

9693

Diag. Cht. No. 1222-3

NOAA FORM 76-35A

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

DESCRIPTIVE REPORT
(HYDROGRAPHIC)

Type of Survey HYDROGRAPHIC
Field No. PE-10-1-77
Office No..... H-9693

LOCALITY

State VIRGINIA
General Locality CHESAPEAKE BAY ENTRANCE
Locality NAUTILUS SHOAL

19 77

CHIEF OF PARTY
Carl W. Fisher

LIBRARY & ARCHIVES

DATE 8/29/77

9693

HYDROGRAPHIC TITLE SHEET

H-9693

INSTRUCTIONS - The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.

FIELD NO.

PE-10-1-77

State Virginia

General locality Entrance to Chesapeake Bay Entrance

Locality Nautilus Shoal

Scale 1:10,000

Date of survey 20-30 June 1977

Instructions dated 17 June 1977

Project No. OPR-516-PE-77

Vessel NOAA Ship PEIRCE (S328) -- Launches 1008 and 1009 (2838 and 2839) and skiff (2837)

Chief of party Commander Carl W. Fisher, NOAA; Commanding Officer

Surveyed by LCDR K.J. Schnebele, LTJG T.L. Lillestolen, ENS P. McGrath, ENS K. Cox,

Soundings taken by echo sounder, ~~hand lead, pole~~ Ross Model 5000 and Raytheon DE-719B

Graphic record scaled by digital echo sounder/ CM, KJS, MH, KLC, DAH, CWF, BM, PM

Graphic record checked by KJS, CM

Protracted by _____ Automated plot by Calcomp plotter-618

Verification by _____ B.J. Stephenson

Soundings in ~~fathoms~~ feet at MLW ~~MLLW~~

REMARKS: See attached "List of Record Changes" for corrections required to

automated survey data

Applied to stats 12/6/77
[Signature]

DESCRIPTIVE REPORT

TO ACCOMPANY

HYDROGRAPHIC SURVEY H-9693

Field Number PE-10-1-77

//
A. PROJECT

This survey was added to the DELMARVANC Project Instructions (OPR-516-PE-77 dated 21 January 1977), as change No. 9 (dated 10 June 1977) in order to resolve a major chart deficiency in the portrayal of Nautilus Shoal at the entrance to Chesapeake Bay. The sheet layout was specified in a letter from Chief, Requirements Branch (dated 17 June 1977).

//
B. AREA SURVEYED

The survey covers the area called Nautilus Shoal at the entrance to the Chesapeake Bay near Cape Charles, Virginia. The area is bounded by the Bay Bridge-Tunnel on the west and Fisherman's Island to the north. More specifically the limits of hydrography are:

1. From $75^{\circ}52.9'$ west longitude to $75^{\circ}01.2'$ west longitude or the Bridge-Tunnel.
2. And from $37^{\circ}01.0'$ north latitude to the shore of Fisherman's Island or $37^{\circ}05.2'$ north latitude whichever is further south.
3. Excluding the southwest corner of the sheet south of $37^{\circ}03.0'$ north latitude and west of $75^{\circ}59.5'$ west longitude.

The period of hydrography ran continuously from 22 June through 30 June 1977 (Julian Days 173-180).

//
C. SOUNDING VESSEL

Hydrography was conducted entirely with Launches and a skiff. The launches used were type I launches equipped with hydroplot systems and Ross Digital echo sounders (Model 5000). The skiff used was a

sixteen foot Monark equipped with a Raytheon DE-719B shoal water fathometer. This fathometer was hull-mounted in the skiff immediately prior to the survey. It was located near the stern on the port side (adjacent to the Del Norte stand). In this location the transducer was subject to turbulence generated by the hull frequently causing a poor return on the graphic record. Consequently, some sections of the skiff work are difficult to interpret but are adequate to depict the general bottom.

The vessel numbers assigned in this survey are as follows:

<u>Vessel</u>	<u>EDP VESNO</u>
Launch 1008	2838
Launch 1009	2839
Skiff	2837

D. SOUNDING EQUIPMENT AND CORRECTION TO ECHO SOUNDINGS

The following sounding equipment was used for this survey:

<u>Vessel</u>	<u>Echo Sounder</u>	<u>Remarks*</u>
2838	Ross Model 5000, S/N 1079	Sheet 2, depths 5-30 feet
2839	Ross Model 5000, S/N 1055	Sheet 1 & 1A, 5-50 feet**
2837	Raytheon DE-719B, S/N 7430	Fisherman's Island shoal 3-27 feet

*Note: the reference to sheets indicates which plotter field sheets were run by the respective vessel; see Section E for description of field sheets.

**Note: Vessel 2839 encountered isolated depths in excess of ninety feet at the northwest edge of the sheet under the Bridge-Tunnel.

- 1) Sound Velocity Corrections: Corrections were derived from bar checks for the launches and sounding pole comparisons for the skiff. The average corrections from the bar checks were graphed and velocity tables scaled at 0.2 foot intervals. The corrections observed for the skiff were plotted and a curve fit to these points with the slope observed from the bar checks. (the slopes should be identical because both echo sounders are calibrated at 4800 ft./sec). The skiff velocity table was scaled from this curve at 0.2 foot intervals.

Note that the static draft of the launches and skiff are implicitly included in the velocity tables and not included as a separate correction.

The following velocity tables were used for this survey:

Table 1 ----- Vesno 2839, J.D. 173-180
Table 2 ----- Vesno 2838, J.D. 173-180
Table 3 ----- Vesno 2837, J.D. 178-180.

- 2) Initial and other instrument corrections. All echo sounders were maintained at zero initial. No problems were encountered with any of the units which would effect the accuracy of the soundings or require additional instrument corrections.
- 3) Settlement and Squat. Settlement and squat corrections for the launches were observed in Fort Lauderdale, Florida, in February 1977. The TRA Corrections Abstract (appended) tabulates the S & S correctors applied for the various engine RPM's used on line. Corrections were applied for changes of 0.2 foot.

The settlement and squat of the skiff (Vesno 2837) was negligible for the speeds used on line and hence no correction was applied.

Note that copies of the velocity tables, TC/TT tapes, and TRA Correction Abstracts are appended to this report. Other abstracts and graphs are included in the field records of this survey.

E. HYDROGRAPHIC SHEETS

The field sheet is a 1:10,000 scale sheet, 36" X 54", oriented east-west. The field sheet is composed of three plotter sheets which were protracted and plotted using the ship's hydroplot system and Complot Roll-Bed Plotter. The majority of the area is covered by two sheets: Sheet 1 covering the middle of the field sheet; Sheet 2 covering the east side. A smaller sheet 1A was added to cover the northwest corner of the field sheet.

The field data is presented on four plotter sheets; the mainscheme lines, crosslines and splits are shown on one copy of each sheet (3 total) plus one additional copy of sheet 1 showing developments and detached positions. The single development on sheet 2 is shown on a page size insert to this report (Section K).

The field records will be transmitted to the Atlantic Marine Center for verification and smooth plotting. The smooth sheet projection parameters are appended, as are the field sheet parameter tape listings.

F. CONTROL STATIONS

Three stations were used to control this survey. The datum used is North American 1927. As shown below two stations were located by

* Filed with field records

Operations Division, AMC, using third-order traverse procedures. Computations and abstracts of observations are available from AMC. Copies of the station descriptions for these AMC stations is appended to this report for reference. A list of geographic positions for each station is also appended (Signal List).

<u>Station Number</u>	<u>Name</u>	<u>Reference</u>
090	Del Norte site at Cape Henry Light House (1977)	AMC
091	H-6-VA-77	AMC
092	FEN 1960	Virginia Quad 370753 Station 1029

✓
G.

HYDROGRAPHIC POSITION CONTROL

All control for this survey was Range/Range using Del Norte equipment. The units were some of those retrofitted during the 1976-1977 layup period to improve accuracy and performance (the MSO-6 Retrofit). The DMU was a model RO3c and the Trisponder was a model 217c. The specific unit serial numbers and usage is tabulated below.

<u>Del Norte Equipment</u>	<u>Serial Number</u>	<u>Location</u>
DMU/Master	298/187	Skiff (2837)
DMU/Master	180/169	Launch 1008 (2838)
DMU/Master	162/1070	Launch 1009 (2839)
Remote Code		Station
72	1065	092
74	188	091
78	218	090

The Del Norte equipment was calibrated over a known baseline of 14148 meters both before and after the survey (on 20 June and 30 June). The baseline was the computed distance between stations 90 and 91. The observed readings on all units agreed to within 3 meters of the computed distance. On nearly daily basis the units were field checked by observing the readings at an offshore pipe whose location was independently fixed (see appended letter from AMC, Operations Division, date 28 June 1977). The observed readings agreed to within 5 meters of the computed distances. Because of the excellent agreement between the pre and post-calibrations and daily field checks, electronic control correctors of zero meters were carried throughout the survey. Copies of calibration abstract and field check results are included in the survey records.

The Del Norte equipment performed very well during the survey. At times the signal from station #90, located on Cape Henry Lighthouse was erratic. It appears that the erratic readings might have been caused

by skipping or attenuation of the signal or both. The unit was located much higher than necessary from the ranges being worked (approximately 50 meters high for working ranges of only 14-19 kilometers) which could contribute to the skip problem. Haze and generally restricted visibility was the typical weather condition whenever station #90 was erratic, so signal attenuation could have been contributing to the problem. The other units were being worked at much closer ranges and consequently were not as susceptible to attenuation problems. Note that station #090 was used predominately to control the hydrography in the northwest corner of the field sheet (plotter sheet 1A). All erratic readings have been "time and coursed" in the field record.

Appended to this report is a "list of record changes" to be made during verification of the position overlay for this survey. Included in the list are three positions which must be "force plotted" at the geographic positions given. They represent erratic Del Norte readings at the beginning or end of a line which cannot be "time and coursed" by the hydroplot system.

Station elevations did not cause a significant slope distance correction to the hydrographic positions. Stations #91 and #92 were mounted on 10 and 20 foot sections of tower, respectively, with resulting elevations of about 10 and 15 meters above water level. Station #90 was about 50 meters above water level. At the working ranges; however, the slope distance corrections would be less than two meters from any of the stations.

In verifying the position plot of this survey, substantial speed changes of the launches over periods of one to two minutes will be apparent. These changes in the speed-over-ground are real and not the result of Del Norte malfunctions. They are probably caused by a combination of:

1. The strong tidal current shears observed in the area (estimate variations in surface current on the order of a knot over distance of 1/2 to 1 nautical mile), and
2. The variations in speed-over-ground (with engine RPM held constant) as the launch loses and then gradually regains its ability to plane.

An Abstract of Corrections to Electronic Position Control is appended. As stated before, correctors of zero meters were carried throughout the survey.

H. SHORELINE

No shoreline is shown on the field sheet. The MLW line was delineated

** Filed with field records*

along the south shore of Fisherman's Island; however, the beach in the area slopes very gradually and the MHW line may be as much as 30 to 100 meters further inshore.

A rough comparison was made with the shoreline from Chart 12222. While it appears that the charted shoreline is adequate for the 1:40,000 charting scale; after enlarging, it is not adequate to match the 1:10,000 scale hydrography. Either updated photography should be obtained, or perhaps the shoreline could be transferred from a large-scale prior survey or T-Sheet -- neither of which were available in the field. Existing prior hydrographic and topographic surveys ^{of 1954} are not adequate; the shoreline is subject to constant change.

A word of caution. The nearshore hydrography shows that substantial depth changes have occurred in the area south of Fisherman's Island. It is likely that the shoreline has also shifted since the date of any of the prior surveys listed in the Project Instructions.

I. CROSSLINES

Crosslines amounted to 11% of the total miles of sounding lines run (excepting developments). Agreement on all lines was excellent; almost always within one foot except in areas of sand wave features.

In the vicinity of 37°03.7' N, 076°00.0' W and 37°02.0' N, 076°59.0' W several additional lines were run perpendicular to the mainscheme lines. These lines serve to show the typical variability and shape of the sand wave features in these areas, and should help with the interpretation of the features seen on the mainscheme lines.

J. JUNCTIONS

As specified in the Project Instructions, this survey is intended to junction with the most recent edition of the published chart -- not with any prior or contemporary surveys.

Included with the field records are copies of the field plotter sheets showing the charted soundings. West of 075°54.0' W longitude, the soundings were transferred from a photographic enlargement of Chart 12222 (scale 1:40,000; 18th edition; March 26, 1977). East of this longitude charted soundings were taken from Chart 12221 (scale 1:80,000; 42nd edition; October 16, 1976).

In general, the quality of the junction degrades from east to west across the sheet with the most significant differences occurring in the vicinity of the Chesapeake Bay Bridge-Tunnel. It appears that most bathymetric

features with depths less than 22 feet have been eroded and/or shifted. ✓
Depths greater than 40 feet have generally been filled, except under
the Bridge-Tunnel where scouring has occurred.

Along the east side of the survey, the junction is good except that the
18 foot curve has shifted offshore (southeast) approximately 0.2 N.M.
in the vicinity of $37^{\circ}04.3'$ N, $075^{\circ}53.0'$ W.

Along the north side, east of Fisherman's Island, the 6, 12 and 18 foot
curves have been cut back -- shifted northwest -- in the vicinity of
 $37^{\circ}04.8'$ N, $75^{\circ}55.7'$ W. This shift brings the curves into agreement ✓
along $75^{\circ}56.1'$ W where the chart shows a discontinuity; however, it
does create a junction problem where the 6 and 12 foot curves leave the
north side of the sheet.

In the same area, at approximately $37^{\circ}05'$ N, $75^{\circ}55'$ W, Chart 12222 and
this survey show a twenty-foot trough extending northeast into the shoaler
water. The feature has widened and deepened on this survey which causes a ✓
local junction problem. Note that Chart 12221 does not even attempt to
show this feature.

East of this area, in the northeast corner of the survey, the junction ✓
is good with the 15 to 17 foot charted depths.

~~Along the south side of the sheet, the field sheet is generally one foot
deeper than the chart from the eastern limit west to $75^{\circ}54.5'$ W. In the~~ ✓
southeast corner ($37^{\circ}01'$ N, $75^{\circ}53'$ W) the charted 30 foot contour has
shifted slightly northwest. *The present smooth sheet does not show the 30 foot
curve in this area.*

Progressing west along the ^{smooth} southern limit, the quality of the junction
degrades with the ~~field~~ ^{smooth} sheet soundings varying from $2'$ to $6'$ feet deeper ✓
than the chart. This does not effect the location of any charted contours,
but it does suggest that the charted 20 and 21 foot sounding south of
the sheet between $75^{\circ}56.0'$ W and $75^{\circ}57.5'$ W have deepened.

The charted 18 foot shoal at $37^{\circ}01.0'$ N, $75^{\circ}58.8'$ W, was confirmed by
this survey. The larger 16 foot shoal in the vicinity of $37^{\circ}01.0'$ N, ✓
 $75^{\circ}59.5'$ W, was not observed at the edge of the survey limits. It has
likely been eroded.

Along the western side of the survey and the Bridge-Tunnel, the junction ✓
is at best marginal. The closed 18 foot curve around $37^{\circ}02'$ N, $75^{\circ}59'$ W,
has shifted eastward and been reduced in area. The contour should be
recharted to conform with this survey.

Elsewhere along the western edge, soundings 4 to 5 feet deeper than ✓
charted were observed except adjacent to Nine Foot Shoal and the exten-
sion of Inner Middle Ground. These shoals show considerable shifts (on

the order of 0.5 n.m.). The deeps under the high bridge (37° 05.²3' N, 75° 59.5' W) have increased substantially. It is unlikely that an adequate junction can be made along the Bridge-Tunnel.

In summary, it appears that a marginally adequate junction can be made with the chart, except in the area of the Bridge-Tunnel. Some bending of the charted contours will be required, but this can be done in almost all cases without sacrificing navigational safety; that is, the chart will show depths shoaler than those observed on this survey. The survey should be carried further west in order to effect a junction across the Bridge-Tunnel, but until the work can be accomplished, a cautionary note on the chart at Inner Middle Ground should serve to warn the mariner that the shoal is shifting from its charted position.

See Quality Control Report

K.

COMPARISON WITH PRIOR SURVEYS

The following numbered presurvey review items were investigated in this survey:

PSR #47 Shoaling, reported 1973, at 37° 02.8' N, 75° 57.3' W. The area was covered by the regular mainscheme hydrography and clearly shows depths of 19 to 20 feet in the area as part of a gradually rising bottom. Depths of 15 feet were observed 0.5 n.m. southeast of the area. The reported shoaling should be deleted once the charted soundings have been changed to reflect the results of this survey. *Concur RBS #1477*

Origin CL 1245 (73)

PSR #48 Submerged wreck at 37° 05.0' N, 75° 56.6' W. The area was searched by the skiff with echo sounder on Julian Day 180. Two possible spikes were investigated as well as the charted location but no indication of wreckage could be found. *Origin NM 31 (63)*

<u>Location Investigated</u>	<u>Field Reference</u>	<u>Position Numbers Used</u>
37° 05.0' N, 75° 56.6' W	Charted Position	5267-5310
37° 04.99' N, 75° 56.40' W	#1M, spike seen between P.N. 5007-5008	5228-5268
37° 04.75' N, 75° 56.78' W	#1N, spike seen between P.N. 5047-5048	5311-5380

The investigation consisted of repeated runs over the positions at 20 meter spacing. A total of four hours was spent searching in the area. Depths in the search area ranged from 4 to 10 feet. Visibility in the water was nil due to wave action and alongshore currents suspending sediments. It is highly doubtful that a wreck of the described size (123 feet) could have been missed within the search area. The reported

position is frankly suspicious because it involves such a precise range (and bearing) from Cape Charles Light -- exactly 6000 yards. The reported position is also in an area subject to strong tidal currents, wave action and active sand transport. Over a period of years, the mass of the wreck should have resulted in the formation of a "tombolo-like" feature between the wreck and shore. Nothing like that was observed. *Concur See H/T*
 It is recommended that a "PD" notation be charted with the wreck symbol.

PSR #49 Effective cleared depth of 15 feet at 37°02.4' N, 75°56.2' W. The area was covered by regular mainscheme hydro and proved to be a broad shoal area with depths of 15 to 18 feet. No indication of wreckage was seen on the fathograms (P.N.'s 2006-2007, 2024-2025). Considering the amount of sediment transport occurring in the area, it is likely that a wreck dating from 1930's would have been silted over by this time. This survey neither proves or disproves the existence of the wreck, so recommend that it remain as charted. *Origin H-6438 (39) WD. Concur*

PSR #50 Effective cleared depth of 11 feet at 37°03.3⁷' N, 75°54.0' W. The area was covered by regular mainscheme hydro and found to be a flat bottom with depths of 25 to 28 feet. At 37°03.43' N, 75°53.98' W, between positions 2597 and 2598, an unusual depression in the bottom was observed. It could possibly be scouring caused by the nearby wreckage (this position is about 150 meters north of the charted position). No indication was seen on the adjacent lines, so the wreckage is probably oriented north-south about the charted position. The wreck should definitely remain as charted. *See writer's Report Origin H-6438 (39) WD*

Only two prior surveys were available for comparison in the field:

<u>Survey</u>	<u>Scale</u>	<u>Date</u>
H-7750	1:40,000	1948-50
H-8218	1:25,000	1954

In combination, these two prior surveys cover the entire work area. A cursory comparison indicates that these surveys are the source of the presently charted soundings. The following prior surveys were also listed in the Project Instructions (Change No. 9) but not available in the field:

<u>Survey</u>	<u>Scale</u>	<u>Date</u>
H-364	1:40,000	1852
H-1875	1:10,000	1880
H-4926	1:20,000	1929
H-6438 WD	1:40,000	1939
H-7791	1:10,000	1949
H-8217	1:10,000	1954

The agreement with H-7750 and H-8218 is poor throughout the shoal

areas (also see the comments under section J. Junctions). A listing of all changed features would be superfluous. It is recommended that the charted features originating with these prior surveys be updated by the results of this survey in the common area.

The observed changes are certainly due in large part to the alterations in tidal current patterns which resulted from the construction of the Chesapeake Bay Bridge-Tunnel. Seasonal changes in the location of the shoal areas is also highly probable because of their exposure to storm wave action.

✓
L. COMPARISON WITH THE CHART

The survey was compared with the charts listed in Section J., Junctions, of this report. Within the survey area, the charts need a complete revision of soundings and contours.

In addition to the Pre-Survey Review items, the chart shows a non-dangerous sunken wreck at about 37°01.4' N, 75°53.6' W which was neither proved nor disproved by this survey. It should remain as charted. ✓
concur

On Julian Days 173 and 174, Launch 1009 encountered numerous "strays" on the fathograms. Several typical locations were developed as tabulated below and the "strays" were not observed. Note that the transducer on Launch 1009 was cleaned and the AGC circuitry of the Ross echo sounder readjusted because it was suspected that this was contributing to the stray returns. In addition, note that numerous sightings of sharks, sea turtles, skates, and various fish were reported by the Launch crews. Marine life may have been the cause of many "strays". These "strays" were inserted in the field records pending further development. In order to speed processing of the survey, these strays are tabulated as records to be deleted by AMC Processing Division during the position plot stage of verification (refer to the appended List of Record Changes). *Changes were completed during verification, and type of changes was filed with the field records.*

The following is a list of developments conducted to investigate strays or newly found features:

<u>Field Reference</u>	<u>Latitude & Longitude</u>	<u>Development Position Numbers</u>	<u>Remarks</u>
1A	37 01.0' N 75 58.8' W	1221-1230	Stray from #0115 + 1, Disproved
1B	37 01.4' N 75 58.8' W	1187-1196	Stray from #0091 + 5, Disproved

<u>Field Reference</u>	<u>Latitude & Longitude</u>	<u>Development Position Numbers</u>	<u>Remarks</u>
1C	37°04.1' N 75°58.8' W	1177-1186	Stray from #0099 + 5, Disproved
1D	37°01.55' N 75°57.07' W	1355-1379	Spike from #0589 + 6, No shoaler sounding obtained but feature is confirmed. Least depth = 12 feet. <i>repeated</i>
1E	37°02.27' N 75°58.95' W	1335-1344	Spike from #0084 + 3, Disproved
1F	37°02.6' N 75°58.8' W	1302-1312	Strays from #0110 + 1, 0110 + 3 and 0121 + 6; Disproved
1G	37°01.75' N 75°59.00' W	1345-1354	Sand wave peak from #0066 + 7; No shoaler depth obtained. Least depth = 12 feet.

Spike was not confirmed and appears no better than other spikes considered disproved

Developments 1M and 1N are discussed in Section K with presurvey review items.

2A	37°02.12' N 75°55.48' W	2962-2973	Shoal from #2191 + 4 and 2222 + 2 confirmed. Least depth = 10 feet. (Plot is attached)
2B	37°03.62' N 75°56.23' W 5.73	2992-3063	Large shoal area. Least depth = 6 feet.

Sand waves are a significant feature in this survey. In particular note the region bordering a line connecting the following points in the depth range of 18 to 24 feet:

37°04.0' N : 76°00.0' W
37°02.0' N : 75°59.0' W
37°01.5' N : 75°56.5' W

Selected lines were run perpendicular to the mainscheme in this area in order to show another aspect of the wave patterns. The waves typically rise 3 to 5 feet above the general bottom and significantly change the least depth of an area. The waves can be expected to shift position subject to changing current conditions and thus cannot be charted accurately. It would be prudent to add a charted note in the vicinity of 37°02' N, 75°59' W, stating that:

"Migratory sand waves may extend five feet above general depth in this area".

✓
M. ADEQUACY OF SURVEY

This survey is complete and adequate to supercede prior surveys for charting purposes; except for charting shoreline as discussed in Section H.

✓
N. AIDS TO NAVIGATION

Six buoys were located in this survey. The descriptions and characteristics agree with those on the charts and in the Light List. The buoys are positioned adequately to serve their intended purpose. In fact, they are better indicators of the deepest passage through Nautilus Shoal than is the presently published chart. *See Verifier's Report*

✓
O. STATISTICS

	<u>V E S S E L N U M B E R S</u>			<u>Totals</u>
	<u>2837</u>	<u>2838</u>	<u>2839</u>	
Position Numbers used	5000-5380	2000-3074	0001-1403	2858
Nautical Miles Sounding Lines	21	303	340	664
Square Miles Surveyed	0.9	12.5	13.5	26.9
Bottom Samples	-----			.6
Tide Stations (30 days)	-----			2

✓
P. MISCELLANEOUS

Note the comments regarding sand wave features in Section L.

An unusually steep slope was observed at 37°01.95' N, 75°56.60' W, which suggests a solid rock feature in this typically sand bottom area.

Q. RECOMMENDATIONS

Specific recommendations regarding certain charted features are made in Section L.

R. AUTOMATED DATA PROCESSING


The following hydroplot system programs were used in acquiring and processing the data:

RK111	Range/Range Real Time Hydroplot	1/30/76
RK201	Grid, Signal, and Lattice Plot	4/18/75
RK211	Range/Range Non-Real Time Plot	5/04/76
RK330	Reformat and Data Check	11/10/72
AM602	Elinore	5/20/75

S. REFERENCES TO REPORTS

None

Respectfully submitted for approval,


Kurt J. Schnebele
LCDR., NOAA

APPROVAL SHEET

The field work on H-9693 (PE-10-1-77) was carried out under my immediate daily supervision which included participation in data acquisition, processing and checking. This report, the field sheet, and all accompanying field records have been reviewed by me and are approved. The survey is complete and adequate to supercede prior surveys. However, the junctioning of this survey with the published chart (see Section J) suggests a need for future adjoining surveys to determine the total extent of depth change throughout the entrance to Chesapeake Bay. This is especially important because the prior surveys were conducted prior to the construction of the Chesapeake Bay Bridge Tunnel, which appears to be the predominate factor causing changes in depth.

Carl W. Fisher

Carl W. Fisher
CDR., NOAA
Commanding Officer

SIGNAL LIST
PE-10-1-77

090 7 36 55 34382 076 00 27083 254 0050 000000

091 7 37 02 44530 076 03 46565 254 0000 000000

092 7 37 05 36243 075 58 17556 250 0000 000000

VELOCITY TAPE LISTINGS

PE - 10 - 1 - 77

Table No. 1 (2839)

000105 0 0018 0001 000 283900 010177
000183 0 0020
000250 0 0022
000267 0 0024
000286 0 0026
000305 0 0028
000324 0 0030
000343 0 0032
999999 0 0034

Table No. 2 (2838)

000125 0 0018 0002 000 283800 010177
000185 0 0020
000255 0 0022
000280 0 0024
000305 0 0026
000332 0 0028
999999 0 0030

Table No. 3 (2837)

000040 0 0006 0003 000 283700 010177
000107 0 0008
000175 0 0010
999999 0 0012

TRA Correction/Table Indicator (TC/TI Tape)

H-9693

173000 0 0000 0003 178 283700 001977
144752 0 0002 0002 174 283800 001977
212924 0 1002 0002 177 283800 001977
155838 0 0000 0002 178 283800 001977
160329 0 0002
151145 0 1002 0001 173 283900 001977
151246 0 0002
152519 0 0000
191325 0 1002
184119 0 0000 0001 174 283900 001977
190424 0 1002
192205 0 0000
194845 0 1002
154002 0 0000 0001 176 283900 001977
160814 0 1002
155308 0 0000 0001 177 283900 001977
160120 0 1002
125922 0 0000 0001 178 283900 001977
131005 0 1002
164618 0 0000
152144 0 1002 0001 179 283900 001977
175819 0 0000
140753 0 0002 0001 180 283900 001977
152702 0 0000
154550 0 1002
162317 0 0000



CO CWF
FDB KB

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY

Atlantic Marine Center
439 West York Street
Norfolk, VA 23510

June 28, 1977

CAM102S/RS

TO: NOAA Ship PEIRCE
FROM: *[Signature]* R. E. Stachon
THRU: Chief, ^{NX} Operations Division

SUBJECT: Positioning of a Calibration Site for OPR-516, Nautilus Shoal

On 23 June, 1977, Operations Division personnel assisted in establishing a geodetic position on a Del Norte calibration site. The calibration site consists of a pipe driven into the ocean bottom in a shoal area known as Smith Island Inlet. The calibration site was controlled by range-azimuth from triangulation station WISE RM-6 using third order procedures. Four positions using a WILD T-2 were observed at WISE RM-6. Azimuth was determined from Triangulation Station CAPE CHARLES NEW LIGHTHOUSE. Distance from WISE RM-6 to the calibration site was obtained with a K & E Ranger IV. Fifteen distance readings were taken, ten of these readings in meters and five in feet (which were later converted to meters). Meteorological measurements were also taken and the mean observed distance was adjusted to them. A slope to geodetic computation was made on the corrected slope distance. The geographic position of the calibration site was determined by a forward position computation utilizing a Wang 600 Programmable Calculator. An azimuth check was made to CAPE CHARLES 771 st. AN/FPS TOWER.

Field notes and computations are being retained at Operations Division. The final geographic position of the calibration site is:

Latitude - 37°05'30."4447
Longitude- 75°55'20."8033



RECOVERY NOTE, TRIANGULATION STATION

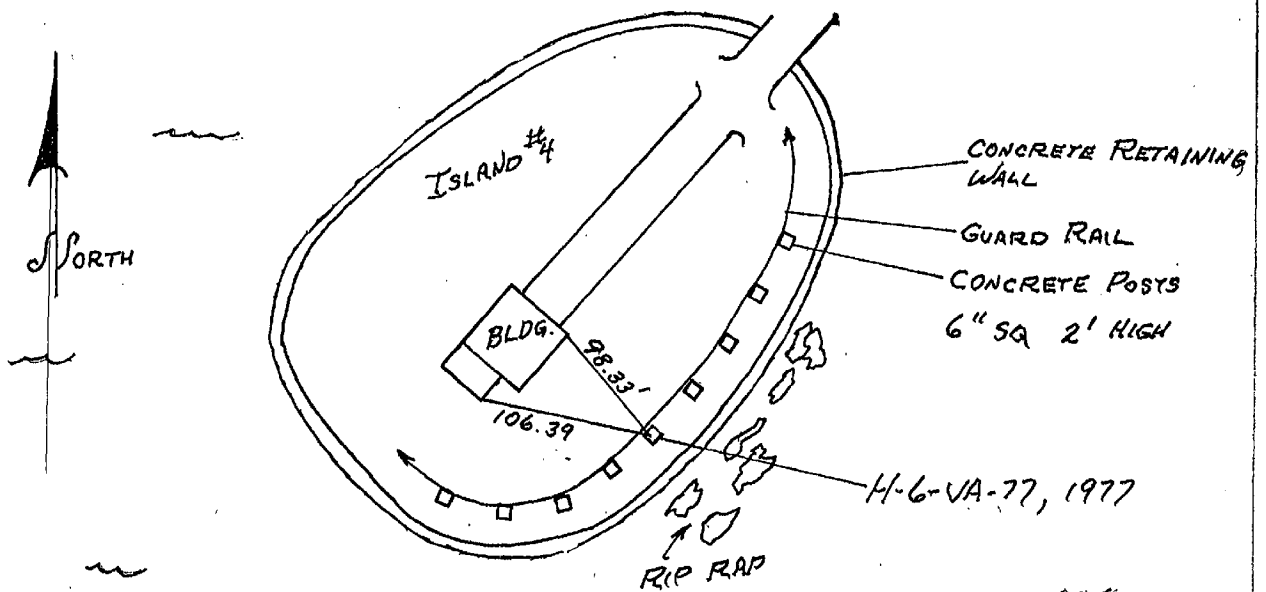
R

NAME OF STATION: H-6-VA-77, 1977
 ESTABLISHED BY: R. Whitfield YEAR: 1977 STATE: Virginia BENCH MARK ALSO
 RECOVERED BY: * YEAR: COUNTY: Is. #4, Ches. Bay-Bridge Tunnel
 AIRLINE DISTANCE AND DIRECTION FROM NEAREST TOWN:
 HEIGHT OF TELESCOPE ABOVE STATION MARK FEET. HEIGHT OF LIGHT ABOVE STATION MARK FEET.

DISTANCES AND DIRECTIONS TO AZIMUTH MARK, REFERENCE MARKS AND PROMINENT OBJECTS WHICH CAN BE SEEN FROM THE GROUND AT THE STATION				
OBJECT	BEARING	DISTANCE		DIRECTION
		FEET	METERS	
X = 2,711,186.67 Y = 268,539.07			Lat. 37-02-44.5295 Long. 76-08-46.5648	° ' "

The station is located on the southeast side of Island #4 of the Chesapeake Bay-Bridge Tunnel. The station is a standard NOS disk stamped H-6-VA-77, 1977 epoxied to the top of a 6" x 6" x 2' concrete post that supports the guard rail around the island.

For permission and information to work on islands contact Mr. J. Clyde Morris, Executive Director Tel: 464-3511.



* Name of chief of party should be inserted here. The person who actually visited the station should sign his name at the end of the recovery note.

RECOVERY NOTE, TRIANGULATION STATION

R

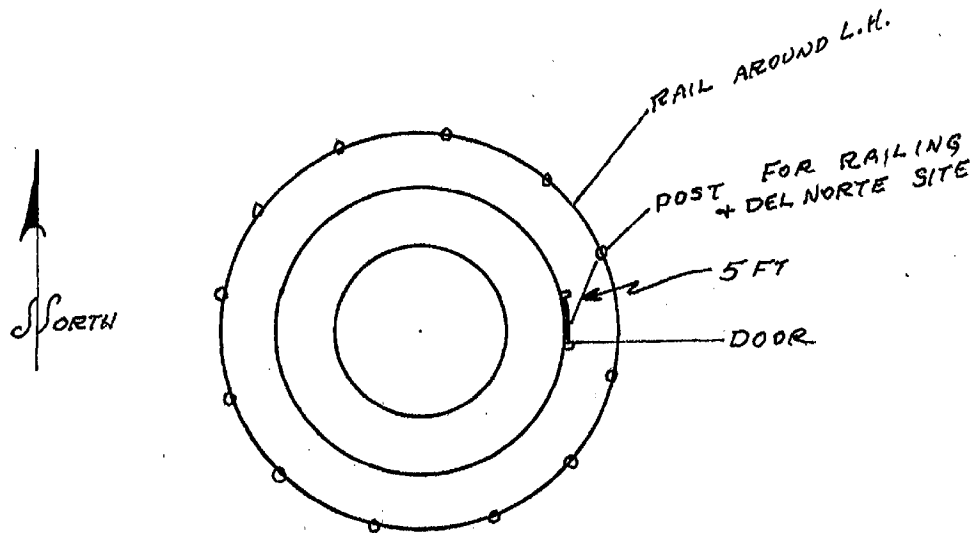
NAME OF STATION: Del Norte site at Cape Henry Lighthouse
 ESTABLISHED BY: J.D. Shea YEAR: 1977 STATE: Virginia BENCH MARK ALSO
 RECOVERED BY:* YEAR: COUNTY: at Fort Story
 AIRLINE DISTANCE AND DIRECTION FROM NEAREST TOWN:
 HEIGHT OF TELESCOPE ABOVE STATION MARK FEET. HEIGHT OF LIGHT ABOVE STATION MARK FEET.

DISTANCES AND DIRECTIONS TO AZIMUTH MARK, REFERENCE MARKS AND PROMINENT OBJECTS WHICH CAN BE SEEN FROM THE GROUND AT THE STATION				
OBJECT	BEARING	DISTANCE		DIRECTION
		FEET	METERS	
X = 2,728,501.66 Y = 225,474.38			Lat. Long.	° ' '' 36-55-34.3817 76-00-27.0828

The station is located on the rail around the walkway atop the Cape Henry Lighthouse (new) at Fort Story. The site is the post supporting the railing approximately 5 feet northeast of the door.

For entry to the lighthouse, contact the Coast Guard personnel at the site.

A lift for hauling equipment to the top is available in the Lighthouse also 110 volt for power.



* Name of chief of party should be inserted here. The person who actually visited the station should sign his name at the end of the recovery note.

FIELD TIDE NOTE H-9693

Field tide reduction was based on predicted tides from Hampton Roads, Virginia, zoned to the Nautilus Shoal area. The suggested zoning from the Project Instructions (Change No. 9) was modified slightly and used as follows:

<u>Plotter Sheet</u>	<u>Time High Water</u>	<u>Time Low Water</u>	<u>Ratio</u>	<u>Remarks</u>
1 & 1A	-0 ^h 59 ^m	-1 ^h 06 ^m	1.23	West of 75°56'30" W, Longitude
2	-1 ^h 25 ^m	-1 ^h 30 ^m	1.36	East of 75°56'30" W, Longitude

The predicted tides were interpolated at 0.2 intervals using program AM 500 (11/10/72).

The gages listed on the attached request for verified heights were operating during the survey. The two gages at Fisherman's Island were installed and leveled by the East Coast Tides Party. At the time of this report, the records of the installations and complete 30-day operation (30 days on 21 July 1977) were not available.

August 4, 1977

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY

TIDE NOTE FOR HYDROGRAPHIC SHEET

Processing Division: Atlantic Marine Center:

Hourly heights are approved for Form 362

Tide Station Used (NOAA Form 77-12): 863-2065 Fisherman's Island, South

Period: June 22-29, 1977

HYDROGRAPHIC SHEET: H-9693

OPR: 516

Locality: Nautilus Shoal, Chesapeake Bay Entrance

Plane of reference (mean ~~lower~~ low water): 4.8 ft.

Height of Mean High Water above Plane of Reference is
3.4 ft.

Remarks:

1. East of 75°58.7' zone direct.
2. West of 75°58.7' apply + 10 minute time correction and range ratio x 0.91.

Don M. Spillman
Chief, Tides Branch

H-9693

GEOGRAPHIC NAMES

Name on Survey	Source of Name										
	A	B	C	D	E	F	G	H	K		
	ON CHART NO.	ON PREVIOUS SURVEY NO.	ON U.S. QUADRANGLE MAPS	FROM LOCAL INFORMATION	ON LOCAL MAPS	P.O. GUIDE OR MAP	GRAND MCNALLY ATLAS	U.S. LIGHT LIST			
NAUTILUS SHOAL											1
NINE FOOT SHOAL											2
INNER MIDDLE GROUND											3
NORTH CHANNEL											4
FISHERMANS ISLAND											5
											6
											7
											8
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											25

APPROVED

Chas. B. Huntington

STAFF GEOGRAPHER - C5112

16 Sept. 1977

APPROVAL SHEET
FOR
SURVEY H- 9693

- A. All revisions and additions made on the smooth sheet during verification have been entered in the magnetic tape records for this survey. A new final position printout has/~~has not~~ been made. A new final sounding printout has/~~has not~~ been made.
- B. The verified smooth sheet has been inspected, is complete, and meets the requirements of the Provisional Hydrographic Manual. Exceptions are listed in the Verifier's Report.

Date: August 17, 1977

Signed: William L. Jones

Title: Chief, Verification Branch

HYDROGRAPHIC SURVEY STATISTICS

H-9693

RECORDS ACCOMPANYING SURVEY: To be completed when survey is registered.

RECORD DESCRIPTION		AMOUNT	RECORD DESCRIPTION		AMOUNT	
SMOOTH SHEET		1	BOAT SHEETS & PRELIMINARY OVERLAYS		9 11	
DESCRIPTIVE REPORT		1	SMOOTH OVERLAYS: POS. ARC, EXCESS		2	
DESCRIP-TION	DEPTH RECORDS	HORIZ. CONT. RECORDS	PRINTOUTS	TAPE ROLLS	PUNCHED CARDS	ABSTRACTS/SOURCE DOCUMENTS
AGGON-ENVELOPES	1					1
CAHIERS	1		1 with			
VOLUMES	3					
BOXES			1 smooth pos. & sndg.			

T-SHEET PRINTS (List)

SPECIAL REPORTS (List)

OFFICE PROCESSING ACTIVITIES

The following statistics will be submitted with the cartographer's report on the survey

PROCESSING ACTIVITY	AMOUNTS		
	PRE-VERIFICATION	VERIFICATION	TOTALS
POSITIONS ON SHEET			2858
POSITIONS CHECKED		281	
POSITIONS REVISED		3	
SOUNDINGS REVISED		232	
SOUNDINGS ERRONEOUSLY SPACED		0	
SIGNALS (CONTROL) ERRONEOUSLY PLOTTED		0	
	TIME - HOURS		
CRITIQUE OF FIELD DATA PACKAGE (PRE-VERIFICATION)	1	0	
VERIFICATION OF CONTROL		1	
VERIFICATION OF POSITIONS		19	
VERIFICATION OF SOUNDINGS		29	
COMPILATION OF SMOOTH SHEET		8	
APPLICATION OF TOPOGRAPHY		1	
APPLICATION OF PHOTOBATHYMETRY		0	
JUNCTIONS		0	
COMPARISON WITH PRIOR SURVEYS & CHARTS		8	
VERIFIER'S REPORT		6	
OTHER			
TOTALS	1	72	

Pre-Verification by F. L. Saunders	Beginning Date 07/18/77	Ending Date 07/18/77
Verification by F. L. Saunders, B. J. Stephenson	Beginning Date 07/18/77	Ending Date 08/15/77
Verification Check by W. L. Jonns	Time (Hours) 6	Date 08/16/77
Marine Center Inspection by Hydrographic Inspection Team, AMC	Time (Hours) 35	Date 08/17/77
Quality Control Inspection by R.W. Dartzavian	Time (Hours) 28	Date 9/16/77
Requirements Evaluation by S. Baumgardner	Time (Hours) 6	Date 11/15/77

Carters "hr" 11/2/77

Reg. No. 9693

The Computer and Excess Sounding Cards for this survey have not been corrected to reflect the changes made to the Computer Card and Excess Card Printouts at this time of the review.

When the cards have been updated to reflect the final results of the survey the following shall be completed:

CARDS CORRECTED

DATE _____ TIME REQ'D _____ INITIALS _____

REMARKS:

Reject Rec. No 12627.

Reg. No. _____

The magnetic tape containing the data for this survey has not been corrected to reflect the changes made during evaluation and review.

When the magnetic tape has been updated to reflect the final results of the survey, the following shall be completed:

MAGNETIC TAPE CORRECTED

DATE _____ TIME REQ'D _____ INITIALS _____

REMARKS:

H-9693

Information for Future Presurvey Reviews

This survey was basically conducted to resolve conflicts in charted curves. An excellent survey was made but did not cover to the fullest extent the area of the charting inadequacy. An extension should be made of the survey area to include the areas outlined in paragraph 2 of the Quality Control Report and the Presurvey Review items not verified or disproved by the present survey in paragraph 3 of the Quality Control Report and paragraph K of the Descriptive Report.

<u>Position Index</u>		<u>Bottom Change</u>	<u>Use</u>	<u>Resurvey</u>
<u>Lat.</u>	<u>Long.</u>	<u>Index</u>	<u>Index</u>	<u>Cycle</u>
370	760	5	9	10 years
370	761	5	9	10 years

c. The development of the bottom configuration and the investigation of least depths is considered adequate. However, an indication of a wreck is described by the hydrographer in Section K, Presurvey Review Item #50, in the Descriptive Report. A limited investigation of this indication would have been appropriate to verify or disprove the original finding. *See Quality Control Report*

4. Condition of Survey

The Smooth Sheet and accompanying overlays, hydrographic records, and reports are adequate and conform to the requirements of the Provisional Hydrographic Manual.

5. Junctions

There are no contemporary surveys to join this survey. Junction was to be made with the most recent chart, #12221^{and} ~~and~~ It is the opinion of the verifier that an adequate junction cannot be made without having similar curve displacement. Section J of the Descriptive Report explains the junctional problems in detail.

6. Comparison With Prior Surveys

- a. H-7750 (1948-50) 1:40,000 ✓
- H-7791 (1949) 1:10,000 ✓
- H-8217 (1954) 1:10,000 ✓
- H-8218 (1954) 1:25,000 ✓

These prior surveys cover the area of the present survey. A comparison between the present and prior surveys reveals that the area has undergone extensive changes. Nautilus Shoal is basically in the same area, but has reduced in size. The most extensive depth differences are in the vicinity of the fixed bridge section of the Chesapeake Bay Bridge Tunnel. These changes are attributed primarily to natural shifting of the bottom sediments, tidal currents, local storms and longshore current.

The more completely developed present survey is adequate to supersede the prior surveys within the common area.

- b. H-6438 WD (1939) 1:40,000

This survey was not available for direct comparison at the time of this report. However, Presurvey Review Item #50, a wreck, effective cleared depth of 11 feet, charted in

latitude 37° 03.3⁷₅'; longitude 75° 54.00', originates with H-6748 WD (1939). A depth of 14-feet on the wreck was brought forward to H-8218 (1954) from the above survey in latitude 37° 03.39', longitude 75° 53.15'. An indication of scouring around a wreck and a probable wreck indication was found on the graphic record of the present survey in latitude 37° 03.41', longitude 75° 53.98'. The wreck indication on the graphic record reduced to a 7.6-foot depth. Depths on the present survey were found to be comparable to depths on H-8218 (1954) in the vicinity of the wreck, with a 14-foot depth brought forward from the above wire drag survey to H-8218 (1954). The present survey shows a 7-foot WK.

See Quality Control Report

7. Comparison With Charts 12222 (18th Edition, March 26, 1977) ⁵⁶²
 12221 (42nd Edition, October 16, 1976) ¹²²²

a. Hydrography

See Quality Control Report

The charted hydrography originates primarily with the previously discussed prior surveys, which require no further discussion. The following charted items have not been verified or disproved by the present survey and are brought to your attention:

(1) The obstruction, PA, charted in latitude 37° 05' 16", longitude 75° 59' 38", source ~~not ascertainable~~, should be retained as charted. ^{LNM 24/72}

(2) The pile, charted in latitude 37° 05' 09", longitude 76° 00' 00", source ~~not ascertainable~~, should be retained as charted. ^{LNM 14/61}

(3) The sunken, non-dangerous wreck, charted in latitude 37° 01.4', longitude 75° 53.6', source ~~not ascertainable~~, should be retained as charted. ^{US NAVY WRECK LIST 1957}

Presurvey Review Item #50, previously discussed in Section 6b of this report, a wreck, effective cleared depth of 11 feet, in latitude 37° 03.3⁷₅' and longitude 75° 54.00' is recommended to be charted as a wreck covered by a reported seven-feet in latitude 37° 03.41' and longitude 75° 53.98' until an adequate investigation determines a least depth and position of this danger. The wreck, ANGLO-AFRICAN, a 4,186 ton vessel, construction unknown, was reported sunk in 1909. Additional Presurvey Review Items were adequately discussed in Section K of the Descriptive Report.

Due to the priority of this survey and the extensive changes, the source of each charted depth was not ascertained during verification.

Except as noted above, the present survey is adequate to supersede the charted hydrography within the common area.

b. Aids to Navigation

The presently charted floating aids to navigation adequately mark the features intended, with the following exceptions: Substantial changes in the bottom configuration of the charted hydrography have taken place and to more adequately mark the features intended buoy N"2" should be moved to latitude $37^{\circ} 01' 32.28''$, longitude $75^{\circ} 54' 42.51''$ and buoy N"4" should be moved to latitude $37^{\circ} 02' 02.73''$, longitude $75^{\circ} 56' 20.73''$.

8. Compliance With Project Instructions

This survey adequately complies with the Project Instructions, with the exception of Section 2.2. The area surveyed is highly changeable and it would be impossible to fulfill this section adequately without additional extensive enlargement of the project.

9. Additional Field Work See Quality Control Report

This is an excellent basic survey; however, the following additional field work is recommended:

The wreck, cleared by an effective depth of 11-feet in latitude $37^{\circ} 03.37'$, longitude $75^{\circ} 54.00'$ should be investigated and its present condition ascertained at a future time.



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Atlantic Marine Center
439 West York Street
Norfolk, Virginia 23510

File No: D6-5
Ser. No: 77-106

August 17, 1977

CAM3/RAT

TO: RADM Robert C. Munson
Director, Atlantic Marine Center

FROM: *[Signature]*
CDR Robert A. Trauschke
Chief, Processing Division

SUBJECT: Hydrographic Inspection Team Report, H-9693 (1977)

This survey was conducted by the NOAA Ship PEIRCE in 1977. It is part of OPR-516, DELMARVANC, and has a high priority because of obvious discontinuities on the current nautical chart.

FIELD WORK

The work was accomplished in general compliance with the Project Instructions. The quality of the field data is excellent. This fact is the biggest single reason for the establishment of the new record of only five weeks (versus 20 weeks) to completely process a survey.

The Hydrographic Inspection Team has only one area of concern on this survey, and that is Presurvey Review Item #48. The HIT Team does concur with the field's recommendation. It is felt, however, that the development should not have been excessed in the field. This determination should be made during and after verification of the survey. We realize that it was skiff work, there were no indications of the wreck, and the hydrography did not add anything to the sheet, so accordingly it was a waste of time to log the data.


VERIFICATION

The Hydrographic Inspection Team suggested the addition of a number of dashed depth curves to delineate and highlight some features.


HIT was conducted throughout the processing cycle. Altogether, the HIT Team devoted about 35 hours to this survey.





Survey H-9693
Examined and Approved:
Hydrographic Inspection Team
Date: August 16, 1977


CDR Robert A. Trauschke, NOAA
Chief, Processing Division


^{NX}
CDR Charles H. Nixon
Chief, Operations Division


C. Douglas Mason, LT, NOAA
Chief, EDP Branch


R. D. Sanocki
Technical Assistant
Processing Division


Guy F. Trefethen
Verification Branch

Approved/Forwarded


Robert C. Munson
RADM, NOAA
Director, Atlantic Marine Center



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

C352

September 16, 1977

TO: *A. J. Patrick*
A. J. Patrick
Chief, Marine Surveys Division

THRU: Chief, Quality Control Branch

FROM: R. W. DerKazarian *RW DerKazarian*
Quality Evaluator

SUBJECT: Quality Control Report for H-9693 (1977), Nautilus Shoal,
Chesapeake Bay Entrance, Virginia

Survey H-9693 was inspected to evaluate the accuracy and adequacy of the survey with respect to data acquisition, delineation of the bottom, determination of least depths, navigational hazards, junctions, sounding line crossings, smooth plotting, decisions and actions taken by the verifier, and the cartographic presentation of data. In general, it was found to conform to the National Ocean Survey's standards and requirements except as follows:

1. An inadequate number of bottom characteristics were obtained for this survey. Prior bottom characteristics were not carried forward because of the changeable nature of the bottom. See section 1.6.3 of the Provisional Hydrographic Manual.

2. To reiterate recommendations in the Descriptive Report, the Chief of Party's "Approval Sheet," and the Verifier's Report, it is recommended that the survey area be extended. Additional coverage is desirable in the vicinity northward of the Chesapeake Bay Bridge and Tunnel from Nine Foot Shoal to North Channel to adequately junction charted curves, and in the vicinity of latitude $37^{\circ}01.00'$, longitude $75^{\circ}56.30'$, to resolve the 8-foot difference between the charted depths and the present survey depths along the south central limits of the survey.

3. Presurvey Review item 50, a sunken wreck, charted as effective cleared depth 11 feet in latitude $37^{\circ}03.37'$, longitude $75^{\circ}54.00'$ from H-6438 WD #37/03/25.1 (1939) is shown on the present smooth sheet as 7 feet and is relocated. *λ 75/53/58.1*
Although the graphic record shows indications of scouring, the trace interpreted as a return is very questionable. It is recommended that a wire-drag investigation of the wreck be made to determine a clearance depth and location for the wreck. *7 ft discredited by H-9904 (1980) and H-9921 (1981) 11/22/82*
29.

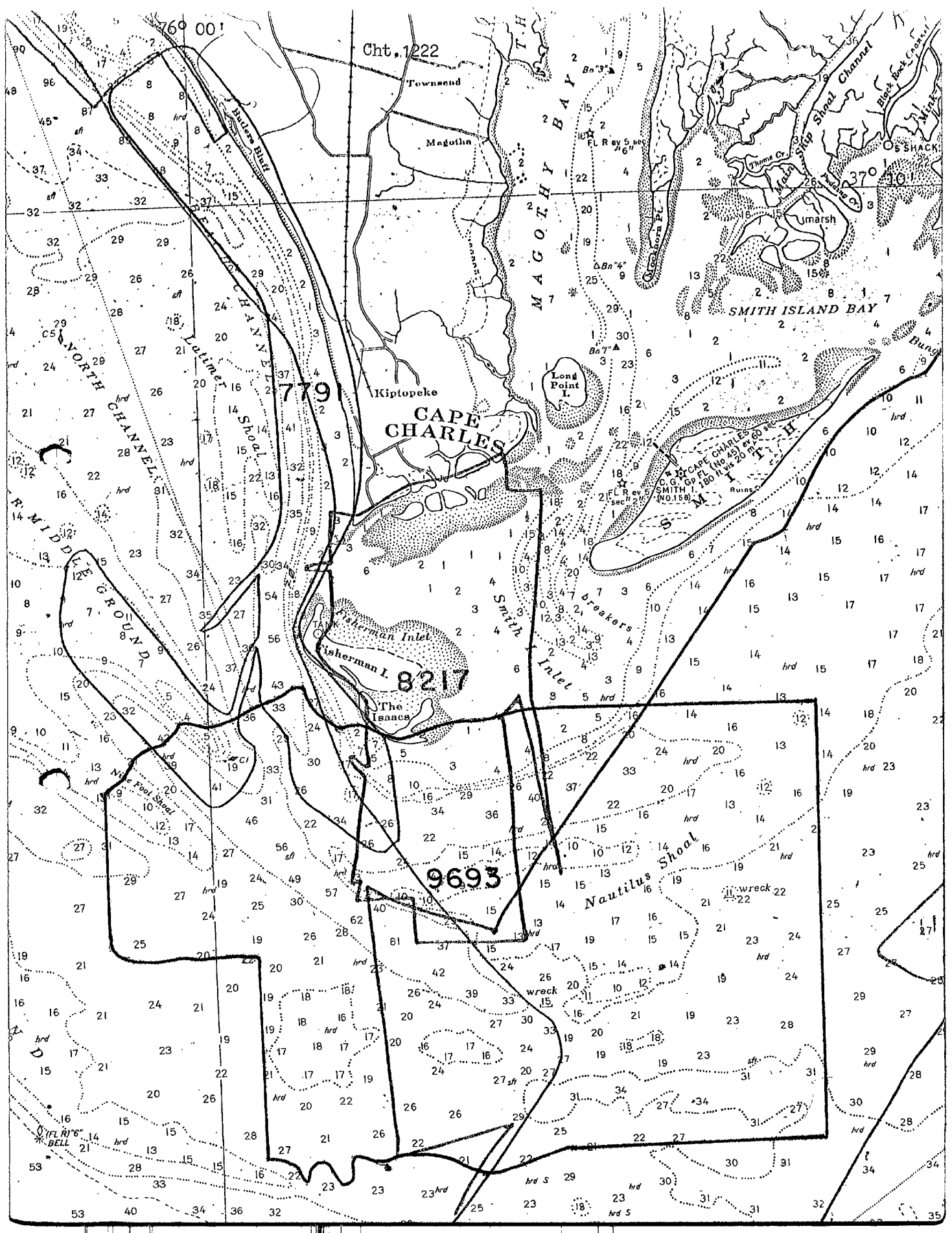


4. This additional information should be noted under the Comparison with Chart:

The 4-foot and 8-foot soundings on chart 12221 from L-1214 (60), Bp-60365, in latitude $37^{\circ}04.97'$, longitude $76^{\circ}00.18'$ and latitude $37^{\circ}04.78'$, longitude $75^{\circ}59.92'$ respectively, fall in present depths of 8-11 feet. The bottom has changed in this area and the soundings should be deleted from the chart.

Numerous charted soundings that fall in the southeast portion of the present survey originate with an unverified reconnaissance hydrographic survey conducted by the NOAA Ships RUDE and HECK in 1974 (L-596 (1974) Bp-88697). Generally these soundings are within 1 to 4 feet of present depths but several differ much more. Because of the changeable nature of the bottom, these soundings should be superseded by present depths.

cc:
C351



Cht. 1222

779

CAPE CHARLES

8217

9693

MAGOTHY BAY

SMITH ISLAND BAY

MIDDLE GROUND

NORTH CHANNEL

Nautilus Shoal

Fisherman Inlet

The Inanna

Smith Inlet

Kiptopeke

Townsend

Magotha

Long Point I.

CAPE CHARLES LIGHT

Marsh

Ship Channel

Black Rock Channel

OS SHACK

BELL

wreck

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FL R 6 sec

FL R 7 sec

FL R 8 sec

FL R 9 sec

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FL R 11 sec

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