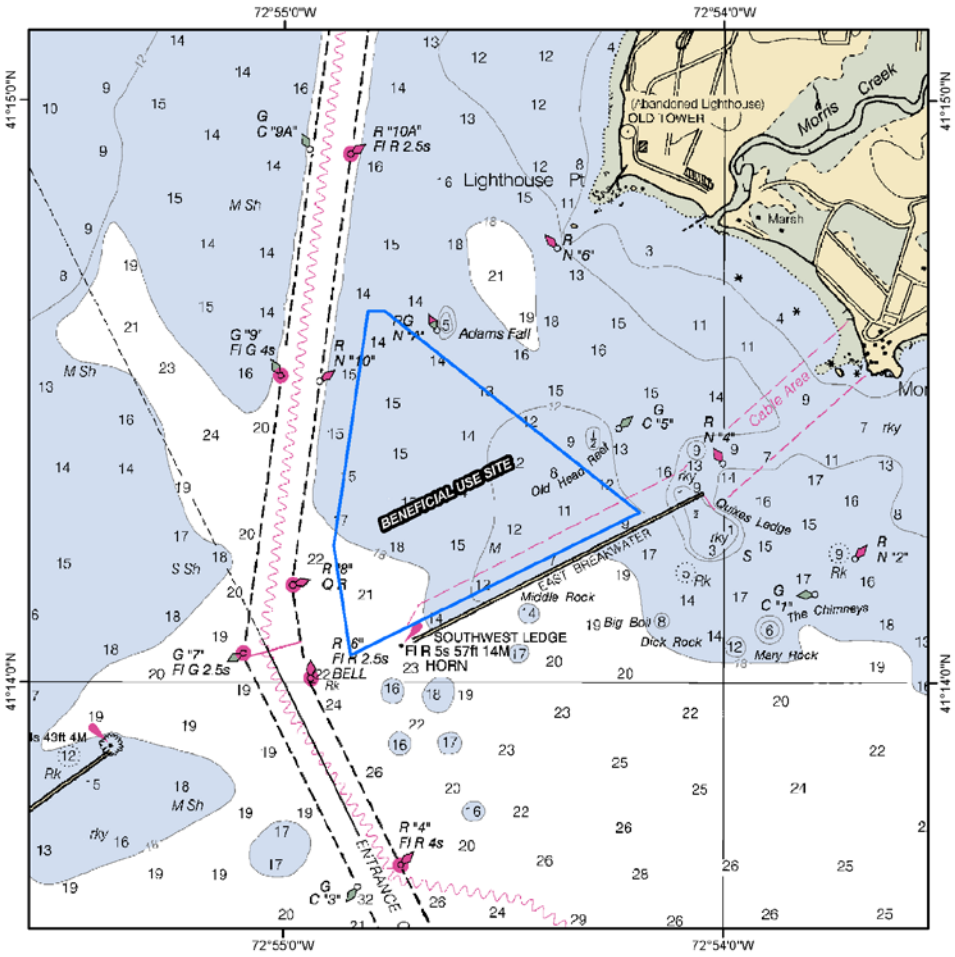
NEW HAVEN HARBOR
CONNECTICUT
NAVIGATION IMPROVEMENT PROJECT

INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT

APPENDIX I
BENTHIC RESOURCES

Environmental Sampling and Survey
In Support of Beneficial Use
Site Characterization FINAL

New Haven Harbor Feasibility Study
Shellfish Habitat Creation Area
New Haven, CT



US Army Corps
of Engineers ®
New England District

March 2017

ENVIRONMENTAL SAMPLING AND SURVEY

IN SUPPORT OF

BENEFICIAL USE SITE CHARACTERIZATION

NEW HAVEN HARBOR FEASIBILITY STUDY

SHELLFISH HABITAT CREATION AREA

NEW HAVEN, CONNECTICUT

March, 2018

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Planning Division
Environmental Resources Section
U.S. Army Corps of Engineers
New England District
Concord, Massachusetts

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1.0 INTRODUCTION

The Federal navigation project (FNP) in New Haven Harbor, located in New Haven, CT, consists partly of a main channel and maneuvering basin that were designed in the late 1940's and constructed in 1950 (Figure 1). The existing project depth is -35 feet at mean lower low water (MLLW). The New Haven Port Authority, in partnership with the Connecticut State Port Authority, requested that the New England District (NAE) of the US Army Corps of Engineers (USACE) conduct a Feasibility Study to evaluate whether navigation improvements, deepening and widening the channel and maneuvering basin, to the existing FNP at New Haven Harbor are warranted and in the Federal interest.

In May and August of 2017, field studies were conducted to: 1) provide baseline information on biological resources, specifically the benthic communities, of the proposed improvement portions of the study area; 2) define the existing sediment types and benthic community structure of a potential placement area being considered for beneficial use (shellfish habitat creation) (Figure 2); and 3) to evaluate the bathymetry and bottom characteristics of the potential shellfish habitat creation area.

2.0 MATERIALS AND METHODS

2.1 Bathymetry and Side Scan Sonar

Survey efforts were conducted on 2 May of 2017 by staff from the NAE Environmental Resources Section. Work was carried out onboard the R/V Nomad, a 25 foot SBI Defender outfitted for coastal survey operations. Vessel positioning was achieved using a Hemisphere Vector VS330™ Real Time Kinematic (RTK) position and heading system interfaced to a computer running Hypack® survey software for navigation. RTK corrections from the CTDOT/UCONN VRS network were received in real time through a cellular internet connection.

Hydroacoustic data was collected using an Edgetech 6205 multiphase echosounder with a 230/550 kHz side-scan and 230 kHz bathymetry frequency configuration. The Edgetech 6205 was interfaced with a Teledyne DMS10 motion sensor and the Vector VS330™ position and heading system. The sonar head was fixed to an adjustable survey boom mounted along the starboard side of the vessel. The face of the sonar head was adjusted to be 16 inches below the water surface. Prior to the start of the survey effort a patch test was conducted to correct for pitch, roll, and yaw deviations resulting from sensor misalignment and to account for the latency of the system. Conductivity, temperature, and depth (CTD) profiles were collected throughout the survey using a Sontek Castaway®–CTD and were uploaded to Hypack® to correct for speed of sound variations in the water column.

The hydroacoustic survey of the shellfish habitat creation area (Figure 3) was conducted using a line spacing of 200 feet in order to achieve full coverage of the site. Bathymetric and side-scan sonar data was viewed in real time on the survey vessel and recorded in Hypack®. The vessel operator navigated all transects at a speed of approximately 4 knots while recording data. Transects were run in opposite directions to minimize non-recording time.

Transect information including the number, filename, start and stop time, direction, and pertinent observations were recorded in a field log throughout the survey.

Bathymetric data was processed in Hypack® MBMax. The 230 kHz data from each transect was filtered to flag erroneous sonar returns (i.e. inaccurate bottom depth outputs resulting from acoustic artifacts, noise in the water column, or vegetation) and manually reviewed by a sonar technician for accuracy and to remove spurious points. Tide corrections were made in Hypack® by applying local tide model offsets from the NOAA Vertical Datum Transformation (VDatum) tool to the RTK orthametric heights recorded in the field. The finalized data set was exported from Hypack® MBMax as averaged soundings using a 3x3 foot grid spacing with depths referenced to Mean Lower Low Water (MLLW). This file was then used to generate depth contours and a triangular irregular network model in ESRI ArcGIS.

Side-scan sonar data from the 550 kHz channel of each transect was imported to Chesapeake Technology (CTI) SonarWiz 6 software for processing and analysis. Processing included digitizing of the first signal return to remove the water column portion of the sonar record, and adjustments for signal attenuation with distance using Time Varied Gain (TVG) corrections. The processed track lines were combined into a high resolution mosaic and used to interpret the surficial sediment type and delineate features of interest within the survey area.

2.2 Sediment Sampling for Grain Size and Benthic Community Analysis

Sediment sampling activities were performed on 1 August of 2017 by staff from the NAE Environmental Resource Section. Work was carried out onboard the R/V Nomad using the same positioning and navigation equipment as in May of 2017.

Ten sample locations were established within the project area to collect samples for benthic community analysis. Seven stations were located within proposed improvement areas and three stations were located in the shellfish habitat creation area (Figure 4). At all ten stations, a 0.04 m^2 sized VanVeen grab sampler was used to collect benthic samples for community analysis. For the three stations located in the shellfish habitat creation area, a second grab was taken at each location for grain size analysis.

Each sample for benthic community analysis was sieved with seawater thorough a 0.5 mm sieve and preserved in 10% formaldehyde with 0.1% rose Bengal stain. Samples were kept in formaldehyde solution until processed at the NAE environmental laboratory located at Ft. Devens, MA. At the time of processing the samples were washed on a 0.5 mm sieve to remove the preservative and remaining fine sediment. The material was then sorted under a low-power dissecting microscope where organisms were removed from the sediments and transferred to jars containing 70% ethanol. Organisms were identified to the lowest taxon possible and enumerated.

Grain size analysis was also performed by the NAE environmental laboratory. Samples were prepared according to the guidance in ASTM D421-85, Dry Preparation of Soil

Samples for Particle-Size Analysis and Determination of Soil Constants, and analyzed according to ASTM D422-63, Standard Test Method for Particle-Size Analysis of Soils using sieve nos. 4, 10, 40, 100, and 200. There were no deviations from the established laboratory testing protocols.

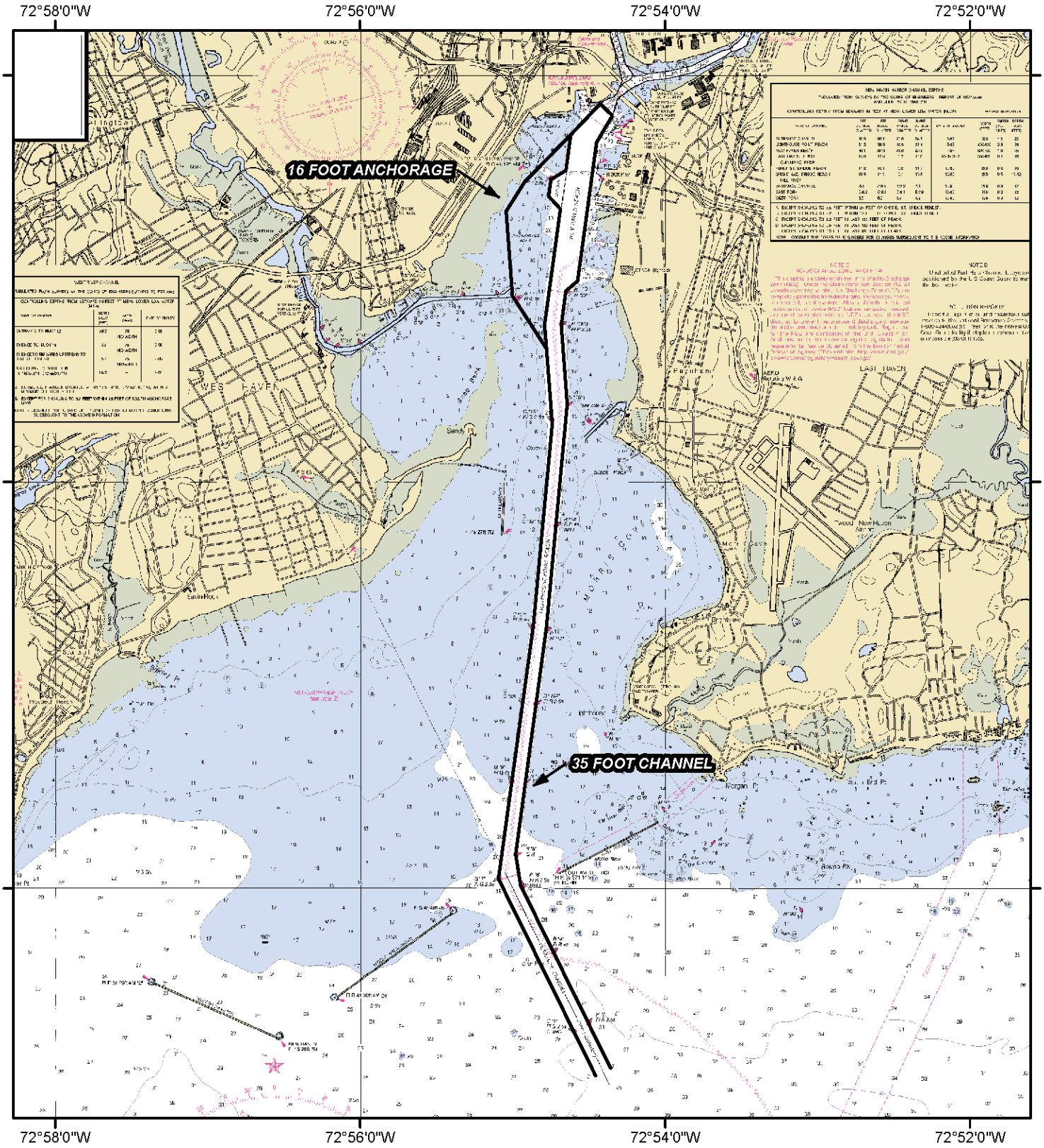

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FIGURE 1:
NEW HAVEN HARBOR, NEW HAVEN, CT
FEDERAL NAVIGATION PROJECT

N
W E
S

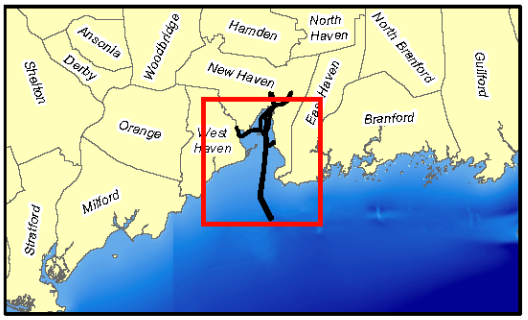
0 2,500 5,000 7,500 10,000 Feet

0 0.5 1 1.5 2 Miles

1:65,000

NOAA CHART 12371

GCS NAD1983



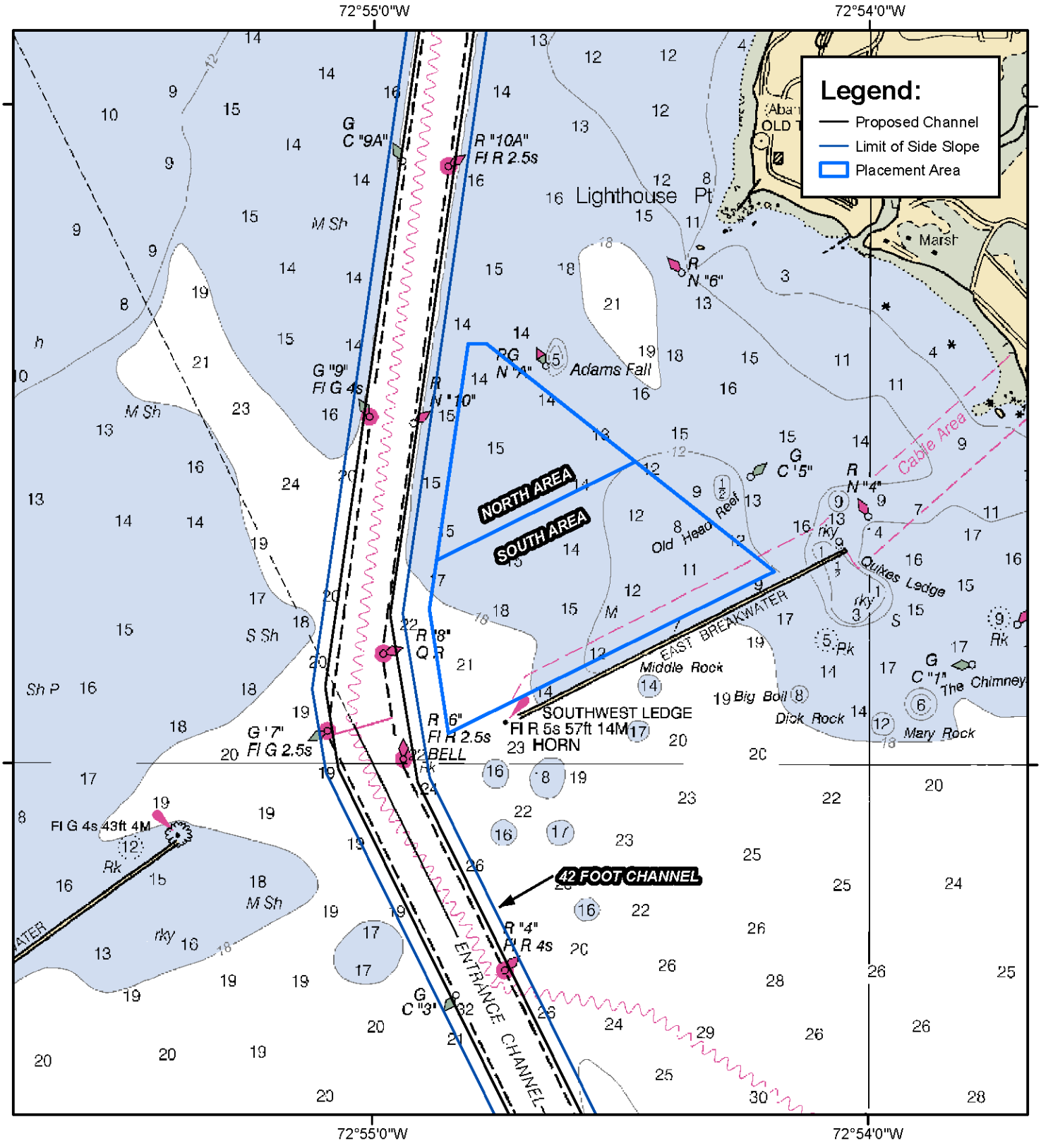


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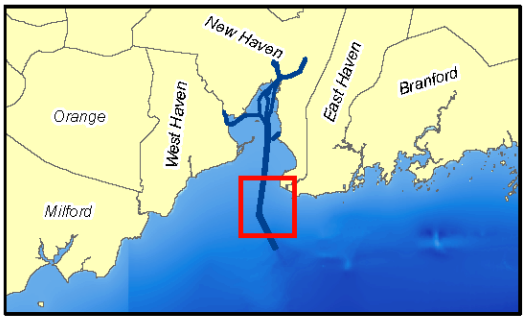
FIGURE 2:
NEW HAVEN HARBOR, NEW HAVEN, CT
SHELLFISH HABITAT CREATION AREA

0 1,000 2,000 3,000 Feet
0 0.1 0.2 0.3 0.4 Miles
1:15,000

NOAA CHART 12371

GCS NAD1983



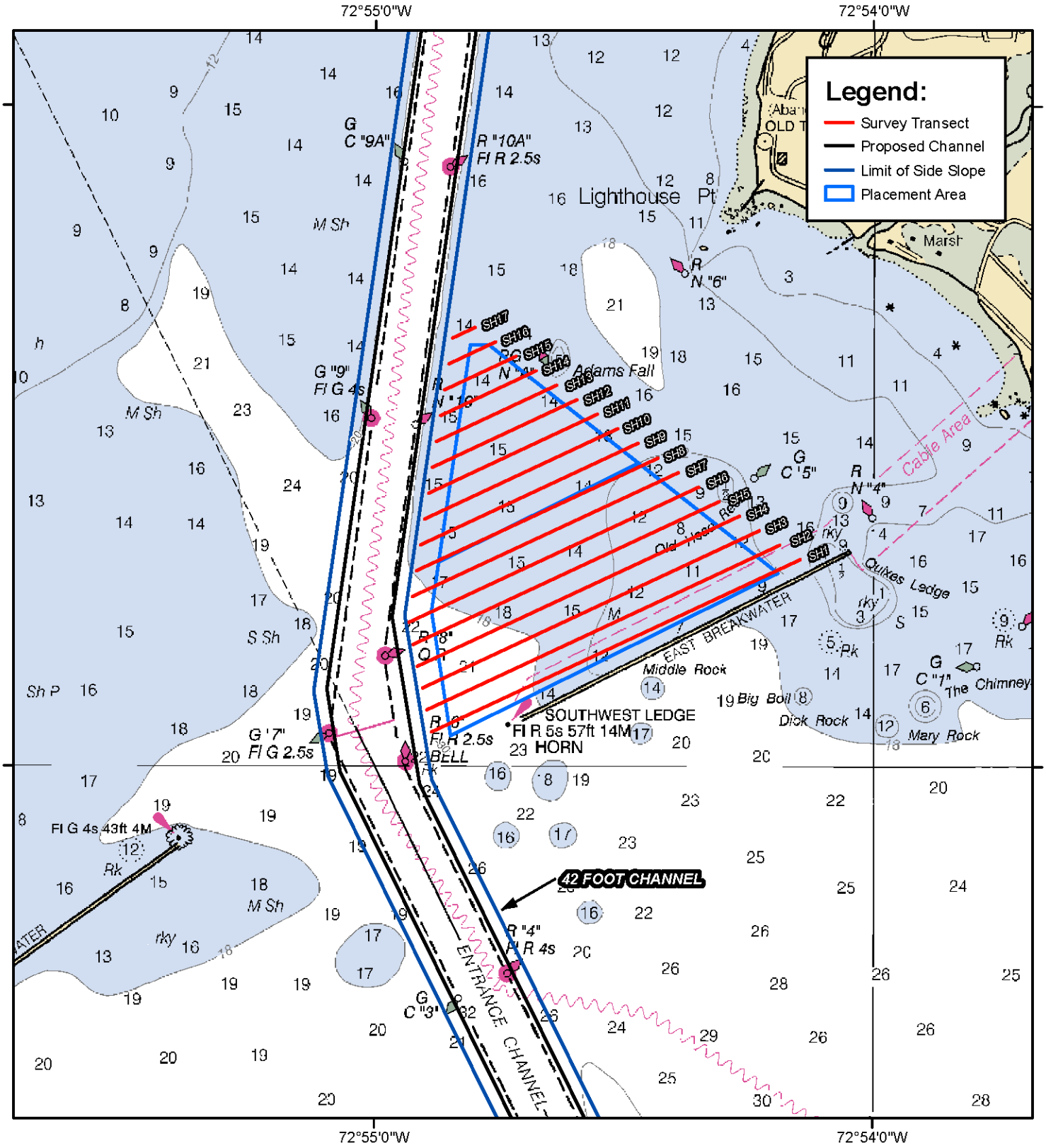


FIGURE 3:
NEW HAVEN HARBOR, NEW HAVEN, CT
SHELLFISH AREA SURVEY PLAN

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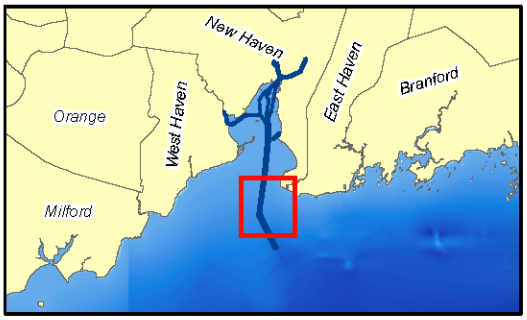
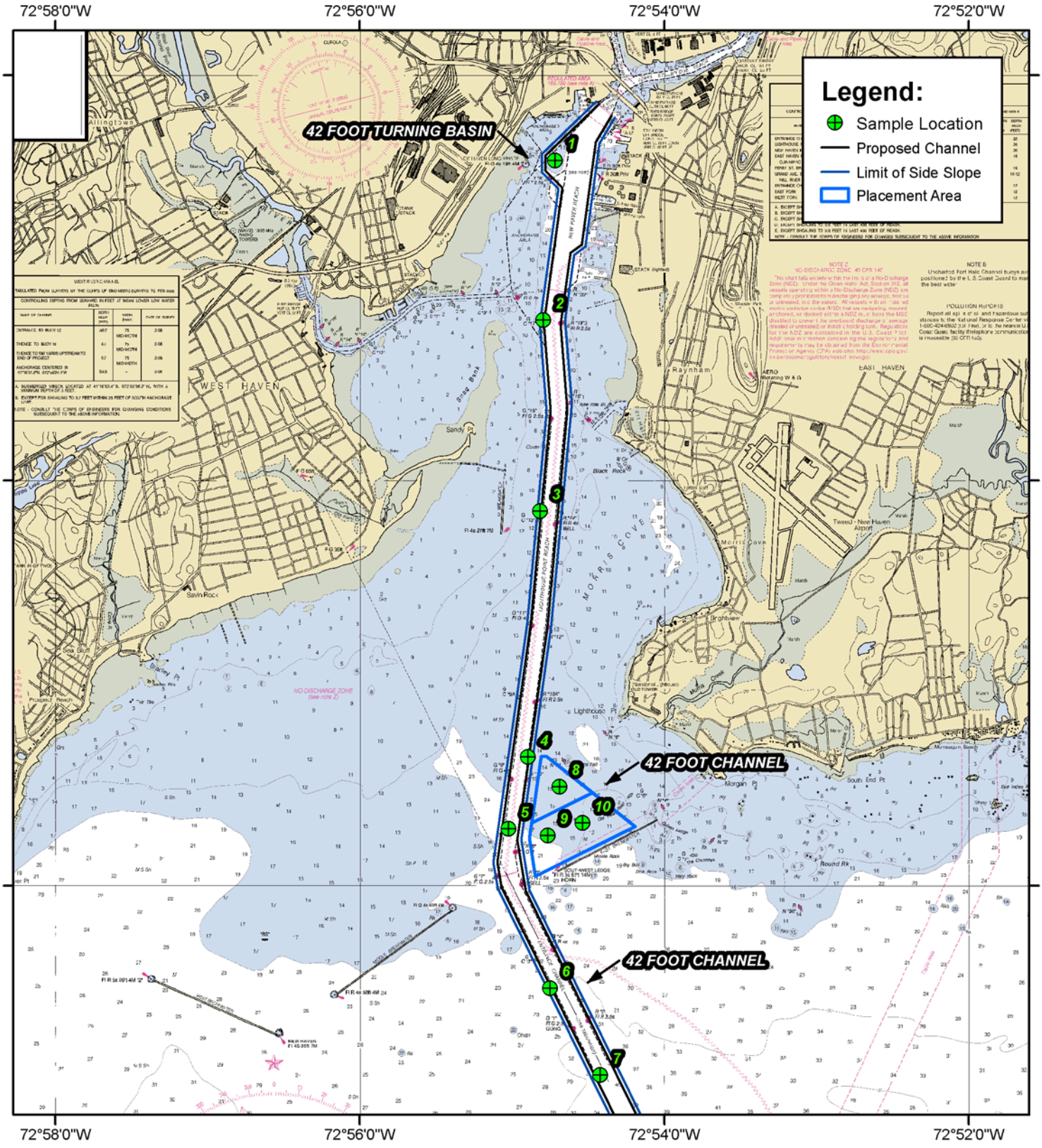
0 1,000 2,000 3,000 Feet
0 0.1 0.2 0.3 0.4 Miles
1:15,000

NOAA CHART 12371

GCS NAD1983





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New England District

FIGURE 4:
NEW HAVEN HARBOR, NEW HAVEN, CT
2017 BENTHIC SAMPLE LOCATIONS

N
W E
S

0 2,500 5,000 7,500 10,000 Feet

0 0.5 1 1.5 2 Miles

1:65,000

NOAA CHART 12371

GCS NAD1983

3.0 RESULTS AND DISCUSSION

This section summarizes results obtained from benthic community analysis of sediments from the within the New Haven Harbor improvement project and the potential shellfish habitat creation site. The physical testing of sediments and sidescan survey of the shellfish habitat creation site are also summarized.

3.1 Bathymetry and Side Scan Sonar

Water depths in the vicinity of the shellfish habitat creation area ranged from -11 to -29 feet MLLW. The seafloor in the survey area was characterized by a gentle slope to the west with a sharp transition to the deep area located in the southwest corner of the site. Interpretation of the side scan sonar data documented a uniform area of low backscatter corresponding to fine grained sediments in the northern portion of the survey area. The southern third of the site contained complex patches of high and low backscatter corresponding to areas of coarser sediment or shell within the ambient fine grained material. A band of coarse substrate was observed to extend approximately 1,000 feet into the site from the eastern boundary in the vicinity of the area marked as Old Head Reef on NOAA chart 12371. Other notable features identified in the side scan sonar mosaic included numerous well defined high-backscatter targets corresponding to rock along the tow of the eastern breakwater; and a long linear feature inshore of breakwater, interpreted to be a cable running from Morgan Point to the Southwest Ledge Lighthouse.

3.2 Benthic Community Analysis

Ten grab samples for benthic community analysis were processed at the NAE Environmental Laboratory. Counts of organisms by sample station are summarized in Tables 1 and 2.

New Haven Harbor Navigation Improvement Areas

The benthic communities of the improvement areas in the New Haven inner harbor area (i.e., areas of the harbor north of sandy point), represented by stations #1 and #2, contained a mix of opportunistic benthic species such as the polychaete *Streblospio benedicti*. The benthic communities in these silty sediment environment were generally low in diversity and dominated by only a few species (Table 1). The outer harbor stations (stations #3 - #7), which had silty-clayey sediments, contained a mix of opportunistic species and mid-successional stage organisms such as the tubiculous polychaetes *Clymenella torquata* and *Spiochaetopterus oculatus*. The communities in the outer harbor stations were higher in diversity than the inner harbor stations and individuals tended to be distributed among species more evenly.

Shellfish Habitat Creation Area

The benthic communities of the shellfish habitat creation area in the New Haven Harbor, represented by stations #7, #8, and #9 contained a mix of opportunistic benthic species

such as the polychaete species *Streblospio benedicti* and *Capitella* sp. as well as late-successional stage organisms such as the bivalve *Yoldia limatula*. The benthic communities in these silty sediment environment were generally moderate in diversity and contained an even distribution of individuals among species (Table 2).

3.3 Grain Size Analysis

Three sediment samples were analyzed for grain size distribution at the NAE Environmental Laboratory. The sediments collected from all stations within the shellfish habitat creation area were predominately silt with trace amounts of fine sand. The results of grain size analysis are summarized in Table 3. Grain size curves and full testing results are provided in Attachment 1.

Table 1. Benthic invertebrates collected from the New Haven Harbor Navigation Improvement Areas in May, 2017. Numbers are per 0.04 m^2

STATION NUMBER	1	2	3	4	5	6	7
ANNELIDA							
POLYCHAETA							
Aricidea sp.	-	-	-	-	-	-	1
Alitta succinea	-	1	2	5	-	-	2
Capitella sp.	-	-	4	-	-	3	4
Clymenella torquata	-	-	-	15	-	-	11
Diopatra cuprea	-	-	-	-	1	-	-
Glycinde solitaria	-	-	1	-	-	1	-
Leitoscoloplos fragilis	-	-	-	2	-	-	7
Nephtys incisa	-	1	-	-	-	-	-
Orbinia sp.	-	-	-	2	-	-	2
Pectinaria gouldii	1	-	-	-	-	-	-
Pherusa sp.	-	-	-	-	-	5	-
Polydora sp.	-	-	-	-	2	-	-
Spiochaetopterus oculatus	-	-	-	3	1	-	
Streblospio benedicti	13	7	9	4	6	-	4
OLIGOCHAETA							
Unidentified Oligochaete sp.	-	10	2	5	-	-	2
ARTHROPODA - CRUSTACEA							
AMPHIPODA							
Unidentified Gammaridae	-	-	-	1	3	2	-
Ampelisca abdita	3	-	-	8	-	6	74
Corophium sp.	-	-	-	1	-	3	-
CUMACEA							
Unidentified Cumacean	-	1	-	-	-	-	-
DECAPODA							
Pagurus longicarpus	-	-	-	-	-	2	-
Neopanope sp.	-	-	-	-	1	-	-
MOLLUSCA							
BIVALVIA							
Anadara ovalis	-	-	-	-	-	1	-
Ensis directus	-	-	-	-	-	-	1
Mulinia lateralis	-	-	-	4	-	-	-
Yoldia limatula	-	1	6	-	4	-	-
GASTROPODA							
Haminoea solitaria	-	6	2	1	-	-	-
Nassarius trivitatus	3	-	5	-	4	-	-
Urosalpinx cinerea	-	-	1	-	-	-	-
INDIVIDUALS / SAMPLE	**20**	**27**	**32**	**51**	**22**	**23**	**108**
SPECIES / SAMPLE	**4**	**7**	**9**	**12**	**8**	**8**	**10**

Table 2. Benthic invertebrates collected from the New Haven Harbor Shellfish Creation Area in May, 2017. Numbers are per 0.04 m^2

STATION NUMBER	8	9	10
ANNELIDA			
POLYCHAETA			
Alitta succinea	2	3	2
Capitella sp.	17	6	22
Glycinde solitaria	3	-	-
Leitoscoloplos fragilis	-	-	3
Nephtys incisa	1	4	-
Orbinia sp.	-	-	1
Pectinaria gouldii	1	-	1
Spiochaetopterus oculatus	-	2	6
Streblospio benedicti	21	-	15
OLIGOCHAETA			
Unidentified Oligochaete sp.	-	-	2
ARTHROPODA - CRUSTACEA			
AMPHIPODA			
Ampelisca abdita	-	1	-
CUMACEA			
Oxyurostylus smithii	3	-	-
MOLLUSCA			
BIVALVIA			
Mulinia lateralis	-	-	1
Yoldia limatula	7	6	15
GASTROPODA			
Haminoea solitaria	4	-	-
INDIVIDUALS / SAMPLE	**59**	**22**	**68**
SPECIES / SAMPLE	**9**	**6**	**10**

Table 3: Summary of Grain Size Results from the New Haven Harbor Shellfish Creation Area

Sample ID	%Cobble	%Gravel		%Sand			%Fines
		Coarse	Fine	Coarse	Medium	Fine	
Station 8	0.0	0.0	0.0	0.2	0.9	2.7	96.2
Station 9	0.0	0.0	0.0	0.1	1.7	5.8	92.3
Station 10	0.0	0.0	0.0	0.0	0.6	8.4	91.0

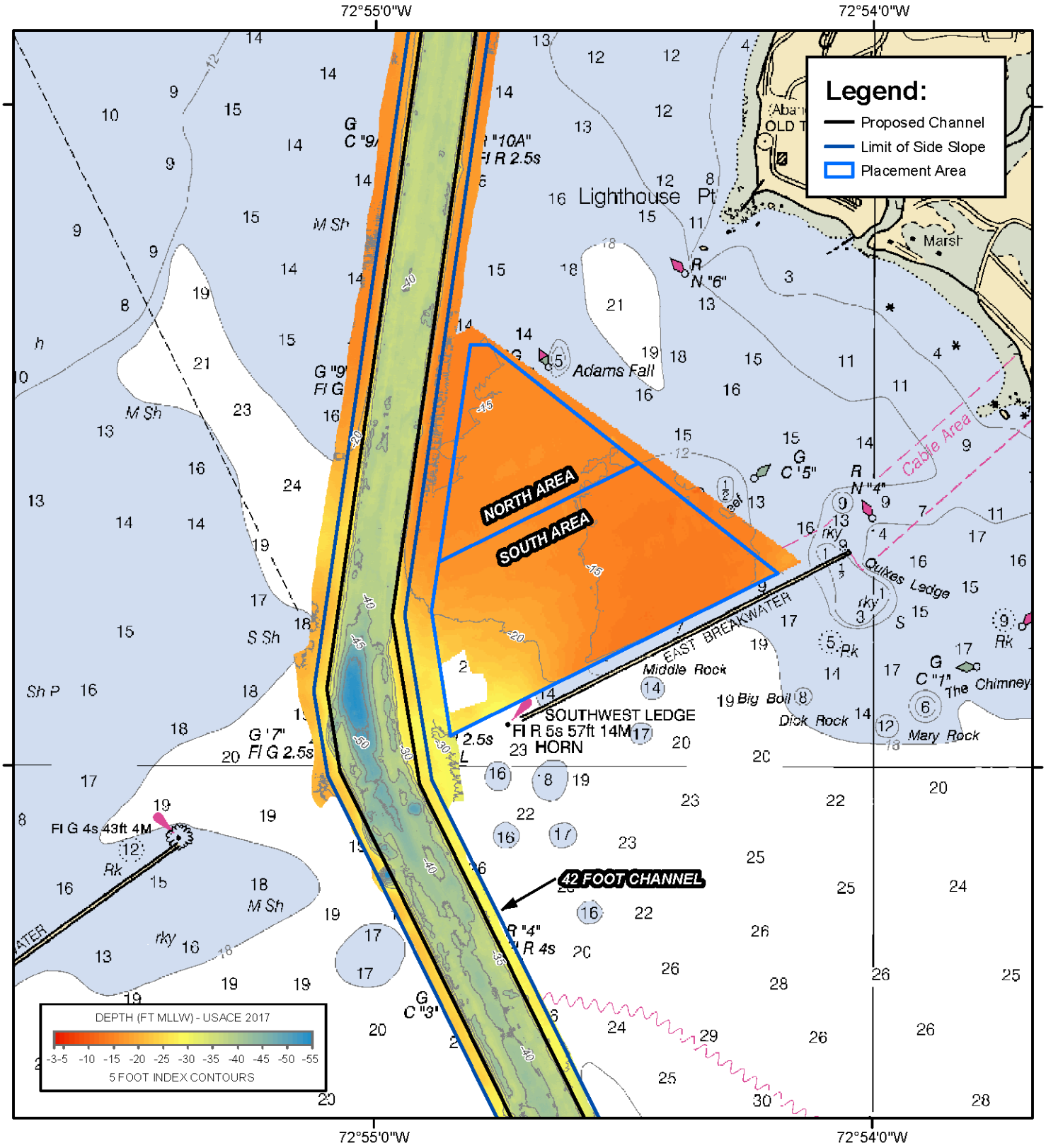

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FIGURE 5:
NEW HAVEN HARBOR, NEW HAVEN, CT
SHELLFISH AREA BATHYMETRY

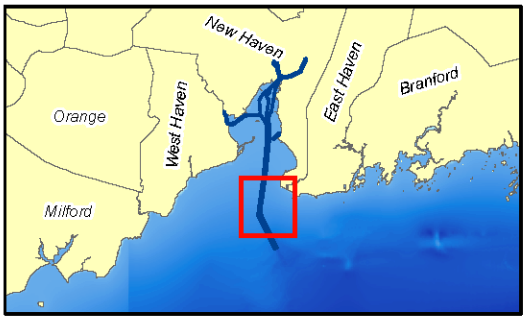
0 1,000 2,000 3,000 Feet

0 0.1 0.2 0.3 0.4 Miles

1:15,000

NOAA CHART 12371

GCS NAD1983



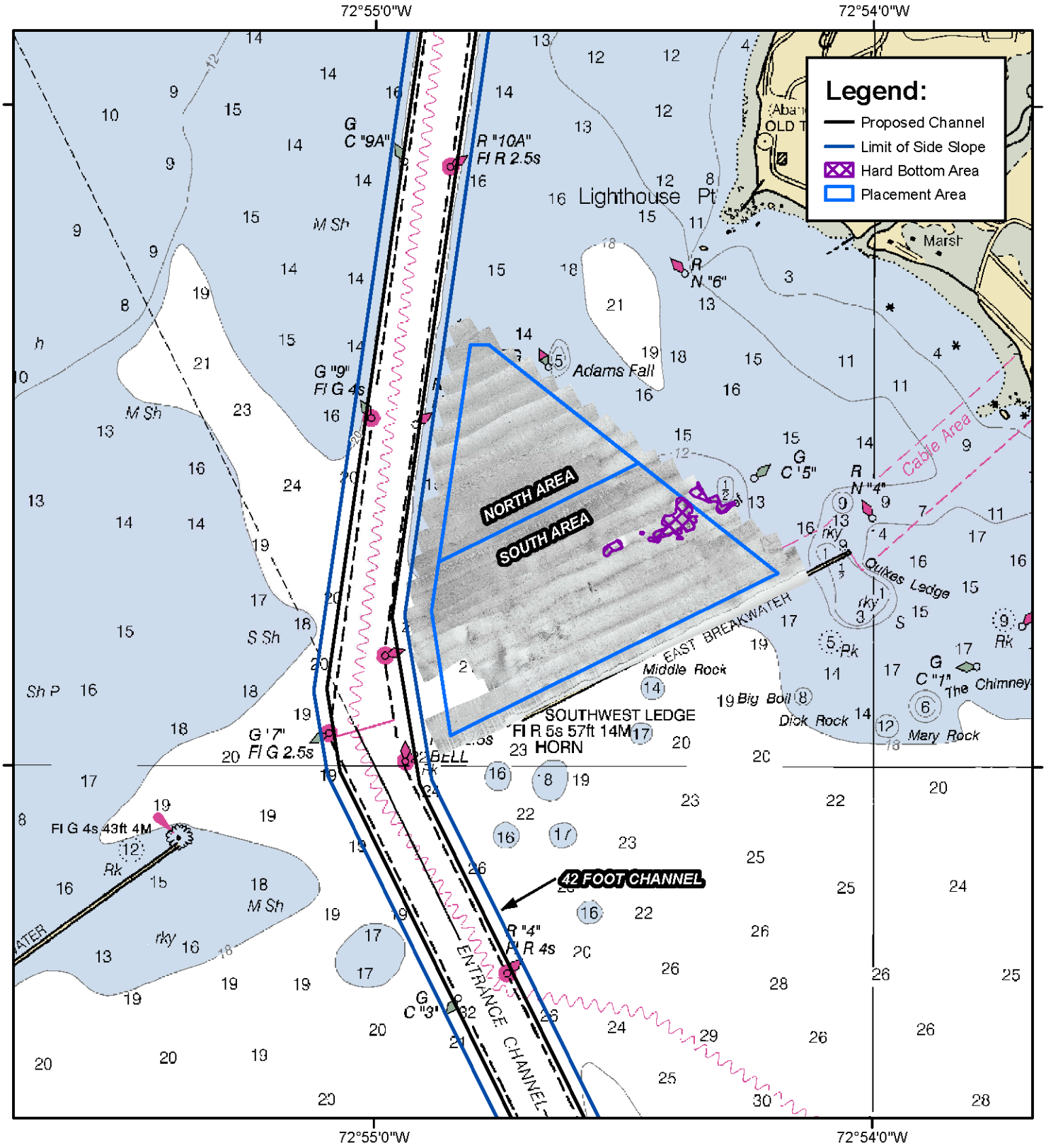


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FIGURE 6:
NEW HAVEN HARBOR, NEW HAVEN, CT
SHELLFISH AREA SIDE SCAN SONAR

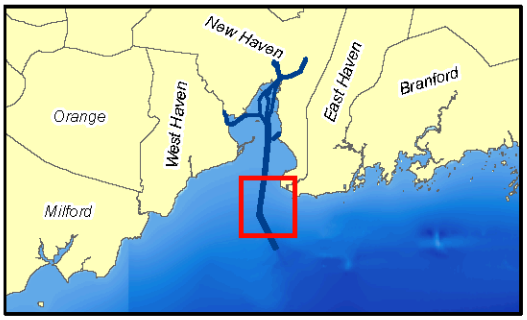
0 1,000 2,000 3,000 Feet

0 0.1 0.2 0.3 0.4 Miles

1:15,000

NOAA CHART 12371

GCS NAD1983



APPENDIX A

GRAIN SIZE CURVES
(ON FILE AT USACE-NAE)