APPENDIX E
FIELD SURVEYS PERFORMED IN SUPPORT OF SELECTING A SITE AT THE REEF RUNWAY SHALLOW-WATER RECOVERY AREA

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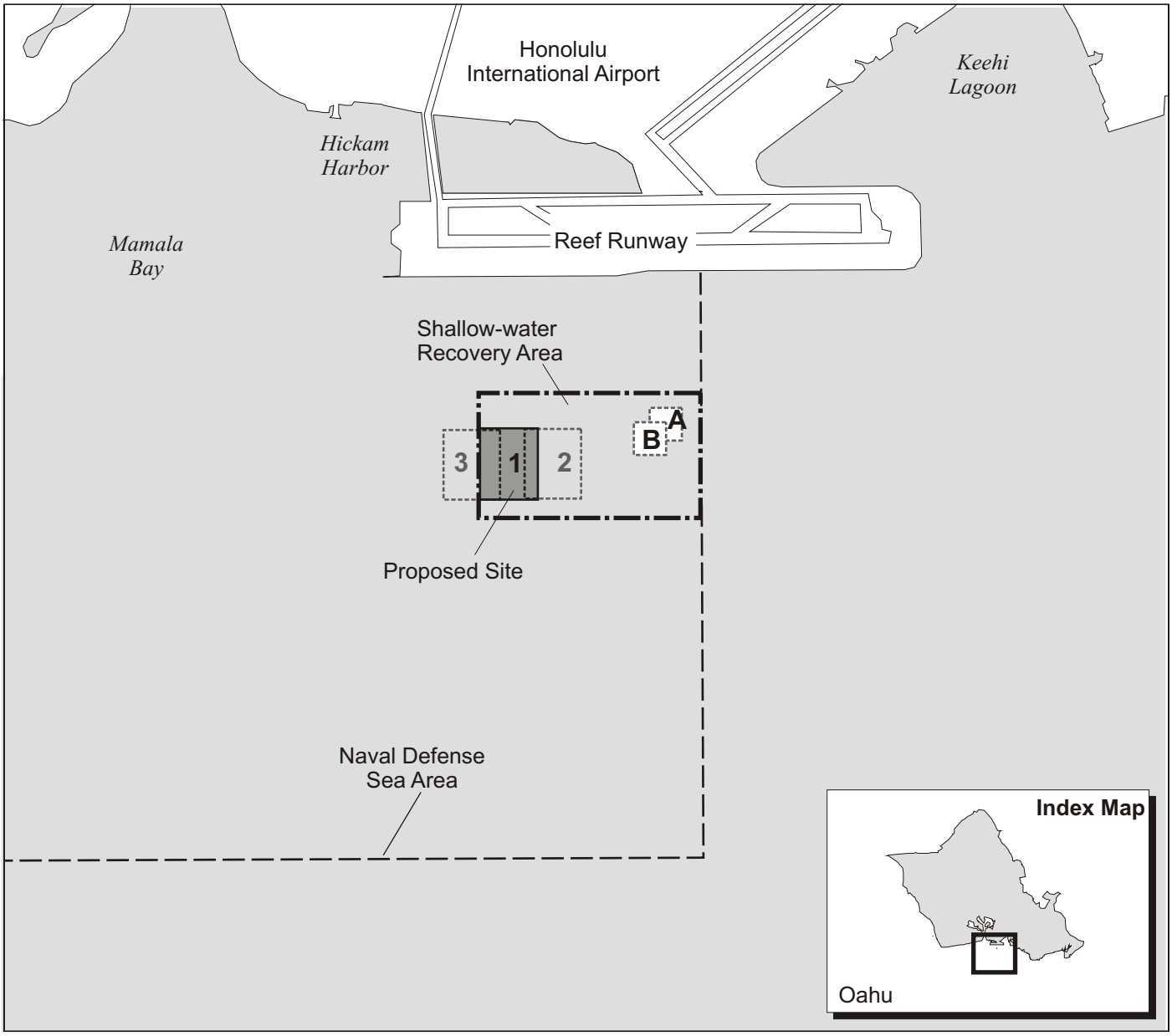
Background

This appendix discusses the scope of field activities performed in support of the Environmental Assessment and serves as a compendium for much of the baseline (spatial) data used to support the analysis and selection of a preferred site at the Reef Runway shallow-water recovery area. The results of these investigations have been incorporated into the relevant technical sections of the Environmental Assessment. The selection of the Reef Runway shallow-water recovery area as the preferred action has been documented in appendix D, Location Assessment. Appendix D established program goals, objectives and technical criteria against which five candidate shallow-water recovery sites could be compared and rank ordered. The Reef Runway shallow-water recovery area was clearly rated as the preferred site for this operation.

The Reef Runway shallow-water recovery area defines a rectangular area approximately 5,900 feet (1,800 meters) east to west, by 3,280 feet (1,000 meters) north to south. The northern boundary of the shallow-water recovery area is approximately one-half nautical mile (1 kilometer) from shore. Figure E-1 shows the relative position of the shallow-water recovery area relative to the western end of the Reef Runway at Honolulu International Airport.

The term “recovery area” denotes a broad study area within which multiple opportunities exist to “footprint” the position of *Ehime Maru* during shallow-water recovery operations, as well as accommodate the mooring system for the diving support barge. The extent of the mooring system, as defined by the anchor points, defines the outer edge of the area of greatest potential disturbance. Therefore, the optimal positioning of the mooring system dictates the selection of a “site” for the preferred action. Details of the mooring system are described in a later section. The dimensions of the current mooring plan would define a site requirement of roughly 2,100 feet (640 meters) by 1,750 feet (533 meters) (figure E-1).

The Reef Runway shallow-water recovery area was expanded to its current size as a result of changing mission requirements and the discovery of sensitive marine habitat during field studies. Early requirements for the diving operation had required a shallow-water berth for *Ehime Maru* with a seafloor depth of between 72 and 100 feet (22 and 30 meters) and a preliminary four-point mooring plan with a footprint of 1,000 feet by 1,000



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A/B Candidate Sites - Initial 1,000- by 1,000-foot (300- by 300-meter) sites based on 72 to 100 feet (22 to 30 meters) of sea water depth requirement and preliminary mooring plan

A - Original Navy selected location

B - Modified location based on input from State of Hawaii Department of Land and Natural Resources, U.S. Fish and Wildlife Service, and National Oceanic and Atmospheric Administration (National Marine Fisheries Service)

1/2/3 Candidate Sites - 1,750- by 2,100-foot (533- by 640-meter) sites based on depth of 115 feet (35 meters) of sea water and modified mooring plan.

1 - Preferred site based on input from State of Hawaii Department of Land and Natural Resources, U.S. Fish and Wildlife Service, and National Oceanic and Atmospheric Administration (National Marine Fisheries Services)

2 - Viable secondary site - meets mission and environmental criteria

3 - Excluded site did not meet mission requirements

Reef Runway Shallow-water Recovery Area and Proposed Site, Oahu

NORTH

No Scale

Figure E-1

E_1RecoveryArea060101

feet (300 by 300 meters). Under this scenario, the Navy had initially identified a candidate site in the northeast portion of the current shallow-water recovery area (see box A on figure E-1). Initial bathymetric and marine habitat surveys focused on collecting data for this relatively small area. Subsequent spot dives by consultants in collaboration with State of Hawaii Department of Land and Natural Resources, U.S. Fish and Wildlife Service, and National Marine Fisheries Services personnel determined that there was sensitive seagrass habitat in the shallower, northeast portion of the site and that it would be beneficial to adjust the site to the south and west to minimize potential impacts from the operations (box B on figure E-1).

Near the mid-point of the Environmental Assessment, the depth requirement for the shallow-water berth was modified (deepened) to a depth of 115 feet (35 meters). In addition, the mooring system evolved to a 6-point system with an anchor spread of roughly 2,100 feet (640 meters) by 1,750 feet (533 meters). At that juncture, the study area was expanded to the present configuration shown in figure E-1 and field studies were restarted to assess the larger area and new criteria. Boxes 1, 2 and 3 on figure E-1 represent mission capable seafloor areas that were selected by the diving support contractor for bedding down *Ehime Maru* and successfully mooring the 450-foot (137-meter) diving support barge. Again, state and federal regulators collaborated with the Navy and Navy contractors to select the most environmentally sensitive location and mooring scheme that would satisfy the mission objectives.

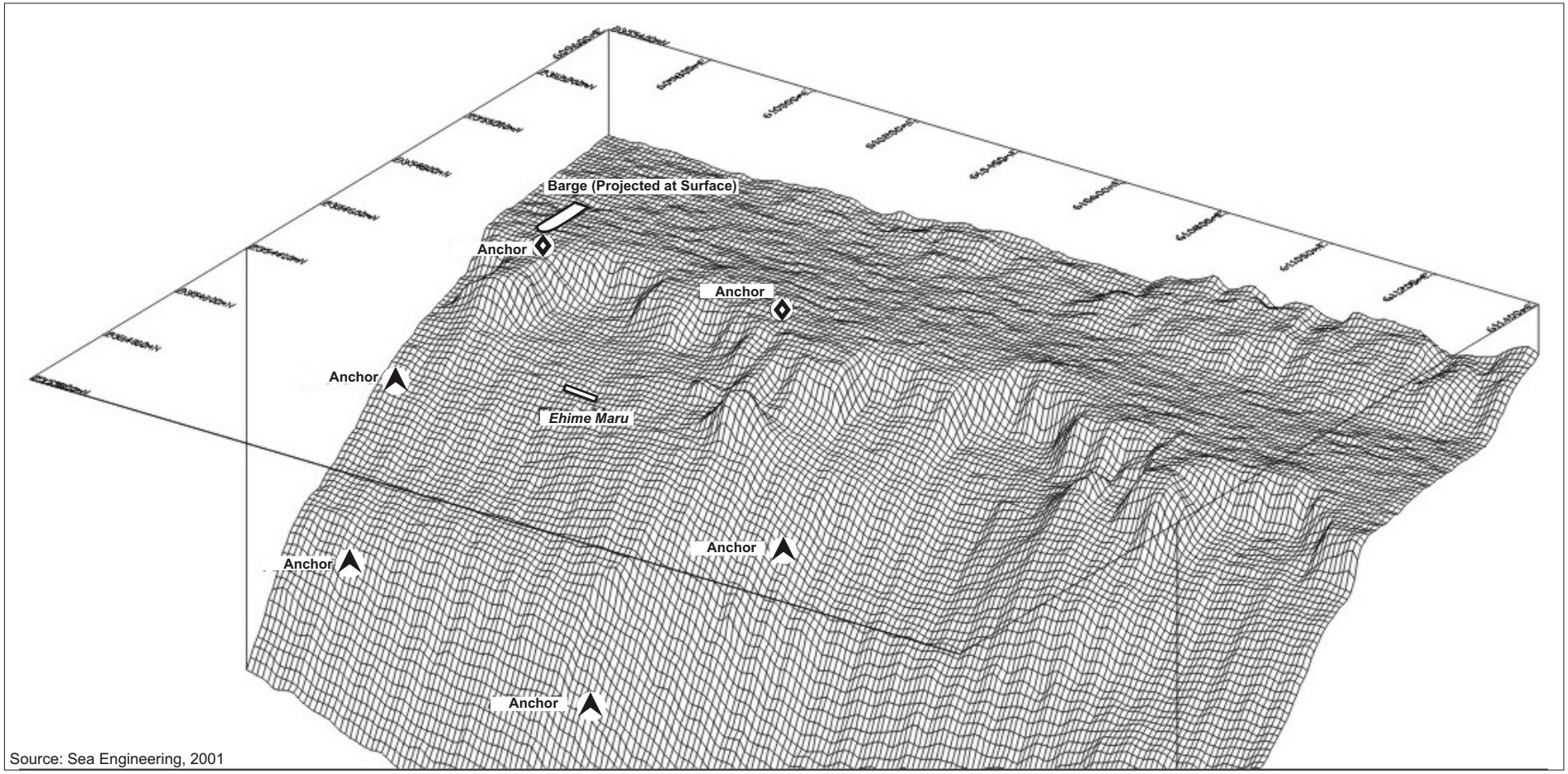
Based on this collaboration, Site 3 (figure E-1) was eliminated because it conflicted with the approach corridor to Honolulu International Airport. Sites 1 and 2, however, were deemed mission and environmentally viable. Regulators dove the two sites on May 31 and again on June 4, 2001. Based on their observations, and discussions on modifying the mooring system, Site 1 was selected as the formal Reef Runway Shallow-water Recovery Site. Figure E-2 is a 3D perspective of the site, looking northwesterly at a low-angle, and shows the relative relief of the seafloor, the position of *Ehime Maru* (and diving support barge), and the array of proposed anchor points. The reader should note that the relief in the figure has been exaggerated over 10 times in order to portray subtle seafloor features at the site and vicinity (the vertical scale is larger than the horizontal scale by 10:1).

Scope of Field Studies

As discussed, two generations of field study were completed in order to satisfy changing mission requirements. For purposes of this appendix, information will be presented as if it were performed during one operation, unless there is a notable difference in scope between the two survey efforts. Four types of studies were performed, as described below.

Bathymetric Surveys

Bathymetric data were collected on April 28, and May 9 and 10, 2001, using an Odom Hydrotract single beam echo-sounder (200 kHz transducer). A line spacing of 50 feet was used for the April 28 survey, and a line spacing of 100 feet was used for the surveys on the expanded study area on May 9 and 10. A bar check was performed to calibrate the survey system on each day prior to data collection. Bathymetry data points were collected each 0.25 seconds along each survey line, and navigation data were collected each 1



Source: Sea Engineering, 2001

LEGEND

- 8,000-pound Anchors
- Embedded Anchors

NORTH

No Scale

3-D Perspective of Mooring Plan at the Reef Runway Recovery Area

Figure E-2

E_2_3dPerspective060301

second. The bathymetry and navigation data were reviewed and edited line by line using Hypack software to remove spurious data points. Data were corrected to the MLLW datum using predicted tides from the closest NOS station. All surveys were conducted in the UTM-4 (Universe Transverse Mercator, Zone 4) projection, WGS84 datum and presented at a working scale of 1:20,000.

Side-scan Sonar

Side scan sonar data were collected on May 17, 2001 using a C-Max CM800 dual frequency side scan sonar. Lines were run shoreline-parallel at a spacing of 328 feet (100 meters). Data were collected using the high frequency mode (325 kHz) at 100-meter range, giving 100 percent overlap between the survey lines. A geo-rectified sonar mosaic of the data was constructed using SonarWiz software (Chesapeake Technology, Inc.).

Marine Habitat Video Surveys

A video survey was also conducted of the seafloor using a unique system called the Sea-All (trademark) video system, that consists of a high-resolution, color video underwater camera integrated with a digital global positioning system (DGPS). The camera is aligned for a downward view of the seafloor while the survey vessel slowly moves along a defined transect line. A computer-based DGPS navigation system directs the pilot of the survey vessel along pre-planned transect lines.

The camera was maintained approximately 10 to 15 feet (3 to 5 meters) above the bottom. The camera's field of view is approximately the same width as the distance of the camera above the substrate. The DGPS coordinate information is superimposed on the video image before recording onto Hi-8 videotape. Video tapes are then analyzed and attributes assigned for each data point/coordinate surveyed.

The original site area was surveyed along transects on 100-foot (30 meter) centers, and the expanded western portion of the site was surveyed on 125-foot (38 meter) transects. These data were also compiled at 1:20,000 scale, rectified and composited with the bathymetric base map.

Sub-bottom Profiles

Sub-bottom data were collected on May 21, 2001 using an Edge Tech 0408 dual channel sub-bottom fish with a frequency range pf 0.4 to 800 kHz. Survey lines were conducted in the cross-shore direction at a spacing of 328 feet (100 meters). Isopach values were measured using the X-Star processing system.

Mooring Plan

The mooring plan has been specifically designed and engineered by Crowley Marine Services to support the mission of their diving support barge (CMC 450-10) at the Reef Runway Shallow-water Recovery Site. The mooring design is intended to provide sufficient station-keeping for conducting dive operations over *Ehime Maru* and to provide for precision positioning during the final lift operation.

The design is based on meteorological data (i.e., wind, seas, and current) as compiled by the Naval Pacific Meterological and Oceanography Center and on ocean bottom sediment distributions as remotely interpreted from sub-bottom profile surveys provided by Sea Engineering, Inc. The plan assumes 40 knots (80 kilometers per hour) of maximum wind speed and 1 knot (2 kilometers per hour) of maximum current. Preliminary data would suggest that the bottom materials consist of a layer of sand and/or coral rubble of varying thickness over a hard coral or volcanic rock substrate. The exact thickness of sand is unknown beneath the vessel and each anchor point however, isopach maps interpolated from the sub-bottom profiles indicate that there should be sufficient sand/rubble thickness to anchor the four southerly reaches of the mooring system by conventional anchors. The two northerly, or nearshore anchor reaches would not have enough sand to provide sufficient holding power. It is currently envisioned that core samples will be taken at the two northerly anchor points to evaluate material types and strengths.

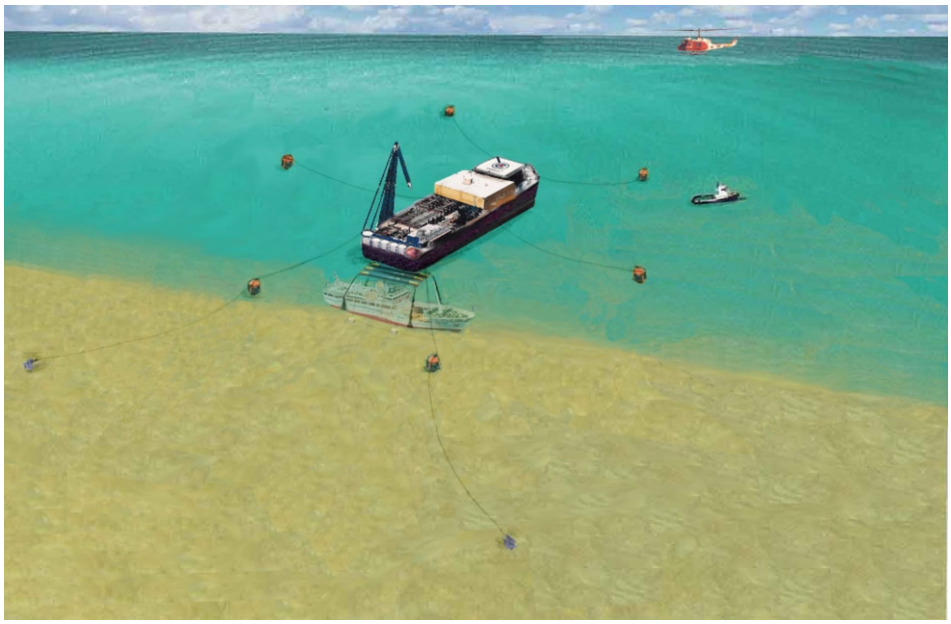
The precise coordinates (hours/minutes/tenths of a second) of the anchor points at the shallow-water recovery site are:

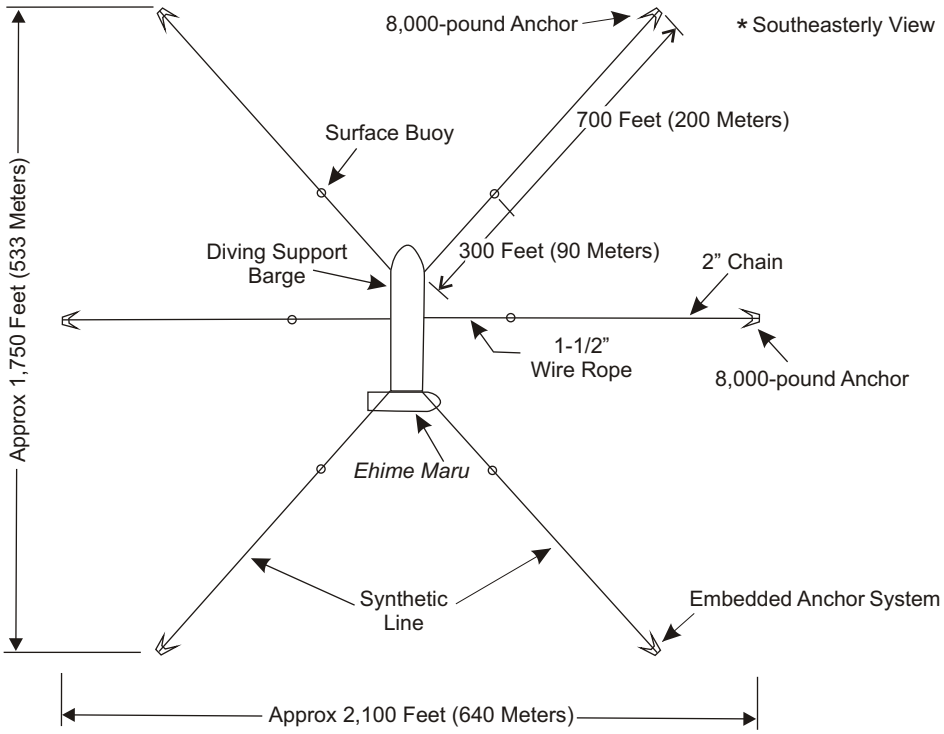
	Latitude	Longitude
Vessel:	21 17 31.3	157 56 24.2
NW Anchor:	21 17 38.4	157 56 32.1
NE Anchor:	21 17 38.2	157 56 16.2
E Anchor:	21 17 28.4	157 56 08.9
SE Anchor:	21 17 21.0	157 56 16.4
SW Anchor:	21 17 21.2	157 56 32.5
W Anchor:	21 17 29.5	157 56 35.4

Mooring System Description

The proposed plan is a hybrid six-point mooring system consisting of a combination of traditional anchor arrangements with two embedded anchor points in the hard rock areas identified above (figure E-3). The final design and exact position of the two northerly, or nearshore, embedded anchor points will be determined in part based on the results of the core analysis.

The CMC 450-10 will be fitted with three double-drum RB-90 winches. Each winch will be equipped with two 1-1/2 inch wire ropes. The two bow wires (southerly legs) and the two midship wires (port and starboard sides) will be led through swivel fairleads (guides) on deck. These wires will be connected to 50-kip (thousand pounds per square inch of force) surface buoys that will, in turn, be anchored on the bottom using 8,000-pound NAVMOOR high holding-power anchors or equivalent, and 400 to 700 feet of 2-inch oil rig quality chain. HMPE Spectra pendants (brand of special synthetic, non-stretch rope) may be added to the wire from the barge to the mooring buoys. The horizontal reach of each leg (combined length) will be approximately 1,000 feet (305 meters).





Diving Support Barge and Mooring Plan Schematic

Figure E-3

No Scale

The two stern wires (northerly legs) consisting of Spectra connecting pendants and low energy absorption components will be connected to an embedded anchor system. This system will consist of a driven piling with a suitable connection for mooring pendants. The driven piling is envisioned to be 24 inch diameter by ½inch wall thickness pipe driven to a depth of approximately 40 feet (12 meters). This method of installation will not produce spoils or debris at the penetration point. This installation will require the pile driver to position two or three 8-10 ton Danforth anchors at the nearshore position. These temporary anchors would be connected to the derrick barge by wire only and would be required for approximately two weeks. The anchors and wires can be located to minimize bottom scouring as the location of the driven pile is not a precise position. The height above the seafloor at the connection point will be optimized to eliminate any bottom scouring by the connected pendant. Upon completion of the project, the piles will be cut flush with the sea floor. Preliminary force analysis indicates that the estimated maximum static beam load is 75,000 lbs and the maximum static longitudinal load is 14,000 lbs.

Environmental Considerations

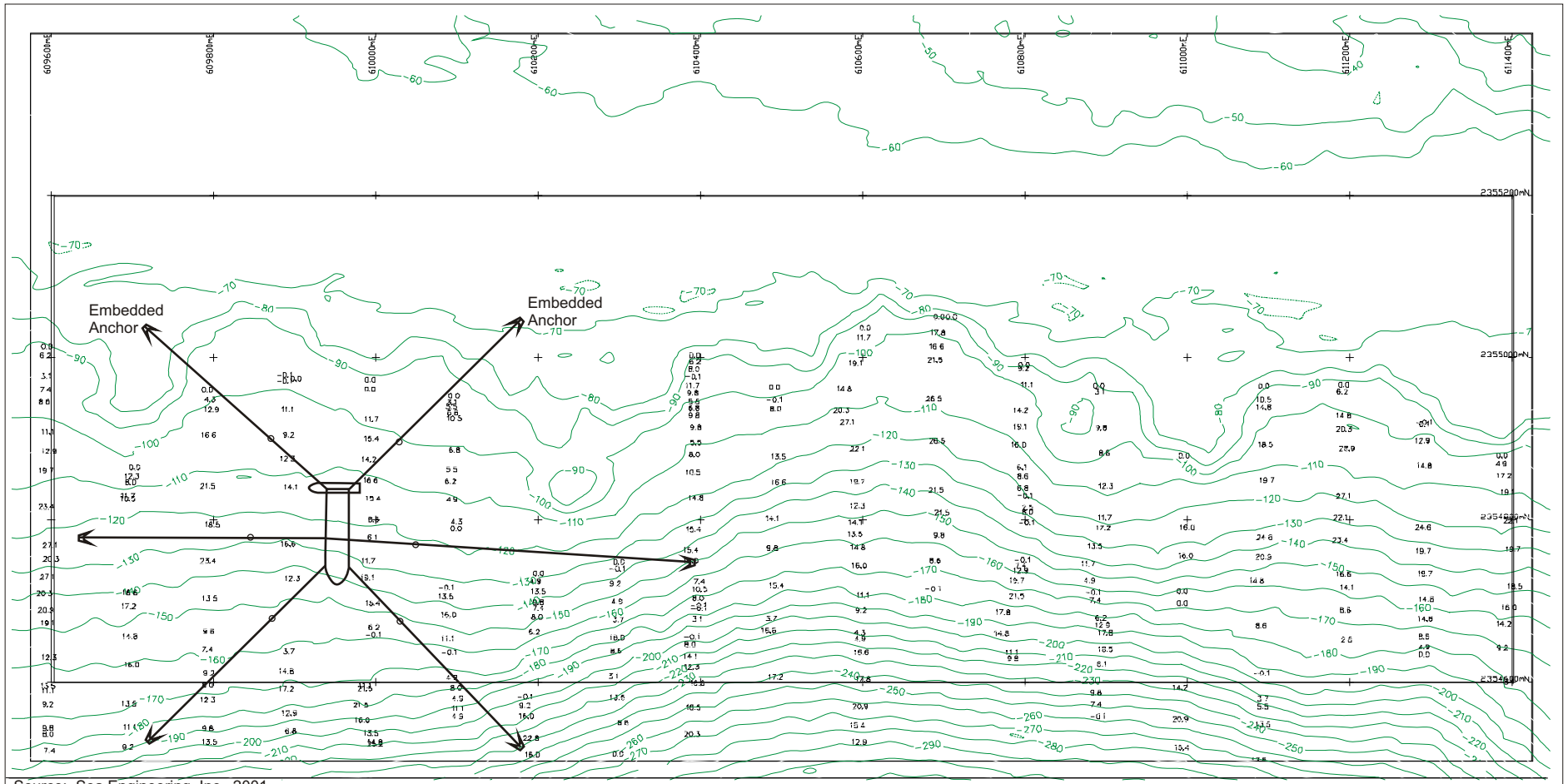
The seafloor above the 70-foot (21 meter) contour is intermittently populated by several species of seagrass, coral and other biological organisms that could be impacted by the mooring system. To the maximum extent practicable, effort will be made to design the final mooring system to minimize anchor and chain drag and to avoid setting anchors in environmentally sensitive areas. To that end, the embedded anchor system for the nearshore anchor points should all but eliminate any damage to the immediate area from bottom scouring by the anchor gear.

Salient Features of the Physical and Environmental Setting of the Reef Runway Shallow-water Recovery Area

Seafloor Morphology

The Reef Runway area seafloor can be characterized in terms of several geomorphic features. Figures E-4 and E-2 illustrate the configuration of the seafloor in plan view and 3D perspective, respectively, and the features are discussed in order from the north (shallower depths) to the south as follows.

- Upper wave cut terrace—a relatively flat, non-descript seafloor area generally above the 70- to 74-foot (21- to 23-meter) contour. The upper terrace slopes gently to the south at about 1 percent. Local relief is typically low (less than 2 feet (.6 meters) achieving maximum relief of 18 feet (6 meters) in the northeast corner.
- Wave cut escarpment—a distinct break in slope is present at about the 70 to 74 foot contour (21 to 23 meter) marking a transition between the upper terrace and a lower terrace at approximately 100 feet (30 meters). The break in slope is the back scarp of the ancient wave cut terrace developed during a glacial sea stand. The escarpment is pronounced, with a height of about 30 feet (10 meters), and slopes generally ranging from 10 to 15 percent. It bisects the study area from east to west and forms three irregular coves, and correspondingly, three southward projecting points, or lobes at the intersection of the coves. The lobes are easily detected on figures E-2 and E-4, and are discussed later for their prominence in supporting critical marine habitat.



Source: Sea Engineering, Inc., 2001

LEGEND-

—0— Lines of Equal Depth to Seafloor (In Feet)

Seafloor Bathymetry, Reef Runway Shallow-water Recovery Area

NORTH

Scale: 1:5,000

0 328 656 984 1312 Feet

0 100 200 300 400 Meters

Figure E-4

E_4ReefBathymetry

- Lower terrace—a moderately narrow strip of seafloor between the 100- and 120-foot (30- and 37-meter) contours. The lower terrace will serve as the foundation for the hull of Ehime Maru during recovery operations. The terrace ranges from 300 to over 650 feet (91 to 198 meters) in width. Local relief is generally less than 1 foot (.3 meter), and slopes are moderate, grading toward the ocean at 3 to 7 percent. The seafloor gradient at the vessel location will be southerly at 3 to 6 percent.
- Lower slope—at around 120 feet (37 meters), the seafloor steepens to over 10 percent and plunges to great depths outside of the recovery area. The deepest portion of the recovery area is near the south central boundary at 350 feet (107 meters). The slope is relatively uniform and featureless.

Seafloor Materials

The seafloor at the shallow-water recovery area is composed of a combination of surficial sand and coral rubble over a hard substrate of coral and/or volcanic rock. Side-scan sonar transects and sub-bottom profiling was performed to attempt to map the distribution and thickness of surficial deposits (unconsolidated sand and coral rubble) at the recovery area, especially as it influenced the selection and placement of the mooring system.

Surface conditions were not conducive to producing clean side-scan sonar signatures, and although the data were interpreted, the records are not considered to be particularly good and therefore have not been included herein. The sub-bottom profiling provided better records (i.e., cleaner signatures for picking the sediment/rock interface). The results of that survey were used to develop figure E-5, an isopach map of the shallow-water recovery area. An isopach map portrays contours of equal thickness, in this case, feet of unconsolidated sediment over hard rock. As previously mentioned, the data are actually compiled and interpreted from a series of readings made along a widely-spaced (100-meter centers [300-foot]) transects. The isopach map is contoured using an interpolating program, and therefore, it is somewhat diagrammatic.

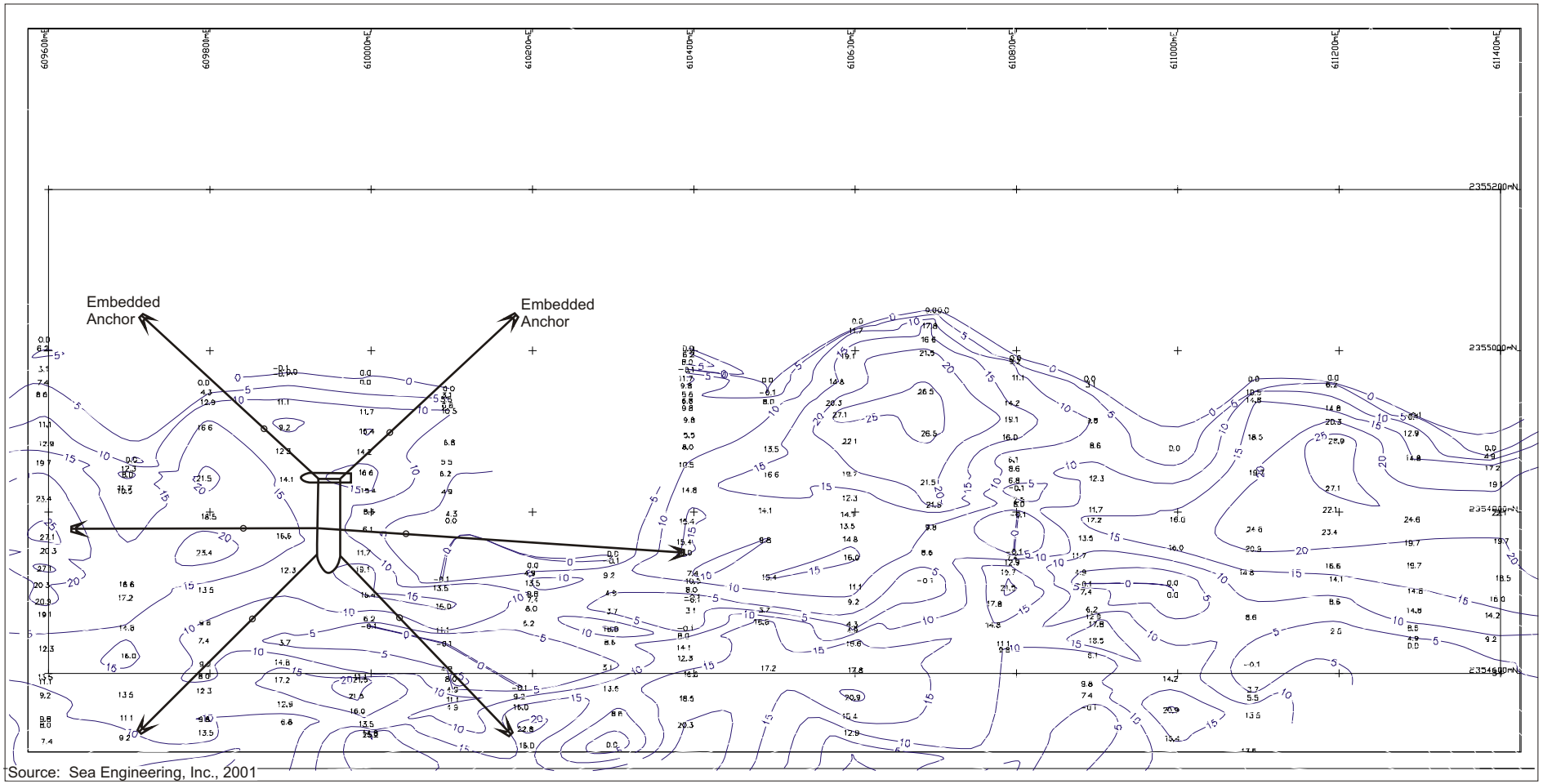
Seafloor materials are currently interpreted to be as follows:

Upper terrace—primarily limestone (old coral) overlain by a thin veneer of sand and coral rubble. The northeast corner of the study area is composed of high relief coral.

Escarpment—as above, the escarpment is primarily exposed coral and coral rubble.

Lower terrace—primarily sand and coral rubble with apparent greatest thickness near the midline of the cove areas, reaching greater than 25 feet (8 meters). The sand/coral rubble deposits thin rapidly toward the escarpment face and laterally toward the lobes, revealing exposed rock.

Lower slope—most of the slope is covered with a sand blanket that generally varies between 5 and 25 feet (2 and 8 meters).



Source: Sea Engineering, Inc., 2001

LEGEND-

—0— Lines of Equal Sediment Thickness (In Feet)

Isopach Map, Reef Runway Shallow-water Recovery Area

NORTH

Scale: 1:5,000

0 328 656 984 1312 Feet

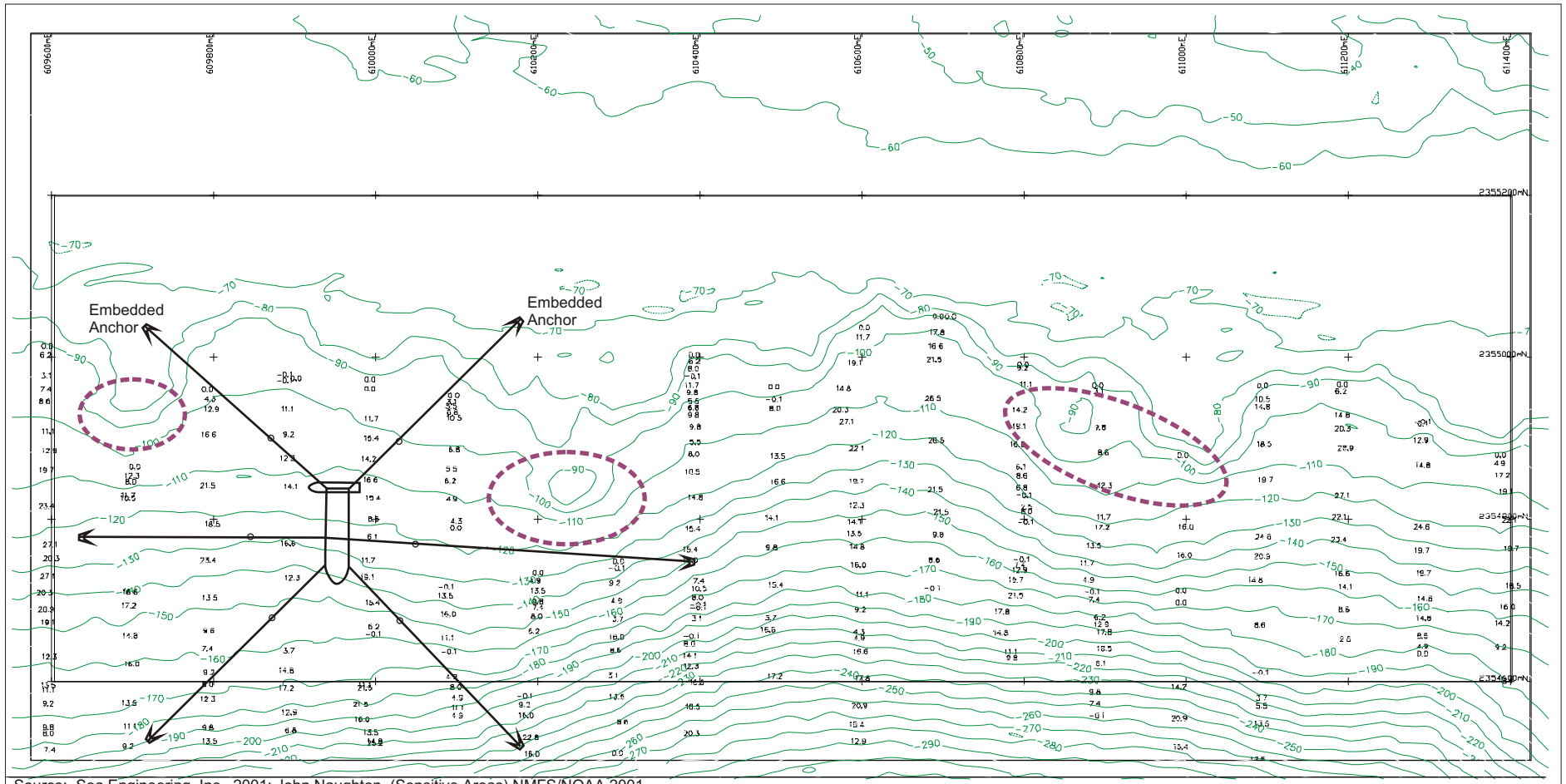
0 100 200 300 400 Meters

Figure E-5

E_5IsopackMap

Sensitive Habitat

Results of the video surveys performed at the Reef Runway shallow-water recovery area are discussed in detail in section 3.2.3 of the Environmental Assessment and in Appendix J, Marine Surveys, and are not repeated here. Figure E-6 is included to complete the suite of survey data collected to support the environmental analysis.



Source: Sea Engineering, Inc., 2001; John Naughton, (Sensitive Areas) NMFS/NOAA,2001

LEGEND-

—0— Lines of equal depth to seafloor (in feet)

High vertical relief with good coral growth and diverse and abundant reef fish associated with caves and layers

NORTH

Scale

0 328 656 984 1312 Feet

0 100 200 300 400 Meters

Seafloor Bathymetry and Sensitive Resources, Reef Runway Shallow-water Recovery Area

Figure E-6

E_6Sensitve Habitat

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