APPENDIX D
LOCATION ASSESSMENT

LOCATION ASSESSMENT

Study of Candidate Shallow-water Recovery Sites to Support Diving Operations for *Ehime Maru*

April 27, 2001

Prepared by: EDAW, Inc.
Prepared for: U.S. Army Space and Missile Defense Command
Huntsville, Alabama

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Purpose

This Location Assessment was conducted to quickly evaluate the site characteristics of five candidate shallow-water recovery sites, or berthing sites, selected by the Navy to perform recovery operations on *Ehime Maru*. This study supports the environmental assessment (EA) for the recovery operations and resulted in a recommendation as to which of the candidate shallow-water work sites should be advanced as the "preferred action" and "alternative sites" for inclusion in the EA.

The EA was prepared under an extremely compressed schedule in order to achieve the most favorable weather period (and sea state) for performing the recovery operation (July–October). Since time was of the essence and a suitable number of alternative sites had been identified by the Navy, it was deemed unnecessary to identify additional candidate sites. Instead, the location assessment concentrated solely on evaluating the comparative attributes of the Navy-picked candidate shallow-water recovery sites in order to support a ranking and decision.

Background

When the decision was made to attempt the recovery of *Ehime Maru*, Naval Sea Systems Command (NAVSEA) Supervisor of Salvage (SUPSALV), Mobile Diving and Salvage Unit One (MDSU-ONE), and Pacific Fleet (PACFLT) maintenance personnel developed a preliminary slate of sites that could potentially serve as shallow-water work sites for the recovery operations. The locations were selected based on their extensive knowledge of Hawaiian coastal waters and their understanding of the engineering requirements for the recovery operation. The early mission critical requirements of the shallow-water recovery sites included:

- An expanse of relatively flat seafloor at about 115 feet of sea water (FSW) (35 meters) (sufficient depth of water to clear the vessel, spreader beam, support barge and associated rigging)
- Favorable sea state (to minimize diver safety issues)
- A relocation transit corridor with minimal seafloor relief (to minimize the potential for seafloor collision while towing and to minimize adjustments to the lift rigging)
- Reasonable proximity to Navy support and emergency services

Based on professional judgment, the Navy identified five candidate shallow-water recovery sites as potentially suitable to achieve the recovery operations (figure D-1):

- Reef Runway—On the southern coast of Oahu at approximately the mid-point of the Reef Runway, Honolulu International Airport (21° 17.6′ N/ 157° 55.8′ W) (figure D-2)
- Ewa Beach—a site approximately 3.3 nautical miles (nm) (6 kilometers [km]) west–southwest from the mouth of Pearl Harbor, Oahu (21° 17.5′ N/ 158° 00.8′ W) (figure D-3)
- Waianae Coast—a site approximately 1 nm (91.8 km) northwest of Barber's Point Harbor, Oahu (21° 19.8′ N/ 158° 08.3′ W) (figure D-4)
- Penguin Bank—a shoal approximately 28 nm (51 km) southwest of Pearl Harbor, situated in the open channel west of Molokai (20° 53.5′ N/ 157° 45.0′ W) (figure D-5)
- SW Molokai—approximately 1.9 nm (3.5 km) east–southeast of Laau Pt., in the lee of Molokai (21° 05.0′ N/ 157° 17.0′ W) (figure D-6)

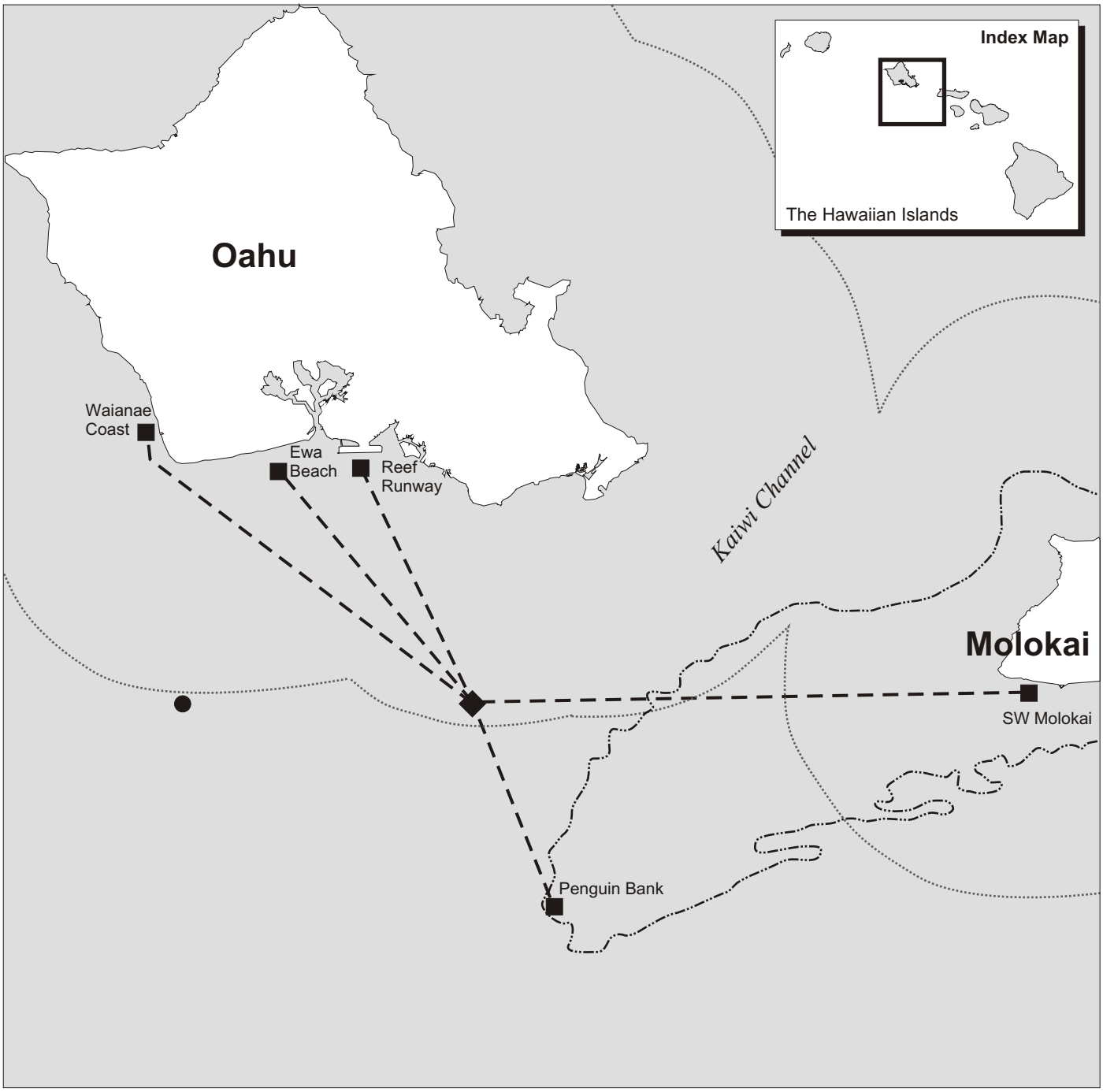
Referenced figures D-2 through D-6 are attached at the end of this report.

Findings

Based on the scoring methodology described later in this report, Reef Runway was clearly rated as the preferred site. The Reef Runway Site rated a weight-adjusted score of 3.88 (out of a possible 5.00). Reef Runway scored well based on the attributes of its transit corridor (direct with favorable seafloor profile); its historically disturbed environmental setting; proximity to Pearl Harbor (where the Navy can provide more responsive security, technical, and emergency services); and its position relative to tower controlled airspace of Honolulu International Airport, which ensures a high degree of enforcement of low-flying aircraft.

The next highest ranked alternatives were scored 2.96 and 2.86 for Ewa Beach and Waianae Coast, respectively. It is recommended that Ewa Beach and Waianae Coast be retained for further analysis. Ewa Beach shares many of the logistical attributes of Reef Runway in being close to Pearl Harbor; however, it rates slightly lower due to increased seafloor relief along the transit route, slightly rougher sea states, observed listed species, and close proximity to aquaculture farming. Attributes of Waianae Coast include the best seafloor conditions for stabilizing the vessel hull, enforceable airspace, and acceptable sea states for transit and recovery operations.

It is recommended that Southwest Molokai and Penguin Bank be dropped from further consideration. On the five-point scale, Southwest Molokai and Penguin Bank scored 2.27 and 2.25, respectively. Both Penguin Bank and Southwest Molokai are within the Hawaiian Islands National Humpback Whale Marine Sanctuary. In addition, the Penguin Bank seafloor is below the preferred depth for the recovery operation; plus, it is situated in



LEGEND

- Current Location
- Candidate Shallow-water Recovery Sites
- Deep-water Relocation Site
- Penguin Bank
- U.S. Territorial Waters
- Potential Transit Routes

NORTH

No Scale

Candidate Shallow-water Recovery Sites

Figure D-1

D1PotentialRecovery051601

the open channel, an area of extremely volatile sea state. Southwest Molokai was also considered unsuitable due to the dangerously shallow transit route the vessel would have to take across Penguin Bank, its relatively pristine environmental setting, and the difficulty of providing support and emergency services for a moderately long-term operation.

Study Approach

The study was conducted using a systematic approach:

- Program goals were developed in discussion with NAVSEA SUPSALV and PACFLT Maintenance management.
- Program goals were translated into workable objectives and technical criteria.
- Metrics were developed to support the criteria that were consistent and relevant to the evaluation.
- Interviews were conducted with knowledgeable civilian, military, contractor and agency personnel, and data was collected to support the criteria requirements.
- Criteria were applied in a systematic way in order to evaluate the relative opportunities and constraints of each candidate site.
- Weights and scores were developed to reflect the value of each criterion relative to the overall set.
- Sensitivity analyses were performed to evaluate the relative biases and effects of various weighting factors.
- Rank ordering of the shallow-water recovery sites was performed to support a recommendation for inclusion into the EA for further study.

Concurrent with, and closely following this study, field surveys were performed consisting of spot dives, controlled subsurface video transects, and detailed fathometric soundings done on three of the locations (Reef Runway, Ewa Beach, and Waianae Coast). Only individual dive reports (spot observations) were available at the time of this study.

Study Assumptions

Study Elements

The recovery operation is very complicated and encompasses many work stages described in detail in the EA Description of Proposed Action and Alternatives. This study addresses two aspects of the recovery:

1. The evaluation and selection of a shallow-water recovery site
2. The evaluation of transit routes from the current deep water position (accident site) to the shallow-water recovery sites (berth sites)

The deep-water relocation site was not a focus of this study because there were few, if any, discriminating factors that would support the distinction among alternative sites at this stage.

Study Area

Each shallow-water recovery site was initially defined as a 1,000-foot by 1,000-foot (300-meter by 300-meter) plot. The center point of the plot was the latitude/longitude coordinates provided by the Navy (listed above). The plot reflects a rough estimate of the size of the diving barge, plus the estimated spread of the mooring lines. There was some margin provided to allow for flexibility in adjusting the footprint of the vessel (191 feet by 30.5 feet [57.9 meters by 9.2 meters]) within the plot. A detailed mooring plan is provided in section 2.0 of the EA. At the time of the final report, the mooring footprint had grown to roughly twice the original dimensions.

Weather

The study was predicated on average meteorological conditions for the period July through October provided by the Navy's Meteorology and Oceanography Center in Pearl Harbor. Many factors in this study are tied to the "sea state," a seaman's term for the combination of swell and wind. During the summer months, Hawaiian weather is dominated by moderate trade wind flows. Trade wind flows occur 90% of the time producing average winds from the east-northeast at 10 to 15 knots (20 to 30 kilometers per hour) during July, August, and September and increase to 10 to 20 knots (20 to 40 kilometers per hour) during October. Average seas during this period are to the west–southwest at 3 to 6 feet (1 to 2 meters) during July, August, and September, and 4 to 7 feet (1.2 to 2.1 meters) during October. There was no information available on average sea states (categories) for this period; however, wind speeds and wave heights of this nature are correlative with sea states of 2 to 4. Local mariners familiar with weather conditions at each of the candidate shallow-water recovery sites provided a "seaman's eye" for input to the sea states at each of these sites.

Kona winds frequently occur during the winter, in the months of November through February. These winds are primarily from the south and have associated waves from the southeast and west with heights of 10 to 15 feet (3 to 5 meters). The implication of this change is that prevailing sea states can change dramatically, and accidental oil spills, which would normally flow offshore, could flow onshore and become problematic. The initial vessel lift and relocation to the shallow-water recovery site will be done only when there is a forecasted period of stable weather. The recovery operations would be subject to typical and atypical weather conditions.

Seafloor Conditions

Although the gross physical attributes of each site can be characterized by analyzing maps, literature, and interview data, detailed follow-on surveys must be performed in order to validate bottom sediments and profile, environmental conditions, and presence of critical seafloor structures, such as buried cables, fueling lines, sewers, etc. Seafloor profiling was scheduled along the transit routes to identify obstacles to vessel towing.

Evaluative Criteria

Development of Goals for the Location Assessment

Based on stated goals of NAVSEA and PACFLT management, the following goals and objectives were established for this study:

- Maximize dive team safety
  - Minimize operating risks to divers at shallow-water recovery sites
  - Maximize the probability of stabilizing the vessel
  - Minimize disruption to diver communications
  - Maximize emergency response capabilities

- Maximize probability for successful lift and relocation operations
  - Minimize transit risk
  - Maximize technical support to the recovery operations

- Maximize public health and safety
  - Minimize intrusions from inquiring public during recovery operations
  - Minimize the potential for public exposure to accidental releases

- Minimize environmental impacts
  - Minimize the potential for environmental effects due to accidental spills

Evaluative Criteria Application and Analysis

The following section describes the criteria and measures supporting each of the program goals and objectives mentioned above. Following each criterion, a short analysis is provided which describes the appropriate score.

Goal 1—Maximize Dive Team Safety

Objective: Minimize Operating Risks to Divers at Shallow-Water Recovery Site

Criterion: Prefer shallow-water recovery sites where prevailing wind and sea state is favorable to diving operations.

Rationale: Wave height and wind can complicate barge and diving operations, resulting in a higher accident incident rate.

Metric: Sea state charts from U.S. Navy Dive Manual, SS521-AG—PRO-010; January 1999.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following prevailing conditions as assessed by a seaman's eye:

Score 5—Sea state "0" (ripples with scales, but without foam crests); light air < 2 knots.

Score 4—Sea state "1" (small wavelets still short but more pronounced; crests have a glassy appearance but do not break); light breeze < 5 knots.

Score 3—Sea state "2" (large wavelets, crests begin to break; foam of glassy appearance, perhaps scattered whitecaps); gentle breeze <10 knots.

Score 2—Sea state "3" (small waves, becoming longer; fairly frequent whitecaps), moderate breeze 11 to 16 knots.

Score 1—Sea states "4" and greater (larger than moderate waves taking a more pronounced long form; many white caps are formed; chance of spray); fresh breeze to hurricane > 16 knots.

Analysis: Since site specific data were not available for each individual site, the following sea states were assessed based on the "seaman's eye" approach:

Reef Runway—Generally sea states 3, and on windy days, sea state 4; **Score 2**

Ewa Beach—Generally sea states 3 to 4; **Score 2**

Waianae Coast—Leeward coast of Barber's Point provides wind shadow; generally sea state 2; **Score 3**

Penguin Bank—Exposed to open channel; sea state 4 plus; **Score 1**

SW Molokai—Leeward coast of Molokai; generally sea states 2-3; **Score 3**

Objective: Maximize the Probability of Stabilizing the Vessel at the Shallow-Water Recovery Site

Criterion: Prefer shallow-water recovery sites with flat bottoms with sandy substrate of sufficient thickness to promote vessel embedment.

Rationale: Flat, sandy bottom conditions are preferred for stabilizing the vessel during recovery operations. A hard surface, uneven surface (local relief) or tilting surface gradient, may trigger the need for secondary support systems including sand bags, cradles or anchoring systems to ensure vessel stability. Mud bottoms are least preferred due to the amount of force necessary to overcome the mud suction following recovery operations.

Metric: Average seafloor gradients in percent (down slope from 72 FSW to 100 FSW) [22 to 30 meters]; local relief (surface features/perturbations, e.g., coral heads) in feet/ meters; and bottom sediment types (rock/coral, sand, or mud) as observed from preliminary dive observations.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

> ***Score 5***—Seafloor gradients < 3%; minimal local relief (< 1 ft) [0.3m]; and sand blanket of greater than 2 feet [0.6m].
>
> ***Score 4***—
>
> ***Score 3***—Seafloor gradients > 3 < 6%; moderate local relief (>1 < 3 feet) [> 0.3m < 1 meter]; sand blanket/veneer and/or rubble over exposed coral or rock.
>
> ***Score 2***—
>
> ***Score 1***—Seafloor gradients > 6%; significant relief (> 3 feet) [1 meter]; mud bottom.

Note: Intermediate scores (Scores 2 and 4) can be achieved by combinations of category attributes.

Analysis: Assessment made from initial dive reports and interpolation of bathymetric maps.

> **Reef Runway**—Seaward gradient is approximately 4 to 5%; an ancient shoreline escarpment bisects the site at approximately 70 to 85 feet (21 to 25.7 meters); gradients appear to get slightly steeper below the escarpment but bottom conditions get sandier; local relief generally ranges from 0 to 2 feet (0 to 0.6 meters); much of the site is covered with patches of sand (less than 6 inches) mixed with coral rubble over rock; **Score 3**
>
> **Ewa Beach**—Seaward gradient appears to range from approximately 4.6 to 8.4%; local relief is generally less than 1 foot (0.3 meters); hard sand with shells and silt; **Score 2**
>
> **Waianae Coast**—Seaward gradient is relatively flat at 1.3 to 2.0%; local relief appears to be generally less than 1 foot (0.3 meters), however, local coral in-shore increase relief at 2 to 3 feet (0.6-1 meters) in height. Extensive sand cover; **Score 4**
>
> **Penguin Bank**—Seafloor gradient roughly flat; local relief is predicted to be significant, with coral heads and general hard coral surface; **Score 1**
>
> **SW Molokai**—Seaward gradient appears mild at < 3%; local relief is unknown as are bottom sediments; **Score 3** (preliminary)

Criterion: Prefer shallow-water recovery sites where bottom currents are minimal.

Rationale: Bottom currents can increase the risk of diving operations by potentially destabilizing the vessel while at berth. In addition, stiff bottom currents force the diver to wear additional weights, forcing the diver to exert more energy and decreasing their ability to "off gas" nitrogen in the blood stream.

Metric: Bottom current velocities in knots from MK 21 Mod 1 General Characteristics; U.S. Navy Dive Manual, SS521-AG—PRO-010; January 1999

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5— < 1.0 knots

Score 4-

Score 3— > 1.0 < 1.5 knots

Score 2-

Score 1— > 1.5 knots

Analysis: Bottom currents are a significant factor, but not a discriminator based on scant site-specific data at this juncture.

Reef Runway—Navy dive reports of 0.5 to 1.0 knots; **Score 5**

Ewa Beach—Estimated currents (seaman's eye) of 0.5 to 1.0 knots; **Score 5**

Waianae Coast—Estimated currents (seaman's eye) of 0.5 to 1.0 knots; **Score 5**

Penguin Bank—Unmeasured. Estimated to be greater than nearshore counterparts; **Score 3**

SW Molokai—Estimated bottom currents of 0.5 to 1.0 knots; **Score 5**

Objective: Minimize Disruption to Diver Communications

Criterion: Prefer shallow-water recovery sites where airspace can be controlled from ground surface to a minimum of 2,000 feet (610 meters).

Rationale: Divers use a "coms box" to communicate with the support barge during recovery operations. Positive communication is essential to a safe operation of this magnitude and complexity. Low flying aircraft, in particular helicopters, generate significant levels of noise that have been proven to degrade diver communication under similar circumstances, thus significantly increasing the risk of an accident. Although temporary flight restrictions can

be established "to prevent unsafe congestion of sightseeing aircraft above an incident or event" (14 FAR Part 91.137(a)(3), it is often difficult for the Federal Aviation Administration (FAA) to enforce the restrictions in remote areas.

Metrics: Controlled airspace down to surface. Reference, meeting with FAA/DOT on April 20, 2001.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5—Pre-existing Class B (tower controlled) airspace—high enforcement potential

Score 4—Class D airspace—tower communication can be established

Score 3/2—Class C airspace; can establish temporary flight restrictions with high confidence of FAA enforcement

Score 1—Class G airspace; uncontrolled

Analysis: Based on established FAA airspace maps.

Reef Runway—Class B; within tower controlled airspace of Honolulu International Airport; **Score 5**

Ewa Beach—Class D airspace; **Score 4**

Waianae Coast—Class D airspace; **Score 4**

Penguin Bank—Class G airspace; **Score 1**

SW Molokai—Class G airspace; **Score 1**

Objective: Maximize Emergency Response Capability at Recovery Site

Criterion: Prefer shallow-water recovery sites that are in close proximity to emergency services.

Rationale: The diving barge has limited medical support capabilities. In the event of a life-threatening accident, the amount of time required to transfer a diver or barge worker to a hospital could be critical. Depending on the recovery site location, such transfer could be made by boat (direct from the barge to shore) or by medevac helicopter (round-trip). The Fleet Recompression Chamber (FTRC) is at MDSU-ONE facilities, Pearl Harbor.

Metric: Elapsed time to reach the FTRC. Critical decompression injuries can occur after 30 minutes.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5—Respond in < 15 minutes

Score 4-

Score 3— > 15 < 30 minutes

Score 2-

Score 1— > 30 minutes

Analysis:

Reef Runway—Boat can make FTRC at Pearl Harbor in < 15 minutes; **Score 5**

Ewa Beach—Boat can make FTRC at Pearl Harbor in < 15 minutes; **Score 5**

Waianae Coast—Will require transfer to shore and helicopter medevac, but can be achieved in less than 30 minutes; **Score 3**

Penguin Bank—Will require transfer to shore and round trip pick-up by medevac helicopter (> 30 minutes); **Score 1**

SW Molokai—Will require transfer to shore and round trip pick-up by medevac helicopter (> 30 minutes); **Score 1**

Goal 2—Maximize Probability of Successful Lift and Relocation Operations

Objective: Minimize Transit Risk to Shallow-Water Recovery Site

Criterion: Prefer shortest/most direct transit route to recovery site.

Rationale: Transit distance and course changes will increase the time in transit. The relocation operation will take place in a forecasted window of favorable weather. The longer the relocation period, the greater the probability of encountering negative changes in sea state.

Metric: Distance (nm) to candidate recovery sites.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5—<15 nm (27.3 km)

Score 4—15 to 17.9 nm (27.3 to 32.5 km)

Score 3—18 to 21.9 nm (32.5 to 39.8 km)

Score 2—22 to 25.9 nm (39.8 to 47.1 km)

Score 1—> 26 nm (47.1 km)

Analysis:

Reef Runway—14 nm (25.5 km) from current vessel location to recovery site. **Score 5**

Ewa Beach—17 nm (31 km); **Score 4**

Waianae Coast—23 nm (42 km); **Score 2**

Penguin Bank—12.3 nm (22.4 km); **Score 5**

SW Molokai—31 nm (56.4 km); **Score 1**

Criterion: Prefer Transit Routes where prevailing wind and sea state is favorable to successful relocation to recovery site.

Rationale: During transit, prevailing wind and sea conditions will have a significant influence on the rolling of the tow vessel and the dynamic loading of the rigging.

Metric: Sea state charts from U.S. Navy Dive Manual, SS521-AG—PRO-010; January 1999.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5—Transit route encounters following seas.

Score 4—

Score 3—Transit route encounters head seas.

Score 2—

Score 1—Transit route encounters beam seas.

Note: Intermediate scores (Scores 2 and 4) can be achieved by combinations of category attributes.

Analysis:

Reef Runway—Transit route is a beam sea; **Score 1**

Ewa Beach—Transit route is a beam sea; **Score 1**

Waianae Coast—Transit route is a following sea; **Score 5**

Penguin Bank—Transit route is a head sea; **Score 3**

SW Molokai—Transit route is a head sea; **Score 3**

Criterion: Prefer transit routes with uniform ascending seafloor gradients (i.e., minimal local relief) to recovery site.

Rationale: Towing the vessel near the seafloor (15 to 100 feet) [5 to 30 meters] provides for more favorable (stable) currents relative to the upper end of the water column. The marginal seafloor clearance also enhances the ability to set the vessel down, and later recover it, in the event of an equipment failure. The uniformity of the seafloor (lack of rapid changes in seafloor relief) improves the ability to control the tow clearance, minimizing the risk of collision. Uniform seafloor gradients minimize the use of winches in adjusting for significant changes in relief, further reducing the risk of single-point equipment failure.

Metric: Seafloor profile along projected direct transit routes to each recovery site (National Oceanic and Atmospheric Administration, 2001b). Assumes some flexibility in routing adjustments to avoid major seafloor discontinuities (reference figures D-7 and D-8 at the end of this appendix).

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5—Uniform and relatively gradual regional (monoclinal) gradient/little local relief

Score 4-

Score 3—Abrupt/steep regional gradient; significant changes in local seafloor relief

Score 2-

Score 1—Abrupt/steep regional gradient; major seafloor discontinuities

Note: Intermediate scores (Scores 2 and 4) can be achieved by combinations of category attributes.

Analysis: Based on preliminary profiles developed from small-scale bathymetric maps.

Reef Runway—Relatively consistent regional gradient ascending rapidly toward the shallow-water recovery location. No significant local relief discernable at coarse map scales; detailed route surveys pending; **Score 5**

Ewa Beach—Favorable regional gradient with several minor negative corrections of 33 to 49 feet (10 to 15 meters); **Score 3**

Waianae Coast—Regional gradient has several significant negative corrections of approximately 120 to 197 feet (40 and 60 meters); **Score 2**

Penguin Bank—Radically steep initial ascent to Penguin Bank; **Score 2**

SW Molokai—Steep initial ascent (approximately 1,500 feet [455 meters] over a couple of nm). Approximately 70% of the route transects Penguin Bank at shallow depths of 24 to 27 fathoms (144 to 162 feet [44 to 49 meters]). High collision potential, plus shallow margins between vessel and critical coral habitat; **Score 1**

Objective: Maximize Technical Support to the Recovery Operation

Criterion: Prefer shallow-water recovery sites in close proximity to Navy Emergency Ship Salvage Material (ESSM) and MDSU-ONE support services

Rationale: Lessens response time (improves efficiency) for unanticipated load-out and support needs.

Metric: Boat response times from Navy ESSM and MDSU-ONE facilities, Pearl Harbor, to dive barge operations.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5— < 15 minutes

Score 4— > 15 < 30 minutes

Score 3— > 30 minutes < 1 hour

Score 2— > 1 hour < 2 hours

Score 1— > 2 hours

Analysis: Estimated response times based on distance.

Reef Runway—3.5 nm (6.4 km) from ESSM (less than 15 minutes); **Score 5**

Ewa Beach—5.3 nm (9.6 km) from ESSM (between 15 and 30 minutes); **Score 4**

Waianae Coast—15 nm (27.3 km) from ESSM (between 30 minutes and 1 hour); **Score 3**

Penguin Bank—30 nm (54.6 km) from ESSM (between 1-2 hours); **Score 2**

SW Molokai—43 nm (78.2 km) from ESSM (> 2 hours); **Score 1**

Goal 3—Maximize Public Health and Safety

Objective: Minimize Intrusions from Inquiring Public During Recovery Operations

Criterion: Prefer shallow-water recovery sites where a 1-mile (1.6-kilometer) surface security buffer can be enforced by Navy safety craft

Rationale: The diving operation is likely to generate intense interest and curiosity from the public. The fact that the recovery operations will be close to shore and visually observable will encourage small boats to intrude upon the operation. The ability to establish and control a 1 nm (1.9-km) stand-off perimeter around the recovery operations will be essential to protect the safety of both the general public and divers.

Metric: Type of support required from MDSU-ONE. Of particular note, Navy craft that would be sent to support shallow-recovery sites on southern Oahu are of smaller size and faster, than support vessels that would be used to navigate the open channel. The larger ships would be obtained from another command and would require considerable logistical support.

Range: Candidate sites were scored 5 (high) or 1 (low) based on the following performance guidelines:

Score 5—Line of site monitoring from Pearl Harbor tower of Naval Defense Sea Area; small patrol craft dispensed on-demand.

Score 1—Continuous patrols by large craft required 24/7

Analysis:

Reef Runway—Site can be monitored from the Pearl Harbor tower in the Naval Defense Sea Area. Small patrol craft can be dispatched on demand; **Score 5**

Ewa Beach—Must be secured by large patrol craft, 24/7; **Score 1**

Waianae Coast—Must be secured by large patrol craft, 24/7; **Score 1**

Penguin Bank—Must be secured by large patrol craft, 24/7; **Score 1**

SW Molokai—Must be secured by large patrol craft, 24/7; **Score 1**

Objective—Minimize the Potential for Public Exposure to Accidental Releases

Criterion: Prefer shallow-water recovery sites that are not near public and high-use recreational beaches

Rationale: Beaches are one of Hawaii's most important assets enjoyed daily by large numbers of the public. An accidental spill at a recovery site could potentially deposit oily waste on a public beach, or create an oil slick directly offshore that would inhibit recreational activity. There is also a nuisance

factor that could include secondary concerns related to odors, or the closure of the beach during clean-up.

Metric: Distance (nm) to public beaches; prevailing winds and currents

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

> ***Score 5***—Prevailing winds/currents are off-shore; nearest recreational beach > 3 nm (5.5 km)
>
> ***Score 4***—
>
> ***Score 3***—Prevailing winds/currents project near-shore; nearest recreational beach > 1nm < 3 nm (1.8–5.5 km)
>
> ***Score 2***—
>
> ***Score 1***—Prevailing winds/currents project toward shore. Site is adjacent to a high use public beach

Note: Intermediate scores (Scores 2 and 4) can be achieved by combinations of category attributes.

Analysis:

> **Reef Runway**—Ewa Beach is approximately 3.8 nm (7 km) to the west; Sand Island State Park is about 2.6 nm (4.75 km) to the east; recreational boating at Kalihi Channel, 1.75 nm (3.2 km) to the east. Inside the Naval Defense Sea Area, civilian boats are not allowed; prevailing winds are favorable; **Score 5**
>
> **Ewa Beach**—Ewa Beach Park, about 1.6 nm (3 km) to the northeast, is a typical public beach park with some offshore fishing and diving. Oneula Beach Park is about 1.1 nm (2 km) due north; prevailing winds are favorable; **Score 3**
>
> **Waianae Coast**—The Waianae Coast area has a lot of coastal nearshore activity. Ko Olina Beach Park is 0.8 nm (1.6 km) southeast; Makiawa Beach Park is 1.1 nm (2 km) feet north—northeast; Kahe Point Beach Park is 1.4 nm (2.5 km) north (snorkeling area); Barber's Point Harbor is 1 nm (1.8 km) southeast; Nanakuli Beach is 2.6 nm (4.6 km) due north. Prevailing winds off-shore; **Score 2**
>
> **Penguin Bank—No local beaches; Score 5**
>
> **SW Molokai**—Holeono Point is 1.8 nm (3.3 km) to the east (harbor and airport); Laau Point is 1.9 nm (3.5 km) to the northwest. Not a high use beach but has beach activities including surfing and fishing; **Score 4**

Criterion: Prefer shallow-water recovery sites in close proximity to emergency spill response teams

Rationale: The ability to control accidental spill releases is primarily a function of response time.

Metrics: Distance (nm) to ESSM and/or private remediation cooperatives.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5— < 10 nm (18.2 km)

Score 4— > 10<20 nm (18.2 to 36.4 km)

Score 3— > 20<30 nm (36.4 to 54.5 km)

Score 2— > 30<40 nm (54.5 to 72.7 km)

Score 1— > 40 nm (72.7 km)

Analysis:

Reef Runway—3.5 nm (6.4 km) to ESSM; **Score 5**

Ewa Beach—5.3 nm (9.6 km) to ESSM; **Score 5**

Waianae Coast—15 nm (27.3 km) to ESSM; **Score 4**

Penguin Bank—30 nm (54.5 km) to ESSM; **Score 2**

SW Molokai—43 nm to ESSM; **Score 1**

Criterion: Prefer shallow-water recovery sites that are not near aquaculture farms or highly used commercial/recreational fishing areas.

Rationale: Reduce the risk of impeding access to commercial or highly used recreational fishing areas. Reduce the potential for impacting such areas in the event of accidental release.

Metric: Distance (nm) to known aquaculture/nearshore fishing areas. Prevailing wind directions are factored in.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5—Nearest commercial/high-use fishing area > 3nm (5.5 km)

Score 4—

Score 3—Nearest commercial/high-use fishing area > 1 nm < 3nm (1.8 to 5.5 km)

Score 2-

Score 1—Site is < 1 nm (1.8 km) to a commercial/high-use fishing area

Note: Intermediate scores (Scores 2 and 4) can be achieved by combinations of category attributes.

Analysis:

Reef Runway—Existing aquaculture farm 0.75 nm (1.4 km) northeast on the inside of the reef along the east and south edge of the runway (0.5 fathoms); aquaculture site 1.85 nm (3.4 km) east of the site at the mouth of Kahili Channel; some activity south of Reef Runway in the nearshore waters including sport diving, shell collecting trolling and bottom fishing (Marine Atlas of the Hawaiian Islands). Gill netting off the east end of Reef Runway. Prevailing winds are favorable; **Score 4**

Ewa Beach—Leased aquaculture site is 0.8 nm (1.5 km) southeast of the site; existing scientific aquaculture site at unknown distance to the east (Telecon with NMFS/ State Dept of Fisheries); fish haven is 0.65 nm (1.2 km) southwest of site. Shore fishing at Ewa Beach which includes poll and line fishing, crabbing, gill netting, lobster fishing, and bottom fishing in off-shore (plus 30 feet [9 meters]); **Score 2**

Waianae Coast—North of harbor is shore fishing; bottom fishing at the harbor mouth and off beaches; spear fishing, commercial lobster (greater depths and rock substrates). Less than 1 nm (1.8 km) to the harbor mouth. Prevailing winds favorable; **Score 2**

Penguin Bank—Some diving. No known aquaculture farms; **Score 5**

SW Molokai—Trolling and bottom fishing in area; throw netting and pole/line fishing from the shore. Not heavily fished; **Score 5**

Goal 4—Minimize Environmental Impacts

Objective: Minimize the Potential for Environmental Affect Due to Accidental Spills

Criterion: Prefer shallow-water recovery sites that are not near to marine sanctuaries/refuges, coral reefs, listed species and critical habitat.

Rationale: Hawaiian coastal waters constitute a delicate ecosystem for numerous marine and terrestrial species of flora and fauna. Many species and habitats are protected by law. It is preferred that shallow-water berths fall outside of Federal/State managed waters.

Metrics: Known State and Federal environmentally managed lands, waters, species, and habitats as identified above.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5—No listed species or critical habitat in the near vicinity.

Score 4—

Score 3—No listed species or critical habitat in the recovery site footprint.

Score 2—

Score 1—Site is in existing sanctuary/refuge/reserve; listed species/ habitat prevalent.

Analysis:

Reef Runway—not in a sanctuary or reserve; no listed species observed; small patches of sea grass inside northeast corner; productive coral only in shallow water. No sea turtles observed; **Score 4**

Ewa Beach—green sea turtles prevalent; productive coral in shallower depths and patches of sea grass; **Score 2**

Waianae Coast—listed species; green sea turtles (however, probably do not feed off sandy bottom) and whales off-shore. Not a sanctuary or refuge; **Score 2**

Penguin Bank—Located in the Humpback whale sanctuary; healthy coral beds; other mammals under the Marine Mammal Protection Act; **Score 1**

SW Molokai—Located in the Humpback whale sanctuary; green sea turtles habitat, variety of shore birds; other mammals under the Marine Mammal Protection Act; **Score 1**

Criterion: Prefer shallow-water recovery sites that are not adjacent to environmentally sensitive shoreline types.

Rationale: Certain shoreline types (i.e., rock, beach, mudflat, etc.), are considered to be differentially sensitive to the effects of oil spills due to the nature of the shoreline materials, and the types and diversity of flora and fauna that live in the habitat. Environmental Sensitivity Index Maps are used by the Coast Guard as a way to characterize the potential vulnerability of such coastline features to accidental spills and the ability to clean it up. In some cases, there can be multiple shoreline categories.

Metrics: Sensitive shoreline types (Coast Guard Meeting, 4/18/01). NOAA models for a design spill to be factored in.

Range: Candidate sites were scored from 5 (high) to 1 (low) based on the following performance guidelines:

Score 5—Shoreline sensitivity index is 1–2 (exposed rocky shores and seawalls; exposed wave-cut platforms and exposed piers)

Score 4—Shoreline sensitivity index is 3–4 (fine-grained sand beaches; medium to coarse-grained beaches)

Score 3—Shoreline sensitivity index is 5–6 (mixed sand and gravel beaches; gravel beaches and exposed rip-rap)

Score 2—Shoreline sensitivity index is 7–8 (exposed tidal flats; sheltered rocky shores and coastal structures)

Score 1—Shoreline sensitivity index is 9–10 (sheltered tidal flats; wetlands)

Analysis:

Reef Runway—Shoreline sensitivity of 7; **Score 2**

Ewa Beach—Mixed coastline index; **Score 4**

Waianae Coast—Shoreline sensitivity of 4; **Score 4**

Penguin Bank—Not proximal to shore. **Score 5**

SW Molokai—Shoreline sensitivity of 4; **Score 4**

Weights

The raw scores, as defined in the tables in the previous section, were weighted in order to better reflect their true contribution to the overall performance of the mission. The weights were developed in discussion with NAVSEA and PACFLT managers and reflected the emphasis Navy decision makers placed on both the program goals and the individual criteria supporting those goals.

Program Goals

Diver safety was determined to be the number one consideration in the operation, closely followed by the success of the mission, and then public health and safety and the environment. The weight allocation broke down as follows:

Goal 1—Diver Safety—35%

Goal 2—Mission Success-25%

Goal 3—Public Health & Safety-20%

Goal 4—Environmental Sensitivity-20%

Criteria Weights

Within each goal area, supporting criteria were further weighted to reflect the value that each had on the overall goal. The breakdown, also shown on table 1, are as follows:

Goal 1—Diver Safety

- Recovery sites with favorable sea states—25%
- Recovery sites with flat/sandy bottoms—30%
- Recovery sites with minimal bottom currents—15%
- Recovery sites with controlled airspace—10%
- Recovery sites close to emergency services—20%

Goal 2—Mission Success

- Transit routes which are direct/short—25%
- Transit routes with best sea states—30%
- Transit routes with favorable seafloors—30%
- Recovery sites in proximity to technical services—15%

Goal 3—Public Health and Safety

- Recovery site proximity to Navy security—25%
- Recover site proximity to public beaches—25%
- Recovery site proximity to spill response—25%
- Recovery site proximity to aquaculture farms—25%

Goal 4—Environmental Sensitivity

- Recovery site proximity to marine sanctuaries—75%
- Recovery site proximity to sensitive coastline—25%

Scoring

Each candidate shallow-water recovery location was scored using the scoring ranges defined for each criterion defined in the Evaluative Criteria section. On the basis of raw scores, the highest to lowest rated shallow-water recovery locations were:

- Reef Runway 61
- Ewa Beach 47
- Waianae Coast 46
- Penguin Bank 38
- SW Molokai 35

The scoring was re-evaluated using the weighting factors. The weight adjusted scores were developed by simply multiplying the individual raw scores for each criterion times the criteria weight and then times the goal weight. Instead of a whole number, this leaves a fractional product. A perfect score (highest rated in each category) would provide a cumulative score for all four goals of just 5. The weight adjusted scores resulted in a modified rank order as follows:

- Reef Runway—3.88
- Ewa Beach—2.96
- Waianae Coast—2.86
- Penguin Bank—2.27
- SW Molokai—2.25

Various sensitivity analyses were run to determine the possible effect of biasing the outcome from extraordinary weighting of each goal relative to the others. Within a reasonable realm of weighting, the scores were relatively stable and the ranking was unchanged.

Reef Runway was the highest rated site for each of the program goals. Based on the cumulative scores, it was recommended that Reef Runway be carried forward in the EA as the preferred location, and that Ewa Beach and Waianae Coast also be carried forward for further detailed analyses. It is the recommendation of this study that SW Molokai and Penguin Bank be dropped from further consideration in the EA. The attributes underpinning these conclusions are summarized near the front of this report under "Findings."

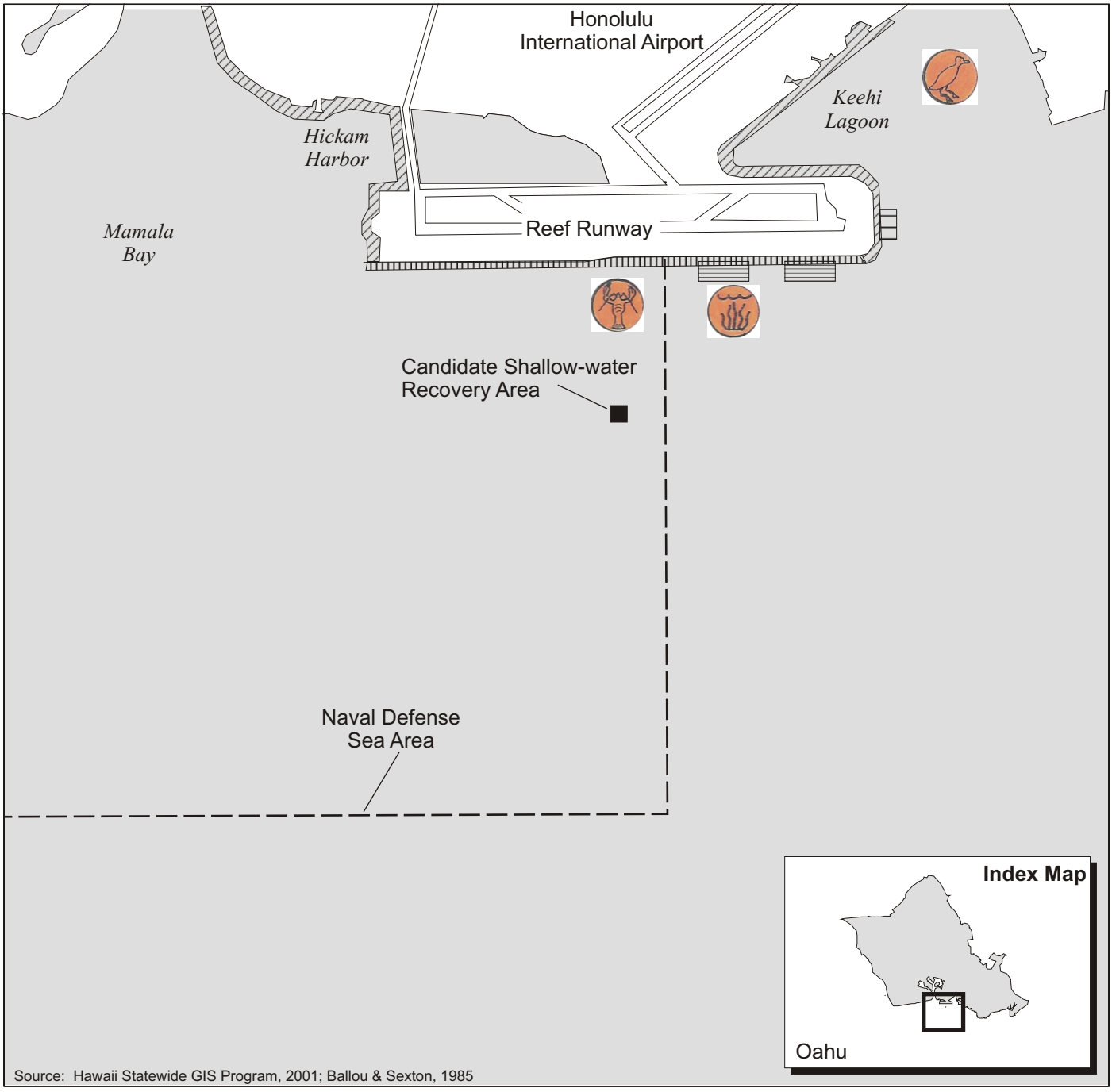
Table 1: Shallow-water Recovery Site Weights and Scores

Goal 1- Diver Safety Goal Weight-	35%	Reef Runway		Ewa Beach		Waianae Coast		Penguin Bank		Southwest Molokai	
Recovery sites with favorable sea states	25%	2	0.5	2	0.50	3	0.75	1	0.25	3	0.75
Recovery sites with flat/ sandy seafloors	30%	3	0.90	2	0.60	4	1.20	1	0.30	3	0.90
Recovery sites with minimal bottom currents	15%	5	0.75	5	0.75	5	0.75	3	0.45	5	0.75
Recovery sites with controlled airspace	10%	5	0.50	4	0.40	4	0.40	1	0.10	1	0.10
Recovery sites close to emergency services	20%	5	1.00	5	1.00	3	0.60	1	0.20	1	0.20
Raw Score		20		18		19		7		13	
Weighted			3.65		3.25		3.70		1.30		2.70
Goal Adjusted Score			1.28		1.14		1.30		0.46		0.95

Goal 2- Mission Success Goal Weight-	25%	Reef Runway		Ewa Beach		Waianae Coast		Penguin Bank		Southwest Molokai	
Transit routes which are direct/short	25%	5	1.25	4	1.00	2	0.5	5	1.25	1	0.25
Transit routes with best sea states	30%	1	0.30	1	0.90	5	0.90	3	0.90	3	0.90
Transit routes with favorable seafloors	30%	5	1.50	3	0.60	2	0.60	2	0.60	1	0.30
Recovery sites in proximity to tech services	15%	5	0.75	4	0.60	3	0.45	2	0.3	1	0.15
Raw Score		16		12		12		12		6	
Weighted			3.80		3.10		2.45		3.05		1.60
Goal Adjusted Score			0.95		0.78		0.613		0.763		0.4

Goal 3- Public Health & Safety Goal Weight-	20%	Reef Runway		Ewa Beach		Waianae Coast		Penguin Bank		Southwest Molokai	
Recovery site proximity to Navy security	25%	5	1.25	1	0.25	1	0.25	1	0.25	1	0.25
Recovery site proximity to public beaches	25%	5	1.25	3	0.75	2	0.50	5	1.25	4	1.00
Recovery site proximity to spill response	25%	5	1.25	5	1.25	4	1.00	2	0.50	1	0.25
Recovery site proximity to aquaculture farms	25%	4	1.00	2	0.50	2	0.50	5	1.25	5	1.25
Raw Score		19		11		9		13		11	
Weighted			4.75		2.75		2.25		3.25		2.75
Goal Adjusted Score			0.95		0.55		0.45		0.65		0.55

Goal 4- Environmental Sensitivity Goal Weight-	20%	Reef Runway		Ewa Beach		Waianae Coast		Penguin Bank		Southwest Molokai	
Recovery site proximity to marine sancturaries/ listed species	75%	4	3.00	2	1.50	2	1.50	1	0.75	1	0.75
Recovery site proximity to environmentally sensitive coastline	25%	2	0.50	4	1.00	4	1.00	5	1.25	4	1
Raw Score		6		6		6		6		5	
Weighted			3.50		2.50		2.50		2.00		1.75
Goal Adjusted Score			0.70		0.50		0.50		0.40		0.35
Total Score			3.88		2.96		2.86		2.27		2.25



LEGEND

- Boulder Beaches and Riprap Structures
- Exposed Tidal/Reef Flats
- Sheltered Rocky Shores/Harbor Structures
- Candidate Shallow-water Site

WILDLIFE

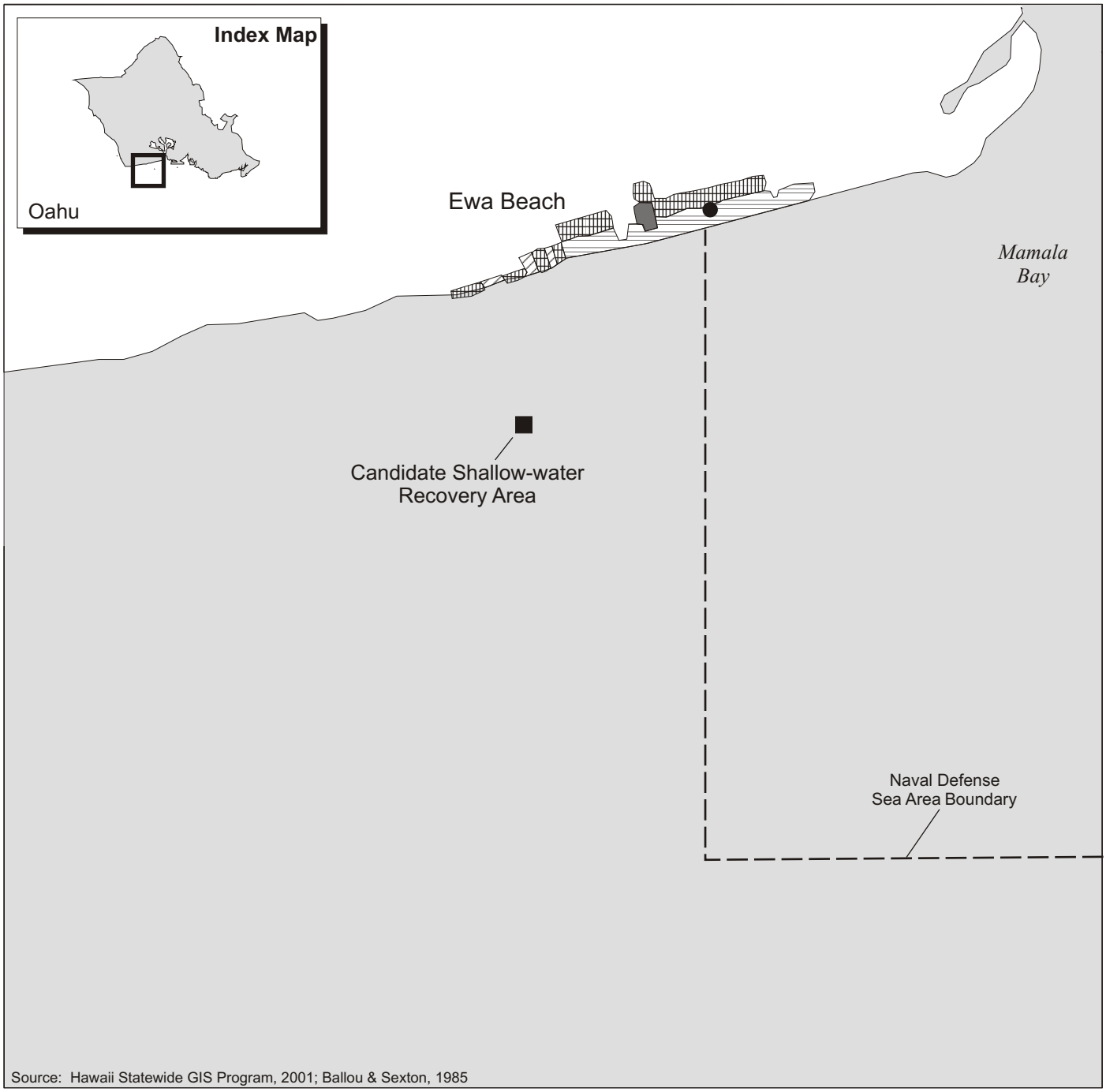
- Seagrasses
- Lobster
- Pelagic Bird

Reef Runway Site

NORTH

No Scale

Figure D-2



LEGEND

- Coarse-grained Sand Beaches
- Exposed Rocky Shore and Seacliffs
- Boulder Beaches and Riprap Structures
- Exposed Wave-cut Platforms
- Candidate Shallow-water Site

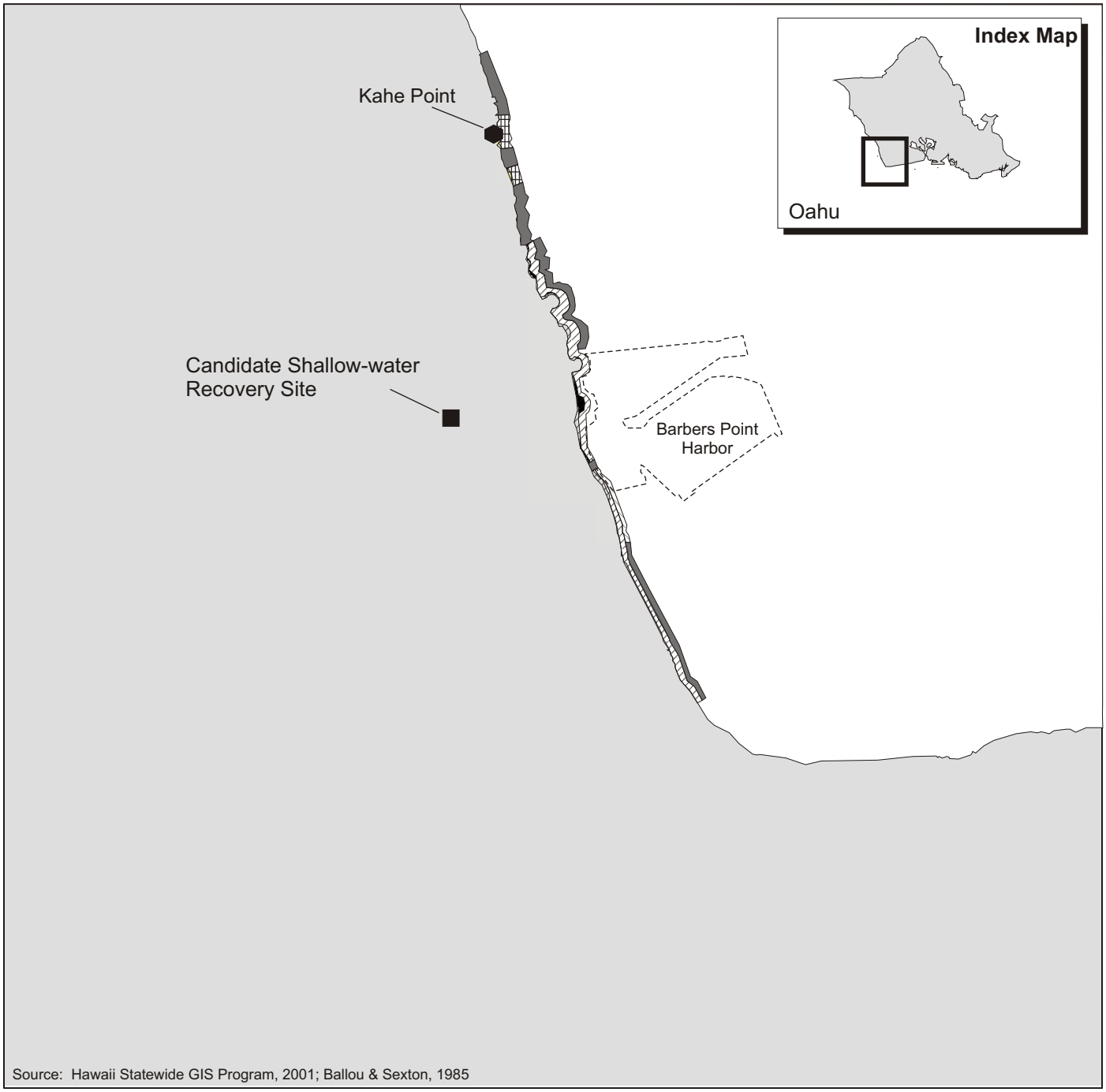
Ewa Beach Site

NORTH

No Scale

Figure D-3

d3EwaBeach



LEGEND

- Boulder Beaches and Riprap Structures
- Exposed Rocky Shore and Seacliffs
- Exposed Wave-cut Platforms
- Coarse-grained Sand Beaches
- Sheltered Rocky Shores / Harbor Structures
- Candidate Shallow-water Site

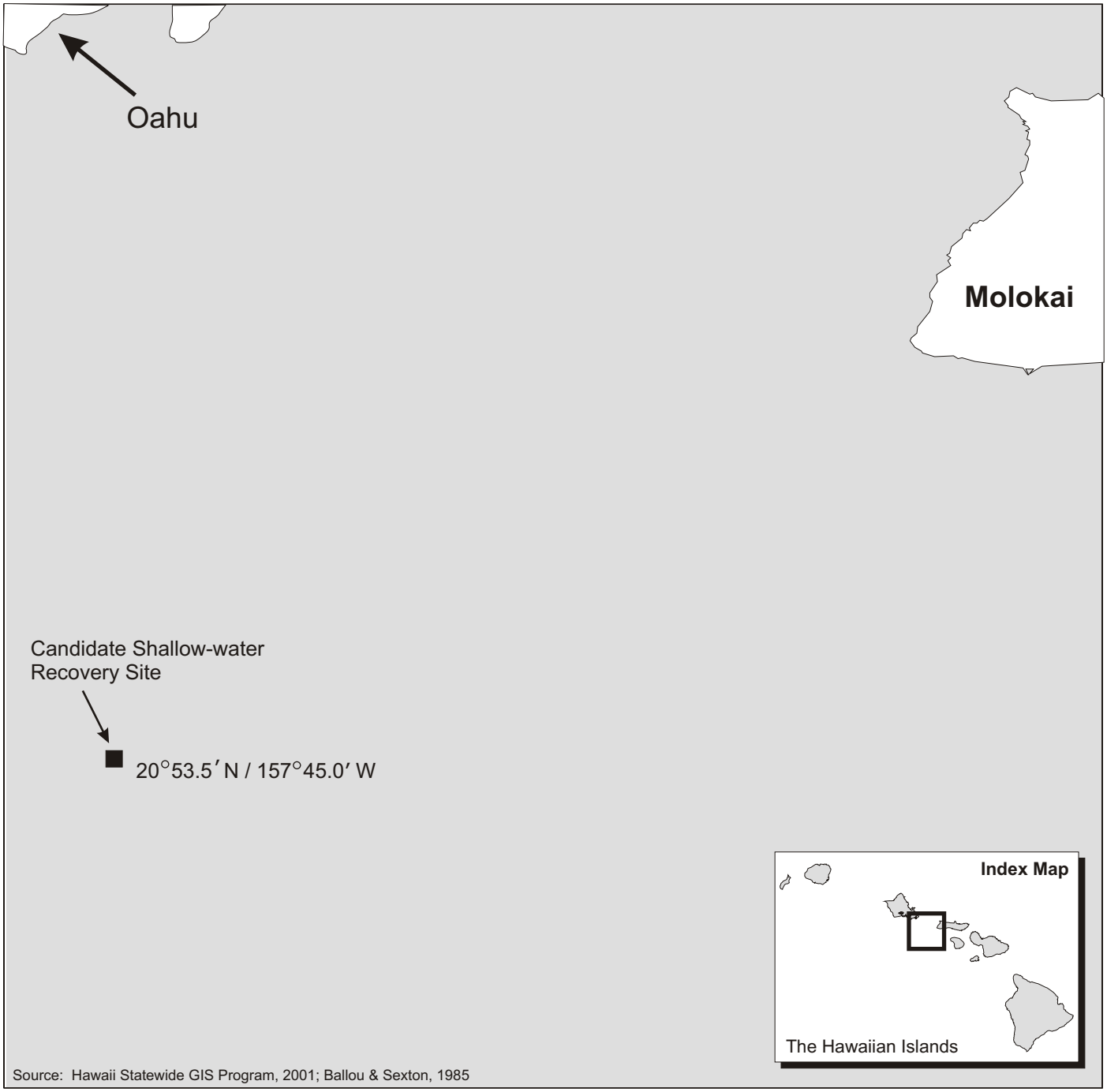
Waianae Coast Site

NORTH

No Scale

Figure D-4

d4WaianaeCoast



LEGEND

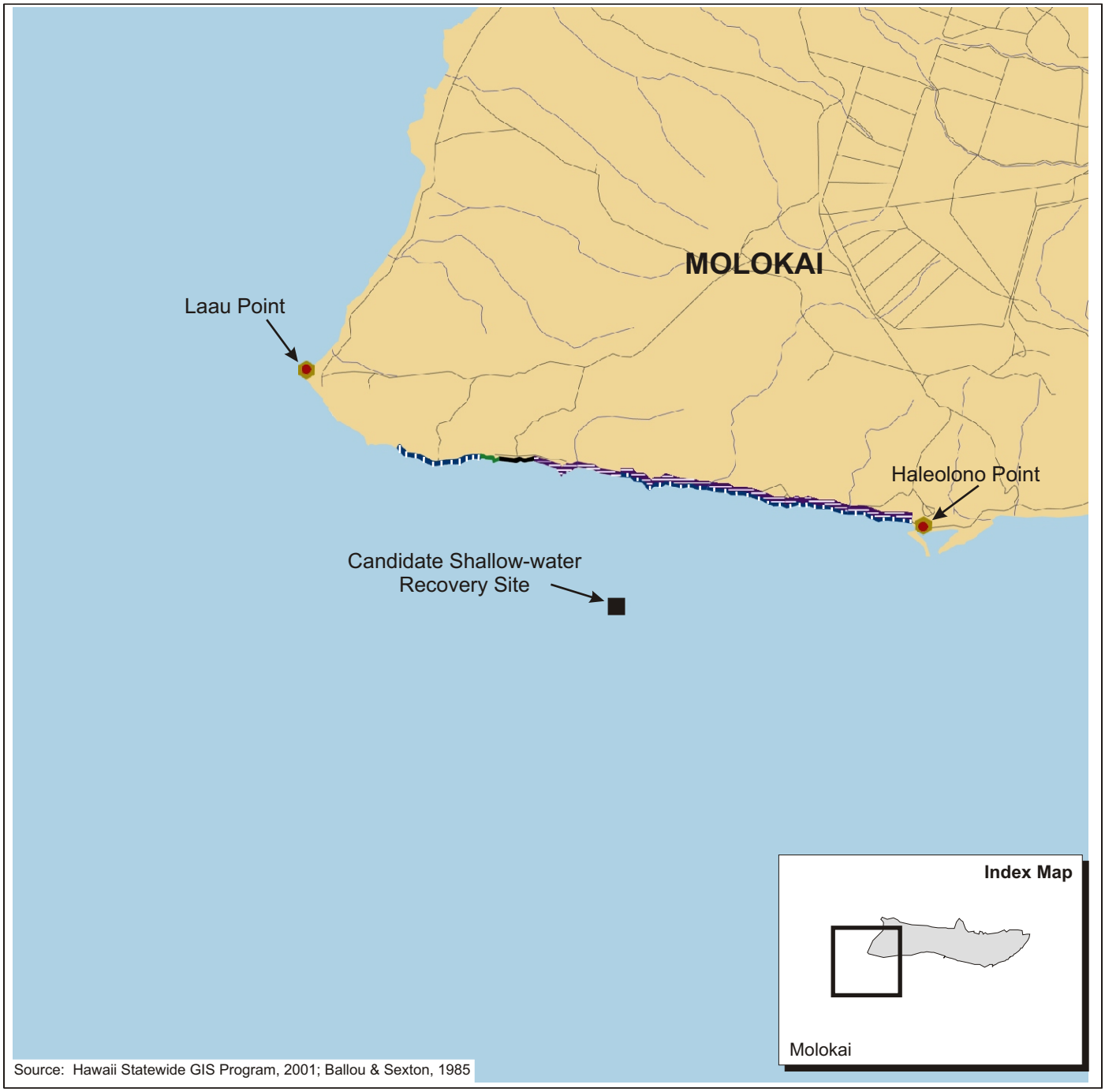
■ Candidate Shallow-water Recovery Site

Penguin Bank Site

NORTH

No Scale

Figure D-5



LEGEND

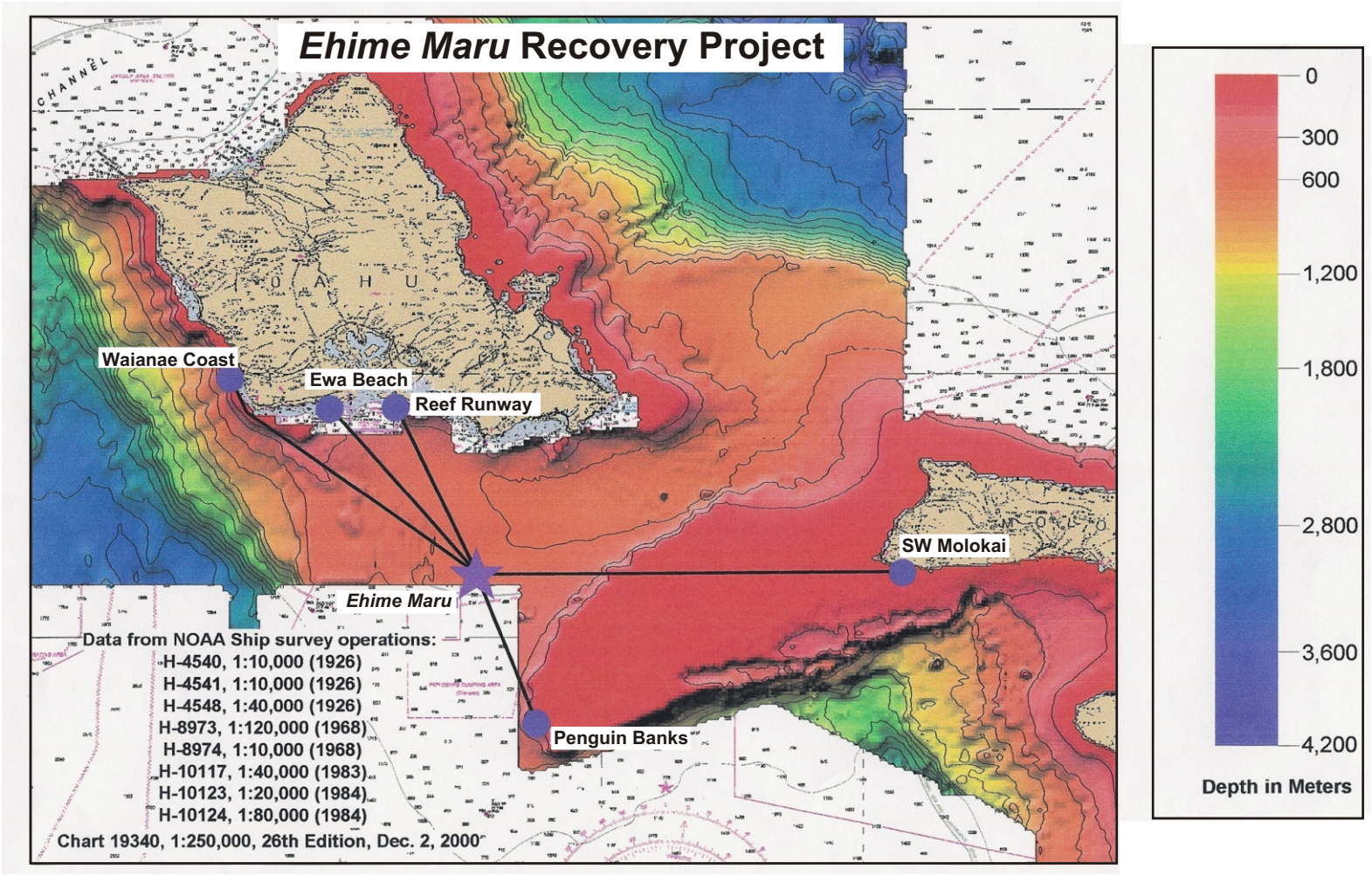
- Candidate Shallow-water Recovery Site
- Landmarks
- Boulder Beaches and Riprap Structures
- Fine-grained sand beaches
- Coarse-grained Sand Beaches
- Exposed Wave-cut platforms

SW Molokai

NORTH

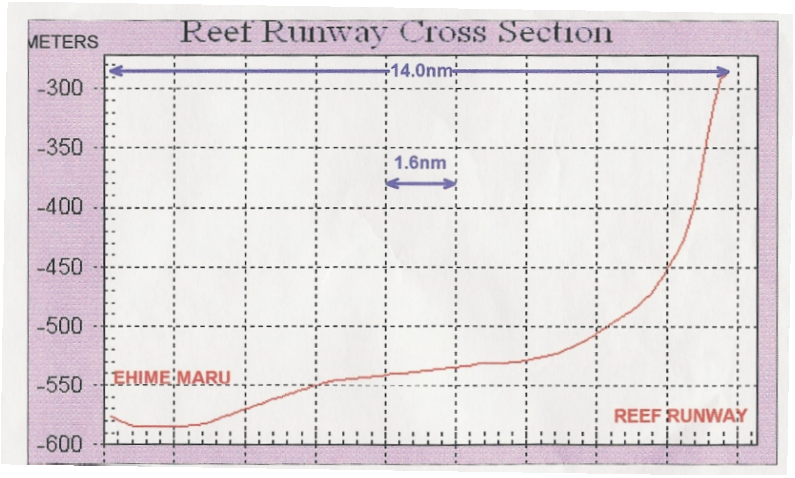
No Scale

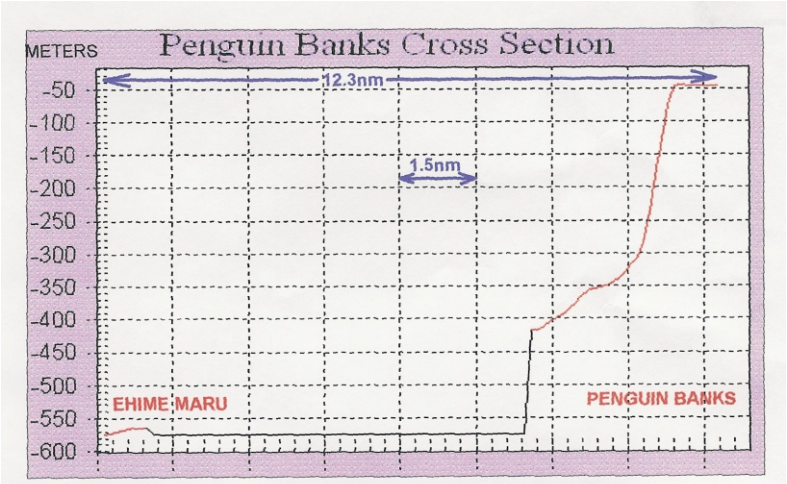
Figure D-6

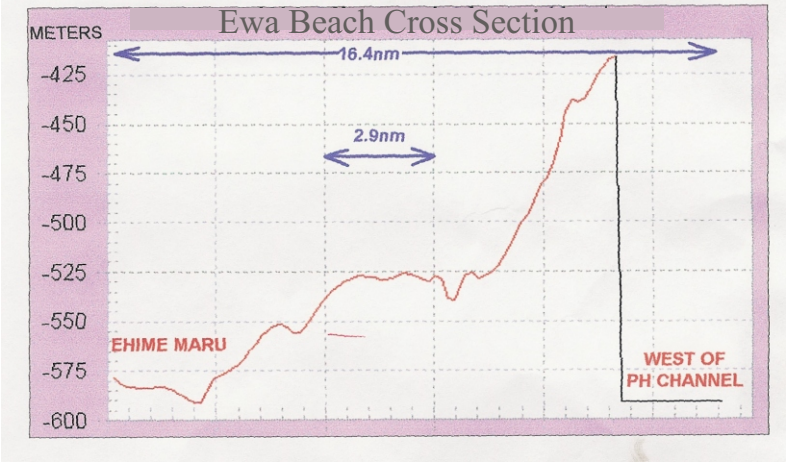


Regional Bathymetry, Map (NOAA)

Figure D-7



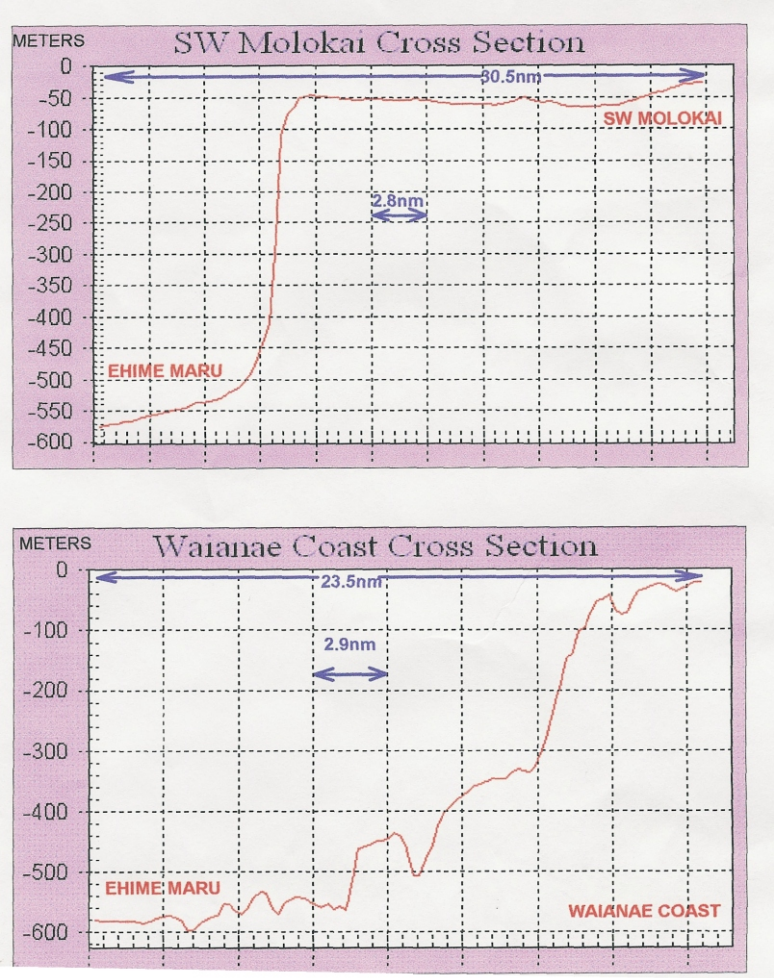




Source: National Oceanic and Atmospheric Administration, 2001a; Office of Coast Survey, Pacific Hydrographic Branch, 2001

Transit Route Profiles (Page 1 of 2)

Figure D-8



Source: National Oceanic and Atmospheric Administration, 2001a; Office of Coast Survey, Pacific Hydrographic Branch, 2001

Transit Route Profiles (Page 2 of 2)

Figure D-8

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