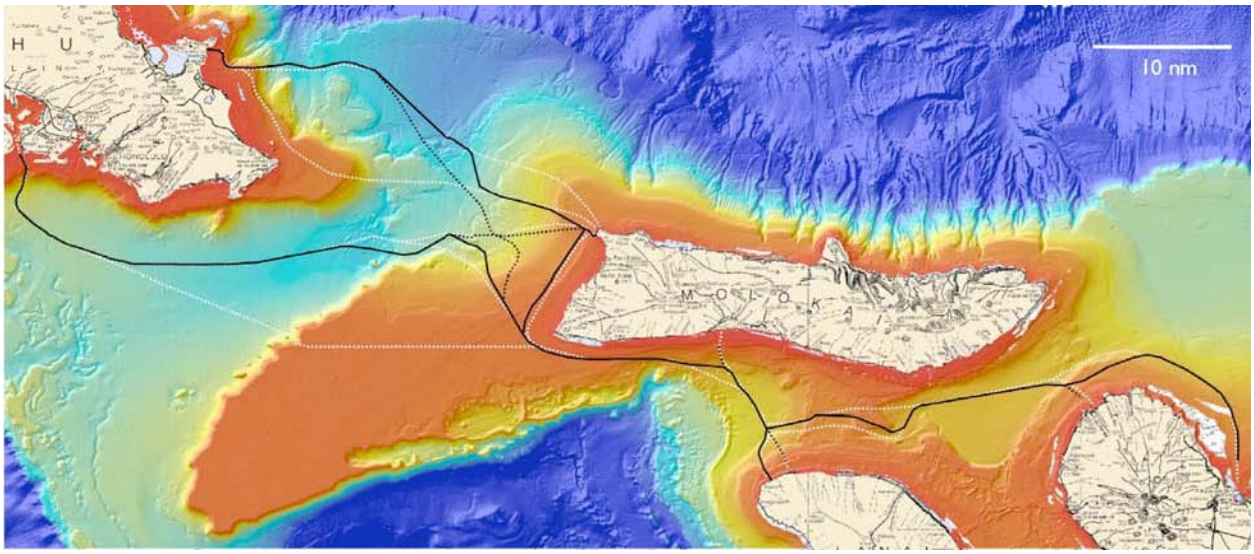
Interisland Cable Ocean Floor Survey

Final Report



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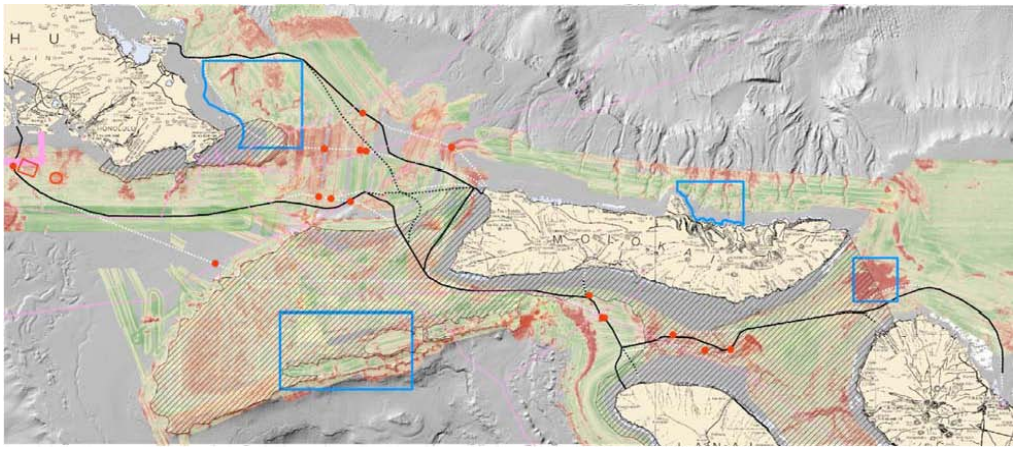
1. Executive Summary

This report contains the results of the ocean floor survey conducted between the Hawaiian Islands of Oʻahu, Lānaʻi, Molokaʻi and Maui. The purpose of this survey was to determine the feasibility of physically laying a power transmission cable on the sea floor between these islands for the purpose of transmitting renewable energy generated on Lānaʻi and Molokaʻi to Oʻahu and possibly Maui. The results of the survey show that laying a power transmission cable between the islands is physically possible via a number of different routes. Each route presents its own engineering and environmental challenges.



Recommended (black) and alternate (dashed) cable routes, other routes surveyed (white dashed), on sunlit bathymetry (gray)and seafloor acoustic imagery (red = strong, green = weak).
Pink = existing cable;
Red dot = observed cable crossing
Blue box = bottom fish refuge;
Red box/circle = dump areas
Ruled area = humpback whale sanctuary

Certain questions, however, remain unanswered, including:

- How to precisely lay the cables around deep-water obstacles, such as former reefs, dumped materials and munitions;
- How to connect the cables to shore under (via micro-tunnels) and/or over (via dredged micro-channels) fringing coral reefs that are up to 2 km across; and,
- Whether and/or how to bury the cables in areas of hard substrate.

These questions will be resolved when the cable developer is hired. The environmental impacts of the project will be addressed in the environmental impact statement ("EIS") for the proposed interisland cable.

The Department of Business, Economic Development, and Tourism would like to thank the University of Hawaii at Mānoa School of Ocean and Earth Science and Technology for their research hard work on this project.

2. Background

On October 20, 2008 the State of Hawai‘i ("State") entered into an Energy Agreement between it and Hawaiian Electric which was signed by the Governor of the State of Hawai‘i, the Department of Business Economic Development and Tourism (DBEDT), the Consumer Advocate, and Hawaiian Electric, on behalf of itself and its subsidiaries, Hawaii Electric Light Company, Inc. and Maui Electric Company, Limited (collectively, the "HCEI Parties").

The Energy Agreement commits the HCEI Parties to pursue a wide range of actions with the purpose of decreasing the State's dependence on imported fossil fuels through substantial increases in the use of renewable energy and implementation of new programs intended to secure greater energy efficiency and conservation.

In the Energy Agreement, Hawaiian Electric has committed to integrate and, with the assistance of the State, to accelerate the commitment for up to 400 megawatts ("MW") of wind energy into the O‘ahu electrical system (the "Interisland Wind Initiative"). The wind energy is expected to be produced by one or more wind facilities located on the islands of Lāna‘i and/or Moloka‘i and transmitted to O‘ahu and potentially Maui via an undersea cable (the "Interisland Cable").

With respect to the Interisland Cable, the State agreed to coordinate with developers, contractors, and/or Hawaiian Electric as the circumstances merit, on all matters related to the development of the Interisland Cable. The State delegated the responsibility of the Interisland Cable development to DBEDT. As lead agency for this effort, DBEDT's tasks include, but are not limited to, conducting or having contractors and/or consultants conduct the appropriate engineering and design of the Interisland Cable, assist with the acquisition and approvals of all necessary off-shore and on-shore land rights permits and approvals including the EIS.

The Interisland Cable, as envisioned, consists of an undersea transmission cable system with a minimum transfer capability of four-hundred (400) megawatts ("MW") to integrate either 1) the proposed two-hundred (200) megawatt wind facility on Lāna‘i and the two-hundred (200) megawatt wind facility on Moloka‘i with O‘ahu's electric grid; or, (2) possibly a single wind facility located on either Lāna‘i or Moloka‘i with O‘ahu's electric grid. A later phased cable extension to Maui is also proposed.

As part of this work effort, the State will draft a programmatic EIS for the Interisland Wind Initiative, with input from the wind developers on Lāna‘i and Moloka‘i and from HECO and MECO on O‘ahu and Maui. The wind developers are responsible for drafting their own respective Environmental Assessments and/or EISs for their individual wind farms. HECO and MECO are responsible for drafting their own respective EAs and/or EISs for the utility infrastructure upgrades on O‘ahu and Maui. The State is responsible for drafting the required environmental review documentation for the Interisland Cable.

Before proceeding with the considerable cost and work effort associated with the EIS for the Interisland Cable, DBEDT needed to first determine if laying a power transmission cable on the ocean floor between the islands O‘ahu, Lāna‘i, Moloka‘i and Maui was feasible from a physically standpoint. DBEDT contracted with the University of Hawaii at Mānoa, School of Ocean and Earth Science and Technology (UHM-SOEST) to compile all existing ocean floor

data, to survey the gaps in the ocean floor data, and to recommend cable routes based on the survey results to facilitate this investigation.

The project was broken into two (2) discrete tasks with subtasks and sequential program review.

- **Task 1: Compile existing data regarding bathymetry, critical habitats, and seafloor; and,**
- **Task 2: Collect and process bathymetric and seafloor data**

The results of both tasks are described below.

3. Task 1

For Task 1, DBEDT asked UHM-SOEST to perform a desktop study to compile/process relevant existing ocean floor data, determine critical gaps in existing information, and recommend a program of new data collection and interface with DBEDT and its consultants, contractors and advisors on engineering and design parameters of the proposed cables and routes.

3.1. Compilation of Existing Data

As part of Task 1, UHM-SOEST made a digital compilation of publicly available bathymetry data gridded at 10 meters, for the seafloor area between Oʻahu, Molokaʻi , Lānaʻi and Maui. Figure 1 below in an example of the bathymetric data available as of April 30, 2009.

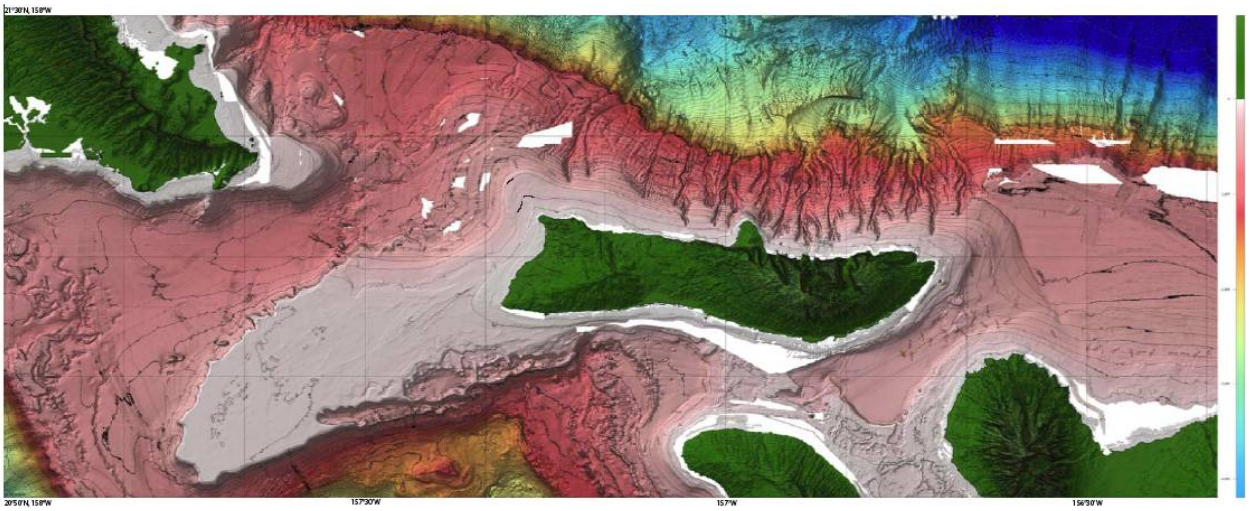


Figure 1 – Bathymetric data as of April 30, 2009

UHM-SOEST consulted with the State Office of Planning, which has an extensive GIS database, including marine layers (http://hawaii.gov/dbedt/gis/download.htm COASTAL/MARINELAYERS) that include the location of existing public submarine cables (http://hawaii.gov/dbedt/gis/cables.htm), the Hawaiian Islands Humpback Whale National Marine Sanctuary (http://hawaii.gov/dbedt/gis/sanctuary.htm) and other restricted/managed areas.

UHM-SOEST reviewed and collected data from the National Oceanic and Atmospheric Administration (NOAA) commissioned study which describes the near-shore benthic habitats in the main Hawaiian Islands. (See Figure 2). The benthic region begins at the shore line (intertidal or eulittoral zone) and extends downward out to sea. See NOAA National Centers for Coastal Ocean Science (NCCOS). 2007. Atlas of the Shallow-Water Benthic Habitats of the Main Hawaiian Islands. NOAA Technical Memoradum NOS NCCOS 61, Biogeography Team. Silver Springs, MD. 331 pp.

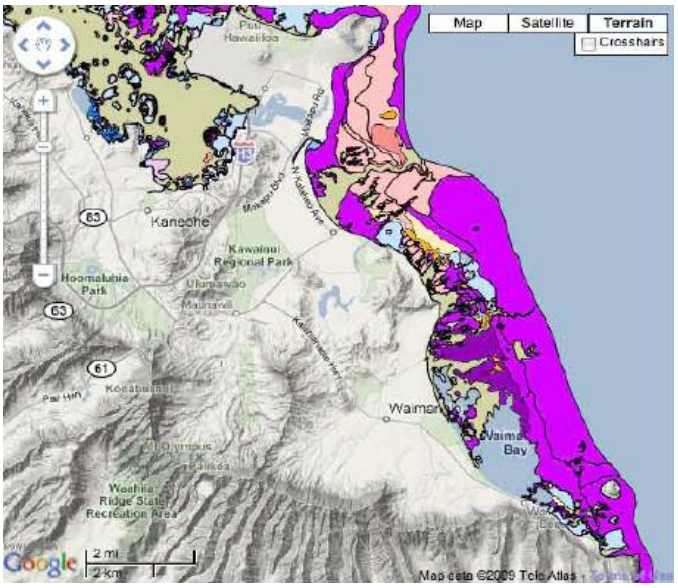


Figure 2- Near shore benthic habitat off of Kāneʻohe

UHM-SOEST reviewed and collected data from the United States Geologic Service studies of the benthic habitats offshore the south coast of Molokaʻi. (See Figure 3 and http://coralreefs.wr.usgs.gov/Molokaʻi.html).

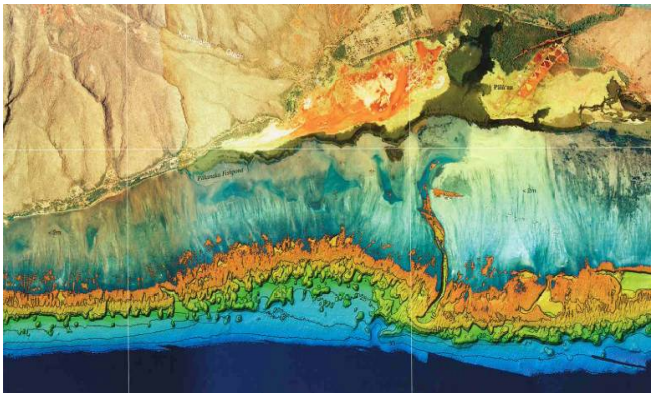


Figure 3 - Near Shore benthic habitat near south Moloka'i

UHM-SOEST also reviewed and collected data from 30 KHz sidescan sonar coverage offshore SE Oʻahu and north of Maui. (See Figure 4).

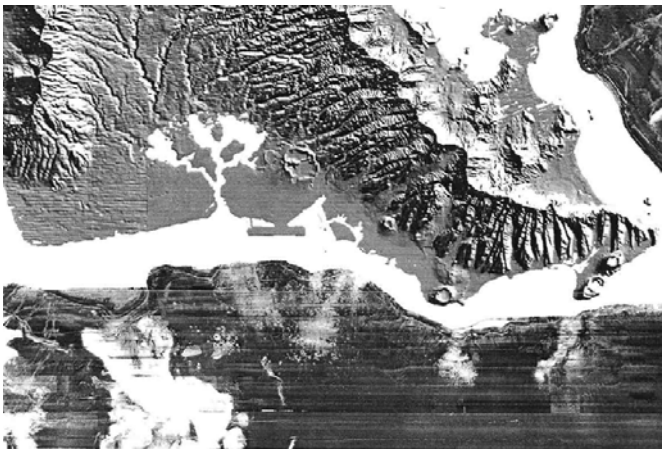


Figure 4 - 30 KHz sidescan sonar coverage offshore SE Oʻahu

3.2. Gap Analysis

Once the data collection was complete, UHM-SOEST determined it had bathymetry data covering ~95% of the study region (see Figure 1). Of the ~5% data gaps remaining, certain critical points including the shallow water areas east of Kailua-Makapuu, around ʻIlio Point NW Molokaʻi, south of central Molokaʻi, north of Lānaʻi, and north of Kahalui Maui that needed to be surveyed in order to better define the recommended and alternate undersea cable routes between Oʻahu, Lānaʻi, Molokaʻi and Maui.

3.3. Cable Landing Sites

Cable routes are uniquely prescribed by their end points. The final landing sites for the cable will be selected after the environmental review for the Interisland Wind and Interisland Cable project are complete. Sites needed to be identified however, in order to conduct the ocean floor survey. DBEDT asked UHM-SOEST to consider landings at Pearl-Honolulu Harbor and Kāneʻohe (to connect to the ʻIwilei and Koʻolau sub-stations) on Oʻahu, NW Molokaʻi and north Lānaʻi (to connect to proposed wind farms), and south Molokaʻi (as part of a possible land-sea route between NW Molokaʻi and Lānaʻi). Where underwater cables would best link to the Maui electric grid has not been determined. Therefore the candidate sites on NW Maui and near Kahalui are provisional.

3.4. Technical Cable Requirements

Following the collection of data, UHM-SOEST met with DBEDT and its consultants to determine the following key parameters for the proposed undersea power cables:

- High voltage, direct current cables are recommended for the size (~400 MW) and length of submarine cables (>20 miles) envisioned.
- Existing (double armored) cable technology and laying techniques (direct lay or buried) can be utilized at ocean depths to 800 m.
- For cable protection, burial 1-2 m sub-bottom is desirable in water 100 m or shallower, and may be considered for all water depths.
- Cables should be routed to avoid steep slopes, sharp changes in slopes, suspended spans, or bending radii less than 6 m. Cables can be lain on slopes up to 30 degrees, and up to 45 degrees with cable anchoring.
- Directionally drilled micro-tunnels used in shore areas to minimize impacts can be up to 1.5 km long.

3.5. Initial Cable Route Suggestions

Based on the desk-top study and gap analysis, the technical cable requirements, available information on proposed sites for cable landings and converter stations, and it's knowledge of marine geology, benthic biology and oceanography, UHM-SOEST developed a set of initial submarine cable routes and alternatives.

Principles that guided UHM-SOEST's recommended routes included:

- minimize distance (given cost of cable);
- keep depth above 800 m (for better navigation and less weight of cable during laying);
- minimize length in whale sanctuary and other marine protected/restricted areas;

- minimize crossing of steep slopes, hard grounds, important benthic habitats, precious corals and dumped materials;
- minimize crossing existing telecom cables; and,
- prefer crossings at high angles.

From existing data UHM-SOEST recognized numerous constraints, including:

- no viable route north of Molokaʻi given the submarine canyons and landslides;
- connecting Molokaʻi, Lānaʻi, and Maui will require cables in the whale sanctuary;
- offshore areas less than 120-m-deep were sub-aerially exposed and eroded during the last glacial maximum 20,000 years ago;
- during subsequent sea level rise, modern coral reefs grew and now fringe all the islands;
- living (including precious) corals and extremely rugged seafloor dominate between east Lānaʻi and west Maui – Kihei;
- generally steep edges of Penguin Bank and Oʻahu approaches;
- no viable route across SE Penguin Bank (rugged and steep paleo-reef slopes);
- deep former reefs occur in some places between the islands; and,
- material dumped south of Pearl and Honolulu Harbors.

Using these criteria and the data collected previously, UHM-SOEST developed nine (9) possible routes shown in Figure 5.

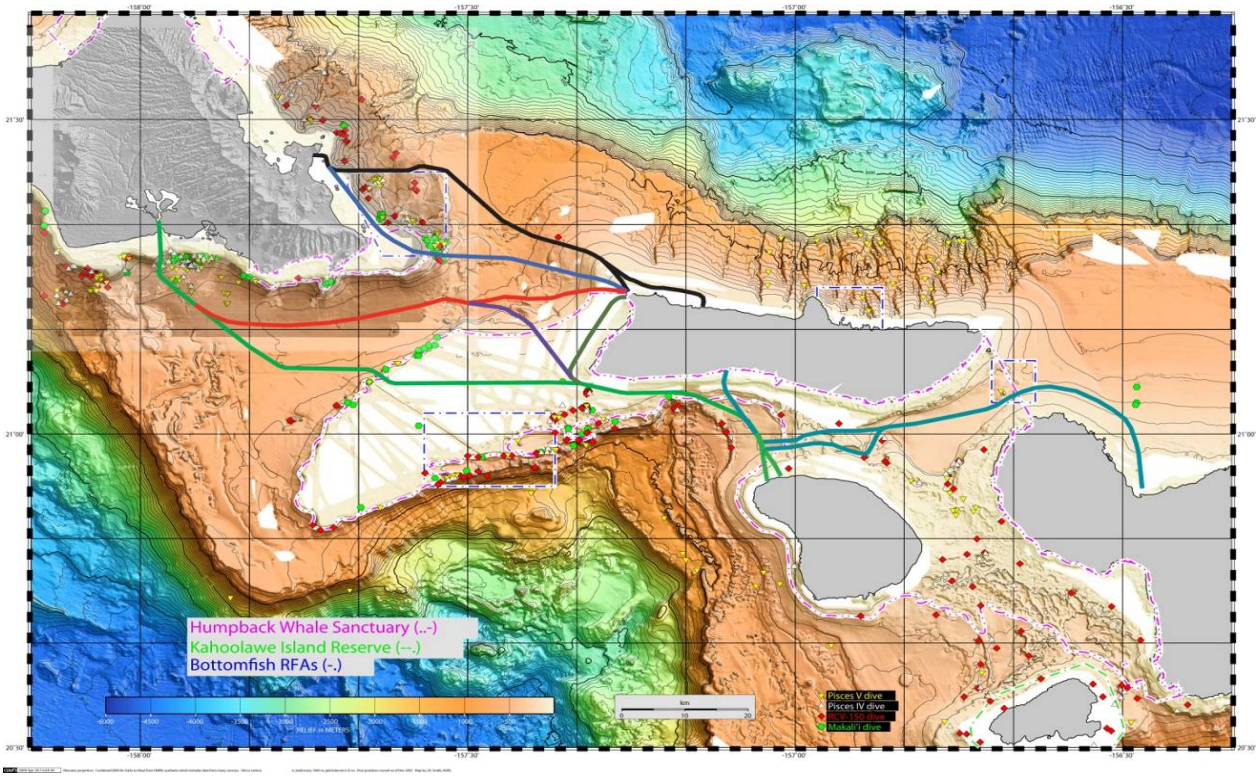


Figure 5 - Initial Cable Route Suggestions

4. Task 2

For Task 2, DBEDT asked UHM-SOEST to collect and process and analyze uncharted bathymetric data, sidescan, seafloor sampling and video of the targeted seafloor along the possible routes identified in Task 1. (See Figure 5). For this task DBEDT also asked UHM-SOEST to recommend routes for the Interisland Cable between Oʻahu, Lānaʻi, Molokaʻi and Maui based solely on the information gathered. The route recommendations were to be based on analyses of seafloor characteristics, bathymetry data, video and interface with DBEDT and its consultants, contractors and advisors on engineering and design parameters of the proposed cables and routes. Task 2 was broken down into the following sub-tasks:

- Task 2a: Collect and process new bathymetric data of nearshore Lānaʻi and south of Molokaʻi.
- Task 2a: Determine the initial recommended and alternative routing corridor for the undersea cable between Oʻahu, Molokaʻi , Lānaʻi and Maui based on the new and existing bathymetric data, along with landing sites on Oʻahu, Molokaʻi , Lānaʻi, and Maui.
- Task 2b: Based on the recommended and alternative routes for the cable perform a combination of sidescan/subbottom profiling along the seafloor between the islands.
- Task 2b: Based on the sidescan/subbottom profiles, determine what changes need to be made to the recommended and alternative routing corridor for the undersea cable between the islands.
- Task 2c: Based on the amended recommended and alternative routing corridors of the undersea cable, perform camera/video surveys of the seafloor and seafloor sampling along various points along the route.
- Task 2d: Prepare a Task 2 technical final report detailing the steps taken to determine the recommended and alternative routes for the undersea cable and provide GIS maps of the final recommended routes and alternatives.

4.1. New Data Collection

To develop the initially proposed routes and alternatives, UHM-SOEST collected new data that included (1) shallow water multibeam bathymetry mapping (using the 25’ NOAA survey launch R/V Ahi) to fill the existing shallow water (<200 m depth) data gaps around where the cables may be routed, and (2) cruises of R/V Ka’imikai-O-Kanaloa (see Figure 6) that surveyed along the proposed cable routes using deep-towed sub-bottom profiling and sidescan, camera/video transects, and seafloor sampling at various points. (See Figure 7).

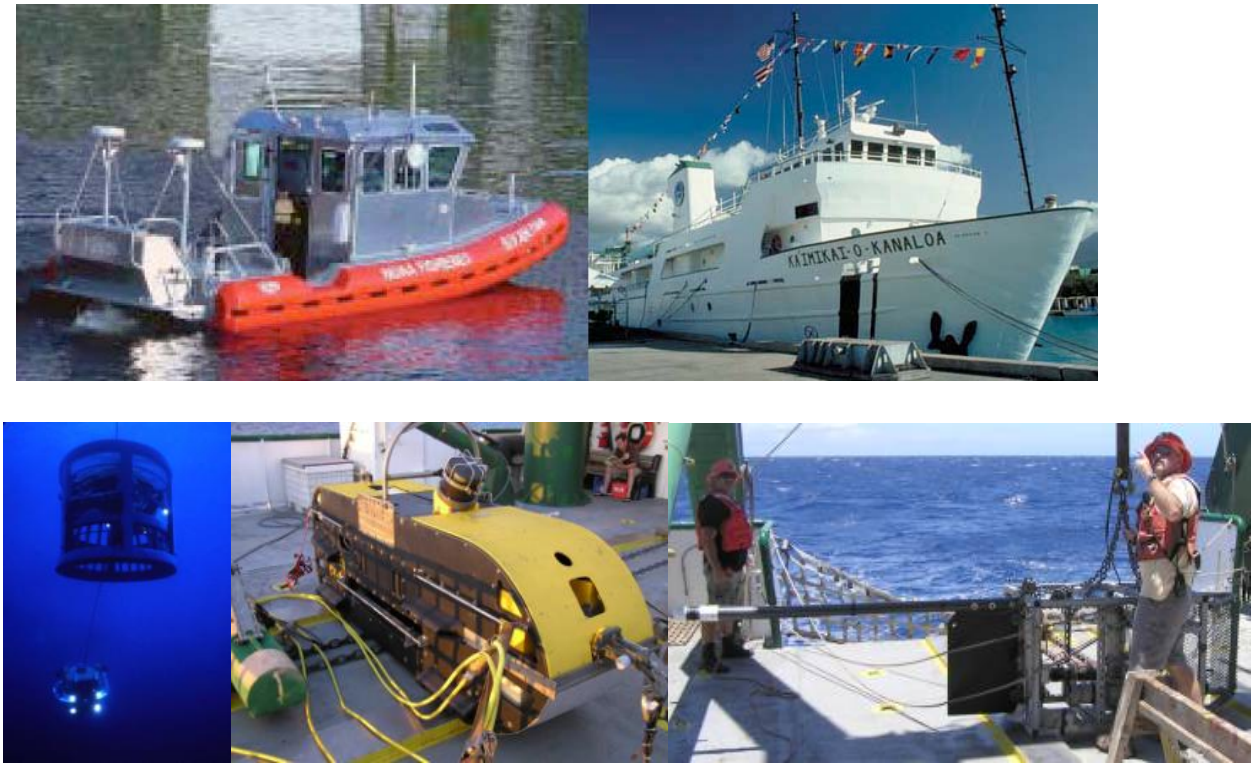


Figure 6 – R/VAhi and Ka'imikai-O-Kanaloa, ROV video camera, Deep tow Sonar, and Tow Cam and Magnetometer

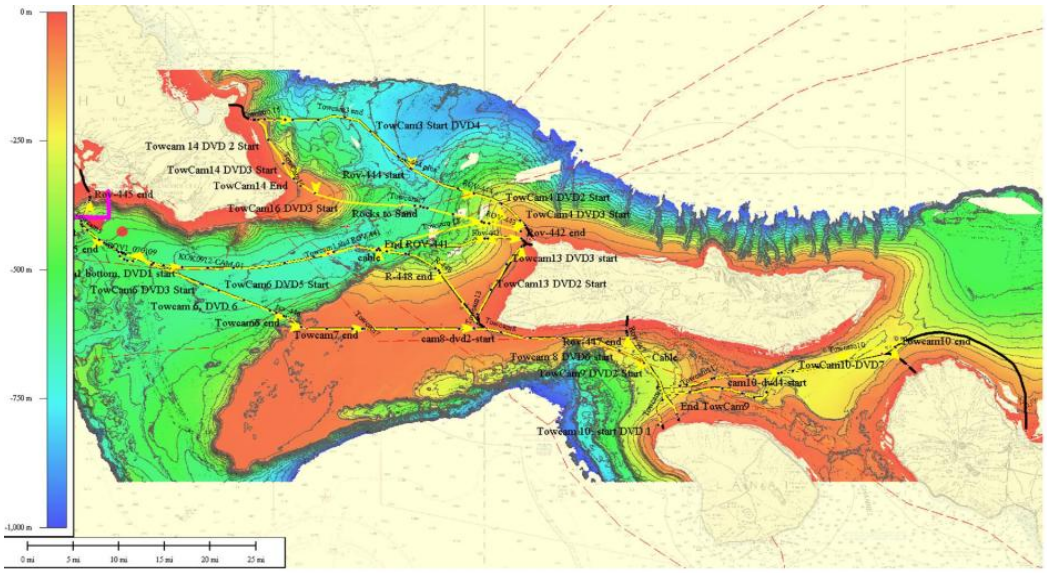


Figure 7 Camera/Video Surveys

Additional swath bathymetry data from an independent two-day R/V Kilo Moana (Figure 8) cruise in July was also added to fill deeper water data gaps, resulting in a nearly complete grid of swath bathymetry, and one that fully covers all the considered cable routes.

Figure 8 R/V Kilo Moana

Detailed near-shore surveys to better characterize the shallow-water substrate will be performed when the exact landing sites are determined.

4.2. Recommended submarine cable routes and alternatives

Following analysis of the new and existing information, UHM-SOEST recommended and identified alternate undersea cable routes between O‘ahu, Moloka‘i , Lāna‘i and Maui, based on the discussion and data interpretation that follows. An integrated ARC-GIS project volume of the seafloor data, together with the recommended routes, accompanies this report (the sub-bottom profiles, core descriptions, magnetometer and CTD profiles are in separate files, previously supplied). Priority was given to determining viable routes where the cable may be laid.

The areas where the cable may be buried or covered, and at what cost, remains to be determined. The issue of burying the cable will be looked at in greater detail in the forth coming environmental review for the interisland cable project.

4.3. Routes to Pearl-Honolulu Harbor

For the proposed inter-island power cable to reach the ‘Iwilei sub-station in Honolulu they have to cross the wide coral reef along the south O‘ahu shore. Five reef crossings have been dredged previously (Figure 9), the three deepest being the entrances to Pearl Harbor, Ke’ehi Lagoon and Honolulu Harbor, the two others being at either end of the Honolulu airport runway.

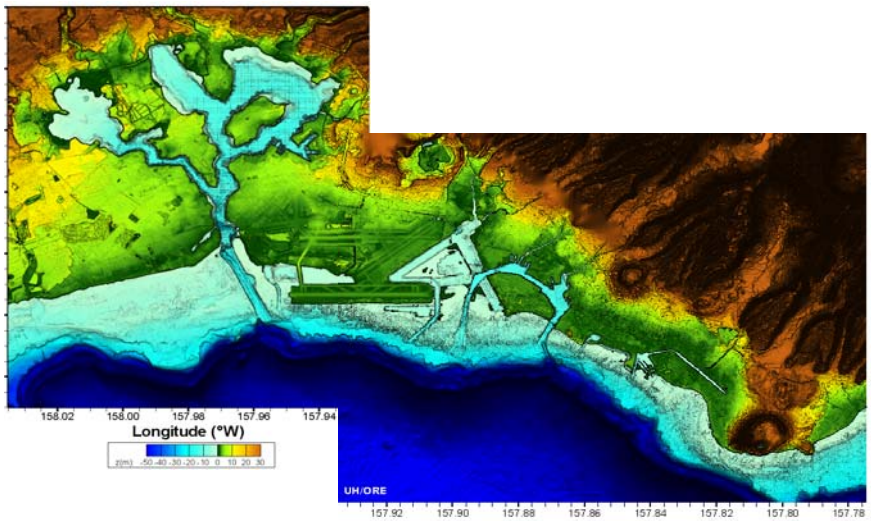


Figure 9 – Honolulu and Pearl Harbors

Dredged materials from these and other excavations (e.g. Ala Wai canal), plus several man-made materials and munitions, have been dumped over the years to the south of Oahu. See Figure 10.

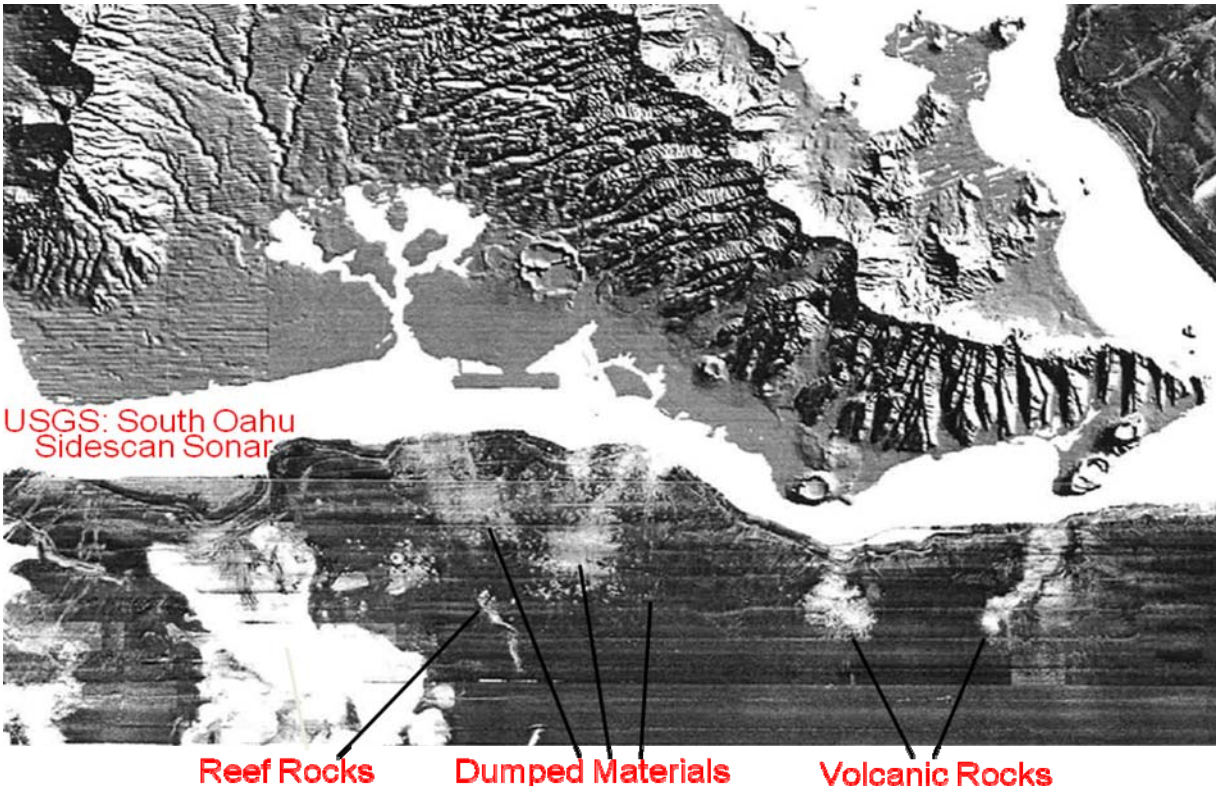


Figure 10 Dump material south of Honolulu Harbor

UHM-SOEST recommends the undersea cables should avoid, to the extent possible, this region of dumped materials by routing the cables to the east or to the west of the large concentration of debris that occurs south of Honolulu airport. Either choice does not obviate the need for careful placement to avoid less concentrated debris and munitions scattered further away. UHM-SOEST recommends the western route to avoid high concentrations of debris immediately south of the Honolulu Harbor entrance, to keep the submarine cable away from the high-use areas offshore Waikiki-Kaka'ako, and to not impede plans for future seawater A/C (and other) pipes off Honolulu-Waikiki.

A cable laid to the entrance of the Pearl Harbor dredged channel could be routed ashore to the converter station, and another cable from there to the Iwilei substation, in several ways in part depending on the desired location and permitting of the converter station. This route could involve a combination of underwater segments (e.g., the various dredged channels, the submarine terrace south of the reef runway, through Ke'ehi lagoon, and under Sand Island Bridge to west Honolulu Harbor) and/or subaerial segments (e.g., edge of reef runway, Pearl Harbor military base, H1 right-of-way). The identification of these terrestrial and amphibious alternatives is beyond the scope of DBEDT/UHM-SOEST contract.

4.4. Pearl Harbor/Honolulu Harbor to Lāna‘i

The UHM-SOEST recommended cable route between Pearl and Honolulu Harbor and Lāna‘i trends SSW from the entrance of the Pearl Harbor dredged channel down the slope, with minor course changes to avoid obstacles identified in the sidescan sonar and bathymetry. (See Figure 11). The sub-bottom profile shows no significant sonar penetration, indicating a compact/hard substrate. At the base of slope (~400 meters water depth) the route curves to the southeast (to avoid the paleo-reef further south and west) and then east.

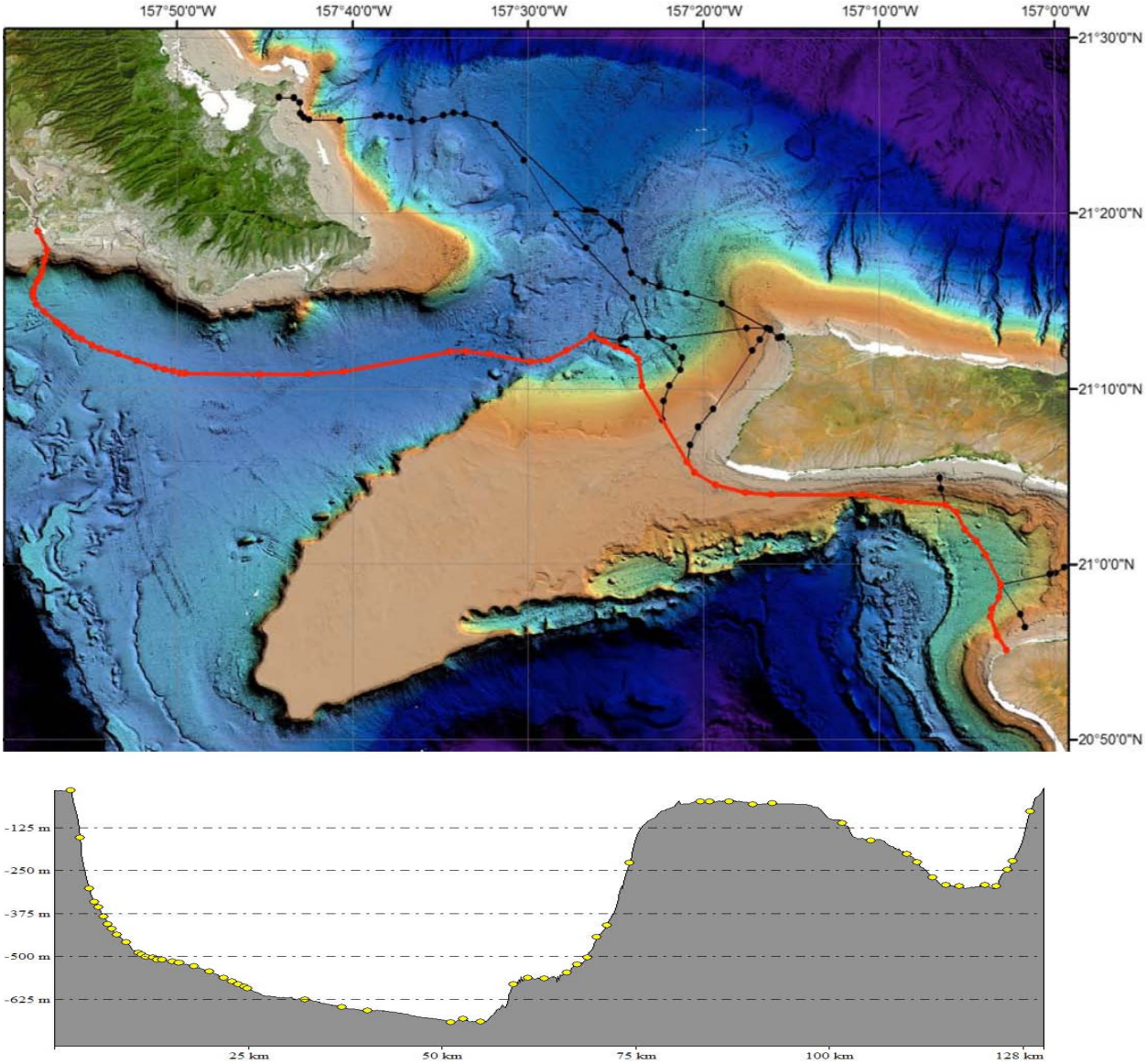


Figure 11 - Pearl-Honolulu to Lanai

The route stays south of the main dumping fields and just north of a telecom cable (that may have become buried, UHM-SOEST did not see it in sidescan or video). Here the profile shows significant sub-bottom reflections and gravity coring penetrated ~1m of sandy mud, indicating

good potential to bury a cable. This route weaves between a myriad of dumped materials and munitions that litter the seafloor until passing east of Diamond Head.

O‘ahu and Moloka‘i were once connected by surrounding coral reefs in much the same way as Lāna‘i and west Maui are today. That former reef edge is now at depths of 650-750 m in the Ka‘iwi Channel. The recommended cable route continues east with good sub-bottom reflectors until crossing the former reef edge. Thereafter sub-bottom reflectors are observed only intermittently and the substrate is often compact/hard.

The recommended route avoids outcrops and scours seen in the sidescan and rises up onto Penguin Bank at a place where the slope is less steep than further west, and via a sloped channel that is more easterly of the route originally considered. On top of Penguin Bank, to the west and south of Moloka‘i, the substrate is compact/hard. Gravity core catchers returned carbonate sand and gravel, but there was no significant core penetration. There is a sand dune field off the SW corner of Moloka‘i. (See Figure 12).

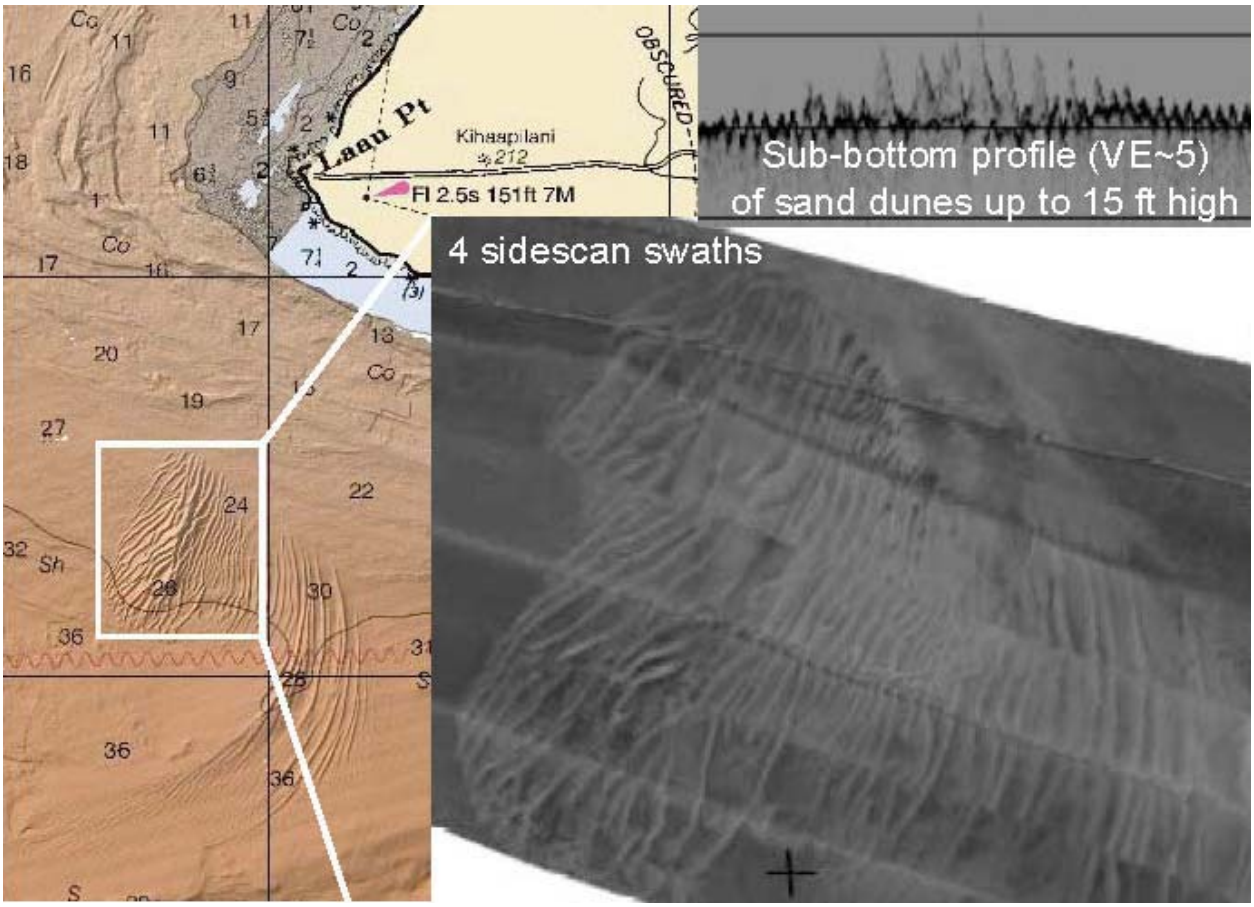


Figure 12 – Sand Dunes off the SW Corner of Moloka‘i

The route continues east, staying south of the Moloka‘i’s fringing coral reef and north of an existing telecom cable, submarine canyon head and paleo-reef complex. The narrow corridor between these bounding features is a critical path and choke point for all the recommended cable routes connecting O‘ahu, Moloka‘i and Lāna‘i. Curving to the SE and then south, the route crosses a terrace at ~300 m depth with good sub-bottom reflectors (although poor core recovery

of sandy mud) before climbing the slope up to NW Lānaʻi where there are sandy beaches and a narrow fringing reef.

4.5. Kāneʻohe to NW Molokaʻi

The recommended cable route from Kāneʻohe to NW Molokaʻi lands at Kāneʻohe Marine Air Station on Oʻahu where a cable could be run along the H3 right-of-way to the Koʻolau substation. (See Figure 13). Near shore to the east there is a 2 kilometer wide reef terrace. Along part of this route the substrate remains thinly sedimented over reef rock until passing around the submarine canyon head east of Kailua and down off the shelf. Coring the slope recovered 1 meter of silty mud.

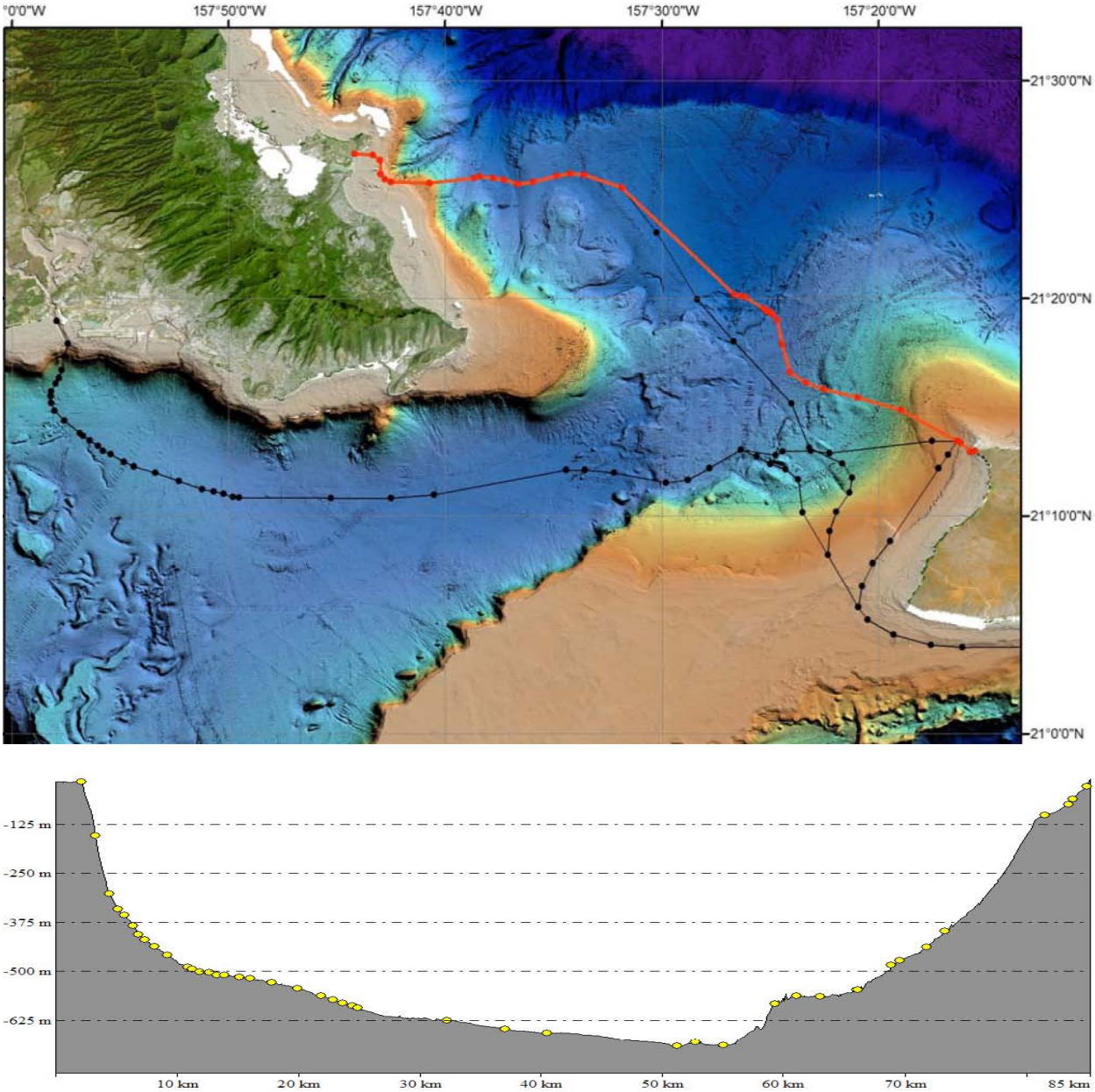


Figure 13 - Kāneʻohe to NW Molokaʻi

The easterly route crosses low-relief channels coming off Waimanalo and stays north of the bottom fish refuge until turning around it (and associated deep former reef) to the SE. The 700-800-m deep flat area has good sub-bottom reflectors (though core recovery of the carbonate mud-silt-sand was spotty). These reflectors end when the route crosses onto a deep former reef to the SE. The route weaves around rock outcrops seen in the sidescan and up the slope to NW Moloka‘i. Sidescan indicates that the shelf north of north west Moloka‘i is hard reef substrate, with rugged karst in places. To avoid the worst of this, the route comes in from the WNW towards ‘Ilio Point, crosses a low point in the relict reef edge, then trends SE to where the modern reef is narrowest (allowing the cable to pass underneath in a micro-tunnel). At the coastal end of a dirt road there is a sandy landing site. A cable right-of-way could pass along the dirt road to the proposed wind farm further east. (See Figure 14).

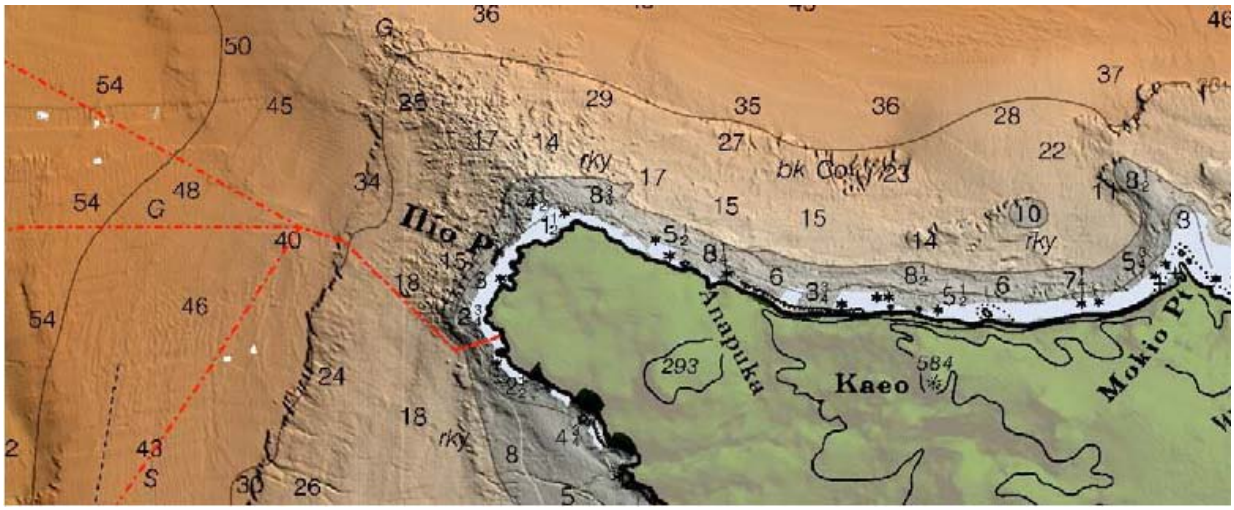


Figure 14 - ‘Ilio Point on NW Molokai

4.6. NW Molokai to Lanai

The route from ‘Ilio Point retraces the same route that comes from Kāne‘ohe, before turning SW to parallel the west Moloka‘i shore where it stays below the relict reef edge in muddy (low backscatter) sediments identified on the sidescan. The mud field ends to the SW and the route passes onto the compact sand with dunes that characterizes the current-swept top of Penguin Bank. Off SW Moloka‘i the route merges with that from Pearl Harbor to Lāna‘i. Almost the whole route is within the Humpback Whale Sanctuary. (See Figure 15).

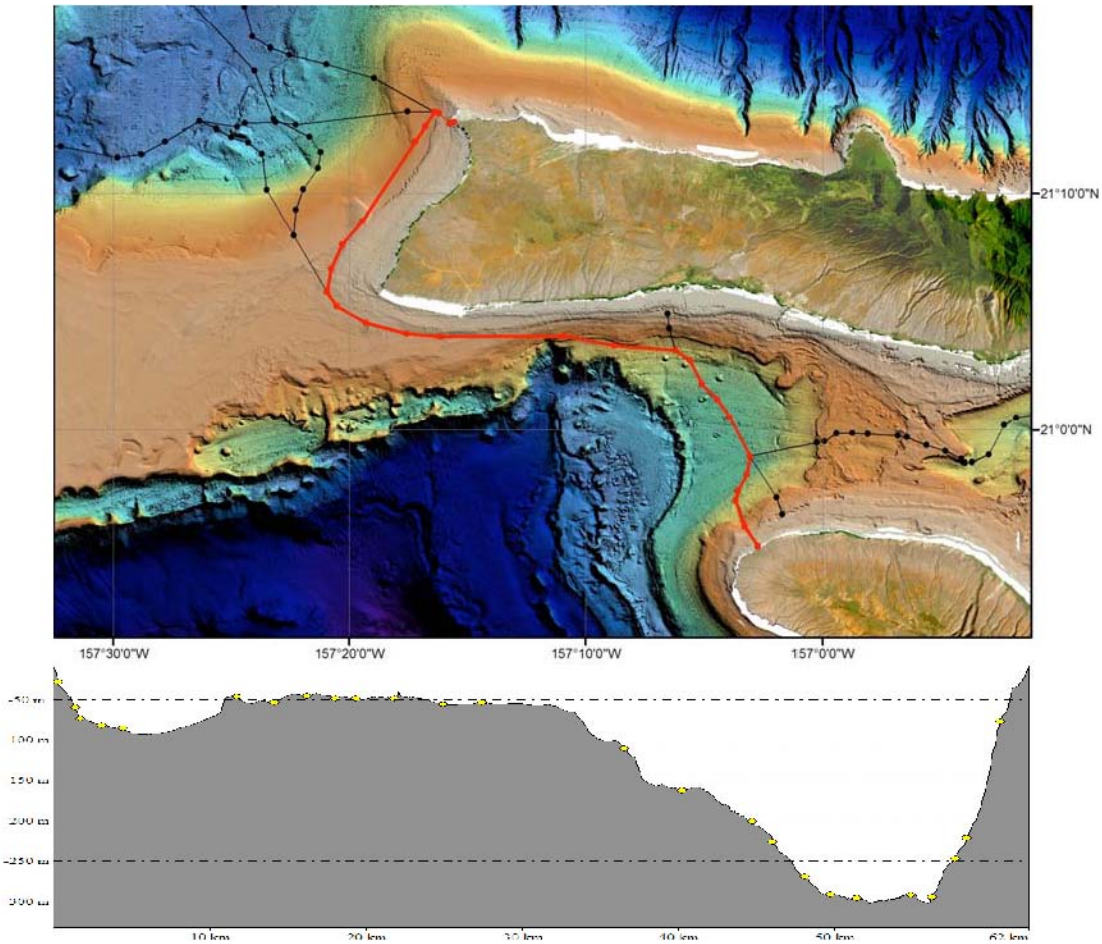


Figure 15 - NW Moloka‘i to Lāna‘i

4.7. O‘ahu to Moloka‘i /Lāna‘i to Maui

The recommended routes linking O‘ahu-Moloka‘i-Lāna‘i can be extended within the whale sanctuary east to Maui, but there are two areas where particular care will be required. The first is crossing the relict reef in the Kalohi Channel between Moloka‘i and Lāna‘i, particularly its steep east and west edges. Two alternative routes were investigated to cross this, and the recommended route is a variation and combination of them both. It uses the northern of the two small channels originally identified to cross the western reef edge. But the new swath bathymetry and deep-towed sidescan data show that the steep eastern edge can’t be traversed exactly where surveyed. Rather, UHM-SOEST proposed a route across the SE nose of the relict reef, where the slope is gentler, to link up with the southern route. The only other passage off the relict reef to the thickly sedimented floor of the Pailolo channel is slightly further south along the axis of a steep-sided, E-W-trending, narrow chute whose floor is only ~50 m wide in the west where it rises up onto the relict reef platform. That platform is current swept and thinly sedimented reef rock, with no sub-bottom reflectors.

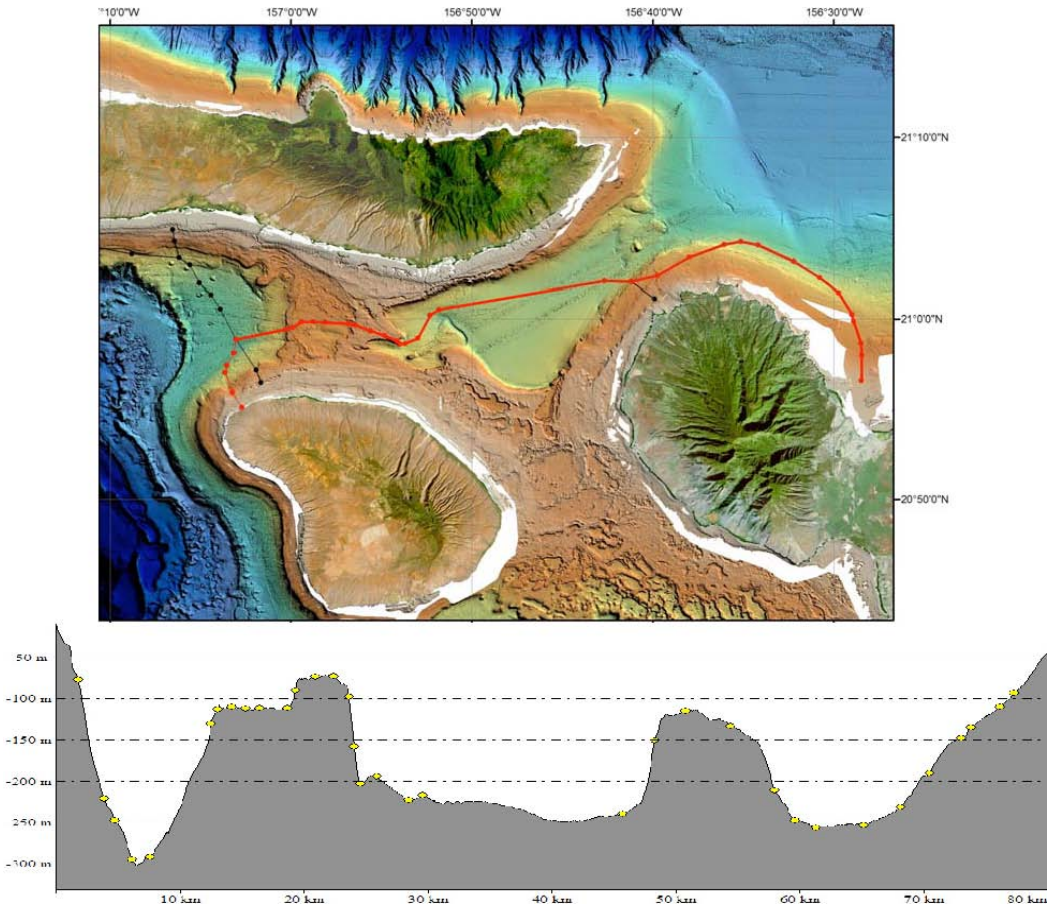


Figure 16 – Oahu – Moloka‘i - Lāna‘i to Maui

The ~270-300-m deep central Pailolo channel has good sub-bottom reflectors in sandy sediments east of where the surveyed route to Maui branches, NW of Kapalua. Another submerged relict reef is encountered there and to the NE with rough rocky seafloor and supporting a benthic fishing reserve. (See Figure 17).

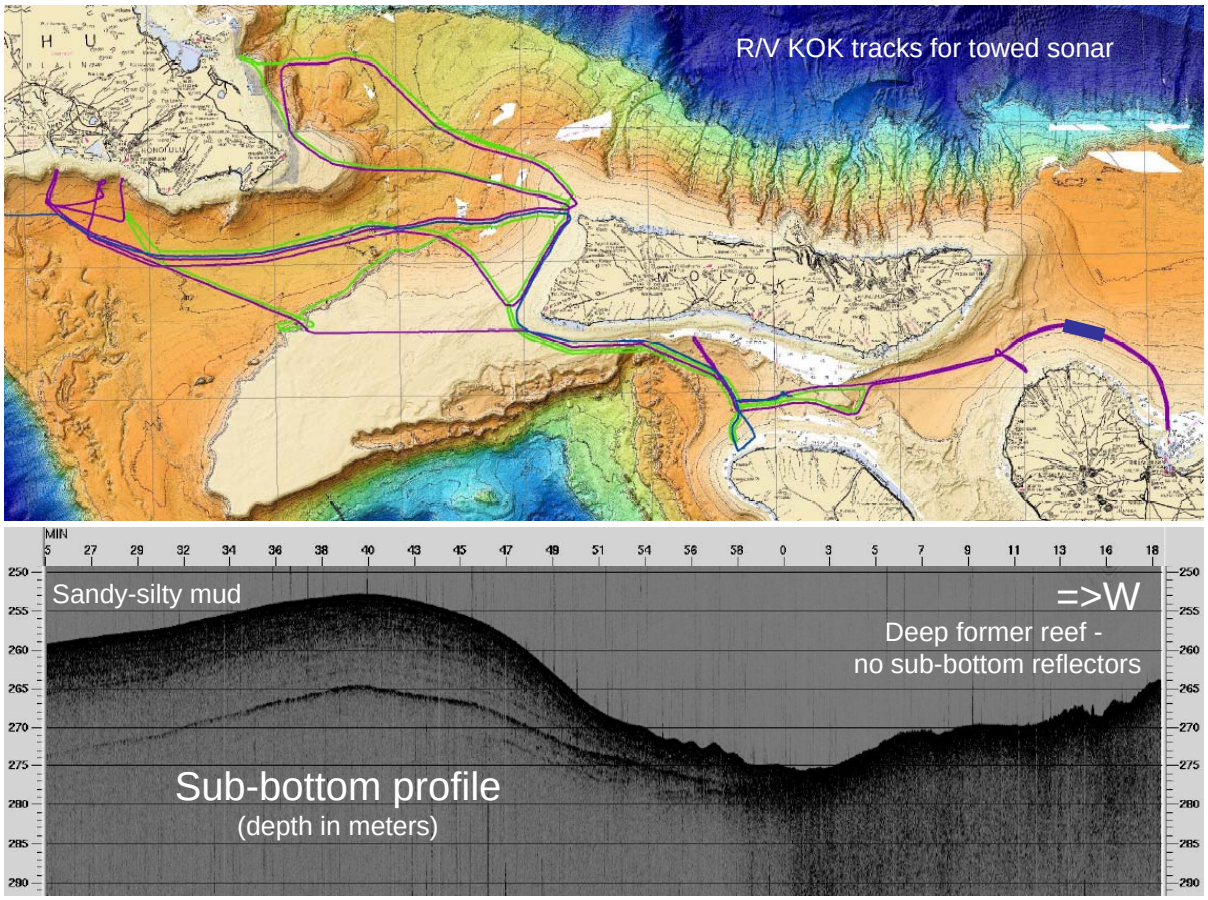


Figure 17 - Substrate north of Maui

Based on USGS 30 kHz sidescan, and swath bathymetry, UHM-SOEST moved the recommended cable route to Kahalui south of the BFRA and closer to west Maui (where the seafloor acoustic returns are weaker) until it passes into the area of good sub-bottom reflectors and muddy sand NE of west Maui, and then turns south to Kahalui. The surveyed spur route towards Kapalua, west Maui, is a viable and shorter alternative, depending on whether a converter station could be established on the narrow coastal strip and efficiently linked to the electricity grid.

4.8. Alternative Routes

If a land-sea cable route from NW Molokaʻi to Lānaʻi is contemplated, then a possible alternate route from south Molokaʻi would be under/across the 2 kilometer wide reef offshore Pala'au or Hale'o'lono and then SSE to Lānaʻi. (See Figure 15 or 19). To combine with that route, UHM-SOEST surveyed and include an alternate route from Pearl-Honolulu Harbor to NW Molokaʻi. The route follows the route from Pearl Harbor to Lānaʻi until, instead of turning SE, it continues

east up the west Moloka‘i slope to ‘Ilio Point. On much of that slope, the sub-bottom profile shows no significant penetration, indicating a compact/hard substrate.

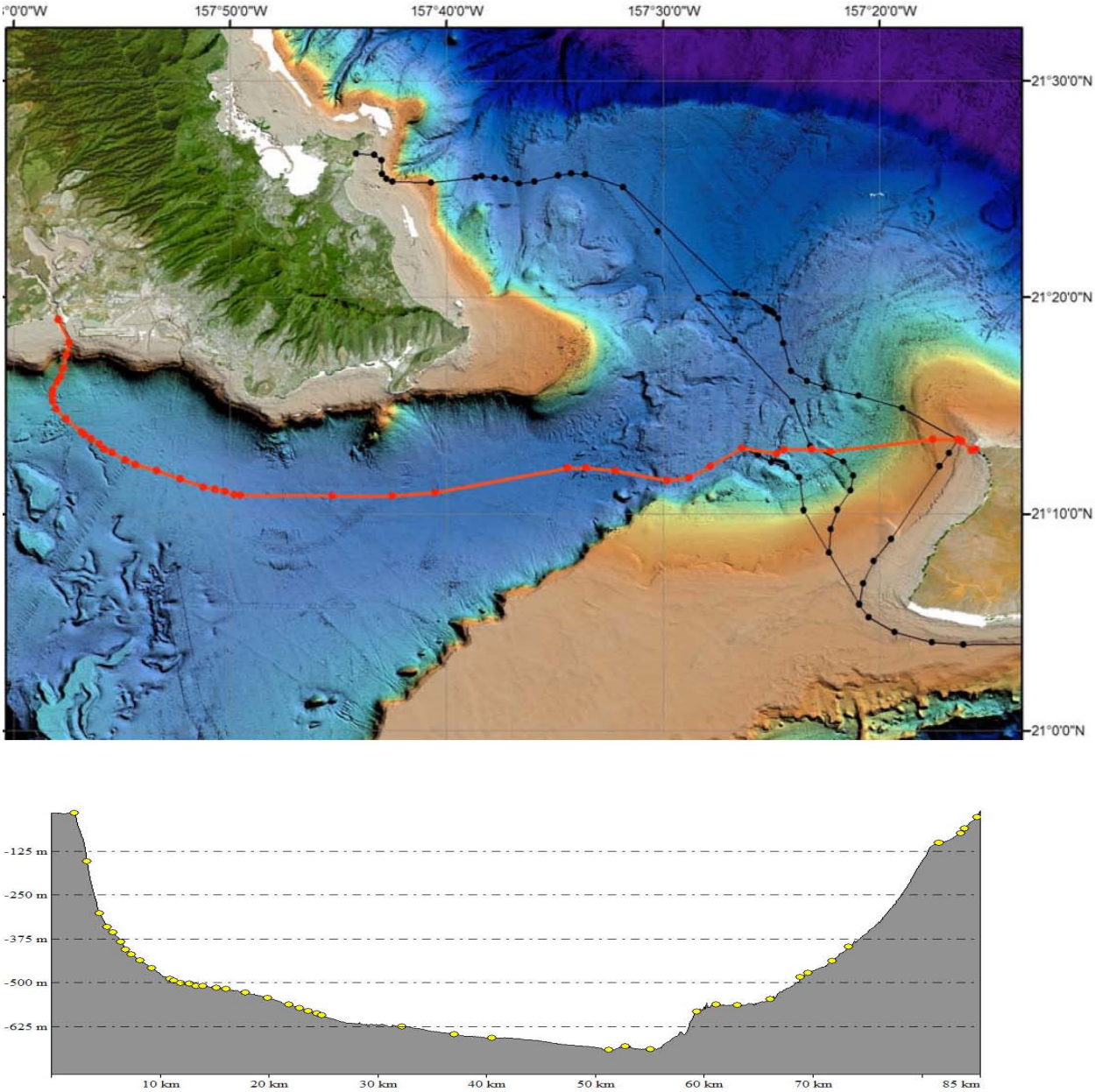


Figure 18 - Pearl/Honolulu to Moloka‘i

If, for whatever reason, cable landings at NW Moloka‘i are excluded then, based on swath bathymetry and acoustic imagery, UHM-SOEST recommends an alternate route from Kāne‘ohe directly to Lāna‘i that joins the two recommended routes from Kāne‘ohe and to Lāna‘i with a SE-trending segment across the deeper relict reef areas at the foot of slope west of Moloka‘i. UHM-SOEST predicts a hard substrate along much of the joining segment.

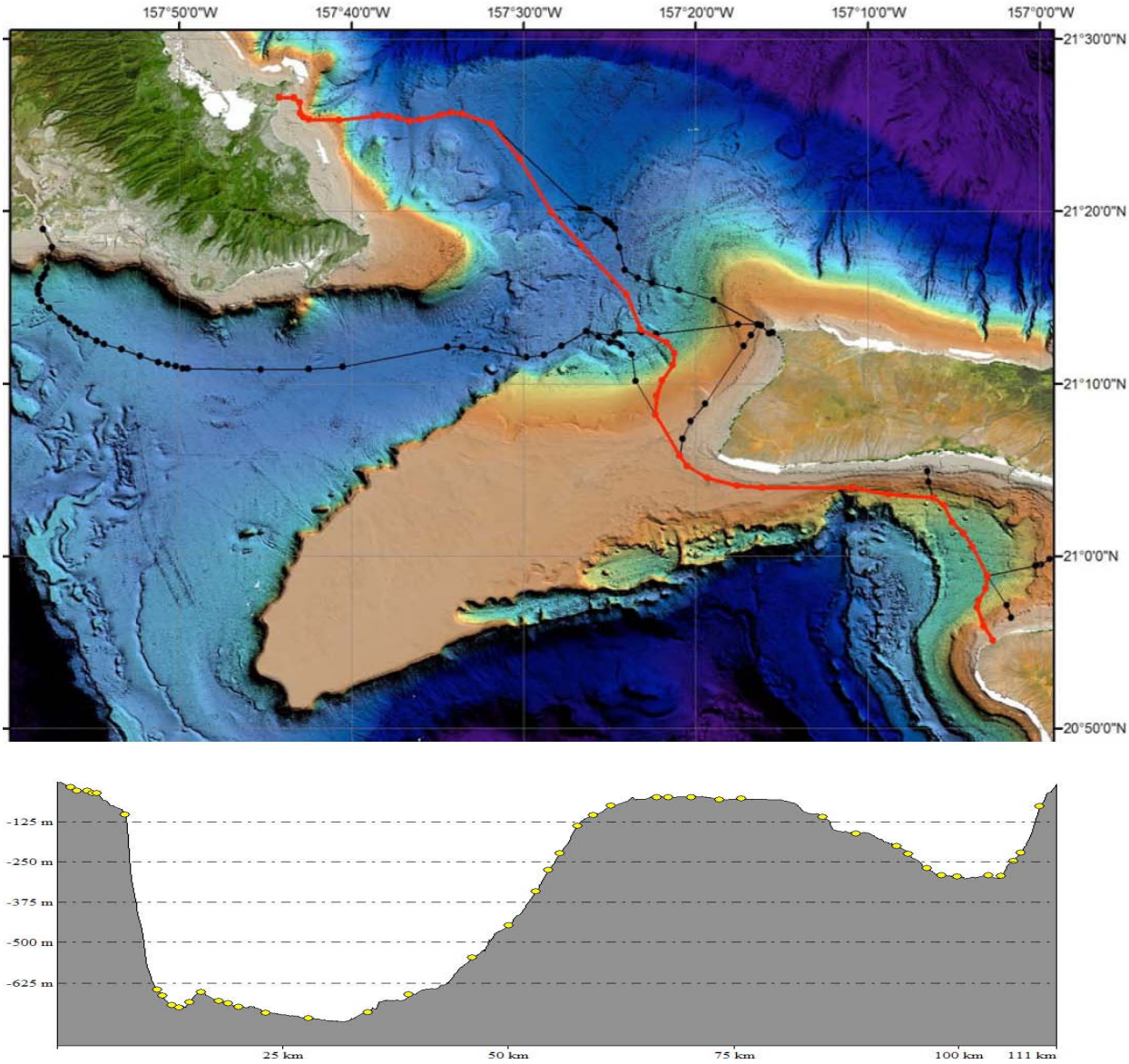


Figure 19 - Kāneʻohe to Lānaʻi

4.9. Routes not recommended

The Pearl Harbor to Lānaʻi cable route east across Penguin Bank is not viable because of the steep western edge of Penguin Bank. UHM-SOEST surveyed potential crossing points along the western steep edge, but only found vertical cliffs and boulder-strewn channels that would prevent cable laying. Although somewhat shorter, this route also entails longer stretches in the Humpback Whale Sanctuary.

The Kāneʻohe to NW Molokaʻi cable route considered along the Waimanalo-Makapuʻu Shelf is subject to intense fishing and anchoring, crosses the SE Oʻahu portion of the Humback Whale Sanctuary as well as precious coral beds on the slope east of the Makapuʻu Shelf, which has a hard substrate with numerous rock ledges. This route is not recommended.

5. Existing seafloor cables

The reported positions of existing seafloor cables are not always reliable. (See figure 20, but note that the route alternatives are those initially proposed, not the final ones).

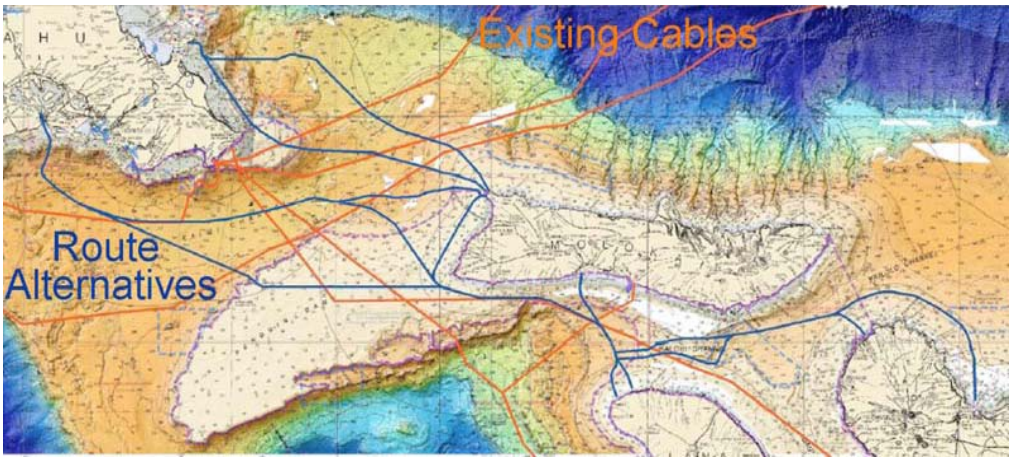
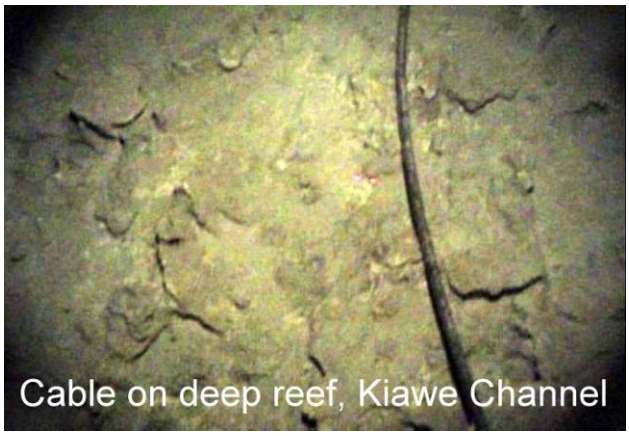


Figure 20 - Existing cables in red

Figure 21 below also shows the reported location of cables (light pink lines) and where actually seen (indicated by a red dot - linked to a corresponding video frame in the ARC-GIS project volume accompanying this report – such as that at right). Inspection reveals that some cable crossings are quite close to their reported positions, whereas others are not. Other supposed cables were crossed without evidence (possibly buried in sediment), and some unknown cables were seen.



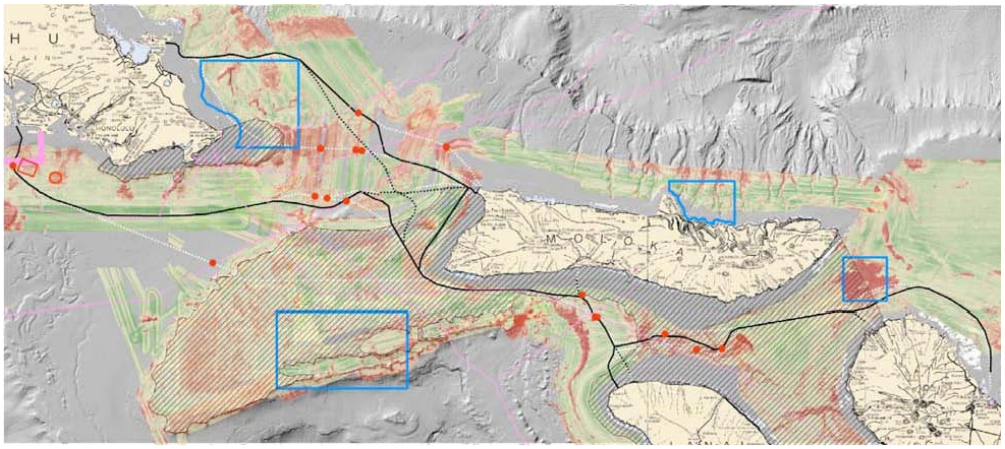


Figure 21 - Cables identified

Some portions of existing cables can also be identified in the deep-towed sidescan (e.g., south of west Moloka‘i). Also shown on Figure 21 above are the recommended (black) and alternate (dashed) cable routes, other routes surveyed (white dashed), on sunlit bathymetry (gray) and seafloor acoustic imagery (red = strong, green = weak). Blue boxes are bottom fish refuges; ruled areas are the Humpback Whale Sanctuary.

6. Cable burial

Sub-bottom profiling and coring reveal that only the deeper water areas have a muddy seafloor substrate that would readily facilitate burying the proposed interisland cable. This mud typically contains 20-30% sand. These areas include the deep water Ka‘iwi channel south of O‘ahu, the deep water area east of Waimanalo, the terrace at ~300 m depth between Moloka‘i and Lāna‘i, the central part of the Pailolo channel between Moloka‘i and Maui, and NE of west Maui approaching Kahului.

In contrast, the shallow water areas surrounding the islands, where cable burial may be most desired, have a hard substrate of active/relict coral reef and/or compact sand. Areas of relict reef rock are also identified in some deep-water areas of the interisland channels and slopes.

The environmental review for the Interisland Cable project will further investigate the impacts caused or avoided by burying the Interisland Cable, and will also consider other alternatives to cover the cable to better protect it and the marine environment.

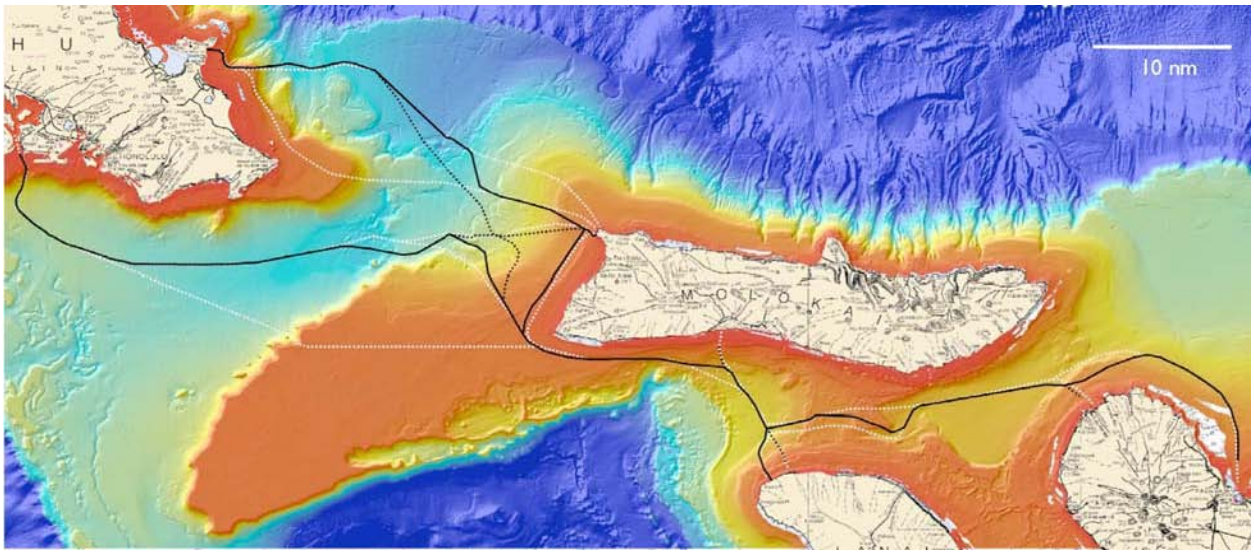
7. Benthic macro fauna

Beyond the shallow reefs, benthic macro fauna (e.g., fish, rays, seastars, urchins, seapens, and sponges) are sparsely observed on the video tows and ROV dives along the proposed routes.

Exceptions to this generally occur in the precious coral beds on the slope east of the Makapu’u Shelf and along the easterly transect across Penguin Bank. The two somewhat shorter routes originally considered to cross these benthic habitats, both of which entail longer stretches in the Humback Whale Sanctuary, are not recommended.

8. Summary

From previous and newly acquired ocean floor surveys UHM-SOEST has identified a set of inter-island routes where underwater power cables may be laid to connect O‘ahu, Moloka‘i, Lāna‘i and Maui.



The routes avoid the bottom fish refuge areas. They minimize but can’t eliminate segments within the Humpback Whale Sanctuary, and cross areas of hard substrate and fringing coral reefs. Challenges remain, including:

- precisely laying the cables around deep-water obstacles, such as former reefs, dumped materials and munitions;
- connecting the cables to shore under (via micro-tunnels) and/or over (via dredged micro-channels) fringing coral reefs that are up to 2 km across;
- whether and/or how to bury the cables in areas of hard substrate.