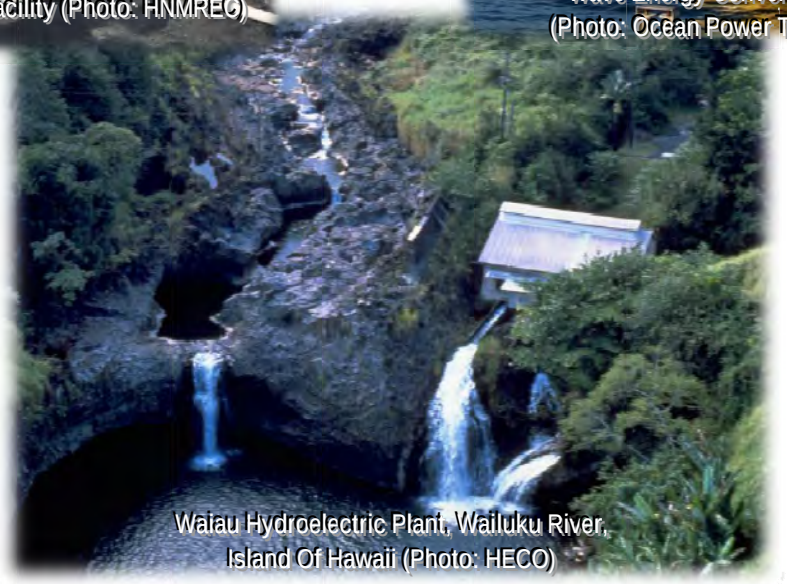
Hydroelectric Power Assessment - State of Hawaii

Section 905(b) WRDA 1986 Analysis Report Reconnaissance

Experimental OTEC Facility (Photo: HNMREC)

Wave Energy Conversion Device
(Photo: Ocean Power Technologies)



Waiau Hydroelectric Plant, Wailuku River,
Island Of Hawaii (Photo: HECO)

Prepared for:

U.S. Army Corps of Engineers
Honolulu District
Civil and Public Works Branch
Programs and Project Management Division

May 2011

Prepared by:
EA/HHF Joint Venture
1221 Kapiolani Boulevard, Suite 1030
Honolulu, HI 96814

For more information or copies of the report, please contact:

Deborah Solis
U.S. Army Corps of Engineers, Honolulu District
Civil and Public Works Branch
Programs and Project Management Building
230 Fort Shafter, HI 96858-5440
(808) 438-0701

TABLE OF CONTENTS

LIST OF MAPS

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
DBEDT	Department of Business, Economic Development and Tourism
DLNR	Department of Land and Natural Resources
DOA	Department of Agriculture
DOE	Department of Energy
DOI	Department of the Interior
EIS	Environmental Impact Statement
EPRI	Electric Power Research Institute
ft	feet
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FCSA	Feasibility Cost Sharing Agreement
GIS	Geographic Information System
HAR	Hawaii Administrative Rules
HECO	Hawaiian Electric Company
HRS	Hawaii Revised Statutes
HTRW	Hazardous, Toxic, and Radioactive Waste
km	kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
LIDAR	Light Detection and Ranging
m	meter
MMS	Minerals Management Service
MW	megawatt
NED	National Economic Development
NFIP	National Flood Insurance Program
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
OC-OTEC	open cycle ocean thermal energy conversion
OCS	Outer-Continental-Shelf
OREZ	Ocean Renewable Energy Zone
OTEC	ocean thermal energy conversion
OTECA	Ocean Thermal Energy Conversion Act

OWC	oscillating-water-column
R&D	Research and Development
U.S.	United States
USACE	United States Army Corps of Engineers
USBR	United State Bureau of Reclamation
WEC	wave energy conversion
WRDA	Water Resource Development Act

EXECUTIVE SUMMARY

Based on a request from the State of Hawaii to help address the State of Hawaii's 2030 Clean Energy Initiative and meet the State's goal of 70 percent clean energy by 2030, the U.S. Army Corps of Engineers, Honolulu District (USACE) received appropriation from Congress in Fiscal Year 2009 to initiate a reconnaissance study. The designated non-federal sponsor is the State of Hawaii Department of Business, Economic Development and Tourism (DBEDT). The purpose of the reconnaissance phase is to determine if there is a federal interest for USACE to participate in a cost-shared feasibility phase study that will identify, evaluate and recommend solutions to address the potential hydroelectric power needs in the State of Hawaii. The reconnaissance phase culminates in this Section 905(b) of the Water Resources Development Act (WRDA) of 1986 analysis, a Project Management Plan (PMP) and the Feasibility Cost Share Agreement (FCSA). The Section 905(b) analysis documents the basis for the federal interest determination and establishes the scope of the feasibility phase. This analysis will be used to provide the plan formulation rationale within the PMP and associated with the Feasibility Cost Share Agreement (FCSA). This document fulfills the commitment of the WRDA 1986 Section 905(b) Analysis.

The State of Hawaii plans to achieve the goal of 70% clean energy with a combination of improvements in efficiency and renewable energy. The goal of the feasibility study is provide recommended solutions in hydroelectric power in which USACE may implement on a cost-shared basis to help the State of Hawaii reach their Clean Energy Initiative goal of 40 percent renewable energy by 2030.

Over 160 potential hydropower, ocean thermal and wave energy options were considered throughout the State of Hawaii. In partnership with DBEDT, an initial screening of these sites was conducted on their potential energy capacity, the potential percent increase in renewables generated per island, the type of hydroelectric system proposed, the estimated incremental energy cost, and an independent screening of environmental and social factors such as potential to adversely affect species or habitat protected under the Endangered Species Act. The projects were then screened for the potential federal interest under USACE authorities and missions. This resulted in a shortlist of 33 potential traditional hydroelectric projects and several additional ocean thermal and wave projects. From this shortlist, four projects were identified that are within the USACE authorities and missions. The feasibility study will focus on evaluating potential solutions at the following four projects:

- Puu Lua-Kitano-Waimea Hydroelectric Plant, island of Kauai,
- Wave Energy Conversion (WEC) Technology Test Hub Kaneohe Bay (Offshore of Kaneohe Marine Corps Base – Hawaii), island of Oahu,
- Ocean Thermal Energy Conversion (OTEC) facility, offshore of Kahe Point, Island of Oahu, and,
- Ocean Renewable Energy Zone (OREZ) for WEC/OTEC development throughout the State of Hawaii

The reconnaissance study has resulted in the finding that there is a federal interest in continuing the project development into the feasibility phase. The report provides a summary of

problems and opportunities within the study area, the planning objectives and constraints, the basis for the federal interest determination and the proposed schedule and budget for the feasibility study. A joint feasibility study and environmental impact statement (EIS) is proposed. The estimated completion date of the study is 2017 or approximately 57 months after execution of the FCSA and is subject to the availability of federal and non-federal funding.

HYDROELECTRIC POWER ASSESSMENT: STATE OF HAWAII
SECTION 905(b) (WRDA 86) ANALYSIS

1. STUDY AUTHORITY

This reconnaissance report was prepared in accordance with Section 905(b) of the Water Resource Development Act (WRDA) of 1986 and under the authority of Section 209 of the Flood Control Act of 1962 (PL 87-874), which reads as follows:

"The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the following named localities: *Provided*, That after the regular or formal reports made on any survey are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of any examination or survey to be made and a report thereon submitted to Congress, if such review is required by the national defense or by changed physical or economic conditions: *Provided further*, That the Government shall not be deemed to have entered upon any project for the improvement of any waterway or harbor mentioned in this title until the project for the proposed work shall have been adopted by law: … Harbors and rivers in Hawai`i, with a view to determining the advisability of improvements in the interest of navigation, flood control, hydroelectric power development, water supply, and other beneficial water uses, and related land resources…."

Funds in the amount of $287,000 were appropriated in fiscal year 2009 to conduct the reconnaissance phase of the study.

2. STUDY PURPOSE

The purpose of the reconnaissance phase study is to determine if there is a federal (United States Army Corps of Engineers, Honolulu District [USACE]) interest in participating in a cost shared feasibility phase study that will identify, evaluate, and recommend solutions to address the problems and opportunities in developing hydroelectric power including ocean energy potential in the State of Hawaii. The reconnaissance phase was initiated on May 15, 2009. The purpose of this Section 905(b) Analysis is to document the basis for the federal interest and establish the scope of the feasibility phase. As the document that establishes the scope of the feasibility study, the Section 905(b) Analysis is used as the chapter of the project management plan that presents the reconnaissance overview and formulation rationale. An alternative will be in the federal interest if a limited qualitative analysis determines that the economic and environmental benefits of the project outweigh the costs.

The documents produced as part of this effort include:

a. Section 905(b) Analysis (this document)

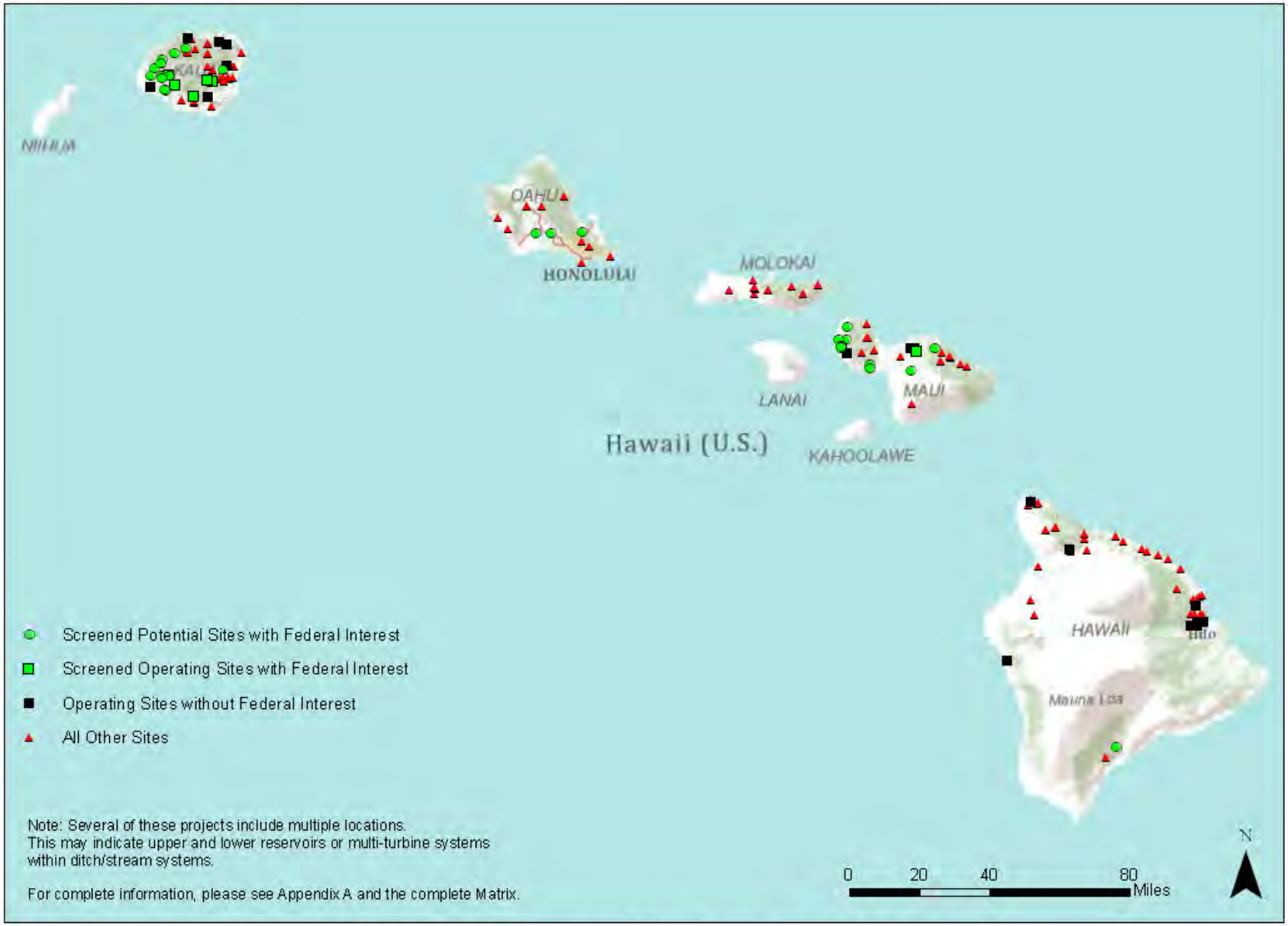
b. Technical Appendix - includes a detailed methodology describing the data gathering and screening process, as well as details related to the individual hydroelectric power generating technologies.

c. Matrix of sites and criteria examined (in Microsoft Office Excel format as Appendix A and ArcGIS format)

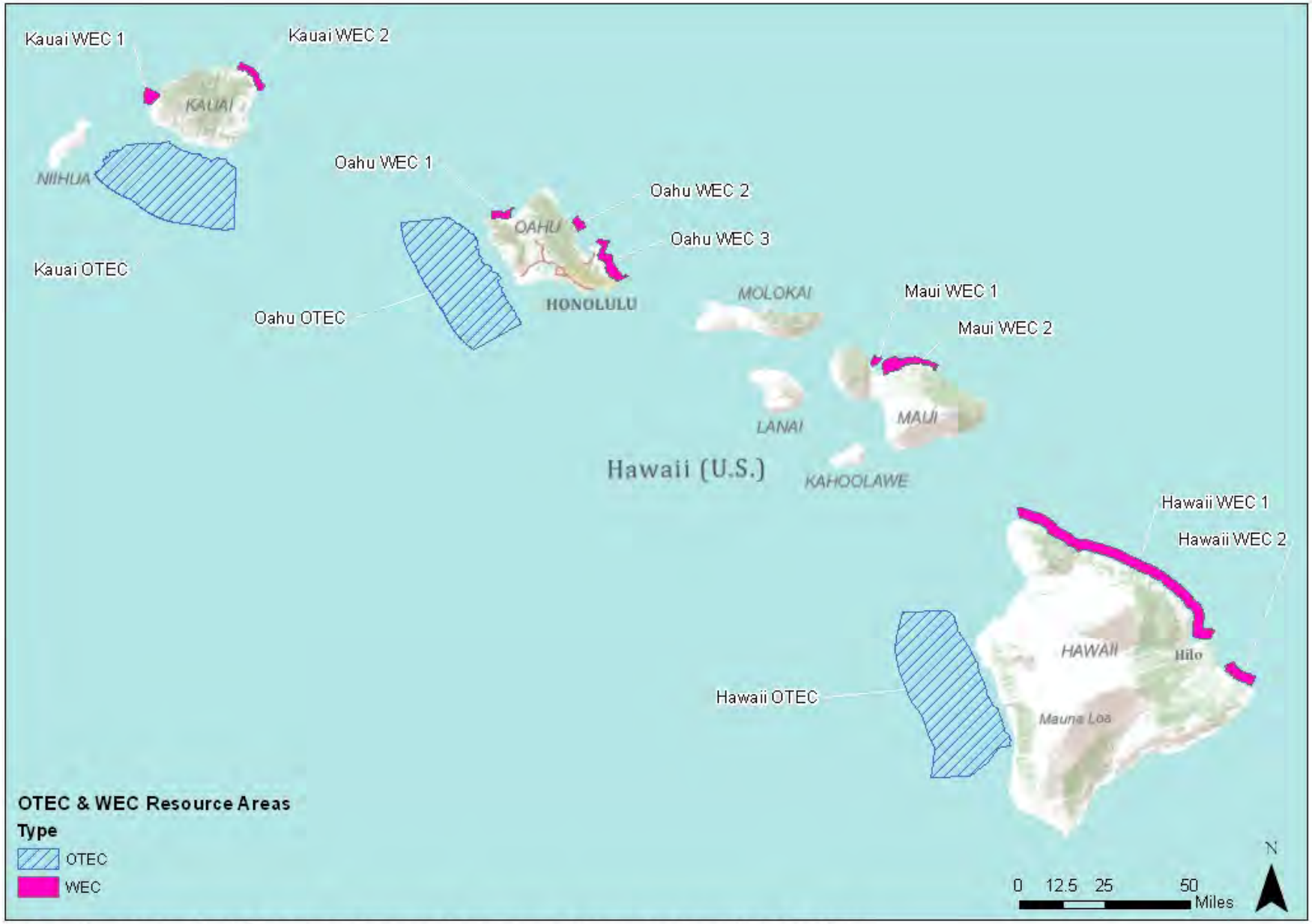
3. LOCATION OF STUDY, NON-FEDERAL SPONSOR AND CONGRESSIONAL DISTRICTS

The reconnaissance study area includes all major populated islands in the State of Hawaii: Hawaii, Maui, Molokai, Lanai, Oahu, and Kauai (including the State of Hawaii's 1st and 2nd Congressional Districts). The feasibility study area includes only those areas that have a federal interest and are within USACE authorities and missions. The non-federal sponsor is the State of Hawaii's Department of Business, Economic Development and Tourism (DBEDT). Additional sponsors may be added, including but not limited to, the State of Hawaii Department of Agriculture (DOA), the City and County of Honolulu's Board of Water Supply, individual county Public Works departments, and other state and county agencies.

The analysis of all sites is located in the Technical Appendix. A complete listing of the identified and potential conventional hydropower sites is found in Appendix A. All identified hydropower locations are shown on Map 1. These sites include currently operating projects, screened sites with greater potential (green boxes), screened sites with greater potential and federal interest (green circles), and other sites (red triangles). Statewide potential ocean energy resource areas are identified on Map 2. Map 3 identifies the specific location and layout of the recommended Kokee/Kekaha area and Puu Lua-Kitano-Waimea hydropower project. More detail on proposed ocean energy areas can be found in the Technical Appendix.

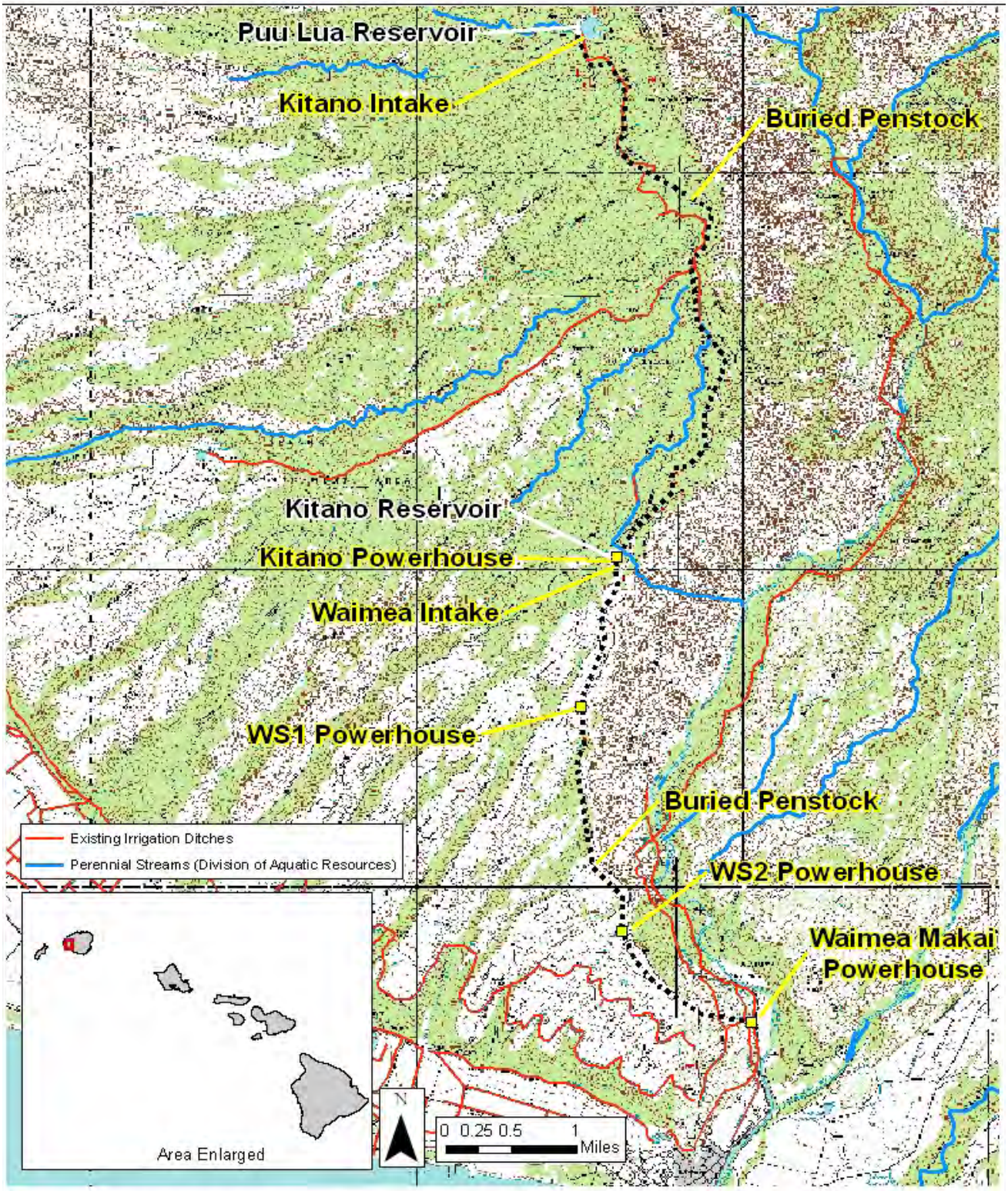


Map 1 - Hydropower Projects Identified in the State of Hawaii



Map 2 - Potential Ocean Thermal Energy Conversion (OTEC) & Wave Energy Conversion (WEC) Resource Areas in Hawaii

Prepared by EA Honolulu. Data from State of Hawaii GIS Oct. 2010 & EA Engineering



Map 3. Potential Puu Lua - Kitano Hydropower Location

4. GENERAL SCOPE AND METHODOLOGY

This report is intended to research, compile, and assess prospective hydroelectric power sources in the State of Hawaii using existing reports that have identified a wide array of hydropower and ocean energy resources. These studies include assessments of conventional hydropower (run-of-the-river, run-of-the-ditch, pumped storage, conventional storage, and in-line technologies), ocean thermal energy conversion (OTEC) and wave energy conversion (WEC). Generation of power from ocean current and tidal resources were not covered in this report as these were not considered to be viable in the Hawaiian Islands due to poor resource availability (Electric Power Research Institute [EPRI] 2008). Section 5 of this document lists a subset of the studies reviewed for this report. For the scope of this report, one hydropower site was proposed with cost and schedule as an example potential project. The criteria used to identify this site is expanded below and within Section 6 Part h: Conclusions of Preliminary Screening.

For conventional hydropower, over 50 literature sources were consulted, including reports commissioned by State and local agencies, federal databases and websites, and communications with key individuals around the State. Data collected was standardized in a database that provides information on over 160 sites throughout the State. Projects identified in this database include existing/operating hydropower plants, those that were active at one time but have since fallen into disuse, and those that were proposed but never built. Sites presented in the database were linked with geospatial coordinates referencing their location in the State, and integrated into a GIS. In addition to data collected in the literature review, data fields were populated based on geospatial and economic analyses. Sites were then screened based on economic and environmental/social considerations identified in the site database to provide recommendations of projects that may be feasible for further development. To assess ocean energy potential, the resource for WEC and OTEC technologies (areas with favorable wave climate and minimum temperature differentials and depth, respectively) was assessed in the context of potential constraints on development. Recommendations for ocean energy are presented as areas with high resource availability and few development constraints. The factors listed below are a broad listing of the components identified in the Technical Appendix and Appendix A.

Environmental Considerations: Hydropower and Ocean Energy

a. Known aquatic habitat impacts
    - Marine Sanctuaries
    - Critical and Endangered habitat
b. State Water Classification
    - Marine Class AA
    - Inland Class 1a, 1b
c. Conservation District: Protective Subzone (Inland waters)
d. Cultural Impacts: Areas of high significance for Native Hawaiians.
e. Potential impacts to recreational/commercial uses of the area
    - Water Sports
    - Proximity to navigation channels

- Prominent tourism areas

Economic Considerations: Hydropower

a. Capacity
b. Calculated Incremental Energy Costs
c. Accessibility

Sites with a known Federal Interest

Hydropower: Although the State of Hawaii has abundant rainfall it has limited resources for large-scale river-based hydropower projects. The topography of the Hawaiian Islands lends itself to small streams with flows that fluctuate considerably from month to month, appropriate for only small hydropower plants. The majority of existing and proposed systems are run-of-the-river plants on the islands of Kauai and Hawaii. However, in addition to natural streams, the State has extensive irrigation systems in place from the former sugar and pineapple plantations. Many of these systems are located on Kauai, Hawaii, and Maui, however, most of these plantations have since closed or been consolidated. The existing ditch and reservoir infrastructure could be upgraded to combine run of the ditch/river with pumped storage to produce more energy than run-of-the-river alone.

The sites identified were ranked upon the general economic and environmental/social factors identified in the General Scope and expanded upon in the Technical Appendix. Sites with enough information for a closer examination were identified as possible project sites if they could potentially provide cost-effective energy production at a rate comparable to existing utility rates based on $0.25/kWh. Potential sites were also identified if a system would be feasible based on location, transmission line connectivity, and land uses. It is also important for proposed sites to be located in an area of fewer environmental and social concerns. Projects in popular tourist locations and similarly unfavorable sites can be built, but costs would rise due to delays and opposition from the public. The site needs federal interest, preferably in flood control or other primary USACE interest.

Analysis of these factors reduced the number of potential sites and highlighted the viability of hydropower in the Waimea Canyon ditch system in particular. The proposed project at Puu Lua-Kitano-Waimea is located in the Waimea Canyon area of Kauai on the existing Kokee and Kekaha irrigation ditch system (see Map 3). This project site effectively meets each of the criteria for a viable hydropower project location discussed above. This area has been identified in nine proposals over the past 40 years as a potential hydropower location, and has two small existing hydropower plants, thus providing an adequate amount of information to allow for further investigation. Analysis shows that energy production at this site would be comparable to existing utility rate. Also, projects in this area are expected to have fewer environmental impacts than other conventional run-of-the-river projects considered, as most plans use a century-old irrigation system and existing reservoirs. Additional site specific characteristics that elevate this site in the rankings include the fact that the proposed project is within the State Land Use Agriculture zone and could be combined with irrigation improvements to reduce costs for farmers. Also, the irrigation system is already constructed, which decreases permitting costs (although not eliminating them completely). Finally, the site

is upstream from a USACE flood control levee which currently does not meet FEMA levee certification requirements of providing protection against the 100 year flood.

OTEC: Optimal OTEC conditions require an annual average temperature difference of about 20 degrees Celsius (°C) between the warm surface water source and the cold water source (typically 1,000 meters in depth). This band of prime temperature differential runs roughly between the Tropic of Cancer and Tropic of Capricorn. Due to the prevailing currents around the State of Hawaii, the leeward coasts are best suited for OTEC with consistently higher temperature differentials than the windward coasts. Even a 1°C change in the temperature differential can yield a 15 percent change in OTEC power output. OTEC systems could be placed anywhere around the Hawaiian Islands, but preferably 10 to 20 kilometers (km) off of their leeward coasts in close proximity to the existing electrical grid. In the State of Hawaii, OTEC is best suited to Oahu, Kauai, and Hawaii. The islands of Maui, Molokai, and Lanai share a shallow shelf that limits development off their leeward and southern coasts. Map 2 shows statewide areas with high resource potential and few constraints on development. There are two potential sites that are recommended for further study. One is located 10 km off Kahe Point on Oahu. This location is within relatively close proximity to the Kahe Point Substation (138 kilovolts [kV]). The second would be at Keahole Point, 10 km off the Kona Coast on Hawaii. This site is within relatively close proximity to the Keahole Point Substation (69 kV).

WEC Sites: Prevailing winds and currents produce good wave conditions on all the northern and many of the windward shores of the Hawaiian Islands. The State of Hawaii's narrow coastal shelf limits wave technology to within one to three km of the shoreline as current WEC systems function in depths of less than 70 meters. In areas with wide continental shelves, WEC systems can be sited in a larger area (DBEDT 2010). Map 2 shows statewide areas with high resource potential and few constraints on development. Siting a WEC near an onshore power substation would optimize the overall cost of this renewable energy resource. Therefore, based on wave conditions, depth, and proximity to substations, there are two potential sites identified in this document, one located at North Beach at Kaneohe Marine Corps Base on Oahu, and at Pauwela on the north shore of Maui.

5. PRIOR REPORTS AND EXISTING PROJECTS

The reconnaissance study began with a literature review of over 50 sources written during the past thirty years. The documents include studies by the USACE, utility companies, the U.S. Department of Energy (DOE), private contractors, the University of Hawaii, and news articles. Sites which passed the initial screening criteria and fell within USACE project areas are listed below and highlighted in Table 1. The complete listing is available in Appendix A. The proposed example projects outlined here were discussed in the following reports:

General Background Information on Hydropower in Hawaii:

- Feasibility of Utilizing Existing Water Systems for Pumped Storage Hydroelectric Systems for the Island of Maui (Cedric D.O. Chong & Associates, Inc. 2007).

Assesses the feasibility of utilizing existing water reservoirs for pumped storage hydroelectric systems to support the continued development of wind energy on the Island of Maui. Existing water reservoirs on the island were identified and screened for potential use as pumped hydroelectric systems.

- Integrated Resource Plan Evaluation Report, 1998 – 2017 (HECO, 2002).

  Provides updates and revised action plans for resource options available for meeting future energy needs within the HECO coverage area, including renewable energies like hydroelectric systems.

- National Hydroelectric Power Resources Study: Regional Assessment: Alaska and Hawaii (USACE 1981).

  Assesses developed and undeveloped hydropower resources in the State and provides a regional ranking specific projects and sites recommended to be studied in further detail.

- Pumped Storage in Hawaii – A Statewide Site Survey (W.A. Hirai & Associates, Inc. 1980).

  Surveys prospective pumped storage sites in the State and provides rough-cut economic analysis for screened sites.

- Renewable Energy Technology Assessments (Black and Veatch 2005).

  Reviews the best options for renewable energy development on Kauai. Chapter on Hydropower provides insight on history of hydro on the island and potential projects.

- Select Hawaii Renewable Energy Project Cost and Performance Estimates (Global Energy Concepts, LLC 2004).

  Provides information on hydroelectric projects identified as part of the Hawaii Energy Strategy.

- Summary Report for Hydroelectric Power, State of Hawaii (USACE 1978).

  Provides reconnaissance-level information for the formulation and evaluation of hydroelectric power facilities on Kauai, Molokai, Maui and Hawaii.

- Technology Assessment: Small Pumped Hydro Storage (Hawaii Renewable Energy Development Venture 2009).

Provides a reference on small hydro developments and existing/proposed projects State-wide.

- U.S. Hydropower Resource Assessment for Hawaii (Francfort 1996).

  Describes the resource assessment results for the State of Hawaii as analyzed in a broader DOE effort to estimate undeveloped hydropower potential in the United States.

- U.S. Hydropower Resource Assessment Final Report (Idaho National Engineering and Environmental Laboratory 1998).

  Describes the resource assessment results for the State of Hawaii as analyzed in a DOE effort (expanded from the 1996 effort) to estimate undeveloped hydropower potential in the United States. This expanded effort analyzed undeveloped potential in the context of various environmental, social and institutional constraints on development.

USACE Island-Specific Reports:

- Hawaii: Flood Control: The Keaiwa-Meyer Reservoir project site is within the Paauau, Hawaii, flood control project area. This includes a levee, hardened walls, floodplain easements and management areas constructed in 1984. This report does not specifically identify potential hydropower sites, but does highlight potential flooding hazards within the area.

- Kauai: Reconnaissance Study: Hawaii Water Management: Pioneer Mill, Kokee Kekaha, East Kauai, Waiahole, Upper and Lower Kula, Kauai, 2005

- Maui: Maui has a variety of USACE reports which covered geographic areas of interest for hydropower. Many potential hydropower projects in Maui called for the use of existing irrigation ditches and/or streams on West Maui for run-of-the-river/run-of-the-ditch systems. Changes and alterations in stream and irrigation flow could have an impact on estimated capacity and costs of these hydropower plants. A specific breakdown of projects and their associated USACE report is available in Table 1.

  - Kahoma Stream Flood Control, Maui

  - Reconnaissance Study: West Maui Watershed Project (includes all of the West Maui drainages from the south at Mā‘alaea, west at Lahaina, north at Honokōhau, and east at Wailuku), 2009.

- Oahu: One project fell within the USACE 1980 Kaneohe-Kailua flood control project area. This includes the Kamooalii-Kaneohe drainage basin, which is bounded on the west and south by the Koolau Mountain Range, on the east by the remnants of

Kaneohe volcanic cone, and on the north by Kaneohe Bay. This report provides general background information on location for a proposed site, but no data specifically for hydropower. The Reconnaissance West Honolulu Watershed Study (2003) provided excellent background information that could be used for sites in the Waikele area, but did not specifically address hydropower topics. Changes and alterations in stream and irrigation flow in this area could have an impact on estimated capacity and costs of these hydropower plants.

Site-Specific Hydropower Reports for Puu Lua Kitano, Kauai

The USBR (2004) report identified the Puu Lua Kitano Kekaha area specifically with maps and data identifying the location of projects, potential capacity, and possible linkages using existing irrigation systems. A Catalog for Potential Sites for Renewable Energy (2006) referenced the Puu Lua Kitano area as a previously identified potential hydropower site, and listed other existing and proposed sites on Kauai. A Black and Veatch (2005) report, commissioned by the KIUC, compiled a listing of all proposed hydropower sites on the island of Kauai, and identified key components such as conceptor, date of plan, capacity, type of system, estimated cost and feasibility. The Puu Lua area was highlighted as "new-promising". The USACE flood control project at Waimea River provides background information on the general location, and highlights the problems associated with flooding and sediment deposition within the Waimea River.

General and site specific reports for ocean renewable energy systems:

- "Wave Energy Resources and Economic Assessment for the State of Hawaii" (Hagerman 1992).

  Assesses Hawaii's wave energy resource. Constraints on development are discussed but not explicitly considered in power calculations.

- "Economics of Ocean Thermal Energy Conversion (OTEC)" (Vega 1992).

  Discusses Hawaii's ocean thermal resource and the potential development of OTEC electricity generators.

- "Ocean Thermal Energy Conversion Primer" (Vega 2003).

  Discusses global ocean thermal resource and the cost and environmental constraints on developing this potential.

6. PLAN FORMULATION

In order to focus USACE planning effort and eventually select and recommend a plan to be authorized by the federal government, the feasibility study will utilize the six planning steps

that are set forth in the Water Resources Council's Principles and Guidelines to focus the planning effort. The six planning steps are: 1) specify problems and opportunities, 2) inventory and forecast conditions, 3) formulate alternative plans, 4) evaluate effects of alternative plans, 5) compare alternative plans, and 6) select a recommended plan. The iterations of the planning steps typically differ in the emphasis that is placed on each of the steps. In the early iterations, those conducted during the reconnaissance phase, the step of specifying problems and opportunities is emphasized. That is not to say, however, that the other steps are ignored since the initial screening of preliminary plans that results from the other steps is very important to the scoping of the follow-on feasibility phase studies. The sub-paragraphs that follow present the results of the initial iterations of the planning steps that were conducted during the reconnaissance phase. This information will be refined in future iterations of the planning steps that will be accomplished during the feasibility phase.

a. NATIONAL OBJECTIVES:

1) The national or federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements. Contributions to National Economic Development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. Hydropower and ocean energy production in the State of Hawaii can be used to decrease reliance on imported fuels and minimize environmental impacts due to petroleum power generation. Investments in wave and ocean thermal energy systems can be used to produce new technologies for the nation while providing energy security for the islands.

2) Flood control is a primary objective of the USACE. Conventional hydropower sites may be located within areas of known flood hazards. As the administrator of the National Flood Insurance Program (NFIP), FEMA is responsible for assessing flood hazards and related risks nationwide. However, FEMA relies on communities, State agencies, and Federal agencies to construct or restore flood protection systems, such as levees, in an effort to meet new guidelines for each levee system to be 1-percent-annual-chance flood protection listed in Section 61.12 and Section 65.14 of the NFIP regulations. (FEMA 2010) Pursuing USACE secondary interests in hydropower also have the potential to fulfill primary concerns involving flood control.

3) Navigation is also a primary concern for the USACE. The navigation mission is to provide safe, reliable, efficient, effective and environmentally sustainable waterborne transportation systems for commerce, national security, and recreation. The development of hydropower must also consider implications on this USACE national initiative.

4) Conventional hydropower projects may potentially be located on an existing irrigation system. Thus by keeping irrigation systems operational, hydropower indirectly has the potential to promote agriculture in the State of Hawaii, a state that lacks food security and imports the majority of its goods. Additionally, hydropower also has the potential to affect farmland being used for biofuel feedstock production, which may provide an additional alternative energy source for meeting the Clean Energy Initiative Goals for the State of Hawaii.

b. PUBLIC CONCERNS:

A number of public concerns have been identified during the course of the reconnaissance study. The concerns outlined below were identified through review of prior reports and public comments on those reports. Additional input was received through coordination with DBEDT and potential sponsor(s), and some initial coordination with other agencies. The public concerns that are related to the establishment of planning objectives and planning constraints are:

1) Endangered Species and Critical Habitat: The State of Hawaii has the greatest number of endangered and threatened species of any state in the U.S. Due to the unique geography and isolation many species are endemic to the State of Hawaii. Development of sites can potentially introduce non-native species to a region/watershed and/or negatively affect existing species. See Appendix D for an endangered species list and pertinent agency communications.

2) Cultural: Loss or alteration of water resources may impact traditional, cultural activities for Native Hawaiians. This may include streams that have physical structures, heiau, taro lo‘i, fishponds, homesteads, gravesites, etc., and those that have additional religious, cultural, or historic significance.

3) Recreation/Tourism: The public could object to the continued use of water for irrigation and hydropower rather than having this returned to the streams. Wave energy sites may be close to shore, obstructing views, and limiting access for water sports and fishing. OTEC could be visible from shore, and long-term fishing impacts are unknown.

4) General: There is a public distrust of dams due to the deadly Kaloko Dam failure in 2006. The public may have safety and maintenance concerns and objections to construction.

5) Cost: The public and government will object if hydropower and ocean energy result in higher electricity costs. Relining reservoirs and constructing access roads can be challenging and costly. Funding may not be available or may be variable.

6) Legal: There is currently on-going streamflow litigation for some streams in the state, which could have impacts on future allotments of water use. Recent DLNR inspections have concluded that most reservoirs in the State of Hawaii are in need of repair. This will increase the cost associated with reservoir-based projects.

7) Agricultural: Irrigation waters could be reduced or altered during construction of hydropower projects. Demands could change based on the type of agriculture being pursued.

c. PROBLEMS AND OPPORTUNITIES:

The evaluation of public concerns often reflects a range of needs that are perceived by the public. This section describes these needs in the context of problems and opportunities that can be addressed through water and related land resource management.

1) Problems:

- The State of Hawaii has limited fossil fuel energy resources, and must import virtually all of its energy from thousands of miles away. The high cost of imported oil leaves the State vulnerable to price fluctuations and interruptions in supply.
- The State of Hawaii currently produces a small amount of renewable energy, and must produce 40 percent in twenty years per recent legislation (Hawaii Revised Statutes [HRS] 269-91 Renewable Portfolio Standard including ACT 155 (09), HB 1464: Clean Energy Omnibus Bill 2009).
- Drainage areas in the State are small and have a relatively short distance from the headwaters to the ocean.
- Many streams in Hawaii have variable stream flow that could pose problems for power production during low rainfall periods.
- Conventional hydropower projects can change the hydrology in a watershed with changes in release time periods, frequencies and amounts. This change in the hydroperiod can adversely impact groundwater recharge, which is a concern especially in areas under drought conditions or with declining groundwater reserves.
- The State of Hawaii has limited and isolated electrical grids. Though interconnections are currently in the planning stages, at present each island must produce all of its own energy. Each island has gaps and lacks storage capability within their own grid, limiting total non-firm inputs. This presents concerns in response to natural disasters such the 2006 earthquake originating off the coast of Hawaii which caused blackouts on several of the major islands.
- The State of Hawaii has more rare and endangered species than any other state, including forests birds, terrestrial invertebrates, freshwater and marine fish, and various flora. Development must be carefully situated to not damage habitat or increase invasive species.
- Development is limited in protected areas around the state, including state and federal parks and ocean areas such as the Hawaiian Islands Humpback Whale National Marine Sanctuary. Essential Fish Habitat and coral reefs will be of concern for ocean or nearshore related activities. Hydropower proposals located in State of Hawaii Class 1a or 1b waters would result in conflict with the State Department of Health over appropriate use of these waters.

- Stream and ocean waters can have high cultural values and use for Native Hawaiians. Significant cultural opposition can be anticipated for many large development projects. Water rights and usage is a hotly contested issue in the State of Hawaii, and citizen groups are active and vocal in this regard.
- State residents would be opposed to developments that limit their recreational and/or cultural use of streams and ocean sites.
- OTEC and WEC are new technologies that require additional research and development (R&D) for large-scale commercial viability.
- No first generation WEC systems are cost competitive in the State of Hawaii. Present cost-competitiveness for intermittent non-dispatchable electricity in the State of Hawaii is less than $0.12/kWh.
- There is a lack of consistent funding that is required for industry to proceed from concept design to the required pre-commercial demonstration phase for OTEC technology.
- Constructing new power plants requires multiple permits from federal, state and local governments and agencies.
- Procedures for executing permits and approvals are constantly changing. The State does not offer a uniform, streamlined process for fulfilling permitting requirements.
- The Public Utilities Commission approval of power purchase agreements can take one year or longer.
- There have been few ocean energy projects and the permitting process is not clearly defined or well established for these systems. For example, for wave energy projects to be located on the outer continental shelf (OCS), the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), formerly Minerals Management Service (MMS) of the Department of the Interior (DOI) will issue leases, easements, and rights-of-way and will conduct any necessary environmental reviews including those under the National Environmental Policy Act (NEPA). The Federal Energy Regulatory Commission (FERC) has exclusive jurisdiction to issue licenses and exemptions for the construction and operation of wave energy projects and will conduct any necessary analyses, including those under NEPA, related to those actions. FERC, however, will not issue a license or exemption until the applicant has first obtained a lease, easement, or right-of-way from BOEMRE. Moreover, BOEMRE and FERC can choose to become a cooperating agency in the preparation of any environmental document required under either process. This does not preclude other DOI agencies (e.g., United States Fish and Wildlife Service, National Oceanographic Atmospheric Administration, the National Park Service, and the Bureau of Indian Affairs) from intervening. This situation could lead to the requirement of two distinct Environmental Impact Statements (EISs) (although similar in content): one for BOEMRE and subsequently another for FERC.

2) Opportunities:

- The State of Hawaii has high rainfall, steep temperature gradients between shallow and deep ocean waters, and a favorable wave climate. These resources provide favorable conditions for ocean and hydropower. Tapping into these resources could provide a large percentage of renewable energy for the State. Increases in renewable energy could provide consumers with stable utility rates rather than variable oil pricing.
- As part of the Hawaii Clean Energy Initiative (HCEI), DBEDT, with assistance from various Hawaii state and county agencies, federal agencies, the U.S. Department of Energy (National Renewable Energy Laboratory), and private stakeholders, is developing A Guide to Renewable Energy Facility Permits in the State of Hawaii. This guide provides the first comprehensive overview of the renewable energy permitting process in the State of Hawaii. Until the Guide is complete in early 2011, existing drafts are available on the HCEI website. Resource-specific sections have been created to provide federal and state approvals for hydroelectric and marine/ocean thermal energy conversion, while four other sections provide county-specific information. At the end of each draft guidebook currently available to the public, there is a checklist to determine which permits/approvals may be required for a specific project. To compliment the Guide, DBEDT and PB Americas are developing an online Permit Wizard linked to the HCEI website, also expected to be complete in early 2011, which will enable users to generate a permit plan for any project based on project-specific information provided by the developer/user. DBEDT is also assisting other state agencies to provide online permitting ability. While these resources are a good starting place for developers, laws, legislation, and procedures for executing these permits and approvals are constantly changing. Currently the State is developing a streamlined process for fulfilling permitting requirements as set forth under HRS 201N. To help meet Hawaii's aggressive clean energy goals, county, state, and federal agencies in Hawaii are working to expedite permit processing for renewable energy and energy efficiency projects.

<u>Hydropower</u>:

- Hydropower is a well-known technology that is scalable and durable. Hydropower systems can be combined with additional USACE projects for flood control, water supply, and sediment management.
- There is a long history of hydropower in the State. Historically, plantations in the State operated small hydropower turbines to pump irrigation water to upper fields. As energy prices declined, many of these systems fell into disrepair. Recent increases in energy costs may make these small systems feasible once again.
- Combining energy production with existing irrigation systems could help reduce costs for farmers. Systems could be combined to produce diversified agriculture and/or biofuels.

- Small hydropower can be used to bolster electricity in isolated areas in the State of Hawaii.
- Pumped storage hydropower can work in tandem with abundant non-firm energy in the State (solar, wind) to work as a battery for this system.

OTEC and WEC:

- The State of Hawaii has limited high-technology jobs; a new energy technology test zone could spur job growth and research in the energy technology sector.
- WEC and OTEC systems have the potential to capture large amounts of clean, local, renewable energy for the State, and serve as an example for other energy projects worldwide.
- The military is the Hawaiian Electric Company's (HECO) largest customer, and offshore projects in military-use waters could reduce military energy expenditures. The WEC project at Kaneohe could produce 20 percent of the energy needs of the Marine Corps Base. Closed system OTEC could produce up to 100 megawatts (MW) of energy due to pipe intake limitations. Open system OTEC could generate up to 2.5 MW, but has the added benefit of dual function as a power plant and desalinization plant (Hagerman 1992; Vega 2003).
- Creating centralized energy hubs could reduce costs by consolidating infrastructure. Streamlining site-specific permitting requirements can enable energy developers to simply connect to the grid.
- Resource energy zones could identify ocean energy resource hotspots, and allow for a coordinated and streamlined permitting process within these areas, reducing risk and cost for pilot projects.
- Ocean energy is experimental, but is carbon neutral. It could produce energy with minimal impacts on limited land resources, minimizing historical/cultural and terrestrial habitat degradation.
- An ocean renewable energy zone (OREZ) could allow developers to focus the process of developing energy in acceptable and permitted sites. This could be combined with an energy hub to reduce electrical infrastructure costs. OREZ zones and hubs could be set up to avoid sensitive marine habitat and recreational use areas.

3). Expected Future Condition for No Action Alternative

The State is currently using imported oil to meet 95% of the energy demands. The State hopes to increase the amount of renewable energy to 40% by the year 2030 to meet the energy needs. This will be done though the implementation of different types of renewable energy potentially including wind, ocean, solar, geothermal, hydroelectric and biomass energy. If no action is taken to develop the hydropower energy resources available in the State, the burden of meeting the State mandate of supplying 40 percent of the State's energy through renewable sources will fall on wind, solar, and geothermal resources. Opportunities to combine hydropower systems with additional USACE projects for flood control, water supply, and sediment management will not be realized. Opportunities to combine energy

production with improvements to existing irrigation systems to help reduce costs for farmers will also not be realized. The State will lose the opportunity to become a world leader in ocean energy by not taking advantage of the favorable development conditions found in the Hawaiian Islands. This will also result in the loss of potential high-technology jobs in the State.

d. PLANNING OBJECTIVES:

The Federal objective of contributing to the national economic development while protecting the nation's environment provides the foundation for the specific planning objectives of this study. The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes.

The goal of this reconnaissance study is to identify federal interest in proceeding with feasibility phase for potential hydropower and ocean energy sites in the State of Hawaii to help the State of Hawaii reach their Clean Energy Initiative goal of 40 percent renewable energy by 2030. The Hawaii Hydroelectric Power Source Alternative Assessment feasibility study goal is to identify methods to be implemented that reduce Hawaii's reliance on petroleum through an increase in hydropower and ocean energy power. This 905(b) focuses on four projects from the initial screening:

- Puu Lua-Kitano-Waimea Hydroelectric Plant, island of Kauai,
- Wave Energy Conversion (WEC) Technology Test Hub Kaneohe Bay (Offshore of Kaneohe Marine Corps Base – Hawaii), island of Oahu,
- Ocean Thermal Energy Conversion (OTEC) facility, offshore of Kahe Point, Island of Oahu, and,
- OREZ for WEC/OTEC development throughout the State of Hawaii.

Objectives supporting this goal include, but are not limited to:

1) Reduce reliance on petroleum for energy needs. The State currently derives 60 percent of its electricity from oil burning power plants. Coal and waste incineration also provide energy in the State, but the percentage of renewable energy sources has decreased over the past forty years due to bagasse and hydropower reductions. As part of Hawaii's Clean Energy Initiative with DBEDT, DOE, and the associated utilities, the State has a goal of producing 70 percent clean energy by 2030 with 30% from efficiency measures and 40% from locally generated renewable sources. Given that the State has the highest energy costs in the nation, projects that may seem challenging or too expensive on the continental U.S. may be cost-effective in the State of Hawaii. Local energy systems will keep money in the State.

2) Combine needed system updates for flood control, water supply, and water quality with new energy systems, maximizing the system's value.

3) Combine energy production with existing infrastructure or projects, minimizing new impacts on the land, and allowing agriculture to function in tandem with energy production.

4) Streamline permitting through identified ocean renewable energy resource zones to decrease cost and risk for ocean energy developers and help the State to preserve its natural resources.

5) Encourage utilization of ocean energy potential production or R&D by developing physical energy hubs would allow new energy systems to link more quickly and easily into the existing electrical grid by sharing costs for transmission lines, substations, and permits.

e. PLANNING CONSTRAINTS:

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in this study include, but are not limited to:

1) Compliance with county land use plans and zoning:

- County of Kauai: Kauai General Plan
- County of Maui: General Plan 2030
- County of Hawaii: County General Plan
- Hawaii County Water Use and Development Plan

2) Applicable Executive Orders, Statutes, and Regulations including:

<u>National:</u>

- Clean Water Act
- Clean Air Act, Sction 176(c)
- Coastal Zone Management Act
- Comprehensive Enviromental Response Compensation, and Liability Act (CERCLA)
- Endangered Species Act
- Energy Policy Act
- Environmental Protection Agency's General Conformity Rule (58 Federal Register 63214, 30 Nov 93)
- Federal Power Act
- National Energy Act
- National Environmental Policy Act (NEPA)
- National Historic Preservation Act
- National Marine Fisheries Service

- National Oceanic and Atmospheric Administration (NOAA)
- Marine Mammal Protection Act
- Minerals Management Service (MMS) Final Rule on Renewable Energy and Alternative Uses of Existing Facilities on the Outer Continental Shelf
- Bureau of Ocean Energy Management, Regulation and Enforcement BOEMRE regulations
- Outer Continental Shelf Lands Act
- Marine Protection, Research and Sanctuaries Act, Section 103
- Submerged Lands Act
- U.S. Fish and Wildlife Coordination Act

State:

- HRS 205: Land Use Commission
- HRS 205a: Coastal Zone Management and associated Ocean Resources Management Plan
- HRS 343: Environmental Impact Statements
- HRS Title 12: Conservation and Resources, which includes but is not limited to:

    - HRS Chapter 174C: State Water Code
    - HRS Chapter 179: Dams and Reservoirs
    - HRS Chapter 183-184: Forestry and Wildlife, Recreation Areas
    - HRS 201N Renewable Energy Facility Siting Process
    - HRS 269-91 Renewable Portfolio Standard including ACT 155 (09), HB 1464: Clean Energy Omnibus Bill 2009

- Hawaii Administrative Rules (HAR) 11-54: Water Quality Standards
- HAR 11-200: Environmental Impact Statement Rules
- HAR 13-167 to 13-171 : Department of Land and Natural Resources (DLNR) Commission on Water Resource Management
- HAR 13-190: Dams and Reservoirs
- HAR 15-36: Renewable Energy Facility Siting Process
- State of Hawaii House Bill 1351 HD 2 SD1 CD 1 Act 122 (09) Relating to Private Agricultural Parks
- State of Hawaii Public Utilities Commission Regulations

USACE:

- EC1165-2-209 Civil Works Review Policy
- EM 1110-2-1304 Civil Works Construction Cost Index System
- EM 1110-2-1701 Hydropower
- EM 1110-2-3600 Management of Water Control Systems
- EM 1165-2-1 Digest of Water Resources Policies and Authorities
- EM 1110-2-3001 Planning and Design of Hydroelectric Power Plant Structures

- ER 385-1-31 Safety and Occupational Health The Control of Hazardous Energy
- ER 1105-2-100 Planning Guidance Notebook
- ER 1110-2-1150 Engineering and Design for Civil Works Projects
- ER 1110-2-1 Provisions for Future Hydropower Installations at Corps of Engineers Projects
- ER 1110-2-1454 Corps Responsibilities for Non-Federal Hydroelectric Power Development Under the Federal Power Development Act
- ER 1110-2-1460 Hydrologic Engineering Management
- ER 1110-2-1463 Hydrologic Engineering for Hydropower
- ER 1110-2-4401 Engineering and Design Clearances for Electric Power Supply Lines and Communication Lines over Reservoirs
- ER 1130-2-510 Hydroelectric Power Operations and Maintenance Policies
- ER 1165-2-114 Use of Excess Power Revenues to Assist in Repayment of Irrigation Costs
- EP 1130-2-510 Hydroelectric Power Operations and Maintenance Guidance and Procedures
- EP 1165-2-316 Rules and Regulations Governing Public Use of Corps of Engineers Water Resources Development Projects.

f. MEASURES TO ADDRESS IDENTIFIED PLANNING OBJECTIVES:
This study looked at the statewide potential to produce hydropower and ocean energy. A wide variety of sites and projects were considered, some of which were found to be infeasible due to technical, economic, or environmental constraints. Each measure was assessed and a determination made regarding whether it should be retained in the formulation of alternative plans. Additional applicability to existing or proposed USACE projects was also considered. The descriptions and results of the evaluations of the measures considered in this study are presented below. The sites that have a Federal interest and have passed the screening criteria are listed in Table 1.

Preliminary Scenarios to Address Identified Planning Objectives:

1) No Action. The USACE is required to consider the option of "No Action" as one of the alternatives in order to comply with the requirements of NEPA. No Action assumes that no project would be implemented by the federal government or by local interests to achieve the planning objectives. No Action, which is synonymous with the Without Project Condition, forms the basis from which all other alternative plans are measured. In this scenario, the State could choose to develop other sources of alternative energy to meet their renewable energy goals.

2) Non-Structural:

The State is in the process of promoting energy efficiency under Hawaii's Renewable Portfolio Standard law. The State can reduce its energy needs by increasing energy efficiency, limiting growth, and actively promoting energy

conservation. This would not produce additional energy or lessen the State's reliance on primarily importing oil for power production.

OREZ: An OREZ would designate waters off the coast of the Hawaiian island as pre-permitted areas for ocean energy technology development. Ocean energy technologies are new and will require continued R&D. An OREZ area would enable R&D and/or developers to get projects in the water by reducing permitting costs. Current permitting involves overlapping federal, state, and county jurisdictions, and may result in multiple EISs for the same location. DBEDT is currently working on coordinating federal, state, and county agencies to streamline permitting for ocean renewable energy site(s). These improvements could attract R&D and/or new developers by reducing their risk and permitting costs by agreeing to develop within a particular location with shared infrastructure. OREZ should allow for projects to get into production faster and contribute to the renewable energy needs of the State.

3) Structural:

Hydropower and ocean energy projects will all have a structural component. There are several types of hydropower systems; conventional storage, which uses a dammed river, run-of-the-river/ditch, which uses a penstock to capture flow without a dam, and pumped storage, which uses two connected reservoirs. In pumped storage, the system operates as a peak time battery, pumping water uphill during periods of low demand, and releasing it during periods of peak demand. Traditional storage and run-of-the-river can negatively impact stream hydrology and habitat. Hydropower structural impacts can be minimized by using existing reservoirs for pumped storage and irrigation ditches in place of natural streams. Existing reservoirs and ditches are expected to have lower biotic activity due to isolation from natural streams and channelization, reducing potential environment impact as compared to natural water bodies and channels. In addition, use of existing structures is expected to be more acceptable from the community's perspective as compared to building new structures. Existing hydropower plants could be updated, as modern hydropower turbines have greater efficiency than the currently operating systems. Turbines can be installed in operating irrigation ditches.

OTEC and WEC: In addition to non-structural permitting improvements, OTEC and WEC could benefit from construction of substation or electric hub. This would be sited to allow for multiple pilot and commercial devices to be linked to the existing energy grid, sharing costs for substations, transmission lines, and permitting. Potentially significant concerns are related to the construction of a hub. These are similar to those associated with the construction of any power plant, shipbuilding and the construction of offshore platforms. This technology may require anchoring to the seabed, and both systems need an undersea cable to connect to the existing electrical grid.

There are numerous WEC concepts discussed in the literature which range from simple sketches to reports of at-sea tests. Some are shoreline based[1] while others are seabed-mounted or moored in depths of less than 70 m. According to their directional characteristics they can be classified as point absorbers, terminators and attenuators. Point absorbers have dimensions that are small relative to ocean wave lengths and are usually axis-symmetric[2]. The principal axis of terminators is aligned perpendicular to the direction of wave propagation and in the case of attenuators[3], parallel to the direction of propagation. These have dimensions in the order of the wave lengths.

WECs currently applicable in the State of Hawaii can be categorized under two operating principles: oscillating water column (OWC); and, wave-activated. The OWC devices use wave action to expand and compress air above a water column, to rotate an air turbine-generator (e.g., the Oceanlinx project, planned for installation off Pauwela, Maui by 2012, sized at less than 2.7 MW). The wave-activated devices oscillate due to wave action relative to a fixed part of the device and use a hydraulic system to turn a motor-generator; or a linear generator that generates electricity by moving a magnetic assembly within a coil; or direct rack and pinion mechanical coupling.

g. PRELIMINARY SITES:

Preliminary sites are comprised of one or more management measures that met the initial screening criteria. The descriptions and results of the evaluations of the preliminary plans that were considered in this study are described below:

1) Preliminary Sites Eliminated from Further Consideration:

Conventional Hydropower:

Upon analysis of the sites throughout Hawaii, a list of sites that had a Federal interest and passed the preliminary screening criteria are listed in Table 1. The criteria used in the Section 905(b) Analysis for conventional hydropower included economic feasibility, environmental impacts and social acceptance. Economic feasibility was based on calculated cost per kilowatt hour (kWh). Projects with high cost per kWh were eliminated from the economic ranking. The current HECO rate of $0.25 on Oahu was used as a cut off for these projects. Environmental/social impacts were calculated independently from costs. This allows for separate rankings that include the entire site inventory in case costs or other factors change. Sites were eliminated if the original documentation listed them as unfeasible due to the pristine nature of the site and/or high tourism/recreational use value. This includes sites with known native or endangered species habitat and locations within national refuges. These sites also include plans which fell into critical habitat areas, HAR 11-54

[1] The 500 kW OWC Limpet (Land Installed Marine Powered Energy Transformer) has been operational since 2000.
[2] The 40 kW OPT heaving buoy is currently under testing in Kaneohe Bay, Oahu, State of Hawaii.
[3] The 3rd generation Pelamis (~ 500 kW) is scheduled for deployment at the European Marine Energy Center (EMEC) in 2010.

specified Class 1a or Class 1b waters, and streams listed on the State GIS 1990 Hawaii Stream Assessment as High Cultural Value. For a complete description of methodology and statewide listing of sites, see Appendix A and the Technical Appendix.

Ocean Energy:

Ocean energy sites can be potentially sited in a much larger ocean area and are not characterized by the same site-specific problems as conventional hydropower. To identify feasible areas for ocean energy development, areas within Class AA marine waters and marine life sanctuaries were eliminated. A two nautical-mile buffer was established around harbors to minimize boating interference. Recreational user conflicts would be low for OTEC due to the distance from shore, but wave energy sites would need to be examined on a site specific basis. For a complete description of methodology and statewide listing of sites, see the Technical Appendix.

2) Preliminary Sites for Further Consideration:

Conventional Hydropower:

For a complete listing of sites see Appendix A. A shortlist of other potential conventional hydropower sites that passed the initial screening is presented in Table 1. These projects have fewer known environmental concerns, low economic costs per kilowatt, and identified federal interest. These sites are also presented in Map 1.

Based on the scope and budget of this effort, we could only afford to analyze one location. The Puu Lua-Kitano-Waimea Hydroelectric Plant on Kauai was recommended for further feasibility study based on the availability of detailed project information as well as conformity with USACE interests and other favorable environmental, social and economic attributes. Its listing in this document should not preclude a closer examination of the sites listed in Appendix A. This area includes multiple proposals over the years with various powerhouse locations along an existing irrigation ditch network. This reduces overall environmental impacts on the site, and provides multiple uses of the water in the valley. The scale of a hydropower project in the area can vary from upgrading existing hydropower plants, the construction of a single 1.7 MW system, two 3 MW projects, or a combination of these projects. Potential energy production ranges from 1.7-8 MWs, increasing the percentage of renewable energy on the island by 12-50%. The incremental energy costs are lower due to existing infrastructure and access, and vary from four to six cents per kilowatt hour. The Puu-Lua Kitano site is of federal interest, as flood control and water management projects can be combined with hydropower systems.

Ocean Energy:

Based on the research presented in the Technical Appendix and the screening of ocean energy projects, the following projects were recommended for further feasibility study:

- WEC technology test hub off Kaneohe Marine Corps Base Hawaii, Oahu
- OTEC off Kahe Point, Oahu
- OREZ for WEC/OTEC development in the State of Hawaii

3) Alternative Implementation Authorities: USACE, in partnership with other federal agencies (DOE, Department of Defense, NOAA, etc.), and the State of Hawaii and/or county sponsors believe that investment in wave and ocean energy will help create new jobs, reduce energy imports, reduce energy-related emissions, and ensure that the U.S. maintains a technological lead in developing advanced energy technologies. The State of Hawaii is an opportune location because of the abundant renewable resource potential of waves and the large dependency on imported oil for power generation.

h. CONCLUSIONS FROM PRELIMINARY SCREENING:

Table 1 presents a complete listing of potential conventional hydroelectric projects that cleared the preliminary screening and have identified federal interest (as described above in Section 6 (g) (1)) This includes costs which are lower than current $0.25/ kWh rates, accessibility, and lower environmental/social considerations based on state water classifications, endangered species, cultural concerns, and tourism. The Puu Lua-Kitano-Waimea project has the potential for implementation under the reconnaissance study guidelines. This proposal was conceived by the U.S. Bureau of Reclamation (USBR) in 2004, and considered feasible by the Kauai Island Utility Cooperative Renewable Energy Technology Assessments Report (Black and Veatch, 2005). The project would use two powerhouses in order to produce three to seven MW.

Table 1 - Traditional Hydroelectric Projects with a Federal Interest and Passing Screening Criteria

Operating Plants

SITE ID (NUMERICAL)	PROJECT NAME	ISLAND	TYPE OF PROJECT	CALCULATED CAPACITY	% HYDRO/ISLAND	% RENEWABLE ON ISLAND	% INCREASE IN RENEWABLES	INCREMENTAL ENERGY COST (2011$/kWh)			FEDERAL INTEREST	Environmental/Social Concerns
--	--	--	--	MW	Calculations are based on current MW capacity plus project MW capcity			From Source	INL Calculated	Used for Screening		
85	Keaiwa-Meyer Reservoirs	Hawaii	ROTR	0.280	2%	0%	0%	N/A	0.09	0.09	Yes Flood Control Paaua Stream	Medium
155	Waimea / Kakaha Mauka Powerhouse	Kauai	Operating ROTR	2.900	25%	17%	21%	0.014	0.06	0.01	Yes Water Management Flood Control 2005	Low
50	Kekaha-Waimea	Kauai	ROTR	1.700	16%	11%	12%	0.04	0.06	0.04	Yes Flood Control 2003 Water Management 2005	Medium
156	Hydro Kaumakani - Makaweli (Waiahi Gay & Robinson)	Kauai	Operating ROTR	0.750	8%	5%	5%	N/A	0.04	0.04	Yes Hydropower Feasibility 1980	Low
73	Kitano-Waimea - Waimea Makai Powerplant	Kauai	ROTD	2.900	25%	17%	21%	0.05	0.07	0.05	Yes Water Management Flood Control 2005	Medium
145	Lower Lihue/Waiahi Powerplant	Kauai	Operating ROTD	1.100	11%	7%	8%	N/A	0.06	0.06	Yes USBR	Low
117	Waimea	Kauai	Storage	1.500	14%	10%	11%	N/A	0.06	0.06	Yes Flood Control 2005	Medium
74	Puu Lua-Kitano	Kauai	ROTD	2.970	25%	18%	21%	0.06	0.06	0.06	Yes Water Management Flood Control 2005	Medium
99	Mana Ridge (3rd phase)	Kauai	ROTD	2.000	18%	13%	14%	N/A	0.07	0.07	Yes Hydropower Feasibility 1980	Medium
56	Puu Lua-Kokee, Phase 1 (Kitano Hydro)	Kauai	ROTD	1.650	16%	11%	12%	0.07	0.08	0.07	Yes Water management Flood Control	Medium
146	Upper Lihue (Waiahi) Power Plant	Kauai	Operating ROTD	0.800	8%	5%	6%	N/A	0.070	0.07	Yes USBR	Low
91	Puu Opae (2nd phase)	Kauai	ROTD	0.700	7%	5%	5%	N/A	0.07	0.07	Yes Water Management 2005	Medium
68	Kokee Ditch	Kauai	ROTD	0.430	5%	3%	3%	N/A	0.08	0.08	Yes Water Management 2005	Medium
95	Wailua Reservoir (Above)	Kauai	ROTR	0.309	3%	2%	2%	0.101	0.10	0.10	Yes USBR	Medium
106	Kokee Water Project	Kauai	Storage		0%	0%	0%	0.14	0.09	0.14	Yes Water Management 2005	Medium
111	Puu Lua Reservoir	Kauai	Storage	1.700	16%	11%	12%	0.149	0.208	0.15	Yes Water Management 2005	Medium

Operating Plants

SITE ID (NUMERICAL)	PROJECT NAME	ISLAND	TYPE OF PROJECT	CALCULATED CAPACITY	% HYDRO/ISLAND	% RENEWABLE ON ISLAND	% INCREASE IN RENEWABLES	INCREMENTAL ENERGY COST (2011$/kWh)			FEDERAL INTEREST	Environmental/Social Concerns
--	--	--	--	MW	Calculations are based on current MW capacity plus project MW capcity			From Source	INL Calculated	Used for Screening		
59	Wainiha	Kauai	ROTR	0.430	5%	3%	3%	0.24	0.06	0.24	Yes Hydropower Feasibility 1980	Medium
162	Alexander Reservoir {1,2, 28}; Kalaheo {5, 6, 25, 29, 32}	Kauai	Operating ROTR	0.085	1%	1%	1%	N/A	0.13	0.13	Yes Hydropower Feasibility 1980	Low
11	Honokawai	Maui	Pumped Storage	30.000	476%	36%	56%	0.03	0.04	0.03	Yes Watershed Management 2009	Low
29	Kaheawa Windfarm PSH	Maui	Pumped Storage	50.000	794%	48%	94%	N/A	0.04	0.04	Yes Watershed Management 2009	Medium
27	Option 1 - Pioneer Mill Co. (See 147 Makila Hydro for dual reference)	Maui	Pumped Storage	14.681	233%	22%	28%	0.04	0.04	0.04	Yes Water Management Recon 2005	Low
26	Kahoma	Maui	Pumped Storage	30.000	476%	36%	56%	0.04	0.04	0.04	Yes Watershed Management West Maui 2009 /Flood Control completed 1990	Medium
12	Option 2 - Kaanapali Development	Maui	Pumped Storage	6.878	109%	11%	13%	#DIV/0!	0.05	0.05	Yes Watershed Management 2009	Low
121	Wailoa Ditch	Maui	Storage	1.900	30%	3%	4%	N/A	0.06	0.06	Yes potential water management	Medium
4	Puu Moe/Maalaea	Maui	Pumped Storage	30.000	476%	36%	56%	0.09	0.04	0.09	Yes Watershed Management West Maui 2009	Medium
25	Lahaina PSH	Maui	Pumped Storage	10.700	170%	17%	20%	0.09	0.04	0.09	Yes Watershed Management 2009	Medium
154	HC&S Wailoa Ditch Hydropower - Hamakua	Maui	Operating ROTD	0.500	8%	1%	1%	N/A	0.10	0.10	Yes potential water management	Low
43	Option 4 - DWS - Kula Agricultural Park	Maui	Pumped Storage	7.174	114%	12%	13%	0.10	0.05	0.10	Yes Watershed Management	Medium
28	Kahoma Reservoir/Crater Reservoir	Maui	Pumped Storage	4.300	68%	7%	8%	0.106086751	0.13	0.11	Yes Watershed Management 2009/Kahoma Stream	Low
66	Honokohau Ditch	Maui	ROTD	0.130	2%	0%	0%	N/A	0.11	0.11	Yes Watershed Management 2009	Medium
115	Waikele	Oahu	Storage	0.430		1%	1%	N/A	0.08	0.08	Yes Watershed Management West HNL Study	Medium
19	Nuuanu Reservoir/Kaneohe-Kailua Reservoir	Oahu	Pumped Storage	9.600		13%	15%	#DIV/0!	0.12	0.12	Yes Flood Control 1980	Medium
88	Pearl Harbor Spring	Oahu	ROTR	0.080		0%	0%	N/A	0.13	0.13	Yes Watershed Management Central Oahu Study	Low

The upper component would use the existing upper Puu Lua reservoir as the intake, with a powerhouse located at the lower Kitano reservoir. The lower component would use the Kitano reservoir as the intake with a powerhouse and discharge to the lower Waimea River or existing irrigation system (USBR, 2004). Two small additional powerhouses would be located along this lower buried penstock to recover energy for irrigation pumping, but not to generate electricity for general consumption. Map 3 presents the major components of the proposed system. The reservoir intakes and flumes would be upgraded, and the open ditches would be replaced with buried pipes. An access road may need to be constructed along portions of the ditch above Kekaha.

The Puu Lua Reservoir, built in 1925, can store 262 million gallons and was rated as a low potential hazard by DLNR. The reservoir does not have a spillway. DLNR and the USACE recommended general maintenance, removing trees, identifying ponding sources, and determining if a spillway is needed. The Kitano Reservoir, built in 1928, can store about 289 million gallons. The reservoir had a limited visual inspection in 2006, and was listed as no immediate threat. The spillway was noted as requiring corrective action (DLNR, 2006). If the reservoirs are used, both should be lined to minimize leakage.

This project has additional interest for the USACE, State, and local users. Construction of this project could be combined with other system upgrades for cost efficiency and multiple benefits.

- Flood Control: The Puu Lua-Kitano-Waimea project is located in a sediment-heavy watershed that is prone to flash flooding. The upper reservoir no longer meets DLNR standards. The Waimea River Flood Control Project does not meet current FEMA levee certification requirement of providing protection against the 100 year flood. Updating and managing this system could reduce the risk of flooding and decrease siltation maintenance costs.
- Water Quality and Navigation: Sediment deposition in the Waimea River is problematic not only for flood control, but for water quality in the river and coast. The sediment also contributes to the siltation of the nearby Kikiaola Light Draft Harbor. To address these problems, the USACE is working on the Kekaha Regional Sediment Management study (USACE, 2010).
- Irrigation: The irrigation system was built and maintained by Kekaha Sugar until 2000 when operations ceased. It is currently managed by the Kekaha Agriculture Association. The federal government has authorized funds to update the system through the Hawaii Water Management Project. The construction contract for this project is expected in 2012.
- Military: The 28 mile long Kekaha Ditch system prevents flooding in the low-lying area and roadways surrounding the Pacific Missile Range Facility in Polihale. Keeping the ditches in use would encourage agriculture in the area and maintain a buffer between development and military uses. As this area is used for ballistic missile testing, the military would prefer it remain undeveloped.
- Energy: Maintaining the irrigation system allows for the potential growth of biofuels, including ethanol production. Ethanol could be used for electrical

production, and to fulfill a 2006 State mandate that requires gasoline to contain 10 percent ethanol.

The potential magnitude and types of benefits from the proposed actions would reduce reliance on imported oil and help the State of Hawaii reach their renewable energy goals. The conventional hydropower project recommended would likely have a minimal impact on native species, streamflow, and recreation as it is within an in-use irrigation system rather than a pristine river. This project could be combined with existing USACE projects within the watershed to help with flood control and sediment and irrigation management.

The Department of Hawaiian Homelands has a claim for 30% of potential water in the area. This should not limit the project, as run-of-the-river-systems allow water to be used downstream for secondary purposes.

Ocean thermal energy systems can be grouped by use within OREZ and energy hubs to reduce infrastructure costs and impacts. Ocean thermal energy can be placed further from shore, reducing viewshed and permitting problems. An extensive discussion of costs and impacts can be found in the Technical Appendix.

i. ESTABLISHMENT OF A PLAN FORMULATION RATIONALE

The conclusions from the preliminary screening form the basis for the next iteration of the planning steps that will be conducted in the feasibility phase. The array of alternatives listed for each site in appendix A could be expanded and include more site specific information to be examined in the feasibility phase. Future screening and reformulation will be based on the following factors expanded in the Technical Appendix: Revised costs of construction if needed, proximity to existing electrical substations/transmission lines, public acceptance of projects, site-specific technical and engineering considerations and environmental and/or cultural impacts.

7. FEDERAL INTEREST

The Corps of Engineers Civil Works Direct Program, Program Development Guidance, Fiscal Year 2013 (EC 11-2-200, dated 31 Mar 2011), indicates that there is federal interest in the development of hydropower projects and it states that the 'Development of new or existing projects, timely rehabilitation of aging projects and facility modernization or improvements is also a priority of budget funding.'" The limited economic and environmental analyses of the Puu Lua-Kitano-Waimea Hydroelectric Plant alternative indicate that there is a federal interest to proceed to the feasibility phase. Promoting renewable energy is the primary output of the alternatives to be evaluated in the feasibility phase, there is a strong federal interest in conducting the feasibility study. There is also a federal interest in other related outputs of the alternatives including flood control, irrigation, drinking water and navigation that could be developed within existing policy. Based on the preliminary screening of alternatives, there appears to be potential project alternatives that would be consistent with Army policies, costs, benefits, and environmental impacts. These alternatives have the potential to increase State energy security. A stronger flexible electrical grid could help the State during natural disasters and oil shortages or cost fluctuations. Energy expenditures will also be kept in-state rather than exported. New technologies can be developed for export to other states. Updated hydropower infrastructure can benefit agriculture and drinking water supplies by keeping water systems maintained and in operation. Renewable energy systems can be combined with flood control projects and sediment management projects.

8. PRELIMINARY FINANCIAL ANALYSIS

As the local sponsor, DBEDT and/or additional State, county, and federal sponsors will be required to provide 50 percent of the cost of the feasibility phase. The local sponsor is also aware of the cost sharing requirements for potential project implementation. A letter of intent from the local sponsor stating a willingness to purse the feasibility study and to share in its cost, and an understanding of the cost sharing is required for project construction.

9. ASSUMPTIONS AND EXCEPTIONS

The following critical assumptions will provide a basis for the feasibility study:

a. Reliance on imported oil for the majority of the State's energy needs is expensive and makes the State highly susceptible to price fluctuations. Each island has an isolated electrical grid, and is unable to store or share energy across the State. If the main power plant on an island is damaged, the island may have a blackout until the system is repaired. This can lead to flight disruptions, lost income, food insecurity, general private property security concerns, and health risks. Inter-island cables between Maui County and Oahu are being considered, but as of 2010 the electrical grids of the individual islands are still isolated.

b. Development of renewable energy in the State of Hawaii will keep energy expenditures within the State, supporting local industries. Widespread renewable

energy systems could reduce electric costs, benefiting residents, industry, agriculture, and the military.

c. Hydropower: Projects in locations with high environmental and/or recreational costs were eliminated. Sites with known public objections were ranked lower in social feasibility, but if energy prices climb in the future, residents could become more amenable to potential projects.

d. OTEC and WEC: Locations were chosen based on the best available knowledge of resources. Sites within major marine life protection zones and Class AA waters were avoided, but each proposed site would require study. Both OTEC and WEC systems need to be within a reasonable reach of the existing electrical grid, and will need undersea cables to reach shore. Long-term effects from seabed anchoring for OTEC and WEC are unknown.

e. OTEC: OTEC is a new technology and permitting requirements may change. Currently NOAA is the authority for licensing the construction and operation of commercial OTEC plants. The original OTEC Act (OTECA) gave the Secretary of Energy the authority to exempt Test Plants from NOAA's licensing requirements. NOAA is currently in the process of developing new licensing regulations. Under OTECA, NOAA is required to coordinate with Coastal States and the U.S. Coast Guard as well as other federal agencies. An EIS would be required for each license. It is expected that the majority, if not all, federal, state, and local requirements would be handled through the NOAA licensing process.

f. WEC: These systems would need to be within one to three km of shore, due to available resources and current WEC designs. Sites located in known high recreational use areas were eliminated, but additional user objections could be expected. Depending upon locations, WEC sites could require an EIS for FERC, and/or BOEMRE/State of Hawaii.

g. The resulting document will be an integrated Feasibility Report and EIS. The EIS will meet both NEPA and State of Hawaii regulations and policies (HRS 343).

h. Proposed conventional hydroelectric power projects were located within existing USACE project areas.

i. Federal interest in ocean technology is a new proposal, and as a new power plant the project would require a FERC license, and/or a NOAA, BOEMRE, or State permit. Coordination with the USACE would need to be examined. A letter of intent from the local sponsor stating a willingness to pursue the feasibility study and to share in its cost is required.

10. FEASIBILITY PHASE MILESTONES

Task/Milestone	**Completion Date**	**Related Activities**
Execute Feasibility Cost Sharing Agreement (FCSA)	Jan 2013	Project Management Plan outlining the detailed scope and coordination process for the feasibility study and Peer Review Plan are completed prior to the signing of the FCSA.
Project Development Team Kick-off Meeting	Feb 2013	
Visioning Session	Mar 2013	
Defining Goals, Objectives, Problems, Opportunities	May 2013	Identify "spin-off" projects for non-federal sponsors and partners
Stakeholder Assessment and Involvement Plan	April-Jan 2014	
Federal Notice of Intent for an EIS	May 2014	
EIS Public Scoping Meeting	May 2014	
EIS Public Scoping Meeting Report	June 2014	Identify priority baseline conditions analysis to support non-federal sponsor/partner activities
Update Peer Review Plan	July 2014	The Peer Review Plan will be updated as needed based on scoping process.
Feasibility Scoping Meeting Report (aka Baseline and Future Conditions Report	Sept 2015	Identify "spin-off" projects for non-federal sponsors and partners
District/State Quality Review	Oct 2015	
Agency Technical Review	Nov 2015	
Division/Headquarters USACE Review	Dec 2015	
State EIS Prep Notice	Dec 2015	
Feasibility Scoping Meeting	Jan 2016	Includes USACE Vertical Chain of Command (District to Headquarters), Non-Federal Sponsors Vertical Chain of Command and key State and Federal Resource Agencies
Preliminary Alternatives Formulation Briefing Report (75 percent complete Document)	August 2016	
Value Engineering Workshop	Sept 2016	
AFB Report (75 percent complete Doc)	Nov 2016	Identify "spin-off" projects for non-federal sponsors and partners

Task/Milestone	Completion Date	Related Activities
District/State Quality Review	Dec 2016	
Agency Technical Review	Feb 2017	
Division/Headquarters USACE Review	April 2017	
Alternatives Formulation Briefing	May 2017	Includes USACE Vertical Chain of Command (District to Headquarters), Non-Federal Sponsors Vertical Chain of Command and key State and Federal Resource Agencies
Preliminary Draft Pilot/Feasibility Report and EIS	Sept 2017	Identify "spin-off" projects for non-federal sponsors and partners
District/State Quality Review	Oct 2017	
Agency Technical Review	Nov 2017	
Division/Headquarters USACE Review	Dec 2017	
Draft Feasibility Report and EIS Notice of Availability	Feb 2018	
Public Comment Period	Dec 2017 - March 2018	
Public Hearing	Dec 2017 - March 2018	Identify "spin-off" projects for non-federal sponsors and partners
Independent External Peer Review	Dec 2017 - March 2018	
Preliminary Final Feasibility Study and EIS	Sep 2018	Identify "spin-off" projects for non-federal sponsors and partners
District/State Quality Review	Oct 2018	
Agency Technical Review	Dec 2018	
Division Review	Feb 2019	
Final Feasibility Study and EIS	Mar 2020	
Washington Level of Review	Apr-May 2020	
Record of Decision	Jul 2020	
Design Agreement	Aug 2020	Dependent upon Congressional Approval.
Design Phase	Sept 2020-May 2021	
Construction Begins	Jun 2022	Dependent upon Congressional Approval

11. FEASIBILITY PHASE COST ESTIMATE

The cost estimates reflect the estimated costs for the feasibility study for the following recommendations:

a. Puu Lua-Kitano-Waimea Hydroelectric Plant, Kauai

b. WEC technology test hub off Kaneohe Marine Corps Base Hawaii, Oahu

c. OTEC off Kahe Point, Oahu

d. OREZ for WEC/OTEC development in the State of Hawaii

The costs may be adjusted during the development of the FCSA based on the availability of funds from the non-federal sponsors. The project management plan will define which activities or portions thereof that will be funded by the non-federal cost share as either cash or work-in kind.

Puu Lua-Kitano-Waimea Hydroelectric Plant Feasibility Phase Cost Estimate

A study to determine the feasibility of developing a hydroelectric plant at the existing Puu Lua and Kitano reservoir area is recommended. The study would consider installation of two hydroelectric systems on the existing Kokee and Kekaha ditches. Two additional small hydropower systems could be used exclusively for irrigation pumping. This project would help to update and maintain the irrigation system in the area, and could be combined with downstream flood control projects. Table 2 presents the costs associated with this feasibility study.

TABLE 2. Hydropower Feasibility Study Cost Estimate.

Activity	**Cost Estimate**
Project Management	$80,000
Stakeholder Collaboration/Public Involvement	$50,000
Topographic/Bathymetric Surveys/Light Detection and Ranging (LIDAR)	$120,000
Hydrology and Hydraulic Studies	$200,000
Geotechnical Studies	$50,000
Engineering Design Analysis	$150,000
Economic Analysis	$100,000
Real Estate Analysis	$50,000
Environmental Studies/Surveys/EIS Report	$280,000
Fish and Wildlife Coordination Act	$50,000
Hazardous, Toxic, and Radioactive Waste (HTRW) Studies/Report	$10,000
Cultural Studies/Report	$35,000
Cost Estimate	$35,000
Plan Formulation and Evaluation	$25,000
USACE Model Certification	$0
USACE Agency Technical Review	$50,000
USACE Independent External Peer Review	$200,000
Final Report Documentation	$20,000
Contingencies (@ 10 percent)	$150,000
TOTAL	**$1,655,500**

Wave Energy Conversion Feasibility Phase Cost

A study to determine the feasibility of implementing WEC devices in the State of Hawaii is recommended. The study would consider installing a mini wave-hub in Kaneohe Marine Corps Base Hawaii on the windward coast off Oahu. The concept is to expand existing facilities, where Ocean Power Technologies is currently testing their 40 kW prototype, to provide berthing for as many as four WEC devices in the 100 to 500 kW range. The mini-wave-hub would allow for testing of bigger systems and deeper waters as well as allowing testing by other power providers. Table 3 presents the costs associated with this feasibility study.

TABLE 3. Wave Hub Feasibility Study Cost Estimate.

Activity	**Cost Estimate**
Project Management	$150,000
Stakeholder Collaboration/Public Involvement	$50,000
Topographic/Bathymetric Surveys/LIDAR	$200,000
Engineering Design Analysis	$200,000
Economic Analysis	$75,000
Real Estate Analysis	$50,000
Environmental Studies/Surveys/EIS Report	$280,000
Fish and Wildlife Coordination Act	$50,000
HTRW Studies/Report	$10,000
Cultural Studies/Report	$35,000
Cost Estimate	$35,000
Plan Formulation and Evaluation	$25,000
USACE Model Certification	$0
USACE Agency Technical Review	$50,000
USACE Independent External Peer Review	$50,000
Final Report Documentation	$50,000
Contingencies (@ 10 percent)	$132,500
TOTAL	**$1,457,500**

OTEC Feasibility Phase Cost Estimate

A study to determine the feasibility of implementing OTEC plants in the State of Hawaii is recommended. The study would first consider a demonstration or pre-commercial plant (Vega and Nihous, 1994) sized at 5 to 10 MW to be deployed off Kahe Point as well as a 50 MW commercial plant (Vega and Michaelis, 2010) to be deployed off Kahe Point in Oahu. This site was selected because of its relatively close proximity to existing electrical substation (138 kV) and transmission lines. Table 4 presents the costs associated with this feasibility study.

TABLE 4. OTEC Feasibility Study Cost Estimate.

Activity	**Cost Estimate**
Project Management	$150,000
Stakeholder Collaboration/Public Involvement	$50,000
Topographic/Bathymetric Surveys/LIDAR	$200,000
Engineering Design Analysis	$200,000
Economic Analysis	$75,000
Real Estate Analysis	$50,000
Environmental Studies/Surveys/EIS Report	$280,000
Fish and Wildlife Coordination Act	$50,000
HTRW Studies/Report	$10,000
Cultural Studies/Report	$35,000
Cost Estimate	$35,000
Plan Formulation and Evaluation	$25,000
USACE Model Certification	$0
USACE Agency Technical Review	$50,000
USACE Independent External Peer Review	$50,000
Final Report Documentation	$50,000
Contingencies (@ 10 percent)	$131,000
TOTAL	**$1,441,000**

Renewable Energy Zone

A study to determine the viability of developing a resource energy zone for OTEC and WEC is recommended. These resources cover a large geographic area, and a specialized permitting zone could allow new technologies to reduce permitting costs and risks. Table 5 presents the costs associated with this feasibility study.

TABLE 5. Renewable Energy Zone Feasibility Study Cost Estimate.

Activity	Cost Estimate
Project Management	$80,000
Stakeholder Collaboration/Public Involvement	$50,000
Topographic/Bathymetric Surveys/LIDAR	$120,000
Hydrology and Hydraulic Studies	$200,000
Geotechnical Studies	$50,000
Engineering Design Analysis	$150,000
Economic Analysis	$100,000
Real Estate Analysis	$50,000
Environmental Studies/Surveys/EIS Report	$280,000
Fish and Wildlife Coordination Act	$50,000
HTRW Studies/Report	$10,000
Cultural Studies/Report	$35,000
Cost Estimate	$35,000
Plan Formulation and Evaluation	$25,000
USACE Model Certification	$0
USACE Agency Technical Review	$50,000
USACE Independent External Peer Review	$200,000
Final Report Documentation	$20,000
Contingencies (@ 10 percent)	$150,000
TOTAL	**$1,655,500**

11. VIEWS OF OTHER RESOURCE AGENCIES

Because of the funding and time constraints of the reconnaissance phase, only limited and informal coordination has been conducted with other resource agencies. Views that have been expressed are as follows:

a. DLNR: Not involved in the construction of new energy, but will need to coordinate with permits for ocean and hydropower.

b. DBEDT: In favor of new energy technology systems.

c. Agribusiness Development Corporation – DOA: Strongly supports the Kekaha/Waimea project.

13. POTENTIAL ISSUES AFFECTING INITIATION OF FEASIBILITY PHASE

a. The availability of federal and non-federal cost share funding could affect the initiation of the feasibility study. The scheduled signing of the FCSA in January 2013 assumes that both federal and non-federal funding will be received by October 2012 (FY13). The signing of the FCSA could be delayed if either party cannot provide their share of the study cost due to shifting budgetary priorities and resource limitations.

14. RECOMMENDATIONS

I recommend that the Hydroelectric Power Assessment: State of Hawaii study proceeds into the feasibility phase. This recommendation is based on the results of the analysis on the Puu Lua-Kitano-Waimea Hydroelectric Plant alternative. The analysis demonstrates that the project is consistent with Army and budgetary policies and will likely meet the criteria for Federal participation in project implementation. It is recognized and understood that upon completion of this feasibility study, extensive review is required at several levels in the Executive Branch of the Federal Government and may also be required at state and local levels. Consequently, the recommendations made in this report may be changed. The following paragraph is required in my recommendations. The recommendations contained herein reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect program and budgeting priorities inherent in the local and state programs or the formulation of a national Civil Works construction program. Consequently, the recommendations may be modified at higher review levels within the Executive Branch before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the State of Hawai`i, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Date 28 JUN 2011

Douglas B. Guttormsen, P.E
Lieutenant Colonel, U.S. Army
Commanding

REFERENCES

Black and Veatch. 2005. Renewable Energy Technology Assessments. Prepared for Kauai Island Utility Cooperative. March.

Cedric D.O. Chong & Associates, Inc. 2007. Feasibility of Utilizing Existing Water Systems for Pumped Storage Hydroelectric Systems for the Island of Maui. Prepared for HECO and MECO. March.

Conner, A.M., Francfort, J.E., and Rinehart, B.N. 1998. U.S. Hydropower Resource Assessment Final Report. Prepared for the DOE Assistant Secretary for Energy Efficiency and Renewable Energy Under DOE Idaho Operations Office. December.

Cruz, J. 2008. "Ocean Wave Energy: Current Status and Future Perspectives" Editor. Published by Springer-Verlag.

DBEDT. 2006. A Catalog of Potential Sites for Renewable Energy in Hawaii in Response to Act 95, Session Laws of Hawaii 2004. Global Energy Systems. December.

DBEDT. 2010. Renewable Energy OTEC. Online at < http://hawaii.gov/dbedt/info/energy/renewable/otec >. Accessed October 2010.

DLNR. 2006. Dam Safety Program Kauai. Online at <www6.hawaii.gov/dlnr/reports/dam-inspections/>. Accessed October 2010.

EPRI. 2008. *Hawaii Ocean Current Resources and Tidal Turbine Assessment.* EPRI. Report # 1018027. September.

FEMA 2010. Levee System Management. Online at <http: www.fema.gov/plan/prevent/fhm/lv_intro.shtm>. Accessed December 2010.

Francfort, J.E. 1996. U.S. Hydropower Resource Assessment for Hawaii. Prepared for the DOE, Assistant Secretary for Energy Efficiency and Renewable Energy Under DOE Idaho Operations Office. September.

Global Energy Concepts, LLC. 2004. Select Hawaii Renewable Energy Project Cost and Performance Estimates, 2004. Prepared for DBEDT. July.

Hagerman, G. 1992. Wave Energy Resources and Economic Assessment for the State of Hawaii. Prepared for DEBDT. June.

Hawaii Renewable Energy Development Venture. 2009. Technology Assessment: Small Pumped Hydro Storage. July.

HECO. 2002. Integrated Resource Plan Evaluation Report, 1998 - 2017. Docket No. 95-0347. December.

Idaho National Engineering and Environmental Laboratory. 1996. U.S. Hydropower Resource Assessment Final Report. September.

Idaho National Engineering and Environmental Laboratory. 1998. U.S. Hydropower Resource Assessment Final Report. December.

USACE. 1978. Summary Report for Hydroelectric Power, State of Hawaii. October.

USACE. 1981. National Hydroelectric Power Resources Study: Regional Assessment: Alaska and Hawaii. Volume XXIII. September.

USACE, 1982. Wailua River Hydropower - Final Interim Survey Report and Environmental Statement.

USACE. 2010. Kekaha Sediment Management Study. Online at <http://gis.poh.usace.army.mil/rsm/kauai.htm>. Accessed October 2010.

USBR. 2004. Small Hydropower Potential on East Kauai Water User Cooperative Lands and Other Kauai Agricultural Water Delivery Systems. U.S. Department of the Interior, Lower Colorado Region. November.

Vega, L.A. 1992. "Economics of Ocean Thermal Energy Conversion (OTEC)" in R.J. Seymour, ed. *Ocean Energy Recovery: The State of the Art*, American Society of Civil Engineers, New York.

Vega, L. 2003. "Ocean Thermal Energy Conversion Primer", *Marine Technology Society Journal*, Vol. 6, No. 4, Winter 2002/2003, pp. 25-35.

Vega**,** L.A. and Michaelis, D. 2010. "First Generation 50 MW OTEC Plantship for the Production of Electricity and Desalinated Water", *Offshore Technology Conference (OTC 20957)*. May.

Vega, L.A. and Nihous, G.C. 1994. "Design of a 5 MWe OTEC Pre-Commercial Plant", *Proceedings Oceanology International '94 Conference*, Brighton, England. March.

W.A. Hirai & Associates, Inc. 1980. Pumped Storage in Hawaii - A Statewide Site Survey. Draft Final Report. Prepared for the Hawaii Integrated Energy Assessment, Dept. of Planning & Economic Development, State of Hawaii. September.