

U.S. Hydropower Resource Assessment for Hawaii

**Prepared by:
James E. Francfort**

**Project Manager:
Ben N. Rinehart**

Published September 1996

**Idaho National Engineering Laboratory
Renewable Energy Products Department
Lockheed Martin Idaho Technologies Company
Idaho Falls, Idaho 83415**

**Prepared for the
U.S. Department of Energy
Assistant Secretary for Energy Efficiency and Renewable Energy
Under DOE Idaho Operations Office
Contract DE-AC07-94ID13223**

ABSTRACT

The U.S. Department of Energy is developing an estimate of the undeveloped hydropower potential in the United States. The Hydropower Evaluation Software (HES) is a computer model that was developed by the Idaho National Engineering Laboratory for this purpose. HES measures the undeveloped hydropower resources available in the United States, using uniform criteria for measurement. The software was developed and tested using hydropower information and data provided by the Southwestern Power Administration. It is a menu-driven program that allows the personal computer user to assign environmental attributes to potential hydropower sites, calculate development suitability factors for each site based on the environmental attributes present, and generate reports based on these suitability factors. This report describes the resource assessment results for the State of Hawaii.

CONTENTS

ABSTRACT	iii
ACKNOWLEDGMENTS	vii
INTRODUCTION	1
Model Development	1
Model Goal	1
Dam Status	2
ASSESSMENT RESULTS	2
Summary Results	2
Detailed Results	7
OBTAINING INDIVIDUAL STATE INFORMATION	8
ADDITIONAL HYDROPOWER EVALUATION SOFTWARE INFORMATION	9
REFERENCES	10
APPENDIX A—Summary Report	A-1
APPENDIX B—Hawaii Sites Listing	B-1
APPENDIX C—Individual Resource Database Listing	C-1
APPENDIX D—List of 19 Additional Hydropower Sites	D-1

FIGURES

1. Number of sites, by capacity groups, with HES-modeled undeveloped hydropower potential	3
2. The nonmodeled and HES-modeled undeveloped hydropower potential	3
3. The number of sites with undeveloped hydropower potential and the total megawatts of HES-modeled undeveloped hydropower potential	4
4. The Wainiha Hydroelectric Plant, on the Island of Kauai, is an example of a developed site in Hawaii	4
5. Number of sites with undeveloped hydropower potential in the Hawaii Islands	5
6. Megawatts of HES-modeled undeveloped hydropower potential in the Hawaii Islands	5

TABLES

1. Undeveloped hydropower potential summaries for Hawaii	2
--	---

ACKNOWLEDGMENTS

The authors thank Peggy A. M. Brookshier and John V. Flynn of the U.S. Department of Energy, and David Rezachek of the State of Hawaii for their active participation and timely comments.

U.S. Hydropower Resource Assessment for Hawaii

INTRODUCTION

In June 1989, the U.S. Department of Energy initiated the development of a National Energy Strategy to identify the energy resources available to support the expanding demand for energy in the United States. Public hearings conducted as part of the strategy development process indicated that undeveloped hydropower resources were not well defined. As a result, the Department of Energy established an interagency Hydropower Resource Assessment Team to ascertain the undeveloped hydropower potential. In connection with these efforts by the Department of Energy, the Idaho National Engineering Laboratory designed the Hydropower Evaluation Software (HES), which has been used to perform a resource assessment of the undeveloped conventional hydropower potential in over 30 states. This report presents the results of the hydropower resource assessment for the State of Hawaii. Undeveloped pumped storage hydropower potential is not included.

The HES was developed as a tool to measure undeveloped hydropower potential regionally or by state. The software is not intended to provide precise development factors for individual sites, but to provide regional or state totals. Because the software was developed as a generic measurement tool encompassing national issues, regional and state totals must be considered judiciously; various local issues may skew undeveloped hydropower potential totals. The information for the resource assessment was compiled from the Federal Energy Regulatory Commission's Hydroelectric Power Resources Assessment database and several other sources. Refer to DOE/ID-10338, the *User's Manual* (Francfort, Matthews, Rinehart 1991) for the specifics of the software and to DOE/ID-10430.1, the *Status Report* (Conner, Francfort, Rinehart 1996) for an overview of all resource assessment activities to date.

Model Development

Hydropower Evaluation Software, both a probability-factor computer model and a database, is a menu-driven program that is intended to be user-friendly. Computer screens and report-generation capabilities were developed to meet the needs of users nationwide. The software uses environmental attribute data for each potential site to generate an overall project environmental suitability factor (PESF) between 0.1 and 0.9. The PESF reflects the considerations that (a) environmental concerns can make a potential site unacceptable, prohibiting its development (for a suitability factor of 0.1), or (b) if there are no environmental concerns, there is a higher likelihood of site development (0.9 indicating the highest likelihood of development). A combination of attributes can result in a lower suitability factor because multiple environmental considerations would reduce the likelihood that a site may be developed to its physical potential.

Model Goal

The goal of the HES is to assemble an accurate resource database of all sites with undeveloped hydropower potential in the United States for use as a planning tool to determine the viable national hydropower potential. Undeveloped hydropower potential is not limited to the development of new sites; it also includes the development of additional hydropower generating capacity at sites that currently have hydropower, but are not developed to their full potential. This undeveloped hydropower potential is a source of nonpolluting, renewable energy available to meet the growing power needs of the United States. The HES should help make this goal obtainable and ensure a set of uniform criteria for national assessment.

Dam Status

The effects of environmental attributes vary by dam status. The dam status classifications used are as follows

- W = Developed hydropower site with current power generation, but the total hydropower potential has not been fully developed. Only the undeveloped hydropower potential is discussed in this report.
- W/O = Developed site without current power generation. The site has some type of developed impoundment or diversion structure, but no developed hydropower generating capability.
- U = Undeveloped site. The site does not have power generation capability nor a developed impoundment or diversion structure.

two individual sites are larger than 10 MW (Figure 1).

The nonmodeled undeveloped hydropower potential total for Hawaii was identified as 428 MW. The HES results lowers this estimate about 84% to 67 MW. The greatest reduction in undeveloped hydropower potential, by MW, occurs at sites with no structures in place (undeveloped category). These sites have an HES-modeled undeveloped hydropower potential of 52 MW, a 354 MW reduction in the estimated undeveloped hydropower potential (Figure 2). The developed sites, with power, have the lowest percentage decrease in modeled undeveloped potential capacity. The unadjusted potential is 2.9 MW, and the modeled capacity is 2.6 MW, a 10% decrease in capacity (Figure 2). As can be deducted from Figure 3, the developed sites without power have the smallest HES-modeled average capacity per site (1.8 MW), and the undeveloped sites have the highest HES-modeled average capacity per site (3.0 MW). Figure 4 illustrates a developed site on the island of Kauai.

ASSESSMENT RESULTS

Summary Results

A total of 25 sites (Table 1) have been identified and assessed for their undeveloped hydropower potential. The HES results for individual site capacities range from 73 kilowatts (kW) to 16 megawatts (MW). Most of the HES-modeled potential sites in Hawaii are small hydropower sites; only

The potential sites are usually discussed and summed by river basins for most state reports. However, there are no large (by contiguous state standards) river basins in Hawaii, so the sites are identified for each of the individual Islands. The 25 identified sites are located on 4 of the Islands. The number of sites per Island range from 3 on Honolulu, to 9 on Kauai (Figure 5). Honolulu has the most undeveloped hydropower potential (35 MW) of the 4 Hawaii Islands (Figure 6).

Table 1. Undeveloped hydropower potential summaries for Hawaii. The table contains the nonmodeled undeveloped nameplate potential and the HES-modeled undeveloped hydropower potential totals.

	Number of projects	Nameplate potential (MW)	HES-modeled potential (MW)
With Power	1	2.9	2.6
W/O Power	7	19.6	12.8
Undeveloped	17	405.6	51.6
State Total	25	428.1	67.0

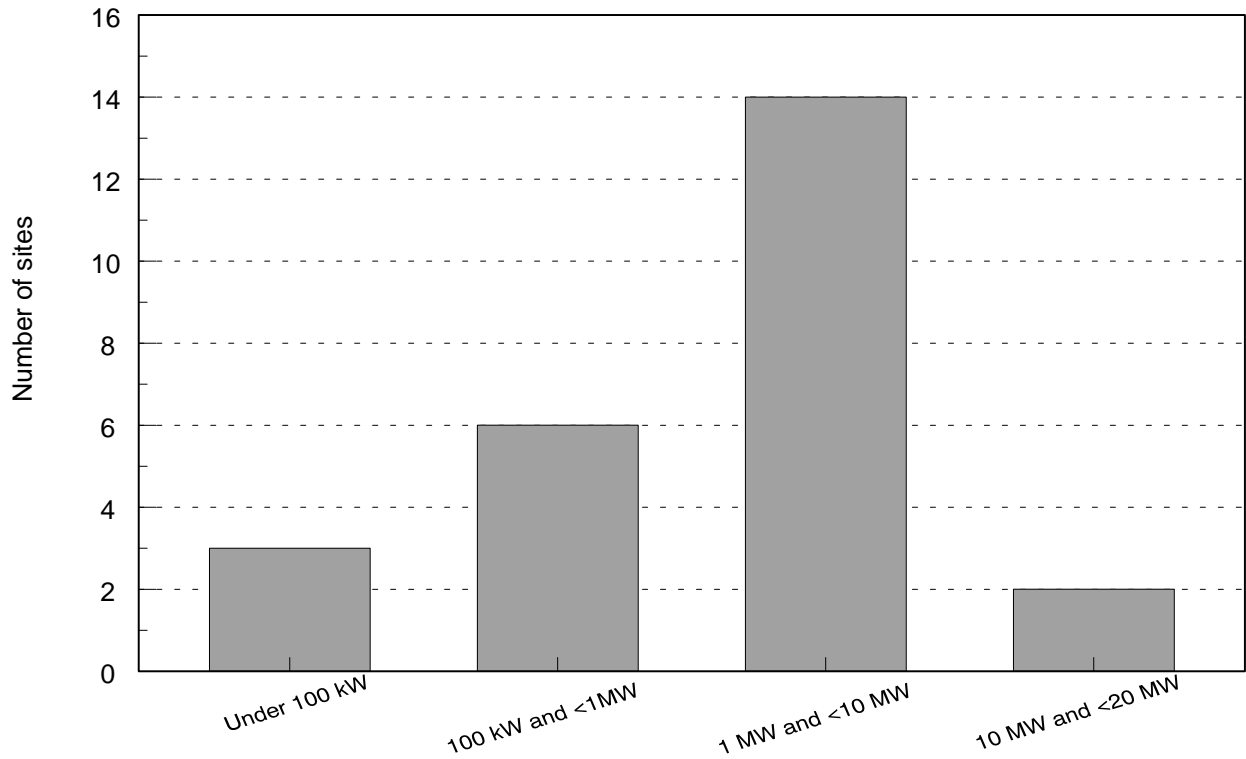


Figure 1. Number of sites, by capacity groups, with HES-modeled undeveloped hydropower potential.

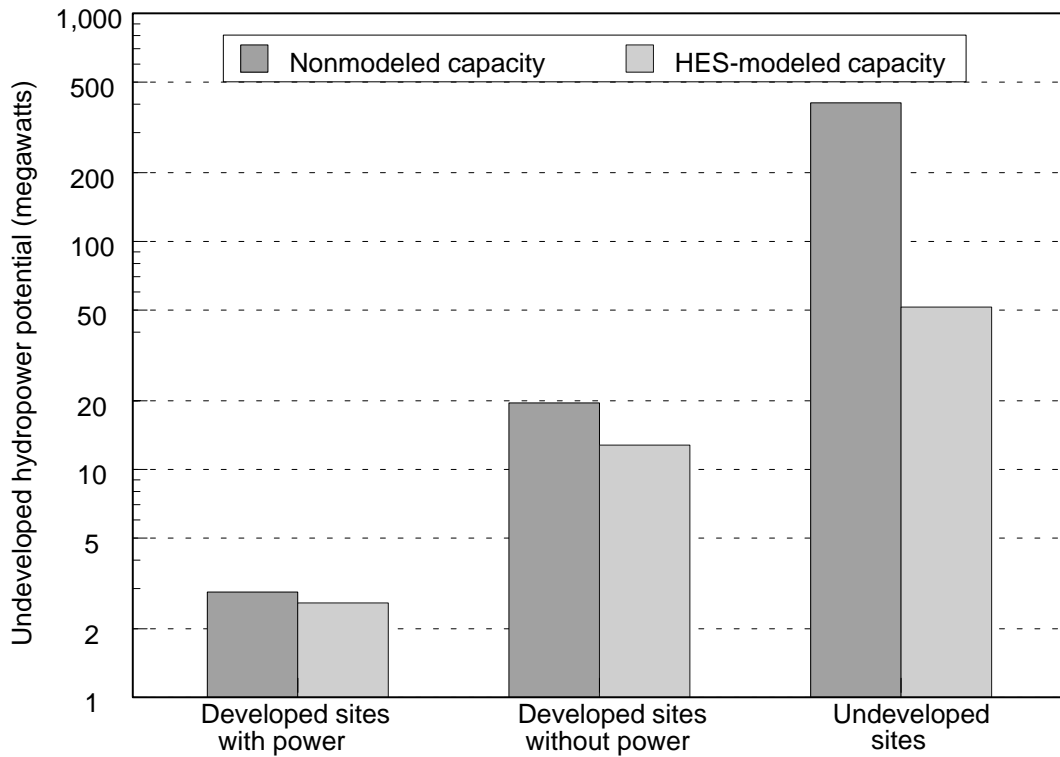


Figure 2. The nonmodeled and HES-modeled undeveloped hydropower potential.

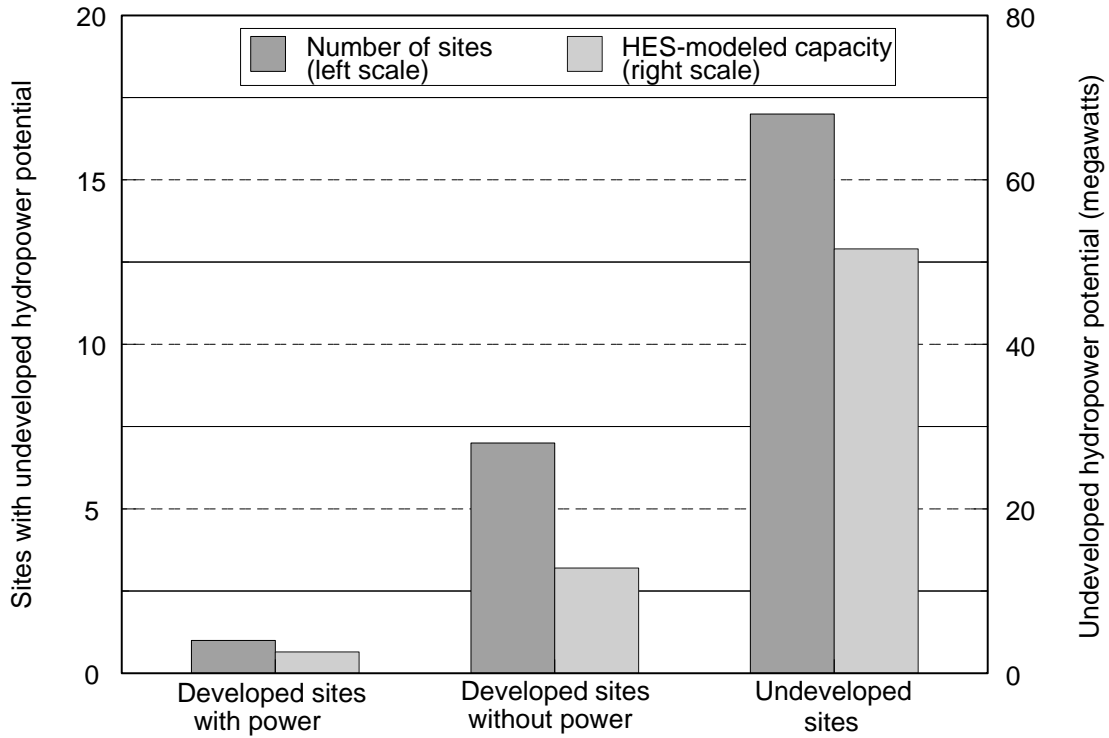


Figure 3. The number of sites with undeveloped hydropower potential and the total megawatts of HES-modeled undeveloped hydropower potential.

Figure 4. The Wainiha Hydroelectric Plant, on the Island of Kauai, is an example of a developed site in Hawaii. The Wainiha plant, located on the Wainiha River, has a nameplate capacity of 3,600 kW and it produces an average of 24 million kWh of electricity annually. The plant has a gross hydraulic head of 560 feet and it has an average inflow of about 80 cubic feet per second of water.

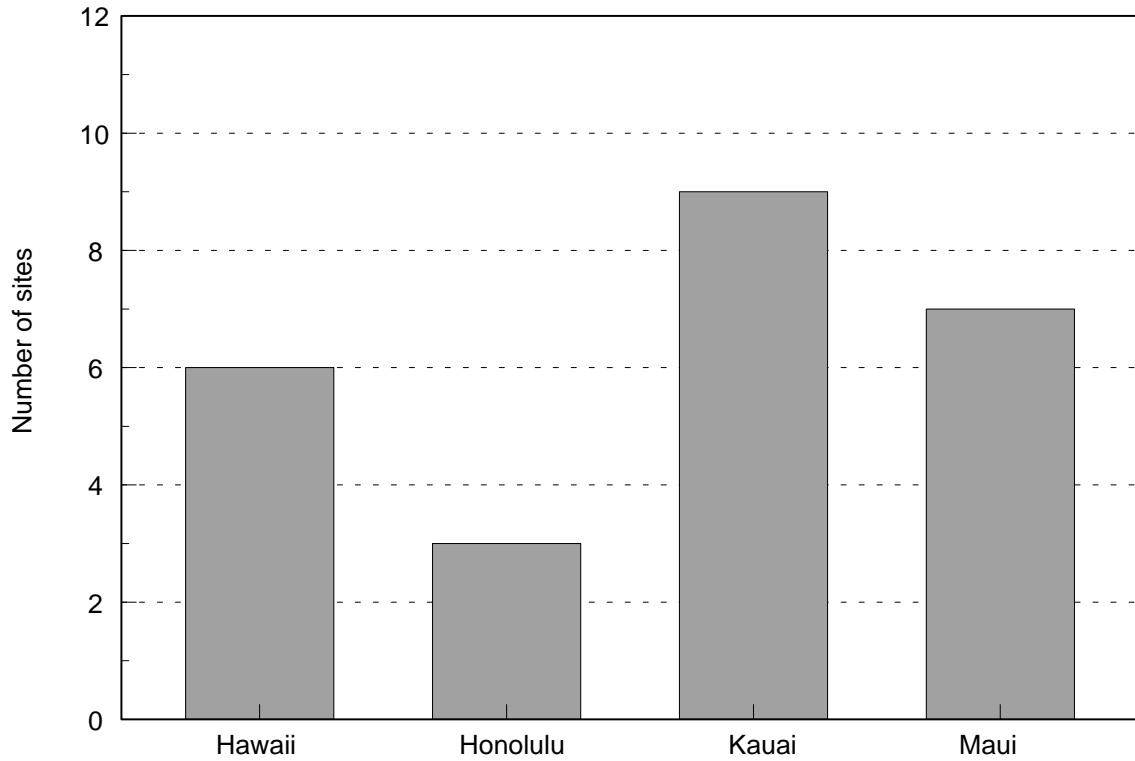


Figure 5. Number of sites with undeveloped hydropower potential in the Hawaii Islands.

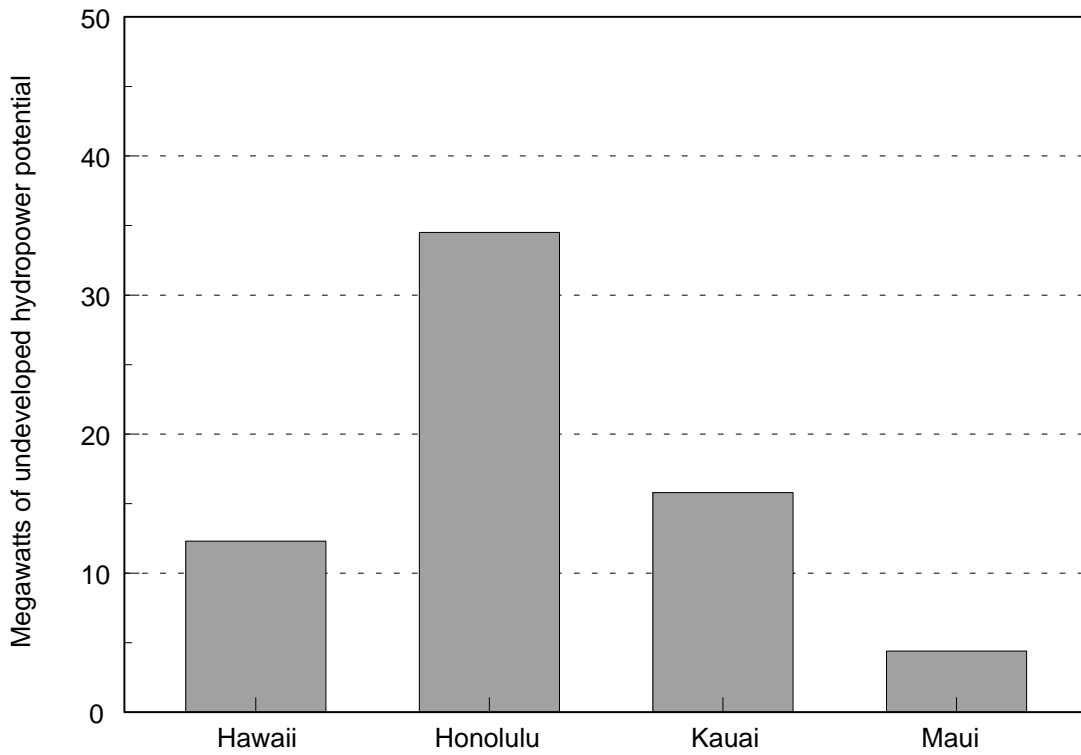


Figure 6. Megawatts of HES-modeled undeveloped hydropower potential in the Hawaii Islands.

The State of Hawaii also provided information on an additional 19 hydropower sites, having about 10 MW of undeveloped capacity. There is not sufficient data available to model these sites. The 19 sites are included in Appendix D, so the reader is aware that these sites have been identified as potentially having some hydropower capacity.

Detailed Results

The appendices contain, in the form of HES-generated reports, detailed information about the undeveloped hydropower potential in Hawaii.

Appendix A summarizes the undeveloped hydropower potential by dam status groups. It provides the number of sites, nonmodeled undeveloped hydropower potential, and HES-modeled undeveloped hydropower potential based on the dam status.

Appendix B lists the project numbers, plant name, stream name, if a site is Federally owned, nonmodeled undeveloped hydropower potential, and HES-modeled undeveloped hydropower potential. The sites are grouped by dam status.

Appendix C contains a resource database list for each of the 25 sites in Hawaii. Information includes plant name, stream, state, county, river basin and owner names, project number, name plate and HES-modeled undeveloped hydropower potential, the unit and plant types, dam status, latitude, longitude, and the environmental factors that the HES uses to determine the project environmental suitability factor.

Appendix D lists an additional 19 hydropower sites reported by the State of Hawaii. These sites are not included in the HES results.

OBTAINING INDIVIDUAL STATE INFORMATION

Additional copies of the hydropower resource assessment results for individual states are available and can be obtained by writing or calling the authors or the National Technical Information Service (NTIS).

Telephone Orders—(703) 487-4650. NTIS sales desk and customer services are available between 8:30 a.m. and 5:00 p.m., Eastern Standard Time.

Fax—(703) 321-8547. Customers may fax their orders to NTIS. These orders may be charged to a NTIS deposit account, American Express, VISA, or MasterCard.

Mail Orders—Mail orders should be sent to National Technical Information Service, Document Sales, 5285 Port Royal Road, Springfield, VA 22161. Call the sales desk for prices before placing an order.

Method of Payment—Customers may pay for reports (and other NTIS products and services) by (a) credit card (American Express, Visa or MasterCard); (b) check or money order on a United States bank payable to NTIS; (c) a NTIS deposit account; or, (d) by asking to be billed (add \$7.50 per order), United States, Canada, and Mexico, only.

Handling Fee—A \$3.00 handling fee per total order applies to orders from the United States, Canada, and Mexico. Handling charges do not apply to rush order service or pick-up orders.

Postage and Shipping—Orders are shipped first class mail, or equivalent, to addresses in the United States, Canada, and Mexico.

Order Turnaround Time—Orders for technical reports generally are shipped within 2 to 8 days of receipt. For faster service, NTIS offers rush order service.

Rush Order Service—Call 1-800-533-NTIS. In Virginia, Canada, and Mexico call (703) 487-4700. For NTIS rush order service add \$15.00 per item. This guarantees that an order will be processed through NTIS within 24 hours of its receipt. These orders receive immediate, individual attention. The items ordered are delivered by first call mail. Call NTIS for information on rush order service for computer products.

For Help in Tracing an Order—Call (703) 487-4650 and request the customer service option.

ADDITIONAL HYDROPOWER EVALUATION SOFTWARE INFORMATION

Additional information concerning the HES can be obtained by contacting Ben Rinehart or Jim Francfort at the addresses provided below. Copies of the software and the User's Manual may also be obtained from these individuals.

Ben Rinehart, Project Manager
Idaho National Engineering Laboratory
P.O. Box 1625, MS 3830
Idaho Falls, ID 83415-3830
(208) 526-1002

Jim Francfort
Idaho National Engineering Laboratory
P.O. Box 1625, MS 3875
Idaho Falls, ID 83415-3875
(208) 526-6787

Information concerning the State of Hawaii's involvement with the resource assessment or about the identified sites may be obtained by contacting:

David Rezachek
State of Hawaii
P.O. Box 2359
Honolulu, Hawaii 96804-2359
(808) 587-3814

REFERENCES

Francfort, J. E., S. D. Matthews, and B. N. Rinehart, 1991, *Hydropower Evaluation Software User's Manual*, DOE/ID-10338, Idaho National Engineering Laboratory, Idaho Falls, Idaho.

Conner, A. M., J. E. Francfort, and B. N. Rinehart, 1996, *Uniform Criteria for U.S. Hydropower Resource Assessment, Hydropower Evaluation Software Status Report-II*, DOE/ID 10430.1, Idaho National Engineering Laboratory, Idaho Falls, Idaho.