

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF HAWAII

----In the Matter of----)
)
PUBLIC UTILITIES COMMISSION)
)
Instituting a Proceeding to)
Investigate the Issues and)
Requirements of Adopting or)
Establishing Standards for Solar)
Water Heater Systems as Mandated)
by Act 204, Session Laws of)
Hawaii (2008).)
_____)

DOCKET NO. 2008-0249

DECISION AND ORDER

FILED
2009 JUL -11 P 2: 27
PUBLIC UTILITIES
COMMISSION

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DECISION AND ORDER

By this Decision and Order, the commission establishes standards for Solar Water Heater Systems ("SWHS"), pursuant to Act 204, Session Laws of Hawaii (2008) ("Act 204"), Section 3, codified as Hawaii Revised Statutes ("HRS") § 269-44 by adopting the Residential Solar Water Heating System ("RSWHS") Standards and Specifications, with modifications, which are attached to this Decision and Order as Exhibit I. In doing so, the commission approves in part, and rejects in part, the Stipulation in Lieu of Final Statements of Position, Hearing and Briefs ("Stipulation") filed on April 28, 2009.

Any interested persons may provide comments regarding the SWHS standards established in this docket by July 31, 2009. If revisions are warranted, a final decision and order on the SWHS standards will be filed by October 30, 2009.

I.

Background

A.

Act 204

Act 204 requires "the installation of solar water heater systems, comparable renewable energy systems, or demand gas water heaters in all new residential development projects constructed after January 1, 2010" and restricts "the solar thermal energy system tax credit available for single-family residential properties to those properties for which building permits were issued prior to January 1, 2010."¹ The stated purpose of Act 204 is "to increase the use of renewable energy to protect our environment, reduce pollution, make housing more affordable, and enhance Hawaii's local economy[.]"²

Section 3 of Act 204, codified as HRS § 269-44, directs the commission to "adopt or establish by rule, tariff, or order, standards for solar water heater systems to include, but not be limited to, specifications for the performance, materials, components, durability, longevity, proper sizing, installation, and quality to promote the objectives of [HRS] section 269-124."³ Under HRS § 269-44, the commission must comply by July 1, 2009, or as soon as reasonably practicable.

¹See Act 204, Section 1.

²Id.

³Id. Section 3.

B.

Procedural History

On September 26, 2008, the commission issued its Order Initiating Investigation to Adopt or Establish Standards for Solar Water Heater Systems ("Initiating Order") to examine the issues and requirements of adopting or establishing standards for SWHS as mandated by HRS § 269-44.⁴

In the Initiating Order, the commission, sua sponte, designated HAWAIIAN ELECTRIC COMPANY, INC. ("HECO"); HAWAII ELECTRIC LIGHT COMPANY, INC. ("HELCO"); MAUI ELECTRIC COMPANY, LIMITED ("MECO")⁵; KAUAI ISLAND UTILITY COOPERATIVE ("KIUC"); and the DEPARTMENT OF COMMERCE AND CONSUMER AFFAIRS, DIVISION OF CONSUMER ADVOCACY ("Consumer Advocate")⁶ as parties to this docket.⁷ In addition, the commission invited any individual, entity, or organization desiring to intervene as a party or to participate without intervention in this proceeding to file a motion not later than twenty days from the date of the order.

⁴The investigation was initiated pursuant to Act 204, HRS §§ 269-6 and 269-7, and Hawaii Administrative Rules ("HAR") § 6-61-71.

⁵HECO, HELCO and MECO are hereafter collectively referred to as the "HECO Companies."

⁶The Consumer Advocate is statutorily mandated to represent, protect, and advance the interests of all consumers of utility service and is an ex officio party to any proceeding before the commission. See HRS § 269-51 and HAR § 6-61-62.

⁷Aside from the HECO Companies, KIUC, and the Consumer Advocate, a copy of the Initiating Order was served on: (1) the Mayors of the City and County of Honolulu, and the counties of Hawaii, Kauai, and Maui; and (2) representatives of the Hawaii Solar Energy Association ("HSEA") and the Building Industry Association of Hawaii.

On October 14, 2008, HSEA submitted a Motion to Intervene and Become a Party to this proceeding ("HSEA's Motion to Intervene"). On October 16, 2008, HONEYWELL INTERNATIONAL INC. ("Honeywell") filed a Motion to Participate without Intervention ("Honeywell's Motion to Participate") in this proceeding.⁸

By Order Granting Intervention and Participation, filed on December 19, 2009, the commission approved HSEA's Motion to Intervene and Honeywell's Motion to Participate. The HECO Companies, KIUC, the Consumer Advocate, and HSEA are collectively referred to as the "Parties" and Honeywell is referred to as the "Participant."

On January 20, 2009, the Parties and Participant submitted a Stipulated Procedural Order for the commission's review and approval pursuant to the Initiating Order. On February 12, 2009, the commission issued its Order Approving, With Modification, Stipulated Procedural Order Filed on January 20, 2009 ("Procedural Order"), establishing the issues and a regulatory schedule to govern the proceedings.

Pursuant to the Procedural Order, the Parties and Participant held and participated in technical meetings and discussions. On April 28, 2009,⁹ the Parties and Participant

⁸By letters dated and filed on October 20, 2008, and October 21, 2008, HECO informed the commission that it does not oppose the granting of intervenor status to HSEA and participant status to Honeywell, respectively, provided that HSEA and Honeywell do not broaden the issues or delay the proceeding.

⁹By letter dated April 14, 2009, the commission approved the Parties and Participant's request filed on April 6, 2009, for a

submitted their Stipulation and accompany exhibits (i.e., Exhibits A-D).

To facilitate review of the Stipulation, the commission issued information requests ("IRs") on May 15, 2009, for which the Parties and Participant provided responses on May 29, 2009. Further, on June 1, 2009, the Parties and Participant submitted their Stipulation Setting Forth Proposed Alternatives to the Third-Party Administrator ("Alternatives Stipulation") in response to a commission letter dated May 8, 2009.

C.

Issues

As set forth in the Procedural Order, the issues in this docket are:

1. Between OG-300¹⁰ and the RSWHS Standards,¹¹ which is the more appropriate and reasonable standard for the commission to adopt or utilize as the basis to establish standards for solar water heater systems to comply with the requirements of Section 3, Act 204, and why?

thirty-day extension of time (from April 6, 2009 to May 6, 2009) to submit their settlement agreement. Concurrently, in reliance on the Parties and Participant's representation that they had reached a global settlement of all the issues, the commission canceled all remaining procedural steps in the docket.

¹⁰The "OG-300" is a nationally recognized standard for solar water heating systems set forth in the Solar Rating and Certification Corporation's ("SRCC") Document OG-300 "Operating Guidelines and Minimum Standards for Certifying Solar Water Heating Systems." The June 2008 version of the OG-300 was attached to the Initiating Order as PUC Exhibit I.

¹¹The "RSWHS Standards" is the September 19, 2007 version of the HECO Companies' standards for their Residential Efficient Heating Program, which was attached to the Initiating Order as PUC Exhibit II.

- (a) If the response to issue no. 1 is OG-300, how should it be modified to address Hawaii specific requirements, if at all?
 - (b) If the response to issue no. 1 is the RSWHS Standards, how should it be modified, if at all? Is the RSWHS Standards too stringent?
- 2. Regardless of the above, what are the standards the commission should adopt or establish to comply with the requirements of Section 3, Act 204, and why?
 - 3. Once adopted or established, what is the most reasonable and feasible method of updating the standards for solar water heating systems in Hawaii?

D.

Parties and Participant's Stipulation¹²

In the Stipulation, the Stipulating Parties state that they have "reached a global settlement on all issues of this proceeding[.]"¹³ The Stipulating Parties attest that the Stipulation formally memorializes their agreements and proposed

¹²The Parties and Participant state that the order granting Honeywell participant status limited its participation in this docket to receiving all filings, responding to information requests, and filing a final position statement in this proceeding. Thus, they state that Participant is not a required signatory to this Stipulation. However, according to the Parties and Participant, Participant was actively engaged in the technical meetings, discussions, and settlement conferences that occurred, and that Participant "agrees to the terms of this Stipulation as agreed to by the [] Parties, and has elected to sign this Stipulation in lieu of filing a final statement of position." See Stipulation at 3 n.3. Thus, the commission will deem the Stipulation as a document agreed to and filed by the Parties and Participant, and on a going forward basis will refer to the Parties and Participant, when applicable, as the "Stipulating Parties."

¹³See Stipulation at 11.

resolution of the issues of this docket. Nonetheless, the Stipulating Parties also state that they understand and acknowledge that the commission is not bound by the Stipulation and that the commission, as the "ultimate decision-making body" will determine whether any of the agreements agreed upon are consistent with the public interest and applicable laws.

1.

Standards to be Adopted or Established

With respect to which standards the commission should adopt or establish, the Stipulating Parties assert that the "RSWHS Standards are more appropriate and reasonable than the OG-300 Standards for adoption by the Commission pursuant to the requirements of Act 204, and that the Commission should adopt the RSWHS Standards as modified in Exhibit A [of the Stipulation] to comply with the requirements of Act 204[.]"¹⁴ The Stipulating Parties agree that the RSWHS Standards are not too stringent and state that these standards foster competition by allowing multiple alternative SWHS solutions for families with different requirements.

In comparison with the OG-300, the Stipulating Parties contend that the RSWHS Standards are preferable since they provide flexibility, and have a lower cost and proven track record. The Stipulating Parties state that while both the RSWHS Standards and the OG-300 Standards require that a given

¹⁴Id. at 9.

model of approved solar collector be certified under the OG-100 Standards, "unlike the RSWHS Standards, the OG-300 Standards utilize a set of inflexible system design variables which, due to the fact that solar water heating systems installed at different locations face different sets of constraints (even when identical technologies are employed), generally require each individual system installed to undergo its own separate OG-300 system certification."¹⁵ According to the Stipulating Parties, the application fee for an OG-300 system certification is \$1,750 per system as opposed to the RSWHS Standards which has no such requirement. Thus, the Stipulating Parties contend that the adoption of the RSWHS Standards would result in substantially lower SRCC application and program fees.

They also contend that while the RSWHS Standards require that a sufficient amount of water will be heated by a compliant system to offset at minimum 90% of a given household's water heating needs (regardless of where the household is located), the OG-300 has no such requirements. Additionally, the Stipulating Parties state that the RSWHS Standards require SWHS to be "custom-designed to individual families' hot water use by tailoring the systems to family size, available solar resource taking into account site location and collector rating corrections based on collector tilt/orientation, and

¹⁵See Stipulation, Exhibit B at 2.

the annual average water main temperature for each of the various islands[.]”¹⁶

In addition, the Stipulating Parties state that building contractors in Hawaii are familiar with the RSWHS Standards since they have been in use for the last twelve years. Also, while the RSWHS Standards were developed by the HECO Companies for their Residential Efficient Water Heating Program, the Stipulating Parties represent that KIUC adopted the standards ten years ago and that they are currently in use by KIUC. The Stipulating Parties state that “positive results achieved under the RSWHS Standards in Hawaii have been verified by four separate third-party empirical studies.”¹⁷ While in contrast, according to the Stipulating Parties, there is no Hawaii-specific field data with respect to demand and energy impacts of OG-300 systems and that existing information regarding the demand and energy impacts of OG-300 Standards in Hawaii has only been based on computer models.

Moreover, the Stipulating Parties represent that the relative strengths of the RSWHS Standards versus the OG-300 Standards provide substantially greater benefits to homeowners while doing so at a lower cost. The Stipulating Parties further diagram the differences between the OG-300 Standards and

¹⁶See Stipulation at 6.

¹⁷See Stipulation, Exhibit B at 2.

the RSWHS Standards in Table 1 entitled "Comparison of the OG-300 Standards and RSWHS Standards", attached as Exhibit B to the Stipulation.¹⁸

2.

Stipulating Parties' Proposed Modifications

With respect to RSWHS Standards (the September 19, 2007 version) which was attached to the Initiating Order, the Stipulating Parties state that they should be modified by:

- (1) Deleting the Solar Collector BTU/Day Output by Hawaii Sunshine Zone ("Output Table") and HECO Solar Water Heating Systems Accepted Products List ("Products List") from the standards to instead be separately kept and maintained by an administrator;
- (2) Adding a definitions section (i.e., Part I);
- (3) Adding a new Part VI and Attachment 1 covering the procedure for updating and/or amending the standards as further agreed to by the Stipulating Parties; and
- (4) Making certain other modifications, including without limitation the use of an administrator to administer the RSWHS Standards ("Administrator"), which are reflected in Exhibit A of the Stipulation.¹⁹

In addition, the Stipulating Parties agree that the Administrator shall also be responsible for keeping and maintaining a sunshine map for each island, the current version

¹⁸Id. at 3.

¹⁹In addition, the modifications agreed to by the Stipulating Parties are illustrated in "black-line" format as Exhibit C of the Stipulation.

of which is attached as Exhibit E to the Stipulation (the "Sunshine Maps"). According to the Stipulating Parties, the Sunshine Maps reflect the solar energy in terms of calories per square centimeters per day on each island and since these maps simply reflect factual information and data, the Stipulating Parties agree that there should be no formal process to amend or update these maps. Instead, the Stipulating Parties state that any amendments or updates should be made only subject to prior approval by the Administrator.

With respect to the Administrator, the Stipulating Parties agree that the Administrator of the RSWHS Standards for the HECO Companies should be the third-party administrator of energy efficiency demand-side management programs as defined in HRS § 269-122 ("Third-party Administrator"), and (b) the Administrator for KIUC should be (1) KIUC for all solar systems installed under a KIUC-sponsored solar program, and (2) the Third-party Administrator for all solar systems that are not installed under a KIUC-sponsored solar program.

3.

Method to Update Standards

The Stipulating Parties agree that the most reasonable and feasible method of updating and/or amending the SWHS standards in Hawaii after adoption of them in this proceeding is set forth and described in Part VI and Attachment 1 of the modified version of the RSWHS Standards attached as Exhibit A to

the Stipulation. Generally, the Stipulating Parties agree that: (1) future updates and/or amendments to the SWHS standards should require commission approval through the filing of an application as set forth in HAR Chapter 6-61 or may be requested by an Administrator (i.e., the Third-party Administrator or KIUC, as applicable) with the commission subsequently opening a proceeding; and (2) updates and/or amendments to the Output Table and Products List, which will be separately kept and maintained by the Administrator, may be made through an Administrator/RSWHS Committee ("Committee") process through which uncontested updates and/or amendments can be expedited by an Administrator, with contested updates and/or amendments utilizing a dispute resolution process with the commission as the arbiter of last resort.

II.

Discussion

A.

Standards to be Adopted or Established

According to the Stipulating Parties, the RSWHS Standards are the appropriate standards for the commission to adopt to satisfy the requirements of Act 204. They specifically assert that the RSWHS Standards are not too stringent and that in comparison with the OG-300 Standards, the RSWHS Standards are preferable since they provide flexibility and have a lower cost and proven track record.

Upon review, the commission finds it reasonable and appropriate to adopt the RSWHS Standards over the OG-300 Standard, subject to the modifications described below. As set forth in the Stipulation, the commission finds that the RSWHS Standards appear to be more preferable for SWHS in Hawaii than the OG-300 Standards. Unlike the OG-300 Standards, which are minimum standards instituted by a national body (i.e., the SRCC) for nationwide use, the RSWHS Standards were developed by the HECO Companies which are Hawaii entities and have been utilized throughout Hawaii for approximately twelve years. Thus, under the circumstances, the commission accepts the Stipulating Parties' contention that "building contractors in Hawaii are familiar with the RSWHS Standards[.]"²⁰

In addition, the commission finds that adoption of the RSWHS Standards would result in lower SRCC application and program fees. While both the RSWHS Standards and OG-300 Standards require that each given model of approved solar collector be certified under the OG-100 Standards, as indicated by the Parties and Participant, adoption of the OG-300 Standards may also require OG-300 system certification which is estimated to cost approximately \$1,750 per system. Among other things, in response to PUC-IR-105, the Stipulating Parties state that based upon the existing combinations of systems now approved for the HECO program, the additional OG-300 charges and fees are approximately \$15,000 -- \$30,000 per participating manufacturer,

²⁰See Stipulation at 6.

or \$250,000 in total, which they surmise will be passed on to consumers. In contrast, the Stipulating Parties indicate that implementation of RSWHS Standards would result only in OG-100 costs and expenses, which currently are estimated to be \$500 for each new collector certified and an additional \$100 for each "similar model."²¹

Further, while the RSWHS Standards have a Minimum Solar Contribution requirement of "greater than or equal to" 90%, the OG-300 Standards have no similar requirement.²² Additionally, the RSWHS Standards appear to provide greater flexibility to meet diverse consumer needs. For instance, among other things, the OG-300 has a "Collector Tilt" requirement of eighteen degrees and no system sizing flexibility, while the RSWHS Standards have a "Collector Tilt" range between fourteen-to-sixty degrees and system sizing flexibility.²³ Further comparisons between the OG-300 and RSWHS Standards are set forth as Table 1, Exhibit B to the Stipulation.

Based on the foregoing, the commission adopts the RSWHS Standards over the OG-300 Standard, subject to the modifications described below.

²¹According to the Stipulating Parties, the cost of program participation per manufacturer is presently in the range of \$1,000 -- \$1,500, with quarterly certification maintenance fee of \$0.02 per square foot installed (less than \$1.50 per system). See Response to PUC-IR-105.

²²See Stipulation, Exhibit B at 3.

²³Id.

B.

Modifications to the Proposed Standards

The Stipulating Parties propose certain changes to the September 19, 2007 version of the RSWHS Standards, which were attached to the Initiating Order. Specifically, the Stipulating Parties propose to: (1) add a definition section; (2) delete the Output Table, Product List, and Sunshine Maps from the RSWHS Standards and require these documents be kept and maintained by the Administrator; (3) add a new part to the standards and Attachment 1 concerning updating procedures; and (4) make certain other modifications, including without limitation the use of an Administrator to administer the RSWHS Standards. In particular, the Stipulating Parties agree that the Third-party Administrator should be the Administrator of the RSWHS Standards for the HECO Companies and for all systems not installed under a KIUC-sponsored program, while KIUC will act as the Administrator for the standards for all solar systems that are installed under a KIUC-sponsored solar program. These proposed changes are reflected in Exhibit A of the Stipulation, and are hereafter generically referred to as the RSWHS Standards.²⁴

Here, the commission agrees with the addition of a definition section to the RSWHS Standards, and also accepts that certain modifications to the September 17, 2007 version of

²⁴In addition, the modifications agreed to by the Stipulating Parties are illustrated in "black line" format in Exhibit C of the Stipulation.

the RSWHS Standards are appropriate due to "technological advancements" as represented by the Stipulating Parties.²⁵

However, the commission finds the other amendments agreed to by the Stipulating Parties, as described above, to be inappropriate or unnecessary, and concludes that those portions of the Stipulation and Exhibit A should be rejected.

1.

Designation of Administrator is Unnecessary

The Stipulating Parties submitted their Alternatives Stipulation on June 1, 2009, in response to the commission's request that they submit an agreement setting forth proposed alternatives to involvement by the Third-party Administrator in administering the RSWHS Standards should the commission decline to task the Third-party Administrator with the responsibilities contemplated in the Stipulation.²⁶ In their Alternatives Stipulation, the parties contend that the Third-party Administrator is the most appropriate entity to undertake the responsibilities of administration of the RSWHS Standards, and

²⁵See Stipulation at 7.

²⁶In administering the SWHS Standards, the Third-party Administrator would be required, under the Stipulation, to: (1) act as the custodian and to maintain the Output Table, Product List, and Sunshine Maps; (2) form a Residential Solar Water Heating System Committee (i.e., the Committee); (3) approve solar water heating contractors for the installation of solar systems (Stipulation, Exhibit A, Section 5.01); and (4) approve the use of certain design and materials prior to installation of the systems (Stipulation, Exhibit A, Sections 3.01, 3.06, 4.03, 4.06, and 4.13).

that the electric utilities should not act as "Administrator" except for their own utility-sponsored programs.²⁷

In addition, while agreeing that a feasible alternative to the Third-party Administrator could be the respective building departments from each of the counties,²⁸ the Stipulating Parties recognize that the current law does not explicitly authorize the commission to transfer or delegate such duties and functions to the building departments which may, according to the Stipulating Parties, require new legislation. Thus, they contend that if the commission is not able or inclined to task the Third-party Administrator as the Administrator of the RSWHS Standards, the only other "feasible" alternative would be the commission itself.

²⁷According to the Stipulating Parties, requiring the electric utilities to administer the SWHS standards (aside from those they sponsor) is not "desirable" due to the following: (1) the HECO Companies are no longer sponsoring any of the programs due to transition of the programs to the Third-party Administrator; (2) allowing or requiring the utilities to administer standards over programs they no longer sponsor would be inconsistent with transition of the HECO Companies' energy efficiency programs to the Third-party Administrator; (3) the administration of SWHS that are not installed under a utility-sponsored program goes beyond the scope of electric services that the electric utilities are required to provide to their respective customers; (4) an expansion of these duties and services would require additional resources, create potential liabilities for electric utilities, and could require extensive modifications to their tariffs/rules; and (5) before the utility could become the "Administrator" for non-utility sponsored programs, a surcharge or other rate recovery mechanism would need to be established to allow the utilities to recover the costs and expenses they would incur as the "Administrator." See Alternatives Stipulation at 6-7.

²⁸According to the Stipulating Parties, the county building departments could be a feasible alternative to the Third-party Administrator since these departments already perform certain regulatory, inspection, and oversight functions over the installation of various SWHS on each of the islands, pursuant to existing county plumbing and electrical codes.

Nonetheless, the Stipulating Parties recognize that Act 204 does not require the commission to identify an entity to administer the SWHS standards. As such, the Stipulating Parties agree that the commission does not need to assign or establish an Administrator at this time, and could at its discretion elect to simply adopt standards for SWHS. The Stipulating Parties state that they would be supportive of removing all references to "Administrator" except as they relate to their proposed amendment process as set forth in Attachment 1 of Exhibit A to the Stipulation.

Upon review, the commission finds that a designation of an Administrator for the RSWHS Standards is unnecessary. This finding is based on the Stipulating Parties' statement that they would support the removal of all references to "Administrator" aside from those references related to their proposed amendment process. Given this position, it does not appear that provisions that refer to an Administrator are essential to the RSWHS Standards. The commission also agrees with the Stipulating Parties that Act 204 does not require the commission to assign or obligate an entity to administer the SWHS standards.

Additionally, it appears that certain provisions of the standards that refer to the Administrator can be amended by removing the references to the Administrator with minimal impact on the RSWHS Standards. For instance, Section 5.01 of the RSWHS Standards requires that solar systems be installed by licensed solar water heating contractors approved by the Administrator. When asked about the necessity of this provision,

the Stipulating Parties stated that reference to the Administrator can be stricken and recommended that the section be revised to read: "Solar systems shall be installed by properly licensed contractors."²⁹ However, with respect to other provisions that place the Administrator in the role of a "safety valve", the commission finds it appropriate to substitute the respective county building departments since, as represented by the Stipulating Parties, these departments "already, pursuant to existing County plumbing and electrical codes, perform certain regulatory, inspection and oversight functions over the installation of various solar water heating systems on each of the islands including, without limitation, administering and/or enforcing their applicable electrical and plumbing codes."³⁰ Thus, to the extent that the building departments of the respective counties already review and have oversight functions over portions of the installation of SWHS, the commission finds it reasonable and appropriate to allow their approval to satisfy certain provisions of the RSWHS Standards. In so doing, the commission is not extending the duties and obligations of the building departments, but merely allowing their approval over matters already under their purview to satisfy the requirements of the RSWHS Standards.

Based on the foregoing, the commission concludes that the designation of an Administrator to administer the RSWHS Standards as contemplated in the Stipulation is unnecessary and,

²⁹See Response to PUC-IR-103.

³⁰See Alternatives Stipulation at 7.

thus, those portions of the Stipulation (and Exhibit A) are rejected. Portions of the RSWHS Standards that refer to an Administrator, as proposed by the Stipulating Parties, are modified either by removal of the provision or reference entirely, or by allowing the approvals of the building department of the respective counties, which already have oversight functions over portions of the installation of SWHS, to satisfy the requirements of the standards for SWHS, as established in this Decision and Order, and reflected in the attached Exhibit I, herein.

2.

Other Amendments

a.

Output Table, Products List, and Sunshine Maps

Given the commission's determination that an Administrator to administer the RSWHS Standards is unnecessary, the commission also rejects the Stipulating Parties' proposal with respect to the Output Table, Products List, and Sunshine Maps. The Stipulating Parties' recommendation to remove these documents from the RSWHS Standards and to require the Administrator to keep and maintain them is, at this juncture, inappropriate, and is rejected.

Upon review, the commission finds that the Output Table and Sunshine Maps contain valuable information with regards to the output of OG-100 certified collectors based on location, which appears to be necessary to determine percentage of solar fraction which is used to determine system performance. At this

juncture, there does not appear to be an alternative means to determine system performance within the RSWHS Standards. Thus, the commission finds it necessary and reasonable to continue to include the Output Table and Sunshine Maps within the RSWHS Standards at this time.

In doing so, however, it appears that the Output Table, filed with the commission, may only contain information with regards to HECO and the island of Oahu. Thus, the record on this matter may be incomplete. To the extent that the Output Table, filed in this proceeding, only pertains to the island of Oahu, the commission finds it reasonable and appropriate to require MECO, HELCO and KIUC to file their respect Solar Collector BTU/Day Output by Hawaii Sunshine Zone tables for the islands of Maui, Molokai, Hawaii, Kauai, and Lanai, if applicable, within ten days of the date of this Decision and Order. The documents will be deemed incorporated within the RSWHS Standards (i.e., an extension of the Output Table) upon their filing. In the alternative, the Stipulating Parties may opt to file a consolidated Output Table that contains information pertaining to all of the islands, which upon its filing will be deemed to replace the Output Table adopted in this Decision and Order, as part of the RSWHS Standards.

With respect to the Products List, however, the commission agrees with the Stipulating Parties' initial assessment that such a document is beyond the scope of the

requirements of the standards for SWHS as set forth in Act 204.³¹ Moreover, inclusion of a product list could result in negative consequences such as, but not limited to, unnecessarily restricting the type of products that can be utilized for the installation of SWHS in Hawaii for compliance with these standards, which could unreasonably increase the costs to homeowners. Recognizing that the information contained in the Products List could benefit the public in the short-term, the commission will place the most recent version of the Products List on the commission's website for informational purposes only. This will be a static document, with no means for updates or revisions and will be accessible on the commission's website for a period of three years from the date of this Decision and Order, at which time, due to technological advancements and possible amendments to the established standards, the list would contain less relevant information.

In sum, the commission concludes that the RSWHS Standards should continue to include the Output Table and Sunshine Maps, while the Products List should be removed. Consistent with the commission's determination, portions of the Stipulation (and Exhibit A) are thus rejected accordingly. In addition, to the extent that the Output Table, filed in this proceeding, only pertains to the island of Oahu, MECO, HELCO and KIUC shall file their respect Solar Collector BTU/Day Output by Hawaii Sunshine Zone tables for the islands of Maui, Molokai,

³¹See Stipulation at 7.

Hawaii, Kauai, and Lanai, if applicable, within ten days of the date of this Decision and Order. In the alternative, the Stipulating Parties may opt to file a consolidated Output Table that contains information pertaining to all of the islands, which upon its filing, will be deemed to replace the Output Table adopted in this Decision and Order, as part of the RSWHS Standards.

b.

Retrofit Systems and Other Types of Structures

Certain provisions in the standards proposed by the Stipulating Parties include sizing and other requirements for retrofit systems and other types of structures.³² In response to PUC-IR-101 which asked whether these provisions are necessary under Act 204, the Stipulating Parties state that they would not object if these provisions were eliminated from the standards.³³

Section 2 of Act 204, codified as HRS § 196-6.5 ("Solar water heater systems required for new single-family residential construction"), requires the commission to establish or adopt SWHS standards under HRS § 269-44.³⁴ Section 1 of

³²See Stipulation, Exhibit A, Sections 3.01.1 (Water Storage) and 3.03.4 (Solar Fraction) and Stipulation, Exhibit C at 21.

³³See Response to PUC-IR-101.

³⁴In addition, the Legislature in 2009, passed House Bill No. 1464, House Draft 3, Senate Draft 2, Conference Draft 1 ("H.B. 1464, C.D. 1") which amends HRS § 196-6.5 to clarify that the requirement under the section is for "a new single-family dwelling" (emphasis in the original). H.B. 1464, C.D. 1 was transmitted to the Governor of the State of Hawaii on

Act 204 sets forth the legislature's intent by stating that the purpose of Act 204 is to increase the use of renewable energy by, among other things, requiring the installation of solar water heater systems in all new residential development projects constructed after January 1, 2010.³⁵

Given the legislature's intent to have Act 204 apply to new construction, the commission finds it reasonable and appropriate to eliminate all references to retrofit systems and systems for other types of structures in the RSWHS Standards.³⁶ References to retrofit and other types of systems could be construed as being beyond the scope of the commission's purview and contrary to legislative intent. Moreover, inclusion of such language may lead to confusion with regards to the applicability of the standards.

Based on the foregoing, the commission concludes that all references to retrofit and other types of structures should be eliminated from the RSWHS Standards, and consistent with this determination relevant portions of the Stipulation (and Exhibit A) are thus rejected.

May 11, 2009 and was signed into law on June 25, 2009, as Act 155.

³⁵See Act 204, Section 1.

³⁶The Third-party Administrator may establish SWHS standards for retro-fit systems and systems for structures that are not single-family residential homes.

c.

Conforming Amendments

In addition to the changes and modifications to the RSWHS Standards discussed above, the commission also finds it appropriate to include certain conforming amendments for clarity, consistency, and accuracy, which are reflected in Exhibit I of this Decision and Order. For instance, Section 4.07 of the Stipulating Parties' proposed standards refers to a "List of Accepted High-Efficiency Electric Water Heaters" and use of high-efficiency electric water heaters.³⁷ Given that the commission is tasked to adopt or establish standards for solar water heater systems, the commission finds and concludes that references to high-efficiency electric water heaters are inappropriate and thus, will eliminate these references. The Stipulating Parties agree with the commission's decision on this matter.³⁸

In addition, Part I of the standards proposed by the Stipulating Parties regarding definitions is amended for consistency by deleting references to items and entities that are no longer referred to in the standards. Accordingly, the commission has revised the RSWHS Standards as necessary for clarity, consistency, and accuracy (a few of which are discussed above). The applicable portions of the Stipulation (and Exhibit A) are thus rejected and modified.

³⁷See Stipulation, Exhibit A at 5 (emphasis added).

³⁸See Response to PUC-IR-102.

C.

Method to Update Standards

The procedures that the Stipulating Parties agreed-upon for updating the RSWHS Standards established in this docket, are described in Attachment 1 of Exhibit A to the Stipulation. Generally, the Stipulating Parties propose that: (1) future updates and/or amendments to the RSWHS Standards should require commission approval through the filing of an application as set forth in HAR Chapter 6-61 or may be requested by an Administrator with the commission subsequently opening a proceeding, and (2) updates and/or amendments to the Output Table and Products List, which will be separately kept and maintained by the Administrator, may be made through an Administrator/Committee process through which uncontested updates and/or amendments can be expedited by an Administrator, with contested updates and/or amendments utilizing a dispute resolution process with the commission as the arbiter of last resort. The Committee, described above, would be formed and selected by the Administrator.³⁹

³⁹With respect to the Committee, the Stipulating Parties agree that the Administrator shall: (1) be responsible for the formation of the Committee which shall include as members representatives from each electric utility and may include representatives from the Consumer Advocate and the commission (at their discretion), and representatives from the HSEA and building associations; and (2) select a maximum of ten representatives to serve on the Committee that "best represents as broad a cross-section of various differing interest groups in the solar water heating industry as can reasonably be achieved under the circumstances." See Stipulation, Exhibit A at 14 (Attachment 1).

Given the commission's decision with respect to the necessity of an Administrator, and regarding the Output Table and Products List, as set forth above, the commission finds it appropriate to accept in part, and reject in part, the Stipulating Parties' proposal regarding the method to update the RSWHS Standards. Specifically, the Stipulating Parties' proposal to require the filing of an application under HAR Chapter 6-61 to request any updates or amendments to the RSWHS Standards for commission review and approval appears to be reasonable. This process is consistent with the commission's process for similar matters and invokes the procedures established under HAR Chapter 6-61, Rules of Practice and Procedure Before the Public Utilities Commission.

However, the Stipulating Parties' agreement with respect to the procedures to update the Output Table and Products List are unnecessary given the commission's previous determination to continue to include the Output Table as part of the standards while the Products List would not be maintained, but would be available for informational purposes only. In addition, based on the commission's prior determination that the designation of an Administrator is unnecessary, the role of the Administrator with respect to updates and amendments to the standards should be eliminated, for consistency.

Based on the foregoing, the commission concludes that the portions of the Stipulation regarding updates to the SWHS standards should be accepted in part, and rejected in part,

to reflect the determinations set forth above, and that the RSWHS Standards proposed by the Stipulating Parties (i.e., Exhibit A of the Stipulation) should be modified accordingly.

D.

Comment Process

The commission recognizes that the SWHS standards, established pursuant to HRS § 269-44 in this proceeding, could, in the near future, profoundly impact any person or entity involved in or associated with the building of residential single-family homes. Thus, at this time, the commission finds it reasonable and in the public interest to institute a process to receive comments from any affected entity (including the Parties and Participant) and the general public with respect to the SWHS standards attached as Exhibit I to this Decision and Order. Those interested in submitting comments shall adhere to the following procedures:

1. Any interested person may submit comments regarding the SWHS standards attached as Exhibit I to this Decision and Order by sending written comments to the commission by mail addressed to: Public Utilities Commission, State of Hawaii, 465 South King Street, Room No. 103, Honolulu, Hawaii, 96813. Electronic comments may be submitted to the commission by e-mail at Hawaii.PUC@hawaii.gov.

2. All comments should reference Docket No. 2008-0249 and must be received by July 31, 2009 ("Comment Period").
3. Comments should be sufficiently detailed and should contain a full explanation and sufficient support to justify any requested revisions to the SWHS standards.
4. Comments received during the Comment Period will be: (a) made available for public inspection on the commission's website at <http://www.puc.hawaii.gov/> and; (b) forwarded to the Parties and Participant for a response, to be filed by August 31, 2009.

If revisions are warranted, a final decision and order on the SWHS standards will be filed by October 30, 2009. Any subsequent revisions and updates to the RSWHS Standards will be subject to the procedures set forth in the standards and discussed in Section II.C, above.

III.

Orders

THE COMMISSION ORDERS:

1. The commission establishes standards for SWHS, as required under Act 204 (codified as HRS § 269-44), by the adoption of the RSWHS Standards, with modifications, as set forth in Exhibit I of this Decision and Order.

2. The Parties and Participant's Stipulation, filed on April 28, 2009, is approved in part, and rejected in part, as described in Section II of this Decision and Order.

3. To the extent that the Output Table, filed in this proceeding, only pertains to the island of Oahu, within ten days of the date of this Decision and Order, MECO, HELCO and KIUC shall file their respect Solar Collector BTU/Day Output by Hawaii Sunshine Zone tables for the islands of Maui, Molokai, Hawaii, Kauai, and Lanai, if applicable. The documents will be deemed incorporated within the RSWHS Standards (i.e., an extension of the Output Table) upon their filing. In the alternative, the Stipulating Parties may opt to file a consolidated Output Table that contains information pertaining to all of the islands, which upon its filing will be deemed to replace the Output Table adopted in this Decision and Order, as part of the RSWHS Standards.


4. A process to solicit comments from interested persons with respect to the standards for SWHS attached as Exhibit I to this Decision and Order is established, as set forth in Section II.D of this Decision and Order.

DONE at Honolulu, Hawaii JUL - 1 2009.


PUBLIC UTILITIES COMMISSION
OF THE STATE OF HAWAII

By: 
Carlito P. Caliboso, Chairman

By: 
John E. Cole, Commissioner

By: 
Leslie H. Kondo, Commissioner

APPROVED AS TO FORM:


Ji Sook Kim
Commission Counsel

2008-0249.SWH Standards.laa

**RESIDENTIAL SOLAR WATER HEATING SYSTEM
STANDARDS AND SPECIFICATIONS**

Effective as of July 1, 2009

PART I – DEFINITIONS.

“Commission” means the Public Utilities Commission of the State of Hawaii.

“HAR” means the Hawaii Administrative Rules, as amended.

“HRS” means the Hawaii Revised Statutes, as amended.

“RSWHS” means Residential Solar Water Heating System.

“Solar Collector BTU/Day Output by Hawaii Sunshine Zone” means the listing of accepted collectors and their output ratings for each sunshine zone as described in Section 4.02 of these Standards and Specifications.

“Standards and Specifications” or “RSWHS Standards and Specifications” means this Residential Solar Water Heating System Standards and Specifications.

The following abbreviations used, and their meanings, shall be as follows:

“BTU” means British Thermal Unit.

“PSI” means Pounds per Square Inch.

“F.” means Fahrenheit.

PART II – GENERAL.

2.01. APPLICATION AND USE OF RSWHS STANDARDS AND SPECIFICATIONS.

HRS § 196-6.5 mandates that on or after January 1, 2010, no building permits shall be issued for a new single-family dwelling that does not include a solar water heater system that meets the standards established under HRS § 269-44, unless a variance is approved by the energy resource coordinator.¹ HRS § 269-44² provides that the Commission, not later than July 1, 2009 or as soon as reasonably practicable, shall adopt or establish by rule, tariff, or order, standards for solar water heater systems to

¹HRS § 196-6.5 was established by Section 2, Act 204 of the 2008 Session Laws of Hawaii (“Act 204”), and amended pursuant to Section 14, Act 155 of the 2009 Session Laws of Hawaii.

²As established by Section 3, Act 204.

include, but not be limited to, specifications for the performance, materials, components, durability, longevity, proper sizing, installation, and quality to promote the objectives of HRS § 269-124.

2.02. OTHER DOCUMENTS. Values, forms, tables, charts, approvals, and Policies and Procedures referred to herein are hereby incorporated into these RSWHS Standards and Specifications.

2.03. SYSTEMS. Solar systems installed shall conform to applicable local building, plumbing and electrical codes, these Standards and Specifications, and other requirements described in this document. Where discrepancies, if any, exist between local codes in effect at that time and these Standards and Specifications, local codes shall govern.

PART III – SYSTEM REQUIREMENTS.

3.01. SYSTEM DESIGN. Systems shall be designed specifically for residential water heating. Systems shall be of forced circulation or thermosiphon design which contains potable water. Systems may consist of single or multiple tanks and/or collectors. Multiple tank systems shall have the tanks connected in series. Multiple collector systems shall have the collectors connected in parallel. Single and multiple collectors shall be plumbed in a reverse return (i.e., opposite-end) method to achieve balanced flow through collectors. The solar return collector connection shall be at the highest point on each collector. Systems shall be designed to prevent back-siphoning. Acceptable system designs for forced circulation systems are bottom-return, side-return and top-return. Side-return and top-return system designs shall incorporate check valves and heat loops. Multiple tank bottom-return system designs shall incorporate swing check valves. Forced circulation system component sequence shall conform to Figure 1 for bottom-return systems; to Figure 2 for side-return systems; to Figure 3 for top-return systems; or which conform with applicable county building codes and are approved by the respective county building department. Thermosiphon system designs shall conform to the manufacturer's recommendations. System mounting method shall conform to the mounting method as set forth in the manufacturer's recommendations and applicable county building codes and approved by the respective county building department. Systems installed in areas which experience freezing conditions shall incorporate appropriate freeze protection measures.

3.02. SYSTEM PERFORMANCE. Systems shall be designed to provide a minimum of 90% of the annual average water heating load, except as provided for in Section 3.03.4 of these Standards and Specifications; to provide consistency of performance over the life of the system; and to achieve a minimum 15 year useful life.

3.03. SYSTEM SIZING. Systems shall be sized to yield an acceptable solar fraction. Solar fraction, expressed as a percentage, is the contribution by the solar system to the average daily water heating requirements. Solar fraction is a function of the actual system hot water storage, design finish tank temperature, daily BTU requirement to achieve design finish tank temperature, and daily collector output as determined by collector tilt, orientation and sunshine zone.

3.03.1. Water Storage. The minimum water storage for the combined capacity of the primary and any additional tanks in systems for new single-family residential construction shall be based on the number of bedrooms as listed in Table 1.

3.03.2. Tank Temperature. The design finish tank temperature shall be 130 degrees F.

3.03.3. Daily BTU Requirement. The daily BTU requirement for the actual system storage shall be determined from Table 2 for the island on which the system is installed.

3.03.4. Solar Fraction. The system design solar fraction shall be not less than 90% and not more than 110% of the total actual system storage BTU requirement. The solar fraction shall be determined by dividing the total adjusted collector BTU output per day by the total actual system storage BTU requirement per day as provided on Form 1.

3.04. COLLECTOR TILT. Collectors shall be tilted not less than 14 degrees and no more than 60 degrees from the horizontal. Forced circulation system collectors mounted on roofs whose pitch is less than 14 degrees shall be tilted to no less than 20 degrees and no more than 30 degrees. Thermosiphon system collectors mounted on roofs whose pitch is less than 14 degrees shall be tilted to no less than 20 degrees and no more than 30 degrees. Collectors mounted on roofs whose tilt is above 35 degrees shall have their output rating derated by percentages listed in Table 3. Collector tilt factors shall be determined by rounding collector tilt to the nearest 5 degrees.

3.05. COLLECTOR ORIENTATION. Collectors shall be oriented between South of due East and South of due West. Collectors oriented East of 135 degrees true or West of 225 degrees true shall have their output rating derated by the percentages shown on Chart 1, Orientation Factors for Solar Installations (Compass Rose Diagram). Chart 1 shows allowable collector orientations and orientation factors corrected for magnetic deviation.

3.06. COLLECTOR SHADING. Collectors shall not be shaded by any permanent obstacle at any portion of the time after 9:00 a.m. or before 3:00 p.m. on December 21 or any other day of the year.

PART IV – PRODUCTS.

4.01. GENERAL. All products used for system installations must conform to these Standards and Specifications.

4.02. COLLECTOR RATINGS. Collectors shall be of the liquid type and shall have a current Solar Rating & Certification Corporation OG-100 rating and certification. Collector output ratings shall be based on OG-100 Category C data for clear sky, mildly cloudy, and cloudy sky conditions and shall be correlated to the applicable sunshine map and the “Solar Collector BTU/Day Output by Hawaii Sunshine Zone” table for the island on which the system is installed.

The sunshine maps reflect the solar energy in terms of calories per square centimeters per day on each island and are attached to these Standards and Specification as Attachment B.

A listing of accepted collectors and their output ratings for each sunshine zone, “Solar Collector BTU/Day Output by Hawaii Sunshine Zone” are attached to these Standards and Specifications as Attachment A. The sunshine zone closest to the collector installation site shall be used to determine collector output. Sites equidistant between two zones may be considered to be in either zone. Sites in the 300 zone shall be considered to be in a 350 zone for system sizing purposes.

4.03. COLLECTOR MATERIALS. For flat plate collectors, collector frame material shall be aluminum, stainless steel or copper. Collector glazing shall be low-iron tempered solar glass. Collector waterways shall be of Type M minimum copper tube.

4.04. COLLECTOR/SYSTEM MOUNTING BRACKETS. Collector/system mounting brackets which secure the collector/system to the support structure or directly to the roof structural member shall be designed specifically for the equipment to be bracketed and shall be fabricated by an established manufacturer.

4.05. COLLECTOR/SYSTEM LEG SETS. Collector/system leg sets which secure the collector/system to the support structure or directly to the roof structural member shall be designed specifically for the equipment to be supported and shall be fabricated by an established manufacturer.

4.06. COLLECTOR/SYSTEM SUPPORT STRUCTURE. Collector/system support structure shall be of structurally sound material. The material shall be of non-corrosive metal channel or similar sections of approved material and finish which are compatible with the collector, collector mounting brackets, collector leg supports and leg set cross braces. Acceptable support structure materials are extruded aluminum solar strut, channel and double T, isolated galvanized steel and UV resistant plastic. Unless otherwise consistent with applicable building codes and approved by the respective county building department, solar strut shall be 1 5/8" x 1 5/8" x 1/8" in size, channel and double T shall be 3" x 1" x 1/8" in size, and angle aluminum shall be 2" x 2" x 3/16" in size. Wood or wood products are not acceptable.

4.07. TANKS. Tanks shall be designed specifically as residential water heaters or water storage tanks. The manufacturer shall provide a warranty over new tanks for at least 5 years. The new tank shall be listed in the most current Air-Conditioning, Heating and Refrigeration Institute's Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment. In single tank systems, the tank shall be equipped with an internal thermostat and heating element rated at not more than 4500 Watts. In single tank systems, the lower element, if any, shall be disabled at the upper element. In multiple tank systems, the tank which directly supplies the hot water load shall have an internal thermostat and heating element of an approved rating and the lower element, if any, shall not be disabled.

4.08. PUMP. Pumps shall be of a circulating type. The pump shall be designed to attain the manufacturer's recommended collector flow rate for the total number of system collectors and the total developed head of the solar lines. AC powered pumps shall be compatible with the pump controller. DC powered pumps shall be compatible with the photovoltaic module. Pump isoflanges are not acceptable in lieu of ball valves.

4.09. CONTROLLER. Controller shall automatically control the operation of the circulating pump so that optimum system performance is attained. The controller shall be compatible with the circulating pump. Controller sensors shall be thermistors, which conform to the manufacturer's specifications for the controller.

4.10. PHOTOVOLTAIC MODULE. Photovoltaic modules used to power DC pumps shall be compatible with the pump's performance rating and power requirements.

4.11. TIME SWITCHES. All systems shall have time switches, which control the operation of the auxiliary heating system. Acceptable time switches are electric, electronic and spring-loaded mechanical switches. Electric and electronic time switches shall have a manual override feature.

4.12. ELECTRICAL CONDUCTOR. Electrical conductors exposed to direct sunlight shall have sunlight resistant insulation. Conductors interconnecting the photovoltaic module and DC circulating pump shall not have more than a 3% voltage drop over the one way distance between the pump and module. Refer to Table 5 for conductor sizes based on one way distances.

4.13. PIPING. Piping shall be copper tubing Type M minimum. Solar supply and return pipe shall be sized to attain the manufacturer's recommended collector flow rate for the total number of system collectors and pump size. The pipe size for forced circulation systems with not over 120 square feet of collector area and not over 120 feet total round trip distance shall be 1/2-inch minimum. The pipe size for forced circulation systems with collector area over 120 square feet and/or over 120 feet total round trip distance shall conform to applicable county building codes and be approved by the respective county building department. The pipe size for water heater/storage tank supply, distribution, multiple tank interconnections and overflow lines shall be 3/4-inch minimum. The hot and cold supply lines to a thermosiphon system shall have a pipe size of 3/4-inch minimum. Water heater flex connectors are not acceptable.

4.14. FITTINGS. Fittings shall be bronze, brass, or wrought copper approved for potable water distribution. Factory installed galvanized tank nipples are acceptable.

4.15. PIPE SUPPORTS, BLOCKS AND SPACERS. Pipe supports shall be copper, stainless steel or other approved material. Rooftop piping support blocks or spacers, when used, shall be 2" x 4" painted wolmanized wood blocks, UV resistant non-metallic spacers, solar strut or equal.

4.16. VALVES. Valves shall be bronze or brass.

4.16.1. Ball Valves. Ball valves shall be provided to isolate major system components such as tanks, collectors and circulating pumps. Factory supplied pump isolation flanges are not acceptable to isolate the pump in lieu of ball valves. A ball valve or pump isolation flange is not required between the tank and pump as long as the pump remains above the top of the tank.

4.16.2. Check Valves. Check valves shall be provided with side-return, top-return and multiple tank, bottom-return forced circulation systems or where back siphoning may occur. Check valves shall be of the swing check type.

4.16.3. Flush Out Valves. Flush out valves shall be provided to allow for storage tank and collector draining and periodic flushing. Acceptable valves are hose bibs and boiler drains.

4.16.4. Pressure Relief Valve. A pressure relief valve shall be provided at the collector(s). The pressure setting shall be non-adjustable and rated at 125 or 150 PSI. The valve lever shall be stainless steel and the valve pin shall be brass.

4.16.5. Temperature & Pressure Relief Valve. A temperature & pressure relief valve shall be provided for single or multiple pressurized water storage tank systems provided that the location complies with local code requirements. The temperature and pressure relief settings shall be non-adjustable and rated at 210 degrees F. and 150 PSI, respectfully.

4.17. UNIONS. Unions shall be bronze or brass. Unions shall be used to connect dissimilar piping materials. Dielectric unions connecting corrosion causing dissimilar metals are acceptable.

4.18. TEMPERATURE MEASURING DEVICE. A temperature-measuring device shall be provided to measure the temperature of the storage tank, which directly supplies the hot water load. Acceptable temperature measuring devices are temperature gauges and electronic temperature devices.

4.19. FASTENING HARDWARE. All fastening hardware, including, but not limited to, strut-nut sets, through-bolt sets, lag-bolt sets, and hanger-bolt sets, shall be stainless steel Series 300 minimum or other approved material.

4.19.1. Strut-Nut Sets. Strut-nut sets shall consist of one strut nut, bolt, and flat or lock washer each. The size, length and quantity of strut-nut sets shall be that recommended by the manufacturer or one strut-nut set per collector mounting bracket with a minimum bolt diameter and length of 5/16" by 3/4", whichever is greater.

4.19.2. Through-Bolt Sets. Through-bolt sets shall consist of one bolt, nut, flat or fender washer and lock washer each. The size, length and quantity of through-bolt sets shall be that recommended by the manufacturer or one through-bolt set per collector mounting bracket with a minimum bolt diameter and length of 5/16" by 3/4", whichever is greater.

4.19.3. Lag-Bolt Sets. Lag-bolt sets shall consist of one lag bolt and one flat or fender washer. Lag bolt diameter shall be that recommended by the manufacturer or 5/16-inch minimum, whichever is greater. Lag bolts shall be of sufficient length to penetrate a minimum of 1-3/4 inches into the roof structural member. The number of anchoring lag bolts shall be that recommended by the manufacturer or that listed in Table 4, whichever is greater.

4.19.4. Hanger-Bolt Sets. Hanger-bolt sets shall consist of one hanger bolt and lock washer each and two nuts and flat or fender washer each. Hanger bolt diameter shall be that recommended by the manufacturer or 3/8-inch minimum, whichever is greater. Hanger bolts shall be of sufficient length to penetrate a minimum of 1-3/4 inches into the roof structural member. The number of anchoring hanger bolts shall be that recommended by the manufacturer or that listed in Table 4, whichever is greater.

4.20. INSULATION. Piping insulation shall be flexible and elastomeric with a minimum wall thickness of 1/2 inch and a minimum design temperature of 220 degrees F.

4.21. SOLDER. Solder shall be lead free.

4.22. FLASHING. Flashing, when used, shall be designed to positively seal roof penetrations resulting from the solar system installation. Acceptable flashing materials are lead, copper, aluminum or other approved material. Lead shall not be used where water supplying a catchment system contacts the flashing.

4.23. OTHER PRODUCTS. Neoprene, EPDM spacers or other approved material shall separate corrosion causing dissimilar metals. Minor component products not otherwise listed in these Standards and Specifications may be used provided that their use does not detract from overall system performance.

4.24. PRODUCT WARRANTIES. Manufacturer warranties shall apply to all products. Contractors and/or vendors who unilaterally extend manufacturer product warranties shall provide the solar system purchaser with a written statement that the extension is not guaranteed by any other party.

4.25. ASBESTOS PROHIBITION. No materials containing asbestos shall be used in any product.

PART V – EXECUTION.

5.01. GENERAL. Solar system installations shall result in fully operational systems. Solar systems shall be installed by properly licensed contractors. All required governmental permits shall be issued prior to system installation. Installations shall be in accordance with applicable governmental codes and these RSWHS Standards and Specifications or manufacturer's recommendations where they meet or exceed these Standards and Specifications.

References to the approval of respective county building department in these Standards and Specifications are not intended to obligate the county departments to extend or broaden their purview in any manner. However, to the extent that the county building departments already have inspection and oversight functions over the installation of various portions of solar water heater systems through county building codes, their approval will concurrently satisfy relevant portions of these Standards and Specifications.

5.02. COLLECTORS/SYSTEMS. Solar collectors/systems, mounting brackets, leg sets, support structure and support structure anchoring fasteners shall be attached to form a secure mechanical bond between adjoining components and the roof structural members.

5.02.1. Collectors/Systems. In multiple collector systems, collectors shall be installed with the same tilt and orientation. Solar collectors/systems shall be mounted in a stand-off method with a minimum of 1-1/2 inches between the roof and the bottom edge of the collectors/system, except where the collectors are integrated into the roof.

5.02.2. Mounting Brackets. Mounting brackets shall secure flush mounted collectors directly to the collector support structure or the roof structural members. Unless otherwise provided by the collector manufacturer, a minimum of four brackets per collector shall secure each flush mounted collector. For mounting brackets which require penetration of the collector box, the number of fasteners attaching each bracket to the collector shall equal the number of holes in the bracket, unless otherwise provided by the collector manufacturer. Collector box penetrations by mounting bracket fasteners shall be positively sealed to prevent moisture infiltration. Brackets attached directly to roof structural members shall be secured with a minimum required diameter anchoring fastener. Brackets attached to support structures shall be secured with lock-nut sets on "solar strut" and with through-bolt sets on channel.

5.02.3. Mounting Flanges. Fastening of collectors with mounting flanges directly to the support structure through the mounting flange is acceptable provided that this is consistent with the collector manufacturer's recommendations. When collectors with mounting flanges are fastened directly to the support structure through the mounting flange, collectors shall be secured with strut-nut sets or through-bolt sets. These bolt-sets shall be through-bolted to the support structure in accordance with the collector manufacturer's recommendations, or secured with a minimum of four bolt-sets of the size and length described for mounting brackets per collector, whichever is greater.

5.02.4. Leg Sets. Leg sets shall secure tilted collectors directly to the collector support structure or the roof structural members. The type, number, location and installation method of leg sets shall be in accordance with the collector manufacturer's recommendations. Unless otherwise provided by the collector manufacturer, each tilted collector shall be supported by a minimum of two leg sets. For leg set brackets which require penetration of the collector box, the number of fasteners attaching the collector leg sets to the collector shall equal the number of holes in the leg set bracket, unless otherwise provided by the collector manufacturer. Collector box penetrations by leg set bracket fasteners shall be positively sealed to prevent moisture infiltration. Leg sets shall be secured to the support structure with strut-nut sets on "solar strut" and with through-bolt sets on channel. Leg sets which are 4 feet or longer in length shall be cross-braced diagonally. Cross braces shall be through bolted to the leg sets.

5.02.5. Support Structure. Collector/system support structures shall be anchored by fasteners firmly secured to the roof structural members. Support structure runners, when used, shall be located no farther in than 24 inches from the shorter ends of the collector(s). Anchor fasteners along each runner shall be located no farther from the edge of outer most collector than one-half the collector width and no farther than 4 feet apart. Collector/system support structure anchoring fasteners shall not be exposed on the interior side of roof structural members. Support structures installed parallel to the roof ridge shall provide sufficient clearance from the roof covering to allow for adequate water and debris shed.

5.03. TANKS. Water heaters and/or storage tanks shall be plumbed so that the attached equipment, cover plates and warning labels are visible and accessible. Attached equipment shall be defined as pump, controller, time switch, piping and any other components attached or connected to the tank. All pressurized tanks shall be equipped with a securely attached temperature and pressure relief valve. Piping connections to the tank shall be made with brass or bronze fittings. The tank combination temperature and pressure relief valve drain line shall be securely attached to the temperature and pressure relief valve and shall terminate no more than 2 feet nor less than 6 inches above the ground and pointing downward. Adjustable auxiliary heating thermostats shall be set at 120 degrees F.

5.03.1. Ground Mounted Tanks. Vertical and horizontal ground mounted tanks shall be set level on concrete or other approved base extending not less than 3 inches above the adjoining ground level. Cement bricks placed between the tank and the supporting base shall support tanks. Cement bricks shall be whole and of a nominal minimum size of 2 inches high, 3 inches wide and 7 inches long. A minimum of three bricks evenly spaced shall be used to support vertical tanks. Bricks are not required for tanks with non-metallic bottoms. Horizontal tanks shall be supported in accordance with the tank manufacturer's

recommendations. Acceptable leveling devices are manufactured plastic shims, or other approved material. In side-return, top-return single and multiple tank systems, the solar return line shall be plumbed with a heat loop which extends to within 12 inches of the bottom of the tank. Required swing check valves shall be installed horizontally on the solar return line at the bottom of the heat loop. In bottom-return multiple tank systems, the required swing check valve shall be installed horizontally at the solar return line connection to the tank drain port. Nipples replacing manufacturer supplied tank drain valve shall be of sufficient length to allow adequate access to tank sensor. All contractor installed flush out valves shall have thread caps with hose washer securely attached to the valve.

5.03.2. Roof Mounted Tanks. Roof mounted thermosiphon system tanks shall be supported by the number of tank supports, support fasteners and tank mounting brackets recommended by the manufacturer or those which correspond to the tank length ranges shown on Table 6 for Minimum Thermosiphon System Tank Supports, Support Anchoring Fasteners and Tank Mounting Brackets, whichever is greater. The number of supports and fasteners are based on roof structural member spacing of 24 inches on center or less. The length of tank supports shall be not less than the tank diameter or width and shall conform to Section 4.06. Collector/System Support Structure of these Standards and Specifications. Each tank support shall be installed parallel to and directly over a roof structural member. Each tank support shall be securely attached to the roof structural member with a minimum of 2 anchoring fasteners per support, which shall be located no farther than 4 inches from the ends of each support. Tank mounting brackets shall be located on and secured to opposite sides of each tank support. Tank mounting brackets shall be secured to the tank supports with strut nut sets on "solar strut", with through-bolt sets on channel, and with lag bolt-sets on approved plastic lumber.

5.04. CONTROLLERS. Pump controllers shall be installed in accordance with manufacturer's recommendations. The top of the controller shall not be higher than 6 feet, 7 inches above the floor/ground level and shall not be located behind the tank. Controller sensors shall be attached at the hottest and coldest points in the solar piping loop by stainless steel clamps. Collector sensors shall be attached no farther than 6 inches from the collector header connection to the solar return line. Tank sensors shall be attached no farther than 12 inches from the coldest point at the tank on the solar supply line. Attachment of the tank sensor to factory provided tank sensor stud is permitted. Controller sensor attachment shall form a positive mechanical bond between the sensor and the sensing point to optimize heat transfer to the sensor. The sensor shall be clamped on its flanged end. Clamping of sensors over the sensor "barrel" end is unacceptable. Sensors shall be connected to sensor wire with all plastic wire nuts. Wire nuts shall be sealed with silicon and wrapped with electrician's tape. Sensor wiring shall be secured in a workmanlike manner.

5.05. TIME SWITCHES. Time switches shall be installed in accordance with manufacturer's recommendations. The top of the time switch shall not be higher than 6 feet 7 inches above the floor/ground level and shall not be located behind the tank. Time switches shall be set so that tank thermostats are not energized during the solar day (i.e., between 9:00 a.m. and 3:00 p.m.). Recommended automatic time switch settings are 4 p.m. "on", 5 p.m. "off". Multiple automatic time switch settings, exclusive of the solar day, are acceptable. At a minimum, electric time switches shall have at least one "off" tab securely affixed to the face of the timing mechanism and electronic time switches shall be programmed to turn off within 24 hours of being turned on. Time switch wiring shall be secured in a workmanlike manner.

5.06. PHOTOVOLTAIC MODULES. Photovoltaic modules shall be securely installed with approved support structure materials in the same tilt and orientation as the system collectors. Module location shall conform to Section 3.06 Collector Shading. Wire nuts used to interconnect module and pump shall be all plastic and shall be sealed with silicon and wrapped with electrician's tape.

5.07. PIPING, FITTINGS AND VALVES. Solder joints shall be sanded, fluxed and soldered with approved solder. Threaded fittings and valves shall be wrapped with Teflon or equal tape and/or joint sealant. Piping shall be plumb and level where practical. Vertical piping shall be supported at each story or at maximum intervals of 10 feet. Horizontal piping shall be supported at approximately 6-foot intervals. Pipe supports shall not penetrate piping insulation. Rooftop piping shall be raised off the roof by blocks or spacers. Blocks/spacers shall be placed at approximately 6-foot intervals on straight runs and not more than 2 feet of each side of an angular joint. Piping shall be attached to blocks/spacers with acceptable pipe supports. Blocks/spacers shall be adhered to the roof. Roof penetration shall not be made to attach blocks/spacers to the roof. Valves, including hose bibs and boiler drains, shall be installed in the sequence shown on the accepted system schematic.

5.08. PIPING INSULATION. Insulation shall be installed on all new hot water piping, including solar supply and return lines and on accessible existing hot and cold water supply pipe for a minimum of 6 feet leading to the system. Insulation is not required on the cold water supply line to thermosiphon systems. The tank temperature and pressure relief overflow line and collector pressure relief overflow line, where present, shall be insulated to within the 12 inches of the end of exposed pipe. Insulation butt joints shall be sealed in accordance with manufacturer's recommendations. Packing of insulation butt joints in attics and within walls, in lieu of sealing, is acceptable. Abutment of valves, unions and tees with pipe insulation is acceptable. Insulation shall in no way restrict the operation of any valve. Collector headers and interconnections shall be insulated. Collector headers and interconnections insulation may be slit and ny-tied without sealing. The entire circumference of rooftop exposed insulation shall be UV protected. Acceptable UV protection is latex based paint. UV protection of insulation on exterior vertical piping is acceptable.

5.09. ROOF/WALL/CEILING PENETRATIONS. Roof penetrations shall be detailed on system mounting detail drawings and shall be positively sealed in accordance with standard roofing practices. Flashing installed on metal roofs shall be compatible with the roofing material. Exterior/interior wall penetrations shall be made watertight. Ceiling penetrations shall be sealed.

5.10. TEMPERATURE MEASURING DEVICE. In forced circulation systems, the temperature-measuring device shall be installed at the hot water outlet port on the tank, which directly supplies the domestic hot water load. In thermosiphon systems, the temperature-measuring device shall be installed only on an accessible hot water supply after the storage tank and before any hot water fixture; the device shall not be required on inaccessible hot water supply lines.

5.11. OTHER PRODUCTS. Minor component products not otherwise listed in these Standards and Specifications shall be installed in a professional, workmanlike manner in accordance with manufacturer's recommendations.

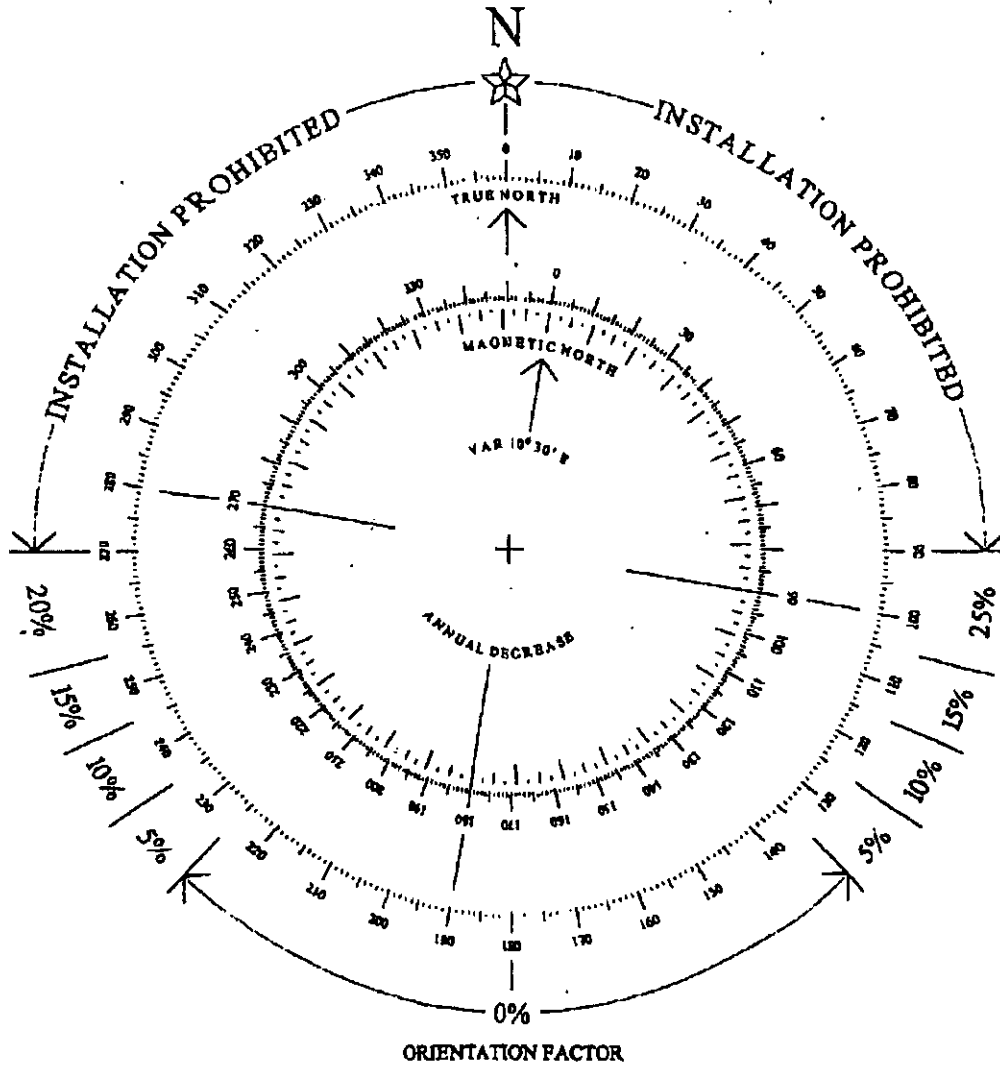
5.12. SYSTEM WARRANTY. Contractors shall provide full labor warranty for one (1) year from the date each system is installed. Contractors and/or vendors who unilaterally extend manufacturer product warranties shall provide the solar system purchaser with a written statement that the extension is not guaranteed by any other party.

PART VI – AMENDMENTS AND MODIFICATIONS TO THESE STANDARDS AND SPECIFICATIONS.

6.01. Unless otherwise provided for by the Commission, any amendments or modifications to these Standards and Specifications (including the Solar Collector BTU/Day Output by Hawaii Sunshine Zone Table and the sunshine maps for each island, i.e., Attachments A and B, respectively) will be initiated through a filing of an application with the Commission as set forth in and compliance with HAR Chapter 6-61, and require express Commission approval.

RESIDENTIAL SOLAR WATER HEATING SYSTEM STANDARDS AND SPECIFICATIONS

Chart 1. Orientation Factors for Solar Installations



This compass rose diagram is to be used in conjunction with Table 4 and Form 1.

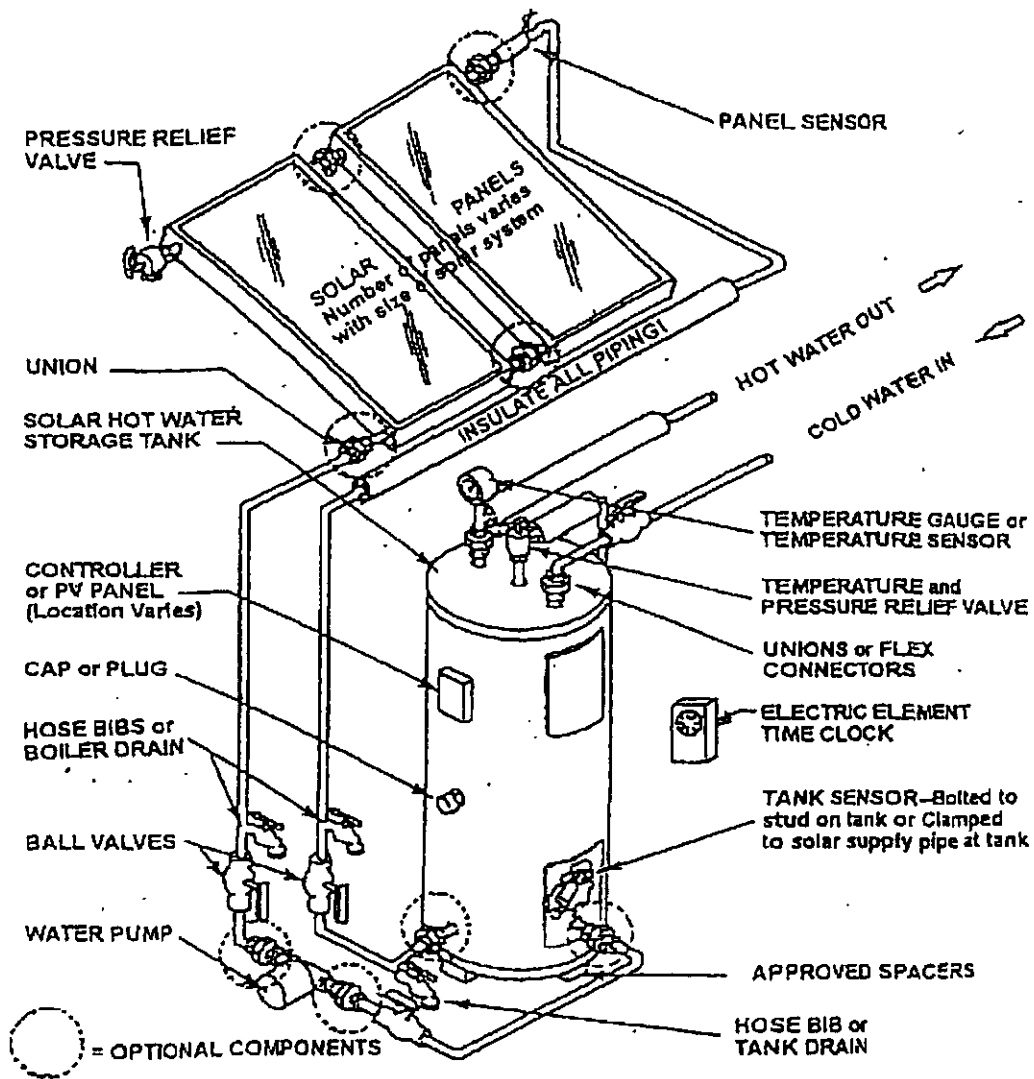
Steps to determine True direction of solar collector panels using the compass rose:

1. With a Magnetic compass, determine the Magnetic bearing (direction) that the long axis of the panels will sit at when installed. This bearing must be between 080° and 260° Magnetic, (090° and 270° True).
2. On the compass rose, lay a straightedge along the X at the center of the compass rose and, using the inner circle, through the Magnetic bearing (determined in step 1).
3. Read the True bearing from the outer circle. This is the True bearing which is used to determine the orientation factor, if any, which must be used on Form 1.

True compass direction can also be found on the Island of Hawaii by adding 10° to the Magnetic compass bearing. (The current magnetic variation in Hawaii is 10° East).

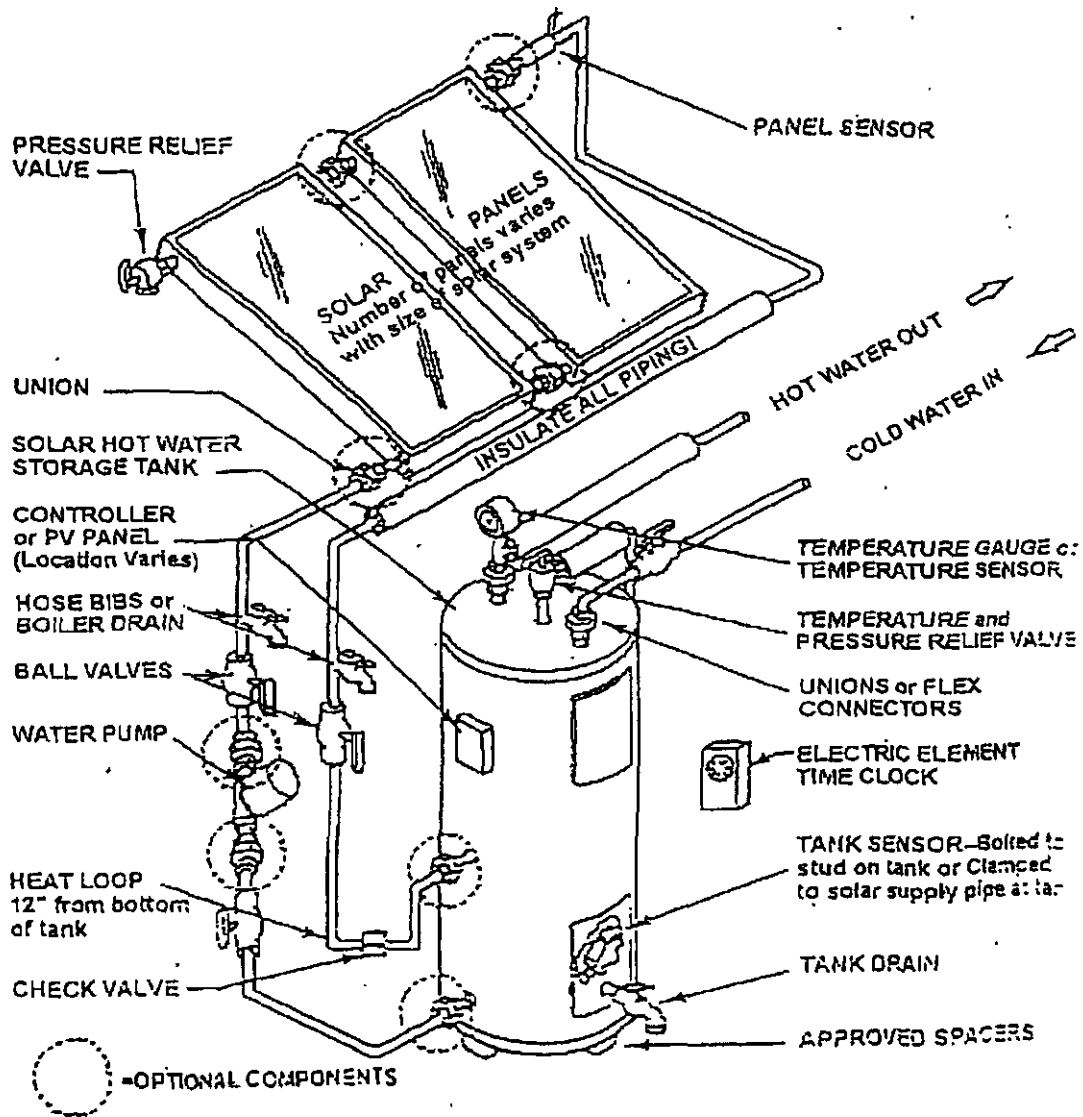
Compass Rose Diagram courtesy of Hawaii Electric Light Company

FIGURE 1.
 BOTTOM-RETURN RESIDENTIAL FORCED CIRCULATION SYSTEM DESIGN



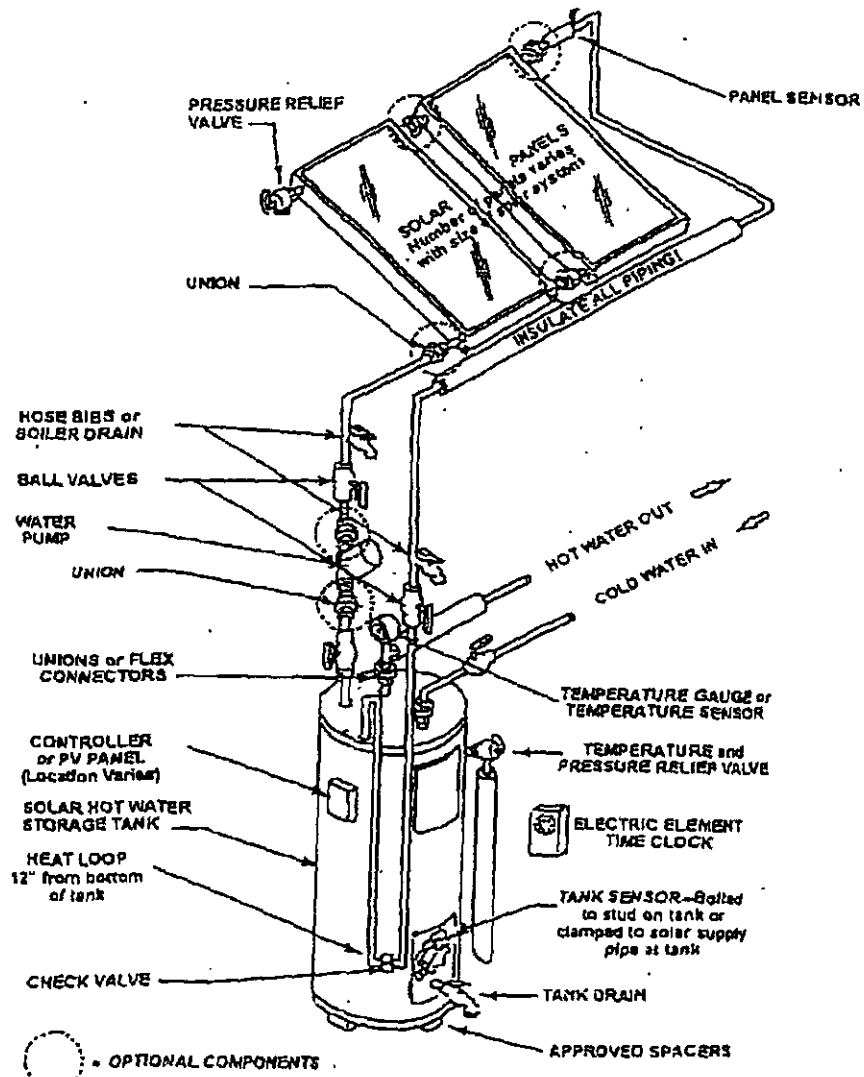
Reference: HECO Residential Solar Water Heating System Standards and Specifications Section 1.04. System Design

FIGURE 2.
SIDE-RETURN RESIDENTIAL FORCED CIRCULATION SYSTEM DESIGN



Reference: HECO Residential Solar Water Heating System Standards and Specifications Section 1.04. System Design

FIGURE 3.
TOP-RETURN RESIDENTIAL FORCED CIRCULATION SYSTEM DESIGN



Reference: HECO Residential Solar Water Heating System Standards and Specifications Section 1.04. System Design

Form 1. Residential Solar Water Heating System Sizing Tool

SYSTEM DATA

1	System Type	Active/Passive
2	Sunshine Zone	300 350 400 450 500
3	Collector Manufacturer	
4	Collector Model Number	
5	Collector Size	
6	Absorber Coating	Chrome / Paint
7	Collector Orientation	Degrees
8	Collector Orientation Factor	%
9	Collector Mounting Method	Flush / side tilt / end tilt
10	Collector Tilt	Degrees
11	Collector Tilt Factor	%
12	Actual Hot Water Storage	Gallons
13	Back-Up Heating Type	Electric / Gas / Heat Pump
14	Pump Type	AC / DC / None
15	System Solar Fraction	%

HOT WATER STORAGE SIZING

	gal/day	Line
1. Hot Water Use: Number of Bedrooms _____	_____	1
2. Total Number of Additional Showers / Day (_____ x 10 gal.)	_____	2
3. Tub Bath Hot Water Use (No. of Tub Baths Taken/Week _____ x 20 ÷ 7 days)	_____	3
4. Clothes Washing Hot or Warm Water Use (No. Loads/Week _____ x 18 ÷ 7 days)	_____	4
5. Required Storage (add Lines 1, 2, 3, 4) or Table 1 minimum which ever is greater)	_____	5
6. Actual System Storage from Table 2) gals	_____	6
7. Tank #1	_____	7
8. Tank #2	_____	8
9. Tank #3	_____	9
10. Total Actual System Storage/BTU's/Day (add Lines 7,8,9)	_____	10

COLLECTOR OUTPUT SIZING

11. Collector Rated BTU Output/Panel/Day/Sky Condition (from Attachment A)	_____	11
12. Number of Collector	_____	12
13. Total Collector BTU Output/Day (Multiply Lines 11 and 12)	_____	13
14. Off-Orientation BTU's Required/Day (Multiply Chart 1 Factor & Line 13)	_____	14
15. Off-Tilt BTU's Required/Day (Multiply Table 3 Factor & Line 13)	_____	15
16. Total Adjusted Collector BTU Output/Day (Subtract Lines 14 & 15 from Line 13)	_____	16

SOLAR FRACTION

17. Percent Solar Fraction (Divide Line 16 by Line 10 BTU/day value)	_____	% 17
--	-------	------

Tables 1-6. RESIDENTIAL SOLAR WATER HEATING SYSTEM STANDARDS AND SPECIFICATIONS

Table 1. Minimum Water Storage for New Construction

No. of Bedrooms	Storage
1-3	80 gal.
4-5	120 gal.
Over 5	120 gal. plus 20 gal. per additional room

Table 2. Daily BTU Requirements for Common Nominal Size Residential Heaters and Storage Tanks at 55 Deg. Rise to Tank Temperature of 130 Deg.

<u>Nominal Storage Capacity</u>	<u>Daily BTU Requirement</u>	<u>Nominal Storage Capacity</u>	<u>Daily BTU Requirement</u>
30 gals.	13,745	70 gals.	32,071
40 gals.	18,326	80 gals.	36,652
50 gals.	22,908	90 gals.	41,234
52 gals.	23,824	100 gals.	45,815
60 gals.	27,489	115 gals.	52,687
66 gals.	30,238	120 gals.	54,978

Table 3. Tilt Factors

<u>Tilt (in deg.)</u>	<u>Add'l Collector BTU</u>	<u>Tilt (in deg.)</u>	<u>Add'l Collector BTU</u>
14	0%	50	15%
35	0%	55	20%
40	5%	60	25%
45	10%		

Table 4. Minimum Support Structure Anchors*

<u>No. of Collectors</u>	<u>Collector Size</u>	<u>No. of Anchors</u>
1	Any size	4
2	3' x 7' or 3' x 8'	4
2	1 @ 3' x 8' or 1 @ 4' x 8'	4
2	4' x 6' or 4' x 8' or 4' x 10'	6
3	3' x 7' or 3' x 8'	6
3	2 @ 3' x 8' or 1 @ 4' x 8'	6
3	1 @ 3' x 8' or 2 @ 4' x 8'	6
3	4' x 6' or 4' x 8' or 4' x 8'	8
4	3' x 7' or 3' x 8'	8
4	2 @ 3' x 8' and 2 @ 4' x 8'	8
4	4' x 6' or 4' x 8' or 4' x 10'	10

* Applies to extruded aluminum sizes: 1 5/8" x 1 5/8" x 1/8" solar strut, 3" x 1" x 1/8" channel & double T, 2" x 2" x 3/16" angle aluminum.

Table 5. Minimum Conductor Size for PV Powered Pumps (One Distance)

Module Output	18 AWG	16 AWG	14 AWG	12 AWG	10 AWG	8 AWG
5 W	54 ft	109 ft	219 ft	327 ft	545 ft	>1000 ft
10 W	26 ft	52 ft	104 ft	156 ft	269 ft	429 ft
20 W	n/a	26 ft	52 ft	78 ft	130 ft	208 ft
43 W	n/a	n/a	24 ft	36 ft	60 ft	96 ft

Table 6. Minimum Thermosiphon System
Tank Support Anchoring Fasteners & Tank Mounting Brackets

Tank Length	No. of Tank Supports ¹	No. of Support Fasteners ²	No. of Tank Mount Brackets ³
48" – 56"	2	4	4
69" – 75"	3	6	6
91" – 108"	4	8	8
120" – 130"	5	10	10
160"	6	12	12

¹ Based on typical rafter/joist spacing of 24" on center or less. For rafter/joist spacing greater than 24" on center refer to Section 3.03.2

² Minimum of 2 support fasteners per support of 5/16" diameter for direct mount method. Fasteners of sufficient length to penetrate a minimum of 1 ¼" into the roof structural member.

³ Tank mounting brackets shall be located on and secured to opposite sides of each tank support.

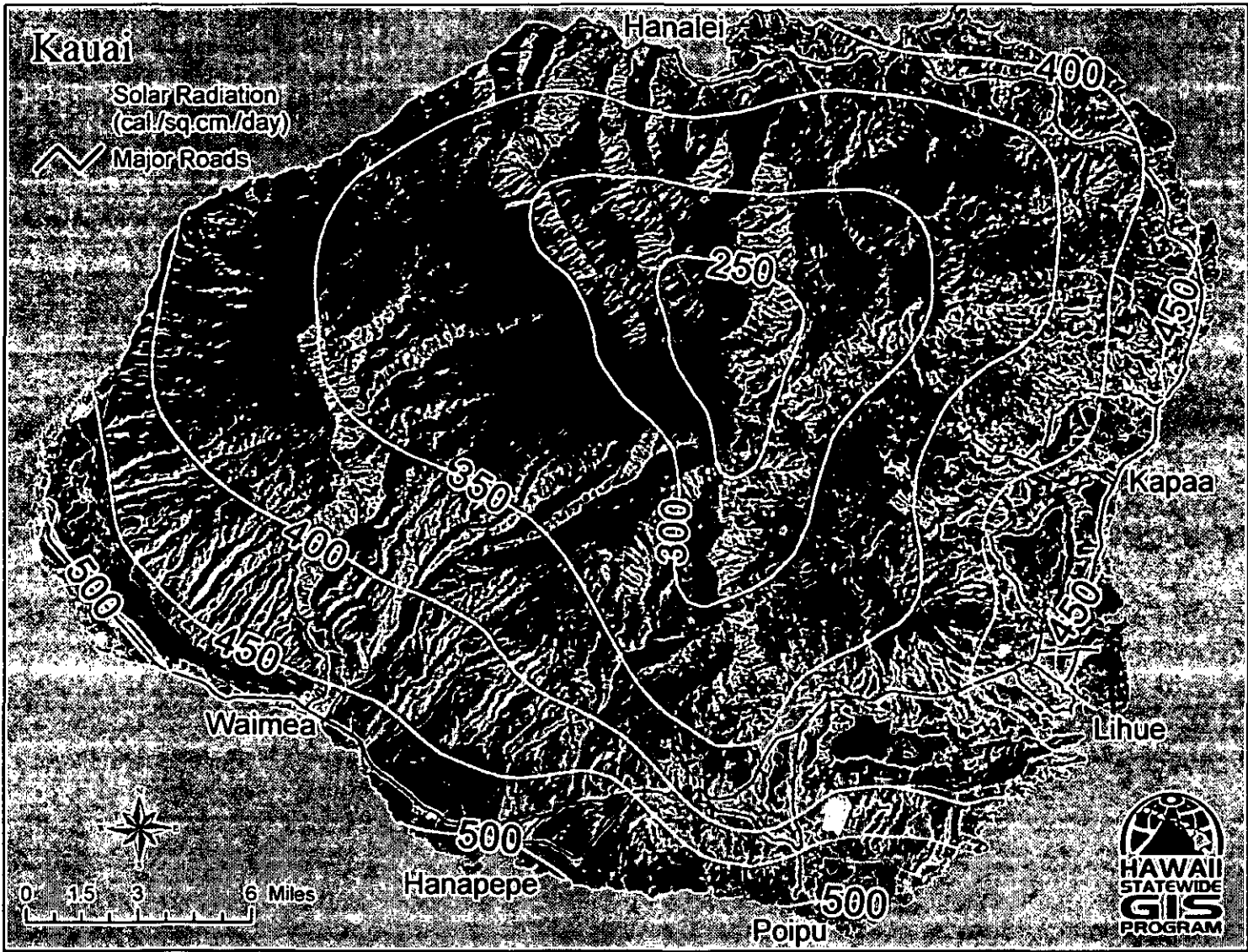
OG-100 Protocol Format		(BTU/sq ft day)	1845	1661	1476	1292	1107
Hawaii Sunshine Zone		(Cal/sq cm/day)	500	450	400	350	300
Nom. Size	Coating	Model					
3' x 7'	Paint	AE-21E	17,528	14,707	11,808	9,299	9,299
		EP-20	17,528	15,182	12,792	10,332	10,332
		EP-21	19,373	16,605	13,776	11,365	11,365
		EPI-308CU (3' X 7')	18,450	15,656	12,792	9,815	9,815
		EPI-308SS (3' X 7')	18,450	15,656	12,792	9,815	9,815
		J Collector	20,295	17,079	13,776	10,849	10,849
		L Collector	13,838	11,861	9,840	7,232	7,232
		MSC-21E	17,528	15,182	12,792	9,815	9,815
		SSP-21	18,450	16,131	13,776	10,849	10,849
		ST-21E	17,528	15,182	12,792	9,815	9,815
		SunPro21	18,450	15,656	12,792	9,815	9,815
3' x 7'	Selective	AE-21	19,373	16,605	13,776	11,365	11,365
		Aprilus AP-10	11,070	9,489	7,872	6,716	6,716
		B1	21,218	18,503	15,744	12,398	12,398
		EC-20	18,450	16,131	13,776	11,365	11,365
		EC-21	20,295	17,554	14,760	12,398	12,398
		K Collector	21,218	18,503	15,744	12,915	12,915
		M Collector	17,528	15,182	12,792	9,815	9,815
		MSC-21	19,373	17,079	14,760	11,882	11,882
		SSC-21	19,373	16,605	13,776	11,365	11,365
		3' x 8'	Paint	AE-24E	19,373	16,605	13,776
EP-24	22,140			19,452	16,728	13,432	13,432
EPI-308CU (3' x 8')	20,295			17,554	14,760	11,365	11,365
EPI-308SS (3' x 8')	20,295			17,554	14,760	11,365	11,365
IP-24	22,140			19,452	16,728	13,432	13,432
MSC-24E	20,295			17,554	14,760	11,365	11,365
SP-24	22,140			19,452	16,728	13,432	13,432
SSP-24	21,218			18,503	15,744	12,915	12,915
SunPro24	21,218			18,028	14,760	11,365	11,365
308P-HP	21,218			18,028	14,760	11,882	11,882
#REF!	#REF!	308C-HP	23,985	20,875	17,712	14,465	14,465
		AE-24	22,140	18,977	15,744	12,915	12,915
		EC-24	23,985	20,875	17,712	14,465	14,465
		IC-24	23,985	20,875	17,712	14,465	14,465
		MSC-24	22,140	19,452	16,728	13,432	13,432
		SC-24	23,985	20,875	17,712	14,465	14,465
		SSC-24	22,140	19,452	16,728	13,432	13,432
4' x 6'	Paint	AE-26E	21,218	18,028	14,760	11,882	11,882
		MSC-26E	21,218	18,028	14,760	11,882	11,882
4' x 6'	Selective	AE-26	23,063	19,926	16,728	13,432	13,432
		MSC-26	23,985	20,875	17,712	14,465	14,465
		SLCO-30	24,908	21,349	17,712	14,465	14,465
		SSP-32	28,598	24,670	20,664	17,048	17,048
4' x 7'	Paint	AE-28E	23,063	19,926	16,728	12,915	12,915
		MSC-28E	23,985	20,400	16,728	12,915	12,915

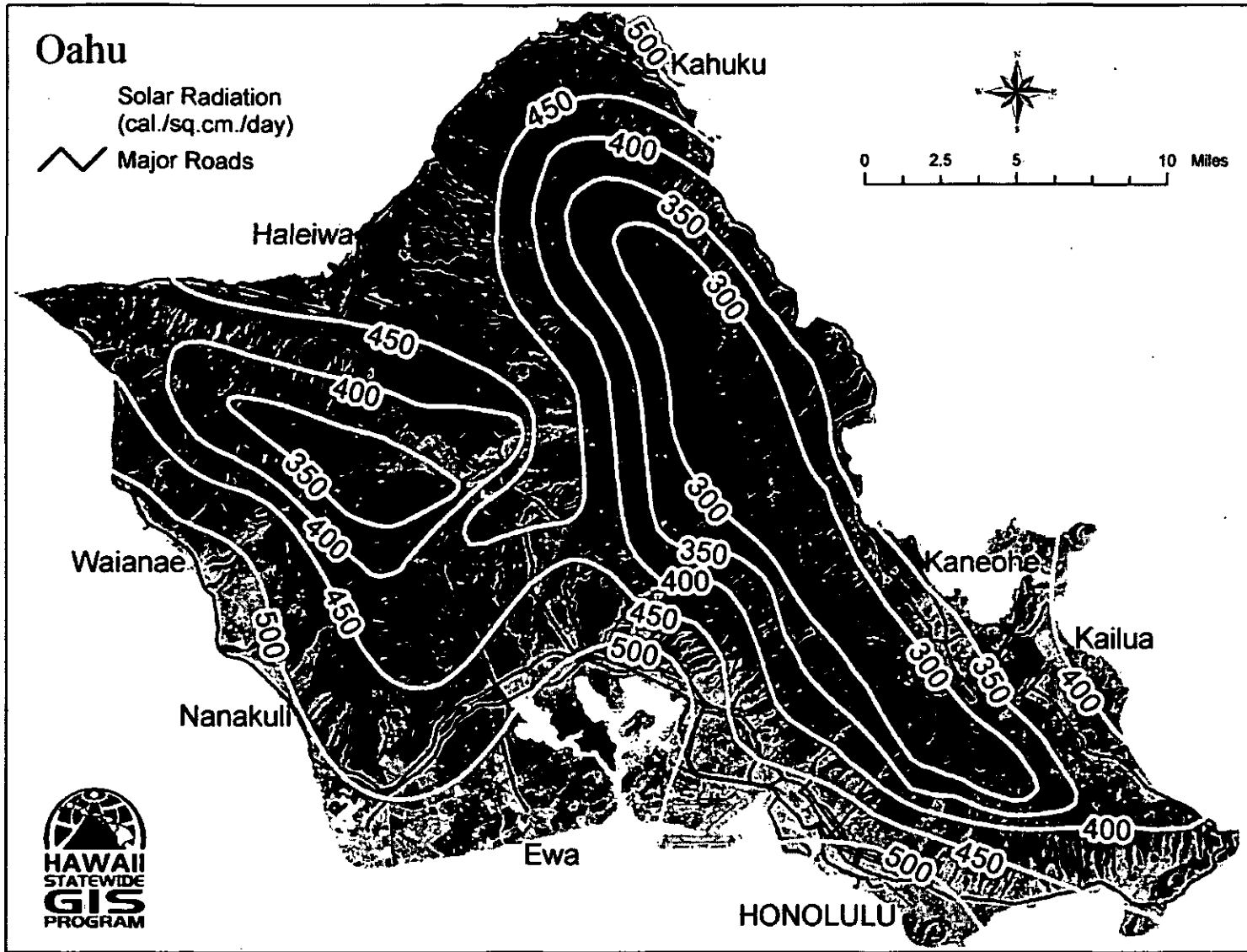
OG-100 Protocol Format	(BTU/sq ft day)	1845	1661	1476	1292	1107	
Hawaii Sunshine Zone	(Cal/sq cm/day)	500	450	400	350	300	
Nom. Size	Coating	Model					
4' x 7'	Selective	AE-28	25,830	22,298	18,696	14,981	14,981
		Gobi 3366	27,675	24,196	20,664	17,048	17,048
		MSC-28	26,753	23,247	19,680	16,015	16,015
#REF!	#REF!	408P-HP	28,598	24,196	19,680	14,981	14,981
		AE-32E	26,753	22,773	18,696	14,465	14,465
		EP-32	29,520	25,619	21,648	17,564	17,564
		EPI-308CU (4' x 8')	28,598	24,196	19,750	16,531	16,531
		EPI-308SS (4' x 8')	28,598	24,196	19,750	16,531	16,531
		IP-32	30,443	26,094	21,648	17,564	17,564
		MSC-32E	26,753	22,773	18,696	14,981	14,981
		SLCR-30	30,443	26,568	22,632	19,114	19,114
		SP-32	29,520	25,619	21,648	17,564	17,564
		SunPro32	27,675	23,721	19,750	15,498	15,498
#REF!	#REF!	408C-HP	33,210	28,940	24,600	19,631	19,631
		AE-32	29,520	25,619	21,648	17,564	17,564
		EC-32	31,365	27,517	23,616	19,114	19,114
		Gobi 408	34,133	29,415	24,600	20,147	20,147
		IC-32	31,365	27,517	23,616	19,114	19,114
		MSC-32	29,520	25,619	21,648	17,564	17,564
		SC-32	31,365	27,517	23,616	19,114	19,114
		SLCO-32	32,288	27,991	23,616	19,114	19,114
		SLCR-32	32,288	28,466	24,600	20,147	20,147
		SSC-32	30,443	26,568	22,632	18,598	18,598
#REF!	#REF!	410P-HP	35,055	29,889	24,600	18,598	18,598
		AE-40E	33,210	28,466	23,616	18,598	18,598
		EP-40	36,900	32,261	27,552	22,214	22,214
		IP-40	37,823	32,736	27,552	22,214	22,214
		MSC-40E	33,210	28,466	23,616	18,598	18,598
		SP-40	36,900	32,261	27,552	22,214	22,214
		SSP-40	35,978	31,312	26,568	21,697	21,697
		ST-40E	32,288	27,517	22,632	17,564	17,564
		SupPro40	35,055	29,889	24,600	19,114	19,114
#REF!	#REF!	410C-HP	41,513	35,582	29,520	23,764	23,764
		AE-40	36,900	31,787	26,568	21,697	21,697
		EC-40	38,745	33,684	28,536	23,247	23,247
		Gobi 410	42,435	36,531	30,504	25,313	25,313
		IC-40	39,668	34,633	29,520	23,764	23,764
		MSC-40	38,745	33,684	28,536	23,247	23,247
		SC-40	38,745	33,684	28,536	23,247	23,247
		SLCO-40	38,745	33,684	28,536	22,730	22,730
		SLCR-40	40,590	35,582	30,504	25,313	25,313
		SSC-40	37,823	32,736	27,552	22,730	22,730

OG-100 Protocol Format	(BTU/sq ft day)	1845	1661	1476	1292	1107
Hawaii Sunshine Zone	(Cal/sq cm/day)	500	450	400	350	300
Nom. Size	Coating	Model				
4' x 12'	Paint	412P-HP	42,435	35,582	28,536	21,697
4' x 12'	Selective	412C-HP	49,815	43,173	36,408	29,446
5' X 7'	Selective	Aprius AP-20	21,218	18,977	16,728	14,465
		Aprius AP-22	23,985	21,349	18,696	16,015
7' x 7'	Selective	Aprius AP-30	32,288	28,466	24,600	21,181
Notes:						
1. Values for the 350 and 450 Sunshine Zones are interpolated assuming a linear relationship.						
2. Values for the 300 Sunshine Zone equals the 350 Sunshine Zone per Section 2.02.						

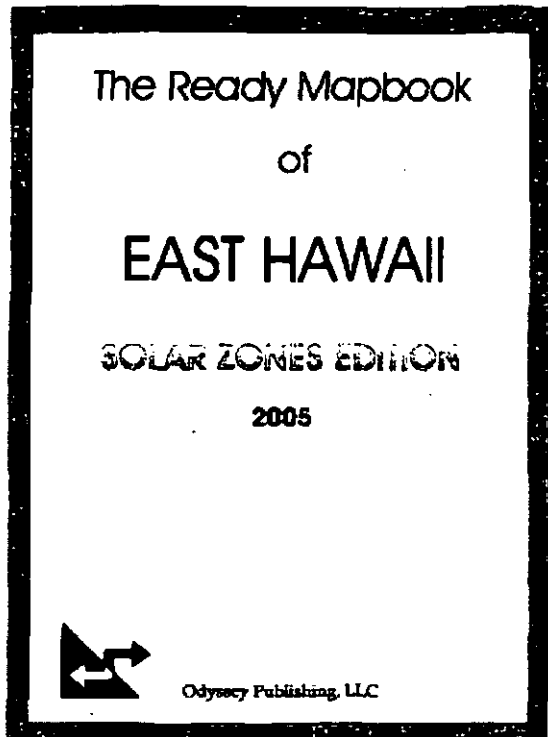
Hawaii Sunshine Zone Btu Ratings								
<u>Supplier</u>	<u>Collector Model #</u>	<u>Nominal Size</u>	<u>500</u>	<u>450</u>	<u>400</u>	<u>350</u>	<u>Type</u>	<u>Coating</u>
Solene	SLCO-32P	4 x 8	24,908	20,875	16,728	12,915	Flat Plate	Black Paint
Solene	SLCO-40P	4 x 10	29,520	25,145	20,664	16,015	Flat Plate	Black Paint
Heliodyne	Gobi 336 013	4 x 7	23,985	20,875	17,712	14,465	Flat Plate	Black Chrome
Heliodyne	Gobi 406 001	4 x 7	25,830	22,773	19,680	16,015	Flat Plate	Selective
Heliodyne	Gobi 406 002	4 x 7	23,985	20,400	16,728	12,915	Flat Plate	Black Paint
Heliodyne	Gobi 408 001	4 x 8	31,365	27,517	23,616	19,114	Flat Plate	Selective
Heliodyne	Gobi 408 002	4 x 8	29,520	25,145	20,664	16,015	Flat Plate	Black Paint
Heliodyne	Gobi 408 013	4 x 8	29,520	25,145	20,664	16,531	Flat Plate	Black Chrome
Heliodyne	Gobi 410 001	4 x 10	39,668	34,633	29,520	24,280	Flat Plate	Selective
Heliodyne	Gobi 410 002	4 x 10	36,900	31,787	26,568	20,664	Flat Plate	Black Paint
Heliodyne	Gobi 410 013	4 x 10	36,900	31,787	26,568	21,181	Flat Plate	Black Chrome

SUNSHINE MAPS FOR THE HAWAIIAN ISLANDS





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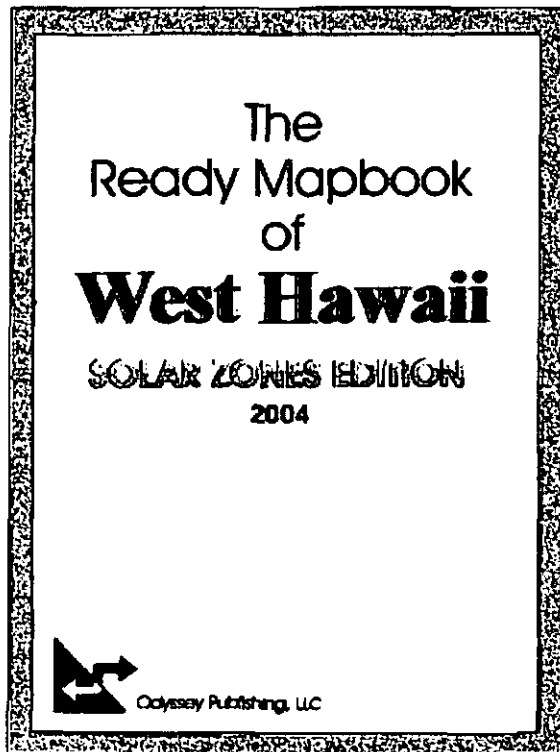
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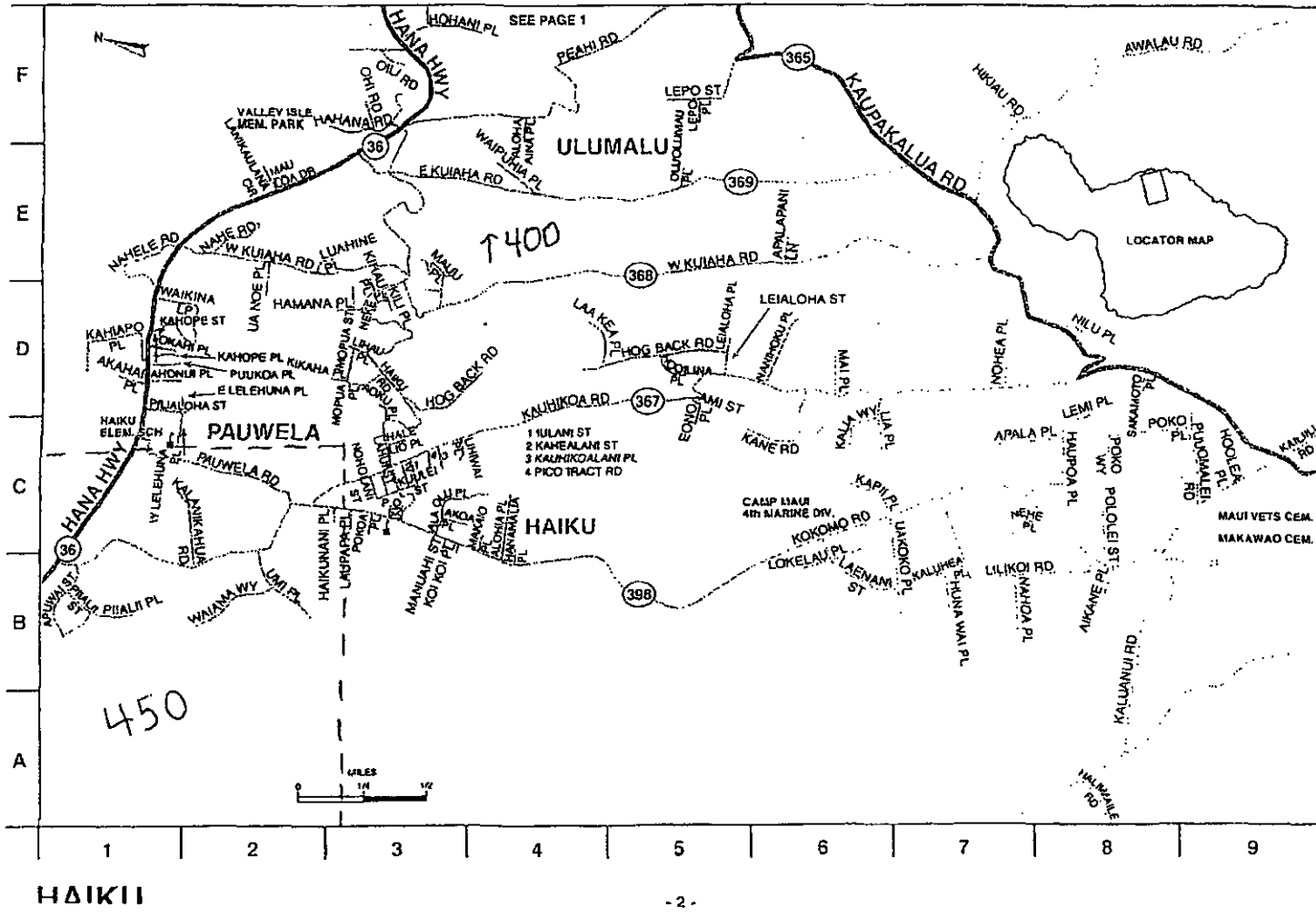
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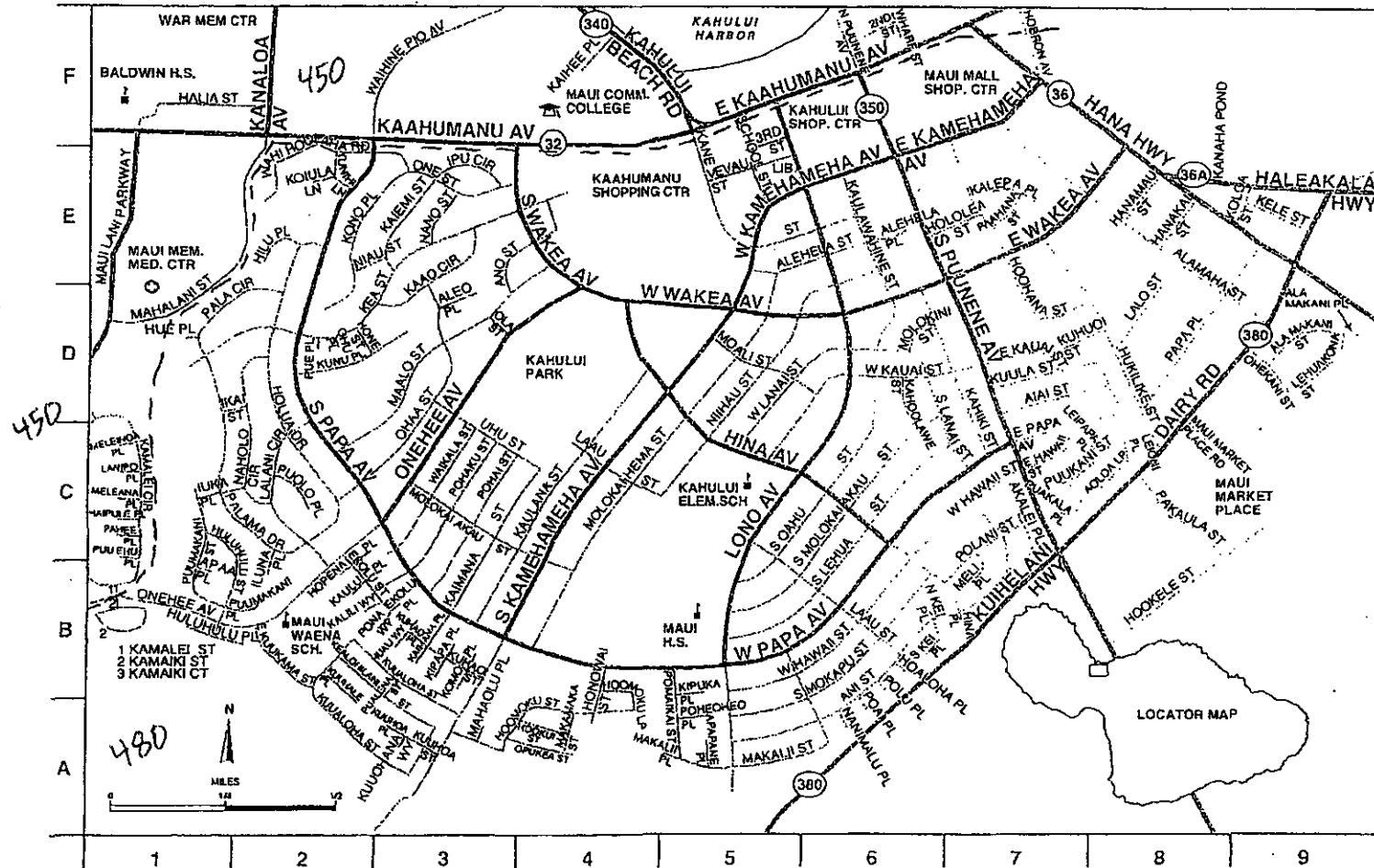
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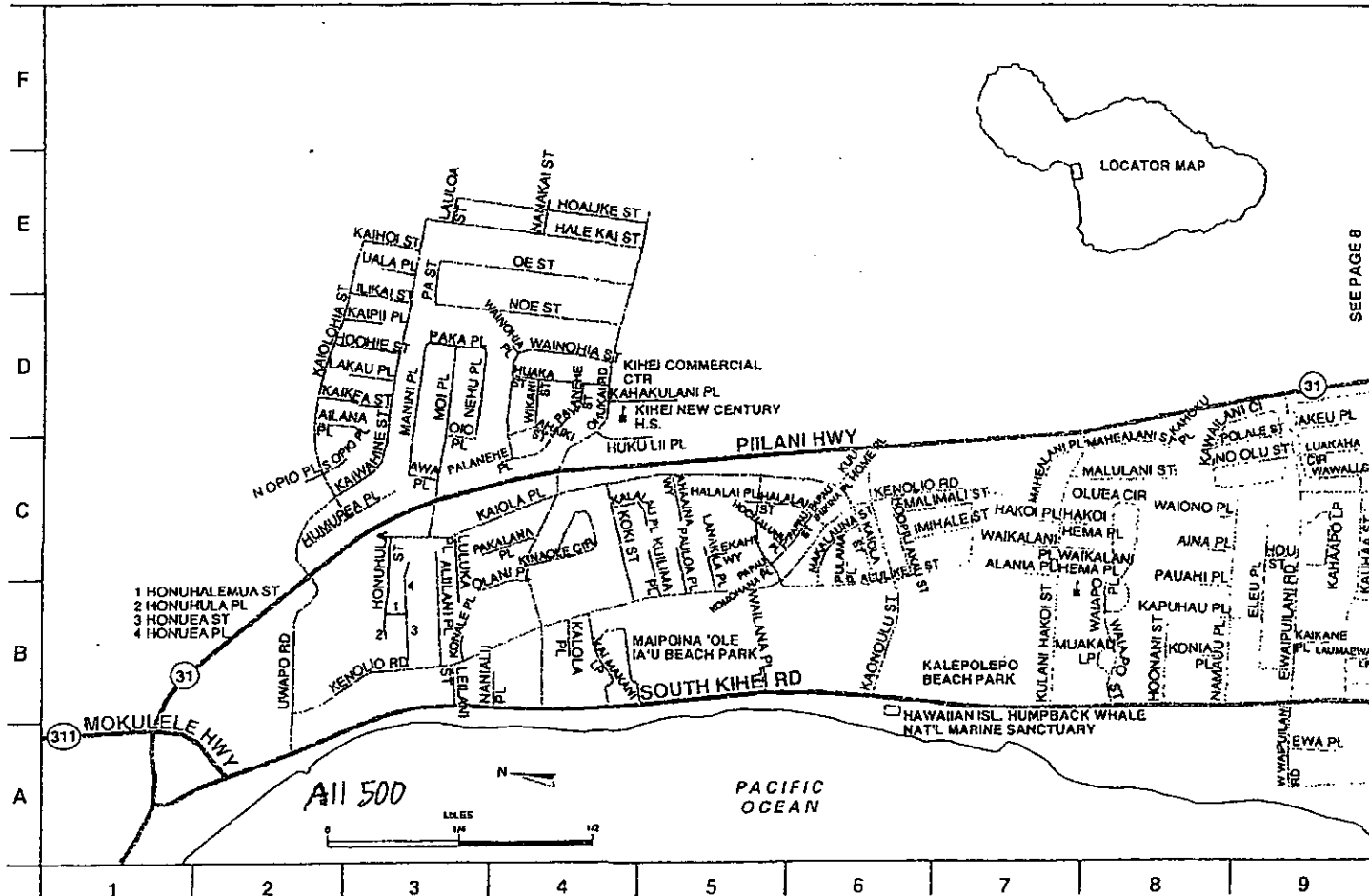
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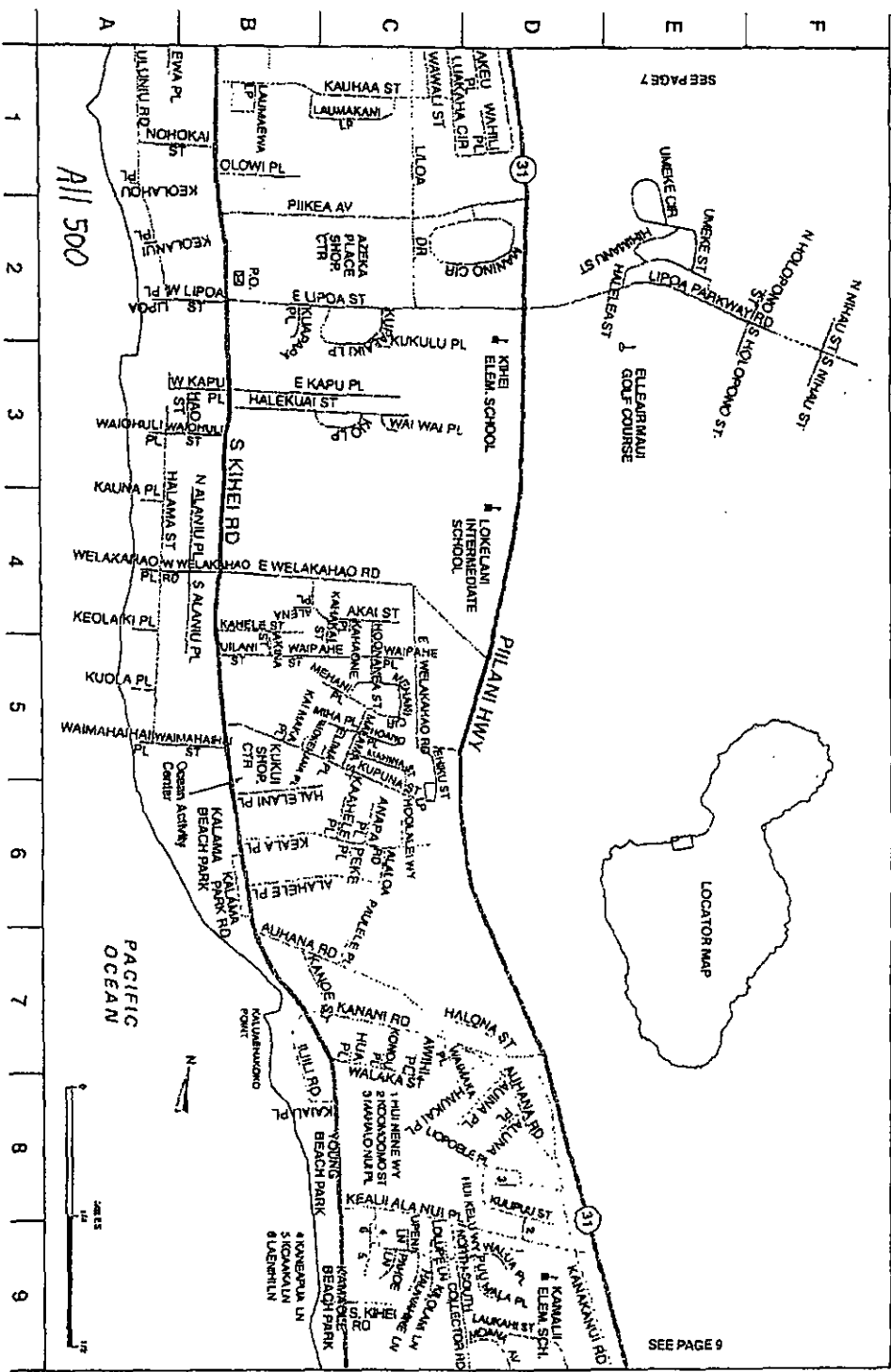


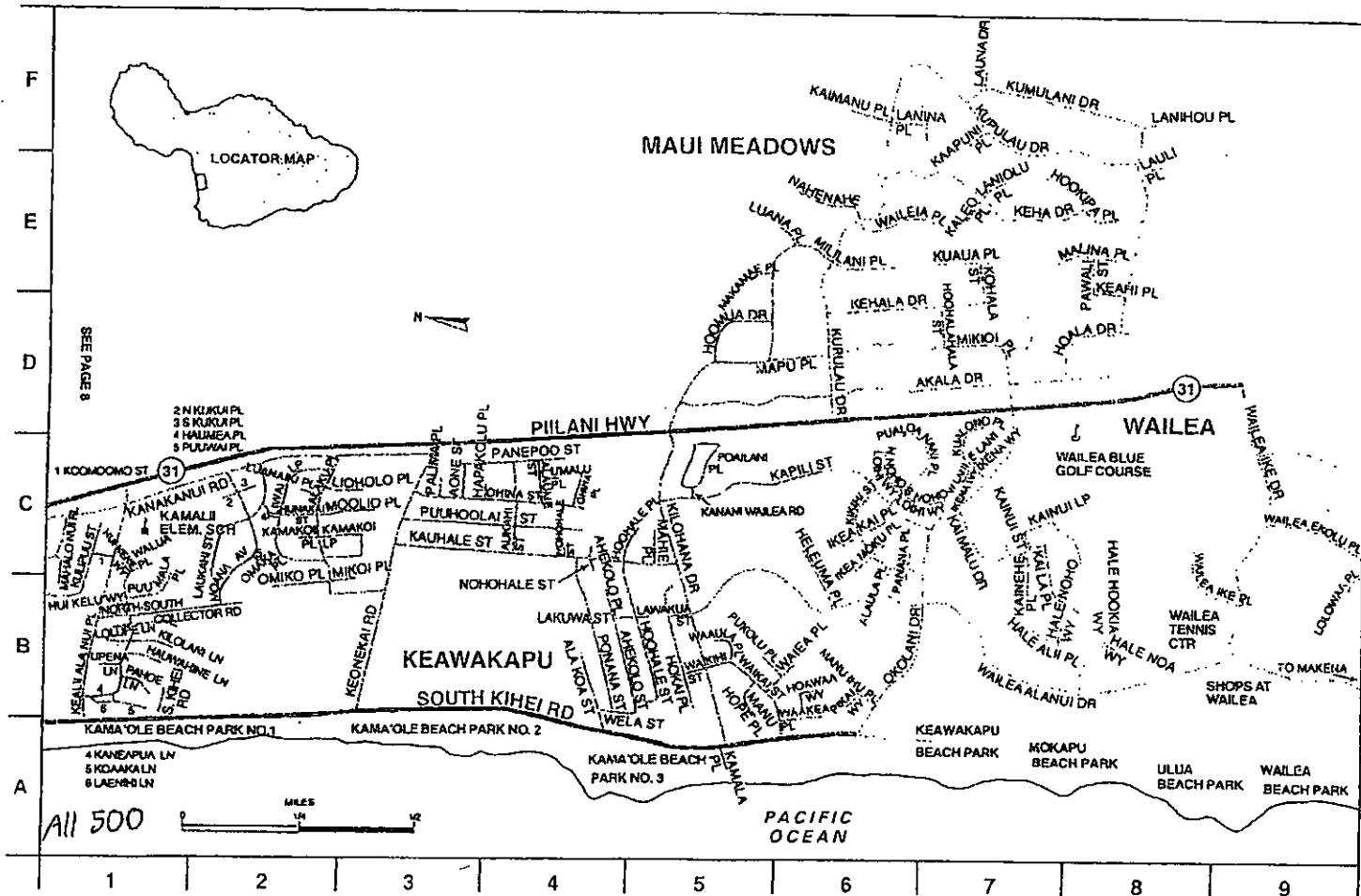


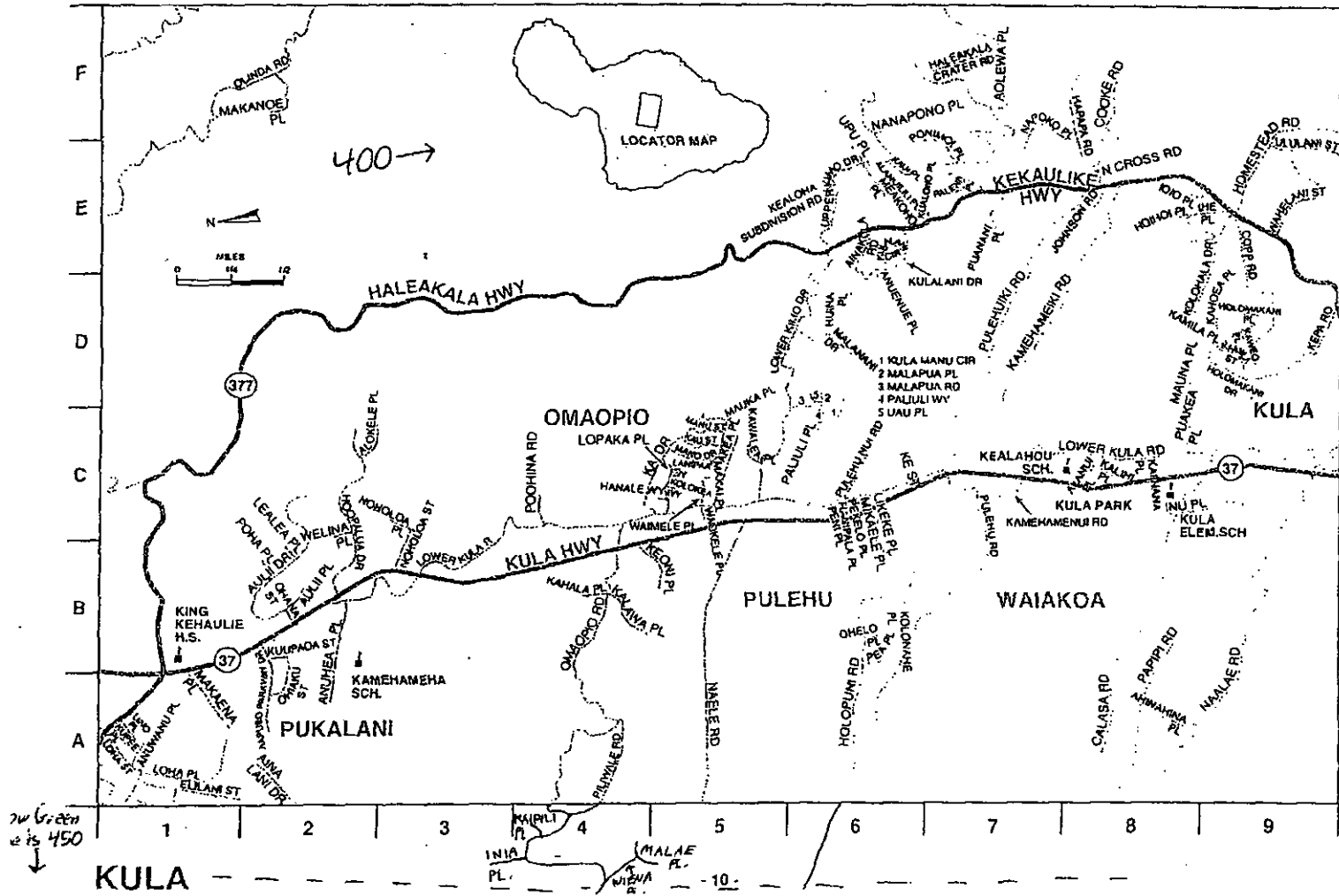


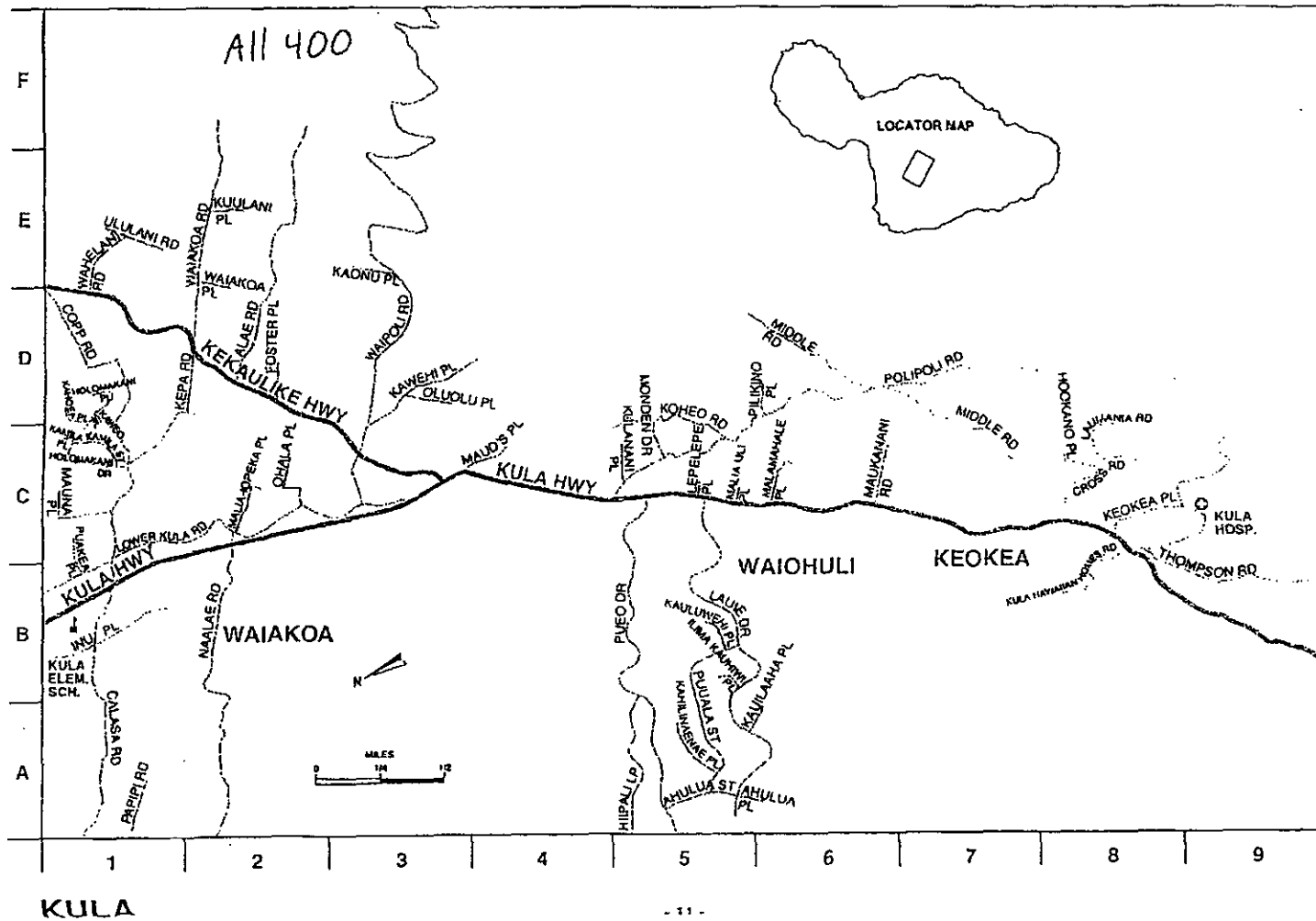
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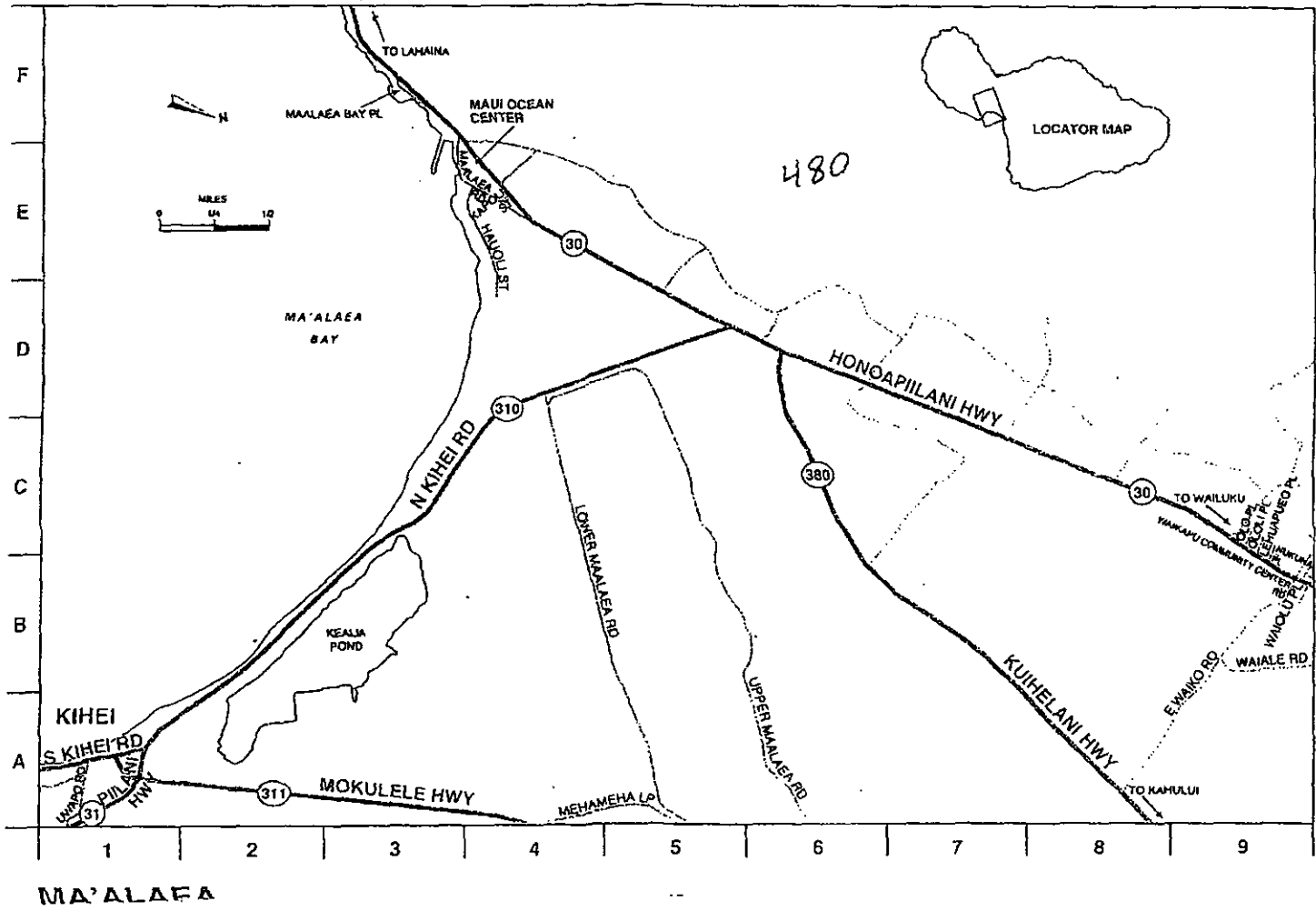


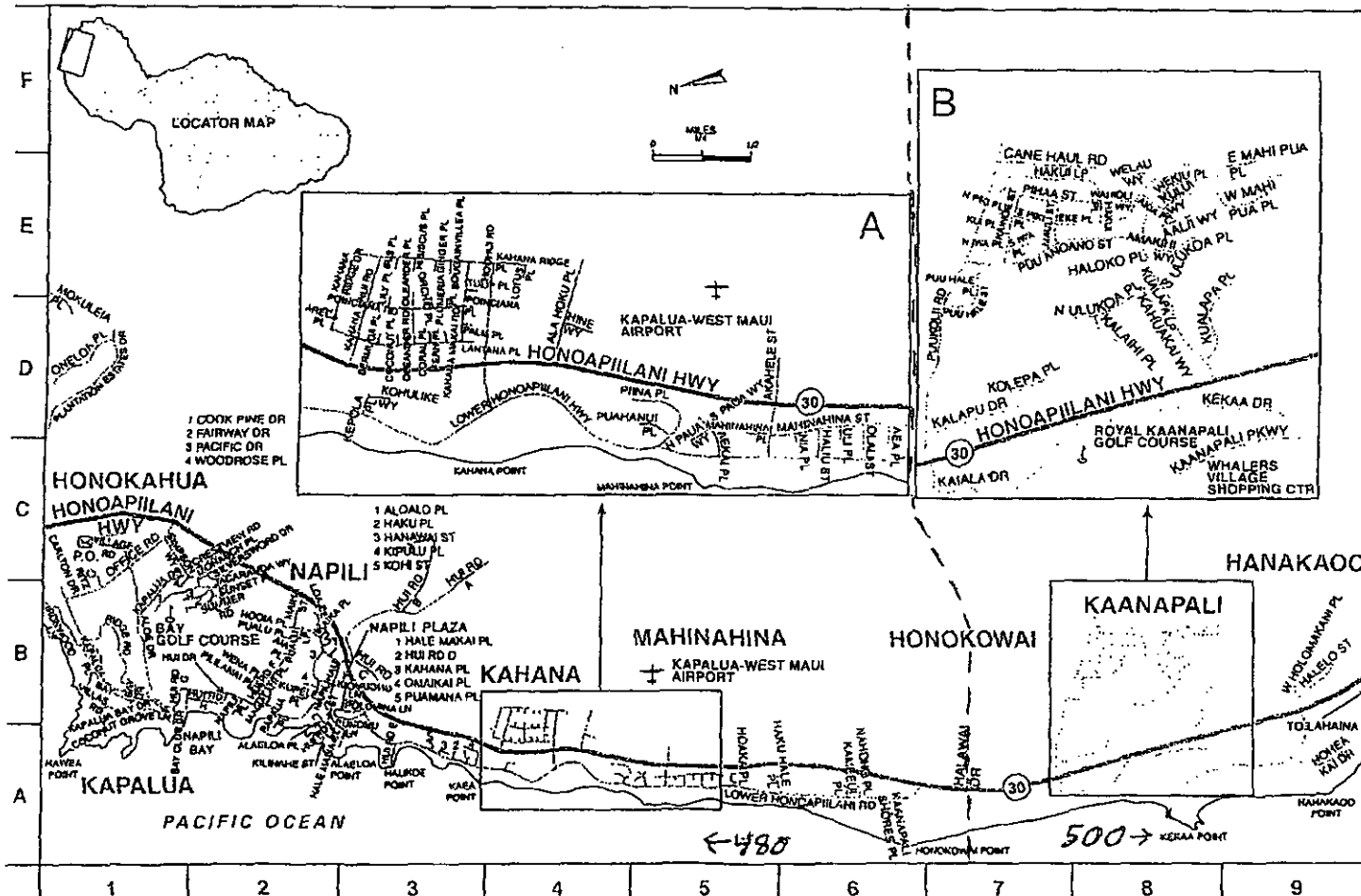


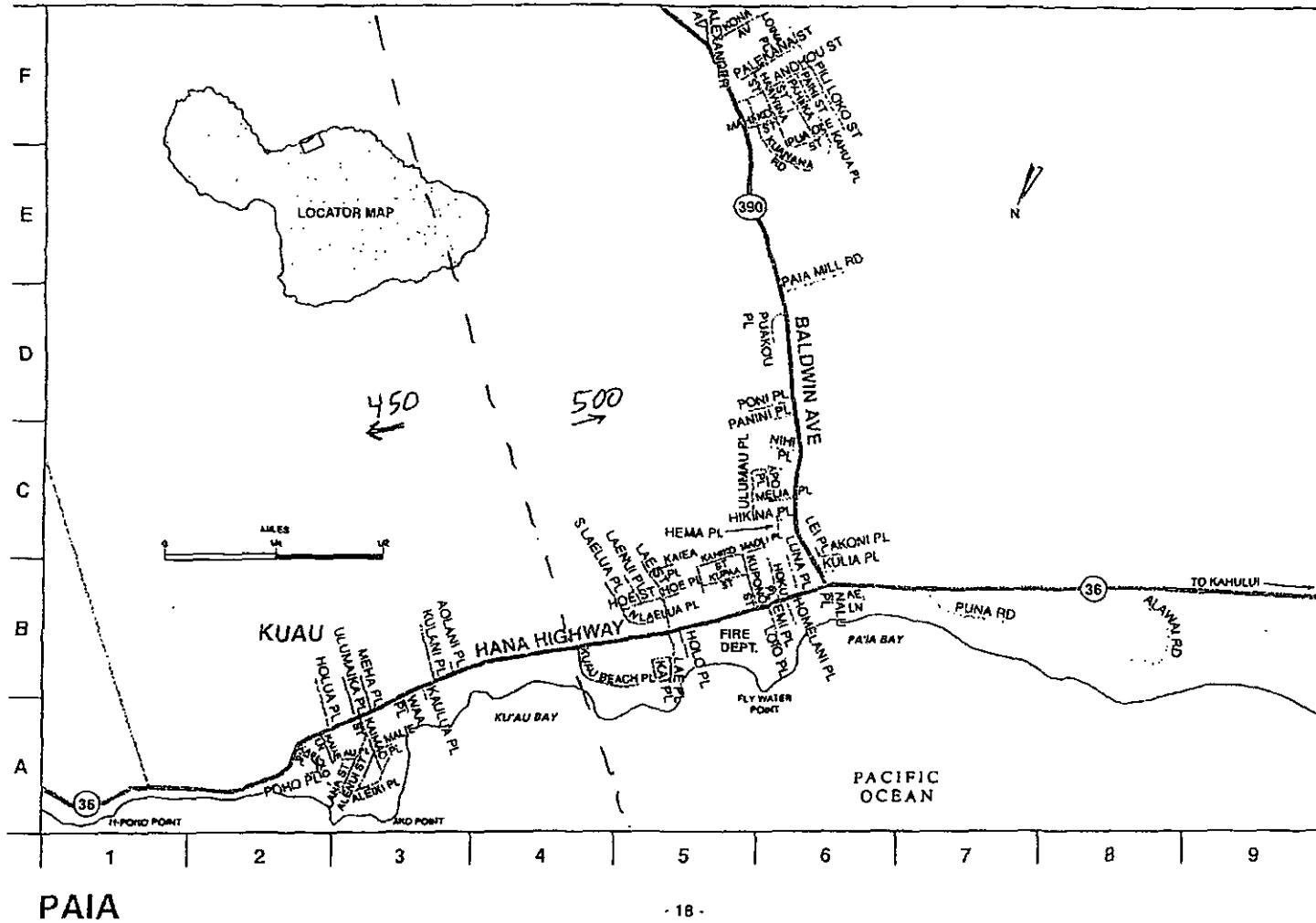


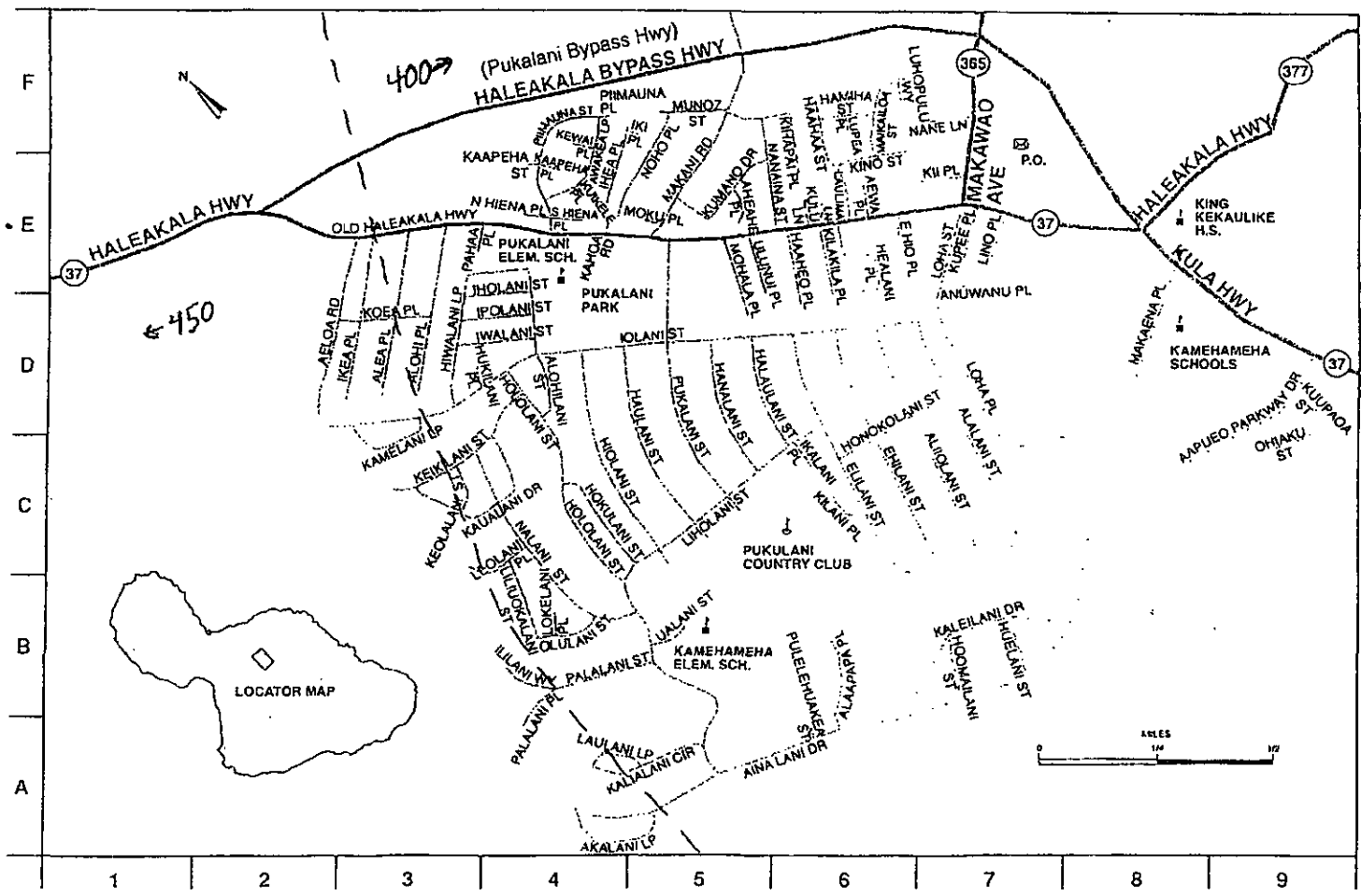


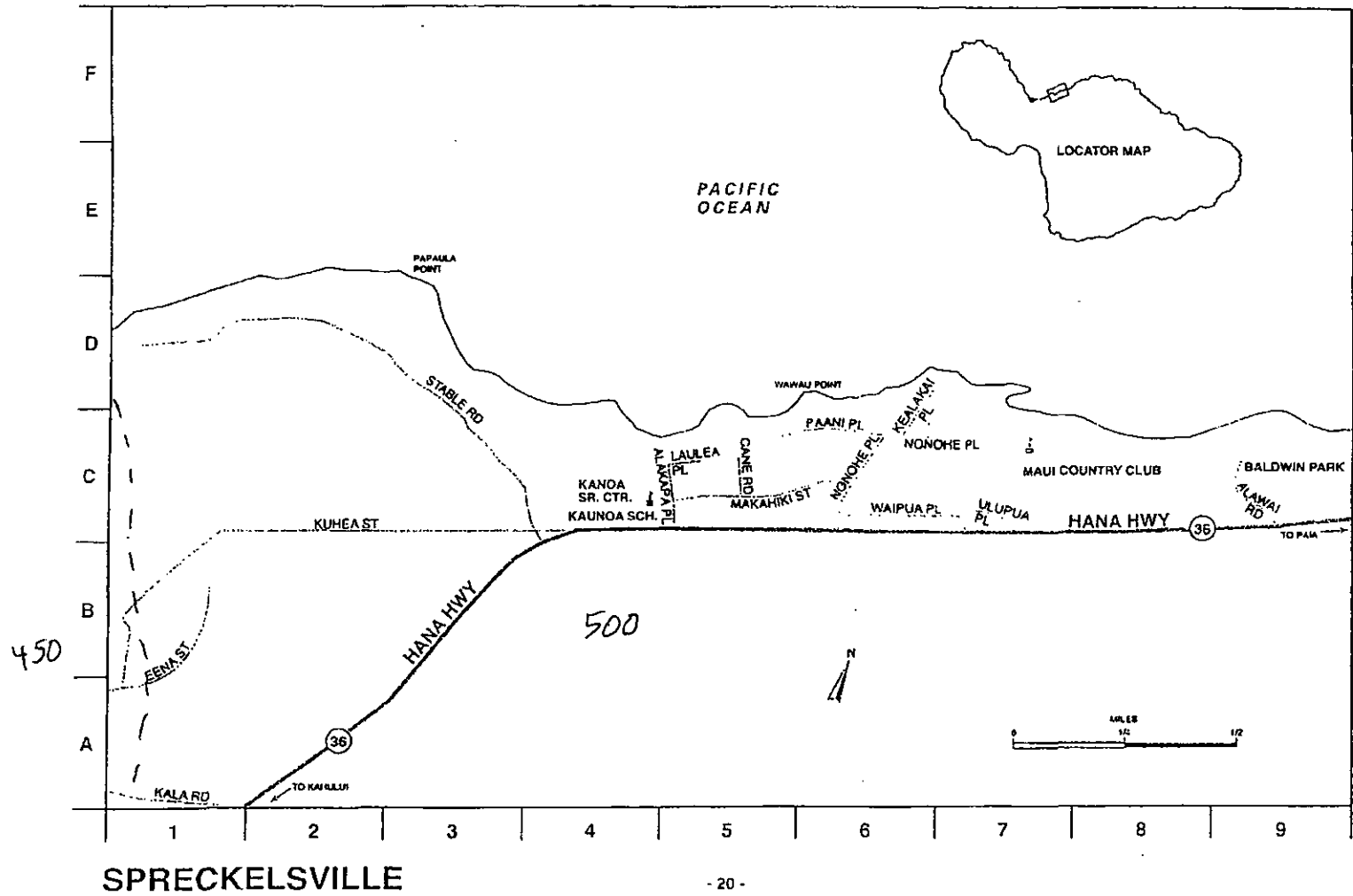
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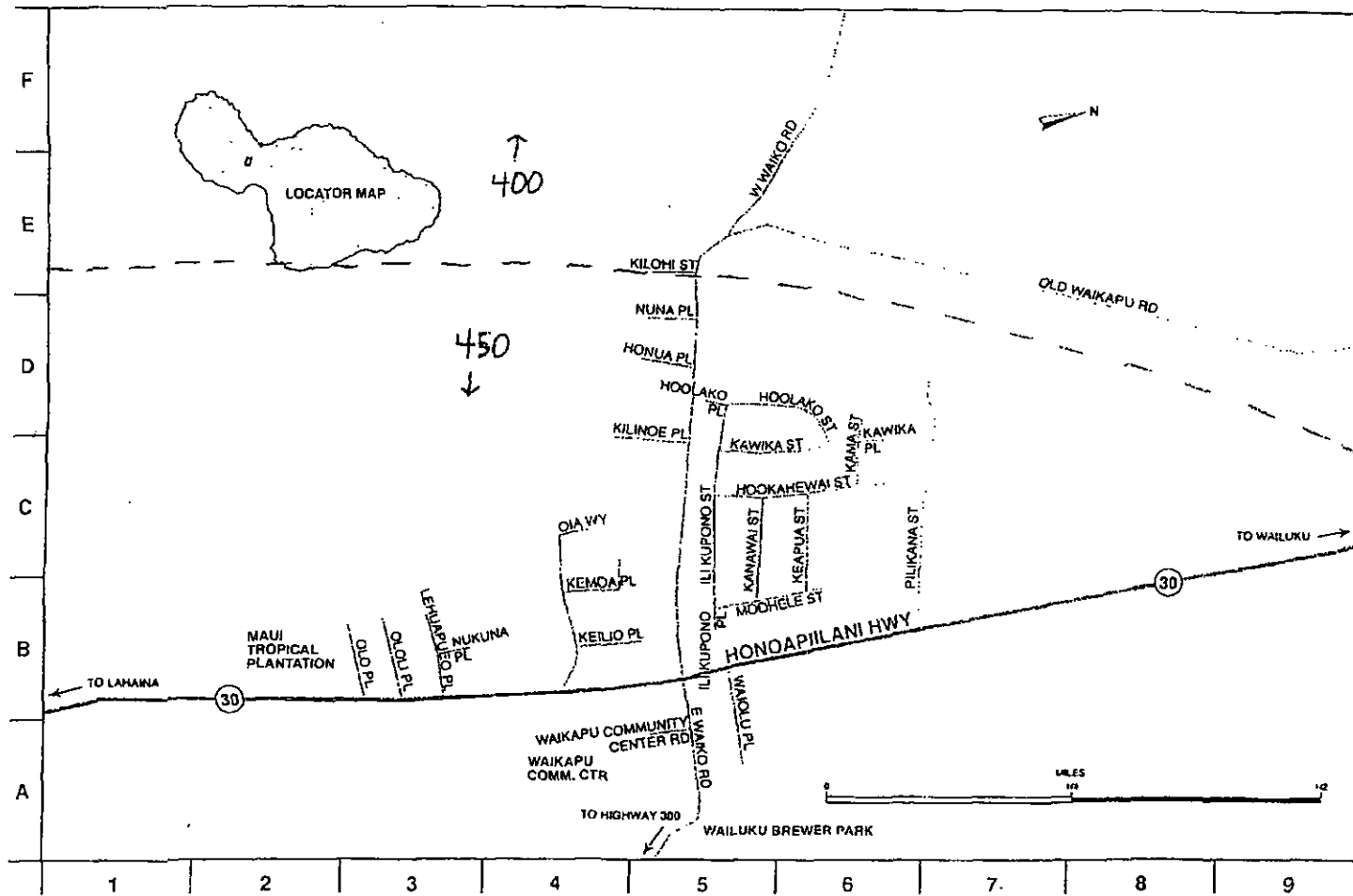






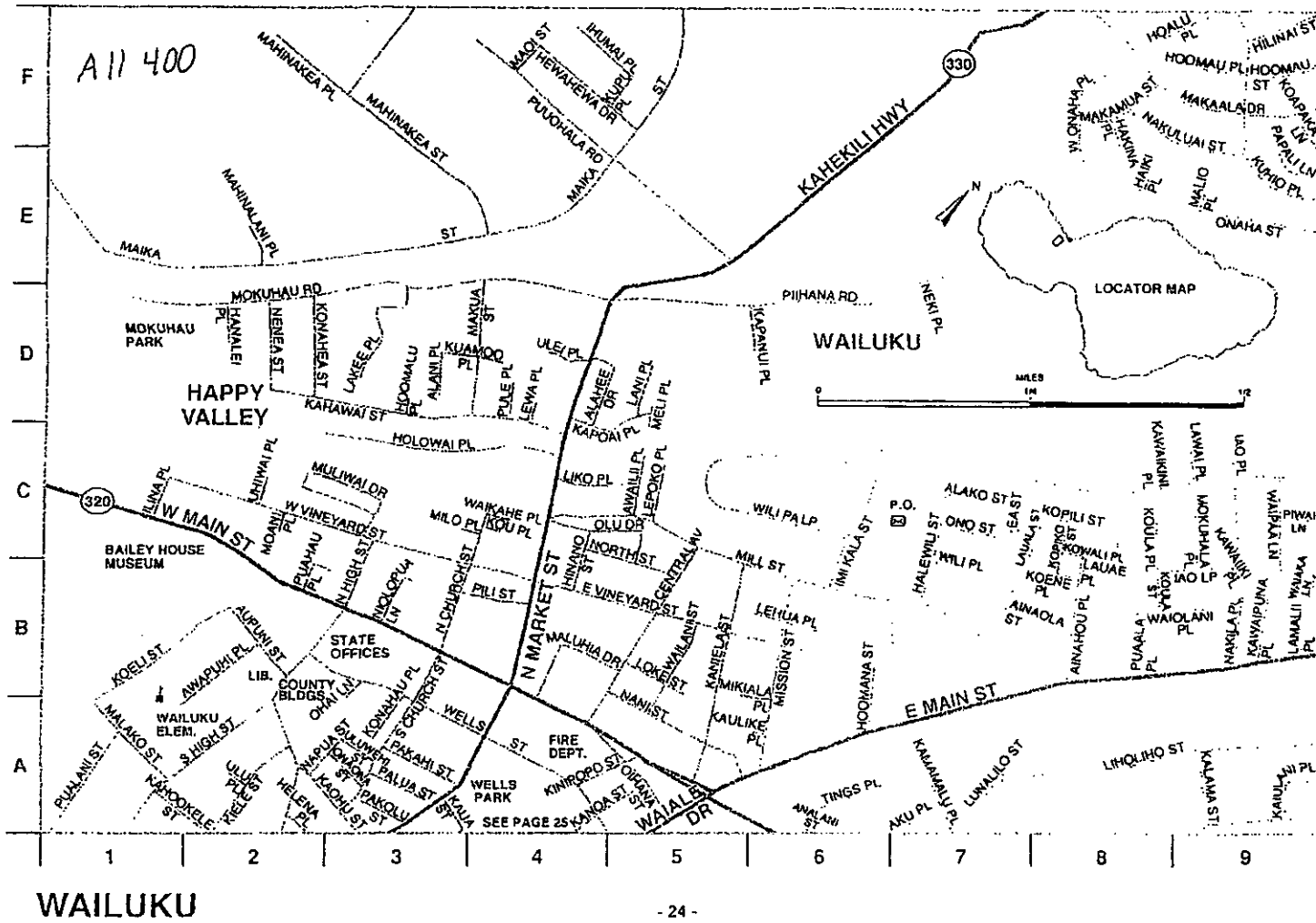






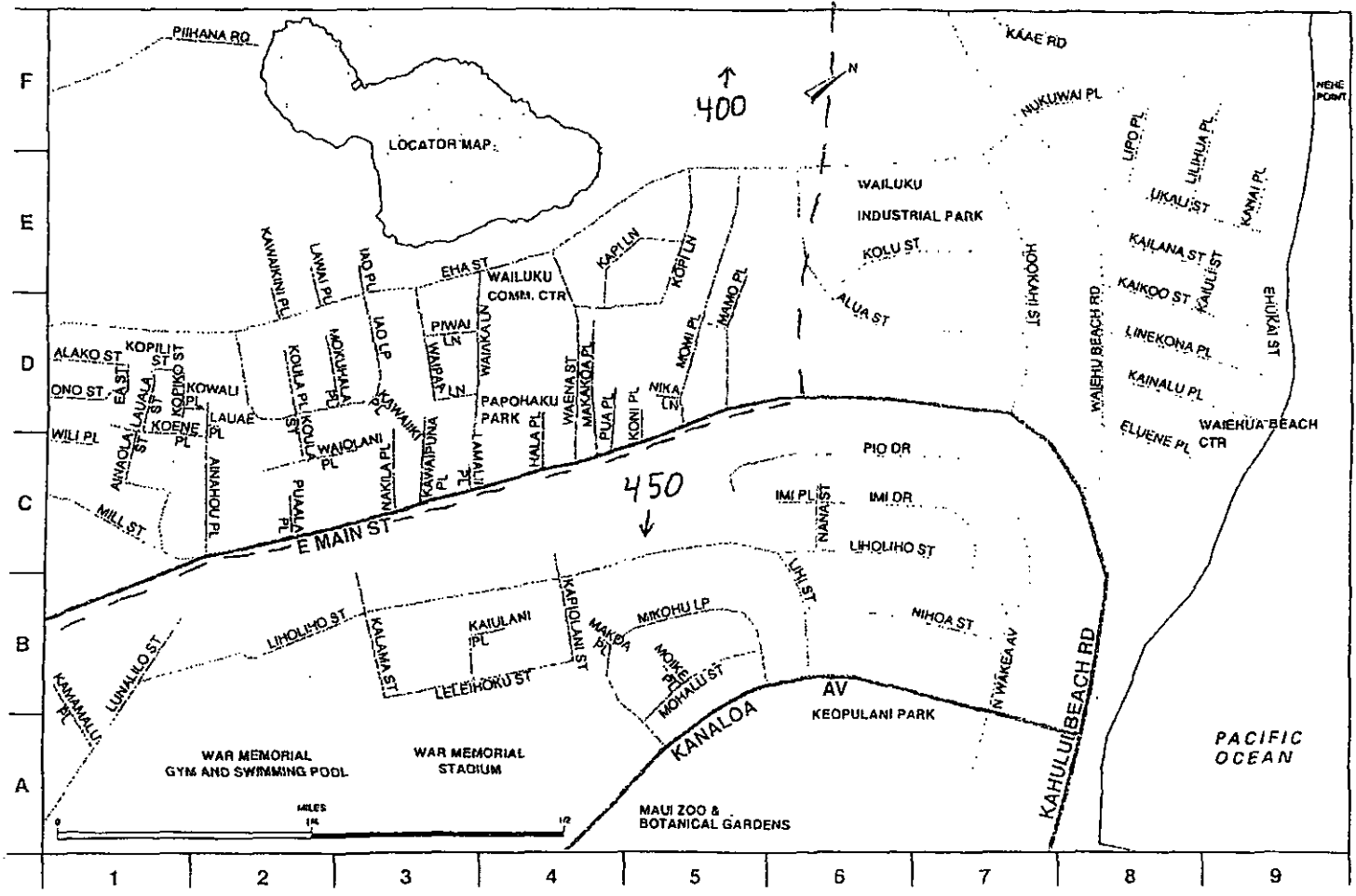
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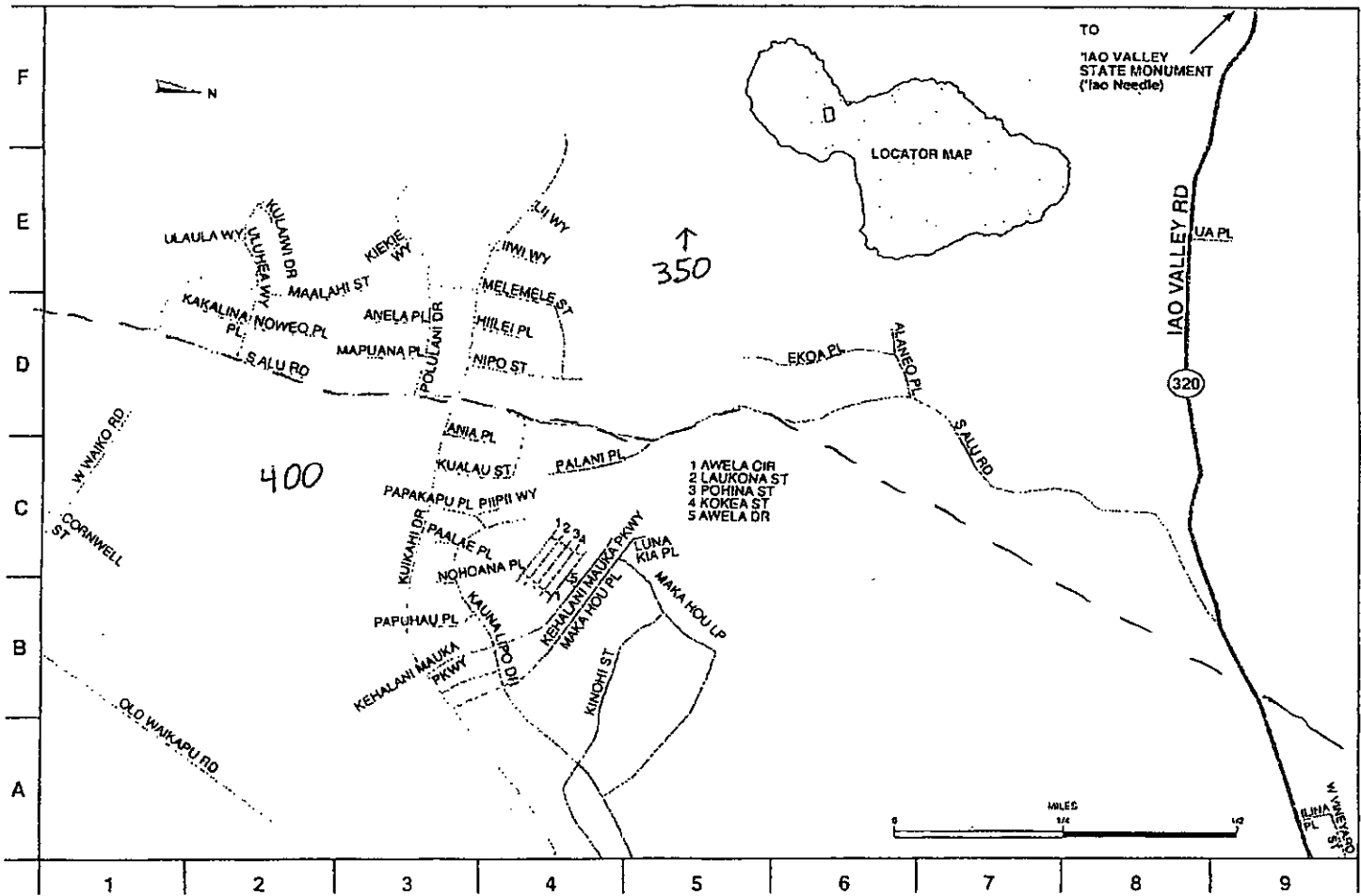


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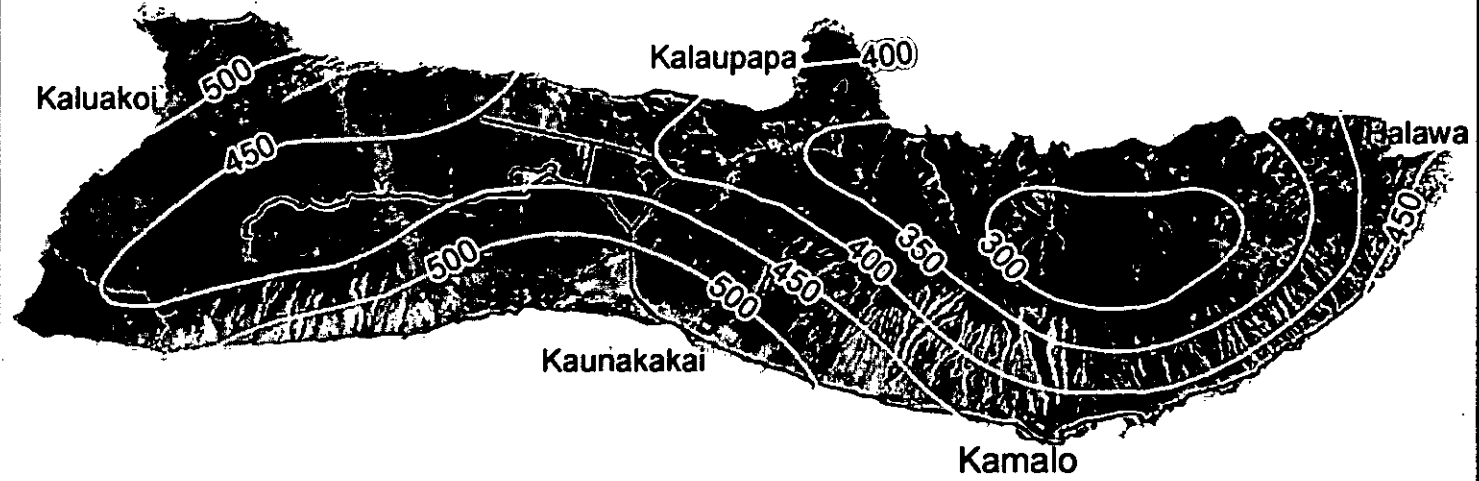
Molokai

Solar Radiation
(cal./sq.cm./day)

Major Roads



0 2.5 5 10 Miles



Explanation of Moloka'i Sunshine Zones

Please note on the island of Moloka'i that the following applies:

1. From Kamalo to Waialua on the east end along the shoreline and makai (ocean side) of the highway is designated as a 450 sunshine zone.
2. Mauka (mountain side) of the highway between Kamalo and Waialua is designated as a 400 sunshine zone.
3. Maunaloa and Mo'olehua will be designated as 450 sunshine zones.

Explanation of Lāna'i Sunshine Zones

The island of Lāna'i shall be deemed a 400 sunshine zone with the exception of Manele. Manele on Lanai shall be considered a 500 sunshine zone.

CERTIFICATE OF SERVICE

The foregoing order was served on the date of filing by mail, postage prepaid, and properly addressed to the following parties:

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