



STATE OF HAWAII  
DEPARTMENT OF LAND AND NATURAL RESOURCES  
COMMISSION ON WATER RESOURCE MANAGEMENT  
P.O. BOX 621  
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STAFF SUBMITTAL

for the meeting of the  
COMMISSION ON WATER RESOURCE MANAGEMENT

May 24, 2005  
Honolulu, Oahu

Request to Enter Into a Contract for Professional Services  
To Develop a Computer Software Application to Estimate Irrigation Requirements

CONTRACTOR:

University of Hawaii  
College of Tropical Agriculture and Human Resources

SUMMARY OF REQUEST:

Staff is requesting that the Commission authorize the Chairperson to enter into a contract for professional services to develop a computer software application, which will provide an initial attempt towards standardizing the estimation of reasonable irrigation water demands statewide for various vegetation types based on regional climate. This will be particularly helpful in the evaluation of water use permits and implementation of the Hawaii Water Plan (HWP).

LOCATION MAP: Statewide application

BACKGROUND

As part of its general powers and duties, under §174C-5(1) Hawaii Revised Statutes (HRS) the Commission:

*“Shall carry out topographic surveys, research, and investigations into all aspects of water use and water quality”*

Similarly, under §174C-31(c)(3) HRS regarding the Hawaii Water Plan (HWP), the Commission shall, among other things:

*“Study the quantity and quality of water needed for existing and contemplated uses, including irrigation, power development, geothermal power, and municipal uses”*

Further, §174C-31(g)(1) HRS, identifies maximizing reasonable-beneficial water use as an objective of the HWP and its component parts.

Lastly, the Water Code and its Administrative Rules require that applicants for water use permits shall establish that the proposed use of water is a reasonable-beneficial use as defined in §13-171-2 Hawaii Administrative Rules:

*“Reasonable-beneficial” use means the use of water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is not wasteful and is both reasonable and consistent with the state and county land use plans and the public interest.”*

#### NEED FOR STANDARD ESTIMATION OF IRRIGATION REQUIREMENTS

When evaluating existing or new water use permit applications and the reasonableness of irrigation water demands, staff has relied on three planning guidelines and any localized actual use data. Two county water use guidelines are recognized first. Staff compares the requested amount for specific crops with those published on Table 4-4 in the 1992 Draft Oahu Water Management Plan (Exhibit A). Other county water use and development plans do not have similar water use planning guidelines; however, staff uses Table 4-4 for designated ground water management areas on other islands (Molokai & Maui) when similar crops are defined. For crops not listed in Table 4-4, staff will then use county consumption guidelines as specified in Table 100-18 of the 2002 Water System Standards, State of Hawaii (Exhibit B). In addition to the county guidelines, staff has used duties determined by the Commission in other cases, such as the baseline duties of 2,500 and 3,500 gallons per acre per day (gpd) for diversified agriculture based on the Waiahole and Laie contested case findings, respectively, and duties determined from Commission actions in regular meetings. These estimates can then be adjusted based on other local factors such as climate and similar water uses in the area. In addition to these planning guidelines, staff also considers applicants' historic water use records for existing uses in newly designated ground water management areas. Wherever possible, any request is also compared with similar existing uses in the area. Based on these analyses, staff makes its recommendations to the Commission for consideration when making its decision on the reasonableness of an irrigation allocation request.

Problems have arisen when applicants have hired consultants to do irrigation demand estimations and the methods they have used have been varied and unfamiliar to Commission staff, which has no current expertise in agronomy. In recent applications for irrigation needs, staff has spent considerable time trying to determine if an irrigation request is reasonable based on the best information available. Some applicant's even choose to assume different climatic conditions, i.e. lower than normal rainfall years versus established and published long-term average climatic conditions, which result in inconsistent application of data and increased staff review and analyses to determine reasonable-beneficial irrigation uses. Sometimes staff has rejected the consultant's

analyses and determined that allocation requests were too high at times. Yet, staff also recognizes that there are factors that are difficult to compare consistently even between areas with similar climate, such as soil characteristics, irrigation methods (e.g., overhead sprinkler, drip irrigation, etc.), and plant/crop differences.

Given the complexity of determining accurate irrigation water use requirements, there is a need for a formal standardized method to define reasonable irrigation water demands based on the factors listed above. Also, while the Hawaii Supreme Court ruling on the Waiahole Contested Case Hearing's first Decision and Order affirmed the water use permit applicant's burden to justify their proposed use of water, the Court also opined that the Commission did not provide adequate analysis in its determination that diversified agriculture requires 2,500 gallons per acre per day of water.

The use of a single baseline value for diversified agriculture or demands irrespective of location may not be an accurate representation of the amount of water that is actually needed for healthy plant cultivation or propagation. This is especially true for irrigation in different climatic regions over varying soil types. The following section describes a practical, rational, and systematic means to estimate reasonable amounts of irrigation water required, based on a standardized methodology.

### SCOPE OF SERVICES

The proposed services are to develop a computer software application for Commission staff to use to determine reasonable irrigation demands. Staff has been working in consultation with the University of Hawaii College of Tropical Agriculture and Human Resources over the past year to address the need for an irrigation standard for Hawaii. A copy of the proposal is attached (Exhibit C).

#### General Methodology

The estimation of gross plant irrigation requirements will be based on a water budget recognizing the crop root zone considerations. The term gross irrigation (i.e., irrigation make up water) is used to indicate the total amount of water required with the irrigation efficiency, rainfall, and groundwater contributions factored in. This can be described by the following simplified equation:

$$IRR = \frac{ET_c - R_e - G}{f_i}$$

Where  $IRR$  is gross irrigation requirement,  $ET_c$  is crop evapotranspiration,  $R_e$  is effective rainfall,  $G$  is groundwater contribution, and  $f_i$  is the irrigation efficiency. The pan evaporation method will be utilized to determine reference evapotranspiration. The product of reference evapotranspiration and published crop coefficients will yield  $ET_c$ . Effective rainfall is the portion of rainfall available in the root zone for plant use and can be expressed as precipitation minus the combined groundwater drainage and surface runoff. Irrigation efficiency varies depending on the method of application.

### Standardized Data Sets

In order to standardize analysis of irrigation requirements, crop coefficients, soil type, rainfall, and evaporation, data would be extracted from published long-term data and analysis. This information is available to the general public and would allow applicants to use it to help define their water allocation requests. The use of published data and analysis could avert challenges to the results of the estimates of irrigation requirements. Specifically, staff is proposing to use the Department of Land and Natural Resource's Rainfall Atlas, R76, 1986, which has been used as the standard long-term baseline monthly rainfall average and median throughout the state. It has been used in the numerical models that have currently helped establish the sustainable yields for Pearl Harbor and used in other numerical modeling investigations in the state. Likewise, the DLNR Pan Evaporation: State of Hawaii 1894-1983, R74, 1986 provides the best long-term statewide estimate of pan evaporation. It would be good to update these reports as well, but it is the best information available at this time and is beyond the scope of work for this project. Soil characteristics will be determined from United States Department of Agriculture Soil Conservation Service's Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii, 1972-73. The application will utilize Geographic Information System (GIS) technology to overlay Tax Map Key data with rainfall and evapotranspiration datasets to determine local climate and soil characteristics.

### User Inputs

The user would be required to input the location, crop type(s), orchard row spacing, net irrigated acreage, and irrigation method(s). The application may also be used with GIS to help determine net irrigated acreage, unless the user specifies some other acreage. Other optional inputs would be crop rotation and fallowing practices. Rainfall and evaporation parameters based on the standardized datasets will already be part of the application and should not be necessary, unless better localized data is available and can be used in lieu of the standardized data set.

### Outputs

The output would be a table of the irrigation requirement estimate in units of gallons or million gallons per day for the specified crop type(s), irrigation method(s), and other significant factors. Other output tables and graphs will also be produced.

### Calibration and Validation

The computer application will be calibrated and validated before final product delivery. A sensitivity analysis will also be conducted on the major input parameters.

### Time Table

The project would be completed within 18 months of commencement.

### Deliverables

The final deliverables under this proposed contract would be: (1) Microsoft® Windows-based user-friendly computer application, that would allow for user updates of

methodology parameters, such as rainfall and evaporation, and GIS input capabilities, (2) written reports and/or oral presentations to staff at the completion of major work elements, and (3) a final report.

During development, the contractor will work closely with key Commission staff in order to ensure that the final product meets with staff's needs and expectations. The contractor will also provide training on use of the application and the procedure to update input parameters.

FUNDING

The cost of the proposed services is not to exceed \$100,000, which is to be paid out of the Commission's FY '06 budget allocation.

RECOMMENDATION

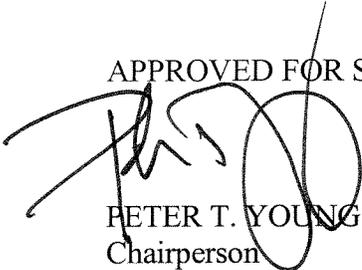
Staff recommends that the Commission authorize the Chairperson to enter into a contract for professional services to develop a computer software application to estimate irrigation requirements. The terms of this contract will be subject to the approval of the Chairperson and the department's Deputy Attorney General. Contract execution will be done in accordance with Chapter 103D, HRS, and Chapter 3-122, Hawaii Administrative Rules.

Respectfully submitted,



DEAN A. NAKANO  
Acting Deputy Director

APPROVED FOR SUBMITTAL:



PETER T. YOUNG  
Chairperson

- Exhibit A Table 4-4 in the 1992 Draft Oahu Water Management Plan
- Exhibit B County consumption guidelines as specified in Table 100-18 of the 2002 Water System Standards, State of Hawaii
- Exhibit C Draft Proposal