



STATE OF HAWAII  
DEPARTMENT OF LAND AND NATURAL RESOURCES  
**COMMISSION ON WATER RESOURCE MANAGEMENT**  
P.O. BOX 621  
HONOLULU, HAWAII 96809

**STAFF SUBMITTAL**

for the meeting of the  
**COMMISSION ON WATER RESOURCE MANAGEMENT**

April 29, 2015  
Līhu'e, Kaua'i

Request to Authorize the Chairperson to  
Enter into Joint Funding Agreements with U.S. Geological Survey  
To Conduct a Study on Low-Flow Characteristics for Streams  
In Southeast Kaua'i, Hawai'i

SUMMARY OF REQUEST:

Staff requests that the Commission on Water Resource Management (Commission) authorize the Chairperson to enter into multiple Joint Funding Agreements (JFA) with the U.S. Geological Survey (USGS) to conduct a study of Low-Flow Characteristics for Streams in Southeast Kaua'i, Hawai'i.

BACKGROUND:

Under the State Water Code (Code), Chapter 174C, Hawaii Revised Statutes (HRS), the Commission has the responsibility of establishing Instream Flow Standards (IFS) on a stream-by-stream basis whenever necessary to protect the public interest in the waters of the State. Early in its history, the Commission recognized the complexity of establishing IFS for the State's estimated 376 perennial streams and instead set interim IFS at "status quo" levels. These interim IFS were defined as the amount of water flowing in each stream (with consideration for the natural variability in stream flow and conditions) at the time the administrative rules governing them were adopted in 1988 and 1989.

The Hawaii Supreme Court, upon reviewing the Waiahole Ditch Contested Case Decision and Order, held that such "status quo" interim IFS were not adequate to protect streams and required the Commission to take immediate steps to assess stream flow characteristics and develop quantitative interim IFS for affected Windward Oahu streams, as well as other streams statewide. The Hawaii Supreme Court also emphasized that "instream flow standards serve as the primary mechanism by which the Commission is to discharge its duty to protect and promote the entire range of public trust purposes dependent upon instream flows."

The Commission is tasked with establishing instream flow standards by analyzing "the importance of the present or potential instream values with the importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting

such uses.” While the Code outlines the instream and offstream uses to be analyzed, it assumes that hydrological conditions will also be analyzed as part of setting IFS. The complexity lies in the variability of local surface water conditions that are dependent upon a wide range of factors, including, but not limited to rainfall, geology, topology and human impacts, as well as the availability of such information.

In striving to fulfill the mandates of the Code and Hawaii Supreme Court, the Commission staff has proceeded to focus on priority areas in developing measurable instream flow standards. One such example is a study recently completed by the USGS, in cooperation with the Commission, on the *Low-Flow Characteristics of Streams in the Lahaina District, West Maui, Hawai‘i* (Scientific Investigation Report 2014-5087). With this information, the Commission will be able to move forward in assessing the range of instream and non-instream uses in relation to specific hydrologic conditions.

The history of large-scale sugarcane cultivation in Southeast Kaua‘i by Lihue Plantation, Grove Farm, Koloa Plantation, McBryde Sugar Company, and Olokele Sugar Company has left extensive and complex irrigation systems that continue to serve municipal, hydropower, and agricultural uses. Over the past several years, the Commission has received several complaints and inquiries for streams in the region including Wailua, Waikomo, Lāwa‘i, and Hanapēpē. Additionally, the USGS has worked with the Kaua‘i Department of Water consistently over the past two decades in assessing groundwater hydrology for the Southern Līhu‘e Basin. This combination of issues and work in Southeast Kaua‘i have made it ripe for the assessment of instream flow standards by the Commission.

On April 15, 2015, following initial discussions, USGS prepared the attached Joint Funding Agreement and Study Proposal (Exhibit 1).

#### SCOPE OF SERVICES AND FUNDING:

The attached study proposes a 4-year cooperative study of the main streams within eleven watersheds in Southeast Kauai. The objectives are to: 1) quantify the amount of water available under natural, low-flow conditions upstream of existing surface-water diversions; and 2) characterize the magnitude and frequency of low flows at selected sites downstream of diversions. The main streams included in this study are within the watersheds, or surface water hydrologic units, of Wailua, Hanamā‘ulu, Nāwiliwili, Puali, Hulē‘ia, Waikomo, Aepo, Lāwa‘i, Kalāheo, Wahiawa, and Hanapēpē (see page 12, Exhibit 1). The study will run from June 1, 2015 to April 30, 2019. The total cost will be \$707,000.

USGS will undertake this study in five steps:

- 1) Conducting background research on existing surface water diversions, rainfall, groundwater, and surface-water data;
- 2) Conducting stream reconnaissance surveys to understand the general hydrologic conditions of streams;
- 3) Establishing low-flow partial records stations upstream from existing diversion intakes to quantify streamflow under natural, undiverted low-flow conditions;
- 4) Conducting seepage analyses to characterize gains and losses in streamflow; and
- 5) Preparing maps to be published as part of the report.

JFA Period 1: June 1, 2015 to June 30, 2017. The total cost for Period 1 is \$446,000 (Commission (\$312,200) and USGS (\$133,800)). The major tasks include planning, background research, reconnaissance, and establishment of partial-record sites.

JFA Period 2: July 1, 2017 to April 30, 2019. The total cost for Period 2 is \$261,000. The USGS and the Commission will share in the cost, but have also agreed to seek other funding partners to reduce the cost for each cooperating agency. The major task will be continued data collection and analysis.

The funds for the Commission’s share of JFA Period 1 (\$312,200) are available from the Department’s FY 2015 Budget, LNR 404, Water Resources Program. Funding for Period 2 will come from the Commission’s general fund, special fund, or a combination of both, depending upon available funding.

ENVIRONMENTAL REVIEW (CHAPTER 343)

Hawaii Revised Statutes (HRS) Chapter 343 does not apply because this is a data collection and research study. Hawaii Administrative Rule §11-200-8(A)(5) exempts classes of action including, “Basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to and environmental resource.”

RECOMMENDATION:

1. Staff recommends that the Commission authorize the Chairperson to enter into a Joint Funding Agreement between the Commission and the U.S. Geological Survey to conduct a Study on Low-Flow Characteristics for Streams in Southeast Kaua‘i, Hawai‘i from June 1, 2015 to June 30, 2017 (Period 1),
2. Staff recommends that the Commission authorize the Chairperson to enter into a subsequent Joint Funding Agreement (Period 2) between the Commission and the U.S. Geological Survey to continue to conduct a Study on Low-Flow Characteristics for Streams in Southeast Kaua‘i, Hawai‘i from July 1, 2017 to April 30, 2019.

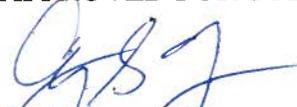
The terms of these agreements will be subject to the availability of funding and the approval of the Chairperson and the Department’s Deputy Attorney General. Contract execution will be done in accordance with Chapter 103D, HRS, and Chapter 3-122, Hawaii Administrative Rules.

Respectfully submitted,

  
W. ROY HARDY  
Acting Deputy Director

- Exhibit 1. USGS Joint Funding Agreement and Proposal for a Study on Low-Flow Characteristics for Streams in Southeast Kaua‘i, Hawai‘i.

APPROVED FOR SUBMITTAL:

  
CARTY S. CHANG  
Interim Chairperson



## United States Department of the Interior

U.S. GEOLOGICAL SURVEY  
Pacific Islands Water Science Center  
1845 Wasp Boulevard, Building 176  
Honolulu, Hawaii 96818

Phone: (808) 690-9600/Fax: (808) 690-9599

April 10, 2015

Mr. Roy Hardy, Acting Deputy Director  
State of Hawai'i  
Department of Land and Natural Resources  
Commission on Water Resource Management  
P.O. Box 621  
Honolulu, Hawai'i 96809

Attn.: Dean Uyeno

Dear Mr. Hardy:

Subject: Joint Funding Agreement between the State of Hawai'i Department of Land and Natural Resources Commission on Water Resource Management (CWRM) and the U.S. Geological Survey (USGS) for a cooperative study to assess low-flow characteristics for streams in Southeast Kauai, during the period June 1, 2015 to June 30, 2017

Enclosed is a Joint Funding Agreement between the State of Hawai'i Department of Land and Natural Resources Commission on Water Resource Management (CWRM) and the U.S. Geological Survey (USGS) for a cooperative study to assess low-flow characteristics for streams in Southeast Kauai, during the period June 1, 2015 to June 30, 2017. The total cost of the agreement is \$446,000, which will be shared by the CWRM (\$312,200) and the USGS (\$133,800).

The objectives of this 4-year cooperative study on the study-area streams are to (1) quantify the amount of water available under natural, low-flow conditions upstream of existing surface-water diversions; and (2) characterize the low flows at selected sites downstream of diversions. Low-flow characteristics will be expressed as estimates of selected natural low-flow duration discharges between the 50 and 95 flow-duration percentiles. Low flows are defined as less than median flow conditions. Included in the study are the main streams within the eleven watersheds of Wailua, Hanamaulu, Nawiliwili, Puali, Huleia, Waikomo, Aepo, Lawai, Kalaheo, Wahiawa, and Hanapepe.

This study will provide current surface-water data and information that will assist the CWRM in assessing in-stream and off-stream uses of the surface-water resources in Southeast Kauai. Results from this study will be published in the USGS Scientific Investigations Report series and made available on the internet. The total cost for this study is \$707,000, which will be shared by the CWRM (\$494,900) and the USGS (\$212,100).

**EXHIBIT 1**

2015 APR 15 PM 09:30

A more detailed description of the scope of work, budget, and timeline for the study is attached to the Joint Funding Agreement. Costs by agreement period are summarized below. The total cost for the first agreement period is \$446,000, which will be shared by the CWRM (\$312,200) and the USGS (\$133,800). The total cost for the second agreement period is \$261,000, which will be shared by the MDWS (\$182,700) and the USGS (\$78,300).

Category	June 1, 2015- June 30, 2017	July 1, 2017- April 30, 2019	Total
Labor <sup>1</sup>	\$ 315,911	\$ 213,393	\$ 529,304
Travel	\$ 93,128	\$ 32,832	\$ 125,960
Supplies	\$ 11,640	\$ 0	\$ 11,640
Science Support <sup>2</sup>	\$ 25,321	\$ 14,775	\$ 40,096
<b>Total</b>	<b>\$ 446,000</b>	<b>\$ 261,000</b>	<b>\$ 707,000</b>
CWRM	\$ 312,200	\$ 182,700	\$ 494,900
USGS	\$ 133,800	\$ 78,300	\$ 212,100

<sup>1</sup> Labor includes salary and indirect costs for leave, facilities, and overhead assessments

<sup>2</sup> Science support includes indirect costs for project management, technical services, and report processing fees

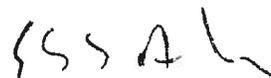
If you are in agreement with this study, please sign and return a copy of the enclosed Joint Funding Agreement.

The legal authority for the USGS to enter into this agreement is 43 USC 50. Work performed with funds from the agreement will be conducted on a fixed price basis. This means that invoices will be based on the agreed-upon amount, rather than actual itemized expenses. Your agency will be billed using form DI-1040, according to the terms of the agreement. The results of all work under the agreement will be available for publication by the USGS.

During the course of this jointly planned study, USGS may provide unpublished USGS data or information to your agency for review. In accepting the unpublished data or information, your agency agrees to be bound by the USGS non-disclosure policy for unpublished USGS work products. Guidance concerning USGS's non-disclosure policy is explained in USGS Fundamental Science Practices (<http://www.usgs.gov/fsp/policies.asp>).

If you have any questions, or would like more information about this study, please feel free to contact me at 690-9602 or by e-mail at [santhony@usgs.gov](mailto:santhony@usgs.gov). Thank you for your continued interest in working with the USGS to provide water-resource information for the State of Hawai'i.

Sincerely,



Stephen S. Anthony  
Center Director

Enclosures

**U.S. DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY**

**JOINT FUNDING AGREEMENT**

Customer #: 6000001189  
Agreement #: 15WSHI000000019  
Project #: ZH00FYQ  
TIN #: 99-0266119  
Fixed Cost Agreement YES

FOR

WATER RESOURCES INVESTIGATIONS

**THIS AGREEMENT is entered into as of the, 1st day of June, 2015 by the U.S. GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the COMMISSION ON WATER RESOURCE MANAGEMENT, DEPARTMENT OF LAND AND NATURAL RESOURCES, STATE OF HAWAII, party of the second part.**

1. The parties hereto agree that subject to availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation a study to assess low-flow characteristics for streams in Southeast Kauai, according to the scope of investigations provided in attachment 1, herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50; and 43 USC 50b.
2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) includes In-Kind Services in the amount of \$0.00
  - (a) by the party of the first part during the period

Amount	Date	to	Date
\$133,800.00	June 1, 2015		June 30, 2017
  - (b) by the party of the second part during the period

Amount	Date	to	Date
\$312,200.00	June 1, 2015		June 30, 2017
  - (c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.
  - (d) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.
3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.
4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.
5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.
6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

- 7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.
- 8. The maps, records, or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records, or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at costs, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records, or reports published by either party shall contain a statement of the cooperative relations between the parties.
- 9. USGS will issue billings utilizing Department of the Interior Bill for Collection (form DI-1040). Billing documents are to be rendered Quarterly. Payments of bills are due within 60 days after the billing date. If not paid by the due date, interest will be charged at the current Treasury rate for each 30 day period, or portion thereof, that the payment is delayed beyond the due date. (31 USC 3717; Comptroller General File B-212222, August 23, 1983).

**U.S. Geological Survey  
United States  
Department of the Interior**

**Commission on Water Resource Management  
Department of Land and Natural Resources  
State of Hawaii**

USGS Point of Contact

Customer Point of Contact

Name: Chui Cheng  
 Address: USGS - PIWSC  
 1845 Wasp Blvd., Bldg. 176  
 Honolulu, Hawaii 96818  
 Telephone: 808-690-9594  
 Email: ccheng@usgs.gov

Name: Dean Uyeno  
 Address: CWRM - DLNR  
 P.O. Box 621  
 Honolulu, Hawaii 96809  
 Telephone: 808-587-0249  
 Email: dean.d.uyeno@hawaii.gov

Signatures and Date

Signature:

Date:

Signature:

Date:



Name: Stephen S. Anthony  
 Title: Center Director

Name: Carty S. Chang  
 Title: Interim Chairperson

## Scope of Investigations

### Low-Flow Characteristics for Streams in Southeast Kauai, Hawaii

U.S. Geological Survey  
Pacific Islands Water Science Center

#### SUMMARY

For over a century, many streams in southeast Kauai, Hawaii, were diverted to provide for large-scale sugarcane cultivation. Lihue Plantation, Grove Farm, Koloa Plantation, McBryde Sugar Company, and Olokele Sugar Company were among the large-scale sugarcane plantations that operated extensive surface-water diversion systems in the area. Collectively, the diversion systems captured an average of over 350 million gallons of surface water per day. These diversion systems span multiple drainage basins, transporting surface water to a network of reservoirs before distributing it to the plantation fields. Hydropower was also harnessed in some areas to supplement energy sources. Today, many of the diversion systems remain active and provide water for domestic uses, diversified agriculture, and cultural purposes.

Competition for limited water resources has been, and continues to be a major issue in Hawaii. With increasing water demands, it is critical to effectively manage the State's water resources for current and future needs. The proper management of the water resources requires an understanding of the current hydrologic conditions of the surface-water flows. Unfortunately, existing data that capture the recent hydrologic conditions of the study area are scarce. Additional scientific information, especially streamflow data, is needed to establish technically defensible instream flow standards that will support equitable, reasonable, and beneficial allocation of the water resources in the State.

The study area includes 11 drainage basins, from Wailua in the north to Hanapepe in the south. The objectives of this 4-year cooperative study on the streams in the study area are to (1) quantify the amount of water available under natural, low-flow conditions upstream of existing surface-water diversions; and (2) characterize the magnitude and frequency of low flows at selected sites downstream of diversions. The scope of the study includes a reconnaissance survey of the study area to provide insight into the surface-water diversion systems and the effects of these systems on stream low flows. Seepage gains and losses will also be quantified along the study-area streams.

This cooperative study will provide an understanding of the streams in southeast Kauai with current surface-water data. This study will assist CWRM in determining equitable, reasonable, and beneficial instream and off-stream uses of the surface-water resources in the area. This study will also provide an understanding of the interaction between groundwater and surface water, which will assist the Kauai County Department of Water in identifying areas where groundwater withdrawal may affect streamflow. Results from this study will be published in the USGS Scientific Investigations Report series and made available on the internet. Based on an initial estimate of about 40 measurement sites and 10 seepage analyses, a total of about \$707,000 is needed for this 4-year study.

## INTRODUCTION

For over a century, many streams in southeast Kauai, Hawaii (fig. 1) were diverted to provide for large-scale sugarcane cultivation. Lihue Plantation, Grove Farm, Koloa Plantation, McBryde Sugar Company, and Olokele Sugar Company were among the large-scale sugarcane plantations that operated extensive surface-water diversion systems in the area. Collectively, the diversion systems captured an average of over 350 million gallons of surface water per day. The largest diverter was Lihue Plantation and its diversion system in the Lihue area diverted an average of 100 to 140 million gallons per day. These diversion systems span multiple drainage basins, transporting surface water to a network of reservoirs before distributing it to the plantation fields. The Hanalei Tunnel was constructed to transport surface water from Hanalei River to the Wailua River basin. Waita Reservoir, the second-largest reservoir in Hawaii with a 2.3-billion gallon capacity, is located in the Mahaulepu area and it received water diverted from Waiahi Stream (Wailua River basin) and Kuia Stream (Huleia Stream basin). Hydropower was harnessed in some areas to supplement energy sources. Water stored in Alexander Reservoir, which has a capacity of over 800 million gallons, was used to generate hydropower at the Kalaheo Powerplant in Hanapepe (Wilcox, 1996). With the closure of sugar plantations beginning in the late 1990s, ownership of the land and uses of surface water have changed. Today, about 45 percent of southeast Kauai is privately owned, and many of the diversion systems remain active and provide water for domestic uses, hydropower, diversified agriculture, and cultural purposes.

The Hawaii State Water Code mandates that the Commission on Water Resource Management (CWRM) establish a statewide instream-use protection program (Chapter 174C-71, Hawaii Revised Statutes). The principal mechanism that CWRM has for the protection of instream uses is to establish instream flow standards. "Each instream flow standard shall describe the flows necessary to protect the public interest in the particular stream. Flows shall be expressed in terms of variable flows of water necessary to protect adequately fishery, wildlife, recreational, aesthetic, scenic, or other beneficial instream uses in the stream in light of existing and potential water developments including the economic impact of restriction of such use" (Chapter 174C-71, Hawaii Revised Statutes). In 1988, CWRM set interim instream flow standards for all streams in the State of Hawaii. Subsequently, the interim instream flow standard was defined as the amount of water in the stream as of June 15, 1988 (Section 13-169-44, Hawaii Administrative Rules). This method of setting instream flow standards was challenged in a contested-case hearing related to water diverted by the Waiahole Ditch system on Oahu. In August 2000, the Hawaii Supreme Court, in a landmark decision, overturned the method used by CWRM in setting instream flow standards and ordered that CWRM set quantitative instream flow standards for the streams affected by the Waiahole Ditch system. In addition, CWRM must also set quantitative instream flow standards for all perennial streams statewide. CWRM has recognized certain uses as beneficial, including: (1) maintenance of fish and wildlife habitat, (2) outdoor recreational activities, (3) maintenance of ecosystems such as estuaries, wetlands, and stream vegetation, (4) aesthetic values such as waterfalls and scenic waterways, (5) maintenance of water quality, (6) the conveyance of irrigation and domestic water supplies to downstream points of diversion, and (7) the protection of traditional and customary Hawaiian rights.

## PROBLEM

Existing surface-water diversion systems in southeast Kauai are vast and complex, and the degree to which they alter the flow of streams in the study area is uncertain because limited data are available for the diversion systems and intakes that are currently in operation. Surface water from streams mixed with groundwater pumped from wells is transported across drainage basins. In some of the heavily developed areas, the stream is used as a conduit for transporting water between several pass-through reservoirs, leaving no single reach of the stream with unregulated flow. Kauai is among the most geologically complex of the eight main Hawaiian islands (Macdonald and others, 1960) and Lihue basin is one of the most geologically complex areas on the island. Izuka and Gingerich (1998) found that low permeabilities of the volcanic rocks of southern Lihue basin result in high inland groundwater levels and a high proportion of groundwater discharging to streams. This interaction between groundwater and surface water is critical to understanding available water resources on the island.

Effective management of the State's water resources for current and future needs requires an understanding of the current hydrologic conditions of surface-water flows, which is available from active continuous-record stream-gaging stations or can be estimated from long-term historical streamflow records. Out of 13 continuous-record streamflow-gaging stations in the study area, only 2 of the stations are currently in operation with more than 10 years of unregulated-streamflow record (Table 1). Both of these stations are located in the Wailua River basin. Results from this study will build on the existing knowledge base on the groundwater occurrence in southern Lihue basin characterized by Izuka and Gingerich (1998). Most importantly, scientific information generated from this study will assist CWRM in determining equitable, reasonable, and beneficial instream and off-stream uses of the surface-water resources in southeast Kauai. Results from the study will assist CWRM in (1) documenting water rights and uses associated with the streams in the study area; (2) assessing the effects of existing uses on these streams; and (3) determining quantitative and technically defensible instream-flow standards for these streams.

**Table 1.** Continuous-record streamflow-gaging stations in southeast Kauai, Hawaii.

Station no.	Station name	Period of record	Years of record <sup>1</sup>	Flow
16047000	Koula River at Koula near Eleele	1910-1939	6	Regulated
16049000*	Hanapepe River below Manuahi Stream near Eleele	1917-2014	90	Regulated
16052500	Lawai Stream near Koloa	1963-1972	9	Regulated
16053000	Kamooloa Stream near Koloa	1939-1941	-	Natural
16053800	Kamooloa Stream near Puhi	1963-1970	5	Regulated
16054000	Kuia Stream near Koloa	1939-1941	-	Natural
16054500	Kuia Stream near Puhi	1963-1966	1	Regulated
16055000	Huleia Stream near Lihue	1912-1970	6	Regulated
16060000*	South Fork Wailua River near Lihue	1912-2014	97	Regulated
16063000	North Fork Wailua River at altitude 650 ft near Lihue	1914-1985	69	Regulated
16068000*	East Bank of North Fork Wailua River near Lihue	1912-2014	99	Natural
16071000	North Fork Wailua River near Kapaa	1952-2003	51	Regulated
16071500*	Left Branch Opaekaa Stream near Kapaa	1960-2014	54	Natural

\* In operation 2014 water year

<sup>1</sup> Number of water years with complete record as of the end of 2014 water year

## OBJECTIVES AND SCOPE

The study area (Fig. 1) includes 11 drainage basins, from Wailua in the north to Hanapepe in the south. The objectives of this 4-year cooperative study on the study-area streams are to (1) quantify the amount of water available under natural, low-flow conditions upstream of existing surface-water diversions; and (2) characterize the low flows at selected sites downstream of diversions. Low-flow characteristics will be expressed as estimates of selected natural low-flow duration discharges between the 50 and 95 flow-duration percentiles. The scope of the study includes a reconnaissance survey of the study area to provide insight into the surface-water diversion systems and the effects of these systems on stream low flows. This information will be used to determine the number of measurement sites at which streamflow data will be collected to determine select natural low-flow characteristics. Seepage gains and losses will also be quantified along the study-area streams. This study will not address any aspect (e.g., distribution, abundance, reproduction, and recruitment) related to native stream fauna (fish, shrimp, and snails) and invertebrate species. This study also will not address water requirements for agricultural, aesthetic, or recreational uses.

## APPROACH

To accomplish the objectives of this study, the USGS proposes to undertake a 4-year study in a 5-phased approach:

1. *Background research* will be conducted to gather information on existing surface-water diversions in the study-area streams. This effort will include compiling diversion records filed with the State and communicating with present landowners and diversion-system operators on the current status of the diversion systems. Available rainfall, groundwater, and surface-water data of the study area will be compiled.
2. *Stream reconnaissance surveys* will be conducted to provide a general understanding of the hydrologic conditions of the streams in the study area, and to identify stream reaches that are substantially affected by diversions or interactions with groundwater. Existing surface-water diversion-system intakes, either abandoned or in operation, will be documented with photographs and a handheld GPS unit. Discharge-measurement sections will be selected upstream and downstream from diversion intakes for the partial-record stations (see item 3) and seepage analyses (see item 4). Locations of the measurement sections will be documented with a handheld GPS unit and flagged on site.
3. *Partial-record stations* will be established upstream from existing diversion intakes to quantify the amount of water available under natural, undiverted low-flow conditions in the streams in the study area (OBJECTIVE #1). If appropriate, natural flows also may be estimated by obtaining measurements of both the diverted flow at the ditch intake and the remaining flow downstream from the diversion. About 40 partial-record stations will be established and about ten discharge measurements will be made at each station during periods of independent flow recessions. Low-flow characteristics, expressed as estimates of selected natural low-flow duration discharges between the 50 and 95 flow-duration percentiles, will be estimated using record-extension methods that relate flow measurements at the low-flow partial-record stations and concurrent daily flow at index stations (Hirsch, 1982). Two record-extension methods will be

considered in extending streamflow records for this study and they are (1) the graphical-correlation technique described by Searcy (1959, p.14); and (2) the Maintenance of Variance Extension Type 1 (MOVE.1) technique described by Hirsch (1982). Both record-augmentation techniques assume that the relation between concurrent records at the index and partial-record site is the same for any time period (Ries, 1993, p.21).

4. *Seepage analyses* will be conducted to characterize gains and losses in flow along the stream, downstream of diversions, within the study area (OBJECTIVE #2). The seepage runs will follow the Pacific Islands Water Science Center's (2012) Guidelines for Conducting, Reporting, Reviewing, and Archiving Seepage-Run Measurements. A seepage analysis consists of multiple discharge measurements made nearly simultaneously at selected sites along the stream. For streams with active diversions, the seepage analyses will be conducted below the points of diversion during controlled releases of flow into the streams from the diversions. A controlled flow release is the partial or full restoration of flow to the stream from the diversion for an extended period to allow continuous flow over the studied reach, so that measurements of streamflow can be made in stream reaches that may be dry under diverted conditions. Information from the seepage analyses during controlled flow releases will provide insight related to streamflow during natural-flow conditions. Cooperation between the owners of existing diversions and USGS is necessary to coordinate the controlled flow releases and discharge measurements. If such cooperation cannot be achieved, seepage analyses will be conducted where flow is present and the absence of flow at selected sites downstream of existing diversions will be documented. Based on initial research, existing seepage data are available for North Fork Wailua River, South Fork Wailua River, Hanamaulu Stream, Huleia Stream, and Hanapepe River. As part of this study, a seepage analysis will be conducted for each of the main streams in the study area and results will be compared to previous seepage analyses for streams with existing seepage data.
5. *Maps* will be prepared and published as part of the report (see PRODUCTS) that document photographed sites, partial-record stations, and discharge-measurement sites for the seepage analyses. All maps will be made available digitally.

### QUALITY ASSURANCE

The quality assurance procedures that will be used to guide data-collection and review activities are contained in the USGS Pacific Islands Water Science Center Surface-Water Quality-Assurance Plan (Rickman, 2012) and in the USGS Data Management Planning Considerations Checklist (2014). Existing discharge measurements from USGS paper files will be entered into the NWIS database and checked for data-entry errors. New discharge measurements made as part of this study will be checked prior to entry into the NWIS database (OSW Technical memorandum 2012.03). Hand-computed discharges will be independently checked by an experienced hydrographer prior to entry into the NWIS database. Discharge measurements made by inexperienced hydrographers will be checked by an experienced hydrographer, who will provide immediate feedback and necessary corrections to the measurements. Discharge measurements that are inaccurate and unusable will be flagged "not used" in SiteVisit. All field notes from new discharge measurements will be archived following the USGS Pacific Islands Water Science Center Data Management Plan

(Jeppesen, 2012). Seepage runs will follow the Pacific Islands Water Science Center's (2012) Guidelines for Conducting, Reporting, Reviewing, and Archiving Seepage-Run Measurements.

### PRODUCTS

The study will take approximately 4 years from the time data collection begins. Data and results of all analyses will be documented and published in the USGS Scientific Investigations Report series. The report will be made readily available to the public through the internet. The probable report title and milestone dates are listed in Table 2.

**Table 2.** Milestone dates for planned report.

Probable title	First draft	Review	Approval	Publication
Low-Flow Characteristics for Streams in Southeast Kauai, Hawaii	9/2018	10/2018	1/2019	4/2019

### BUDGET SUMMARY

A total of about \$707,000 is needed for this 4-year study. A cost breakdown is provided in Table 3. Labor includes salary and indirect costs for leave, facilities, and overhead assessments. Science support includes indirect costs for project management, technical services, and report processing fees. The budget for phase 1 is about \$446,000 and it covers the project tasks outlined in Table 4 for a period of 25 months from June 1, 2015 to June 30, 2017. The budget for phase 2 is about \$261,000 and it covers the project tasks outlined in Table 4 for a period of 22 months from July 1, 2017 to April 30, 2019. Progress letters summarizing status of the study will be provided on a quarterly basis.

**Table 3.** Project budget for the study.

Category	Phase 1	Phase 2	Total
	June 1, 2015- June 30, 2017	July 1, 2017- April 30, 2019	June 1, 2015- April 30, 2019
Labor	\$ 315,911	\$ 213,393	\$ 529,304
Travel	\$ 93,128	\$ 32,832	\$ 125,960
Supplies	\$ 11,640	\$ 0	\$ 11,640
Science Support	\$ 25,321	\$ 14,775	\$ 40,096
Total	\$ 446,000	\$ 261,000	\$ 707,000

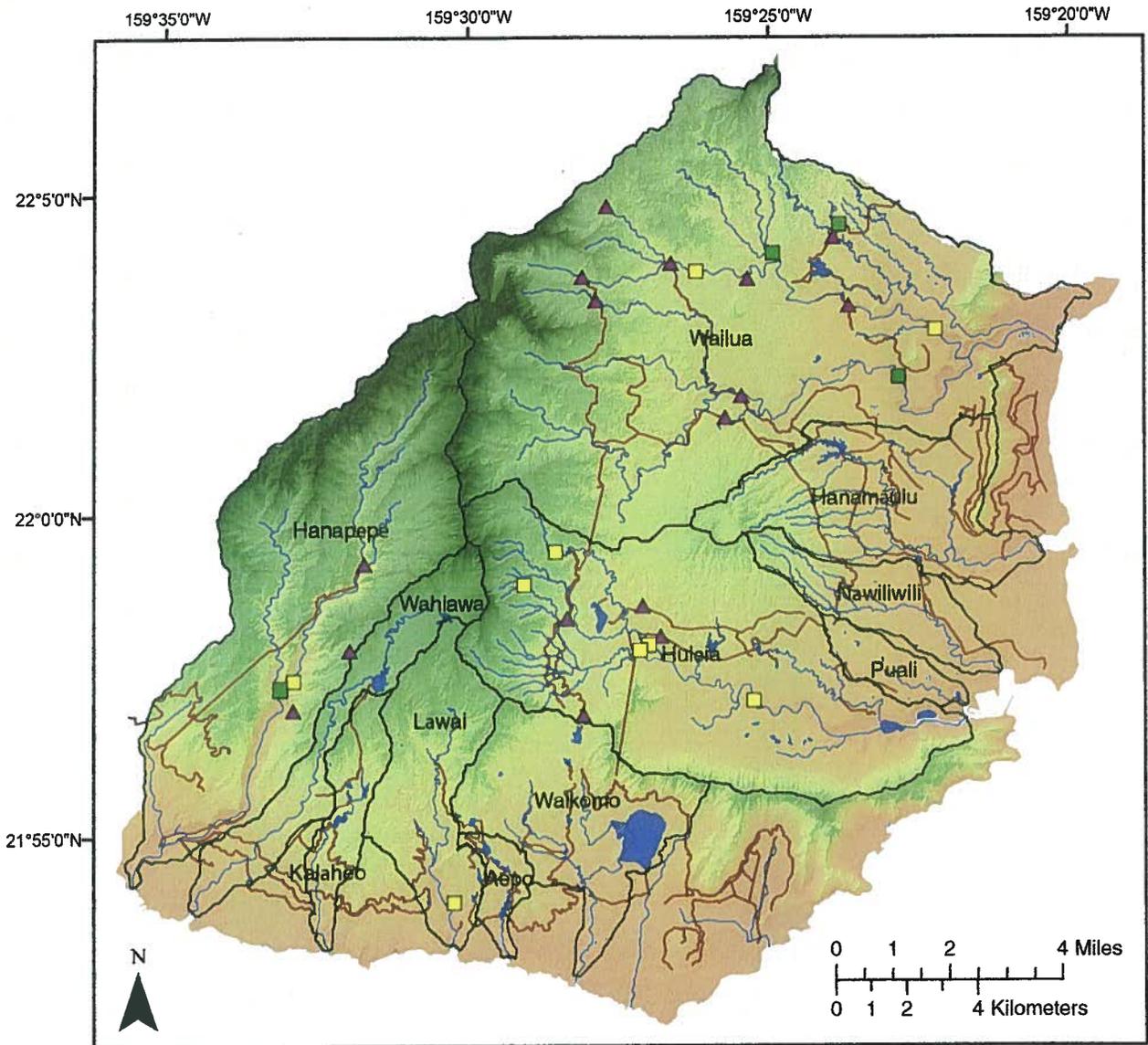
## TIMELINE

The major tasks and associated periods of activity for this study are summarized in Table 4.

**Table 4.** Timeline for major project tasks.

	2015			2016				2017				2018				2019	
	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr												
<b>PHASE 1</b>																	
Background research																	
Reconnaissance																	
Partial-record sites																	
<b>PHASE 2</b>																	
Seepage runs																	
Data analysis																	
Report writing																	
Report review																	
Publication																	

**Figure 1. Study area.**

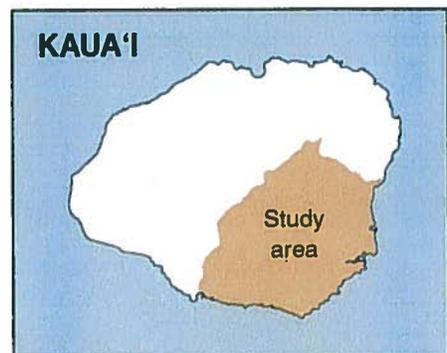


**EXPLANATION**

-  Drainage basins within study area
-  Diversion systems

**Selected USGS gaging stations**

-  Surface-water gage, active
-  Surface-water gage, inactive
-  Diversion intake, inactive



## REFERENCES

- Hirsch, R.M., 1982, A comparison of four record extension techniques: *Water Resources Research*, v. 18, no. 4, p. 1081-1088.
- Izuka, S.K., and Gingerich, S.B., 2003, Ground water in the southern Lihue basin, Kauai, Hawaii: U.S. Geological Survey Water-Resources Investigations Report 98-4031, 71 p.
- Jeppesen, H.A., 2013, Data Management Plan of the Pacific Islands Water Science Center – Policy and Procedures for the Management and Archival of Data: U.S. Geological Survey Pacific Islands Water Science Center, 8 p.
- Macdonald, G.A., Davis, D.A., and Cox, D.C., 1960, Geology and ground-water resources of the Island of Kauai, Hawaii: *Bulletin 13, Hawaii Division of Hydrography*, 212 p.
- Pacific Islands Water Science Center, 2012, Guidelines for conducting, reporting, reviewing, and archiving seepage-run measurements, 13 p.
- Rickman, R.L., 2012, Surface Water Quality-Assurance Plan for the Pacific Islands Water Science Center: U.S. Geological Survey Pacific Islands Water Science Center, 90 p.
- Ries, K.G., III, 1993, Estimation of low-flow duration discharges in Massachusetts: U.S. Geological Survey Open-File Report 93-38, 59 p.
- Searcy, J.K., 1959, Flow-duration curves, manual of hydrology—part 2. Low-flow techniques: U.S. Geological Survey Water-Supply Paper 1542-A, 33 p.
- U.S. Geological Survey, 2007, Facing tomorrow's challenges—U.S. Geological Survey science in the decade 2007–2017: U.S. Geological Survey Circular 1309, x + 70 p.
- U.S. Geological Survey, 2013, Cooperative Water Program, accessed February 1, 2015, at <http://water.usgs.gov/coop/about/>.
- U.S. Geological Survey, 2014, Data Management Planning Considerations – Checklist, accessed February 9, 2015, at <http://www.usgs.gov/datamanagement/plan/dmplans.php>.
- Wilcox, Carol, 1996, Sugar water: Hawaii's plantation ditches: Honolulu, University of Hawai'i Press, 191 p.