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For the meeting of the
COMMISSION ON WATER RESOURCE MANAGEMENT

August 21, 2018
Līhu'e, Kaua'i

Amended Interim Instream Flow Standards
For the Surface Water Hydrologic Unit of
Wailua (2040): Waikoko and North Fork Wailua Streams

SUMMARY OF REQUEST:

Staff is requesting that the Commission consider the recommendations for amending the interim instream flow standard (Interim IFS) for two streams contained within the Wailua surface water hydrologic unit in East Kaua'i:

WAILUA (2040): Waikoko Stream (Tributary of South Fork Wailua River)
WAILUA (2040): North Fork Wailua River (i.e., Wai'ale'ale Stream)

LOCATION MAP: See Figure 1

BACKGROUND:

The State Water Code (Code), Chapter 174C, Hawai'i Revised Statutes (HRS), provides that the Commission may adopt interim IFS on a stream-by-stream basis or a general IFS applicable to all streams within a specified area. This submittal seeks to address two streams in East Kaua'i.

The current interim instream flow standards (interim IFS) for the streams being considered were established by way of Hawai'i Administrative Rules (HAR) §13-169-48, which, in pertinent part, reads as follows:

Interim instream flow standard for Kaua'i. The Interim Instream Flow Standard for all streams on Kaua'i, as adopted by the commission on water resource management on June 15, 1988, shall be that amount of water flowing in each stream on the effective date of this

standard, and as that flow may naturally vary throughout the year and from year to year without further amounts of water being diverted off stream through new or expanded diversions, and under the stream conditions existing on the effective date of the standard...

The current interim IFS became effective on December 31, 1987. Thus, the status quo interim IFS, in effect, grandfathered all then-existing diversions that were registered with the Commission in subsequent years. Following the initial registration of stream diversion works, any new or substantially modified stream diversion works has structure required a permit for construction and amendment to the interim IFS.

Under the Code, the Commission has the responsibility of establishing IFS on a stream-by-stream basis whenever necessary to protect the public interest in the waters of the State. In the 2000 appellate ruling on the first Waiāhole Ditch Contested Case Decision and Order (“*Waiāhole I*”), the Hawai‘i Supreme Court 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.” 94 Haw. 97, 148, 9 P.3d 409, 460. The Code defines an instream flow standard as a “quantity or flow of water or depth of water which is required to be present at a specific location in a stream system at certain specified times of the year to protect fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses.” See HRS § 174C-3 (“Definitions”). In considering a petition to amend an interim instream flow standard, the Code directs the Commission to “weigh 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.” HRS § 174C-71(2)(D).

“Instream use” means beneficial uses of stream water for significant purposes which are located in the stream and which are achieved by leaving the water in the stream. Instream uses include, but are not limited to:

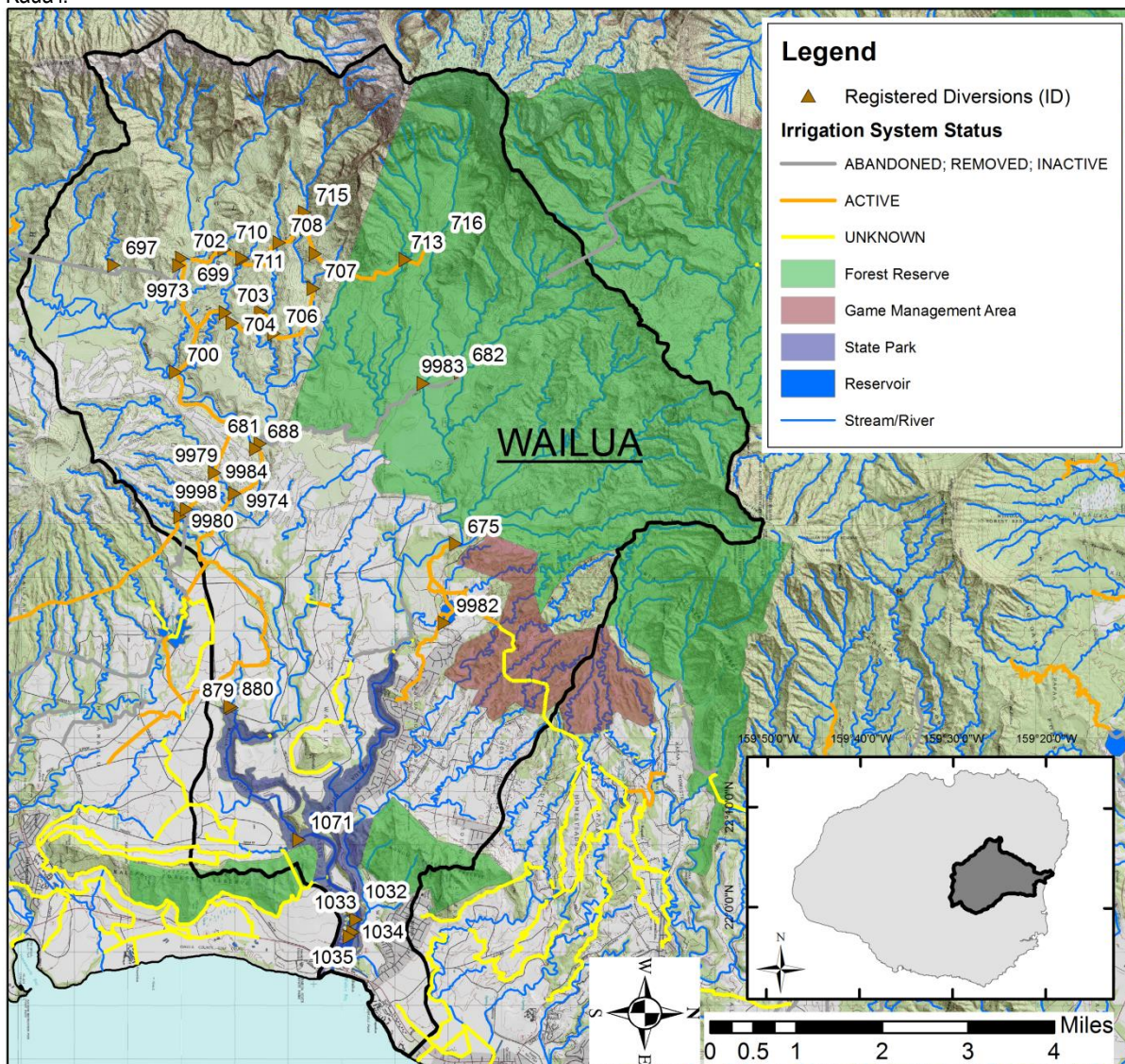
- 1) Maintenance of fish and wildlife habitats;
- 2) Outdoor recreational activities;
- 3) Maintenance of ecosystems such as estuaries, wetlands, and stream vegetation;
- 4) Aesthetic values such as waterfalls and scenic waterways;
- 5) Navigation;
- 6) Instream hydropower generation;
- 7) Maintenance of water quality;
- 8) The conveyance of irrigation and domestic water supplies to downstream points of diversion; and
- 9) The protection of traditional and customary Hawaiian rights.

“Noninstream use” means the use of stream water that is diverted or removed from its stream channel and includes the use of stream water outside of the channel for domestic, agricultural, and industrial purposes.

Since the establishment of the Stream Protection and Management Branch in July 2002, the Commission has been developing a framework for setting measurable instream flow standards statewide. This framework involves an assessment of natural flow conditions for the current climate period (1984-2013), an analysis of the instream uses protected by the State Water Code, the existing and planned off stream uses of surface water, and the availability of water from multiple sources.

The assessment of instream uses for the Wailua watershed has been separated into multiple phases, the first of which addresses interim instream flow standards for the West Branch of the North Fork Wailua River (hereafter referred to as Wai‘ale‘ale Stream) at diversion 716 and the Waikoko Stream at diversion 713. These registered diversions occur on land owned by the State of Hawai‘i (Figure 1).

Figure 1. The Wailua hydrologic unit, State of Hawai‘i-owned land, registered diversions (ID) and irrigation systems in East Kaua‘i.



HISTORICAL CONTEXT

The Līhu‘e Basin in Southeast Kaua‘i is an important economic, social, cultural, educational, recreational, industrial, agricultural, and residential region for the Island of Kaua‘i. Today, it is the primary center for importing and exporting products, houses the state and county governments, and is home to many residents. Historically, the Līhu‘e Basin was a focal region in Hawaiian culture; where the King and much royalty lived, where cultural and spiritual practices were carried out, and where large populations inhabited. The Wailua ahupua‘a, in particular, has tremendous importance as one of two religious and political centers of Kaua‘i (The other being Waimea) as evidenced by its full name: “Wailua Nui a Ho‘āno” or great sacred Wailua. The many significant religious and cultural archaeological sites as well as the substantial potential for food production in the area also suggest the region was a population center for Kaua‘i (Kekua and Alapa‘i, 2010).

The expansive Wailua complex of heiau that still exists today is evidence of the great cultural and historical importance of the region. The region was divided into two distinct places: sacred areas associated with the high chiefs, Kahuna and royalty in the lower reaches on either side of the river; and the commoners living on lands along the middle to upper reaches. Kaua‘i’s large canyons and substantial rainfall-driven streamflow supported irrigated cultivation along its main watercourses far inland (e.g., Wailua, Hanapepe, Waimea), and thus the development of considerable populations which had, at best, infrequent contacts with the sea (Handy and Handy 1972). Such a backland population was an anomaly across the Hawaiian Islands, but resulted in much terracing above stream flood stage which was used for taro lo‘i. Wailua (meaning “two waters”) contains the islands’ piko (literally navel) that physically and spiritually provides the waters that nourish the island. The names Wai‘ale‘ale (“rippling water”) and Waikoko (“blood water”) provides a metaphorical reference to the life-giving properties of water as part of the island’s circulatory system. The archaeological evidence and historical record suggests Wailua was developed as an expansive food-producing region with land and water stewardship guided by the ‘aha moku system. The Royal court traveled to Kawaikini, the summit of Mt. Wai‘ale‘ale to pay homage to the cyclical patterns they perceived in weather, rainfall, and streamflow.

On April 29, 2015, the Commission authorized the Chairperson to enter into a Joint Funding Agreement between the Commission and the United States Geological Survey (USGS) for a cooperative study to assess low-flow characteristics for streams in Southeast Kaua‘i, spanning watersheds from Wailua to Hanapepe. The agreement was then signed on May 5, 2015. The study is anticipated to be completed in the last quarter of calendar year 2019, with substantial fieldwork completed by the first quarter of calendar year 2019. This agreement is supporting fieldwork, data analysis, and documentation resulting in the production of a USGS Scientific Investigations Report. Because the fieldwork and analysis is ongoing, only point measurement data and completed seepage run data that have been collected and made available through the National Water Information System (<https://waterdata.usgs.gov/nwis>) as well as historical data, were compiled for this recommendation.

In 2015, Commission staff began to research the history of individual diversions and irrigation systems in Southeast Kaua‘i. The streams in Southeast Kaua‘i were diverted as part of sugarcane plantation irrigation systems starting in the late 1880s. The ‘Ili‘ili‘ula-North Wailua Ditch was used to bring water from tributaries of the North and South forks of the Wailua River to Waiahi Stream, itself a tributary of the South Fork Wailua, in order to generate hydropower and irrigate sugarcane. The first hydropower plant, now called the Lower Waiahi Hydropower plant, was built in 1914 and currently has a 800 kilowatt capacity. In 1931, the Upper Waiahi Hydropower plant was built at the 1,050 ft. elevation with a 500 kilowatt capacity. In total, there are 15 diversions which contribute to ditch flows in the ‘Ili‘ili‘ula-North Wailua Ditch (Upper Waiahi Hydropower plant) or the South Intake Ditch and North Intake Ditch (Lower Waiahi Hydropower plant). With the passage of the Hawai‘i State Water Code, these diversions were registered, with the instream flow standard adopted as status quo in 1988.

Towards the closure of Līhu‘e Plantation in 1999, the operation of the ‘Ili‘ili‘ula-North Wailua Ditch, its diversions and the associated hydropower plants were transferred to Kaua‘i Electric Company and then to Kaua‘i Island Utility Cooperative (KIUC). Despite the cessation of sugarcane cultivation, streamflow has continued to be diverted by KIUC for hydropower. The KIUC is a not-for-profit utility owned by the people of Kaua‘i (rate payers) and managed by a governing board. The Board has a goal of generating 70% of the electrical needs of the island from renewable resources by 2030, with hydropower being an important, consistently reliable, energy source that stabilizes the power generating portfolio.

There are nine registered diversions on the ‘Ili‘ili‘ula-North Wailua Ditch that feed the upper Waiahi Hydropower plant. Two of these diversions are located on land owned by the State of Hawai‘i (Table 1): one on a tributary of the North Fork Wailua River (Wai‘ale‘ale Stream) and one on a tributary of the South Fork Wailua River (Waikoko Stream).

Table 1. Registered diversions, stream name, registrant, and their registered primary use on land owned by the State of Hawai‘i that divert water into the ‘Ili‘ili‘ula-North Wailua Ditch.

Diversion Registration ID	Diversion name	Stream name	Registrant	Hydrologic Unit	Primary Use
716	Bluehole Intake	Wai‘ale‘ale (North Fork Wailua tributary)	Līhu‘e Plantation	Wailua	Hydropower & Sugarcane Irrigation
713	Waikoko Intake	Waikoko (South Fork Wailua tributary)	Līhu‘e Plantation	Wailua	Hydropower & Sugarcane Irrigation

The USGS maintained continuous flow monitoring stations on the ‘Ili‘ili‘ula-North Wailua Ditch for extended periods of time; the first at the Bluehole Intake (USGS 16061000) and the second past the Waikoko Stream Intake (USGS 16061200) on the ditch (Table 2).

Table 2. USGS ditch flow monitoring on the 'Ili'ili'ula-North Wailua Ditch. [cubic feet per second (million gallons per day)]

Station ID	Station name	Period of record	Median amount measured
16061000	'Ili'ili'ula-North Wailua Ditch blw Bluehole	1932-1985	19.0 (12.3)
16061200	'Ili'ili'ula-North Wailua Ditch blw Waikoko	1965-2002	21.0 (13.6)

In 1991, a massive flood damaged diversion 716 on Wai'ale'ale Stream and in April 1992, the diversion was repaired. In the seven years prior to the damage (calendar years 1984-1990), daily flow at the USGS station 16061200 on the Ili'ili'ula-North Wailua Ditch averaged 14.5 million gallons per day (median 14.54 million gallons per day). In the seven years post-damage repair (calendar years 1993-1999), flow at the USGS station 16061200 averaged 13.3 million gallons per day (median flow 13.57 million gallons per day). This decline in flow captured occurred when essentially equivalent average flow (31.00 million gallons per day vs. 29.34 million gallons per day) and median flow (18.74 million gallons per day vs. 19.39 million gallons per day) occurred at USGS station 16068000 on the East Branch of the North Fork Wailua River.

In the fall of 2016, heavy machinery was used to partially remove the concrete structure that forms the dam of the Bluehole Intake on Wai'ale'ale Stream. Since that time, Wai'ale'ale Stream has flowed past the diversion during all but the most extreme low-flow periods. However, mauka to makai flow has not been legally established for either stream, impeding cultural uses of the area including traditional and customary gathering practices and spiritual practices. Commission staff has received a number of informal and formal complaints and inquiries (e.g., phone calls, letters, emails) regarding instream flow standards in this region (Table 3).

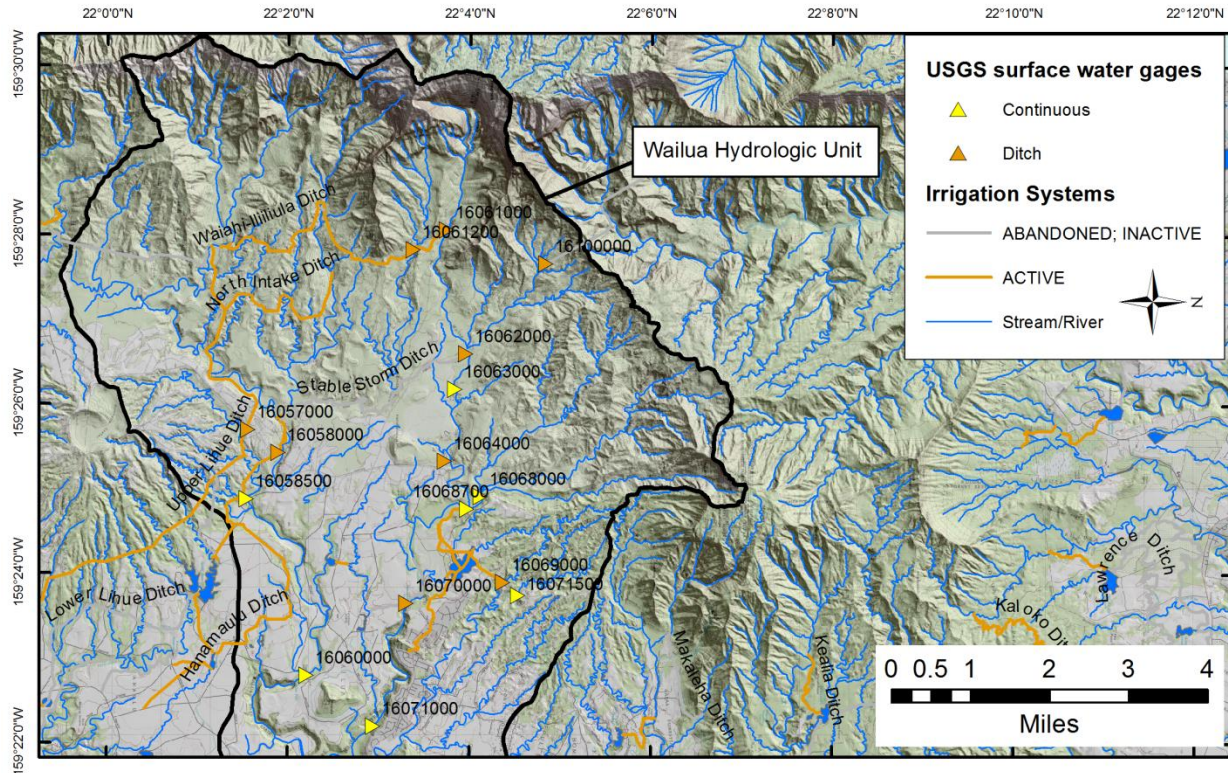
Table 3. Summary of complaints and inquiries to commission staff associated with the NF Wailua and Waikoko streams in the Wailua Hydrologic Unit, East Kaua'i.

Date	Description of Complaint
December 1, 2016	Traditional cultural practices and gathering rights affected by diversions in the upper reaches of the Wailua River.
December 12, 2016	Aesthetic value harmed by lack of mauka to makai flow; impaired traditional and customary gathering practices.
April 6, 2017	No mauka to makai flow from the sacred Wai'ale'ale.
October 12, 2017	KIUC's diversions have a detrimental impact on the environment, human health, and religious and cultural values.
January 22, 2018	KIUC is diverting water for Grove Farm.

Historically, these streams provided excellent habitat for native aquatic fauna. However, the purposeful introduction and continued propagation of non-native fish and invertebrate species that prey upon native species has almost completely eliminated native aquatic fauna. Continuous mauka to makai flow is estimated to naturally occur 100-percent of the time in all perennial streams in the Wailua Watershed. However, only two long-term continuous gaging stations exist in the watershed: one that monitors natural flow (USGS 16068000); and one that monitors regulated flow (USGS 16069000) below diversions on the South Fork Wailua River (Figure 2). Recently, a continuous flow gaging station was established on Waiahi Stream above the Upper Waiahi Hydropower Plant tailrace to monitor natural flows (USGS 16057900).

In October 2015, Commission staff began to reach out to irrigation managers, community groups, land owners, ‘Aha Moku representatives and stakeholders in order to better understand the current state of water management and to gather information regarding instream uses in Southeast Kaua‘i. In January 2016, staff began conducting field investigations with managers and stakeholders, installing stream monitoring stations, and surveying stream resources (Table 4).

Figure 2. Historic and current USGS gaging stations for ditches and streams in the Wailua Watershed.



Based upon the best available information, as presented in the Instream Flow Standard Assessment Report (IFSAR) and provided in this submittal, staff has developed a recommendation that seeks to protect instream uses while providing for some noninstream uses. The recommendations provided herein have also been developed in consideration of interim IFS values that were adopted by the Commission for previous areas of Kaua‘i (i.e., Waimea Watershed Agreement). As in those decisions, the Commission staff has relied upon the basic tenets of adaptive management, which are to: 1) Establish management objectives; 2) Implement management decisions; 3) Monitor effectiveness of decisions; 4) Evaluate results of management; and 5) Revise management decisions as necessary¹. Should initial management decisions need further amendment, the decisions can then be revised and the process repeated. This is a learning process that can be repeated over and over, until a sound management decision is reached. Due to the complex and dynamic nature of Hawai‘i’s stream systems, adaptive management affords staff the ability to proceed in making reasonable management decisions and

¹ Adapted from The Instream Flow Council, 2004, p.126.

ensuring that impacts are minimized in the face of uncertainty, thus allowing staff to proceed responsibly while advancing the clear intentions of the State Water Code.

Table 4. Summary of field investigations and meetings, by date, taken by Commission staff in support of amendment to the interim instream flow standards for Southeast Kaua'i. [GF = Grove Farm; KIUC = Kaua'i Island Utility Cooperative, EKWU = East Kaua'i Water Users]

Date	Description
January 12-13, 2016	WB NF Wailua field investigation; SF Wailua stream diversions investigation
February 5, 2016	Site visits with GF; Upper Līhu'e Ditch and Hanamaulu Ditch Intakes
February 12, 2016	Site visits with GF; Papuoa Reservoir Ditch & Waita-Koloa Ditch
March 1, 2016	Site visit with US Fish & Wildlife on NF Wailua River
November 2, 2016	Site visit with Kaua'i Ranch on Kealia Stream; Kealia Ditch measurement
November 2, 2016	Site visit with KIUC on NF Wailua River
December 8, 2016	Site visit with EKWU; Makalahena and Kapahi ditch; Wailua Reservoir Ditch
December 8, 2016	Site visit with GF; ditch measurements
December 8, 2016	Site visit with Kaua'i Ranch; Kealia Ditch measurement
February 22, 2017	NF Wailua River habitat survey
March 22, 2017	NF Wailua River habitat survey
March 23, 2017	Installation of gaging station on Upper Līhu'e Ditch at USGS 16057000
April 12, 2017	Installation of gaging station on Hanamaulu Ditch at USGS 16058000
September 8, 2017	Site visit with GF; ditch measurements
September 18, 2017	Site visit with GF; ditch measurements
September 22, 2017	Site visit with GF; ditch measurements
December 2017	Meeting with GF
January 18, 2018	Recon site investigation for establishment of stream gaging station below Bluehole Intake
January 22, 2018	Community meeting with other DLNR staff regarding State jurisdictions on Water use in Līhu'e Basin; NF Wailua flow measurement
February 12-13, 2018	Installation of gaging station on NF Wailua; flow measurement
March 13, 2018	Stream recon above and below Hanamaulu Ditch Intake for gaging stations
April 17, 2018	Meeting with interested community members regarding cultural practices
April 20, 2018	Meeting with 'Aha Moku representatives regarding cultural practices in Wailua
May 4-5, 2018	Site visits with 'Aha Moku representatives and cultural practitioners in SE Kaua'i
May 21, 2018	Seepage run measurements on the 'Ili'ili'ula-North Wailua Ditch
May 29, 2018	Site visits with 'Aha Moku representatives and cultural practitioners in SE Kaua'i
June 15, 2018	NF Wailua River flow measurement
June 21, 2018	Public fact-gathering meeting in Līhu'e
July 13, 2018	NF Wailua River flow measurement
July 30, 2018	Meeting with Puna District 'Aha Moku representatives

ISSUES/ANALYSIS:

This section of the submittal begins with general considerations of issues that broadly apply to the development of an interim IFS for any stream in Wailua (Figure 1). The general considerations are followed by a simplified schematic diagram and assessment summary. The summary identifies key points from the IFSAR and is by no means intended to substitute for the

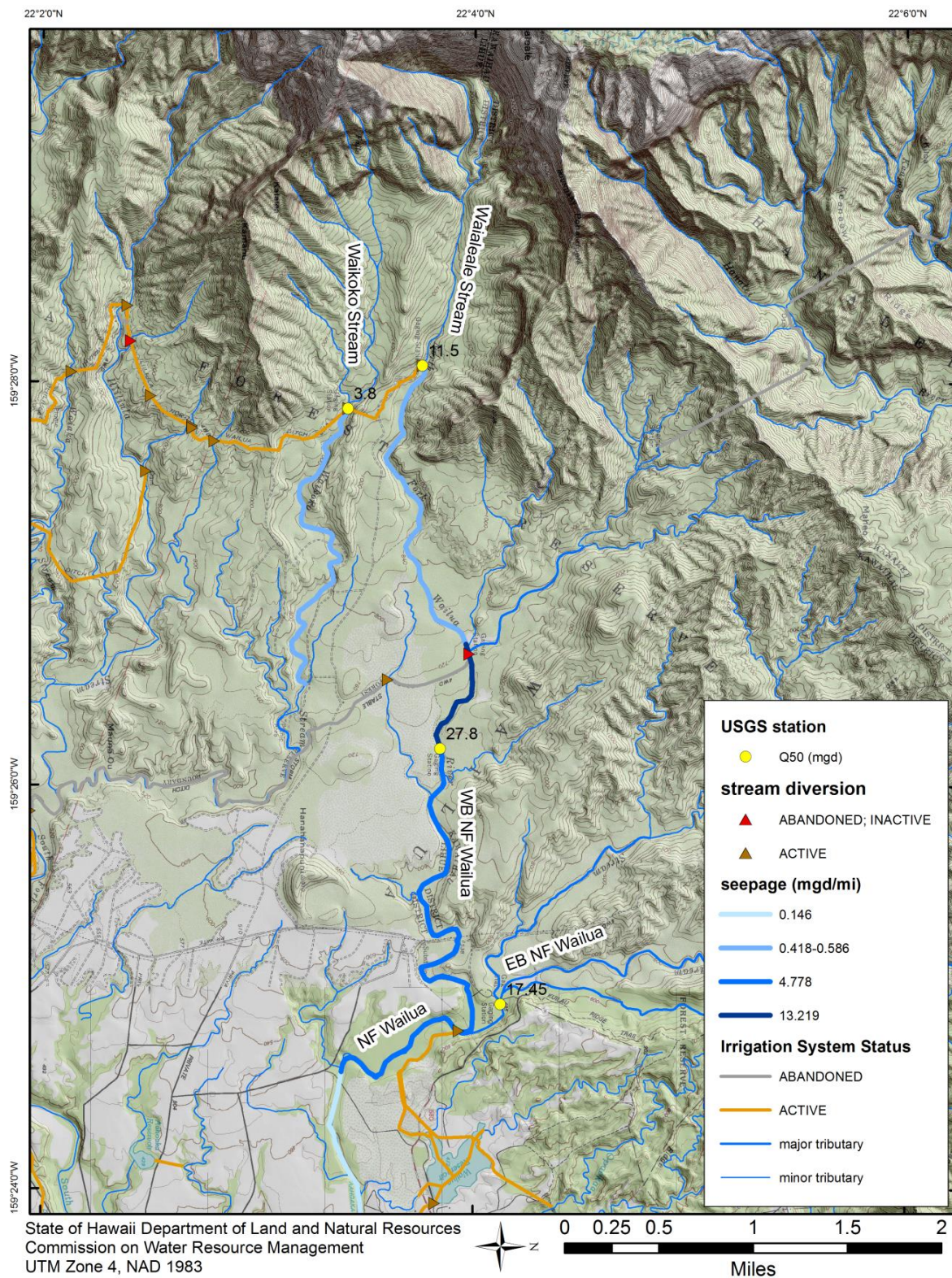
information compiled in the report. Likewise, the schematic diagram is a simplified representation of the streams and irrigation systems and is not intended to substitute for the information compiled in the report.

In developing the interim IFS recommendations, staff has attempted to remain consistent in weighing all of the instream and noninstream uses of each stream based upon the best available information presented in the IFSAR, along with the oral and written comments received through the public review process. Needless to say, this process has proved challenging due to the unique nature of each stream, whether in attempting to compare stream characteristics across multiple hydrologic units or within Wailua itself. Further, the substantial groundwater gains and large area encompassed by the watershed impacts the perceptions of reduced flow on downstream users.

The first step in developing the IFS is assessing the specific hydrologic characteristics of the hydrologic unit. Streams are largely characterized by the different geologic components that affect flow regimes, particularly the groundwater contribution to streamflow. The amount of water flowing in a given stream is also affected by regional climate variations (e.g., rainfall, fog drip, solar radiation) and the topography defining the catchment area. The quantity and quality of data available that is reflective of these geologic and hydrologic characteristics varies considerably from stream to stream. For streams with available measured data, the process for developing an interim IFS may be greatly different from that of streams with limited hydrologic data.

The next step is to weigh often competing instream and noninstream uses of water against the amount of water available to accommodate the needs of these uses. Again, the quantity and quality of information varies from stream to stream. This step is further complicated by the tremendous variability of instream and noninstream uses across and within surface water hydrologic units. For example, one stream may support extensive taro cultivation while another may primarily support domestic uses. The potential of the stream and hydrologic unit to support additional water use in the future has also been considered. The public trust purposes of water: (1) water in its natural state; (2) water for traditional and customary practices; (3) water for domestic uses; (4) water for the Department of Hawaiian Home Lands, must be protected whenever feasible. There are no absolute priorities amongst the public trust purposes. In considering noninstream uses, the Commission must weigh competing public and private water uses on a case-by-case basis. In allowing for noninstream uses, the “object is not maximum consumptive use, but rather the most equitable, reasonable, and beneficial allocation of state water resources, with full recognition that resource protection also constitutes ‘use’.” *In re Waiola O Molokai*, 103 Hawai‘i 401, 430, 83 P.3d 664, 693 (2004). The process requires weighing the present or potential instream and noninstream uses based upon best available information.

Figure 4. Estimated median streamflow (million gallons per day) and streamflow gains (million gallons per day per mile) for Waikoko and Waialeale streams and the West Branch of the North Fork Wailua River.



Specific Hydrologic Considerations: The hydrologic characteristics of a stream are critical to determining the interim IFS recommendation. These characteristics indicate the effects of geology and soils on the flow of water in the stream. Of great importance is the concept of a gaining and losing stream reach. A gaining reach is typically interpreted as where the streambed intersects the underlying water table and groundwater contributes to streamflow as seepage or springs. In East Kaua‘i, streams are generally gaining from their headwater reaches at high elevations all the way to the lower elevation reaches. The considerable groundwater gains from springs is due to the infiltration of rainfall on ridges radiating from Mt. Wai‘ale‘ale as well as water that percolates from the high elevation Alaka‘i Marsh. In such a situation, even when a diversion withdraws 100% of stream water, inflow from springs downstream continue to provide surface flow. For example, even when the Bluehole Intake on Wai‘ale‘ale Stream removed 100% of the stream’s flow, there was a 2.28 cubic feet per second (1.47 million gallons per day) gain in streamflow 1.1 miles downstream on May 4, 2017 (Figure 4).

Without long-term continuous monitoring of streamflow, other methods must be employed to estimate the natural availability of surface water at these locations. Natural flow duration discharge characteristics were estimated using a variety of data sources, including partial-record gaging stations with an index station on the East Branch North Fork Wailua River (USGS 16068000), drainage basin characteristics relative to a long-term continuous record of stream flow, and ditch gaging records. Continuous ditch flows were available at the Bluehole Intake (USGS 16061000) on Wai‘ale‘ale Stream and on the ‘Ili‘ili‘ula-North Wailua Ditch below the Waikoko Stream intake (USGS 16061200), with many years of overlapping records (see Table 2). Using continuous-record gaging station data that represents historic (pre-1984) and current (1984-2013) climate periods, adjustments can be made to estimated surface flow available at the Bluehole Intake on Wai‘ale‘ale Stream (Figure 3). Using these data and adjusting for changes in rainfall over time as represented by an index station (USGS 16068000), estimates of low-flow statistics can be made (Table 5).

Table 5. Estimated natural low-flow exceedance values for two streams above the diversion on the ‘Ili‘ili‘ula-North Wailua Ditch in the Wailua Hydrologic Unit using record augmentation with ditch flow monitoring data converted to the current (1984-2013) climate period with USGS 1606800 as an Index Station. [cubic feet per second (million gallons per day)]

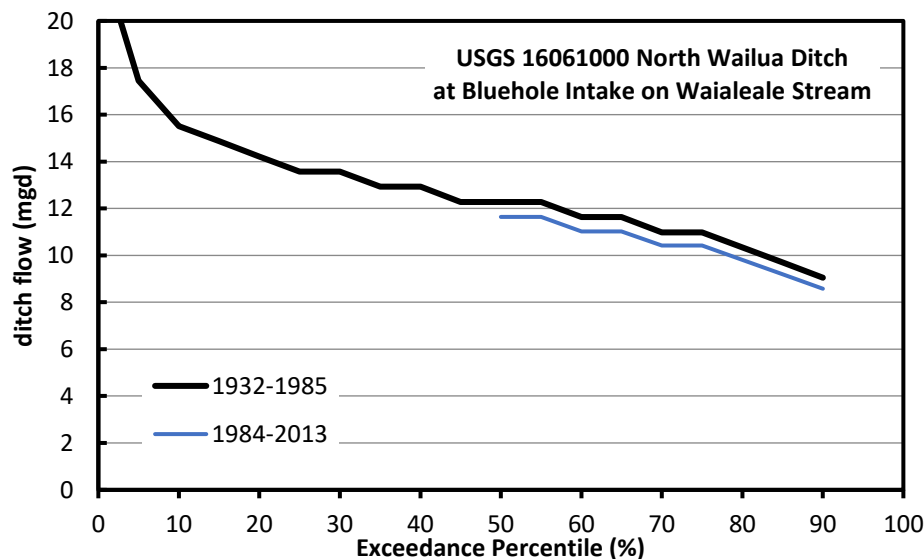
Stream	Estimated natural-flow Q ₅₀	Estimated natural-flow Q ₆₀	Estimated natural-flow Q ₇₀	Estimated natural-flow Q ₈₀	Estimated natural-flow Q ₉₀
Wai‘ale‘ale	17.7 (11.5)	17.2 (11.4)	16.2 (10.5)	15.2 (9.8)	13.1 (8.5)
Waikoko	3.9 (2.5)	2.9 (1.9)	1.9 (1.3)	1.9 (1.3)	1.63 (1.0)

The Wai‘ale‘ale Stream would naturally contribute approximately 41% of the median (Q₅₀) flow (43.0 cubic feet per second; 27.8 million gallons per day) to the West Branch of the North Fork Wailua as measured at USGS 16063000 at an elevation of 640 ft. Further, this represents only 46% of the total flow at the confluence of the East and West Branches of the North Fork Wailua River. The groundwater gains and estimated median streamflow for Wai‘ale‘ale and Waikoko streams are identified in Figure 4. As groundwater contributes substantially to surface flow in these streams below the diversions, the restoration of stream flow will have a negligible effect on groundwater recharge.

Other methods may be employed to establish the availability of water at these diversions using basin characteristics and modeling with index stations, point measurements at partial-record gaging stations and record augmentation, or rainfall-runoff modeling. Using the mean baseflow index and watershed characteristics of nearby stations, the median baseflow (BFQ₅₀) for Wai‘ale‘ale Stream was estimated as 5.64 million gallons per day.

In previous USGS studies on Maui, the flow that supports full or nearly full habitat restoration has been estimated as: (1) the Q₇₀ flow, the magnitude of total flow that occurs at least 70-percent of the time (Oki et al. 2010, USGS SIR 2010-5011); (2) 80-percent of the natural median flow (Gingerich and Wolff 2005, USGS SIR 2005-5213); or (3) a flow equal to 64% of median baseflow (Gingerich 2014, East Maui Contested Case Hearing). However, the applicability of habitat models developed on Maui to streams on Kaua‘i is unknown. If we assume that the flow that supports 90% of the available habitat (H₉₀) is also 64% of BFQ₅₀, this equates to 3.60 million gallons per day in Wai‘ale‘ale Stream at the Bluehole Intake. Long-term declines in rainfall on Mt. Wai‘ale‘ale and throughout the State of Hawai‘i have affected both groundwater recharge and the contribution of groundwater to streamflow (Oki 2004), resulting in declines in surface flow.

Figure 3. Estimated flow exceedance values of Wai‘ale‘ale Stream at the Bluehole Intake based on USGS ditch gaging records for the period of record (1932-1985) and corrected to the current climate period (1984-2013) based on declines in streamflow calculated using USGS 16068000 EB NF Wailua River records (1932-2013).



Another factor in the selection of interim IFS sites, though not necessarily hydrologic in nature, is the accessibility of each proposed site for monitoring and regulation by Commission staff. For Wailua, major diversions are usually situated in high elevations and monitoring stations are challenging to install and maintain. An interim IFS on Wai‘ale‘ale Stream can be monitored about 1000 ft. below the Bluehole Intake, although seepage gains between these points results in approximately 0.45 million gallons per day of streamflow, even when there is no flow past the diversion. Measurements made at this location are provided in Table 6.

Instream Use Considerations: Cultural practitioners regard the Wai‘ale‘ale region as sacred for gathering, ceremonial and religious rites. The maintenance of instream flows is important for the protection of traditional and customary practices, as they support stream (e.g., hihiwai, ‘ōpae, ‘o‘opu) and riparian (vegetation) resources for gathering. Pre-contact Hawaiian communities cultivated taro intensively throughout the lower reaches of the Wailua Ahupua‘a. The large tracks of protected mauka lands were kept as Crown Land during the Great Mahele (in 1848) or as private lands of Kamehameha III (Kauikeaouli) and no Land Court Awards (LCA) were given in the vicinity of the affected reaches. A total of 25 LCAs were awarded for approximately 75 acres in Wailua, all in the lowest reaches of the watershed in what is now the Wailua State Park. Present day, most of Wailua is owned and managed by either Grove Farm (private) or the State of Hawai‘i as Forest Reserve or State Parks (zoned conservation). Of the estimated 5.1 square miles of pre-contact irrigated wetland agriculture, approximately 4.0 square miles (78 percent) existed on land currently owned by the State of Hawai‘i. No written or oral testimonies received indicated that a lack of streamflow limited taro production.

Table 6. Stage and flow measurement at CWRM gaging station 2-191 on the North Fork Wailua River below the Bluehole Intake. [cubic feet per second (million gallons per day)]

Date	Time	Stage (ft.)	Flow
1/18/2018	10:15	2.38	6.74 (4.36)
1/22/2018	15:41	2.20	4.06 (2.26)
2/13/2018	9:40	1.82	0.73 (0.47)
3/13/2018	8:16	3.17	59.38 (38.38)
3/13/2018	14:20	3.47	91.69 (59.26)
6/15/2018	10:10	3.02	29.04 (18.77)
7/13/2018	12:53	2.32	4.85 (3.14)

While the traditional Hawaiian ahupua‘a concept is based on the premise of mauka-to-makai flow, it is difficult to fully represent the importance of surface water from Wai‘ale‘ale Stream to Kaua‘i and Hawaiian culture. The region is highlighted in Hawaiian chants and in the Kumulipo, the Hawaiian creation story. The image of freshwater flowing mauka to makai is fundamental to both the physical and spiritual force which drives Hawaiian cultural practices. As such, the great historical and cultural importance of water from Mt. Wai‘ale‘ale contributing to surface flow in Wailua cannot be understated.

Recreation within streams and the aesthetic value of flowing water (e.g., contrasting to a dry streambed) are also important. The local community values the use of these streams for swimming, hiking, fishing, and hunting activities. Surface water quality, especially at the mouth of the river, is of great concern to community members. However, this is greatly influenced by runoff events transporting fecal bacteria from mammals and subsurface flows transporting cesspool effluent into the stream. As such, restoration of low flows in the headwaters will have little impact to water quality at the river mouth.

The streams in Wailua are currently dominated by a variety of non-native aquatic species that were purposefully introduced for recreational fishing and consumption. Species such as the smallmouth (*Micropterus dolomieu*) and largemouth (*Micropterus salmoides*) bass, tilapia (*Oreochromis* spp.) and Tahitian prawn (*Macrobrachium lar*) are commonly found throughout,

preying upon native ‘o‘opu and ‘ōpae species. Native ‘o‘opu species (e.g., *Awaous stamineus*, *Eleotris sandwicensis*, *Sicyopterus stimpsoni*) are only found in the lowest reaches and do not survive in the middle and uppermost reaches due to predation. While the maintenance and restoration of stream habitat improves with increased streamflow, the presence of non-native species that dominate these streams limits the improvement in habitat available to native species. Other instream uses that must be considered include maintenance of water quality (e.g., temperature, dissolved oxygen, turbidity), instream hydropower, and ecosystem services (e.g., supporting riparian species of value, streambank stability, biogeochemical cycling, groundwater recharge, impacts to estuaries).

There are currently no domestic uses of water within the Forest Reserve or downstream of the reserve. Other considerations include critical habitat for the endangered Newcomb’s Snail (*Erinna newcombi*) which includes springs adjacent to the stream upstream of the Bluehole Intake. The original extent of critical habitat was determined based on reports provided by scientists with the University of Hawai‘i to the U.S. Fish and Wildlife Service (USFWS). Recent surveys by USFWS found no evidence that this species exists either upstream or downstream of the diversion structure and further, restoration of flows will not impact springs which feed the stream and originate as high elevation rainfall (USFWS memo dated 12 March 2018). However, the current absence of the species in these areas does not diminish the conservation value of restored flow.

Noninstream Use Considerations: The diversions on Wai‘ale‘ale Stream and Waikoko Stream are part of the ‘Ili‘ili‘ula-North Wailua Ditch that eventually supplies water to the penstock of the Upper Waiahi Hydropower plant (Figure 5). While the current use of this ditch by KIUC is the generation of hydropower, these diversions were originally built by Līhu‘e Plantation as part of an integrated system to move water around the Līhu‘e Basin for the production of both hydropower and to irrigate sugarcane and other crops. KIUC does not control the use of the water once it leaves the tailrace of the Lower Waiahi Hydropower plant. Recent monitoring of the hydropower tailrace provides the average flow of water through the Upper (19.3 million gallons per day) and Lower (25.7 million gallons per day) Waiahi Hydropower plants when they are operational. From 2014-2016, the combined energy produced from the two Waiahi hydropower plants equates to the annual power consumed by approximately 1,250 homes.

There are two factors that determine the economic impact of the Waiahi hydropower plants: (1) the production cost of using an alternative source of energy for KIUC customers; and (2) the fuel saved by not using diesel generators. The combined average annual energy output of the Upper and Lower Waiahi hydropower plants is 8,760 megawatt hours. The fixed cost to maintain the plants is \$240,000 per year plus administration/unplanned costs which equates to \$400,000 per year (~\$50 per megawatt hour). If the KIUC fuel contract is for ~\$70 per barrel this equates to \$18.62 per million British Thermal Units (mmbtu) for diesel fuel. The most efficient diesel generator produces 9.6 mmbtu per megawatt hour, equating to \$179 per megawatt hour. Thus, these two hydropower plants combined produce a savings of \$129 per megawatt hour or approximately \$1,130,000 per year for KIUC customers. By using hydropower, KIUC avoids purchasing 674,000 gallons of fuel per year. This savings is passed on, indirectly, to KIUC’s customers.

The partial list below summarizes some of the economic and environmental impacts of limiting water availability to KIUC:

- \$1,130,000 cost savings compared to diesel fuel
- The greenhouse gas emissions equivalent of 8,760 megawatt hours generated per year by diesel fuel generators burning 674,000 gallons (16,050 barrels) of diesel: 6,901 metric tons CO₂ equivalent per year

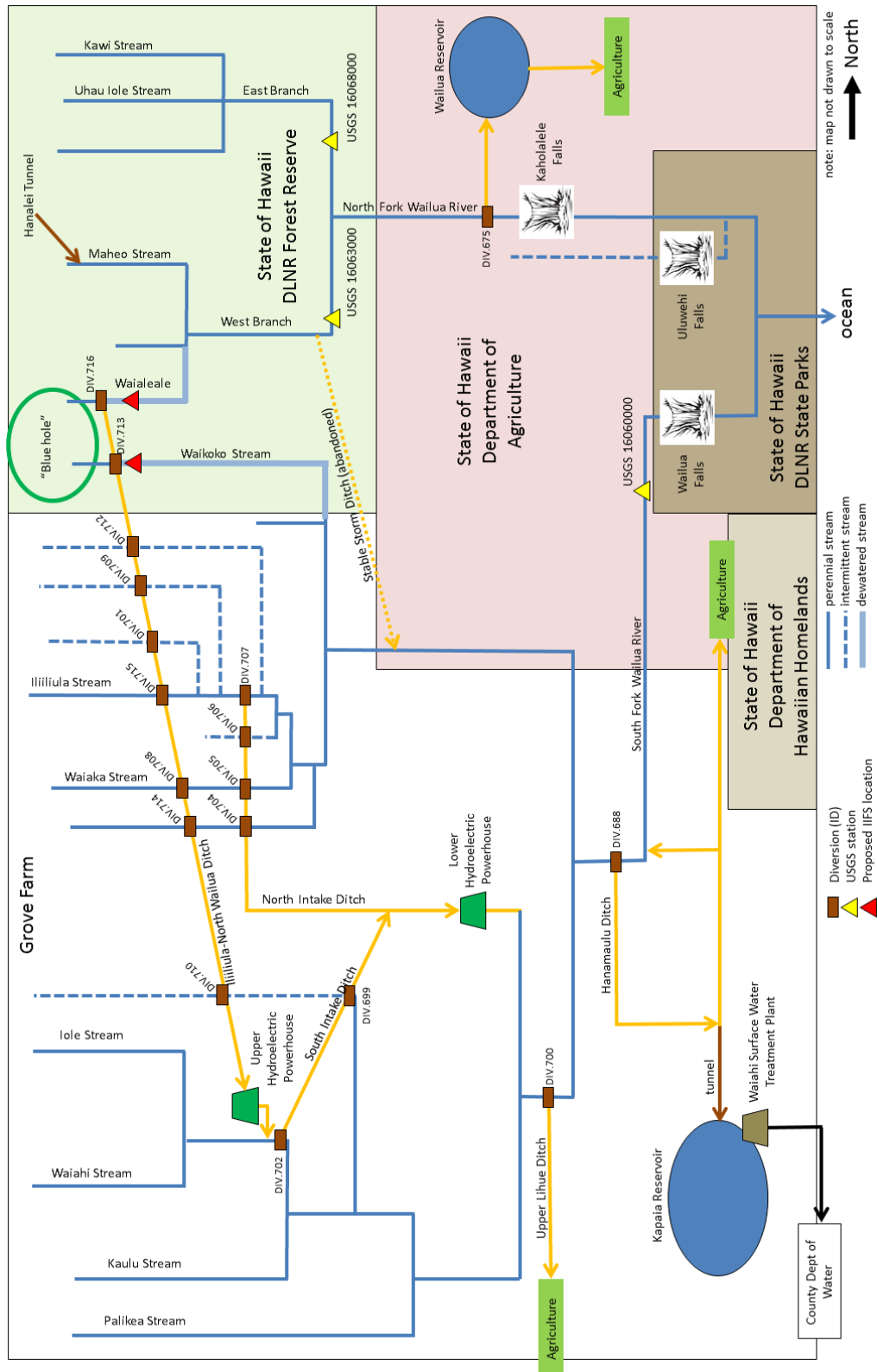
Impact to Hawaiian Home Lands

The Department of Hawaiian Home Lands (DHHL) Wailua land holdings exist south of Wailua River, east of Kālepa Ridge. The DHHL has a tentative reservation of 7.564 million gallons per day of non-potable water in Wailua, of which there is a projected demand of 0.337 million gallons per day by 2031. Currently, non-potable water supply can only reach DHHL parcels via the Hanamā‘ulu Ditch on the South Fork Wailua River (REG.681) through Reservoir 21 (Figure 5). To meet the DHHL needs for these lands, infrastructure must be upgraded to connect Reservoir 21 to DHHL via an existing tunnel through Kālepa Ridge. This system does not draw water from the North Fork Wailua River. To the extent that flow restoration on Wai‘ale‘ale Stream will decrease the movement of water from the North Fork Wailua to the South Fork Wailua, this will impact the availability of water diverted by the Hanamā‘ulu Ditch. However, this represents less than 10% of the current average flow at diversion 681 and less than 4% of the total water available. Water availability for DHHL land will be addressed by an interim IFS on the South Fork Wailua River and will not be greatly affected by a decision regarding an interim IFS for Wai‘ale‘ale or Waikoko streams.

Impact to Municipal Water Supply

The Waiahi Surface Water Treatment Facility (SWTF) provides 3.6 cubic feet per second (2.3 million gallons per day) of potable water to the Līhu‘e-Hanamā‘ulu Water District (or approximately 50% of the total average daily water needs for the water district). This water originates in Waiahi Stream on the South Fork Wailua River and is diverted by the Hanamā‘ulu Ditch at diversion 681 and then to Kapaia Reservoir (Figure 5). As with DHHL, to the extent that flow restoration on Wai‘ale‘ale Stream will decrease the movement of water from the North Fork Wailua to the South Fork Wailua, this will impact the availability of water diverted by the Hanamā‘ulu Ditch. However, water availability to the Waiahi SWTF will be addressed by an interim IFS on the South Fork Wailua River and will not be greatly affected by a decision regarding an interim IFS for Wai‘ale‘ale or Waikoko streams.

Figure 5. Simplified schematic diagram of registered surface water diversions, hydropower plants, major off-stream water uses, and proposed interim IFS locations overlaying land ownership in the Wailua Hydrologic Unit, Kaua'i.



Assessment Summary of Instream Uses: Wai‘ale‘ale and Waikoko streams

Hydrology. Based on the available information and field investigations, Wai‘ale‘ale and Waikoko streams naturally flow mauka to makai 100-percent of the time. At the ‘Ili‘ili‘ula-North Wailua Ditch, median flow in Wai‘ale‘ale Stream is estimated as 17.7 cubic feet per second (11.5 million gallons per day) and in Waikoko Stream as 3.9 cubic feet per second (2.5 million gallons per day). During the plantation era, 100% of baseflows were diverted by the Bluehole Intake on Wai‘ale‘ale Stream as well as the intake on Waikoko Stream. Damage to the dam structure on Wai‘ale‘ale Stream in the fall of 2016 has resulted in some restored flow returning below the Bluehole Intake and there is leakage of water past the Waikoko Stream diversion. Current (2016-present) operation of these diversions has permitted continual flow downstream of the diversions and numerous springs continue to contribute to surface flow. Stream restoration will slightly increase the flow of water in the North Fork Wailua at the mouth and slightly decrease the flow of water in the South Fork Wailua at the mouth, but will have no impact on groundwater recharge, as the groundwater supports gaining stream reaches throughout the watershed.

Maintenance of Fish and Wildlife Habitat. Wai‘ale‘ale and Waikoko streams would naturally provide mauka to makai streamflow year-round and as such, could provide substantial habitat for freshwater fauna. It is likely that native species, including ‘o‘opu nōpili (*Sicyopterus stimpsoni*), ‘o‘opu alamo‘o (*Lentipes concolor*), ‘o‘opu nākea (*Awaous stamineus*), and ‘ōpae kala‘ole (*Atyoida bisulcata*) once inhabited these stream reaches. However, previous surveys by the Division of Aquatic Resources (DAR), US Fish and Wildlife Service, and private consultants, have found few to zero native species in the Wai‘ale‘ale and Waikoko streams. The long-term diversion of water from these streams and the introduction of non-native species have had a strong negative impact on the community of native species. Further, despite the restoration of some flows to Wai‘ale‘ale Stream for 1.5 years, no native species have returned to the reach below the diversion. The presence of large populations of non-native species, especially smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), tilapia (*Oreochromis spp.*), and Tahitian prawn (*Macrobrachium lar*) throughout the Wailua watershed limits the recolonization of these reaches by native species. Because of these non-native species, restoration of streamflow will have little impact on native stream fauna.

Outdoor Recreational Activities. Wai‘ale‘ale and Waikoko streams provide local residents and tourists with recreational opportunities along their upper reaches. Swimming is common in the stream above the diversion due to the pools created by the dams. The streams are also utilized by hunters when they camp nearby. Often inspired by social media, many people hike along the streams and banks, despite the lack of formal trails. Fishing for smallmouth bass is common in the middle and lower reaches. Restoration of streamflow may increase the abundance of bass desired for recreational fishing, but is likely to have little impact on the recreational activities of the watershed.

Maintenance of Ecosystems. The riparian zone is dominated by non-native vegetation throughout the watershed. Surface flow provides habitat for native damselfly species and may connect populations of the endangered Newcomb’s snail (*Erinna newcombi*), which inhabits

springs along the stream channel. Restoration will improve stream ecosystem function, but will have little impact on nearshore ecosystems.

Aesthetic. Wai‘ale‘ale Stream is particularly important for its aesthetic value as it originates in the Bluehole region of Mt. Wai‘ale‘ale, which has aesthetic value to hikers and cultural practitioners. Restoration will support continual mauka to makai flow that improves the aesthetic value of the stream.

Maintenance of Water Quality. Wai‘ale‘ale and Waikoko streams are classified by the Department of Health as Class 1b inland waters in the upper elevations and Class 2 inland waters in the lower elevations. They do not appear on the 2014 List of Impaired Waters in Hawai‘i, Clean Water Act §303(d), although there was insufficient data to support any conclusions. Restoration of flow will have a small effect on stream temperature below the diversion, but will have little to no effect on water quality at the mouth of the river, which is driven by the abundance of cesspools and non-native mammals in the watershed.

Conveyance of Irrigation and Domestic Water Supplies. Wai‘ale‘ale and Waikoko streams are not used for the conveyance of irrigation or domestic water supplies.

Protection of Traditional and Customary Hawaiian Rights. Historically, only the lower one-third of the ahupua‘a was occupied by home sites, as the mauka most land was designated as Crown Lands which prevented the development of taro lo‘i along Wai‘ale‘ale and Waikoko streams. Due to the substantial gains in streamflow from groundwater inflows, reduced flows below the diversions in Wai‘ale‘ale and Waikoko streams do not currently affect taro cultivation. However, traditional gathering of plants, fungi, and aquatic fauna in Wailua is common, and stream restoration will benefit this. The region has tremendous historic and cultural importance and features prominently in Hawaiian spiritual practices. The waters carry the literal and spiritual nourishment from the mountain to the ocean that Hawaiian communities have relied upon for generations. As such, the physical presence of stream diversions has a negative effect on these practices and restoration of mauka to makai streamflow is critical to protecting Hawaiian culture.

Noninstream Uses. The diversions on Wai‘ale‘ale Stream (REG.716) and Waikoko Stream (REG.713) are part of the ‘Ili‘ili‘ula-North Wailua Ditch. The water is taken from the stream channel and combined with other surface water sources to generate hydropower by KIUC. The water is then returned to the Waiahi Stream, a tributary of the South Fork Wailua River. The KIUC is a not-for-profit utility that functions for the benefit of all Kaua‘i Island rate payers. Thus the entire Kaua‘i Island community connected to the electrical grid benefits from this use. The Wai‘ale‘ale and Waikoko diversions contribute about 50%, and 17% of the total flow in the ‘Ili‘ili‘ula-North Wailua Ditch, respectively. Each million gallons per day of flow returned to streams is estimated to reduce the total hydropower output by 4-5% during low flow periods.

ENVIRONMENTAL REVIEW CHAPTER 343, HAWAII REVISED STATUTES

Hawaii Revised Statutes, Chapter 343 is inapplicable because the amendment of an interim IFS is not an “action” and, alternatively, does not constitute a trigger under HRS § 343-5(a).

RECOMMENDATION:

WAI‘ALE‘ALE STREAM RECOMMENDATION:

Water from Wai‘ale‘ale Stream is diverted at an elevation of 1,100 ft. by Kaua‘i Island Utility Cooperative in order to operate a hydropower plant. Due to numerous springs along the banks and groundwater gains within the stream channel, the stream gains approximately 2.28 cubic feet per second (1.47 million gallons per day) between the diversion and the confluence with the next stream at an elevation of approximately 700 ft. The stream could support native aquatic species if it wasn’t invaded by non-native species (e.g., smallmouth bass, largemouth bass, Tahitian prawn), which both compete for resources and prey upon native species recruiting to the stream. Despite existing operations providing mauka to makai stream flow, there is no legal protection for this flow and historically (status quo at the time of registration), the dam diverted 100% of low flows (approximately median flow and below). In order to balance instream and noninstream uses of the Wai‘ale‘ale Stream, restored flow should result in suitable aesthetic value, should not inhibit traditional gathering practices, and adequately maintain mauka to makai connectivity for traditional and customary practices. While it is difficult to quantify the impact a lack of streamflow may have on such practices, at minimum, mauka to makai flow is necessary to support these practices.

A connectivity flow could be established at an estimated flow of 1.5 cubic feet per second (1.0 million gallons per day), which would have a negligible (~5%) negative impact on hydropower production, but provides mauka to makai connectivity. However, given the substantial historical and cultural importance of Mt. Wai‘ale‘ale, Wailua watershed, and Wai‘ale‘ale Stream, in particular, staff believes that this level of restoration may not be adequate to meet the needs of cultural practitioners.

Alternatively, the restoration of 5.4 cubic feet per second (3.5 million gallons per day) will substantially improve the protection of instream uses. This will have a negative impact (~16% reduction annually) on hydropower production, especially during low flow periods. Such a restoration would protect the traditional and customary practices that rely on the life-giving mauka to makai flows envisioned in Hawaiian chants and reestablish the aesthetic value of the stream. Utilization of the waters from Mt. Wai‘ale‘ale must be done with deference to these practices while recognizing the important value Hawaiian culture places on this region. This flow restoration will provide for ecosystem services such as expanding the availability of habitat for native damselfly species and the endangered Newcomb’s snail while increasing the availability of habitat for native aquatic species, if their predators are removed. Further, the recreational value of the stream in the affected reach will be maintained if these flows are restored. By contrast, if the natural flow in the stream (complete removal of the diversion) is re-established, there would be a large negative impact (~50% reduction) on hydropower production during all but high flow periods, likely resulting in the closure of the hydropower plants.

Therefore, staff recommends that one measurable interim IFS be established for Wai‘ale‘ale Stream:

- Proposed Interim IFS: Near an altitude of 1,050 feet, below the ‘Ili‘ili‘ula-North Wailua Ditch, the interim IFS shall be established at an estimated flow of 6.2 cubic feet per second (4.0 million gallons per day). This value represents 5.4 cubic feet per second (3.5 million gallons per day) of restoration at the diversion and plus the approximately 0.8 cubic feet per second (0.5 million gallons per day) in seepage gain. Due to the uncertainty surrounding this value, the interim IFS may be revised by a future Commission action as more data are gathered.
- The Commission makes all findings of fact in the submittal in support of this recommendation.

In addition to the General Recommendations listed below, staff recommends approval of the following adaptive management strategies for Wai‘ale‘ale Stream:

- Follow-up surveys of instream biota by the Division of Aquatic Resources to determine the impact restored flows have on the population of native and non-native species above and below the diversion.
- Follow-up surveys of cultural practitioners to determine the impact restored flow have on traditional and cultural practices.

WAIKOKO STREAM RECOMMENDATION:

Staff recommends that one measurable interim IFS be established for Waikoko Stream:

- Proposed Interim IFS: Near an altitude of 1,075 feet on Waikoko Stream, below the ‘Ili‘ili‘ula-North Wailua Ditch, the interim IFS shall be 1.3 cubic feet per second (0.8 million gallons per day). This value represents 33% of the currently estimated total median flow (Q_{50}) of 2.5 mgd above the diversion. Due to the uncertainty surrounding this value, the interim IFS may be revised by a future Commission action as more data are gathered.
- This decision is based on the above submittal which shall constitute the Commission’s findings of fact in support of this decision.

In addition to the General Recommendations listed below, staff recommends approval of the following adaptive management strategies for Waikoko Stream:

- Follow-up surveys of instream biota by the Division of Aquatic Resources to determine the impact restored flows have on the population of native and non-native species above and below the diversion.

GENERAL RECOMMENDATIONS:

Staff recommends approval of the following adaptive management strategies for the hydrologic unit being considered:

IMPLEMENTATION

- KIUC shall be responsible to improve the efficiencies of the transport of water in the ‘Ili‘ili‘ula-North Wailua Ditch by limiting leakage at adits, from the siphon, and from

unlined portions of the ditch, minimizing off stream water losses and impacts to the natural stream resources.

- Within one year, if they receive a long-term water lease from the Board of Land and Natural Resources, KIUC will redesign the diversion intakes to provide a continuous wetted path over the diversion, eliminate overhanging structures, and improve the safety and aesthetic look of the diversion.
- Staff shall continue to coordinate with KIUC to enforce the provisions of the State Water Code.
- Staff shall continue to coordinate with KIUC to identify and determine appropriate actions with regard to attaining the proposed interim IFS values downstream of existing diversion structures.
- Staff shall continue to assess existing conditions and the status of all diversions, in coordination with the Division of Aquatic Resources other state or federal agencies to determine if any modifications are possible to improve habitat conditions for stream biota.

MONITORING

- Staff shall maintain a continuous gaging station on Wai‘ale‘ale Stream to monitor compliance with the interim IFS and make periodic measurements on Waikoko Stream to assess the attainability of the interim IFS.
- KIUC will maintain continuous monitoring stations on the ‘Ili‘ili‘ula-North Wailua Ditch at the former USGS gaging stations at the Wai‘ale‘ale Stream diversion and Waikoko Stream diversion as well as tailrace monitoring for each of the hydropower plants.

EVALUATION

- Within three years from the date of adoption of an interim IFS, staff shall report to the Commission on the progress of implementing the interim IFS and the application of the adaptive management strategies outlined above, and the impacts of the interim IFS upon instream and noninstream uses.
- Within one year, KIUC shall report to the Commission on the status and implementation of their diversion modifications and provide data on the volume of water delivered by each diversion and total water diverted by the ‘Ili‘ili‘ula-North Wailua Ditch.

Respectfully submitted,




JEFFREY T. PEARSON, P.E.
Deputy Director


Note: Exhibits 1 and 2 are available from the Commission website at http://dlnr.hawaii.gov/cwrm/surfacewater/ifs/wailua_ifs/.

- Exhibit 1 DRAFT Instream Flow Standard Assessment Report for Wailua Unit 6040,
PR-2018-06
- Exhibit 2 Compilation of Public Review Comments for Wailua Unit 6040, PR-2018-07
- Exhibit 3 U.S. Fish and Wildlife Service Memo dated March 12, 2018

APPROVED FOR SUBMITTAL:



SUZANNE D. CASE
Chairperson

MEMO Department of the Interior U.S. Fish and Wildlife Service Pacific Islands Fish and Wildlife Office		
ROUTING		DATE: 3-12-18
1. Greg Koob - Conservation and Restoration Program Manager 2. Michelle Clark - PIFWO Kauai Island Team Biologist 3. File		SUBJECT: Trip Report - Makaleha Stream, Makaleha Springs, and North Fork Wailua Stream, Kauai
FROM: Gordon Smith	FWS-PIFWO, Honolulu	(808) 792-9457

Makaleha Stream at the site of Makaleha Spring and the North Fork Wailua River in the vicinity of the `Ili`iliula ditch diversions (the “Blue Hole diversion”) were surveyed for the presence of *Errina newcombi* (Newcomb’s snail) on March 6 and 7, 2018. Weather and hydrologic patterns were typical of winter/spring conditions with intermittent showers and episodic high flows in the weeks prior to field visits (Figure 1).

The purpose of the survey was as follows:

1. Makaleha Stream and Spring - this is location is described in previous FWS reports as a known location with an extant population of Newcomb’s snail. The most recent FWS survey was in 2003 and field notes indicate that “few” snails were observed. The intent of the survey was to relocate the population and if possible obtain digital photographs of snails in-situ, as well as photomicrographs of egg masses which apparently have not been previously documented.
2. North Fork Wailua River, `Ili`iliula ditch diversion - Mike Kido of the Hawaii Stream Research Center reported snails at an unspecified location upstream of this diversion in 1995. Based on that report, critical habitat for Newcomb’s snail was designated immediately upstream of the diversion and extends to the headwaters of the stream. Snails have not been observed at this location in subsequent surveys despite several visits to the area by FWS biologists and others. The intent of the survey was to thoroughly examine the stream channel and adjacent tributaries to confirm the presence of snails in this reach of the N. Fork Wailua River.

Results and observations:

1. Makaleha Springs consists of several large springs that originate from a boulder-and-bedrock-covered hillside that is heavily vegetated. All of the tributary spring channels were searched for snails for approximately two hours. Only two juvenile-sized individuals were found. The snails were located within a crevice and could not be successfully photographed. Three Hester-Dendy artificial substrate plates were installed in the vicinity of the snails (Figure 2). If snails move onto the artificial substrate plates they can be safely removed from the water to better observe and photograph snails and egg masses. A follow-up visit to the site in late April or early May is recommended.

2. The North Fork Wailua River was surveyed approximately 500m upstream and 500m downstream of the diversion over a four-hour timeperiod (Figure 3). In addition, all seven of the smaller valley wall tributaries encountered were thoroughly examined from 50m to 300m up-gradient from their confluence with the main channel. The survey effort extended from about 10am to 2pm with a short break for lunch. No snails were observed.

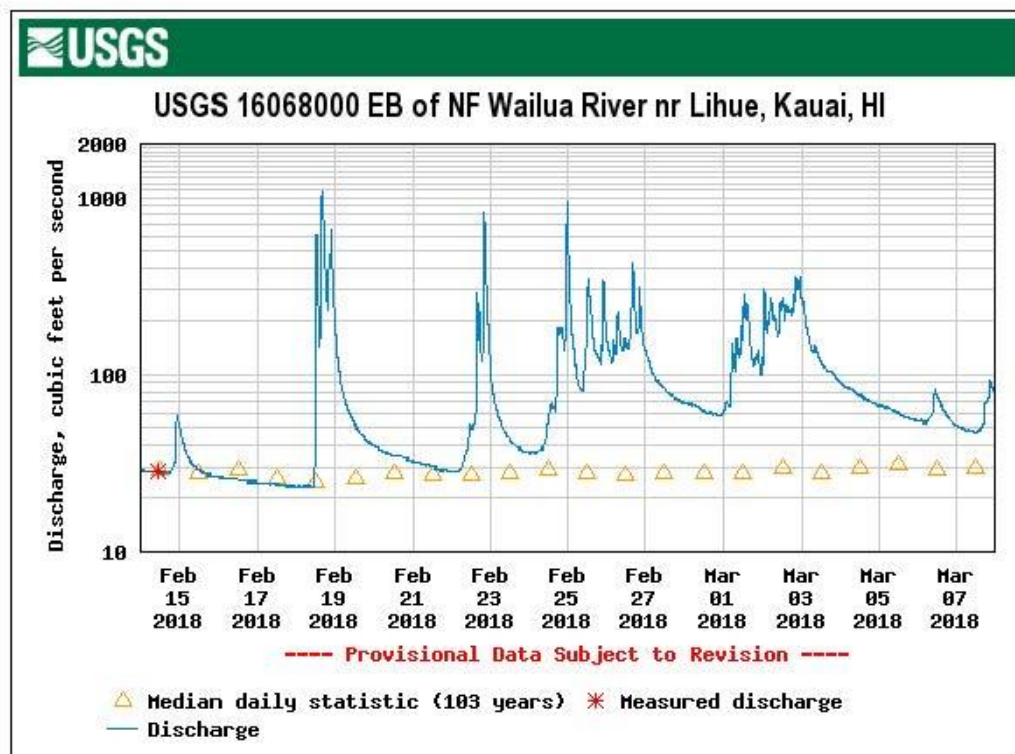


Figure 1. Daily discharge at the N. Fork Wailua River guage indicating episodic high flows in the two weeks prior to survey dates.

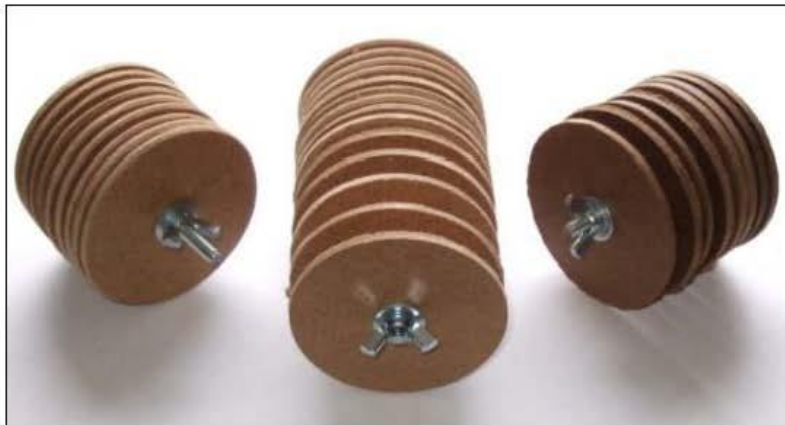


Figure 2. Hester-Dendy artificial substrate samplers

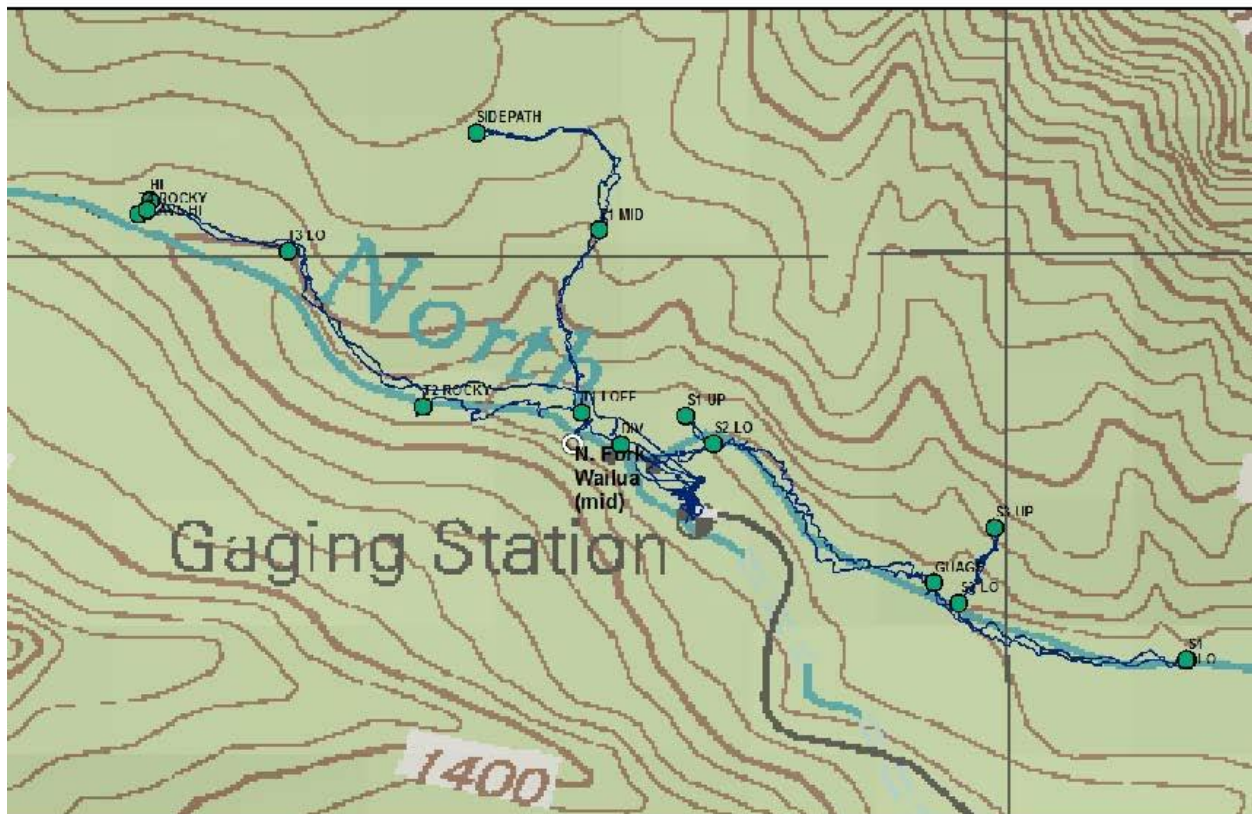


Figure 3. GPS tracklog and waypoints from Newcomb's snail survey in the vicinity of the "Blue Hole" diversion. Waypoints indicate small tributary streams entering main channel.