STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
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STAFF SUBMITTAL

COMMISSION ON WATER RESOURCE MANAGEMENT

April 20, 2021
Honolulu, Hawai‘i

Draft Amended Interim Instream Flow Standards For the Surface Water Hydrologic Unit of Wai‘oli (2018) Wai‘oli Stream, Halele‘a, North Kaua‘i

SUMMARY OF REQUEST:

No action. Staff is sharing information and draft recommendations for amending the interim instream flow standard (interim IFS) for one stream in the Wai‘oli surface water hydrologic unit in North Kaua‘i:

WAIOLI (2018): Wai‘oli 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 one stream in north Kaua‘i.

The current interim IFS for the stream being considered was established under Hawaii Administrative Rules (HAR) §13-169-45, which, in pertinent part, reads as follows:

> Interim instream flow standard for Kaua‘i. The Interim Instream Flow Standard for all streams on Kauai, 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 October 8, 1988. Following the initial registration of stream diversions works, any new or substantially modified stream diversion works structure requires a permit for construction and amendment to the interim IFS.

LEGAL AUTHORITY

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[1] ("*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, an analysis of the

[1] *In re Water Use Permit Applications*, 94 Hawai‘i 97, 9 P.3d 409 (2000).

instream uses protected by the State Water Code, the existing and planned non-instream reasonable and beneficial uses of surface water, and the availability of water from alternative sources.

The assessment of instream uses for the Waiʻoli hydrologic unit will address the interim IFS for Waiʻoli Stream (Figure 1).

HISTORICAL CONTEXT

Waiʻoli, which literally translates as "joyous waters," is an ahupuaʻa in the moku (district) of Haleleʻa in Northern Kauaʻi. It was also called "the birthplace of rainbows" and was one of the most agriculturally productive regions on Kauaʻi (Handy, 1991, p. 419).

The Waiʻoli Valley Taro Hui and their ancestors have been cultivating kalo in Waiʻoli Valley since time immemorial. As a part of the background information reviewed by the Board of Land and Natural Resources for the February 28, 2020 Amendment to the Grant of Term for a Non-Exclusive Easement, the research conducted by the Office of Hawaiian Affairs ("OHA") established that this loʻi kalo irrigation system has been in existence since before the arrival of Westerners in Hawaiʻi. Moʻolelo, geneaological scholarship, Māhele documentation, and Native Testimony in support of Land Commission Awards in particular, establishes loʻi use in Waiʻoli from the 1500s.[2]

While there is no written record of Waiʻoli prior to the advent and proliferation of writing in the Hawaiian Islands, moʻolelo (oral histories) as well as mele and oli (songs and chants) were documented and distributed in the mid-1830s via Hawaiian Language Newspapers (nūpepa) (Nogelmeier, 2003, 107). Around the same time, nūpepa, as well as reports and journals, began to record the great extent of kalo cultivation in Waiʻoli. Various crops of both native and foreign origin were grown to sustain the resident population and, at the height of the whaling industry and the American Board of Commissioners for Foreign Missions, the various ships and mission ports scattered around the islands (Ka Nupepa Kuokoa, 25 May 1865).

The 1990 Hawaiʻi Stream Assessment (HSA) identified Waiʻoli Stream as one of only six (6) throughout the state that historically supported more than fifty acres of kalo cultivation – the HSA's largest category. Further, the HSA classified Waiʻoli as a candidate stream for protection based on its outstanding diversity and blue ribbon recreation resources.

With the passage of the State Water Code, existing wells and stream diversions were registered with the Commission by May 31, 1989, with the instream flow standard adopted as status quo in 1988. While a number of registrations identified their end-use of the East Waiʻoli Ditch, and one

[2] Moʻolelo of Pīkoi and Lonoikamakahiki confirm that a Native population was living in the Waiʻoli area before the arrival of westerners in Hawaiʻi. *No Lonoikamakahiki*, Ke Auokoa, 19 January 1871. According to Abraham Fornander, Kākuhihewa, who was a main character in these moʻolelo, was born around 1540 and was the 15th Aliʻiʻaimoku of Oʻahu. Fornander 1880: 272-73. Esther Mookini puts Keawe's birth, another main character in these moʻolelo, some time in the 16th century. *Translation Makes Hawaiian Treasure Accessible*, Honolulu Advertiser & Star Bulletin, 20 January 1991.

user registered their use of West Waiʻoli Ditch in 1989, the only operator that was assigned to these diversions was KOBAYASHI H (Table 1).

Table 1. Diversion registrations associated with Waioli Stream, file reference name, registrant, declared primary use

Diversion name	ID	File reference	Registrant	Area (acres)	Primary Use	notes
East Waioli Ditch	1412	KOBAYASHI H	Harold Kobayashi	37	Taro	19+ end users; Waiʻoli Valley Taro Hui
West Waioli Ditch		KOBAYASHI H	Harold Kobayashi	37	Taro	Waiʻoli and Mamalahoa Streams

Water from the main stem of Waiʻoli Stream is conveyed to the tributary on the right bank via a mānowai at about the 160 foot elevation. A diversion (i.e., the poʻowai) then conveys water to the East Waiʻoli Ditch. There is also a branch of the East Waiʻoli Ditch named the Sin Tai Wai Ditch which is located in the middle of the loʻi fields (see Figure 5). The end users that applied for registrations are identified in Table 2.

In April 2018, nearly 48 inches of rain fell in the watersheds of North Kauaʻi, producing some of the most extreme flooding conditions in recorded history. The original mānowai location was destroyed and temporarily moved, although subsequent flooding in 2021 resulted in the original location being more favorable again.

In February 2019, Commission staff conducted a site visit with irrigation managers, community groups, landowners, and stakeholders in order to better understand the current state of water management and to gather information regarding instream uses in Waiʻoli. Follow-up fieldwork and stakeholder meetings have added to our understanding of the system.

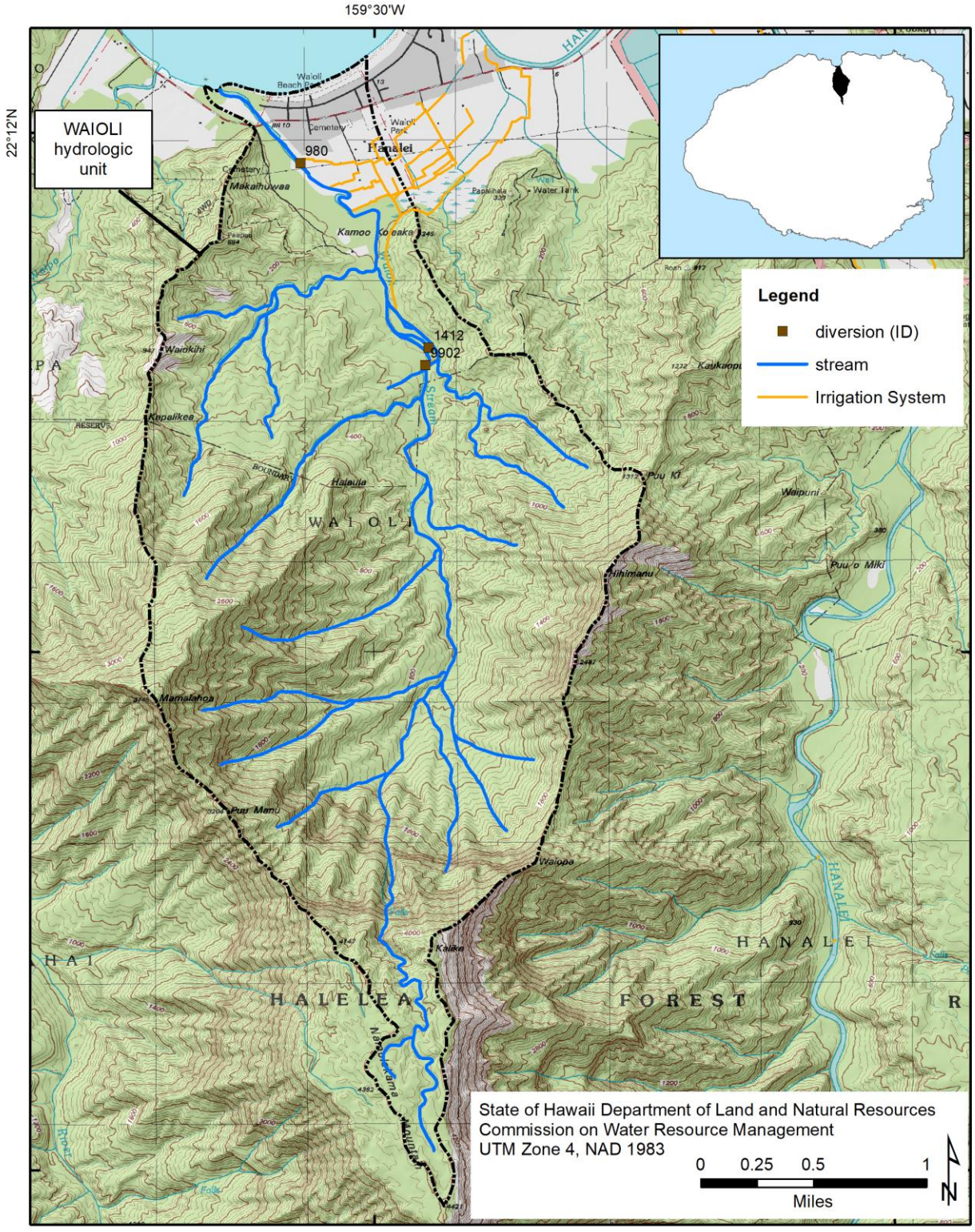
Based upon the best available information, as presented in the Instream Flow Standard Assessment Report (IFSAR)[3] and provided in this submittal, staff has developed a recommendation that seeks to balance public trust uses. The Commission staff has relied upon the basic tenets of adaptive management, 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 necessary[4]. Should initial management decisions need further amendment, the decisions can then be revised, and the process repeated. Due to the complex and dynamic nature of Hawaiʻi's stream systems, adaptive management affords staff the ability to proceed in making reasonable management decisions and 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.

[3] https://dlnr.hawaii.gov/cwrm/surfacewater/ifs/2018-Waioli/
[4] Adapted from Annear, T., I. Chisholm, H. Beecher, A. Locke, P. Aarrestad, C. Coomer, C. Estes, J. Hunt, R. Jacobson, G. Jöbsis, J. Kauffman, J. Marshall, K. Mayes, G. Smith, R. Wentworth, and C. Stalnaker. 2004. Instream Flows for Riverine Resource Stewardship, Revised Edition. Instream Flow Council, Cheyenne, WY. 268 pp.

Table 2. Registered end users of East Waiʻoli Ditch (and Sin Wai Tai branch ditch), file reference name, registrant, declared primary use, instream use, and appurtenant rights claim Kauaʻi. [-- = not available]

File reference	Registrant	Area (acres)	Primary Use	Instream use	Appurtenant right claim	notes
WILCOX C&G	Carol and Gaylord Wilcox	44	Taro, flowers, landscape	No	No	Parcel is leased for taro
YAGIHARA SH	Scott Yagihara	1.75	Taro	No	No	
WATARI H	Hideo Watari	6	Taro	No	Yes	Additional 6 acres leased from Waioli Corporation; 13.5 acres leased from USFWS in Hanalei
WAIOLI CORP	Barnes Riznik	30	Taro	No	No	
TASAKA K	Kenichi Tasaka	--	Taro	No	No	Incomplete declaration
TASAKA B	Bobby Tasaka	9.5	Taro	No	No	
TAI HOOK W	Wilbert Tai Hook et al.	12	Taro	No	Yes	Also irrigates 7 acres of taro from Hanalei River
SPECER CHK	Charles Spencer	0.237	Taro	No	Yes	Also irrigates 7 acres of taro from Hanalei River
SAY P	Paul Say	7	Taro	No	No	Parcel is leased for taro
REYES J	John Reyes	2.06	Taro	No	Yes	
OMO P	Patrick Omo	2.98	Taro	No	No	
MITSUI MM	Mike Mitsui	11	Taro	No	No	
MIIKE D	Donald Miike	7.9	Taro	No	No	Registration says East Waiʻoli Ditch from Hanalei Stream
MASADA FARM	James Masada/ Conrad Inaod	3.5	Taro	No	Yes	
KAONA FARM	Clarence Kaona	3.53	Taro	No	No	
HARAGUCHI T	Tomio Haraguchi	6.57	Taro	No	No	
GARMA N	Norbert Garma	10.28	Taro, fish pond	No	No	End user of Sin Tai Wai Ditch from Waiʻoli Stream
DAWA	Mrs. Dawa	1.75	Taro	No	No	
ANDRADE C	Carlos Andrade	--	Taro	No	No	No known acreage
ANDERSON GA	George Anderson	8.81	Taro, fish ponds	Yes	No	End user of Sin Tai Wai Ditch

Figure 1. USGS topographic map of the Waiʻoli hydrologic unit, registered diversions (ID) and irrigation systems in Kauaʻi.



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. The general considerations are followed by a simplified schematic diagram and assessment summary.

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, along with the oral and written comments received through the public review process. This process is challenging due to the unique nature of each stream. Further, the unique values of each stream cannot simply be plugged into a formula to determine the interim IFS. Issues such as accessibility, ground water gains or surface water losses, the number and type of downstream users, the presence of non-native aquatic species, or the condition of the riparian habitat or estuary all factor into the proposed recommendation.

The first step in developing the interim 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 amount and distribution of rainfall-runoff and 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. In Waiʻoli Stream, for example, the only long-term records of natural or regulated (diverted) stream flow occurred from 1914-1932.

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 loʻi kalo 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 uses of water identified are: (1) water in its natural state; (2) water for traditional and customary Native Hawaiian practices; (3) water for domestic uses; and (4) water for the Department of Hawaiian Home Lands. The process is based upon best available information when weighing the present or potential, instream and noninstream uses.

GEOLOGIC CHARACTERISTICS

Kauaʻi is the most geologically complex island of the main Hawaiian Islands, but subsurface geohydrologic information is not as well developed as in other areas of Hawaiʻi[5]. Waiʻoli

[5] Gingerich, S.B. 1999. Estimating transmissivity and storage properties from aquifer tests in the Southern Lihue Basin, Kauai, Hawaii. US Geological Survey Water-Resources Investigations Report 99-4066.

Stream drains an amphitheater-shaped watershed in the headwaters, transitioning to a narrower, v-shaped watershed through the middle reaches, and then opens up again closer to the coast with a broad flood plain typical of older Hawaiian watersheds. The north coast of Kauaʻi is primarily composed of the shield-building stages of the Waimea Volcanic Series produced during the formation of the original Olokele Caldera, with the rejuvenated lavas of the Koloa Volcanic Series appearing primarily east of Hanalei. The Waiʻoli hydrologic unit is composed of a single geologic formation: tholeiitic Waimea Canyon Basalt of the Napali Formation. The Napali Formation is a thick accumulation of many thin lava flows created during the shield-building phase of Kauaʻi and is highly permeable[6]. Deeply buried dikes are likely to influence transmissivity and submarine groundwater discharge. High-level water is not consistent due to the highly varied thickness and distribution of the lavas and do not make for a reliable source. Dike-impoundments are present in the mountainous north part of the Waiʻoli watershed but not in well-defined patterns. The coastal plain and current shoreline are the result of higher sea levels between 1500 and 4000 years ago supporting reef development further inland. Baseflow in Waiʻoli is supported by continuous groundwater discharge from thick layers of thinly-bedded basalts and associated breccia of the Napali formation in the Waimea Canyon Basalt, supporting mauka to makai flow 100 percent of the time. The different members of the Waimea Canyon Basalts likely have varying degrees of permeability due to localized differences in the thicknesses of lava flows. Towards the coast, the valley is partly filled with alluvium and rejuvenated-stage volcanic rocks forming a flattened valley floor.[7] These sediments vary widely in hydraulic properties but generally have conductivities several orders of magnitude lower than that of lava-flow aquifers, but similar to that of deeply weathered basalt.[8]

The current sustainable yield for the Hanalei Aquifer System is 35 mgd, and the current (January 2021) 12-month average pumpage from the aquifer system is 0.151 mgd. There are two existing wells in the Waiʻoli hydrologic unit and one (2-1130-002) is reporting its use, with a 12-month average pumpage of 0.000 mgd (Table 3).

Table 3. Well number, name, owner, elevation, pump capacity (million gallons per day, mgd), and 10-year mean pumpage (mgd) for the Hanalei Aquifer System, Kauaʻi. [-- = not available]

well number	well name	well owner	ground elevation (ft)	well depth (ft)	pump capacity (mgd)	Initial head above msl (ft)
2-1130-001	McPeek Kosteletsky	Romney Smith	20	170	0.01	4.0
2-1130-002	Lot 41	Richard Henkels	18	165	--	10.18

[6] Macdonald et al., 1960
[7] Izuka, S.K., Engott, J.A., Rotzoll, K., Bassiouni, M., Johnson, A.G., Miller, L.D., Mair, A. 2015. Volcanic aquifers of Hawaiʻi—Hydrogeology, water budgets, and conceptual models. USGS SIR 2015-5164.
[8] Lau, L.S., Mink, J.F. 2006. Hydrology of the Hawaiian Islands. University of Hawaiʻi Press.

SPECIFIC HYDROLOGIC CONSIDERATIONS

The hydrologic characteristics of a stream are critical to determining the interim IFS recommendation. These characteristics indicate the effects of geology, climate, and soils on the flow of water. Of great importance is the concept of a gaining or losing (i.e., groundwater recharging) 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. On Kaua‘i, streams are generally gaining from their headwater reaches at high elevations all the way to the lower elevation reaches.

Continuous mauka to makai flow is estimated to naturally occur 100-percent of the time in the main stem of Wai‘oli Stream. From 1914 to 1932, USGS monitored natural flow conditions at an elevation of 550 feet at USGS 16105000 (drainage area 1.9 mi^2, mean annual rainfall 167 inches). Low-flow characteristics for this period of record are provided in Table 4.

Table 4. Estimated natural low-flow duration exceedance values for USGS 16105000 from 1914-1932 [cubic feet per second (million gallons per day)] note: values may differ due to rounding

Station	Elevation (ft)	Q_{50}	Q_{55}	Q_{60}	Q_{65}	Q_{70}	Q_{75}	Q_{80}	Q_{85}	Q_{90}
USGS 16105000 1914-1932	550	20 (12.9)	19 (12.3)	17 (10.3)	16 (9.0)	15 (9.7)	14 (9.0)	13 (8.4)	12 (7.8)	11 (7.1)

Point measurements have recently been made in the Wai‘oli hydrologic unit by CWRM staff, USGS, and a consultant for the Wai‘oli Taro Farmers Hui as described in Table 5.

Table 5. Point measurements in the Wai‘oli Hydrologic Unit and mean daily flow (mdf) at USGS 16108000 on Wainiha River with associated percent flow duration value. [cubic feet per second (million gallons per day)]

Agency	Date	Wai‘oli Stream at 160 ft	Wai‘oli Tributary at 160 ft	East Wai‘oli Ditch at Intake	Wai‘oli Stream at 40 ft	MDF on at USGS 16108000	Percent Flow Duration Value
CWRM	02/09/2019	32.7 (21.1)		15.6 (10.1)		208 (134)	Q_{14}
USGS	02/19/2020				22.0 (14.2)	183 (118)	Q_{29}
USGS	07/01/2020				11.5 (7.4)	53.4 (34.5)	Q_{80}
USGS	12/03/2020				15.2 (9.8)	57.8 (37.4)	Q_{76}
Consultant	01/10/2021	19.0 (12.3)	1.2 (0.8)	9.3 (6.0)		43.9 (28.4)	Q_{94}
Consultant	03/22/2021	44.5 (28.8)				136 (87.9)	Q_{24}
Consultant	03/23/2021	39.5 (25.5)	3.5 (2.3)	9.0 (5.8)		102 (66.6)	Q_{35}

To assist with estimates of natural (undiverted) low-flow duration values, Commission staff developed regression models to predict flow-duration values at gaged locations (historic and

current) using basin characteristics. Selected gaged locations were located on the windward (north) side of the Kauaʻi island and spanned from Kalalau Stream to the West to Halaulani Stream to the East. Basin characteristics and hydrologic data for the study area were collected and analyzed (Table 6). The products of the analysis are a set of regression equations that can be used to estimate natural (undiverted) Q_{50}, Q_{70}, and Q_{90}, at gaged and ungaged sites.

Table 6. Summary of basin characteristics for selected locations in the Waiʻoli hydrologic unit used in regression equations for estimating selected flow-duration statistics. (Source: USGS National Water Information System) [Flows are in cubic feet per second]

USGS Station ID	stream name	Period of Record	Q_{50}	Q_{70}	Q_{90}	Mean Annual Precipitation (in)	drainage area (mi^2)
16106000	Lumahai	1914-1933	65	50	37	211.67	6.84
16105000	Waiʻoli	1914-1932	20	15	11	167.46	1.90
16108000	Wainiha	1984-2013	77	60	47	254.15	10.45
16114000	Limahuli	1994-2005	6.1	5.2	4.2	102.73	1.37
16103000	Hanalei	1984-2013	137	105	81	186.78	18.51
16101003	Hanalei	1984-2013	63	51	37	225.87	7.15
16097000	Pōhakuhonu	1984-2013	7.1	5.7	1.6	120.81	1.72
16097500	Halaulani	1984-2013	6.8	5.5	4.3	113.85	1.203
16115000	Hanakapiai	1984-2013	7.4	5.6	4.5	143.12	2.746
16117000	Kalalau	1932-1954	5.2	4.4	3.7	129.21	1.603

The regression analysis was evaluated to make sure that the general assumptions were met for each watershed: (1) the equation adequately describes the relation between the dependent and independent variables; (2) the mean residual error is close to zero; (3) the variance of residual error is constant and independent of input variables; (4) values of the residual error are normally distributed; (5) values of the residual error are independent of each other; (6) independent variables are not correlated; and (7) the signs and magnitudes of the coefficients determined for the significant, independent variables are hydrologically reasonable (Fontaine et al. 1992). All streamflow and basin characteristics were log-transformed to satisfy the normality assumption. Due to correlation, certain basin characteristics were eliminated. The final models were selected based on: (1) the proportion of total variation explained, R^2; (2) the standard error of the estimates, SE; (3) the probability of significance for an independent variable, p; (4) that p had to be less than 10 percent for each independent variable to be included. The resultant model values closely approximated select low-flow duration discharge values with a high ($R^2 > 0.85$; NSE > 0.85) degree of accuracy (Table 7).

Table 7. Summary of regression equations developed for estimating selected flow-duration statistics of perennial streams in north Kaua‘i. [statistic: Q is total flow, Q_{xx} is the xx-percent flow duration; statistic estimator: DA is the log+1 transformed drainage area; MAP is the log of the mean annual precipitation for the drainage area (inches); R^2: adjusted coefficient of determination, SE: average standard error of estimate; NSE: Nash-Sutcliffe model efficiency coefficient; n =10]

Statistic	Regression model	R^2	SE	NSE
Q_{50}	Log Q_{50} = -2.59571 + 1.080127*DA + 1.43876*MAP	0.92	0.161	0.934
Q_{70}	Log Q_{70} = -2.52934 + 1.079495*DA + 1.363094*MAP	0.91	0.160	0.933
Q_{90}	Log Q_{90} = -2.59571 + 1.10177*DA + 1.541503*MAP	0.86	0.220	0.892

Basin characteristics for four locations in Wai‘oli were then determined to estimate low-flow characteristics (Table 8): 1) the Wai‘oli Stream at 20 feet is located near the outlet of the stream, at an elevation of 20 feet; 2) the Wai‘oli Stream at 100 feet is in the middle reach of Wai‘oli Stream below the confluence of the tributary on the right bank; 3) Wai‘oli Stream at 160 feet is located upstream of the mānowai at 160 feet in elevation; 4) Wai‘oli Tributary at 160 feet is located on the tributary on the right bank above the inflow from the mānowai.

Table 8. Summary of basin characteristics for selected locations in the Wai‘oli hydrologic unit used in regression equations for estimating selected flow-duration statistics.

Site name	elevation (ft)	Mean Annual Precipitation (in)	drainage area (mi^2)
Wai‘oli at 160 ft	160	159	3.33
Wai‘oli at 100 ft	100	156	3.80
Wai‘oli at 20 ft	20	150	5.01
Wai‘oli Tributary at 160 ft	160	135	0.46

The regression equations were applied at four selected ungaged sites in Wai‘oli to estimate selected natural low-flow duration discharge exceedance values for the current (1984-2013) climate period (Table 9).

Table 9. Estimated natural low-flow duration exceedance values for different elevations in the Wai‘oli hydrologic unit for the 1984-2013 based on regression models using basin characteristics [cubic feet per second (million gallons per day)]

	Discharge (Q) for a selected percentage ($_{xx}$) discharge was equaled or exceeded		
Site name	Q_{50}	Q_{70}	Q_{90}
Wai‘oli at 160 ft	18.2 (11.8)	14.4 (9.3)	10.1 (6.5)
Wai‘oli at 100 ft	19.8 (12.8)	15.7 (10.1)	11.0 (7.1)
Wai‘oli at 20 ft	23.8 (15.4)	19.0 (12.3)	13.2 (8.5)
Wai‘oli Tributary at 160 ft	4.4 (2.9)	3.6 (2.3)	2.4 (1.5)

Another factor in the selection of an interim IFS site is appropriateness of the site selection for monitoring and regulation by Commission staff. The stream channel immediately below the East Wai‘oli Ditch Intake (Diversion 1412) is still on the tributary and would not account for the flow

in the main stream. However, downstream of the confluence is straight with an appropriate gage pool suitable for monitoring streamflow.

IMPACT TO HAWAIIAN HOME LANDS

The Department of Hawaiian Home Lands (DHHL) does not have any land holdings in or near Wai‘oli which would benefit from either instream flow standards or the use of water through the East Wai‘oli Ditch. In November 2020, the Department of Hawaiian Home Lands held a beneficiary consultation to consider the Wai‘oli Valley Taro Hui’s request to continue its ancient use in support of a long term water lease. In January 2021, the Hawaiian Homes Commission voted to accept the beneficiary consultation report recommendations that it not seek a reservation of water from Wai‘oli Stream and support the Hui’s application for its continued use at a gratis rate.

IMPACT TO MUNICIPAL WATER SUPPLY

The Wai‘oli Stream does not provide water for the County of Kaua‘I, Department of Water Supply municipal system, nor does it provide water for any private potable water systems.

AVAILABILITY OF ALTERNATIVE WATER SUPPLIES

Groundwater
While it is the Commission’s policy that outside of water management areas water use should be matched to the quality of water needed, the Water Code does not preclude potable groundwater use for agriculture, landscape and golf course irrigation, or other non-potable needs. Currently, groundwater is only used to meet potable needs in the Hanalei region and there are no existing wells that could meet the non-potable demands of lo‘i kalo.

CONSISTENTCY WITH THE HAWAI‘I WATER PLAN

The Water Resource Protection Plan (WRPP), updated in 2019,[9] provides an outline for the conservation, augmentation, and protection of water resources. The legal framework of the Code for developing interim IFS as outlined in this submittal is covered in more detail and context in the WRPP.

[9] State of Hawai‘i Commission on Water Resource Management. 2019. Water Resource Protection Plan 2019. Prepared by Townscape, Inc. https://dlnr.hawaii.gov/cwrm/planning/hiwaterplan/wrpp/

Assessment Summary of Instream Uses: Waiʻoli Stream

Maintenance of Fish and Wildlife Habitat
Previous surveys by the Division of Aquatic Resources (DAR) found that several native species inhabit low and middle elevation reaches in Waiʻoli, including ʻoʻopu nōpili (*Sicyopterus stimpsoni*), ʻoʻopu nākea (*Awaous stamineus*), āholehole (*Kuhlia xenura*), ʻōpae ʻoehaʻa (*Macrobrachium grandimanus*) and ʻōpae kalaʻole (*Atyoida bisulcata*). The HSA ranked Waiʻoli Stream as having substantial aquatic resources (3 out of 4) with the presence of ʻoʻopu nākea, ʻoʻopu nōpili, 3 native group two species, and only 1 introduced group one species.

Outdoor Recreational Activities
The Waiʻoli hydrologic unit supports swimming, hiking, fishing, hunting, boating, and scenic views activities. Swimming is common in larger pools in Waiʻoli Stream and its tributaries. There are trails along the stream with hiking opportunities. Hunting takes place in the upper reaches of the watershed. The HSA identified nine recreational experiences with three high quality experiences, giving it a regional ranking of outstanding (4 out of 4) for the Island of Kauaʻi and a statewide ranking of outstanding (4 out of 4). Waiʻoli Stream was listed as a candidate stream for protection by the HSA for its "diversity" of recreational experiences and as a "blue ribbon" resource with the very best resources.

Maintenance of Ecosystems
The HSA indicated the presence of a palustrine wetland and 30% of the watershed remains in native forest. Four species of threatened or endangered birds are found in Waiʻoli, including native wetland bird species. The valley is being invaded by hau bush (*hibiscus tiliaceus*) and California grass (*Uroshloa mutica*), with feral pigs feeding on groundcover and uprooting the soil.

Aesthetic Values
Waiʻoli Stream supports aesthetic value throughout, but especially near the highway and residents that live along the stream.

Maintenance of Water Quality
Waiʻoli Stream is classified by the Department of Health (DOH) as Class 1b inland waters in the upper elevations and Class 2 inland waters in the lower elevations. It does not appear on the 2014 List of Impaired Waters in Hawaiʻi, Clean Water Act §303(d), although there was insufficient data to support any conclusions. The abundance of non-native mammals in the watershed are likely to contaminate the stream. From 2001 to 2003, the DOH Clean Water Branch measured various water quality parameters in Waiʻoli Stream (Table 10) and from 2003 to 2005 the EPA supported additional stream sampling near the mouth of Waiʻoli Stream (Table 11).

Conveyance of Irrigation and Domestic Water Supplies
A short reach of a tributary of Waiʻoli Stream is used for the conveyance of irrigation or domestic water supplies diverted from the main channel at the mānowai, until it is intercepted by the poʻowai and conveyed to the East Waiʻoli Ditch.

Table 10. Mean, standard deviation (SD), and sample size of various water quality parameters measured by the State of Hawai‘i Department of Health Clean Water branch from 2001 to 2003 at one downstream (elevation 1 ft a.s.l.) and one upstream (10 ft a.s.l.) site.

	Lower Wai‘oli			Upper Wai‘oli		
Parameter	Mean	SD	n	Mean	SD	n
DO (%)	98.2	14.7	10	96.4	13.4	10
ORP (mg L^{-1})	285.8	44.8	8	325.0	34.8	8
pH	7.449	0.228	10	7.572	0.180	9
Salinity (mg L^{-1})	0.034	0.011	10	0.027	0.008	10
SpCond (µS cm^{-1})	0.0851	0.0109	10	0.0074	0.0082	10
Temp (°C)	20.4	1.0	10	20.0	1.0	10
Turbidity (mg L^{-1})	4.56	4.73	17	2.34	1.34	17

Table 11. Mean, standard deviation (SD), and sample size of various water quality parameters measured by the Environmental Protection Agency from 2003 to 2005 at one site near the mouth.

	Wai‘oli at mouth		
Parameter	Mean	SD	n
DO (mg L^{-1})	7.16	1.61	27
Enterococcus Bacteria (mpn)	1596.8	4096.3	24
pH	6.755	0.211	16
Total Suspended Solids (mg L^{-1})	12.1	16.7	28
Salinity (mg L^{-1})	1.22	3.36	29
SpCond (µS cm^{-1})	2147.9	5768.6	28
Temp (°C)	21.31	1.60	28
Turbidity (mg L^{-1})	13.1	22.8	28

Protection of Traditional and Customary Native Hawaiian Rights

Lo‘i kalo cultivation, is a traditional and customary Native Hawaiian practice, a public trust use, and an instream use of water. During the registration period (1988-1989), approximately 113 acres of land were being leased for lo‘i cultivation associated with the East Wai‘oli Ditch as submitted by the registrants (see Table 2), however there may have been some double counting regarding the exact acreage. In 2007, Gingerich et al. [10] identified 45.01 acres across three lo‘i complexes in Wai‘oli. Using satellite imagery, Perroy et al. (2016[11]) estimated that there were 31.36 acres of lo‘i in the Wai‘oli hydrologic unit, with another 69.76 acres of lo‘i outside of the hydrologic unit also dependent on the Wai‘oli Stream water (total of 101.12 acres), although small streams also contribute some surface water.

[10] Gingerich et al. 2007. Water use in wetland kalo cultivation in Hawaii. US Geological Survey Open File Report 2007-1157.

[11] Perroy et al. 2016. The evolving agricultural landscape of post-plantation Hawaii. Applied Geography, 76(4): 154-162.

Table Error! No text of specified style in document.**-1.** Complex and lo‘i measurements, area (acre), and calculated water use (gallons per acre per day; gad) by location in the East Waioli Ditch. (Source: Gingerich et al., 2007)

location	Date/time	Area (acre)	Measurement (mgd)	Water Use (gad)
Ka01A-CI	8/8/2005 08:50	32.89	4.2	130,000
	9/21/2005 11:47	32.89	4.2	130,000
Ka01B-CI	8/8/2005 10:00	2.98	0.36	120,000
	9/21/2005 12:46	2.98	0.55	180,000
Ka01C-CI	8/8/2005 11:32	5.46	0.54	100,000
	9/21/2005 12:11	5.46	0.38	70,000
Ka01D-CI	8/8/2005 15:05	4.18	0.15	36,000
	9/21/2005 15:10	4.18	0.25	60,000
Ka01B-LI	8/8/2005 14:00	0.21	0.076	370,000
	9/21/2005 13:37	0.21	0.047	230,000
Ka01C-LI	8/8/2005 10:30	0.16	0.028	170,000
	9/21/2005 12:55	0.16	0.019	120,000

The maintenance of instream flows is important for the protection of traditional and customary Native Hawaiian practices, as they support stream (e.g., hīhīwai, ‘ōpae, ‘o‘opu) and riparian (vegetation) resources for gathering. The use of Wai‘oli’s stream water to produce lo‘i kalo for subsistence and cultural purposes is recorded in Land Commission Awards as early as 1850. Historical records also document the exchange or sale of products as a traditional and customary practice in this kalana (area)[12]. A Cultural Impact Assessment (CIA) for the Wai‘oli Ahupua‘a documented forty-one (41) Royal Patent Grants or grants of land sold from the Government body of land (prior to the illegal overthrow). There are fifty-five Land Commission Awards documented in the Buke Māhele for Wai‘oli Ahupua‘a.[13] A 2019 OHA report found that forty-one (41) kuleana awards had at least one (1) ‘āpana that was lo‘i, although that survey was not exhaustive (Tong 2019). Based on a thorough review of these and other documents, a significant majority of LCAs have more than one (1) ‘āpana; some, up to six (6). Records from the Māhele indicate that, at that time, the system provided water to kuleana parcels, many of which were engaged in kalo cultivation (DLNR, Land Division, 2020).

Research for the CIA’s figures/tables was based solely on primary source archival materials in English and ‘Ōlelo Hawai‘i and the use of ESRI ArcGIS software to contextualize the geospatial locations of historic maps and land features. Based on this research, the CIA estimated that, *at minimum*, 34.57 acres of the Wai‘oli Lo‘i Kalo Irrigation System was in lo‘i between 1830-1860, with all the rights and access to water necessary to irrigate those fields. The documentation provided is contemporaneous with the use of lo‘i on these same parcels today.

[12] Winter, K.B., et al. 2018. The Moku System: Managing Biocultural Resources for Abundance within Social-Ecological Regions in Hawai‘i. Sustainability, 10, 3554.

[13] One of these LCA claims is crossed out in the Buke Māhele, at least two LCAs have duplicate helu (two numbers for the same award), and of course most LCAs have multiple ‘āpana, ranging from 1-6 parcels.

Historic maps establish that the ʻauwai system was partly surveyed and recorded 147 years ago (Figure 2). This extremely early depiction confirms the existence of the mānowai and poʻowai as well as the extent of the ʻauwai system. When coupled with the Māhele claims (discussed above), this quantification and recognition of appurtenant rights for this acreage is reasonable based on an exhaustive survey of Māhele and other data.

All of this underscores the extent and interconnectedness of the Waiʻoli Loʻi Kalo Irrigation System at the time of the Māhele as well as how little the system has changed over the last 170 years (Figure 3). This early depiction confirms the existence of the mānowai and poʻowai as well as the extent of the ʻauwai system.

Two (2) hoʻi (returns or outtakes) from Waiʻoli Stream return water to Hanalei River, all eventually terminating in Hanalei Bay. The hoʻi temper and distribute the overflow from floods, reducing the force and impact of floodwaters on Hanalei town (Kīpuka Kuleana, 2020). Waiʻoli's Loʻi Kalo Irrigation System, which was built centuries ago to be self-sufficient and allow for continuous stream flow, feeds loʻi in both Waiʻoli and Hanalei (Figure 4). Thus, the use of water for kalo irrigation is largely non-consumptive and almost entirely within the Waiʻoli Watershed.

The HSA archeological summary identified six known archeological sites, but there was limited survey coverage and predictability. The National Register of Historic Places identifies the valley as having excellent examples of particular site types, sites that contain important information, and culturally noteworthy sites.

Figure 2. Register Map 2625 depicting the location of the mānowai, poʻowai, and hoʻi, in relation to Waiʻoli Stream and the East Waiʻoli Ditch (ʻauwai), Kauaʻi.

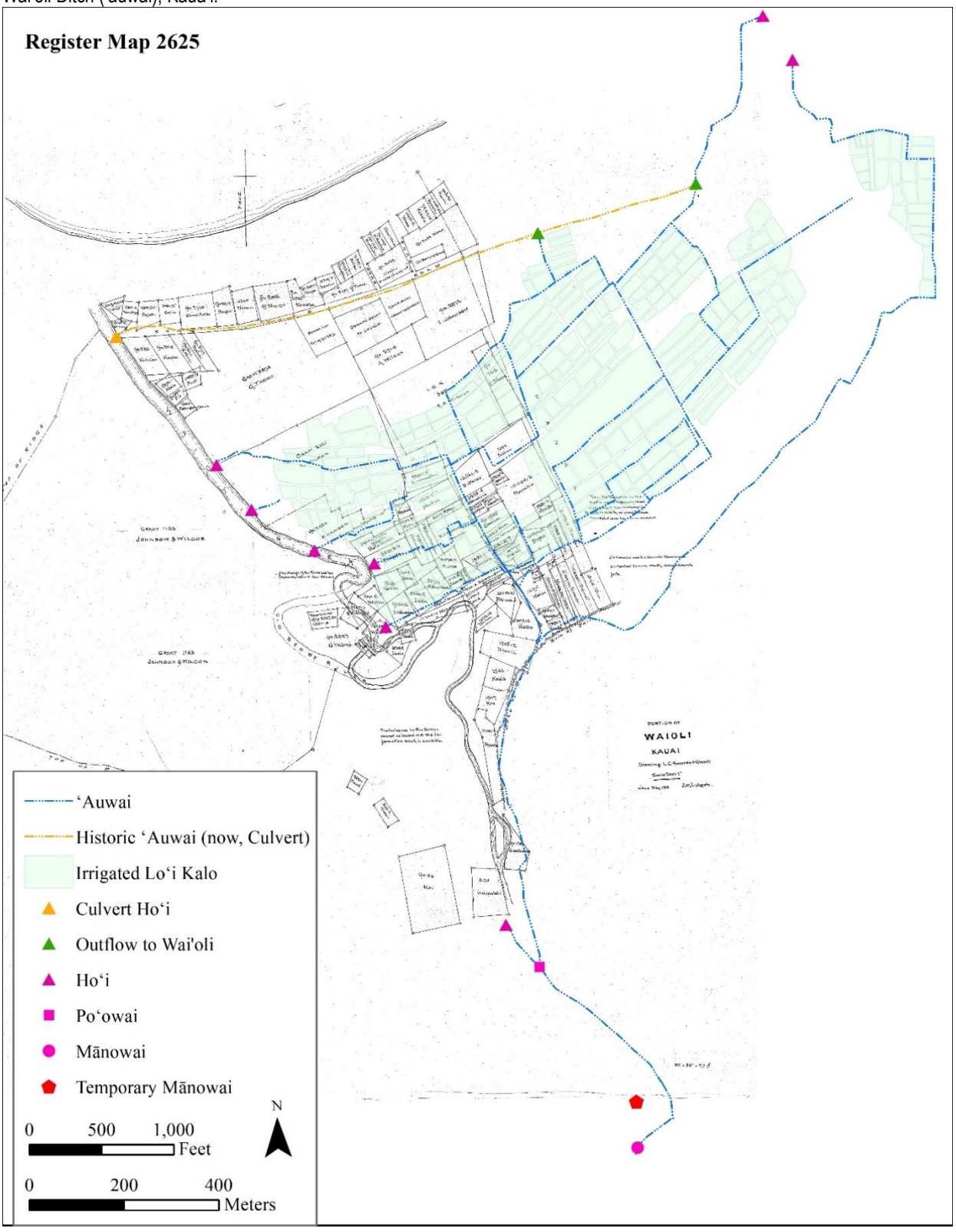


Figure 3. Geographic depiction of parcels with appurtenant rights and their use in relation to the ʻauwai and hoʻi, Waiʻoli Stream and the East Waiʻoli Ditch (ʻauwai), Kauaʻi.

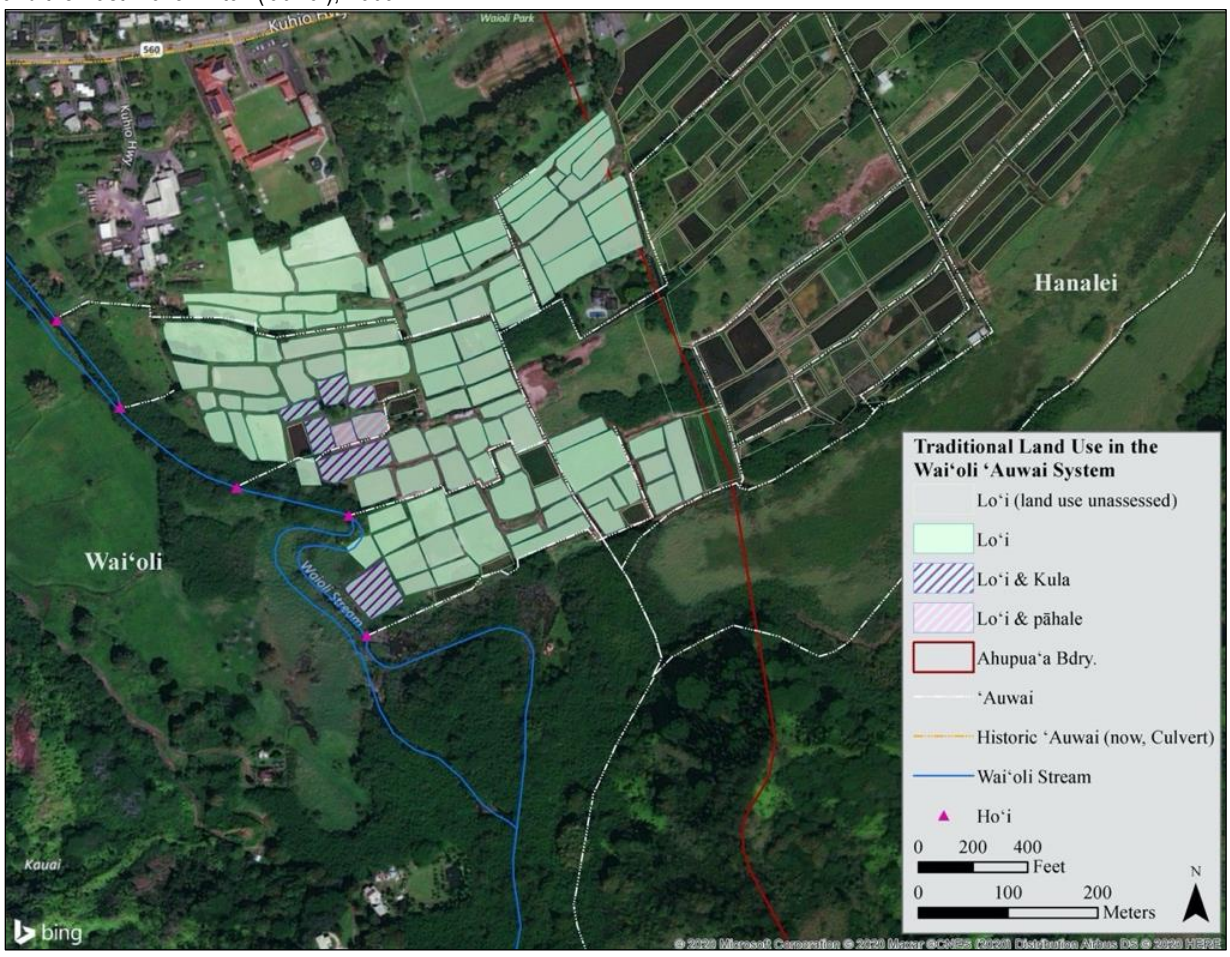


Figure 5 provides a simplified schematic of the spatial arrangement between the historic USGS station 16105000, mānowai, poʻowai, ditches and hoʻi on Waiʻoli Stream with estimated low-flow duration exceedance values.

ENVIRONMENTAL REVIEW CHAPTER 343, HAWAIʻI REVISED STATUTES

The proposed action does not meet or trigger the applicability requirements under Hawaiʻi Revised Statutes §343-5, therefore an Environmental Assessment is not required.

Figure 4. Geographic depiction of lo‘i irrigated with the East Wai‘oli Ditch (‘auwai) and associated ho‘i in the Wai‘oli and Hanalei hydrologic units, Kaua‘i.

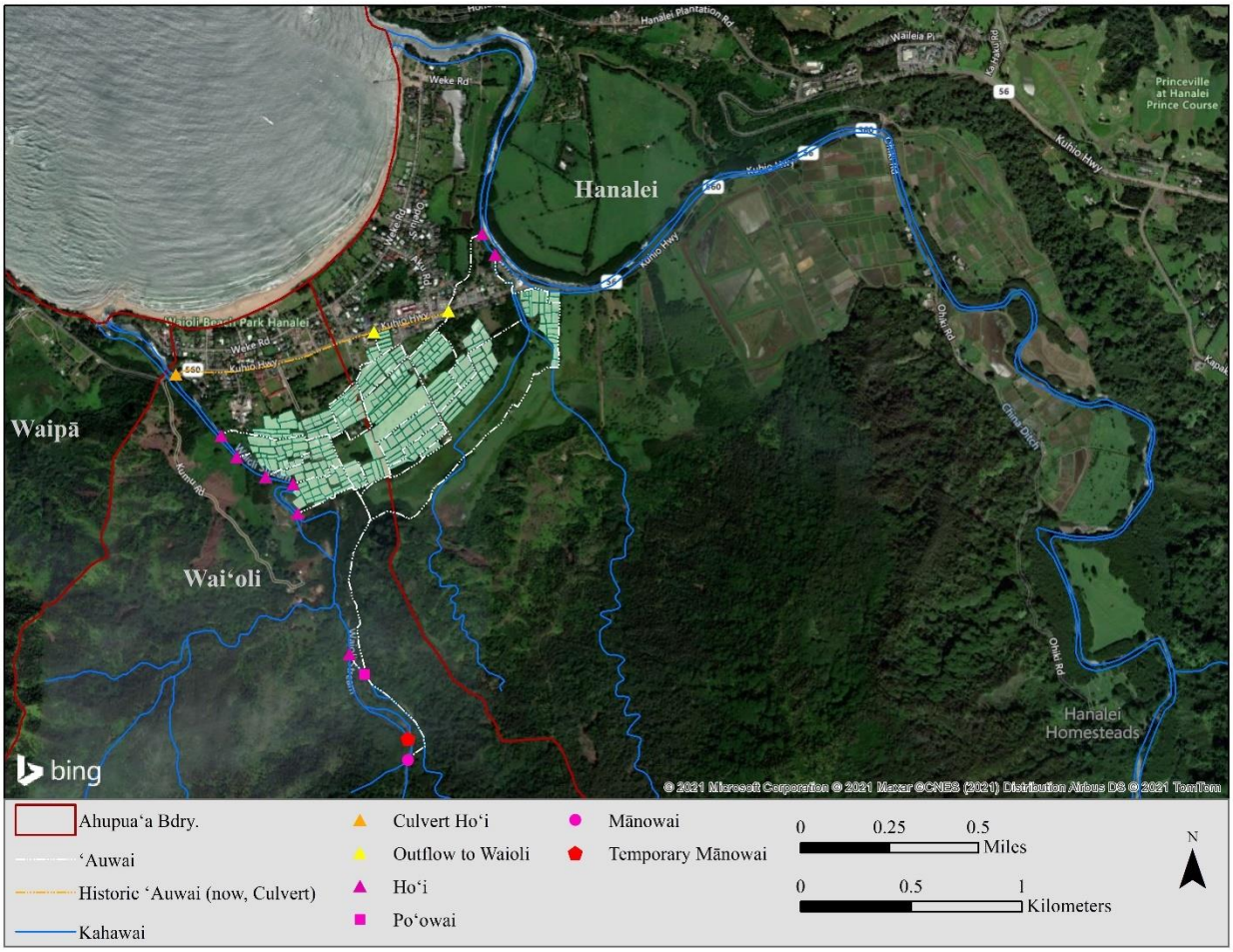
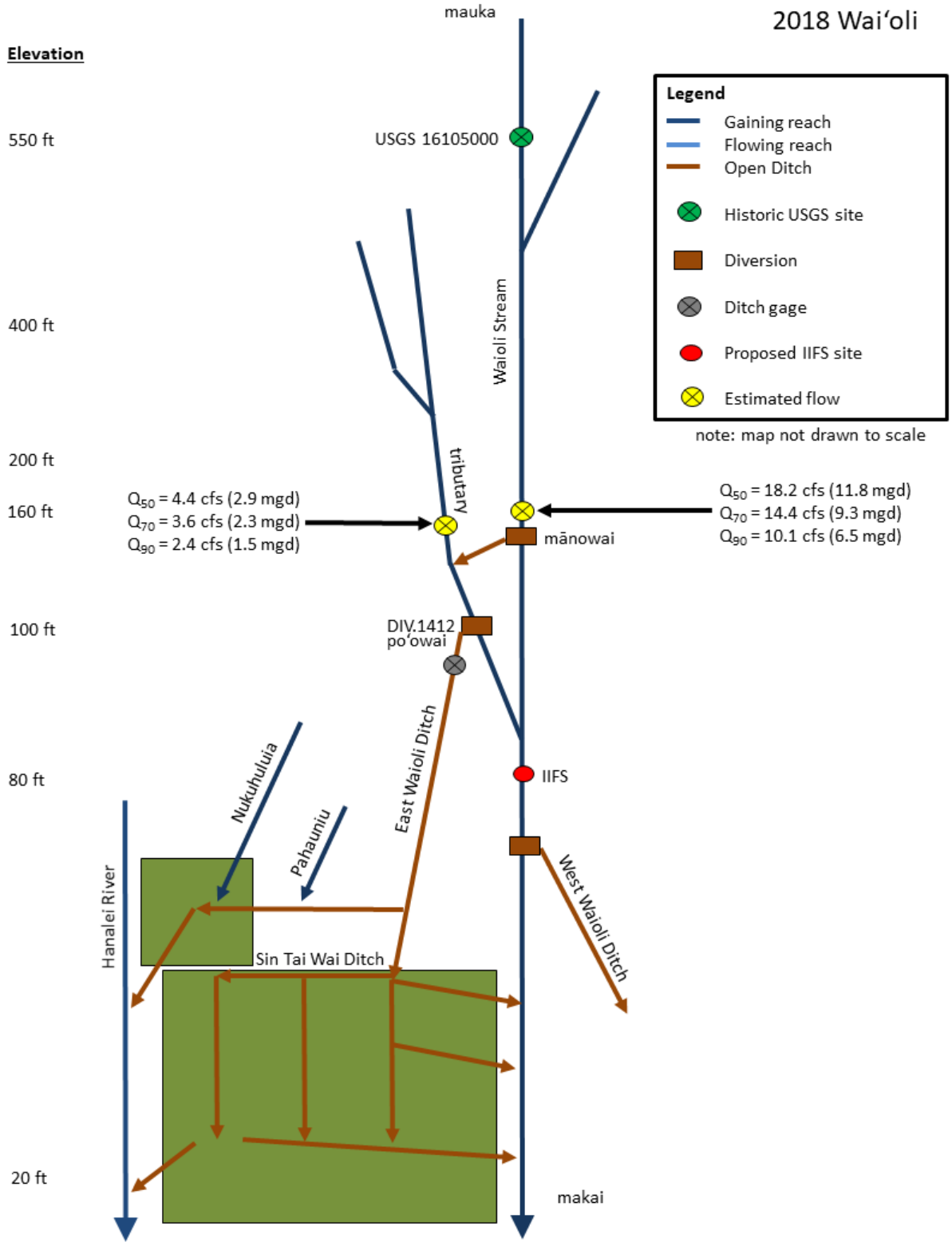


Figure 5. Schematic depiction of Wai‘oli Stream, historic USGS monitoring station, and estimated flows, in relation to the East Wai‘oli Ditch, lo‘i and associated ho‘i in the Wai‘oli and Hanalei area.



DRAFT RECOMMENDATION

- Proposed Action: Amended Interim IFS
  Supporting the Native Hawaiian custom of keeping half of the stream's flow remaining in the stream[14], staff recommends that one measurable interim IFS be established for Wai‘oli Stream near an altitude of 40 feet, below the confluence of Wai‘oli Stream and the Wai‘oli tributary on the right bank. The interim IFS shall be established at a flow of 6.3 cfs (4.0 mgd) at all times, unless the Commission declares an emergency or water shortage. This value represents 50% of the estimated 90th percentile flow (Q_{90}) at the po‘owai, which was estimated to be 12.5 cfs (8.0 mgd). Thus, it is expected that during drought conditions, only 50% of the water, shall be diverted from the stream in order to protect instream values. This results in a varying amount of water for kalo production based on the amount of water flowing in the stream (Table 12). The interim IFS may be revised by future Commission action as more data is gathered.

Table 12. Low-flow duration values in Wai‘oli Stream, Wai‘oli tributary, and downstream points based on the proposed IIFS.

location	Q_{50}	Q_{70}	Q_{90}
Wai‘oli Stream above mānowai	18.2 (11.8)	14.4 (9.3)	10.1 (6.5)
Estimated tributary inflow on right bank	4.4 (2.9)	3.6 (2.3)	2.4 (1.5)
Total water available at po‘owai	22.6 (14.6)	18.0 (11.6)	12.5 (8.0)
IIFS below confluence of tributary with Wai‘oli Stream	6.3 (4.0)	6.3 (4.0)	6.3 (4.0)
Available at the po‘owai	16.3 (10.6)	11.7 (7.6)	6.3 (4.0)
Return flow to Wai‘oli Stream (estimated at 85%)	13.9 (9.0)	9.9 (6.4)	5.3 (3.4)

MONITORING

- The Wai‘oli Valley Taro Hui will monitor East Wai‘oli Ditch below the Diversion 1412 intake and report the quantity of water removed at the po‘owai to the Commission monthly (e.g., estimated daily flows).
- Staff shall make periodic low-flow measurements in the stream and at the ditch intake.
- Staff will work with the Wai‘oli Valley Taro Hui to make synoptic measurements within Wai‘oli to better understand gains in streamflow from the historic USGS station to the mānowai.

EVALUATION

- Within five 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.

[14] Dr. Lilikalā Kame'eleihiwa testimony in Waiāhole CCHOA95-1, Commissions FOF No. 976 (CCHOA95-1 Dec. 24, 1997) and Emma Metcalf Nakuaina, Ancient Hawaiian Water Rights: And Some of the Customs Pertaining to Them, in Hawaiian Almanac & Annual For 1894. (1893) p. 79.

- As the current lack of data regarding stream flows have affected Commission staff's ability to estimate low-flow characteristics, if sufficient data are gathered to warrant revising the interim IFS, that will be done at a future Commission date.

Ola i ka wai,

M. KALEO MANUEL
Deputy Director

Note: Exhibit 1 is available from the Commission website at http://dlnr.hawaii.gov/cwrm/surfacewater/ifs/kauai/2018-waioli/.

Exhibit 1 DRAFT Instream Flow Standard Assessment Report PR-2021-01

APPROVED FOR SUBMITTAL:

SUZANNE D. CASE
Chairperson