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

For the meeting of the
COMMISSION ON WATER RESOURCE MANAGEMENT

July 20, 2021
Honolulu, Hawaiʻi

Draft Amended Interim Instream Flow Standards
For the Surface Water Hydrologic Unit of Kiʻikiʻi (3082)
Kaukonahua Stream, Waialua, Oʻahu

SUMMARY OF REQUEST

No action. Staff is sharing information and draft recommendations for amending the interim instream flow standard (interim IFS) for one stream within the Kiʻikiʻi surface water hydrologic unit in the region of Leeward Oʻahu:

KIIKII (3082): Kaukonahua Stream

LOCATION MAP: See Figure 1

LEGAL AUTHORITY:

The State Water Code (Code), Chapter 174C, Hawaii 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 draft submittal seeks to address one stream in Leeward Oʻahu.

The current interim IFS for the stream being considered were established by way of Hawaii Administrative Rules (HAR) §13-169-49, which, in pertinent part, reads as follows:

> Interim instream flow standard for Leeward Oahu. The Interim Instream Flow Standard for all streams on leeward Oahu, as adopted by the Commission on Water Resource Management on October 19, 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

Item B-2

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 10, 1988. 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 diversions works, any new or substantially modified stream diversion works 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 Hawaiʻi 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.

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 Instream Flow Assessment Report (IFSAR), 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, the various instream and noninstream uses of water, and the logistical challenges of instituting an interim IFS. Whether attempting to compare stream characteristics across multiple hydrologic units or within a single one, no single principal or equation determines the rate of flow restoration. However, the principals established by the State Constitution, the laws dictating the Hawaiʻi State Water Code (HRS 174C), and the statutes which are used to implement these laws (HRS) are applied equally.

The assessment of instream uses for Oʻahu began with the Waiāhole Ditch Combined Contested Case Hearing (CCH-OA95-1), which concluded with the 2006 Decision and Order by the Commission and with it's final appeal to the Intermediate Court of Appeals concluded in 2010. In this submittal, the Commission will address the interim IFS for Kaukonahua Stream in Leeward Oʻahu in the Kiʻikiʻi (3082) hydrologic unit (Figure 1).

HISTORIC CONTEXT:

The hydrologic unit of Kiʻikiʻi incorporates the ahupuaʻa west of Kawailoa, including portions of Paʻalaʻa, Kamananui, and Waiʻanae Uka, with important cultural sites and large pre-contact populations. The perennial streams that flow from the Koʻolau mountains into Kaiaka Bay are Helemano, Poamoho, and Kaukonahua Streams, the latter of which is composed of the north and south forks. These streams historically supported wetland agriculture in the lower elevations, and terraced agriculture on the flat lands between stream gulches in the upper elevations. Inland from Kawailoa is Wahiawa, the only extensively flat lands at high elevation on Oʻahu, where extensive loʻi, sweet potato and yam plantations were irrigated from springs along the Waiʻanae side of Kaukonahua. Additionally, extensive terracing above and below the present-day Wahiawa Town drew water from Kaukonahua Stream[1].

Dating back to at least the 12th Century, Wahiawā was identified with the ruling aliʻi of Oʻahu. The sacred place of Kūkaniloko, just northwest of Wahiawā, was one of two sacred places which kapu chiefesses went to give birth to their children. Additional archeological evidence suggests agriculture supported a large population center.

In 1889, Castle & Cooke incorporated the Waialua Agricultural Company and purchased a sugarcane plantation in Waialua initially started by Levi and Warren Chamberlain in 1865[2].

[1] Handy and Handy. 1972. Native Planters in Old Hawaii: Their Life, Lore, and Environment. Bishop Museum Press, Honolulu.
[2] Wilcox, C. 1996. Sugar Water: Hawaii's Plantation Ditches. University of Hawaiʻi Press, Honolulu.

Immediately, Castle & Cooke began to invest and upgrade the plantation, constructing a new mill, expanding acreage, building a railway, and investing in groundwater and surface water resources. Between 1900 and 1906, Castle & Cooke had constructed four surface water systems to provide storage and distribution of diverted stream water to all areas of the plantation: the Wahiawā/Oʻahu/Ito Ditch system, Helemano/Poamoho/Taneda Ditch system, ʻŌpaeʻula Ditch system, and the Kamananui Ditch system. As the Company developed water resources through stream diversions, groundwater development, and irrigation systems, more acreage was planted and sugar production increased from 5,000 tons per year to 20,000 tons per year by 1905. The use of mechanical harvesting further increased the harvestable acreage.

Renamed Waialua Sugar Company, the plantation's four surface water systems were interconnected to reservoirs, the largest being Lake Wilson, or Wahiawā Reservoir. Storage was particularly important since historically, streamflow was extremely unreliable. The 2.5 billion gallon Wahiawā Reservoir was constructed in just two years and became the largest reservoir in Hawaiʻi. It is notable for being an instream reservoir at such a high elevation (1000 feet a.s.l) and that it can provide water to almost all of Waialua Sugar Company's fields. The dam rose 98 feet above the stream bed and inundated the gulches of both forks, with a total surface area of approximately 0.28 square miles. The elevation at the top of the dam is approximately 843 feet above sea level (asl).

James Dole formed the Hawaiian Pineapple Company in 1901, growing pineapples on 64 acers of land purchased from savings he brought from Boston. In 1913, Dole purchased a new machine that increased the rate of pineapple processing to 35 pineapples per minute, and subsequently increased the potential acreage that could be harvested.

In 1932, Castle & Cooke purchased a 21% interest in the Hawaiian Pineapple Company and in 1960, purchased the remaining shares, with Waialua Sugar Company remaining a subsidiary of Dole Corporation. In 1985, Castle & Cooke merged with FlexiVan Corp, becoming the Dole Food Company. The Waialua Sugar Company closed in 1996 due to economic pressure from international competition. Following the end of sugarcane production, Dole Food Company converted much of the land into diversified agriculture, growing a variety of products, mostly for local consumption, that continue today. In 2007, 18 commercial farms were relying on the irrigation system ranging in size from eight to 2,000 acres.

In 1927, the City and County of Honolulu's Wahiawā Wastewater Treatment Facility began discharging treated effluent into the reservoir.

In 1957, the Territory of Hawaiʻi Department of Land and Natural Resources' (DLNR) Division of Fish and Game designated Lake Wilson as the Wahiawā Public Fishing Area through a cooperative agreement with Castle & Cooke. The park is located on the South Fork Kaukonahua Stream and includes a boat launch, trails, and picnic facilities.

In 1987, with the passage of the State Water Code (HRS 174C), all wells and stream diversions had to be registered with the Commission by May 31, 1989. A list of the registered stream diversions for the Kiʻikiʻi hydrologic unit are provided in Table 1.

Figure 1. Streams, reservoirs, irrigation systems, registered stream diversions, with active and discontinued USGS stream gaging stations in the Ki'iki'i hydrologic unit, Leeward O'ahu.

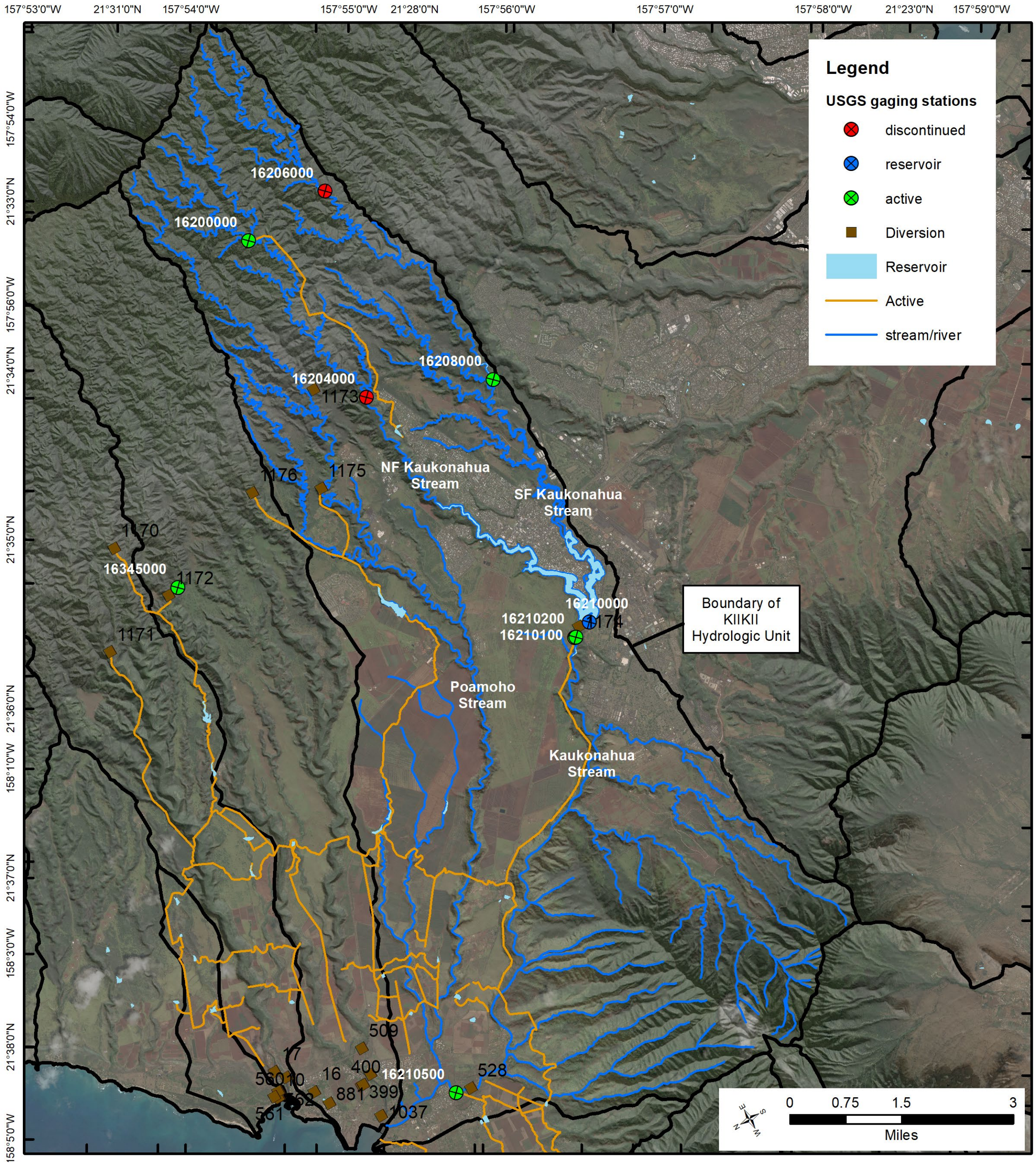


Table 1. Registrant, diversion ID, diversion name, stream, and additional information in the Kiʻikiʻi hydrologic unit, Oʻahu.

Registrant	Diversion ID	Diversion Name	Stream Name	Additional Information
WAIALUA SUGAR	1173	Poamoho Tunnel	Poamoho	Diverts water from Poahomo Stream to NF Kaukonahua Stream
WAIALUA SUGAR	1176	Helemano Intake	Helemano	Diverts water to Helemano Ditch
WAIALUA SUGAR	1175	Poamoho Intake	Poamoho	Diverts water to Helemano Ditch
WAIALUA SUGAR	1174	Wahiawā Reservoir	Kaukonahua	Diverts water from Wahiawā Reservoir to Wahiawā Ditch
ISHIDA H	528	Kaukonahua Pump	Kaukonahua	Pump from Kaukonahua Stream

Note: *Diversions originally registered by Waialua Sugar Company, Inc. are now owned and operated by Dole Food Company, Inc.*

HYDROGEOLOGIC CONTEXT:

The Kiʻikiʻi hydrologic unit drains a region on the north shore that includes groundwater and runoff from both the Koʻolau and Waiʻanae mountains, including an area identified as the Schofield Plateau. The Schofield Plateau is a unique geologic formation around the Schofield region where a large body of high-level groundwater occurs that is different from either dike impounded or perched groundwater sits in the saddle between the Koʻolau and Waiʻanae mountains[3]. The plateau is approximately 14 miles wide and 5 miles long, rising from sea level on the north and south sides to approximately 1,000 feet in elevation. The region has a unique geologic history due to its overlaying layers of lava, ash, and debris deposits[4]. Some ground water is perched within the weathered ash beds overlaying more dense lava flows[5]. Structural barriers, including rift-zone intrusives, stray dikes that are not part of a well-defined rift zone, and two extensive impounding structures generate groundwater head discontinuities ranging from the tens to hundreds of feet[6]. In the late 1930s, Swartz[7] mapped the electrical conductivity of saltwater beneath the freshwater in the region and delineated the absence of saltwater within a range of depths in the Schofield Plateau, identifying the northern and southern limits of the high-level water. Dale and Takasaki[8] referred to these geohydrologic barriers as water dams, possibly of intrusive rock that may be a composite of dike-intruded rock, erosional surface rock on Waiʻanae Volcanics buried by Koʻolau Basalt, and massive lavas. The Schofield Plateau high-

[3] Nichols, W.D., Shade, P.J., Hunt Jr., C.D. 1996. Summary of the Oahu, Hawaii, regional aquifer-system analysis. U.S. Geological Survey Professional Paper 1412-A.

[4] Stearns H.T., Vaksvik, K.N. 1935. Geology and ground-water resources of the island of Oʻahu, Hawaiʻi. U.S. Geological Survey, Division of Hydrography Bulletin 1, p. 479.

[5] Rosenau, J.C., Lubke, E.R., Hakaara, R.H. 1971. Water Resources of North-Central Oʻahu, Hawaiʻi. U.S. Geological Survey Water-Supply Paper 1899-D.

[6] Hunt Jr., C.D. 1996. Geohydrology of the Island of Oʻahu, Hawaiʻi. U.S. Geological Survey Professional Paper 1412-B.

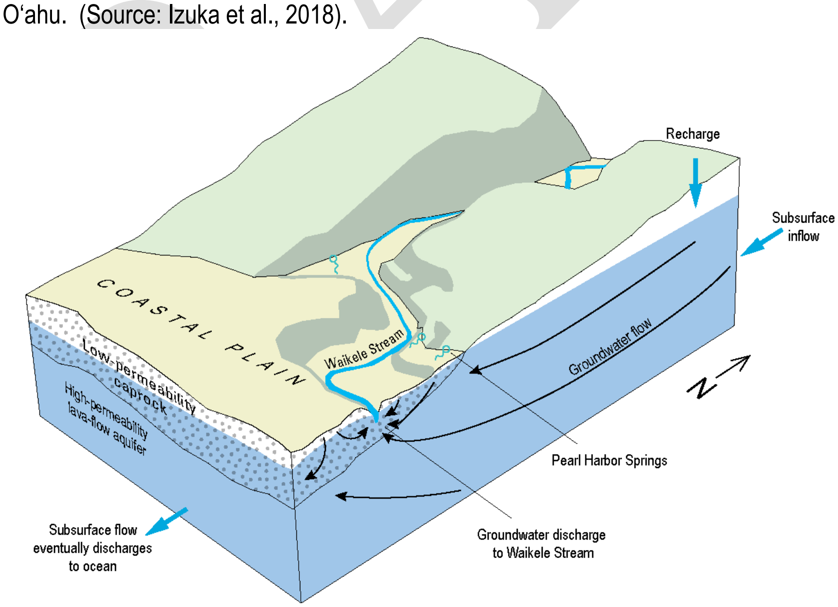
[7] Swartz, J.H. 1940. Resistivity survey of Schofield Plateau, *in* Stearns, H.T., ed., Supplement to the geology and ground-water resources of the island of Oʻahu, Hawaiʻi: State of Hawaiʻi, Division of Hydrography Bulletin 5, p. 56-59.

[8] Dale, R.H., and Takasaki, K.J. 1976. Probable effects of increasing pumpage from the Schofield ground-water body, Island of Oʻahu, Hawaiʻi. U.S. Geological Survey Water-Resources Investigations Report 76-47.

level groundwater is impounded to an elevation of 187-300 feet above sea level (asl) in permeable Koʻolau lava flows[9]. This contrasts with the basal aquifer which sits approximately 20 feet asl to the north and 30 feet asl to the south of the plateau. The water occurs in permeable Koʻolau lava flows and is considered continuous and very flat beneath much of the plateau. However, many unconformities add complexity to these generalizations: i.e., on the western side of the plateau's southern limit, there is a dike-intruded ridge of Waiʻanae Volcanics plunging eastward that is overlain by Koʻolau Basalt, compartmentalizing groundwater movement[10]. Despite the importance of this water body to the regional water cycle, the specific movement of water within and from it is not well understood. Transitional areas have been inferred from groundwater levels in wells that, in some cases, were likely penetrating Waiʻanae Volcanics. A detailed description of the groundwater occurrence, movement, and interactions with surface water in this area is described by Nichols et al.[11]. Incision by streams into the high-level groundwater generates gaining streamflow while low-elevation stream reaches gain flow from basal aquifer discharge (Figure 2).

Wahiawā Reservoir is located below the confluence of the North Fork Kaukonahua and South Fork Kaukonahua Streams. During stream channel development, surface water from the Waiʻanae Range diminished upon reaching the porous Koʻolau geology, recharging the groundwater system. The Koʻolau streams, and to some extent the Waiʻanae streams, cut deep gulches, exposing layer by layer the underlying geology. These stream channels have exposed subsurface water flows that contribute spring flow and groundwater gains to each stream.

Figure 2. Model of the relation between groundwater discharge in and near semi-confining caprock overlying the high permeability lava flow on Oʻahu. (Source: Izuka et al., 2018).



[9] Visher, F.N., Mink, J.F. 1964. Ground-water resources in Southern Oʻahu, Hawaiʻi. U.S. Geological Survey Water-Supply Paper 1778. 133 p.
[10] Hunt Jr., C.D. 1996. Geohydrology of the Island of Oʻahu, Hawaiʻi. U.S. Geological Survey Professional Paper 1412-B.
[11] Nichols, W.D., Shade, P.J., Hunt Jr., C.D. 1996. Summary of the Oʻahu, Hawaiʻi, regional aquifer-system analysis. U.S. Geological Survey Professional Paper 1412-A.

SURFACE FLOW:

Streamflow conditions have been monitored in the Kiʻikiʻi hydrologic unit at various elevations by the US Geological Survey (USGS). Two long-term continuous monitoring stations above the Wahiawā Reservoir continue to operate: USGS 16200000 North Fork Kaukonahua Stream at 1150 feet asl funded by the City and County of Honolulu and USGS; and USGS 16208000 South Fork Kaukonahua Stream at 860 feet asl funded by the Commission and USGS. Estimated low-flow duration discharge characteristics for various USGS stations in the Kiʻikiʻi hydrologic unit in the 1984-2013 climate period are provided in Table 3.

Table 3. Estimated median (Q_{50}) and low flow (Q_{70} to Q_{95}) values for USGS stations in the Ki'iki'i hydrologic unit for the 1984-2013 climate period. (Source: Cheng, 2016) [values in cubic feet per second (million gallons per day)]

station ID	station name	elevation (ft)	discharge (Q) for a selected percentage (xx) discharge was equaled or exceeded			
			Q_{50}	Q_{70}	Q_{90}	Q_{95}
16200000	NF Kaukonahua abv RB	1,150	6.3 (4.07)	3.7 (2.39)	1.7 (1.10)	1.0 (0.65)
16201000	RB of NF Kaukonahua	1,200	4.0 (2.59)	2.6 (1.68)	1.3 (0.84)	0.84 (0.54)
16204000	NF Kaukonahua	930	11.4 (7.35)	6.0 (3.88)	1.9 (1.23)	1.1 (0.71)
16206000	SF Kaukonahua	1,070	5.0 (3.23)	2.6 (1.68)	1.0 (0.64)	0.51 (0.33)
16208000	SF Kaukonahua at Pump E	860	8.2 (5.30)	4.6 (2.97)	1.8 (1.16)	0.95 (0.61)
16211003	Poamoho Stream	1150	2.8 (1.81)	1.6 (1.03)	0.65 (0.42)	--

As the reservoir formed by Wahiawā Dam (diversion 1174) is built instream, all flows (low and high flows) are captured by the dam. Therefore, the entirety of the flow-duration curve can be utilized to estimate water availability from Wahiawā Reservoir as depicted in Figure 3 and detailed in Table 4. Currently, very little water is returned to the stream below the reservoir at least 30% of the time, as evident in Table 5.

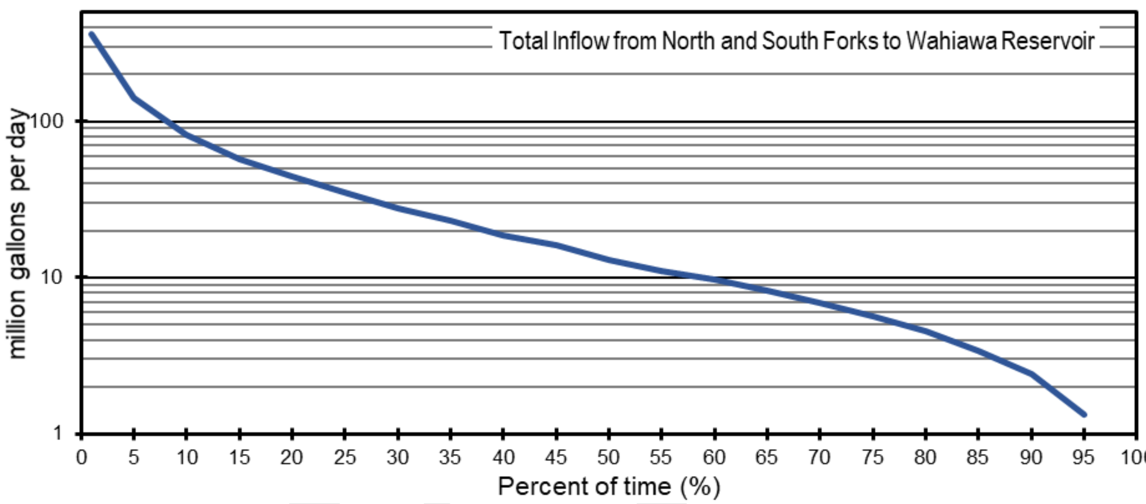
Table 4. Estimated flow-duration curve values for North Fork Kaukonahua (NF) and South Fork Kaukonahua (SF) inflow tributaries to Wahiawā Reservoir at USGS stations for the 1984-2013 climate period, Leeward O'ahu. [values in cubic feet per second (million gallons per day)]

station ID	tributary	discharge (Q) for a selected percentage (xx) discharge was equaled or exceeded										
		Q_{5}	Q_{10}	Q_{20}	Q_{30}	Q_{40}	Q_{50}	Q_{60}	Q_{70}	Q_{80}	Q_{90}	Q_{95}
16204000	NF	143 (92)	82 (53)	43 (28)	27 (17)	18 (11.6)	11.4 (7.35)	8.8 (5.69)	6.0 (3.88)	3.8 (2.46)	1.9 (1.23)	1.1 (0.71)
16208000	SF	76 (49)	46 (30)	25 (16)	16 (10.3)	11 (7.11)	8.2 (5.30)	6.2 (4.01)	4.6 (2.97)	3.2 (2.07)	1.8 (1.16)	0.95 (0.61)
	Total	219 (142)	128 (83)	68 (44)	43 (28)	29 (19)	20.2 (13.1)	15 (9.7)	10.6 (6.9)	7.0 (4.5)	3.7 (2.4)	2.05 (1.32)

Table 5. Selected streamflow parameters and flow duration discharge exceedance values for stations below Wahiawā Dam in the Kiʻikiʻi hydrologic unit, Oʻahu, Hawaiʻi. (Source: USGS 2020) [Flows are in cubic feet per second (million gallons per day]

					discharge (Q) for a selected percentage ($_{xx}$) discharge was equaled or exceeded			
station ID	station name	period of record	mean daily flow	14-day low flow	Q_{50}	Q_{70}	Q_{90}	Q_{95}
16210200	Kaukonahua blw Wahiawā Reservoir	2012-P	42.2 (27.3)	0.042 (0.027)	20.5 (13.3)	0.20 (0.13)	0.06 (0.04)	0.05 (0.03)
16210500	Kaukonahua at Waialua	2012-P	44.4 (28.7)	0.17 (0.11)	20.3 (13.1)	0.94 (0.61)	0.42 (0.27)	0.39 (0.25)

Figure 3. Estimated total flow duration curve for the combined inflow to Wahiawā Reservoir from the north and south forks of Kaukonahua Stream, Oʻahu.



<u>OTHER HYDROLOGIC CONSIDERATIONS</u>:

Evaporation from Wahiawā Reservoir

To estimate the water lost through evaporation from Wahiawā Reservoir, total daily evaporation I and solar radiation I data are available from the Schofield Barracks remote automated weather station (RAWS) approximately 1.9 miles away from Wahiawā Reservoir. From 1 January 2012 to 30 June 2018 (2373 days), E was available for 1853 days (78.1%) and solar radiation for 1946 days (82.0%) from this station. Missing data were gap-filled using a combination of linear correlation with total daily solar radiation ($E = 0.0003*R + 0.0487$; $R^2 = 0.88$), or the mean E for the Julian day (i.e., the same day of the year counted continuously from January 1) from all other years ($n = 3$ to 6). Evaporation from the reservoir varied seasonally, with total mean values peaking from May to August above 6.53 in per day and an average loss of 0.142 million gallons per day (Table 6).

Table 6. Estimated mean monthly evaporation (inches) from the surface of Wahiawā Reservoir from 2012-2018 and daily volume lost (million gallons per day, mgd).

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
inches	4.17	4.51	5.54	6.20	6.73	6.76	6.93	6.67	6.26	5.50	4.44	4.09
mgd	0.103	0.123	0.137	0.158	0.166	0.172	0.171	0.164	0.159	0.136	0.113	0.101

Current Use of Recycled Water
The Wahiawā Wastewater Treatment Facility (Wahiawā WWTF) produces R-1 level recycled water that is currently discharged into Wahiawā Reservoir. The Schofield Barracks WWTF was recently upgraded from R-2 to R-1 level treatment and is now mostly used in the Hawaii Agricultural Foundation Agricultural Park at Kunia via a new pipeline. However, a small amount (<0.5 mgd) of R-1 water from Schofield Barracks WWTF is discharged into Wahiawā Ditch below Wahiawā Reservoir.

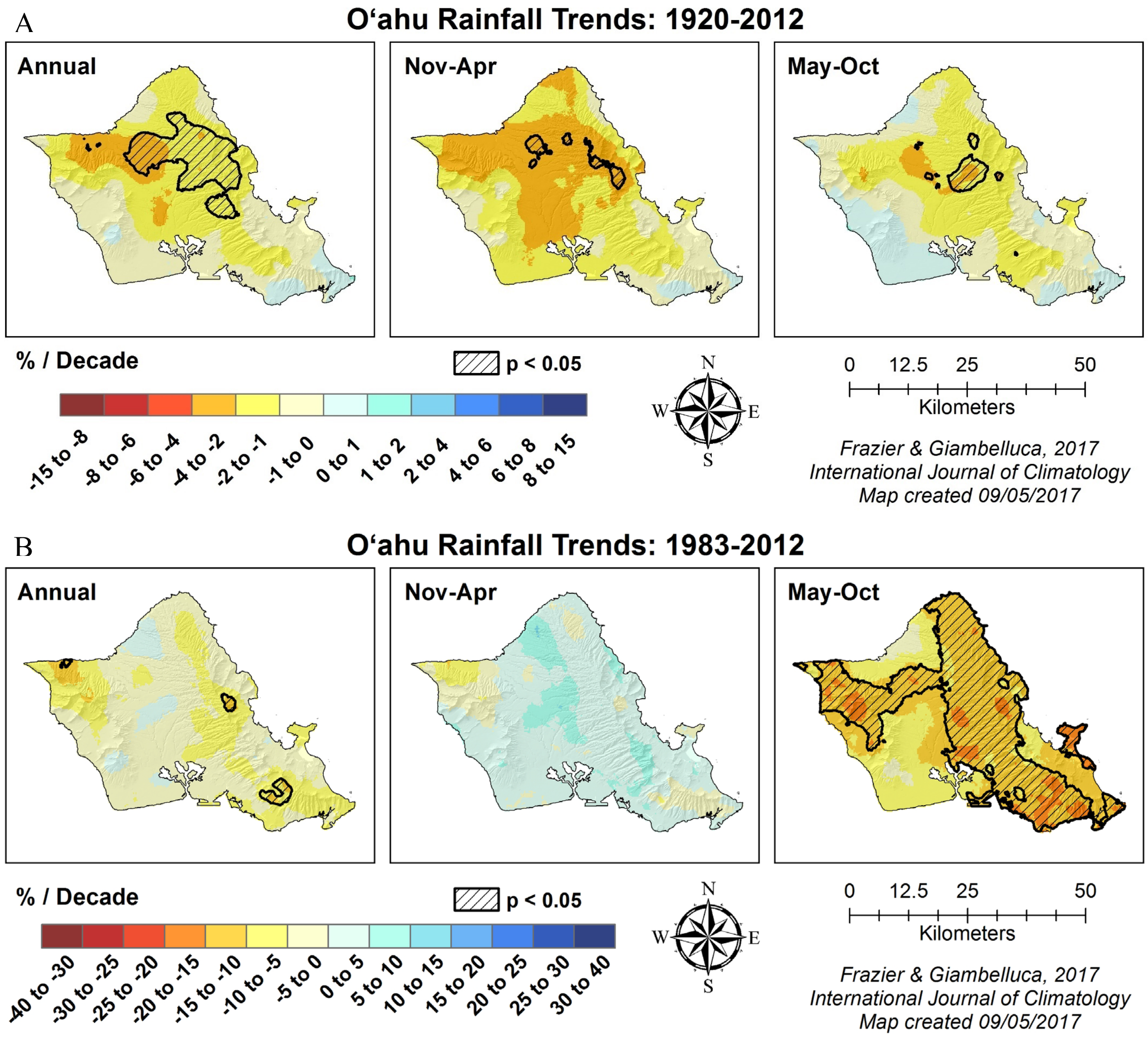
Long-term Changes in Rainfall
Long-term (1920-2012) and recent (1983-2012) trends in rainfall indicate significant declines in rainfall across some areas of Oʻahu, particularly during the dry season, including in the Kiʻikiʻi hydrologic unit (Figure 4)[12].

ISSUES/ANALYSIS:

The next step to developing an IFS 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 priority is always given to the four public trust purposes of water: (1) Water in its natural state; (2) Water used for traditional and customary practices; (3) water for domestic uses; (4) water reserved for the Department of Hawaiian Home Lands. If there is sufficient water to meet the instream uses, then off stream uses can be considered. The process is to be based upon best available information when weighing the present or potential, instream and noninstream uses.

[12] Frazier, A.G. Giambelluca, T.W. 2017. Spatial trend analysis of Hawaiian rainfall from 1920 to 2012. International Journal of Climatology, 37(5): 2522-2531.

Figure 4. Annual, wet season (Nov-Apr) and dry season (May-Oct) rainfall trends for the 1920-2012 (A) and 1983-2012 (B) periods, O'ahu. Hashed line areas represent significant trend over the period. (with permission from Frazier and Giambelluca, 2017)



Instream Use Considerations:
The maintenance of instream flows is important for the protection of traditional and customary Hawaiian rights as they relate to the maintenance of stream (e.g., hīhīwai, ʻōpae, ʻoʻopu) and riparian (vegetation) resources for gathering, recreation within streams, and the cultivation of taro.

The maintenance and restoration of stream and wetland habitat benefits from increased streamflow. A lack of continuous flow downstream of the Wahiawā Reservoir affects the availability of habitat for endemic aquatic species, the ability of the estuary to support endangered waterbirds, and the functioning of the bay and nearshore ecosystem. Below

Wahiawā Reservoir are 9.2 miles of potential stream habitat that are affected by low-flow conditions (see Table 5). Historic biota surveys by the Division of Aquatic Resources have identified numerous endemic species including ʻōpae kalaʻole (*Atyoida bisulcate)* and ʻoʻopū nākea (*Awaous stamineus*) in the lower reaches[13]. Increased streamflow will support the upstream recruitment of post-larvae juveniles, and the downstream dispersal of larvae. In 2021, Commission staff coordinated with staff from the Department's Division of Aquatic Resources (DAR) to survey biota below Wahiawā Reservoir at five elevations and found newly recruiting ʻoʻopū nākea at multiple elevations. Streamflow also benefits the muliwai at the mouth of the stream in Kaiaka Bay by supplying colder freshwater and nutrients that increase the productivity of the base of the aquatic food chain as well as reduced salinity important for juvenile fish[14]. Improved ecosystem function will support the growth of limu, a valuable cultural and natural resource.

Other instream uses that must be considered in Kiʻikiʻi include the maintenance of water quality (e.g., temperature, dissolved oxygen, transport of sediment and turbidity), the aesthetic value of water flowing in a stream, and ecosystem services (e.g., supporting riparian species of value, streambank stability, biogeochemical cycling), and the recreational value of the fishery in Wahiawā Reservoir to the community.

Current Diverted Flows from Wahiawā Reservoir to Wahiawā Ditch:
The original Wahiawā Ditch was a critical piece of infrastructure that supplied irrigation water to approximately 4,856.2 hectacres (ha) of cultivated sugarcane and some of the irrigation needs of 1,618.7 to 2,023.4 ha of pineapple, turning marginal land in Waialua into highly productive agricultural land (Figure 6)[15]. While sugarcane is no longer the principal crop grown in the region, a variety of other crops are grown on the land (Table 7) including papaya, mango, coffee, cacao, flowers, bananas, avocado, limes, lychee, macadamia nuts, and other tree crops. During the sugar plantation, approximately 20 to 30 mgd flowed in Wahiawā Ditch below the Wahiawā Reservoir. Current ditch flow rates are far below historic levels due to decreased demand for irrigation water and an increased reliance on groundwater sources (Figure 5). Table 8 provides annual flow statistics for Wahiawā Ditch from 2012 to 2021. The current (2020) estimated water demands for agriculture in the Wahiawā Ditch service area are 6.16 mgd, although the extent that certain crops rely on groundwater sources instead of Wahiawā Ditch (e.g., seed corn) included in this estimate is not clear.

The Agribusiness Development Corporation (ADC) is proposing to construct a new stream diversion works that includes a pump to withdrawal up to 5.1 mgd of water from Wahiawā Reservoir to support agriculture on ADC and Office of Hawaiian Affair lands recently acquired from the Galbraith Estate through a purchase by the Trust for Public Land (Figure 6). The

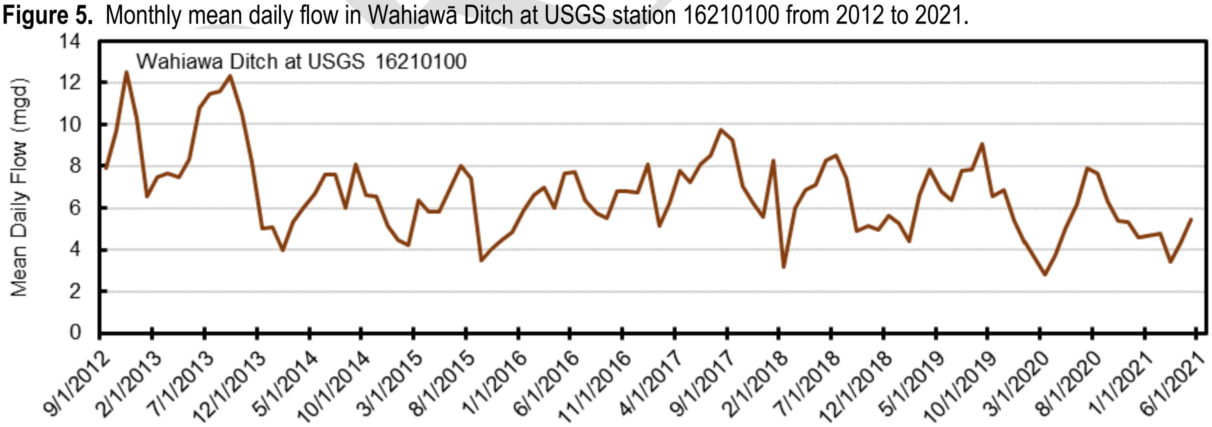
[13] Parham, J.E., Higashi, G.R., Lapp, E.K., Kuamoo, D.G.K., Nishimoto, R.T., Hau, S., Fitzsimons, J.M., Polhemus, D.A., Devick, W.S. 2008. Kiikii, Oahu (Watershed Code 36006). In: Atlas of Hawaiian Watersheds and Their Aquatic Resources. Division of Aquatic Resources, State of Hawaii Department of Land and Natural Resources.
[14] Keala, G., Hollyer, J.R., Castro, L. 2007. Loko iʻa: A Manual on Hawaiian Fishpond Restoration and Management. College of Tropical Agriculture and Human Resources, University of Hawaiʻi at Mānoa.
[15] Wilcox, Carol. 1997. Sugar water: Hawaii's plantation ditches. University of Hawaii Press, Honolulu, HI.

project also proposes to utilize the Wahiawā's WWTF R-1 effluent through a new pipeline, bypassing the reservoir.

Using the R-1 effluent reduces potential water quality hazards in Wahiawā Reservoir (i.e., eutrophication, bacterial pollution), but does not increase the availability of water during low-flow periods, since this discharge would have been utilized by the pumping upgrades or via the Wahiawā Ditch.

Wahiawā Reservoir is one of the largest reservoirs in the state of Hawaiʻi (Figure 8). In addition to the challenges of managing an instream reservoir under changing climate conditions, the Wahiawā Reservoir is also managed as a freshwater fishery and a recreational area. Reservoir management is dependent on local hydrological conditions (i.e., inflows, evaporation, precipitation), reservoir storage levels (i.e., engineering constraints, system operation, and dam safety rules), broad climatic patterns (seasonality, multi-year climate trends), and potential environmental constraints (i.e., water quality, turbidity, temperature, dissolved oxygen) of downstream flows. Development of a long-range master plan to improve Wahiawā Freshwater State Park and the management of the Wahiawā Irrigation System have identified potential conflicts between the recreational water needs of the community, the irrigation water supply, and flood control functions of the reservoir[16]. Reservoir storage (water level) is affected by inflow and release to Kaukonahua Stream and Wahiawā Ditch (Figure 7). The current dam safety regulations restrict the height of the water level in the reservoir to approximately 65 feet (above the local datum, roughly the stream channel), although the spillway is at 80 feet and the top of the dam is at 88 feet. Heavy rainfall events result in large volumes of runoff and sediment transported into the reservoir and sedimentation has affected the storage capacity of Wahiawā Reservoir to an unknown degree[17]. Improvements to reservoir storage by dredging the reservoir of sediment should benefit all users while meeting dam safety requirements.

Figure 5. Monthly mean daily flow in Wahiawā Ditch at USGS station 16210100 from 2012 to 2021.



[16] Element Environmental. 2007. Assessment of the Wahiawa Irrigation System, Wahiawa to Waialua, Oahu, Hawaii. Prepared for the State of Hawaii Agribusiness Development Corporation.
[17] Falinski, K. and Penn, D. 2018. Loss of reservoir capacity through sedimentation in Hawaiʻi: management implications for the 21st Century. *Pacific Science*, 72(1): 1-19.

Figure 6. Service area for the Wahiawā/Oahu/Ito Ditch from Wahiawā Reservoir.

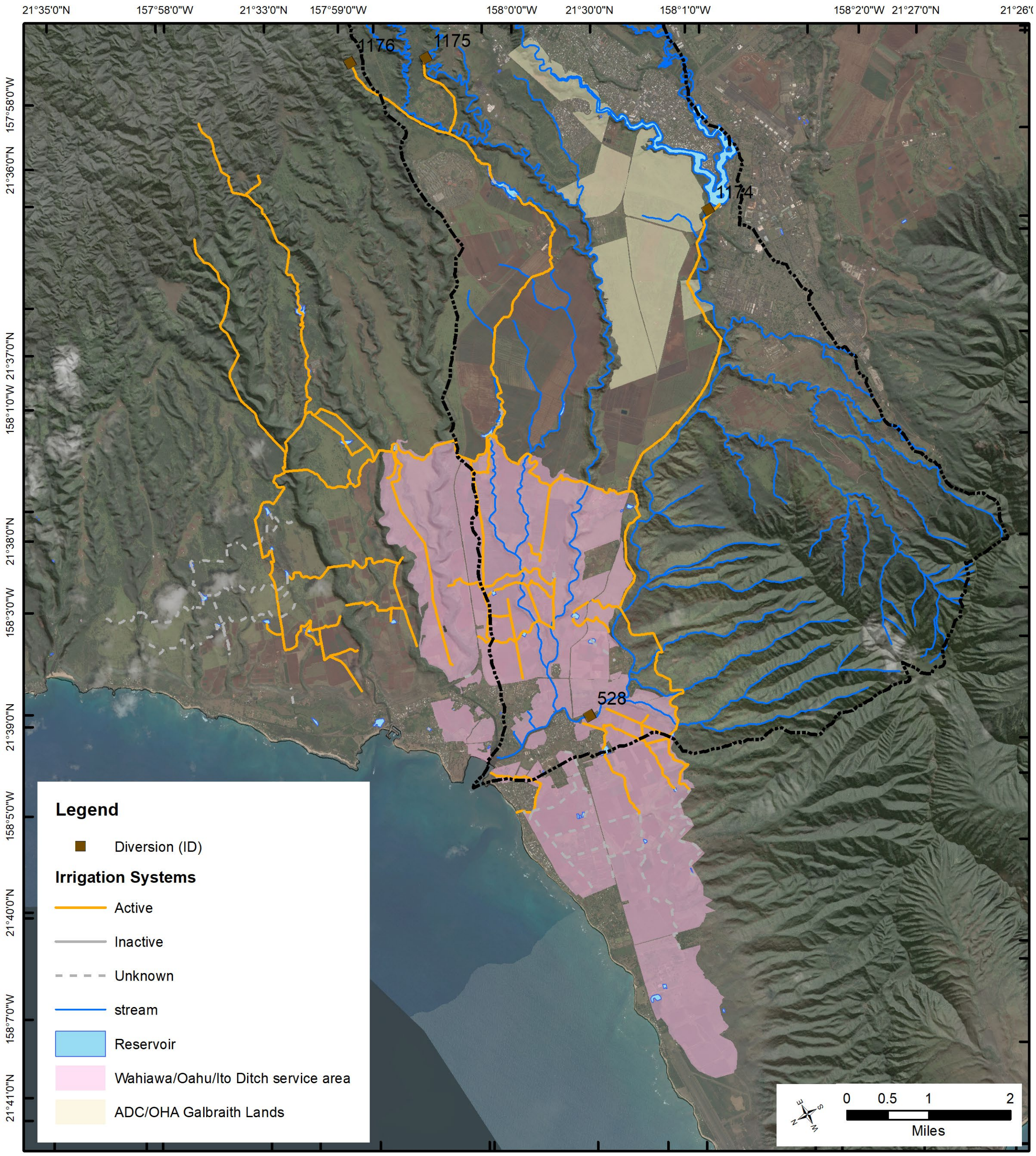


Table 7. Crop area from the 2015 and 2020 agricultural baseline for the Ki'iki'i hydrologic unit and estimated demand (based on estimated general irrigation requirements in gallons per acre per day, gad), O'ahu. [note: not all water is sourced from Wahiawā Ditch] (Source: Perroy et al., 2015).

	2015		2020			2015	2020
Crop	**Area (acres)**	**Area (mi²)**	**Area (acres)**	**Area (mi²)**	**General Irrigation Requirement (gad)**	**Estimated Demand (gpd)**	**Estimated Demand (gpd)**
Pineapple	2987.5	4.668	3130	4.890	2200	6.573	6.885
Coffee	--	--	19.2	0.03	3400		0.065
Diversified Crop	1351.7	2.112	2435	3.804	3400	4.596	8.278
Pasture	1050.9	1.642	1084	1.694	400	0.420	0.434
Seed Production	542.7	0.848	605.4	0.946	3400	1.845	2.058
Tropical Fruits	51.8	0.081	73.0	0.114	3400	0.176	0.248
Papaya	40.3	0.063	40.3	0.063	2200	0.089	0.089
Commercial Forestry	26.2	0.041	26.2	0.041	1800	0.047	0.047
Aquaculture	20.5	0.032	33.3	0.052	--	--	--
Banana	11.5	0.018	11.5	0.018	4000	0.046	0.046
Flowers / Foliage / Landscape	10.9	0.017	10.9	0.017	3000	0.033	0.033
Dryland Taro	1.3	0.002	1.3	0.002	10,000	0.013	0.013
Total	6095.4	9.524	7469.4	11.671		13.838	18.196

Table 8. Selected ditch flow parameters for USGS station 16210100 Wahiawā Ditch below Wahiawā Reservoir by year O'ahu, Hawai'i. (Source: USGS 2020) [Flows are in cubic feet per second (million gallons per day]

year	mean daily flow	14-day low flow	discharge (Q) for a selected percentage ($_{xx}$) discharge was equaled or exceeded			
			Q_{50}	Q_{70}	Q_{90}	Q_{95}
2013	13.85 (8.95)	4.70 (3.04)	13.00 (8.40)	10.52 (6.80)	7.11 (4.59)	4.82 (3.11)
2014	9.63 (6.23)	5.00 (3.23)	8.97 (5.80)	6.74 (4.35)	4.73 (3.06)	3.97 (2.57)
2015	8.51 (5.50)	3.70 (2.39)	7.85 (5.07)	6.07 (3.92)	3.76 (2.43)	3.29 (2.13)
2016	10.18 (6.58)	5.74 (3.71)	10.30 (6.66)	6.97 (4.50)	5.14 (3.32)	4.39 (2.84)
2017	11.50 (7.43)	5.37 (3.47)	11.30 (7.30)	8.52 (5.50)	5.80 (3.75)	4.53 (2.93)
2018	9.87 (6.38)	4.08 (2.63)	10.10 (6.53)	7.84 (5.07)	4.22 (2.73)	2.89 (1.87)
2019	10.45 (6.76)	5.34 (3.45)	10.30 (6.66)	8.69 (5.62)	5.75 (3.71)	4.78 (3.09)
2020	8.11 (5.24)	2.86 (1.85)	7.17 (4.63)	5.48 (3.54)	3.35 (2.17)	2.24 (1.45)
2021*	6.96 (4.47)	4.67 (3.02)	6.48 (4.19)	5.16 (3.33)	3.76 (2.43)	3.35 (2.16)
2012-2021	10.31 (6.66)	2.86 (1.85)	9.80 (6.33)	7.27 (4.70)	4.66 (3.01)	3.60 (2.33)

*up to June 1, 2021

Availability of Alternative Water Sources

In some locations, groundwater can be a viable and reliable alternative to streamflow, especially when prolonged drought conditions reduce the availability of surface water. Table 9 identifies the Honolulu Board of Water Supply (HBWS) groundwater wells and recent pumping rates for the Wahiawā Aquifer System and Table 10 identifies the wells registered by Dole Foods Company in the Kiʻikiʻi hydrologic unit.

Table 9. Groundwater pumpage from source wells for the Honolulu Board of Water Supply from the Wahiawā Aquifer System from January 2013 to June 2020. [Flows iin million gallons per day, mgd]

well ID	well name	Pump capacity (mgd)	average monthly pumpage (mgd)	median monthly pumpage (mgd)	maximum monthly pumpage (mgd)
2901-011	Wahiawa I-1	3.456	1.417	1.948	3.644
2901-012	Wahiawa I-2	3.456			
2902-001	Wahiawa II-1	3.024	1.249	1.326	2.525
2902-002	Wahiawa II-2	2.520			

Table 10. Groundwater pumpage statistics from wells operated by Dole Foods Company Hawaiʻi in the Kiʻikiʻi hydrologic unit for different periods of time. (Note: -- value is unknown , n/a = not applicable) [Flows in million gallons per day, mgd]

		average monthly pumpage (mgd)		median monthly pumpage (mgd)		maximum monthly pumpage (mgd)	
well ID	well name	1980-1995	1995-2020	1980-1995	1995-2020	1980-1995	1995-2020
3102-002	Helemano Pump 24	1.544	0.000	0.934	0.000	6.446	0.000
3203-002	Waialua Pump 26	1.752	0.000	1.103	0.000	5.852	0.001
3408-004	Pump 1	1.749	0.512	1.579	0.351	5.682	5.492
3407-001	Pump 7B	2.222	0.543	1.416	0.059	1.416	0.059
3404-001	Waialua Pump 17	5.390	0.000	3.272	0.000	24.625	0.000

Figure 7. Mean monthly surface water elevation in Wahiawā Reservoir from 2005 to 2020 measured at USGS 16210000.

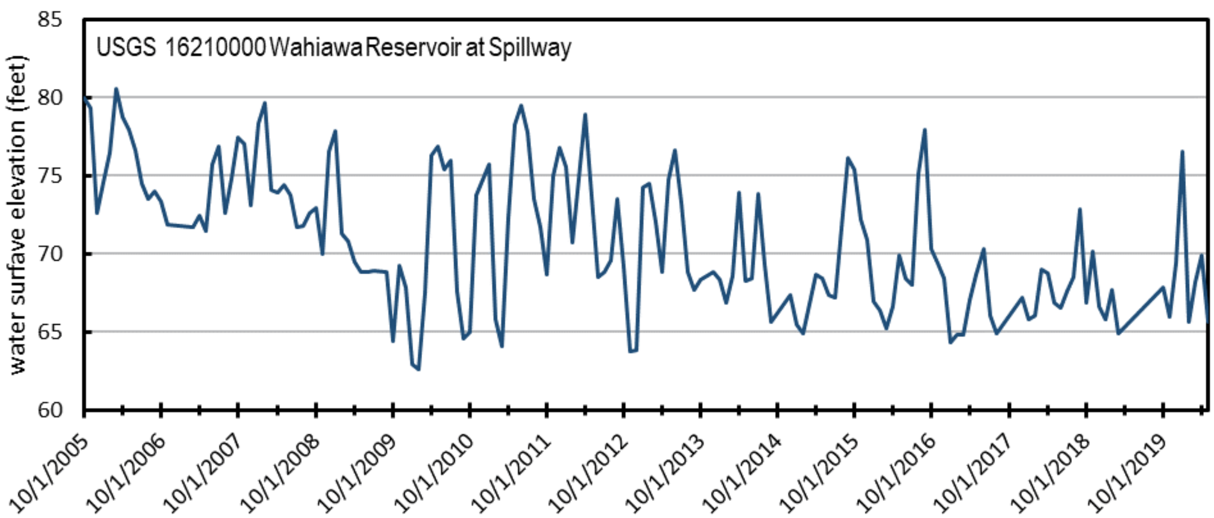
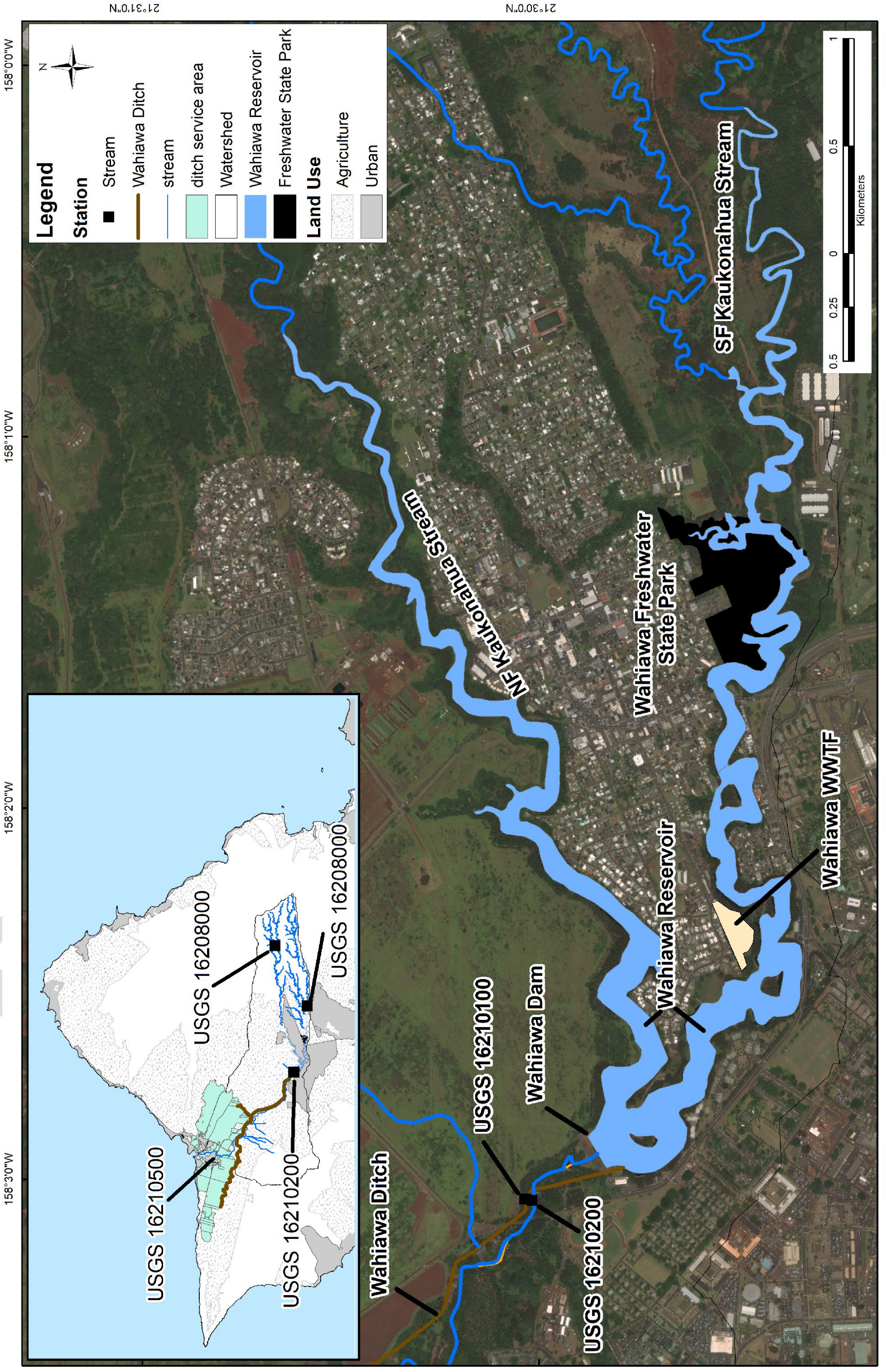


Figure 8. Map of stream inflow and outflow from Wahiawā Reservoir and surrounding lands with Wahiawā Ditch service area and currently active USGS stream gaging stations identified in the insert.



CONSISTENCY WITH THE HAWAIʻI WATER PLAN

The Water Resource Protection Plan (WRPP), updated in 2019,[18] 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.

Assessment Summary: Kaukonahua Stream

Maintenance of Fish and Wildlife Habitat. The Hawaii Stream Assessment ranks Kiʻikiʻi hydrologic unit aquatic resources as "moderate" (2 of 4). ʻOʻopu nākea (*Awaous stamineus*) and ʻōpae kalaʻole (*Atyoida bisulcata*) have been found in Kaukonahua Stream. Several native damselfly species (e.g., *Megalagrion sp., Megalagrion nigrohamatum nigrolineatum, Megalagrion hawaiiense, Megalagrion leptodemas, Megalagrion oceanicum*) have also been identified in Kiʻikiʻi. Low- to mid-elevation reaches below Wahiawā Dam have the potential to support ʻoʻopu ʻakupa (*Eleotris sandwicensis*), āholehole (*kuhlia sp.)*, and ʻoʻopu nākea (*Awaous stamineus*), even if the dam prevents colonization of higher elevation reaches[19].

Outdoor Recreational Activities. Kiʻikiʻi has "outstanding" (4 of 4) outdoor recreational opportunities based on the Hawaii Stream Assessment, including camping, hiking trails, fishing, swimming, boating, parks, hunting, and scenic views and was identified as a candidate stream for protection based on its "blue ribbon" recreational resources. However, current dam safety regulations are negatively affecting the freshwater fishery, which necessitates higher reservoir volumes that support spawning and a healthy ecosystem.

Maintenance of Ecosystems. The riparian resources of Kiʻikiʻi were classified as "substantial" (3 of 4) by the Hawaii Stream Assessment. Thirty percent of the hydrologic unit has native forest cover, there are two species of threatened or endangered bird species, two rare plant species, and palustrine wetland identified by the U.S. Fish and Wildlife Service. Part of the hydrologic unit is protected by a forest reserve or natural area reserve.

Aesthetic. Wahiawā Reservoir supports aesthetic value within Wahiawā town and via Wahiawā Freshwater State Park.

Maintenance of Water Quality. The State of Hawaiʻi Department of Health has established total maximum daily loads (TMDL) for upper Kaukonahua (north and south forks of Kaukonahua) above Wahiawā Reservoir to stimulate and guide action that will control sources of excessive nutrients and sediment, and to improve the water quality of the streams so that the designated and existing uses of waterbodies throughout the Kaiaka Bay watershed will be

[18] State of Hawaiʻi Commission on Water Resource Management. 2019. Water Resource Protection Plan 2019. Prepared by Townscape, Inc. https://dlnr.hawaii.gov/cwrm/planning/hiwaterplan/wrpp/
[19] Tingley III, R.W., Infante, D.M., MacKenzie, R.A., Cooper, A.R., Tsang, T-P. 2019. Identifying natural catchment landscape influences on tropical stream organisms: classifying stream reaches of the Hawaiian Islands. *Hydrobiologia*, 826: 67-83.

protected and sustained. Kaiaka Bay has been listed by DOH as an impaired water body under Section 202(d) due to excessive nutrients and turbidity.

Conveyance of Irrigation and Domestic Water Supplies. Kaukonahua Stream is not used for the conveyance of irrigation or domestic water supplies.

Protection of Traditional and Customary Hawaiian Rights. Kiʻikiʻi did not receive a rating for cultural resources by the Hawaii Stream Assessment. There are archeological sites along Kaukonahua Gulch with ʻauwai and terracing, indicating loʻi kalo production was evident. Heiau of different sizes are present and scattered house sites are found in the gulches[20]. Kaukonahua Gulch was the original location of the Keanini stone, although it was moved out of the gulch and placed next to the Kūkaniloko birthing stones. Limu was historically collected from the muliwai in Kaiaka Bay. Stream restoration would likely benefit the return of these cultural practices.

Noninstream Uses. From 2012 to 2021, mean annual flow in Wahiawā Ditch varied from 6.92 cfs (4.47 mgd) to 11.50 cfs (7.43 mgd), with the lowest average 14-day flow ranging from 2.86 cfs (1.85 mgd) to 5.74 cfs (3.71 mgd). The uses for this ditch are primarily diversified agriculture and specialty crops.

<u>DRAFT RECOMMENDATION</u>:

<u>Proposed Action: Amended Interim IFS</u>
Recognizing the reasonable and beneficial uses of water for diversified agriculture and the importance of balancing off-stream and instream uses, staff recommends that one measurable interim IFS be established for Kaukonahua Stream below Wahiawā Reservoir at USGS 16210200 on Kaukonahua Stream. The interim IFS shall be a flow of 3.50 cubic feet per second (2.26 million gallons per day), representing the Q_{90} flow minus the mean daily evaporative loss from the reservoir surface. With sufficient storage of higher flows in Wahiawā Reservoir, current off-stream uses of approximately 10 to 15 mgd are not expected to be affected by this interim IFS. However, there is insufficient data to evaluate if there is sufficient reservoir capacity given the current dam safety regulations to meet new off-stream uses proposed by ADC and meet the interim IFS. Further, current dam safety regulations limit the functionality of the recreational freshwater fishery as reservoir levels remain too low to provide for spawning habitat.

<u>IMPLEMENTATION</u>:

- Staff shall seek to enforce the provisions of the State Water Code should any unauthorized or non-permitted diversions be discovered in the course of its fieldwork. Staff recommends that all owners of unauthorized diversion works structures contact staff to file the necessary applications to seek compliance with all permitting requirements set forth by the Code.

[20] Desilets, M., Orr, M., Descantes, C., McElroy, W., Sims, A., Gaskell, D., Maio Ano, M. 2009. Draft: Traditional Hawaiian Occupation and Lo Alii Social Organization on Oahu's Central Plateau: An Ethno-Historical Study. GANDA ms. As cited in Office of Hawaiian Affairs Traditional Cultural Property Study of Kūkaniloko. 2000.

- Staff shall continue to coordinate with DLNR Engineering Division, DAR, ADC and Dole Foods to identify and determine appropriate actions to attain the proposed interim IFS values downstream of Wahiawā Reservoir.
- Any party diverting water from a stream shall be responsible to maintain system efficiencies, minimize offstream water losses, and minimize impacts to the natural stream resource.

MONITORING:

- State of Hawaii DLNR Engineering Division will continue to co-fund USGS 16210000.
- City & County of Honolulu Department of Environmental Services will continue to co-fund USGS station 16210200.
- Periodic biological surveys shall be conducted, subject to available funding, to monitor the response of stream biota to post-interim IFS implementation.
- Likewise, anyone claiming that negative impacts are a direct result of actions (i.e., diverting too much water, violating the interim IFS) caused by another party, shall monitor and document the impact upon instream or noninstream uses, including economic impacts. Data shall be provided to staff to substantiate any claims.
- All claimants shall cooperate with staff in conducting appropriate investigations and studies, particularly with regard to granting access to stream channels and private property related to such investigations, subject to the provisions of the State Water Code, Chapter 174C, HRS.

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.
- Staff shall assess the implementation of these strategies on an as-needed basis, as may be necessary upon consultation with the affected parties.

Ola i ka wai,

M. KALEO MANUEL
Deputy Director

Note: Exhibit 1 is available from the Commission website at
https://dlnr.hawaii.gov/cwrm/surfacewater/ifs/oahu/3082-kiikii/

Exhibit 1 Instream Flow Standard Assessment Report for Kiʻikiʻi Hydrologic Unit 3082, PR-2020-15

APPROVED FOR SUBMITTAL:

SUZANNE D. CASE
Chairperson