Appendix D

Water Quality and Biological Reconnaissance Surveys of Lower Kaipapa‘u Stream Near Hau‘ula, O‘ahu

AECOS, Inc.

Water quality and biological reconnaissance surveys of lower Kaipapa`u Stream near Hau`ula, O`ahu[1]

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Introduction

The Hawaii Department of Transportation is planning to replace the Kaipapa`u Stream bridge on Kamehameha Highway in Hau`ula, along the windward coast of O`ahu. It is proposed that the bridge will be replaced within the highway right-of-way~~ and without a need to build structures in the stream channel.~~ Please see note in Reference.

On May 14, 2004, two *AECOS* biologists conducted a reconnaissance survey of Kaipapa`u Stream at Kamehameha Highway on the windward coast of O`ahu (Figure 1). The purpose of the survey was to ascertain biological resources found around the Kamehameha Highway Bridge. This report presents the findings of that survey.

General Site Description

Kaipapa`u Stream, State Perennial Stream ID No. 3-1-10, is an interrupted perennial stream that originates in the northern section of the Ko`olau Mountain and descends from an elevation of around 2600 ft (792 m). An interrupted perennial stream is one that flows year-round in the upper reaches and only intermittently at lower elevations. Kaipapa`u Stream flows under Kamehameha Highway and discharges at the shore between Kaipapa`u Point and Hau`ula Beach Park. A fringing coral reef lies offshore.

In the vicinity of Kamehameha Highway, Kaipapa`u Stream is channelized and the banks are hardened in most places. Upstream from the bridge, the left bank of the stream is hardened and yards of neighboring houses abut the wall. The right bank of the stream is an eroding soil bank vegetated with elephant grass (*Pennistum purpureum*). Further upstream, the boulder-bottom stream narrows as it climbs up into the valley. Immediately upstream from the bridge, the stream widens as it flows

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nearly parallel to the bridge. At the time of our survey, the stream was flowing under the right side of the bridge because the left underpass was clogged with broken tree branches (Figure 2). There is a deep pool under the right side of the bridge and then the stream drops slightly and widens as it flows the short distance to the ocean (Figure 3). It is clear that this section of the stream has been channelized, as it flows between houses with large yards and sections of the banks are hardened.

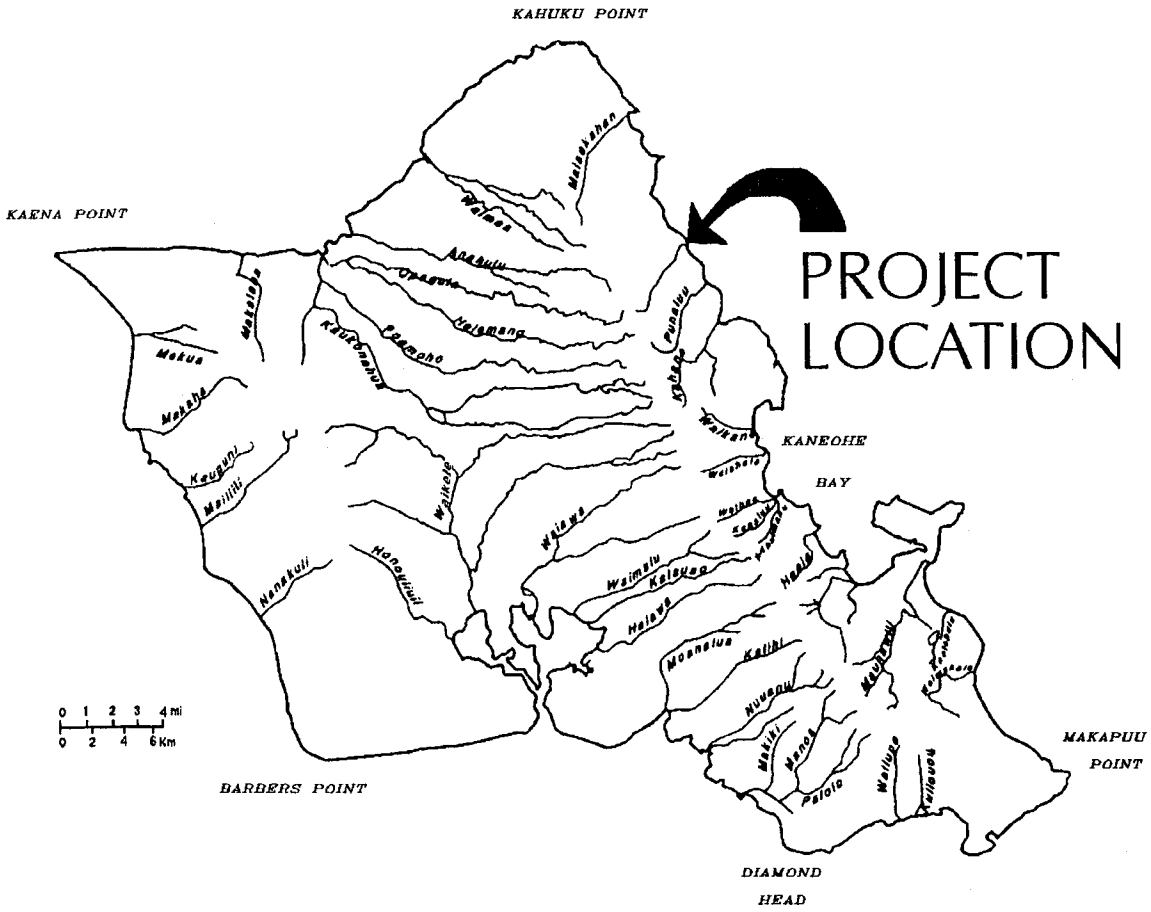

Figure 1. Project location on the Island of O`ahu.

Vegetation

Typical weedy or ruderal plant species and coastal plants were observed in the vicinity of the stream and bridge. False *kamani* (*Terminalia catappa*) and coconut palms (*Cocos nucifera*) were growing near the road and along the stream banks. Umbrella sedge (*Cyperus alternifolius*) and para grass (*Brachiaria mutica*) were growing on the

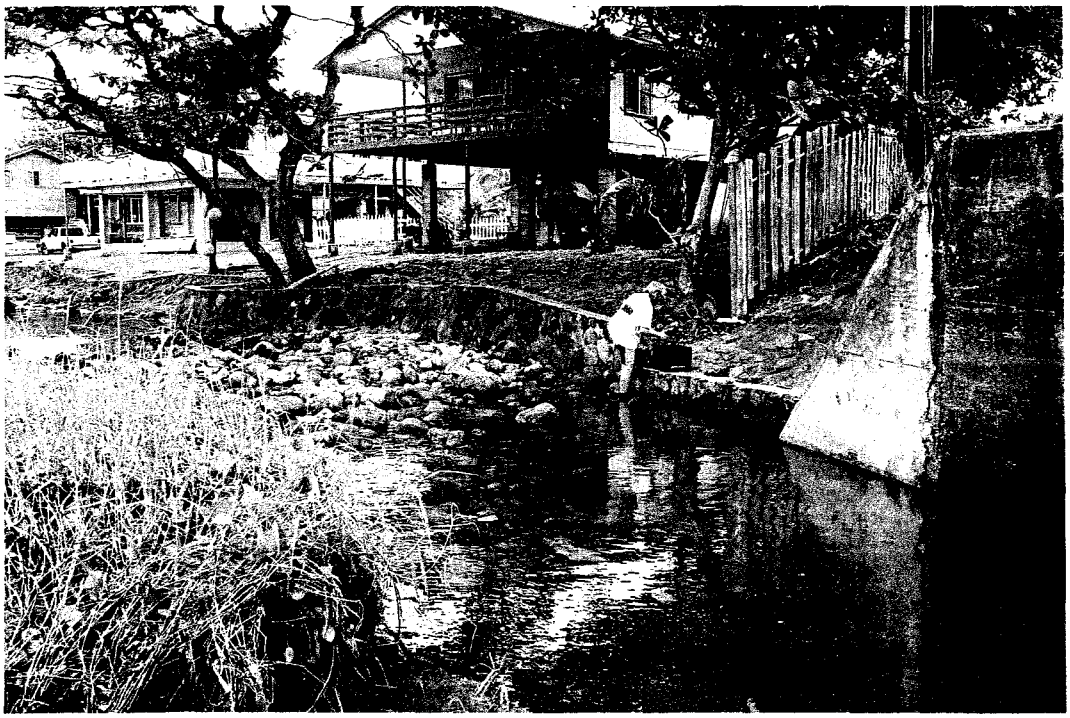

Figure 2. Kaipapa`u Stream upstream from Kamehameha Highway Bridge. Note the significant log jam on the left side of the bridge.

Figure 3. Kaipapa`u Stream at water quality sampling Station 1, downstream from Kamehameha Highway Bridge.

banks and on a sandbar just downstream from the bridge. *Naupaka kahakai* (*Scaevola sericea*), wedelia (*Sphagneticola trilobata*), seashore rushgrass (*Sporobolus virginicus*), and beach morning glory (*Ipomoea pes-caprae*), along with several common ornamental plants were growing throughout the project area. None of these species is listed as threatened or endangered, or otherwise would be considered rare or special by the State or Federal governments (DLNR, 1998; Federal Register, 1999a, b, 2001) and can be replanted when the construction is completed.

Water Quality

On May 14, 2004, *AECOS* biologists collected water samples from three sites around the Kamehameha Bridge on Kaipapa`u Stream. Station 1 was located approximately 12 m downstream from the bridge, Station 2 was located approximately 10 m upstream from the bridge, and Station 3 was located near the shoreline even with the *makai* end of the left bank rock wall. Some parameters were measured by field meter and others in water samples collected in appropriate containers and taken to the *AECOS* Laboratory in Kane`ohe (laboratory Log No. 18741). Table 1 lists field instruments and analytical methods used with these samples.

Stations 1 and 2 were located in the freshwater section of the stream and Station 3 was located near the coast where stream flow and coastal marine waters can mix. The parameters measured at Station 3 can be expected to vary over time as the tide rises and falls and as stream flow increases and decreases dependent upon rainfall in the watershed. The results for the morning of May 14, 2004 correspond in time with a flooding tide, with the a low tide of 0.2 ft (lower low water or LLW) at 05:47 am and a high tide of 1.6 ft (lower high water or LHW) at 13:30 (NOAA, 2004) and heavy rainfall near the headwaters of the stream in the mountains. The water quality of the stream in the project area is dominated by outflow from Kaipapa`u Stream.

The primary purpose of the May 14, 2004 water quality measurements was to characterize the existing aquatic environment, not to set baseline values or determine compliance with Hawaii's Water Quality Standards. In fact, the State criteria for all nutrient measurements, turbidity, and total suspended solids are based upon geometric mean values and a minimum of three separate samples per location would be needed to compute a geometric mean (HDOH, 2000). Nonetheless, our results can be evaluated against the water quality criteria for streams (Table 2) as long as limitations regarding a possible lack of representativeness are realized.

The analyses of the water quality samples collected from Kaipapa`u Stream on May 14, 2004 (Table 3) show normal temperature and pH values, with relatively low percent saturation of dissolved oxygen. Turbidity levels and TSS concentrations were very low. Ammonia and total phosphorus levels were low, but high nitrate+nitrite levels elevated the total nitrogen levels as well.

Table 1. Analytical methods and instruments used for the May 14, 2004 water quality sampling of Kaipapa`u Stream near Hau`ula, O`ahu.

Analysis	Method	Reference	Instrument
Dissolved Oxygen	EPA 360.1	EPA (1979)	YSI Model 550 DO meter
Nitrate + Nitrite	EPA 353.2	EPA (1993)	Technicon AutoAnalyzer II
Temperature	thermister calibrated to NBS cert. thermometer (EPA 170.1)	EPA (1979)	YSI Model 550 DO meter
Total Nitrogen	persulfate digestion/EPA 353.2	D'Elia et al. (1977) / EPA (1993)	Technicon AutoAnalyzer II
Total Phosphorus	persulfate digestion/EPA 365.1	Koroleff in Grasshoff et al. (1986)/EPA (1993)	Technicon AutoAnalyzer II
Total Suspended Solids	Method 2540D (EPA 160.2)	Standard Methods 18th Edition (1992); EPA (1979)	Mettler H31 balance
Turbidity	Method 2130B (EPA 180.1)	Standard Methods 18th Edition (1992); EPA (1993)	Hach 2100P Turbidimeter

D'Elia, C.F., P.A. Stendler, & N. Corwin. 1977. *Limnol. Oceanogr.* 22(4): 760-764.
EPA. 1979. Methods for Chemical Analysis of Water and Wastes. U.S. Environmental Protection Agency, EPA 600/4-79-020.
EPA. 1993. Methods for the Determination of Inorganic Substances in Environmental Samples. EPA 600/R-93/100.
EPA. 1994. Methods for Determination of Metals in Environmental Samples, Supplement 1. EPA/600/R-94/111. May 1994.
Grasshoff, K., M. Ehrhardt, & K. Kremling (eds). 1986. Methods of Seawater Analysis (2nd ed). Verlag Chemie, GmbH, Weinheim.
Standard Methods. 1992. Standard Methods for the Examination of Water and Wastewater. 18th Edition. 1992. (Greenberg, Clesceri, and Eaton, eds.). APHA, AWWA, & WEF. 1100 p.

Despite the fairly rapid stream flow, the water was not well saturated with dissolved oxygen (70 - 76 %), falling short of the percent saturation of dissolved oxygen criterion established by the State Department of Health (> 80%) (HIDOH, 2000). This result is somewhat unusual considering the water was fresh and moving. Values recorded for turbidity (1.98 - 2.02 ntu) and TSS concentrations (0.3 - 8 mg/l) were very low, demonstrating the value of an intact forest in the upper watershed in maintaining good water quality. Although ammonia levels were low (5 µg/l at Station 2 and not

detected in the other two samples), concentrations of the other component of inorganic nitrogen, nitrate + nitrite, were high (246 - 319 µg/L) and accounted for the majority of the total nitrogen concentrations (284 - 403 µg/L). Total phosphorus levels were low (17 - 23 µg/L).

Table 2. State of Hawaii geometric mean criteria for streams (HAR §11-54-05.2(b)(1)).

Total Nitrogen (µg N/l)	**Nitrate + Nitrite Nitrogen (µg N/l)**	**Total Phosphorus (µg P/l)**	**Total Suspended Solids (mg/l)**	**Turbidity NTU**
250.0*	70.0*	50.0*	20.0*	5.0*
180.0**	30.0**	30.0**	10.0**	2.0**

* wet season - November 1 through April 30.
** dry season - May 1 through October 31

- pH - not vary more than 0.5 units from ambient and not be lower than 5.5 nor higher than 8.0.
- Dissolved oxygen - not less than 80% saturation.
- Temperature - not vary more than 1 °C from ambient.
- Specific conductance - not more than 300 µmhos/cm.

Table 3. Water quality characteristics of Kaipapa`u Stream from samples taken on March 14, 2004.

	Time	**Temp. (°C)**	**DO (mg/l)**	**DO % sat**	**pH (pH units)**	**Salinity (ppt)**
Station 1	0950	22.0	6.11	70	7.06	<1
Station 2	1100	22.7	6.34	74	7.52	<1
Station 3	1010	23.3	6.43	76	7.42	<1

	Turbidity (ntu)	**TSS (mg/l)**	**Ammonia (µg N/l)**	**Nitrate + nitrite (µg N/l)**	**Total N (µg N/l)**	**Total P (µg P/l)**
Station 1	1.98	0.3	<1	304	335	20
Station 2	2.12	8	5	319	403	23
Station 3	2.02	0.7	<1	246	284	17

Aquatic Biota

Observations during this survey were limited to the vicinity of the Kamehameha Highway Bridge and a short distance upstream and downstream of the bridge. Even though the Hawaii Stream Assessment ranks Kaipapa`u Stream as having "limited" aquatic resources (Hawaii Cooperative Park Service Unit, 1990), recent studies have found the stream to be one of the best in this regard on O`ahu (Englund, 2000). The upper watershed of Kaipapa`u Stream is largely undeveloped and consists of native

forest. The riparian vegetation, aquatic habitats, and assemblages of native aquatic insects are of the highest quality on O`ahu and the stream should be considered one of the best remaining in the Hawaiian archipelago (Englund, 2000).

Our brief survey revealed quite a few aquatic species in the lower reach (Table 4). The prawn and goboid fishes are anadromous, meaning that they migrate to and from the ocean. The estuary is a gathering point for the juvenile *`o`opu*, which then migrate upstream as they grow larger. *`Opae `oeha`a* are common native residents (remain as adults) in the estuarine environment, and the *`ama `ama* and *aholehole* reside in the estuary as juveniles and migrate into the ocean as they grow. A large school of tilapia resides in the deep pool under the right side of the bridge. We made a possible sighting of the relatively rare (on O`ahu) *`o`opu nopili* (*Sicypoterus stimpsoni*), although we were unable to make a definitive species determination.

Table 4. Checklist of aquatic biota observed in the lower reach of Kaipapa`u Stream at the Kamehameha Highway Bridge.

INVERTEBRATES				
MOLLUSCA, GASTROPODA	(mollusks)			
NERITIDAE				
Neritina vespertina Sowerby	*hapawai* (adults & eggs)	**end**	10	U
ARTHROPODA, CRUSTACEA	(crustaceans)			
PALIEMONIDAE				
Macrobranchium grandimanus (Randall)	*`opae `oeha `a*	**end**	10	U
VERTEBRATES				
VERTEBRATA, PISCES	(fishes)			
CICHLIDAE				
Sarotherodon sp.	tilapia	nat	10	C
GOBIIDAE				
Awaous guamensis (Valenciennes)	*`o`opu nakea*	**ind**	10	O
Stenogobius hawaiiensis Watson	*`o`opu naniha*	**end**	10	C
?Sicypoterus stimpsoni (Gill)	*`o`opu nopili*	**end**	10	R
KUHLIIDAE				
Kuhlia sandvicensis (Steindachner)	*aholehole*	**end**	10	C
MUGILIDAE				
Mugil cephalus L.	*`ama `ama*	**ind**	10	C
POECILIIDAE				
Gambusia affinis (Baird & Girard)	mosquitofish	nat	10	U
Poecilia mexicana (Steindachner)	Mexican molly	nat	10	O

KEY TO SYMBOLS USED IN TABLE 4:

Status:

nat - naturalized. An introduced or exotic species.
ind - indigenous. A native species also found elsewhere in the Pacific.
end - endemic - A native species found only in the Hawaiian Islands.

QC Code:

10 - Observed in the field by aquatic biologist on May 14, 2004.
20 - Collected; identified in the laboratory; specimen(s) not saved.

Abundance categories:
R - Rare - only one or two individuals seen.
U - Uncommon - several to a dozen individuals observed.
O - Occasional - regularly encountered, but in small numbers.
C - Common - Seen everywhere, although generally not in large numbers.
A - Abundant - found in large numbers and widely distributed.
P - Present - noted as occurring, but quantitative information lacking.

Typical intertidal and subtidal invertebrates (mussels and oysters, *Theodoxus cariosus*, *Nerita picea*, and *Littoraria pintado*) were observed close to the shore, but a fair distance from the project area. *Scylla serrata* (Samoan crab), *`o`io* or bonefish (Albulidae), and a *Trachemys scripta elegans* (red-eared slider turtle) were reported by neighbors as being present downstream from the bridge close to the shore.

Discussion

The bridge proposed for this site will be replaced within the highway right-of-way~~and without needing to build structures in the stream~~*, therefore, water quality impacts to the stream and nearshore environment can be largely avoided. None of the area vegetation is threatened or endangered and this construction project provides the opportunity to replace some of the non-native vegetation with more desirable strand trees and shrubs, such as *naupaka* (*Scaevola sericea*), *kamani* (*Calophyllum inophyllum*), *hala* (*Pandanus tectorius*), and *niu* or coconut.

The new bridge design should consider enlarging the openings under the bridge to prevent "log jams," which can result in erosion elsewhere along the stream. Elimination of potential log jams will likely also enhance habitat and passage for some of the native animals such as the *`opae `oeha `a, `o`opu nopili*, and other gobies and minimize the habitat for tilapia.

Some fishing and possibly limu collection occurs just off the shore in this area. It will be important to this user group that the quality of the water in Kaipapa`u Stream is maintained and does not affect their activities.

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References Cited

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National Oceanographic and Atmospheric Administration (NOAA). 2004. Tide predictions. Website URL: http://co-ops.nos.noaa.gov/tides04/tab2wc3.html#167.

NOTE:

* Since initial study, plans include the construction of piers in the stream.

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