
Instream Flow Standard Assessment Report

Island of Maui

Hydrologic Unit 6047

Waikamoi

December 2009

PR-2009-01



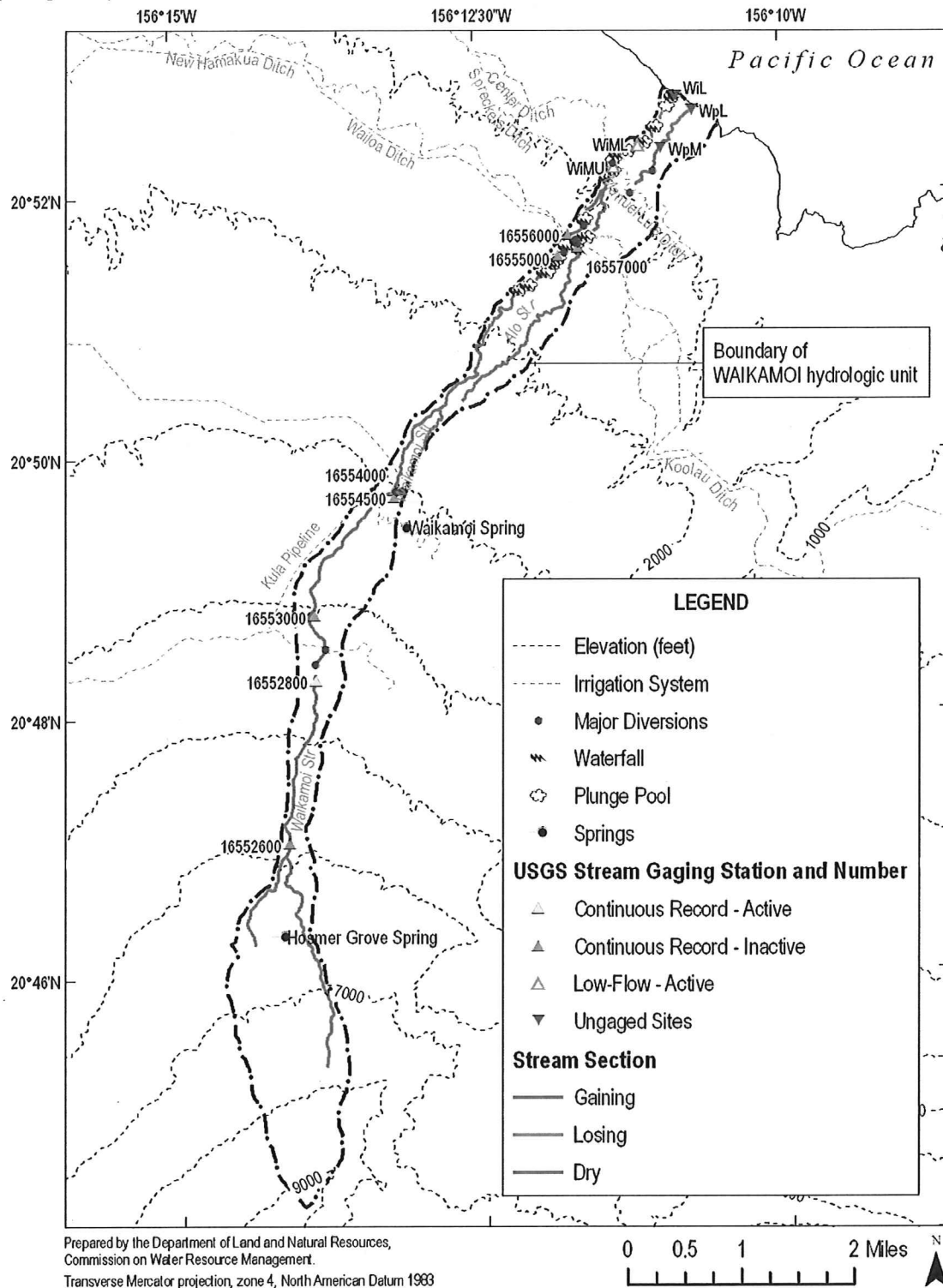
State of Hawaii
Department of Land and Natural Resources
Commission on Water Resource Management



EXHIBIT E-48

TRIAL EXHIBIT AB-156

Figure 3-3. Location of diversions, irrigation systems, USGS gaging stations, and selected ungaged sites in Waikamoi hydrologic unit (Source: State of Hawaii, Office of Planning, n.d.; 1996, 2004c; 2005; USGS, 2001b).



Large waterfalls are obvious “bottlenecks” in the stream ecosystem that restrict the upstream migration of most native aquatic species, except the alamo and opae. These species have fused pelvic fins and the musculature for climbing high vertical walls and inhabiting the upper stream reaches. Therefore, streams with terminal waterfalls may harbor a lower diversity of native aquatic species than those without. On the other hand, terminal estuaries and pools downstream of waterfalls are known to carry a diversity of native species and are ideal spots for traditional gathering.

Irrigation ditches serve as lateral conduits between watersheds, which may contribute to the spread of both native and alien species. The Commission does not condone the release of ditch flows as the correct means of flow restoration, but rather have streamflow bypass the diversion structure and continue to flow downstream. However, streams may be used to convey diverted flow from one ditch to another, introducing alien species from one stream to another. Furthermore, overflow in the ditch could also introduce invasive species into the stream. The potential for introducing species from invasive-dominated terminal reaches to native-dominated mid- and headwater reaches is not a major problem in east Maui due to the presence of large waterfalls. Ford et. al. (2009) discussed how ditches may also be “sinks” where “larvae cannot reach the sea and/or where recruits may not survive to reproduce.” This is especially the case when native amphidromous species inhabit waters upstream of the ditches. The location and types of diversion structure also affect the ability of ability of amphidromous species to migrate upstream.

Diversions have significantly reduced baseflows in the stream, limiting overall habitat for native species. While restoration of streamflow and increased connectivity could lead to the development of a richer and more native-dominated community in the stream, many other factors must also be considered in balancing the benefits of flow restoration to overall stream life versus providing water for agricultural and domestic uses. In addition to dewaterment, predation by native and non-native animals is also an important negative impact on the distribution on the native aquatic species. Some of the potentially harmful non-native species in east Maui include guppies, mosquitofish, swardtails, carp, oriental weatherfish (dojo), goldfish, Louisiana crayfish, apply snails (harmful to taro), and Asian clam (Ford et. al., 2009). In addition, the “aholehole are known to attack nests of goby eggs and may also consume returning post-larval gobies” (as cited in Ford et. al., 2009). Irrigation ditches may contribute to the spread of alien species; on the other hand, they aid in dispersing the native aquatic species, strengthening the overall population and continued survival of the native freshwater species.

Another factor that affects the distribution of native species is the condition of the streambed. Stream channels are often overgrown with alien grasses and shrubs. Vegetation along the stream bank has exposed roots that take up large amounts of water when sufficient flow is in the stream. Thus, during a high flow event, streams that are normally dry become only partially wetted because invasive plants and water thirst roots eventually absorb much of the water. In addition, fallen trees and other debris are found to block sections of the stream, which may reduce streamflow and even divert flow away from the main stream channel in the long term. Without proper maintenance of the streambed, restored streamflow in the upper elevations may not reach the ocean. Plans to rebuild healthy streambeds should be considered to help maximize the flow in the stream.

As stated in Ford et. al. (2009), the “synergistic effects of human alterations have led to a decline in the populations of native freshwater species statewide.” Streamflow has also decreased over the past decade (see Section 3.4) and this has resulted, as generally believed, in less native stream species. While traditional gathering continues in east Maui, area residents are limited to certain areas with adequate streamflow to gather these resources (multiple residents in east Maui, personal communication, October 2008). Streams in east Maui are recognized as important habitats for native Hawaiian stream animals (Gingerich and Wolff, 2005). The maintenance, or restoration, of stream habitat requires an understanding of and the relationships among the various components that impact fish and wildlife habitat, and ultimately, the overall viability of a desired set of species. These components include, but are

Table 4-7. Known distribution of amphidromous species in east Maui streams (Ford et. al., 2009, Table 3).

[X = present; ND = no data]

East Maui Streams (T) = terminal falls	<i>Kuhlia</i> sp.	<i>Eleotris</i> <i>sandwicensis</i>	<i>Stenogobius</i> <i>hawaiiensis</i>	<i>Awaous</i> <i>guamensis</i>	<i>Sicyopterus</i> <i>stimpsoni</i>	<i>Lentipes</i> <i>concolor</i>	<i>Neritina</i> <i>granosa</i>	<i>Neritina</i> <i>vespertinus</i>	<i>Macrobrachium</i> lar (Allen amphidromous)	<i>Macrobrachium</i> <i>grandimanus</i>	<i>Atyoida</i> <i>bisulcata</i>
Honopou		X		X	X	X			X	X	X
Hanehoi											X
Kolea (T)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Waikamoi (T)									X		X
Wahinepe'e (T)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Haipua'ena (T)				X	X	X			X		X
Puohokamoa				X	X	X			X		X
Punalau				X	X	X			X		X
Honomanū											X
Nua'a'ilua				X	X	X	X	X	X		X
Palauihulu/Pi'ina'au	X	X	X	X	X	X	X	X	X	X	X
'Ohia							X			X	X
Waiokamilo (T)				X					X		X
Wailua Nui	X	X		X	X	X			X		X
W. Wailua Iki	X			X	X	X	X		X		X
E. Wailua Iki	X	X		X	X	X	X		X		X
Kopiliula	X	X		X	X	X	X		X		X
Waiohue	X	X	X	X	X	X	X	X	X	X	X
Pa'akea (T)				X	X	X	X		X		X
Kapaula											X
Hanawi	X	X	X	X	X	X	X				X
Makapipi	X	X		X	X	X					X

Since changes to streamflow and stream configurations have raised concerns regarding their impact to on-shore and near-shore activities, the Commission attempted to identify these various activities in relation to Waikamoi and Wahinepee Stream. A 1981 Maui Resource Atlas, prepared by the State of Hawaii Department of Transportation's Harbors Division, inventoried coral reefs and coastal recreational activities. Looking at available GIS data, the Commission identified trolling/bottom fishing, and opihi picking as the only activities that were known to occur or observed at or near Waikamoi (Figure 5-2).

John Clark, in his book *The Beaches of Maui County* (1989), describes the Waikamoi area as follows:

The shoreline from Maliko to Honomanū is characterized by high, steep sea cliffs. Within this long reach of cliffs are a number of bays that are usually little more than wide, moderately deep indentations in the shoreline, usually where streams meet the ocean. The beaches in these areas are narrow stretches of large boulders lying directly at the base of the sea cliffs. Many of these boulder beaches are not accessible at all by land, and if they are, it is only by a hazardous climb using a rope or cable to get down the cliffs. During the winter and spring months these bays are assaulted by heavy surf that sweeps completely across the boulders against the sea cliffs. There are no fringing reefs to check the advance of surf or strong currents. Over the years many fishermen have lost their lives along this dangerous coastline. These rough waters have long been excellent grounds for netting *akule* and *'ōpelu* and for hooking *'ū'ū*, *'āweoweo*, and *āhole*.

There is no public access to any of these shoreline areas except from the ocean. Many of the bays are over one mile away from the Hāna Highway, and all of the land between the highway and the shoreline is private property replete with locked gates and No Trespassing signs.

Another element of recreation is the unique educational opportunities that streams provide for nature study. One way to approach this is to identify established study sites or nature centers that offer structured learning programs. In lieu of that, the Commission considered available GIS data to identify schools in proximity to Waikamoi and Wahinepee Stream that may utilize the stream as part of its curriculum. Although the Commission did not identify any educational facilities in the area, the Sierra Club Maui Group has been hosting education hikes along the Waihinepee Trail at the 600 feet elevation for over two decades (PR-2009-18, 85.0).

See Figure 5-2 for the locations of various recreation-related points of interest. It is important to note that the recreational activities are not limited to the ocean as the figure may suggest. The stream and the surrounding areas are also used for recreational purposes (e.g., hiking, swimming).

Table 6-1. Hawaii Stream Assessment indicators of riparian resources for Waikamoi Stream.

Category	Value
<p>Listed threatened and endangered species: These species are generally dependent upon undisturbed habitat. Their presence is, therefore an indication of the integrity of the native vegetation. The presence of these species along a stream course was considered to be a positive attribute; with the more types of threatened and endangered species associated with a stream the higher the value of the resource. Only federally listed threatened or endangered forest or water birds that have been extensively documented within the last 15 years were included.</p>	3
<p>Recovery habitat: Recovery habitat consists of those areas identified by the USFWS and DLNR as essential habitat for the recovery of threatened and endangered species. Streams that have recovery habitat anywhere along their length were included.</p>	None
<p>Other rare organisms and communities: Many species that are candidates for endangered or threatened status have not been processed through all of the requirements of the Endangered Species Act. Also a number of plant communities associated with streams have become extremely rare. These rare organisms and communities were considered to be as indicative of natural Hawaiian biological processes as are listed threatened and endangered species.</p>	None
<p>Protected areas: The riparian resources of streams that pass through natural area reserves, refuges and other protected areas are accorded special protection from degradation. Protected areas were so designated because of features other than their riparian resources. The presence of these areas along a stream, however, indicates that native processes are promoted and alien influences controlled.</p>	Partially protected
<p>Wetlands: Wetlands are important riparian resources. They provide habitat for many species and are often important nursery areas. Because they are often extensive areas of flat land generally with deep soil, many have been drained and converted to agricultural or urban uses. Those that remain are, therefore, invaluable as well as being indicators of lack of disturbance.</p>	Less than ½-square mi. of palustrine wetlands identified by USFWS
<p>Native forest: The proportion of a stream course flowing through native forest provides an indication of the potential “naturalness” of the quality of a stream’s watershed; the greater the percentage of a stream flowing through native forest most of which is protected in forest reserves the more significant the resource. Only the length of the main course of a stream (to the nearest 10 percent) that passes through native forest was recorded.</p>	30%
<p>Detrimental organisms: Some animals and plants have a negative influence on streams. Wild animals (e.g., pigs, goats, deer) destroy vegetation, open forests, accelerate soil erosion, and contaminate the water with fecal material. Weedy plants can dramatically alter the nature of a stream generally by impeding water flow. Three species, California grass, hau, and red mangrove, are considered to have the greatest influence. The presence of any of these animals or plants along a stream course was considered a potentially negative factor, while the degree of detriment is dependent on the number of species present.</p>	2 (Hau, Pigs)

For the purpose of this section, management areas are those locales that have been identified by federal, state, county, or private entities as having natural or cultural resources of particular value. The result of various government programs and privately-funded initiatives has been a wide assortment of management areas with often common goals. Such designated areas include forest reserves, private preserves, natural area reserves, wildlife sanctuaries, national parks, historic landmarks, and so on. In Waikamoi, about 29 percent of the hydrologic unit falls within the Haleakala National Park, 28 percent within the Koolau Forest Reserve, and 7 percent within the Waikamoi Preserve (Table 6-2).

lichens, or wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 percent.

Table 6-4. Wetland classifications for Waikamoi hydrologic unit (Source: U.S. Fish and Wildlife Service, 1978).

System Type	Class	Regime	Area (mi ²)	Percent of Unit
Palustrine	Forested, broad-leaved evergreen	Semipermanent non-tidal	1.05	20.0
Palustrine	Forested, broad-leaved evergreen	Seasonal/Unknown non-tidal	0.26	4.9
Palustrine	Open Water/unknown bottom	Permanent non-tidal	0.01	0.2
Palustrine	Scrub/shrub, broad-leaved evergreen	Seasonal/Unknown non-tidal	0.35	6.7

A series of vegetation maps describing upland plant communities was prepared as part of a USFWS survey in 1976 to 1981 to determine the current status of native forest birds and their associated habitats. Table 6-5 and Figure 6-3 present the portion of the hydrologic unit (~1000 feet above mean sea level) that was surveyed and the degree of disturbance of native forest. Approximately 39 percent of the unit is predominately native species with little or no alien species.

Table 6-5. Distribution of native and alien plant species for Waikamoi hydrologic unit. (Source: Jacobi, 1989).

Canopy Type	Area (mi ²)	Percent of Unit
Communities totally dominated by native species of plants	2.06	39.3
Communities that have the dominant vegetation layer occupied by native species and the subdominant layer primarily occupied by exotic species	0.18	3.3
Communities dominated by introduced species but contain remnant populations of native species; no native community structure remaining	0.12	2.2
Communities that are totally dominated by introduced plants; virtually no native species remaining	0.53	10.1
Non-vegetated areas or disturbance not determined	0.14	2.6
Unknown	1.25	23.9

Based upon the current designations, the Waikamoi hydrologic unit contains critical habitat areas for ten plant species (Table 6-6). While critical plant habitats are more prominent above the 1,300 feet altitude, the area around 600 feet elevation and along the Wahinepee Trail has a good representation of native endemic plants (PR-2009-18, 85.0). The Sierra Club Maui Group has lead educational hikes in this area for over two decades.

Table 6-6. Percentage of critical habitat areas for Waikamoi hydrologic unit (Source: State of Hawaii, Office of Planning, 2004b).

Scientific Name	Common/Hawaiian Name	Description	Area (mi ²)	Percent of Unit
<i>Argyroxiphium sandwicense ssp. macrocephalum</i>	Silversword, 'Ahinahina	Plant	0.76	14.6
<i>Asplenium fragile var. insulare</i>	No common name	Plant	< 0.01	< 0.1
<i>Brighamia rockii</i>	Pua 'ala	Plant	0.01	0.2
<i>Cyanea copelandii ssp. haleakalaensis</i>	Haha	Plant	0.12	2.3
<i>Cyanea hamatiflora ssp. hamatiflora</i>	No common name	Plant	0.87	16.7
<i>Cyanea mceldowneyi</i>	No common name	Plant	0.80	15.2
<i>Diplazium molokaiense</i>	No common name	Plant	0.21	3.9
<i>Geranium multiflorum</i>	Nohoanu	Plant	0.03	0.6
<i>Phlegmariurus mannii</i>	Wawae'iole	Plant	0.01	0.1
<i>Phyllostegia mannii</i>	No common name	Plant	0.46	8.8

The density of threatened and endangered plant species is high at elevations above 1,300 feet, while the rest of the Waikamoi hydrologic unit, roughly 15 percent, has a low concentration of threatened and endangered plant species at lower elevations (Table 6-7 and Figure 6-4).

Table 6-7. Density of threatened and endangered plants for Waikamoi hydrologic unit. (Source: State of Hawaii, Office of Planning, 1992).

Density	Area (mi ²)	Percent of Unit
High concentration of threatened and endangered species	4.44	84.6
Low concentration of threatened and endangered species	0.81	15.4

A current working paper is being developed by the University of Hawaii's Economic Research Organization (UHERO), entitled *Environmental Valuation and the Hawaiian Economy*, which discusses the use of existing measures of economic performance and alternative statistical devices to provide an economic valuation of threatened environmental resources. The paper focuses on the Koolau, Oahu watershed and illustrates three categories of positive natural capital (forest resources, shoreline resources, and water resources) against a fourth category (alien species) that degrades natural capital. In the case of the Oahu Koolau forests, a benchmark level of degradation is first defined for comparison against the current value of the Oahu Koolau system. The Oahu Koolau case study considers a hypothetical major disturbance caused by a substantial increased population of pigs with a major forest conversion from native trees to the non-indigenous *Miconia* (*Miconia calvescens*), along with the continued "creep" of urban areas into the upper watershed (Kaiser, B. et al., n.d.).

Recognizing that in the United States, the incorporation of environmental and natural resource considerations into economic measures is still very limited, the paper provides the estimated Net Present Value (NPV) for "Koolau [Oahu] Forest Amenities." These values are presented in Table 6-8.

Table 6-8. Estimated Net Present Value (NPV) for Koolau (Oahu) Forest Amenities (Source: Kaiser, B. et al., n.d.).

Amenity	Estimated Net Present Value (NPV)	Important limitations
Ground water quantity	\$4.57 to \$8.52 billion NPV	Optimal extraction assumed.
Water quality	\$83.7 to \$394 million NPV	Using averted dredging cost estimates.
In-stream uses	\$82.4 to \$242.4 million NPV	Contingent valuation estimate for a single small fish species.
Species habitat	\$487 to \$1,434 million NPV	Contingent valuation estimate for a single small bird species.
Biodiversity	\$660,000 to \$5.5 million NPV	Average cost of listing 11 species in Koolaus.
Subsistence	\$34.7 to \$131 million NPV	Based on replacement value of pigs hunted.
Hunting	\$62.8 to \$237 million NPV	Based on fraction of hunting expenditures in state. Does not include damages from pigs to the other amenities.
Aesthetic values	\$1.04 to \$3.07 million NPV	Contingent valuation; Households value open space for aesthetic reasons.
Commercial harvests	\$600,000 to \$2.4 million NPV	Based on small sustainable extraction of koa.
Ecotourism	\$1.0 to \$2.98 billion NPV	Based on fraction of direct revenues to ecotourism activities.
Climate control	\$82.2 million	Based on replacement costs of contribution of all tropical forests to carbon sequestration.
Estimated value of joint services:	\$7.444 to \$14.032 billion	

Following upon the results of the Oahu Koolau case study, the paper provides a brief comparison with the east Maui forests, noting the particular importance of the east Maui watershed as the single largest source of surface water in the state, home to some of the most intact and extensive native forests left in Hawaii, along with having the State's largest concentration of endangered forest birds. In both cases, the Oahu Koolaus and east Maui, the most valuable aspects of the forested areas are believed to be ecotourism, aesthetic pleasure, species habitat, water quality, and water quantity. Both regions are roughly the same

licenses into a single license. In 1986, Native Hawaiian Legal Corporation (NHLC) challenged the Department of Land and Natural Resources (DLNR)'s decision that an Environmental Impact Statement (EIS) was not required and an Environmental Assessment (EA) was sufficient for the issuance of the 30-year lease. The Circuit Court agreed that an EA was adequate, and NHLC appealed to the Supreme Court, who remanded back to Circuit Court to conduct a hearing pursuant to HRS section 343-7(b) on the matter. Further discussions resulted in several decisions, including that the Board of Land and Natural Resources (BLNR) and DLNR must work towards long-term resolution; and that interested parties work together to develop a watershed management plan for the water lease areas. The latter resulted in the creation of the East Maui Watershed Partnership and development of the East Maui Watershed Management Plan.

In 1987, the rate structure of the revocable permits was altered to a fixed flat fee independent of the amount of water diverted by A&B, and the rates were reduced by 25% to discount for the uncertainty that the annual permits would be renewed. However, the payments after 1987 were increased by 25% to remove the discount and convert the rates to long-term lease rentals. In 1988, the State performed an independent audit and set the benchmark rate based on the audit rate of five dollars per million gallons. In fiscal year 1999-2000, the permits were issued to A&B and EMI, with the fixed rates based on an assumed annual flow. The current revocable permits state that their rates are based on a staff appraisal dated May 7, 2001.

The revocable permits are currently regulated by the DLNR's Land Division, which collects fees for the permits. Those permits were most recently renewed in November 2007, with the following rental payments:

Table 13-8. Current revocable permits issued to A&B/EMI.

Revocable Permit No.	License Area	Area (acres)	Monthly Rent in 2008
S-7264	Huelo	8,752.69	\$6,588
S-7263	Honomanu	3,381.00	\$1,698
S-7265	Keanae	10,768.00	\$3,477
S-7266	Nahiku	10,111.22	\$1,427

In May 2001, A&B and EMI filed an Application for a Long Term Water License with the BLNR seeking a long-term 30-year lease rather than continue with year-to-year revocable permits. Shortly thereafter, Na Moku Aupuni O Koolau Hui, Inc. ("Na Moku") and Maui Tomorrow requested a contested case hearing, with NHLC filing on behalf of petitioners Na Moku, Elizabeth Lapenia, Beatrice Kekahuna, and Marjorie Wallett. (In May 2007, Elizabeth Lapenia withdrew from the case and is no longer represented in it.) Concurrently, the Petitioners filed with the Commission a Petition to Amend the Interim Instream Flow Standard for 27 Streams in East Maui.

In May 2002 the BLNR deferred the reissuance of interim revocable permits and granted a holdover of the existing revocable permits on a month-to-month basis pending the results of the contested case hearing. A January 2003 BLNR "Findings of Fact and Conclusions of Law and Order" indicates that the "BLNR may enter into a lease of water emanating from State lands for transfer outside of the watershed of origin provided that such lease is issued in accordance with the procedures set forth in HRS Chapter 171 and provided that all diversions of stream water shall remain subject to the Interim Instream Flow Standards set by CWRM, and to any judgment of a court of competent jurisdiction establishing appurtenant or riparian rights in favor of downstream users (p.12)." This part of the Order was reversed by Circuit Court in October 2003 and the BLNR advised that if it does not believe it has the requisite expertise, it should wait until CWRM has acted or make its own application to establish instream flows. However, the Court Order goes on to state that the BLNR cannot "rubber-stamp" any Commission determination, meaning that at any BLNR contested case hearing, any party may challenge a Commission

driving steam turbine generators to produce electricity. HC&S also produces hydroelectric power from three run-of-river hydroelectric facilities on the Wailoa Ditch, which is supplied with water from several sources in east Maui. The hydraulic turbine generators located at the Kaheka, Paia, and Hamakua facilities on the Wailoa Ditch are capable of producing 4.5 megawatts, 1.1 megawatts, and 150 kilowatts, respectively (G. Hew, personal communication, August 2009).

Power generated from bagasse and the hydroelectric facilities is used to satisfy sugar mill power requirements first, while remaining electricity not used by the mill is sold to Maui Electric Company (MECO) for distribution, which currently amounts to approximately 7 percent of MECO's power sales. HC&S is under contract with MECO to supply, at specified rates, 12 megawatts of power from 7:00 a.m. to 9:00 p.m. daily except Sunday and 8 megawatts at all other times. According to MECO, power is sold as available, with an estimated oil savings of 44,700 barrels per year (MECO, 2008a). The contract provides for monetary penalties if these requirements are not met by HC&S. During black-outs, MECO has requested the help of HC&S to generate backup power until MECO repairs its system.

Water Use

HC&S uses water from three main sources: 1) surface water from the EMI system; 2) surface water from the Wailuku Water system in west Maui that is operated jointly by HC&S and the Wailuku Water Company; and 3) ground water pumped from 16 brackish water wells located on the plantation. The EMI System was designed and constructed to take full advantage of the gravity flow of water from higher to lower elevations, thus minimizing pumping and the additional consumption of electrical power. For this reason, HC&S attempts to divert the maximum possible amount of water into the EMI system at the Wailoa Ditch level, which has a capacity of 195 million gallons per day, where the water can then be distributed by gravity flow to various fields and to HC&S' hydroelectric turbines to maximize the energy efficient use of this water (HC&S, 2009).

Currently, the HC&S sugar plantation consists of approximately 43,300 acres of land. Sugar is cultivated on roughly 35,000 acres, while the balance is leased to third parties, is not suitable for cultivation, or is used for plantation purposes (A&B, 2007). Approximately 29,000 acres are irrigated with water delivered by EMI. The total amount of water HC&S needs from EMI varies largely with weather and seasonal conditions, but ranges from a low of 134 million gallons per day in the winter months to a high of 268 million gallons per day during peak usage in the months of May to October (Findings of Fact, Conclusions of Law, and Decision and Order, 2007). From 2002 to 2004, HC&S received 71 percent of its surface water supply from EMI, while the remaining 29 percent was supplemental ground water. Of the 29,000 acres irrigated with EMI water, approximately 13,000 acres are located in elevations where irrigation with pumped water is either geographically impossible and/or economically impracticable. Since these fields are dependent on water from the EMI System, they are highly susceptible to diminished yields during drought conditions and in the summer months when ditch flows are low (HC&S, 2009).

HC&S uses drip irrigation for most of its fields. Drip irrigation is the most efficient irrigation technology available today, which is typically 90 percent efficient as compared to sprinkler system that is 75 to 85 percent efficient. In 1986, HC&S completed a 12-year project to install a drip irrigation system across the plantation. It was a 30 million dollar investment in water efficiency that would cost 90 million dollars if made today. The sugarcane fields not equipped with the drip irrigation system are irrigated with recycled mill water, which contains particulates that clog up the drip irrigation tubes. Thus, HC&S expended over 1 million dollars to install overhead sprinklers in these fields to be able to utilize the recycled mill water (HC&S, 2009).

Irrigation water is applied based on the daily needs of each field, and not the average daily water use statistic, which at most times is an inaccurate representation of the irrigation requirement for each field. The specific needs of each field are based on the crop cycle and real time measurements of rainfall and

evaporation that determine the soil moisture content of each field. To ensure the most effective and efficient use of water on the plantation, HC&S determines the irrigation requirements for each field on a day-to-day basis using a computerized water balance model. The model is essentially a water budget accounting procedure that balances the moisture input of rainfall and irrigation; the moisture output of evapotranspiration; and the change in soil-moisture storage based on the soil type in each field. A system of 15 automated weather stations is installed across the plantation that transmits hourly data used to compute daily evaporation rates using a modified Penman equation. Rainfall data is recorded daily from 41 manual gauges. Pan ratios documented in Ekern and Chang (1985) are used to estimate the amount of water required in various crop stages. Lastly, irrigation flow rates and the number of irrigation hours applied are also used to determine the water status for each field. The model then prioritizes the irrigation requirements of the fields, indicating which field(s) should receive water next (HC&S, 2009).

Although HC&S does not use the average daily water use statistic in its everyday operations, HC&S did calculate the average daily water use for its west Maui fields for the purpose of the Na Wai Eha Contested Case Hearing. The average daily water use rates for the Waihee-Hopoi fields in west Maui for 2004, 2005, and 2006 were 6,395, 7,831, and 6,254 gallons per acre per day, respectively. For comparison, HC&S also computed the average daily water use for the 29,000 acres of plantation fields irrigated with water delivered from the EMI System, which are somewhat lower because of greater seasonal variation in streamflow and HC&S' inability to supplement the 13,000 acres with pumped well water. The water use rates for these 29,000 acres ranged from a low of 4,619 gallons per acre per day in 2008 to a high of 6,858 gallons per acre per day in 2005 (HC&S, 2009).

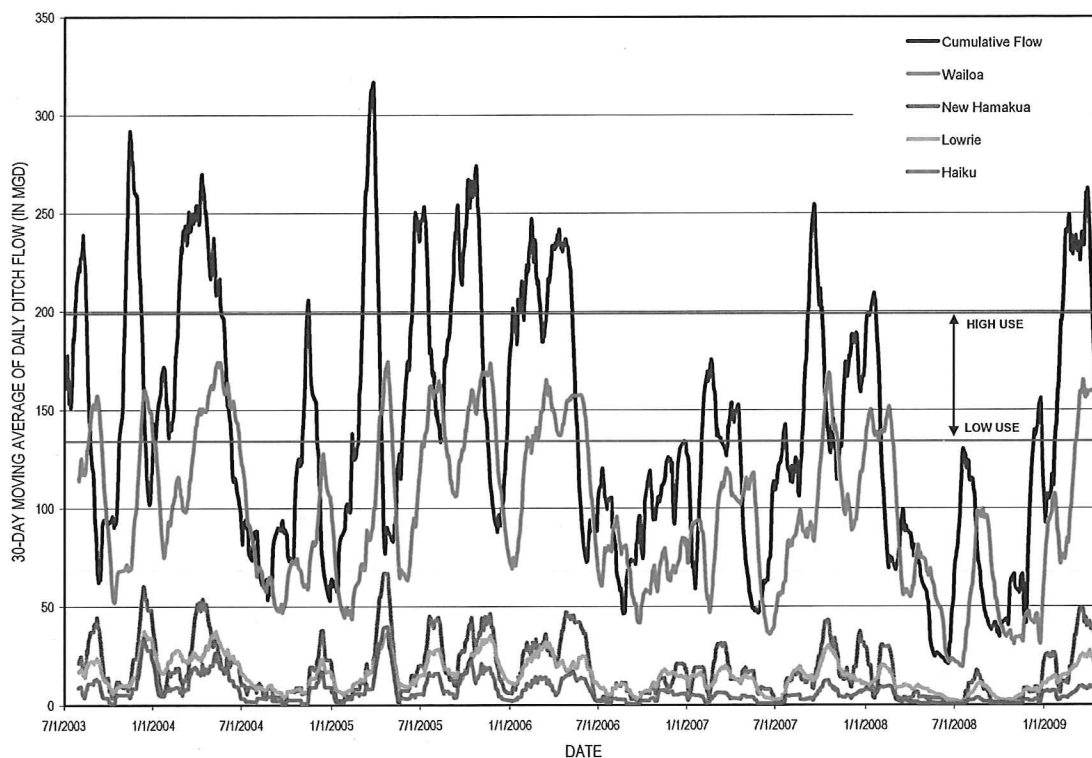
Economic Impact

The availability of surface water and securing this water at reasonable cost are essential to HC&S' ability to grow sugarcane at yields that will enable the company to remain financially viable. Table 13-10 provides a summary of A&B's agribusiness revenues for 2000 to 2008. A&B's four agribusiness companies, one of which is HC&S, saw a revenue increase of 3 percent (\$4.2 million) in 2006 over the previous year, generating an operating profit of \$6.9 million. HC&S itself earned a profit margin of \$2.6 million in 2006. The increase in revenue was attributed to higher revenues in repair services and trucking, higher-power sales, higher equipment rentals and soil sales, and higher specialty sugar and molasses sales. In comparison, lower revenues were reported in the bulk sugar sales (A&B, 2007). The last two years of severe drought conditions had significant impacts on the availability of surface water and crop yields, which lead to sizable financial losses. In 2008, A&B's agribusiness sector reported a \$13 million loss, caused largely by losses at HC&S. HC&S expects its losses to be greater in 2009 as the effects of drought will have greater impact in the 2009 harvest.

Table 13-10. Summary of A&B's agribusiness revenues for 2000 to 2008 (Source: A&B, 2002; 2005; 2007; 2009).

Year	Revenue (dollars)	Operating Profit (dollars)	Operating Profit Margin (percent)
2008	\$ 124,300,000	\$(12,900,000)	(10.4)
2007	\$ 123,700,000	\$ 200,000	0.16
2006	\$ 127,400,000	\$ 6,900,000	5.4
2005	\$ 123,200,000	\$ 11,200,000	9.1
2004	\$ 112,800,000	\$ 4,800,000	4.3
2003	\$ 112,900,000	\$ 5,100,000	4.5
2002	\$ 112,700,000	\$ 13,800,000	12.2
2001	\$ 105,976,000	\$ 5,660,000	5.3
2000	\$ 107,510,000	\$ 7,522,000	7.0

Figure 13-10. Individual and cumulative 30-day moving averages for Wailoa, New Hamakua, Lowrie and Haiku Ditches at Honopou, including estimated range of water use by HC&S (Source: EMI, 2009; HC&S 2009).



Economic Impact

The availability of surface water and securing this water at reasonable cost are essential to HC&S' ability to grow sugarcane at yields that will enable the company to remain financially viable. Table 13-10 provides a summary of A&B's agribusiness revenues for 2000 to 2008. A&B's four agribusiness companies, one of which is HC&S, saw a revenue increase of 3 percent (\$4.2 million) in 2006 over the previous year, generating an operating profit of \$6.9 million. HC&S itself earned a profit margin of \$2.6 million in 2006. The increase in revenue was attributed to higher revenues in repair services and trucking, higher-power sales, higher equipment rentals and soil sales, and higher specialty sugar and molasses sales. In comparison, lower revenues were reported in the bulk sugar sales (A&B, 2007). The last two years of severe drought conditions had significant impacts on the availability of surface water and crop yields, which lead to sizable financial losses. In 2008, A&B's agribusiness sector reported a \$13 million loss, caused largely by losses at HC&S. HC&S expects its losses to be greater in 2009 as the effects of drought will have greater impact in the 2009 harvest.

Civil No. 19-1-0019-01 (JPC)

Defendant A&B/EMI's Exhibit AB-156

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