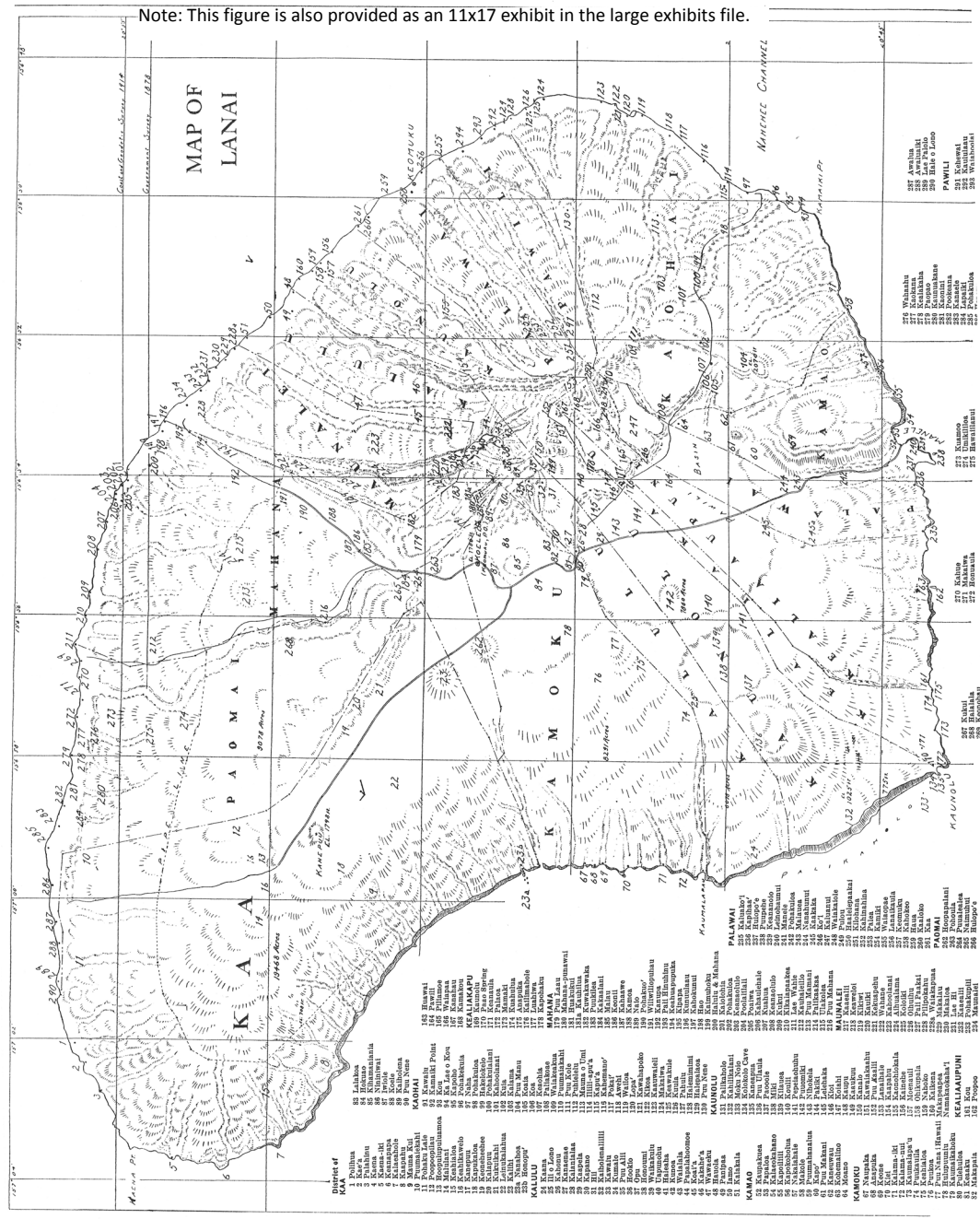


**EXHIBIT "I-9"**  
**PART C**

## Historical Water Resources

**FIGURE 3-20. Map of Lana'i Showing Place Names.** Source: Kenneth P. Emory, *The Island of Lana'i; A Survey of Native Culture*, Bishop Museum Bulletin 12; Honolulu; 1969



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**Existing Resources & Systems**


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**FIGURE 3-21. Water Place Names in Lana'i From Gazetteer of Lana'i in Emory, K.P.; *The Island of Lana'i, A Survey of Native Culture*; Bishop Museum Bulletin 12, Honolulu 1969 - Springs or flowing water highlighted in cyan**

**Partial List Lana'i Place Names Related to Water**

<b>Name</b>	<b>Meaning</b>
Ai-lau	Leaf eating. Taro land in Maunalei, near Kaaealii, according to Namilimili.
Ana-iki	Little cave. Taro land in Maunalei (26a).
Awa-lua	Deep harbor (descriptive). Bay. 287.
Awa-lua-iki	Lesser Awalua (descriptive). Bay. 288.
Hale-aha	Assembly house (once descriptive). Taro land. Head of water tunnel. 41.
Hale O Lono	House of Lono (once descriptive?) Bay. A house of worship to Lono was a common form of heiau. 290.
Hauola	Healing water (descriptive?) Valley mouth. 48.
Hono-umi	Collecting place of Umi, ten stitches. Section of valley. Upper end of Maunalei Valley, against precipice. 38
Hono-wae	Bay. 286
Hua-wai	Water gourd. Bay. 163.
Hulopo'e	Name of a man (personal). Bay. Hulopo'e lived here. 237.
Iamo	A leap feet first into water. Beach. 50.
Ka'a-loko	Pond of Ka'a (descriptive). Bay, fish-pond. 260.
Kaa-pela	Rolling over soft grass (once descriptive). Plateau land. Site of a school house; old name of place close by is Mauipapahu. 29.
Ka-auwai-eli	The dug water course (once descriptive). Small valley mouth. 123.
Kahe'a	Fishing in shallow water (once descriptive?). Beach. 294.
Kahe-mano	Place where sharks habitually run (descriptive). Beach 294.
Ka-hili-ka-lani	Brushing the heavens (descriptive). Cliff. Highest point of Palikaholo and the slope of Kaumalapa'u. 132.
Ka-hoku-nui	The large star (once descriptive?). Beach. A meteor once fell nearby. 197.
Ka-hue	The gourd (once descriptive?). Bay. 270.
Kai-kena	Rustling sea (descriptive). Beach. 160.
Ka-imu-hoku	The star oven (descriptive). Beach. A pit in the sand where a meteor fell. 199.
Kai-nehe	Murmuring sea (descriptive). Beach. 156.
Kai-olohia	Choppy sea (descriptive). Bay. 201.
Kalua-ko'I	The adz pit (descriptive?). Bay. 235.
Kamakou	Lamp with red flame (Andrews), young kou grove (Thrum). Spring. Location approximate. 168
Kanahau	Disagreeable, cold. (descriptive). Spring. Gulch just south of Captain Soule's place. 167.
Ka-piha'a	The driftwood (descriptive). Bay. 236.
Ka-uhi-lua	The double veil (descriptive of rain). Taro land. 181a.
Kau-iki	The small portions (descriptive). Section of valley. This site now marked by a pump. 220.
Ka-ulu-laau	Name of the hero who killed the goblins of Lana'i (legendary). Beach. (See page 13 for story). 292.
Kau-mala-pa-u	Bay. The Kekoewa family say this name should be Kamuela-pa'u; but Mrs. Awili Shaw says that her parents and grandparents called the place Kau-molo-pa'u. None of these names can be translated with any meaning. 73.

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**Historical Water Resources**


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**FIGURE 3-21. Water Place Names in Lana'i From Gazetteer of Lana'i in Emory, K.P.; *The Island of Lana'i, A Survey of Native Culture*; Bishop Museum Bulletin 12, Honolulu 1969 - Springs or flowing water highlighted in cyan**

Kau-no-lu	To give property on a wager secretly, the akua of Molokai. Bay and district. In this word every vowel is accepted equally. Incorrectly given as Kaunalu and Kaonolu. 169.
Ka-wai-a-ka-ahu	Water of Kaahu. Spring. 151.
Ka-walu	The milk. Valley. 33.
Ka-walu	The milk. Valley mouth. 91.
Ke-ana-puka	The arch (descriptive). A sea cave. In his story of Puupehe, W. M. Gibson calls this cave Malauea. 201.
Ke-awa-kule	The bay of the kule fish (descriptive). Bay. 125.
Ke-awe-loi	Keawe making fun. Section of valley. Site of an old pump station. 218.
Kehe-wai	Rivulet (Mrs. Lahilahi Webb). Ridge. Ridge ending at Waiopae. 291.
Ke-kua-pehu	The swelling god. Small valley. 221.
Keone	The sand (descriptive?). Bay. A little sand here. 69.
Ke-ono-hau	The six hau (trees). Small bay. 269.
Kiei	High. Bay. 70.
Kikiwi	Bending down (descriptive). Taro land. Kiki (26a). 219.
Koa	Koa tree (descriptive). Plateau lands. Area covered by koa forest. 106.
Koai'a	A variety of koa tree (descriptive). Valley. Koai'a forest formerly at this place. 45.
Koai'a	A variety of koa tree (descriptive). Valley. Koai'a forest formerly at this place. 105.
Koele	Place seized by a chief (descriptive?). Village. Koele means also dry, but this is not a dry place. 88.
Kolo-kolo	Loud rumbling (descriptive). Sea cave. Freshwater is supposed to be obtainable here. 134.
Lae Hi	Flowing point (descriptive). Point. A point composed of limestone. 231.
Lana'i-hale	House hump (descriptive metaphor). Highest point on Lana'i and spring. Name of spring is Nanaihale. (See 19, p 516). 153.
Mahana-punawai	Spring of Mahana (descriptive). Spring. 181.
Malu-lani	Heavenly shade (legendary). Blend in ridge. Malulani, sister of Pele and Hi'iaka dwelt here. 14.
Mamaki	Name of bush from which mamaki tapa was made. Old village site on coast. 173.
Mauna-lei	Wreath mountain (borrowed?). Village. From name of valley. 234.
Moena-uli	Blue mat. Beach. 157
Pao	The Kahuna, Pao (legendary). Well, tapu to women. 170. aka Pao Spring.
Pahulu	When the goblin Pahulu was killed by Kaululaau (legendary). Well. Rock lined well now in use. 127.
Pali-hinuhinu	Shining as if anointed with oil (descriptive). Cliff. 193
Po-kai-I	Name of a celebrity from Kahiki (Thrum) (legendary?). Old village site. Name of a land section on Oahu. 117.
Pookeana	Beach. 282.
Poo-lali-lali	Greasy head. Beach. 204.
Pulou	Covered out of sight (descriptive). Spring. Makakehau, lover of the girl, Puupehe, was killed here. 249.
Puu-kilea	Hummock hill (descriptive). Hill. Incorrectly given on government map as Puu Kukai. 183.
Puu-maia-kahi	Hill of dropping bananas (descriptive). Hill. Very prominent crater cone. Gibson, in story of Puupehe, refers to banana groves of Waiakeakua which is below this hill. 110.



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**Existing Resources & Systems**

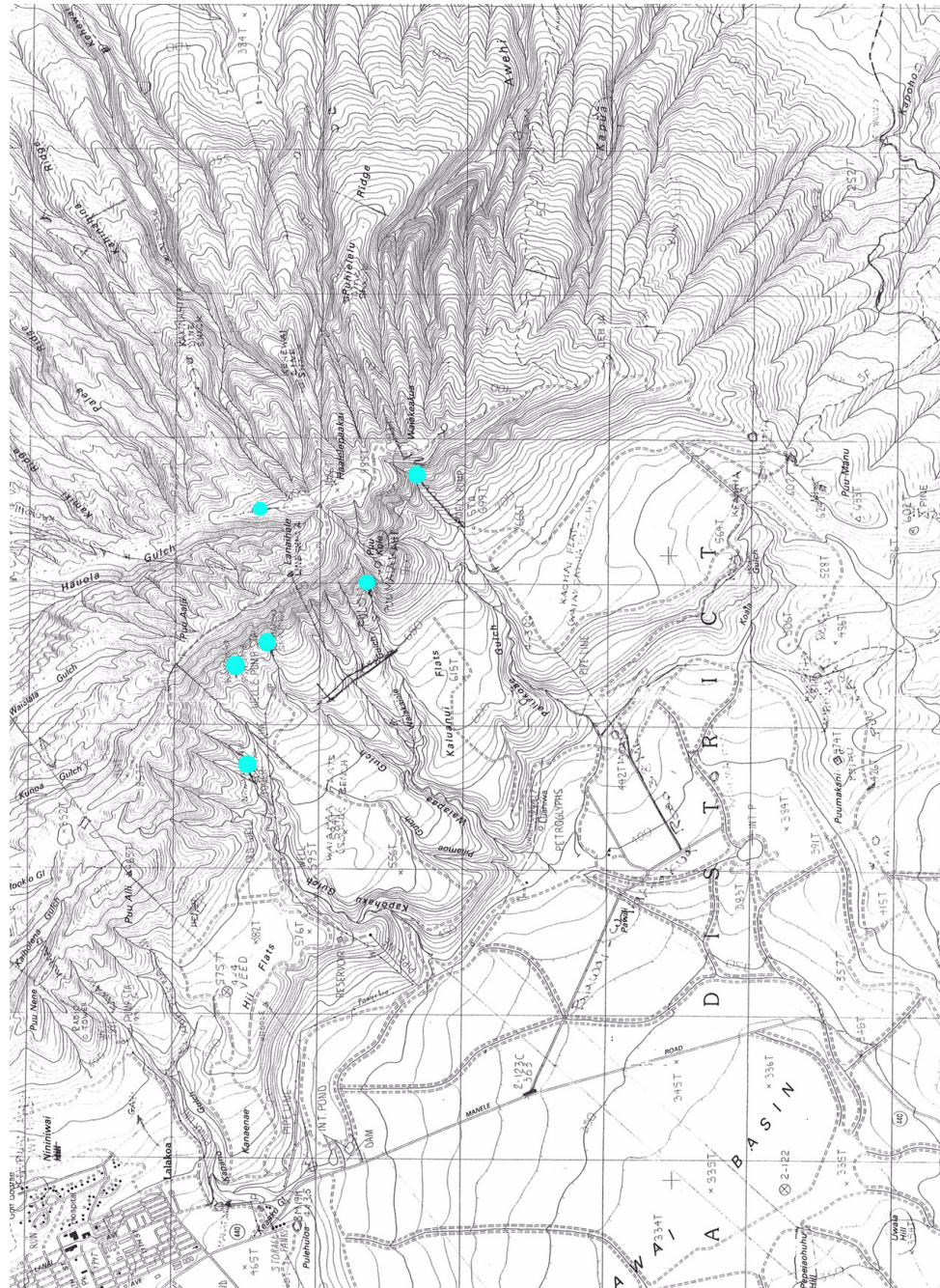

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**FIGURE 3-21. Water Place Names in Lana'i From Gazetteer of Lana'i in Emory, K.P.; *The Island of Lana'i, A Survey of Native Culture*; Bishop Museum Bulletin 12, Honolulu 1969 - Springs or flowing water highlighted in cyan**

Puu Nene	Goose hill (once descriptive). Hill. Feeding ground for geese. 90.
Puu Nene	Goose hill (once descriptive). Hill. Feeding ground for geese. 130.
Ua-punohu	Column of rain (descriptive). Section of valley. 40.
Wai-a-hoo-lai	Calm waters, or water of Hoolai. Beach. 293
Wai-a-ka-pua'a	Pig water. Valley mouth. 228a.
Wai-a-ke-akua	Water of the god (descriptive). Spring. There is another Waiakeakua in Waipaa gulch. 109.
Wai-a-ka-iole	Rat water. Valley. 248.
Wai-alala	Water of Lala, or glistening water (descriptive). Valley. Large tributary gulch to Maunalei on the east. Not Waialala, as given in Andrews Dictionary. 43.
Wai-a-opae	Shrimp polluting waters (Thrum) (descriptive). Valley mouth. 166.
Wai-a-paa	Held water (descriptive?). Valley. 166.
Wai-ka-kulu	Tumbling waters (descriptive). Valley. 39.
Wailoa	Long water (descriptive?). Beach. 119
Wai-lehua	Lehua water. Beach. A landing place on the north shore of Lana'i (19, p. 424)
Wawae-ku	Foot print (Thrum) (descriptive of shape). Hill. 47.
Wili-wili-opu-hau	Grunting of a horse (descriptive). Section of a ridge. At the water trough. A recent name. 191.

## Historical Water Resources

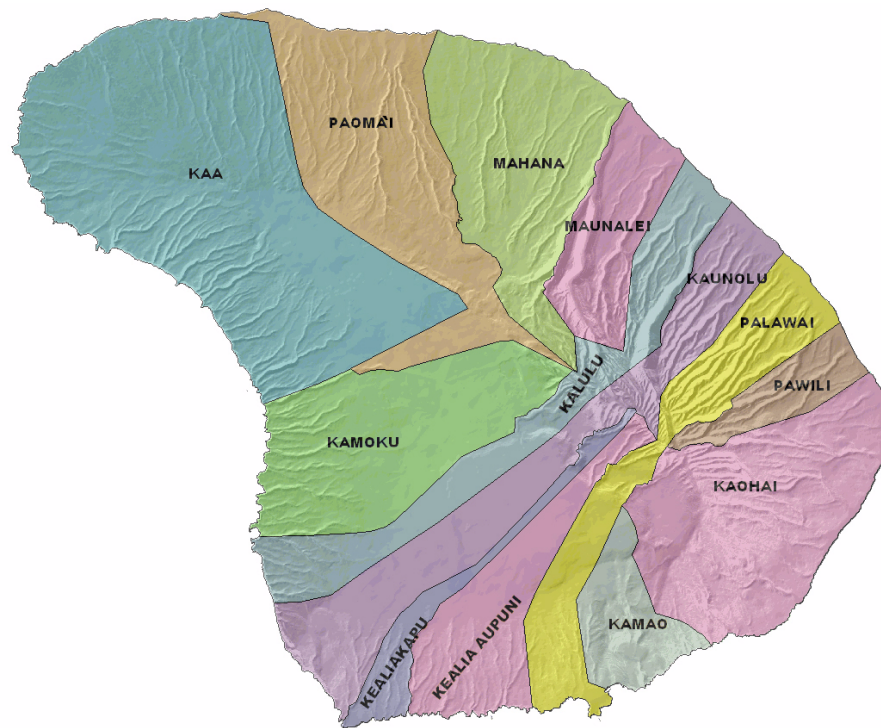
**FIGURE 3-22. Historical Springs of Lana'i** Source: **A Survey of Native Culture**, Bishop Museum Bulletin 12, Honolulu, 1969 - Not all of the springs noted in this reference are plotted here. Some are beyond the extent of this map.



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**Existing Resources & Systems**


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**FIGURE 3-23. Ahupua'a of Lana'i** - Source: Robert Hobdy**Ahupua'a**

The thirteen ahupua'a that make up the island of Lana'i have been described in detail, with comments on place name meanings and traditional uses, in *"The Island of Lana'i: A Survey of Native Culture"* (K.P. Emory, 1924); *"The Story of Lana'i"* (G.C. Munro, 2007); and *"E 'Ike Hou Ia Lana'i: To Know Lana'i Once Again: A Historical Reference and Guide to the Island of Lana'i"* (Lana'i Culture & Heritage Center, 2008). The following notes from Kumu Pono Associates summarize their descriptions: (Source: *Kumu Pono Associates LLC, 2008*)

**Ka'a** (literally, the Rocky area): Ka'a is the largest ahupua'a on Lana'i, comprising some 19,468 acres. It makes up the entire northern end of the island, and hosted many near-shore settlements, from which the rich fisheries were accessed-the turtles of Polihua, once being an important resource of traditional subsistence. In addition to village sites, the near shore lands also hosted many ceremonial sites, including the largest heiau on the island. Near shore springs provided residents with water supplies, and in the uplands, the dry forest zone of the Keahiakawelo-Kanepu'u region supported an extensive dry land agricultural system. Keahiakawelo is one of the most significant storied landscapes on Lana'i, connected with traditions of how people were able to live on Lana'i, and why at one time, Lana'i was noted for purple colored lehua (*Metrosideros*) blossoms. During the Mahele, Chiefess Victoria Kamamalu, claimed and retained the ahupua'a of Ka'a. Uhu (parrot fish) was identified as the kapu fish, and koko (*Euphorbia* spp.), identified as the kapu tree. Four awarded kuleana claims were noted in Ka'a.



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### Historical Water Resources

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**Kalulu** (literally, The shelter): Containing 6,078 acres, Kalulu is one of three unique ahupua'a divisions on Lana'i. On the (kona) leeward side of the island, Kalulu is bounded by Kamoku on the north. It then runs across the island, passing the western banks of Palawai Basin, up the mountain, and then continues to the (ko'olau) windward coast, bounding Maunalei on the north. Along its southern boundary, on both the leeward and windward regions, Kalulu is bounded by Kaunolu Ahupua'a. The leeward and windward coasts of Kalulu take in two significant fisheries-one being a part of the deep sea fisheries of Kaholo (shared with Kaunolu), and the other being the near shore reef-lined fisheries of the windward coast. In the Palawai Basin and mountain lands were extensive agricultural fields, ranging from open kula lands noted for sweet potato plantings, to forest-sheltered dry land field systems. The forest resources included stands of koa and other native woods, and small valleys and gulches where water sources were found. Daniel I'i claimed Kalulu as his personal property during the Mahele, but relinquished it to the King, who retained it as a Crown land. He'e (octopus) was the kapu fish, and 'ahakea (Bobea) was the kapu wood. Seven awarded kulaena claims were noted in Kalulu.

**Kama'o** (literally, The ma'o (*Gossypium tomentosum*) plant): Kama'o Ahupua'a is a southerly facing land division, that is bounded by Palawai on the west and Ka'ohai on the east. Comprising 2,751 acres, Kama'o includes two-thirds of Manele Bay. This bay was the site of a major canoe landing-sandy beach, and was watered by springs, some of which were tapped by diving along the shore with gourds to catch water as it escaped from holes in the caprock. The village of Manele (shared between Palawai and Kama'o Ahupua'a) was a major complex on the coast, with residences, ceremonial sites and lowland agricultural features. In the uplands, native tenants also tended dry land crops, and a major nesting area of 'ua'u (petrels) occurred on the upper slopes which the natives tended, and from which they harvested birds as a source of protein. One of the noted mountain heiau on Lana'i and a major burial site also occur in the upper section of Kama'o. Three place names in Kama'o also bear the name "Kapo," a Hawaiian goddess. One site in the uplands, and two forming coves on the shore. The chief Kahanaumaika'i claimed Kama'o as a personal property, but relinquished it to the Government Land Inventory during the Mahele. He'e (octopus) was the kapu fish, and koko (*Euphorbia* spp.) was the kapu wood. Two awarded kuleana claims were noted in Kama'o.

**Kamoku** (literally, The district): Kamoku Ahupua'a contains 8,291 acres, and is situated on the kona (leeward) side of Lana'i. On the north, it is bounded by Ka'a Ahupua'a. On the south, it is bounded by Kalulu Ahupua'a. Kamoku was noted for its upland forest and springs, with areas developed into an extensive forested dry land agricultural system. Along the shore, its sheltered coves were developed into temporary and long-term residences, from which the rich fisheries fronting the ahupua'a were accessed. At the time of the Mahele, Pali was the Konohiki of Kamoku under the King, and the ahupua'a was retained as a Crown Land. Uhu (parrot fish) was the kapu fish, and koko (*Euphorbia* spp.) was the kapu wood. The important spring watered bay of Kaumalapa'u (an 'ili of Kamoku) was claimed by Oleloa, a woman of chiefly lineage, but relinquished to the government during the Mahele. One awarded kuleana claim was noted in Kamoku.

**Ka'ohai** (literally, The *Sesbania tomentosa* plant): Situated in the southeastern region of Lana'i, Ka'ohai contains 9,677 acres. The coastal zone hosted villages and rich fisheries, including fishponds. Springs were developed to supply water along the coast, and the upper valleys provided seasonal water sources. A major spring in the mountain lands also provide upland residents with water for personal use and agricultural purposes. In the years leading up to the Mahele, Chiefess Kekau'onohi claimed Ka'ohai as a personal land. But during the Mahele, Ka'ohai was claimed by Mataio Kekuana'oa, on behalf of his son, Moses Kekuaiwa. The award was confirmed and recorded by the King. He'e (octopus) was the kapu fish, and

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naio (*Myoporum sandwicense*) was the kapu wood. Kekuaiwa died prior to closure of the Mahele, and his father received the award in his name. Upon Kekuana'oa's death, Cheifess Ke'elikolani inherited the ahupua'a. Two awarded kuleana claims were noted in Ka'ohai.

**Kaunolu** (meaning uncertain): Kaunolu Ahupua'a, like its northern neighbor, Kalulu, spans both the kona and ko'olau regions of Lana'i. It contains 7,860 acres, and extends from the noted deep sea fishery of Kaholo, passes the steep sea cliffs of Pali Kaholo, crosses through the Palawai Basin, ascends the mountain to Pu'u Ali'i, one of the major peaks of Lana'i Hale, and then continues to the ocean on the windward shore. The leeward coast of Kaunolu hosts the major religious, political and social center of Lana'i, and was supplied by water sources in the Kaunolu-Kealia Kapu gulch. In the basin, a spring occurred at Pu'u o Miki, to which the gods resorted. Further inland, the bench lands and forest zone provided shelter for extensive residency and agricultural pursuits, while the deep valleys and mountain lands provided residents with springs and forest resources. Another of the major mountain heiau occurred in the leeward forest zone. On the windward side Kaunolu shared Hauola Gulch (in which water flowed seasonally), with Kalulu, and extended down to the shore where springs and rich reef-sheltered fisheries supported the native tenants. On its eastern, windward side, Kaunolu is bounded by Palawai Ahupua'a to the mountain peak of Lana'i Hale, where it joins with Kealia Aupuni, Kealia Kapu, and then continues down the mountain, through forest and basin, to the ocean. Kaunolu was originally claimed by Keali'iahonui, but relinquished to the Government Land inventory. No specific records documenting the kapu fish and wood were found for Kaunolu. Traditional accounts do celebrate the kawakawa fisheries of Kaholo, along with documentation of a wide range of other fishes known to the region. Thirteen awarded kuleana claims were noted in Kaunolu.

**Kealia Aupuni** (literally, The salt beds of the people/nation): This ahupua'a contains 4,679 acres. On its western side, it adjoins Kealia Kapu, and on its eastern side it is bounded by Palawai. It extends from the ocean to the mountain, taking in fisheries, open kula lands that were formerly cultivated, a portion of the basin, bench lands and mountain forest. Along the coast, each little gulch that forms a cove on the ocean is host to formal villages and temporary fishing camps which were used seasonally over the centuries. In the deep mountain gulches springs occurred, and both stone and forest resources were collected. At its summit, Kealia Aupuni meets Pu'u Ali'i and Lana'i Hale. Within the boundaries of Kealia Aupuni there also occurs a lele (an independent land division), which belongs to Pawili Ahupua'a (an ahupua'a found on the windward side of Lana'i). This lele provided residents of Pawili with fertile kula lands that supported dry land sweet potato cultivation. During the Mahele, Kealia Aupuni was relinquished by Kahanaumaika'i to the King, and in turn conveyed to the government inventory. Uhu (parrot fish) was the kapu fish, and koko (*Euphorbia* spp.) was the kapu wood.

**Kealia Kapu** (literally, The restricted salt beds): A small ahupua'a, containing 1,829 acres, situated on the kona side of Lana'i. Kealia Kapu is bounded on the west by Kaunolu, and on the east by Kealia Aupuni. Small villages occurred along the shore, where the adjoining western valley also hosted a spring. The kula lands of the basin were noted for sweet potato cultivation, and in the uplands mountain springs provided tenants with water for drinking and irrigation of crops. One point of traditional significance of Kealia Kapu is that it was reportedly the pu'uhonua (place of refuge) on Lana'i. In the uplands of Kealia Kapu a rain-making heiau is found, and a major petroglyph field also occurs. Uhu (parrot fish) was the kapu fish. No kapu wood was recorded by Ka'eo. During the Mahele, Kealia Kapu was claimed by and awarded to the chief, Ka'eo.

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### Historical Water Resources

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**Mahana** (literally, Warmth): Mahana Ahupua'a contains 7,973 acres, and makes up the central, northern section of the island. Extending from the reef-banked fisheries to the upland forests, Mahana is bounded by Maunalei on the east, and by Paoma'i on the west. Mahana was watered by a number of springs, seasonal streams and near-shore wells. Villages and areas of residence occurred along the coast, on the kula-middle lands and in the forest-mountain region. Ceremonial sites and other cultural features occur across the ahupua'a, and at one time it was host to an expansive dry land forest which was famed for its grove of purple-blossomed lehua trees (the latter of which was exterminated as a result of goat depredation). During the Mahele, Mahana was claimed by William C. Lunalilo, but was relinquished to the Government land inventory. The kapu fish was he'e (octopus), and the kapu wood was 'ahakea (Bobeia). Six awarded kuleana claims were noted in Mahana.

**Maunalei** (literally, Mountain garland): Maunalei Ahupua'a holds the distinction of being the only land on Lana'i where a stream flowed year round. Deep in the upper valley and gorges, dense forest growth once captured rains from the clouds (thus the name, "Mountain garland," describing the cloud banks which nestled the mountain like a lei), and fed small streams that irrigated lo'i kalo (taro pond fields) into the late 1800s. Maunalei contains 3,342.38 acres, and on its west side is bounded by Mahana Ahupua'a, while on the east and south sides, it is bounded by Kalulu. Native tenants lived upon and utilized most flat and gently sloping areas of Maunalei, with several major villages occurring along the coast, where springs were also found. Smaller settlements of single and extended families occurred in the uplands, and ceremonial sites occurred at various locations in the ahupua'a. Kamehameha I granted Maunalei to the foreigner, John Young, out of gratitude for service Young had provided him during his quest to unify the islands. In the settlement of John Young's estate, Maunalei was given to his daughter, Pane (Fanny) Kekelaokalani. In the Mahele, the title of Maunalei was confirmed to Pane, and her kapu fish was he'e (octopus), the kapu tree was kukui (Aleurites moluccana). Pane Kekelaokalani bequeathed Maunalei to her daughter, Queen Emma Kaleleonalani, whose estate sold the ahupua'a to Walter M. Gibson in 1886. Although records note at least 71 claims to lo'i kalo and one 'auwai, only twelve awarded kuleana claims were noted in Maunalei.

**Palawai** (literally, Fresh water moss): The ahupua'a of Palawai is the third of three ahupua'a on Lana'i that spans both the kona (leeward) and ko'olau (windward) sides of the island. It contains 5,897 acres, hosted fisheries (including fish ponds), kula (dry land) agricultural field systems, forest resources, and numerous fresh water sources with springs and intermittent streams. In the near shore sections of Palawai, potable water sources were developed, and villages established all along the coast. On the leeward side, Palawai is bounded by Kealia Aupuni on the west, and by Kama'o on the east. At the mountain top, Palawai shares the highest peak, Lana'i Hale (site of a traditional spring), as a boundary point, and adjoins Kaunolu and Pawili, from the mountain to the windward coast. The basin region of Palawai Ahupua'a was also the site of the first foreign settlement on Lana'i in 1854, in the form of the original Mormon colony in Hawai'i. During the Mahele, Palawai was awarded to Chiefess Kekauonohi, and later inherited by her husband, Ha'alelea. The kapu fish was anae (mullet) and the kapu wood was 'ahakea (Bobeia). Seven awarded kuleana claims were noted in Palawai.

**Paoma'i** (literally, Sick Pao): Paoma'i, situated in the northern region of Lana'i, contains 9,078 acres, and is bounded by Mahana on the east, and Ka'a on the west. The ahupua'a extends from the reef-lined fisheries, across the kula lands, and into the forest region. Major villages occurred along the coast, where access to fisheries, and near shore water sources sustained the people. On the kula lands a significant portion of the Lana'i dry forest occurred, and gulches hosted potable water that could be collected seasonally. In the uplands, the forest cover supplied people with access to necessary resources for daily life, and sheltered

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cultivated of crops. Several places in the uplands of Paoma'i were noted as gathering places for chiefly and community events. At the outset of the Mahele, Paoma'i was identified as belonging to the King, though Charles Kana'ina made a claim for the ahupua'a on behalf of his son, William C. Lunalilo. The kapu fish was he'e (octopus), and the kapu wood was 'aiea (*Nothocestrum*). At the close of the Mahele, no specific title was listed for Paoma'i, but it later appeared in the Government land inventory, and was sold as a Royal Patent Grant.

**Pawili** (literally, Strike and twist, as of the wind): The ahupua'a of Pawili (also written Paawili), is on the eastern (windward) side of Lana'i, and contains 1,930 acres. Pawili extends from the ocean to the mountain, where it meets Ha'alele Pa'akai, the second highest peak on Lana'i. Pawili is bounded on the south by Ka'ohai, and on the north by Palawai Ahupua'a. It also contains the only formal "Lele" (a detached land division, taking up a portion of another ahupua'a) recorded on the island of Lana'i. The lele of Pawili is situated in the ahupua'a of Kealia Aupuni, and afforded the people of Pawili with fertile lands in the Palawai Basin for the cultivation of crops like sweet potatoes. Along the coast of Pawili, which included an important reef-sheltered fishery, there occurred several villages, one of the major heiau on the island, and other ceremonial sites. Springs and wells were developed in the coastal region, and the deep valleys at the back of Pawili provided seasonal water sources as well. During the Mahele, William C. Lunalilo claimed Pawili, but relinquished it to the Government land inventory. No record of a kapu fish or wood was found in the historical documents. One awarded kuleana claim is noted in Pawili.

The total land area of these thirteen ahupuaa is 88,853.38 acres.

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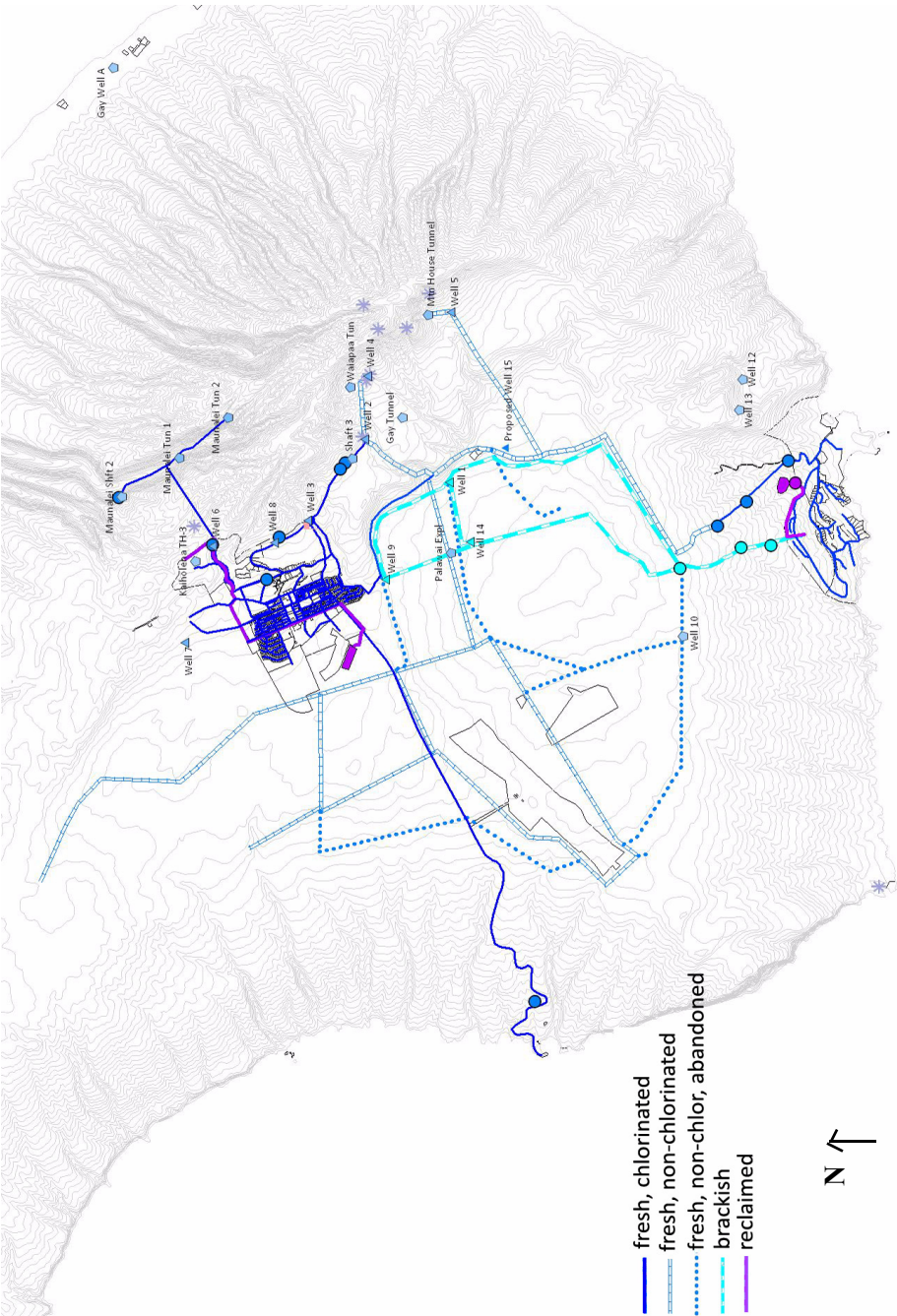
## Water Systems

Lana'i has five water systems. Two potable water systems, Lana'i City to Kaumalapau (PWS 237) and Manele, Hulopo'e and the Palawai Irrigation Grid (PWS 238), are regulated both by the State Department of Health under the Safe Drinking Water Act, and by the Public Utilities Commission (PUC). Potable water rates for these systems have not been updated since June of 1996. Shortly before finalization of this draft, in July of 2009, the Lana'i Water Company received an Amendment to its Certificate of Public Convenience and Necessity, pursuant to §269-7.5 HRS, to provide non-potable water service in Manele-Hulopo'e, as well as to set rates, rules and regulations. There are also two reclaimed water systems. One, Manele Water Resources, LLC, obtained a Certificate of Public Necessity and Convenience from the PUC to deliver reclaimed water for irrigation in the Manele-Hulopo'e area, and was able to set rates in March of 2007. The other remains non-regulated and serves only the Koele Golf course. In addition to these five systems, "Lana'i Holdings, Inc." (LHI) is a private, non-regulated water company which consists of the potable and brackish sources serving these utilities, as well as Castle & Cooke designated uses on any of the above systems. The potable and brackish systems are wholly owned subsidiaries of LHI.

The following schematic, Figure 3-24, shows the approximate alignment of pipes, tanks and wells of the Lana'i water systems.

Water Systems

**FIGURE 3-24. Schematic Layout of Lana'i Water Systems.** Blue is Potable, Aqua is Brackish, Purple is Reclaimed



Notes: This figure is also provided as an 11x17 exhibit in the large exhibits file. Since completion of the review draft in October, 2009, the chlorination point for Manele & the Palawai Irrigation Grid has been moved from Breaker #1 up to the Hi'i Tank site.



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The five water systems on Lana‘i collectively serve about 1,573 meters. Water rates for the potable systems are \$1.10 for the first 25,000 gallons, and \$1.62 thereafter. Water rates for the brackish system are \$3.57 for the first 1,000 gallons per day, \$4.64 for 1,000 to 2,500 gallons per day, and \$5.72 above 2,500 gallons per day. Sewer rates are charged by unit, at a rate of \$56.74 per single family, \$42.21 per multi-family, and \$92.12 per hotel unit. Non-food commercial customers are charged \$9.98 per 1,000 gallons, while those that serve food are charged \$10.07. The Harbor is charged \$10.05 per thousand gallons.

Key system facilities issues include: the need for backup sources to meet reliability criteria and distribute withdrawals; the age and condition of the system; leaks and high pressures in certain areas - especially the irrigation grid; frequent loss of service in the MECO/Miki Basin area; the need for improved monitoring and maintenance; and the small customer base to support the necessary improvements and replacements.

Source capacity of each system is listed in Figure 3-25 below, and in more detail in Figure 3-26. System Standards require that sources be able to meet maximum day demand with an operating time of 16 hours simultaneously with maximum fire flow required independent of the reservoir, assuming the largest pump is down. The standby unit may be used to determine the total flow required. The system should also be able to provide for maximum day demand while simultaneously providing water for a two hour fire for the highest zoning density served, with credit given for 3/4 of reservoir storage.

Maximum day demand is defined as 1.5 times average day demand. The standard means that there should be sufficient source capacity to meet one and a half times average demand plus fire, essentially with 2/3 installed capacity. So, in order to meet system standards, about 2.25 times average day demand in source must be installed. Stated another way, about 44% of the full installed capacity, less the largest unit, should meet or exceed average day demand. With Well 3 down, Lana‘i City fell short of pump capacity standards by 256,113 GPD in 2008. However, with the 2 MG tank, there was adequate fire protection.

**FIGURE 3-25. System Capacities**

System Area	Installed Capacity	2/3 Installed Capacity	Avg Day Metered Demand 2008	Max Day Demand 2008
<b>Koele, City , K‘pau Potable</b>	2,016,000	1,344,000	522,742	784,113
<b>Less Largest Pump</b>	792,000	<b>528,000</b>	522,742	<b>784,113</b>
-----				
<b>Manele Potable w/Well 2/Shaft 3</b>	3,024,000	2,016,000	375,146	562,719
<b>Less Largest Pump</b>	1,296,000	<b>864,000</b>	375,146	<b>562,719</b>
-----				
<b>Manele Brackish golf course &amp; landscape</b>	1,353,600	902,400	760,357	1,140,536
<b>Less Largest Pump**</b>	864,000	576,000	760,357	1,140,536** (N/A)

\*\* The system standard which requires meeting maximum day demand in 16 hours pumping with the largest pump out only applies to potable systems, or systems serving livestock, and so would not apply to Manele brackish irrigation. The information is included here only to indicate the potential irrigation shortfall if a pump went out.

## Water Systems

FIGURE 3-26. Source Capacities By District and Island-wide

Installed and Standard Source Capacities By District					
Lana'i City, Koele & Kaunapau	Manele, Hulopo'e, Palawai, Irrigation Grid		Brackish - Manele, Irrigation Grid, Others		
Source	Source	Source	Source	Source	GPM
GPM	GPM	GPM	GPM	GPM	GPM
Well 6	Well 2/ Shaft 3*	Well 3**	Well 1	Well 1	340
Well 7	Well 3**	Well 4	Well 9	Well 9	300
Well 8	Well 4	Well 5	Well 12	Well 12	NIU
Maunalei - Shaft 2	Well 5	Well 5	Well 14	Well 14	300
Tunnels					
Well 3 (could serve either way)	* Well 2/ Shaft 3 pump to be replaced with smaller pump				
550/OOS	** Well 3 could serve either direction, Lana 'i City or Manele & IGGP. However, it is out of service & will be replaced.				
Total GPM	Total GPM	2,100	Total GPM	Total GPM	940

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**Existing Resources & Systems**


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Reservoirs and storage should be sized to meet maximum day demand plus the highest applicable fire flow for a presumed two hour fire. A table of storage is shown in Figure 3-28.

Overall system capacities are summarized in Figure 3-27, below.

**Developed & Utilized Resources - System Infrastructure**

**FIGURE 3-27. Summary of System Capacities and Use**

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<b>Lana'i City, Koele and Related Areas</b>	<b>MGD 2008</b>
Total Installed Capacity	2.416
Installed Capacity of Potable Sources	2.016
Average Fresh Water Use	0.523 metered / 0.605 pumped
Average Reclaimed Use	0.209 to Koele Golf Course
Capacity of Brackish Sources in Use	0.000
Capacity of Reclaimed Water Facilities	0.400
Average Effluent Production	0.235
Potable Storage	2.786
Non Potable Storage	16.8 active / 22.8 total
Approximate Miles of Pipeline	35.59 miles
 <b>Manele, Hulopo'e and Related Areas</b>	 <b>MGD 2008</b>
Total Installed Capacity	4.518
Installed Capacity of Potable Sources in Use	3.024
Average Potable Use	0.375 metered / 0.683 pumped
Average Brackish Use	0.760 metered / 0.944 pumped
Average Reclaimed Use	0.073 wtf production
Capacity of Brackish Sources in Use	1.354
Capacity of Reclaimed Water Facilities	0.140
Average Effluent Production	0.073
Potable Storage	2.000
Non Potable Storage	17.85 active / 19.35 total
Approximate Miles of Pipeline	43.04 miles*
(*Estimate does not include roughly 14.81 miles of abandoned or out-of-use pipeline in the Palawai Irrigation Grid)	

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## Water Systems

FIGURE 3-28. Lana'i Tanks and Storage

TANK NAME	TANK CAPACITY IN MG	SPILLWAY ELEVATION	GROUND ELEVATION	YEAR BUILT	TANK MATERIAL	USE	C12 SITE	COMMENT
<b>Lana'i City, Koele &amp; Kaunapau</b>								
Maunalei Tank	0.030		1017	1992	Steel	Potable - PWS 237	N	Not In Use
Koele Tank	0.750	2057	2025	1995	Bolted Steel w Glass Fused Coating	Potable - PWS 237	N	SCADA
Lana'i City - Niw'ai Tank		1878	1830	1951	Steel	Potable - PWS 237	N	2 MG Not In Use
New Lana'i City Tank	2.000	1980	1942	2008	Bolted Steel w Glass Fused Coating	Potable - PWS 237	N	Chlorinated at Well 6
Kaunapau Tank	0.022		360	1992	Bolted Steel w Glass Fused Coating	Potable - PWS 237	Y	
Lana'i AWWTF R-1 Reservoir	10.000		1518.5			Non-Potable - Effluent		
Koele Clubhouse Lake 1	1.900		1761			Non-Potable - Effluent		Passive
Koele Clubhouse Lake 2	0.900		1741			Non-Potable - Effluent		Passive
Koele 8th Hole Lake/Reservoir	2.000		1739			Non-Potable - Effluent		
Koele 9th Hole Lake/Reservoir	1.100		1746			Non-Potable - Effluent		
Koele 13th Hole Lake/Reservoir	0.900		1991			Non-Potable - Effluent		
Koele 2nd Hole Lake/Reservoir	1.5					Non-Potable - Effluent		
Koele 3rd Hole Lake/Reservoir - Tee	0.900					Non-Potable - Effluent		
Koele 3rd Hole Lake/Reservoir - Green	0.400					Non-Potable - Effluent		
Koele 6th Hole Lake/Reservoir	1.300					Non-Potable - Effluent		
Koele 17th Hole Lake/Reservoir	0.400		1822			Non-Potable - Effluent		
Koele 18th Hole Lake/Reservoir	1.500		1746			Non-Potable - Effluent		
Potable Storage	<b>2.802</b>							
Non Potable Storage	22.800							Including Passive
Non Potable Active Storage	<b>16.800</b>							
<b>Manele, Hulopo'e and Portions of Irrigation Grid</b>								
Hi'i Reservoir	1.000	1823	1810.2		Concrete Lined		N	PE Cover
Hi'i Tank	0.500	1823.5	1791.5	1952	Welded Steel	Potable - PWS 238	N	
Manele Breaker Tank 1	0.100	1141	1127	1987	Bolted Steel w Glass Fused Coating	Potable - PWS 238	Y	Chlorination Site
Manele Breaker Tank 2	0.100	755.8	742	1987	Bolted Steel w Glass Fused Coating	Potable - PWS 238	N	
Manele Breaker Tank 3	0.300	341	326	1987	Bolted Steel w Glass Fused Coating	Potable - PWS 238	N	
Wells 9 & 1 Control Tank	0.050	1434.5	1420.5		Steel	Non-Potable - Brackish		Abandoned
Palaw ai Brackish Reservoir	15.000	1211	1239		Lined	Non-Potable - Brackish		
Effluent Reservoir	2.800		275		Lined	Non-Potable - Effluent		
Manele GC Pond	1.500		250			Non-Potable - Effluent		Passive
Potable Storage	<b>2.000</b>							
Non-Potable Storage	19.350							Passive
Non-Potable Active Storage	<b>17.850</b>							

## Existing Resources &amp; Systems

FIGURE 3-29. Lana'i Pump Inventory - Source

Well / Source	Pump & Motor Description	Pump Elevation	GPM	Calibrated GPM	24 Hrs	16 Hrs	44.44%	2008 Actual MAV in GPD	Character
6	Submersible Byron Jackson 23 Stage, 1800 RPM, 2500 V with 200 HP Type H 14" Motor installed 2006	863	550		792,000	528,000	352,000	327,912	Potable Drilled 1986
7									Proposed Potable Drilled 1987
								0	<b>Not In Use</b>
8	Submersible Byron Jackson 11 MQH, 20 stage, 1800 RPM with 300 HP Type H, F1 Amp 74 Motor 2300 Volts								Potable Drilled 1990
		782	850	816	1,224,000	816,000	544,000	276,890	pump lowered to 783' 09/09
2	Vertical Turbine Fairbanks Morse Pomona 3 Stages, 1780 RPM with 75 HP Ingersoll Rand Booster FL Amps 90 voltage 480 Frame-L365TP								Potable Drilled 1946
		1,335	1,200	1,152	1,728,000	1,152,000	768,000	2,418	<b>Rarely Used Confined Space Issues</b>
3	Submersible Byron Jackson #781-5-1808 22 Stage 1800 RPM 23 stage w/Byron Jackson Type H 300 HP 14" Motor	866							Potable Drilled 1950
	Submersible Byron Jackson #841-S-0046, 13MQH, 15 stage, 1800 RPM with Byron Jackson Type H 300 HP 14" Motor w/ Amp 74 2300 Volts							0	<b>Out of Service</b>
4		1,253	900	864	1,296,000	864,000	576,000	683,867	Potable Drilled 1950
									<b>Out of Service</b>
5		1,293							Potable Drilled 1950
1	Submersible Crown 340 GPM 9 Stage, 3470 RPM with Hitachi 100 HP Motor Installed 2005	516	340	300	489,600	326,400	217,600	393,981	Brackish Drilled 1945
9	Submersible Byron Jackson 16 stage 600-4114-931-R-005 6 MQH 3600 RPM w Franklin Electric 100 HP Motor Installed 2005 F1-Amp-148 480 Volt	466	300		432,000	288,000	192,000	151,440	Brackish Drilled 1990
12									Brackish Drilled 1990
		-5							<b>Not In Use</b>
14	Submersible Byron Jackson Hitachi 125 HP Motor Installed 2003	400	300		432,000	288,000	192,000	404,714	Brackish Drilled 1995
<b>Source Capacity</b>			4,440		6,393,600	4,262,400	2,841,600	2,241,222	

## Water Systems

**FIGURE 3-30. Lana'i Pump Inventory - Boosters and Totals**

[illegible]

Existing Resources & Systems

FIGURE 3-31. Photo Schematic of Lana‘i Water Systems, Courtesy of Lana‘i Water Company, Inc.



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## Water Systems

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### **Lana‘i City Water System - Potable Uses**

The Lana‘i City Water System serves Koele, Lana‘i City and Kaunalapau. The system has roughly 1,400 service connections, served by two wells, three tanks and roughly thirty-five miles of potable line. Source for this system is currently drawn from two active wells, Well 6 (aka Kaiholena Well 6 - USGS #5054-01) at 1,910’ and Well 8 (USGS # 4753-01) at 1,902’. Well 3 was once an important source for this system, but has since been taken out of service. A replacement for this well is in progress as of this draft, and scheduled to be on-line in 2010.

The system is untreated with the exception of the standard required chlorination, which takes place at the sources, and again at Kaunalapau Harbor tank. Koele, Lana‘i City and Kaunalapau represent three service zones on the system.

Koele is served by Wells 3 and 8, via the 750,000 gallon Koele Tank, with a spillway at 2057.5’. The low elevation limit of this pressure zone is about 1,740’. The Koele Tank primarily serves Koele Villas and lots and the Lodge at Koele, but water from this tank can drop to the City through a PRV.

Lana‘i City is served primarily by Well 6. Well 6 feeds directly to the New Lana‘i City Tank, with a spillway elevation of 1,980 feet. Water from Wells 3 (once replaced) and 8 can also contribute source to Lana‘i City via a PRV from the Koele service area. Well 6 feeds directly to the New Lana‘i City 2,000,000 gallon tank, with a spillway elevation of 1980’.

Kaunalapau is fed from Lana‘i City via a 2-1/4” pipe to the 22,400 gallon steel storage tank at Kaunalapau, with a spillway elevation of 375’. This tank services Kaunalapau Harbor and small surrounding developments.

### **Lana‘i City - Non Potable - Uses - Reclaimed Water**

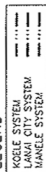
Two wastewater treatment plants serve Lana‘i City. The County’s Lana‘i City Wastewater Treatment Facility has a capacity of about 500,000 gallons per day and treats water to R-3 quality. In calendar year 2008, the Lana‘i City Wastewater Treatment Facility had an influent of about 308,412 gallons per day, and produced about 245,456 GPD of effluent.

From the Lana‘i City Wastewater Treatment Facility, effluent proceeds to the CCR-owned Lana‘i City Auxilliary Treatment Facility where it is further treated to R-1 quality water. The Auxilliary Treatment Facility has a capacity of about 400,000 GPD. In 2008, with an influent of 245,456 GPD, the Auxilliary Treatment Facility produced about 234,093 GPD of R-2 water.

The Auxilliary Treatment Facility has a storage capacity of about 10 MG, with additional storage in water features at the “Experience At Koele” Golf Course of about 13.1 MG. The non-potable system has roughly three miles of waterline. About 209,721 gallons per day were pumped to the “Experience At Koele” Golf Course from the Auxilliary Water Treatment Facility during 2008.



3-46

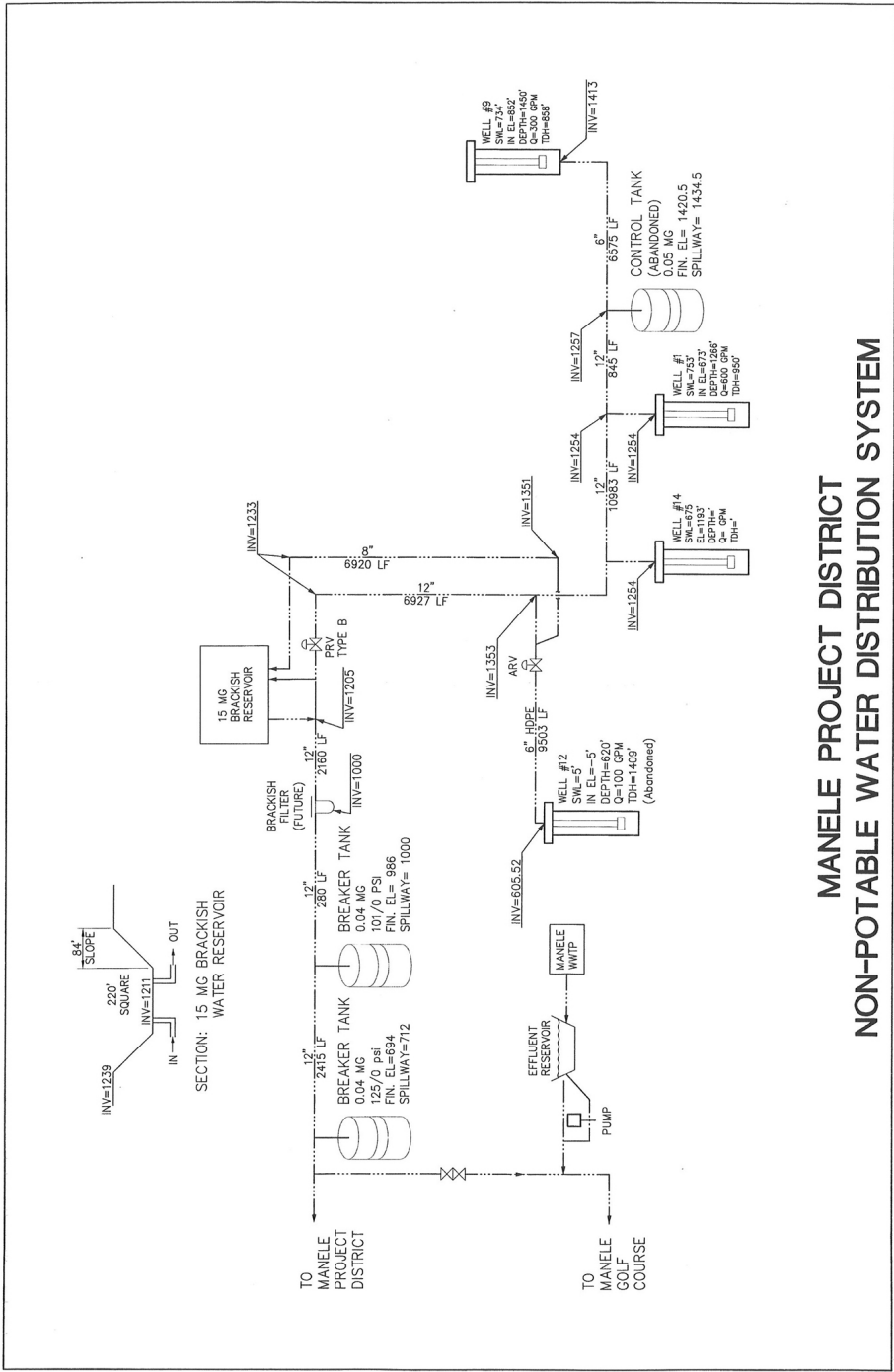


LANANA WATER COMPANY  
LANANA, NV 89006

**Note:** An 11x17 version of this figure is provided in the large exhibits file.

Water Systems

FIGURE 3-33. Manele Non-Potable System Schematic



MANELE PROJECT DISTRICT  
NON-POTABLE WATER DISTRIBUTION SYSTEM

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**Existing Resources & Systems**


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**Manele Water System - Potable Uses**

The Manele Water System serves Manele Resort, Hulopo'e Beach Park, and the Manele Small Boat Harbor, as well as the Palawai Irrigation Grid. It has roughly 200 service connections and is served by two wells, five tanks and roughly thirty-five miles of potable or non-chlorinated waterlines. Water for the Manele system is drawn primarily from Well 4 (aka Soule's Bench Well, USGS #4952-02), with very occasional withdrawals from Well 2/Shaft 3 (USGS # 4953-01). From Well 4, at an elevation of about 2,327', it proceeds to the 1 MG concrete Hi'i Reservoir and 0.5 MG Hi'i Tank at 1,823'. From Hi'i, water is carried to Manele via three steel breaker tanks in series at spillway elevations of 1,141', 755.8' and 341' respectively. Breaker Tanks 1 and 2 have capacities of 100,000 gallons each. Breaker Tank 3 has a capacity of 300,000 gallons. Water for the Palms and multi-family estates at the west end of Manele is channeled into a line just above Breaker Tank 3. From Breaker Tank 3, water continues to the Harbor, the Beach Park and the Hotel.

**Manele Water System - Non Potable Uses**
**Brackish**

Brackish water for landscaping at Manele comes from Wells 1 (USGS # 4853-02), 9 (USGS # 4854-01) and 14 (USGS # 4854-02) at 1,265', 1,411' and 1,193' respectively. A 0.5 MG control tank exists after Well 9 at 1,420.5' with a spillway elevation of 1,434.5', but this control tank is currently bypassed to minimize unnecessary pumping costs. From Wells 1, 9 and 14, water proceeds to the 15 MG Reservoir with a spillway elevation of 1,211'. Water is then piped via two 40,000 gallon breaker tanks with spillway elevations of 1,000' and 712' toward Manele. Just above Manele, brackish water is blended with reclaimed effluent for golf course irrigation. There are roughly seven miles of brackish waterline.

**Reclaimed Water**

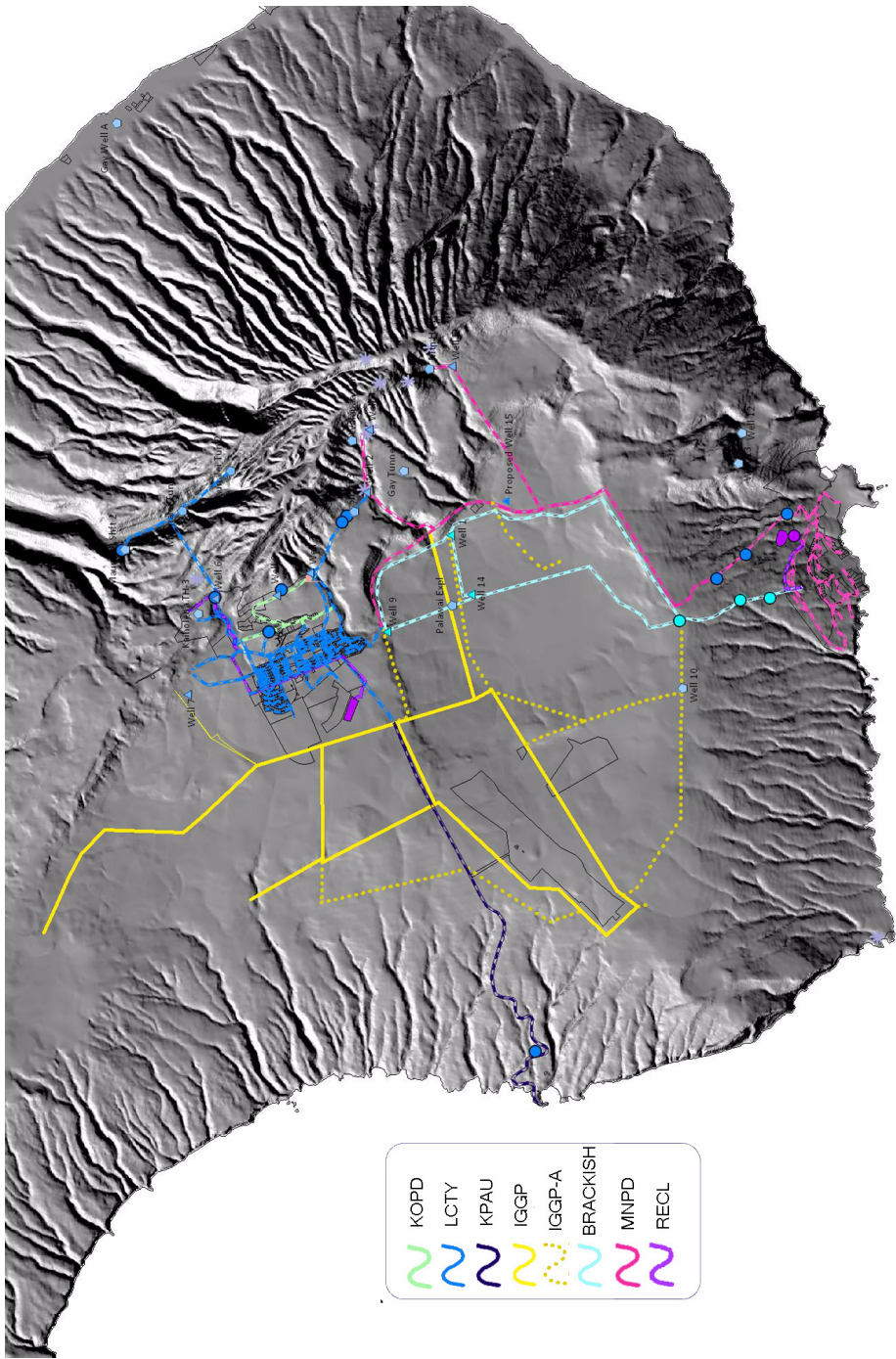
The Manele Wastewater Treatment Facility has a capacity of 140,000 GPD. During calendar year 2008, with an influent of 77,281 GPD, it produced 72,940 GPD of effluent. From the effluent reservoir, this water is pumped directly to the Manele Golf Course via roughly one mile of wastewater line.

**FIGURE 3-34. Wastewater Facility Capacity, Influent and Effluent on Lana'i - 2008**

Name		Capacity	Average Influent	Average Production
Lana'i City WWTF	R-3	500,000	308,412	
Lana'i City Auxilliary WWTF	R-1	400,000	245,456	234,093
Manele WWTF	R-1	140,000	77,281	72,940

Water Systems

FIGURE 3-35. Lana'i Water Systems By District

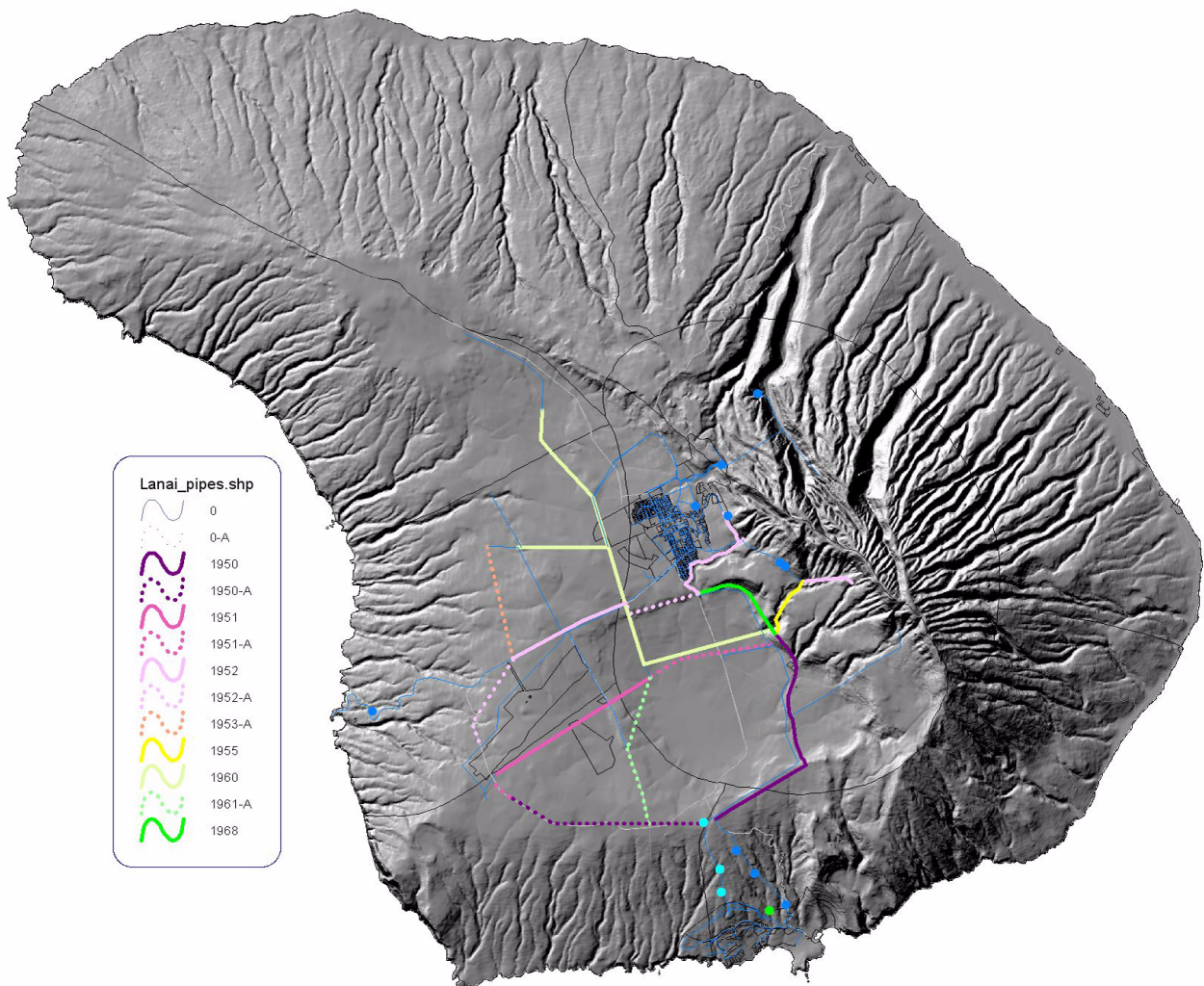


## Existing Resources & Systems

### Pipelines

In all, Lana‘i has roughly 93.44 miles of pipeline, as measured from GIS plots. Of this, about 78.63 miles are active, and 14.81 miles are abandoned or out of use. The age and condition of some of these lines, combined with the lack of customer base to generate adequate revenues for necessary replacements, is a matter of serious concern to both Lana‘i Water Company, Inc. and the community it serves. Long segments of pipe in the irrigation grid, and to the west, south and east of Lana‘i City, are in need of repair, replacement or in some cases possibly abandonment. A portion of the line from Hi‘i tank down to the Palawai Basin is unburied and in a fire-prone area. In addition, some lines are either too small in diameter to satisfy system standards or constructed of problematic materials, such as asbestos-concrete or galvanized iron. These situations will be a challenge for the utility in the coming decade.

**FIGURE 3-36. Palawai Grid Pipe Age Data** Dotted lines in this image are abandoned.





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## Water Systems

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### Developed and Utilized Resources - Wells & Pumps

Lana'i has 23 well holes, of which six or seven are currently in use for its two public water systems. Estimated 24 hour pumping capacity for utilized wells totals 6.934 MGD. At present, Wells 6 and 8 are used for domestic and municipal use in the Lana'i City and Koele Project District areas, as well as for the Airport, Kaunalapau Harbor, north end game management and Miki lumber yard areas. This is PWS 237. Well 4, and occasionally Well 2/Shaft 3, are used for domestic and municipal use in the Palawai Irrigation Grid and the Manele Project District areas. This is PWS 238. Wells 1, 9 and 14 are used for irrigation of the Manele Golf Course and landscaped areas at Manele. Total reported pumpage for calendar year 2008 was 2,241,222 GPD.

### Lana'i City, Koele, Kaunalapau and Related Uses

#### Maunalei Sources

The combined Maunalei sources were once the primary source of drinking water for Lana'i City. Gravity flow from the Upper Maunalei tunnel was conducted via a 2" line to the Lower Maunalei Tunnel, where the flows of the two tunnels combined. At one time, these combined tunnel flows were about 274,000 GPD. However, the average over the period of record entered in this report was closer to 150,000 GPD. From the Lower Maunalei Tunnel this combined tunnel water gravity flowed to the Maunalei Shaft 2 and booster station via a 4" line. The Maunalei shaft ran at a 30 degree slope into the dike complex from an elevation of 851', where it met a concrete floor at 740'. From that point a deep well continued 259' straight down. The well at one time had a submersible 170 GPM Anderson pump. Later reports indicated a 500 or 600 GPM pump to boost the shaft water to the booster. Reported historical flows were about 500,000 GPD. A 750 GPM booster pump lifted water from the Maunalei tank, via another series of 4" lines, 1,100' up and over the ridge and back downward by an 8" line to the Koele 2 MG tank. The Shaft 2 pump was activated only when the Maunalei Tunnel flows were not adequate to keep the Maunalei Tank levels up. Chlorination facilities were located at the 21,000 gallon Maunalei tank. Although zero flows have been reported from Maunalei sources on the periodic pumping reports since 1995, the sources were used most heavily from 1948 to 1994. The 1998 sanitary survey report indicated that the sources were still utilized to serve a bee keeping operation and a boy scout facility. The tank can be chlorinated to accommodate such events. It is not clear from any of the available data whether the lower tunnel still flows at all. It may be possible to further develop pumping capacity in shaft two or the tunnels. It is not clear whether these sources could be utilized for additional development without modifications for two reasons: first the numeric groundwater model indicates that they will cease to run under most pumping scenarios; and second, they may be subject to becoming GWUDI ("*Groundwater Under the Direct Influence*" of surface water).

#### Well 6

Well 6 is currently the major source serving Lana'i City, Koele Project District and related areas. From a pump elevation of 868' (intake elevation 863'), a 550 GPM pump with a 200 HP motor pumps water up to ground level at 1,910 feet and proceeds to the Lana'i City 2 MG tank via a 10" ductile iron pipe. From the 2 MG tank it serves the Koele Lodge and Villas, and Lana'i City. If necessary, water can also be pumped from the 2 MG tank to the higher elevation 0.73 MG Koele Tank, from where it can serve Koele, the City and the Palawai Irrigation Grid. Pipe connections also exist which could send this water toward Manele in an emergency. In calendar year 2008, Well 6 provided an average of 327,912 GPD to the Lana'i City area. Chlorides in the well appear to be stable, though water levels are declining.

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## Existing Resources & Systems

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### Well 7

Well 7 has never been in regular use. It is considered a future Lana‘i City / Koele source, but could be used to serve areas makai of the city, Kaunalapau area, or even to offset pumpage from elsewhere, freeing water for Lana‘i City or even Manele. It has a direct feed to the irrigation system at the north end of the old plantation.

### Well 8

Well 8 is located above the City and *Experience at Koele* Golf Course at about 1,902’ elevation. From a pump depth of 863’ (intake 862’), the pump was recently lowered to 783’ (September, 2009). Water from this well can be sent via 8” ductile iron lines either to the 0.75 MG Koele Tank, or directly to the Koele Lodge, the Koele Villas or the 2 MG City tank. Although it has an 850 GPM pump, with a 300 HP motor, Well 8 is currently pumped less than Well 6. During calendar year 2008, Well 8 provided about 276,890 GPD to the Koele Project District area and the surrounding area. Chlorides are marginally higher than those at Well 6, but both wells are fresh. Water levels show a slight declining pattern.

## Manele, Hulopo’e, Palawai Irrigation and Related Uses

### Well 2 / Shaft 3

Well 2 / Shaft 3 is a potable source, but was once a major source of the plantation’s irrigation water. In a 1989 memo from R.C. Oda to J.H. Parker of Dole Foods, Mr. Oda wrote, “This complex above Kapohaku Gulch has been the plantation’s major source of irrigation water, but deliveries have declined due to the continuing drought.” In 2001, Tom Nance noted that the water levels had recovered about half way to the well’s pre-use level with the facility’s minimal use. (Tom Nance, *Current Status of Lana‘i’s High Level Aquifer as Portrayed by Datea From Its Wells*, September, 2001). The ground elevation at Well 2 is 1,510’ and the pump elevation is at 1,335’. Water travels via a 16” ductile iron line to the Hi‘i Reservoir or Hi‘i Tank, or it can bypass these and continue directly in 8” and 12” lines to the Manele Project District or Palawai Irrigation Grid. The portal to Shaft 3 is located at 1,810’. Shaft 3 is drilled at a 30 degree slope with a slope length of about 620’ - intersecting with Well 2 at an elevation of 1,510’. The complex has a 1,200 GPM vertical turbine pump, and a 75 HP Ingersoll Rand booster pump. Various reports have described proper operation of this complex and how to work with it. One is left with the impression that this complex was not the most convenient to use, even aside from safety issues. Nevertheless, this was a major source of water for the Plantation and one of the least expensive. As shown in Figure 3-9, Well 2 / Shaft 3 has one of the shortest lifts from the pump intake to the tank outlet, which explains why this complex was so economical. Historical estimates of safe yield for this source have ranged between about half a million gallons per day and 1.2 million gallons per day. Annual MAV pumpage has varied over the years from as little as 70,000 gallons to 700,000 gallons. Well 2 / Shaft 3 has been used only sparingly since 1996, in part due to safety issues in the shaft. In calendar year 2008, average pumpage was only 2,418 gallons per day. Water levels are stable, though rarely reported in recent years. Surprisingly for such high level water, there is a slight rising trend in historical chlorides. Replacement of Well 2 / Shaft 3 is planned.

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## Water Systems

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**Well 3**

Well 3 is no longer in use and will be replaced. It has been out of service since period 5 of 2006. Well 3 was located such that it has the most flexibility of any source in the system, but it was most recently used primarily as backup for the Manele system, serving as a secondary backup for the City, Koele and related areas. From a pump elevation of 866', a 900 GPM pump drove water up to an 8" ductile iron line with an invert of 1,845', and from there it could proceed either to the Palawai Basin via 10" ductile iron lines, or to the Manele Project District via 12" and 8" ductile iron lines. Water from Well 3 could also be pumped through 8" and 12" ductile iron lines to the Koele and Lana'i City systems - either via the 0.75 MG Koele Tank or directly toward Koele Villas, Cavendish Golf Course, along West Loop Road and on into the city via Ninth Street. Various estimates of the well's safe yield given from 1957 to 1977 ranged from 65 MGY to 130 MGY or 178,000 to 356,000 GPD. Another estimate was 32 GPM per foot of drawdown. In past years Well 3 was pumped at a rate of about half a million gallons per day, but toward the end of its pumping years, pumpage was closer to 100,000 GPD. Water levels and chlorides are both stable.

**Well 3 Replacement**

As this document is drafted, a replacement for Well 3 is in progress, with completion expected in 2010. The well permit application indicates that Lana'i Holdings, Inc. intends to install the existing Well 3 pump into the new well hole. The well has been drilled, but testing is not yet complete and so a well completion report had not yet been submitted as of this draft. The information on the proposed permit indicates a ground elevation of 1,850', (1,852' at top of casing), and a total well depth of 1,400'. Anticipated water elevation was 1,010'. As with the previous Well 3, this well should be able to serve either the Koele / Lana'i City system or the Manele / Hulopo'e system. System connections are expected to be the same as for the original Well 3, described above.

**Well 4**

This is the island's most productive well, and the primary source serving the Manele, Hulopo'e, Palawai irrigation grid and related areas. Well 4 has been used for both drinking water and plantation irrigation, but is presently the major potable source for Manele. It has a 900 GPM pump with 300 HP motor, which lifts water from the 1,316' pump elevation to ground elevation at 2,327'. The water is transported through 6", 12" and 16" lines to Well 2 and then onward to the 1 MG Hi'i Reservoir or 0.5 MG Hi'i tank. The water can also bypass this storage and feed directly to the Manele Project District or Palawai Irrigation Grid, or theoretically with some valve and system adjustments, it could be fed back to Lana'i City if it were necessary. Keith Anderson, a hydrologist that consulted for Lana'i Water Company during the 1960s and 1970s, estimated safe yields for this well between 200,000 and 300,000 GPD. However, a 1974 Company report considered it the most productive well, with good recharge and ability to deliver 600 GPM (864,000 GPD). Historical annual average use of the well has reached as high as nearly 1 MGD, but in recent years pumpage has been in the 600,000 gallon range. During calendar year 2008, Well 4 provided an average of about 683,867 GPD. Water levels and chlorides seem stable.

**Well 5**

Well 5 has not seen much use since 1994. It is considered a potential backup or future source for the Manele area. Located at 2,296', there is currently no pump in the well. Safe yield estimates for this well have run from about 150,000 GPD to about 220,000 GPD. Historical reports have noted that it needs to be used with caution, and time is needed to allow water to recharge. Despite such caveats, it had a 900 GPM pump and fed into the system around the Palawai Basin. Although data on water levels and chlorides are limited, they seem to be stable.



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**Existing Resources & Systems**


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**Brackish Sources****Well 1**

Well 1 is located at the 1,265' elevation. The elevation of the pump intake is 516'. Water from this well feeds via 8", 10" and 12" waterlines to the brackish 15 MG reservoir and then onward to Manele via 12" lines. Safe yield estimates for this source have ranged from 110,000 to 140,000 GPD or so. The well is fitted with a 340 GPM pump with a 100 horsepower Hitachi motor. Well 1 has been pumping around 400,000 GPD in recent years. Pumpage in calendar year 2008 was 393,981 GPD. Water levels in Well 1 show a declining pattern.

**Well 9**

Well 9 is located at 1,411' and the pump had been located at 950' until October of 2003, when the pump was lowered 42' to about 908'. The pump has since been lowered again, to 466'. The well has a 300 GPM pump and 100 HP motor. Water from Well 9 goes to Manele PD via the 15 MG brackish reservoir. Average pumpage in 2008 was 151,440. Chloride levels look stable. Water levels show a declining trend.

**Well 10**

Well 10 was an experimental well only, drilled to test the extent of the utilizable aquifer at the edges of the Palawai Basin. Although there are discrepancies in reported chlorides, the results were high enough that the well was not considered promising, though it was at one time outfitted with a 300 GPM pump. No pump is currently reported. Ground elevation is 1,228'.

**Well 12**

Wells 12 and 13 were drilled in the southeast rift zone to the east of Manele Resort. Well 12 tested at less than 100,000 GPD, but was thought potentially useful for small amounts of local irrigation use. Well 12 is located at 605' elevation, with the pump 5' below sea level in a thin basal layer. Tests in 2003 revealed low production and high chlorides. (Initial chlorides were 708 mg/L, similar to those found in Well 14.) The well was outfitted with a 100 GPM submersible Plueger Worthington pump and 60 HP motor. There is one full MAV period of data for Well 12. Average pumpage for 1995 was about 14,000 GPD. Well 12 was not utilized during 2008.

**Well 13**

Well 13 was drilled at 695' in 1990, in the hope that it could be used for irrigation of Manele Project District. Pump tests indicated that production capacity would be too low to make it worth outfitting the well. It is not currently in use.

**Well 14**

Well 14 was drilled in the Palawai Basin in 1995. Tests in October 2003 revealed salinity in the 700+ parts per million (ppm) range (i.e. 700+ mg/L). At that time it was thought that the well was not likely to be appropriate for use. However, in April of 2004, pumpage started sporadically and at present the well is pumped regularly and mixed with water from Wells 1 & 9. Average daily pumpage for calendar year 2008 was 404,714 GPD. Chlorides run from 700 to 800 mg/L. Water levels show a declining trend, though the period of record is still rather short.

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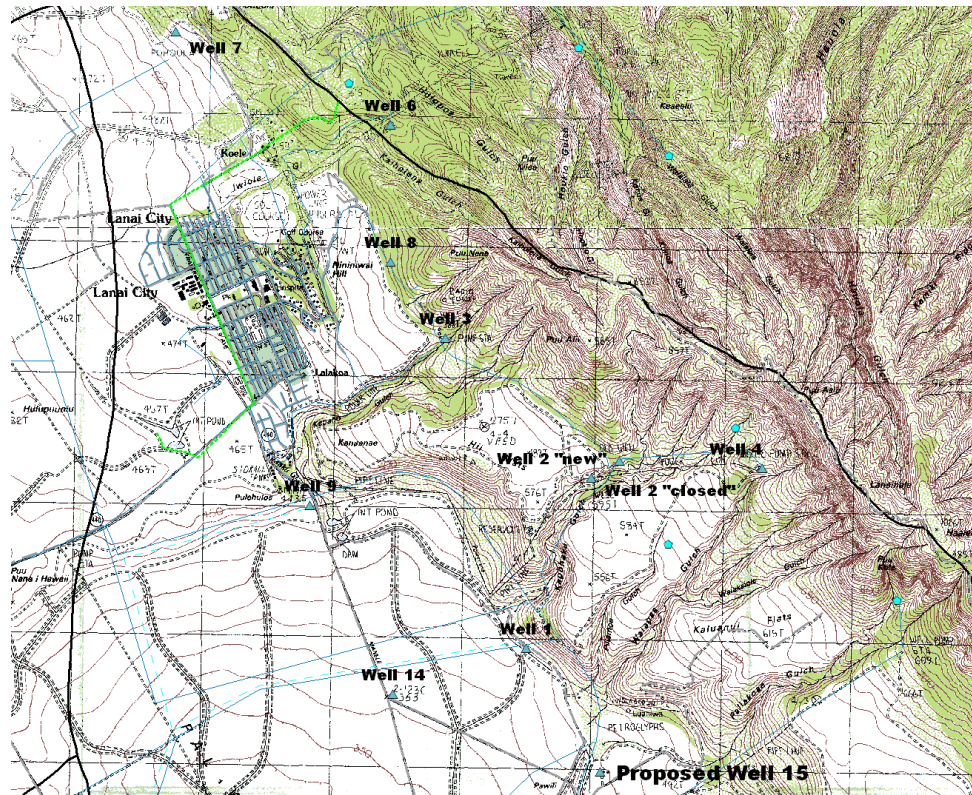
## Water Systems

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### Well 15

As of this drafting, a permit has been approved for drilling of a “Well 15”, (USGS # 4753-01). The proposed site for this well is in the leeward aquifer system, south of Well 1, at an elevation of 1,310’. Total anticipated well depth is 1,200’ with an anticipated water level of 700’. The proposal anticipates a pumping rate of 350 GPM and a withdrawal of 250,000 GPD. The proposed use of the well is listed as municipal, though given the location, it seems more likely to be a brackish irrigation well. (This application was originally submitted as Well 11. It was later decided to change the name to Well 15, since there had once been a wellhole drilled under the name Well 11, though not in use.)

**FIGURE 3-37. Location of Proposed Well 15 Relative to Other Well Sites**



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Maui County Water Use &amp; Development Plan - Lanai

**FIGURE 3-38. Well Holes on Lana'i . CWRM Data Base.**

WELL NO	WELL NAME	YEAR DRILLED	WELL TYPE	GROUND ELEV	WELL DEPTH	BOT HOLE	CASING DIAM	INIT HEAD	INIT CHLOR	TEST GPM	TEST DDOWN	RECENT			
												PUMP GPM	PUMP ELEV	PUMP	PUMP DEPTH
5149-01	Gay Well A	1900	PER	16	60	-44	6	2	821	400		0			
5053-01	Maunalei Tun 1	1911	TUN	1103				1103				0			
5053-02	Maunalei Tun 2	1911	TUN	1500				1500				0			
4852-01	Mtn House Tunnel	1918	TUN	2700				0				0			
4853-01	Gay Tunnel	1920	TUN	1920				0				0			
4952-01	Waipaa Tun	1924	TUN	2220				0				0			
5154-01	Maunalei Shft 2	1936	TUN	851	372	479		735	31	20	2	0			
5253-01	Maunalei Shft 1	1936	TUN	294	293	1		2.4	374			0			
4853-02	Well 1	1945		1265	1274	-9	12	818		300	45	700	300	677	588
4953-01	Well 2	1946		1510	609	901	18	0				1400	1200	1330	180
4852-02	Well 5	1950		2296	1122	1174	18	1570				900	900	1293	1,003
4952-02	Well 4	1950		2327	1178	1149	18	1589		660	16	900	840		
4954-01	Well 3	1950		1850	1199	651	18	1078				300	900	812	1,038
5054-01	Kaiholena TH-3	1950						1064				0			
4953-02	SHAFT 3	1954	SHF					0				0			
5054-02	Well 6	1986	PER	1910	1310	600	16	1005	23	30	50	550	640	868	1,042
5055-01	Well 7	1987	PER	2100	1650	450	8	650	67			500	500	840	1,260
4555-01	Well 10	1989	ROT	1228	1020	208		208	330			300			
4552-01	Well 12	1990	PER	605	630	-25	12	5	708	160	8.2	100	100	-13	618
4553-01	Well 13	1990	PER	695	750	-55	12	20		12	12	0			
4854-01	Well 9	1990	ROT	1411	1451	-40	14	808		336	105.1	300	300	461	951
4954-02	Well 8	1990	ROT	1902	1490	412	14	1014	40	1110	37.9	800	640	863	1,039
4854-02	Palawai Expl	1995	ROT	1193	950	243	14	95	551.1	700	170			0	
4854-02	Well 14	1995	ROT	1193	950	244	14	551	700	300	32.7	300	300	361	833

Note: Initial Head as reported here is not always the same as Initial Water Level. The differences are:

Maunalei Shaft 2 Initial Water Level is 739' vs. 735',

Well 1 Initial Water Level is 876' vs. 818',

Well 4 Initial Water Level is 1,576' vs. 1,589',

Well 5 Initial Water Level is 1,548' vs. 1,570',

Well 9 Initial Water Level is 803' vs. 808'.

Palawai Exploratory Well tested at 710 ppm. chlorides.

PER - Percussion Drilled

TUN - Tunnel

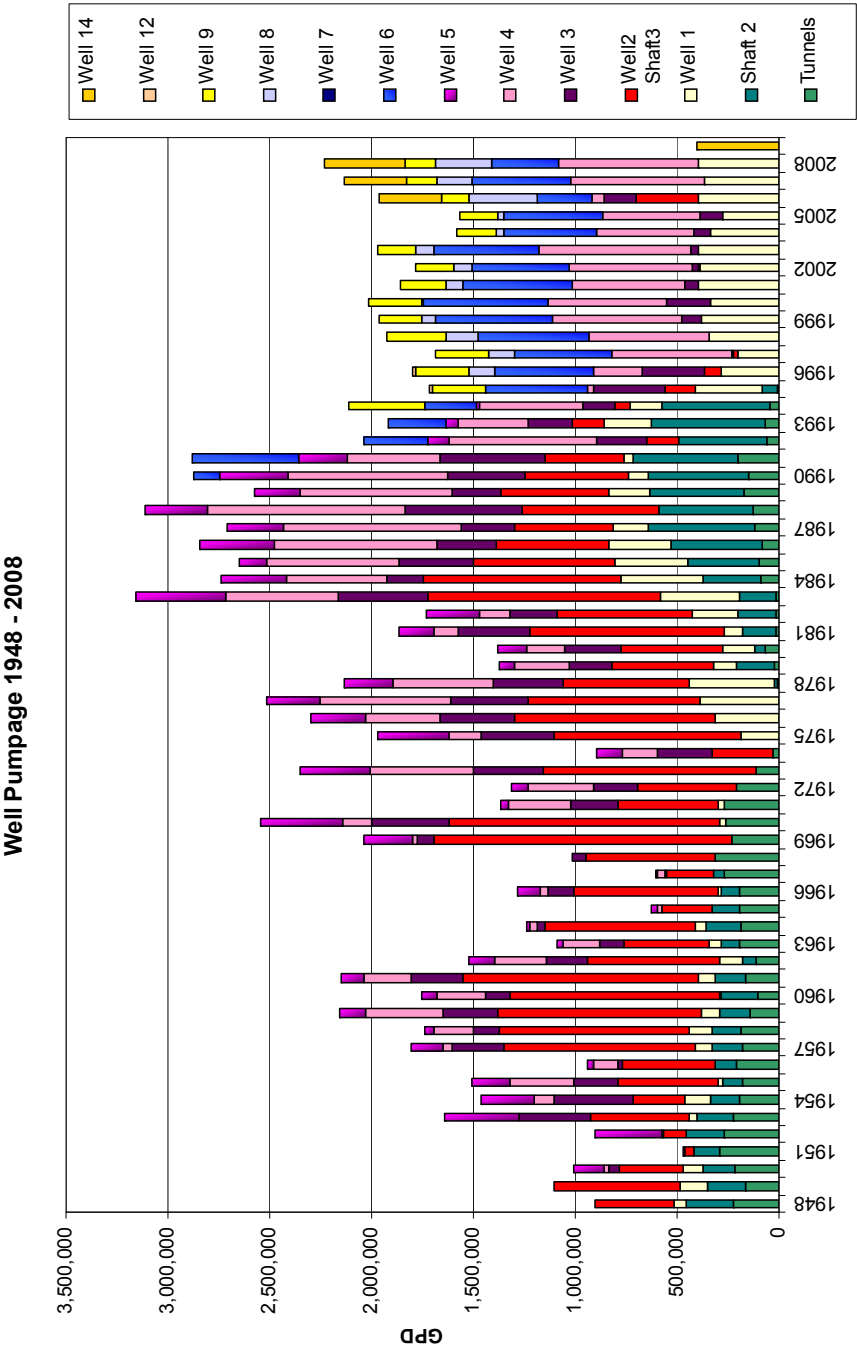
SHF - Shaft

ROT - Rotary Drilled

Existing Resources &amp; Systems

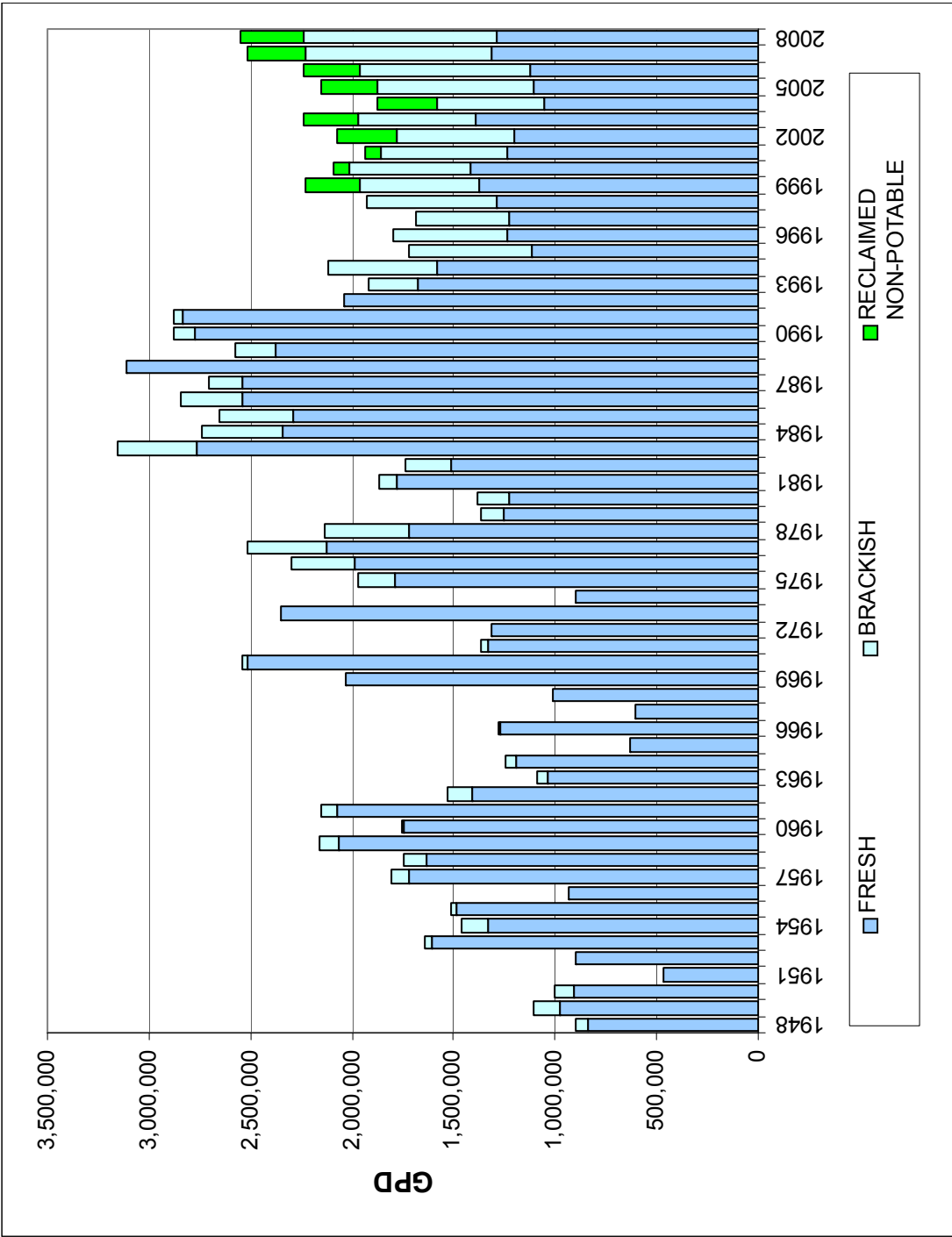
Water Systems

FIGURE 3-39. Well Pumpage 1948-2008



Existing Resources & Systems

FIGURE 3-40. Potable, Brackish and Reclaimed Use 1948-2008



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**Water Systems**


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**FIGURE 3-41. Potable, Brackish and Reclaimed Water Use on Lana'i**

Y E A R	F R E S H	B R A C K I S H	R E C L A I M E D N O N - P O T A B L E	T O T A L
1948	841,493	58,827		900,320
1949	978,123	128,986		1,107,110
1950	911,721	94,945		1,006,666
1951	467,827	19		467,847
1952	901,408	112		901,521
1953	1,605,085	36,000		1,641,085
1954	1,327,285	131,962		1,459,247
1955	1,488,233	21,874		1,510,107
1956	936,721	0		936,721
1957	1,717,501	85,427		1,802,929
1958	1,635,022	106,858		1,741,879
1959	2,067,436	89,792		2,157,227
1960	1,743,534	7,877		1,751,411
1961	2,073,326	77,282		2,150,608
1962	1,412,959	112,962		1,525,921
1963	1,035,603	54,003		1,089,605
1964	1,190,411	51,633		1,242,044
1965	628,425	0		628,425
1966	1,267,929	12,008		1,279,937
1967	605,729	22		605,751
1968	1,015,126	0		1,015,126
1969	2,035,000	0		2,035,000
1970	2,518,299	25,652		2,543,951
1971	1,334,156	29,855		1,364,011
1972	1,312,301	1,041		1,313,342
1973	2,353,307	85		2,353,392
1974	896,784	0		896,784
1975	1,787,159	186,526		1,973,685
1976	1,985,079	316,554		2,301,633
1977	2,121,939	390,689		2,512,628
1978	1,717,594	413,843		2,131,437
1979	1,252,835	116,786		1,369,621
1980	1,227,239	156,429		1,383,667
1981	1,778,975	87,988		1,866,963
1982	1,513,863	220,233		1,734,096
1983	2,769,565	385,881		3,155,446
1984	2,341,790	400,424		2,742,214
1985	2,291,841	357,154		2,648,995
1986	2,541,694	303,792		2,845,486
1987	2,539,017	169,038		2,708,055
1988	3,112,702	0		3,112,702
1989	2,377,393	198,468		2,575,860
1990	2,778,336	96,839		2,875,175
1991	2,830,921	48,201		2,879,121
1992	2,040,515	0		2,040,515
1993	1,679,570	235,279		1,914,849
1994	1,581,981	532,165		2,114,146
1995	1,115,975	602,097		1,718,071
1996	1,237,689	557,909		1,795,598
1997	1,223,283	460,157		1,683,440
1998	1,287,443	638,409		1,925,852
1999	1,377,387	586,321	265,313	2,229,021
2000	1,418,701	598,253	73,432	2,090,386
2001	1,236,517	623,173	73,468	1,933,158
2002	1,202,529	577,552	292,639	2,072,721
2003	1,388,046	583,051	268,252	2,239,350
2004	1,052,044	531,956	294,140	1,878,140
2005	1,103,347	773,182	275,094	2,151,624
2006	1,124,246	838,219	279,980	2,242,446
2007	1,309,528	916,507	286,479	2,512,514
2008	1,291,087	950,135	307,033	2,548,255

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**Existing Resources & Systems**


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**Well Performance and Status**

The pumpage and behavior of each well in terms of chlorides and water levels are provided on pages 61-77 of this chapter, in Figures 3-43 to 3-59. In water levels graphs for all wells, the green line is the initial water level, the yellow line is the action level set in the Lana'i Water Company, Inc.'s (LWCI's) operating guidelines, the red line is the lowest allowable level set in the same guidelines, the pink is the CWRM trigger for designation proceedings, and the dotted black line is the pump level as of the drafting of this document. The red and pink lines are normally so close as to be indistinguishable at the scale presented.

Water levels for the brackish Wells 1, 9 & 14 show a declining trend. Water levels at Well 3 are stable, though the well has not been pumped in some time. Water levels in Wells 6 and 8 show more gradual declining trends, although the pump in Well 8 was recently lowered by 80' (September, 2009). Water levels for Wells 2 and 4 appear relatively stable.

**FIGURE 3-42. Low Water Levels vs. Pump Levels and High Water Levels vs. Action Levels**

Well	Pump Intake Level	Low Water Level	Data * Date	Action Level	High Water Level	Data * Date
Maunalei Shaft 2	no data	668	P2, 1995	none	681	P2, 1995
Well 1	677**	555		550	575	
Well 2	1330	1,398	P10, 2006	1,050	1,441	
Well 3	812	874	P6, 2006	750	992	
Well 4	1316	1,457		1,100	1,495	
Well 5	1293	1,397	P10, 1993	1,100	1,491	
Well 6	868	913		750	924	
Well 7	840				973	P2, 2004
Well 8	863***	904		750	944	
Well 9	461	598		550	650	
Well 12						
Well 14	361	478		400	497	

\* All water level data from Period 7, 2009 unless otherwise noted.

\*\* Well 1 pump intake level is 677 per CWRM data. Water levels are lower than that. Follow up in progress as of this draft.

\*\* Well 8 pump level as of Period 7 was 863.17'. Pump was lowered 80' to 783.17' in September, 2009.