BUILDING COLLABORATION:
Toward Co-management for the Hanalei Ahupua'a, Kaua'i, Hawai'i

Department of Urban and Regional Planning
Planning Practicum 2002
University of Hawai'i at Manoa
Honolulu, Hawai'i

Report Cover:
Jan Schaafsma, Hanalei before 1941, oil painting

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Planning Practicum Fall 2002

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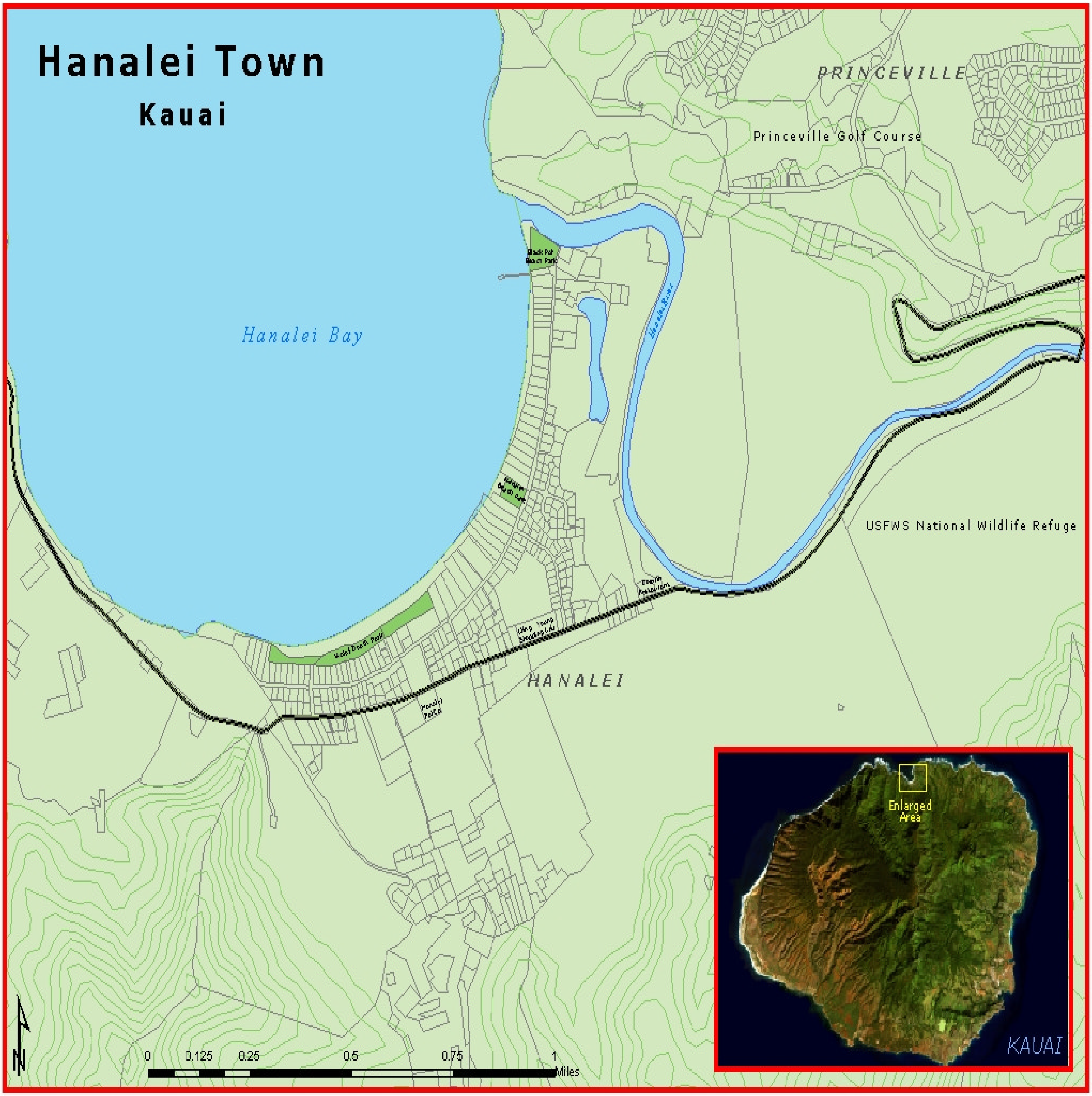
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EXECUTIVE SUMMARY

The purpose of this study is to explore the potential for developing mutual obligation partnerships between the HUI, the Natural Resource Conservation Service (NRCS) of the United States Department of Agriculture (USDA), the Hanalei Community, and other pertinent government agencies in the effort to *malama* the Hanalei watershed according to Native Hawaiian *ahupua'a* values that are both collaborative and beneficial for all stakeholders. It, further, aims to develop a road map for carrying out mutual obligation practices, which may serve as a model for future *ahupua'a* management purposes.

This objective arises from issues that have continuously emerged between two or more stakeholders. The three most prominent have been selected for analysis in order to assist the Hanalei community arrive at alternatives from which stakeholders can select. They are (1) wastewater disposal facility suitable for Hanalei; (2) the perpetuation of taro farming as an economic and cultural practice as well as its ability to serve as a natural habitat for native and endangered birds in Hanalei in co-existence with the bird impoundments at the National Wildlife Refuge; and (3) the coordination of tourism practices with environmental considerations.

1. Wastewater facility

The HUI raised as a situation of priority the need for an effective wastewater disposal facility because, recently, health concerns for Hanalei Bay have arisen due to periodic cases of rashes and cold-like symptoms after recreational use of the bay. Investigation into the cause of this health concern reveals high levels of fecal-indicator bacteria in Hanalei Bay and Stream. The most likely sources are the cesspool and septic systems, deteriorating from overuse, age, environmental constraints, and improper maintenance. For improved water quality in the area, new wastewater treatment systems should be investigated that coincide with the rural character of Hanalei. Education for proper maintenance and evaluation of current cesspool and septic systems is mandatory to begin mitigating system failures immediately. The restrooms at Black Pot Park should be modified as composting facilities or connect to an off-site clustered treatment system. Existing systems in flood-prone and high water table areas should be modified to use percolation beds. Community meetings with a certified engineer will be necessary to design a code-compliant system. Small diameter, low pressure infrastructure is recommended to pump sewage to a wastewater treatment system because of its low cost and long lifecycle. Of the four treatment systems reviewed (standard centralized, wetland, living machine, and septic), several cluster wetland systems should serve problem areas, with the option of centralized wetlands wastewater treatment reserved for consideration only after potential unwanted growth effects have been weighed. A centralized wastewater system will encourage population expansion. Policy changes necessary to control growth, to preserve rural character, and to protect Hanalei from environmental degradation should be enacted. Continued scientific monitoring of water quality is recommended to document changes in water quality resulting from mitigation efforts.

2. The co-existence of taro farming and bird impoundments

Wetland agriculture has been practiced on the Hawaiian Islands since the arrival of the first Polynesians. Not only has it served to feed its native people, it has also provided invaluable habitat for the resident waterbirds. However, within the last 200 years, Hawaiian wetlands have experienced severe size reductions due to extensive draining and filling for agricultural and urban development. It has been estimated that less than 10% of Hawai'i's former wetlands remain today. This habitat reduction has been a major cause in the decline of several of Hawai'i's native waterbirds to the point of extinction.

Presently, the United States Fish & Wildlife Service (USFWS) is tasked with the recovery of these endangered Hawaiian waterbirds, specifically the Hawaiian Stilt (*Ae'o*), Hawaiian Coot *('Ala ke'oke'o*), Hawaiian Moorhen (*'Alae'ula*), Hawaiian duck (*Koloa maoli*) and the Hawaiian goose (*Nene*). However, chronic under-funding has not made this task easy.

The relationship between the bird recovery and taro farming was briefly examined in this report. While it is crucial that endangered waterbirds attain sustainable numbers, it is also essential that taro farming is perpetuated not only for cultural and economic reasons, but also for its significant role in providing suitable habitat for these endangered birds. Despite what appear to be contradictory efforts, the common aim to preserve the *ahupua'a* renders good fodder for deliberating improved collaboration between the USFWS, taro farmers, and the Hanalei community.

3. Coordinating tourism with the environment

The increasing presence of tourists in Hanalei indicates the overall strengths of the tourist industry and prosperity of visitor-oriented businesses. However, it also represents the potential impacts on the natural resources, economic structure, culture and social relations, real estate, property ownership, as well as land use and townscape in this rural town. The impacts should be centered as a major concern for the County and be the driving force behind sustainable tourism plans for Hanalei. Agro-tourism and eco-cultural tourism are emphasized as key development trajectories for sustainable tourism. To manage, change, and mitigate adverse impacts from tourism in Hanalei, several plans and practices are recommended. The proposed visitor center with tourist parking and tourist shuttles can provide information and education for tourists. To reduce high property taxes that drive local people out of the town, a circuit breaker Bill should be encouraged by the County. The collaboration and participation of community is also the key principle of sustainable tourism development. The use permit should be imposed in order to control the amount of vacation rentals in the town. To determine limitations of tourism development, a study of Hanalei's carrying capacity should be conducted, tourist access should be managed, and a survey on the number of tourists and accommodations should be carried out annually. Finally, an environmental, economic, social, and cultural impact assessment on Hanalei should be carried out before proposing further tourism development.

Chapter 1

Introduction

The Hanalei River is a major water body that runs down the Hanalei *ahupua'a* from a climb of 5240 feet up Mount Wai'ale'ale, a natural wonder receiving an average of 450 inches of rain annually, and drains the 23 square mile Valley into the Hanalei Bay. It is a central water system 16 miles in length, running through a forest reserve, agricultural land, wilderness, and pastures. It is the lifeblood of Hanalei.

1.1 Background

In 1991, the Hanalei River was listed as one of the Most Endangered Rivers due to development projects that threatened its water quality and the valley surrounding it. At that time, the primary threats were (1) a proposed hydro-diversion project, (2) a flood control project, and (3) a plan to dredge it. A supplemental threat was the social changes that the Hanalei Valley was undergoing, which forecasted ecological pressures on the Valley's ecosystem. Hanalei was increasingly becoming a target destination for many tourist visitors from the mainland, Canada, and Japan, some of who selected Hanalei as their permanent vacation spot. Locals became alarmed at the social processes attached to a growing in-migration of part-time residents, visible from the town density during the high tourist season and the numerous vacation rentals being built around the town and its vicinity. Local residents were also cognizant of the increasing cost of living introduced by a more affluent, post-professional cohort who arrived in Hanalei to either retire or establish the afore-mentioned vacation rentals. Consequently, local residents raised opposition to the obvious transformations taking place in their community. Tensions ensued, particularly between groups who have a stake in the ecological quality of the Hanalei Valley because of its economic potential and those who aimed to maintain its quality for its own sake. Tension also became evident between the United States Fish and Wildlife (USFWS) personnel and the taro farmers in relation to watershed management[1].

In 1980, after lodging an application with the White House, Mike Kido's initiative won a Heritage standing for the Hanalei River, thus renaming it to a landmark status: the Hanalei Heritage River (HHR). In the wake of its new status, Kido helped to organize a central management organization, which later became the HUI, to oversee the functions of conserving the River's watershed in a method loyal to the Native Hawaiian traditional *ahupua'a* philosophy. What seemed to be the glue that would keep the community together was a value not shared in every respect by all the stakeholders involved with the Hanalei community. Balancing *ahupua'a* with the purpose and/or objectives of their organization/business was not easy. It is within this context, which prompted the United States Department of Agriculture - National Resources Service Council (USDA-NRCS),

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[1] The "tension" mentioned here emerged from interviews and informal conversations with various actors involved in community affairs in Hanalei.

to invite into the community the University of Hawai'i Practicum team. The objective was to help introduce a different angle for addressing the sources of tension, and conceive of a road map to help the community strengthen their collaborative relationship in order to better manage the Hanalei *ahupua'a*-watershed.

The central issues that emerged after interviewing key informants and doing the initial research were briefly stated in the Executive Summary. Details of these issues are expounded in Section 3, Chapters 8, 9, and 10. Each chapter explains the background of each issue before undertaking an earnest analysis of the underlying problems. This section is pre-empted, however, with a somewhat lengthy discussion of the rationale behind the community's feelings of displacement from the "roots of place" brought about by social transformations. In Section 1, the report discusses the "sense of place" local residents attach to Hanalei, embodied in cultural practices, physical artifacts, history, and the general serenity garnered from Hanalei's beautiful ecology. These qualities are what local residents define as Hanalei's *sonata.* Unsurprisingly, the qualities that take prominence in the eyes of the residents have not changed much, at least not since the 1970's. A survey published by a North Shore development plan listed a series of community needs (Muroda, Itagaki, Eckbo, Dean, Austin, and Williams, 1972). Ranked as high priority were:

- "keeping agriculture as an important activity in Hanalei"
- "keep the scenic beauty"
- "better housing"

Two needs were listed as matters of low priority:

- "resort development in agricultural land is given up"
- "keep the population the same".

These findings are consistent with an informal survey conducted at the 2002 Hanalei Taro Festival. Respondents were taro festival participants, who were asked to list as many places, areas, physical artifacts they valued the most. Their values were then transcribed onto a GIS map representing the Hanalei Valley to illustrate where they were. When these responses were translated into a typology, the most frequent responses were related to the environment and community (see Appendix C.3). Clearly, "a sense of place" was the source of continuity for local residents.

The tensions did not stem from wide disagreements over a range of issues; apparently, divergences were minimal. Rather, the cause of disagreement was rooted in the minute details that gave each stakeholder their particular differences, namely the purpose of their stake in Hanalei. For the taro farmers, it was access to agriculture land; for the USFWS, it was their responsibility to the mission of the organization and the mandates of the Endangered Species Act and, tangentially, the Clean Water Act. Businesses were, of course, concerned about upholding their capital. The government remained loyal to generating revenue, and the community their "sense of place". Section 4 discusses options for overcoming the tensions in intra-stakeholder relations. In the spirit of collaboration, some suggestions are given, namely methods for addressing short-term resolution as well as the more long-term goals. Policy suggestions are also provided to encourage the government to incorporate flexibility in their mandates, thereby encouraging greater community involvement in policy development. It is our hope that our study of the Hanalei community and our suggestions are of tremendous use for improved collaboration.

1.2 Methodology

The methodology is broken down into three parts: (1) conceptual, (2) research, and (3) Geographic Information Systems (GIS). The cursory phase commenced with initial attempts to frame the issues confronting the Hanalei watershed and, therefore, the community in a manageable structure for the Practicum class. It was extremely important to prevent the research from straying onto unrelated tangents not vital to the final report, a problem that confronted the Practicum members numerous times. Once the framework was established, Practicum members were able to organize relevant features of the report and divide analysis and preparation according to members' interests and background (i.e. knowledge, expertise). Subsequently, a series of Geographic Information System (GIS) maps were prepared as illustrations of the discourse covered in the report.

1.2.1 Conceptual Methodology

Dudley Kubo, our liaison at the United States Department of Agriculture-Natural Resource Conservation Area (USDA-NRCS), provided insight and profound assistance in developing our conceptual framework. Since he has worked with the HUI and has participated in the Hanalei watershed community management from the get-go, he was instrumental in relating the history of the Hanalei Heritage River. His presentation orientated Practicum members on the issues, which eventually led to a tentative framework. As knowledge about the community began to take shape, the Practicum members refined the conceptual framework into a comfortable format given time and resource constraints, albeit remained true to the interests of the clients involved. The latter was the driving force behind the nuts and bolts of the conceptual framework.

Dr. Mike Kido provided additional support by detailing his experience with bringing Hanalei community members together to supervise and monitor the quality of this new national landmark. His comments about problems with mediating divergent opinions among stakeholders was invaluable for illuminating areas that needed to be included in the conceptual framework, specifically a mediatory road map, which would bring the various stakeholders' wants into a cohesive vision statement that was more specific than is outlined in the Kaua'i General Plan (2000).

1.2.2 Research Methodology

The bulk of the research was library, consisting of materials obtained from the Hamilton Graduate Library at the University of Hawai'i at Manoa, specifically, the Hawaiian Collections, from the Bishop Museum, and supplemented with pertinent articles and books from Dr. Minerbi's personal collections. A file cabinet was developed between Dr. Minerbi and the research assistant to support Practicum members with the necessary documents and/or leads, to which Practicum members later contributed. Several key individuals were invited to speak to the Practicum class or were otherwise contacted for interviews.

A four-day field trip to Hanalei brought the Practicum class, *in situ*, with Hanalei and similar on-going projects outside of Hanalei. Vital informants, selected post-fieldtrip, mediated gaps in information, helping to reconcile inconsistencies that arose from different accounts.

Practicum members divided themselves into four central groups according to their research interests and experiential/academic background. Within these groups, they were responsible for analyzing key issues punctuated by Dudley Kubo. The remainder of the information was obtained from individual interviews with major stakeholders or experts most familiar with the respective sub-topics to facilitate and help finalize the writing of each sub-topic. This aspect of the research process was instrumental for either substantiating or contesting the issues illuminated by resource persons, and assisted in honing in on the most important factors. Each group was then responsible for undertaking background research and for writing their individual topics. GIS maps enabled the Practicum members to visualize spatial dimensions and to analyze land use.

1.2.3 Geographic Information Systems (GIS) Methodology

A GIS (Geographical Information System) is a system for converting tabular geographic data (i.e. roads, people, countries) into a spatial value. The functions of a GIS are inputting, classifying, storing, manipulating, querying, analyzing, and visualizing spatial data. It can aid in the formulation of specific queries, which can be answered using spatial relationships. For this project in Hanalei, GIS has been used not only to produce useful maps for the report, but to help answer many spatial-oriented questions.

The most important part of a GIS is the data. Spatial and tabular data are the matrix from which GIS illustrates the answers to queries and can model possible spatial scenarios. A GIS database was created, containing numerous ArcView projects, shape files (layers), and aerial photos of Hanalei and its adjacent valleys. Much of this data was collected from the State of Hawai'i GIS database and the National Oceanographic and Atmospheric Administration website. Other data was acquired from cooperating agencies including the Hanalei Heritage River (HHR) HUI, the Pacific Disaster Center, the Department of Land and Natural Resources, and the University of Hawai'i Social Science Research Center.

Data collected for this project was used to identify spatial relations within Hanalei Town, the U.S. Fish and Wildlife Bird Refuge and throughout the Hanalei *ahupua'a*. Data was projected, using ArcView v.3.2 and ArcGIS v.8.1, for analysis.

Section I

Collaboration as Key to *Ahupua'a* Management: Preserving the Hanalei Heritage River

Chapter 2

The Basis for Collaboration

Collaboration has become a buzzword often invoked to solve community issues at the multisectoral level. Groups and institutions are said to collaborate when resources, information, strategies, and governance are shared fairly among all involved sectors, otherwise understood as "stakeholders". Functionally, collaboration "brings a broad range of stakeholders – community residents, elected officials, businesses, civic, faith, health and human service, and professional organizations – together to take responsibility over the long term to address issues that matter to the community" (McKieran, Kim & Lasker, 2000). It is, however, an eternal process that takes commitment from all stakeholders and often requires individuals/groups to relinquish the social conditioning that substantiate individualism, atomism, and self-gain, and move towards a cognitive framework that sees oneself as attached to another's well-being, as interdependent with the community, as part of the greater community, and as part of the bigger solution (Himmelman, 1992).

As a broad-based strategy, collaboration aims to change society, "spanning the continuum from social service to social justice" (Himmelman, pg. 12). It strives to strengthen democracy through enlarging the range of empowerment and participation to include even the most disempowered groups into the process of directing social change. It does so by extending governance and decision-making to all stakeholders. These visions are ambitious, which may already be known to those who have dabbled, at the most minimal, in collaboration. Multi-sector collaboration is not easy; participants require deft skills in facilitation, patience, and solid commitment both to the community and the participants. These are only some of the benefits gained from collaboration, however. Gray (1989) lists a compendium of benefits that traditional linear methods of intersectoral social change tactics have been unable to achieve.

Table 1. The Benefits of Collaboration

- Broad comprehensive analysis of the problem domain improves the quality of solutions.
- Response capability is more diversified.
- It is useful for reopening deadlocked negotiations.
- The risk of impasse is minimized.
- The process ensures that each stakeholder's interests are considered in any agreement.
- Parties retain ownership of the solution.
- Parties most familiar with the problem, not their agents, invent the solutions.
- Participation enhances acceptance of solution and willingness to implement it.
- The potential to discover novel, innovative solutions is enhanced.
- Elations between the stakeholders improve.
- Costs associated with other methods are avoided.
- Mechanisms for coordinating future actions among the stakeholders can be established.

Source: Gray, Barbara (1989), Collaborating: Finding Common Ground for MultiParty Problems, San Francisco: Jossey-Bass Publishers.

At its most effective, collaboration empowers communities whilst tackling specific needs (Himmelman, pg. 42) and strives to manage differences between the relevant stakeholders (Gray, 1989). In fact, turbulence between stakeholders is often the impetus behind collaboration and is, in some cases, regarded as the only solution for old animosities. Ultimately, collaboration must represent the means by which all interested parties can explore creative solutions together in order to arrive at a common vision to which all stakeholders can agree. Implicitly, no single group can accomplish collaboration; all interest groups must committedly engage in collaboration. In certain cases, collaboration is more proactive if the common vision is devolved into small group aims, as is the case in Hanalei.

Three key issues have arisen over the situation in Hanalei regarding watershed management. Members of the community have become concerned over the path of development for Hanalei because it poses threats to the quality of the *ahupua'a*. Such concerns have been triggered by the growth of vacation rentals, the increase in pollution, what some perceived as higher than normal flood tables due to the U.S. Fish & Wildlife (USFWS) constructing berms, and the congestion and growth of the town driven by tourism. Specific apprehensions have simultaneously crept up amidst these more general concerns. One is the relationship between the taro farmers and the USFWS over the co-existence of taro *lo'i* and bird impoundments, the key topic for Chapter 9. The taro farmers would like to expand taro farming in the refuge, but the USFWS has exhibited a bit of resistance. More recently, the USFWS personnel have hired a zoologist, Dr. Frederickson, to study the continued viability of wetlands as an effective bird habitat. This initiative has caused taro farmers to become alarmed about their lease on the land, which they fear could be revoked if Dr. Frederickson's study proves the opposite and is accepted as legitimate by the USFWS. According to sympathetic members of the Hanalei community, the USFWS' denial of possible evictions has not assuaged the taro farmers' concern, in light of past actions by the government agency to make decisions about the taro *lo'i* without consulting or informing the taro farmers beforehand. Furthermore, previous responses of USFWS personnel to taro farming have not demonstrated much sensitivity or support for taro farming, causing some members of the community to question their public relations efforts. Adding to the tension is the one-way mechanism of information flow; directives have been top-down and there has been little room for negotiation or consultation with community stakeholders.

The second apprehension is the amount of contamination in the water, namely along the shoreline and at specific locations along the Hanalei River. As explicated extensively in Chapter 8, critical areas related to bacterial accumulation have been identified by the Hanalei Heritage River HUI. Dr. Carl Berg, a HUI member, attributes these critical areas to an ineffective wastewater treatment system. At the moment, Hanalei possesses two cluster systems and a number of individual septic systems, none of which appear to be effective in disposing of wastewater. Hence, he has assessed the need for a better wastewater disposal system for Hanalei to minimize or prevent the release of *e.coli* bacteria into the Hanalei *ahupua'a*. Collaboration would be instrumental for extracting suggestions and opinions from pertinent stakeholders (i.e Kaua'i County, Kaua'i Visitor's Bureau (KVB), and the USFWS) as well as the larger community to arrive at a choice best suited for the Hanalei *ahupua'a*.

These two concerns are nestled in the topic regarding scale and intensity of tourism development for Hanalei. Chapter 10, Tourism, goes into greater detail about the stress that tourism can bring to the community, one of which is directly related to the wastewater disposal issue in that building "out" for tourists can place increased burden on the extant wastewater disposal systems. As a general problem, tourism is attached to additional burdens on the *ahupua'a* in terms of garbage accumulation, increased pollution from intensified human use, and vacation rentals. The "Open District" designation is an added concern because, although regulated, these districts are open to conversion into residential areas or commercial space, factors that prompt town sprawl.

2.1 The Management Structure under Collaboration: Clarifying the Process

Like any group endeavour, collaboration requires organization and management, which sometimes implies a structured governance to formulate the process for collaboration (Himmelman, 1992: 26). Stakeholders may wish to create an organization that can take action to accomplish governance or may opt to utilize an aready established organization. In Hanalei, a good option would be the HUI because it is community-based and membership is broad. This is important for engaging the community in discussions most relevant to their concerns. The HUI would be necessary for administrating as well as facilitating the process for collaboration. It may even administer the selection of a skilled facilitator.

Process is a joint project among the stakeholders. The general framework is a six step activity:

Step 1
Clarify the purpose for collaboration and developing a vision. This may involve a lengthy discussion on what is currently at stake to identify a mission statement.

Step 2
Coordinate ideas to identify goals and objectives. Stakeholders will surely brainstorm various topics of concern most relevant to the groups involved in collaboration. The attempt to coordinate ideas leads to commonalities between issues, bringing the stakeholders to the next step.

Step 3
Find "common ground". Because stakeholders may have divergent views, which oftentimes are elicited from attempting to visualize and articulate commonalities, this activity would entail concerted efforts to mediate divergences in order to arrive at a common ground. "Common ground", participants may discover, is plural.

Step 4
Prioritize goals and objectives. Once common ground has been established, stakeholders will need to prioritize them according to their resource and institutional capacities. The groups may even be divided into subgroups that have the most significant commonalities.

Step 5
Reach an agreement. Decisions are, resultantly, stated and the stakeholders can then conclude with a clear idea of the direction towards which their outcome will go.

Step 6
Implement decisions and plans. Solidifying their outcome vis-à-vis policy may be an option the stakeholders may want to take.

The steps outlined above are a rather general framework of the collaboration process. The context of the community may entail additional activities that are interwoven among the six steps. For example, Hanalei may require a more aggressive form of collaboration in order to settle disputes between stakeholders and/or members of the community. Conflict resolution (CR) sessions may be included before deciding to reach a common agreement. They may interject the ideas coordination session to isolate the root of conflict, and facilitate collaboration with extensive discourse on the assumptions, beliefs, and values of each individual or group. CR sessions may include a trend[s] assessment of the issues to assist the collaborative process focus on ways to eliminate the roots of conflict and assist the community move beyond this difficult stage (Himmelman, 1992:23).

2.2 Establishing a Collaborative Infrastructure

Managing collaboration consists of infrastructural capacity that can facilitate the process. For example, because collaboration takes skill and a degree of public relations acumen, the community must be realistic about their capabilities and resource availability. Individuals, who are capable of facilitating and recognizing specific areas in the process that entail special attention, are necessary. The community may wish to invest time and money on training workshops for their residents to ensure that it has a rich selection of facilitators from whom to choose. As a cost-cutting measure, it can partner with a collaboration non-profit organization or university to provide these workshops at little or no cost.

Another asset that may require development is technical capacity. The community may need a means to document and store meeting notes, Information Technology data, and links to legal opinions, environmental expertise, and policy experts to assist in the process (Margerum, 2002).

To determine where the community is in terms of capacity, it would be required to undertake a survey of its institutional and human resource assets in order to identify weak points or caveats. This should be compulsory for communities that are earnest about developing their collaboration capabilities.

Specific plans for Hanalei are elaborated in Chapter 11, but for the moment the Practicum acknowledges that Hanalei is already equipped with two assets: (1) the HUI, which has already developed an action plan for *ahupua'a*-watershed management, and (2) a common vision: managing the watershed-*ahupua'a*. The HUI's history as keeper of the Hanalei Heritage River (HHR) is explicated in Chapter 3, while Chapter 4 explains how the Native Hawaiian traditional philosophy of *ahupua'a* management can compliment the more scientific-based, watershed management, or vice-versa.

Timeline of Involvement with Managing the Hanalei River

- **July 30, 1998**
  President Clinton designated the Hanalei River as an American Heritage.

- **February 1999**
  The United States Forest Service commits funds to the Hanalei Heritage River Program for five years.

- **June 1999**
  A Navigator Staff is elected from the community, forming the HUI.

- **August 1999**
  The Hanalei Heritage HUI re-convenes to develop an *ahupua'a* management decree.

- **June 1999**
  The Water Watch Work Group is established as the official watch dog committee of the HUI.

  The Long-Term Ecological Monitoring Program (LTEMP) is created.
  - **A watershed action plan is developed over three Phases.**
  - **Phases II & III are outlined, which also emphasizes strategic tourism plans and cultural continuity.**

- **March 2000**
  The Watershed Action Plan is published and becomes official.
  The HHR Newsletter debuted.

- **June 2000**
  Phase I of LTEMP takes place.

- **February 2001**
  Proposal for coral reefs protection and conservation.

- **February 2001**
  Ahupua'a Restoration.

- **March 2001**
  Wahi Pana Protocol for Sacred Places.

- **March 2001**
  Aquaculture in Hawai'i.

- **November 2002**
  The HUI applies for 501C3 standing.

Chapter 3

The HUI[2]: Their Role in Watershed Management and Community Advocacy

The decline of quality in the Hanalei River, specifically in reference to the impact of community changes on the Hanalei environment, prompted Mike Kido to lodge an application with the federal government to officially establish the Hanalei River as a heritage site. On July 30th 1998, President Bill Clinton approved the application, so designating the River as an official American Heritage. Thus, an organization was needed to oversee and monitor the maintenance of the pristine scenery and quality of the River and its surrounding region, and to ensure that numerous activities that took place in Hanalei do not have a cumulative impact on the watershed. By extension, this meant directly partaking in the planning stages of future developments for Hanalei and being able to foresee potential impacts to the community.

After a series of public meetings, the Hanalei River HUI was formed ". . . to provide the leadership, initiative and works to manage and coordinate local activities undertaken through the American Heritage River (AHR) initiative" (http://*hanaleiriver.org*). By definition the HUI is "those community members who participate", therefore, membership is open to anyone living in or involved with the Hanalei community (www.hanaleiriver.org). Decision was and continues to be made by consensus.

During the first year, they developed a fifty-year vision:

> *The Hanalei River HUI strives to malama the ahupua'a (watershed) of Hanalei guided by the Hawaiian principles of malama 'aina (sustainability and stewardship), pono (integrity and balance), laulima (cooperation), and aloha, especially as it applies to cultural equity and respect. We endeavour to keep protected what has been protected. We embrace and support those actions that are appropriate to this place and its heritage, those actions that contribute to our shared vision.*

Within this vision statement, a comprehensive list of objectives emerged, which are grouped under four categories: (1) education; (2) cultural integrity, (3) preserving the

[2] All information in this section was obtained from the HHR HUI website at www.hanaleiriver.org.

qualities of the Hanalei River, and (4) perpetuating an economy "based on diversity, local, small, and [sic] shared prosperity" (www.hanaleiriver.org). From this, key issues were raised, those that were most central to the concerns of the community members:

- Watershed management.
- Perpetuating taro farming.
- Diverting tourism away from simply resort-style to one that is environmentally and culturally responsible.
- Educating the public about local planning, sustainable development and practice, science management, ecological deterioration, and local history.
- Reinventing government in a way that promotes and encourages communication between the HUI, government agencies, and elected bodies.

Many of these issues overlap. To date, the biggest obstacle yet to overcome is transparent and direct communication with government agencies, elected bodies, and other pertinent stakeholders. Seemingly, there is very little transparency in government actions and future plans. A strong concern arising from the paucity of communication is the path of development, as vacation rentals are established ubiquitously throughout the Valley, especially near the shoreline, producing minor debris and water contamination vis-à-vis waste run-off from the houses. Plans to develop the town into an urban center are an additional concern. These changes threaten the small, rural lifestyle that the HUI and other members of the community want to preserve.

The crux of the HUI's concerns is couched in their participatory "location" in the decision-making process. Because direct inclusion would empower HUI members and, therefore, the community, a central seat within the decision-making process would render the leverage required to resist the possible threat of urbanization and environmental degradation to the Hanalei community. These negotiations are still ongoing.

3.1 Bringing Concerns to the Table: Politicizing their Issues

In its first year in operation, the newly developed HHR HUI focused on strengthening community capacity, building organizational structure, and creating viable opportunities that would point the HUI's purpose towards supporting the central tenets of the American Heritage River program, eventually leading to a Watershed Action Plan. This Plan delineated a list of project directives for managing the Hanalei River. The goals were ambitious.

On August 14, 1999, the HHR HUI reconvened to put together a methodology that would steer community members towards an *ahupua'a* management decree, which involved outlining specific areas in need of assessment and monitoring. From this meeting, the HUI listed specific areas inextricable to the vitality of the Hanalei River:

- Sedimentation
- Water quality
- Safety for swimming

- Healthy fish
- Establish baseline for petrochemicals
- Fertilizers
- Wastewater
- Animal feed and ranging effects
- Feral ungulates (pigs and goats)
- Pesticides, Herbicides
- Boats (engines)
- Pathogen (human waste)
- Aquatic/marine habitat
- Recreational use (kayaks)

These areas of concerns converged into a Long-Term Ecological Monitoring Program (LTEMP) that operated as a user-friendly, community-oriented, and affordable system. Don Heacock, an aquatic biologist in the Division of Aquatic Resources at the State Department of Land and Natural Resources, was squired to collaborate with the Hanalei Heritage River Program. The purpose of LTEMP was to ensure the sustainability of the River so that it may continue to be utilized for years to come. It is important to note, also, that LTEMP was devised to address land use practices that encroached upon the comprehensive issues highlighted earlier in this section.

They estimated that the LTEMP program would occur over three phases, with the benefits drawn from each phase being cumulative. After the Water Watch Work Group was established in 1999, which also devised the methodology for monitoring and assessing, plans for the first phase was initiated. The projects during this first phase would be carried out over the course of one year, beginning in June 2000 to June 2001. This phase concentrated on studying the life habits of the *'o'opu*, a valued fish along with the *'o'opu* recreational fishery in the Hanalei Heritage River. It would also begin to lay the groundwork for educational and volunteer programs in light of future studies on the Hanalei River, especially in water quality monitoring. The resulting data would be produced in written summaries and water quality reports, providing a paper trail of evidence to be used as a foundation for later projects in order to build on the initial phase.

The second stage in Phase I involved a bio-assessment and monitoring of the River's health, scheduled to transpire over another year, specifically August 2000 to June 2001, supported with a comprehensive inventory of the watershed (from *mauka* to *makai*) in order to identify existing resources and gaps in information. Findings would be translated onto GIS maps.

Complimenting the LTEMP were Phase I projects on Infrastructure and Land Use and Cultural and Historic assessments. The former's (Infrastructure & Land) focus areas of analysis were transportation and recreational facilities, zoning, actual land use, identification of prime agricultural land, and questions over public access. The latter (Cultural & Historic) was more concerned with preserving archaeological sites and sacred places, place names, scenic view plains, and historic sites in order to preserve the "Sense of Place" developed in Hanalei through years of historical evolution, and about which the locals have come to cherish. The scope of work in both categories would be developed to map out the best strategies to carry out this analysis. For the Cultural & Historic element, an additional task of collecting and recording oral histories from the *Kupuna* would be incorporated.

Phases II & III are still in the planning stages, but the prognosis thus far is that the HUI's primary objectives for the first two years of planning and taking action have notably been achieved.

The next phase is applying for 501 C3 standing, which would not only strengthen the HUI's legitimacy as an environmental management organization, but also place it in the category of Non-profit Organization. The implication of this shift in status is (1) the receipt of continuous funding, allowing the HUI to focus on its programs and to build bridges between stakeholders; and (2) improves upon their work towards educating and mediating disparate viewpoints.

One planning area in need of addressing is reconciling the seemingly divergent ideologies behind *ahupua'a* planning and the more widely accepted, federally supported watershed management approach. The HUI, as a 501 C3 Non-Profit Organization, can play an instrumental role in encouraging Federal and State agencies to incorporate flexibility in policies if the ideology behind them are confrontational to the community's wants. This process of merging together ideologies is perfectly attainable and would achieve the HUI's cultural, ecological, and educational objectives.

Chapter 4

Watershed and *Ahupua'a* Management: Bridging the Gap

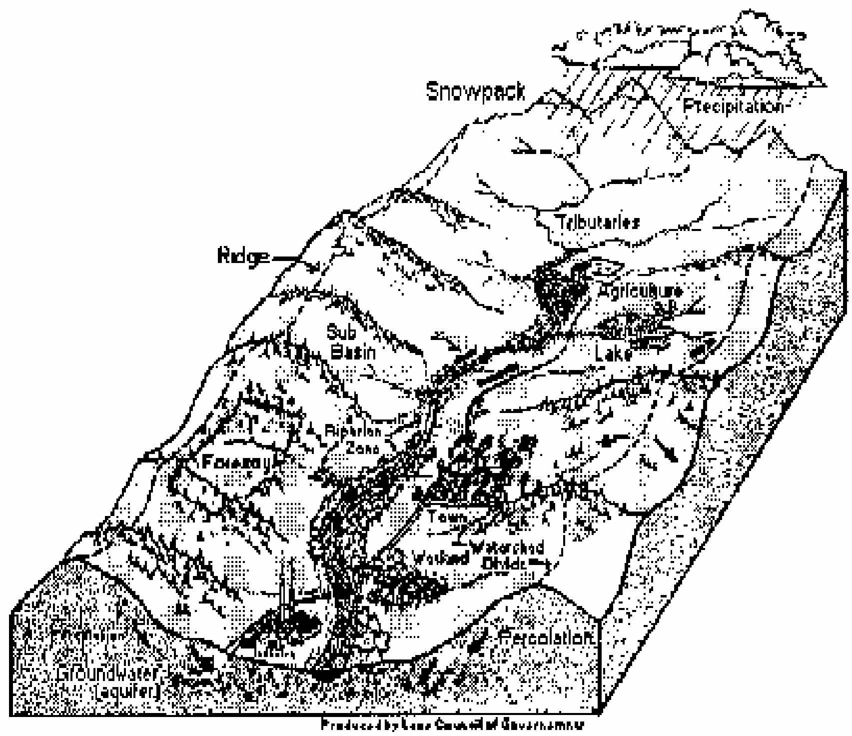
The boundaries of the *watershed* and *ahupua'a*, the Native Hawaiian ancient land division based on the principle of sustainable allocation of resources to communities residing within the *ahupua'a*, are similar in the case of Hanalei Valley (see maps 6 & 7 in Appendix B). They both adhere to the hydrological pattern determined by a major stream/river and its tributaries, from *mauka* (the mountain) to *makai* (the sea). The difference lies in their management approach. While *ahupua'a* views management as a comprehensive, holistic method, watershed management has traditionally focused on the polluted locale independent of the wider watershed region. This caveat has been bridged recently due to the Environmental Protection Agency's (EPA) revamping of the out-dated approach into a model more consistent with *ahupua'a* management (see EPA website at *http://www.epa.gov*). This is called their Watershed Protection Approach Framework (or WPA), developed in 1991 (www.epa.gov). Beyond physicality, the EPA now acknowledges the need to integrate community and cultural context into management policy. The WPA's three key components provide the entry point for integration which, upon the EPA's recommendation, should be carried out according to the community and ecological milieu of the area of concern, and practiced appropriately by the branch agencies stationed at their respective localities. Exactly how this is to be done should be organized with the community in question. For the moment, it is enough to realize that watershed and *ahupua'a* are not entirely distanced by definition or interpretation. Thus, the approaches to both can be complementary and collaborative. Ultimately, these characteristics will be the basis for co-managing the Hanalei *ahupua'a*.

4.1 Defining a Watershed

A watershed is geographically defined as a vast range of land defined by an intricate, natural hydrologic system of underground or surface water that ultimately drains into the same body of water (Revenga, 1998). The type of land designated as a watershed includes farms, ranches, taro patches, metropolitan areas, forests, or a combination of all these. The biota embedded within this range of land is part of the entire watershed, as is the human activity that utilizes its resources. And, because all living species rely on this complex water source, together, they form a community within the larger ecosystem.

Small and medium-sized watersheds systematically interface, constituting a larger one. This interconnection indicates that the degradation of smaller watersheds will eventually debase the larger ones. Therefore, it is important to preserve a watershed by holistically understanding its hydrological mechanism[s].

Figure 1.1. Generic Features of a Watershed



Source: www.epa.gov

Failure to comprehend the interconnection between elements of the watershed's cosmos to each other has severely damaged watersheds. Human-devised projects have been a primary culprit. An example is the construction of dams. These concrete monoliths have disrupted the normal migratory paths of streams/rivers and their habitat, disturbing water levels and destroying the biological environment dependent on them. Agriculture and forestry activities, coupled with the process of urban growth, have also contributed to resource degradation by contaminating aquifers with nitrates and polluted groundwater with caustic substances (i.e. petroleum) (Lant, 1999: 483).

To facilitate the process of integrated management, the Environmental Protection Agency (EPA) introduced a "Watershed Protection Approach", which formulates the framework for protecting the water supply. The framework spun off from annotated evidence revealing the decline of the water supply's health due to a variety of reasons. Apart from land use debacles, some of the other reasons cited by the EPA are:

- Over-harvesting of fish(es)
- Introducing exotic species
- Turbidity
- Polluted runoff from rural agriculture and/or urban waste[s]
- Discharges from industrial or municipal regions
- Depleted or contaminated groundwater
- Bioaccumulation of toxics

- Pollutant deposition due to the air, land, and water cycle
- Landscape modification

Regulatory Federal laws have tended to be disaggregated, focusing on specific bodies of water as opposed to analyzing the contamination in relation to its link with land use and natural erosion within the watershed's hydrological pattern (www.epa.gov). A watershed management approach that connects polluted areas to its root causes helps to mitigate **cumulative impact** (www.epa.gov). Holistically, the gaps that existed in previous conservation tactics can be avoided enabling conservationists to better identify the root of degradation, as well as understand how the root may stem to an adjacent problem. In linking up human, biological, and natural resource conduct – operating as stressors – with the natural hydrological pattern of the watershed *a propos* its respective environmental landscape, conservationists can determine whether a [i.e chronic] environmental trauma is actually tied to a particular stressor at another location in the watershed.

4.1.1The History of Watershed Management

Watershed Management is not a new concept. The United States Inland Waterways Commission first conceived of the water resources management concept as a tool for managing watersheds. It originated in the 1890's and was backed by President Roosevelt. Finally, in 1908 Roosevelt promulgated official protection measures, reporting to Congress that " . . . each river system – from its headwaters in the mountains to its mouth at the coast – is an integrated system and must be treated as such" (Inland Waterways Commission in the EPA website, *www.epa.gov*).

Subsequent legislation followed Roosevelt's directive. The first, the Federal Water Pollution Act in the 1950's and 1960's, pointed to the increasing requirement for a regulation that assured continuous access to clean, potable water. Specifically, the Federal Water Pollution Control Act (1956) ensured federally funded public treatment works, while the Water Quality Act (1965) mandated State-based efforts to "develop water quality standards for interstate waters" (www.epa.gov).

The Clean Water Act led to expensive sewage treatment plants, the construction of which inevitably cost the government something in the area of billions of dollars. Amendments were scribed in the 1972 Federal Water Pollution Control Act, aiming "to restore and maintain [sic] the physical and biological integrity of the Nation's waters" (www.epa.gov, pg. 1) through a designated permitting program[3], which highlighted the condition of effluent water as a springboard to "solve" the water pollution problem. Unfortunately, this strategy introduced related problems associated with chemically transforming industrial and urban water pollution (Lant, 1999: 483).

Further addenda were inscribed for controlling point source problems and protecting underground water. Section (303) established basin plans for consolidating

[3] Permitting is regulated by the National Pollutant Discharge Elimination System (NPDES).

information about discharge and water quality. Section (202) authorized States to develop programs that would "reduce and eliminate pollution to groundwater and surface waters (www.epa.gov, pg. 2).

In 1987, Congress mandated States to "expand their programs of dealing with toxicants, non-point sources, wetlands, water quality standards, and other topics" (www.epa.gov, pg. 2), leading to evidence that non-point source pollution - compounded with habitat degradation – were quantitatively the source of water quality problems (www.epa.gov, pg. 2).

In 1974, the Safe Water Drinking Act (SDWA) was passed, putting into practice a collaborative agenda to protect drinking water (www.epa.gov, pg. 2). This Act drew from the discovery that landfills contaminated groundwater discharge. It led to The Wellhead Protection Program, which marked off the area that was at risk of contamination and required monitoring.

Unfortunately, these programs proved expensive, as they all entailed continuous monitoring over an indefinite period of time. Resultantly, the EPA drew up a plan, called the Watershed Protection Approach (WPA) to undertake monitoring programs that were more cost-effective [by reducing reporting requirements and simplifying the permitting process], albeit equally – if not more – productive. It was also aimed at monitoring techniques in order to minimize cumulative impact.

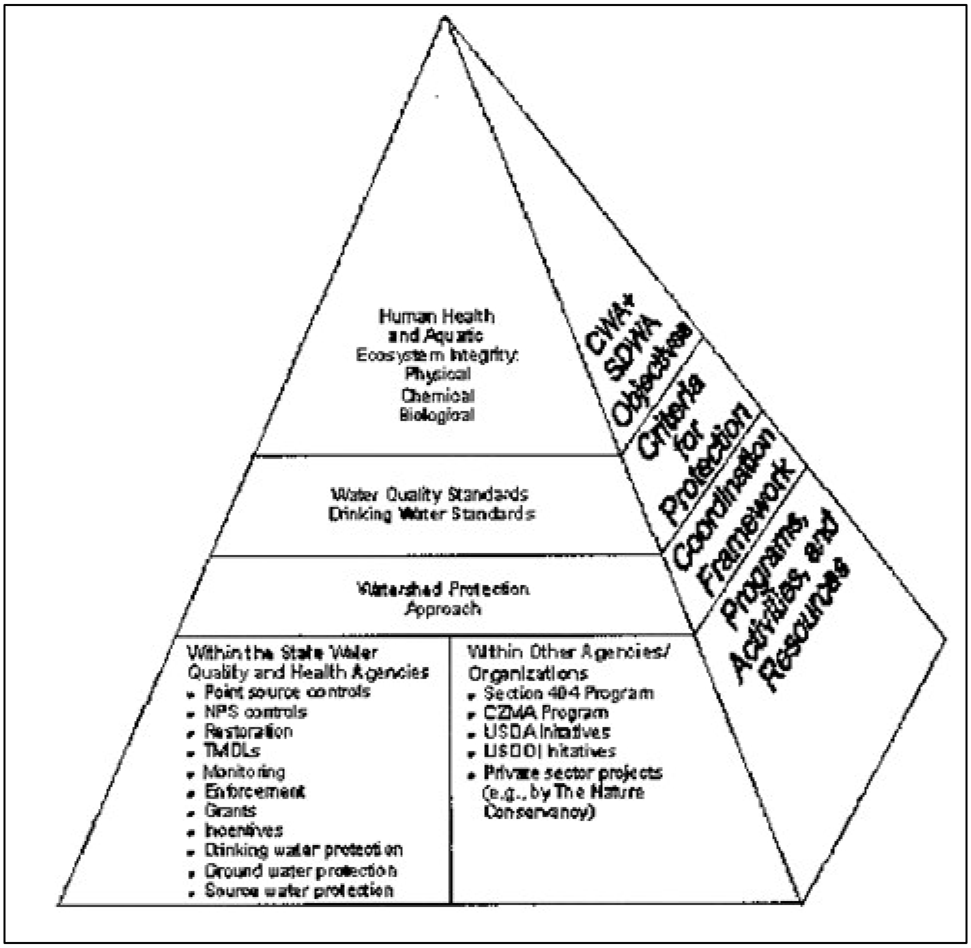
First and foremost, the WPA is a shift in values for watershed management. It is founded upon the belief that watershed management must address the simultaneous imperatives for sustaining human and ecosystem health rather than marginalizing one in favor of the other. As such, it recognizes the multi-faceted aspects involved in watershed maintenance, ranging from chemical (i.e. toxicants) reduction and physical (i.e. circulation and/or turbidity) migration of water to the quality of the habitat (www.epa.gov, pg. 4).

Secondly, the WPA introduced a collaborative methodology for integrating the stakeholders' efforts in monitoring and prioritizing the management process, a strategy that directly engages them in protecting their own waters as well as allows them to directly see results.

4.1.2 The EPA's Vision for the Watershed Protection Approach

The EPA's vision for the WPA is to render a conduit between environmental quality and stakeholders' activities. The WPA's role is illustrated in Figure 1.2.

Figure 1.2. An Emerging Framework for Integrating the Watershed Protection Approach within Watershed Management



Source: www.epa.gov

Stakeholders' activities are considered integral components to the WPA's function because they are responsible for (1) conceptualizing and developing the management plan; (2) for carrying out the planning stages; and (3) for monitoring the phases of the watershed. It is important to note the various responsibilities of public, private, and community stakeholders, as denoted in Figure 1.2. Also, as the diagram implies, these bodies, jointly, are the pillars that uphold the successful fruition of (1) water quality standards, including potable water, (2) an eco-system's integrity, and (3) the health of the community (www.epa.gov, pg. 3).

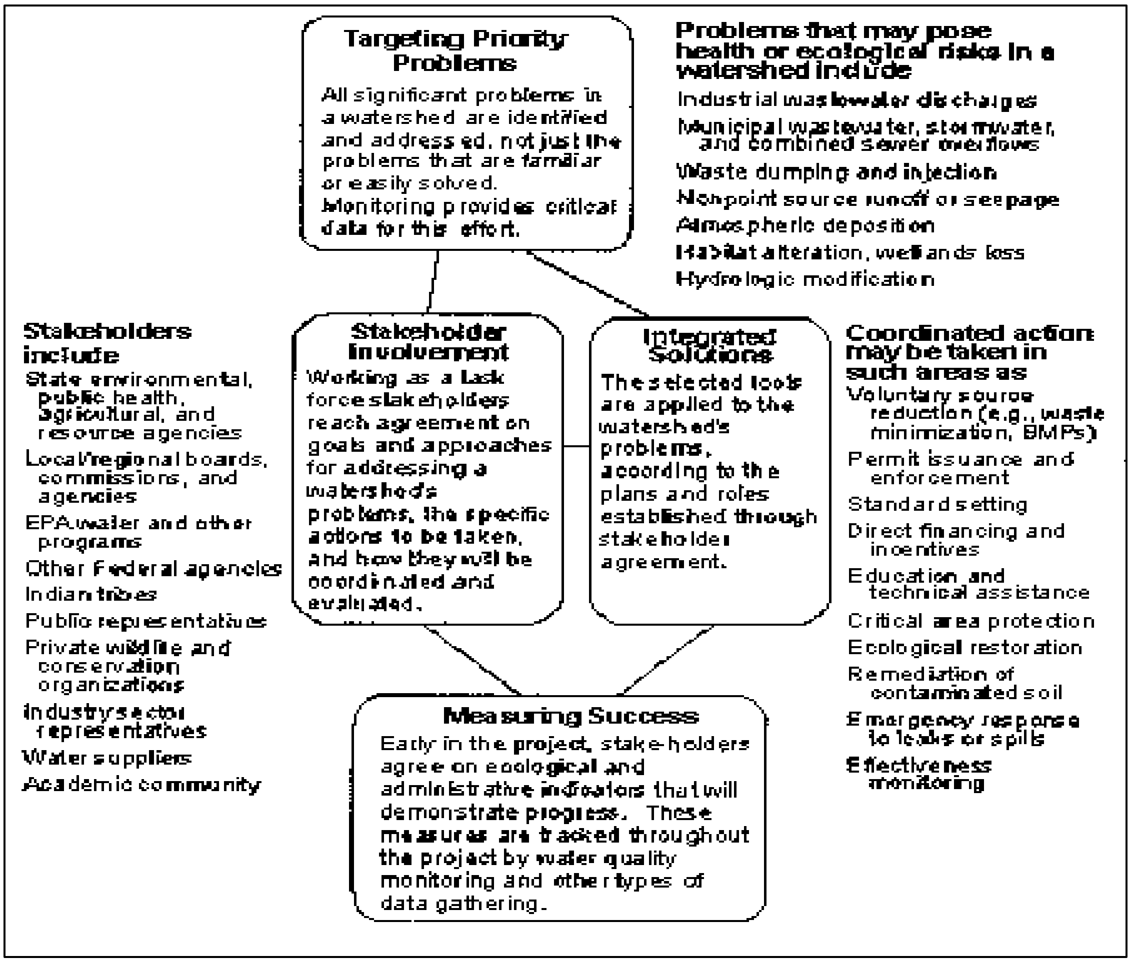
The WPA's framework, itself, is a four-pronged relationship, articulated thus:

1) Target priority problems
2) Stakeholder involvement
3) Integrated solutions
4) Measure success

It is not intended to replace existing programs, but aims to incorporate them into the overall framework of pre-existing mandates and resolutions.

Figure 1.3 illustrates the network between these key features, which are tied together en-route identifying strategies from among the complex web of issues, stakeholder interests, and pathways to management in a collaborative fashion. It, additionally, pinpoints the responsibilities of the four features vis-à-vis the different stakeholders, potential problems, and coordinated actions that can be taken.

Figure 1.3. Four Prongs of the Watershed Protection Approach: Four Features



Source: www.epa.gov

The novelty of this approach is in the renewed attention granted to the role played by the local community, in effect, centralizing them in the planning stages, as conveyed in this quote: *The participation of local organizations ensures that those who are likely to be most familiar with a watershed, its problems, and possible solutions play a major part, often a leadership role* (www.epa.gov, pg. 3). Most importantly, the EPA has taken a stronger interest in Indigenous groups' claim to watershed management. It has cited the need to collaborate with Tribal groups (and by extension Indigenous groups) within the aegis of the EPA's efforts. Despite these new ventures, however, the WPA does not outline a succinct framework for cultural considerations or enforce flexibility when collaborating with community groups. Evidence of this vacuum is found in the WPA's "three key components" (Browner, 1996), denoted as:

1. Geographic Focus
Analyze the drainage system of watersheds to better highlight the source of pollution (Browner, pg. 2).

2. Continuous Improvement based on sound science
Utilize "sound scientific data, tools, and techniques" as a means to "inform the process" (Browner, pg. 3).

3. Partnerships/Stakeholders Involvement
The inclusion of all groups (levels of government, public interest groups, industry, academic institutions, private landowners, concerned citizens), who have a major stake in watershed preservation, in deciding upon a common vision and to develop goals, since watershed issues "transcend political, social, and economic boundaries" (Browner, pg. 3).

Although the third component encourages citizen participation, it explains neither the imperative of exercising cultural sensitivity nor expounds upon the rationale behind maintaining cultural practices in the *malama* of watersheds, a critical element when working with Indigenous groups anywhere. In Hawai'i, specifically, marginalizing Native Hawaiian's traditional values from land use has resulted in clashes with developers (see Water Hearings of 1994 involving Wai'a'hole in (V) Water Issues 1995 and the Public Access Shoreline & Angel Pilago vs. County of Hawai'i County Planning Commission, August 31, 1995). Similarly, non-recognition of Native Hawaiian watershed management principles threatens to lead to future conflict and conceivably dissolve the one characteristic of Hawai'i's communities that has sustained them. Therefore, it is of value to explore this area in watershed management more extensively for the future.

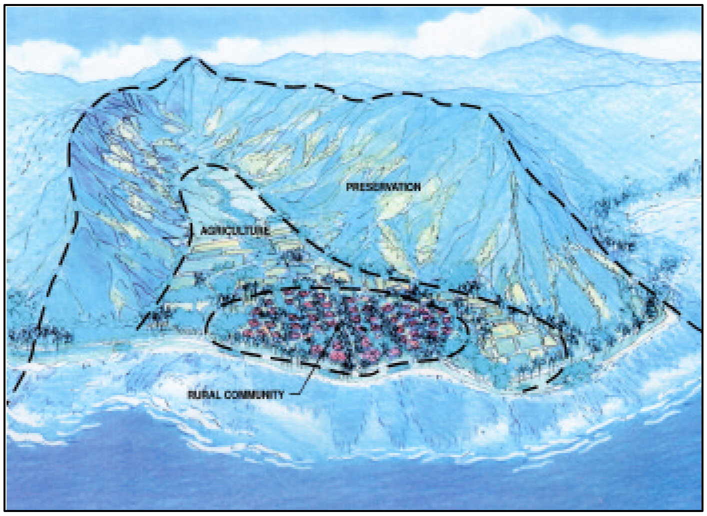
4.2 Ahupua'a Management

Ahupua'a management is the traditional land stewardship philosophy practiced by Native Hawaiians since arriving on the archipelago. Translated literally, it is a unit of land measured by its ability to [re]produce resources for the people "who lived within its boundaries" (Andrade, '00: 2). A*hupua'a*, in fact, possesses two dimensions: (a) the physical and (b) the spiritual.

4.2.1 The Physical Organization of the Ahupua'a

The physical dimension elucidates a sophisticated land division system mandated by an aristocratic landholding social structure, stretching from the top of the inland *mauka* (mountain) ridges, to the *makai* (coastal land) into which major streams and rivers flow (Minerbi, 1999: 210; Andrade, '00: 2; Blane & Chung, n.d.). The pictorial diagram (Figure 1.4) demonstrates how the land was spatially organized into areas that served different functions within the context of an *ahupua'a* land boundary.

Figure 1.4. Pictorial Diagram of Water Dispensation



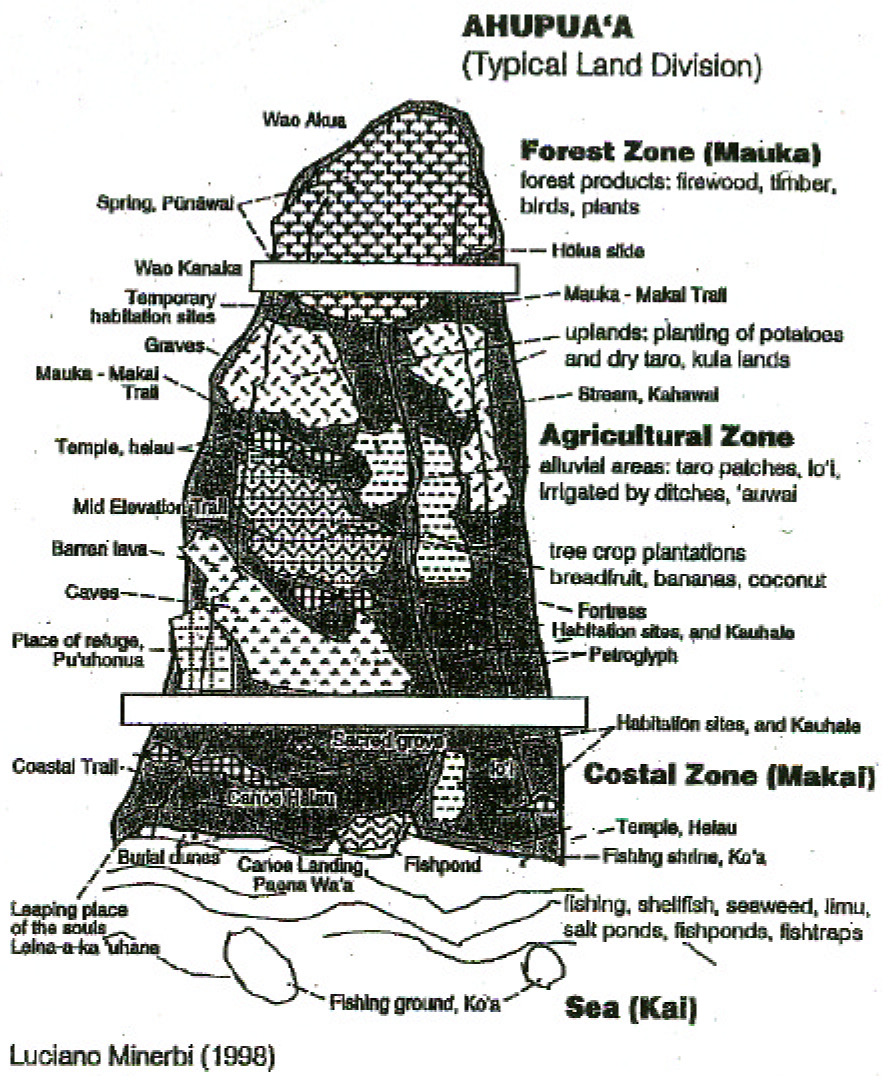
Source: Donoho, Michael (1999)

From this general pictorial diagram, one can imagine the process of water dispensation, commencing at the apex of the mountain located at the rear of the *ahupua'a* boundary and descending between the ridgeline towards the coastal area. Spatially, the communities were situated closer to the coast, while agriculture was restricted inland. The rationale behind this land organization was to take advantage of the natural pattern of resource formation to ensure sustainable use and regeneration of the resources found in each area.

Figure 1.5 better illustrates the system of resource use and conservation based on *ahupua'a* values. The *ahupua'a* was divided into four [ecological] *mokus* (zone). The top of the mountain provided forest and timber resources; the middle upland and middle lowland zones were appropriated for agricultural opportunities, enabling Native Hawaiians to grow potatoes, dry taro, or breadfruit trees; and the coastal zone was reserved for fishing and salt gathering (Minerbi, pg. 212). The land was, then, divided among the different *'Ohana* (families). These land pieces were allocated for their own cultivation, and were further devolved into smaller parcels called *ili* (Andrade, '00: 2). Management of *ahupua'a* was politically decentralized, thus, *'Ohana* could localize activities and develop community plans specific to the *'Ohana* network of that district (Minerbi, pg. 213). Councils facilitated the management of these lands by emphasizing stewardship between the land, the *'Ohana*, and the adjacent communities (Minerbi, pg. 213).[4]

[4] Commoners were given entitlements to land use, called a *kuleana*, but there were certain drawbacks attached. First, these land use rights were sometimes restricted to mere parcels, often not sufficient to provide for an entire family (Derrickson, *et al*., 2002:568). Secondly, they often lost use rights to common lands, which included ". . . access to areas for fishing, hunting, pasture, and collection of forest products" (Derrickson, *et al*., pg. 568). Lastly, the cost of entitlement was expensive given the wages and market value of land at that time (Derrickson, *et al*., pg. 568). These restrictions disempowered the commoners because they were often unwilling to stand in opposition to the local elites if existing claims were in dispute (Derrickson, et al., pg. 568).

Figure 1.5. The *Ahupua'a* Land Management Division of Native Hawaiians



Source: Minerbi, Luciano (1999), "Indigenous Management Models and Protection of the Ahupua'a", Social Process in Hawai'i, Vol. 39.

The *ahupua'a* did not always provide the *'Ohana* with everything they needed, contrary to the idealized model proposed by proponents of cultural preservation (Derrickson, Robotham, Olive & Evensen, 2002:565). Therefore, because some *ahupua'a* were not entirely self-sufficient, communities traded with each other " . . . for items not available or common locally" (Derrickson, et al., pg. 565).

4.2.2 The Spiritual Dimension

Ahupua'a, in spiritual terms, argues for the distinctive *pono* (co-operation) relations between the people and their *'aina* (land/that which feeds).[5] *Ahupua'a*, in this regard, refers to the nexus between Native Hawaiians and their environment; it cannot be taught through modeling systems or instructional books. It is a comprehension that derives from knowing ones' environment and its mortality when misused or abused. For Native Hawaiians, this insight dictated utilization practices, one that emphasized reciprocity and respect; beliefs imbued through a system of land naming and mythical chants that relegates value to places and resources (Andrade, pg. 4), and awakens the conception that the *'aina* and its resources are defined by the capacity to reconstitute what can easily be destroyed. According to Andrade, this intricate method of developing respect (read: stewardship) for *'aina* taught the Hawaiians to view themselves as vital to the *'aina's* evolution, which meant acquiring knowledge for balancing[6] human use with the *'aina's* condition. Deciphering balance was communicated from the *'aina*, the spiritual metaphor elucidated by Andrade (see Andrade, '00, pg. 1).

Water, sacred to the God, Kane, is a central feature of *ahupua'a*. It protracts life to the *'aina* and *'Ohana* for stimulating agriculture and proliferating aquaculture. Surface waters cultivated taro, a staple crop for Native Hawaiians through a sophisticated irrigation system cared for by the farmers. Continuous access often relied upon respect for the growers downstream coupled with assistance in construction. Before the influence of Western commoditicization, water was a communal resource, although according to Dr. Lilikala Kame'eleihiwa[7], it was never truly shared across the *ahupua'a* since they were expected to be self-sustaining.

To practice *ahupua'a* entails developing a state of mind to reflect the 'circle of life' best illustrated by the Hawaiian aphorism: 'if you care for the land, the land will care for you' (Blane and Chung, n.d.: 3). Therefore, *ahupua'a* management cannot be practiced if one views one's benefits above and beyond that of another (Kanahele in Donoho 2001:11). Human activity, in keeping with this philosophy, manifested physical, mental, and spiritual rhythms in order to reconstitute the *'aina* for future generations. It is not unlike the philosophies of indigenous communities around the world, such as the Karen of Thailand, the Inuits in Canada, the Australian Aborigines, and the mainland Native Americans. Taking care to not consume more than one requires is the fundamental ingredient in the *ahupua'a* modus vivendi.

Native Hawaiians so determinedly protected the *ahupua'a* credence that laws were enforced to regulate the ways the *'Ohana* utilized the land (Blane & Chung, pg. 3). If breached, punishment was appropriated, ranging from restricted use for minor violations to *kauwa* (eviction from the land), to death for the most severe crimes (Blane & Chung, pg. 3). Such severity clearly communicates how seriously Native Hawaiians

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[5] This definition was obtained from Carlos Andrade's article, "Ahupua'a, Model or Metaphor?".
[6] Balance is attained by *pono* (proper behaviour), whereby one does not take more than one needs.
[7] Dr. Kame'eleihiwa is an Associate Professor in the Center for Hawaiian Studies at the University of Hawaii at Manoa.

valued managing their resources. The reason can only be understood years after Native Hawaiians have been displaced from their homes. The consequences are visible when measured by the "health" of their communities, implicated in their social status, income and overall condition of the Native Hawaiian community.[8] They have become one of the poorest ethnic groups in Hawai'i and are cited for the highest incarceration rates. Ironically, their traditions and customs continue to represent a sense of place and belonging for all Hawaiian residents, as newcomers have embraced their many traditions and beliefs. Taro farming is one such example. It has been sustained from the time Native Hawaiians began cultivating it thousands of years ago. The *ahupua'a* concept is also enjoying a revival, as its spiritual meaning symbolizes a lifeline amidst a culture of finite resources and declining returns (Blane & Chung, n.d.). These traditions, in fact, have provided the rallying point around which communities today fight for the right to determine use of their land and their community's exposure to tourism development. The strength of their fight signals the need for mediating divergences existing between the *ahupua'a* philosophy and current federal and state regulations.

4.3 Reconciling Ahupua'a and the WPA Approach

To reconcile *Ahupua'a* with the EPA's WPA approach is essentially a call to re-allocate power in the process of decision-making (Stone 1988: 352). Such a manoeuver forces the existing decision-makers to reconsider the present structure of decision-making. The implication behind this rationale, of course, is stronger inclusion of community groups into the grand scale of policy planning, allowing them to explicate concerns and needs of the community. This form of participation involves more than consultation; community leaders are central to the decision-making process and may call for implementing social contracts to coordinate plans for the entire community (Arnstein, 1969). This process is called bottom-up, integrated decision-making.

Simultaneously, a second dynamic occurs; the "boardroom", formerly inaccessible to community interest groups, is opened up to facilitate participation. Therefore, what was previously practiced as top-down now incorporates public interest to the extent that watershed management is planned with community members.

Two benefits arise from bringing together the grassroots faction and the "boardroom". One is increased transparency on issues pertinent to the community. This consolidates trust between community members and higher-up stakeholders because decisions become more transparent and community members stay abreast of prospective future decisions affecting the watershed.

A second benefit is the generation of public support for strategies engendered by the EPA. When the community plays an active role in strategic planning, they are more likely to be open to the EPA's suggestions. Hence, these benefits render incentives on the part of the EPA and public/private agencies to reconcile divergence.

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[8] Sociology experts on Native Hawaiian issues have linked up social stressors, such as the high rate of incarceration, with low economic status.

The crux of reconciling *ahupua'a* with the WPA is learning how to amalgamate culturally significant values held by the community with government policies and mandates. This means greater flexibility in existing mandates is entailed in order to effectively exercise sensitivity to the cultural values deemed important to that community. The organizational structure of the WPA implies that the EPA has indicated a desire to improve upon watershed management guidelines by encouraging agencies to work with community groups and other interest groups in formulating policies that are more locally appropriate. But, more than this, they are open to mediating differences between existing State and Federal policies that may run counter to the community's best interest. To this end, the EPA should provide a clear direction for government and stake holders to achieve mediation, as well as be proactive in enforcing such a method. In this regard, the EPA has yet to clarify the process of organizational networking between government entities, Indigenous groups, the private sector, and the community. More succinctly, the EPA must define entry points where stakeholders can begin collaborating with each other to identify problem areas, whether it is in intra-group communication or in finding commonalities with group interests so that differences may be ironed out *inter alia* comprehensive watershed management.

Figure 1.6. Network and Communication Flows between Stakeholders

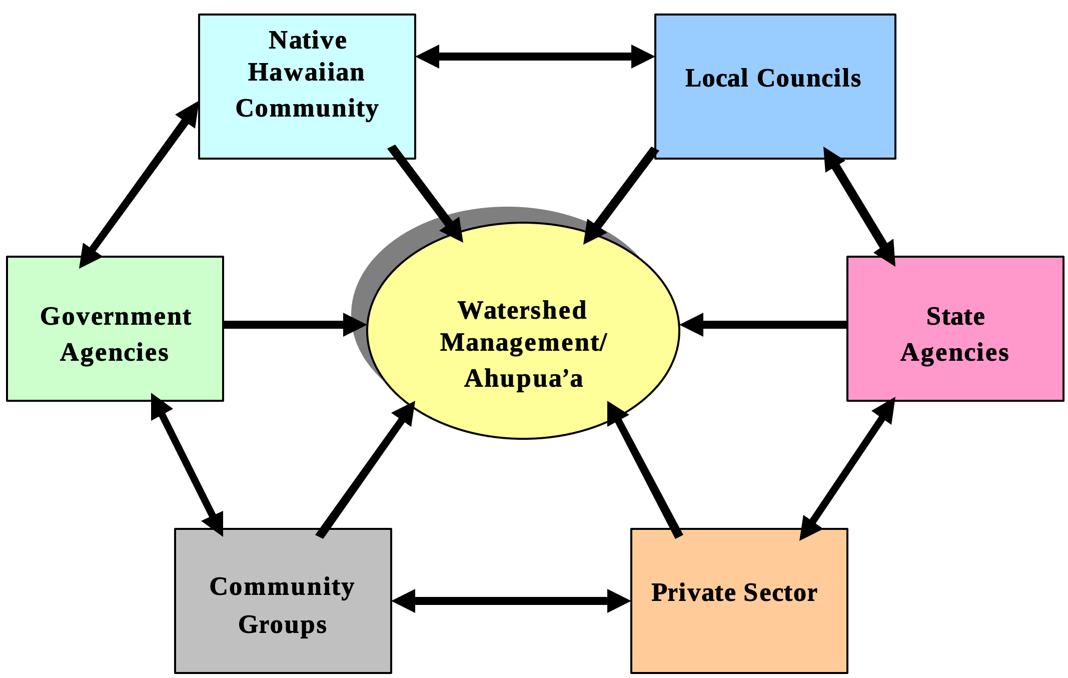

Figure 1.6 is an example of a model for (1) an idealized communication flow between relevant stakeholders and (2) the collaboration of specific agenda of interest groups for identifying and articulating a common community vision while remaining cognizant of the watershed management approach. Communication flow and networking is circular as opposed to top-down. Thus, it is both iterative and collaborative. As per watershed management and *ahupua'a*, entry points must be defined in terms of identifying similar or cohesive goals that can be implemented through coordinated guidelines extracted from

the mandates of each stakeholder group[s]. This process would require prioritizing goals that can be coordinated between groups in order to envision longer-term objectives. At this point, like the *ahupua'a*, accountability measures should also be established for the purpose of de-centralizing control of watershed management in order to preclude any one group from dominating the management process.

4.4 The Hanalei Watershed: Modeling Ahupua'a

The Hanalei Valley is reknowned for its pristine natural setting. It is a pie shaped *ahupua'a* framed by ridges running north to south. On the East lies the Princeville Resort and the Waipa ridge buffers it on the West. Human settlement is situated primarily in the Town center developed along the Kuhio Highway. The Valley, itself, is accentuated with acreages of *lo'i* ponds, the National Wildlife Refuge, a Forest Reserve, and rich biota, all of which is framed by Mt. Wai'ale'ale. The Hanalei Heritage River meanders across this fertile valley, commencing from the pinnacle of Mt. Wai'ale'ale, a height of 5240 feet Above Sea Level (ABS). Population increase, resulting from years of in-migration, and intensive, unsustainable land use has endangered the Valley, and its water bodies, specifically, the Hanalei River and the seashore.

The Hanalei River is an important feature in Hanalei. It has recreational value and for years has supplied the community with rich aquaculture. The *o'opu* is a cherished component of this aquaculture. The Valley, however, has begun to show the signs of stress. A preliminary draft report lists evidence of contaminants present in the Hanalei River (Berg, *et al*. 2000). The authors postulate that the cause is discharge from intensified urban activity. The Report further cites contaminants stemming from "agricultural (taro) field herbicides and pesticides, and roadside herbicides" (Berg, *et al.* pg. 1). Berg *et al*. also cites the presence of 'Sluggo', "used in the area for the control of the invasive apple snails in taro fields . . ." (Berg, *et al.* pg. 2), which could potentially pose threats to water quality. These contaminants were discovered downstream, indicating downstream-related activity. It also indicates that contaminants may have been *flushed* downstream, generated from activity rooted deeper in the *ahupua'a* and carried by the River's natural flow. There are factors to take into consideration. One is cattle-raising, an activity that causes soil erosion and can contaminate water due to feces that deposit along the riverbank (National Academy of Sciences 1970: 110-112).[9] This concern is more pertinent to the land area where bison are raised. Another factor contributing to degradation is siltation from clay deposits, normally found in the upper regions of the *ahupua'a,* which flush down to non-point sources and contribute to sedimentation along the River's waterbed.[10] Other causes are possible contamination to the bird impoundments inside the Refuge resulting from water diversion through pipes installed to feed the impoundments; tourists who engage in kayaking activities upstream and sometimes relieve themselves along the riverbanks without thought to its effects on the water quality; erosion of riparian structures caused by severe flooding. Inland

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[9] Extensive livestock grazing tends to produce soil changes. Soil density increases, reduces pore space, reduces water infiltration, and retards water movement through the soil, causing soil run-off to exacerbate, augment, leading to erosion (National Academy of Sciences, pg. 111).
[10] For an elaborated explanation of sedimentation, see the 7th Annual Watershed Conference, 2002.

settlements, moreover, are slowly emerging due to changes in zoning, posing another threat to the health of the *ahupua'a*. Evidently, the roots of contamination encompass a landmass that is not necessarily restricted to activity along the coastal zones, rendering a strong argument to approach degradation more comprehensively. Presently, the watershed boundary designated by the United States Geographic Service (USGS) does not correspond to the *ahupua'a* boundary, which would make superfluous the objectives set forth in the EPA Watershed Protection Approach (for verification of the USGS go to *http://geonames.usgs.gov/pls/gnis/web_query.gnis_web_query_form*). Instead, it demarcates a 19.1 square mile land area, spanning east to west across the Hanalei *ahupua'a*, from Ha'ena and encompassing the Princeville Resort. Thus, it overlooks the *mauka* region of the Valley as being part of the watershed and would therefore neglect to see it as a source of potential degradation. Moreover, it is not listed as an EPA designated watershed site.[11] Based on this information, one may assume three things:

- The EPA does not have a standardized interpretation of watersheds, meaning watershed boundaries are deduced case by case rather than are viewed as a natural geological reality.

- The EPA does not enforce its policies on itself.

- The USGS does not recognize the Hanalei *ahupua'a* as equivalent to the watershed boundary.

If these assumptions are true and if the EPA is to achieve the objectives outlined in their Watershed Protection Approach, interpretation and recognition of the entire *ahupua'a* as a watershed boundary must be first established. Only when this is acknowledged can collaboration occur between stakeholders from the Hanalei community and Federal and State Agencies. If these assumptions are false, then all recent documents and publications open for public viewing should be updated.

In light of the assumptions stated above, the EPA must also recognize (1) the need for self-enforcement of their own recommendations and (2) standardize the watershed boundary so that it applies to all geological watershed formations. It must, lastly, take responsibility for educating State and Federal agencies on the Watershed Protection Approach and its aims, a move that may facilitate collaborating with the community.

Establishing that the watershed boundary is similar to that of the *ahupua'a* is even more important *a propos* zoning and land use policies, both of which tend to shift with political transitions. Zoning is not fixed; it changes as the need for change is foreseen. Due to zoning instability, land *mauka* within the *ahupua'a* can shift from (i.e) formerly wooded slope to residential district. Knowledge of this fact can forecast potentially critical areas.

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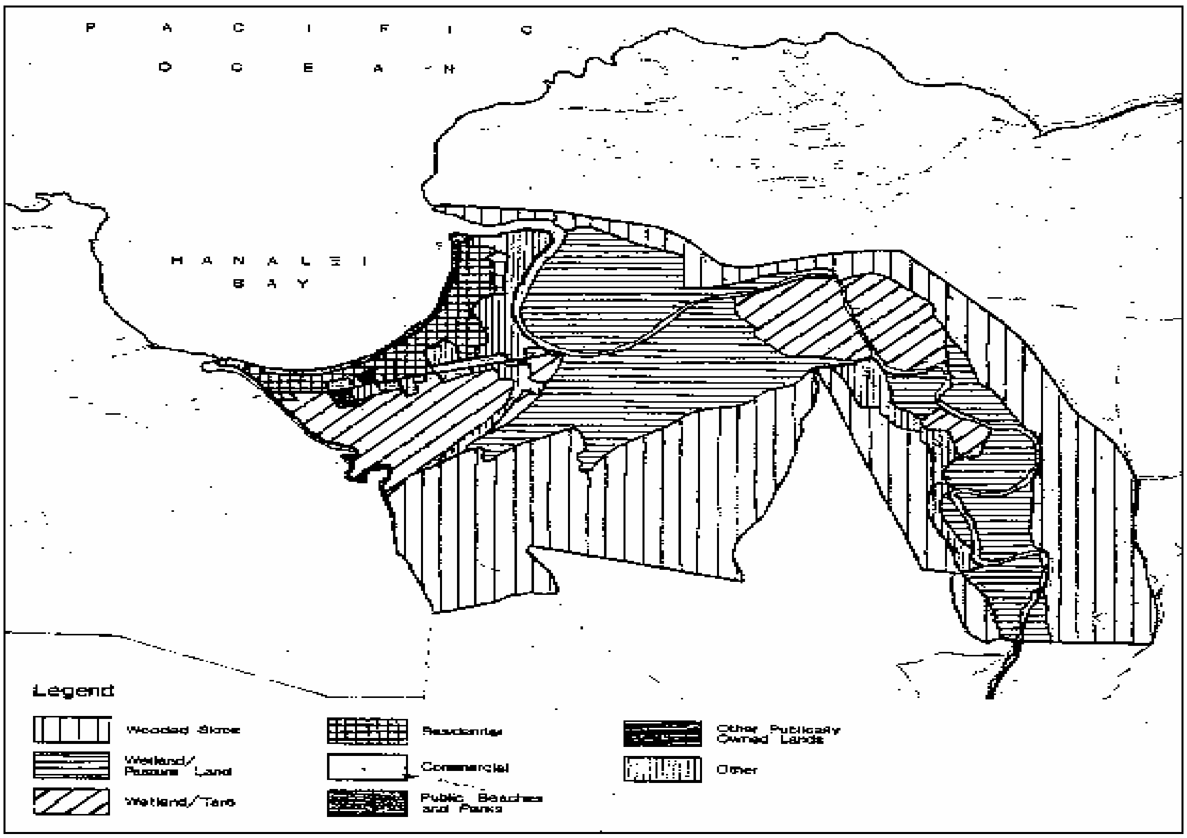
[11] To verify this fact, go to the "Find the Watershed" link under the same website as the USGS.

4.4.1 Zoning

Zoning divides land within a region for specific purposes, not unlike the Native Hawaiian tradition. Unlike the *ahupua'a* tradition, however, the rationale behind these land divisions is not always for the good of the community. Instead, they serve what the government believes will render a high return or deems to be most productive for the government and property owner. These aims are encouragement enough to modify zoning laws. For example, in Figure 1.7 the land is zoned to protect the rural character of Hanalei. A large percentage of this is wooded slope. But, because policies can be changed, zoning can be altered sometimes in consonant with political temperament. Therefore, the protection of rural areas is not absolute.

Figure 1.7. Diagram of Land Division in Hanalei



Source: Hanalei Project, 1999

For Hanalei, the land division of concern is that designated as "O", or "Open District". Under Article 8 of the Kaua'i County Code, these open districts can be allocated for passive or active use in the future. Under passive use, permits are issued for developing such districts "to preserve, maintain, or improve the essential characteristics of land and water areas that are . . ." significant to Hanalei's scenic and recreational value, to support urban areas for accessible purposes, and/or to buffer residential areas from noise, pollution, and visual disturbances (Kaua'i County Code, Section 8.1). Permitting can also be issued, however, for active use, i.e., "residential or other uses"

(Section 8.8, pg. 4), albeit under strict regulations. Despite the regulatory component, "Open District" remains developable.

One gap in the Kaua'i County Code is the absence of guidelines outlining conditions or mandates for future purchase of this district. This means it can be privatized if sold to a wealthy landowner, who can then convert it into a commercial vernacular and possibly lead to tension over the choice between agriculture (i.e taro farming), park space, or urban use. Taking this point further, use can compound the environmental and community issues already confronting Hanalei.

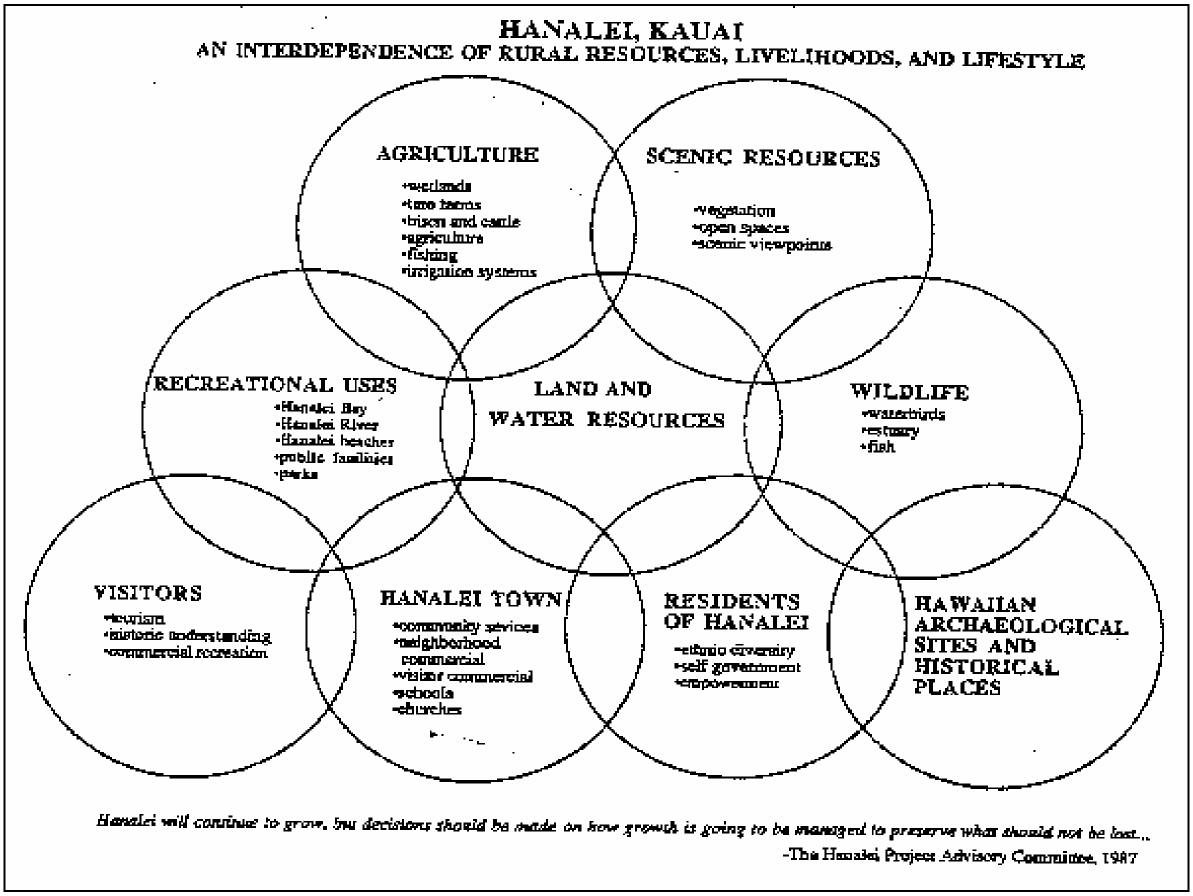
4.4.2 Land Use

The interrelatedness of resource use, population increase, and infrastructural modification with land degradation, increased pollution, and biota reduction are strong reasons for complementing land use patterns with geographical landscape. Whether it be designing a townscape or planning for a sewage system, land use needs to be a corollary to geographical location under the Watershed Protection Approach. The slope of the land, for example, may pose potential cumulative impact if it is encompassed by an extensive drainage system. Understanding the geography can determine whether infrastructural development is a threat to underground aquifers. Understanding present land use by the community can ascertain whether conservation measures will squeeze out traditional community practices. All these considerations are equally intertwined with the people who are connected, at some level and to some degree, with a place. Figure 1.8 exemplifies the inter-relevancy of land use, resource, features, and people involved with Hanalei. It explains the multidimensionality of watershed management and planning for management in drawing a link between all the pertinent elements. More importantly, it illustrates comprehensive planning in diagramming the functional participation of all interest groups.

Looking at the diagram, one can see that watershed management parallels *ahupua'a* management in five ways:

- Identifies valued sites for preservation.
- Divides land for preservation and use.
- Designates land for agriculture use.
- Involves all relevant stakeholders into the planning process.
- Centralizes water and natural resources.

Figure 1.8. A Multidimensional Perspective of Watershed Management and Planning



Hanalei Cultural Resources Management Plan (1989:15).

Ultimately, balancing community-wants, and private and public interests, with the watershed-*ahupua'a* management principles may be the only means to achieving collaboration. Given the similarities between *ahupua'a* and watershed management, the foundation for collaboration already exists. Hence, co-management is certainly possible in Hanalei. The third component of the Watershed Protection Approach – "Partnerships/Stakeholders Involvement" – stresses collaboration vis-à-vis community input and provides the doorway to co-management between community groups. It, further, renders the legitimacy for community involvement. It should, however, include a clear strategic plan that succinctly incorporates the following requisites:

- Flexibility in government policy.
- Acknowledge local knowledge.
- Respect local knowledge.
- Acknowledge contextual differences.
- Synthesize significant cultural values with government policies.
- Improve communication between stakeholders and community.
- Incorporate community leaders into the decision-making process, thereby encouraging transparency and trust.

Section II

A "Sense of Place"

Chapter 5

The Hanalei Community

Hanalei is defined by discoveries and human settlements. Native Hawaiians discovered it. They arrived from the Marquesas Archipelago and the Society Islands, navigating their way across the Pacific Ocean in sophisticatedly carved canoes. It is said that Kaua'i was the first island to have been settled by this Polynesian group before AD 600. Since then, Hanalei has transformed from a primarily agricultural and rural economic foundation operating on a local trade and barter system to a community that, although still relies heavily on farming, is now characterized by a monetary economy dotted with functional industries and small businesses.

The landscape and community changes have paralleled the transition in human settlements. Land use has diversified to integrate a sugar plantation economy, small cash crop farms, and recreational use for tourists. These later developments sprung from the land's previous subsistence agriculture use. Taro cultivation was the genesis for their economic base. Native Hawaiians constructed pre-historic *lo'i* to grow taro, their staple crop. Manipulation of the land, unfortunately, contributed to changes in Hanalei's biota. Settlers introduced plant and animal species, which flourished, died out, or killed off many of the indigenous species. Hanalei today is clearly distinguishable from its historical origins, and its heritage can still be discerned from its present cornucopia state of modernization. It is this sense of place that the community treasures and is the reason visitors return every year.

5.1 Hawaiian History

Despite years of dedicated research, anthropologists still claim that very little is known about pre-historic Hawai'i, namely the relationship between the various Polynesians – Tonga, Samoa, Tahiti, and possibly Maori - who navigated their way to Hawai'i. A curious question is whether or not the Polynesian societies culminated in a unified Native Hawaiian society. Perhaps it never took place. Nevertheless, much has been learned from archaeological and ethnographic research already undertaken.

These first seafarers, it is believed, arrived in two major groups, the first from the Marquesas Islands and the second from the Society Islands (Vinton Kirch, 1973: 2). Based on carbon dating, archaeological artifacts indicate that they arrived as early as A.D 450, perhaps earlier (Vinton Kirch, pg. 4). These artifacts obtained from key sites were a general fare of fishing gear, adzes tools, domestic equipment, and ornaments, from which archaeologists inferred a highly organized society that relied heavily on fishing and agriculture for food, practiced a traditional religion, and were organized into household units (Vinton Kirch, 1973: 8). The excavation of six pre-historic irrigation trails and ancient *lo'i* ponds wider and deeper than the contemporary *lo'i* implies the Hawaiians were very capable agriculturalists (Schilt, 1980).[12] Their staple food was root crops from the taro varieties, including yams and sweet potato (Vinton Kirch, 1973: 8).

The existence of *heiaus*, religious sites of worship, and the formulation of place names that linked Hanalei to the Gods are additional evidence of the sophisticated nature of early Hawaiian society. Specific use values of the *heiaus* indicate that Hawaiian society was organized along a hierarchy. Hommon (1973) suggests that the *luakini heiau* is the most distinguishing feature of the *ali'i nui* (ruling) class. They enjoyed exclusive rights and often made dedications (i.e human sacrifice) to *Ku*, God of War. It was also a site for declaring war on the enemy or defeating them. Sanctification of their monopoly of power was done at the *luakini*.

The organization of early Hawaiian society was stratified, hence, non-egalitarian (Earle, 1973:3). There were two distinct social classes: (1) upper class, the *ali'i nui*, comprised of Chiefs, who ruled the *moku* (or island); and (2)*'Okana* (district) chiefs and chiefs who ruled the *ahupua'a* (local community division) (Earle, 1978:16). This class was rigidly separated from the lower class, both structurally and economically (Earle, pg.13). The *ali'i* ruled with force, waging war to expand their territorial boundaries. They defined and maintained political and religious structures (Hommon, 1973: 6). They ruled territories, marking them with boundaries (*ahupua'a*) determined by their resource and water assets. The King often consolidated territories into socio-political units after war conquests (Hommon, pg. 7).

The lower stratum was the *maka'ainana* (Hommon, pg.5). They consisted of farmers, fishermen, and agriculturalists. They were granted a *kihapai* (family farm) in a land division on which they could farm the land for subsistence purposes. Continued use of the land was contingent upon tribute payments (i.e agricultural goods) required of them (Earle, 1973:3). Certain *ali'i* members went around to the different *ahupua'a* collecting these tributes, a social rite called the *makahiki* collections (Hommon, 1973:7). The *konohiki*, a bureaucrat and member of the *ali'i* class, was responsible for mediating land tenure relations between *ali'i* and *maka'ainana* (commoners) as well as distributing land and water to the various *'Ohana* (Earle, 1973: 3; Earle, 1978: 15). As the *maka'ainana* remained under the guardianship of the *ali'i* class, if land use was mishandled, subsistence use rights were revoked.

The commoners existed under an aristocratic system. Unlike the European model, where lessees were literally under the ownership of the landowner and, therefore, were not granted the freedom to leave of their own accord, the *maka'ainana* could move to another *ahupua'a* if they were unhappy with the treatment imposed by the *konohiki*.

[12] In Schilt's 1980 archaeological study ("Archaeological investigations in Specified Areas of the Hanalei Wildlife Refuge, Hanalei Valley, Kaua'i" 1980), she referred to a 1979 (Ms. 062179) study completed by Paul Cleghorn, who identified six irrigation systems in total. However, five of their locations are unknown. The two mentioned here were both found within the NWR boundaries.

5.1.1 Talking Story with Hanalei Place Names

Place names of Hanalei are rich in references to nature: wind, rain, prominent flora (i.e ti leaf, hibiscus) and fauna (lizards, turtles). They reveal social customs and traditions in pre-historic Hanalei. Additionally, place names are replete with legends detailing stories of Gods. They elucidate how strongly the metaphysical was interwoven in their lives. Such legends link Hanalei to its ancient identity. Kanahele (in Van James 1991: ix) explains that place names "gives me my history, the history of my clan, and the history of my people". The names attached to ecological resources and topographical features illuminate the reverence Native Hawaiians granted to the spiritual world. Place, in the ancient traditions, meant *wahi pana* or a spiritual place the Gods created and infused with their spiritual strength. It was not unusual to associate places with Hawaiian mythology, rendering to them a spiritual essence. Through these mythologies, Kanahele states he understands his history.

The name Hanalei means wreath making or lei valley. The name refers to the rainbows that appeared frequently after the rain showers (Wichman, n.d.:2). The *mo'o* (supernatural lizard), *Ka-mo'o-ka-muliwai*, guarded the mouth of the Hanalei River to prevent *Hiiaka* from crossing to *Ha'ena* "to get *Lohiau* for her sister Pele, the volcano Goddess" (Wichman, pg. 2).

The story of *Ka-ua-hoa* (friendly rain) renders the possibility that the Hawaiians in Hanalei parallel the cultural value in Hommon's (1973) rather general interpretation of social hierarchy. *Ka-ua-hoa* was a warrior who lived in Hanalei around 1660. He went to war against *Ai-kanaha* (leader of men), the future ruling chief, who prevented rain from saving the dying fish, which ". . . gasped in the dry bottom" (Wichman, pg. 2). *Ai-kana's* brother *Kawelo-lei-maku* (beloved by his parents) killed *Ka-ua-hoa* and became a hero, as conveyed in this statement:

Me'e u'i o'Hanalei
The handsome hero of Hanalei

This anecdote reveals the commonality of conflict in prehistory over water use rights and the social value placed on war, as war heroes were revered.

References to warriors are also often found in place names (Wichman, pg. 3):

Ka-pu'ali-o-'Anini (the warrior of *'Anini*)
Narrow ridge between two gulches between *Kaulaahakea* and *Kopuhai'li*

Ka-pu'ali-o-ka-oki (the warrior at the gathering)
Place at the top of *Kapualioanini* Ridge

Na-koa-hai'li (the ghostly warriors)
Boundary marker between *Kakaheua makai* and *Kamo'olehua mauka*

Place names given to features in the landscape further convey the nature of Hawaiians' relationship with their land; place names were granted to landmarks signifying boundaries, to value of environmental processes, and to spiritual value.

i.e Border with Wai'oli

Ka-liko (the bud)
Peak, 4200 feet high; the second highest peak of the Namolokama

Wai-'opa (squeezed water)
Peak, about 2700 feet high, between Hihimanu makai and Kaliko mauka

Hihimanu (manta ray)
Twin peaks, 2478 feet high; one of the three massifs overlooking the valley

Hulu-manu (bird feather)
Spur leading to Kanookoleaka ridge

Pu'u-kokala (peak shaped like a thorn or Spines on a dorsal fin)
Sharp peak between Pu'uki and Wai'opa

Pu'u-ki (ti leaf hill)
Peak, 1312 feet high between Hihimanu mauka and Kamookoleaka makai

Significant regions deemed important are marked off, as in "the Center of the *Ahupua'a*" (Wichman, pg. 12). Place names reveal the importance of this area for agriculture and preservation; as most agriculture takes place in this area of the *ahupua'a* and since the *ali'i* relied on the ability of this area to produce food for collection:

i.e. The Center of the *Ahupua'a* (Wichman, pg. 12-13)

Ka-lehua-hale (the lehua blossom house)
An upland area in upper Hanalei

Ka-wai-lewa (the suspended water)
Peak, 3300 feet, stream and land area

Ke-ana-a-wi (the cave belonging to the freshwater bivalve)
Ridge and waterfall at the extreme head of Hanalei gorge, at the elevation of 2000

Kiloa (to put away for safekeeping – as bundles on a shelf)
Peak of 2390 feet, and land area at its foot

The rains of Hanalei were revered to the same degree as warfare. Aphorisms illuminate the central role rain plays in the life of Hawaiians (Wichman, pg. 13)

Ka ua loko o Hanalei
The soaking rain of Hanalei [Hyde]

Lu'ulu'u Hanalei ia ka ua nui;
Kaumaha I ka noe o Alaka'
Heavily weighted is Hanalei in the pouring rain;
laded down by the mist of *Alaka'i*.
An expression to express the burden of sadness,
the heaviness of grief, and tears
Pouring freely like rain

I noiele I ka 'ia e ka lauakua,
Niua loloka'a ke po'o o Hanalei.
Shaken, beaten by the Laukua wind,
The head of Hanalei reels with dizziness.

Hehi-pua-hala (stepping upon pandanus flowers)
A rain associated with Po'oku. The plains here
were once covered with Pandanus trees

Offerings were often made to the Gods, a key component of their spiritual practices (Wichman, pg. 14). *Heiaus* were the means to spiritual strength and well-being (Wichman, pg. 22).

Ka-ua-kahi-unu (Kauakahi's altar)
A shrine for fishermen. An *unu* was often a crude pile of rocks used for placing offerings to the fishing gods. Sometimes it was more elaborate

Ka-unu-'opua (altar for the worship of '*Opua* gods)
Heiau near the Hanalei River mouth on the river bank

Po'oku (high summit)
The *heiau* was located at the top of the hill of the same name. It was unenclosed and was about two acres in size. It was terraced down on all sides from the central platform. It was of the *luakini* class, a *heiau* where ruling chiefs prayed and human sacrifices were offered.

To truly appreciate the Hawaiian history in Hanalei would entail a full study involving extensive research on oral histories of the Valley and translations of tapes of old Hawaiian interviews. Much of these resources are housed at the Bishop Museum. Interested persons are encouraged to follow up.

5.1.2 Taro Cultivation

Taro cultivation is one facet of the Native Hawaiian culture lauded today because of its legacy. It is what makes Hanalei unique because Hanalei is one of the only places in Hawai'i where taro farming is preserved for its spiritual foundation and its connection to the past. Taro came to Hawai'i with the earliest Polynesian settlers and has been cultivated as a mainstay. According to legend, the roots of the Hawaiians are traceable to the taro plant (*Colocasia esculenta*). Wakea and Papa, the ancient creators, produced *Haloa*. It was still-born, was buried, and evolved into a taro plant. After the birth of *Haloa*, *Haloa's* younger brother (whose name was also Haloa) became the ancestor of the Hawaiians. The legend is told so that people take care of and respect the taro plant, deemed a superior and more sacred brother.

Taro is a marshy plant, so when the Polynesians arrived in Hawai'i and established their first villages along the seacoast near the mouths of streams, it was natural that the first taro plantings were made in the swampy lands found there. The increase in population created the need for more food, so the Hawaiians moved into the valleys and cleared the land of native vegetation. They widened areas beside the streams and springs to create the forerunners of the taro patches. Later, as more taro was needed, the Hawaiians developed an elaborate system of growing this plant in flooded, banked, and terraced plots called *lo'i*.

Picture 1. Taro *Lo'i*

Taro growing in the swampy lowlands was enabled by an irrigation system developed by the early Hawaiians called *'auwai* (Waipi'o Practicum, 1999). They established a water rights system which was restricted to taro. Water for this specific use was given the name *Wai ho'okahe*, while the natural source of water was called *Wai e kahe ana* (Waipi'o Practicum, 1999). Dryland crops had no claim to *'auwai* water.

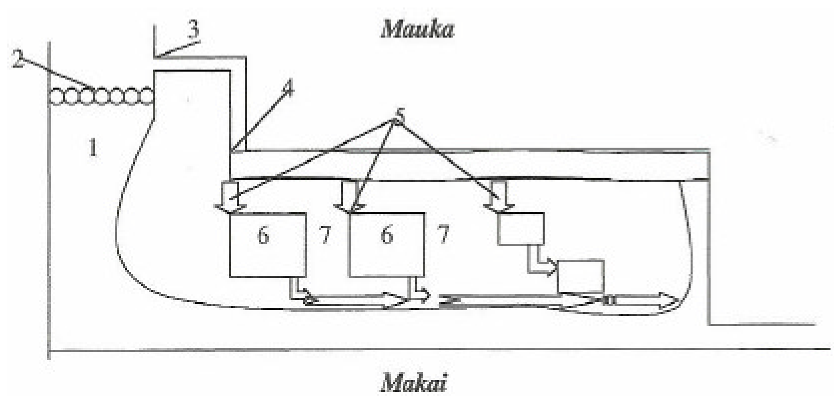
Traditional irrigation systems were developed by the Native Hawaiians to cultivate taro. It is difficult to know exactly how many *lo'i* was under cultivation or how extensive they were across the Hanalei flood plain, however, the archaeologist Timothy Earle (1978) did confirm that they were complex and sophisticated.

A typical pre-historic irrigation system is normally comprised of four components: a dam, ditch complex, pond fields and fish ponds (Earle, pg. 3). The main ditch is positioned against the bend in the river or stream and juts out into the series of *lo'i*. Smaller ditches are constructed from the main ditch to feed into adjacent *lo'i* (Earle, pg. 3). Gravity helps to drain water into the *lo'i*. For flatter areas, the *lo'i* is positioned near a fishpond, which is generally filled, while a small gate controls intake into the *lo'i* (Earle, pg. 3). These irrigation systems were shared between members of the *ahupua'a* (Earle, pg. 5).

Use of the water was regulated by time increments, which varied from a few hours each day for a small taro patch to two or three days for a taro plantation. By rotation with others on the *'auwai*, a grower would divert water from the *'auwai* into his taro. The next, in turn, would draw off water for his allotted period of time. Control of the *'auwai* was directed by the chief holding the most rights to water usage. He was the *luna wai*, or water boss, who directed the cleaning and repair of the *'auwai* and rewarded or punished growers with increased or lessened rights to water usage according to their performance in tending the *'auwai* (Waipio`o Practicum, 1999).

The *'auwai* irrigation ditch system extracts water from the natural streams and feeds the taro fields. The *po'owai* (the headwaters of the *'auwai* system) is located upstream at a point in the *kahawai* (the main stream flow), where water naturally pools. A dam constructed from rocks and mud, called *manowai*, redirects stream flow into the *'auwai*. The *'auwai's* construction begins at the lower end and continues upstream. According to traditional Hawaiian law, at most only half of the *kahawai* could be diverted.

Picture 2. The '*Auwai* System for Taro Farming



1) Kahawai: main stream flow
2) Manōwai: dam barrier that redirects water flow from the kahawai into the 'auwai
3) Po'owai: headwaters of the 'auwai system
4) 'Auwai: irrigation ditch that takes water from the kahawai into the lo'i
5) Makawai: inflow points that regulate water flow from 'auwai into lo'i
6) Lo'i: wetland taro patch
7) Kuāuna: embankment areas separating the lo'i

Source: Waipi'o Valley: Towards Community Planning and Ahupu'a Management, 1999

The taro plant remains a significant food source for many cultures today. Anderson (1996:25) explains that all parts of the taro can be consumed. The corm is usually made into poi while the stem is used in soups. The leaves are put in *laulau* dishes or used in *lu'au*. It is nutritional containing calcium, riboflavin, iron, and thiamin with no cholesterol and almost no fat (Andrade, 2002). Hanalei is one of the places in Hawai'i where taro farmers preserve the spiritual and nutritional foundation of the Hawaiian culture for both Hawaiians and non-Hawaiians.

It is difficult to know exactly how much land was under cultivation or where traditional *lo'i* plots were. But, in the mid-1800's, according to Moffat (1995), more taro cultivation took place in Wai'oli than Hanalei because of the topographical differences:

> *It is interesting that Wai'oli, much smaller and with far less level land than Hanalei, had a significantly larger number of kuleana properties. Judging by the extensive taro farming that occurs in Hanalei today, it would seem that the well-watered Valley must have been home to a considerable population in the original society. Archaeological and other evidence, however, indicates that much of the low lying land in Hanalei was not used extensively for agriculture in earlier times. The variety of taro grown by Hawaiians is reported to do poorly unless grown in cool water, and the broad plains of Hanalei did not have the slope to keep water flowing continuously through the lo'i.* (Moffat & Fitzgerald, 1995:105)

Moffat & Fitzgerald's reference to low taro yields as a function of irrigation that did not have the advantage of a steep slope from the Hanalei River implies that taro may have been grown entirely outside the flat plain region.

5.2 Human Settlement Patterns in Hanalei

Hanalei's settlement history, after Native Hawaiians first discovered Kaua'i, has been peppered with inflows of migrants, first with Christian Missionaries and later by migrants from Asia. The patterns of human settlements greatly influenced transitions in the landscape, population, and social organization, contributing to the slow disintegration of the prehistoric social system.

5.2.1 Arrival of the Europeans

European settlement had repercussions to the extant Native Hawaiian community and Hanalei's natural resources. Armed with ideas of individual land ownership and Christian values, they posed obstacles to the perpetuation of Native Hawaiian society because they developed, with their hosts, social relations predicated on the validity of Western values.

Hanalei was first exposed to the outside world through the Sandalwood Trade in 1811 (Hanalei Yesterday, 1990:4). The *I'li-ahi* was a much sought after commodity, but the exogenous consumption of this resource eradicated the formerly dense supply and put the trade to an end in 1829 (Schilt, 1980:5). It was not until 1815 that the Europeans gained a foothold in Kaua'i. It was inaugurated by the Russian Envoy, Dr. Georg Anton Schaeffer, who arrived in Kaua'i looking for military reconnaissance (Wichman, n.d.; Schilt, pg. 5; Hanalei Yesterday, pg. 2). He bartered away the Russian ship, Lydia, with King *Kuamuali'i* in exchange for provincial directorship of Hanalei (Schilt, pg. 5). When King *Kuamuali'i* consented, he renamed Hanalei Schaeffer Valley. During this time, Dr. Schaeffer built three forts: Fort Elizabeth (in Waimea), Fort Alexander, and Fort Barclay (Schilt, pg. 5; Hanalei Yesterday, pg. 2). The latter two were erected at the Hanalei River mouth, serving as a security post for potential threats to the new Schaeffer Valley.

As Provincial Director, Dr. Schaeffer aimed to develop Hanalei into an entrep?t, a plan that never came to fruition because the loamy sandy shore obstructed building capabilities (Hanalei Yesterday, pg. 4). He also attempted to colonize Hanalei by Russianizing the inhabitants and converting their names to Russian (Schilt, pg. 5). The Native Hawaiians opposed his colonizing efforts and evicted him.

European entrepreneurs followed Dr. Schaeffer's initial expedition. They discovered that Hanalei possessed a rich, fertile climate for agriculture and ranching, encouraging them to either buy or lease land to establish large plantations or cattle ranches. One of those recorded was Richard Carleton, who bought acres for a cattle ranch in the 1830's. He eventually sold it to the French entrepreneur, Dudroit, who established a beef and butter export business (Hanalei Yesterday, pg. 2).

On the plantations, the Europeans experimented with several crops, from silkworm plantations to tobacco and oranges. In 1838, Charles Titcomb leased 90 acres from King Kamehameha III to develop a silk plantation (Hanalei Yesterday, pg. 2). Coffee and sugar dominated, however, until rice became the major export crop. Sugar plantations were established where the Princeville Resort is now as well as in the Hanalei flatlands. On the sugar plantations, absentee landlordism was not uncommon (Hanalei Yesterday, pg. 4).

Coffee eventually replaced sugar at the Princeville Resort, while rice replaced sugar in the flatlands. Entrepreneurs jumped on the chance to capitalize on the coffee market. Godfrey Rhodes and Thomas Brown, for example, leased a total of 150 acres on both sides of the Hanalei River and began planting coffee in 1842. Being unsuccessful in his silk business, Charles Titcomb joined the coffee business and leased 90-acres of land in 1844. Kuna, a town two miles up Hanalei Valley near the Hanalei Bridge, German immigrants Wunderberg and Archer owned a coffee farm. John Bernard and Goddfrey Rhodes founded a coffee plantation in 1842, but caused conflict with the indigenous taro farmers because they claimed he pulled taro from the *lo'i* and diverted water away to feed his plantation. Another coffee plantation was established in the old sugar plantation land, where approximately 170,000 trees were planted (Schilt, pg. 6).

Pretty soon coffee plantations dominated the entire valley covering at least 1,000 acres (Cook, 1999; 1,000 Friends of Kauai, 1990). By 1845, at least 100,000 acres was under coffee cultivation in the Hanalei Valley (Schilt, 1980: 6). A local resident commented on the landscape, "…its fields of coffee in bloom—the white starry blossoms looking like snow on the drooping branches and delighting the eye for nearly a mile along the river bank" (King, 1991: 26).

The coffee landscape did not last long because blight and other diseases after 1852 ravaged the plantations. To cope with the blight, Charles Titcomb again shifted to planting and milling sugarcane. Abandoning coffee cultivation in 1862 in the same vain, Robert Crichton Wyllie, a Scotsman and advisor to Kamehameha IV, followed Titcomb and entered the sugar business with his large acres of land along the river and on the hill above the present Hanalei Bridge. Wyllie built a steam-powered sugar mill with Glasgow-made machinery at the east side of the Hanalei River that formed a cluster of camp housing, storage buildings, a post office, and butcher shop (see Appendix D.1). Newly established sugarcane plantations attracted Chinese and Japanese immigrants. The valley became extensively cultivated for the sugarcane, but such landscape quickly disappeared by 1880 as the sugarcane plantations moved to places with a drier climate, such as Kilauea (Cook, 1999; King, 1991; Wilcox, 1991; 1,000 Friends of Kauai, 1990).

While tracts of land in Hanalei were being converted to plantation agriculture, the first Missionaries arrived in 1820 (Hanalei Yesterday 1990: 2). Their places of worship soon dotted the Halelea District. The first was a Protestant mission, which established roots in Waimea, where they converted the indigenous locals to Christianity and formed a native congregation. Together, they constructed the Wai'oli Meeting Hall in 1841. In 1864, a Catholic contingency erected a church on the Hanalei River's west bank near the mouth (Hanalei yesterday, pg. 2). Many of the missionaries launched manufacturing factories and small businesses. The very first store was built in the 1840's behind the Old Catholic Mission House (Schitt, 1980:7).

By instituting trade relations with the outside world and inaugurating businesses, foreigners introduced a foreign currency that forecasted Hanalei's inevitable conversion to a material exchange system, employing hard currency *in lieu* of the traditional exchange system. It not only widened the doors to further penetration from the outside, but transformed the manner in which individuals interacted with each other. As currency became valued over the traditional method of exchanging goods and service in kind, communities became increasingly dependent on currency for their livelihood. This evolving lifestyle only heightened as Asian settlements became more prevalent in Hanalei.

5.2.2 Asian Plantation Labour and Settlement History

The Asian migrants arrived because of the sugar plantations established in the Hanalei Valley; they were recruited to work in the fields. Attached to Asian migration was the growing demand for rice, a demand that developed into a large industry soon after the sugar industry became defunct, credited in part to growing competition in

California (Hanalei Yesterday, 1997). Cultivation took advantage of the "lower flood plains and the marshy lowlands of both the leeward and windward coasts of the Island" and the water rights under the old Hawaiian system (Hanalei Yesterday, pg. 1). These small rice plantations replaced the ancient Hawaiian *lo'i*, evidenced from archaeological digs that disinterred digging stick artifacts in layers below the rice paddies (Schilt, 1980). The Chinese expanded upon the irrigation system, however, to feed the acres of flat rice paddies. They constructed the "China Ditch"[13], a major irrigation system in Hanalei Valley (Hanalei Yesterday, pg. 2).

The first Asian settlers were the Chinese, many of whom arrived in the 1860's to work on the sugar plantations. They introduced rice cultivation as a means to feed their communities (Hanalei Yesterday, pg. 1). The burgeoned rice industry can be correlated with an increase of the Chinese population. In 1866, 164 Chinese were documented. Subsequent years marked a steady growth of Chinese migrants. In 1878, there were 265 documented Chinese individuals; in 1884 there were 459. By 1896, the Chinese population had grown to 689 (Hanalei Yesterday, pg. 2). By the 1890's, rice had replaced sugar as the primary agricultural industry in Hanalei, with Hanalei producing the largest amount of rice and devoting the most extensive acreages to rice cultivation, averaging approximately 10% of arable land or "750 acres of the total 7,321 acres of rice fields in Hawai'i" (Hanalei Yesterday, pg. 1). As Chinese migrants saw the vitality of rice as an income-generating crop, more entered the industry. Rice mills dotted the landscape throughout the *makai* side of the Hanalei Valley, having flourished because of the success of the rice industry. According to a government survey, in 1893 five rice mills existed.

Hanalei also diversified in terms of employment. By the early 1930's, occupations ranged from farming, mercantilism, and fishermen to more professional careers, such as teachers, attorneys, doctors, and government workers. In 1922, the Kaua'i Electric Company created jobs, but eventually shut down. In 1930-31, Kaua'i Electric had no employees (Hanalei Yesterday, 1997).

When the Chinese population began to decline in the 1890's after the enactment of the Chinese Exclusion Act precluding further Chinese migration and labour importation, rice cultivation shifted into the hands of Japanese (1890's) and Filipino[14] (1930's) migrants, encouraging future settlements (Hanalei Yesterday, pg. 3). The decline of the Chinese population, aided by stringent price competition from rice industries in California, cultivation in Hanalei experienced a gradual death (Hanalei Yesterday, pg. 16)[15]. In the early 1920's Hanalei accounted for 50 % of rice production in all of Hawai'i. By the mid-1920's, the rice industry had dwindled (Riznik, 1989; Wilcox, 1981; 1,000 Friends of Kauai, 1997). Despite a mild resurgence in the 1930's,

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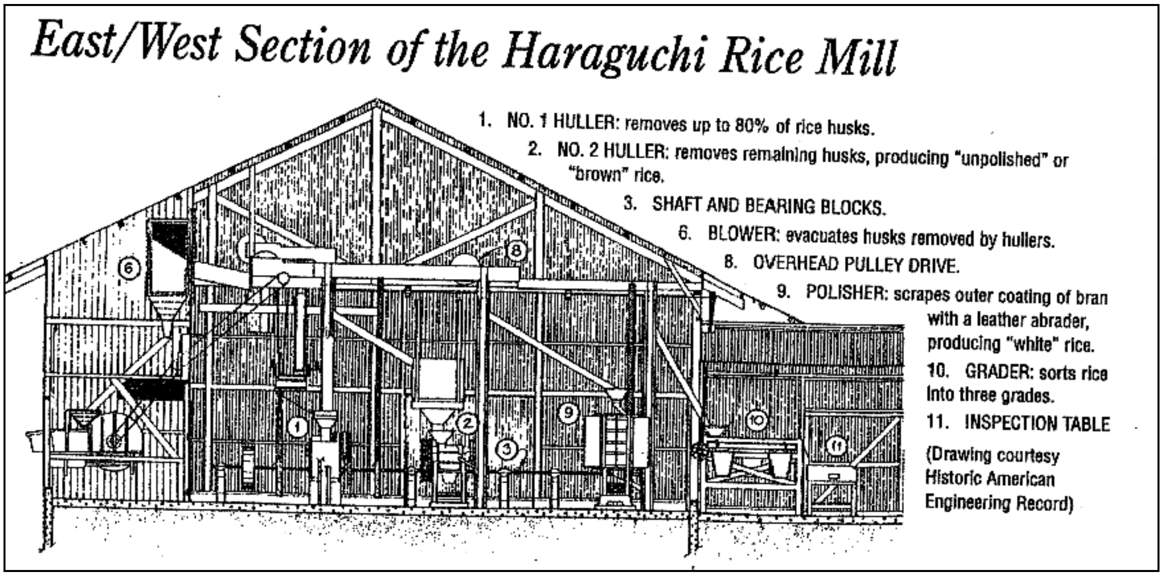
[13] The China Ditch may have been built over pre-historic *lo'i*.

[14] Many of the Japanese and Filipinos were also recruited to work on the sugar plantation (Hanalei Yesterday, pg. 11).

[15] The total population followed the decline of the rice industry, decreasing from 2549 in the 1920's to 1,182 through to the 1970's when it the community exhibited signs of new immigration (Hanalei Yesterday, pg. 17).

largely through the efforts of the Japanese farmers, rice farming eventually died out.[16] According to Rodney Haraguchi, one of the remaining farmers from that time period, apart from increased rice imports from California, which augmented from 9.5 million pounds to 31 million pounds, the labour intensiveness of rice cultivation contributed to its demise. The rice industry lasted for approximately 80 years (Hanalei Yesterday, 1997:16). The only memorial to that time period today is the *Ho'opulapula* Haraguchi Rice Mill, now a property of the National Register and is a reminder of that phase in Hanalei's history.

Picture 3. Cross-sectional Diagram of the Ho'opulapula Haraguchi Rice Mill



Source: Hanalei Yesterday, 1000 Friends of Kaua'i, Hanalei, Kaua'i: (date).

In the 1940's, more Japanese migrated to Hanalei from surrounding areas and began to cultivate taro for both commercial and subsistence, feeding Hanalei and surrounding areas. These new *lo'i* also utilized the old Native Hawaiian irrigation systems. In 1918, taro was regarded as possessing the same commercial viability as rice, leading to its resurgence, but this time cultivated primarily by the Japanese population. It was marketed as poi or as a raw crop. By 1949, there were 116 active taro acres documented in Hanalei all farmed by Japanese, Chinese, Filipino, Hawaiian, and Caucasian farmers (Hanalei Yesterday, pg. 17).

5.2.3 Ethnic Composition

Culture in Hanalei is traditional and diverse. Native Hawaiian influences have maintained their integrity and has become intertwined with the Western and Asian influences. A 1914 Polk-Husted Directory listing Hanalei area residents provides an idea of the ethnic composition in the early 20th century (see Appendix A.10). Based on their

[16] When Japanese farmers gradually took over the old Chinese rice paddies, they introduced a new rice variety: mochi (Hanalei Yesterday, pg. 17). It proved popular, leading to a "Black Market" for this particular rice variety (Hanalei Yesterday, pg. 17).

family names, this listing gives an indication of the Hawaiian, Chinese, Anglo, Japanese, and Filipino ancestry. As a result, the people of Hanalei experience a montage of Hawaiian, Western, or Asian cultural practices. Today, Hanalei retains some while others have disappeared.

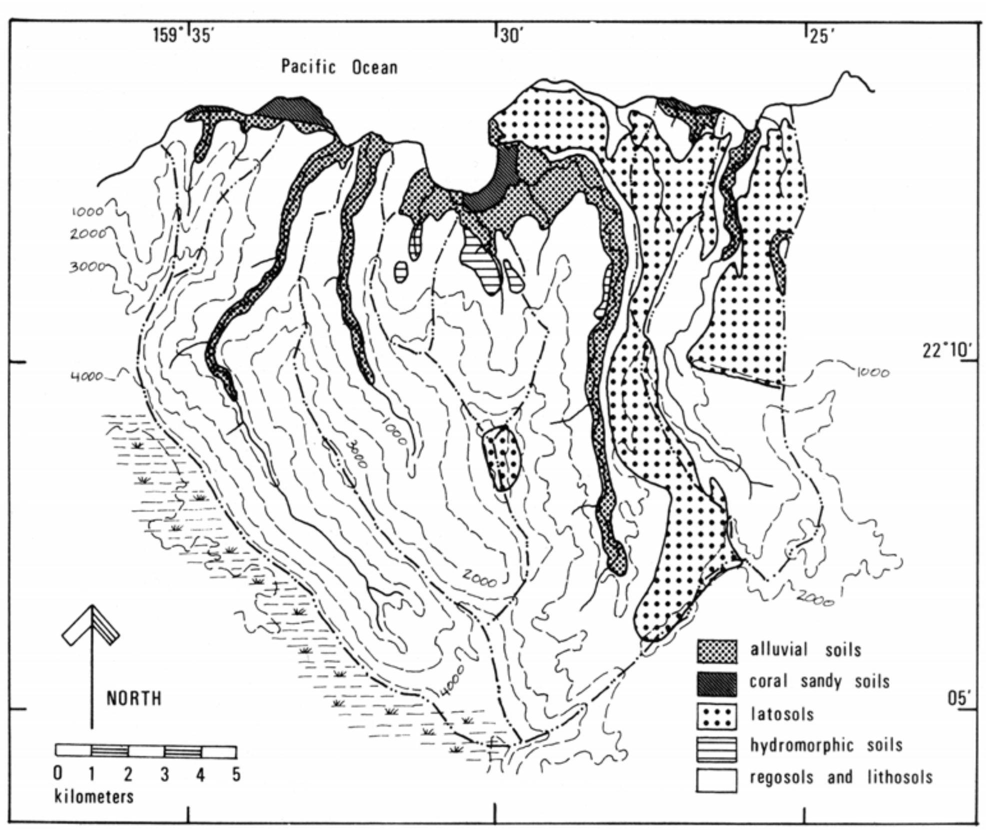
The migrants, bearing their knowledge, customs, and credos, imported a profusion of cultural heritage, enriching Hanalei's human landscape. Missionaries inducted Christianity, converting many to establish a functional and active community; Chinese migrants transplanted their traditions, celebrating ancient holidays such as Chinese New Year and *Ching Ming* (Grave Decorations Day); the Japanese imported Buddhist and Shinto cultural celebrations like *Obon* (Hanalei Yesterday, 1997:11). They acquainted the community to the Bon Dance, which became a community event in July. These "immigrant" traditions blended with the Native Hawaiian customs, and from this mosaic a local essence characteristic of Hanalei materialized, borne from a bridging of social networks by which a community character slowly evolved. Locals speak fondly of the *Hukilau*, a community activity that brought many to the Hanalei seashore. This was a fishing activity, usually led by a *konohiki*, a leader ". . . whose fishing rights went back to the allocations given by ruling Hawaiian chiefs" (Hanalei Yesterday, pg. 13). Participants, grabbing onto a wide net that stretched across the beach, caught volumes of *akule* and *opelu*. The catch was distributed amongst themselves to take home. Continued practice of the *hukilau* entailed the care of a *ku'ula* (stone carved fishing God) to ensure a bountiful fish harvest (Hanalei Yesterday, pg. 13). These traditions all combined with Native Hawaiian traditions of *lei* making, *lauhula* weaving, traditional hunting and gathering, *hula*, multi-cultural cooking, traditional medicine, and gift-giving (The Hanalei Project and Community Associates, 1988; 1000 Friends of Kaua'i, 1997). Although many of these traditional practices began to slowly demise in the 1950's, they, nevertheless, are cherished today. Many locals, in fact, have attempted to revive many of the customs. Today, this sense of place is bound together in the continued cultivation of taro, considered by locals to be the ". . . most important and significant feature of Hanale'i's identity of cultural, historical, and scenic significance" (Hanalei Yesterday, 1997:17). It represents the thread that connects present Hanalei to its pre-historic existence. Among the Hawaiian cultural practices, taro farming is the most visible and vibrant in Hanalei. Today, there are only twenty or so taro farmers, but the small number of farmers does not minimize taro farming's cultural significance. It continues to be a major food source for others today.

5.3 Physical environment

The Hawaiian archipelago was created from volcanic eruptions that formed mountains of 2000 to over 13,000 feet Above Sea Level (Vinton Kirch, 1973: 5). The windward side is more eroded because the trade winds blow across them from the northeast side. Sometimes, they collide with colder air coming down from the north to generate a precipitous, wet climate. Kaua'i is especially susceptible to this climatic interchange due to its location. It experiences heavy rainfall, hurricanes, and tsunamis; annual rainfall along the coast is measured at 1700 mm and 2600mm, while Mt. Wai'ale'ale, situated at the center of the island, has been dubbed the wettest place on earth because it experiences the heaviest rainfall, receiving more than 10,000 mm annually.

The volcanic ash produced by the eruptions transformed Kaua'i into a lush, deeply forested island. Combined with pre-existing soils, and mild climatic variation between both lowland and upland regions, Hanalei's soil composition consist of alluvial, non-calcerous flatland soils in the lowlands and along valley streams and considered to be most important for agriculture; coral sandy soil, mixed with calcerous marine organism fragments, concentrated in the ocean front; a small batch of latosols, which sits at the intersections of Hanalei, Waipa, and Wai'oli; vegesols and lithosols, not usually effective for maintaining traditional agriculture, were concentrated *mauka* of Hanalei *ahupua'a*, where wild species and vegetation grew (Earle, 1978: 28). The spatial distribution of soil literally dictated how it was manipulated for agriculture and other land use.

Map 1. Soil Map of the Halelea District



Source: Earle, Timothy K. (1978), Economic and Social Organization of a Complex Chiefdom: The Halelea District, Kaua'i, Hawai'i, Mueseum of Anthropology, University of Michigan No. 63: Ann Arbor, Michigan.

5.3.1 Changes in Land Use Patterns

Landscape changes in the Hanalei *ahupuaʻa* have largely paralleled its land use and landownership history. Agriculture has dictated land use, thus sustaining its rural features until the early to mid 1900's, when modernity began to exact its influence. Generally speaking, the history of agriculture can be divided into four periods: 1) 750 A.D. to 1840; 2) 1840 to 1880; 3) 1880 to 1960; and 4) 1960 to 2002. In each successive period people have altered, added, obliterated, preserved, or restored an element or a combination of elements in Hanalei's landscape.

Period	**Agriculture**
750 AD-1840	**Taro and breadfruit**
1840-1880	**Plantation (silk, coffee, tobaco, sugar, and rice) and cattle ranching**
1880-1960	**Rice (earlier) and taro (later)**
1960-2002	**Taro**

Before Polynesian settlement, the landscape was typified by swampy wetlands. After 750, the Hawaiians transformed the wetlands into taro *loʻi* and *ʻauwai* for agricultural use. The majority of Hawaiians living in Hanalei were commoners (*makaʻainana*) whose engineering skills were applied to construct dams, ditches, and ponds (1000 Friends of Kaua'i, 1990). A hula song documented the natural beauty of Hanalei and reveals the presence of agricultural practice:

He Oli

Halau Hanalei I ka nini a ka ua;
Kumano ke po'o-wai a ka liko;
Naha ka-opi-wai a Wai-aloha;
O ke kahi koe a hiki I Wai-oli.
Ua ike ʻa.

[Translation]

A Song

Hanalei is a hall for the dance in the pouring rain;
The stream-head is turned from its bed of fresh green;
Broken the dam that pent the water of love—
'Naught now to hinder its rush to the vale of delight.
You've seen it (*Emerson, 1991: 155*).

Up until 1830 and beyond, the Hawaiians established their settlement along the beach for drier climate and fishing opportunities (Map 1 in Appendix B). They built grass-thatched houses in the middle of gardens of fruit trees, vegetables, and flowers. Some of them also built individual homesteads in the Valley. Since flat plains near the beach had sandy soil and lacked adequate water, they set up taro patches mostly *mauka* Hanalei Valley (Wilcox, 1917). Taro farmers walked to the patches everyday and came back to their houses on the beach at night. Other taro patches were constructed along the bank of two rivers. A swampland, unsuitable for agriculture, stretched between the two rivers (Ronck, 1985; Wilcox, 1991). By the early 1840's, the landscape of taro and water did not remain unaffected, when the majority of the land was converted to plantation agriculture.

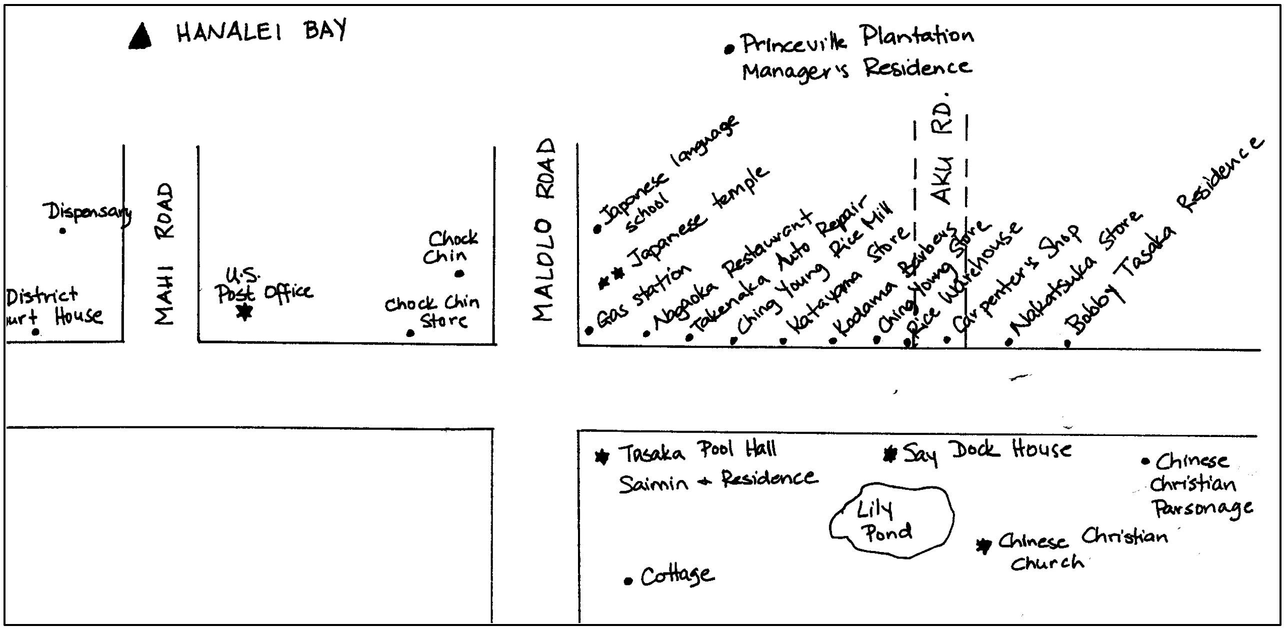
Neophyte roads and bridges (see Map 2 in Appendix B) expedited Western settlement, whose arrival triggered radical landscape changes between 1840 and 1880. Their plantations cleared the forested vegetation and paved the way towards an agriculture export economy. These initial plantation crops significantly altered the landscape as plantations grew to occupy vast tracts of arable land.

Rice cultivation followed the plantation period. Rice farmers took advantage of existing taro *lo'i* and *'auwai* developed by ancient Hawaiians. A local resident noted that rice cultivation in the valley presented "a dismal swampy appearance" (King, 1991: 37). A journal kept by a traveler on Kaua'i writes an alternative description of the valley in 1895, depicting it as an industrious setting: "Rice fields and taro patches covered the flat bottom lands as far as the eye could see. …the winding river with a barge loaded with rice slowly drifting down on its placid surface . . . we crossed the river on a bridge and the road followed the winding course of the river for quite a distance. . . many Chinamen were working in the fields" (Knudsen, 1991:153). The Chinese rice farmers were later joined by Japanese immigrants. They added to Hanalei's population, intensifying both the rice industry and the number of settlements (Map 3 in Appendix B).

Infrastructure also intensified with subsequent settlements. In 1908, electricity arrived through the Wainihia Power Plant, replacing gas lamps. Beachside property was appropriated for sale, further entrenching land and property ownership, and improved road systems connected Hanalei to adjacent towns (Hanalei Yesterday, 1997: 8). The addition of the Hanalei Bridge and Pier promoted commerce and trade.

The rice industry engendered other commercial ventures; small, family-owned grocery stores and other businesses developed along the main road, Kuhio Highway, especially between 1890 and 1925 when Hanalei was the most prosperous. These grocery stores provided the hub for community interaction "where people gathered to exchange the local news" (Hanalei Yesterday, pg. 9). Other businesses were developed, creating new occupations. Resultantly, a town center and strong community relations materialized. By 1935, a town center was fully established, as exemplified in this reconstructed map (see map 2, below).

Map 2. The Commercial Core of Hanalei, c. 1935



Source: Reproduced from the original in Hanalei Yesterday, 1997, 1000 Friends of Kaua'i: Hanalei

(*) buildings still standing (**) Buildings moved

The demise of the rice industry allotted room for a revival of the taro landscape in Hanalei by the 1960's. Planting imported taro *huli* or a young plant from Waimea on the east side of Hanalei River took place in 1940's, and Hanalei farmers converted well-maintained paddy fields and irrigation systems back to taro *lo'i* and *'auwai.* In 1949, the farmers cultivated 116 acres of taro. By the 1960's, taro replaced rice to become the dominant crop in the valley. In 1997, taro cultivation area in the Hanalei district was about 220 acres, of which 125 acres are located in HNWR (Wilcox, 1981; 1,000 Friends of Kaua'i, 1997). Hanalei today is wonderfully summarized in the Kaua'i General Plan: *Hanalei has friendly people and caring merchants. With its surrounding taro fields and its inventory of historic sites and buildings, Hanalei is a place of great beauty and cultural interest. The taro mill and taro cultivation continue to expand, restoring areas cultivated in ancient times. Small businesses are thriving. Walkways link all parts of town. A shuttle bus helps local residents to get around, as well as giving visitors the option of leaving their car at Princeville. Public parking is provided in the rear of buildings and/or screened from the road by landscaping* (Planning Department, County of Kaua'i, 2000: 6-3).

5.3.2 Transitions in Land Ownership

Pre-history Hawai'i exhibited a system of land-control restricted to the *ali'i* class. This changed when King Kamehameha IV promulgated the Great Mahele land distribution in 1848.

5.3.2.1 The Great Mahele (1848)

The Great Mahele of 1848 was a formal land distribution law. It was preempted by Missionary appointments to key government posts, which the Crown issued due to fears of foreign invasion (Kelly, 1940: 59). Three Acts called for the creation of a Board of Commissioners to "adjudicate land claims placed before them" (Kelly, pg. 61); land distribution amongst the *ali'i* class; and the award of small land parcels to commoners called the Kuleana Act of 1850 (Kelly, pg. 62). In effect, the Great Mahele institutionalized private ownership.

From 1850 to 1855, the King's Land Commission consisted of five men:

- John Ricord (Chairperson) – government official
- James Kanehoa – government official, son of John Young and advisor to King Kamehameha I
- John Papa I'i – highly educated Hawaiian scholar
- Samuel Manaiakalani Kamakau (replaced Neuku Namau'u) – highly educated Hawaiian scholar Joshua Kekaulaha

Under their direction, the King divided the land into four main groups:

- Crown lands
- Government lands
- *Konohiki* lands (chiefs)
- Individual *kuleanas* were scattered among all three

Under the Kuleana Act, commoners were instructed to file a claim to receive *kuleana* lands (a piece of fee simple land). A *kuleana* was granted to the *maka'ainana* if he could prove that he and/or his family had been cultivating it for at least two years. This meant that they had been working the land prior to the *Mahele* with permission from their *konohiki* under the ancient system. The land could be broken up into different parcels equaling a few acres at most. *Kuleanas* were considered to be prime agriculture lands and were usually used for taro cultivation.

Moffat and Fitzpatrick (1995) list the amount of *kuleana* grants awarded in each *ahupua'a* in Hanalei and the surrounding region, cited from the Indices of Awards (see L.C maps in Appendix B):

- 19 with Kalihikai
- 55 within Hanalei
- 70 in Wai'oli

Some of the biggest acres in Hanalei were distributed amongst foreigners. One of the first grantees was a man named J. Kellit. He may have been a missionary. The biggest recipient was the Wilcox family, one of the first Westerners to settle in Hanalei. They were missionaries and established the Wai'oli Mission House. They also received land in Wai'oli.

Table 2. Major Land Grantees of the Great Mahele[17]

No.	Bk	Grantee	Locality	Area	Date
99	1	Kellit, J.	Hanalei, Kukui	75.00 ac.	1848
100	1	Kellit, J.	Hanalei, Kukui	68.40 ac.	1848
251	1	Nuuanu, AS	Hanalei	37.82 ac.	1859
4831	23	Wilcox, AS	Hanalei	8.62 ac.	1904
4845	23	Wilcox, AS	Hanalei	984 ac.	1904
5018	23	Trustees of the Wai'oli Mission House	Hanalei	9,945s. ft.	1907
4846	23	Allen, WF	Hanalei	879 ac.	1904
6086	28	Makee, CB	Wai'oli, Hanalei	3.59 ac.	1914

Sales of land were made to individuals, many of whom had Hawaiian surnames. Thirty six land sales in Hanalei have been documented. However, the anthropologist Marion Kelly (1940) believes most Hawaiians were actually displaced by the new land ownership laws. Throughout Hawaii, about 70% became landless because they lost their fee simple title based on the argument that, since traditional land use did not endorse individual land ownership, it was never theirs in the first place (Kelly, 1940:66). Another factor for displacement was the allocation of land to mainly foreigners and members of the *ali'i* class (Kelly, pg. 67).

5.3.2.2 Land Ownership Today

Western settlement in Hawaii introduced individual landownership. Although many of the old homesteads remain, as do the land grants provisioned through the Great Mahele, Hanalei landownership today is dominated by old scions of the Missionaries and by Asian settlers, private corporations, and the Federal and State government. Others were bought by either private corporations and individuals, while the Federal and State governments attained the remainder. Many of the kuleana land grants provisioned from the Great Mahele remain in existence. They are located sporadically in Hanalei Town, at best.

Based on the 1972 land census data, out of the total acreage of 85,992.6 in Hanalei, 1.89% has been appropriated for urban development, 0.26% for rural land use, 22.79% allocated for agriculture, while the remaining 75.07% (about 64,553 acres) is tied up in conservation land (Kaua'i County Inventory Report, 1974:13). Approximately 67,298 acres were classified as Open land, designating them for passive, active, or residential use (Kaua'i County Inventory Report, pg. 16). By extension, these areas can be re-zoned or appropriated for uses that could have implications to the ecology of Hanalei or may even heighten existing tensions between interest groups.

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[17] A more complete list is inserted as A.11 in the appendix.

Land holdings are now classified as either Fee Simple or Lease Hold (Kaua'i County Inventory Report, pg. 25). Both classifications are further categorized into private or government ownership. The largest landowners in Hanalei today are the Princeville Corporation, which owns land *mauka* of the Valley and adjacent to government land, Kamehameha Schools, and State and Federal Governments. The National Wildlife Refuge (NWR) is issued as Federal Government Land. They are followed by the Ching Family, William Mowry, the Gaylord Wilcox Trust, the Kobayashi Family, Patricia Sheehan, Wai'oli Corporation, and Kaua'i County. The rest are individual land holdings. The colour-coded map illustrates the different land-ownership in Hanalei, illustrating the spatial distribution of land ownership and their size (see Appendix B.24). Some of the land grants awarded from the Great Mahele are still in existence, but they are only small parcels of land and would not significantly affect the community (see Appendix B.27 & 28). The salient concerns are the large landowners because they may eventually sell land to real estate agents or developers, who could in turn convert such land into residential or commercial districts.

Chapter 6

Transformation of the Ecology

The Hanalei *ahupua'a* lies in the major vegetation area, identified by Earle (1978) as Zone D. Within this zone there are two climatic conditions, divided cross-sectionally, based on elevation and rainfall: the 'middle phase' (D2) is the upper area and receives more than 3800mm of rainfall annually, while the 'lower phase' (D1) receives less than 3800mm of rainfall per year (Earle 1978:29).

Most of the native species are located in D2. Native trees, such as *ohia-lehua*, predominate here, as do wild, feral plants that grow spontaneously, such as banana, taro, and yam. Other common native plants are ferns and the medicinal tonic, *'awa* (Earel, pg. 30). The D1 phase, on the other hand, is more commonly associated with introduced species (Earle, pg. 29). Here, the fruits upon which Native Hawaiians depended were grown as agriculture crops. However, native plants were not uncommon. Native Hawaiians generously depended upon these for daily consumption: bananas, breadfruit, and some mountain apple (Earle, pg. 30).

The Polynesians introduced non-native fauna and flora species, which ultimately competed with the native vegetation, killing off many. The Westerners had a greater, more profound impact on the fecund vegetation. Tracts of Pandanus trees were cleared for pastureland, while native grasses in the lowlands were converted into plantations. Similarly, Asian immigrants introduced rice and a different variety of taro.

Today, Hanalei is confronted with introduced species that threaten agricultural viability and continuation of some Native Hawaiian species. They sometimes contaminate the soil and become problematic for local farmers. The climatic conditions in Hanalei have also culminated in severe weather patterns that alter the ecology. The last section in this chapter details the numerous floods Hanalei has encountered over the years, explaining the damage each has done to the Valley.

6.1 Apple Snail, Pomacea canaliculata

The Apple snail, *Pomacea canaliculata*, is believed to have been introduced to Hawaii sometime before 1989 as a food resource and is now the most widely distributed and rapidly spreading of the four species of alien Apple snails in the State. Within three years, it has been deliberately spread to most of the other main Hawaiian Islands, where it either escaped or was deliberately released into taro patches (Lach et al., 2000). It has become a serious pest for taro (*colocasia esculenta*), the traditional staple of Hawaiians and other Pacific islanders. Although the damage to taro production has not been officially quantified, there are cases that indicate that the snail infestation is a serious matter. In one case, a Kaua'i farmer previously harvested eighty (80-pound) bags of taro, where after the snail took over, he can only manage to harvest three bags from a particular *lo`i* (Greer, 2002). Snail densities in taro fields have been reported as high as 130 snails per square meter (m^2) (Lach & Cowie, 1999).

Apple snails live in freshwater habitats. There have been preliminary observations in Hawai'i that suggest that *P. canaliculata* is sufficiently tolerant of sea water to survive long enough to be carried by currents from one stream mouth to another. However, they generally do not live in salty or brackish-water environs. This Apple snail inhabits slow-moving or stagnant water in lowland areas such as swamps, marshes, ditches, lakes and rivers. *P. canaliculata* is known to be able to survive for up to 3 months without water (Cowie, 2002).

Apple snails feed on large plant matter (*macrophytophagous*), which includes taro plants. The snails consume all parts of the taro plant. Damage to the *huli* (stem) and the *lau* (leaves) reduce the plant's ability to be replanted. Feeding on the *kalo* (corm) not only reduces the overall weight of the product, but more work is put into cutting out the feeding scars in the preparation process.

In addition to the economic benefits of the snails as escargot, these snails have been introduced in other places as biological control for aquatic weeds, usually resulting in the destruction of non-weed species as well, due to their generalist feeding behavior. Inadvertent spread of the snail has been assisted by, among other things, floods and typhoons, infested plantings, release from aquariums, escape from aquaculture ventures and their use as fishing bait (Cowie, 2002).

P. canaliculata have separate sexes (*dioecious*), perform internal fertilization and lay eggs outside the female's body (*oviparous*). They lay their salmon-colored eggs above water on exposed substrates, such as vegetation or rocks. It is believed that this is done to avoid predators or low oxygen levels in their often near-stagnant habitats. In Hawaii, juvenile snails usually hatch out of their shell between 7 to 21 days after they are laid. On average a female can lay about 4,400 eggs per year. Here in Hawaii, it takes approximately 10 months for the snails to sexually mature. In other parts of the world, depending on location, it can be as little as 2 months (Southeast Asia) or up to 2 years (Argentina) to reach sexual maturity (Lach, et al., 2000).

There are no known major natural enemies of the Apple snail in Hawai'i. In Hanalei, ducks, egrets, and other birds, frogs and toads, prawns and crayfish, and fish and insects, such as dragonflies prey upon the snails. However, little has been studied on the Hawaiian predators and the impacts of their predation on the snail population. Predator numbers in Hanalei, especially the Koloa, but are not high enough to adequately control the Apple snail.

The Apple snail population has potentially severe implications to the island's natural environment and human health. The snails are now rapidly extending into non-agricultural areas. It can spread diseases to native snails and other gastropods as well as directly compete for food and habitat. The snails are also vectors for various disease-causing organisms. The rat lungworm that causes potentially fatal eosinophilic meningoencephalitis (central nervous system disease) and schistosomes that cause dermatitis and intestinal flukes that cause inflammation, ulceration, diarrhea and anemia. One everyday problem that farmers face is potentially cutting their feet on the sharp edges of the snail as they walk inside the *lo'i* (Cowie, 2002).

6.2 Epidemic Management Strategies

It is extremely difficult to eradicate established Apple snail populations without having deleterious effects to the environment and human health as well as the farmer's pocketbook. The use of chemicals over large areas is expensive and often inappropriate for public health and environmental concerns. Biological control may reduce pest populations to acceptable levels; however it poses other risks that are not intended. The Apple snail itself is an example of an introduced biological control gone awry. Traditional management practices may be able to limit the damage, but it cannot completely annihilate the snail populations.

But while it is not completely effective and requires large amount of time and manual labor, experts agree that cultural management practices provide the safest way to control the pest population. Examples are provided below (Cowie, 2002):

- Handpicking.
- Use of ditches in combination with periodic slow lowering of the water level to "trap" snails in the ditches and handpicking.
- Using wire-mesh grills to trap bigger snails and hand picking.
- Maintaining clean areas to reduce egg-laying sites and for easy location of adults.
- Careful inspection of plantings for signs of snails as well as diseased parts.
- Attract snails for pick up using attractive bait; however this might facilitate pest numbers by providing additional food.
- Raising water temperature to above 45º C for extended periods by covering wet-fallow patches with black plastic sheeting on sunny days, however this is expensive on a large scale and the snails can escape by burying into the soil.

The further spread of *P. canaliculata* to other parts of the State must be prevented. It is clear that Apple snails are causing major damage to taro cultivation in Hawai'i. The current interest in Apple snail aquaculture as a viable industry must be scrutinized in light of the existing damage to taro farming. The expansion or promotion of this aquaculture venture might exacerbate the pest problem even further. From historical, cultural and current economical points of view, it is clear that taro farming far outweighs Apple snail aquaculture in importance to Hawai'i's way of life; therefore more emphasis must be put into assisting and perpetuating the cultivation of taro in Hawai'i.

In order to understand the extent of the Apple snail predicament in Hawai'i, more effort must be made to examine the economic impacts from this infestation. One major step is to reconcile farmer confidentiality, yet find out the economic loss from diminished production yield. This requires both farmer willingness and agency effort. Additionally, more research has to be done that primarily focuses on Apple snails and their role in Hawaii's taro cultivation. State and Federal agencies, i.e. UH Manoa, USDA and other related agencies must put more emphasis on this issue. The consumption of poi is a huge part of the Hawaiian way of life. Certainly, politicians eat poi, too.

6.3 Asiatic Clam, Corbicula Fluminea

The Asiatic clam (*Corbicula fluminea*) is a small freshwater bivalve mollusk. It has two thick, hinged shells, characterized by a series of distinctive concentric ridges. Adults rarely grow larger than 40 mm (1.5"), and are commonly about the size of a nickel. The genus *Corbicula* lives in temperate to tropical southern Asia west to the eastern Mediterranean; Africa, except in the Sahara desert; southeast Asian islands south into central and eastern Australia.

It fouls the solid surfaces it settles on, competes with native species, and can alter benthic substrates. It feeds on plankton, requires high levels of dissolved oxygen, and is intolerant of pollution. The Asian clam is hermaphroditic – meaning both sexes are found in the same animal – and is capable of self-fertilization. Larvae brooded in the parent's gills are released through the excurrent siphon into the water column as active post-larval juveniles, with the ability to resist downstream transport by currents. A single, prolific clam can release hundreds or even thousands of juveniles per day, up to 70,000 per year. Spawning can occur almost continuously at water temperatures exceeding l6º F. Asian clams can reach densities of 10,000 to 20,000 per square meter, potentially releasing several million juveniles daily into the same area of the water column (Balcom, 1994).

The Asiatic clam, widely distributed in streams, reservoirs and taro patches on Kaua'i, Maui and O'ahu, is believed to have been smuggled in by Asian immigrants for food purposes (DAR 2002). Living Asiatic clams were first observed being sold in a local market in Kailua (Oahu) in August 1977, having been illegally imported through a Los Angeles exporter. *C. fluminea* was first discovered on Kaua'i in 1982 where it had spread to reservoirs and irrigation ditches and to five rivers and streams in eight watersheds (Eldredge, 1994).

In areas where there are high concentrations of the clam, they filter out nutrients in the water. The typical life cycle of the Asiatic clam is about two years; however little is know about their lifespan in Hawai'i.

The main problem from this alien species to taro farmers is their burrowing activities, which create holes in the *lo'i* that let water out. Cuts can also result from a farmer stepping on the sharp edges of the shell.

The current condition of the Asiatic clam in Hawai'i is not well known. However, while there is an apparent impact from these clams to taro farming, the Apple snail problem appears much more severe.

6.4 Other Alien Species

According to sources, such as the 2002 Draft Revised Recovery Plan for Hawaiian Waterbirds, other alien species like the cattle egret (*Bulbulcus ibis*), Black-crowned night heron (*Nycticorax nycticorax)*, Barn owl *(Tyto alba pratincola)*, bullfrog (*Rana catesbeiana*), cane toad (*Bufo marinus*) as well as dogs, cats and rats, all found on Kaua'i have had a negative impact on the population of the native waterbirds that reside there as well as the rest of the State. Their primary impact is through the predation of the adults, chicks and even the eggs.

6.5 Native Species of Special Concern

Native species are in danger of extinction if introduced species are not controlled. For Hanalei, the *o'opu* takes primary consideration, as the community seems to have adopted it as their mascot fish. For the Fish and Wildlife service, the moorhen, the coot, and the *koloa maoli* have been listed as endangered birds. These birds are the reason the National Wildlife Refuge was created in 1972.

6.5.1 Hihiwai, Neritina Granosa

The *Hihiwai* is one of the three endemic fresh and brackish water snails found in Hawai'i. *Hihiwai* can grow up to 1-1/2 inches in diameter. Its shell can be rough or smooth. *Hihiwai* live in lower and middle stream reaches and is generally found on bedrock, boulders, and gravel substrates, positioning themselves in currents of high continuous flow. Its diet consists of algae from rock surfaces. *Hihiwai* have been a sought-after food item for native Hawaiians and more recently been used as an indicator of ecological health of Hawaiian stream systems (Kido et al., 1997).

Threats include predation by the Tahitian prawn (*Macrobrachium lar)*, the Black Crown Night Heron *(Nycticorax nycticorax)* and humans as well as sedimentation, water diversions and poor water quality. While there is little knowledge on the actual population status of the *hihiwai*, it is generally accepted that there has been a general decline due to the threats mentioned above.

6.5.2 O'opu, Hawaiian Freshwater Gobies

Five species of native *o'opu* occur in streams in the Hawaiian Islands. These Hawaiian *o'opu* have recently been reclassified: four species are now considered endemic, and one species *o'opu nakea* (*A. guamensis*) is considered indigenous (found in Hawaii and elsewhere in Polynesia). According to Timbol, all five *o'opu* species occur in Hanalei.

O'opu has an amphidromous life cycle. *O'opu* spend their entire adult lives in freshwater streams. They reproduce in the stream, laying their eggs on the upper surfaces of rocks and hatch within 48 hours. Larvae then drift out to the ocean and spend up to 5 months in a planktonic state. The post-larval *o'opu*, called *hinana*, then migrate back to live the rest of their lives in the streams.

Species such as *o'opu nakea, o'opu nopili* (*S. stimpsoni*), and *o'opu hi'ukole or alamo'o* (*L. concolor)* are capable of climbing areas of rapids and even waterfalls. *O'opu hi'ukole* is the strongest climber and is capable of climbing very tall waterfalls. Individuals have been reported to climb waterfalls as high as 1,000 feet (CQFE, 2002).

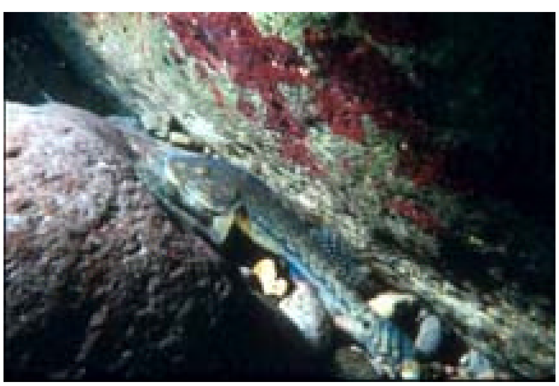
O'opu nakea is known to migrate downstream to spawn on riffles situated just upstream of the ocean. The first large rainstorm in the fall is believed to trigger the downstream spawning runs. However, juveniles have been found throughout the year, which indicates that some degree of reproduction occurs throughout the year (CQFE, 2002).

A major ecological requirement for *o'opu* is the need to pass through a stream mouth twice during their lives, once as an egg and the other as a juvenile traveling back up the stream. Therefore, in order to maintain the existence of *o'opu* in streams, there must be access to and from the ocean. Stream channelization and diversions are great threats to the native fish populations. Other threats include poor water quality and sedimentation. In the case of *O'opu nakea*, over-harvest is a specific threat due to the fact that it is actively fished for (Bishop Museum, 2002).

The American Fisheries Society considers *O'opu hi'ukole* threatened and *O'opu nakea* and *o'opu nopili* to be species of special concern (Bishop Museum, 2002).

The following has been taken from the Division of Aquatic Resources (DLNR) webpage, *http://www.hawaii.gov/dlnr/dar/stream_natives.htm*

O'opu nakea, *Awaous guamensis*



Appearance: Mottled brown and black with a white underside. Vertical dark and light bands are visible on the dorsal and caudal fins, and there is a dark patch on the caudal peduncle.
Size: Length up to about 14 inches.
Habitat: Usually found in the lower to middle stream reaches.
Diet: Omnivorous feeding mostly on filamentous green algae, crustaceans, worms, snails, and aquatic insects.
Distribution: Indigenous; also found in other Pacific Islands.
Interesting Facts: The name nakea means "whitish", probably referring to the o'opu's white underside. Hawaiians favored this goby as a food fish probably because of its large size.

O'opu hi'ukole or O'opu alamo'o, *Lentipes concolor*

Appearance: Juveniles and females are a mottled olive to brown color. The males have black heads and orange tails, as in the photo.
Size: Length up to 5 inches.
Habitat: Usually found in the upper stream reaches.
Diet: Feeds on plant and animal matter.
Distribution: Endemic to Hawai'i.
Interesting Facts: This fish has several Hawaiian names which is dependent upon the island the person comes from. The name alamo'o is used on the Big Island, originating in the Hilo area, and mo'o means "lizard-like" referring to the appearance of the head. The name hi'ukole is used elsewhere and means "red tail" referring to the male fish with the orange tail.

O'opu nopili, *Sicyopterus stimpsoni*

Appearance: Highly variable; juveniles and females are usually mottled brown or gray; males are slate gray-blue with striped or variegated markings, or black with white stripes and have a pronounced dorsal fin (male in photo).
Size: Length up to 7 inches.
Habitat: Usually found in the middle stream reaches, preferring fast-flowing water.
Diet: Feeds on algae growing on rocks.
Distribution: Endemic to Hawai'i.
Interesting Facts: Nopili received its name because of its ability to cling (*pili*) fast to wet stones. The early Hawaiians favored this goby as food and as a symbol of good luck.

O'opu naniha, *Stenogobius hawaiiensis*

Appearance: Easily identified by a black band that extends diagonally through the eye. The body is yellow-brown in color and may be marked with 9 to 11 vertical black bands on its sides.
Size: Length up to about 5 inches.
Habitat: Found in the estuaries and lower stream reaches, preferring soft bottoms.
Diet: Omnivorous feeding on plant and animal matter.
Distribution: Endemic to Hawai'i.
Interesting Facts: The name naniha means "avoidance" in Hawaiian, but the significance of this is not known.

O'opu akupa or o'opu okuhe, *Eleotris sandwicensis*

Appearance: Dark brown or black in coloration with separate pelvic fins.
Size: Length up to about 13 inches.
Habitat: Estuaries and lower stream reaches.
Diet: Feeds on invertebrates and small fishes.
Distribution: Endemic to Hawai'i.
Interesting Facts: Unable to climb above waterfalls and fast flowing stream sections.

6.5.3 Hawaiian Common Moorhen, ?Alae?ula, Gallinula chloropus sandvicensis

The Hawaiians called this species ***?Alae?ula***, or "bird with red-fronted shield". In Hawaiian legends, the ?Alae?ula is said to have carried fire to the Islands.

The *?Alae?ula* is very similar to the mainland moorhen by having a dark grey to black plumage with a white streak on each side and white on the undertail coverts forming an inverted "v". Depending on sex and age, the legs are green with varying amounts of orange and yellow. The bill is red with a yellow-orange tip and a large red frontal shield. The frontal shield however, appears slightly larger and extends higher up the forehead than on its mainland relatives. Juvenile birds have more of a browner plumage with less colorful and smaller frontal shields. Chicks are downy black with red bills and spots on the plumage (Birding Hawai'i, 2002).

The *?Alae?ula* is a subspecies of the Common Moorhen or Gallinule (*Gallinula chloropus*), which has a wide range throughout the world except Australia. The *?Alae?ula* was first noted by naturalists during Captain Cook's voyage in 1779. The Hawaiian moorhen croaks, cackles and clucks similar to other forms around the world with a higher pitch than Coot. With little experience, one can tell the difference between calls made by the two sexes (Birding Hawai'i, 2002).

The *?Alae?ula* is often regarded as the most secretive of the native waterbirds. They can be found in freshwater marshes, taro patches, irrigation ditches, reservoirs, and wet pastures. They seem to prefer dense emergent vegetation near open water, floating on barely emergent mats of vegetation, and water depths of less than 3 feet. The *?Alae?ula* eats mollusks, insects, water plants, and grasses (USFWS, 2002).

Nesting occurs year-round but there seems to be an active season from March through August. Nesting occurrence is related to water levels and vegetation growth. Egg clutch is usually 5 to 6 eggs with an incubation period of about 22 days. *?Alae?ula* are excellent swimmers and their chicks can swim soon after hatching (USFWS, 2002).

The *?Alae?ula* are currently only found on Kaua'i and Oahu but were also formerly found on Maui, Molokai and the Big Island. On both Kaua'i and Oahu, it can be found in streams, ponds, rivers, ditches, lakes and canals. The Oahu population is widely spread but is mostly found between Haleiwa and Waimanalo. On Oahu it is easily seen at James Campbell National Wildlife Refuge on the north shore. On Kaua'i, although the *?Alae?ula* can be seen at many locations, the Hanalei NWR and Huleia NWR are two excellent locations to observe them. *?Alae?ula* are year-round residents (Birding Hawai'i, 2002).

There are only a few historical population estimates for the *?Alae?ula*. It is believed that they were common on all the main Hawaiian Islands in the 1800's but drastically declined by the mid 1900's. In the 1950's and 1960's, surveys estimated no more than 57 individuals. The spread of aquaculture in the 1970's and 1980's helped boost the *?Alae?ula* population by providing more suitable habitat (Birding Hawai'i, 2002).

Kaua'i moorhen population has been historically abundant due most likely to the large tracts of suitable wetland habitats that the island offers. A sharp decline in population starting in the 60's is caused or influenced by the sharp increase in the coot population. In the winter of 1997, the number of moorhens in the Hanalei NWR had dropped to a maximum of about 30 - 50 birds, compared to roughly 350 birds just a few years back. The number of Coots has now dropped to normal following its peak count, however the *?Alae?ula* population has not returned to the high numbers previously recorded. Engilis & Pratt (1993) gave an estimate of 500 individuals for Kaua'i based on a USFWS report and this number certainly appears feasible with the amount of suitable habitat. It is uncertain whether the increased Coot population is preventing the *?Alae?ula* numbers from coming back (Birding Hawai'i, 2002).

The primary threat to the ?*Alae*?*ula* has been loss of wetland habitat. Other factors include introduced predators, alien plants, introduced fish, disease, hybridization, and environmental pollutants (USFWS, 2002).

Only a few specific ?*Alae*?*ula* papers have been published and even less information are known on its feeding habitat requirements. The Hawaiian Moorhen was listed as an endangered species in 1967 under the Federal Endangered Species Act.

6.5.4 Hawaiian Coot, 'Alae ke'oke'o, Fulica alai

Known to the Hawaiians as ***'Alae ke'oke'o***, or "bird with white frontal shield". The top was said to have been singed when the bird tried to carry fire.

The Hawaiian coot has an all black or dark gray plumage with white undertail coverts. The frontal shield is usually white but can vary from bluish white to yellow to dark blood red, with some adults showing a large red knob on top of frontal shield along with a dark band on bill. Both sexes look very much alike. Legs are gray and lobed. Juveniles are browner with greyish bills while chicks are black and downy with reddish-orange feathers on the head (Birding Hawai'i, 2002).

It is very similar to the American Coot (*Fulica Americana Americana*), but is slightly smaller in size and has a larger, more bulbous white frontal shield. The taxonomic status of the Hawaiian Coot has been subject to much debate in the past and was only recognized as a distinct species in 1993. The *'Alae ke'oke'o* call is composed of short, harsh croaks and squeaks, that is lower pitched than that of the Moorhen (?*Alae*?*ula*). (Birding Hawai'i, 2002)

Coots are found in fresh and brackish-water marshes and ponds. They rarely fly; however, they are capable of sustained flight close to the water. The *'Alae ke'oke'o* builds floating nests in aquatic vegetation, and contains egg clutches of 4 to 10 eggs. Chicks are able to run and swim soon after hatching. Hawaiian Coots normally breed from March through September. The *'Alae ke'oke'o* eats seeds and leaves of aquatic plants, insects, tadpoles, and small fish (Birding Hawai'i, 2002).

Except Kaho'olawe and Lanai, there are an estimated 2,000 to 4,000 Hawaiian Coots existing in all the main Hawaiian Islands. Pratt, Bruner and Berrett also state that there are some stragglers that can be found in the Northwestern Hawaiian Islands up to Kure. In the state, Oahu is said to have the largest population while Maui has the second largest population. It is believed that the population varies according to climatic and hydrological conditions.

The *'Alae ke'oke'o* was described as being common and widely distributed before 1900 (Wilson and Evans, 1989). They could be found in taro patches, ponds, marshes, brackish-water lakes, reservoirs and streams. A decline in the population has been observed and by 1947 the species future was described as "problematic" (Birding Hawai'i, 2002). Studies done in the late 1950's though the 1960's suggest a population of only about 1,000. This led to the Hawaiian coot being listed as an endangered species in 1970.

It has been difficult to assess the number of *'Alae ke'oke'o* in the state due to high variability of the populations from year to year. It is believed that movement of birds between islands during unusual rainfall to take advantage of newly available wetland areas is one reason for such fluctuation. (Birding Hawai'i, 2002) For example, Ni`ihau experiences high number of coots usually during the winter because the lakes there are usually flooded. In the late 1990's a huge increase in numbers was noted at the Hanalei NWR, recorded at almost 800 birds. Such high numbers had a negative impact to the taro farming industry in the Hanalei area as the birds caused damage to the crops. The numbers have returned to a more normal level, although it is uncertain what happened to the additional birds.

While there have been studies on the American Coot, there is very little information on their Hawaiian cousins. Known investigations include a 1985 study by Byrd, Coleman, Shallenberger and Arume on the 'Alae ke'oke'o breeding biology and an unpublished 1997 report by Seymour and Keenan that provides a basic account of feeding activity in managed and unmanaged wetlands at Hanalei NWR (Birding Hawai'i, 2002).

The primary threat to the *'Alae ke'oke'o* is similar to the Hawaiian moorhen, which is the loss of wetland habitat as well as other factors including introduced predators, alien plants, introduced fish, diseases, hybridization, and environmental pollutants (USFWS, 2002).

6.5.5 Hawaiian Duck, Koloa maoli, Anas wyvilliana

The Hawaiian name for the *Anas wyvilliana* is ***Koloa maoli,*** which means "native duck". The Hawaiian Duck was first described to science by Sclater during the voyage of the H.M.S. Challenger in 1875 (Birding Hawai'i, 2002).

Koloa are mottled brown and resemble female Mallards. Males have darker heads and tails than females in general and sometimes exhibit a green sheen on the head. Both sexes have a blue-green speculum bordered by white on both sides. Both sexes have orange legs and feet. Bills are brown, greenish, or dull orange. Juveniles are similar to adults but are less marked, while chicks are yellow and black/brown. The size of adult males is usually between 19-20 inches, while female are typically 16 -17 inches. The

Koloa have a much softer Mallard-like "quack", however they are not as vocal as the Mallard (Birding Hawai'i, 2002).

Koloa eat mollusks, insects as well as freshwater vegetation. They sexually mature when they are about one year old and are known to nest year-round, however the main breeding season is between January and May. Two to ten eggs are laid in a well concealed nest lined with down and feathers. The incubation period is around 30 days (Birding Hawai'i, 2002).

The *Koloa maoli* was once thought as a race or sub-species of the Mallard, however scientific studies have shown that they are genetically distinct from each other (Birding Hawai'i, 2002).

The *Koloa* was historically present on all the main Hawaiian Islands except for Lanai and Kaho`olawe. Around the turn of the century, the population began to decline due to factors such as habitat loss, hunting, predation by dogs (*Canis familiaris*), cats (*Felis catus*), rats (*Rattus* sp.), mongoose (*Herpestes auropunctatus*) and cross-breeding with the Mallard Ducks (*Anas platyrhynchos*). Surveys conducted by Schwartz around 1949 estimated the population to be approximately 30 birds on O'ahu and about 500 individuals on Kaua'i. Permanent populations of *Koloa* in Hawai'i, Moloka'i and Maui were believed to be nonexistent. Around 1960, it was assumed that they were no longer a population on O'ahu, therefore leaving Kaua'i as the only island with a population of the duck (Birding Hawai'i, 2002).

In 1962, a Koloa restoration program was initiated and by 1979, about 350 Koloa had been released on Oahu and Hawaii as part of this program. Current estimated populations say there are about 2,000 Koloa on Kaua'i-Ni`ihau, 300 on Oahu, 25 on Maui, and 200 on the Big Island (USFWS, 2002). However, accurate estimations are difficult to achieve due to the Koloa's tendency to utilize remote streams and bogs that are usually not surveyed.

Kaua'i has always had the most number of Koloa due to the high rainfall and large habitat area. Places where Koloa can be found include the Hanalei NWR, Huleia NWR, Wailua Reservoir, the Koloa Reservoirs (near Koloa Town) and the wetlands of the Mana Plain. Birds are also frequently observed deep in the mountainous river valleys of the island, and have been recorded way up in the Alakai Swamp (Birding Hawai'i, 2002).

The ancient Hawaiians engaged in hunting trips into the island's interior in search of Koloa, showing that these areas have always been important habitat areas (Birding Hawai'i, 2002). Observations have been conducted that support the fact that the Koloa spend their days in the upland areas and fly down to lower elevations during the night. However, to fully understand the ecology of the Hawaiian Duck, more focused research still needs to be conducted.

The primary cause for the historical decline in numbers is loss of wetland habitat and hunting. Because their nests are established on the ground, they are highly vulnerable to predation from introduced animals (e.g., rats, dogs, cats). The chicks are sometimes eaten by bullfrogs and egrets. Another factor includes hybridization (mating with other duck species), invasion of wetlands by alien plants, disease, and sometimes environmental pollution.

The Hawaiian Duck was listed as an endangered species in 1967 under the Federal Endangered Species Act.

6.5.6 Hawaiian Stilt, Ae`o, Himantopus mexicanus knudseni

The Hawaiian Stilt, also known as ***Ae'o*** in Hawaiian, embodies its description of "walking on stilts" with its long pink legs and comparative long dark bill. Its Latin name, *Himantopus mexicanus knudseni*, comes from V. Knudsen, who supplied the first specimens studied in 1888 by L. Stejneger.

Ae'o has a black-brown color with a white spot above their eye and white breast. Males are slightly larger than females, and have a glossier black appearance. Females have a browner back, as do the juveniles, and chicks are pale gray with black markings (*http://www.birdinghawaii.co.uk*). The stilts have a loud, sharp "keek" or "kip, kip, kip" that may be repeated many times, especially when they feel threatened or agitated.

The *Ae'o* is unmistakably a waterbird, able to walk around in shallow bodies of water, sinking its bill into the mud, looking for invertebrates and other aquatic organisms for food. The stilt also likes larger organisms such as worms, crabs, and fish (*http://fws.gov*).

The Hawaiian Stilt is found in a variety of water habitats, including ponds, taro *lo'i*, ditches, along the edges of reservoirs, and wetlands on all of the main islands. Banko (1988) states that Stilts for the majority of their time inhabit agricultural areas such as settling basins, taro fields and wet pastures, but tend not to use reservoirs. Birds may travel between Ni'ihau and Kaua'i depending on the weather. The stilts like Ni'ihau when the wet summers fill the shallow playa lakes with rain water (www.birdinghawaii.co.uk). The birds tend to remain on Kaua'i during El Niño years when the weather is dry.

Nesting and feeding sites are separate from each other. Nest sites are frequently on low islands within bodies of fresh, brackish, or salt water (*www.fws.gov*). Feeding habitats are in other areas of shallow water. Ae'o like to loaf around in open mudflats, pickleweed mats, and open pasturelands where visibility is good and predator populations are low (www.birdinghawaii.co.uk).

As with the other Hawaiian waterbirds, historic numbers of Stilts are unknown. Engilis & Pratt (1993) estimated the statewide stilt population to consist of between 1200 and 1600 individuals, with Kaua'i, Oahu and Maui supporting 92% of the population. Current population levels appear to be highly dependent on rainfall patterns much as they are for Hawaiian Coot (www.birdinghawaii.co.uk).

Banko (1988) reported that use of Kaua'i wetlands had increased dramatically since 1956, when regular record keeping began. He also reported that summer counts were higher than winter counts (almost double) and explained this as post - breeding dispersal from Ni'ihau of adults with young.

Once again information on specific habitat and feeding requirements is very scarce for the Hawaiian Stilt. There is some understanding of the species particular requirements. However the information needed to create or manage habitat that will support individuals once they are attracted to a site and begin to breed and nest is not available.

Threats to the Stilt and other waterbirds include the loss of wetland habitats and introduced predators. The Hawaiian Stilt was once a popular game bird, but waterbird hunting was banned in 1939 (www.fws.gov). The Hawaiian Stilt gained further protection when the U.S. Fish and Wildlife Service listed it as an endangered species in 1970.

6.5.7 Hawaiian Goose, Nene, Branta sandvicensis

The ***Nene***, or Hawaiian Goose, is the Hawai'i State bird. The *Nene* is endemic to the main Hawaiian Islands, but today found only on Kaua'i, Maui and Hawai'i. Adults are medium-sized with a black face, crown and band around the neck. Coloring is yellow-cream to brown, with distinct markings on the sides of the neck, and dark bill and legs. The partially webbed black feet enable them to walk more easily on rugged lava flows. Its honking is similar to a Canadian goose, but the Nene also utters a quiet "nah" or "nay" (www.birdinghwaii.co.uk).

Based on the genetic analysis, the *Nene* has been linked to the Canadian goose and also that the common ancestor of all Hawaiian geese settled the islands within about the past 500,000 years. This happens to be about the time volcanoes first created the big island of Hawai'i, which suggests that the birds arrived when that island was still young.

Fossil records show that the Hawaiian Goose used to live on all the main Hawaiian Islands. It is believed that they were abundant (about 25,000 birds) on the Big Island before the arrival of Captain James Cook in 1778. Today, the Big Island is the only place where they are found naturally in the wild. The initial decline in population is attributed to hunting and collecting of their eggs. In 1951, the *Nene* population was estimated at only 30 birds. Their continued decline has been caused by the introduction of alien plants and animals. Captive breeding programs and predator control has helped the species come back from the brink of extinction.

Approximately 550 - 600 *Nene* exist in the wild today, of which are about 200 on Kaua'i. The Kaua'i population appears to be the strongest and most rapidly expanding population on the Islands.

On Kaua'i *Nene* can be seen almost anywhere. They are present all year, but during the winter months when birds have goslings they are much harder to find.

It was once thought that *Nene* naturally lived and preferred high altitude areas, e.g. the rugged lava fields of the Big Island, however, this idea has been discounted due to recent observations. *Nene* frequent scrubland, grassland, golf courses, and sparsely vegetated slopes. On Kaua'i, they can be found in open lowland country. The historical move away from the wetland and lowlands was probably due to disturbance by humans.

The *Nene's* vegetarian diet consists of seeds of grasses and herbs as well as leaves, buds, flowers and fruits of various plants. The *Nene* does not appear to need fresh water but will use it when available.

The breeding season is from November to June. Their nests are lined with down and are well hidden under bushes. Although there are other species of geese that are winter migrants to the islands, the *Nene* is the only goose species that currently breeds here. The Nene seems to prefer nesting in the same nest area, often a "*kipuka*" (an island of vegetation surrounded by lava). 2 to 5 white eggs are usually laid with an incubation period of about 30 days. It takes about 11 to 14 weeks after hatching before the Nene goslings are able to fly. During the fledging period, the adults become flightless. This is a particularly dangerous time for the birds, as they make easy prey for introduced predators.

The Hawaiian Goose was listed as an endangered species in 1967 under the Federal Endangered Species Act.

6.6 Establishing Collaborative Guidelines for Protecting Native Species

The 2002 Draft Revised Recovery Plan for Hawaiian Waterbirds (DRRPHW) clearly identifies conditions that must be met (as well as the steps to achieve such conditions) in order to downlist and de-list these endangered waterbirds. Such criteria include protection and active management of specific wetland habitats, having multiple, viable populations on specific islands, and achieve stable and increasing numbers of birds above a specific minimum population over a particular period of time.

However, it seems that there is a general lack of knowledge regarding the precise status of these endangered waterbirds. Granted that the actual census of each species is impossible to achieve, even past observational data have not been updated due to lack of funding and personnel. There needs to be more concerted and coordinated effort by all the agencies and organizations to look at the status of Hawai'i's endangered waterbirds.

These systemic problems are ultimately due to funding inadequacies. The DRRPHW states that in order to ensure the recovery of these waterbirds, approximately 44 million dollars is needed. It further attests that the potential date of delisting is 2015 if all necessary actions are implemented. This translates to an annual budget of 3.38 million dollars specifically dedicated to endangered waterbird activities.

While there have been numerous Federal, State, local and private actions to aid in the recovery of the Hawaiian endangered waterbirds, there are still many gaps in our understanding of these species. The DRRPHW accurately identifies the need for collaboration of these groups in order to achieve the stated goal. The sharing of resources, i.e. funding, personnel, information, is one way of achieving "more bang for your buck". A true collaboration process will ultimately lead to a more focused and effective plan that all collaborators will implement in their respective roles and capabilities.

In terms of management, the DRRPHW states, "[T]he key to the success of this general recovery strategy will be the formation of productive partnerships among Federal, State, and local agencies, private organizations, and individuals. Partnerships have been instrumental in achieving past conservation efforts and are essential to protect and manage existing wetlands. Such partnerships also result in greater community support to ensure long term wetland and waterbird protection".

There needs to be more emphasis on collaborations with community members including community groups and organizations as well as individual members like taro farmers and others who encounter these birds on an everyday basis. The utilization of community members in the conservation effort makes sense, for it not only increases education and awareness levels of the people involved, but others in the general population, probably more effectively than conventional educational methods.

So far, little has been done on documenting and assimilating traditional knowledge into current research into the endangered waterbirds or anything else for that matter. Individuals, who have a strong connection to the land because of their life or occupation, hold a wealth of knowledge that can assist in unraveling the mysteries for which "trained" researchers are looking for answers. Let us not fail to appreciate traditional culture, rather let us take advantage of it by involving farmers, fishermen, hunters and community members who have a special bond to the subject of interest.

6.7 Hanalei's Flora

According to Char, a total of 161 vascular plants species were recorded in her survey. Of those, 88 (55%) were introduced or exotic species; 60 (37%) were native; and 13 (8%) were Polynesian introductions. Among the 60 native plant species, 27 were indigenous, or occurred naturally in Hawai'i and elsewhere, and 33 were endemic (occurred naturally in Hawaii only). Char noted that approximately 75% of the Pteridophytes (ferns and fern allies) were native, while the majority of the flowering plants (Monocots and Dicots) were introduced.

6.7.1 Taro (Kalo), Colocasia esculenta

Taro grows in tropical Africa, the West Indies, the Pacific Nations and in countries bordering the Indian Ocean in south Asia. In Hawai'i, where cultivation has been the most intense, there were more than 300 varieties of taro. Approximately 87 of these varieties are still recognized today, with slight differences in height, stalk colour, leaf or flower colour, size, and root type. Some of the local varieties are *Mo'i Lehua*, *Ha'akea* and Chinese (*Bun Long*).

Taro is a plant that requires an ample water supply. Today in Hawai'i, the major production is concentrated in lowland river valleys where a year-round flow of water is assured. Under this wetland system, water is carefully fed or channeled into fields called patches, which are surrounded by raised banks to retain water. Hawai'i's system of raising taro by channeling water into the taro patches called *lo'i* contrasts with the system found in most other Pacific areas where the crop relies mainly on natural precipitation or the drainage of water into swampy areas, rather than on directed irrigation from rivers or streams.

The four major river valleys in which wetland taro is grown in Hawai'i today are Waipi'o (Island of Hawai'i), Hanalei (Kaua'i), Keanae (Maui), and Wailua (Maui. Taro is also found in two or three smaller valleys on Kaua'i and Maui. Steep mountains rise above the taro valleys of Waipi'o, Hanalei, and Keanae-Wailua. These form major watershed or catchment areas where the sizeable streams provide the year-round water needed for wetland taro cultivation.

6.7.2 Hau, Hibiscus tiliaceus

Early Polynesian voyages brought *Hau* to traditional Hawai'i due to its importance in everyday life. *Hau* yields a lightweight tough lumber that had multiple uses for the Hawaiians. The naturally curved branches of this plant's softwood are used to make canoe outriggers. Cork-like *hau* wood pieces were used as floats on fishnets. The soft wood was also used in starting fires. The bark was used to make cordage or ropes (White, 1994). The *hau* tree also has properties that are used in traditional medicine (Tan, 2001).

Hau is found and used throughout tropical and subtropical Polynesia, Melanesia and Micronesia and is valued for its usefulness to the traditional life of island people. The plant was so highly prized in traditional Hawai'i that permission to cut it was required of the village chief. Today, it is called an invasive plant, and with its rapid and dense growth, if left unattended can take over areas. *Hau* grows well near the ocean, streams, and in moist sloping areas up to the 2000 foot elevation. As this shrub spreads, it forms an impenetrable jungle of interwoven, curved and twisted springy arching branches (White, 1994).

The main concern of the *Hau* tree in the Hanalei area is the dense groves along the Hanalei River which present a flooding hazard. It would be interesting to see if there is a correlation of Hau cover along the banks of the Hanalei River and the extent or severity of flooding. However, it is recommended that regular clearance of *Hau* be conducted, especially in critical sections of the river. Periodic control of the plant will most probably aid in lessening the severity of flooding events as well as preventing the *Hau* "bush" from getting too dense and harder to cut down.

6.8 Hanalei's Marine Environment

Marine investigations in Hanalei Bay have been conducted by several researchers in the past (DeFelice, Friedlander, Smith and Frederick, 1997). The studies did not specifically look at the impacts to the marine ecosystem from water quality. However, they contain important background information that can be utilized if the need for future investigations regarding the health of the marine ecosystem becomes necessary.

6.9 Effects of Flooding on Ecology

Flooding could be claimed as the longest and biggest standing issue in Hanalei. Its history is interspersed with flooding traumas that exacted damage to the infrastructure of the town, agriculture, and imposed inconveniences to the town people. To illustrate how prone Hanalei is to flooding, in 1995, Hanalei experienced <u>two</u> *one hundred year floods* within weeks of each other. The whole town was shut down and damage was seen in several places. The reason for Hanalei's vulnerability is because geographically it is on a floodplain where flooding is common. But, the recent major flooding prompted the community to seek for an explanation of sudden floodings. Some believe the construction of berms on either side of the Hanalei River was a key explanatory for the flooding. However, a staff of the USFWS claimed that berms, alone, could not cause the flood; rather it is the combination of berm construction and the shallowing of the river bottom over time. A hydraulic engineer of U.S. Army Corps of Engineers (ACOE) agreed that the change in water depth of Hanalei River could be one of a number of factors causing flooding in Hanalei.

In 1975, the Federal Emergengy Management Agency (FEMA) contracted the American Corps of Engineers (ACOE) to determine the flood elevations, boundaries and floodways for various streams throughout the State of Hawai'i. The Flood Insurance Study (FIS) was completed in 1977, and in 1979, FEMA published flood maps under the National Flood Insurance Program (begun in 1968) for the island of Kaua'i that included the Hanalei River. The flood insurance rate maps were designed for communities participating in the flood insurance program and a flood insurance policy was stipulated in exchange with a flood ordinance from the counties.

As shown in Appendix B.24, since the publicaton of the flood insurance rate maps, encroachments have occurred in Hanalei. Some community members attribute them to newly constructed berms, built in the 1980's, by the USFWS on the Hanalei Refuge. The date of construction on Bill Mowry's land, however, is unknown since there is no record of a permit with the Kaua'i County or the Army Corps of Engineers (ACOE). According to Air Survey Hawai'i's records dated June 1981, aerial photographs show no berm construction. But in January 1983, the Mowry's berm could be seen in the aerial photograph. Some information on the USFWS berms could be retrieved. Any constructions prior to November 1981under Kaua'i County was grandfathered in.

In the 1980s, the USFWS changed its original plan from expanding taro acreage to building more impoundments to augment the habitats for the waterbirds (*It's About the River*, August 2000, Vol 1, Issue 3, p.1). Berms were built twelve feet in height, exceeding the ACOE permit of 4-feet high, to create a boundary for the impoundments. Regardless, the permitting process went through [unnoticed] as the County declined to get involved, claiming that the County had no authority over the Federal agencies. This was able to occur because the ACOE permit did not require a public notice *(It's About the River*, August 2000, Vol 1, Issue 3, p.1). County ordinance in Kaua'i, additionally, did not have grading requirements for agriculture land, where usually any elevation above 3 feet must get the permission from the county. With the berm height much higher than the permit would allow, the ACOE staff that completed the limited study on impacts of the berms believed violations may have occurred in the building of these berms. ACOE may have the power to rescind its earlier permit, but it did not have any authority over another Federal agency.

In 1999, the Federal Emergengy Management Agency (FEMA) commissioned the Army Corps of Engineers to do a limited study on the impact of the berm on Mowry's land on "100 year floods". Mike Sheehand, whose property was close to Mowry's, thought the berm was an impediment and urged a study on its impact. During the study, ACOE found that there was another encroachment from the USFWS's property.

The study found that the impact of the berms on the floodplain is significant; the berms raised the flood level behind the berms during high flood conditions (Hanalei River HUI Minutes, April 8, 2002). By referring to the Flood Plain Re-analysis of the Hanalei River, encroachments were evident. The maximum increase in water surface elevation caused by the cumulative effect of the encroachments from both sides of the Hanalei River was estimated at 2.1 feet above the 100-year base flood without encroachments. It was 13.67 feet above sea level, but with encroachments, it was 15.79 feet. Separately, the increase in water surface elevation of Mowry's berm is to the maximum of 0.74 feet and the increase in water surface elevation of the USFWS's berms is up to a maximum of 2.12 feet at specific points (*Flood Plain Re-analysis of Hanalei River*, October 1999).

However, the study did not investigate the effects of the berms on the low flood conditions that Hanalei had grown accustomed to over time. The community raised several issues about the berms' impacts on the Hanalei Bridge, including increased frequency of flooding in the taro fields, road floodings, and a series of floods in the town. The study was a one-dimensional model due to limited time allocated for the study and funding constraints. A two-dimensional model was recommended in the study.

The 2-D model uses grids and cells and illustrates eight different directions that the flow can take. Though it requires more extensive topography and hydraulic study than the one-dimensional model, it would provide more accurate data about the effects of flooding. It would also explain the effect of the *Hau* bush. The vegetation of *Hau* bush on one side of the riverbanks shifted the current and volume of river water and caused erosion on the other side of the riverbanks, especially at the Dolphin Restaurant. Moreover, since the data available date back to 1975, the new study will be able to tell the changes in water depth of the Hanalei River as well.

A HUI member stated that several meetings were arranged among ACOE, FEMA, FWS, County Public Works, and the community to seek alternative solutions, which ultimately ranged from changing the flood map, to mitigation of the effect on the floodplain, to removing the berms. While removing the berms would be difficult because of a lack of funding for removal or reconfiguration of the berms, and because both FEMA and the ACOE do not have authority over another Federal agency (i.e. FWS), changing the flood maps by FEMA was more likely to happen. On November 8, 2001, FEMA presented the revised flood maps for Hanalei Valley, reflecting changes in floodwater paths and velocities, to a Hanalei community forum. In 2002, FEMA produced the revised flood insurance rate map, indicating the changes in Hanalei's flood plains.

6.9.1 Recommendations for Improving Inter-Agency Public Relations a propos Flooding Issues

The outcome from the Hanalei Heritage River Community Forum, which representatives of FEMA, the ACOE, County Public Works, the USFWS, and other stakeholders attended, was an agreement to enforce a public notice requirement and, if necessary, a public hearing process for future projects. Collaboration among inter-agencies and comments on future projects from related agencies is highly recommended in order to minimize unsatisfactory outcomes. The ACOE also suggested the HHR HUI review future projects (*It's About the River*, August 2000, Vol 1, Issue 3, p.6). Moreover, Federal agencies should comply with the Executive Order 11988 of Floodplain Management 1977.[18] Executive order 11988 directs all Federal agencies to avoid, if possible, development and other activities in the 100-year base floodplain. Where the base floodplain cannot be avoided, special considerations and studies for new facilities and structures are needed. Design and sighting are to be based on scientific, engineering, and cultural resources, and the planned lifespan on the project. Federal agencies are required to adhere to three requirements:

- Reduce the risk of flood loss

[18] See Appendix A.8.

- Minimize the impact of floods on human safety, health, and welfare
- Restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibility (*http://www.usbr.gov/laws/eo11988.html*).

Finally, adequate provisioning of funding and/or grants for necessary studies (i.e. the Flood Plain Re-analysis of Hanalei River) should be orientated into the comprehensive flooding policy in order to gain a thorough understanding of and to find optimal solutions when problems arise.

DURP Planning Practicum 2002

750 A.D-1840
Taro and Breadfruit

1837
Waioli Mission House was constructed.

1840-1880
Plantation (silk, coffee, tobacco, sugar, and rice) and cattle ranching.

1875
The Hawaiian Duck was first described to science by Sclater during the voyage of the H.M.S. Challenger.

1880-1960
Rice (earlier) and taro (later).

1906
The Chinese cemetery was constructed in Hanalei.

1924
Haraguchi family moved in.

1930s
The gradual resurgence of taro as a commercial crop occurred as the economic viability of rice diminished.

400 — 1800 — 1840 — 1870 — 1900 — 1930

400 A.D
Taro came to Hawaii with the earliest Polynesian settlers in their canoes.

1779
The 'Alae'ula (Hawaiian Moorhen) was first noted by naturalists during Captain Cook's voyage.

1848
Land in Hawaii was redistributed in an action called the Great Mahele. This resulted in many taro patches being abandoned and still others being used for non-traditional crops that generated cash income.

1860s
Rice cultivation took off in Hanalei.

1890s
Hanalei became the largest rice area in the island.

1912
Hanalei Bridge was constructed.

1911
Hanalei Pier was built.

1911
Old Ching Young Shopping Mall was built.

1930
Haraguchi Rice Mill was constructed.

DURP Planning Practicum 2002

1960-Present
Taro

1967
The Hanalei Bridge was reinforced.

1970
Hawaiian coot was listed as an endangered species.

1970
The Hawaiian Stilt gained further protection when the U.S. Fish and Wildlife Service listed it as an endangered species.

1977
Hawaiian Waterbirds Recovery Plan was completed.

1979
FEMA published flood maps under the National Flood Insurance Program.

1985
Master plan for the Hawaiian Wetlands National Wildlife Refuge Complex.

mid 1980s
FWS's berms were built.

1985
The North Shore Development Plan was adopted.

1986
Island Power Company Inc. submits the Draft Environmental Impact Staement for proposed Hanalei River Hydroelectric Project.

Early 1990s
Nutrient management program has been introduced to taro farmers in Hanalei by Agricultural extension agency.

1990s
Apple Snail became a major pest in Hawaii.

1991
The new domestic wastewater treatment was published, cesspool was limited.

1992
Hurricane Iniki: caused great flooding.

1992
Due to Iniki Hurricane, tourism dropped down significantly.

1996
Neil Berg's water quality study found that level of N and K, and soil sediment increased.

1997
Vacation Rental started booming in Hanalei.

1998
Real estate boomed in Kauai.

1998
Commercial Boat Trip was banned in Hanalei River.

1998
Department of Agriculture pushed the Hanalei NWR's 10-year lease for taro farmers back.

2000
Fresh water monitoring in Hawaii has been conducted formally.

2000
Kauai General Plan was adopted.

2001
Carl Orazio studied the water quality of organic and inorganic contaminant in Hanalei.

2002
FEMA changed the floodmap for Hanalei.

2002
Dr. Leigh Federickson from the University of Missouri has been appointed by FWS to conduct a three-year study to improve habitat for the endangered birds in the Hanalei refuge.

1960 — 1970 — 1980 — 1990 — 2000 — 2005

1961
The last time rice grown in Hanalei Valley.

1967
The Hawaiian Duck, the Hawaiian Moorhen, the Hawaiian Goose were listed as an endangered species under the Federal Endangered Species Act.

1972
Hanalei NWR was formally established.

1972
Kauai's first North Shore Development Plan was drafted.

1979
A study was done by a graduate student in Zoology at the University of Hawaii at Manoa, Robert Broshears.

1981
Ching Young Village Shopping Center was built.

1982
Rice Mill was restored.

1982
The North Shore Development Plan was updated.

June 81- Jan 83
Mowry's berm was built.

1988
Hanalei Cultural Resources Management Plan was drafted.

1994
Significant yield loss had been documented due to the drought of Niihau.

1994
Tourism business started to recovered slowly.

1995
Tom Alexander was appointed as a new manager and stayed for 7 years.

1999
The Waterbird Use of Taro and Pond Habitats on the Hanalei NWR:1999 Report was conducted by Adam Asquith, and Christian Melgar, personnel of the refuge at that time. Asquith and Melgar indicated that waterbird counts on the refuge are conducted at least monthly in 70s until after the impoundments' construction.

1999
FEMA commissioned ACOE to do the study on the impact of berms on floodplain in Kauai.

2005
The cesspool will be prohibited on the whole island.

2008
Comprehensive Management Plan will have been completed.

Chapter 7

Historic and Cultural Heritage in Hanalei: Community Continuity

Being a small rural area in Kaua'i, Hanalei displays a unique historic and cultural heritage, a testimony to its pre-history and more contemporary past. The heritage includes tangible and intangible resources, such as archeological sites, rural landscape, architecture, and cultural practices (see Appendix B.9 and B.10). Some of the resources are recognized as regionally and nationally significant and listed on the State and National Register of Historic Places (Table 3), and others are considered important by locals.

Table 3. Sites in Hanalei on the State and Federal Register of Historic Places

Site Name	Hawaii State Register (Year)	National Register (Year)
A. S. Wilcox Beach House	1987	1993
Douglas Baldwin Beach House	1987	1988
Hanalei Bridge		1978 E
Hanalei Elementary School	1988	1990
Hanalei National Wildlife Refuge Historic and Archaeological District		1980 E
Hanalei Pier	1979	1979
Haraguchi Rice Mill	1983	1983
Lihue Hongwanji Mission	1977	1978
Mahamoku	1987	
Pu'u Poa Marsh		1982 E
Say Dock House	1988	
Wai'oli Mission District		1973

Note: An 'E' stands for 'eligible' for the National Register but a property has not been listed on the Register

Source: State Historic Preservation Division, Department of Land and Natural Resources, State of Hawaii http://www.state.hi.us/dlnr/hpd/register/regmaui.pdf

The historic and cultural resources result from long-term human interactions with nature, commercial development in Hanalei's changing economic base, and cultural and social activities. These resources represent the cultural continuity of Hanalei - an indicator of where they came from, where they are, and where they are going - which partly shapes how Hanalei physically looks today. In addition, they are a remarkable source of pride and identity among the residents and are a point of attractiveness for the visitors.

Although local strenuous efforts for historic preservation took place after the mid-1960s, dangers to the historic and cultural resources have loomed large in the efforts. Some of Hanalei residents carried out preservation activities, such as rehabilitation and restoration of historic properties, and others took part in local planning and zoning issues to reflect their concerns for the resources. By contrast, having introduced planning and zoning tools to save the resources, Kaua'i County Government has formerly emphasized economic growth over historic preservation. Such pro-growth stance resulted in the development of the Princeville resort accelerating resort development in Hanalei. Today, despite efforts for preserving the resources, pressures from resort development that have already encroached upon Hanalei put some of the resources in danger. To cope with this problem, it is imperative that the local people continue their actions for preservation and that the government launches a collaborative preservation policy with concerned citizens.

7.1 Archaeological Sites

As the first Hawaiian settlement in Hanalei took place before A.D. 600 or within the 200-300 year period of initial colonization, the pre-history and history of Hanalei covers perhaps between 2,300 and 2,600 years of human activities. Although some scholars have carried out archaeological studies in Hanalei and have identified many archaeological resources, its scale and scope have not been to the full extent. What is worse, by 1850 Western plantation agriculture replaced traditional irrigation systems that the Hawaiians developed, destroying invaluable archaeological evidence. Rice cultivation later on also spoiled Hanalei's archaeological sites. Nonetheless, archaeologists and anthropologists have located and recorded *heiau*, agricultural and habitation sites, and two major ditches in Hanalei (see Appendix B.9).

Kauai's North Shore has numerous *heiaus* (traditional Hawaiian places of worship, ceremonies, or other religious practices). Some are in the Hanalei *ahupua'a*. Wendell Bennett (1931) archaeologically surveyed the island of Kaua'i and identified four *heiau* in Hanalei Valley. In 1997, Anan Raymond and Virginia Parks (1999) discovered another *heiau* in the valley with staff of Hanalei National Wildlife Refuge and local volunteers. They named it the Hanalei *heiau*. Locations of each *heiau* vary within the valley: The Pooku *heiau* lies at the east bluff of the valley, a short distance from the opening of an alluvial fan; the Hanalei *heiau* is at southwest of Pooku *heiau* directly across Hanalei River; Kalama-iki and Kapaka *heiau* are at four miles up the valley; and Kapaka *heiau* sits further inland. Each *heiau* also varies in shape and size as their functions and significances differ. It is noteworthy that the Pooku *heiau*, whose shape and size are the most complex and largest *luakini* type, is thought to have served ceremonial and religious functions not only in Hanalei, but also in the entire Halele'a District.

Agricultural and habitation sites are located within Hanalei Valley. The valley is surrounded by ridges 3,439 feet high, and the Hanalei River runs about 9 miles through there (Handy, 1972). Many of the agricultural sites are associated with taro farming or rice cultivation, and so are the habitation sites. In the Valley, Cleghorn (1979) observed that extensive taro *lo'i* (irrigated terraces), *'auwai* (irrigation ditches), and farmland for dry land cultivations had existed. Moreover, he discovered seven agricultural complexes on the steep valley slopes above the major *'auwai*. Some taro *lo'i* and *'auwai* in the valley are still actively functioning today, while others have become inactive or are defunct. To date, *Hanalei's irrigation system, an intricate pattern of 'auwai with major and minor supply lines and drainage ditches, is the determining element in the spatial organization of [the] Valley* (The Hanalei Project and Land and Community Associates, 1988: 61). Along the river, particularly at narrow areas of the Valley, several habitations sites have been found with stone platforms, walls, and enclosures. Adjacent areas disinterred fragmented artifacts from the historic period, such as pottery and fire bricks, were identified (Cleghorn, 1979).

Among all active traditional *'auwai*, there are two major ditches in Hanalei Valley. The first is the China Ditch that starts upstream around the Hanalei Homesteads and runs 2.3 miles along the western bluff of the Valley. The name derived from the fact that Chinese farmers constantly used, improved, and maintained the ditch in the mid-19th century. With gravity flow, it feeds water through a sub-system of *'auwai* into the Hanalei National Wildlife Refuge (HNWR) for the U.S. Fish and Wildlife Service (FWS) as well as taro patches for some taro farmers on the HNWR. The second is the Kuna Ditch that also starts upstream, but runs along the eastern edge of the valley floor. Functions of the ditch resemble those of the China Ditch. Based on an archeological study, it is most likely that the Hawaiians constructed the original Kuna Ditch. Its physical integrity is not preserved since Chinese and Japanese rice farmers made some modifications before and the USFWS have recently done alteration to the two ditches (The Hanalei Project and Land and Community Associates, 1988; 1000 Friends of Kaua'i, 1990).

7.2 Rural Landscape

The contemporary landscape of Hanalei is not a product of professional practitioners, namely landscape architects or designers. It has never even been designed by laymen. It has not resulted from the application of academic or professional design standards, theories, or philosophies of landscape architecture (Murtagh, 1997; US Department of the Interior, 1990). It differs from the natural landscape that remains relatively intact from human intervention because it displays landscape characteristics that are defined as "the tangible evidence of the activities and habits of the people who occupied, developed, used, and shaped the land to serve human needs; they may reflect the beliefs, attitudes, traditions, and values of these people" (US Department of the Interior, 1990: 3). Remarkable examples of the landscape characteristics abound in Hanalei: "[T]he shape, location, and orientation of taro *lo'i*, the pond fields; the location, size, and orientation of complex field irrigation and drainage systems; the location and orientation of habitation sites and agricultural structures; the location and alignment of roads; the location and design of bridges; and the location of vegetation" (Riznik, 1989: 49). Creating ample open space collectively, these define the landscape of Hanalei as "rural" that both local residents and visitors appreciate and value (Picture 4).

Picture 4. Hanalei Valley

7.3 Architecture

Even though William Murtagh (1997), a famous professor of historic preservation, states that there is no significant architecture in Hanalei, there is a notable architectural tradition. As Hanalei is a rural residential community, the architectural tradition is primarily observable in old houses. However, Hanalei town, a local commercial and social center, and its hinterland have also maintained an historic agricultural, commercial, and social structures and infrastructure, some of which have been entered in the State and National Register of Historic Places in the 1970s and 1980s. The architectural tradition of those properties is certainly simple, yet remains a unique remnant of Hanalei's past history.

Agricultural lifestyle and Western architecture influenced residential architectural styles in Hanalei (Picture 5). A vernacular rice farmer's house is a wooden, unpainted structure with a ridged roof, dating back from the late nineteenth century. The Say Dock House, one of the remaining vernacular rice farmer's houses with concrete threshing floors, was constructed in the 1890's and became listed on the State Register of Historic Places after its restoration in 1988. Wai'oli Mission House is a typical American architectural work. Built in 1837, the house is a two-story, timber-structure detached dwelling with a cross-gabled roof, a side entrance, and a front *lanai* on both sides. It originally had four rooms and a separate kitchen, but missionaries later expanded the house by adding several rooms and a rear *lanai* and connected it to the kitchen between 1840 and 1860. Meanwhile, some residential buildings adopted the cottage and bungalow style, while others introduced the beach house style. Among the latter, beach houses in Hanalei, such as A. S. Wilcox Beach House and Mohamoku, characterized by a huge lawn and open *lanai*. Some of the remaining beach houses, built by the prominent families between 1910 and 1935, still stand along Weke Road (Riznik, 1987; The Hanalei Project and Land and Community Associates, 1988; 1000 Friends of Kaua'i, 1997).

Picture 5. A Vernacular House

Apart from farmer's residences, agricultural structures, such as stables and rice mills, adopted the vernacular architectural style. In particular, the rice mills situated on the large rice plantation were usually a two-story, rectangular building with a wooden structure. In Hanalei, there were four rice mills by the 1930s. The only remaining rice mill with wooden, tin-roofed structure is the Haraguchi Rice Mill that was built in 1930 by Kahei Haraguchi on the site after the Man Sing Mill was purchased in 1924 and burned down in 1930 (Pictures 6 and 7). His family operated the mill until 1960, but the family carefully preserved and restored its structure and milling machinery in 1982 and 1992. Listed on National and State Register of Historic Places in 1983, the mill functions as a museum of rice cultivation and processing for schoolchildren (Conrow, 2000; The Hanalei Project and Land and Community Associates, 1988; 1000 Friends of Hanalei, 1997).

Picture 6 and 7. Haraguchi Rice Mill

Source: Planning Department, County of Kaua'i

Commercial buildings generally adopted a vernacular architecture, bungalow style, or standard storefront style of the mainland (Pictures 8 and 9). Located along Kuhio Highway, most of the buildings are one and two-story structures. Some of the commercial buildings were demolished over the years while others were renovated for residential use (The Hanalei Project and Land and Community Associates, 1988). Not commercially functioning any more, a two-story standard storefront style commercial building still stands in Hanalei is Ching Young Store. In 1911, the store was purchased by Ching Young, a Chinese immigrant who lived in Kapa'a. Three years later he moved to Hanalei and started a business. In the old days, the store mainly served rice to farmers. Later, it sold supplies to people who lived and worked in Hanalei for nearly 70 years. The store operated its business until 1981 when the Ching Young family built the Ching Young Village Shopping Center two blocks down the highway. The store was closed for several months in that year, but it reopened as the exhibition center for Hawaiian history and culture. Today, it is one of the visitor attractions in Hanalei (Duffy, 1983; Tin-Yuke, 1979).

Picture 8 and 9. Commercial Buildings

The architectural styles of Hanalei's infrastructure are a reflection of the engineering technology available at a specific time period and the dependence on trade to sustain an agricultural economy. The Hanalei Pier was built, replacing an older wooden pier, with a long concrete structure in 1911 for commercial use. A wooden deck was placed on top of it (Picture 10). Reinforced concrete, a new construction material, came to substitute the wooden deck in 1921. Concrete pilings supported the concrete structure. The end of the pier was not covered with a roof until the 1940s.

The pier functioned primarily as a freight center, loading mainly rice grown in Hanalei and unloading canned goods, groceries, and farm supplies. It is a recreation place for residents and visitors today (Ronck, 1985; 1000 Friends of Kaua'i, 1997). In 1912, the Hanalei Bridge was constructed with the Pratt through-truss span by the Honolulu Iron Works Company for the County of Kaua'i's County Belt Road Plan (Picture 11). Specialized bridge builders, Hamilton and Chambers, pre-constructed many pieces of the steel bridge structure in New York and transported them to Hawaii, and the pieces were put together on site. When the bridge's physical integrity was deteriorated more than 20 years ago, it was reinforced with a Warren truss. Since its construction, the bridge has facilitated island-wide traffic on the North Shore and transporting agricultural commodities, particularly taro (Riznik, 1989). At present, the bridge has a symbolic and protective function: "Not only does it make an ideal, quaint entry to one of the island's most tranquil communities, but it protects the otherwise inaccessible destination from rampant development" (Kido, 1999:12).

Picture 10 and 11. Hanalei Pier and Bridge

Historic social places in Hanalei display either an eclectic or an ethnic style of architecture. Unlike the more western-style Wai'oli Hui`ia Church built in 1912, the Wai'oli Meeting Hall, a former religious and educational center, is an example of a truly eclectic architectural style (Picture 12). Hawaiians and an American carpenter built the hall and a wooden bell tower in 1841 under the direction of Reverend William Alexander after fire and wind destroyed two previous meetinghouses. Construction of the hall used both American and Hawaiian building methods and materials. Its structure is a Western-style timber-frame, but the hall adopted the Hawaiian building style, typified by a surrounding, four-sided *lanai*. The shape of its roof was steeply hipped with thatched materials, but the roof materials were replaced by shingles when restored in 1921. The building material, *ohia* timber, was supplied locally. Other Hawaiian building material used for the raised platform of the earthen floor is *`Ili`ili* or fine pebble stones (Riznik, 1987). The Chinese Cemetery is an example of an ethnic style of architecture (Picture 13 and 14). The Yee Hop Tong, the Hanalei Chinese fraternal society formed by the early Chinese immigrants, constructed the cemetery in 1906. The Chinese called it Ah Goong San (Grandfather's mountain). A semi-circular cement altar that marks the cemetery was also constructed in the cemetery area. The altar was designed to have space in the center for offering foods to ancestors and the deceased. Graves surround it on both sides (1000 Friends of Kaua'i, 1997).

Picture 12. Wai'oli Meeting Hall

Picture 13 and 14. Chinese Cemetery

Source: Planning Department, County of Kauai

7.4 Local Efforts for Historic Preservation

There are two agents for historic and cultural preservation: the Kaua'i County Government and the community. The community draws attention to a structure it wishes to preserve. The Kaua'i County government, in turn, can support community efforts by administering development ordinances that would buffer destruction of buildings valued to be of historic and/or cultural significance. Preservation has not always preempted development plans, however.

7.4.1 Kaua'i County Government

The Kaua'i County Government has tried to preserve historic and cultural resources of Kaua'i's North Shore since as early as the 1970's. In 1972, the government produced the first North Shore Development Plan. The plan did not consider values invoked to justify preserving the scenic highway and bridges, but recognized the importance of protecting rural characteristics of the North Shore, including Hanalei. One of the prominent features of the plan was to encourage development of Princeville resort as a villa and resort community for high income people. The government expected that the development would alleviate growth pressures in Hanalei, but instead it accelerated growth there (Riznik, 1989). The government subsequently introduced several administrative tools for land use protection, such as North Shore Development Plan Update, Comprehensive Zoning Ordinance, and Special Management Area Rules and Regulations. But, planning and zoning priority has deferred to concerns for development over historic preservation.

Fortunately, the Kaua'i General Plan lays out much needed efforts for historic preservation among other goals and objectives. Adopted in 2000 by the government, the plan includes historic preservation as one of its major themes. It provides Heritage Resources maps that display inventoried historic properties and archeological sites in Kaua'i. Concerning historic preservation, these maps are to guide the preparation of Development Plans and additional preparation of new or revised existing land use ordinances and regulations. The plan states that "Historic and cultural resources help to give Kaua'i its unique identity - to establish a 'sense of place'" and that "Historic preservation has become increasingly important to the visitor industry and therefore to the Kaua'i county" (Kaua'i General Plan, 2000:3-5). Having recognized the importance of historic preservation, the plan employs administrative, financial, and public education policies for the resources. While the plan addresses the future direction for Kaua'i over a 20-year period, its efforts for historic preservation are to be judged in 2020.

7.4.2 Local Community

The Hanalei community has actively strived for historic preservation with determination since the mid-1960s. In the past, when a community survey was conducted, it revealed that people in Hanalei favored and supported the perpetuation of agriculture in Hanalei Valley. The protection of Hanalei's scenic beauty was most prominent among other community concerns. Today, in keeping the same attitude, the community is concerned about preventing the loss of Hanalei's rural character and cultural traditions from resort development. Thus, the people have historically participated in local planning and zoning issues, such as monitoring new private residential, recreational, and commercial development projects, requested permission for rezoning, and proposed the demolition of the Hanalei Bridge by the State Department of Transportation. They succeeded in making their voices reflect their desire to adjust local planning and zoning plans to complement historic preservation, but their efforts were not able to alleviate, if not eliminate, the development pressures (Riznik, 1989; The Hanalei Project and Land and Community Associates, 1988).

In spite of uncontrolled development in Hanalei, practical individual or collective initiatives for historic preservation have taken place. Some people rehabilitated their properties or historic landmarks by using Federal preservation tax incentive programs, while others restored buildings and structures, i.e. Haraguchi Rice Mill, Say Dock House, and Waioli Meeting Hall and Mission House. The Hanalei Elementary School was turned into the Hanalei Shopping Center through adapted use. Resident and civic group actions triggered the repair and reconstruction of Hanalei Bridge and Pier (1000 Friends of Kaua'i, 1997). Aside from those personal or group preservation activities, the Hanalei Project Advisory Committee and a consultant company wrote Hanalei Cultural Resources Management Plan in 1988 for preservation planning. The plan was designed to compliment the North Shore Development Plan Update that the committee did not feel sufficient for protecting Hanalei's natural, agricultural, scenic, archeological, historical, architectural, and cultural resources. It included inventoried Hanalei's resources, an analysis of major conditions and issues, a set of consensus goals and objectives, and recommendations of tools and techniques for land use protection (The Hanalei Project and Land and Community Associates, 1988). Even though the plan itself has never had power to police zoning and development activities, it is significant in documenting values and concerns of the community that the public and private sectors tend to ignore or forget. All of these initiatives are a symbol of the community's struggle with change and development.

7.5 Challenges for and Threats to Historic and Cultural Resources

Development is the chief obstacle to historic and cultural structures. It not only demolishes buildings the community cherishes, but also succeeds in displacing families and lower-income property owners.

7.5.1 Pressures from Resort Development

Agricultural land use dominates the landscape of Hanalei, but it is not as significant in the local economy as the tourist industry. Ever since tourism came to Hanalei, it has exclusively become the local economic base for employment and income. In addition, it has certainly increased employment opportunities and people's income compared to the previous agricultural economy. Regardless of opposition from concerned residents and citizens, resort development has been promoted by representing Hanalei's natural beauty in an appealing way and advertising the numerous recreational activities offered around the North Shore. Because tourism attracts people and offers lucrative chances, resort development has intensified over time.

One of the pressures from the resort development is what Melnick (1987:47) calls "a model of the classic tourism paradox: frequented by tourist because of its beauty, its natural, historic, and scenic resources are threatened by the very presence of large number of visitors". In Hanalei, among many issues and problems, local residents have been concerned about or troubled with tourists walking into taro patches, waterskiing in the vicinity of the HNWR, increased tourist vehicle traffic and traffic safety, numerous commercial tour boats, and the normal associated impacts on water quality, of the tourist helicopter flights, additional wastewater generated by tourists, and tourist-oriented commercial growth (The Hanalei Project and Land and Community Associates, 1988).

Another pressure is challenges to land use regulations and zoning that have been implemented to protect historic and cultural resources. They have proposed resort development projects in Hanalei, including condos, golf courses, or luxury hotels. Although land use regulations and zoning are intended to protect and enhance public safety, health, and welfare, not all proposals considered to have a negative impact on the public interest have materialized. Nonetheless, with or without permission, they have established vacation rentals for tourists and modern, gigantic second homes for high income people in the town, who only come once in a while. Vacation rentals and second homes have not only deformed the vista along the beach but also spoiled the rural ambience of Hanalei.

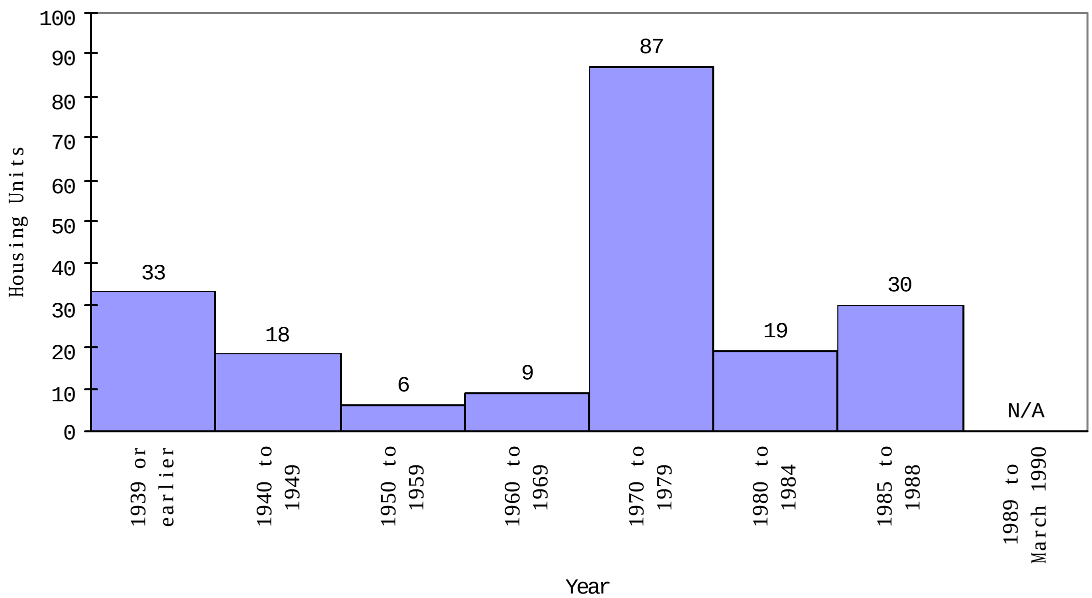
Picture 15. Construction of a New House

7.5.2 Displacement

Resort development has brought about a vicious cycle of displacement. The cycle starts when property value is determined by the real estate market. The property value or market price applies to all lands, and sale of any valuable lands usually increases the property value of adjacent lands. Similarly, as a developer builds a house on the land, the development raises the market value of the land and its adjacent area. Because the government assesses the property tax based on the market value, a rising market value is directly translated into higher property taxes on both local and non-local property owners. This also affects renters in the form of higher rents for the owners. Typically, the local property owners cannot pay the taxes so that they must sell their lands to a realtor and leave for more affordable places, and the cycle goes back to the beginning. In Hanalei, while few local residents chose to move out by intentionally selling their properties for economic profits, many of them have suffered from the vicious cycle of displacement as a property owner or renter.

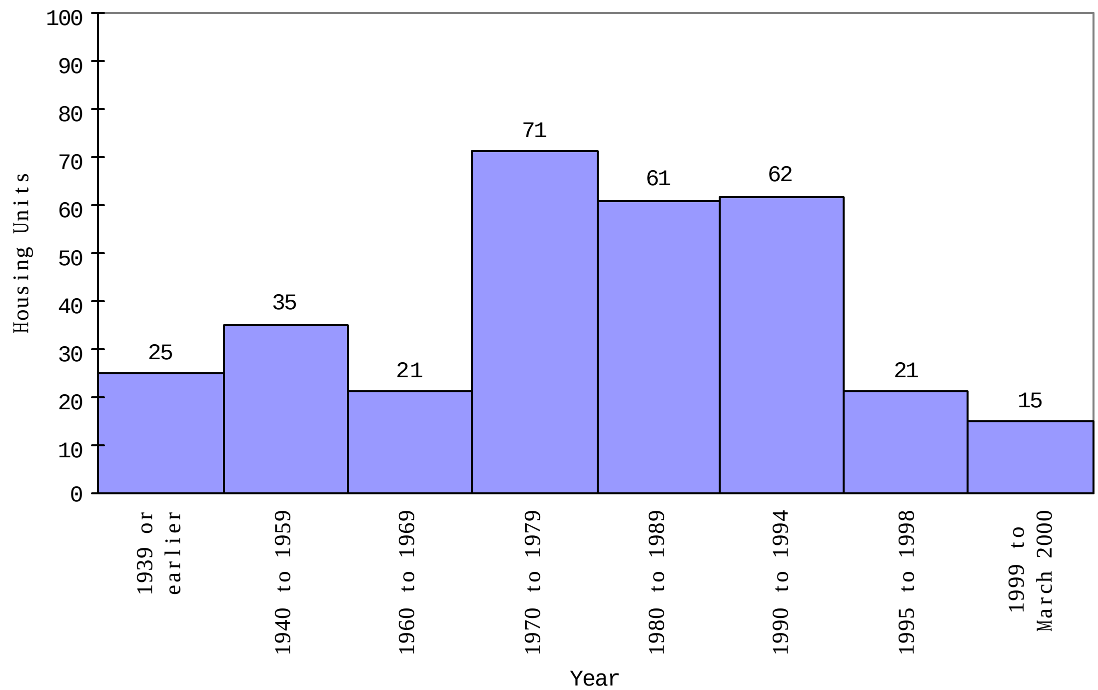
Consequently, what Hanalei has not been able to preserve is its rural small community. As mentioned before, developers have demolished houses and constructed new ones in their place, partly on demand by new residents. A comparison of Census 1990 and 2000 confirms this trend (Graphs 1 and 2). According to Census 1990 and 2000, the total number of housing units by March 1990 was 202; by March 2000 the number had increased to 311. A number of housing units built in 1939 or earlier, and from 1970 to 1979 decreased from 33 to 25 and from 87 to 71, respectively. Though the loss of older houses was not as many as that of newer ones, historic values of the former are much more significant and more irreplaceable compared to the latter. Data from the Census 2000 shows that the construction of new housing units is concentrated during the period 1970 and 1994. In twentyfour years, 194 new housing units were built to replace the older ones. Fortunately, new construction was managed and abated after 1995 as new housing units built decreased from 21 (between 1995 and 1998) to 15 (between 1999 to March 2000).

Graph 1. Number of Housing Units Built by March 1990



Source: Department of Business, Economic Development & Tourism, State of Hawaii http://www.state.hi.us/dbedt/census2k/profile-kauai/

Graph 2. Number of Housing Units Built by March 2000



Source: Department of Business, Economic Development & Tourism, State of Hawaii
http://www.state.hi.us/dbedt/census2k/profile-kauai/

Although strenuous local efforts for historic preservation took place after the mid-1960s, dangers to the historic and cultural resources have overshadowed the acceptance of large-scale development. Some Hanalei residents carried out preservation activities, such as rehabilitation and restoration of historic properties, while others took part in local planning and zoning issues to reflect their concerns for the resources. By contrast, having introduced planning and zoning tools to save the resources, the Kaua'i County Government has formerly emphasized economic growth over historic preservation. Such a pro-growth stance has resulted in the development of the Princeville Resort, thereby accelerating resort development in Hanalei. Today, despite efforts for preserving the resources, pressures from resort development, which have already encroached upon Hanalei, have endangered some of the resources. To cope with this problem, it is imperative that local people continue their actions for preservation. In support, the government should utilize its regulatory power to launch a collaborative preservation approach with concerned citizens.

7.5.3 An Urban Design Analysis of Hanalei Town

An analysis of the urban design of a settlement was carried out through an on-site survey and an examination of its physical features to identify spatial patterns of Hanalei town and its hinterland. This is a method conceived by Kimura (1976). He explains that there are four elements of a physical settlement which more or less influence their shape and structure. The four elements are: 1) settlement function; 2) natural determinants; 3) activity patterns, and 4) ambient quality.

Each settlement element possesses different architectural properties. Settlement function refers to primary and secondary function that a settlement performs, and they are usually associated with economic and social activities. Natural determinants are landforms, water bodies, and vegetation that help us describe the shape of the settlement. Activity patterns involve hinterland, land use arrangements, building development patterns, focal organization, and movement systems. These features help us identify a surrounding region, general land use patterns, architectural styles, central location, and traffic networks of the settlement. Ambient quality is a combination of the above-mentioned three elements, and it stimulates a sense and image of place. By combining these four elements into a research framework, it is intended to analyze, understand, and describe the general spatial patterns of the Hanalei area (the town and its hinterland).

Just like any human settlement, Hanalei serves two dominant functions for its residents and visitors: (1) economic and (2) social. They can be ranked as primary and secondary. The primary function of the town is exclusively a tourist attraction. Its secondary function, by contrast, is a local commercial and community center for the residents and service-sector employees. As observed, the dominance of tertiary-sector activities is corroborated by the Census 2000 data.

Occupation	Number	Percentage
Primary-sector[19]	42	18.3
Secondary-sector[20]	19	8.3
Tertiary-sector[21]	168	73.4

Industry	Number	Percentage
Primary-sector	53	23.1
Secondary-sector	11	4.8
Tertiary-sector	165	72.1

Source: U.S. Bureau of the Census, 2000.

Activity patterns in Hanalei town generally reflect the configuration of its built environment. An identifiable hinterland that consists of taro fields, cattle ranches, and the USFWS National Wildlife Refuge encompasses the town. Weke Road runs through the town, paralleling the coastal line, while Kuhio Highway cuts through the edge of town. The highway forms the major vehicular circulation artery for the residents and visitors; other roads and streets play a minor role in the system. There is almost no pedestrian circulation, except at the town center.

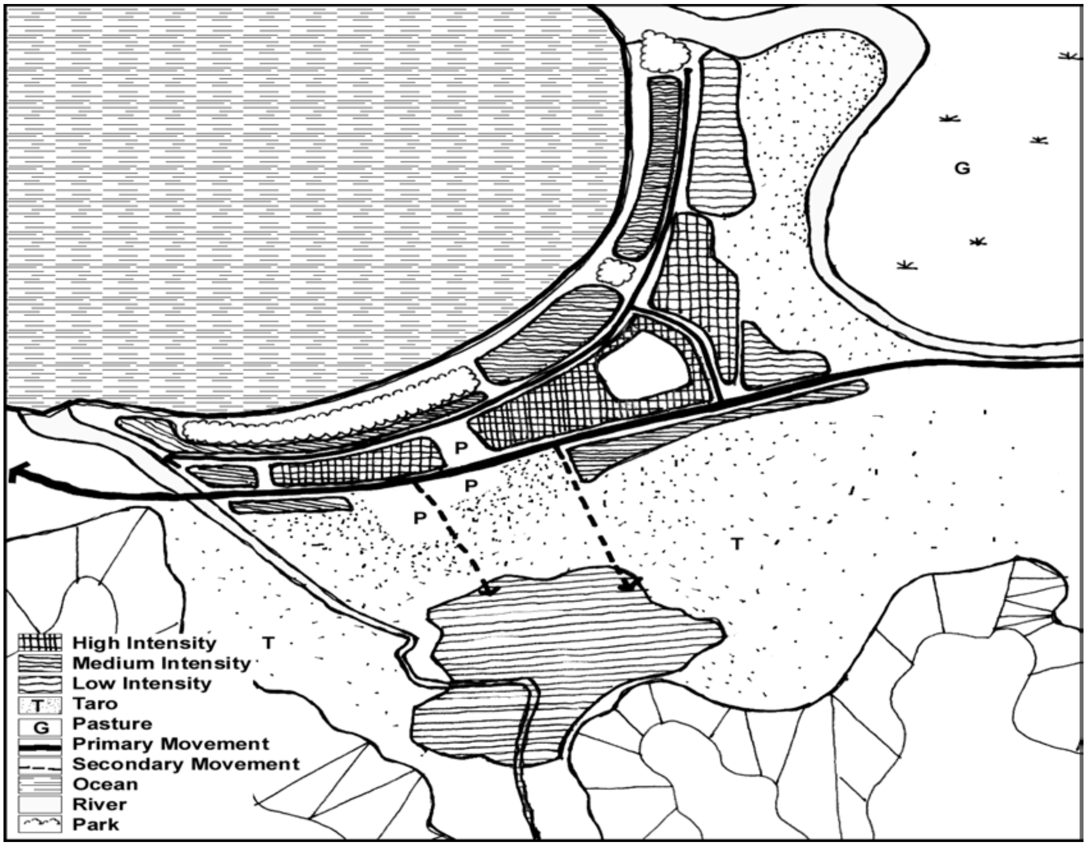
[19] Agriculture, Forestry, and Fisheries
[20] Construction, Manufacturing and Transportation
[21] Wholesale and Retail Trade, Finance, Insurance, and Real Estate, Professional, Scientific, Management, Administrative, and Waste Management Services, Educational, Health and Social Services, Arts, Entertainment, Recreation, Accommodation and Food Services, Other services, and Public Administration

Residential is the prominent land use in the town, but other land use include commercial and public. The residential area is exclusively located near the shoreline. A commercial strip is fully established along both sides of the highway, and the town's major economic center is around Ching Young Shopping Village and the Old Hanalei School Shopping Center. Most of the commercial structures are single-story, except for some structures at the town center. Whereas the architectural style of many commercial structures is vernacular, others have adopted a bungalow style or standard front store architecture. Major community facilities include churches, the Hanalei School, and parks. All the churches in the town are along the highway. Wai'oli Hui'ia Church, built by missionaries and locals around 1912 at a site adjacent to Wai'oli Park, is one of the historical landmarks in the town. Hanalei Beach Park, together with Hanalei Pier, another landmark in the town, and Wai'oli Beach Park stand at the both ends of the coast of Hanalei Bay.

Settlement functions, natural determinants, and the activity patterns of Hanalei characterize a unique ambient quality. Although some people may describe this differently, Hanalei's ambient quality seems to represent a combination of rural, tranquil, tiny resort, and compact. This, in turn, translates into a remarkable mixture of sensory images of the place: 1) pre-modernity and modernity; 2) natural and artificial; 3) nostalgia; and 4) linearity.

Interpretation of these sensory images is subjective, but is nevertheless believed to grasp some formal and structural reality of the area. One can visually experience pre-modern and modern settings from site to site around the town. They are embodied in the architecture, cultural practices, such as taro farming and poi making, and to tourist-oriented commercial activities. The town's hinterland has undergone long-term human intervention, but today it seems difficult to distinguish what is natural and artificial as physical alteration has become intermingled with the natural landscape. The townscape and landscape reminds one of the good-old-day rural lifestyle or at least gives one an idea about what and how it was to live in a small rural area. As you drive or walk along Kuhio Highway, one can view a commercial-strip vista at the both ends of this linear corridor. Map 3 summarizes the activity land use pattern for the Hanalei area.

Map 3. Activity Land Use Pattern



7.6 Demographic Transitions

The trend in landscape transformation reflects the changes in the demographic population in terms of race, employment, and sense of "community". Such changes link Hanalei to the cultural continuity conundrum afflicting many communities pertaining to questions of degree of change, types of changes, and conservation the town must undergo in order to accommodate these changes (Minerbi, 1980). These physical transformations are symptomatic of the transitions in demographic patterns that have taken place over the years.

7.6.1 Population Demographics

The population in Hanalei has increased considerably since the arrival of the early Polynesians. As mentioned in the history section new settlements, brought about by Hanalei's potential for prosperity, facilitated population increase. As economic businesses took off, a new cohort of individuals entered Hanalei. In addition to numerical changes, throughout the years Hanalei's demographics has also exhibited shifts in ethnic make-up, transitioning from purely Hawaiian to the appearance of a Caucasian cohort and a number of Asian migrants. There are no census records accounting for the exact population in the early period of Hanalei's history. The only written records are congregational rosters for the district of Halelea. Based on these rosters, there is evidence of a decline in population for the Halelea District.

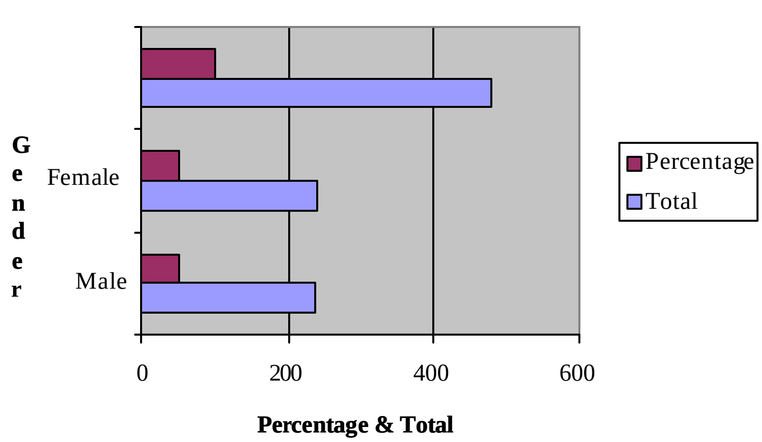
Table 4. Population of Wai'oli Congregation, 1800's

Halelea District	
Year	Population
1835	3,107
1837	3,024
1840	2,889
1846	2,512
1847	2,698
1849	2,335
1853	1,998
1860	1,641

Source: Riznik, Barnes (1989), Wai'oli Mission House Hanalei, Kaua'i; Grove Farm Homestead and Wai'oli Mission House

These data are not sufficient to convey exactly how population changed over the years. Other factors in history, such as the Chinese Exclusion Act, can be used to explain a reduction in the Chinese migrant population around the late to early 1900's. Apart from this, there is very little to rely on. Hence, understanding historical demographic trends is difficult to ascertain. Nevertheless, according to Hanalei Yesterday (1990), the congregational roster does indicate a relative decline in racial composition, specifically for the Native Hawaiian and Asian populations.

Graph 3. Hanalei Population by Gender



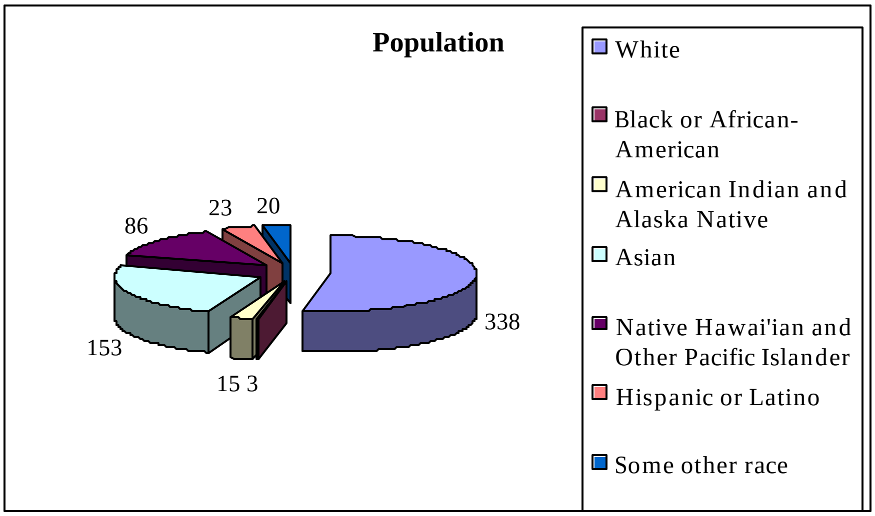
Today, based on the 2000 Census count, total population in Hanalei is 478. This is an increase of 92 from the 1990 census, which recorded 386 residents.[22] Of the 478, women comprised 50.2% percent, slightly out-numbering men, who comprised only 49.8%. The statistics for women parallel the total population increase, as the 2000 Census indicates a growth of 19 for the population of women. In contrast, the male population decreased by 2.

22 The published tabulations did not specify whether this population consisted of part-time and/or full-time residents.

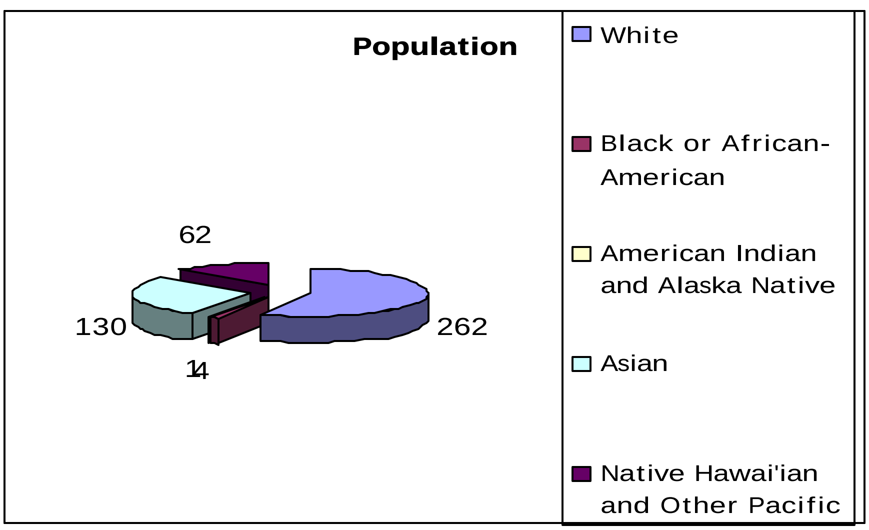
7.6.1.1 Ethnic Make-up

The 2000 Census indicates that Hanalei is comprised of a range of ethnicities. The largest cohort is White (70.7%), while the Asian population closely follows (32%). The remaining ethnicities are Black or African-American (0.6%), American and Alaska Native (1.6%), Native Hawaiian and Pacific Islanders (18%), Hispanic/Latino (4.8%), or "some other race" (4.2%).

Graph 4. Census 2000 (in number)



Graph 5. Census 1990 (in number)

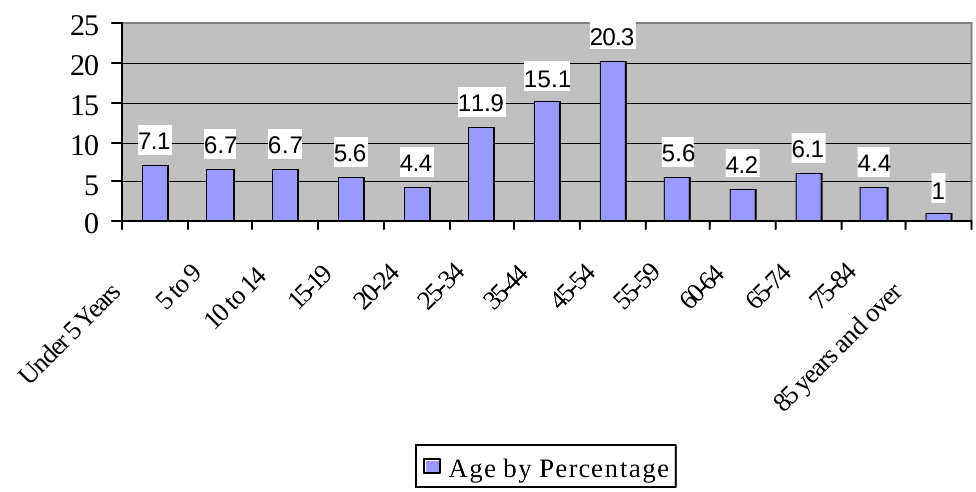


Since 1990, there has been an increase of White (+76), Asian (+23), and American Indian and Alaska Native (+15) ethnicities, but the Native Hawaiian and Pacific Islanders and African-American/Black has declined by 24 and 1, respectively.

7.6.1.2 Age Demographics

The Census 2000 age distribution of the residents ranges between less than 5 to over 85 years of age. This indicates a strong diversity in age groups. Most of the residents are categorized as being between the ages of 45 and 54, indicating that Hanalei has attracted a near retirement, post-professional group over the years.[23] This can be an indication of the income levels of individuals entering Hanalei, which further implies a rising cost of living if the assumption, regarding income level, of this cohort fits the post-professional stereotype. The median age is 40.2.

Graph 6. Age Distribution



Of the total population, 15% are 65 years and over. The retirement age is still relatively small, but may change as individuals make the decision to retire in Hanalei. The strong presence of a post-professional cohort is an indication of future retirement trends. If the present cohort remains in Hanalei, this means 20.3% of this cohort will contribute to the 65 and over age group.

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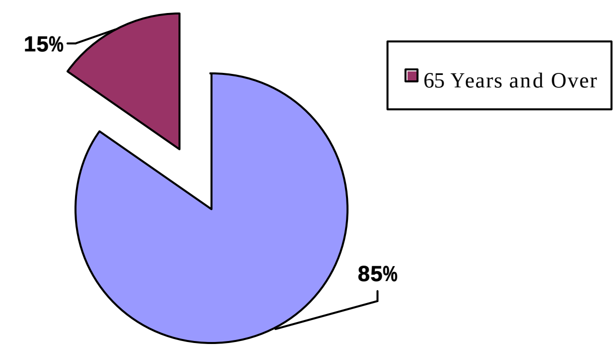
[23] There are no statistical data for Hanale'i, specifically, for age groups in the 1990 Census.

Graph 7. Percentage of Persons 65 Years and Over to Total Population

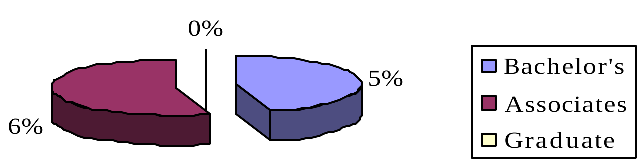


7.6.1.3 Education Demographics

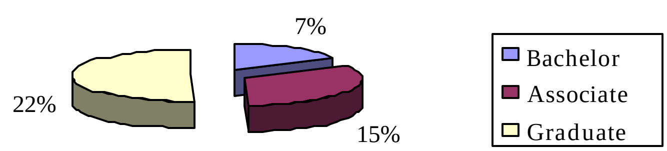
Another important indicator that reflects Hanalei's transition to a professional population is educational attainment. Again, by comparing the 2000 Census data with that from 1990, one can decipher the population trend towards a core professional cohort, who have established themselves in Hanalei. In comparing both sets of data, it is clear that the number of individuals possessing Graduate degrees increased to 22% in 2000 from 0% in 1990. This strongly implies that Hanalei's population is increasingly become a community of professionals.

Graph 8 and 9. A Comparison of Educational Attainment: 1990 & 2000

Educational Attainment (1990)



Educational Attainment (2000)



7.6.2 Households

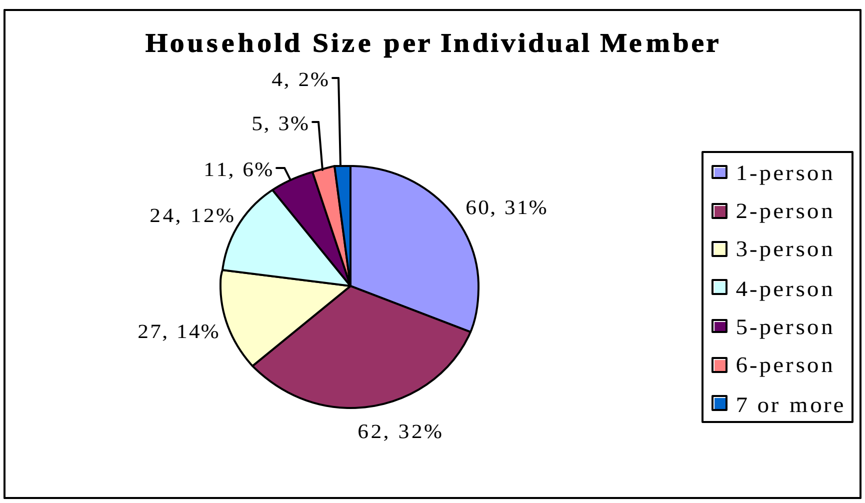
The household demographics indicate that the nuclear family model typifies the Hanalei household. There are 193 households listed, classified as Family Households (59.6%) and Non-family Households (40.4%). Under family households, 24.9% have children who are under 18 years of age, married couples comprise 39.9%, and female householder with no husband present makes up 10.4%. Among non-family households, defined as "householder living alone", 6.2% are single individual household 65 years and older, while 31.1% constitute the remainder.

Table 5. Percent of Total Households

		Family Households				Non-family Households			Average Population	
				Type of Family			Householder Living alone			
Town	Total House holds	Total	With own Children under 18 years	Married Couple Family	Female Householder, no husband present	Total	Total	65 years and over	Householder Living alone	Family
Hanalei	193	59.6	24.9	39.9	10.4	40.4	31.1	6.2	2.48	3.10

Each household is further devolved to specific sizes. One (31%) and two-person (32%) households predominate. They are followed by 3 and 4-person households. Families with 7 or more persons comprise only 2.1% of the total household population. The average household size is 2.48 persons, while the average family size is 3.1 persons.

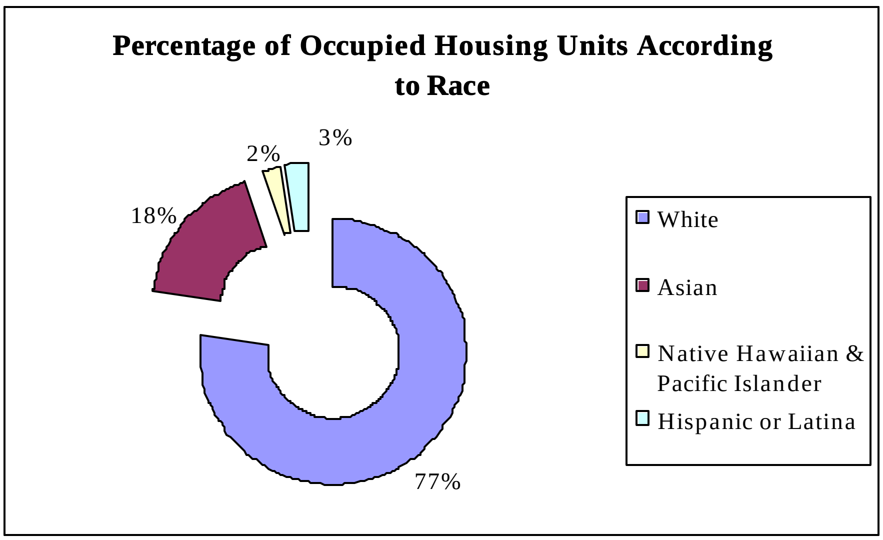
Graph 10. Household Size

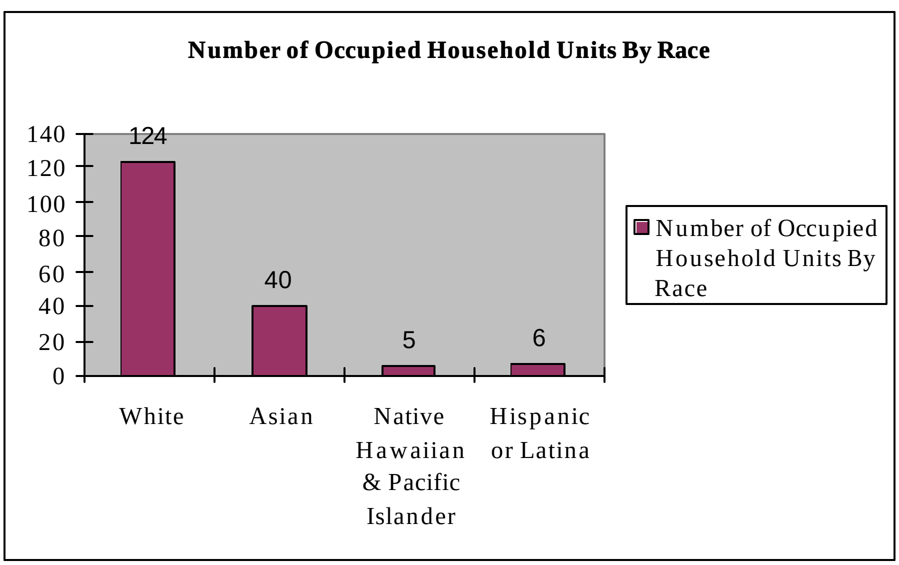


7.6.2.1 Race Distribution of Households

The race distribution of households is verified in the two ensuing pie graphs, differentiated by number and percentage. The distribution is better outlined in the provided tables (in Appendix A). White households (87.6%) are the majority in Hanalei, while Asian households (20.7%) are the second largest. The two smallest ethnic household groups are Hispanic/Latina (3.1%) and Native Hawaiian/Pacific Islander (2.6%). Most of the households are single race, comprising 87.6%. Multi-racial households constitute only 12.4%. Because households indicate a more permanent settlement, the household census may render a stronger indication of ethnic population settlement in Hanalei.

Graph 11 and 12. Racial Breakdown of Households (by percentage and number)

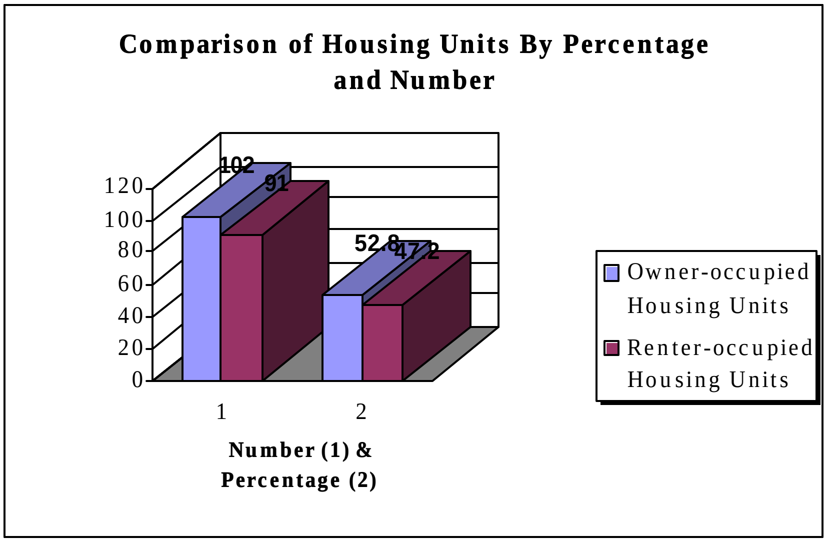




7.6.3 Housing Units

Housing units offer insight on the shift of permanent settlements in Hanalei to more part-time or rental ownership. This graph indicates a growing part-time resident population facing Hanalei today based on the growth in renter-occupied housing units. It further implies that Hanalei is becoming a vacation town for part-time residents. Of the total occupied housing units, 102 are owner-occupied, while 91 are renter-occupied, which is 47.2% of the total housing units. This poses threats to the sense of smallness and community cohesion characterizing Hanalei because the high number of renter-occupied housing units reflects a growing temporary resident cohort.

Graph 13. Housing Units by Number and Percentage



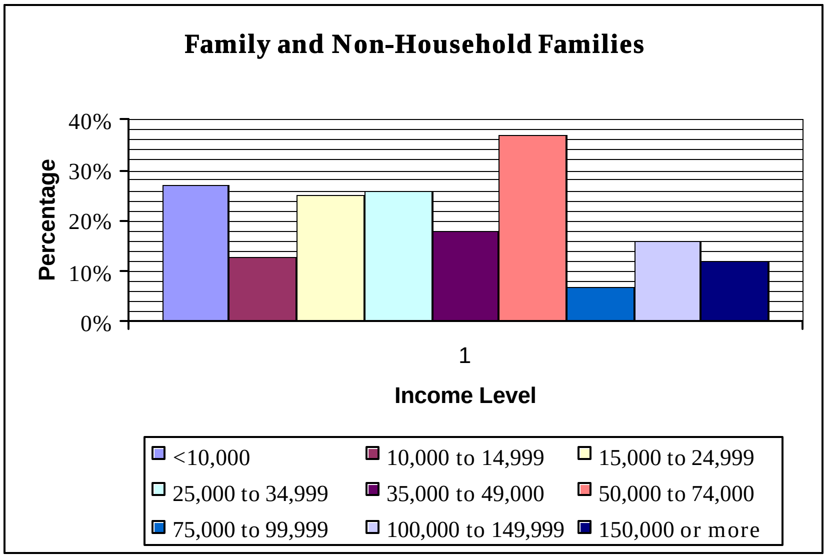
7.6.4 Income Level by Household

The 2000 Census income statistics demonstrate that Hanalei is a middle-income community. The majority of income earners fall in the $50,000 to $74,000 income range, although a sizeable number are grouped in the $15,000 to $24,999 (25%) range as well as in the $25,000 and $34,999 (26%) income range. It has a median annual household income of $34,375.

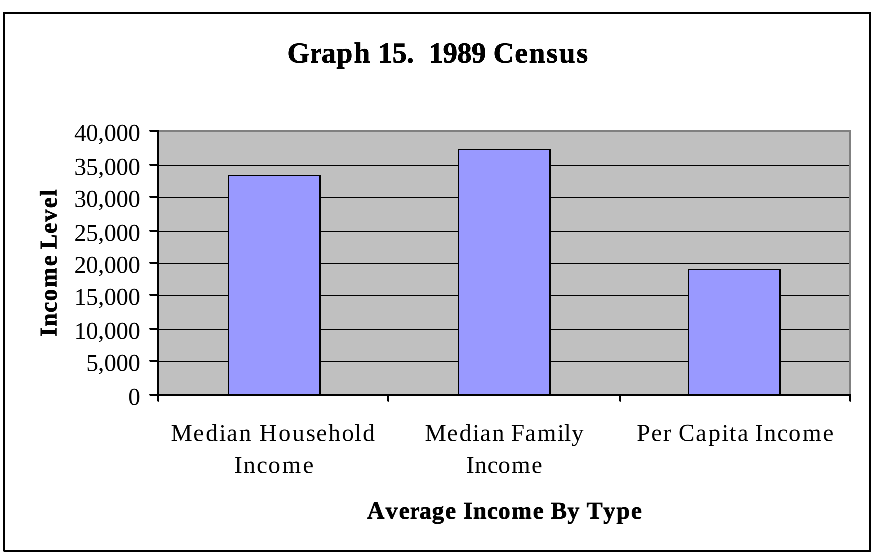
These data imply a growing settlement of upper middle class income earners, which reflects a rise in the cost of living in Hanalei, driven by the latter group (over $50,000 income earners). This may have detrimental effects for those who live at or below the poverty level or even at the $15,000 to $24,000 income range. It is important to note that 27% make less than $10,000, a cohort whose existence in Hanalei is threatened as incoming high-income earners push up housing prices, particularly if this demographic trend continues in the future.

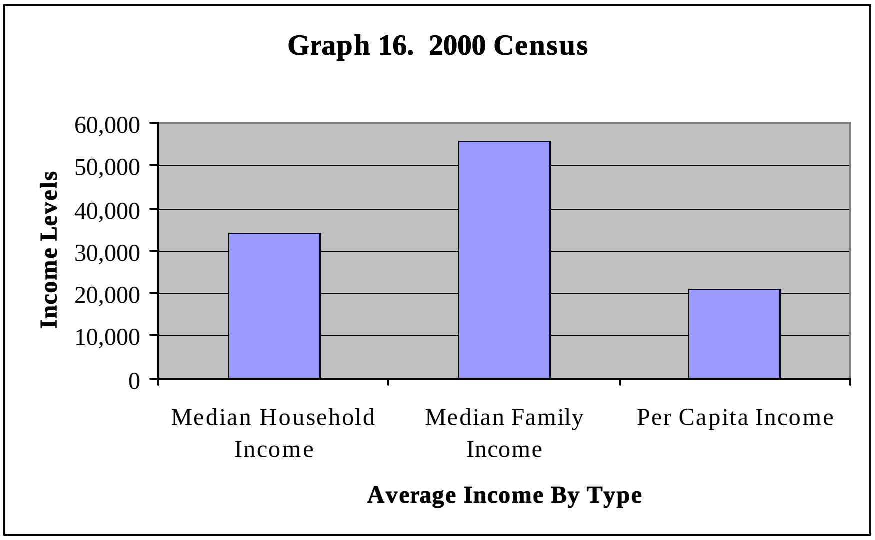
The graphs comparing the median household income, the median family income, and per capita income from the 1989 Census to the 2000 Census are additional evidence proving that the average income cohort has increased in a ten-year period. The graphs illustrate the growth in median income family household. The Median Household Income increased to $34,375 from $33,304, the Median Family Income simultaneously increased by $18,442, from $37,308 to $55,750. The Per Capita Income showed a corresponding increase of $21,241 from $18,981.

Graph 14. Income for Family and Non-household Families



The demographic change in income earning residents in Hanalei corresponds to the growth in individuals living below the poverty level. In 1989, the number of individuals living below the poverty level was 13.2% (U.S. Census Bureau of the Census, Census 1990), but by 2000 the percentage had risen to 25.3% (U.S. Census Bureau of the Census, Census 2000). This increase occurred primarily in individuals 18 years and over, whose numbers rose from 13.4% to 22%. For persons 65 years and over below poverty level, the number had decreased from 5.5% to 0% (U.S. Census Bureau of the Census, 1990 & 2000). This could simply mean that individuals in this age bracket who had registered below the poverty level in 1989 had passed away. These statistics hint at the growing in-migration of more affluent individuals.





It is important to note that as more affluent professionals migrate into Hanalei to establish either permanent or part-time residency, the real-estate sector, sometimes in alliance with the State government, capitalize on the opportunity to increase the property value of housing, a maneuver that is presently being politically challenged in the City Council election. One City Council candidate has proponed freezing the property value in order to prevent the out-migration of long-term residents because he estimates that this policy endeavour will preclude the skyrocketing of property taxes, making cost of living more expensive for long-term, albeit less affluent households.

7.7 Overcoming Milestones

Some local residents have voiced displeasure in the population and development trend afflicting Hanalei. While planning must employ the concept of balancing the interests of all community voices, regardless of ethnic background, income level, or social status, it may sometimes lean in favour of one interest group in order to achieve an overall balance within the community, a process that may *prima facie* insinuate bias towards a particular group. However, as vacation rentals continue to crop up and high income earners purchase land for erecting larger scale housing, concerns over how local old-timers can protect themselves from being pushed out of Hanalei are entertained. The reality of planning, however, must contend with the idea that communities do have limitations, cognizance of which has forced some community members to brainstorm ideas on how to retard developments that prove detrimental to the community *in toto,* in light of social processes that Hanalei is currently undergoing. Social processes also call into question changes governments are willing to undergo to support the community (see "*Community and Government*" Chapter 11 in this report). Some Hanalei residents fear that social processes are threatening the sense of cohesion for which Hanalei has been known. Another source of concern is the traditional practice of taro. As an economic function, taro provides employment for the community as well as contributes diversity to the economic base of Hanalei. For others, however, it is symbolic of Hanalei's connection to its Native Hawaiian past. As such, it plays a prominent role in the minds of local residents for depicting the local "sense of place" characterizing Hanalei.

In raising awareness to a community's limitations two queries are posed:

- To what degree can a community continue to develop and change without threatening Hanalei's natural beauty?

- To what extent should the community change in order to accommodate such transformations, without sacrificing the community tradition(s) it has already developed and continue to treasure?

Social changes that have followed the development path, which Hanalei is presently undergoing, have ultimately changed the entire face of a community, concomitantly destroying natural resources and features strongly defining that community. These questions are prominent in the minds of community leaders, often engendering tensions between the community and other interest groups.

Resultantly, three key issues have emerged that require special attention:

1. Threats to water quality based on evidence of enterococci bacteria in certain areas of the Hanalei River, presumably from an inadequate sewage treatment system. Resultantly, some members of the community have promoted research to study the social and environmental impact incurred from establishing a wastewater treatment plant that fits the size requirements of the Valley and compliments the constitution of Hanalei's watershed.

2. The co-existence of taro *lo'i* and bird impoundments arising from possible increase of bird impoundments by the United States Fish & Wildlife SErvice. The USFWS is responsible for managing the National Wildlife Refuge and propagating Hanalei's endangered bird species.

3. A tourism town plan well-suited for Hanalei given, again, its size and watershed requirements.

These salient issues are interconnected with Hanalei's *ahupua'a*-watershed management objectives, bringing multi-dimensionality to the conundrums confronting the community.

Section III

Issues and Recommendations

Chapter 8

Developing Wastewater Treatment Facilities to Improve Water Quality

Raindrops falling on a mountaintop can pick up and transport pollutants by migrating on a path to Hawai'i's coastal waters. Though a few raindrops may seem insignificant, the impact of heavy rainfall over a period of time can transport massive amounts of pollutants into receiving waters (HAEQ, 1999). Most of Hawai'i's water bodies have variable water quality due to stormwater runoff (Surfrider, 2002). The most significant pollution problems in Hawai'i are siltation, turbidity, organic enrichment, toxins, pathogens, and pH from nonpoint sources, including agriculture and urban runoff (NRDC, 2002). These problems can be traced to specific pollutants including bacteria, pesticides, fertilizers, sediment, oil, and grease, all of which have harmful effects on both the health of the public and environment. Some harmful effects of "polluted runoff" (also known as 'nonpoint source pollution') include increased risk of disease from water recreation, fish kills, algal blooms, and destruction of aquatic habitats (HAEQ, 1999). Very few point sources discharge into Hawai'i's streams. Most industrial facilities and wastewater treatment plants discharge into coastal waters (NRDC, 2002).

As a tourist destination, the Hanalei area on the Island of Kaua'i offers a wide variety of recreation. Swimming, surfing, fishing, and boating are among the most popular forms of recreation in the ocean, while fishing and kayaking are the most popular forms of recreation in the Hanalei River and estuary. Those who participate in water sports on Kauai's North Shore in particular are at risk from several potential health hazards, including skin rashes, diarrhea caused by Giardia and other pathogens, and leptospirosis. In October1997, the Department of Health issued a health warning when 12 people, and possibly other unreported cases, became ill with ciguatera fish poisoning after eating surgeon fish, known in Hawai'i as *kole.* The inflicted individuals consumed contaminated fish caught off the north shore of Kaua'i between Anini and Hanalei (ProMed, 1997).

Currently, County officials, concerned about pollution at swimming beaches, are asking the Department of Health to test coastal waters. Kaua'i Mayor Maryanne Kusaka said citizens have raised questions about the safety of swimming areas such as those in Hanalei Bay near the mouth of the Hanalei River (Honolulu Advertiser, 2002). Tests there have shown occasional spikes in indicator bacteria.

Eugene Akazawa, of the DOH's Clean Water Branch, states that the large variation in average readings for sites is not something to which a great deal of importance should be attached. Water quality readings can vary dramatically with weather conditions, so when averages are based on a relatively small number of readings, such things as an occasional heavy rain can result in skewed averages (Environment Hawai'i, 1994). According to Hawai'i's 1998 305(b) report, most of the state's water bodies have variable water quality that declines when stormwater runoff carries pollutants into surface waters (NRDC, 2002).

8.1 Research Identifying Problem

The Clean Water Branch of the Hawai'i Department of Health (HDOH) runs a statewide beach water-quality monitoring program. On a weekly basis throughout the year, the Hawai'i Department of Health monitors a total of 42 beaches. This includes 14 beaches on Oahu, 11 beaches on Maui, 11 beaches on Kaua'i, and 6 beaches on Hawai'i. Beaches are monitored for *Enterococcus* and *Clostridium perfringens*, indicator bacteria of fecal contamination. One criterion for an indicator organism is that it be consistently present in human feces in substantial numbers so that its detection will be a good indication that human wastes are entering the water (Tortora, 1992). Bacteria (versus other indicators) are also used because the tests are reliable, simple, and inexpensive.

The State also tracks a monthly mean bacteria count for about 80 sites. For *Enterococcus* the statewide standard is 7colonies/100ml (this is stated as 7 CFU) and for *C. perfringens* 5 colonies/100ml, (5 CFU) (Surfrider, 2002). Hawai'i's bacteria standard is one of the strictest in the nation; federal guidelines are more liberal: 35 CFU (Environment Hawai'i, 1994). In general, high enterococci levels are associated with beaches that receive a large amount of freshwater (surface or underground). Particularly in Hawai'i, where enterococci are naturally found in tropical soil and animal wastes (Environment Hawai'i, 1994). When such bacteria are found in nearshore waters, they may indicate contamination from the soil rather than sewage pollution (Surfrider, 2002). By itself, *Enterococcus* is not the best indicator organism (Environment Hawai'i, 1994). In fact, other fecal bacteria indicators are not reliable in Hawai'i, because they are already found in freshwater streams, even in the absence of fecal contamination. The Environmental Planning Office of the Hawai'i Department of Health (DOH) revised the standards in 1998, adding the indicator organism *C. perfringens*. It is used to confirm elevated levels of *Enterococcus* densities (Surfrider, 2002).

In 1992, Hanalei Bay Landing (about 18 CFU) was given a "very poor" rating, among the top five worst water quality shorelines found on Kaua`i (Environment Hawai'i, 1994). In 2001, Station 805, Hanalei Bay Pavilion exceeded bacteria and pathogen criteria 12 times (out of 52 tests) (EPA, 2001).

If waters where enterococci levels exceed state standards were unsafe, then it would seem that some of the state's most popular recreational waters should be placed off-limits. But because *Enterococcus* is found in tropical soils, the state relies on additional factors, such as the presence of raw sewage, when evaluating whether conditions warrant closing a beach. Beach closings and advisories due to sewage spills are instituted by the respective county agencies. These agencies are issued permits by the state DOH, which requires them to post closings and issue press releases if a spill has the potential to affect areas accessible to the public (Surfrider, 2002).

According to the HDOH, the main causes of beach closure are tar balls, flooding, sewage spill, or precautionary. The greatest regional threat is nonpoint source pollution. The HDOH staff contacted by Surfrider indicated they felt that the water quality indicators the state uses do not accurately represent water quality. Also, staff and lab support lack necessary funding (Surfrider, 2002).

The Hanalei Heritage River Program has also been testing more than 20 designated sampling points on the river and in Hanalei bay for bacterial contamination (Environment Hawai´i, 2002). But even if they find high counts of bacteria, a beach cannot be closed based on a citizen's group water quality monitoring data (EPA, 2001).

The HUI was also interested in finding out about general pollutants in the Hanalei River. Dr. Carl Berg, Hanalei HUI Water Quality Project Leader, with assistance from a State fisheries biologist and others, collected samples over several days in December of 2001 (Orazio, 2002). In association with USGS, the Colombia Environmental Research Center (CERC) conducted the various chemical tests of these samples, looking at hydrocarbons, organochlorides, and metals. Hydrocarbons are associated with fuel, which could come from boats, tractors, and runoff from the road. Organochlorides cover the range of herbicides and pesticides, termiticides, dieldrin, and DDT, for example. Metals are associated with radiator fluid and wear and tear from brake pads.

Some early analyses pointed to high levels of iron in lower parts of the river; however, high background levels of iron are common in Hawai'i streams due to iron leaching from the tropical soil and rock. Another hypothesis for the cause was from Sluggo, a snail pesticide taro farmers use for controlling invasive apple snails in taro fields (Orazio, 2002). Sluggo is made up of iron phosphate. However, this hypothesis would require further testing for other contaminants to be proven significant.

One of the known pesticides used on the wetlands of the Fish and Wildlife Bird Refuge and on the roadsides by Department of Transportation to control California grass is Roundup, a water-soluble herbicide (Smith, 2002). Herbicides such as this contain a surfactant that allows poison to get into the plant. The function of a surfactant allows tallomine to reside, but the poison breaks down. There have been thousands of tests to detect the poison but none on tallomine (Berg, 2002). There is currently no good technique for measuring tallomine, and the bioaccumulation of pesticides in crabs tested were minimal. There is a concern to understand the amount of pesticides and herbicides in the water because high levels could be devastating to coral reefs. Coral reefs are a basis of the food chain in the ocean, and negative effects on the reef could be devastating to the bay.

Overall, tests found no major sources of hydrocarbons, organochlorides, or metal contamination (Berg, 2002). The final report should be available in early 2003.

8.1.1 Hypothesis of Cause

There are a variety of activities in the Hanalei River and Bay that could be attributed to the high bacterial counts recorded. Agricultural and local town activities, as well as the impact of thousands of tourists visiting the area per day are potential sources of contamination (Orazio, 2002). Local belief was that sewage from summer boats caused a host of various ailments in swimmers and surfers, most notably rashes. Samples were taken in 2001 by Dr. Berg and volunteers in partnership with State Department of Health to assess the impact of summer boating. Interestingly, these tests showed that bacteria counts were not correlated with the number of summer boats (EPA, 2002). Increased boater education and enforcement may have improved conditions.

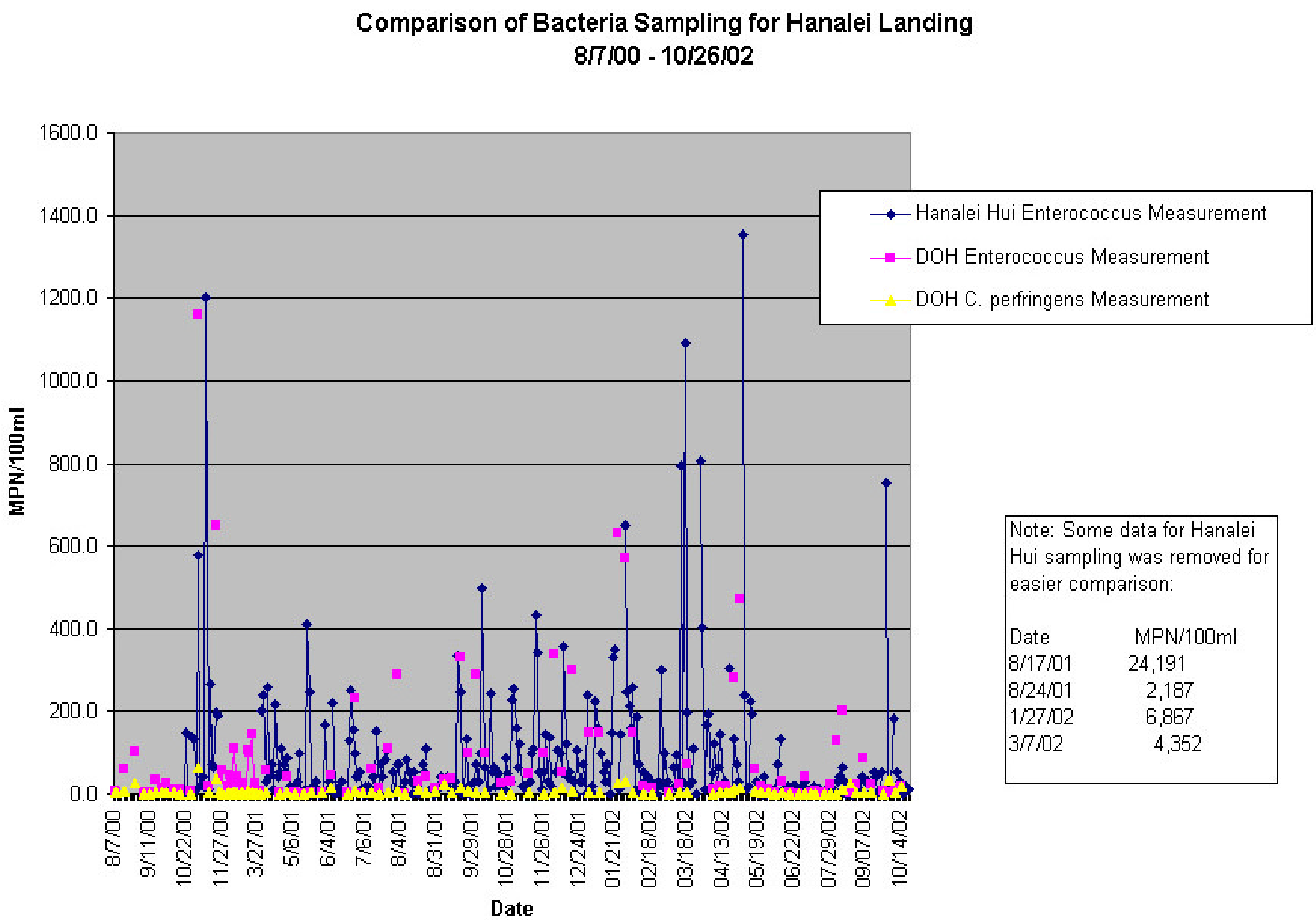
More likely, contributing factors point to heavy use of the beach park restrooms and area vacation homes (most with very old cesspools), along with decreased river flow during the summer (EPA 2002). The soils in the area *makai* side of the main road and closest to the bay are defined as Mokuleia fine sandy loam. This type of soil has a reef substratum and will not hold wastewater because it is highly permeable. Sewage effluent from cesspools and septic systems will drain fast and come out at nearshore waters (Smith, 2002). Also, large amounts of nitrogen, sodium, and chlorinated organic compounds may be discharged into groundwater (Marsh, 1991). High concentrations of nitrate can contribute to excessive growth of aquatic plants, depletion of oxygen, fish kills, and general degradation of aquatic habitats (USGS, 1999). Results from the CERC tests do not show particularly high levels of nitrogen, but do show high amounts of sodium. This is most likely because the river is brackish quite a ways up from the mouth. More information can be extracted once the final report is released.

The bacterial map (see Graph 17) uses Hanalei HUI's geometric mean weekend data from November 2000 – 2002. The geometric mean over the two years of bacterial sampling gives a rough idea of where bacterial counts are highest. This graph helps to locate the highest problem areas so that they can be targeted and mitigated.

The areas of most concern are the moderate/high (171-291MPN) counts of enterococcus. An area of high concern begins at the last sharp turn of Hanalei River, where a large red dot (signifying a high count (292-689MPN) of bacteria) is followed by all orange dots (signifying moderate/high count) out into the ocean. A closer look at bacterial map B.11, B.12, and B.13 (in appendix B) show site numbers 1, 3, 50, 51, 101, 102, and 103 with moderate-to-high bacterial counts. All these areas are considered a high priority because of the number of recreational water users in these areas. These site numbers indicate areas that are near public restrooms, Weke Road boat landing, and irrigation ditch outfalls. The bathrooms at Black Pot Park were closed in February 2002 because of public concern and portable toilets were provided to the area for public use. Bacterial counts before and after closure of the restrooms showed a considerable decrease in number from both the DOH and Hanalei HUI data (Water Pollution at Black Pot Park, April, 2002).

A second cluster of moderate/high bacterial counts are at sites 56, 57, and 63. A restaurant, vacation rentals, and irrigation ditch outfalls are located in this area. The third cluster of bacterial counts of concern is located near the Hanalei Bridge and a few sites downstream. These include sites 2, 59, 61 and 64 on bacterial map 2. Irrigation outfalls from taro lo'i and impoundment ponds are near these high counts. Besides a fecal indicator, enterococci are found in Hawai'i's tropical soils. Water running through these irrigation ditches may be concentrating the bacteria as it travels from one *lo'i* or pond to another. Other indicators for these areas may be necessary to determine the actual cause of the high bacterial counts.

Graph 17. Bacterial Map



The bathrooms at Black Pot were closed on February 7, 2002. Before the 2/18/02 mark, there were high readings of bacteria, which were taken before 2/7. After 2/7, the readings are low, as you can see in the chart. But, on 2/25 the count jumps and 3/15 is even higher than before 2/7. This analysis excludes extremely high counts (see graph inset). Several hypotheses can be formed as to the cause of these observations. It is possible that the bathrooms at Black Pot Beach Park are not the source of bacterial observation in this area. It is also possible that bacteria continued to leech out of the soil after the bathrooms were closed, particularly during the periods of flooding and high rainfall.

The ambiguity of these findings stresses the need for more fecal indicators. These findings do not rule cesspool and septic systems as the reason for high bacterial counts, but additional study is required to determine it as the sole resource.

There is some skepticism in using solely bacteria as a fecal indicator to test for sewage contamination. Soil is considered the most likely source for high indicator bacteria, including enterococci, and do not necessarily reflect the degree of fecal contamination (Hardina, 1991). An interest of the CERC report was in further screening of nonylphenol related compounds and caffeine as potential indicators of urban activity. Dr. Roger Fujioka, research scientist at the Water Resources Research Center at UH Manoa, suggests against using caffeine as an additional fecal indicator. Caffeine is passed through urine as well as excrement and could test positive at monitoring sites where swimmers frequent. In Hanalei, coffee was at one time grown in the valley near the Hanalei River, and may also have an effect on caffeine levels in the water (Berg, 2002).

Other indicators of sewage include estradiol and nicotine. Estradiol is found in estrogen supplements and birth control pills. Again, Dr. Fujioka felt these were not reliable enough. He is working on an indicator currently, an F+ virus, which grows on coliform bacteria, present mainly in humans, birds, and swine. The F+ virus is among the three most promising alternative indicators of fecal contamination of environmental waters, which include *C. perfringens* (consistently found in moderate levels of sewage), the group of DNA somatic viruses of coliform bacteria, and the male-specific RNA viruses of coliform bacteria (Fujioka, 1997).

It would be useful for the Hanalei HUI to test for *C. perfringens* in addition to the currently tested enterococci.

8.1.2 Existing Wastewater Treatment

According to the EPA's definitions, wastewater is the spent or used water from homes, communities, farms and businesses that contain enough harmful material to damage the water's quality (www.epa.gov). It includes both domestic sewage and industrial waste from significant sources. Hanalei does not have any major industries to generate significant amounts of industrial wastewater, therefore, the Practicum concentrated only on the environmental impact of wastewater from domestic sources.

Organic pollutants, bacteria and viruses, may be all found in domestic wastewater. Untreated or improperly treated wastewater can cause serious harm to the environment especially to the surface and ground water body, and can threaten human health. Wastewater treatment systems are designed to remove or break down contaminants before they enter groundwater, nearby streams, or the ocean. Hanalei does not have any public centralized treatment facility. Only the Ching Young Village and Hanalei Center have private compact wastewater treatment facilities. Three types of "treatment options" currently operate in Hanalei Town and the surrounding area. The first is piping wastewater directly into the natural environment. The second is conventional cesspools, while the third is septic tanks with field disposal system.

8.1.3 Pipe into the Environment without Treatment

This is an illegal way to dispose of wastewater, but it still exists in Hanalei, especially in old houses and those near surface water bodies. Wastewater can carry disease-causing bacteria, viruses, and other pathogens, as well as organic wastes containing nutrients that promote algae growth and lower oxygen levels in surface water. This waste affects fishing and recreational uses of the river and ocean. Untreated wastewater will cause serious negative impacts to the environment and public health.

8.1.4 Conventional Cesspool System

A cesspool system is a leaching system that includes leach lines, leach beds, or seepage pits. Technically, a cesspool has no septic tank upstream, so the wastewater from the home enters into the environment directly, and the soil in the drain field or soil absorption field absorbs the wastewater treats it through physical, chemical, and biological processes. Before 1900, cesspools were the primary method used to treat domestic wastewater in Hawai'i. Many Hawai'i residents still use this type of on-site wastewater disposal system.

In 1991, the wastewater policy was changed because of public concern about negative environmental impacts and the degradation of drinking water quality caused by improperly treated domestic wastewater. The Department of Health (DOH) did extensive research on the issue. They drew the conclusion that cesspool systems be phased out, gradually.

The new domestic wastewater rule was published in 1991. According to the new rule, cesspool systems are still legal in Kaua'i, but permits are issued based on drinking water quality protection criteria. No cesspools are allowed in areas above drinking water supplies. In some areas one cesspool per acre is allowed because discharges at this density will not affect drinking water quality. In areas where there is no drinking water supply, cesspools are still allowed.

8.1.5 Conventional Septic System

Septic systems are another common on-site wastewater treatment method in Hawai'i. This sytem includes two parts: (1) septic tank and (2) soil absorption system. Wastewater flows from the household sewage pipeline into an underground septic tank first. Within the tank bacteria partially decompose and liquefy solids and settle-able solids (sludge) and float-able solids (scum) are separated from the liquid wastewater and left in the tank and into the drain field or disposal field. The latter component will treat the wastewater similarly to a cesspool system.

Compared to the cesspool system, septic systems are relatively reliable because of the primary treatment performed in the septic tank. Some new houses use this system as do some houses where systems have been replaced. Septic systems are recommended by the Department of Health as preferable to cesspools for individual on-site treatment in Hanalei. Septic systems are a relatively reliable on-site treatment method when properly maintained.

8.2 Community Reactions to the Problem

The concerns of the community were strong enough to prompt political action. At a Council Committee meeting, residents produced test results from Hanalei Bay, which indicated high levels of bacteria were present (PIO, 2002). At least two popular swimming beaches recently have had high counts of the bacteria that public health officials use to gauge the safety of coastal waters (Honolulu Advertiser, 2002). Mayor Kusaka wrote a letter to DOH asking that an intensive study be done on the quality of recreational waters to make sure they are safe for use. The Mayor also ordered that the bathrooms at Black Pot Beach be closed for needed repairs and an assessment of their contribution to poor water quality in the area.

8.3 Funding Sources

A variety of funding sources are available for a community to install a wastewater treatment facility in their area. Most likely, the owner of the premises is to construct and pay for the terminal manhole and any pipe work leading from the premises to the terminal manhole. The government will provide and pay for the new public sewers and the sewer linking the terminal manhole to the public sewers (EPD, 2002).

Several financing sources are available for the government. These include: bonds, state revolving funds, state bond banks, grants, short-term financing (loans and anticipation notes), system development charges, developer contributions, assessments, privatization, lease/purchase, dedicated capital and bond coverage funds, operating revenues, and investment income (Raftelis, 1993). Some of the options that will be discussed here include state revolving funds, grants, and privatization.

1. State Revolving Funds

Financial assistance is available so that cities can construct treatment facilities in compliance with the law. The Clean Water Act prescribes performance levels to be attained by municipal sewage treatment plants in order to prevent the discharge of harmful wastes into surface waters (Copeland, 1999). They do this through State Water Pollution Control Revolving Funds (SRFs). One of these specifically is 66.418 - Construction Grants for Wastewater Treatment Works. States continue to receive federal grants, but now they provide a 20% match and use the combined funds for making loans to communities. The intent for these SRFs was to assist in the transition from federal to state and local financing. Loans are to be repaid to the SRF within 20 years, beginning within one year after project completion, and the locality must dedicate a revenue stream (from user fees or other sources) to repay the loan (Copeland, 1999).

There are a variety of requirements that must be met by the state to first ensure compliance with the Act and qualify for the SRF. After meeting requirements, states may also use the funds to support other types of water quality programs, such as those dealing with nonpoint source pollution and protection of estuaries, an added benefit especially for Hanalei. Decisions on which projects will receive assistance are made by states using a priority ranking system that considers the severity of local water pollution problems (Copeland, 1999).

Even if Hanalei is able to fulfill all the requirements necessary for the SRF, it has been shown that small communities have had problems with the SRF program. Many have limited financial, technical, and legal resources and have encountered difficulties in qualifying for and repaying SRF loans. These communities often lack an industrial tax base and thus face the prospect of very high per capita user fees to repay a loan for the full capital cost of sewage treatment projects (Copeland, 1999). Hanalei may be able to depend on its tourist industry, but this factor should be heavily considered before attempting the paperwork for the SRF.

2. Grants

The Water and Waste Disposal Program of the Farmers Home Administration was founded under the consolidated Farm and Rural Development Act in 1940. It is considered one of the oldest and most successful financing programs in the country (Curley, 1993). The WWDP is both a grant and a loan program. A calculation is figured on the annual debt service payments the sewer district would be able to pay each year, and the shortfall is funded as a grant. Besides the tremendous paperwork and average three-year delay in obtaining the loan, a WWDP is an attractive program for rural populations under 10,000.

3. Privatization

In addition to the Clean Water Act, other legislation that has affected the water and wastewater industry includes the Water Pollution control Act, Safe Drinking Water Act, and Clean Air Act. Increasing regulation has made it more expensive to meet these standards. Local governments are looking for alternatives to provide funding, and the private sector offers an opportunity to raise the needed capital. It is not surprising that government funding programs have many rules and regulations that are largely absent from private funding programs (Curley, 1993). However, legislation has also made it undesirable for private industry to be involved in public sector projects. The Economic Recovery Act of 1986 and the Deficit Recovery Act of 1987 significantly restricted tax advantages and the use of tax-exempt financing, discouraging private sector involvement in public infrastructure activities (Raftelis, 1993).

Even with these disincentives, privatization remains a viable option of public/private partnerships to address environmental infrastructure needs. Tax benefits are still available, which would lower the costs of environmental services, and could be shared with the public in the form of lower user fees. Examples of these partnerships would include privatization, which is full ownership by the private firm from design to operation, and turn key facility, which is designed and operated by the private firm but owned by the public sector. The Princeville Corporation may be interested in developer financing, where the private firm finances the construction of a facility in return for the right to build houses or stores also serviced by the same facility. In any case, privatization as a public/private partnership is based on the concept of sharing benefits and risks (Raftelis, 1993).

Other financing programs from the private sector include municipal bonds and conventional bank loans.

8.4 Projection of Future Wastewater Issues based on "No Change" and Current Development Trends

Septic systems are like a chain; from design and location, to maintenance and proper use. If one link has a problem it will cause the system to fail (Robotham, 2000). Therefore, in Hanalei, septic systems contribute to water pollution.

8.4.1 Continued failure of Existing Septic Systems

Possible problems can be predicted based on the septic situation in Hanalei.

a. Unapproved system design. The depth to groundwater is an important factor to septic system design. This is not only for groundwater protection, but also for ensuring efficient operation of systems. Due to seasonal flooding and the location of Hanalei on the coast, Hanalei has a relatively higher water table. If the disposal section is located within the high water table area, the sewage effluent can easily contaminate the groundwater. If the design did not follow regulations the system could be too close to the water table, or the disposal soil may not be appropriate. All of these elements will cause a system to fail.

b. Over-capacity. The size of the septic tank and leaching field should be big enough to accommodate the quantity of the wastewater generated each day. Usually the scale of the system depends on the number of bedrooms. In Hanalei, because of the development of tourist industry, many old residential buildings are converted into bed and breakfasts, vacation rentals, and commercial buildings. In these cases, if the septic system is not improved, the system will be over-capacity and fail. Failure is caused by higher water volumes and low retention times that interfere with proper treatment in the tank and flood the leech filed.

c. Lack of system maintenance. Even the best-designed and operated septic system eventually fails without periodic inspection and maintenance. Inadequate maintenance results in clogging of the septic absorption field (Dickey, 2002). In general, a septic tank should be pumped by a licensed pumpery every three to five years. Pumping a septic tank is expensive, costing between $100 and $250 (Robotham, 2000). Users may ignore this maintenance, or they may be unwilling to spend money on it. In many cases, as more solids build up, they are more likely to flow out of the tank and into the drain field. Clogged septic leech fields must be replaced at a much higher cost than routine pumping. These three factors are the main reasons that septic systems continue to fail in Hanalei.

8.4.2. Continued Development Pressures, Increased Re-Development Related Impact

The Kaua'i General Plan (2000) describes Hanalei as a low growth area: *Urban development in the Hanalei and Wainiha-Hayena areas is undesirable because of the special character of the area, limited roads and other services, and environmental factors.* New development on the North Shore is to be concentrated in Princeville and Kilauea (Kaua'i County, 2000). A small number of additional single family units and a 20% increase in commercial development are projected for 2020.

Table 6. Demographic Projection Summary

Year	Resident	Single Family	MF/Resort	Commercial	Industrial	Government
	(Population)	(Units)	(Units)	(Sq.Feet)	(Sq.Feet)	(Capita)
2000	933	297	58	106,542	3,920	379
2020	1,065	319	58	118,352	4,321	458

Source: Kaua'i Water Department, 2002

Redevelopment, however, will continue to contribute to larger wastewater loads in Hanalei. Large new residential development in Hanalei has increased property taxes on all homes in the area. Increased property taxes have forced residents to sell their home. The home is then developed into a larger residential dwelling, which in turn further increases property taxes. Unless constrained, this cycle of redevelopment will continue well into the future.

As traditional Hanalei homes are redeveloped into larger vacation homes, the prevalence of septic system failure will likely increase. Larger homes produce greater amounts of wastewater. This volume of wastewater is less compatible with septic systems and the soil conditions in Hanalei than that from the previous, smaller homes.

Vacation homes and vacation rentals may make a sizable contribution to future wastewater issues in Hanalei. Owners may not be aware of the condition of the septic system or proper maintenance practices. Temporary users of the dwelling may assume that a sewer system is in use and may not understand the limitations of the wastewater system.

8.5 Estimated Wastewater Load

A wastewater treatment design should begin with a reference of size. This simple methodology allows an accurate estimate of potential wastewater loads. The amount of wastewater produced by the community will determine the most appropriate methodology.

Potential wastewater load is estimated using projections from the Kaua'i Water Department presented in the "Water Plan 2020". The Kaua'i Water Department projections are based on resident and visitor population forecasts in Kaua'i County's Kaua'i General Plan, 2000.

> *Historical trends and economic development plans for the Kaua'i General Plan (KGP) were used to forecast growth or decline of various demographic categories on the island of Kauai. Projections were prepared as part of the KGP process for the year 2020, expressed as low-to-high range of growth considered being both realistic and desirable for the future of Kaua'i. These projections are used as the basis for developing water demand forecasts for Water Plan 2020.*
>
> *Consistent with the Kaua'i General Plan (2000) and for purposes of Water Plan 2020, the Department Of Water has taken a conservative approach in defining service areas of the existing water systems in effect [in Hanalei], limiting them to areas that have appropriate planning and zoning approvals in place.*

Population projections were limited to these areas with proper zoning in place to allow development. Using the projected water data, a simple methodology allows an estimate of potential wastewater loads in Hanalei.

Table 7. Demographic Projection Summary Water Use Categories and Service Connections

Year	**Resident**	**Single Family**	**MF/Resort**	**Commercial**	**Industrial**	**Government**
	(Population)	**(Units)**	**(Units)**	**(Sq.Feet)**	**(Sq.Feet)**	**(Capita)**
2020	933	297	58	106,542	3,920	379
2050	1,065	319	58	118,352	4,321	458

Source: Kaua'i Water Department, 2002

Table 8. Historical and Forecasted Water Use

	Historical Water Use (1,000 gallons/day)				**Forecast Water Use (1,000 gallons/day)**		
	1995-96	**1996-97**	**1997-98**	**1998-99**	**2005**	**2010**	**2020**
Hanalei	168	171	162	161	174	177	181

Source: Kaua'i Water Department, 2002

8.5.1 Wastewater Load Estimate Methodology

Water in = Wi
Water out=Wo
Peak water in=Wip
Peak water out=Wop

Wi is equal to the estimated daily freshwater consumption data provided.
Wo is the amount of water that could potentially enter a wastewater treatment system through a hypothetical collection system.

Wip is the amount of water used on days exhibiting the most consumption.
Wop is the amount of water that could potentially enter a wastewater treatment system through a hypothetical collection system on the most consumptive day.

$Wi = Wo$ **and** $Wip = Wop$

Wo will be set equal to *Wi*, and *Wip* set to equal *Wop*. While some water is used for lawn care and other purposes, it is safe to assume that a majority of the freshwater consumed will enter the treatment system.

$Wip = 1.5(Wi)$ **or** *Peak water in = 150% of water in.*

Often there are periods when a treatment system must process more water than the daily average. To ensure proper capacity, peak water use is estimated at 150% of daily water use. This multiplier is utilized by the Kaua'i Water Department in estimating peak flow for freshwater systems. Using it here will ensure that the wastewater system capacity meets or exceeds the freshwater supply capacity.

$Wop = 1.5(Wi)$ **or** *Peak water out = 150% of water in.*

Wip = Wop, therefore, the amount of wastewater processed on the most water consumptive day of the year is equal to 150% of the water used on an average consumption day. These formulas have been entered into the table below.

Table 9. Historical and Forecasted Water Use and Wastewater Load

+Kaua'i Water Department *estimated figures	**Historical (1,000 gallons/day)**				**Forecast (1,000 gallons/day)**		
	1995-96	**1996-97**	**1997-98**	**1998-99**	**2005**	**2010**	**2020**
Water Use+	168	171	162	161	174	177	181
Wastewater*	168	171	162	161	174	177	181
Peak Water Use*	252	256.5	243	241.5	261	265.5	271.5
Peak Wastewater*	252	256.5	243	241.5	261	265.5	271.5

8.5.2 Additional Issues

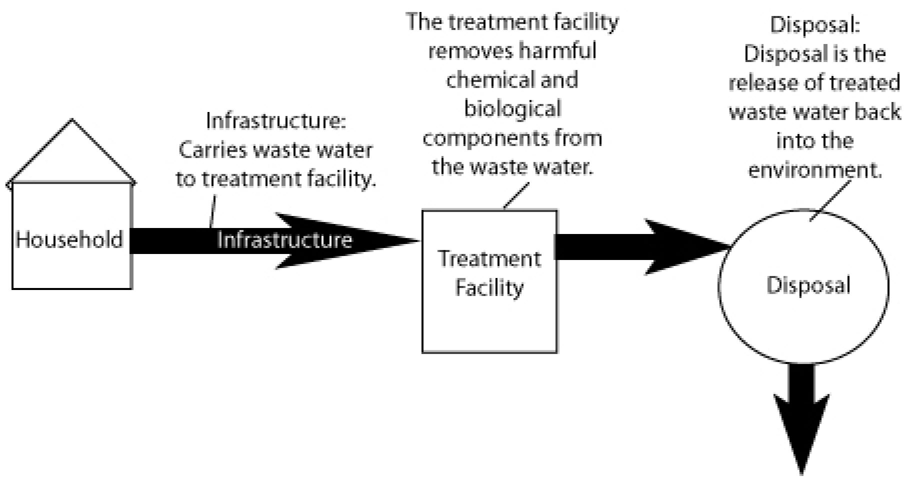
These estimates are presented as a basis for considering wastewater treatment options only. It is important that additional deductions are made from the wastewater load to account for agricultural uses. It is also important to make additions to the wastewater load to account for sources of wastewater that do not originate from the freshwater supplier.

1. Ground Water Infiltration

If traditional infrastructure is chosen as an infrastructure option, up to 50% additional groundwater will enter the sewer system. Systems fed by traditional infrastructure will need an additional 50% capacity.

2. General Wastewater Methodology

Three components are required for wastewater treatment: **infrastructure, treatment,** and **disposal.**

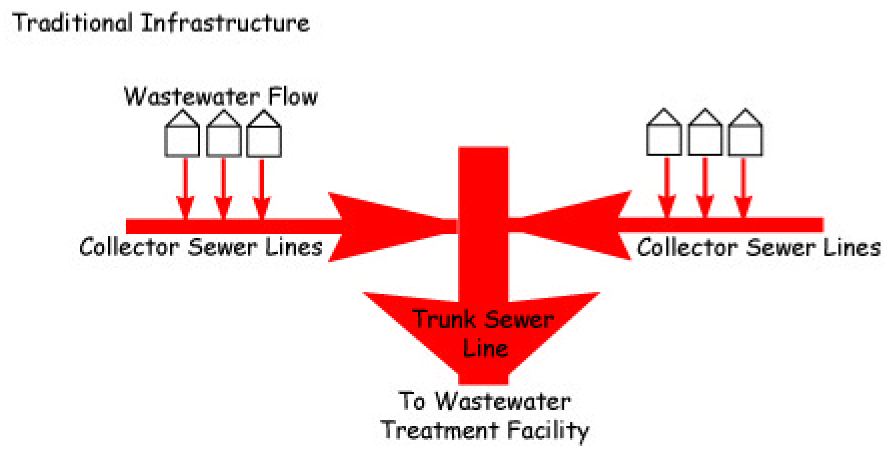


8.6 Wastewater Collection System Infrastructure

Infrastructure carries wastewater from the *source* (residential and commercial districts) to the treatment facility. Traditional infrastructure should be designed with the natural slope and contours of Hanalei. Such a design utilizes gravity wherever possible to move wastewater towards the treatment facility. Traditional infrastructure requires lift stations to move wastewater against gravity.

Two alternative methods are presented which operate without gravity flow. These systems utilize small diameter hoses and small pumps at each home to force wastewater to the treatment facility. This modern method works extremely well in conjunction with existing septic systems. Pre-treatment in on-site septic systems increased the effectiveness of later centralized treatment. Most importantly, these systems have lower installation and maintenance costs. This solution is ideal for small towns like Hanalei.

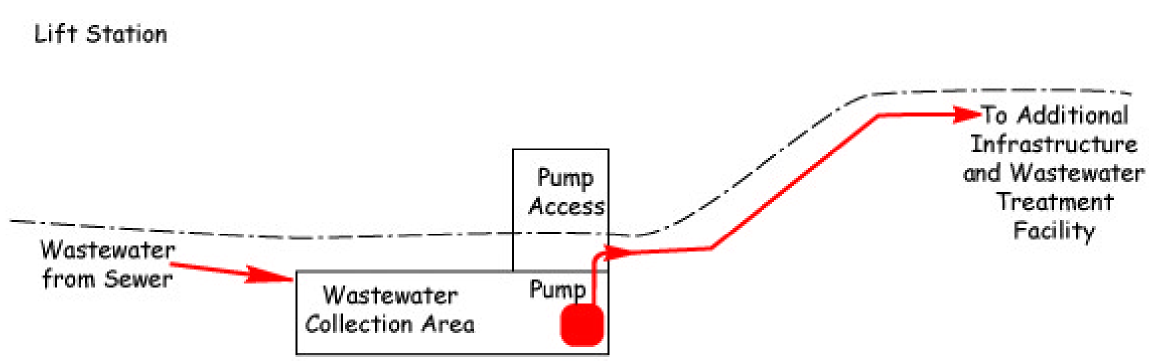
A. Traditional Infrastructure



The traditional sewer infrastructure is a network of piping. This network usually utilizes the flow of gravity to concentrate and transport wastewater to a central treatment facility. The smallest pipes in the system are called "collectors". These pipes provide a point of connection for homes and businesses. The collectors drain into larger "trunk" lines. In a small city this may be the largest sewer infrastructure necessary. In large urban areas trunk lines drain into interceptors. These massive pipes may be 10' in diameter and carry millions of gallons of wastewater each day.

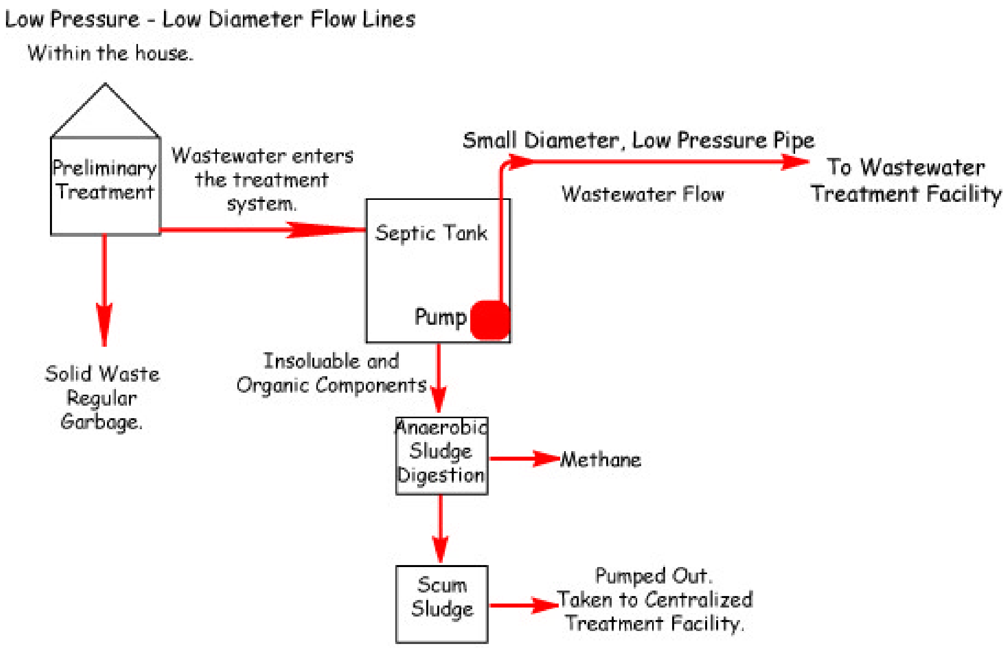
Traditional sewer infrastructure has many disadvantages. Installation requires massive excavation and trenching on streets and in county right-of-ways. The system must be designed to flow with gravity, limiting the placement of the treatment facility and often necessitating lift stations. Ground water infiltration may add up to 50% to the existing wastewater flow, requiring a larger, more costly treatment facility. Finally, maintenance is costly and requires regular excavation and traffic disruption.

B. Lift Stations



Where the gravity flow of wastewater infrastructure is impeded, it is necessary to pump the wastewater to a higher elevation. Lift stations concentrate the wastewater from trunk lines from a low-lying area in an underground concrete tank. Pumps lift this wastewater to infrastructure at a higher elevation. While not uncommon, lift stations are expensive to construct.

C. Small Diameter, Low Pressure Flow Lines



Low pressure, small diameter flow lines are an alternative means of conveying wastewater from the home to a treatment facility. A Septic Tank Effluent Pumping system (STEP) utilizes a small pump that is placed in an existing septic tank or cesspool (Schmidt, 2002). A small diameter hose is attached through which wastewater is pumped to the treatment facility. This system is very efficient. Pre-treatment in the on-site system prevents objects from clogging the small diameter sewer lines, and increases the efficiency of the centralized treatment facility.

A grinder pump system utilizes a pump (about $2,500 each) roughly the size of a washing machine to expel water through small diameter pipes. This type of system does not utilize existing septic systems, and instead grinds the sewage before pumping it to the centralized treatment facility (Schmidt, 2002).

This type of system has several advantages over traditional infrastructure. The components are less costly, require less maintenance, and instillation requires less trenching. The system is pressurized, so it is not necessary to design with gravity and the overall length of infrastructure is reduced. Its greatest advantage is possibly the elimination of ground water infiltration. This type of infrastructure has been successfully used throughout the country to provide sewer service to otherwise unserviceable areas.

8.6.1 System Cost Comparison

The cost of each of the infrastructure will vary. Cost should be considered in light of efficacy, locational appropriateness and ecological compatibility. The following table is an example of a cost comparison between the three different systems.

Table 10. Comparing Costs across Wastewater Systems

System	Users	Total Cost	Maintenance/yr	Cost per User
Conventional System	550	$7,857,000	$100,800	$14,500
Grinder Pump System	550	$6,155,000	$31,500	$11,200
STEP System	550	$5,675,000	$36,000	$10,400

Source: Schmidt (2002).

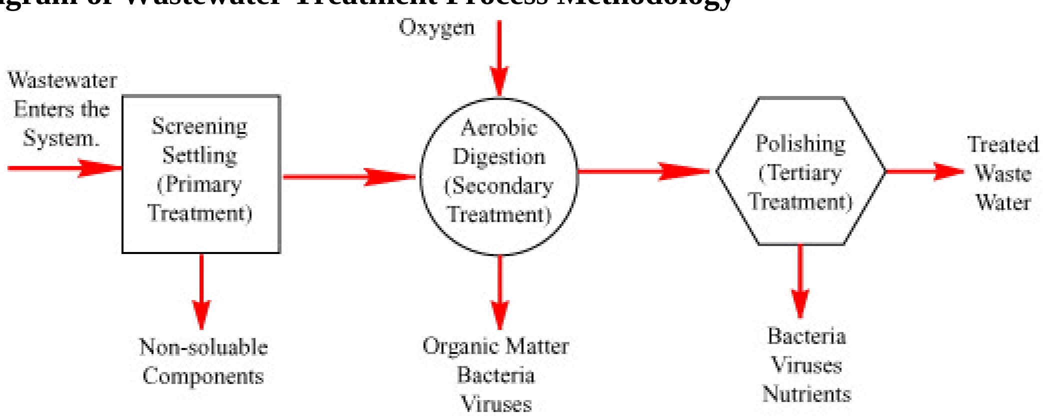
8.7 Treatment

Wastewater, whether collected and processed centrally or disposed of in septic systems, is treated in several standardized steps. Each step removes impurities from wastewater to achieve water qualified for release into the environment. To better explain the operation and suitability of wastewater treatment options presented, it is necessary to first explain the function of these steps.

Wastewater is comprised on 99.9% water (Kimball, 2002), non-dissolved solids, organic matter, nitrogen, phosphorus, minerals, bacteria, and viruses. A treatment regime should address the removal of all these components from the wastewater.

The organic component of wastewater is determined by measuring biochemical oxygen demand (BOD). BOD is the amount of oxygen necessary for bacteria and other organisms in the wastewater to breakdown the organic components in a 5 day period (Kimball, 2002). One part per million of oxygen is indicative of drinking water, while wastewater requires several hundred ppm (Kimball, 2002).

Diagram of Wastewater Treatment Process Methodology



Stage 1 Preliminary Treatment – Filtering/Screening

This simple stage collects large materials, which enter the wastewater system before they damage equipment later in the process. There are many accounts of large and unusual objects collected at this stage.

Stage 2 Primary Treatment - Settling

The first major component of any wastewater treatment regime is the settling area. In this stage wastewater enters a holding basin where non-dissolved solids are allowed to settle to the bottom (sludge) and rise to the surface (scum). This step occurs in all sewage treatment options. Public facilities may use constructed containers or buried tanks, while septic systems contain a cell where waste water is allowed to settle before draining to the leech lines. This step may remove 50%-70% of suspended matter from the wastewater and up to 33% of the BOD (Kimball, 2002).

Sludge and scum are hazardous materials that may contain heavy metals, industrial toxins, organic matter, nitrogen, phosphorus, minerals, bacteria, and viruses. Sludge is processed in closed vessels where *anaerobic* (without oxygen) bacteria already present in the sewage break down the various components (Kimball, 2002). Methane is produced and may be captured and utilized as a fuel source. When *anaerobic* digestion is complete, the remaining matter is dried and disposed of in sanitary landfills.

Septic systems also "digest" organic matter anaerobically before discharging the water to leech lines, which drain into the ground. In the case of a septic tank, settled sludge is pumped out at regularly scheduled intervals then transported to a wastewater facility for further treatment.

Stage 3 Secondary Treatment – Lowering BOD

The second stage in modern treatment system is *aerobic* (in the presence of oxygen) digestion. Here, bacteria and micro-organisms which utilize oxygen breakdown remaining organic components. After secondary treatment, wastewater typically contains 90% less BOD (Kimball, 2002), 99% less bacteria, and 90% less viruses (The Marine Conservation Society, 2002).

Many treatment facilities add chemicals such as cholorine[2] and discharge the water after this stage. Secondary treatment does not remove nitrogen or phosphorus. It is these elements of wastewater that, when discharged into water bodies, cause algae blooms (Kimball, 2002).

Stage 4 Tertiary Treatment – "Polishing"

A final treatment may be applied to wastewater to ensure that bacteria and viruses have been eradicated, and to remove remaining nitrogen and phosphorus. Tertiary treatment is generally optional, and may be accomplished a number of ways, depending heavily upon system design.

Typical wastewater treatment solutions may utilize chlorine, ozone, or other chemicals to kill remaining bacteria and viruses (additive), others may use ultraviolet light techniques (non-additive) (The Marine Conservation Society, 2002).

Chemical processes have been developed to accomplish *nutrient stripping* – the removal of nitrogen and phosphorus from wastewater. This technology is additive and requires the use of many compounds whose long term effect on the environment may not be completely known.

An alternative concept of nutrient stripping is to use the inorganic nutrients as fertilizers in planted wetlands or planted fields. Planted field application is limited to moderate wastewater loads because of size considerations. Planted wetlands may be constructed to treat individual or municipal volumes of wastewater.

Tertiary treated water is at, or near, drinking water quality levels, and is generally cleaner than the water into which it is discharged. This should not, however, interfere with consideration of the types of chemicals, which have been added to the water to achieve this quality. The long-term effect of discharging chemically treated wastewater into sensitive ecosystems may be unpredictable and unknown.

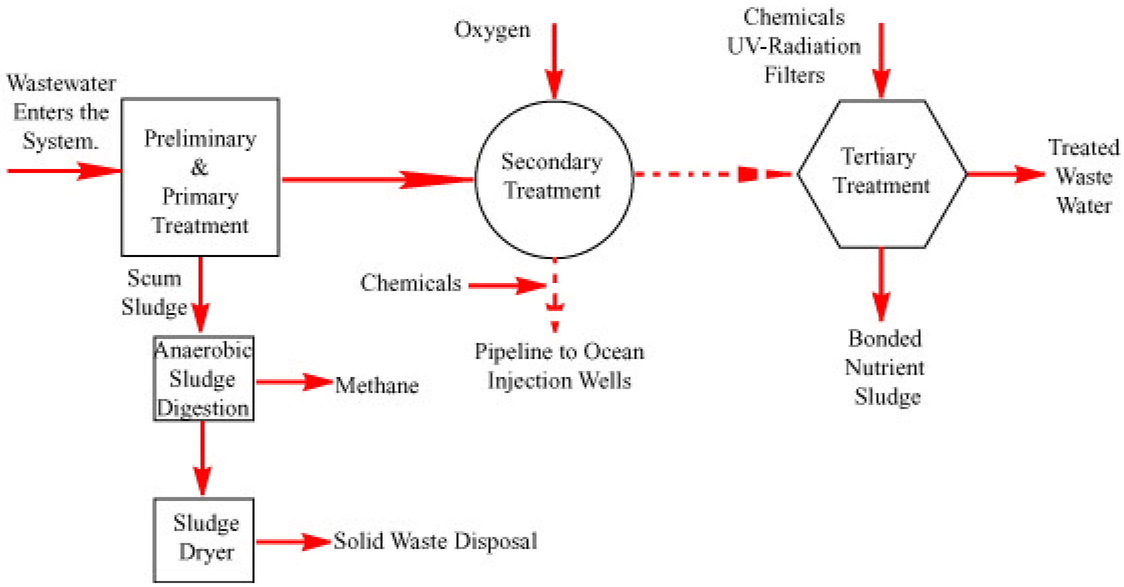
8.7.1 Treatment Options

The treatment option chosen by the community will be the most visible aspect of the wastewater treatment system. Five major treatment options are presented here. This is by no means an exhaustive list; each community must identify constraints and determine an option appropriate to their circumstances.

The major options presented here - traditional treatment, constructed wetlands treatment, living machine contained system, and septic systems – can be engineered to serve under varying constraints. Each also follows the treatment methodology previously described.

All treatment options begin with screening and settling stages. The secondary treatment is also consistent across most systems. The tertiary treatment is where the most variation in technique and technology occurs.

A. Traditional Treatment Facility – Secondary Treatment, Tertiary Treatment



Traditional treatment systems are the most common type of treatment method in Hawai'i. These systems utilize mechanical, biological, and chemical processes to remove harmful components from wastewater. Hanalei has two existing traditional treatment *package plants* serving local businesses. Princeville is also served by a package plant.

1. Preliminary and Primary Treatment

Traditional treatment facilities are the most common type in Hawai'i. Underground infrastructure collects and concentrates wastewater. Wastewater drains to the treatment facility where it is screened and passed to a settling tank. Sludge and scum separate from the wastewater during settling, and are removed for processing.

2. Secondary Treatment

After setting, wastewater is passed to a secondary treatment cell where aerobic organisms digest organic components, bacteria, and viruses. In Hawai'i this is generally the highest order of treatment applied to wastewater before chemicals are added and it is released into the ocean by use of *outfalls* (multi-mile pipelines) or into the ground by injection wells.

3. Tertiary Treatment

Additional treatment of the wastewater to tertiary levels is possible though expensive to construct and operate. Tertiary level treatment may be accomplished several ways. Ultraviolet light and micro-porous filers are non-additive technologies which remove bacteria and viruses from the wastewater. Ultraviolet light kill most bacteria and viruses, while the micro-porous filter contains holes too small for viruses and bacteria to pass through.

Removal of bacteria and viruses may also be accomplished using additive technologies; chemicals such as chlorine or ozone (highly unstable oxygen molecules which bind to bacteria and viruses) may be added to the wastewater before discharge. Additive techniques have the disadvantage of contributing chemicals to the effluent discharge.

Nutrient stripping is a technique, which removes nitrogen and phosphorus from wastewater. Compounds that bond to nitrogen and phosphorus are added to the wastewater. After bonding with nutrients the compound falls out of the wastewater. It is then removed and treated with sludge.

A.1 System Considerations

There are several factors to take into account for each system when deciding upon the best wastewater treatment facility.

1. Disposal of by-products

The assumption is made that sludge and scum will be taken to a remote facility for processing. This is done because it would be beyond of the means of most small treatment facilities to operate their own sludge drying beds. Each system option will produce approximately the same amount and type of sludge and scum. All systems will produce a byproduct that must be disposed of as solid waste.

2. Discharge effects

Traditional treatment methods introduce chemicals such as chlorine into the effluent before it is discharged. The long term effects of these chemicals on the ecology of the environment into which they are introduced must be studied.

Wastewater treated to the secondary level and then discharged still contains 100% of its inorganic nutrients. These nutrients encourage algae blooms, kill aquatic life, and severely damage coral.

Effluent discharge effects will vary by the level of treatment given to the wastewater. Water treated to tertiary levels would conceivable cause fewer environmental changes than primary treated water. This may depend greatly on the methods used to treat water to tertiary levels.

3. Flooding considerations

With proper sighting, traditional sewage treatment facilities will not pose a potential environmental or health hazard during periods of flooding. Unfortunately, because most infrastructures are designed to take advantage of gravity, treatment systems are often located in low areas near coasts and rivers. The dual advantage of this type of sighting is reduced need for expensive lift stations and convenience of discharging into a water body. This type of sighting must be avoided because severe flooding experienced along the Hanalei River may cause waste to seep from enclosures.

4. Odor

Measures can be taken to mitigate the odor produced by all wastewater treatment facilities. Traditional wastewater treatment facilities are not widely considered to be odor-free to the same extent that other methods discussed are.

5. Bulk, Mass, and Appearance

Traditional wastewater treatment facilities are less than desirable structures. The site size necessary for a treatment plant depends on its capacity. Facilities to treat commercial facilities, often called *package plants*, are relatively small and unobtrusive. Municipal facilities are generally larger, and often placed near the outskirts of town because of their unsightly appearance. Traditional treatment facilities are closed to the public by means of a fence or wall.

6. Safety considerations

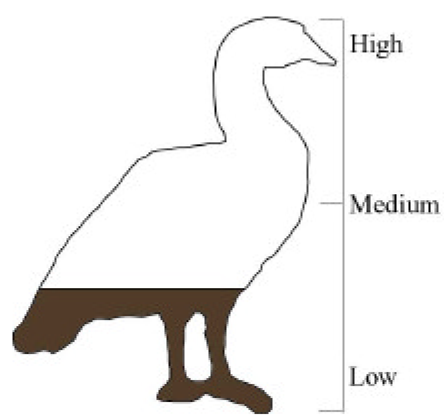
Traditional wastewater treatment plants have few safety considerations as they are closed to the public by means of a fence or wall.

7. Cost

The cost of traditional sewage treatment facilities varies by capacity, technology, and treatment level. Systems designed to treat water to tertiary levels will be much more expensive than simple advanced primary treatment. Several small package plants may be more economical than a single centralized facility if traditional treatment is chosen.

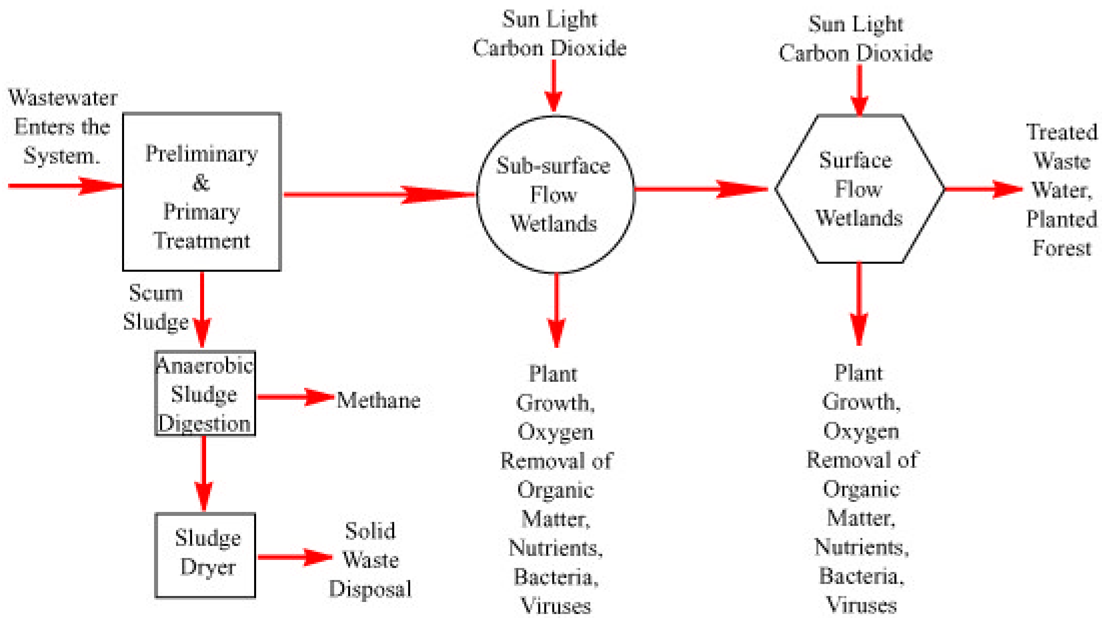
Traditional Treatment Facility

Summary	**High**	**Average**	**Low**
Discharge effects		X	
Effluent Quality	X	X	X
Flooding considerations		X	
Odor		X	
Bulk, Mass, and Appearance	X	X	
Safety considerations		X	
Cost	X	X	
Maintenance Labour	X		



Low Sustainability

B. Constructed Wetlands Treatment



Constructed wetlands are becoming an increasingly popular wastewater treatment alternative. These systems are inexpensive to construct and maintain, they require few moving parts and no chemicals. Their versatility allows systems to be constructed at the individual or municipal scale. Constructed wetlands also have a lower psychological impact on effected neighborhoods than traditional treatment facilities – constructed wetlands can be viewed as an amenity.

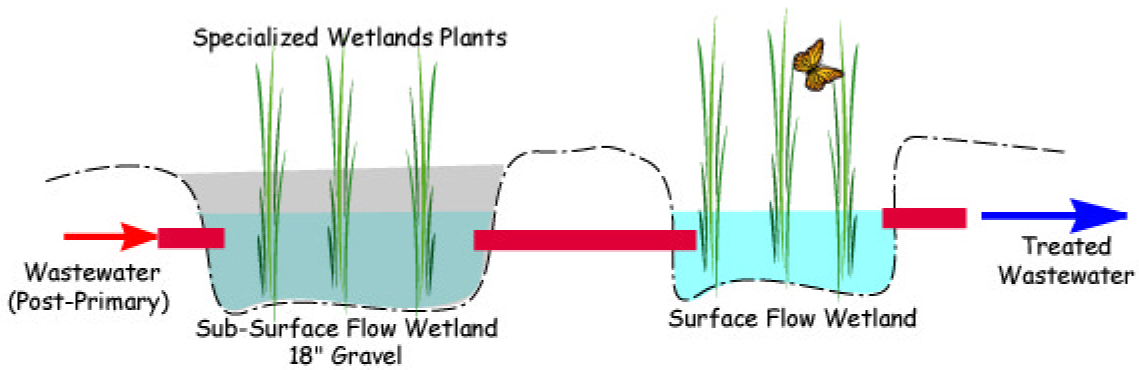
1. Preliminary/Primary Treatment

In a constructed wetlands treatment system preliminary and primary treatment is accomplished in the same manner as other systems. A screening process removes large potentially damaging materials from the waste stream. Wastewater is then passed to a primary treatment *cell* (tank) where sludge and scum separate. Sludge is then removed for proper treatment.

2. Secondary Treatment

Constructed wetland wastewater treatment differs from traditional secondary and tertiary treatment. Wastewater first enters a cell where oxygen is introduced into the effluent to encourage the growth of bacteria. The effluent is then transferred to a constructed wetland or shallow pond. Plants grown in the wetland absorb organic matter and inorganic nutrients, beneficial bacteria harbored by the plants' roots also assist in the reduction of BOD, nitrogen, and phosphorus in the wastewater. A University of South Alabama study measured the quality of effluent from secondary wetland treatment cells and found that 76.8% BOD, 99% Fecal Coliform, and 40.2% Ammonia were removed (University of South Alabama, 2002).

Surface Flow and Sub-Surface Flow Type Wetlands



There are two types of wetlands constructed for wastewater treatment. Surface flow wetlands allow effluent to flow through a shallow pond planted with appropriate local species. Species type is determined by identifying local varieties of aquatic plants capable of surviving water conditions and assessing their nutrient uptake abilities.

Subsurface flow wetlands are a shallow pond similar to the previous type. The pond, however, is filled with gravel to a depth of 18". Plants are rooted in the gravel bed, and a water depth of 12" is maintained (Pee Dee, 2000).

Surface flow wetlands typically provide better habitats for wildlife and are less expensive to construct. Subsurface flow wetlands create a stronger filtering process and lower BOD more per given area (Tanner, 2002). Subsurface flow wetlands leave "less possibility for human or wildlife contact with wastewaters and less potential for insect infestation" (Tanner, 2002).

To achieve maximum benefit, secondary treatment could be performed in a sub-surface flow wetland cell. Wastewater can then be transferred to a surface flow wetland cell for tertiary "polishing" treatment.

3. Tertiary Treatment

Water flows from the subsurface type wetland into a second surface flow wetland cell. Here water is "polished" by additional wetland plantings. The University of South Alabama found that after tertiary wetlands treatment 90.7% BOD, 100% Fecal Coliform, and 99.9% Ammonia are removed from the wastewater (University of South Alabama, 2002).

B.1 System Considerations

Like the traditional system, constructed wetlands must be subjected to the same considerations.

1. Disposal of by-products

The assumption is made that sludge and scum will be taken to a remote facility for processing. This is done because it would be beyond the means of most small treatment facilities to operate their own sludge drying beds. Each system option will produce approximately the same amount and type of sludge and scum. All systems will produce a byproduct that must be disposed of as solid waste.

2. Discharge effects

Constructed wetlands treatment systems use no chemicals. Discharged water may meet drinking water standards. Discharge of treated water from small systems into planted forests ensures remaining nutrients are removed, and contributes to aquifer recharge.

3. Flooding considerations

Flooding is a major consideration in the sighting of wetlands treatment systems. While significant advances in pond liner technology prevent waste from seeping into the ground, severe flooding, such as that experienced in Hanalei, could potentially introduce large amounts of post-primary treatment wastewater into the local eco-system.

The sighting of constructed wetlands treatment system is much more versatile than that of traditional systems. The natural appearance of the system allows it to be constructed in the vicinity of the community rather than on the edge of development. This allows more flexibility in communities planning for gravity flow infrastructure.

4. Odor

Wetlands treatment systems are designed to be odor free. The biological system created in the wetland naturally destroys offensive odors.

5. Bulk, Mass, and Appearance

Constructed wetlands are natural in appearance. There exists little difference in appearance between a constructed wetland and a natural one. Some constructed wetlands even attract visitors because of the scenic value. A range of site sizes is presented in the cost estimate table.

6. Safety considerations

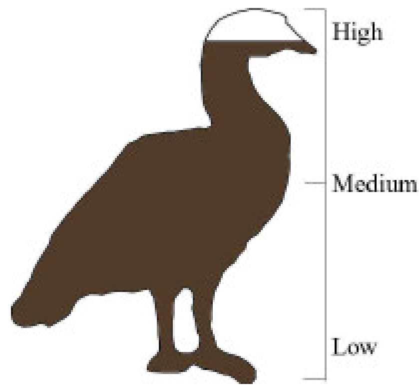
Constructed wetlands have been made extremely safe by two recent developments. Extremely strong polymer based plastic liners prevent seepage from the wetland in a variety of harsh conditions. These relatively inexpensive liners carry multiple year warranties against defects. Second, sub-surface flow wetlands prevent public contact with wastewater and insect infestations. When wastewater reaches the surface flow wetland cell it is significantly less prone to contaminating humans, wildlife, and insects.

7. Cost

System cost will vary by size. Wetlands are easily constructed, sub-surface flow wetlands costing slightly more due to gravel component.

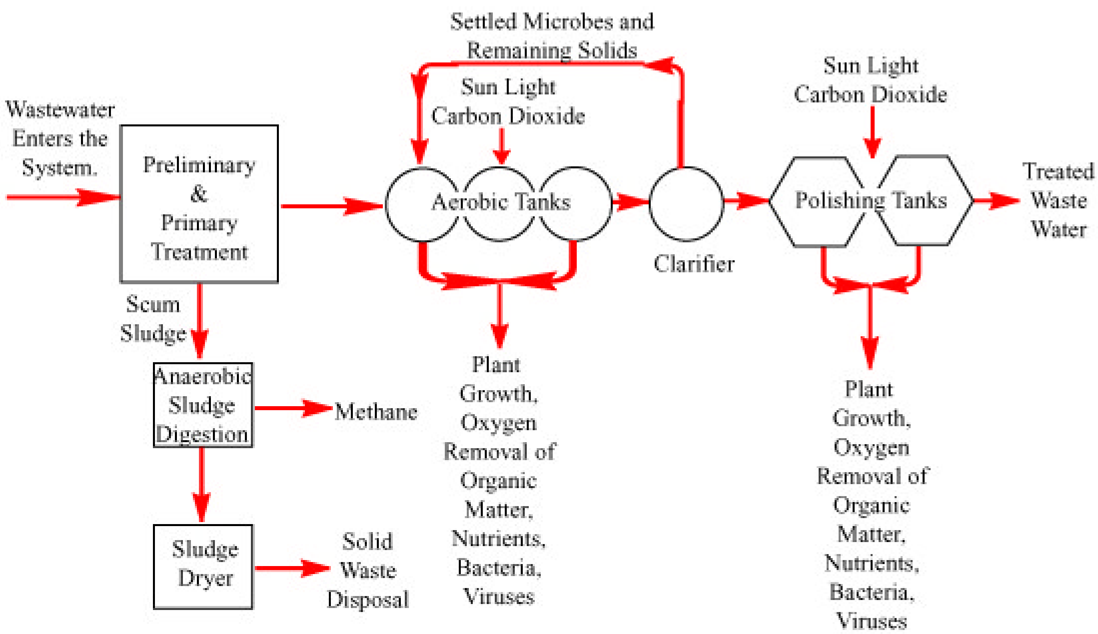
Constructed Wetlands Facility

Summary	High	Average	Low
Discharge effects		X	X
Effluent Quality	X	X	
Flooding considerations	X		
Odor			X
Bulk, Mass, and Appearance			X
Safety considerations		X	X
Cost		X	X
Maintenance Labour			X



High Sustainability

C. Living Machine Contained System



The Living Machine is a process designed by Living Machines, INC., which mimics the actions of the ecosystem in constructed wetlands, but in a much smaller area. Living Machines utilize large planted tanks instead of constructed ponds.

1. Preliminary/Primary Treatment

A Living Machine receives wastewater in a settling cell in the same manner as other systems. A screening process removes large potentially damaging materials from the waste stream, and insoluble matter is allowed to settle. Anaerobic bacteria feed on organic matter, with resultant methane filtered through charcoal to remove odors. Wastewater is then passed to a secondary closed aerobic reaction cell (Living Technologies, 2002)

2. Secondary Treatment

The closed aerobic reactor introduces oxygen to the wastewater to encourage the growth of beneficial bacteria and the reduction of BOD. Plants located in the tank remove nitrogen and other nutrients from the effluent. Effluent is then passed to a series of open aerobic reactors. These tanks, containing a variety of plants, complete the removal of nitrogen and reduce the BOD to secondary treatment standards (Living Technologies, 2002).

Finally, a clarifier tank allows microbial organisms and any remaining solids to settle out of the treated water before it receives tertiary treatment. Sludge from the clarifier is returned to the closed aerobic reactors for additional purification (Living Technologies, 2002).

3. Tertiary Treatment

A final tank contains a variety of microbial organisms which remove any remaining organic matter and nutrients from the wastewater. These tanks may be connected in series to meet the most stringent of water quality standards.

C.1 Systems Considerations

The Living Machine, similarly, is subject to the same system considerations.

1. Disposal of by-products

The assumption is made that sludge and scum will be taken to a remote facility for processing. This is done because it would be beyond the means of most small treatment facilities to operate their own sludge drying beds. Each system option will produce approximately the same amount and type of sludge and scum. All systems will produce a byproduct that must be disposed of as solid waste.

2. Discharge effects

Living Machine treatment systems use no chemicals. Discharged water meets the DOH R2 standards for recycled water, which means recycled water can be used for agriculture. It may also meet drinking water standards. Discharge of treated water from small systems into planted forests ensures remaining nutrients are removed, and contributes to aquifer recharge.

3. Flooding considerations

Flooding is a consideration in the sighting of Living Machine treatment systems. Severe flooding such as that experienced in Hanalei could potentially introduce large amounts of post-primary treatment water into the local eco-system if the facility were to be flooded.

The sighting of Living Machines is much more versatile than that of traditional systems. The garden/greenhouse appearance of the system allows it to be constructed in the vicinity of the community rather than on the edge of development. This allows more flexibility in communities planning for gravity flow infrastructure.

4. Odor

Living Machine treatment systems are designed to be odor free. The biological system created in the tanks destroys offensive odors.

5. Bulk, Mass, and Appearance

Living Machines may be constructed in a green house or in the open. Many Living Machines are open for tours upon request, and hold educational programs for local students. A range of site sizes is presented in the cost estimate table.

6. Safety considerations

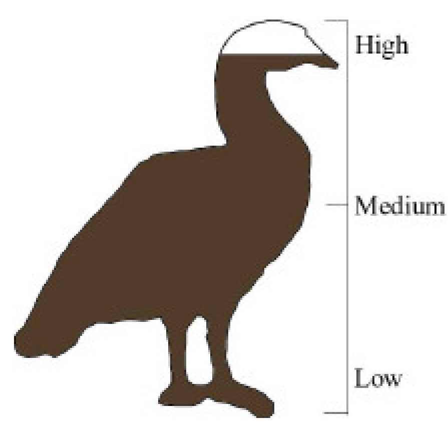
Living Machines have no special safety issues.

7. Cost

The cost of the Living Machine treatment facilities varies by capacity, technology, and treatment level. Systems designed to treat water to tertiary levels will be more expensive than tertiary treatment. Similarly, system cost will increase as service capacity expands. A small Living Machine in conjunction with other treatment options may be more economical than a single centralized facility. Unless constraints are prohibitive, a constructed wetland treatment system will probably deliver greater capacity at a lower cost of construction and operation than a Living Machine.

Living Machine Contained System

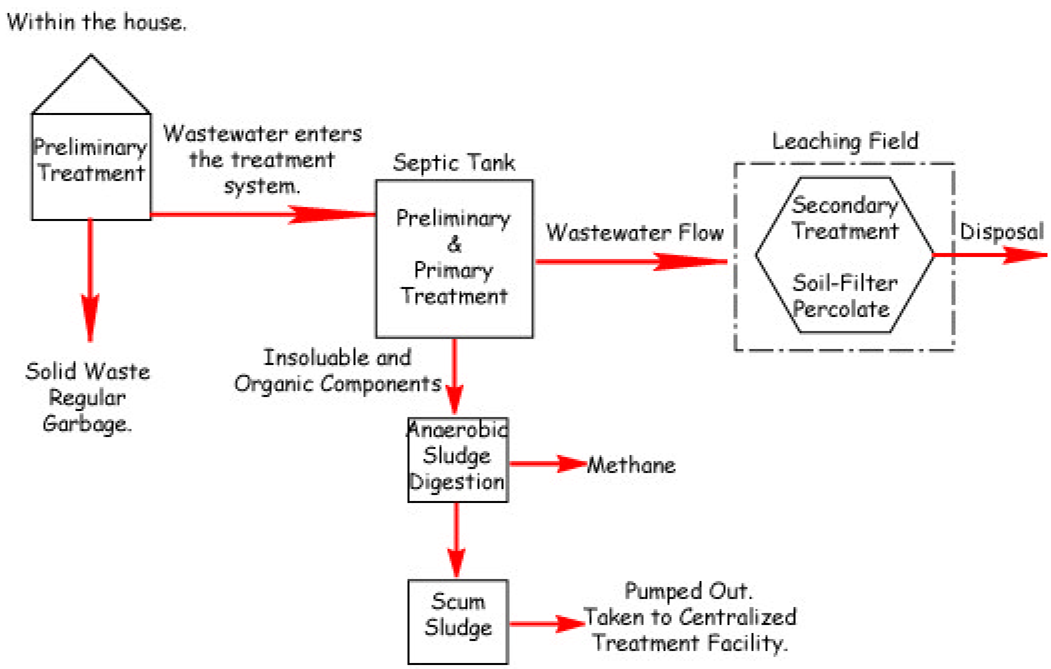
Summary	High	Average	Low
Discharge effects		X	X
Effluent Quality	X	X	
Flooding considerations		X	X
Odor			X
Bulk, Mass, and Appearance		X	X
Safety considerations			X
Cost	X	X	X
Maintenance Labour		X	X



High Sustainability

For additional information on the Living Machine or a financial assessment for constructing a living machine in Hanalei, contact Chad Durkin. He is a human ecologist presently employed with Ocean Arks International: 808-392-0210 or 802-860-0011. One can also visit the website at *www.oceanarks.org*. A parameter sheet is attached at the end of this report.

D. Conventional Septic System



Septic systems house a living ecosystem. This system is sensitive and requires care and occasional maintenance. A properly operating septic system will sufficiently treat wastewater for release into the environment. Septic systems are a viable option when site conditions and system design are correct.

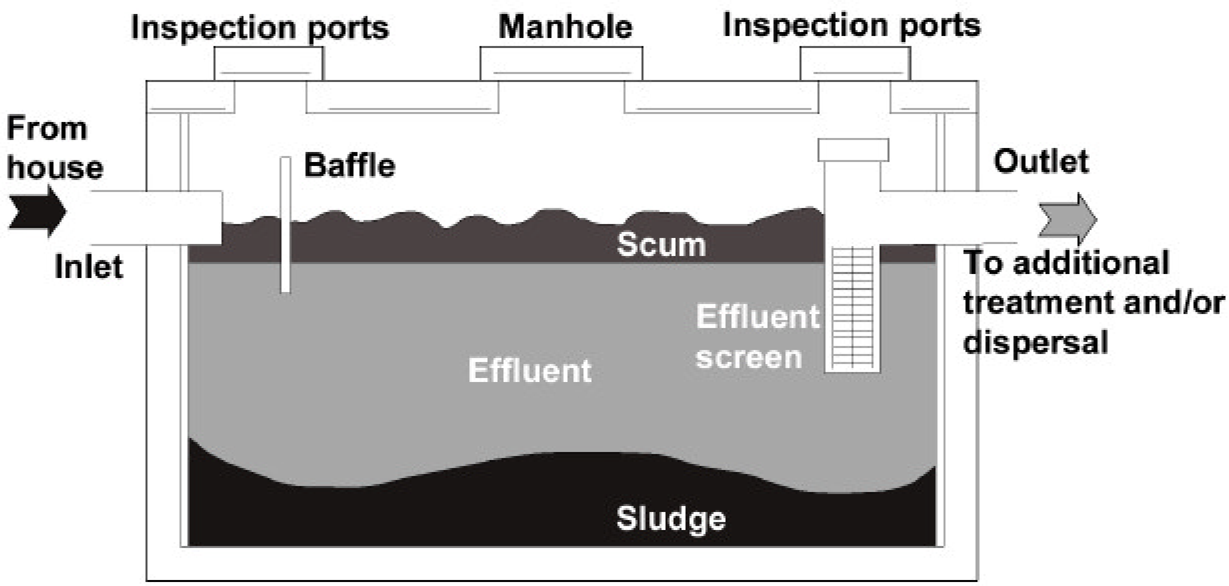
1. Preliminary Treatment (Within household)

On-site septic systems are a common treatment method in Hawai'i. To properly care for the system, the user should keep the solid waste and regular garbage out of the system. This part of preliminary treatment takes place within the individual household.

2. Preliminary/Primary Treatment

Part of preliminary and primary treatment occurs in the septic tank. Figure 6 shows the components of a typical septic tank. A septic tank can remove many of the settleable solids, oils, greases, and floating debris in the raw wastewater, achieving 60% to 80% removal (EPA, 2002). Within the tank, the wastewater is screened again, and a small part of untreatable solid waste is separated. Bacteria partially decompose and liquefy the solids, so the organic components are "digested" anaerobically in the tank. The heavier solids (sludge) settle to the bottom and the grease and fatty solids (scum) float to the top. The settled sludge is pumped out at regularly scheduled intervals, and transported to a wastewater facility for further treatment. Baffles in the tank provide maximum retention time of solids to prevent inlet and outlet plugging, and to prevent rapid flow of wastewater through the tank. The effluent screen in the outlet tee can keep large solid waste in the tank.

Picture 16. Typical Single-compartment Septic Tank

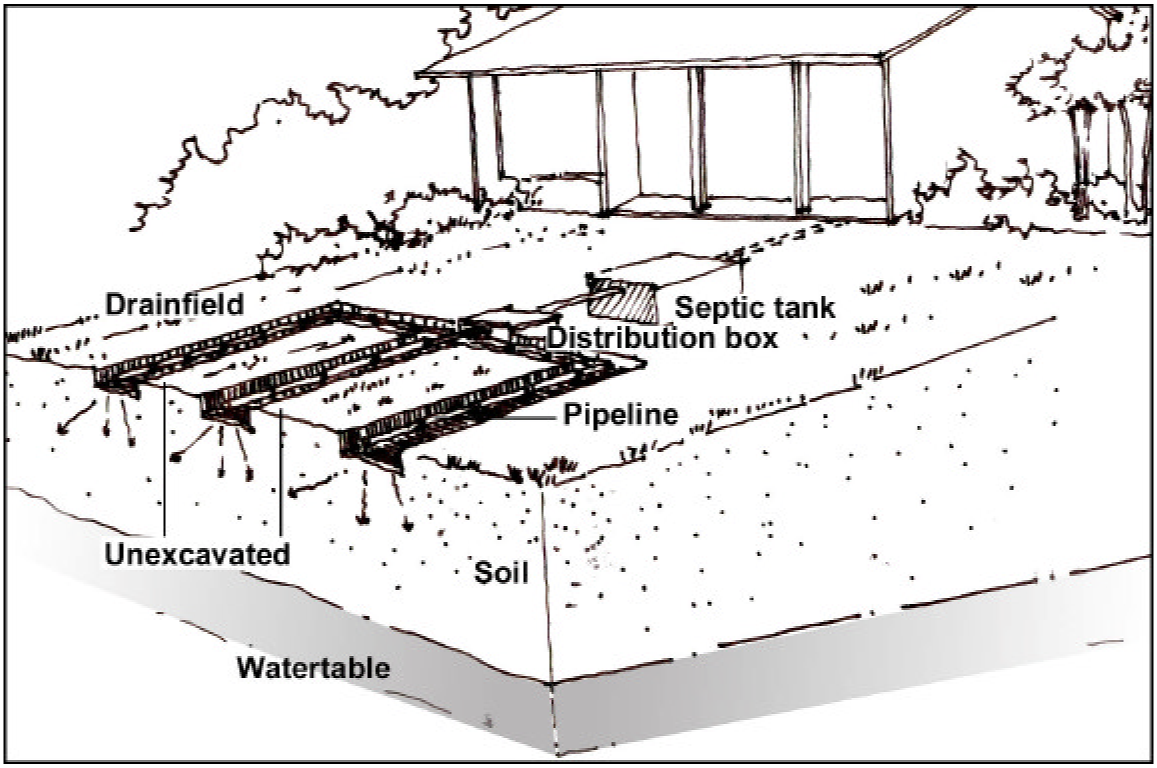


3. Secondary Treatment/Disposal - Leaching Field

The difference between septic systems and the previous three methods is that the secondary treatment and the disposal are combined together in the leaching field. The *effluent* (liquid portion) flows through an outlet on the septic tank to the soil absorption field. The soil absorption field treats the effluent by natural physical, chemical, and biological processes (Robotham, 2000). The soil filters remaining minute solids, some dissolved solids, and pathogens. Water and dissolved substances slowly percolate outward into the soil and down toward ground water or restrictive layers. A portion of the water evaporates into the air, and plants growing over the drain field lines utilize some of the water.

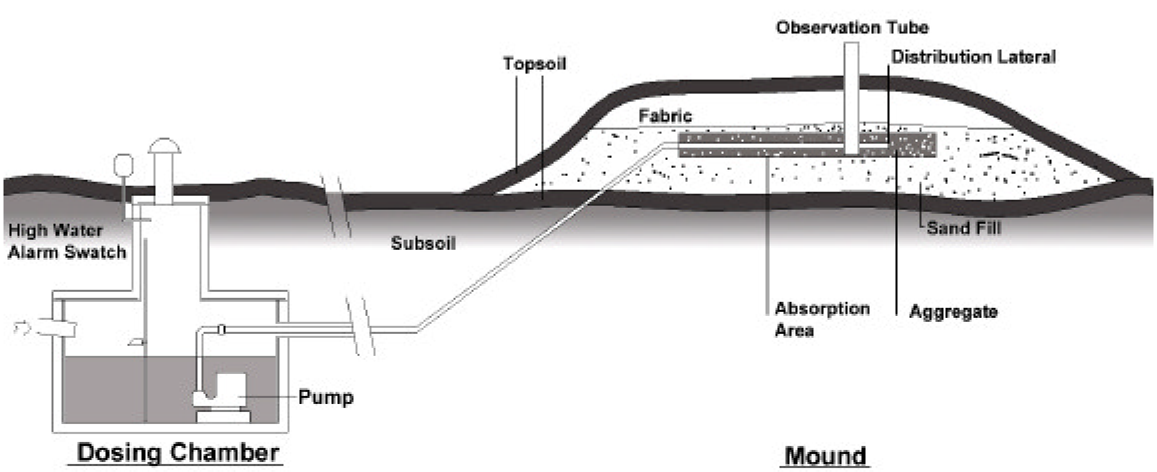
Conventional septic systems can remove 20% of Nitrogen from the wastewater (EPA, 2002). The flow out of the tank is not "polished" enough, so additional treatment is provided by the leaching field.

The performance of conventional septic systems relies primarily on treatment of the wastewater effluent in the disposal field. Based on the soil percolation, local water table, and site slope, the onsite wastewater disposal regulation dictates the design of the leaching field. Subsurface Wastewater Infiltration System (SWIS) is the most commonly used system for the dispersal of onsite wastewater



To offset inadequate vertical separation in locations with a high water table, the design can raise the infiltration surface by creating a mound. If the underlying soil is slowly permeable, it might be advantageous to raise the raise the infiltration surface with a mound system constructed of suitable sand fill.

Picture 17. Typical Mound System



D.1 Environmental Considerations

1. Disposal of by-products

To begin the study, the assumption is made that sludge and scum will be taken to a remote facility for processing. The total by-product of the area using the septic system will be approximately the same as other options. Septic systems require maintenance to keep the system working well. The primary maintenance is to clean the tank – pump the sludge and scum out. This is generally done by a specialized company. They will transport the sludge to the nearest treatment plant.

2. Discharge effects

Secondary treatment and discharge are combined in the disposal field. The discharge field is on-site. The quality of the treated wastewater depends on the quality of the disposal field. A constructed mound uses soil to raise the disposal field. It is used where the soil does not have enough absorption capacities or where the water table is too high.

3. Flooding considerations

Flooding is a consideration for the septic system, during flooding, the tank will fill with water and the leaching field will be disrupted, the whole system will fail temporarily.

4. Odor

The septic treatment system is designed to be odor free. The anaerobic treatment process within in the tank can cause the odor, but proper tank conditions can keep odor within the tank. Improper operation and maintenance can cause odor to come from the leaching field.

5. Bulk, Mass, and Appearance

The septic treatment system is usually small scale, and the components are constructed underground.

6. Safety considerations

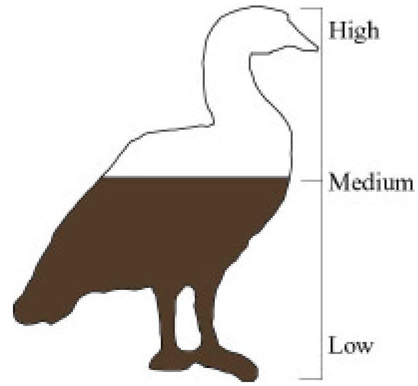
The septic system is a natural way to treat wastewater, therefore, the system depends on the environment. Soil type, seasonal high water table, and slope are factors that need to be considered for the safety of system design. Because the septic system is owned by an individual owner, operation is an important element. All of these factors can cause the failure of the system and create negative impact to local water quality.

7. Cost

Septic systems are subject to a one time installation fee and a pumping charge to remove sludge every 2 to 3 years. Additional maintenance costs are likely to be incurred where proper care practices are not followed.

Conventional Septic System

Summary	High	Average	Low
Discharge effects	X	X	X
Effluent Quality		X	X
Flooding considerations	X		
Odor			X
Bulk, Mass, and Appearance			X
Safety considerations			X
Cost			X
Maintenance Labour			X



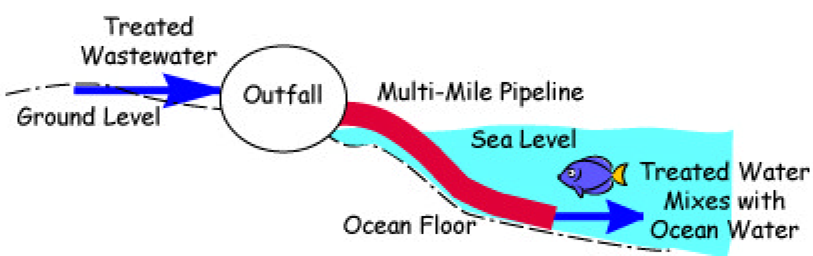
Medium Sustainability
Will work well when at capacity and properly maintained.

8.7.2 Disposal Options

In a properly designed and operated wastewater treatment system, after preliminary, primary, and secondary treatment process, the system has already removed most impurities from the wastewater, and it is of sufficient quality to release into the environment. In Hawai'i, for most treatment facilities, secondary treatment is the highest order of treatment applied to wastewater before it is released into the ocean by use of multi-mile pipelines or injected into the ground. Treated wastewater can also be discharged into the environment directly, like the leaching field of septic system.

Some wastewater may be recycled. Recycled water can be used on golf courses, or agricultural crops. Tertiary or higher-level treatment will be required.

A. Outflow

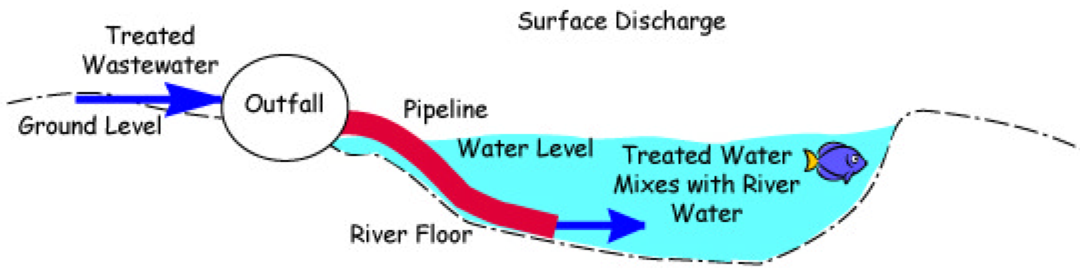


This method of wastewater disposal is utilized by the Honolulu Sand Island wastewater treatment facility. A pipeline discharges treated wastewater several miles off shore and several hundred feet underwater. Microorganisms in the ocean then utilize the inorganic nutrient components (nitrogen and phosphorus) of wastewater.

Determining placement and length of the pipeline ocean currents must be studied. Based on these factors a suitable length and location is chosen to prevent the inorganic nutrients from returning to shore, and to prevent massive algae blooms.

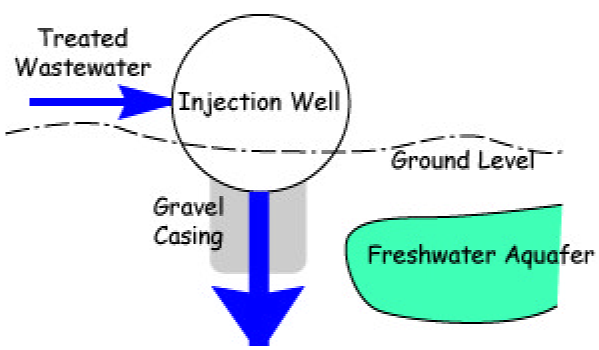
The use of a pipeline to dispose of post-secondary treatment effluent may be prohibitively expensive because of the length of pipe necessary to prevent nitrogen rich wastewater from returning to shore and/or causing massive algae blooms.

D. Surface Water Disposal



Surface water disposal is similar to an ocean outfall. Treated water is released through a pipe into a river. Here the treated wastewater mixes with river water, further diluting any remaining contaminants. Water discharged in this manner must meet exacting quality standards.

E. Injection wells



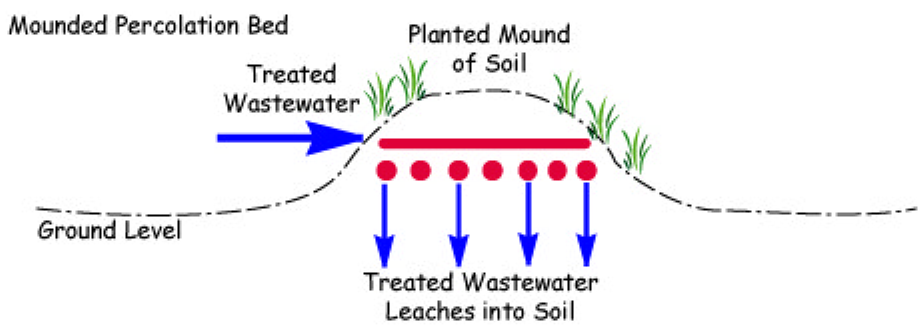
An alternative to discharging effluent into the ocean is the use of injection wells. Injection wells are drilled deep into the ground above, below, or adjacent to drinkable ground water supplies. Treated wastewater is pumped into these wells and discharged into the ground. Care is taken to place these wells sufficiently far from drinkable water sources to avoid contamination.

Even with proper placement, wastewater discharged into the wells may seep through fissures in volcanic rocks or lava tubes and into aquifers or the ocean. Maui County's injection wells are improperly placed for the amount of effluent discharged. This may have contributed to a 2001 algae bloom between Kaanapali to Kapalua that resulted in a loss of tourism equaling "from 5 percent to 10 percent in gross revenues during the algae bloom" (Honolulu Star Bulletin, February 10, 2002).

Injection wells are prohibited in inland areas where clean drinking water aquifers are located. Hanalei sits partially within this Underground Injection Control Line.

C.1 Injection Control Line Map

Mounded Percolation Bed



A mounded percolation bed is used where soil absorption is not adequate to accommodate underground leech lines. A mounded percolation bed may also be utilized to move leech lines above the high water level of minor floods and high tides. This method works best for the wastewater of one user, or small group of users, and would not be appropriate for a large scale treatment facility.

Leech lines are buried in a mound of soil elevated sufficiently to be free of high tides and flood waters. The mound is planted to improve soil retention and nutrient absorption, adding an additional level of wastewater treatment. A small *dosing* pump may be necessary to raise wastewater from a septic tank to mound level.

8.7.2.1 Water Recycling

In Hawai'i it is possible to recycle wastewater for agricultural and lawn care applications. This wastewater must be treated at the tertiary level, and agents must be added to kill any remaining bacterial or viral components. Hawai'i guidelines require the use of ultraviolet radiation to kill pathogens in recycled water.

The amount of recycled wastewater used in Hawai'i doubled between 1993 and 2001 to 23 million gallons a day. Care must be exercised when considering the demand for recycled wastewater. In Maui it was hoped that almost all wastewater would be reused on golf courses, however, the consumers never materialized and the county is forced to overload "emergency" injection wells on a continual basis (Honolulu Star Bulletin, February 10, 2002). The guidelines for water recycling are included on the interactive CD-ROM.

8.7.2.2 Sludge and Scum Disposal

Large wastewater treatment plants are equipped with sludge and scum digesters and drying beds. This technology is beyond the scope of this report. For a facility of the size addressed by this plan, it is most feasible to transport sludge and scum to a larger facility for proper disposal.

8.8 System Configurations

Based on the number of users, treatment systems can be separated into three categories: individual on-site treatment system, cluster treatment system, and centralized treatment system. Hanalei might require a combination of these systems. On-site systems serving outlying areas, cluster systems in small residential areas, and centralized systems in more populated and commercial areas.

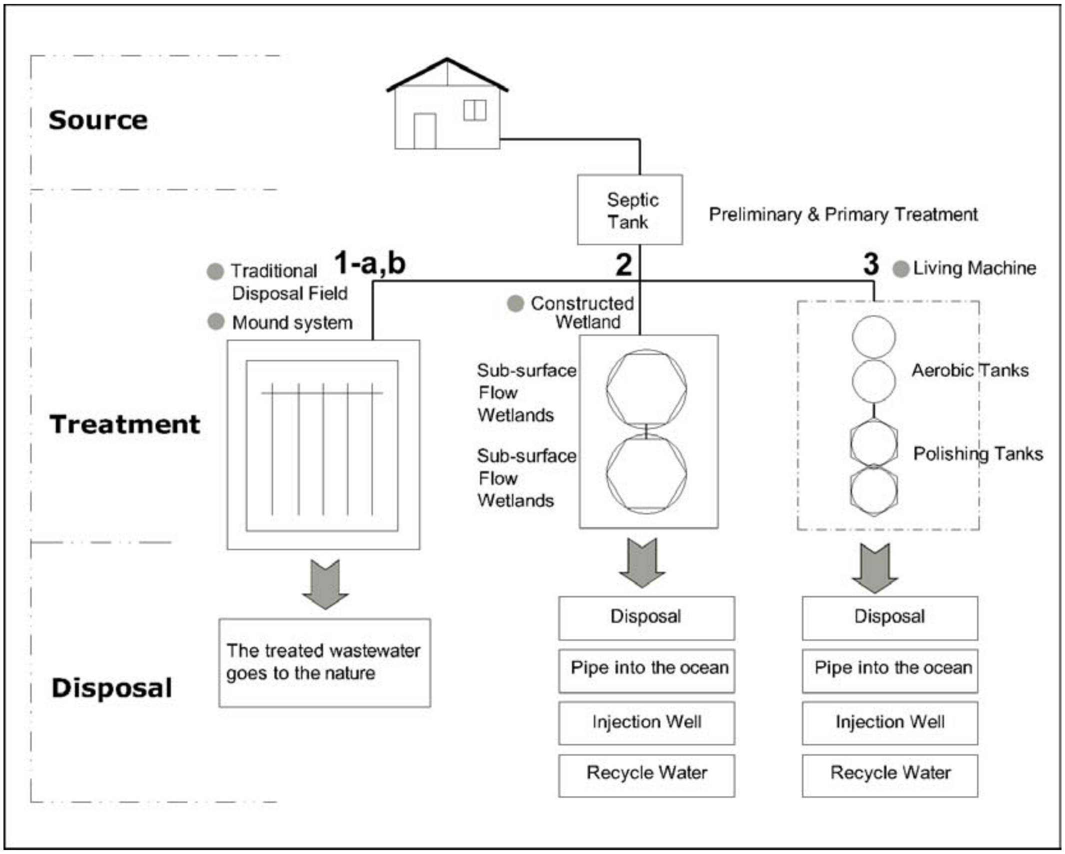
8.8.1 Individual On-site System

This system handles the wastewater from one residence on-site. It is very common in small communities where homes are not close together (Purdue University, 2002). The small amount of wastewater is treated on the site of its source, therefore, the cost of collection and transportation is saved. The disadvantage is that on-site systems have to be operated and managed by the individual owner. It relies on owner behavior and it is difficult to keep all of the systems working well.

Septic systems, small constructed wetland, and living machine are all possible choices for this system. Figure 1.9 is a diagram of an on-site system. Only septic systems are commonly used in on-site applications.

On-site systems work best on large lots. Septic systems require a low water table and permeable soils to treat wastewater. A variety of alternative onsite system designs are available to accommodate a range of difficult site and soil conditions. The most appropriate system depends on factors such as soil permeability, depth to water table, and depth to limiting layer.

Figure 1.9. Individual On-site Treatment System

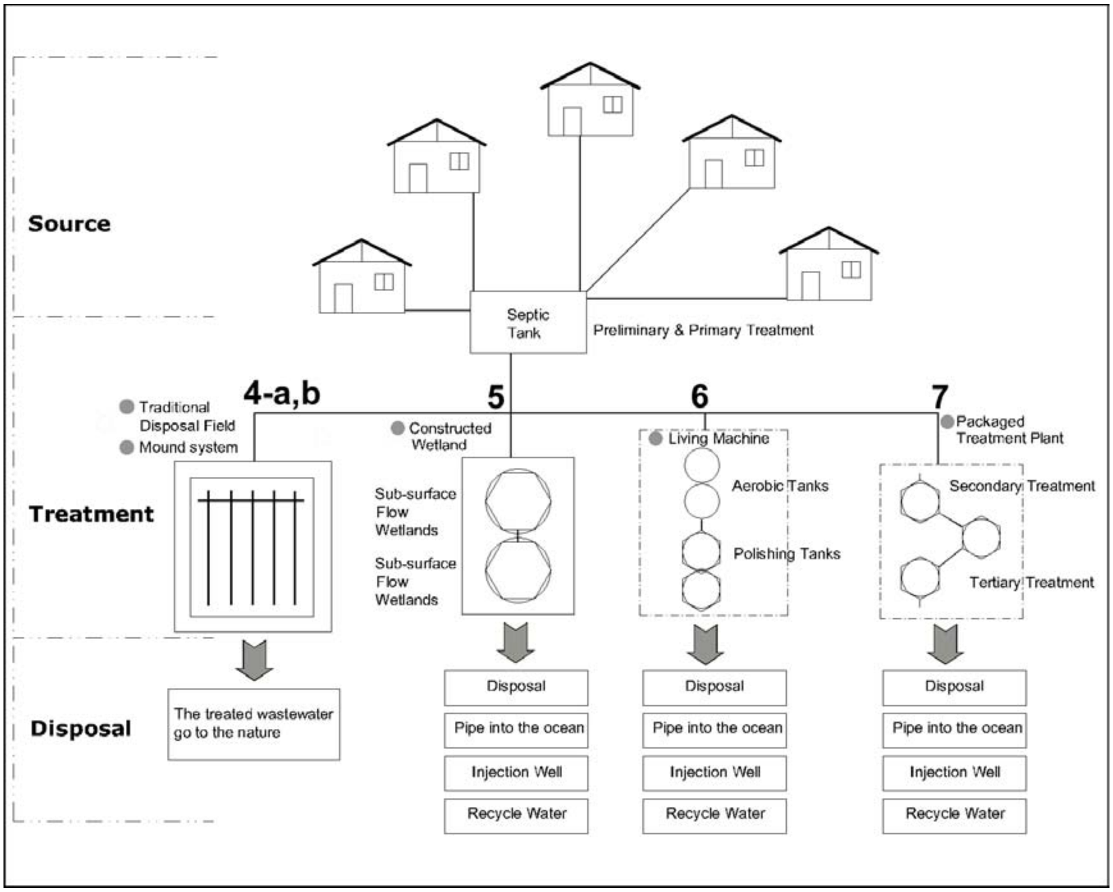


8.8.2 Cluster System

In some neighborhoods individual onsite systems are inappropriate, either because lots are too small or because other land characteristics make them impractical. In this situation, a cluster system might be appropriate (Purdue University, 2002). A cluster system normally uses low-cost alternative sewers to collect wastewater from households which concentrated together and transport it to a treatment/disposal facility. Septic systems, constructed wetlands, living machine, and traditional treatment are all possible choices for this system. Figure 1.10 gives a diagram of cluster system. This type of system can be suitable for developments or neighborhoods of up to 100 homes but is often used for smaller groupings (Purdue University, 2002).

As with any treatment system, a maintenance program is essential to ensure proper operation of a cluster system. Compared with conventional collection and treatment systems, cluster systems require minimal maintenance. The maintenance program, however, should always be in place and clearly spelled out to homeowners who use the cluster system (Purdue University, 2002).

Figure 1.10. Cluster Treatment System

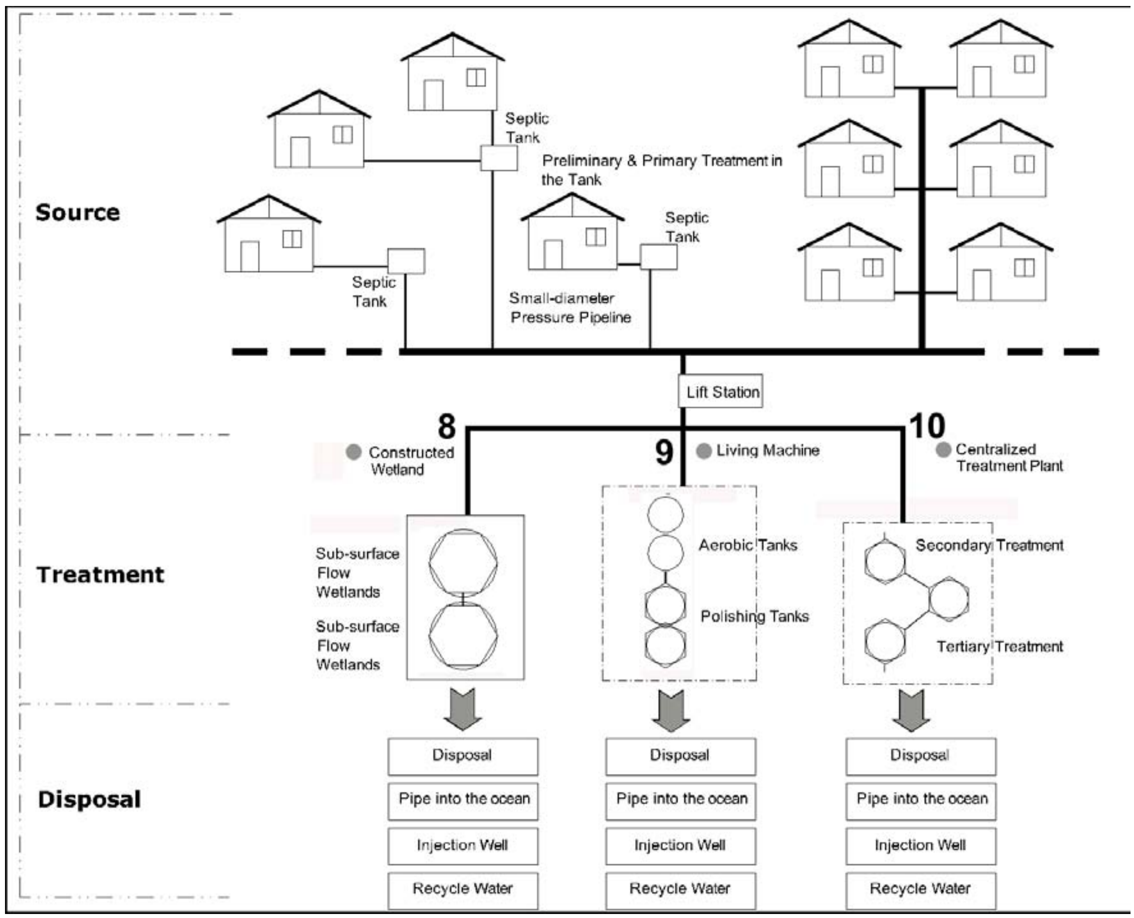


8.8.3 Centralized System

In more densely settled areas, where multiple cluster systems are needed and onsite systems are not practical, a centralized wastewater system might be necessary (Purdue University, 2002). Centralized systems need a sewer system to collect the wastewater. However, it is almost never practical for small communities because of the high cost. Conventional sewers usually account for over three-quarters of the total cost of a conventional wastewater collection and treatment system. If no lift stations are required, an alternative sewer – small-diameter gravity, pressure, and vacuum sewers – can save 25% to 50% of the capital cost of wastewater collection in small communities (Purdue University, 2002).

Constructed wetland, living machine and traditional treatment are all possible options for a centralized system. Figure 1.11 gives a diagram of the centralized system. Natural treatment technologies, such as constructed wetlands and Living Machines, generally require larger land areas than mechanical systems. Since this system treats the wastewater at a centralized location, less operation and maintenance is required of individual users. Despite the high cost of system construction for small community like Hanalei, in the long term it is still possible and reliable.

Figure 1.11. Centralized Treatment System



8.9 Comparing Wastewater Treatment Systems

Table 11 summarizes and compares each treatment system detailed above. The system constraints will be discussed from the aspects of flooding consideration, smell, bulk/sight, safety consideration, costs, and any specific constraints for that system. Evaluation will identify which systems can probably be used in Hanalei. To begin the study, the assumption is made that sludge and scum will be taken to a remote facility for processing. Each system option will produce approximately the same amount and type of sludge and scum. All systems will produce a byproduct that must be disposed of as solid waste.

Table 11. A Compendium of Treatment System Comparisons

Treatment System	System Components	Discharge of Wastewater	Constraints	Possibility for Hanalei
Individual On-Site System				
1-a. On-site septic tank + On-site field disposal (Conventional septic system)	Preliminary treatment in house - short pipeline - preliminary primary treatment in septic tank - short pipeline - secondary treatment and discharging within an on-site leaching field.	Because of the combination of secondary treatment section and discharging section, the discharge field is on-site too.	?Out of the flooding area. ?Little of odor in the yard. ? Safety considerations -rely on good soil type, low ground water table, low bedrock and slope, and good maintenance of individual owner. ?Small scale, in the yard. ?Low costs.	Yes
1-b. On-site septic tank + On-site mound disposal filed (alternative of septic system)	The same. A constructed absorption field or mound replaces the regular leaching field. Therefore a dosing pump or siphon is often used due to the mound is constructed at higher elevations than the septic tanks.	The same. The constructed mound uses good observation soil or material, which can raise the disposal field. So it is used in place where the soil does not have enough absorption capacities or in the place where is high seasonal water table is.	?Out of the flooding area. ?Little of odor in the yard. ? Safety considerations - because the mound is designed and constructed so the soil type, ground water table, low bedrock and slope are not problems, system relies on a good maintenance of individual owner. ?Small scale, in the yard. ? Low cost.	Yes
2. On-site septic tank + Small scale on-site constructed wetland	The primary treatment in the septic tank - short pipeline to an oxygen cell increase the bacteria - short pipeline to a pond, plant growth to remove the impurities.	The properly treated wastewater can be discharged by several ways. But for the individual on-site system, the possible way is dispose to the environment directly.	**?** Out of the flooding area. ?Can be designed odor free. **?** Safety considerations -using strong polymer based plastic liners prevent leak from the wetland, and using sub-surface flow wetlands for secondary treatment to prevent public contact with wastewater and insect infestations. ?Small scale and is well-suited in the yard. ? Low cost.	It is possible but not recommended.

Treatment System	System Components	Discharge of Wastewater	Constraints	Possibility for Hanalei
3. On-site septic tank + Small scale on-site living machine treatment facility	The primary treatment in the septic tank - short pipeline to a closed secondary aerobic reaction cell to get the growth of bacteria, and plants remove impurities - short pipeline to a clarifier tank to separate the remaining solids - series of tank to improve the treatment quality.	The properly treated wastewater can be discharged by several ways. But for the individual on-site system, the possible way is dispose to the environment directly.	?Do not need to be out of flooding area. ?Odor free. **?** Safety considerations - if the individual owner have enough knowledge about this system and can operate and manage the system properly, basically there is no special safety concerns involving Living Machines. ?Small scale, can be suited in the yard. ? Low cost.	It is possible but not recommended.
Cluster System				
4-a. Several on-site septic tanks (or one medium size septic tank) + medium size disposal field near to the tanks	Preliminary treatment in house - short pipeline - preliminary primary treatment in septic tank - pipeline from each tank goes to a near leaching field to do secondary treatment and discharging.	The combination of secondary treatment section and discharging section. The discharge field gets wastewater from several closed household.	**?** Out of the flooding area. ?No odor in the yard. ? Safety considerations - rely on good soil type, low ground water table, low bedrock and slope, and good maintenance of individual owner. ?Small scale, near to the yard. ?Low costs.	Yes
4-b. Several on-site septic tanks (or one medium septic tank) + mound disposal field near to the tanks	The same. A constructed absorption field or mound replaces the regular leaching field. Therefore a dosing pump or siphon is often used due to the mound is constructed at higher elevations than the septic tanks.	The same. The constructed mound uses good observation soil or material, which can raise the disposal field. So it is used in place where the soil does not have enough absorption capacities or in the place where is high seasonal water table is.	?Out of the flooding area. ?No odor in the yard. ? Safety considerations - because the mound is designed and constructed so the soil type, ground water table, low bedrock and slope are not problems, system relies on a good maintenance of individual owner. ?Small scale, near to the yard. ?Low cost.	Yes

Treatment System	System Components	Discharge of Wastewater	Constraints	Possibility for Hanalei
5. Several on-site septic tanks (or one medium size septic tank) + medium scale constructed wetland near to the tanks	The primary treatment in the individual septic tank on-site - pipeline to an oxygen cell increase the bacteria - short pipeline to a pond, plant growth to remove the impurities.	The properly treated wastewater can be discharged by several ways. Depend on the situation, and the quality of the treated wastewater, dispose to the environment directly, pipe to the ocean, or injection well are all possible solution.	? Out of the flooding area. ?Can be designed odor free. ? Safety considerations -using strong polymer based plastic liners prevent leak from the wetland, and using sub-surface flow wetlands for secondary treatment to prevent public contact with wastewater and insect infestations. ?Medium scale; can be suited in a small area near to the individual tanks. ? Low cost.	Yes
6. Several on-site septic tanks (one medium size septic tank) + medium scale living machine treatment facility near to the tanks	The primary treatment in the individual septic tanks on-site - several pipelines transport wastewater to a secondary aerobic reaction cell to get the growth of bacteria, and plants remove impurities - short pipeline to a clarifier tank to separate the remaining solids - series of tank to improve the treatment quality.	The properly treated wastewater can be discharged by several ways. Depend on the situation, and the quality of the treated wastewater, dispose to the environment directly, pipe to the ocean, or injection well are all possible solution.	? Do not need to be out of flooding area. ?Odor free. ? Safety considerations - if the owners have enough knowledge about this system and can operate and manage the system properly, basically there is no special safety concerns involving Living Machines. ?Medium scale; can be suited in the yard. ? Low cost.	Yes
7. Several on-site septic tanks (or one medium size septic tank) + Packaged treatment facility (or wastewater go the)	The primary treatment can be done in on-site tanks and pipe to the packaged treatment facility or pipe the wastewater to the packaged treatment facility by expensive bid-diameter pipe directly - within the treatment facility, wastewater go through the primary, secondary, and tertiary treatment process.	The properly treated wastewater can be discharged by several ways. Depend on the situation, and the quality of the treated wastewater, dispose to the environment directly, pipe to the ocean, or injection well are all possible solution.	? Do not need to be out of flooding area. ?Odor free. ? Safety considerations - basically there is no special safety concerns involving Living Machines. ?Medium scale; can be suited in the yard. ? Low cost.	Yes

Treatment System	System Components	Discharge of Wastewater	Constraints	Possibility for Hanalei
Centralized Treatment System				
8. Centralized constructed wetland	Wastewater can be collected by regular big diameter pipe to the constructed wetland or the wastewater can be treated on-site preliminarily, and using small-diameter pressure pipe to transport the treated wastewater to the main pipeline and go to the centralized constructed wetland facility. If the centralized facility is located in high elevation, the pump lift station is required.	The treated wastewater can be discharged by several ways. Depend on the situation, and the quality of the treated wastewater, dispose to the environment directly, pipe to the ocean, or injection well are all possible solution.	?Out of the flooding area. ?Can be designed odor free. ? Safety considerations -using strong polymer based plastic liners prevent leak from the wetland, and using sub-surface flow wetlands for secondary treatment to prevent public contact with wastewater and insect infestations. ?large scale, need a large area to fix in, but without physical construction rise on the ground, so almost no scene disturbance. ? Low costs.	Yes
9. Centralized living machine facility	The same.	The same	?Out of the flooding area. ?Can be designed odor free. ? Safety considerations - basically there is no special safety concerns involving Living Machines. ?Large scale, the scene preservation should be concerned about. ? Low costs.	Yes
10. Centralized treatment plant	The same.	The same	**?** Out of flooding area. ?Odor free. **?** Safety considerations - basically there is no special safety concerns involving Living Machines. ? Large scale, the scene preservation should be concerned about. ? Low costs.	Yes

8.10 Wastewater Treatment System Design for Hanalei

The previous section discussed several wastewater treatment options. That section focused on the wastewater and the physical, chemical and biological processes used to treat it. In summary, different options use different ways to remove impurities from wastewater in each step to achieve water adequate for release into the environment. This section discusses potential design constraints and system design options in Hanalei.

Choosing a treatment option is the core part of the wastewater treatment system design. In addition to the treatment method, a treatment system also includes wastewater collection and discharge of the treated wastewater. A successful system design should address all of these aspects based on the constraints of each specific case. It is important to note that the recommendations of the practicum can only provide a basis from which to design an appropriate wastewater treatment system for Hanalei. Practicum recommendations should not replace community involvement with trained wastewater engineers in determining the best wastewater treatment options for Hanalei.

8.10.1 Constraints

The location of Hanalei limits the number of wastewater treatment types that can be considered when choosing possible solutions. Generally we can categorize the limitation into the location limitation constraints, the cost and benefit constraint, and the community's concern constraints. We will discuss each constraint separately as follow.

The constraints of the location limitation are the criteria used for choosing the location of each treatment system. Hanalei town has a low elevation because of its location in a flood zone. Furthermore, it is located in close proximity to the coast, increasing its vulnerability to water hazards. These factors are compounded by the fact that Hanalei experiences high rates of annual rainfall, causing Hanalei and the surrounding area to have a relatively high water table. A high water table is a big potential threat to the disposal field for the septic system. Most current onsite wastewater system codes require minimum separation distances of at least 18 inches from the seasonally high water table or saturated zone irrespective of soil characteristics. Generally, 2 to 4 feet separation distances have proven to be adequate in removing most fecal coliforms in septic tank effluent (Ayres Associates, 1993). The topology of Kaua'i Island causes the valley to suffer from flooding easily. All these elements work together to impose constraints on the type of wastewater treatment system suitable for Hanalei.

Constraints	Considerations
Community Concerns Community Impact	The location and type of system will factor into community concerns. Different configurations will have varying levels of impact on the community. Perceptions: Wastewater treatment issues in Kapa'a.
Proximity to Coastal Areas	Coastal Zone Management Leaching of Wastewater into Water Bodies
High Water Table (Low elevation)	Occasional Submergence of Leach Lines
High Rainfall	Potential to Flood Constructed Wetlands
Flooding	Leaching of Wastewater into Water Bodies Submergence of Wastewater Treatment Facility Submergence of Leach Lines
Low Evaporation	
Soil Type	The soil of Hanalei is generally agreeable for proper septic system drainage; it is a loamy clay type soil, meaning that it is sandy and allows for drainage, but the clay allows for adsorption of nutrients and pathogens.
Facility Cost	The type and size of facilities will determine cost. A combination of on-site, clustered, and centralized treatment options to reduce overall cost.
Infrastructure Cost	Infrastructure is expensive. Short term goal: eliminate as much bacterial contamination of water bodies as possible. Long term goal: plan for a centralized wastewater treatment facility.
Land Ownership	Determine available land. Determining land that is close to reduce infrastructure costs. Determine land that may be used for a wastewater treatment facility with minimal community objections.
Industrial Connections	None. Potential industrial connections would demand more stringent treatment methods than domestic wastewater. Industrial waste may contain a high amount of chemicals.
Underground Injection Control Line	Injection is not allowed Mauka of the Underground Injection Control Line.

8.11 Interdisciplinary Design Approach

To best assess wastewater treatment options within these constraints, the practicum team held a *design charette.* A *charette* is a group exercise, which utilizes an interdisciplinary approach to problem solving. Practicum members divided into two groups, each with members trained in a variety of backgrounds including biology, planning, design, and economics. Each group then evaluated potential sites utilizing a map that visually displayed the constraints.

The Hanalei community may consider conducting a similar charette aided by wastewater professionals, or a group exercise which identifies community concerns as additional constraints to system design. The community may also consider conducting a survey to identify community reactions to planning alternatives. For details on the charette, please see Appendix C.1.

8.12 Design and Implementation Recommendations for Hanalei

For small communities in Hawai'i the decision to upgrade wastewater treatment systems is complicated. Most of Hawai'i's small communities currently employ septic systems with great success. Septic systems are the preferred treatment method in almost instances. Only when these systems are unable to function properly, and wastewater hazards occur, should alternative treatment techniques be investigated.

An intervention must be made in locations where wastewater has had an unacceptable environmental impact. It is necessary to find alternative wastewater treatment options to purify effluent locations where existing systems are functioning incorrectly. This does not necessarily include the installation of infrastructure and a centralized wastewater treatment system. The most cost-effective solution to wastewater treatment problems is often a management plan that focuses on mitigation of septic tank systems.

Cluster systems (piecemeal solutions) are cost effective, short-term, reliable solutions for treating wastewater "problem areas". These systems serve only those areas where existing systems are creating wastewater hazards.

Maintenance and proper management of existing septic systems should be attempted before an expensive centralized treatment system is constructed. Only when alternative solutions have been determined to be inappropriate should a small community plan a centralized wastewater treatment facility.

Recommendations are presented by implementation range. Short-term recommendations represent mitigation measures and planning steps that should be taken immediately to preserve public health. These recommendations are designed to have the greatest impact and lowest cost.

1. **Short-term:** Hold community wide meeting to discuss wastewater options and the proposed project. Collect community concerns, comments, desires, etc. for consideration in the implementation of wastewater treatment in Hanalei.

2. **Short-term:** Encourage policy change. (See *Policy Change*)
    a. Implement policy which supports the actions the community determines are appropriate.

3. **Short-term:** The ambiguity of current bacterial findings stresses the need for additional fecal indicators. Additional study is required to determine septic systems and cesspools as the sole source of high bacterial counts measured in Hanalei Bay and Hanalei River.
    a. Perform additional fecal indicator tests to verify the findings of the Hui and hypothesis of septic systems and cesspools as bacterial contributors.

4. **Short-term:** Attempt to mitigate septic system issues while considering future treatment options.
    a. Maintenance assessment of residential cesspool and septic systems. Provide public education on good septic system use habits and proper maintenance. Provide residents with a "maintenance folder" to track system maintenance.

5. **Short-term:** Provide immediate treatment to Black Pot Beach Park bathrooms if further testing verifies the presence of fecal matter in Hanalei River and Bay.
    a. Consider using composing toilets as an immediate solution.

    b. Combine the treatment of waste from beach park facilities with treatment of waste from surrounding residential users in a clustered treatment system.

6. **Short-term:** Develop a complete wastewater design, choosing infrastructure, treatment, and disposal options for a long-term wastewater treatment solution.
    a. Identify areas for immediate action

        i. The practicum developed the following assessment methodology to map areas where immediate wastewater treatment would likely have the greatest effect on water quality. This methodology is based on a combination of criteria: within the flood zone, potential overcapacity septic systems, high wastewater generation, within the coastal zone, type of existing system, and neighboring an area of high bacterial measurement.

        ii. The following table summaries the data and assumptions used, and weights them based on importance to the wastewater impacts. The data used are based on TMK number, therefore, a critical value was calculated for each parcel. Parcel with a low critical value have a high potential to be contributors to wastewater risks. Bacterial measurement data is not linked to individual parcels, so it is not possible to include this criterion into the calculation. Instead, this data is presented as an overlay on the Potential Critical Areas map. This display shows high bacterial measurements correlate to the potential critical areas (see Potential Critical Areas map).

Criteria	**Data by Parcel**	**Assumption**	**Rank Value**	**Weight**
Prone to Flooding	Flooding zone	-	-	1
Vacation Rentals or (Potential overcapacity septic systems)	Standard deviation of the water consumption by month (2001)	The great seasonal change of water consumption will cause the on-site treatment system fail by over capacity.	1 - >10 2 - 6,10 3 - 3,6 4 - 1,3 5 - 0,1	3
Average Water Consumers.	Average water consumption (2001)	The more water consumption, the more wastewater generation.	1 - >60 2 - 45,60 3 - 30,45 4 - 15,30 5 - 0,15	2
Coastal Zone	Properties data	Coastal zone has high water table, and due to near to the water bodies, it is easy to cause the water quality degradation.	1 - in 2 - out	1
Existing Treatment System	DOH data	-	1 - nothing 2 - cesspool 3 - septic	2
Area of High Bacterial Measurements	DOH & HUI data	-	-	-

b. Provide immediate solutions in the form of user education, maintenance assessments, and onsite wastewater modifications or cluster treatment configurations to areas indicated by the above assessment methodology.

    i. Maintenance assessment of high-risk areas. Determine if household chemicals used may be interfering with the ability of the septic system to treat wastewater. Correct maintenance backlogs and educate on the effects of household chemicals on the operation of the system.

    ii. Utilize higher-than-flood level mounded percolation beds to adapt existing on-site systems in high-risk areas. Mounded percolation beds have the advantage of being flood-proof, whereas a package disposal plant is not. The mounds may only need to be several feet high to be out of the flood zone. (see *Sample Onsite and Cluster System Design for Hanalei*).

        1. This modification is ideal for areas where wastewater treatment will not be extended, such as farmers' residences within the Hanalei Refuge.

    iii. Utilize alternative infrastructure and clustered treatment systems to provide immediate service to high-risk areas. Treat wastewater in a small-scale constructed wetland or package treatment plant. Dispose of water in a mounded percolation bed or injection well.

c. Choose a long term wastewater treatment alternative through community based process.

    i. The Practicum recommends the use of constructed wetlands for several reasons. The appearance of constructed wetlands is compatible with the current character of Hanalei. Constructed wetlands are less costly to construct, operate, and maintain. Wetlands can easily treat wastewater to the tertiary level and remove nutrients, at a fraction of the cost of using traditional treatment to achieve this level of quality.

        1. Alternative One - The Clustered Wetland Treatment System. (see *Sample Cluster System Design for Hanalei*)
            a. Cluster systems are recommended specifically because they will not have the same adverse impact on development as a centralized treatment facility. (see *Policy Change*.)

        2. Alternative Two - Centralized Wetland Treatment System. (see *Sample Centralized System Design for Hanalei*)

a. Care must be take when if a centralized wastewater treatment facility is chosen, additional wastewater treatment capacity will encourage growth, especially in areas that were previously considered marginal land. (see *Policy Change*).

ii. Small diameter, low pressure infrastructure is recommended to pump sewage to the wastewater treatment system.

1. STEP systems should be used to modify existing septic systems, and grinder pumps should be installed in new residential development. This system is recommended because of its many advantages over traditional infrastructure.

iii. An injection well is recommended for disposal of treated wastewater.

1. This option may be impractical if the treatment facility is located significantly mauka of the underground injection control line.

d. Seek Funding

e. Choose site based on community criteria and constraints.

f. Apply for applicable permits and funding

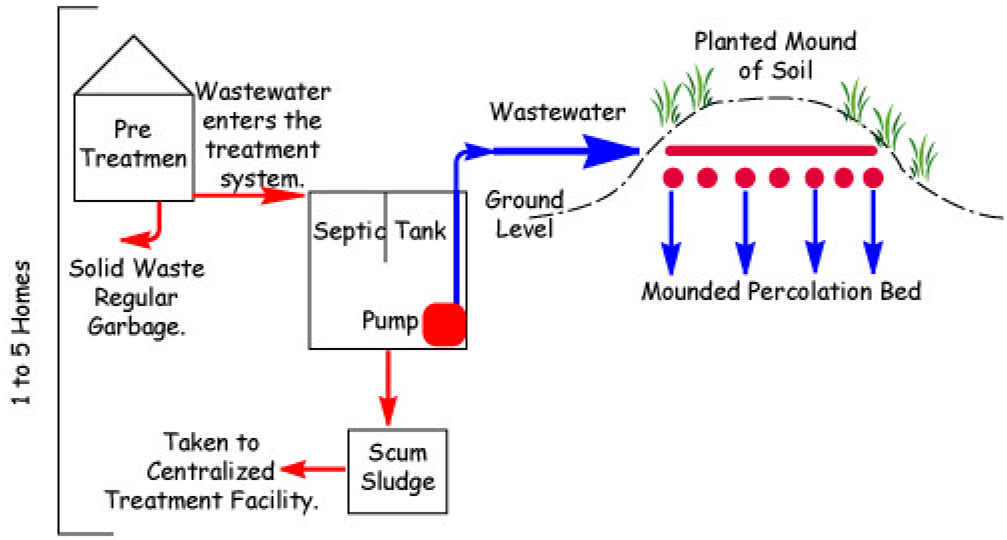
7. **Short-term:** Construct a wetland treatment cell to remove nutrients from taro *lo'i* runoff.
   a. This cell should act as both a buffer to remove nutrients before they are introduced into the Hanalei River and as a settlement pond for sediment.

8. **Mid-term:** Implement completed wastewater design for a permanent, long-term wastewater treatment solution.

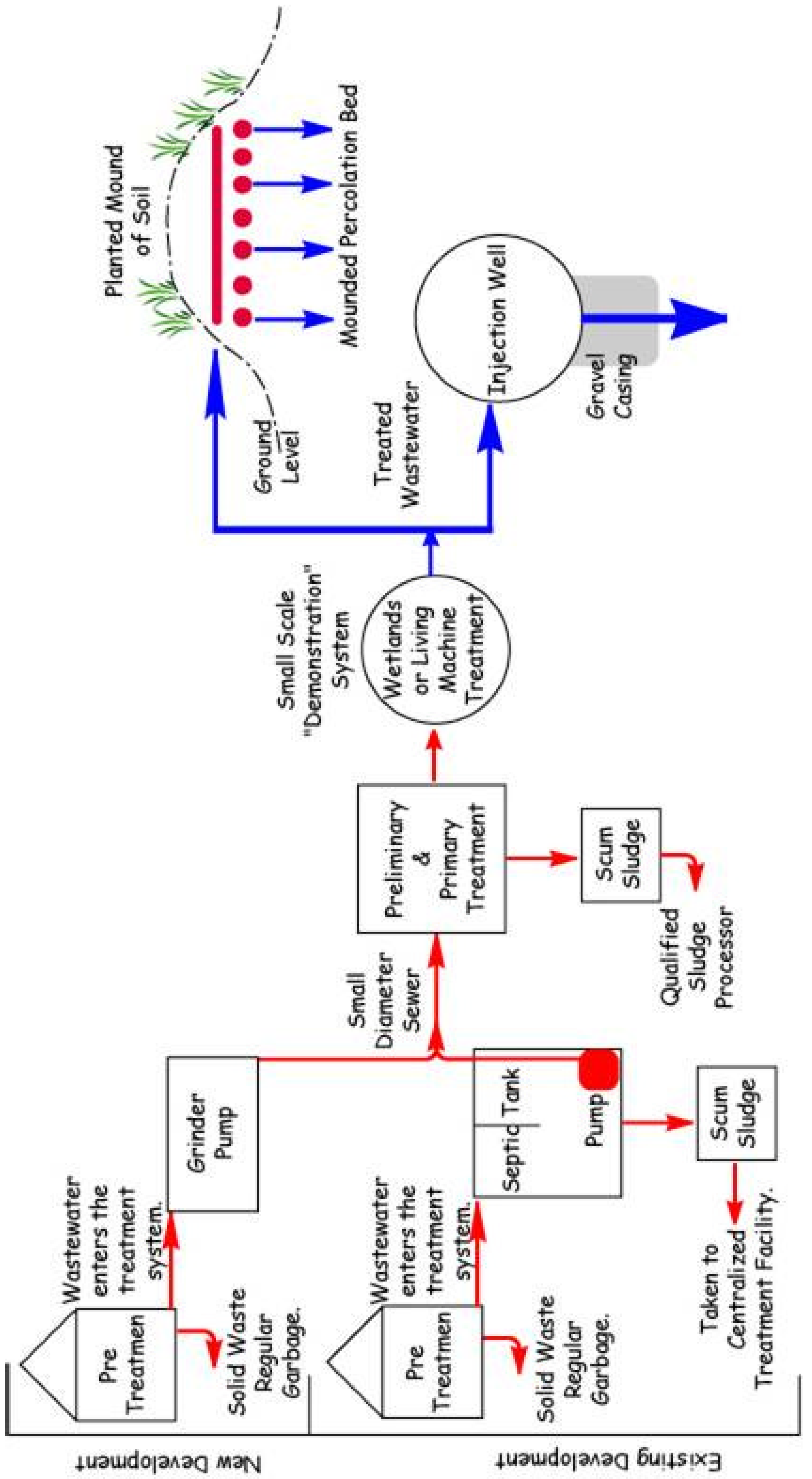
9. **Long-term:** Monitor for change.
   a. Develop community-based indicators. (See *Monitoring*)

8.12.1 Design Samples

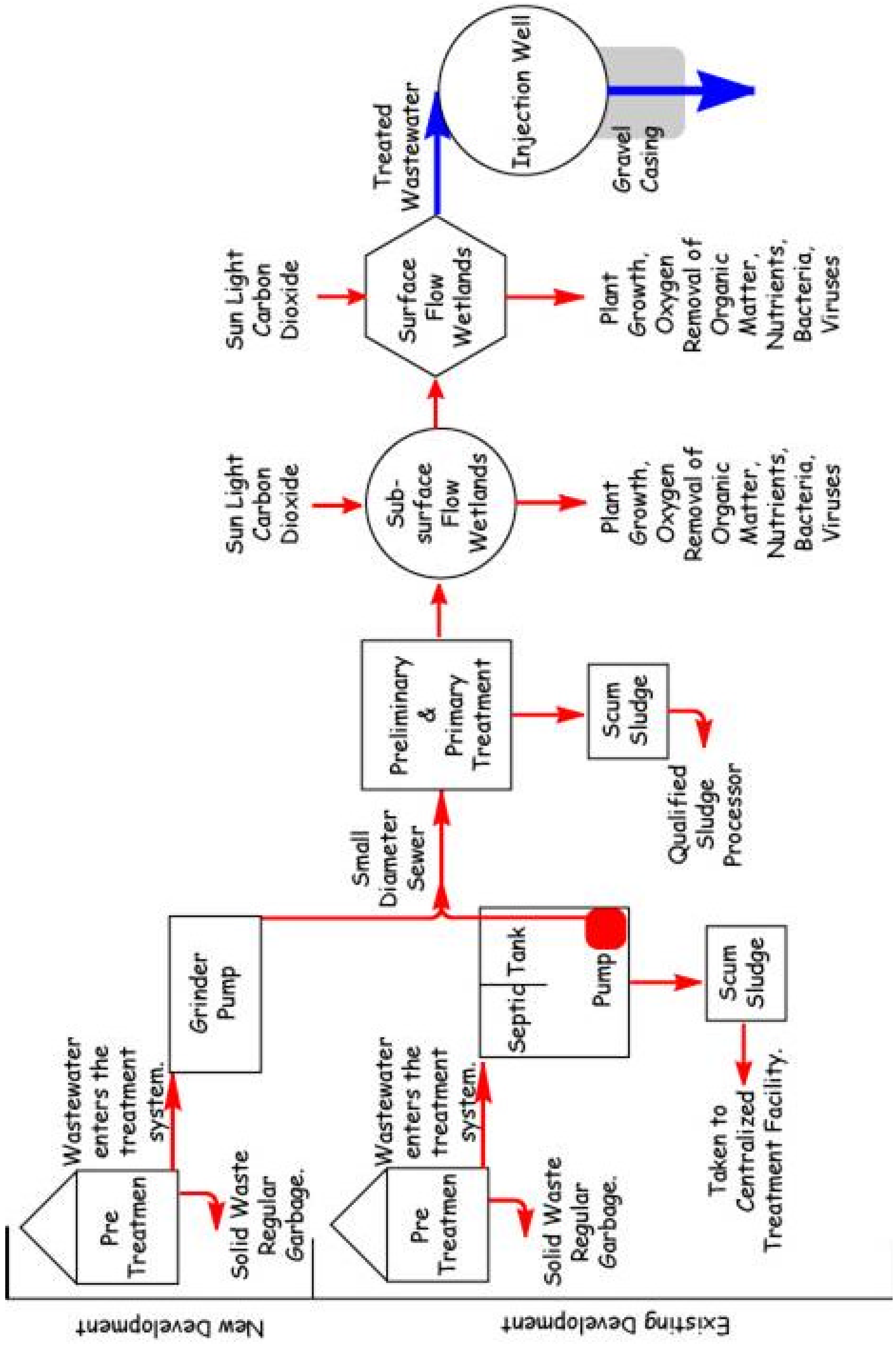
1. Short Term, Onsite and Cluster System Design for Hanalei



2. Sample Cluster Design System for Hanalei



3. Sample Long Term, Centralized System Design for Hanalei



8.13 Organization and Permitting

Proper permitting must be secured to engage in wastewater treatment activities. The addition of a mounded percolation bed to an existing septic system to mitigate a high water table problem would require only the review and approval of a certified engineer and the Hawai'i State Department of Health Wastewater Division. For larger systems, especially those requiring infrastructure, an organization must be formed to oversee the construction of the wastewater treatment facility. Later this organization will take responsibility for maintaining the system and collecting fees.

8.13.1 Organization

A managing organization is responsible for funding, operating, monitoring, and maintaining a wastewater treatment system. The organization must determine finance options and a fee structure to repay loans and maintenance costs.

The benefits of good management include (University of Minnesota Extension, 2002):

- Reduced overall costs
- Longer system life
- Improved system performance
- Increased reliability and overall satisfaction

The organizational structure chosen will be determined by the project and community. Hawai'i law allows several possibilities for system management, the two most common being county governments (Lihue) and development/homeowner associations (Princeville). To determine the most suitable for Hanalei it will be necessary to seek legal council.

8.13.2 Permitting

Permits are issued for a number of situations. They are discussed here:

1. Onsite System Permitting
Individual Wastewater Systems and Private Sewage Treatment System Review
Hawai'i State Department of Health Wastewater Division

This requires a review of onsite systems. A licensed engineer should first approve the systems. The Hawaii DOH approves the system plan for construction, and later the constructed system for use.

2. Infrastructure Permitting
Easement Acquisition
Kaua'i County

Buried infrastructure is generally placed in the public right-of-way. No additional easements may be necessary where public right-of-way exists, such as along streets.

Where adequate easement is not available, the county must use eminent domain to acquire public right-of-way at market value.

Excavating

Kaua'i County

Permit to Excavate Public Right-of-Way (Trenching).

3. Site Regulations

Land Acquisition

Kaua'i County

Once a suitable site has been chosen it will be necessary to acquire it. The County has power of eminent domain which allows it to force the sale of land at market prices to allow a public use. The ability to apply eminent domain will depend on the organizational structure of the treatment facility.

Zoning

Kaua'i County - Planning Department

If existing zoning does not allow for the intended use, a change in zoning may be necessary.

4. Treatment Works

Permits for the treatment works generally cover all activities at a wastewater facility including treatment and discharge. Each permit requires engineering review and continued monitoring to determine if the plant performs within legal discharge specifications.

National Pollution Discharge Elimination System Individual Permit

Hawai'i State Department of Health Wastewater Division

Permit forms and comprehensive manuals are available on the CD-ROM included in this report. This permit, mandated by the EPA, is the primary permit required for wastewater treatment and discharge. One NPDES permit covers operation of the treatment facility and disposal of effluent.

The NPDES Individual Permit is regulated under the Hawai'i Administrative Rules, Chapter 11-55, Water Pollution Control, which was effective on November 7, 2002.

Section 401 Water Quality Certification

Hawai'i State Department of Health Wastewater Division

Permit forms and comprehensive manuals are available on the included CD-ROM.

A section 401 Water Quality Certification is required for any facility discharging into state waters. The applicability of this permit will be determined by the Hawai'i State Department of Health Wastewater Division upon system design review.

Section 401 Water Quality Certification (WQC) is regulated under Hawaii Administrative Rules, Chapter 11-54 Water Quality Standards effective April 17, 2000.

5. Environmental Impact Statement – State
Office of Environmental Quality Control

The state or county agency issuing a permit for activities that may require an EIS is responsible for determining the need for an EIS. This includes all public projects using state or county lands or funds.

6. Disposal Options Additional Permits

Some disposal options require permits in addition to, and separate from, those for the treatment works. Contact the Hawaii State Department of Health Wastewater Division for required permits in special cases.

6.1 Injection Wells
Underground Injection Control Permit
Permit forms are available on the included CD-ROM.
Hawai'i State Department of Health Wastewater Division

Data on existing water quality, treated water quality, and capacity are required to obtain this permit for the operation of an injection well. If the potential well site is mauka of the underground injection control line (map B.26) public notice is required.

6.2 Mounded Percolation Bed (Onsite or Cluster use)
Individual Wastewater Systems and Private Sewage Treatment System Review
Hawai'i State Department of Health Wastewater Division

This entails a review of on-site systems. Systems should first be approved by a licensed engineer. The Hawaii DOH approves the system plan for construction, and later the constructed system for use.

6.3 Water Recycling
Certified Design and Written Approval.
Hawai'i State Department of Health Wastewater Branch
Written approval is required for operation of a wastewater recycling system. Guidelines for the treatment and use of recycled water are also included on the CD-ROM.

7. Special Land Designations

A facility placed on various state or government owned, or conservation zoned lands will require a special use permit.

7.1 Conservation District Use Application
State Department of Land and Natural Resources
This is required for use in conservation district lands.

7.2 Special Permit in the State Land Use Agricultural and Rural Districts
State Land Use Commission (15 acres or less: County)
This is required for use of agricultural and rural districts.

7.3 Department of the Army Permit for Activities in Waterways
Army Corps of Engineers
This is required for modification to navigable waterways.

7.4 Hawai'i Coastal Zone Management Program (Federal Consistency).
Department of Business, Economic Development and Tourism
This is required for development in the Coastal Management Zone.

7.5 Flood Determination in General Flood Plain District
Kauai County
For areas in critical flood zones
- Development applications in Flood Hazard Districts
- Flood Hazard Variance

8.14 Monitoring

Research into wastewater treatment in Hanalei resulted from issues concerning contamination of water sources by faulty septic systems and flooding. The effectiveness of mitigation actions will be evidenced through a drop in water contamination. A positive change in water quality following the implementation of wastewater mitigation measures will indicate that the problem assumption is correct (Lesnet, 2002).

Indicator Functions
- Measure progress
- Explain sustainability
- Educate
- Show linkages
- Motivate
- Focus action on the issues

(Hart, 1998)

To monitor the change in water quality in Hanalei several indicators should be developed. An introduction to indicators is presented, followed by several recommended indicators which track changes in water quality over time.

8.14.1 Indicator Theory

> *The traditional measures that we use tend to show a community as disconnected segments: the environment, the economy and the society. An environmentalist wants to improve air quality. A business person wants to increase profits. The health professional wants to improve people's health. However, the traditional ways we use to measure progress in these areas don't take into account the connections among these three areas* (Hart, 1998).

Indicators are a means of measuring, and tracking change in a complex system. Indicators are built to measure change over time. In the case of water quality, indicators attempt to measure progress towards, or movement away from water quality goals. Indicators become increasingly valuable over time. As information is collected, indicators can be compared to previous years to increase awareness of community well being.

Indicator measurements can be used to improve communities by evaluating the area in which a community is strong, and target weakness. When action is taken to improve community weaknesses, its effectiveness is measured against existing indicator measurements.

Indicators may have several impacts on a community as measurements are observed and action taken. Community indicator events should seek to stimulate outcomes in each area.

1. Political outcomes

Political outcomes resulting from indicator measurements include raising awareness, creating community, and education. The media plays a great role in shaping perceptions, it is not only important to use the media to raise awareness, but also to become a dependable resource for the media. Community buy-in, shared interests, and common goals are political outcomes.

2. Policy outcomes

Policy outcomes resulting from indicator measurements include the use of indicators in planning and maintaining future projects, creation or modification of existing programs, and influencing individual attitudes toward the environment. It is important to remember that the indicator will measure the end effect of all influences, a combination of personal, private, and public actions are more likely to cause noticeable change in an indicator rather than a single policy action.

3. Change

Change is reflected in the movement of indicator measurements towards positive or negative trends. The effect of actions on an indicator is difficult to estimate. It is only with repeated measurements that trends become apparent. It takes even longer to verify that they will continue towards a desired change. Indicators do not create change, but change may result from actions taken in response to an indicator.

Characteristics of a Good Indicator

- **Address carrying capacity -** An indicator of sustainability needs to address the carrying capacity: whether the community is using resources at a rate faster than they are being renewed or restored. Is the community using up its capital or is it living off the interest and reinvesting or enhancing its community capital? In many cases this means not measuring things in terms of monetary value. It is not the total dollar value of housing stock in a community that is important to sustainability; it is whether or not there are enough houses that people can afford.

- **Relevant to community -** What is sustainable in Seattle is not what is sustainable in Tucson, Miami, or Berea, Kentucky. Sustainable solutions in metropolitan areas will be different from sustainable solutions in rural areas. Communities should select indicators that are relevant to their situations.

- **Understandable to the community -** How many people have ever seen a part per billion? We need to develop indicators that speak to people, so that they understand what they personally are doing that is causing problems and what steps, however small, they might be able to take to help solve the problem. How about pounds of pollution per mile or gallon? Tons of pollution per year? This will also help the general public understand why some laws go into effect and help prevent backlash against regulations that work.

- **Useable by the community -** If indicators are not used by the community, they will not have any effect on what people do. Indicators need to help people see how they can change their behavior to have a positive effect on community sustainability.

- **Long term view -** Sustainability is a long term goal. We need long term indicators. This means 25 or 50 years in the future, not 5 or 10 years.

- **Show linkages -** Traditional indicators tend to be narrowly focused on one aspect of a community. When you focus on increasing the number of jobs without looking at the details—the types of jobs, whether the jobs are long term, and whether they have health benefits—you may just be setting the community up for more problems down the road (Hart, 1998).

The measurements obtained through utilizing indicators as progress guidelines report the influences of a wide variety of factors on a community. No one action is usually responsible for all change in an indicator. No action has effect on only the measured data, either. Communities are changed through a complex scheme of cause and effect. It is as impossible to measure all influences bringing about change. For this reason, indicators must have a clearly defined goal, and the possible interaction among economy, society, and environment must be considered.

A. Scientific Indicators for Hanalei

Continued Monitoring by the HUI

Scientific indicators utilize data to track change over time. An example of this type of monitoring is the work done by the HUI. It is recommended that the HUI continue monitoring bacterial counts in the waters surrounding Hanalei. Results should be published in one or more public forums (see *Public Forums for Indicator Results*).

Increased Monitoring by the State Department of Health

It is also recommended that the Department of Health perform more frequent monitoring in the Hanalei area. These results should be collected and published with the Hui data.

Tracking Underground Water Quality Change

To track possible changes in underground water quality, newly available data from the Kaua'i Water Department on bacterial counts at the Hanalei freshwater pump heads should also be collected and published.

B. Examples of Community-Based Indicators for Hanalei

Community indicators, while not as accurate as scientific based indicators, provide public education and awareness on water quality issues.

Water Related Skin Irritations

Water related skin irritations can be reported and placed in a box at beach park displays. These reports can be summarized and published monthly. The community is then empowered to observe the change in water quality over time based on personal experiences. Any change resulting from the implementation of wastewater treatment may then be tracked.

Fish size

The beach park display can also collect reports of the variety and size of fish caught in Hanalei. The size of fish could be tracked over time as an indication of water quality. Any change resulting from the implementation of wastewater treatment may than be tracked.

C. Public Forums for Indicator Results

Indicators should be published in multiple public forums. By publishing indicators, public awareness is raised and the community may easily track change over time.

Newsletter

The HUI should continue to publish monitoring data in its monthly newsletter, and include new indicators and data.

Web Page

A compilation of scientific and community based indicator information can be published on a web page.

Educational Displays

Educational displays could be placed at beach parks, in downtown Hanalei (Ching Young Center), and possibly at the Hanalei Refuge. These displays should contain recent indicator data and a collection area for reports of water related skin irritations and fish size.

Media

Monthly reports can be submitted to local newspaper, radio, and television outlets to raise water quality issue awareness.

Elected Representatives and Local Celebrity

Engage elected representatives and local celebrity to participate in water sampling. Hold a public awareness event.

8.15 Policy Change

To protect Hanalei from environmental degradation, now and in the future, the community should collaborate to enact policy changes which have positive long term effects. Based on the practicum analysis of community issues in Hanalei, the following policy changes are recommended. These changes should not be made verbatim. Change should result from community meetings and decision making processes, which allow the community to actualize a common acceptable vision for the future of Hanalei.

To lessen the overall public health impact of wastewater loads from septic systems, it is recommended that enforcement of existing growth policies be adhered to for Hanalei. This includes the limitations placed on development by the historic one-lane bridge, and additional policy changes, which regulate growth in the interim period before a centralized wastewater treatment facility is constructed.

1. Wastewater Treatment Education

- Continuous assessment maintenance on residential cesspool and septic systems
- Provide public education on good septic system use habits and proper maintenance. Provide residents with a "maintenance folder" to track system maintenance.

2. Enforcement of Septic System Regulations

- Designate a special district around Hanalei Bay which mandates that septic systems be designed based on high-tide water levels.
- Increased or mandatory inspection of new systems in sensitive areas, including coastal and flood zones.

3. New Developments

- Place a moratorium on further large single-family development until a suitable wastewater treatment system is in place.
- Require new single-family development to connect to centralized sewer system.

4. Transient Accommodations

- Educate visitors to avoid placing solid waste into the septic system.
- Provide septic system maintenance education to the owner/operator of transient accommodations.

5. Scale of development

- Preserve the rural character of Hanalei and mitigate public health concerns by considering design and scale guidelines.
- Environmental constraints in Hanalei are not conducive to large residential development and the accompanying wastewater load.
- Constraining new development to the scale of existing structures to preserve the rural character and partially mitigate wastewater issues.

6. Existing Cesspools

In 1991 a moratorium was placed on the citing of new cesspools in critical wastewater disposal areas, such as Hanalei. Federal regulations require that cesspools with a capacity greater than 1000 gallons must be eliminated by 2005. Public meetings have been held on a measure, prohibitting the use of all cesspools throughout the state.

To comply with new and proposed regulations, households with existing cesspools should be identified. Funding in the form of tax credits or grants should be investigated for upgrades of existing cesspools.

8.16. Land Use and Development Pressure

The relationship between land use and wastewater infrastructure is two-fold: (1) land use affects the current and future per user cost of providing wastewater infrastructure to small communities; and (2) installation of sewer service opens previously marginal lands for development, increasing pressure on the community (Lesnet, 2002).

8.16.1 Infrastructure Cost

In a small community, several factors will dictate infrastructure cost. Most significantly, the type of sewer infrastructure chosen will dictate system cost. Modern small diameter sewer lines are vastly more cost effective than traditional gravity flow infrastructure.

Existing land use patterns in a community will also partially dictate the cost of wastewater infrastructure installation. A small, low density residential development will have a greater cost-per-user for infrastructure installation than a equivalent moderate to high density development.

Future development also factors into the cost of wastewater infrastructure. Land use plans for small communities preparing for centralized wastewater treatment should compliment infrastructure installation by designating land at higher density levels where centralized service is provided.

8.16.2 Development Pressure

In some instances, wastewater treatment capacity causes additional development pressure on a community. The extension of a sewer trunk line, new sewer service, and extra sewer capacity, are all factors that may lead to urbanization of previously undeveloped or rural land. This "leap frog" development is typical of the mainland, but also applies to small communities in Hawai'i.

By adding wastewater treatment capacity to a small town, such as Hanalei, developers are given the ability to build on open land that was incompatible with septic systems. This can have devastating consequences in areas valued for their rural character and sense of place.

One strategy to direct development and delay urbanization is a carefully planned and phased investment in wastewater infrastructure. By exercising a variety of traditional land use control policies, and limiting infrastructure extension to existing development at existing wastewater capacity, this effect can be constrained. Infrastructure implementation and investment should never be used as the sole constraint to development, it is a weak control strategy best complimented with strong land use planning and control.

A second strategy is to limit treatment capacity to the current wastewater load or projected load for ideal development levels. This approach carries some inherent risks. Increased capacity may become unavoidable in the future, necessitating the expansion of existing facilities or construction of additional facilities. In either case, it is more economical to initially build a facility of adequate capacity, and then add additional capacity later.

Chapter 9

Building an Opportunity for the Co-existence of Taro *Lo'i* and Bird Impoundments

Although the National Wildlife Refuge (NWR), since its establishment in Hanalei in 1972, has co-existed with taro farmers, there continue to be minor tensions between the NWR administrators (or U.S. Fish & Wildlife personnel) and proponents of taro farming (both town members and farmers). The thrust of this tension lies in the question of whether or not taro *lo'i* can continue to co-exist with the bird impoundments built by the USFWS to support the propagation of threatened and endangered birds in Hanalei. Proponents of taro farming – and the farmers, themselves – recognize the economic and cultural value of taro farming. The USFWS, on the other hand, are required to maintain a viable habitat to support endangered and threatened birds until they are de-listed under the Endangered Species Act (1973). Farmers on the Refuge are concerned about continued access while NWR administrators are bound to the by-laws of the Department of Interior and the Endangered Species Act (TenBruggencate, *It's About the River*, March 25, 2002)**.**

9.1 Issues Definition

Human contact has undisputably altered Hawai'i's wetlands from their original pristine states. As explained in the history of Hanalei, fossil evidence indicates that pre-historic lowland vegetation cover was more diverse, which suggests a swamp-like environment (Burney, 2001). Before Western contact, it is estimated that there were between 24,700 and 61,800 acres in taro cultivation in Hawai'i (Greer, 2002). Since then, Hawaiian wetlands have experienced severe size reductions due to extensive draining and filing for agricultural and urban development. It has been estimated that less than 10% of Hawai'i's former wetlands remain today. The remaining unmanaged wetlands are being overgrown with non-native species like pickleweed (Batis maritime) and various invasive grasses. This loss has had an increasing effect on the native waterbirds. Human intervention is, therefore, needed to reverse the decline in Hawaiian wetlands and the dependent wildlife.

Compounded with this dramatic loss of wetlands has been the dramatic decline in endemic waterbird population, including the Hawaiian Stilt (*Ae'o*), Hawaiian coot (*'Ala eke'oke'o*), Hawaiian Moorhen *('Alae'ula*), Hawaiian duck (*Koloa maoli*) and the Hawaiian goose (*Nene*), for which this section will touch upon. All these birds are listed as endangered and are currently receiving special protection and management. There is now a dilemma on how to best assure that the populations of these endangered birds increase to a healthy and sustainable level.

In the remaining wetlands of Hawai'i, including all protected areas designated to protect endangered species, the question remains regarding how and what activities are compatible with the rehabilitation of these populations? This is in consideration of the fact that modern activities, such as encroaching through filling in wetlands for development, previous hunting pressures and introduced species have been major factors for the current critical conditions of these species.

To alleviate the further decline of species, the USFWS bought, in 1972, a large parcel of land in the Hanalei Valley from the Princeville Corporation for wetland management purposes. This became the Hanalei National Wildlife Refuge. In the mid 1980's USFWS determined that the Refuge should not be composed of just managed habitat requirements that endangered waterbirds needed, but also of taro cultivation. Hence, allowing for the simultaneous cultivation of taro and existence of bird impoundments. Eighty acres of constructed wetland habitats or impoundments have been built in the Refuge and, at present, nine farmers lease approximately 125 acres of taro fields (Kido, 2002).

Unfortunately, of late, there have been some apprehensions between stakeholders on the question of whether taro farming is compatible with the bird impoundments in the Hanalei NWR (TenBruggencate, March 25, 2002). Our observations have led Practicum members to believe that this issue should be non-existent. Unfortunately, this issue came about because of some break down in communication, which has induced misunderstandings and assumptions about each other. The U.S. Fish & Wildlife induced part of the communication problem in that they imposed certain management decisions without clarifying their position on such decisions. One example of this is in regards to the special use permit extended to the Refuge farmers; the length of the permit was reduced periodically from nine years to seven years, then to one year without clearly explaining the rationale behind the changes. In 1998, the USFWS increased the permit term to up to ten years, but renewal every year is based on an evaluation process for continuation. Consequently, because of these changes, farmers on the Refuge have felt uncertain about their continued position in the Refuge. The feeling of uncertainty over access to agricultural land can be extremely traumatic, especially for those who have practiced agriculture for years prior to the creation of the Refuge in 1972.

Another cause of concern is the pending study by Dr. Frederickson on the viability of Hawaiian wetlands for serving as a habitat for waterbirds. The study is to be conducted on the Refuge and details of the study have not been made public to either the community or the taro farmers. Community members are a bit apprehensive about the reason for conducting such a study and uncertain about the policy implications of such a study on the continuation of taro farming on the Refuge. Because of this pending study, plans to expand taro farming in the Refuge are moribund until the findings of the research have been produced, contradicting the original plan to expand taro farming to 200+ acres (*It's About the River*, 2000, Vol.1, Issue 2, p.3).

By the same token, the USFWS is – by law - bound to regulations and mandates. It is part of their job description to carry out these mandates. As a federal Refuge, they must oversee the utilization of the land on the Refuge to support the propagation of endangered or threatened species. They have acknowledged their need for the farmers on the Refuge because the taro *lo'i* have provided to some extent a habitat for the waterbirds. Furthermore, the Refuge personnel have stated their reliance on the taro farmers for maintaining the condition of the Refuge vis-à-vis farming practices. And, on the matter of the lease, Refuge personnel have repeatedly indicated that they have no intention of terminating taro farming in the Refuge.

Stakeholders can take comfort in the fact that both the Refuge personnel and farmers on the Refuge have an interdependent relationship; Refuge mandates help to maintain the quality of the land area encompassed by Refuge boundaries, while the Refuge personnel rely on the farmers to maintain the *lo'i* to support the ecological aims of the Refuge. Such cognizance encourages stakeholders to move towards a more productive relationship. For the moment, it is safe to state that both the taro farmers and the U.S. Fish & Wildlife have legitimate rationale for their viewpoints.

9.2 The Hanalei National Wildlife Refuge

The overall mission of the National Wildlife Refuge System is to conserve and manage fish, wildlife, and plants and their habitats within the System for the benefit of present and future generations of the people of the United States.

The purposes of the System are:

- *To provide a national network of lands and waters designed to conserve, manage, fish, wildlife, and plants and their habitats;*
- *To conserve, manage, and where appropriate, restore fish and wildlife populations, plant communities, and refuge habitats within the System;*
- *To conserve and manage migratory birds, anadromous or interhurisdictional fish species, and marine mammals within the System;*
- *To provide opportunities for compatible uses of refuges consisting of fish and wildlife dependent on recreation, including fishing and hunting, wildlife observation, and environmental education;*
- *To preserve, restore, and recover fish, wildlife, and plants within the System that are listed or are candidates for threatened species or endangered species under Section 4 of the Endangered Species Act of 1973 (16 U.S.C. 1533) and the habitats on which these species depend; and*
- *To fulfill as appropriate international treaty obligations of the United States with respect to fish, wildlife and plants, and their habitats.*

National Wildlife Refuge System Improvement Act of 1997

The Hanalei National Wildlife Refuge (NWR) was formally established in 1972 and is one of three National Wildlife Refuges on the island of Kaua'i run by the U.S. Fish & Wildlife Service (USFWS). The main goals are to conserve, manage, and restore the habitat and wildlife, in this case the endangered Hawaiian waterbirds, including the Hawaiian Stilt (*Ae'o*), the Hawaiian Coot *('Ae eke'oke'o*), the Hawaiian Moorhen (*'alae'ula*), the Hawaiian Duck (*Koloa maoli*) and the Hawaiian goose (*Nene*). Absence of mongoose, a major predator, makes Kaua'i one of the best places in the State for bird rehabilitation. Currently, the Refuge covers about 917 acres, farmers; houses, irrigation ditches, constructed impoundments, grasslands, and mountain slopes. Approximately 125 acres are in the taro fields that are leased by nine farmers (Kido, 2002). Within each of these farms, the taro *lo'i* are divided into quarter-acre parcels for easier maintenance. There are four impoundments in the Refuge, each occupying an area of 20 acres. Three are on the makai side of the Refuge and separated from taro fields by a dike (Leinecke, class lecture, 2002).

The taro industry is one of the key economic engines in Hanalei and is deeply integrated into the cultural values of the residents as well as the tourism industry. The scenery overlooking the Hanalei NWR has been referred to as "the most photographed locale in Hawai'i". There are a total of twenty-five taro farmers in Hanalei and adjacent areas, four of which live within the Refuge. It is approximated that 75% of taro in the State comes from Kaua'i's North Shore, including Hanalei (Hobey, 2002).

Taro farmers in the Hanalei NWR are under a special use permit agreement with the U.S. Fish & Wildlife Service. Due to the sensitivity of bird populations and their habitat requirements, it is essential that farmers comply with certain "best management practices". There are, however, substantial benefits from farming in the Refuge. Taro farmers pay a relatively low amount for leasing a parcel of the land and enjoy a state-of-the-art irrigation system designed and maintained by the USFWS. These benefits are provided by the USFWS for losses incurred as a result for the requirements of the special use permit.

9.3 Federal and State Laws and Regulations

The topics mentioned above do have protection under the law. These same laws provide provisions for which government agencies, such as the USFWS, are obligated to adhere.

9.3.1 Traditional and Customary Rights

Native Hawaiian rights, access to Native land, and protection of agricultural lands are sanctioned in the State of Hawai'i Constitution. There are several articles that articulate such protections. Article XI, Section 3 refers to agricultural lands. It reads "[T]he State shall conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency and assure the availability of agriculturally suitable lands. The legislature shall provide standards and criteria to accomplish the foregoing" (*www.hawaii.gov/lrb/con/conart11.html*). At the moment, the County of Kaua'i has land allocated as "Open" District, which partially supports Article XI, sec.3. However, the fact that permitting can be granted for potential development somewhat dilutes the protection guaranteed in this mandate.

Under Article XII, Section 7, "[T]he State reaffirms and shall protect all rights, customarily and traditionally exercised for subsistence, cultural, and religious purposes and possessed by *ahupua'a* tenants who are descendants of Native Hawaiians who inhabitated the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights".

9.3.2 Water Rights

Article XI, Section 7 of the Hawai'i State Constitution states that "the State has an obligation to protect, control and regulates the use of Hawai'i's water resources for the benefit of its people". It further states that "the legislature shall provide for a water resources agency, which as provided by law, shall set overall water conservation, quality and use policies; define beneficial and reasonable uses; protect ground and surface water resources, watersheds and natural stream environments; establish criteria for water use priorities while assuring appurtenant rights and existing correlative and riparian uses and establish procedures for regulating all uses of Hawaii's water resources".

Additionally, section 174C-101(c) provides that "traditional and customary rights of *ahupua'a* tenants who are descendants of Native Hawaiians, who inhabited the Hawaiian Islands prior to 1778, shall not be abridged or denied by this Chapter. Such traditional and customary rights shall include, but be not limited to, the cultivation or propagation of taro on one's own kuleana and the gathering of *hihiwai, opae, o'opu, limu*, thatch, *ti leaf, aho cord*, and medicinal plants for subsistence, cultural, and religious purposes". Agricultural land, in this regard, is protected under the aegis of this Statute, referring specifically to the flatlands in the back of Hanalei town, including the USFWS (see State Land Zoning map in Appendix B.20). Supporting this mandate is Section 174C-101 (d), which sustains appurtenant water rights <u>even in the absence</u> of a permit. Therefore, traditional and customary rights ensured by the Hawai'i State Constitution is not ". . . diminished or extinguished by a failure to apply for or to receive a permit under this chapter" (Native Hawaiian Access III, Working Draft, 2002).

9.3.3 Endangered Species Act of 1973

The purpose of the Endangered Species Act 1973 is to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered and threatened species, and to take such steps as may be appropriate to achieve the pruposes of the treaties and conventions set forth in sub-section [a] of this section".

9.3.4 National Wildlife Refuge System Administration Act of 1996

The Act provides guidelines and directives for administration and management of all areas in the national Wildlife System, including 'wildlife refuges, areas for the protection and the conservation of fish and wildlife that are threatened with extinction, wildlife ranges, game ranges, wildlife management areas, or waterfowl production areas".

The Act was recently amended by Public Law 105-57 under the National Wildlife System Improvement Act of 1997. The new law amends and builds upon the 1966 Act to ensure that the National Wildlife Refuge System is managed as a national system of related lands, waters, and interests for the protection and conservation of the Nation's wildlife resources.

9.3.5 Wilderness Act 1964

This Act directs the Secretary of the Interior to review and recommend to the President roadless areas of five thousand contiguous acres or more under his jurisdiction for preservation as wilderness ares.

9.3.6 Refuge Recreation Act of 1962

This Act authorizes appropriate public recreation uses of national fish and wildlife conservation areas, which are compatible with the primary purposes of such areas.

9.3.7 USFWS Service Manual

The chapter in the manual – Land Use and Management Series: Part 601 FW 3 - supports policies for maintaining and restoring, where appropriate, the biological integrity, diversity, and environmental health of the National Wildlife Refuge System. This policy is an additional edict for refuge managers to follow while attaining the System mission and purpose(s) of the Refuge. It provides for the "consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges and associated ecosystems. Further, it provides refuge managers with an evaluation process to analyze their refuge and recommend the best management direction to prevent further degradation of environmental conditions; and where appropriate and in concert with refuge purposes and System mission, restore lost or severly degraded components:.

Another chapter – Land Use and Management Series: Part 603 FW 2 – outlines policies for determining the compatibility of existing and proposed uses of National Wildlife Refuges. The objectives of this chapter include providing guidelines for determining compatibility or proposed uses of the NWR and procedures for documenting and periodic review of present refuge uses. Further, the chapter ensures that management of proposed and present Refuge use follow compatibility policies, laws, and regulations.

For Hanalei, in order to achieve its mission of de-listing endangered waterbirds, they must adhere to additional policies described in the Hawaiian Waterbirds Recovery Plan. This Recovery Plan was revised this year.

9.3.8 2002 Draft Revised Hawaiian Waterbirds Recovery Plan

The objective of the Draft recovery plan is to identify actions needed for the recovery of Hawai'i's four endangered waterbirds so that their protection by the Endangered Species Act is no longer necessary. Actions called for in the revised plan include increasing populations throughout each species' historical range; establish a network of protected and managed wetlands; removing the threat of Koloa-mallard hybridization; supplementing populations of Hawaiian moorhen; controlling predators; and conducting public education and information programs.

To de-list, the recognized wetlands should be protected and managed in accordance with management practices outlined in the recovery Plan. The monitoring of populations should show that they are stable or increasing above a minimum for at least five consecutive years (Koloa-2000; coot -1,800; moorhen – 1,500; and stilt – 1,500). Finally, there should be multiple viable breeding populations existing on several of the main Hawaiian Islands indicated in the Plan. And to de-list, recognized wetlands should be protected and managed in accordance

9.4 Comprehensive Management Plan

Currently, the USFWS is in the process of conducting a comprehensive management plan, which should be completed in 2008. Unfortunately, this lack of an updated comprehensive management plan of the Hanalei NWR adds to the concerns regarding land tenant security issues and the possible discontinuation of taro farming in the Hanalei NWR (see more in Jan TenBruggencate, Honolulu Advertiser, Kaua'i Bureau, March 25, 2002).

Taro farmers are issued Special Use Permits (SUP) under a number of specific conditions. The SUP has strict regulations for land use and agricultural practice. The farmers leasing from the NWR are expected to abide by the regulations, otherwise face eviction.

9.4.1 Special Use Permit Conditions

Taro farming is currently permitted on the Refuge because the current land use practices provide wetland habitat for the birds. Occasionally, wildlife management and bird use conflicts with optimum taro water management and production (e.g. maintaining wet fallow fields, waterbirds feeding on taro) so permit fees are set at an appropriate rate to compensate farmers for losses incurred as a result of the requirement to favor the birds. In addition, some farming practices may be modified or restricted to enhance waterbird production. A Special Use Permit (SUP) is granted for lessees on the NWR, but is attached to regulations that restrict farming practices and other behavioural practices in so far as such regulations meet the requirements of the Endangered Species Act. Stated alternatively, the SUP's purpose is to inhibit certain behaviours that would cause harm to the ecology of the Refuge or obstruct their goals for delisting the endangered waterbirds.

The framework of the SUP is directed at land use, agriculture practice(s) *a propos* taro farming in terms of fallowing, application of fertilizers and pesticides, ownership of pets and animals, use of land for other purposes besides taro farming, and general maintenance. The SUP also holds lessees responsible for waterbirds sighting, involving them in data collection. In summary:

1. Only taro farming is allowed under the SUP. Therefore, introducing other plants or animals without the consent of the Refuge mananger is not allowed in order to protect the Native plants.

2. Taro fields must be in fallow at all times, meaning crop rotation must be exercised to support this regulation.

3. Only 25% of taro land can be in dry fallow, but not more than six months.

4. Fallowing must be at a minimum of thirty (30) days. Any exceptions are granted only with written approval; approvals are granted within ninety (90) days.

5. Farmers must use only the herbicides and pesticides approved by the NWR, as determined by the EPA. If farmers choose to apply other types, they must solicit the approval of the Refuge manager.

6. The lessee must help to maintain irrigation ditches and participate in taro farming activities. They must also clean, maintain, and repair ditches and/or roads, and document damages.

7. Lessees must report waterbirds (or nests, thereof) sightings to the Refuge Manager or biologist within 48 hours.

8. Residences, ownership of animals, alternative agriculture are not allowed unless approved.

9. Residents are also required to remain within the designated areas as identified on a map provided to them by the Refuge Manager.

As far as maintaining the quality of the Refuge, the USFWS's concerns about pesticide and herbicide use are legitimate. To the extent that taro farming can contribute to a decline in water quality or hurt the ecology of the NWR, the USFWS supports the regulations to which farmers are bound. The next sections expound upon some of these points.

9.5 Taro Farming in Hanalei

Taro can be cultivated under both wetland and dryland (upland) conditions. In Hanalei, wetland taro cultivation is the common agricultural practice. The wetland, or *lo'i* system, takes advantage of taro's flood tolerance, as it receives the highest precipitation on Kaua'i (see Table 12), and is located in a flood zone.

Table 12. Precipitation from Selected Stations, Island of Kau'i, 2000

Stations	Year/Normal	Annual	% Annual normal
Anahola	Normal	50.0	40.0
	2000	19.99	
Hanalei	Normal	110.0	67.7
	2000	74.46	
Omao	Normal	60.0	62.7
	2000	37.61	

Source: Hawaii Agricultural Statistics Service, 2000

Taro is planted or sown using a huli, part of the harvested plant. The *huli* consists of about 10 inches of leaf stem (with the leaves trimmed) attached to 1/8 inch to 1/4 inch of the crown of the corm. The huli is prepared at the same time the taro is harvested. Taro bears short underground stems called a corm (*ha*). Here, the plant stores starch produced by the leaves. The corm can grow as large as six inches in diameter.

For propagation, the *huli* (the planting material) consists of a 1/2 inch thick slice of the top of the corm attached to 6 to 10 inches of the leaf-stem. These protrude above the water where planted. The bottom of the corm/root is saved for cooking and eating, making taro a recyclable plant. In 6 to 12 months, depending upon plant variety along with soil and water conditions, the taro should be ready to harvest. Each parent tuber produces from two to l5 *`oha*, side tubers of corms, up to 6 inches in diameter. *`Oha* refers specifically to the suckers or shoots concentrically growing from the corm of the taro plant. They are, then, harvested between 12 and 18 months after planting.

Today, Hanalei is the largest production of wetland taro throughout Hawai'i. Approximately, seventy five to eighty percent of taro in Hawai'i came from Hanalei (Yamamoto, October 21, 2002). The largest taro acreage in the district is within the boundary of the Hanalei National Wildlife Refuge and consists of approximately 125 acres. According to the USDA, varieties that are grown in Hanalei area are mainly *Lehua Mao'li*, *Lehua Kaua'i*, and the cross between *Lehua Palauian* and *Lehua Kaua'i*. These taro are mainly for poi production island-wide. A poi mill (the Hanalei Poi Factory) was recently built in Hanalei Town, as the new-generation taro growers aspire to add value to their locally grown crops and enhance the community's economic activities through poi manufacturing. Hanalei poi is produced in a unique process to add longer shelf life to poi, to maintain its fresh taste, and provide alternatives for poi lovers.

Unfortunately, the farmers are faced with bottlenecks that can obstruct yield. They are pests, weeds, and diseases. To eliminate them, they must apply a pesticide that can contaminate the water even under strict regulation, the salient concern for the USFWS.

9.6 Pests, Weeds, and Disease Problem/ Control for Taro Farming in Hanalei

Pests, weeds, and taro diseases pose problems for the farmers because they can decrease farmers' annual revenue if untreated. On the other hand, caution must be emphasized on the degree and extent of treatment.

9.6.1 Pests

Crayfish and apple snails are the most common pests for taro farmers in Hanalei. Snails feed on taro leaves and stems, causing serious injuries to young plants (Mitchell and Maddison, 1983, p.185). An interview with Rod Cowie revealed that the apple snail, intended to be an ingredient for hotel restaurants, was first introduced in Maui in 1989. In the same year, it spread to Kaua'i and became a major pest in 1990. Cowie explained that apple snails feed on the underwater parts of taro, and also the leaves that come into contact with water. Damaged corms would take unnecessary time and labor force to clean up, therefore contributing to another aspect of economic loss.

Water level plays an important part in controlling some pests. Water level should be high enough to prevent weeds from growing, but should also be low enough to prevent crayfish from moving around freely and damaging the huli. Apple snails can be scooped out from small pools of water that are allowed to form in the taro field, or by baiting them with chicken feed.[24] Cayuga black ducks can control small and medium size apple snails and crayfish. However, because importation of this kind of duck has been made illegal, Cayuga black duck must be obtained from a local source. Other ducks also could be trained to eat apple snails and crayfish. Also, a screen can be placed over water inlets to prevent pests from entering from fresh water sources.

Cowie also explained that taro farmers called for help from the Department of Agiculture in 1990, but the remedy action faded out in 1994, due to the dilemma of profit-making apple snail farms and yield-losing taro farmers. Farmers should take action by documenting yield loss as a result of uncontrolled apple snails. Also, yield loss would surely have economic effects on poi production, and finally to consumers. Significance of such yield lost and extended economic effect would be an important tool to call for immediate action to control apple snails. It seems like more research needs to be done on how to control this pest effectively, but without the support from government agencies, the problem will not be solved. Another possibility is that the farmer and Department of Agriculture could acquire support from other agencies or non-government research agencies to deal with the problem.

9.6.2 Weeds

Weed in taro *lo`i* compete with taro for nutrients, resulting in slow growth and small corms. Wetland taro practice of draining and drying *lo`i* periodically provides an optimal

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[24] See Biology Section, Apple Snails for further details.

condition for weed growth. Weeds are also subject to growth on high spots (above at least the 1 inch-high water level) and uneven areas of the *lo`i*. Weeds should be pulled out and taken away from the *lo'i* before plantation and during the early stage of taro. When taro leaves are big enough, they should automatically shade out the weeds. In fact, Chinese geese are considered an effective method for weed control. The aquatic fern "*azolla*" also has many advantages toward wet taro production. When azolla forms a complete mat over taro *lo'i*, it will help suppress weeds, lower water temperature, and provide an additional source of nitrogen. Azolla should be planted in the *lo'i* before the huli are planted. Recent research project on Kaua'i has demonstrated that azolla can reduce weeds up to 86%.

9.6.3 Diseases

Major taro diseases are pocket rot and leaf blight. Ridomil Gold, a systemic fungicide, has been the only registered chemical allowed to be used in taro *lo`i*. Good production practices play an important role in controlling diseases, which include using disease-free materials in planting processes; avoiding walking through wet fields, which spreads the disease carried by farmer's clothes from one *lo`i* to another; providing enough spacing between taro plants to allow leaf surfaces to dry quickly; curing *huli* for 3 to 5 days to allow cut surfaces to dry and form a callus to protect them from diseases; isolating *lo`i* into small portions instead of one big *lo`i*; fallowing the land or rotate other crops between each taro cultivation; applying compost into dry fallow; removing and destroying diseased plants; and monitoring leaf calcium level and maintaining the recommended calcium level to prevent development of root rots. Dr. James Silva explained that two varieties of the same fungus cause both root rot and leaf blight disease (Waipi'o Practicum, 2001). Leaf blight can spread through raindrops and wind. Planting *huli* 30" apart from each other is found to be an effective practice to control spread of leaf blight. Increasing distance also yields better quality corms. Corms are likely to be bigger, healthier, and heavier, which are desirable when sold as table taro.

Dr. Silva further explained that taro farmers reported severe cases of pocket rot disease after hurricane Iniki struck the island in the 1990s. The study of the disease has begun since that period. The study finding has shown that high levels of nitrogen made taro more susceptible to leaf blight disease. Also, taro that develops pocket rot is likely to develop leaf blight because starch is pulled from the leaves to help build a rot barrier around the infected part of the corm to prevent pocket rot from spreading. However, the study has shown no correlation between nitrogen levels and pocket rot. Calcium from phosphoros nutrient is possible, albeit insignificant, to cause taro to be more susceptible to pocket rot. Secondary organisms are associated with pocket rot, as they feed on dead tissues that are infected by primary organisms that cause pocket rot and make the rot worse. Pocket rots can be reduced by allowing for a fallow period - to dry the patch, plant ground covering plants, and till. These practices will allow microorganisms to feed on spores of fungus that cause the disease. When new *huli* are planted, they should be clean from pocket rot spores. Pocket rot diseases can also spread through dirty taro bags that carry disease spores, which are used to transport corms to factories, and are rotated among taro farmers.

These bottlenecks are the impetus for applying herbicides and/or other applications that would mitigate the propagation of weeds, pests, and other diseases, which again is the concern of the USFWS. Their mission is to propagate the endangered waterbirds as well as ensure that water and ecological qualities in the Refuge are not disturbed. The mission behind the latter is to minimize cumulative impact. These are all components for managing the Hanalei watershed-*ahupua'a*, in general.

9.7 Regulations and Permits for Taro Farming

Generally taro farming practice may comply with various regulations. The table below summarizes permits, services and contacted agencies that may be useful for general taro cultivation activities in a community.

Table 13. Lists of agencies crucial for taro cultivation activities

Taro Cultivation Activities	Permits	Agency
Diverting water for irrigation	Stream alteration permit and stream diversion works permit	Hawaii Department of Land and Natural Resources (DLNR)
Using water from stream/ or dam sites in State of Hawaii Conservation Land Use Districts	Conservation district use permit	DLNR, office of Conservation and Environmental Affairs
USDA cost-sharing benefits for soil erosion and water management systems	Soil and water conservation district	The Farm Service Agency (FSA) Natural Resources Conservation Service (NRCS)
Restoring lo`i and use of earth-moving equipment	Department of the army permit or 404 permit	Army Corps of Engineers; local soil and water conservation district (SWCD) under NRCS
Registering lo'i as a cultural resource	Section 106 permit	DLNR, Historic Preservation Office
Discover human bones or other artifacts in taro patch	Section 106 permit	DLNR, Historic Preservation Office Local police department
Sharing and learning from taro growers in the area	N/A	Taro growers' associations (hui); contact CTAHR for nearest group (Waipa group in Hanalei)
Irrigation water outflow	401 Water quality certification permit, National Pollutant Discharge Elimination System (NPDES) permit	Department of Health, Clean Water Branch
Soil erosion and nutrient runoff	Soil and water conservation district	Natural Resources Conservation Service (NRCS)
Taro farming in Hanalei, Kauai	Special use permit (lease agreement)	U.S. Fish and Wildlife Service

Source: Mauka to Makai, CTAHR, 1997

9.8 Agricultural Activity in Hanalei

Two environmental consequences associated with taro cultivation are increased turbidity (sediment) and nutrient levels (hypernutrification) in the streams and down stream bodies of water that received outflow from *lo'i* (CTAHR, 2000). With modern cultivation methods, chemical contamination from pesticide and herbicide application is also a concern. Sediment and nutrient loads degrade water quality, and threaten the habitats of plants and animal. According to Griffin (2000), the Hanalei *ahupua`a* presents several signs of ecological stress. Increases in nutrient and sediment loads in the lower river are among the notable signs. He claimed that water runoff from approximately 100 acres of the lower flood plain in Hanalei *ahupua`a*, used intensively for taro cultivation and cattle grazing, has contributed to sedimentation and nutrient loading in the lower river. Water quality measurements in 1995 have indicated a concentration of sediments and nutrients in the river body that flows through the Hanalei NWR area and where taro is cultivated. Floodplain modifications, namely the construction of berms on the Hanalei National Wildlife Refuge (NWR), may also increase flood, soil erosion, and sediment and nutrient levels in the Hanalei River (Griffin, 2000). In Griffin's same report, a study by Berg and Calhoun (1997), monitoring ambient water quality levels within irrigation ditches and outflows, taro ponds, and waterbird impoundments, indicated levels of nitrate and nitrite, potassium, and ammonia 4 to 40 times higher in water body that received outflow from taro fields than upstream water. The study also discovered that sedimentation has increased from 2 to 4 pounds per acre per day throughout the Hanalei NWR.

Modern farming method, especially the introduction of synthesis fertilizers, has contributed to a significant amount of nutrient loads down stream. Hawai'i State laws in nutrient management include Hawai'i Revised Statute 342D on water pollution. The regulation was enacted in 1993 to control and abate pollution (CTAHR, 2000). This statute is implemented through Hawai'i Administrative Rule 11-54 (1992), which establishes Water Quality Standards for the state. Supporting laws include statute HRS 342E (1993) Nonpoint Source Pollution Management and Control. Taro farming is grandfathered in permits enacted after the farming operation.

9.8.1 Water Management for Agricultural Purposes in Hanalei and its Effect on the Waterbody

This section discusses water intake and water outflow system in taro farming and their possible effects on the water quality of the Hanalei River. Basic knowledge about water management in taro farming will also be analysed in relation to co-establishment of waterbird refuge within the area in the latter section.

9.8.2 Water Intake and Irrigation System for Wetland Taro

The geography of Hanalei is highly suitable for wetland taro cultivation. By using the wetland method, taro is planted in *lo'i*. The taro plants in *lo'i* are kept flooded under a few inches of water. Water must constantly flow evenly through the *lo'i* system in order that taro yields are productive. According to Handy (1972), there are four periods during taro growth requiring proper irrigation maintenance:

1. Irrigation: Until the first leaf of the taro plant is unfurled, ample irrigation is required. Care must be taken to prevent the water from washing out the soil around the new plantings.

2. Drying: After the first leaf unfurls, the plant cuttings are pressed firmly into the soil. The surface of the *lo'i* should not be flooded but kept damp until the first two leaves appear.

3. Moderate Flooding: After the first three leaves are unfurled, water should be let into the *lo'i*, the degree of flooding regulated at the *makawai* of each *lo'i*. The amount of water inflow increases as the new shoots have grown around the main plants.

4. Full Flooding: Until the plants reach full maturity, the *lo'i* should be fully flooded with fresh water. The *lo'i* requires constant, yet regulated flow. The plant reaches full maturity when the leaves are completely unfurled, begin to yellow, and almost resemble a "wilted" appearance. During this time, weeding is performed as needed. It is well known among taro growers that if water becomes stagnant, the taro plants will rot and die. Thus, it is crucial to assure adequate water flow.

Table 14. Comparison of Surface Water Divisions from the Hanalei River

	Mean (MGD)	**% of Mean Flow**	**Year Closed**
Hanalei Tunnel	18	13.10%	
China Ditch	18	13.10%	
Kuna Ditch	-	-	
Hanalei NWR	15	10.90%	

MGD stands for million gallons per day
Mean flow for Hanalei River estimated at 137 MGD

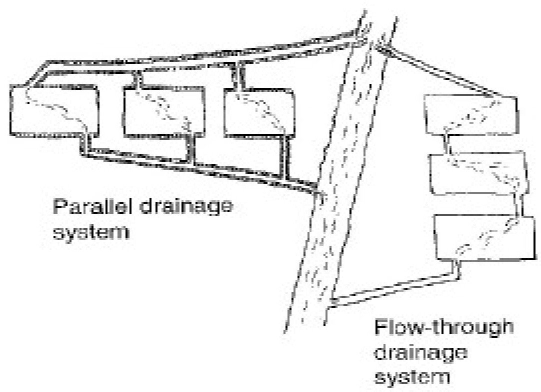
Source: USGS Stream Gauge records; HI DLNR, 1991; Berg and Calhoun, 1997

The USFWS has improved upon the irrigation system for taro ponds and impoundment ponds in the Refuge. Currently, only water diversion operated by NWR is used for taro cultivation. The system is a mix between the *'auwai* system and the closed pipe system. CTAHR (1997) suggests that water flow can be ranged from 1.2 to 12 gallons/ sf^2/day (52,272 gal/ acre/ day to 522,720 gal/ acre/ day). The amount of water required depends on the crop stage, planting density and arrangement, taro variety, soil amendment and fertilization regime, *lo`i* drainage scheme, irrigation system management, and weed, pest, and disease control management. Water temperature under 78 °F is desired in order to prevent growth and spread of rot root disease. Water with higher flow rate, more in depth, and shading are likely to be cooler than water in the opposite condition.

9.8.3 Water Outflow from Irrigation System

There are two typical *lo`i* arrangement patterns for wetland cultivation that reflect a unique drainage system and design. The drainage system may be a parallel, central drainage pipe or canal, or flow-through drainage system as shown in picture 18.

Picture 18. *Lo`i* Arrangements and Drainage systems



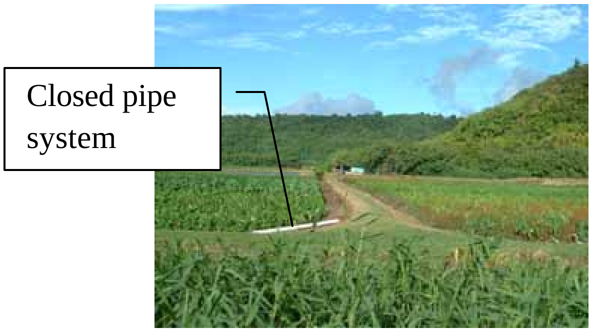
Source: Mauka to Makai, CTAHR, 1997

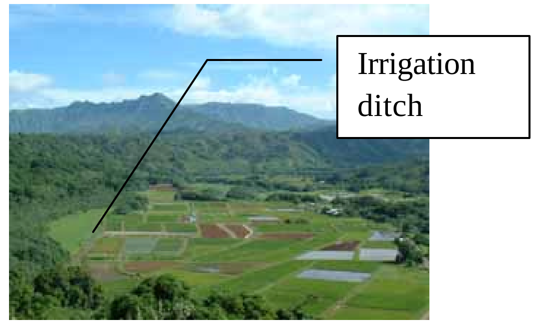
Although the parallel drainage system uses more water than the flow-through system, its features have the following advantage:

- Allow any combination of wetting and drying
- Provide water of equal temperature to each *lo`i*
- Reduce risk of pest and disease transmission
- Keep nutrients from affecting adjacent *lo`i* at different crop stages

However, both systems allow most of the water to return to the *`auwai*. It is recommended that the distance from the water entrance to the exit location should be as far apart as possible to increase water circulation and to reduce water stagnation. Using an outflow pipe that is larger than the inflow pipe and installing the outflow pipe at a steeper angle than the inflow pipe also helps improve water drainage and circulation (CTAHR, 1997). Open channels can also be used to control water flow in taro patches. The advantage of using open channel is that it is easier to unclog than the piping system. Nevertheless, an open channel system constitutes several disadvantages: (1) it is more difficult to control; (2) it is less precise; (3) it requires more attention; and (4) it provides for higher temperature water than the closed pipe system.

Picture 19 and 20: Combined auwai and closed pipe irrigation system in Hanalei





As mentioned in the beginning of the section, two environmental consequences associated with taro cultivation are (1) increases in turbidity (sediment) and (2) nutrient levels (hypernutrification) in the streams and down stream bodies of water that received outflow from *lo'i*. The section below describes how soil sedimentation and nutrient loads at different stages of taro farming activities can affect water quality.

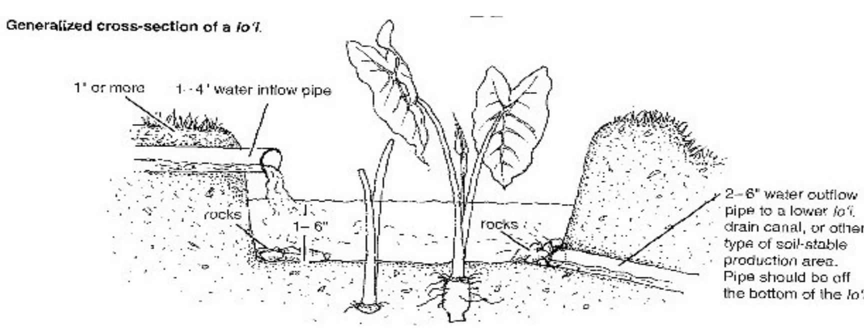
9.9 Taro Farming Activity and its Effect on Water Quality in Hanalei

Taro farming has been associated with root causes of water contamination. Most of its contributive factors are tied to soil sedimentation, nutrient overload and chemical contamination.

9.9.1 Soil Sediments

Soil erosion can occur in many stages of taro cultivation: (1) when the banks are first built; (2) when banks are left bare without vegetation; (3) when water first flows into the *lo'i*, and (4) during fertilization, weeding, harvesting. Soil erosion can also occur if an outflow pipe is placed incorrectly. It can lead to soil loss from the *lo`i* bottom into run-off (CTAHR, 1997). The proper placement of the outflow pipe is demonstrated in picture 21.

Picture 21. Proper placement of outflow pipe



Source: Mauka to Makai, CTAHR, 1997

9.9.2 Nutrient Loads from Water Outflow

Fertilization is one of the major causes of hypernutrification. Nitrogen, phosphorus, and potassium are the major nutrients needed by plants. Commercial fertilizers may contain one or more of these basic nutrients. Normally, soil and plant-tissue should be sent to a commercial lab or the CTAHR Agricultural Diagnostic Service Center to analyze current nutrient status and the right amounts of fertilizers and soil amendments needed to apply in different growth stages of a crop. According to CTAHR (1997), taro demands nutrients only during rapid leaf growth period, especially nitrogen (N) and Potassium (K). Phosphorus will usually be applied at the first stage of planting. In fact, run-off containing nutrients at the last stage, corm growth, will damage the corm (become loliloli, soft and gummy). Excessive amounts of fertilizer may cause economic loss and toxicize crops, soils, beneficial soil microorganisms, and the surrounding environment. Appendix A.4 summarizes toxic conditions caused by excessive fertilization.

9.9.3 Chemical Contaminants from Pest Controls

Pesticide availability and pesticide regulations change frequently (CTAHR, 1997). Pesticide for taro is limited by the fact that taro is a minor crop - not enough economic incentive for manufacturers to invest on research. Pesticides used for taro are usually those used on fruits and vegetables, or other roots and tuber plants. Insecticidal soaps can also be used to control soft-bodied, non-waxed, and newly hatched insects. The Hawai'i Department of Agriculture and UH-CTAHR can provide information on available pesticide for taro. According to the Special Use Permit issued by the USFWS, the only herbicides and fungicides authorized for use on the Refuge include Rodeo, Roundup, and Ridomil. These herbicides should be applied according to EPA-approved container label, or as modified by an EPA "special needs restriction".

9.9.4 Chemical Contaminants from Weed Controls

Herbicide is generally used to control weeds on the banks during production, and in the *lo`i* before production. Roundup Ultra is currently available for weed control on the banks. Using herbicide in production wetland (on the bank) is only allowed in dry *lo`i*, and must wait at least 30 days after applying herbicide before planting crops. Using herbicide on the bank when *lo`i* is flooded will need a supplement of Special Local Need (SLN) label from the Hawai'i Department of Agriculture to legally operate. Applying herbicide directly to the weeds growing in the water is prohibited. Thus, herbicide usage in taro cultivation has a relatively small chance of downstream contamination.

9.9.4.1 Organic and Inorganic Containment in Hanalei Water Body from Pesticide and Herbicide Usage

A study done by an environmental chemistry research team in 2001 provides levels of organic and inorganic contaminants in water sample, sediments and biota sample collected from the Hanalei River. By comparing the findings with the EPA's numeric criteria in their water quality standards database for priority pollutants, the majority of pollutants are below standard *(http://oaspub.epa.gov/pls/wqs/wqsi _epa _criteria.report*).

The numeric criteria of EPA's water quality standard are divided into six categories. The first category is an acceptable amount of pollutant in freshwater body (freshwater Criteria Maximum Concentration or CMC). The second category is an amount of pollutant that would have a negative effect on freshwater body in a continuous period (freshwater Criterion Continuous Concentration or CCC). The third category is an acceptable amount of pollutant in saltwater body (saltwater CMC). The fourth category is amount of pollutants that would have a negative effect on saltwater bodies in a continuous period (saltwater CCC). The fifth category is amount of pollutants allowed in drinking water and consumption by organisms. The last category is amount of pollutants allowed for consumption by organisms.

For Polycyclic Aromatic Hydrocarbons, the EPA's numeric criteria for amount of pollutants allowed in drinking water and consumption by organism is the most astringent. Pollutants collected from sample sites, when compared with EPA standards, have shown lower levels than the standards. However, the level of organochlorine pesticides in biota, when compared with the drinking water standards, has shown that the pollutant level exceeds the standards. High levels of Dieldrin are found in downstream biota. Chlordane is also high in downstream biota. Even though they may not exceed fresh water contamination standards, it still exceeds the standard for continuous contaminant level in fresh water, drinking water, and consumption by organisms. DDE and DDD findings are limited in precision of contaminant level. The EPA standard for DDE, DDD, and DDT in drinking water has shown 0.00059, 0.00083, and 0.00059 microgram per litre (ug/L) consecutively, while the finding only reported < 0.02 ug/L for DDD and DDE and <0.01 ug/L for DDT (CTAHR, 2000). A more precise study should be conducted to monitor the exact level of DDE, DDD, and DDT. However, level of DDT that would affect fresh water quality over continuous period is at 0.001 ug/L (CTAHR, 2000).

High levels of nonachlor are also revealed, but the EPA standards do not list this pollutant as priority pollutant. Levels of alpha-BHC and beta-BHC are acceptable when compared with the consumption by organism standards, but more refined studies are needed if drinking water standards are to be used as a criterion. Levels of Heptachlor and Heptachlor epoxide may exceed standard levels allowed continuously in freshwater bodies, but again more refined studies need to be done to verify the exact amount of pollutants. However, levels of Heptachlor epoxide found in downstream biota clearly exceed standard levels allowed continuously in fresh water and drinking water. A more refined study for PCB levels is also needed.

In sum, most of the elements listed as priority pollutants are below EPA standards, however, a more precise study should be conducted to find the exact level of mercury because the concentration level at some sample sites (25546 upstream 2, and 25548 downstream 4) have exceeded standards for drinking water. DDE and DDD findings are also limited in precision for contaminant levels. A more precise study should be conducted to monitor the exact levels of DDE, DDD, and DDT. A more refined study of levels of alpha-BHC and beta-BHC are needed for comparison with drinking water standards. Levels of Heptachlor and Heptachlor epoxide may exceed standard levels allowed continuously in freshwater body, but refined studies need to be done to verify the exact amount of pollutants. However, levels of Heptachlor epoxide found in downstream biota clearly exceed the standard level allowed in fresh and drinking water.

9.10 Mitigating Water Pollutants from Taro Farming Activities

There are strategies for minimizing the introduction of pollutants into the water; they range from manipulating the physical landscape to managing the proper application of fertilizers into the taro *lo'i*.

9.10.1 Sediment, Soil Erosion Control and Bank Maintenance

For sedimentation problems, building a proper bank that resists erosion and proper placement of the outflow pipe will help reduce levels of soil sedimentation from the water outflow system. Proper construction of bank and *auwai* plays a major role in reducing soil sedimentation in run-off. Banks' soil layers should be thoroughly compressed together. Well-compacted banks are water-tight sealed and resistant to the destructive force of digging crayfish. Sprinkling water between layers of soil while building the bank will help drive out air pockets and bind soil together more firmly. Non-soil debris should be removed from soil that is used to build banks. The outside edge of the bank should have a gradual slope of 45 degree to allow ease in mowing grass, while the inside edge of the bank should have a steeper slope of 65 degree to limit weed growth (CTAHR, 2000). Grass and ground cover should be planted on the banks. Water inflow and outflow should be ceased while fertilization, weeding, and harvesting are taking place, and the pipe to resume water flow should be inserted only after the disturbed soil has settled well. Banks should be maintained and repaired regularly. Grass and ground cover should be trimmed and weeds should be controlled. Tractor wheels and mower blades may damage the bank and create more erosion. Chinese geese, donkeys, weedwacker, hands, and Roundup Ultra herbicide can be used to control weeds on the banks. Flat rocks and concrete blocks are best material for constructing the '*auwai*. A ten percent slope of the sides of the '*auwai* is preferred. Gentle slope allows water to flow over and not to cut into the side of the '*auwai* to reduce erosion (CTAHR, 2000).

In a personal communication, Dr. Silva added that soil sedimentation is subject to leaching to water bodies after the harvest period (during the fallow period to dry out the field for 1-2 months and tilting period before new *huli* are planted), when heavy rain carries out loose soils into the river. Phosphorus is attached to those sediments and is simultaneously carried out into the water body. Sediments are very fine; use of screens over outflow pipes will not significantly reduce sediments. The best way to reduce sediment runoff is to allow soils to settle overnight after tilting, before letting water flow out from the field.

9.10.2 Fertilizer Management Regulations

Farmers' involvement in conservation planning by NRCS is voluntary. Under the 1985, 1990, and 1996 Farm Bills, however, farmers' benefits from federal programs are tied to approved conservation plans. In addition, a nutrient management plan is required in conservation plans. To develop a conservation plan, NRCS will assess the vulnerability of natural resources at the site and possible risks from current land uses. Then, farmers are referred to CES for recommendations on appropriate fertilizer applications. Most states have laws regulating fertilizers to ensure consumer nutrient content in products, but few states regulate either the misapplication of fertilizers and/or nutrient pollution. However, since 1996 National Water Quality Inventory conducted by the Environmental Protection Agency (EPA) alleged that Nitrogen and Phosphorus are the leading causes of declining water quality, there is an increasing trend in regulatory legislation that requires farmers to develop nutrient management plans because the recognition of association between agricultural nutrient application and deteriorated water body quality.

9.10.3 Nitrogen (N) Fertilizer and Water Management

Fertilizer forms, application method, and water management contribute to nitrate leaching through soil. Common forms of N used are urea, ammonium, and nitrate. Each form is different in mobility, transformation, and volatilization characteristics. Ammoniacal forms are less vulnerable to leaching. Aqua ammonia and diammonium phosphate are least mobile, so that 73-93% is likely to be retained within 4 inches from top of the soil. Urea and nitrate are prone to leaching immediately after application. Urea will be converted to ammonium by enzyme urease within one to four days depending on amount of the enzyme found in soil. Microorganisms will transform Ammonium ions to nitrate, which then become vulnerable to leaching. Nitrification inhibitor can delay conversion of ammonium to nitrate. Since ammonium fertilizers are not mobile in soil, they should be applied near plant roots. On the other hand, urea and nitrate, which are more mobile, can be applied anywhere near the plants. However, nitrogen applications should be made when demand from crop is highest, usually at the early stages of crop growth, when the crop grows rapidly. N may not be needed when plant reaches its mature stage. Quantity of N applied should respond to crops' requirement at the different stages of growth. Irrigation water should also be managed to avoid N leaches. But in the case of irrigation by furrowing, water management may be difficult because water is often over-applied at the head of the furrow to ensure enough water reaches the end. Nitrate leaching usually occurs when no crops are planted in the field. Growing crops help remove water and nutrients from soil, therefore minimizing the amount of water and N moving below the root zone. Nitrate losses are greater in the wet season because heavy rain causes nitrate leaching. Thus, N application should be limited and nitrification inhibitors should be applied (CTAHR, 2000).

9.10.4 Phosphorus (P) Fertilizer and Water Management

Simple superphosphate, concentrated superphosphate, rockphosphate, and ammonium phosphates are common forms of fertilizer P. Rock phosphate is the only form that is not soluble. P nutrient carried by other forms of fertilizer P is readily available to crops, but only in soils that do not absorb P strongly. Hawai'i soil tends to be P-sorbing, thus, surface application of P is usually ineffective because P does not move to root zone. P fertilizers applied to soil surface are also subject to movement by erosion, and P in solution can be transported in runoff. Incorporating P into the soil minimizes its vulnerability to erosion loss. However, in high P-sorbing soil, P should be strictly applied within a zone, two inches below and two inches to the side of the seed row. Rock phosphate should be applied only to acidic soils by mixing thoroughly into root zone to maximize its contact with soil and promote acidulation reaction. Chemical reaction with soil acids is crucial before the P content becomes available to plants.

9.11 The Benefits of Good Practice of Fertilizer Applications

Applying nutrients only in amounts that plants are expected to absorb can reduce hypernutrification in taro ponds outflow (CTAHR, 2000). In fact, applying fertilizer (especially N and K) frequently in small quantities using formulations recommended for each soil and leaf tissue test will result in better growth and less fertilizer loss. Thus, using ready-mixed fertilizers is not recommended because proportion required in each *lo`i* varies depending on soil and plant analysis. Knowing the effective way to apply each fertilizer will also help enhance yield and lower nutrient runoff. P is assumed to be more effective when applied separately from N and K and should be applied under the soil surface to enhance corm growth. P, in soil, is an immobile substance. Applying P on the surface will not benefit the corms, but will stimulate feeder roots to grow on the surface, which will be damaged by foot traffic and dry soil. Controlling nutrient losses and soil management and upkeep, thus, would help reduce overuse of fertilizers. The U.S. Army Crops of Engineers recommended ways to control nutrient loss and sedimentation from erosion as follows (CTAHR, 1997):

- Establish vegetation on berms and banks before water is allowed to flow through the *lo`i* system
- Place drainpipe intakes far enough above the bottom of the lo`i to minimize the amount of soil run-off
- Stop water flow into *lo`i* before applying fertilizer
- Keep water in the *lo`i* without draining for at least one week after fertilizer application to allow water and fertilizer to penetrate into soil
- Block off inlets and outlets to the *lo`i* during planting, weeding, and harvesting operations
- Vegetate any areas of bare soil in the area surrounding the *lo`i* where water travels; grasses are especially good at trapping sediment and nutrients from entering the water ways
- Apply fertilizer frequently in small quantities

- Using formulations designed for specific soil and leaf-tissue nutrient condition, will promote better growth and reduce fertilizer loss

Dr. Silva maintains that nutrient loads from outflow system can be reduced by stopping water flow in and out from the taro fields when applying fertilizers. Fertilizers should be divided into small portions, and then applied two to three times to maximize absorption by plants and to minimize nutrient leaching. There used to be nutrient monitoring of water outflow from taro field. Although not regularly monitored, the result has shown lower levels of nitrogen contamination in water when the recommended practice of fertilizer application and water inflow-outflow were followed.

Fallowing is also important in taro cultivation practice because it naturally fertilizes the soil and helps to reduce the use of fertilizers. Adding organic matter to the soil in the fallow period between wet taro crops will benefit the soil by providing food and improving soil aeration for soil microorganisms. In return these microorganisms will attack the pathogenic ones that cause diseases. Sedgewick (1902) and Hawai'i Agricultural Research Station (1930) confirm that taro and crops that are grown on exhausted soils are more likely to develop diseases than those crops grown on fertile or fallowed soils. Fallowing allows microorganisms in the soil to decompose taro tissues remained in the soil after harvested. Pathogens embedded in the tissues will be exposed to its parasites in the decomposition process, weakened, and become harmless for new *huli*. However, soil in fallowing period should be moderately dry and free of weeds that pathogens could survive on (CTAHR, 1997). Soil that is allowed to fallow at least for six months would increase yield, enhance corm quality, and less subject to diseases and pests (CTAHR, 1997). Three month should be allowed for green manure, cover crops, or other fresh plant residues, and one month for compost, to completely decompose before flooding the taro pond. However, there are costs associated with fallowing the land because it means leaving the land unproductive during the fallowing period.

9.12 Nutrient Management Program in Hanalei

Nutrient management was first introduced as a strategy to maximize crop yield at the time that inorganic fertilizers became available. However, as economic analysis of farm profitability became more advanced, the strategy has shifted toward optimizing economic returns from fertilizer investments. During the past five decades as the environmental awareness has become intense, a better understanding of relationships between farming practice and the ecology has been established. The main concern of farming's effect on the environment has been focused on soil and water deterioration, especially in soil lost from erosions, and over-applied fertilizers (CTAHR, 2000). Thus, nutrient management today will evolve between optimizing productivity, profits, and environmental quality.

The application of N and P has been a major concern because of their potential risks on the environment. There is a growing trend that farmers may have to keep record of fertilizer use in the same way that applies to pesticides use. Farmers not only need to be aware of production costs, but also environmental costs from their practices. Thus, nutrient management plan is becoming as critical as financial plan. The goals of nutrient management are to ensure an adequate amount of nutrients are available for crops and to minimize nutrient loss in runoff and leaching from root zones. The plan should cover evaluations of sites' environmental concerns, the availability of soil nutrient, appropriately calculating the nutrient amount, specifying the amount that can be applied, and explaining the appropriate method for applying nutrients. The U.S. Department of Agriculture agencies, such as the National Resources Conservation Service (NRCS) and the Cooperative Extension Services (CES), can assist in developing nutrient management plan.

Nutrient management programs have been introduced to taro farmers in Hanalei in the early 1990s by the Agricultural extension agency (Silva, 2002) as part of a soil analysis program. Then the UH Department of Agriculture provided additional research support between1997-1998. Before the soil analysis program started, farmers were already using ready mixed fertilizers, which put an excessive amount of nutrients into the *lo'i* and wasted money, especially on phosphorus, the most expensive nutrient of the three (N,P,K). The study first found 500 ppm of phosphorus in sample soils resulting from the application of ready mixed fertilizers and naturally high phosphorus. Only about 40 ppm is needed for taro. Thus, in some fields, there is no need to apply phosphorus at all. Knowing this would help save farmers' money and reduce nutrient runoffs.

The extension agency also provided educational programs on nutrient management to farmers. The main purpose of this program is to help reduce production costs in fertilizers and reduce negative effects on the environment. Roy Yamakawa, an extension agency officer, encourages farmers to do a soil analysis. The expense is relatively cheap, costing about $10 per analysis. The analysis is usually done every two to three years; each time farmers came in for advice when they came across problems with the crops. For farmers, saving money on fertilizer is the main incentive for doing a soil analysis. Elemental fertilizers were also recommended.

The extension agency receives $20,000 per year from the Board of Agriculture. Combined with $10,000 of funding from the WHIP program, there is only $30,000 available for research on taro pests, disease control, and issues related to taro production.

Dr. Silva pointed out that after the soil analysis program some farmers still continue to use ready-mix fertilizer, as they have gotten accustomed to that practice. In an interview, Dr. Penn added that farmers' misunderstanding of fertilizer recommendation as "minimum requirement" needs to be corrected because those recommendations are supposed to be "maximum requirement". Also, farmer's mentality that "the more fertilizer added the better the taro yields" has contributed to weaknesses in the nutrient management program implementation. Dr. Silva also believed that a large number of birds have contributed to high levels of nutrient loads and bacteria counts in the water bodies because birds manure also contain N, P, K and microorganisms.

9.13 Total Maximum Daily Load (TMDL) Program for Hanalei

Dr. Penn explained that according to section 303D of the Clean Water Act, at present, only the Hanalei River has been listed for turbidity in the list of water impairments. The Hanalei HUI has requested the EPA to prioritize the Hanalei River in the Total Maximum Daily Load (TMDL) development program. In order to be prioritized, both the stream and coastal waters must be listed in the impairment water list. TMDL for turbidity can be determined by total suspended solid standard, multiplied by stream flow, when compared with total existing suspended solid loads. From this, the amount of suspended solid that needs to be reduced is determined. Fresh water monitoring in Hawai'i began to be conducted formally only about two years ago. The Hanalei stream is monitored once a month at two locations. One is upstream and the other near the river mouth (where sea tide meets river current). Water monitored upstream would determine level pollutants generated by natural component in the watershed, while water monitored down steam would reflect all land use activities downstream. With present conventional pollutant monitoring (temperature, salinity, PH, oxigen, N, P, total suspended solid, turbidity, and silica), the data will not be able to identify the exact source of such pollutants. More intensive sample testing and isothropic tests are required to be able to pin point the source of pollutants. EPA encourages local participation in the TMDL program development because local residents are great sources of information in identifying possible locations of pollutants.

9.14 Settlement Pond or Constructed Wetland

Settlement ponds or constructed wetlands can be established to serve as a natural flood plain to absorb or filter exceeding nutrient loads and sediments from land use activities before entering a water body. Wetlands help break down water-borne pollutants and capture flood-borne sediments. These actions help keep coastal water clear (*www.kilaueapoint.com*).

9.14.1 Living Machine and Polyculture Pond

The concept of the Living Machine and the polyculture pond can be used to reduce pollutants in the water body used for aquaculture and taro production activities. Actually, the living machine and the polyculture pond are based on the same concept: "biofilter". The polyculture pond, however, refers to the Hawaiian traditional practice of integrating aquaculture with the taro production system. Plants and organisms are used in the treatment system to absorb exceeding nutrients and sediments before water is discharged back into the natural system. This practice is claimed to be an immitation of natural wetlands, but is more efficient in terms of space used. Plants that are commonly used in the system include taro and *ong choy*, which at the same time can be harvested and eaten (Asato, 2000). This system can also be used as a means for reintroducing native endangered plants back to the area. Snails help reduce excess sludge, resulting in clearer water (Ocean Arks International, *http://www.oceanarks.org*).

A Living Machine pilot project was conducted at Farmers Livestock Co-op slaughterhouse in Ewa Plain. The result was satisfactory because the treated water can be reused in the slaughterhouse (Asato, 2000). As for the polyculture pond, a 319 project will be initiated in Hawai'i by the DLNR, aiming to demonstrate that integration of aquaculture with the taro production system can significantly reduce nonpoint source water pollution. The project was aimed at improving the social and economic conditions of taro growers and aquaculturists. The system consists of fish tanks that grow tilapia and Chinese catfish for commercial purposes. Water from these tanks is discharged into *lehua maoli* taro ponds. Then, water from the taro ponds is discharged to the *bun long* taro pond. Next, discharged water from taro ponds is drained in wastewater polyculture ponds (one solarized, the other not) filled with taro, fish, and other aquatic plants. Native wetland plants and fish can also be used in this system, which at the same time help restore them back into the area.

The combination of plants and animals in the system depends on the level of nutrients discharged. Native plants that can be used in the system include *Scrippus* (great bullrush), *Ahuawa*, *Baccopamonneri*, Sugar Cane, *milo*, and *Hau*. Unfortunately, according to Chad Durick, the human ecologist for the Waimanalo Living Machine, apple snails are not used in the system because they do not feed on sludge. The system will control eutrophication, recycle organic and inorganic wastes, decrease soil sediments, and decrease water pollution (*www.epa.gov/owow/nps/Section319lll/HI.htm*). However, an intensive ecological study should be conducted in critical habitat areas to prevent undesirable effects to the ecosystem. For more information on the 319 project, please contact Don Heacock, DLNR, in Lihue: 808-241-3400.

9.14.2 Organic Farming

There are some organic farmers in Kaua'i, one of whom farms in Wai'oli. His organic taro is sent to an organic poi factory on Oahu. However, organic taro has a relatively small market. It is mainly for table taro. To expand the market value of organic poi, more markets need to be developed in order to shift conventional taro farming practice to organic farming. Organic farming is more expensive and not necessary for taro poi, at present. However, organic table taro, like other organic crops, can be sold at a higher price. But organic farming is usually practiced in smaller acreages and may not be sufficient to feed commercial manufacturing. Dr. Silva stated that organic farming is still subject to nutrient leaching, but at a slower release rate than non-organic farming. The reason is organic substances require a longer period of time to decompose; once it does, it provides essential nutrients for plants. Thus, Dr. Silva explained that organic farming, without proper management practice, would still have negative effects to the environment.

9.15 Recommendations on Mitigating Water Pollutants from Taro Farming Activities

- Despite Dr. Silva's assertion that agriculture can harm water quality, he suggested water quality should still be monitored upstream to be able to compare it with water quality downstream. Since nutrient overloads can be induced by wild animals in the forest area (upstream), without upstream monitoring, one can not conclude that high levels of nutrient loads are necessarily attributed to agricultural practice.

- To improve the nutrient management program, educational workshops should be formally promoted, the implementation of which should be monitored.

- Data collection should be conducted regularly on nutrient cycle monitoring, water quality, and amount of money saved when farmers follow advice on the maximum requirement of fertilizer application. Comparative data on nutrient loads in intake and outflow water, before and after best management is practiced (soil analysis and recommended fertilizer application), is an important indicator for implementation. These data would lead to a better design of such a program.

- The use of ready-mix synthesis fertilizers should be monitored and limited. Dr. Penn suspected that the modern use of such fertilizer has contributed to increased levels of nutrient loads in the water body in comparison to the use of only green manure for soil enrichment in traditional Hawaiian practice.

- Intensive water sample tests should be conducted in order to develop an effective water pollution management plan for Hanalei.

9.16 Relationship between the Birds, Taro Lo'i, and the Impoundments

Thus far, two studies have been conducted on the relationship between the birds, taro fields, and impoundment ponds. One study was conducted by the USFWS personnel in 1999. The other was done by Robert Broshears.

9.16.1 Previous Studies

The study conducted by former Refuge personnel entitled *"Waterbird Use of Taro and Pond Habitats on the Hanalei National Wildlife Refuge: 1999 Report"* (Asquith and Melgar, 1999) is a quantitative, comparative analysis of waterbirds nesting on the two habitats: taro fields and impoundment ponds. The study was conducted at least monthly between the1970's and 1982, and in the 1990's. The count data between the 1970's to 1982 represent bird populations before the impoundment ponds were constructed. Data from the 1990's represent bird population post-construction. The authors claimed that although count methodology varied, the results remain reliable for tracking bird populations over the years. Methodologies used in this count were two-fold: (1) observation from observation points above the refuge and (2) observation by walking and driving through the habitat. The count was done by various Refuge staff, thus the data can be considered unbiased. The total acreage of each habitat in the count is not consistent because pond areas varied from 60 to 100 acres in the 1990's, and taro fields varied from 80 to 100 acres (Asquith and Melgar, 1999). Also, during the period of time that the count was conducted, half of the taro patches were in dry fallow or in the full-growth stage, therefore, the observers were not able to see all the birds in the taro patches. Bird behaviour in each habitat was also noted.

Results from the 1999 bird count indicated that numbers of *Koloa* and Coot increased after the construction of impoundment ponds. Large open water area attracted the *coots.* Numbers of Moorhen did not response to the construction of the pond, and Stilt numbers did not increase since 1970's (Asquith and Melgar, 1999). More *Koloa* prefer to loaf in the impoundment pond during the day, but Moorhen, Coots, and Stilts have shown preference for taro field over impoundment ponds. Behavior-wise, birds observed in taro field actively fed, while birds in impoundment ponds loafed, particularly for *Koloa*. The authors also revealed on-going research confirming *Koloa* loafing in streams during the day, and flying to taro patches at night to feed. Coots' and Moorhens' nests are found mostly in taro fields. *Koloa* and Stilts nest equally in both habitats.

The data suggested that taro fields provide good habitat for endangered species, and three out of four species tend to prefer taro fields over impoundment ponds. Even when at least half of the ponds were managed as shallow-water moist soil management unit during 1998 and 1999, Moorhen, Coots, and Stilts still showed preference for taro fields. However, impoundment ponds are still in the process of study and development to be more responsive to the birds needs.

Former zoology graduate student, Robert Broshears, conducted another study in 1979 (*"The Influence of Trophic Interaction on the Distribution and Abundance of Selected Aquatic Species in a Hawaiian Taro Pond Ecosystem")*. The USFWS provided the funding in 1978. The goal was to increase an understanding of the Refuge's trophic ecology and to address aspects of the existing taro ponds attractive to waterbirds to be incorporated in constructing and designing new impoundment ponds. Broshears's study focused on the trophic relationship between the Hawaiian Stilt, a predator, and particular species of vertebrate and invertebrate prey. The Hawaiian Stilt was selected in the study because it is the most carnivorous in comparison to the other three endangered species. Stilts fed on insects, crustaceans, mollusks, and fish (Broshears, 1979). Broshears alleged that benthic infaunal invertebrates are a potential food source for stilts and fish in the Hanalei NWR. Samples in refuge ponds showed two dominant species of the infaunal community. The first is larvae of the midge *Chironomus Hawaiiensis*. The other was an unidentified *tubificid oligochaete.* The study chose *Chironomid lavae* as the focal infaunal species because there are more data from preliminary studies to support.

Broshears studied the distribution of Hawaiian stilt, fish, and *chironomus* larvae, and observed stilt-feeding behaviour. He found a correlation with the agricultural cycle of the taro and the stilts' nesting behaviour. Stilts used taro ponds intensively following the harvest period and remained steady throughout the wet fallow period. Dave Aplin, recreational planner at Hanalei NWR, agreed that stilts enjoyed feeding in taro field after plowing; coots and *koloas* also enjoyed feeding on *huli* residuals and worms in taro field after the harvest period. Broshears also indicated that stilts were less likely to settle in taro fields after the new *huli* were planted and throughout the early stages of taro growth.

Broshears further referred to farmers' observation that tilled wet fallow significantly attracted the birds because tilling increased exposure of invertebrates to the surface. Broshears added that stilts are rarely seen outside taro ponds. There were no observations of feeding in irrigation ditches (Broshears, 1979).

Observations on the distribution of *chironomid lavae* indicated that their population is strongly correlated with water depth and distance from the pond's major water intake. A high concentration of *chironomid larvae* were present in shallow water, but less concentrated near irrigation openings, as strong current decreased oviposition rates and displaced egg masses downstream.

Broshears concluded that Hawaiian Stilts and *chironomid larvae* have shown similar patterns of distribution; they both correlated with the agricultural cycle of taro. Both stilts and *chironomid lavae* increased significantly after the harvest period, but declined during the mature stage. *Chironomid lavae* were restricted to areas of shallow open water. He explained that adult midges attached their eggs to vegetation and other anchored debris. The debris was abundant in newly harvest fields when they were likely to be exposed in shallow water. Such conditions increased oviposition sites to support larger larval populations. On the other hand, distribution of stilts and fish showed an inverse correlation. Although Broshears alleged that stilts would consume fish that strayed into wet fallow pond, in Hanalei the numbers of fish in wet fallow ponds were not sufficient for stilt diets.

9.16.2 In Search of Common Ground

The purpose of this section is not to determine which habitat is most suitable for the rehabilitation of the birds, but rather attempts to look for commonalities in light of the present situation. There is certainly a close and very vital interdependence between the constructed impoundments and the *lo'i* with regards to their practicality for providing crucial habitat to the endangered Hawaiian waterbirds.

Broshears's research findings were reflected in the information received by the Practicum team from the USFWS project leader, Jerry Leinecke. Leinecke confirmed that taro fields at early stages of taro growth are good feeding ground for birds to feed on invertebrates. He also revealed that when taro reached its mature stage the birds migrated to impoundment ponds. The USFWS pamphlet also supported that Hawaiian stilts prefer feeding in shallow, open water, and recently exposed mud because these settings provide worms, crustaceans, and aquatic insects for stilts. Coots are said to wander in shallow water, close to vegetation, feeding on seeds, aquatic plants, invertebrates, and small fish (U.S.WFS, 2002). The pamphlet further suggested that moorhens seek aquatic plants and invertebrates in taro patches, especially in the dense covering of mature plants. Illustrations support such claims. The Moorhen is also documented as a very secretive bird and spends most of the time hiding in the dense taro canopy. Evidently, taro *lo'i* are a favorite place for moorhens because they can move under the thick taro leaves feeding on aquatic plants and animal (*www.kilaueapoint.com*).

In an interview, Dr. Silva opined that taro ponds are excellent habitats for birds. He has observed, in his long-time fieldwork with taro farmers in Kaua'i, coots feed on young taro leaves and keep returning to feed on the same plant until the plants die.

The 2001 Wildlife Habitat Incentives Program (WHIP) formulated by the NRCS has recognized taro patches as necessary habitat for the endangered birds (*www.nrcs.usda.gov/program/whip/factsheets*). The program helps landowners to develop and improve wildlife habitat on private lands and to restore native species of both plants and animals in the area. Taro patch restoration, weed, and pest management are examples of projects included in the program.

In summary, the above studies and empirical evidence have supported the complementary relationship and interdependence of taro fields and impoundment ponds as critical habitat for the endangered Hawaiian waterbirds. Hence, instead of asking which habitat is better, it is more constructive to ask *how the two systems can work together to better aid in the recovery of the endangered waterbirds.*

9.16.3 Future Studies

The USFWS plans to conduct further study on wetland habitat for waterbirds. They have squired Dr. Leigh Federickson from the University of Missouri to conduct a three-year study to enhance the understanding of tropical wetland dynamics and the roles of constructed wetlands and taro *lo'i* in providing habitat for endangered waterbirds in the Hanalei NWR. While the Practicum has not seen Dr. Frederickson's research proposal, we assume his aim is to provide more insight on how waterbirds management can be improved. We hope that his methodology explores the viability of both impoundments and *lo'i* as habitats to support the recovery of these endangered waterbirds.

The other study currently being conducted is by Nan Marie Greer, a Ph.D. candidate at the University of Washington. Her research, "*Kalo Farming: Lessons in Cultural Survival, Wetlands Management, and Traditional Environmental Knowledge in Cultural Survival*", is an anthropological approach, which analyzes specifically the importance of taro farmers' knowledge for perpetuating and protecting endangered waterbirds, and aims to explore a legitimate method for wetland co-management. She is working with taro farmers throughout Kaua'i, save for those on the Hanalei NWR. From what we know, she is utilizing local farmers' knowledge by involving them in the collection of data to explain bird behaviour and population trends.

Nan Greer's findings should be considered when the USFWS decides on a future policy for taro and waterbirds. In fact, anthropological data would only help to enhance knowledge about taro *lo'i* as a waterbird habitat, especially their historical co-existence. There are numerous literature attesting to Native Hawaiian knowledge about birds and their value to the *Kanaka Maoli* (Native Hawaiians). Myths, legends, and stories divulge their special relationship with them. For example, Malo states the *'ale* (mudhen, Gallinula Chloropus) make their resort in the salt and fresh-water ponds. This bird is regarded as a deity and has many worshippers. Its size is nearly that of a domestic fowl, and its flesh is good eating (gamey, very tough). Men captured it by running it down or by pelting it with stone (Malo, 1951:39). Supporting Malo's finding, Fornander (1996) learns that the *'alae* was sacred to the Goddess, Hina (Fornander, pg. 355, 395, 398). And, according to Pukui and Elbert (1987), some water birds were sacred to deities, or were their *kinolau* (bodily form) or family *aumakua* (ancestral guardian spirit). This fact is found in Kamakau's (1976) historical research. *Maui a Kalana* obtained the secret of fire from the great mudhen of Hina, *'Alae-nui-a-Hina*. This was a woman who changed herself in their *'e'epa* forms of mudhens, *'alae* (Kamakau, 1976:116-17).

In light of the Practicum's findings expounded in the previous sections, the following recommendations for future study are offered:

- Encourage a study of ecological impact that includes analyses of changes induced by constructed ponds and introduction of non-native plants for the purpose of supporting the endangered birds' habitat.

- Undertake an extensive study comparing the benefits of re-planting native vegetation versus non-native plants. Such a study would help implement the goal of revitalizing native plants.

- That the USFWS comprehensive plan, to be completed in 2007, address the goals and methods of enhancing and introducing more native plants to the Hanalei Valley. Since taro cultivation is perceived as an important element in the feeding and nesting habits of endangered birds, the USFWS should support taro production. In turn, the abundant and healty taro plants would provide good habitat for the birds. This complementary relationship would enforce a cooperative partnership between taro farmers and the USFWS.

- As per quantitative methods for the study, an appropriate methodology should be applied to prevent count bias. Bird counts have been documented by other studies as problematic because of where the bird counts took place. Birds should be counted in the taro *lo'i*, in the impoundments, and in the river.

- Encourage creative solution to help increase bird numbers, restore native plants and animals, reduce water pollution, and support taro farming activities.

- The study should look into compatibility between waterbirds behaviour and the stages of taro growth. A sample study table is provided in Appendix A.11.

- The study should incorporate local knowledge, especially from taro farmers, as they are familiar with the waterbirds' behavior. Partnership with taro farmers would also strengthen local awareness in waterbirds preservation and sustainability of the habitat because, from agricultural practice, farmers are generally informed on how to perpetuate waterbirds populations and would be able to carry out preservation long after the birds have been delisted.

- Collaboration with other local sectors is encouraged. Possible collaboration could be established between the USFWS, taro farmers, the University of Hawai'i, Dr. Leigh Federickson's research team, the Hanalei community organizations, and other government agencies

Preserving the wildlife's natural habitat and vegetation in conjunction with the wildlife, itself, may be more effective than preserving the wildlife in isolation. The ecosystem is well known for its vulnerability. In collaboration between the U.S. Department of Agriculture and USFWS, a program to support taro farmers can be established, focusing on apple snail control and nutrient and sediment loads management. Such a program would benefit both the endangered birds and the Refuge; more importantly, it would protect water quality that can be damaged from current land use activity in the vicinity. Preserving the environment, as a whole, would make more sense rather than focusing on portions of it in order to mitigate the cumulative impact, about which the EPA is so concerned. Clearly, the decline in numbers of young fish as well as the decrease in size of the adult native fish, *O'opu*, indicates an upset in the ecosystem. Degradation of water quality is claimed to be the main cause of the problem. If no proactive actions are done now, sooner or later, *O'opu* may be listed as another endangered species.

9.17 Partnerships between Taro Farmer and FWS

> *A unique partnership between the USFWS and taro farmers has developed at the Hanalei National Wildlife Refuge. Refuge staffs periodically mow, plow, disk, and flood constructed impoundments to create a diverse community of plants and insects that benefits Hawaii's endangered waterbirds. Farmers use similar techniques on refuge lands to cultivate taro,… while providing additional waterbird habitats. Working together, the taro farmers and refuge staff produce the variety of habitat needed by Hawaiian stilts, coots, moorhens, and ducks for nesting, feeding, and chick rearing*
>
> USFWS, 2002

Picture 22 and 23. Taro fields and Impoundment Ponds in the Hanalei NWR

Nine farmers operate in the USFWS area, four of who live in the area. In total there are twenty-five taro farmers in Hanalei and adjacent areas. However, three of the four taro *lo'i* in the USFWS area, when combined, is larger than all the taro *lo'i* under cultivation. It is undeniable that establishing the Hanalei NWR has posted some restrictions on taro cultivation practice to serve the main purpose of conserving endangered waterbirds. For example, fertilizer, pesticide, and herbicide use are limited because such applications have decreased the numbers of invertebrates in the field. Rotation cropping, which is supposed to enhance soil nutrient naturally, can not be practiced efficiently, since 75% of the field area is required to be planted with taro. As shown in picture 23, taro *lo`i* on the left is clear of weeds, but the one on the right contains weeds.

Picture 24. Clean Taro Pond versus Weeded Taro Pond

In sum, taro farmers in the NWR are required to comply with SUP regulations. The most important requirements are:

- In the case that birds nests are found in taro pond, the spot where nests are found can not be harvested.
- Fallowing is required for at least 30 days to allow invertebrates to increase for the birds to feed on.
- 75% of the area must be planted with taro to provide good bird habitat.
- Some weeds should be allowed in the taro pond as source of feedings for endangered birds.
- One dog is allowed, but must be on a leash; three chickens; and one horse are allowed in the Refuge.
- Maintaining the taro field are regulated in terms of herbicide and fertilizer use in order to minimize disturbance and introduce more invertebrates for the birds;

limitations on fertilizers may also increase crop yields and decrease nutrient loads in run-off.

Some yield losses are also expected from restricted activities and birds feeding behavior in taro fields. Taxonomy of the four endangered birds has suggested possibilities that coots, *koloa* ducks, and moorhens may feed on certain parts of the taro plant (*http://fwie.fw.vt.edu*). Birds may feed on taro corms to obtain calcium, which is an essential nutrient to generate egg shells. Providing adaquate alternative sources of calcium for the birds to feed on may help reduce damage on taro yields. Approximate damage from birds accounts for $25,000 per year (Hobey, 2002). Significant yield losses have also been attributed to 100 year floods. The USFWS explained that flooding incidents has caused extreme siltation and sedimentation in the taro *lo'i.* Flooding also buries worms and invertebrates too deep under the soil for the birds to reach. Only under such extraordinary circumstances will the birds feed heavily on taro plants.

However, the USFWS has provisioned some benefits for the farmers on the Refuge. A relatively inexpensive lease payment of 25$ per acre of farm land annually is imposed, and farmers are allowed to live in the area without additional expenses (Leinecke, 2002). Secondly, the NWR has improved upon the irrigation system for the taro farms and bird impoundments.

The USFWS pamphlet (2002) explained that when the refuge land was acquired in 1973, a significant density of non-native plants was found throughout the Refuge. These introduced non-native plants limited the land's value for wildlife habitat. Thus, the USFWS management goals include creating areas of open water in order toreplace introduced plants with native vegetation. It would, moreover, create nesting areas that are safe from predators. Despite the density of non-native plants they, none the less, are appropriate for nesting and feeding activities for the birds.

9.18 The Potential for Co-existence

The need for a productive partnership between the taro farmers, the Hanalei community, and the USFWS is obvious in Hanalei. While there have been collaborative efforts in the past, previous experiences have resulted in a general apprehensive sentiment among stakeholders. Consultations with all stakeholders demonstrate that they are interested in working together. However, the catalyst to do so has remained elusive.

Hanalei has been a victim of controversies and struggles, including the proposed hydroelectric plant, the boat staging area serving tours to the Na Pali Coast, and the former Department of Transportation's plan to construct a major thoroughfare through Hanalei. Throughout, the community has succeeded in preserving the town's unique cultural and physical identity. The Hanalei community has proven itself to be very active in deciding Hanalei's development path. The community's commitment should serve as a model for other communities in the State.

Although the community has successfully protested inappropriate development pressures to retain its quaint, rural character, community cohesion has paid a price. Despite this, however, it is important to stress that the community has still united under situations that have threatened to alter the town beyond the community's desire. The issues of concern indicate the community's concern for everyday issues. It is crucial that community leaders and institutions work to preserve this unity. These elements form the foundation for enabling the community, taro farmers on the Refuge, and the USFWS personnel to move towards a more productive collaboration. Having said that, to move forward, it would be productive to focus on the common aspects valued by taro farmers, the USFWS, and the community. As per the NWR, taro farming, bird impoundments, and the Hanalei *ahupua'a* are common concerns. The two former (taro farming and bird impoundments) are inter-related, but are nestled in the wider issue of *ahupua'a* management. Although there are a few problems linked to taro farming practices, there are ways to overcome them. Similarly, the USFWS is confronted with more cultural/social issues. They must develop the aptitude for balancing Federal mandates with State laws protecting agriculture, water rights, and the right to farm - even in the Refuge - because the mandates in the State Constitution, which refer to appurtenant water and agricultural rights, do not impose boundaries on its relevancy and/or application. Therefore, it must be assumed that jurisdiction is ubiquitous. As such, the State Constitution and Federal mandates should be harmonized.

Taro cultivation is a valued practice because it is reminiscent of the traditional Hawaiian practice of wetland agriculture. Hence, it has been adopted by the community as a unique cultural feature. Based on historical evidence, wetlands have provided an invaluable habitat for resident waterbirds. However, over the last 150 years, Hawaiian wetlands have experienced severe size reductions due to extensive draining and filling for agricultural and urban development. It has been estimated that less than ten percent of Hawai'i's former wetlands remain today. This habitat reduction is one reason Hawai'i's native waterbirds are endangered.

In addition to the loss of wetland habitat for birds, taro farming has experienced its own obstacles. The intentional and/or accidental introduction of non-native species has resulted in pests and crop diseases. Resultantly, taro farmers are faced with difficulties in perpetuating an important cultural past time.

Presently, the USFWS is tasked with the recovery of these endangered Hawaiian waterbirds, specifically the Hawaiian Stilt (*Ae`o*), Hawaiian coot (*`Ala eke`oke`o*), Hawaiian Moorhen *(`Alae`ula*), Hawaiian duck (*Koloa maoli*) and the Hawaiian goose (*Nene*). However, chronic under-funding has not made this task easy.

Taro farming activities, which include the application of herbicides and/or pesticides to eliminate disease and foreign pests, pose threats to the water quality. These were studied and followed with recommendations. Pocket rot and leaf blight are major taro diseases, while the Apple snail is the major pest species. While some research have been completed to help taro farmers deal with these problems, further research is needed to find a more effective way to manage them. Unfortunately, funding for further research has been insufficient due to a paucity of political support. Thus, there is a need for establishing a strong, state-wide organization to lobby legislatures to protect and support taro production. Support is also needed from non-governmental organizations. Although documenting yield losses can be insensitive, it is a crucial step in raising awareness regarding the extensive economic effects of pests and diseases on the taro farming industry. There needs to be a way to reconcile this predicament.

The Practicum also studied environmental impact associated with taro cultivation. The findings demonstrate that increased turbidity (sedimentation), excess nutrient levels (hypernutrification), and pesticide and herbicide are roots of contamination. If modern farming methods are not properly practiced, especially the introduction of synthetic fertilizers and chemicals, nutrient loads can compound downstream. Although efforts have been undertaken to mitigate increased sedimentation and nutrient levels entering the streams, (i.e. the Nutrient Management Program (NMP) and Total Maximum Daily Load Program (TMDL) they have been met with limited success.

For the NMP, the lack of understanding between agencies and farmers, erroneous farmer perceptions, and insufficient support are probable causes of program ineffectiveness. However, this could be easily corrected through more effective communication between the agencies and taro farmers. Improved knowledge can be acquired through comprehensive educational programs.

As for the TMDL program, present conventional pollutant monitoring concentrations (temperature, salinity, pH, oxygen, Nitrogen, Phosphorus, total suspended solid, turbidity, and silica) will not be able to identify the exact sources of pollutants. Local participation in the TMDL program development is encouraged to utilize the community's knowledge and experience.

Biologists believe that wild animals upstream, cattle, and high bird population in the Hanalei NWR could be the cause of high nutrient and bacteria count levels in the water. Thus, a more refined study on allowable levels of pollutants should be carried out in order to arrive at more effective mitigation programs. Other alternative strategies to minimize impact include wetlands, settling basins, settlement ponds, such as the Living Machine and polyculture ponds. These alternatives may also be a means for reintroducing native wetland plants back to the area.

A study conducted in 2001 showed that organic and non-organic contamination in the Hanalei River from pesticide and herbicide usage was mostly below EPA standards. However, some pollutants were found to exceed the EPA standard. Improvements in this area can be made with the support of USFWS personnel.

To conclude this chapter, while it is crucial that endangered waterbirds attain sustainable numbers, it is also essential that taro farming is perpetuated not only for cultural and economic reasons, but also for its significant role in providing suitable habitat for these endangered birds. The Hanalei National Wildlife Refuge, the taro farmers on and around the Refuge, the Hanalei community and the County, State and

Federal governments all have an important role to play in this particular setting. Although the concerns by involved stakeholders are legitimate, it is possible to find commonalities in viewpoints. For example, all stakeholders are interested in the ecological viability of Hanalei as it serves a purpose for both the USFWS and taro farmers on the Refuge. Such commonalities should be emphasized in order to focus on a collaborative working relationship. And, because there is a foundation for common ground, there is great anticipation for a more productive relationship. The USFWS has already shown their willingness to strengthen their relationship with the community and the Refuge taro farmers in hiring a new Refuge manager. All the stakeholders are now in a position to create a proactive, collaborative environment to work out the kinks in the issues "on the table" in Hanalei.

Chapter 10

Hanalei Tourism and its Compatibility with the Environment

The vast tracts of taro *lo'i* and rich inventory of historic sites and buildings makes Hanalei a place of unique natural resources and cultural interest. The Hanalei Valley Lookout offers a fascinating view of taro fields and lush green valley. Tourists come to Hanalei to experience serenity, which is the reason tourism has become a major economic activity in Hanalei since the Kaua'i County government began marketing it.
Across the one-lane bridge, the entry point into Hanalei, and down the Hanalei River, the pace of life slows considerably. There are many scenic points that attract tourists. Apart from the taro fields, people come for Hanalei's beaches. Hanalei Bay, famous for its spectacular beauty with a long half-moon of sandy beach, has three county parks along the shoreline: (1) Hanalei Beach Park, (2) Hanalei Pavilion, and (3) Wai'oli Beach Park (*http://www.napalishores.com/beaches.htm*). They are all pristine and fairly "non-commercialized" tourist attractions. Hanalei Bay indents the coast a full one mile (1.5km) inland and runs two miles (3km) point to point, with coral reefs on both sides and a patch of coral in the middle. It also boasts a sunken ship that belonged to a king, so divers love it (*http://www.frommers.com/destinations/kauai/0011031960.html*). The bay has the potential for increased tourism development.

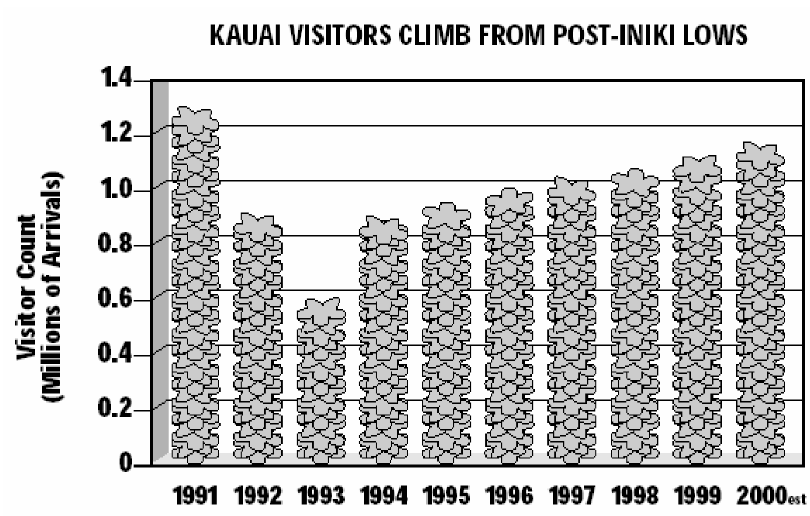
There are also numerous historical sites, such as the Hanalei Bridge, the Haraguchi Rice Mill, and Wai'oli Church and Mission House. Hanalei's natural setting and historical ambience puts tremendous pressure on the town because the tourism industry has potential to expand.

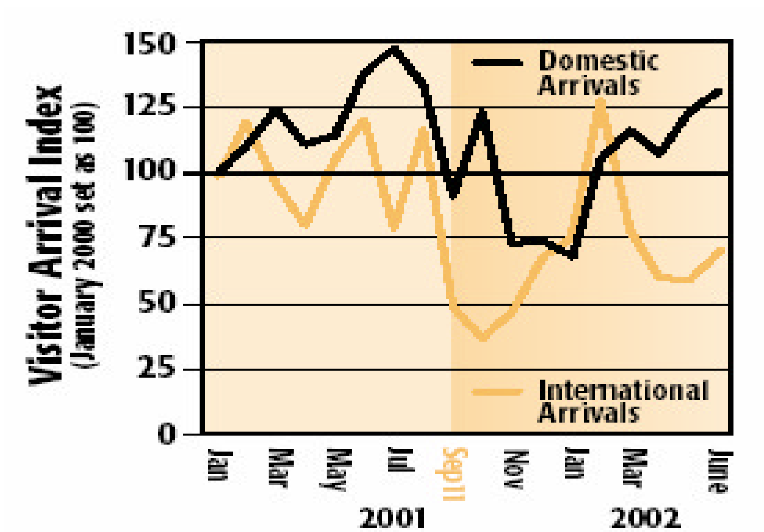
10.1 Kaua'i Tourism Industry and Economic Overview

Tourism is one of the most robust economic sectors in Kaua'i. According to the Economic Forecast provided by the First Hawaiian Bank, tourism has augmented its revenue potential since 2000. Even though the island has yet to exceed the number of arrivals posted in 1991, there has been a steady climb in visitor arrivals after Hurricane Iniki: *The total number of visitors daily to Kaua'i is estimated to be 16-20 thousands per day. Hotel occupancy statistics show a jump to 76% in 2000, up from 72% in the same period last year. In the first half of 2000, eastbound international visitors accounted for 18.5% of total Kauai arrivals. That compared to an average of 13.4% in the previous five years . . . United Airlines now flies a 757 plane direct non-stop to Kaua'i daily from Los Angeles and San Francisco" (http://www.fhb.com/pdf/kauai.pdf).* The 1993 chart on visitor arrivals post-Iniki indicates the unwavering influx of tourists.

About one-third of all jobs in Kaua'i are in the visitor industry, with about 30 cents of every dollar in circulation on Kaua'i originating in a tourist's wallet (Kaua'i Data Book, 2001). The chart of visitor arrival index shows that visitor arrivals fluctuate between June 2001 and June 2002, but the tail end of June 2002 indicates a rise in domestic arrivals. This means Kaua'i remains in high demand despite a downturn of international arrivals.

Graph 18 and 19. Kaua'i Visitors and Arrival Index





Source: Economic Forecast-Kauai Edition, First Hawaiian Bank, 2002

The Kaua'i Visitors Bureau (KVB) has moved its marketing strategies to concentrate on marketing Kaua'i as a long-term vacation spot, in essence, concentrating their marketing efforts on the length of stay rather than the increased number of arrivals, and emphasizing quality rather than quantity. In 2000 Sue Kanoho, Executive Director of the KVB, predicted "by 2002 the island was going to surpass 1.2 million visitors a year, the previous high set before the hurricane. The KVB's marketing campaign that targets specific consumers with specific activities, a strategy that better brands the island. While that campaign continues, Kanoho has shifted gears, working with hotels and travel companies to promote the affordability of the island" (Choo, 2001). According to the increased number of tourists island-wide, there is a high potential for growth in the tourist industry. The KVB's intense marketing policies focusing on the length of stay may have an influence on developing alternative tourist accommodations that highlight Bed and Breakfasts and vacation rentals as opposed to hotels.

Because tourism is the most viable income-generating industry in Hanalei, it is natural that people capitalize on it. Thus, the island's economy has gradually shifted in this direction. Consequently, Hanalei's economy has become more service-oriented. Concomitantly, the average wage is lower than in areas that have a significant manufacturing, academic or scientific-technical economies. In 1994 the average income on Kaua`i was $21,198 (Kaua'i Data Book, 2001).

10.2 Kaua'i Film Industry

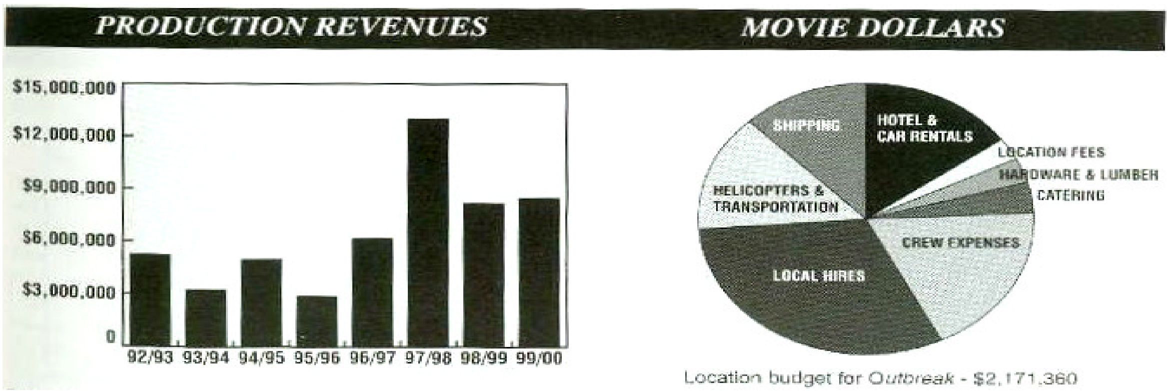
Another major contributor to the tourism sector in Kaua'i is the film industry. The island's picturesque natural resources at the North Shore and the Kalahau trail, which travels along the Na Pali coast, have captured the attraction of the film industry. "Kaua'i Film Industry, which the county administration actively promotes, is now the largest on the neighbor islands. The county employs a full-time coordinator to work with film-makers" (Laney, 2000). Resultantly, the Kaua'i Film Commission has been established as a division of the County Office of Economic Development. Its responsibilities are to facilitate productions by providing recommendations, referrals, and assistance as well as logistical support and problem solving (Kaua'i Data Book, 2001). The commission helps filmmakers apply for film permits from State and County land. There are also some film incentives from the government for enhancing the film industry in Kaua'i. For example, the State of Hawai'i offers a refundable income tax credit of up to 4 percent of the costs incurred in Hawai'i and up to 7 percent to 25 percent of the transient accommodation costs incurred in Hawai'i in production of a motion picture or television film, the budget of which reaches certain thresholds (*http://www.filmkauai.com/note.html*).

In the Kaua'i County Economic Report 2000, of the total $8.5 million in Kaua'i film revenues for the fiscal year 2000 ending in June, $5.5 million came from the movie *"To End All Wars."* That movie accounted for almost 83 percent of Kaua'i crew days in the same year. A strong injection would come from *"Jurassic Park III,"* filmed on the island in September 2000. The historical record of film revenues is punctuated by several big movie shots on Kaua'i. The original "*Jurassic Park"* arrived in FY 1993. For FY 1997, the county's revenues swelled because of profits from *"George of the Jungle*", and in 1998 *"Six Days Seven Nights*" and *"Mighty Joe Young*" drew even more revenue (Laney, 2000).

In 2001, more than 60 film projects were conducted in Kaua'i, bringing in revenue, exceeding $11.4 million, for the County. Over fifty percent of the revenues came from feature films, while another 20 percent from TV series. The remainder came from commercials sport/exercise shows, travelogues, and documentaries (First Hawaiian Bank, 2002). Kaua'i County film commissioner, Judy Drose, says that TV shows are not major motion pictures but do contribute to the economy. "Manhunt," pumped $800,000 into Kauai's economy (*http://pacific.bcentral.com/pacific/stories/2001/04/23/daily68.html*).

The graph below shows the total revenues injected into Kaua'i's economy from the film industry. The chart also represents the budget outflow for the movie, *"Outbreak"*, to various sectors in Kaua'i. A significant percentage of the money from the film industry goes toward hotel rooms and rental cars. Local hires also constitute a large proportion of production budgets. Typically, most feature films hire between 100 and 300 people to fill crew and talent positions. During 2000, 278 island residents found crew positions, while another 151 were cast in various roles. Various local landowners also benefitted from usage fees (Kaua'i Data Book, 2001).

Graph 20. Film Industry Revenues



Source: Kauai Film Commission, Judy Drosd

Clearly, the film industry has a multiplier effect on tourism in Kaua'i in that it helps the KVB promote the beauty of beaches, mountains, and other natural resources, as well as attract tourists from all over the world to visit this island indirectly. A large percentage of tourists come here after watching movies and some of them, especially wealthy people from the Mainland, want to buy up land and build homes.

10.3 Existing Conditions of Tourism in Hanalei

The economy of Hanalei depends heavily on agriculture (i.e taro and poi). It is more dependent, however, on businesses brought in from tourism, the biggest contributor to Kaua'i's county revenue. The natural beauty of Kaua'i, such as beautiful beaches, river, valley, and historical sites are marketing components because they are what attract visitors to the island annually. Most visitors spend a great deal of their time taking advantage of Kaua'i's beauty, spending part of their vacation time swimming, diving, kayaking, and touring the coastline by boat or other marine-related activities. Tourism has been the main economic sector in Hanalei and generated much revenue each year since after Hurricane Iniki in 1992. To examine how the economy of Hanalei is driven by the visitor industry, one can analyze certain indicators:

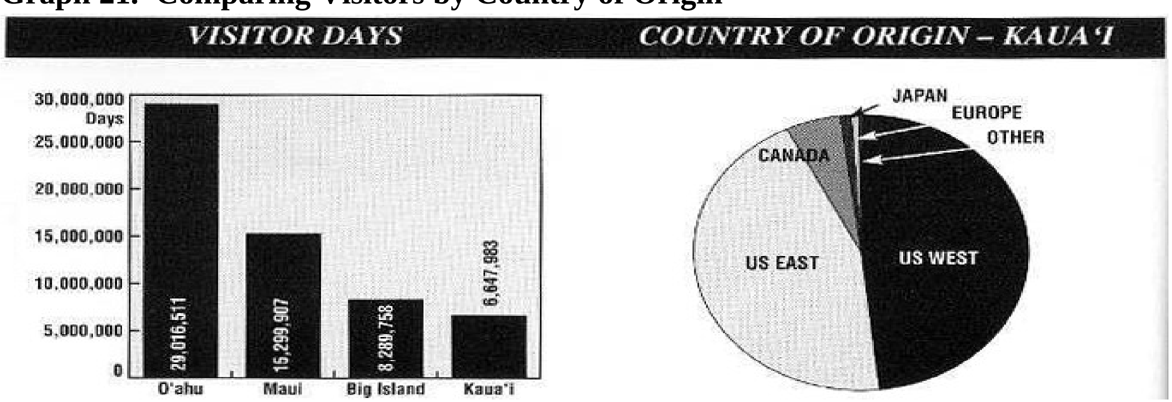
- the type of tourists
- the number of visitors drawn to this area
- the length of stay
- and the expense of visitors

The increase in number of visitors has a direct benefit to the economy; it may help alleviate economic instability. At the same time when encouraging more visitors or expanding tourist businesses, the communities probably become skeptical because rapid growth can destroy community ambiance, heighten pollution problems, and can cause a host of other undesirable outcomes for Hanalei's ecology, natural environment, land quality, townscape, culture, and social relations. This is especially true of small towns like Hanalei. For these reasons, the scope of tourist development at Hanalei should be framed under a "sustainable concept". A comprehensive assessment of tourism development should be undertaken before any further implementation of this sector. However, before providing some recommendations for a sustainable tourism development in Hanalei, the existing conditions of the tourist industry and its current critical effects on the Hanalei community should be examined.

10.3.1 Type & Amount of Tourists

As reported in the Kaua'i General Plan 2000, Kaua'i attracts a proportionately large share of visitors from the Mainland and Canada. In 1999, travelers from the mainland United States and Canada accounted for 88 percent of Kaua'i's visitor days. A smaller percentage comes from Japan. While visitors from Japan accounted for 19 percent of visitor days statewide in 1999, on Kaua'i they accounted for only 5 percent (see the chart below). Sue Kanoho, Executive Director for the Kaua'i Visitors Bureau (KVB), clarifies that the main target of the KVB is the North America market, primarily the East and West coasts. The main reason for targeting these markets is the number of direct flights from Los Angeles and San Francisco to Kaua'i.

Graph 21. Comparing Visitors by Country of Origin



Source: Hawaii State Department of Business, Economic Development and Tourism

Similar to the visitors' trend of the whole island, most of the tourists visiting Hanalei are from the Mainland; only a small number are from other islands or from Asia (i.e. Japanese).

10.3.2 Revenues

Most non-federal taxes are administered and collected by the State. The major sources of revenue include the general excise tax and both personal and corporate income taxes. The County of Kaua'i has no personal property taxes or special levies for school districts, etc. Real property tax rates are set and collected by the Counties. In 1998, the improved residential tax rate was $4.93 per $1,000 valuation, and the commercial rate was $7.59 per $1,000 valuation. Tourists have to pay 4.1 percent for Hawai'i's Gross Excise tax and 2 percent for Harbor tax (*http://hawaii.gov/dbedt/immi/kauai.html).*

On Kaua'i, the State Department of Land and Natural Resources manages several major state parks that are among the island's top tourist attractions. The State reaps most of the tax revenues from the visitor industry, including the Gross Excise Tax revenues from visitor spending, the automobile rental tax, and revenues from airport and harbor operations. The State also collects the 7.25 percent Transient Accommodations Tax (TAT), 44.8 percent of which was transferred to the countries in Fiscal Years 1999 and 2000. Approximately two-thirds of visitor industry revenues are expended locally as wages and purchases of materials and services; these monies are recycled within the local economy (Kaua'i General Plan, 2000).

10.3.3 Tourist Attractions

There are several interesting tourist spots in Hanalei that attract a large amount of visitors. These tourist attractions can be divided into *three* general categories.

10.3.3.1 Natural Tourist Attractions

1. Hanalei Beach Park

This beach looks out to views of the Na Pali coast. There are picnic tables, restrooms and showers. However, swimming can be dangerous and visitors should stick close to the old pier.

2. Hanalei Pavilion

This is another park provided by the Kauai County.

3. Wai'oli Beach Park

It is located on the western side of Hanalei Bay. The county offers a variety of tourist facilities for camping and picnicking.

4. Hanalei Valley and Wetland Taro *Lo'i*

Terraced taro fields blended into wildlife refuges and wild stretches of untouched land are another natural beauty that attracts a lot of tourists. From two Hanalei Valley Lookouts, tourists can see different angles of view down below: one for viewing the Valley and the other one for the Hanalei bay.

5. Hanalei River

It is a great place to kayak and take a boat trip from the Hanalei along the Na Pali Coast. In 1998, Hanalei River became one of only fourteen designated American Heritage Rivers.

6. Hanalei National Wildlife Refuge (HNWR)

It was established in 1972 to protect the endangered Hawaiian duck, the Hawaiian gallinule, the Hawaiian coot and the Hawaiian stilt. The refuge also provides habitat for waterfowl and migratory shorebirds. HNWR consists of existing ponds, ditches and Taro *lo'i*. Although the Refuge is normally closed to the public, visitors can still observe the wildlife from along Ohiki Road and the Hanalei Valley Overlook, situated across the Princeville Shopping Center.

Picture 25. Aerial view of Hanalei Beach and the town

Source: http://www.kauai-beaches.com/beachtour2.htm

Picture 26 and 27. Views of Hanalei Valley and wetland taro lo'i from the lookout

10.3.3.2 Historical and Cultural Tourist Attractions

The historic and natural features of Hanalei are another attraction point. They bespeak of Hanalei's frolic with Western and Asian settlement and evoke nostalgia over the traditional Hawaiian culture that lingers beneath the surface.

1. Wai'oli Meeting Hall

It stands as a tribute to early Hawaiian/American architecture. This historical building is listed on the State and National Registers of Historic Places (*http://www.alternative-hawaii.com/activity/khcnor.htm*).

2. Wai'oli Hui'ia Church

The green wall church, built in 1912, reflects the American gothic architectural style so popular in New England. The shingled church has a belfry tower housing the old mission bell.

3. Wai'oli Mission House

Kaua'i's first settlers from the "outside" world were a pair of missionaries, Reverend William Anderson and his wife, Mary Ann. In 1837, they built the Wai'oli Mission House now used as a community centre and one of the many tourist attractions in Hanalei. It is also on the list of the State and National Registers of Historic Places (*http://www.kauai-hawaii.com/north/waioli_mh.html*).

4. Hanalei Bridge

A one-lane truss bridge built in 1912 and damaged by a tsunami in 1957. It was later reinforced and has been greeting visitors to Kaua'i's North Shore community for nearly a century. This bridge is on the National Register of Historic Places and the community tries to preserve it by resisting the State Transportation Department attempts to widen this bridge. Hanalei Bridge controls the access of visitors and residents to the small community.

Picture 28. Hanalei Bridge

Source: http://www.hawaiiweb.com

Picture 29. Waioli Hui'ia Church

http://www.alohaplentyhawaii.com/sld014.htm

Picture 30. Wai'oli Mission Hall

Source: http://www.alohaplentyhawaii.com/sld014.htm

5. Haraguchi Rice Mill

An agrarian museum located in the taro fields of Hanalei Valley. It is listed on the National Register of Historic Places and dates back to the late 1880s. It was built by the Chinese, but purchased by the Haraguchi family in 1924. It is the only remaining rice mill in all of Hawai'i. The Haraguchi family has restored the mill three times: after a fire in 1930, then again after Hurricane Iwa in 1982 and Hurricane Iniki in 1992. Nowadays, this mill is opened as a museum only for students' educational purpose. As a non-profit operation, visitors are limited to1500 students per year.

6. Hanalei Pier

It was a featured player in the acclaimed film, "South Pacific," shot here in 1958. The pier was built in 1892 and used by local farmers to ship their rice until it was closed in 1933. After Hurricane Iniki, in 1992, the pier was condemned and rebuilt with concrete. The pier is located in Black Pot Beach Park, and is nearly a century old. Now it is a landmark and a hangout spot for local people and tourists.

10.3.3.3 Town's Tourist Attractions

The town, itself, alludes to a nascent artist colony that is not readily visible from the marketing ads that emphasize Kaua'i's beauty.

1. Artists Gallery of Kaua'i

This gallery, which is located in the Old Ching Young Store, exhibits Kauai artists' hand-painted silk, shell jewelry, and woodcrafts.

2. Mark Daniell's Gallery

Original paintings and limited edition prints are provided here.

3. Ola's Hana Lei

Sells American crafts by mainland and island artists. It is located next to Bali Hai Realty.

4. Ching Young Village

Located in the heart of Hanalei next to the Hanalei Post Office, this open-air shopping center started as a general store in 1906. Today it sprawls a block and serves as the community's hub for groceries, photo processing, services, apparel, and eateries. Outdoor benches and tables provide a place to relax. Some shops carry items made by North Shore residents.

5. The Old Hanalei Elementary School

The renovated old Hanalei School located opposite to Ching Young Village is another shopping center in the heart of the town, after the new Hanalei School has been built. It contains shops selling souvenirs, such as surfboards, and batik clothing.

Picture 31 and 32.

Ching Young Village Shopping Center

Restaurants and open space for tourists

Picture 33 and 34.

Old Hanalei Elementary School

Small restaurant and retail shops located along Highway 560

10.3.3.4 Adventure Activities

One can take advantage of a number of activities in Hanalei and the surrounding area. The abundance of nature in the North Shore provides an ample playground for adventure seekers.

- Hiking the Na'Pali Coast
- Biking
- Na'Pali Coast Boat and Helicopter Tours
- Kayaking
- Canoeing
- Swimming
- Surfing
- Windsurfing
- Snorkeling & Diving
- Fishing
- Princeville Resort
- Golfing
- Health Club and Spa (Princeville)
- Shopping
- Restaurants
- Horseback Riding
- Sight-Seeing
- Whale-Watching

10.4 Accommodations

In recent years, the North Shore[25] occupancy rates have generally matched the island-wide average, which shows a slight upward trend between 1997 and 1998 to 70 percent. If the upward trend improves, it could stimulate additional visitor unit development. Table 15 indicates the trend in unit construction. As of 1999, the North Shore had approximately 1,300 visitors units, with Princeville accounting for the majority. Over 600 units were added during the 1970's; additional units (just under 500) were attached during the next decade. In the 1990's units were again augmented, but accounted for less than 100, implying that unit constructions were beginning to decline despite the increase in occupancy rates. The North Shore also has a large number of Bed and Breakfast (B&B) units and houses used as "vacation rentals" (Kaua'i General Plan, 2000).

[25] The North Shore Planning District extends from Maloa'a Bay on the east to Puanaiea Point on the west, which is eight miles west along the Na Pali Coast from Ha'ena. The North Shore includes the communities of Ha'ena, Wainiha, Hanalei, Anini, Kalihiwai, Kilauea, and Princeville (Kaua'i General Plan, 2000).

Table 15. Visitor Units in Kauai by Area and Type, 1999

District	Hotel	Condo Hotel	Other[1]	Timeshare[2]	Area Total	
					Units	Percent Islandwide of Total
North Shore	**250**	**540**	**150**	**350**	**1,300**	**18%**
Kawaihau	1,180	350	190	380	2,110	30%
Lihu'e	750	100	20	320	1,190	17%
Koloa-Po'ipu-Kalaheo	1,010	970	130	240	2,360	34%
West Side	50	-	20	-	70	1%
Islandwide Total	**3,250**	**1,970**	**510**	**1,300**	**7,030**	**100%**
Percent of Total	46%	28%	7%	18%	100%	

[1] Includes the following unit types: individual vacation unit, bed & breakfast, hostel, apartment/hotel, and other. It is estimated that there are 100-200 more B&B's and individual vacation rentals than shone in the statistics

[2] Figures are for registered timeshare units[26] (those which have been designated for sale as timeshare). Timeshare units were not included in hotel, condo/hotel, and other categories to avoid double counting.

Source: Hawaii Visitors & Convention Bureau, Visitor Plant Inventory; newspaper articles in The Garden Island; Pahio Resorts, Inc.; and PlanPacific

In the Kaua'i General Plan 2000, the clear definitions of B&B's and vacation rentals are provided as follows:

1. Bed and Breakfast (B&B's)

The 2000 Kaua'i General Plan defines a Bed-and-Breakfast as ". . . the use of a portion of residence, an additional dwelling unit or a cottage for transient rental (less than 30 days) on a property where the owner resides in the principal residence" (Kaua'i General Plan, 2000). A single B&B unit has an advantage in that the owner normally stays in the same house with tourists and the neighbor can speak directly to the B&B owner if the visitors are a nuisance. However, the impacts on the neighborhood might come from other sources, such as cars, parking, sewage, waste and garbage that the B&B owner cannot resolve.

2. Vacation Rentals

The North Shore also has a large number of Bed and Breakfast (B&B) units and houses used as "vacation rentals" (Kaua'i General Plan, 2000). "A Single-Family Vacation Rental is a single-family dwelling that is used as a transient rental" (Kaua'i General Plan, 2000). But, unlike the B&B, the vacation rental normally has no resident owner who can relate to the neighbors or deal directly with neighbors' concerns. Instead, the owner usually hires a manager to operate his business. The internet is the main catalyst for

[26] A term used to describe the joint ownership of a resort property, such as a condominium, by several families. Each family owns it a certain period of time.

popularizing vacation rentals because it offers cheap or even free advertising. Nowadays, coupled with the lack of Use Permit requirements, the number of vacation rentals in Kaua'i is increasing.

Based on the concept of home-based accommodations, B&B's and vacation rentals are primarily self-managing and aim to minimize eco-social impact on neighborhoods. As locally-owned small businesses, B&B's generate revenues within the Hanalei community directly, while most of vacation rentals invested by rich people from outside the island yield benefits to both non-local and local people. There are a number of local people in Hanalei and nearby town working in these vacation rentals. The B&B's and vacation rental owners or operators including their guests or visitors are likely to buy food and supplies from local businesses that also help create job-holders benefit.

Previously, the 1984 General Plan was silent over alternative lodging units. More recently, the *Comprehensive Zoning Ordinance* (CZO) has included a statement that does not categorize "Bed-and-Breakfasts" under a "specific use" regulation in any zoning district. On the other hand, vacation rentals are regulated under Article 17 of Chapter 8 of the Kaua'i County Code. The CZO only defines "transient vacation rentals" in the context of *"multi-unit buildings"* (i.e. condominiums, apartment, or multi-family buildings) within a *"Visitor Destination Area"* (VDA); it is silent on single-family vacation rentals. In the absence of a specific direction, the Planning Department has developed *in-house policies* for both uses (Kaua'i General Plan, 2000). Since the single-family dwellings are not addressed in the County Code and Hanalei is not in a VDA (the only area in VDA on the North Shore is Princeville), the problem of uncontrolled vacation rentals in Hanalei is critical to retaining the community's small scale. Another significant argument regarding how to control these two types of accommodation is enforcing a Use Permit (Public Hearing with Planning Commission Action). In the Kaua'i General Plan, of the estimated 100 to 200 B&B's operating in Kaua'i today, only eight have obtained Planning Commission-approved Use Permits.

The primary purpose of the use permit procedure is to assure that a particular activity or land use can be integrated into and be compatible with its immediate surroundings. If allowed, the Planning Department or Planning Commission can impose certain conditions which can affect the design (such as height, size, and color) of the planned structure and/or the manner and conduct of the overall operations (such as hours of operation, traffic off-street parking restrictions). If a use permit is approved, the Planning Commission also usually reserves the authority to modify or impose additional conditions. A use permit can be denied if there are no assurances that the use would be compatible in the particular location (the Kaua'i Planning Department).

According to Dee Crowell, Planning Director in the Kaua'i Planning Department, a Use Permit for B&B's is required because it is not listed as a Permitted Use in any Zone District. A Special Permit along with a Use Permit is required if the property is in a Rural or Agricultural State Land Use District. It should be noted that both Use and Special Permits are issued with discretion, which means they can be denied.

Without clear regulations for B&B's and Vacation Rentals from the County, continued operation of such businesses face relative uncertainty. In light of this, the Kaua'i County Planning Department must implement a functional plan in the context of tourism development to address this void.

The lack of an accurate number of accommodations in Hanalei town is another important issue that should be of concern. While B&B's and vacation rentals in the town have increased during the last decade, there is at present no data collection of the number of them. Therefore, it is very difficult to control or plan the development of tourist growth, including regulations to minimize the impact on natural resources, especially water. To implement an effective tourism plan and wastewater management, a survey of the number, location, and type of existing accommodations in the town should be carried out and updated every year.

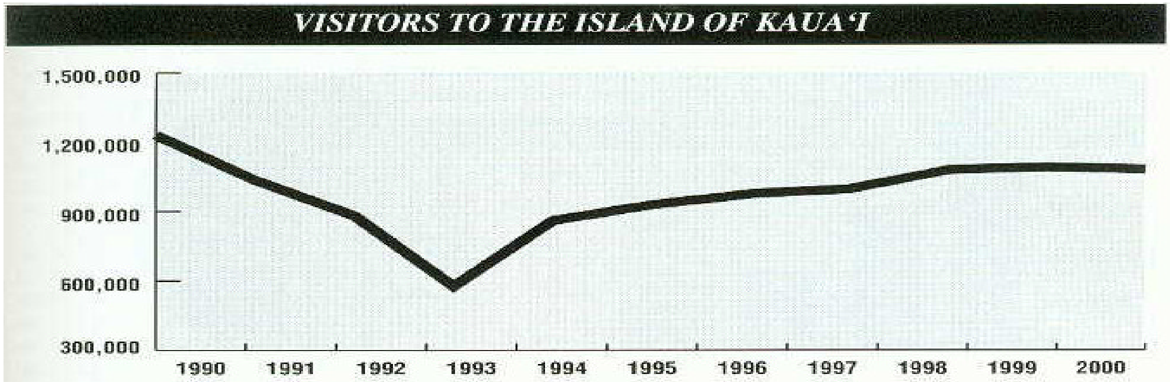
10.5 Critical Situations Related to Tourism in Hanalei

Tourism poses a dual edged sword for Hanalei. On the one hand, it brings in revenue and generates employment for the town. On the other hand, it can contribute to and expedite the town's demise if tourism is not planned responsibly. This dualism is discussed here in the context of situations that are critical to tourism and how tourism is critical to the town.

10.5.1 Hurricanes

Kaua'i has had two hurricanes: Hurricane Iwa (November 1982) and Hurricane Iniki (September 1992). Both wrought extensive damage throughout Hanalei, to the buildings, the crops, coral reefs, particularly to tourism judging from the decline in visitors in years following both hurricanes. The downward trend in visitor numbers threatens employment continuity for locals in and around the Valley, as is demonstrated in Graph 21. Resultantly, the gap ratio of jobs to visitors widened in1982 and 1992. As for employers, they feel the responsibility of job creation for the area: "Following Hurricane Iniki in 1992, hotels tried to keep their workers on well into 1993, even though there were virtually no visitors here for at least 5 to 6 month" (Kaua'i General Plan, 2000).

Graph 22. Correlating Vistor Numbers with Employment



Source: Hawai'i State Department of Business, Economic Development and Tourism

While Kaua'i had the lowest unemployment rate of any neighbor island prior to Hurricane Iniki (4.1 percent in 1991), every year since it has had the highest. In 1995, the average unemployment rate on Kaua'i was 11.5 percent. When Hurricane Iniki hit in 1992, the economy was already suffering from the state-wide downturn in tourism. Despite this phenomenon, tourism and related industries continue to be the major source of jobs on Kaua'i.

In 1994, tourism began to show signs of slow recovery. Several major Iniki-damaged hotels remained closed, such as Sheraton Poipu, Waiohai and Coco Palms. They were the subject of intense efforts by government officials to bring them and the jobs they provided back on track (Kaua'i Data Book, 2001).

10.5.2 Banned Boat Trips

In August 1998, State and County Officials, former Hawai'i Governor Ben Cayetano, enforced a "Cayetano Administration Ban" on all motorized commercial boat operations along the Hanalei River. The boaters without county permits had to move to Port Allen. Non-motorized boating activities, including commercial kayak operations, have been allowed to continue under the State's management program. The three companies owned by Butler, Young and White, which were appealing, had been operating with State and County permits (Sommer, 2002).

The Cayetano ban delighted environmentalists who have been battling the commercial operators since the 1970's. Friction with Hanalei residents opposed to tourism development dates back to the summer of 1977, when a single company began taking tourists from Kaua'i's north shore to the Na Pali Coast in rubber boats. In 1985, the Department of Land and National Resource (DLNR) issued permits allowing 23 boating companies to operate out of Black Pot County Park at the mouth of the Hanalei River. The next year, the state agency increased the number of permits to 47. In 1987, the Kaua'i Planning Commission approved a permit application from Sheehan to open a boat yard on the Hanalei River that would serve as a base for the boating industry. In 1992, the Kaua'i Planning Commission passed a rule limiting the number of boating companies operating out of Hanalei to two motorized vessels, three sailboats and two kayak companies, but the County never enforced the limit. More than twenty companies continued to operate with State permits, but without County permits. In 1997, the county tried to turn the dispute over to the DLNR. The state promptly recommended rules, increasing the number of permits. A coalition of environmental groups, North Shore retirees, and Hawaiian activists shouted down the proposal in an 18-hour marathon public hearing. The Kaua'i business community, which is deeply rooted in tourism, supported the increase in boating permits (Sommer, 2002).

According to Sue Kanoko, Executive Director for the Kaua'i Visitors Bureau, when the North Shore boating was moved from Hanalei River to Port Allen, there was an initial decrease in business in some of the shops in Hanalei. Consequently, the press has characterized this issue as favoring the tourist industry by emphasizing the detrimental loss to the economy and minimizing the benefits to the ecology. The article stated:

> *". . . there is a real concern that the decision will kill the tour boat industry on Kauai's North Shore, which employs several hundred people. The operators have used the river to pick up and drop off passengers for their trips along the scenic Na Pali coast. If the operators are denied use of the river, it is not clear that their businesses can survive. The governor acknowledged that the tour boats are a valuable asset to tourism and should be encouraged, but declared the 'Hanalei estuary is not the place'. He said the river could not handle both commercial tour boats and recreational activities such as swimming and fishing. The decision in effect scraps years of effort to find an acceptable compromise that would limit and regulate but not ban commercial boating. Cayetano said he supports continued boat tours if they operate from existing harbors or a new launch site, but he provided no real alternative to the boating operators. At this point, it is uncertain what can be done to save the industry if the governor's decision stands* (Honolulu Star-Bulletin, August 26, 1998)

Although the boat trip regulation does have an impact on tourism in that it subtracts revenue from Kaua'i, the benefits to the ecology are not easily quantifiable, especially if it is juxtaposed against the biodiversity throughout Kaua'i, including Hanalei. The serenity of the River and its surroundings are better suited for the bird habitats living along the River. This ban also improves the water quality of Hanalei River, which used to be polluted by oil disposals from the boats. Mahina, a local working in the tourist information agency in Hanalei, opined that after the ban on boat trips was imposed, the River has been cleaner.

10.5.3 High Property Taxes

Tourism introduces a high volume of visitors to Hanalei every year. Often, their visits result in a permanent or semi-permanent stay. As the demographic section has illustrated, those choosing to remain tend to be a post-professional, higher income cohort, who purchase properties at inflated assessments set by property owners and real-estate developers. This is compounded by the high property taxes imposed by the County government. However, this increase of property tax makes housing very unaffordable for long-term residents, who do not earn the same annual income. Resultantly, they are priced out of the housing market in Hanalei. According to Chang, a City Council candidate, "many homes and farms in Hanalei have been hit with assessment increases of up to 600 to 700 percent in the last three years . . . at Anini Beach, which has a mix of long-term rentals and vacation rentals, a local family saw its assessment increase by 300 percent this year. People who own property near new home construction in Hanalei are suffering and need the relief of the Bill".

The data in table 15 below demonstrates changes in housing profile in Hanalei in terms of residential movement and homeowners. While the population has increased only by 16.8 percent during the past decade, the population living in the same house in 1995 has increased by 33.3 percent from the number in 1985. The most substantial change is the increased number of residents moving into Hanalei from "different county" and "same county" categories. The homeowners from the same state have slightly decreased, but the homeowners from different states have decreased considerably.

Table 16. A Comparison of Housing in Hanalei, 1985 & 1995

	1995		1985	
	Number	**Percent**	**Number**	**Percent**
Population 5 years and over	437	100	374	100
Same house	260	59.5	195	52.1
Different house in the U.S.	161	36.8	179	47.9
Same state	23	5.3	39	10.4
Same county	96	22.0	34	9.1
Different county	65	14.9	5	1.3
Different state	42	9.6	140	37.4
Elsewhere or abroad	16	3.7	-	-

Source: U.S. Bureau of the Census, 1990 & 2000

10.5.4 High Vacant Housing Units and Declining Permanent Resident

The U.S. Census Bureau reported that in 2000 from among 303 total housing units in Hanalei, 193 (63.7%) were occupied housing units, while 110 (36.3%) were vacant housing units, a very high amount. Among vacant housing units, 93 (84.55%) are used for seasonal, recreational, or occasional purpose and may signify that they are the second home for affluent families. Many of these are B&B's and vacation rentals. Among the occupied housing units, 102 units (52.85%) were owner-occupied, while 91 units (47.15%), almost half, were rental (see Table 17). This numerical data represents the critical situation of declining permanent residents in Hanalei. Local people working in Hanalei have to rent or buy the houses outside, such as in the Ha'ena area on the east coast and spend around 45 minutes driving to the town.

Table 17. Housing Occupancy & Housing Tenure in Hanalei, 2000

Subject	Number	Percent
Total housing units	**303**	**100.0**
Occupied housing units	**193**	**63.7**
Owner-occupied housing units	102	33.7
Renter-occupied housing units	91	30.0
Vacant housing units	**110**	**36.3**
For seasonal, recreational, or occasional use	93	30.7

Source: U.S. Census Bureau, 2000

10.5.5 High Housing Rental

The Census Bureau also indicates an increase in rental rates for Hanalei. As can be seen from the table, the minimum rent rate falls between $500 and $749. The median rent was $911. This means that, based on median household income of $34,375 per year, the monthly household income was around $2,865. Therefore, the housing rental comprises approximately 32% of the median household income, quite a large proportion of a family's expenses (see Table 17). Due to the expensive rent of housing mostly serving tourists, many locals in Hanalei are unable to afford the housing rental.

Table 18. Housing Rental in Hanalei *Source: U.S. Census Bureau, 2000*

Subject	Number	Percent
Specified renter-occupied units	102	100.0
GROSS RENT		
Less than $200	-	-
$200 to $299	-	-
$300 to $499	-	-
$500 to $749	29	28.4
$750 to $999	27	26.5
$1,000 to $1,499	26	25.5
$1,500 or more	5	4.9
No cash rent	15	14.7
Median (dollars)	911	N/A
Median household income (dollars)	34,375	

10.6 Government's Policies toward Tourism

Several government agencies have implemented policies, programs, and specific plans that are related to tourism development. To analyze tourism in Hanalei, these agencies and their policies should be examined as follows.

10.6.1 The Hawai'i Tourism Authority (HTA)

The Hawai'i Tourism Authority has adopted a strategy to develop programs based on special themes, including agriculture, culture, education, health and wellness, nature, sports, science and technology. The intent is to broaden the range of experiences and activities offered to visitors, cultivate niche markets, and create entrepreneurial opportunities. The Draft Tourism Strategies Plan (TSP) also advocates for allowing alternative visitor accommodations within agricultural lands, as one part of a strategy for supporting agriculture-based tourism (HTA, 1999).

10.6.2 County of Kaua'i: The Planning Department

The County of Kaua'i provides basic services and facilities for the tourist industry, such as water supply, roads, fire and police protection, and operation of state parks, especially beach parks that are heavily used by tourists. The County uses a portion of Transient Accommodations Tax (TAT) revenues to support these services. The County also supports tourism market through the Office of Economic Development (OED).

As one part of the major economy, visitor industry is thoroughly examined in section 4 of the Kaua'i General Plan, adopted in November 2000 by the County Department of Planning. In the General Plan, several policies are raised in order to improve tourism in this island, for example, supply of visitor units and location of resort development, alternative to visitor accommodations, and visitor activities. Moreover, this plan also provides two implementing actions. The first is for park and natural areas and the second is for alternative visitor accommodations.

Dee Crowell, Director of the County of Kaua'i Planning Department, indicates that the General Plan does not directly provide a road map for a small town like Hanalei, but outlines a framework for tourism development in the North Shore area. He states that the County's Development Plan has already included tourism issue in its Functional Plan, which focused on infrastructure and other technical issues. The County views Hanalei as a discrete unit separate from the other parts of the island. The Hanalei community also has the unique problems of agriculture, water quality, road, and tourism.

10.6.3 The Kaua'i Visitor's Bureau

The Kaua'i Visitors Bureau (KVB) is a non-profit organization targeted to market aloha, integrity, and respect for the Kaua'i community. Sue Kanoko further states that the KVB does not target developing tourism in one area over another. Therefore, it does not have specific plans for developing tourism for the North Shore, Hanalei town, or any other side of the island. KVB also supports the diversity of accommodations, such as B&B's, vacation rentals, condominiums, etc., as long as the communities support them. Relevant to the environmental issues, Kanoho explains that they are more the responsibility of the Department of Land and Natural Resources (DLNR) and not the responsibility of the KVB, which is a marketing organization and cannot take the lead on infrastructure issues. However, the KVB is sensitive to the concerns of the residents regarding environmental issues and is careful to understand how they market the island with respect to those issues. Kanoko also confirms that the KVB tries to involve all cultures, especially the host culture, into its efforts. All press trips that the KVB hosts attempts to teach some of the local customs to those visitors so they have a taste of the culture.

10.6.4 The State Transportation Department

The State Transportation Department has sought to widen Hanalei Bridge for years. From the State's perspective, expanding access would bring tourism growth to Hanalei and will improve the economy as far as job creation and income provisioning vis-à-vis employment. However, the reconstruction of Hanalei Bridge becomes one of the main arguments between the County and Hanalei community. In the State Department of Transportation's vision, this one-lane bridge is a barrier to further developing Hanalei, but the community regards it as a buffer against hyper-development.

10.6.5 Hanalei National Wildlife Refuge (HNWR)

"The Hanalei National Wildlife Refuge is literally the center of the *ahupua'a*. A 1985 Master Plan for the Refuge exists but is not currently being followed. The Refuge is scheduled to have a Comprehensive Conservation Plan (CCP) developed in 2007. The Hanalei River HUI would like to see this CCP completed as soon as possible so that the Refuge can succeed in its mandate to protect and manage habitat for endangered Hawaiian waterbirds and protect the river and riparian ecosystem" (*www.epa.gov/rivers/sor/sorhanalei.pdf*).

Dave Aplin states that, normally, tourists and birdwatchers rarely have a negative impact on the bird habitats in the refuge because they just watch the birds from the designated area (i.e. the lookout), located far from the taro fields. Moreover, the Refuge is generally closed to the public and only allows a small group of visitors, such as students, researchers, and officials, to visit the impoundment ponds. Dave also claims that the Refuge has already built the new hiking trails and parking lot for visitors in its property, but under its regulation these facilities have never been promoted or widely advertised. Therefore, only a handful of tourists know about and use them. A proper assessment should be carried out to determine whether or not these tourist infrastructures negatively impact the environment.

Generally, the Refuge brings a positive aspect to tourism. State legislator, Nina Morita, indicates that there is a proposed project for moving the current scenic overlook located on the Ohiki Road to the new place, where the NWR proposes the construction of a "*visitor center*" with a few retail shops. This NWR's project aims to provide education for tourists as well as earn some money for covering maintenance costs in the Refuge. However, it may cause adverse effects on the community and the benefit is probably not enough for the Refuge's management. Before construction can even commence, however, it must be planned in adjunct to the Princeville plan because the proposed visitor center will be built on Princeville's land.

10.7 Community's Attitudes toward Tourism

The community has a special interest in maintaining the present small-scale and rural character of Hanalei because they, more than anyone, feel the brunt of change if Hanalei grows to such an extent that discomforts the community.

10.7.1 The Hanalei Heritage River HUI (HHRH)

Tourism-oriented businesses play an important role in the Hanalei community. They offer a large employment market not only to the local people but also to the people outside the town. Wages from tourist businesses expose the sharp contrast with the low-paid job in the agricultural economic sector. The Hanalei HUI's major considerations about the effect of tourism are the conversion of houses to vacation rentals and the consequent declining of low-rent housing stock for local people. The HUI is also concerned about the contribution of wastewater from the tourist accommodations and businesses catering to tourists. Some are on a cesspool system, while others are connected to a cluster system. The Ching Young Village and Hanalei Shopping Center have their own small package systems, but the residents still complain about the smell from the two. An effective wastewater system plan for the town is a necessary project.

10.7.2. Taro farmers

Tourism can prove detrimental to taro farmers because it competes with farmers for labourers. Although wages in the service sector, i.e. businesses who serve tourists, is not exactly high, it is higher than farm wages. Some community members feel that tourism does not directly benefit taro farming because in their view the tourism industry will only push taro farmers out of business in the long run. They do, however, see the benefit from tourism if it is engaged with the community in a responsible manner. For example, the Haraguchi Rice Mill museum was cited as a good target for a tourist package that would educate visitors about the history of Hanalei and its value to the residents. An entrance fee would be imposed to obtain funds for maintainence and staff.

10.7.3 Hanalei Poi Factory

According to the factory's operating managers, the majority of the poi market is in the supermarkets, such as Safeway or Foodland. Only some of its products are sold to the tourist sector, such as Aloha Airline, the Princeville Resort, and the occasional tourist who stops by the factory and buys their products. An increasing number of tourists in Hanalei do not directly spoil the market potential of poi because the market for poi is the local population, not foreigners. However, they see an opportunity to expand sales to the tourists by marketing the health aspects of taro. The town created the taro festival to do just that.

A local suggested the visitor center for taro information and education programs should be implemented with funding coming partly from government and partly from the private sector. A master plan for Hanalei should harmonize tourism, agriculture, and landscape planning.

10.8 The Princeville Development

Princeville is situated on a plateau overlooking Hanalei. It sits directly east of the Hanalei Bay near the Halelea Forest Reserve and Kaweonui Point. It was master-planned as a resort/residential/golf course community and today serves as the major employment center in the area. Accommodations in Princeville include Ali'i Kai, Aston Hanalei Bay Resort and Club Intrawest. Princeville owns the biggest acreage of private land and is complete with water and sewage facilities. With its updated master plan, Princeville continues to develop gradually and provides a wide variety of tourists' facilities, for example, nationally rated golf courses, tennis courts, swimming pool, gym and spa, shopping center, and library. It also has bicycle/pedestrian paths connecting all neighborhoods to the town center and the new development *mauka* of the highway with a high-tech center near the airport. As one of the North Shore's primary visitor destinations providing two full-service hotels, Princeville also contributes to Hanalei's economy by providing job opportunities for its residents. If developed further according to its current proposals, Princeville would have approximately 1100 additional visitor units. Lands not yet zoned, but designated as "Resort" on the General Plan Land Use Map, would accommodate another 280 units. Despite its contribution to employment generation, development should be exercised with caution, as contaminated water could very easily flush back into the Hanalei flatlands, possibly entering underground aquifers.

10.9 Effects of Tourism on Hanalei

The increasing presence of tourists in Hanalei indicates the overall strengths of the tourist industry and prosperity of visitor-dependent businesses, but also represents the potential impacts of visitors on the natural resources, economic structure, culture and social relations, real estate, as well as land use and townscape in Hanalei. These essential effects should be placed as the major concerns of tourism development planning in Hanalei community.

10.9.1Natural Resources

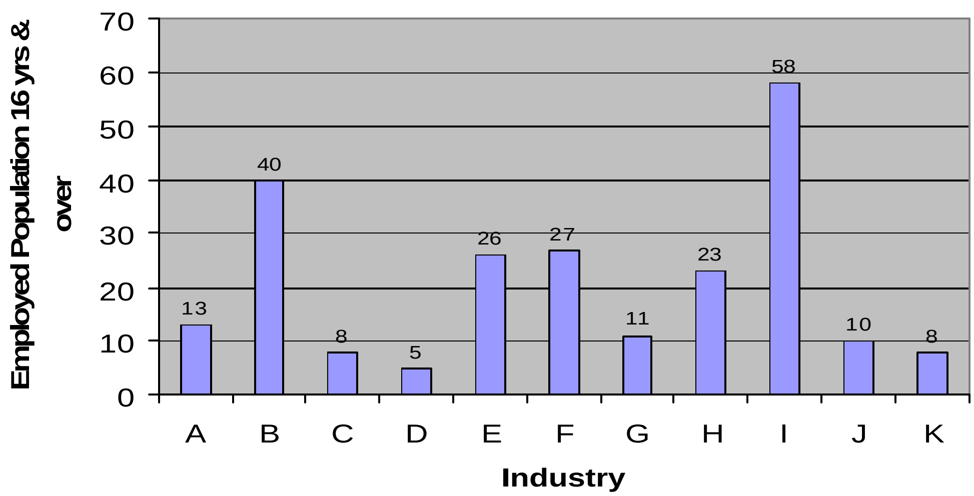
Congestion can erode the beauty of Hanalei. Simply by increasing traffic, the natural setting can degrade the Valley's natural resources. Adventure activities geared for tourists, for example, introduce more traffic onto otherwise natural wildlife. Without regulation, increased traffic brings pollution, contamination, and soil erosion. Moreover, as mentioned earlier, the growth of tourism businesses embodied in B&B's, vacation rentals, shopping centers, restaurants, and tourist agencies increases utilization of local resources in the form of water, spatial land, and coastal resources. They force the town to have to accommodate these seasonal fluxes with modifications in the infrastructure. The reality of a comprehensive wastewater treatment facility was also raised earlier. A centralized wastewater system would help the government to regulate the disposal of wastewater.

10.9.2 Effects on Economy

The strongest benefit to the community that tourism engenders is employment creation. In the Kaua'i business report, Choo (2000) claimed that "bustling streets, busy bike shops, numerous small business owners in and around town represent the best economic times of Hanalei in 2000. Cars line the streets, tourists fill its restaurants and boutiques and hikers jam the nearby Kalalau trailhead, some say as many as 500 a day."

The chart, denoting the labor force industry of Hanalei in 2000, reported by the U.S. Census Bureau shows that out of the 229 samples, the highest proportion of employed civilian population, 58 persons (25.3 percent), are working in arts, entertainment, recreation, accommodation, and food services. These types of jobs are directly related to tourism-oriented businesses. As one can see, the economy of Hanalei town is heavily influenced by the tourist industry.

Graph 23. Selected Labor Forces Industry of Hanalei, 2000



A	=	Agriculture, Forestry& Fisheries
B	=	Construction
C	=	Manufacturing
D	=	Transportation
E	=	Wholesale & Retail Trade
F	=	Finance, insurance, and real estate
G	=	Professional, scientific, management, administrative, and waste management services
H	=	Educational, health and social services
I	=	Arts, entertainment, recreation, accommodation and food services
J	=	Other services (except public administration)
K	=	Public Administration

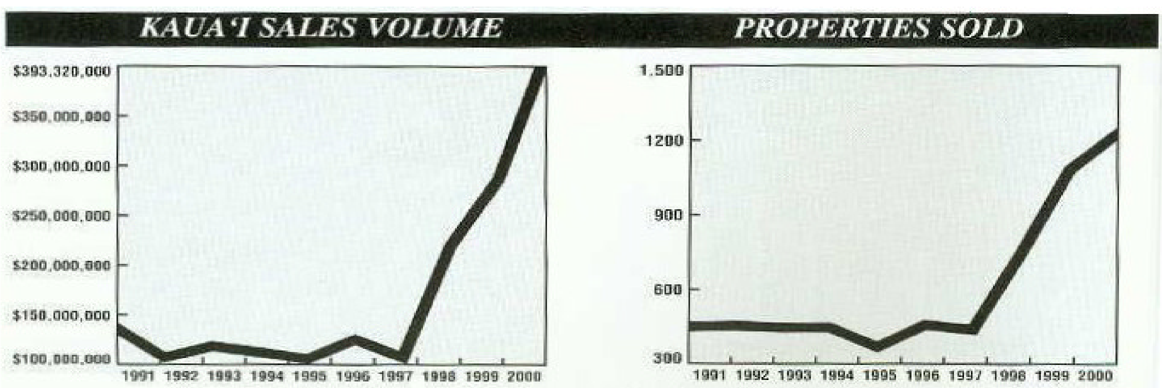
Source: U.S. Census Bureau, 2000

Tourism, unfortunately, produces a backlash effect in that it increases land rent, especially along Kuhio Highway, because it is believed that more business implies the ability to pay higher rent. This is not always the case. Choo (2000) reported that a retail shop owner in town had to relocate her store after her landlord raised her rent by a whopping 25% to about $125,000 a year.

10.9.3 Effects on Real Estate in the North Shore

In 2000, the total real estate sales volume is $393,320,000, which was up 28.4 percent over the record in 1999. Of the 1,297 sales recorded, there were 536 houses, 423 condominiums, and 338 parcels of land sold in 2000, an increase of 14.5 percent over 1999 (see the graphs below). The median price of a single house on the west side of Kaua'i was $170,000 (Dec 2000), while the North Shore commanded a much higher median price of $375,000 (Dec 2000). The Princeville condominium is one of the most popular market sales in Kaua'i. Of the 14 median priced condominiums listed in 2000, six were located in the resort areas of Hanalei and Po'ipu. Another type of real estate is the land market, which also increased. In 2000, the land sales were up 27.5 percent over the 1999 numbers. Of the 24 beachfront sales recorded, the average price was an astonishing $1,901,354. Kaua'i's North Shore accounted for 21 of 24 beachfront sales at an average price of $1,961,381. The highest priced North Shore lot went for $4,150,000 (Kaua'i Data Book, 2001).

Graph 24. Correlation between Property Revenue and Number Sold



Source: Kaua'i Board of Realtors and MLS Hawai'i, Incorporated.

"While the slumping national economy has affected Kaua'i's visitor industry profoundly, the island's real estate sector seems almost untouched by the downturn, and industry has been hot to touch for the past three to four years. Single-family home and condo sales volume as well as their average prices all increased in 2000. With the average home prices jumping almost $100,000 from $325,000 to $418,000 from 1999 to 2000, Kaua'i has seen a tremendous influx of big mainland money, especially on its pricey North Shore. In 2001, 41 two-story townhouses in the Princeville resort area, with units ranging in price from $392,000 to $487,000, were sold out before construction began. The buying spree was evident all throughout the Princeville resort. According to Ken Kubiak, a real estate broker, the total dollar volume sold in the area increased by 35 percent from $54.1 million in 1999 to $72.8 million in 2000. That is more than a 300 percent increase from the $22.7 million in 1996. Kubiak adds that in some cases he has seen prices for individual units rise as much as 100 percent over the past couple of years" (Choo, 2000).

According to the news, the sales volume of real estate in Kaua'i is scaled up and the median price of a single house in the North Shore is higher than that in other areas in Kaua'i. The Princeville property area is one of the most important economic catalysts in the North Shore's real estate development. For land markets, the North Shore is ranked as a leader for selling 21 out of 24 beachfront properties, which are recorded as the highest going prices. Consequently, the flourish of the property market in the North Shore has a direct impact on the Hanalei town. There is a great potential of real estate development in Hanalei and the increase of land price in this small town due to the influx of mainland money.

10.9.4 Effects on Culture and Social Relations

This growing influx of visitors and tourism commercial activities threatens Hanalei's vulnerable rural-character. It is a concern among locals. A HUI member explained that the congestion along the main street and difficulty in finding a parking space is felt by the local residents. And, because more part-time residents are entering Hanalei, the community is losing that cohesive community atmosphere it once had. They do not get to know the established residents and the locals feel the transience. There is also concern over losing park space where people can just go and spend an afternoon with friends and family. Resultantly, the community is quickly losing the harmonious relationship among the residents.

Since natural resources like the Hanalei beach parks are heavily used by both residents and tourists, some conflicts have also surfaced between commercial recreation activities and residents access to the use of these resources.

10.9.5 Land and Home Ownership

Hanalei is currently experiencing a housing shortage because a large number of the properties in town have been purchased and converted into highly profitable vacation rentals. The declining number of full-time residents in Hanalei town is another critical problem in Hanalei because of the rise in land price, expensive land tax rates, and costly housing rentals driven up by the tourism boom. Land taxes are calculated based on the land's potential for development, not its value for agriculture. These factors affect local peoples' ability to afford living in the town. Some have been squeezed out by incoming, more affluent individuals, forcing some local residents to move out of Hanalei to search for cheaper housing.

10.9.6 Effects on Rural Landscape and Townscape

Increased tourism and development in Hanalei imposes a new set of pressure on the rural landscapes that are scenically beautiful and historically significant. Tourism forces the pattern of land use to change from agriculture to tourist-oriented businesses. It induces economic growth and, consequently, motivates the transformation of Hanalei townscape. Many new buildings, such as shopping centers, retail shops, bike shops, restaurants, and accommodations have been erected throughout the town, some obstructing the view of Hanalei's flatlands. These built environments shape and change the landscape feature of this small town with their exotic façade, big signs, materialism, color, and architecture. To protect the habitat of the waterbirds, Dave Aplin states that the number of tourists allowed to enter the Refuge by USF&W is capped at 2,500 per year.

10.10 Tourism Planning For Hanalei

Not unlike other places, Hanalei community leaders are investigating alternative strategies designed to accommodate a tourist industry. The benefits have been noted earlier in this chapter. Nonetheless, although open-minded to tourism development, the community remains skeptical about the rapid growth of the tourism industry and sees it as a mixed blessing. First of all, the scope of tourist development that the Hanalei community is struggling to achieve is not necessarily economically beneficial to all parties. Secondly, the impact of tourism on the community, the ecology, the natural environment, and culture must be given special consideration. This aspect of tourism development should neither be underestimated nor taken for granted. In fact, the consequences of tourism development should be first assessed before implementing any tourism development plan.

When tourism is properly managed, it can enhance both the physical and the tangible heritage of an area. Hence, it offers a positive way for communities to express pride and their culture identity. It is unfortunate that when tourism is not managed properly, it can cause irreversible damage to the environmental quality, aesthetics, and cultural heritage sites. Worse yet, mass tourism can destroy the ecosystem of a community.

Hanalei's beauty has not gone unnoticed; both temporary and permanent local residents, as well as the tourists who travel there for its serenity and beauty, appreciate it. The extent of this appreciation is evident in their resistance to unfettered tourism, fearing that it would destroy the small-scale lifestyle and the environment for which it has become reknowned. Tourism is, of course, a worldwide phenomenon, but in a small community like Hanalei with a population of only 478 residents, its impact is even more evident. It would be quite easy for a small place to be inundated with tourists if it is allowed to grow to an unmanageable extent; it would radically change the existing way of life. The Hanalei environment, work and leisure habits, indigenous agriculture, traditional values and cultural patterns, socio-political structures, and functioning of the family system would be drastically disturbed when developing tourism irresponsibly. These are the issues that concern the local residents. To achieve the type of tourism that the community envisions, the concept of sustainable tourism, propagated through alternative models like agro-tourism and cultural tourism must be better comprehended by the community. These tourism typologies, embodied in the principle of sustainable tourism, would entail effective levels of control, management, and monitoring. When they are better understood, it will allow the community to envision alternatives that incorporates the community's ideas regarding the question of how tourism should proceed whilst minimizing the negative impact on the *ahupua'a* and the town scale. Envisioning a tourism development plan appropriate for Hanalei would facilitate the design of clear tourism programs that support the educational, historical, and cultural appreciation objectives desired by the community whilst bringing in revenue to the town.

10.11 Defining Sustainable Tourism Objectives

There are several alternative models for sustainable tourism development. Three are discussed here: (1) agro-tourism, (2) eco-tourism, and (3) cultural tourism. All can be applied in Hanalei with creativity to entice tourists. Before discussing each in detail, it is first important to clearly delineate the objectives developed by scholars from this field of study under the themes economy, cultural, social, and environment. They are outlined in table 18. These objectives are compatible with the aims and goals articulated in the Kaua'i General Plan 2000. It also compliments the features of Hanalei appreciated by the community.

Table 19. Objectives for Tourism in Hanalei

Objectives for Tourism Development	**GOALS**
Economic	• Improvement of the Hanalei local economy • Provision of local businesses and employment opportunities for the residents • Generation of increased revenue to maintain historic sites and protected areas at Hanalei
Cultural	• Better knowledge and awareness of conservation among local people and visitors about the rural character of the locality • Appreciation of local natural and cultural heritage at Hanalei • Making sustainable tourism part of the local culture
Social	• Visitor satisfaction and enjoyment • Improvement of living standards and skills of local people • Demonstration of alternative to mass and package tourism and promotion of sustainable tourism everywhere • Enabling all sectors of society to have the chance to enjoy protected areas
Environmental	• Ecological conservation, including conservation of biodiversity, land conservation, watershed management, and air quality maintenance • Minimize tourism negative impact on watershed

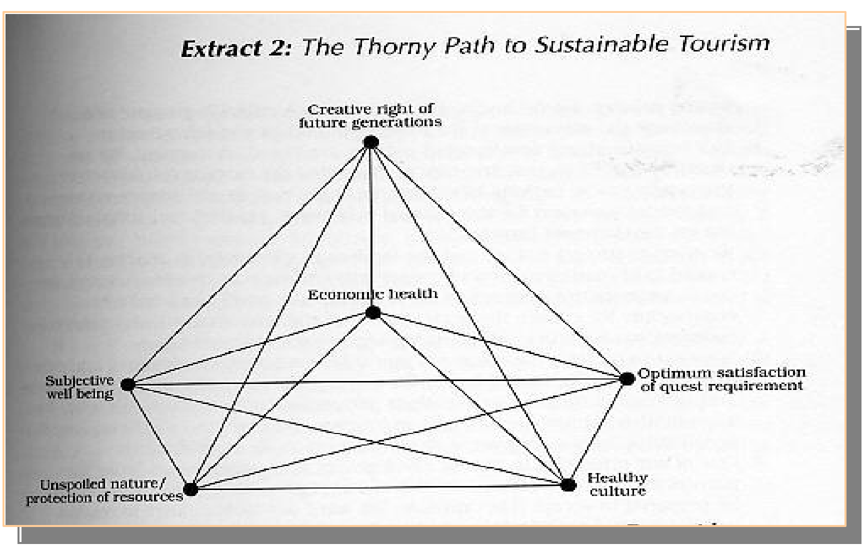
Source: Adapted from FNNPE, 1993

These goals are the pillars of the sustainable tourism model. They help to engineer a sustainable development framework when constructing a plan for tourism development in Hanalei.

10.12 Types of Sustainable Tourism

The intention behind sustainable tourism is balanced development. All the objectives of unspoiled nature, healthy culture, a high degree of subjective well-being, optimum satisfaction of guest requirements, and economic health carry the same weight and are juxtaposed against economic growth, as depicted in the Hansreudi Model of Sustainable Tourism (Hansreudi, 1999:28). Muller Hansreudi introduces the concept of balanced development in his model *"The Thorny Path to Sustainable Tourism"*. This model shows that no objective predominates, ensuring that the interplay of factors can become beneficial to the community and less burdensome.

Figure 1.12. The Hansreudi Model of Sustainable Tourism



Source: Hansruedi, Muller (1999)

Hansreudi's pentagon illustrates that harmony is the key behind environmentally and socially compatible tourism, which enables the community to maximize the returns whilst minimizing repercussions to the ecology and culture. This framework should be applied when brainstorming ideas on alternative tourism development models for Hanalei.

The crux behind Hansreudi's model is that there are limits in available resources and if Hanalei is to continue providing for future generations, it must participate in an ecologically sound tourism practice. This is the only way, also, to rectify the ecological mistakes of the past. Hence, today's generation must create a basis for development that will support generations to come. A more detailed approach to the five elements in Hansreudi's pentagon is listed in Table 19.

Table 20. Articulating Specific Objective Based on Sustainable Principles

Clear Objectives through Sustainable Principles

1. Tourism development should be based on the criteria of sustainability. It should be ecologically bearable, economically viable, and ethically and socially equitable for local communities.
2. Tourism should contribute to sustainable development and be integrated with all aspects of the environment, respecting fragile areas and promoting the assimilation of impacts so that these lie within the capacity limits.
3. Tourism must consider its effects on the cultural heritage and traditions of local communities
4. Participation of all actors in the process is essential
5. Conservation of the natural and cultural heritage involves cooperation, planning and management
6. The satisfaction of tourists and preservation of destination should be determined together with local communities and informed by sustainable principles
7. Tourism should be integrated into local economic development
8. Tourism development should improve the quality of life
9. Planning tourism is important
10. Equity of the benefits and burdens of tourism should be sought
11. Special priority should be given to environmentally and culturally vulnerable areas and areas already degraded
12. Alternative forms of tourism compatible with sustainable principles should be promoted
13. Environmentally compatible management systems should facilitate a sustainable tourism policy
14. The travel industry should promote sustainable development, exchange experience etc.
15. Particular attention should be paid to transportation and the use of non renewable energy
16. Codes of conduct should be established for the main actors
17. All necessary measures should be implemented to promote awareness of sustainable tourism among all involved.

Source: Martin (1995)

These objectives can be applied to the three typologies of sustainable tourism models because each responds to the calls for ecologically friendly and small-scale.

10.12.1 Agro-Tourism

Agro- tourism merges agriculture with the traditional economic growth concept underpinning tourism, albeit incorporates it in a way that will perpetuate the livelihood of taro farmers. This framework places a monetary price on sightseeing (i.e) acres and acres of *kalo lo'i*, the benefits of which can increase farmer income while at the same time maintain the integrity of the taro farming heritage both at the Refuge and Hanalei, in general.

The taro farms at Hanalei cover approximately 120 acres, the majority of which are located within the National Wildlife Refuge. Rodney Haraguchi is the primary taro farmer at the refuge. He can help to support agro-tourism by partnering tourism goals with the Hanalei Poi Factory.

Key community members in the region have advocated agro-tourism. Stacy Sproat, the Waipa Foundation Manager, is one such person. To promote this type of tourism, she suggests expanding the farmer's market. In support of expansion, the Waipa Organic Garden teaches the semantics and processes of organic farming. Their vegetables are a high end value because they are sold to hotels in Princeville and restaurants in the area. The Waipa community

holds a farmer's market every Saturday. On the last day of each month, the community gets together to make poi for their *'Ohana* and educate the community about taro's cultural and health virtues.

The co-owners of the Hanalei Poi Company have toyed with ideas for expanding such activities to appeal to tourists. They have suggested building a taro museum in which tourists can be educated on the historical trajectory of taro's journey from Asia to the Pacific Islands and Hawai'i. It could include a section devoted to displays explaining the value of taro to the Hawaiian heritage. A taro café could be placed within the museum to serve goods made from taro and stimulate ideas on how to make taro flavored coffee. Moreover, a designated taro patch could be regulated for tourism to teach the public about the mechanisms of taro farming. According to the co-owners of the Hanalei Poi Factory, these ideas would provide for and promote venues for value-added products for taro, hence, improving taro yields if demand for these value-added products increase.

Because agriculture in the area is relatively small-scale and does not have a large employment base, agro-tourism would generate opportunities for increasing employment for a significant number of residents, as the possibilities described above would require positions, such as museum curators, care-takers, historians, administrators, tour-guides, janitors, café workers.

A further rationale for agro-tourism is that it would contribute to the aesthetic beauty of Hanalei, where there is a close relationship between scenic beauty and agriculture. Some locals have said that open bird ponds do not look as attractive as the *lo'i* patches.

10.12.2 Eco-Tourism

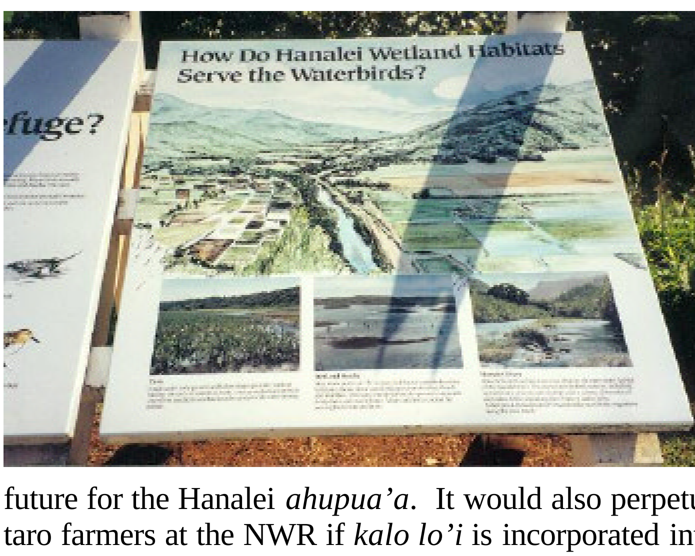
Eco-tourism, by contrast, emphasizes a low impact method of visiting the host community. The World Wildlife Fund for Nature (WWF) defines eco-tourism as tourism, which protects natural areas, a means of economic gain through natural resources preservation, and a merger of recreation and responsibility (France, 1997:18). Eco-tourism focuses on ecological and socio-cultural integrity, responsibility, and sustainability. Table 20 summarizes the environmental impact of tourism.

Table 21. Environmental Cost-Benefit Matrix of Tourism

Benefits	Costs
1. Conservation of Natural areas and wildlife	1. Energy costs of transport
2. Environmental appreciation	2. Loss of aesthetic value
3. Rehabilitation and often also transformation of old buildings and sites facilities	3. Noise
4. Introduction of planning and management	4. Water pollution and the generation of waste
	5. Air pollution
	6. Disruption of animal breeding patterns and habits
	7. Deforestation
	8. Impacts on vegetation through the collection of flowers and bulbs
	9. Destruction of beaches, dunes, coral reefs and many National Parks and Wilderness Areas through trampling and/or the use of vehicles
	10. Change of landscape permanent environmental restructuring
	11. Seasonal effects on population densities and structures

Sources: Mathieson and Wall 1982; Lea, 1988; Pearce, 1989; Ryan, 1991; Burns and Holden, 1995

Eco-tourism, like agro-tourism, contains educational and interpretative components. Stacy Sproat explained that eco-tourism is important not only to tourists but for the Hanalei community as a whole. While eco-tourism generates income, at the same time, it teaches the host community and the younger generation how to respect the natural environment. When the meaning of respect is understood, preservation is a natural by-product because people take better care of the natural environment. This minimizes negative impact and procures a future for the Hanalei *ahupua'a*. It would also perpetuate higher levels of income for the taro farmers at the NWR if *kalo lo'i* is incorporated into the eco-tourism plan for the Hanalei Valley.



10.12.3 Cultural Tourism

Cultural tourism is another sustainable framework that encourages the propagation of culture embodied in the landscape and the people. There are several justifications for developing a cultural tourism plan. Similar to agro-tourism and eco-tourism, the driving point is to manage tourism at a small-scale, albeit aiming to generate revenue. The reason is that tourism, without cognizance to the impact on cultural assets, will only prove detrimental to the community, at large. The social and cultural costs and benefits of tourism are organized in a table format in Table 21.

Table 22. Outline of Impact to Society and Culture in the Host Community

<table>
<tr><th colspan="2">SOCIO-CULTURAL IMPACTS OF TOURISM</th></tr>
<tr><th colspan="2">A. Cultural Impacts</th></tr>
<tr><th>Costs</th><th>Benefits</th></tr>
<tr><td>Disappearance, degradation or commoditization leading to a loss of authenticity of:
• art and music
• handicrafts
• dance
• ceremonies
• architecture
• dress
• food</td><td>Renaissance and / or retention of:
• art
• handicrafts
• dance
• ceremonies</td></tr>
<tr><th colspan="2">B. Social Impacts</th></tr>
<tr><th>Costs</th><th>Benefits</th></tr>
<tr><td>1. Local resentment resulting from the demonstration effect
2. Moral problems:
• crime
• prostitution
• gambling
• decline of traditional beliefs and religion
3. Health problems (eg. Aids)
4. Strains on local hospitality become intolerable
5. Employment in tourism can be dehumanizing
6. Adverse effects on family and community life
7. Neo-colonialism
8. Unbalanced population structures</td><td>1. Tourists gain through relaxation and recreation, a change of environment and social contact with others
2. Locals gain through:
• impetus to modernization
• women given level of independence
• people break out of traditional, restrictive roles</td></tr>
</table>

Source: Mathieson and Wall (1982), Pearce (1989), Ryan (1991)

Contemporary cultural tourism presently displayed in Hanalei is captivated in its geographical landscape. The beauty of the scenic landscape, Native Hawaiian historical structures, such as the *heiau* sitting atop a hill west of the main highway as one enters Kapa'a, and the traditional taro *lo'i*, practiced as it was thousands of years ago, all constitute cultural tourism in this area. The Hanalei River, feeding directly into the Hanalei Bay, is also recognized as one of the most prestigious features of the area. The fact that it has been designated as an American Heritage River provides a good foundation for cultural tourism since it can be used as a marketing point. These features highlight the cultural uniqueness of the region. Zoning requirements, which preclude the high-rise development normally found in Honolulu, maintains the rural character and cultural aspects of Hanalei and inadvertently supports the potential for cultural tourism.

This model encourages those involved with historical preservation and management to take advantage of the significance of this heritage by making it more accessible to visitors. Cultural tourism, in fact, induces the tourist industry to direct and manage tourism in ways that respect and enhance the heritage and living cultures of small communities similar to Hanalei. It, moreover, facilitates a dialogue between conservation interests and the tourism industry about the importance and fragility of the environment and cultures, including the need to achieve a comprehensive sustainable plan for the entire community. More importantly, it encourages tourism developers to conceive of strategies for shaping tourism development policy plans that syncopates well with the Hanalei community's wants.

The tourism framework described above offers possible alternatives, which are compatible with the community's tourism objectives. Agro, eco, and cultural tourism development should pursue this course in order to achieve sustainability given the desires expressed by stakeholders to disturb Hanalei's environment as minimally as possible.

10.13 Proposals

Because of the potentially detrimental impact tourism poses, the Hanalei community should come to a consensus on managing change and mitigating tourism development in the area. The questions that remain pertain to the direction, nature, and rate of change, and the degree to which Hanalei can incorporate new considerations into existing conditions.

The current land use control mechanisms may be inadequate for meeting these pressures. There are also questions concerning the degree of regulatory power behind these measures. Economic reality necessitates a re-consideration of how to use nontraditional resources and nontraditional ways to market the land that signifies the cultural value of Hanalei, in essence, providing a venue for "selling" Hanalei's culture and ecological features.

The Hanalei community proposes the following:

- Educating both residents and visitors about the unique historic, rural, cultural, and natural resources and fragility of Hanalei Town.
- Reducing high property taxes that drive out local residents

- Expanding the traditional market for taro while encouraging its continued viability and vitality as an important traditional food
- Decreasing congestion and improving parking, traffic safety and circulation
- Protecting and enhancing the visual quality of Hanalei town
- Protecting areas that have a special character by establishing one or more historic districts

To support such visions, a clear strategic tourism plan is needed. Here are some suggestions.

1. Educational Learning Center

Perhaps the best way to educate tourists and promote the rural attractions of Hanalei town is first to introduce an Educational Learning Center. The learning center would serve to increase knowledge about the fragility of Hanalei's ecology. It would also provide a form of outreach for residents to make them better aware of the sensitivity of the environmental fabric. Moreover, by establishing a Center, it could serve as a means for imposing a ceiling on the number of visitors accessing Hanalei at any one time. Through this Center, tourists can be introduced to local adventures and B&B accomodations and be required to board a community-owned shuttle, operating from the Center, to transport them to the beachfronts and outdoor destinations specified for tourist attractions.

The Center, if operated by the HUI, would help the community establish a community based economic development project. Community hosts would provide a direct interpersonal connection between visitors and residents in order to advocate a greater understanding of the town's history, culture, and farmers. This would be a great chance for visitors to experience directly how *lo'i* fields are farmed. The Hanalei Poi factory could have tourists participate in the first steps in making poi (cleaning the taro and the pot whole). This would help perpetuate the cultural practices and history of Hanalei taro farmers.

Visitors will also benefit by having a closer relationship and deeper understanding of the community and the culture of taro farming. Community guides and tour operators could assist these farmers periodically by helping on their farms or cleaning the Hanalei river and road trails they use.

Further suggestions for the Educational Learning Center include:

- Providing information to visitors on the history, culture, and processes of taro farming though brochures and tour guides.
- Providing information to visitors about what behaviors are considered appropriate and inappropriate by the host community, to improve mutual respect and respect for the natural environment.
- Coordinating the times for tour operations to head out to designated sites.
- Building a public parking zone at the Educational Learning Center.

Because some areas at Hanalei are environmentally sensitive and some are in flood zones, the hosts are responsible for intercepting visitors before allowing access to these sites. This can be done by establishing a toll booth at the Hanalei Bridge, which charges a small entrance fee into the rest of the Valley (see Appendix B.10). Support from the Hanalei community is important for this type of project to be sustainable over the long term.

The educational learning should also train a local coordinator to work closely with residents, merchants, and visitor industry representatives to ensure that the learning center meets Hanalei's needs. The coordinator would speak to local communities, meet with merchants and government officials, and work towards resolving any problems that arise from tourism in Hanalei.

2. Managing visitors

The Hanalei community (HUI, KVB, residents, etc.), in order to better manage and preserve the agricultural, cultural and historical significance of the town, should ponder over the following key issues:

- How should the Hanalei community be managed and administrated to ensure perpetuation of agriculture, culture, and history for future generations?
- If the community cannot come to an agreement on how tourism will be managed in the present and future, who will ultimately make the decisions?
- How will the community balance present and future agricultural, cultural, historical, and economical needs of the town?
- Should a cap be on the numbers of tourists visiting the area be imposed?
- If a cap on tourist numbers entering Hanalei is imposed, how should the decision be implemented and enforced?

By coming to an agreement on public access and tourism, the community will create more congenial means of dealing with access without necessarily evoking government intervention. Such an agreement would also serve to improve relations in Hanalei while protecting farmers, local residents' land properties, and Bed and Breakfast businesses. Subsequent studies by all agencies are necessary for the final determination of responsibility to the roadways and trails within Hanalei.

3. Tourists should pay for access

The tourism industry took off as a widespread pandemic in the 1960's after statehood, when agriculture went into decline. Beaches turned into semi-exclusive resorts for nonresidents, and regular fishing spots disappeared. Nature preserves have turned into tanning oil slicks. Seven million tourists pass through Hawai'i, each compounding environmental impact in one way or another. Tourism burdens the resources tremendously. They help to deplete the water supply one hotel toilet flush at a time, one golf course watering a day. The idea of tourists paying the true cost for these exploitative pursuits is a policy initiative, which has come at at timely moment for Hanalei (*Ka Leo O Hawai'i*, 2002: 4).

According to Linda Cox, a view has value because everyone uses it, but it is likely that tourists value it more than the residents. The methodologies used to measure the value of a view are:

- Continual analysis - set an amount, then ask respondents if it is worth that much to get a point measure

- Contingent valuation - try to value the view by showing respondents a bundle of tourists' or residents' experiences that have prices on other attributes. If one attribute is the view, then ask respondents what tourists like better. Through this information, establish what the view is worth.

- Visitation methods (indirect)

- Travel cost method - how many people visit per day; how much money is spent to visit the view; allocate the time spent on the view.

These methodologies are useful as guide tools when proposing a market value for the view. Cox explains that a nominal fee will help maintain the physical characteristics of Hanalei Valley, while perpetuating taro farming as a form of subsidy from the County or State.

Similarly, Hanauma Bay exacts a fee on tourists. In Judge Kay's opinion, "[T]ourists must pay for their exploiting of our resources". Judge Alan Kay ruled the City and County of Honolulu has the power to charge non-residents a fee to maintain Hanauma Bay just as it is reasonable for the City and County to make everyone pay for the maintenance of parks and bays. The city gets local residents to contribute through their tax dollars. For non-residents, the city gets it through fees.

Maintenance of Hanauma Bay is also accomplished by closing it to the public one day a week. This helps diffuse the tourist chemical sludge that meanders into the waters of Hanalei. Someone also has to pay to upkeep the facilities, an additional consideration the community should look into.

4. Real Property Tax Re-Assessment

Current residential property tax rates are $4.65 per $1,000 of valuation for structures and $5.64 for land. Kaua'i Mayor Maryanne Kusaka unveiled her FY 2003 budget on March 15th, 2002, proposing an across-the-board reduction in real property tax rates (Sommer, 2002). The philosophy behind this tax cut that is to ensure homeowners are not forced to sell their homes because they cannot afford to pay their property taxes. The Kaua'i County Council's Committee is currently holding up action on a bill proposing to freeze property tax assessments (the Kouchi Bill) for homeowners, farmers, and other property owners. A proponent for the freeze on property tax assessments argues that the absence of such a policy has hit many homes and farms with assessment increases of up to 600 to 700 percent in the last three years.

The bill should be further amended to reflect a roll back period that goes back to earlier than 1999, before sales to mainland buyers forced assessments to spiral upwards. The bill would allow Hanalei residents to remain on their property in the face of skyrocketing assessments and higher tax bills. One resident on the Kaua'i County Council commented that people who own property near new home constructions in Hanalei, Ha'ena, Kilauea and Kekaha are suffering and need the type of relief the bill can provide. According to Peter Nakamura, the Bill was last amended by the Council Committee at two separate meetings: on November 21st and 27th, 2002. The amended version of this Bill (Draft 2) proposed a circuit breaker credit or refund for homeowners in the Homestead class whose property tax assessments exceeded three percent of their household income instead of a valuation exemption, as proposed in the original Bill. Further, this circuit breaker program will be effective during the 2003 tax year; applications for this program need to be filed by February 28, 2003. A public hearing on the original Bill was held on October 10, 2002.

Ray Chang added that the council is hoping to get the bill passed before the new council turnover. It is important for the community, especially those who have been victimized, to give testimony and support for long-time residents, who have had unrealistic valuations on their property. Chang emphasized the importance of community participation in council workshops aimed at reducing property taxes. It is unfortunate that only four members of the public came to the last workshop. The Bill needs more support in order for it to be recognized.

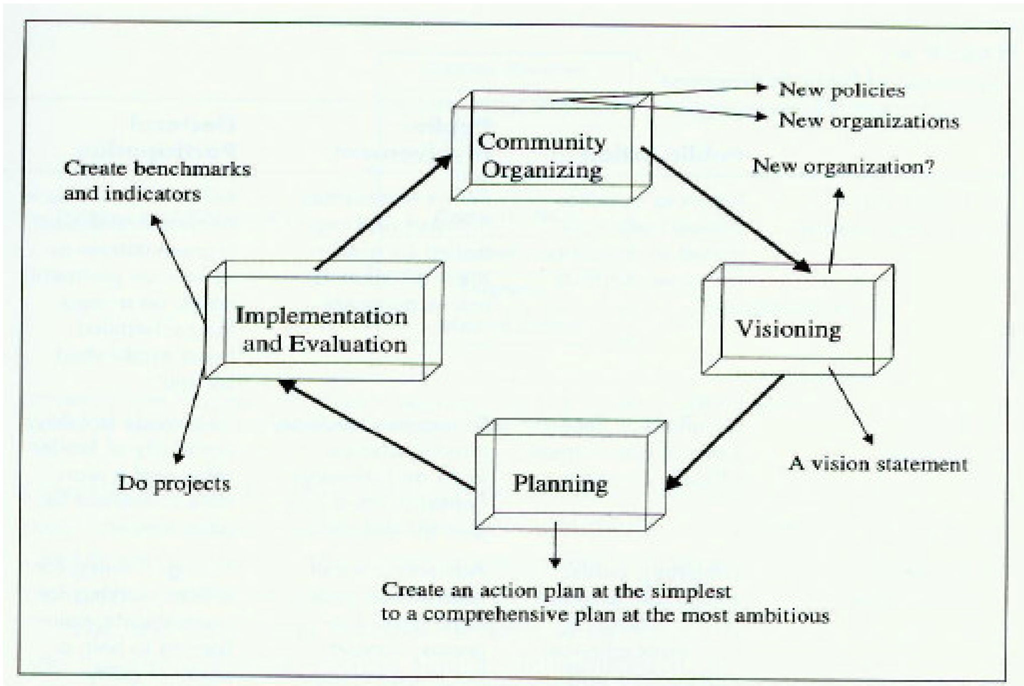
Nina Morita suggested that one way of dealing with tax property in Hanalei is to impose higher taxes on vacation rentals. Vacation rentals should have a different tax rate than B&B's (which are locally owned), and County and State government should subsidize long-time residents with a tax bracket provision or an akin relief program. A tax circuit breaker, sometimes applied to senior citizens, can be the kind of framework for providing relief to local Hanalei residents.

The Federal, State, or County governments are the main actors in implementing these suggestions. Therefore, as Chang mentioned, it is important for the community to participate strongly in order to convince the government to reduce property taxes. The model below can be recommended for planning property tax assessments. The four dimensional boxes comprise a cycle that can be used by the HUI to convince the government to re-assess current tax structures. Regrettably, according to Chang, the community has not fully participated in workshops that target reduction of property taxes on the North Shore.

10.14 Community Participation

For the Hanalei community, in order to continue managing the area and for the taro farmers to remain on the refuge, all must move forward together, each stakeholder recognizing their equal roles in continued maintenance, preservation, protection, and perpetuation of Hanalei. The model below looks at the strengths in community participation for visioning, planning, community organizing, implementing, and evaluating, a viable tourism plan well-suited to Hanalei.

Figure 1.13. Community Participation Model for Social Change

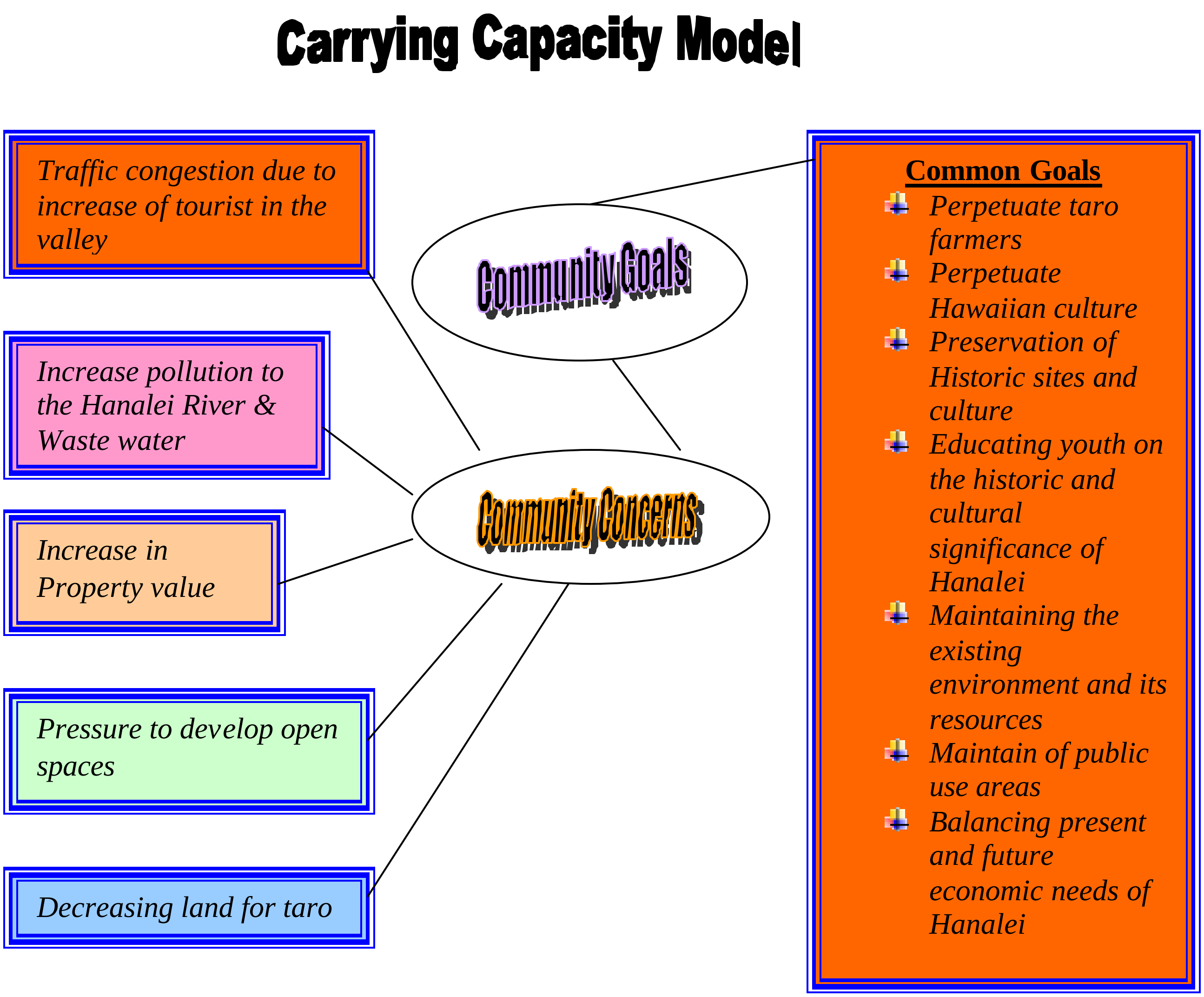


Source: Green & Haines (2002), Asset Building & Community Development, Thousand Oak: California.

Another issue, aside from high property taxes, is protecting open land from development. Taking Wailuku (on Maui) as an example, the Hana Ranch creates land preserves, continues to own the land, and enjoys land tax benefits. The protection agreement was put forward as a conservation easement agreement signed by the Coastal Land Trust. The nonprofit Maui Coastal Land Trust oversees the property, ensuring that current agricultural use, scenic viewpoints, and public access remain unchanged in perpetuity. The contract also calls on the Hana Ranch to set up an endowment fund to help pay for the land trust's ongoing protection efforts (Hurley, 2002). The Hana Ranch is a model for land conservation that may be applied in Hanalei as a means for conserving land, again to perpetuate taro farming and to protect open spaces.

10.15 Carrying Capacity

A carrying capacity model helps managers to think in structured ways about resource problems. It can be a value tool in community education to raise awareness about activities that are consequently detrimental to the environment. The Hanalei community can best determine how carrying capacity interrelates with the community, the ecology, and tourists in order to draw physical limits on use of the area. The carrying capacity model is suggested as a tool in recreational planning and management. It can also be applied for examining alternative ways to reduce wastewater in Hanalei. The carrying capacity model looks at different goals and concerns that the Hanalei community should be studying to determine how to structure tourism capacity. Along with increased tourism activities in the Valley, the Hanalei community should be ready to take responsibility for safeguarding the quality of both recreational resources and visitor experiences. The carrying capacity model should be adapted according to the type of tourist activities, in effect, making them appropriate and sustainable for the area. This type of think tank approach suggested by the model is recommended for structuring carrying capacity.



10.16 Develop Limitations

Measuring carrying capacity helps to visualize limitations on tourism development. The community should be looking at congenial means for dealing with tourist access to the area that does not necessarily involve government intervention, but relies more heavily on individual ethics and one's appreciation for nature's splendor. The agreement contract should serve to improve relations between stakeholders in Hanalei, as well as protect farmers and reduce high property taxes. Putting limits on acceptable use is a necessary component of sustainable tourism.

10.17 Tourist Code of Conduct

Creating a tourist code of conduct would help guide both tourist and resident behavior to practice sustainable tourism in Hanalei. A possible code of ethics is listed below (*The Center for Responsible Tourism)*:

- Instead of only seeing the exotic, discover the richness of another culture and way of life.
- Get acquainted with local customs; respect them.
- Be aware of the feelings of the local people; avoid what might be offensive behavior both to human and nature.
- Travel in the spirit of humility and with a genuine desire to meet locals and respect nature.

10.18 Zoning Control (Comprehensive Zoning Ordinance)

An integrated management zoning plan can help to identify ecologically sensitive areas in the Hanalei *ahupua'a,* and to develop specific sustainable plans for those places where higher levels of tourism development can occur without exacerbating the impact on the ecological and scenic beauty of Hanalei. Planners should work with the community to demarcate the most sensitive areas in the Hanalei *ahupua'a.*

Integrated management addresses a range of potential threats to the *ahupua'a* and accommodates a range of stakeholder interests. It should be structured in correlation with a multiple-use zoning plan so that certain areas are not over-utilized. Such plans, furthermore, should not harm the rural character of the area.

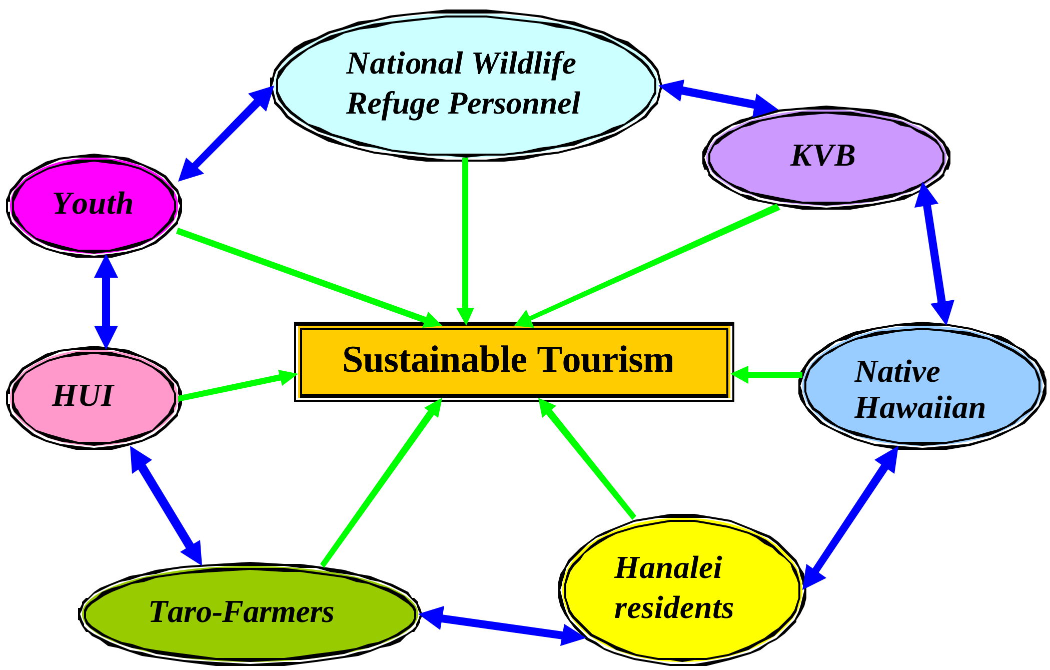
More importantly, zoning provides a clearer picture to planners and stakeholders, studying social and environmental impact, of the sensitivity of these areas along with drawing attention to their limitations. In some cases, environmentally or culturally sensitive sites may require special management to accommodate the specific needs of the areas designated for zoning. Management plans should, then, include guidelines for protecting such places. Management plans should also demarcate places that are highly contaminated by bacteria. Public toilets for tourists should not be placed where they can contribute to more pollution. Zoning ordinances can help to identify localities that are suitable for tourism development without harming the ecology.

10.19 Impact Assessment for Tourism Development

It is strongly recommended that the environmental, economic, social, and cultural impacts on Hanalei be assessed before proposing further tourism development. The community (stakeholders) should first assess whether the identified and anticipated impacts are appropriate. Any proposal for tourism development should first be presented to the Hanalei community and discussed at public hearings before any further decisions are made. The Impact Assessment component of tourism development should be legally mandated in legislation.

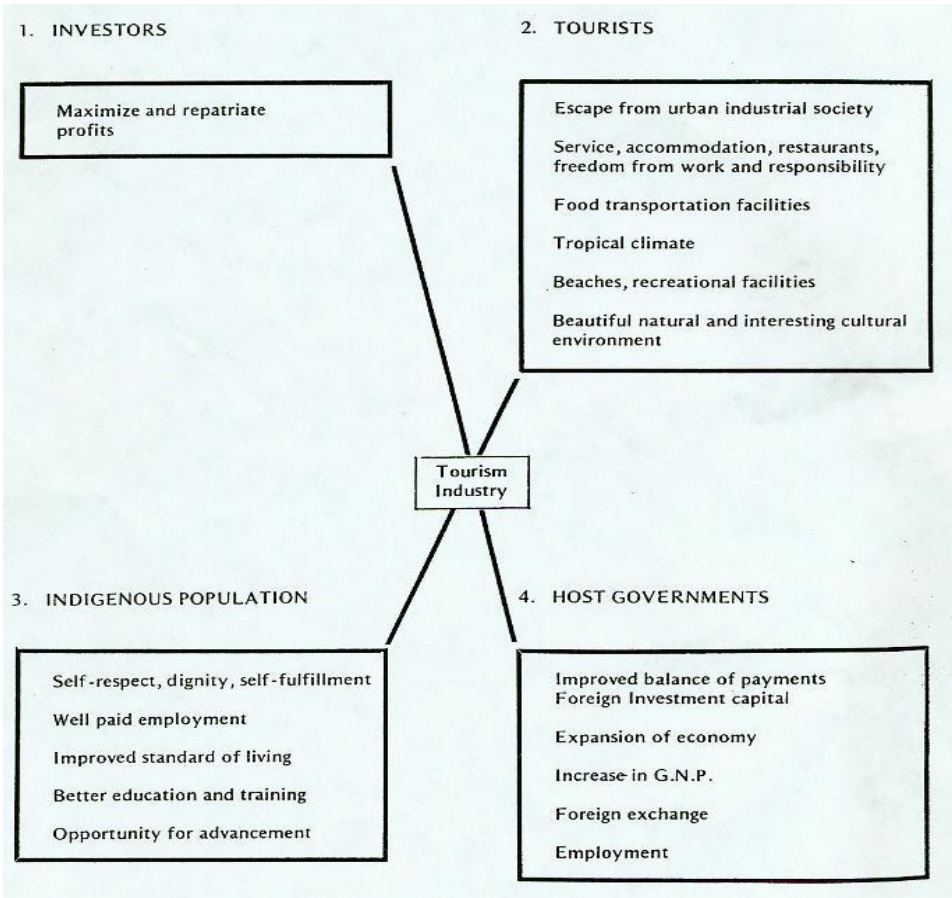
10.20 Work in Partnership

In order for the Hanalei community to have a voice in managing and controlling the future direction of the Valley, all stakeholders should work as partners and move forward together, recognizing their equal roles and interests in continued maintenance, preservation, protection, and perpetuation of the Valley's unique charm. Continuous communication amongst stakeholders is crucial when dealing with old ways of doing things and for implementing new ideas.



The chart explains the importance of tourism linkages to Hanalei's economy. As discussed, community stakeholders are accountable for taking responsibility for the community's outcome. As such, building a roadmap of how they want tourism to proceed in Hanalei must be both a cooperative and collaborative effort. Various agencies should also devise a consistent and practical method for enforcing regulations. The community needs to work together to establish rules that will allow tourism to continue, albeit in a regulated manner. The chart below depicts the goals of investors, tourists, indigenous population, and host government. Rajotte (1978) shows how to study the tourism industry. Through identifying the divergent goals, commonalities can emerge. This is the first step toward understanding possible conflicts and collaboration.

Figure 1.14. Elucidating Divergences to Identify Commonalities



Source: Rajotte, Freda (1978). A Method for Evaluation of Tourism Impact in the Pacific, Center for Pacific Studes, Santa Cruz: University of California.

In summary, drawing upon the sustainable concept framework for tourism development in Hanalei, a few concrete suggestions are recommended for further studies. Firstly, stakeholders should collaborate and advocate for implementing the tax circuit breaker in the Valley. Hence, a more direct survey on the tourism sector in terms of number of tourists coming into Hanalei and accommodation (B&B's & Vacation Rentals) should be undertaken (with annual updates) to verify carrying capacity limitations. From this study, a sustainable tourism plan can be constructed that alleviates – or even avoids - the adverse impact normally produced through tourism. Consequently, to manage B&B's and vacation rentals and control the waste water disposed by tourists, a use permit should be enforced by the County.

Appropriate management strategies and the input of community ideas are crucial for coordinating a comprehensive tourism plan that will maximize benefits to Hanalei that protects not only the *ahupua'a*, but also the historic features and small-scale lifestyle so treasured by the community. Management, however, must also consider the economic benefits of tourism, as it is undisputed that tourism allows the community to continue financially sustaining itself, as has been argued earlier in this section.

Because the Hanalei *ahupua'a's* biotic composition is so fragile it requires special attention. The resource base of this small community is such that the demands for land, water, and waste disposal generated through tourism makes it particularly vulnerable to rapid, uncontrolled tourism development. Given the downside of tourism, it is important to investigate tourism promotion and development that is compatible to the scale of Hanalei town in order to continue sustaining all that the environment - in all its treasured historical features and beautiful ecosystem - offers. These are all central elements of the *ahupua'a*. Hanalei is such a special place that embracing the triad in the *ahupua'a* concept would be useful when conceptualizing an appropriate tourism development plan in Hanalei: *aloha* (respect), *laulima* (cooperation), and *malama* (stewardship). The community should be strongly encouraged to participate in planning for tourism development in Hanalei. The community needs to work together and set rules that will allow tourism to operate, albeit regulated.

Section IV

Improving Community and Government Relations through Collaboration

Chapter 11

Multidimensional Co-existence for Watershed Management in Hanalei

Collaborative planning is important because it allows for greater synergy in the planning process and decision-making compared to the linear - or "competitive" - approach, where the focus is based mainly on one's personal interests. As explained in Chapter 2, collaborative planning forces groups to shift their values from the individual and learn to integrate themselves into the common, community-oriented goal. From the description, analyses, and list of recommendations in the chapters contained in section 3, the essence of development and preservation/conservation efforts in the spirit of *ahupua'a* and watershed management for Hanalei boils down to the realization of co-existence among all stakeholders (i.e. the community, county government, business entities, federal agencies, etc.). Acknowledging, too, one's interdependence with the community, at large, is realizing that the preliminary step toward collaboration, ideally, is to search for a fundamental common ground, from which communication and later a collaborative framework is initiated.

There are two general, open-ended phases in the collaborative process. "Open-ended" is used here intentionally because it implies that stakeholders can define structure and process, and can be tailored to accommodate the community's specific needs and requirements. Having established that foundation, it is important to distinguish between the two phases. The initial, or first, phase addresses short-term goals of the community. This may include resolving conflicts or identifying common interests. The latter, or second, phase addresses long-term goals and is usually grounded in the action plan process or policy formulation. Given the situation in Hanalei, collaboration must carry out both phases.

11.1 Phase 1

Phase 1 focuses on the immediate problems confronting Hanalei. This usually takes the form of identifying institutional and community capacity, conflict resolution, and managing and reconciling differences. It utilizes different tools to accomplish the aims of these processes.

11.1.1 Identifying Institutional and Community Capacity

The Hanalei community is equipped with the HUI, a community action and watchdog group responsible for managing the *ahupua'a*. It has access to Information Technology (IT), which facilitates the function of management, and has trained staff. A community willing to volunteer for clean-ups and watershed monitoring activities further supports it. So far, Hanalei has a strong foundation. However, the community must identify areas where institutional capacity is rather weak. For example, are there trained mediators and facilitators living in and around Hanalei that will be able to effectively manage collaboration meetings? Do they have committed community members who will religiously attend meetings? If not, the community may wish to hire an outside source incrementally to hold training seminars for anyone in the community wishing to learn mediation and facilitation. To encourage community participation in collaboration meetings, the community may need to expand and/or intensify their outreach by utilizing different media to inform the public about these meetings and how involvement benefits the community.

11.1.2 Conflict Resolution

Conflict and tension are two characteristics that trigger apprehension because they imply chaos and discord. By extension, it is often inferred that groups and/or individuals are incapable of cooperating if there is a degree of conflict. A further assumption is that commonalities between groups are absent. On the contrary, conflict and tension are simply responses to decision outcomes that entail re-thinking. They communicate a need to develop a dialogue (Ellinor & Gerard, 1998) between groups in order to understand the underlying problems, thereby opening up opportunities for a better outcome. More importantly, conflict and tension recognize that a shift in hierarchy or management structure to better stabilize relations may be in order (Kiel, 1994). The process of communication, if non-hierarchical and truly participatory, tends to facilitate conflict resolution because participants feel they are a part of the solution and grievances are listened to when aired (Booher and Innes, 1999). The bottom line: chaos and tension entails managing stakeholder relations, often regarded as the first step towards building collaborative relations.

11.1.3 Managing and Reconciling Differences

There are several steps in managing differences. The first is identifying an institution, sometimes referred to as an "Action Group" (Himmelman, 1992) that can oversee the overall process of management, which may involve selecting a facilitator trained to moderate differences without perpetuating the conflict. The HUI is the most logical instrument for the role of Action Group, as they are already responsible for the daily management operations of the *ahupua'a*-watershed.

The second step is to identify the root and the rationale for the conflict. Because this is a subjective exercise, the HUI may wish to introduce a methodology for extracting views and opinions that convey personal feelings about the conflict. One suggestion for a methodology is a survey, which stakeholders would complete. The survey should ask pointed questions about the conflict, but should enquire about positive and negative feelings in order to obtain a holistic understanding from the different stakeholder actors. This survey can help to divulge other factors that have hindered progress in stakeholder relations in the past, such as stereotypes, biases, and deeply rooted animosities.

The third step is to identify a trained facilitator, who has the acumen to mediate divergences. It cannot be stressed enough the importance of selecting a good facilitator who can also mediate because this individual must be able to not only reconcile differences, but manage the ensuing dialogue in such a way that divergent conversation is narrowed towards a focused commonality (Ellinor & Gerard, 1998: 22-3).

Divergent conversation is constructive because "it *expands* what is being communicated by opening up many different perspectives" (Ellinor & Gerard, pg. 22). Some mediation sessions tend to gloss over this crucial phase, but the Practicum feels it is constructive for laying all cards on the table. Convergent conversation is a tool to help bring closure to a conflict, usually by finding commonalities introduced during the conflict (Ellinor & Gerard, pg. 23). It may also help the community transition to the next stage of collaboration. But, most importantly, conversation can create community dialogue, leading to new knowledge about each other and the issue[s] of concern. This process may even illuminate several entry points for co-management that would not have emerged otherwise (Bosch, Gibson, & Jopp, 1998).

The fourth step is to bring all stakeholders together into a meeting room to dialogue. This step is not merely a session to discover commonalities, but is also intended to be an opportunity to visualize the present status of stakeholder relations. It is a process that employs media tools to map out divergences in, say, interests and aims to enlighten correlations between such interests and aims. This can be applied onto a matrix that organizes aims and interests into a cross-sectional format, whereby correlations can be marked with large dots. The dots can later be colour-coded to signify strong, medium, and light correlations. Such a methodology enables stakeholders to visualize correlations.

Figure 1.15. Identifying Correlation Using the Aims & Interests Matrix

					Taro Farmers			
	Aims & Interests							
USFWS								

11.1.4 Qualitative Factors

There are inextricable elements involved in the collaborative process, but may not readily emerge from the course of building collaboration. These elements pertain to the emotive, which are not quantifiable but are just as pertinent to the smooth functioning of collaboration building (Margerum, 2002).

- Inclusiveness

There has to be a general sense of feeling included in the process and being made to believe that one's participation is equally crucial to success of the efforts taken.

- Context

This refers to societal level dynamics, technical complexities, and history. It is complex because individual personalities become a central ingredient in stakeholder interaction. Personality issues are sometimes exacerbated by the history of tension in Hanalei between certain key actors, preventing the group from moving forward.

- Misallocation of power

Power is often manifested in autonomous nodes of decision-making, usually concentrated in the hands of one or two stakeholders. When this happens, other involved stakeholders become marginalized from decision-making, as has occurred with the HUI. The consequence is dissolution of cooperative ties and break down of relationship.

- Empathizing with fellow stakeholders

The integrated collaborative approach emphasizes "placing oneself in the others' shoes", i.e., acknowledging that every stakeholder faces their own limitations and attempting to synthesize those limitations into theirs.

To ensure that the process operates effectively, cognizance of these qualitative factors should be prominent in the minds of all stakeholders.

11.2 Phase 2

This second phase aims to administer long-term goals for the community. The outcome takes the form of policy or contractual agreements between stakeholders, which can be either community-wide or geared for sub-groups from among the different stakeholders. To envision what these policies may be, the Practicum engaged in a charette exercise, whereby the members broke down into three groups concerned with the three issues. Our main focus was to conceive of ways that federal and state agencies, community institutions (i.e. KVB, taro farmers, HUI), and certain individuals (i.e. landowners) can bring together their differences and common interests to isolate points of agreement. The charette raised the topic of what the ideal format of interaction should be, considering all the interest, stakes, ownerships, mandates, as well as short-term and long-term goals and objectives. We also felt that the charette would help to determine how the community will move forward, to which direction, and how fast. The results of the exercise indicated several commonalities amongst all parties. We considered this a positive outcome, since commonalities create fertile ground for a very proactive collaborative relationship for the future.

Another feature that emerged from the charette was the discovery that it allowed for different expressions. We agreed that this feature, given the existing tension in Hanalei, must be allocated sufficient space to be developed and nurtured, as expressions are a spirit possessed by every interested party, albeit expressed differently. While those expressions are understood to be the fruit of different perspectives and limitations, it is also important to recognize the positive alternatives that can surface from approaching the issues from different expressions.

11.2.1 Channels of Influence

Looking at the complexity of interactions among community members and government agencies, and considering the physical, environmental, economic, and institutional concerns that have come about in Hanalei, we attempted to categorize the sequence of issues together with their impact. The purpose was to later invoke the categories and aid the groups to focus in on – and isolate – the most pressing issues in a structured manner. These categorical units are the channels of influence.

In studying these "channels of influence", we discovered three. One is the tourism-agriculture channel, which recognizes that tourism is the economic reality of Hanalei, despite that there are negative impacts from over-relying on Hanalei to economically support the Valley and despited that certain areas are zoned for protection, namely agriculture land. Presented simply, tourism directly impacts the affordability and livability of Hanalei, specifically for local residents. Tourism can also attenuate protected agricultural land if tourism was touted as the only economic service for Hanalei. It this occurs, Hanalei will see a decline in environmental quality and a growth in town sprawl.

A second channel of influence is the "institutional channel". This channel affects the workings of various institutions with community groups in Hanalei. This channel is in everywhere in the sense that institutions, organizations, policy and regulations are common components in all situations in Hanalei. If these institutions can not work together, then the numerous functions in Hanalei (taro farmers, agriculture, tourism, the Refuge) become off balance and some functions are favoured over others.

The third channel of influence is *ahupua'a* - wastewater facility. The type of wastewater facility, as the current cluster system and individual household septic system illustrates, can prove detrimental to Hanalei's water quality. Therefore, the HUI and other groups concerned about the environment can utilize this channel of influence to rally the community to pressure at least the City Council to prioritize wastewater facility.

11.3 Integrated Institutions, Stakeholders, and Issues

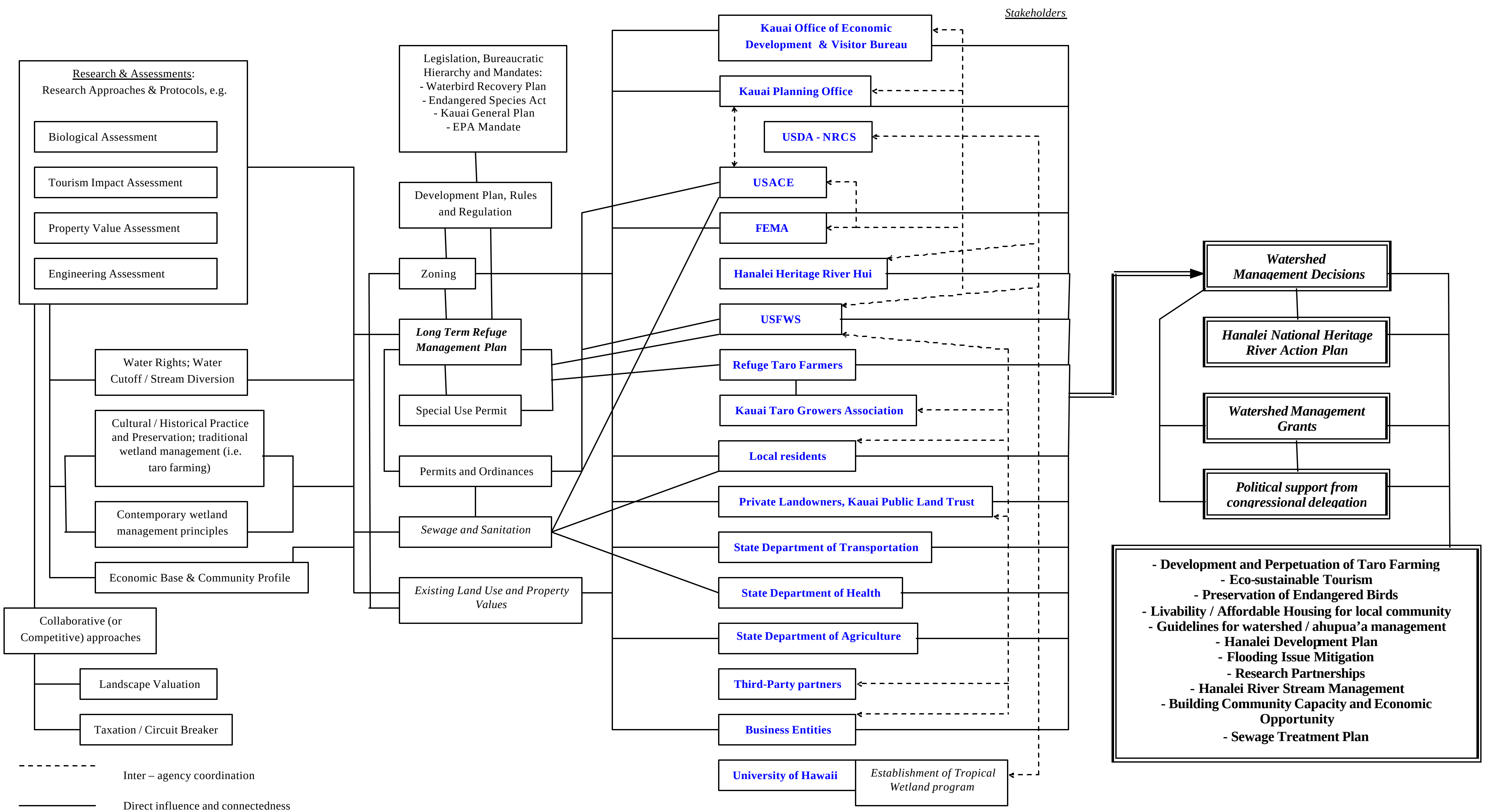
The charette also demonstrated how all stakeholders, the community, and institutions are tethered in issues that ultimately affect the entire community. The chart on the next page depicts each stakeholder's interconnectedness.

In essence, the chart maps out direct influences and inter-relationships (solid arrows), and represent inter-agency coordination (dashed arrows). It consists of four "columns". The first column (the far side of the chart) illustrates the research approach and protocols related to the areas of problematic that are addressed in our study. The second column addresses the regulations and ordinances that are faced by the stakeholders (listed in column three), which will in turn influence what the goals and objectives (in column four) will or will not be achieved.

Looking at research protocols and approaches, the main goal is to recognize the differences between stakeholders and incorporate those that can be synthesized. Specifically, it is important to look at the mandates and/or cultural values and practices to which each stakeholder is bound and seek entry points that can bring these different aspects together into a cooperative agreement. In this way, if the research outcome is adopted by the respective agencies and later converted into a long-term development and management plan, stakeholders most hurt from having been being marginalized from the collaborative process will know that local and/or cultural values have also been considered.

The chart is designed to illustrate the need for understanding (1) the complexity of connectedness between each stakeholders; (2) the rules, mandates, or ordinances related to them; and (3) the future direction idealized in the Hanalei community. Without a thorough understanding of this network, it will be difficult to visualize how the community can holistically work together to achieve its mission.

Stakeholder and Interest Flowchart



Sources:
Planning Charette on Community – Government Issues, Planning Practicum
Fall 2002

11.3.1 The Relationship between Research, Mandates, Rules, Stakeholders and Long-term Community Objectives

It is imperative that research projects conducted in Hanalei seriously take into consideration the traditional/cultural practices that are still of value to the community. For instance, research aimed at establishing a tourism impact assessment will be incomplete without the inclusion of a landscape/scenic view valuation assessment, which will probably differ in perception between visitors' valuation and that of local residents.[27] The chart illustrates how cultural/traditional practices of the community be acknowledged and incorporated into research approaches and protocols. If the outcome of research is used as a baseline study for management plans, the management plan will have incorporated the existing local/traditional practices, as well. Thus, a balance between local/traditional practices and contemporary ones can be achieved.

11.3.2 Placing Oneself in the Shoes of Others

Columns two and three illustrate a simplified model of hierarchy of mandates, regulations, rules and ordinances that directs agencies and stakeholders into a vast array of different directions and operations. The purpose is to understand each agency's mandate, limitations, and restrictions that may ultimately influence and determine the extent of authority and flexibility in the context of planning for the area. It is important to realize the following:

a. Even this simplified version of the bureaucratic and regulatory hierarchy is complicated, implying that the complete hierarchical structure is more complicated.

b. This complicated and comprehensive structure influences not only one particular agency, but affects every stakeholder.

11.3.3 Inter-relations between Stakeholders

Column four illustrates the integrated relationships among stakeholders. The key aspect to consider is that the interrelationships in this model are to be recognized by every stakeholder that has an interest in Hanalei. When integration can be carried out, the goals and objectives can be achieved more effectively. This interconnectedness also implies that both the government and community members and other stakeholders should take part in initiating the integrated mechanism for Hanalei.

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[27] For discussion on valuation methods for scenery, landscape or open space, including the implications thereof, refer again to the Tourism section.

11.4 Policy Implications

The integrated approach is recommended for planning in Hanalei, the following policy implications should be expected for successful implementation of the strategy: [28]

1. The Kaua'i General Plan should be granted earnest attention for the Hanalei area, even going so far as to include a strategic collaborative plan.

2. As an integral part of planning in Hanalei with a holistic perspective in mind, it is imperative for Hanalei and the County government to establish a comprehensive master plan, which ideally should encompass not only physical planning and development, but also components of community empowerment, long term economic base and environmental quality of the entire area.

3. Central to the Integrated Approach are mediation and facilitation in resolving community conflicts, along with increased coordination between government bodies. A strong government role is needed for setting up the pre-condition for the new integrated dynamics among the community in Hanalei.

4. In conjunction with (2) and (3) above, there is an immediate need to identify priority issues for the Hanalei valley. The Hanalei Heritage River HUI has established an action plan. Such an action plan is needed for planning the entire area, including recognizing Hanalei's connectedness with the neighbouring *ahupua'a*.

5. Funding programs and projects is an integral part of planning. For Hanalei, it is even more crucial, as there are many issues that need to be addressed in the shortest time possible. Therefore, it is paramount that political representation be given priority attention.

11.5 Findings and Recommendations

Engaging in the charette and analyzing the two main channels of influence has led us to construct the Integrated Approach Network chart, we were able to determine that a significant key role in achieving success in this process is the County government. In both channels of influence discussed above, we discovered an apparent need for the Kaua'i County government to assume an enhanced role for directing and facilitating development. Central to the Integrated Approach are mediation and facilitation for resolving community conflicts, in addition to increased coordination between government bodies. Moreover, there is a need for the County government to take a stronger, intermediary role to help establish the conditions for a new integrated dynamic between relevant stakeholders.

The role of the County government can take form in a wide array of possibilities. We suggest the following:

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[28] The readers are encouraged to identify a wider range of policy implications not discussed in this report.

1. Initiate a development and/or strategic plan that complement the Kaua'i General Plan.

If this integrated approach is to be implemented for planning in Hanalei, the Kaua'i General Plan should give earnest attention to the Hanalei area. In the current Plan, little mention is given to Hanalei's role in Kaua'i. In fact, it is implicitly presumed that Hanalei is a part of the Princeville resort area. We feel the Valley is important because of its historical significance, its cultural value, and its identity as the "hub" of taro production for all of Hawai'i. Therefore, Hanalei should receive credit for its contribution to Kaua'i County. Updating the Plan to explicitly state Hanalei's virtues will provide the setting for giving a certain sense of priority to Hanalei's development and maintenance.

Although the Kaua'i General Plan as its main policy document directs the County of Kaua'i, it is not readily applicable. In order to interpret the directions within, a development plan specific to Hanalei is recommended as the next step. Considering that *ahupua'a* management in Hanalei has largely been shaped by tensions between stakeholders, a master plan that outlines specific development policies that take into account the integrated interests outlined in the chart is invaluable. In this way, local issues and concerns can be documented and be given proper attention. Linking up the master plan with an area study and assessment of Hanalei, that encompasses the impact of physical planning, community empowerment, diversifying its economic base, and maintaining the environmental quality of the area will be its strength. These issues should be prioritized. Moreover, the master plan accomplishes the collaborative management aims for Hanalei.

The Hanalei Heritage River HUI has already established an action plan. Incorporating the goals behind the action plan situates the HUI in the middle of planning and decision-making, putting the community one step closer to collaborative management.

2. Assume role for facilitation and mediation.

Hanalei is endowed with a unique community-government relationship, which in many instances are not easily resolved. Because of this caveat, the Practicum recognizes the County government and the Hanalei community as being instrumental to playing the role of stewards for the Hanalei *ahupua'a*, and, as stewards, organize a framework for carrying out effective facilitation and mediation. The HUI can take the role of Action Group to manage and plan for collaboration, but the County can provide the training for facilitation and mediation for the community. Funding for such training can also come from the County.

The County's leadership includes, but is not limited to, the four prongs of collaboration with the community.

a) *The betterment of the relationship between the taro farmers and the U.S. Fish and Wildlife.*

The County government can play an active role clarifying the rights and obligations in the issue between the taro farmers and U.S. Fish and Wildlife Services. The Kaua'i County government can reiterate the common goals of both parties, albeit identify entry points for mediation that assists the U.S Fish and Wildlife and taro farmers.

b) *Increased cooperative and/or collaborative works between various research projects.*

We discuss this part in the next section. We would like to stress that this collaboration is in the best interest of the County, itself, as they provide more information and knowledge about the land. As such, it can serve as the basis for future planning.

c) *Initiating community participation in dialogue and resolution process concerning alternative wastewater solutions.*

The Practicum conducted a mini-scale charette exrercise in an attempt to solicit ideas regarding an alternative sewage treatment system. As we found the exercise extremely useful, we also realize that it is the Hanalei community that has more complete information and knowledge about the aims and constraints on the issues, especially regarding the constructed wetland issue. Hence, we recommend that the community engage in such an exercise, as well.

d) *Facilitate and mediate on the issue of flood mitigation.*

As Hanalei is basically a floodplain, it is necessary that the issues pertaining to flooding be addressed appropriately so that the community can obtain a set of solutions, short-term and long-term. However, the fact that a series of solutions has not yet been achieved indicates that the flooding issue must assume priority within the range of issues already confronting the community. We would also suggest that the County initiates or invests in an engineering study, such as an idealized two-dimensional engineering assessment that can complete the understanding of the impacts of berms on Hanalei's flooding situations.

3. Actively engage in and continue the efforts on implementing a tax circuit breaker in order to improve the livability of the area.

As suggested in the Tourism section, the major component for eliciting policies over the tax circuit breaker is active participation from local residents in community meetings. Supplementing this assertion is our belief that a broader vision can materialize from the County government to consider the Hanalei area as a special district for taxation purposes. If Hanalei is to maintain its assignment as an agricultural area based on the County's Comprehensive Zoning Ordinance, while allowing development of tourism-related activities in the spirit of sustainable tourism, it is necessary that a solution be provided for problems that may arise from increases in property value. One alternative angle on this situation is to establish Hanalei as a special district/area for taxation purposes, a strategy that may implement a distinct tax circuit breaker. As a special district, Hanalei can be granted a distinct status that benefits the local residents, albeit have a minimal impact on the county's tax revenue. If such an arrangement can be implemented, it will likely garner a win-win solution for both the County and local residents.

4. Induce Research Collaboration.

Our rationale for this proposition is the potential for developing a holistic, mutual understanding among all stakeholders in Hanalei vis-à-vis coordinating research efforts. This feature of collaboration is imperative to expand stakeholders' understanding of the other's position. Research collaboration should be under the aegis of the *ahupua'a* stewards to ensure that it supports the interests of all Kaua'i residents. In this category of collaboration, we include:

a) *A complementary study bridging biological assessments and anthropological research to learn about the feasibility of the co-existence of taro lo'i and bird impoundments.*

We understand that there have been many research projects proposed or are being proposed to study the area, especially within the Refuge boundaries. Despite the complexity of permitting for such projects, we believe that various research approaches, such as engineering research, biological assessment projects, modern and traditional agricultural management research, and environmental assessments can co-exist based on the realization that each study will richly complement the scope of understanding. We invoke the taro-bird impoundment issue as an example, because little information about the co-existence of taro *lo'i* and bird impoundments has been disseminated, the initiative to squire Dr. Frederickson to conduct a study on wetlands as a viable waterbird habitat is a step ahead. The Practicum members are eager to see the outcome of the research. On the other hand, we have also learned that this issue is multi-dimensional in that it involves the historical relationship between waterbirds and wetlands, specifically taro *lo'i* and waterbirds that go back as far as pre-history. Knowledge of this is obtained from Native Hawaiian legends and "talk story". Supplementing Dr. Frederickson's study with social science research can only augment the community's and the USFWS's understanding of co-existence between the water birds and taro *lo'i.* Beyond this issue, the Practicum group would also hope to see the emergence of a cost-effective watershed management approach in Hanalei, particularly in the Refuge. This may also include initiating a state-wide study on the significance of traditional practices or other traditional environmental knowledge, which can be integrated into the contemporary theories of wetland management.

b) *Promote research between the Kaua'i Visitors Bureau (KVB), County government, and the HUI to study Hanalei's scenic value.*

Considering how attractive Hanalei is, visitors are drawn to the scenery from the Princeville lookout. We suggest that a specific valuation study be conducted on Hanalei's scenery and landscape. Such a study is not uncommon in the field of tourism and economics, yet it requires serious efforts, whether time-wise or resource-wise. From the interview with an expert on valuation methods, Dr. Linda Cox from the University of Hawai'i, we found two feasible ways to conduct a valuation study:

1) Transportation cost approach

This approach correlates the value of a scenery or landscape with travel costs that visitors are willing to spend to visit that spot. This method is quite do-able. However, it will likely reveal significantly different valuation from visitors as opposed to that from the local residents. Also, this model extracts the valuation system based on the current physical set-up that tourists are looking at.

2) Conjoint Analysis approach

This approach solicits information in the form of valuation of different bundles or scenarios. Each scenario is bundled with different or slightly different elements, and respondents are asked to value each. The advantage of this method is that it can be designed to accommodate different physical set-ups. For instance, a scenario that includes a wastewater installation in the middle of the landscape will likely be valued differently as opposed to one that does not. In the long run, it appears that this type of approach will be more suitable to address community concerns and future developments because it injects community values onto a development plan *a propos* scenic value. Nevertheless, regardless of the valuation approach, we believe it is time for Hanalei to be subjected to such study. We believe the information and knowledge about the value of the landscape in, say, the tourism sector, will greatly influence the planning and related policies within that sector.

In addition to the intrinsic importance of coordinating and collaborating research projects and planning approaches, the tangential benefits from such collaborative efforts is the sense of community members accomplish.

Establishing a Master Plan for Hanalei in conjunction with the Kaua'i General Plan is the follow-up we hope to see come out of the research collaboration. The Kaua'i General Plan already provides the general framework for improving upon Hanalei's assets. The Master Plan is distinct, however, in that it will be tailored to address Hanalei's situation.

On a final note, *ahupua'a*-watershed management, at its core, relies on the co-existence and the functional relationship between different institutions. Collaboration is derived from this inter-relationship. Visualizing how the different themes fit together can facilitate collaboration and assist the community to identify communication caveats between institutions. Drawing these links may even support the community in determining weaknesses in their relationship. A model is provided in Appendix C.3 to illustrate this point.

Our Practicum team recognizes the positive, collaborative attempts that have already taken place amongst the stakeholders. We intend this draft report to substantiate Hanalei's assets, albeit illuminate gaps that have not been extensively tackled from previous collaborative efforts.

Chapter 12

Conclusion

The prospect for strengthening network links between stakeholders and participants looks bright for Hanalei because the ingredients are all present:

1. The HUI, a community action group
2. Committed community members
3. A common interest in conserving Hanalei's *ahupua'a*
4. People who care about Hanalei

Moreover, there is very little doubt about the common ground; sustaining the *ahupua'a's* scenic beauty and preserving its "sense of place" embodied in taro farming, historical traditions, and small-scale lifestyle are foremost for community members and stakeholders. Improving collaboration between prominent stakeholders can help to achieve these goals. But, as is reiterated throughout the report, the obstacle confronting the community is ironing out specific differences that appear to have placed a moribund on continued productive relations. Without addressing these divergences, collaboration can not occur to its fullest capacity.

Given the variances in stakeholders' purpose and philosophies, there is obviously a need to tie together those philosophies that complement, while discarding those that will only separate the stakeholders from each other. Throughout this report, the Practicum team has offered recommendations for doing just this, namely steps to build and strengthen collaboration. It may even be beneficial for the community to address each issue separately.

Fundamentally, the objectives of the EPA's Watershed Protection Approach should be invoked to illustrate the parallel between *ahupua'a* and watershed management. The traditional and scientific need not be polarized. The Hanalei community leaders should also capitalize on the EPA's shift towards integrated management, which is inclusive of Indigenous/Tribal ideologies into watershed management planning. Herein is the entry point for the incorporating cultural and/or community context into federal policy. Doing so can only strengthen the case for a complementary relationship between the Traditional and the Scientific. Once this bridge is established, the community can then move forward to begin tackling conflict resolution. As suggested in Chapter 10, successful conflict resolution would entail:

1. An Action Group
2. A trained facilitator
3. A trained mediator
4. Conflict survey

The HUI can serve as Action Group by managing the process of collaboration, comprehensively. In this role, it can assess the community's capacity for facilitation and mediation. The HUI can also administer a stakeholder survey that will help to identify roots of conflict and major differences. Based on the opinions stated in the survey, it can develop a plan to guide the conflict resolution session to ultimately support the path of collaboration.

The long-term goals of the community would be drawing up policy plans specific to Hanalei that is guided by the Kaua'i General Plan 2000, albeit moderated to meet the needs of Hanalei. Policy plans should encompass guidelines for integrated research to integrated management plans for the *ahupua'a*. The Practicum team believes the rationale behind this approach is its potential to move the community towards true collaboration.

Section V

Appendices & References

APPENDIX A TABLES & CHARTS

Appendix A.1. Raw Demographic Data for Hanalei Town

Table 1. Gender Comparison of Population

	Male	Female	
Total	238	240	478
Percentage	49.8	50.2	100

Table 2. Age Comparison of Population

Age	Number	Percentage
Under 5 years	34	7.1
5 to 9	32	6.7
10 to 14	27	5.6
15-19	36	7.5
20-24	21	4.4
25-34	57	11.9
35-44	72	15.1
45-54	97	20.3
55-59	27	5.6
60-64	20	4.2
65-74	29	6.1
75-84	21	4.4
85 years and over	5	1
Median age	40.2	X

Table 3. Comparison of Population by Household

Household Size	Number	Percentage
Total Households	193	100
1-person	60	31.1
2-person	62	32.1
3-person	27	14
4-person	24	12.4
5-person	11	5.7
6-person	5	2.6
7 or more	4	2.1

Table 4. Comparison of Household Types

Housing Tenure	Number	Percentage
Occupied Housing Units	193	100
Owner-occupied Housing Units	102	52.8
Renter-occupied Housing Units	91	47.2

Table 5. Comparing Household Race Composition

Race of Householder	Number	Percentage
Occupied Housing Units	193	100
White	124	87.6
Asian	40	20.7
Native Hawaiian & Pacific Islander	5	2.6
Hispanic or Latina	6	3.1
One Race	169	87.6
Two or more races	24	12.4

Table 6. Comparison of Households over 65 to Rest of Population

Percentage of Persons 65 Years and Over to Total Population		In Numbers
Under 65	84.73	405
65 Years and Over	15.27	73

Table 7: Income Differentials by Income Level

Income in 2000	
Family and Non-family Households	**181**
<10,000	**27**
$10,000 to $14,999	**13**
$15,000 to $24,999	**25**
$25,000 to $34,999	**26**
$35,000 to $49,999	**18**
$50,000 to $74,000	**37**
$75,000 to $99,999	**7**
$100,000 to $149,999	**16**
$150,000 or more	**12**
Median Household income (dollars)	**34,375**

Appendix A.2 Lists of Flora and Fauna

Table 1
List of Aquatic Fauna in Hanalei River and the Kaanaawi Tributary
Island of Kauai

Adapted from Timbol, 1986

Scientific Name	Local Name	Origin[1]	Listing[2]
Annelids (worms)			
Hirudinea	Leech	unknown	none
Oligochaeta	earthworm	unknown	none
Insects			
Diptera:			
Chiromonidae	Midge larvae	endemic	none
Ephydridae	brinefly larvae	endemic	none
Tipulidae	cranefly larvae	endemic	none
Odonata:			
Megalagrion heterogamius	damselfly naiad	endemic	none
Trichoptera:			
Cheumatopsyche analis	caddisfly larvae	alien	none
Oxyethira maya	microcaddisfly larvae	alien	none
Molluscs (snails)			
Erinna aulacospira	pond snail	endemic	none
Neritina granosa[3]	Hihiwai	endemic	depleted in Oahu
Pomacea canaliculata	Apple snail	alien	none
Bivalves (clams)			
Corbicula fluminea	Asiatic clam	alien	none
Crustaceans (shrimp & Prawn)			
Atya bisulcata	Opae kala'ole	endemic	none
Macrobrachium grandimanus[3]	Opae oeha'a	endemic	none
Macrobrachium lar[3]	Tahitian prawn	alien	none
Fish			
Awaous guamensis/ stamineus[3]	O'opu nakea	indigenous	special concern
Eleotris sandwicensis	O'opu akupa or okuhe	endemic	none
Gambusia affinis	mosquitofish	alien	none
Kuhlia sanwicensis[3]	Aholehole	endemic	none
Lentipes concolor	O'opu hi'ukole/ alamo 'o	endemic	special concern
Mugil cephalus[3]	Ama'ama, mullet	indigenous	none
Sarotherodon mossambica[3]	Tilapia	alien	none
Sicyopterous stimpsoni	O'opu nopili	endemic	special concern
Stenogobius hawaiiensis	O'opu naniha	endemic	none
Xiphophorus helleri	swordtail	alien	none
Amphibians			
Rana catesbeiana	bullfrog tadpoles	alien	none
Rana rugosa	greenfrog tadpoles	alien	none

1 Terms used in this column: Endemic= occurring naturally in Hawaii only; indigenous= occurring naturally in Hawaii and elsewhere; alien= brought to Hawaii either intentionally or accidentally by man.
2 Considered as endangered or threatened in official register or scientific publications.
3 Has some economic value.

Table 2
List of Terrestrial Fauna Found Along Hanalei River and the Hanalei Valley
Island of Kauai
Adapted from Berger, 1986

Scientific Name	Local Name	Origin[1]	Listing[2]
Amphibians			
Rana catesbeiana	American bullfrog	alien	none
Rana rugosa	Wrinkled frog	alien	none
Bufo marinus	Giant neotropical toad	alien	none
Reptiles			
Typhlina bramina	Blind snake	alien	none
Scincidae (8 species)	Skinks and Geckos	indigenous	none
Birds			
Anas wyvilliana	Hawaiian duck, Koloa	endemic	endangered
Gallinula chloropus sandvicensis	Hawaiian gallinule, 'Alae 'Ula	endemic	endangered
Fulica Americana alai	Hawaiian coot, 'Alae Ke'oke'o	endemic	endangered
Himantopus mexicanus knudensi	Hawaiian stilt, Ae'*o*	endemic	endangered
Asio flammeus sanwichensis	Hawaiian owl, Pueo	endemic	none
Branta sandvicensis	Hawaiian goose, Nene	endemic	endangered
Drepanididae (honeycreepers)			
Hemignathus virens stejnegeri	Amakihi	endemic	none
Himatione sanguinea	Apapane	endemic	none
Heteroscelus incanus	Wandering tattler	resident	
Pluvialis dominica fulva	Lesser or Pacific golden plover	resident	
Bubulcus ibis	Cattle egret	alien	none
Nycticorax nycticorax	Black-crowned night heron, 'Auku'u	resident	none
Phasianus colchicus	Ring-necked pheasant	alien	none
Streptophelia chinensis	Lace-necked or spotted dove	alien	none
Geopelia striata	Barred dove	alien	none
Tyto alba pratincola	Barn owl	alien	none
Garrulax canorus	Melodious laughing thrush	alien	none
Leiothrix lutea	Red-billed leiothrix	alien	none
Copychus malabaricus	Shama thrush	alien	none
Zosterops j. japonicus	Japanese white-eye	alien	none
Acridotheres tristis	Common Indian myna	alien	none
Longchura punctulata	Spotted munia or ricebird	alien	none
Passer domesticus	House sparrow	alien	none
Cardinalis cardinalis	Cardinal	alien	none
Carpodacus mexicanus frontalis	House finch	alien	none
Mammals			
Lasiurus cinereus semotus	Hawaiian bat	endemic	endangered
Bos spp.	Cattle	alien	none
Capra hircus	Goat	alien	none
Sus scrofa	Pig	alien	none
Mus musculus	House mouse	alien	none
Rattus rattus	Roof rat	alien	none
Rattus elegans	Polynesian rat	alien	none
Rattus norvegicus	Norway rat	alien	none
Felis catus	Cat	alien	none
Canis familiaris	dog	alien	none

1 Terms used in this column: Endemic (occurring naturally in Hawai'i only); indigenous (occurring naturally in Hawaii and elsewhere); alien (brought to Hawaii either intentionally or accidentally by man).
2 Considered as endangered or threatened in official register or scientific publications.

Table 3
List of vegetation found along Hanalei River and the Hanalei Valley
Island of Kauai

Adapted from Char, 1986

Scientific Name	Local Name
Streamside vegetation	
Brachiaria mutica	Californiagrass
Digitaria ciliaris	Hairy crabgrass
Christella dentate	Downy wood fern
Paspalum conjugatum	Hilo grass
Commelina diffusa	Honohono
Coix lachrymal-jobi	Job's tears
Cyclosorus interruptus	Neke (fern)
Ludwigia octivalvis	Primrose willow, Kamole
Cuphea carthagenensis	Puakamoli
Drymaria cordata	Drymaria
Cryptotaenia Canadensis	Honeywort
Pycreus polystachos	Bunchy flat sedge
Colocasia esculenta	Taro
Sacciolepis indica	Glenwoodgrass
Centella asiatica	Pohekula
Hibiscus tiliaceus	Hau
Other vegetation found in the valley	
Mangifera indica	Mango
Gardenia augusta	Gardenia
Hibiscus rosa-sinensis	Red hibiscus
Codiaeum variegatum	Croton
Coffea Arabica	Coffee
Bambusa vulgaris	Bamboo
Blechnum occidentale	Swamp fern
Christella parasitica	Wood fern
Oplismenus hirtellus	Basketgrass
Athriopsis japonica	(Fern)
Syzygium jambos	Roseapple
Eucalyptus robusta	Eucalyptus
Casuarina equistifolia	Ironwood
Adenanthera pavonica	Wiliwili
Melaleuca quinquenerva	Paperbark
Psidium cattleianum	Strawberry guava
Rhodomyrtus tomentosa	Downy myrtle
Dicranopteris linearis	False staghorn fern, Uluhe
Syzygium cumini	Java plum
Nephrolepis multiflora	Sword fern
Hedychium flavescens	Yellow ginger
Dioscorea bulbifera	Bitter yam, pi'oi
Dioscorea pentaphylla	Bitter yam, pi'ia
Microlepia strigosa	Palapalai
Metrosideros collina spp. Polymorpha	'Ohi'a
Pleopeltis thunbergiana	Pakahakaha fern
Psidium guajava	Guava
Diplazium sandwichianum	Ho'i'o
Zingiber zerumbet	Shampoo ginger, 'awapuhi kua hiwi
Cont'd Scientific Name	**Local Name**

Aleurites moluccana	Kukui
Caesalpinia sepiaria	Wait-a-bit
Lantana camara	Lantana
Musa sp.	Banana
Schizostachium glaucifolium	Ohe
Syzygium malaccense	Mountain apple, 'ohi'aai
Piper methysticum	'awa
Cordyline terminalis	Ti
Pisonia umbellifera	Papala-kepau
Psychotria kaduana	Kopiko
Antidesma platyphyllum	Hame
Ilex anomala	Kawa'u
Syzygium sanwicensis	'Ohia'a-ha
Gouldia terminalis	Manono
Pipturis helleri, P. kauaiensis	Mamaki
Perrottetia sanwicensis	Olomea
Freycinetia arborea	'Ie'ie
Elaphoglossum alatum, E. crassifolium, E. hirtum	'Ekaha fern
Adenophorus tamariscinus	Wahine-noho-mauna
Adenophorus pinnatifidus	Graceful kihifern
Grammitis tenella	Kolokolo
Asplenium nidus	Bird's nest fern, 'Ekaha
Kyllingia brevifolia	Kyllingia
Ipomoea alba	White-flowered koali-pehu vine
Pandanus odoratissimus	Hala
Acacia koa	Koa
Andropogon virginicus	Broomsedge

Appendix A.3
Table of Nutrients

Examples of toxic conditions caused by excessive fertilizations include: soil salinity, which will reduce plants' nutrient uptake ability; contamination of groundwater, streams, and coastal areas; delayed harvest or corms that don't form at all due to excessive leaf growth from too much nitrogen; and root burn, which result to root rot (CTAHR, 1997). Salinity could harm taro corms in the fact that taro are best grown in soil with pH 6-6.8, which is moderately acidic, and such acidity helps prevent root rot disease. Table 8 summarizes effects of over and und application of fertilizers in the growth of taro.

Table 1: Roles of Nutrients in the Growth of Taro

Nutrient	Role	Over Application	Under Application
Nitrogen	• Keep the foliage healthy and the leaves green • Promote stem and leaf growth	• Foliage can burn • Leaves can become soft • Corm may become soft • Corm and leaf growth may be impaired	• Stunted growth • Discoloration of leaves
Phosphorus	• Promotes root development	• Can lead to iron deficiency	• May cause scorching of leaf edges, early loss of leaves, small leaves, stunted growth
Potassium	• Protects the plant from fungal disease • Help build proteins • Promote cell division and growth • Stimulates starch production to produce solid corms	• Can cause imbalance in relation to calcium and magnesium levels in the plant	• Leaf edges turn yellow, then brown • Retarded growth • Weakened stems • Small corms

Source: CTAHR, 1997

Appendix A. 4
Impact of Excessive Nitrogen and Phosphorous Levels in Water Bodies

1. Negative Impacts of Excessive Nitrogen Level on Human and Water Bodies

Excessive nitrogen reduces crop quality, increase weed competition effects, and increase the crop's chance to be attacked by plant disease and insects. The effects of excess levels of nitrate $N(NO_3^-)$ is of major concern, because it has greater potential harm on human and ecosystems (CTAHR, 2000). Nitrate contamination cause reduction in blood hemoglobin level in infants and young children. Nitrate is considered a contaminant at a level above 10 ppm (10 mg in 1 liter) in national standard. The effect of nitrogen enrichment on water body will stimulate excessive growth of disastrous aquatic organisms. Algae responds to the increased N and P in water bodies quickly by rapidly increase their population causing algal blooms, and exhaust the oxygen supply in the water. Other organisms will suffer from the lack of oxygen. Nitrate is the most common form of nitrogen, and highly soluble in soil solution. Thus, it can easily permeate into ground water, which is a very important source of drinking water in Hawaii.

2. Negative Impacts of Excessive Phosphorus Level on Human and Water Bodies

Acceptable level of phosphorus is 30-50 parts per million extractable parts. However, millions of extractable parts of P are found in Hawaii farms (J. Silva, personal communication, 2001). Phosphorus does not have direct threat on human health, but usually a concern on contaminating surface water bodies. Phosphorus is immobile, and attached itself to soil. Phosphorus can be carried out to water body by soil erosion and movement dissolving in surface runoff or carried on soil particles that erode from crop fields and washed into water bodies. Phosphorus has similar impact on aquatic organisms as nitrates.

APPENDIX A.5
Flood Events in Hanalei

FEMA and ACOE summarize the flood-damage reports of Hanalei watershed from the first recording in 1877 in Flood Insurance Study, Kauai County: Hawaii. Vol 1 of 2, October 2002 and Main Report: Flood Plain Information Study Hanalei, Kauai, Hawaii, December 1964 as the following:

May 16, 1877
Violent storm and thunderstorm occurred, with water rising to 15 feet.

July 27, 1985
The highest freshet ever experienced in Hanalei: four feet higher than that of 1877.

August 15, 1905
Exceptionally heavy rains washed out small rice patches.

January 16, 1921
The greatest daily rain of 24.4 inches was reported at the power house near Hanalei.

April 1,1948
Flooding caused by tsunami; maximum wave heights along the shoreline ranged 9 to 14 feet.

January 23, 1952
Ching Ma Leong Store flooded up to 10 feet; Kuhio Highway 3 to 4 feet.

November 11 & 12, 1955
Worst recorded flood.

January 26, 1956
Hanalei River overflowed and flooded the highway.

March 9, 1957
Flooding caused by tsunami; maximum wave heights ranged from 17 to 19 feet.

April 17,1963
The Hanalei River rose to the highest level.

December 1- 4, 1969
Flooding caused by large storm centered off-shore; maximum wave height was 25 feet.

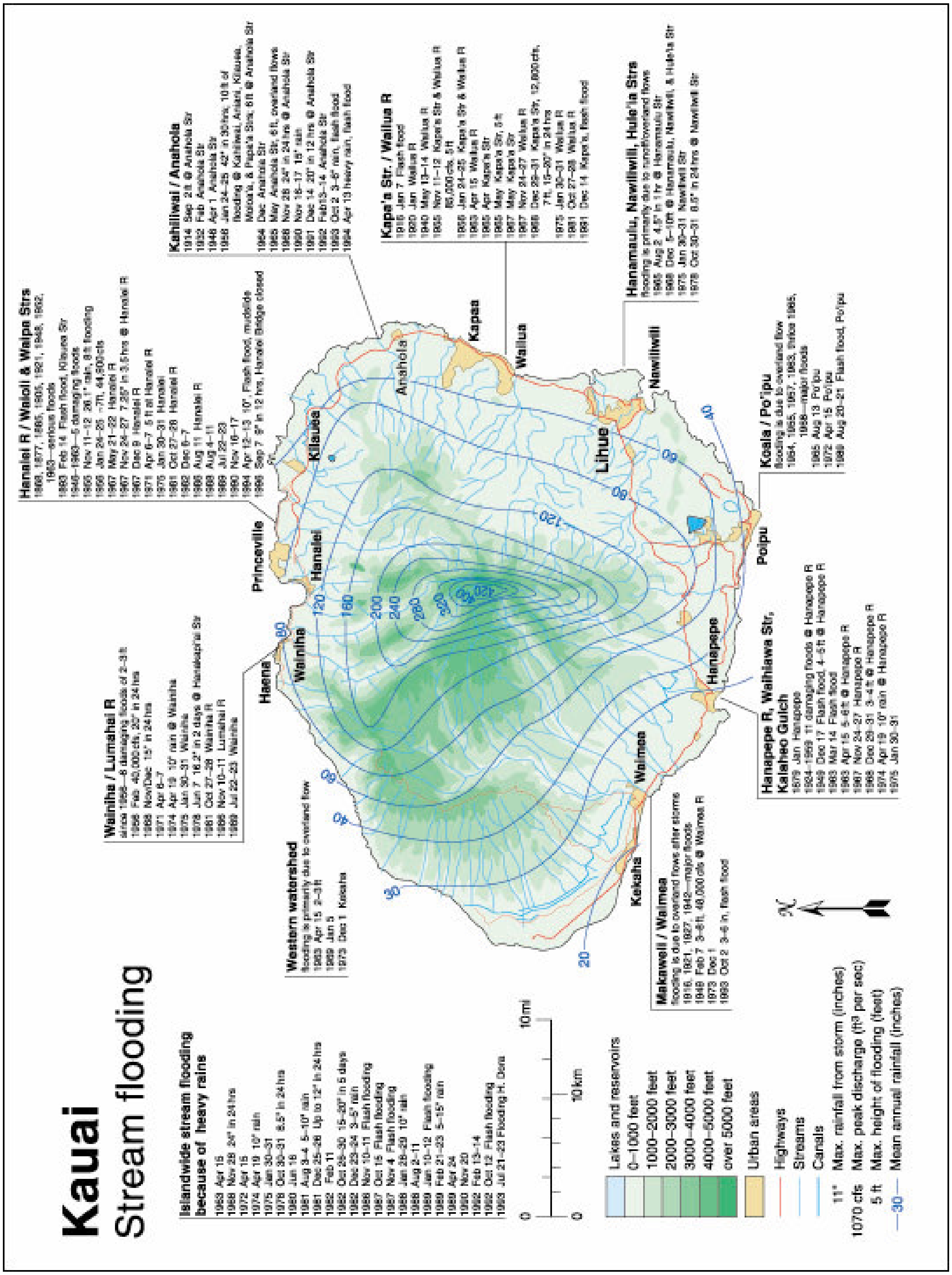
April 19, 1974
Hanalei River overflowed and flooded taro lands and Kuhio highway (3 feet of water).

1992
Hurricane Iniki

APPENDIX A.6

Stream Flooding in Hawai'i

http://www.mothernature-hawaii.com/images/k_flood.jpg



APPENDIX A. 7

Eight Step Planning Process for Floodplain/Wetland Management

http://www.fema.gov/regions/v/env/env6_3.shtm and *http://www.fema.gov/regions/viii/env/8steps.shtm*

This provides a summary of the Eight Step Decision-Making Process for EO 11988 (Flood plain Management) and EO 11990 (Wetland Protection)

Step 1 Determining if the proposed project is located in a wetland and/or the 100 year floodplain (500-year floodplain for critical actions), or if it may affect or be affected by a wetland and/or floodplain.

Step 2 Notify the public as soon as possible of the intent to fund a project in a wetland and/or floodplain, and to involve all affected and interested individuals and groups in the decision-making process.

Step 3 Identify and evaluate practicable alternatives to locating the project in a wetland and/or floodplain (including alternative sites, actions, and the "no action" option). If a practicable alternative exists outside the wetland and/or floodplain, FEMA must locate the project at the alternative site.

Step 4 Identify all potential direct or indirect impacts from the occupancy or modification of wetlands and/or floodplains, and potential direct and indirect support of wetland and/or floodplain development that could result.

Step 5 Minimize potential adverse impacts and support to or within wetlands and/or floodplains to be identified under Step 4, restore and preserve the natural and beneficial values served by floodplains, and preserve and enhance the natural and beneficial values served by wetlands.

Step 6 Reevaluate project to determine if: 1) it is still practicable given exposure to flood hazards, increased hazards to others, and damage to wetland and/or floodplain values; and 2) if alternatives preliminary rejected in Step 3 are practicable given the information gained in Steps 4 and 5. FEMA will not approve actions in a wetland and/or floodplain unless there is no practicable alternative.

Step 7 Prepare and publicize a finding and explanation of any final decision that the wetland and/or floodplain is the only practicable alternative.

Step 8 Review project implementation and post-implementation stages to ensure that the EO requirements are fully met. Oversight responsibility should be integrated into existing processes.

FEMA EA's and EIS's of projects effecting wetlands and/or floodplains, with initial and final public notices (steps 2 and 7 above), will meet most of the EO 8-Step Process document requirements. We must provide full public disclosure to enable the public to adequately influence the outcome of decisions for projects affecting wetlands and/or floodplains.

Initial public notice (step 2) should be published before major project site identification and analysis. An EIS NOI can serve this purpose. The type, placement, and length of comment period for both the initial and final notice will depend upon: 1) the project scale; 2) potential for controversy; 3) degree of public need; 4) number of affected agencies and individuals, and 5) potential wetland and/or floodplain impacts.

The initial public comment period should have at least 10 days or longer if necessary. The initial notice should include:

1. Description of the project and its purpose, and a statement of the intent to approve a project affecting or affected by a wetland and/or floodplain;
2. Description of the type, extent and degree of hazard, and of the wetland and/or floodplain values;
3. A project area map with appropriate scale, or instructions on where to obtain or inspect a map; and
4. Identification of the official or organization that is responsible for the project, and that which can provide further information.

The final public comment period should have at least 15 days. FEMA must wait until the end of the period before taking any action on the project. The final notice should include:

1. A statement of why the proposed action must be located in an area affecting or affected by a wetland and/or floodplain;
2. Description of all significant facts considered in making the determination;
3. A list of the alternatives considered;
4. A statement of whether the action complies with applicable State and local floodplain protection standards;
5. Description of how the project will affect or be affected by the wetland and/or floodplain, and how impact mitigation is to be achieved;
6. A project area map with appropriate scale, or instructions on where to obtain or inspect a map; and
7. Identification of the official or organization that is responsible for project implementation and monitoring, and that can provide further information

Appendix A. 8

Table of Employment Diversity in Hanalei, 1914, 1922, 1930-31

(Hanalei Yesterday, 1000 Friends of Kaua'i, Hanalei, Kaua'i, 1997)

THIS CHART COMPARES INFORMATION found in the telephone directories for 1914, 1922 and 1930–31. The decline in the number of Chinese rice planting companies and ultimately in Chinese stores can be observed. The high number of Kauai Electric workers in the area in the 1922 directory may correlate to the construction between 1908 and 1928 of the Wainiha Power Plant and transmission lines over the mountains to Hanapepe Valley. As seems to have been a practice of Republican party patronage elsewhere in Hawai'i during the period, Hawaiians were the predominant employees in the Hanalei area County Road Department maintaining the new Belt Road.

Occupation	1914	1922	1930–31
RICE PLANTING COMPANIES (or individuals)	12 (Chinese companies)	4 Chinese—3 (Man Sing, See Tai Wai, and Lin Sing Wai) Japanese—1 (Okazaki)	3 Chinese—1 (See Tai Wai) Japanese—2 (Harada, Haraguchi)
MERCHANTS and skilled labor	13 (includes 8 stores, etc. 2 auto livery, 1 carpenter, 1 pool hall, 1 tailor)	12 includes 8 stores 1 barber, 1 insurance agent, 2 auto operators	11 (includes 7 stores 1 service station, 1 restaurant, 1 barber, 1 insurance, 1 mechanic)
Chinese Proprietors Japanese Proprietors	10 3	5 3	4 3
FARMING OR HOMESTEAD	14 (Na Pali Coffee, 3 Taro, 10 Hawaiians—crop not stated)	7 (6 Homesteaders—Hawaiian)	1 (Homesteader—Hawaiian)
COWBOY/ RANCHER	Lists only ranch owner and ranch manager. (2)	8	6
FISHERMAN	2 (Both Hawaiian)	2	2 (Both Japanese)
LAWYER/ DOCTOR	1 lawyer (Hawaiian)		1 doctor
TEACHERS	4	6	10
MINISTERS	2	3	2
GOVERNMENT	7 (includes 1 supervisor, 1 police/jailer, 2 police, 1 representative)	43 (includes 2 police, 1 sheriff, 1 tax assessor and 39 Hanalei and Wainiha road department laborers)	26 (includes 1 representative, 1 supervisor, 1 deputy sheriff, 1 police, 1 tax assessor/collector, 1 district magistrate, and 19 road department laborers, including 1 carpenter, 1 foreman and 1 luna)
KAUAI ELECTRIC	0	14	0

Appendix A. 9

Polk-Husted Directory for Hanalei Residents, 1914

Polk-Husted Directory of Honolulu and the Territory of Hawaii, 1914

Alfred Menefoglio, *Supervisor Hanalei District*
Wm Aarona, *police & jailer*
Ah Lo, *rice planter*
Ah San & Co.
Au Ching, *manager T.S. See Wo*
Au Hoy, General Merchandise & Auto Livery
H. Birkmyre
Chang Bo Leong, *manager Man Sing Co.*
Ching Young, *manager Ching Young Co, Gen'l Merchandise*
Chock Chin, *general store*
Chock Lung, *gen'l merchandise, clothing, hats, shoes, groceries*
Chong Hing, *gen'l mer, groceries, dry goods, men's & ladies furnishings & confectionery*
Chong Sing Co, *rice planter*
Chong Wai C. Co.
Cliffe, Mrs. S.A., *principal Hanalei School*
Cliffe, Thomas, *carpenter*
Deverill, Florence K., *teacher Hanalei School*
Deverill, Sarah B. *(widow W.E.H.) Postmaster, Notary, prop. Hanalei Hotel & Agent*
Interisland Steam Navigation Co.
Hanalei Post Office, Mrs. S.B. Deverill, *Postmaster*
Ho Henry, *Automobile Livery, Prompt & Careful service, Reasonable Rates*
Hookano, *fisherman*
Hop Sing, *general store*
Huddy, Joseph L., *lieutenant police*
Huddy, Manoa
Huddy, Rev Wm, *pastor Kilauea Native Church & district magistrate*
Kaakau, Puhi
Kahai, D.
Mahanaumaikai, Meleana, *(widow Kepoluna)*
Kaheleiki, J.N.
Kaheleiki, Noa
Kaiawe, S.
Kalani, Wm.
Kamoa, S.W.K., *farmer*
Kaneole, Samuel U., *farmer*
Katayama, Y., *cook Mrs. S.B. Deverill*
Kauhaahaa, E.
Kaui, K.K., *farmer*
Kaumealani
Kelau, Silva, *taro planter Kalalau*
Keolewa, J.R., *farmer*
Kuapuhi, J.E., *farmer*
Lima, John, *fisherman*
Long Hoy Co, *rice planters*
Lota, James K., *representative Kauai*
MacKenzie, Charles B., *Haena*
MacKenzie, Mrs. Lani, *teacher Haena School*
Mahilahila, Rev. *pastor Hanalei Native Church*
Maka
Maluna, Soloman, *taro planter*
Man Sing Co, Chang Bo Leong, *manager, rice mill*
Matsumoto, K., *barber & automobile livery*
Miyasaki, F., *pool parlor*
Nakatsuka, I., *general store*
Napali Coffee Ranch, *coffee planters Napali*
Pa, *taro planter, Haena*
Pauole, Robert P., *lawyer*
Princeville Plantation Co, Ltd., *Livestock & Landowners, A.S. Wilcox, Pres., W.F. Sanborn, Manager*
Puulei, Mahi, *police*
Riedel, Frank
Riedel, Meta, *teacher Hanalei School*
Sanborn, Walter F., *manager Princeville Plantation Co.*
See Tai Wai Co. *rice planters & mill*
Sing Fat Wai Co. *rice planters Lumahai*
Sing Yick Co., *rice planters*
Soy Sung Wai Co., *rice planters*
Tai Kan, *general store*
Tai Sing Wai, *Yee On Sing manager, rice planters*
Tam Koi, *tailor*
Werner, Wm., *Deputy Sheriff & Notary Public*
Yee On Sing, *manager Tai Sing Wai*
Young, Sing Wai Co., *rice planters*
Young, Yuen, *rice planter Waipa*

Source: Hanalei Yesterday, 1000 Friends of Kaua'i, Hanalei, Kaua'i: (1997).

Appendix A. 10
Listing of Land Commission Awards after the Great Mahele (1848)

Land Commission Awards			
Awardee	**L.C.A**	**Location**	**Area**
A.B.C.F.M	387	Hanalei	34.20 acres
Dudoit, Jules	27	Hanalei	Gov't. (Cond.Lease)
Hanaimoa	8125	Hanalei	1.00 Ac 3 roods 14 rods
Iikuwa	8224	Hanalei	1.00 Ac 2 roods 12 rods
Kahanuala	7642	Hanalei	1 rood 24 rods
Kahilina	4080	Hanalei	1.00 Ac. 27 rods
Kahio	7671	Hanalei	77 rods
Kaialaweikeau	8521/9663	Hanalei	59 rods
Kalakala	9078/4073	Hanalei	2 Acs 37 rods
Kalawakea	4081	Hanalei	1 rood
Kamakaiwa	4076	Hanalei	2 Acs 2 roods 5 rods
Kamakaulii	9147	Hanalei	1 rood 25 rods
Kealaiki	4083/9137	Hanalei	1 Ac 3 roods 35 rods
Kellett, John	1027	Hanalei	1 Ac 6 rods
Koa	9279	Hanalei	1 Ac 2 roods 31 rods
Kuapuka	9284	Hanalei	2 roods 38 rods
Lua	9956	Hanalei	.75 acres
Mahuahua	3664	Hanalei	1 rood
Makole	10081/3663	Hanalei	1.00 Ac 15 rods
Naiwai and Punonea	10691	Hanalei	2.00 Acs 12 rods
Nainoakua	10328	Hanalei	1.00 Ac 1 rood 7 rods
Nunu	10325	Hanalei	4.0 Acs 38 rods
Namauu, O.	2660/10313	Hanalei	10.0 Acs 33 rods
Paaiki	10648/3816	Hanalei	2.0 Acs 15 rods
Papa	10594	Hanalei	3 roods 15 rods
Puamana	10954-B	Hanalei	2.0 Acs 12 rods
Wahineiki	10955	Hanalei	2.0 Acs 2 roods 19 rods
Waiahu	10954	Hanalei	1 rood 13 rods

Appendix A.11
Sample Table for Spotting Endangered Birds on Taro *Lo'i*

YEARLY TIMELINE: COOTS and TARO

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
COOTS												
TARO												

YEARLY TIMELINE: STILTS and TARO

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
STILTS												
TARO												

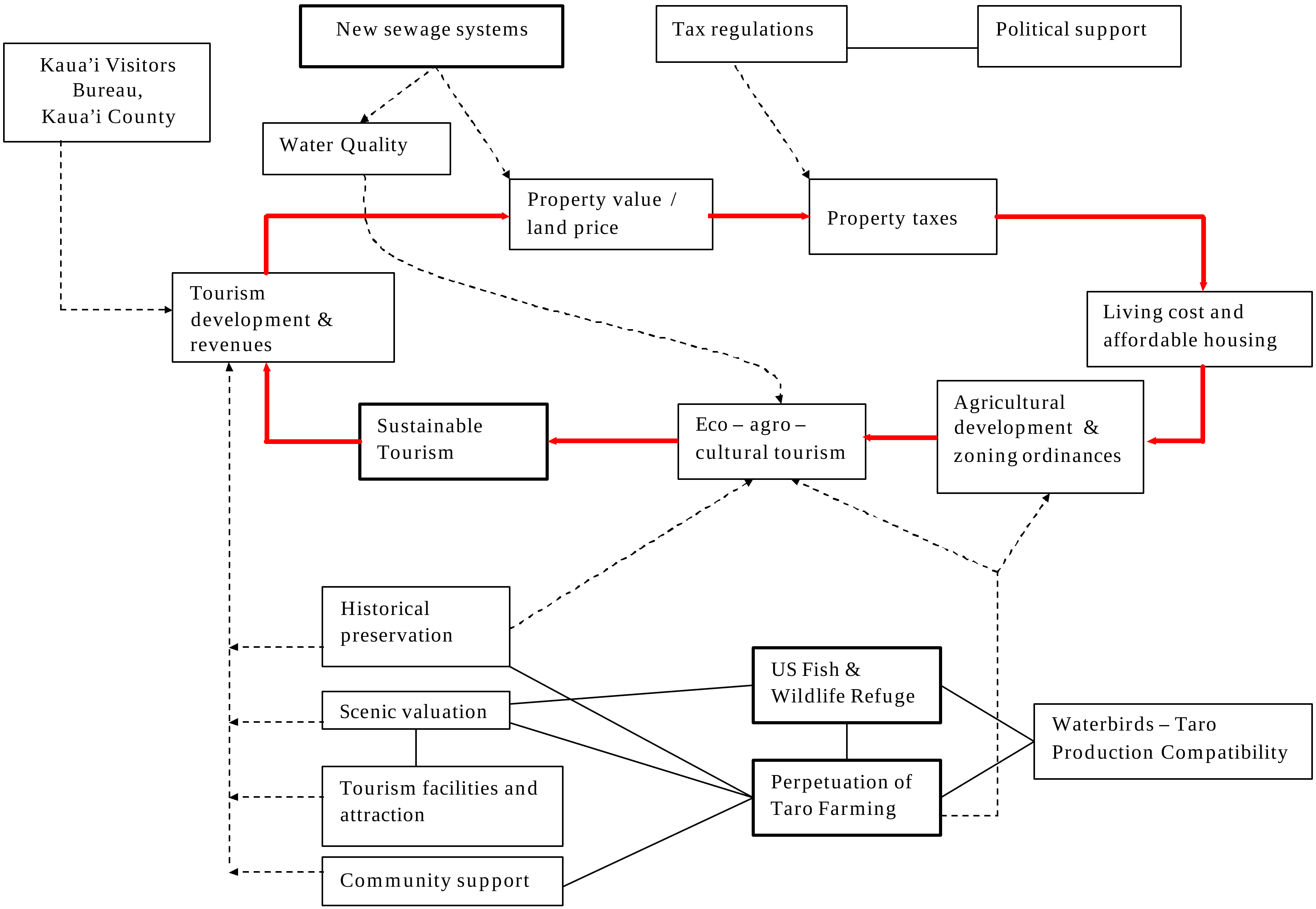
YEARLY TIMELINE: KOLOA and TARO

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
KOLOA												
TARO												

YEARLY TIMELINE: MOORHEN and TARO

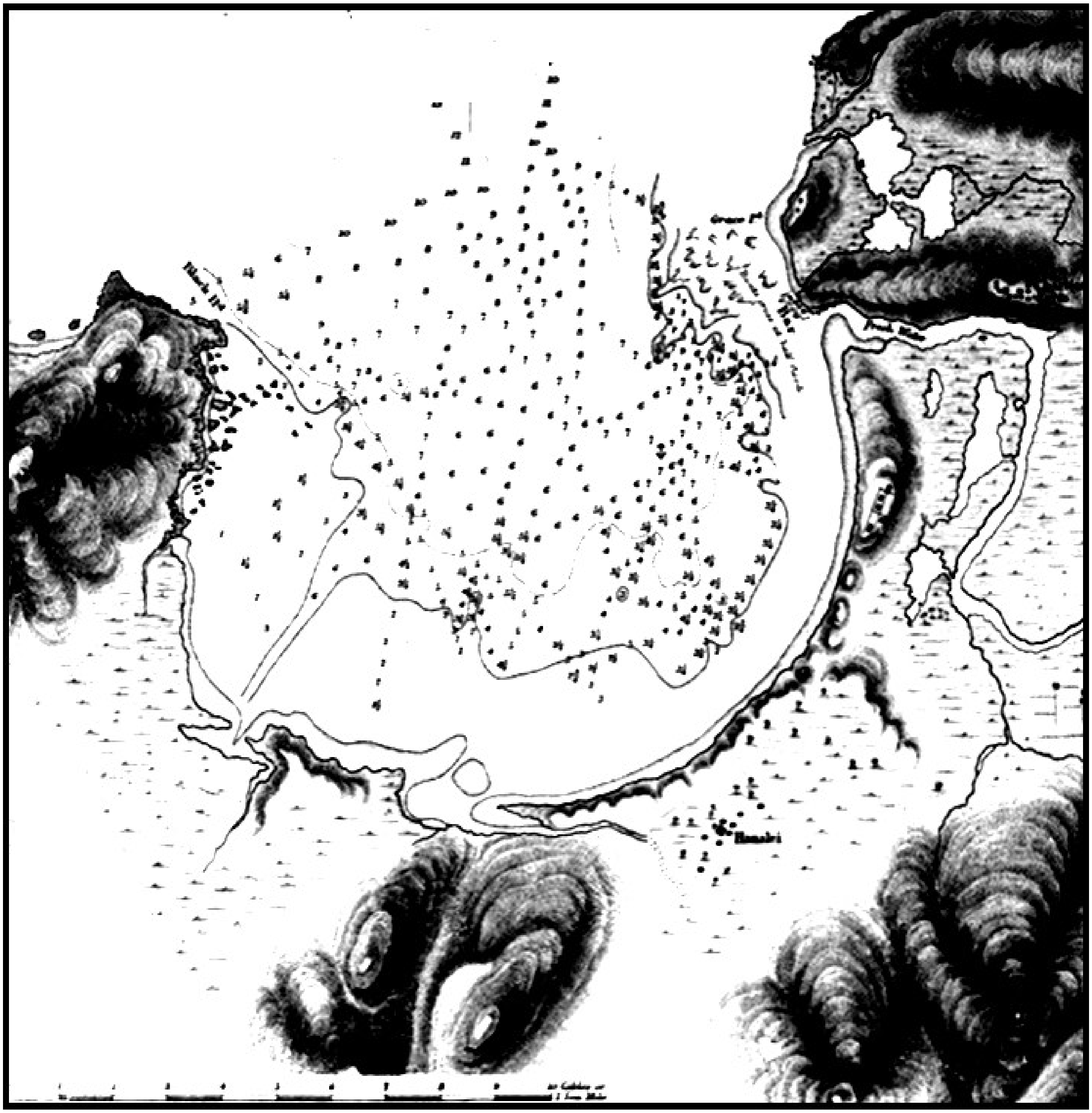
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
MOORHEN												
TARO												

Appendix A.12
Ahupua'a Management Institutional Framework



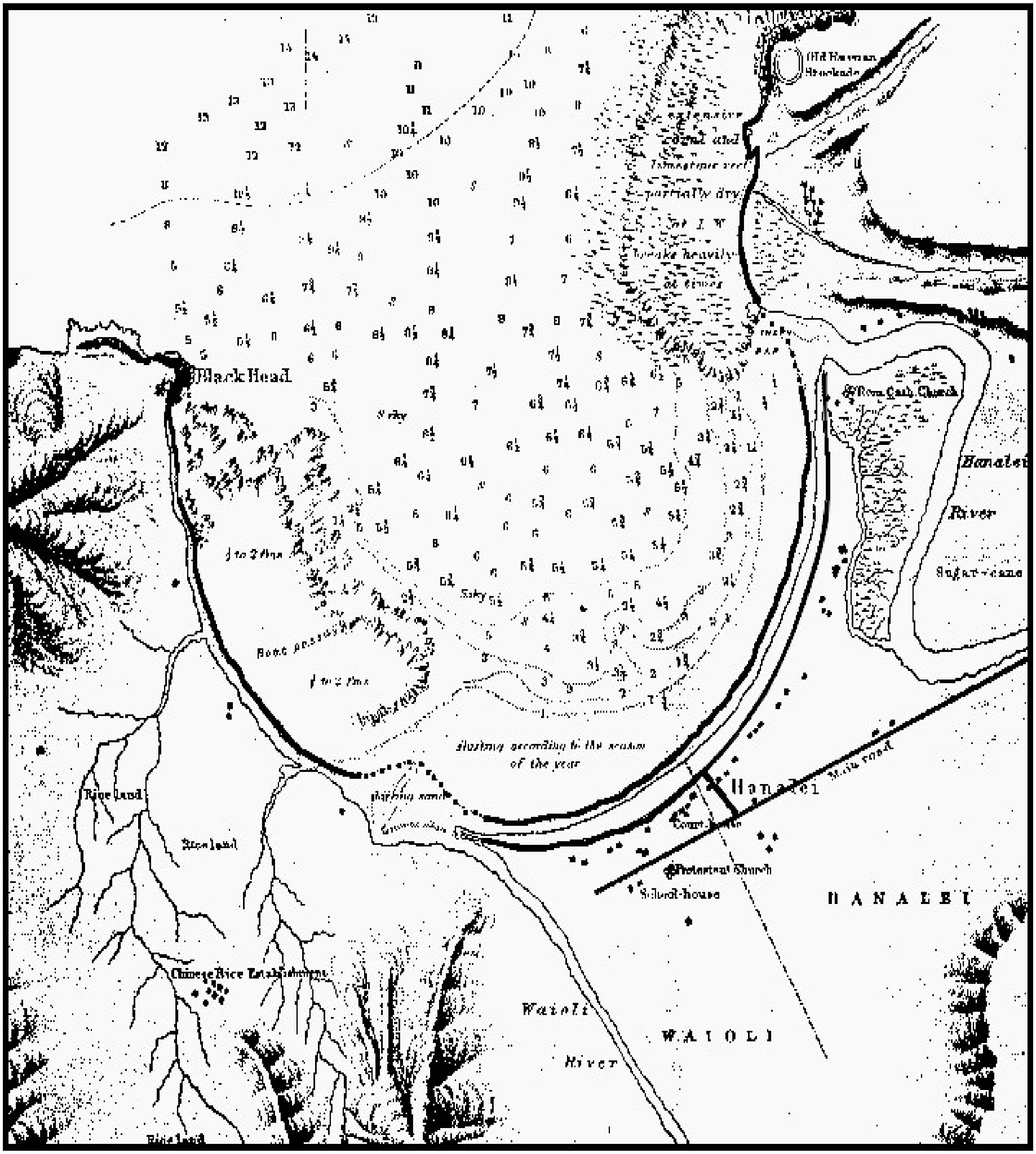
APPENDIX B MAPS

MAP B. 1. Hanalei in 1838



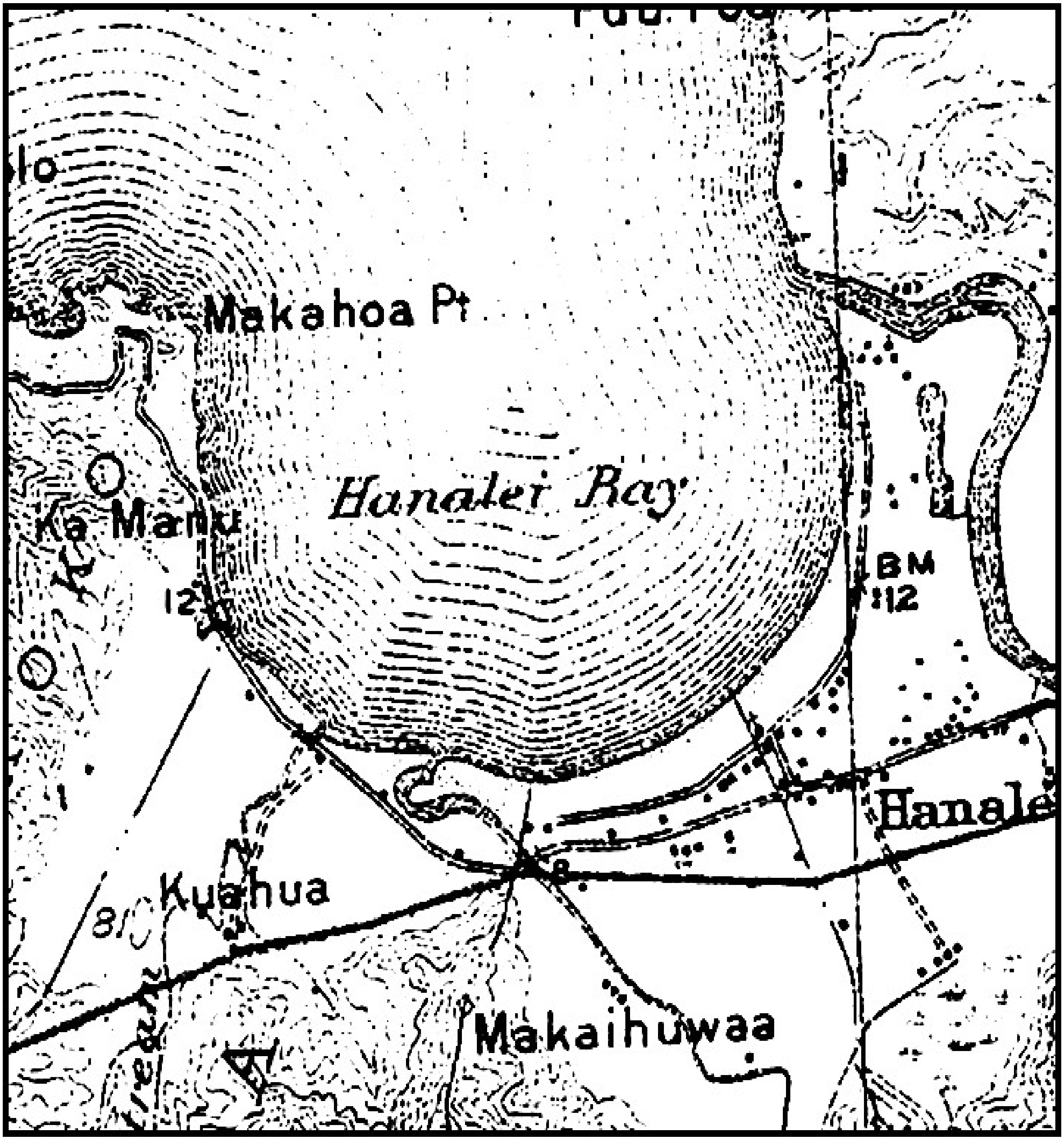
Source: Surveyed in July, 1937 by Captain Edward Belcher (printed in 1838)

MAP B. 2. Hanalei in 1891



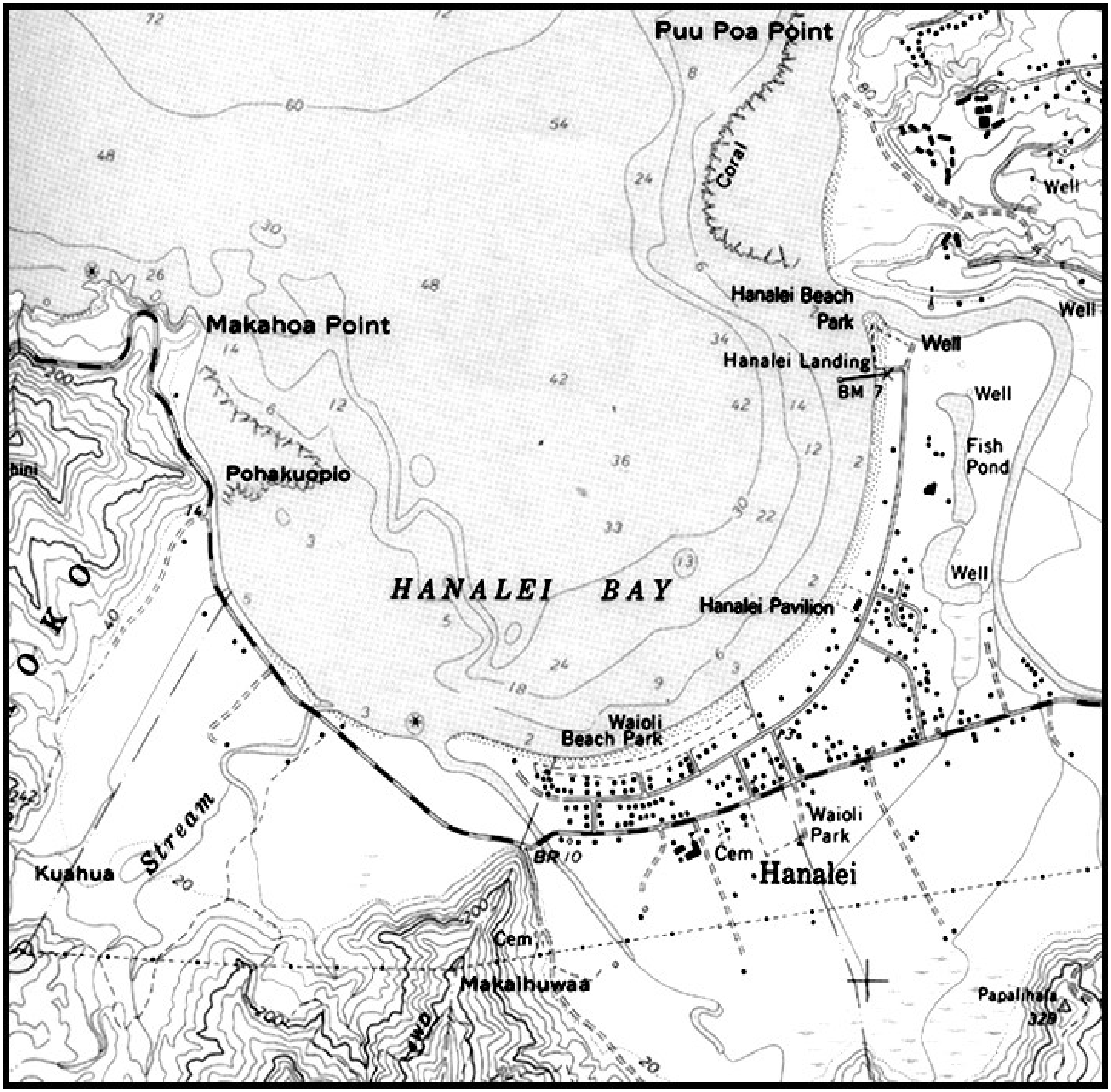
Source: Survey ca. 1884 by Lt. George E.G. Jackson for the Hawaiian Government. Printed in 1891 by the U.S. Hydrologic Office

MAP B. 3. Hanalei in 1903 or later



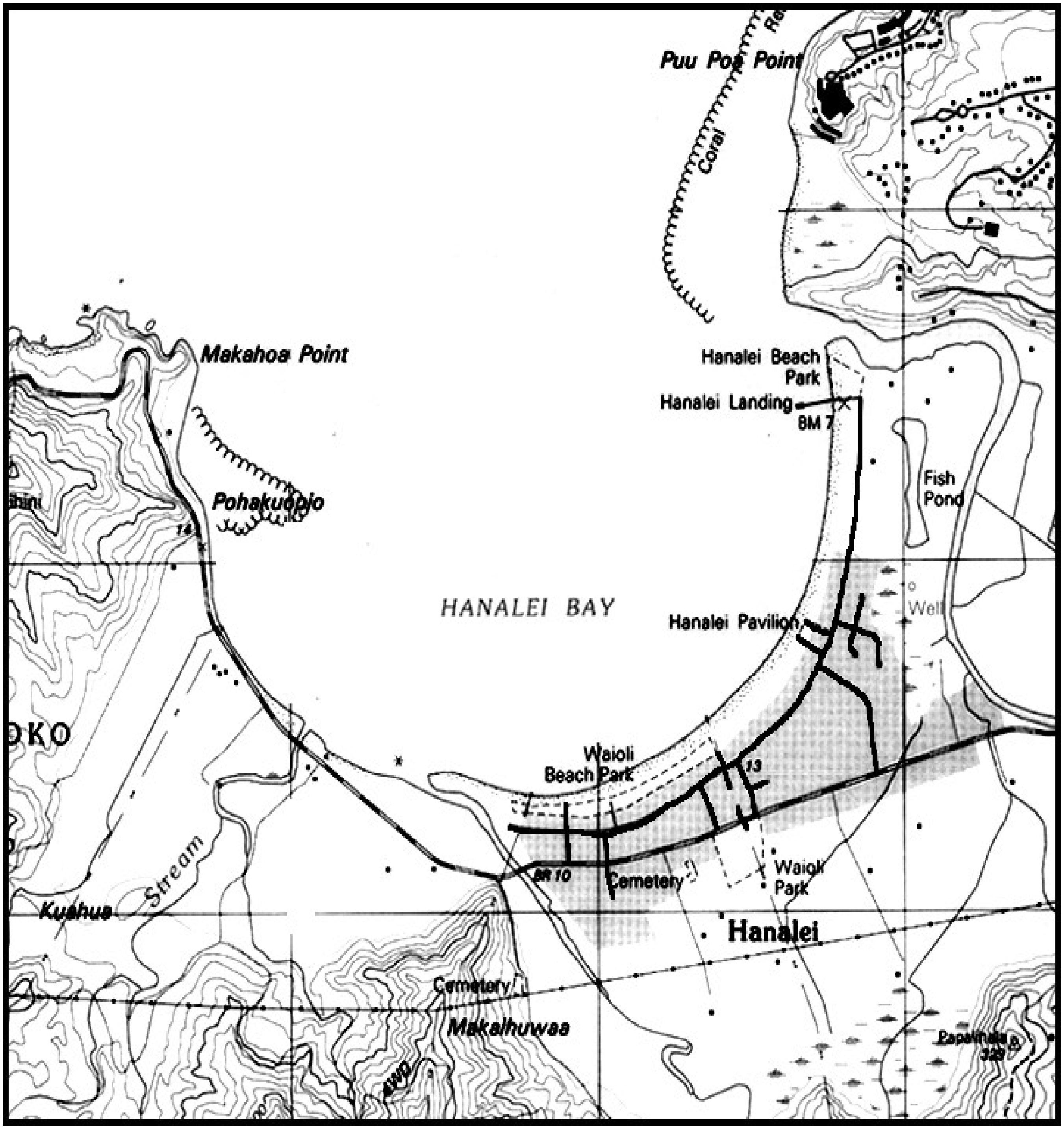
Source: Surveyed by the U.S. Geological Survey, 1910

MAP B. 4. Hanalei in 1986 (1:24,000)



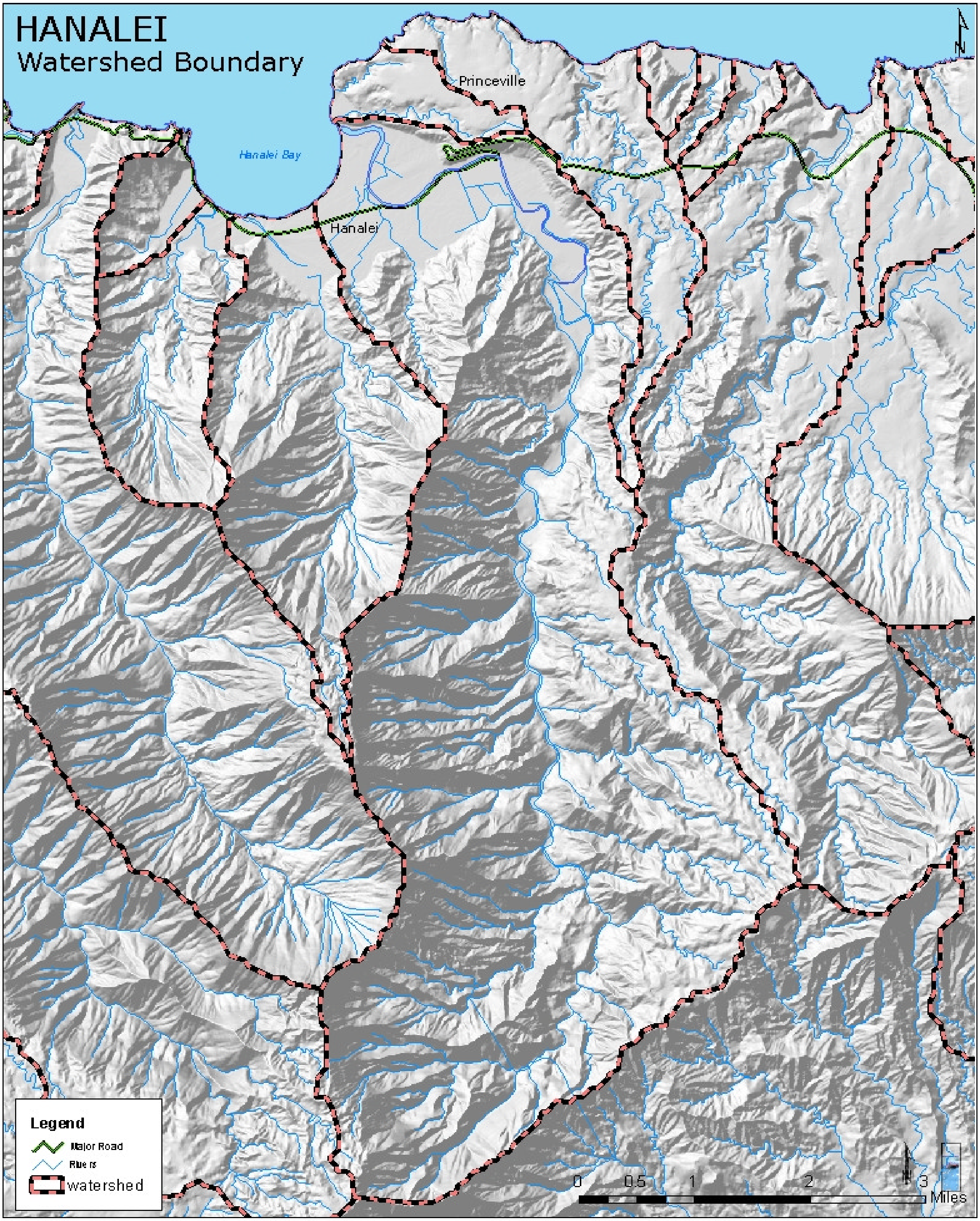
Source: U.S. Department of Interior, Geological Survey

MAP B. 5. Hanalei in 1996 (1:24,000)

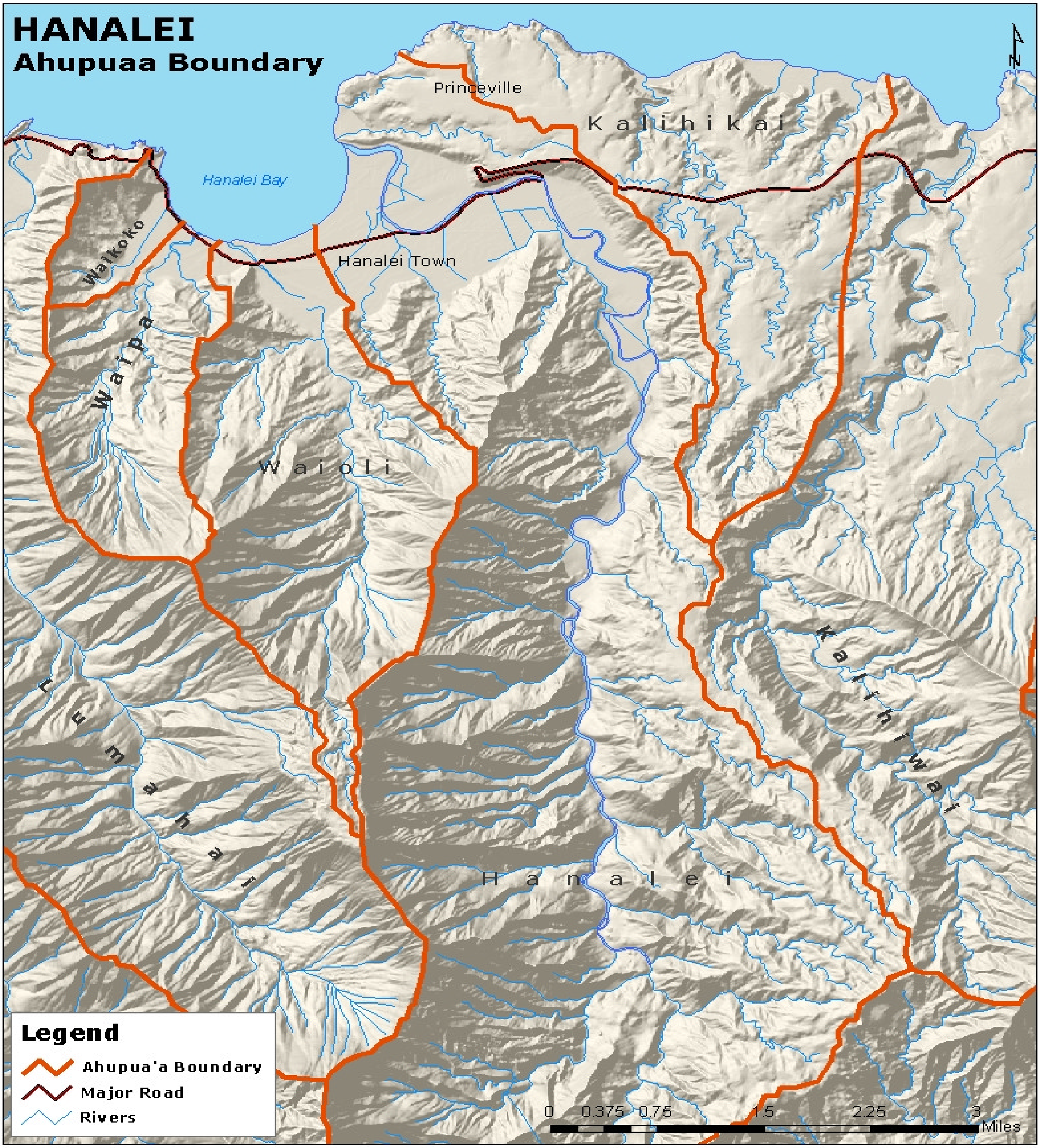


Source: U.S. Department of National Imagery and Mapping Agency

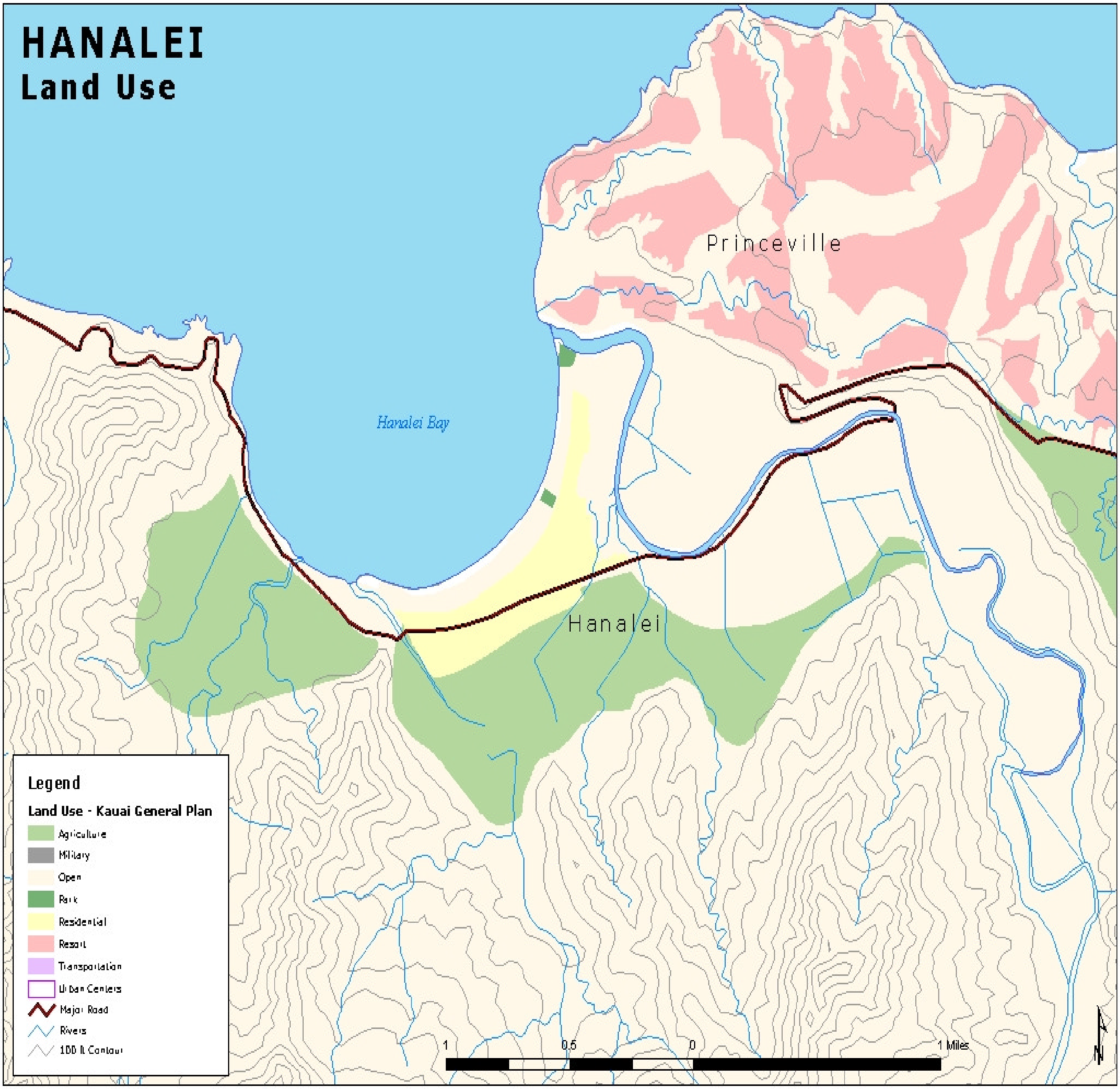
MAP B. 6.


HANALEI
Watershed Boundary
Princeville
Hanalei Bay
Hanalei
Legend
Major Road
Rivers
watershed
0
0.5
1
2
3
Miles

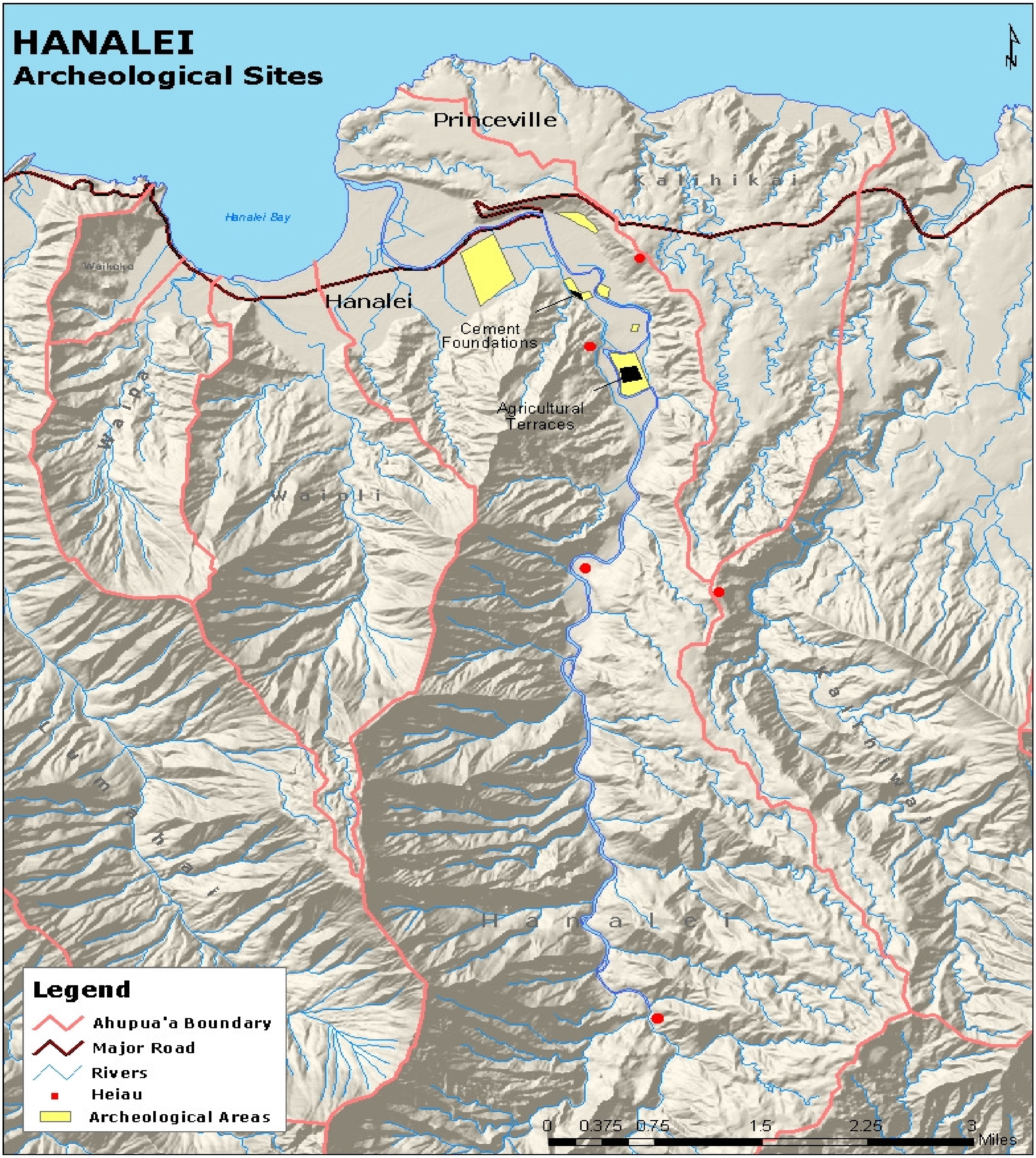
MAP B.7.


HANALEI
Ahupuaa Boundary
Princeville
Kalihikai
Hanalei Bay
Waikoko
Hanalei Town
Waipa
Waioli
Kalihiwai
Lumahai
Hanalei
Legend
Ahupua'a Boundary
Major Road
Rivers
0 0.375 0.75 1.5 2.25 3
Miles

MAP B. 8.

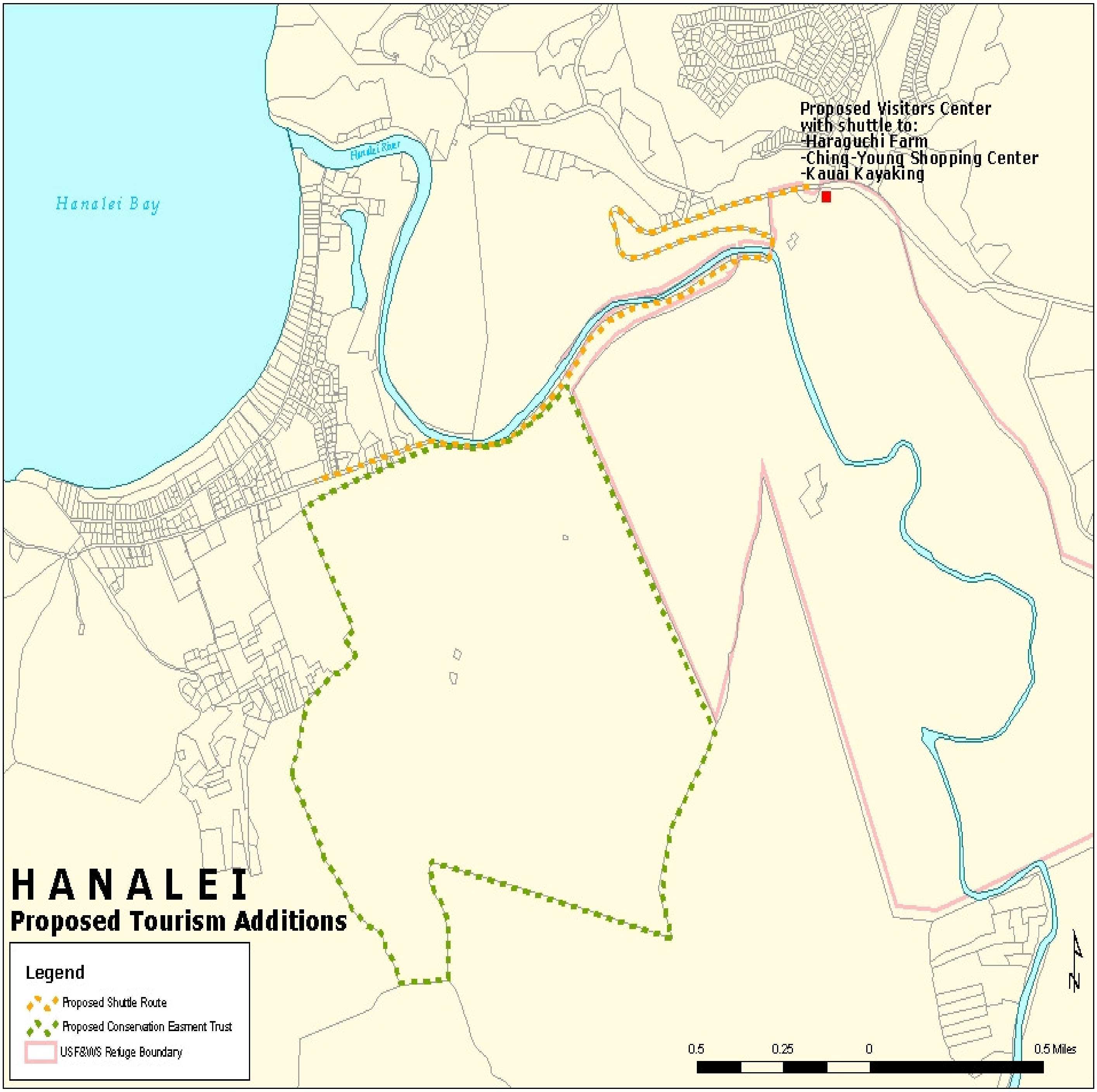

HANALEI
Land Use
Princeville
Hanalei Bay
Hanalei
Legend
Land Use - Kauai General Plan
Agriculture
Military
Open
Park
Residential
Resort
Transportation
Urban Centers
Major Road
Rivers
100 ft Contour
1
0.5
0
1 Miles
N

MAP B. 9.

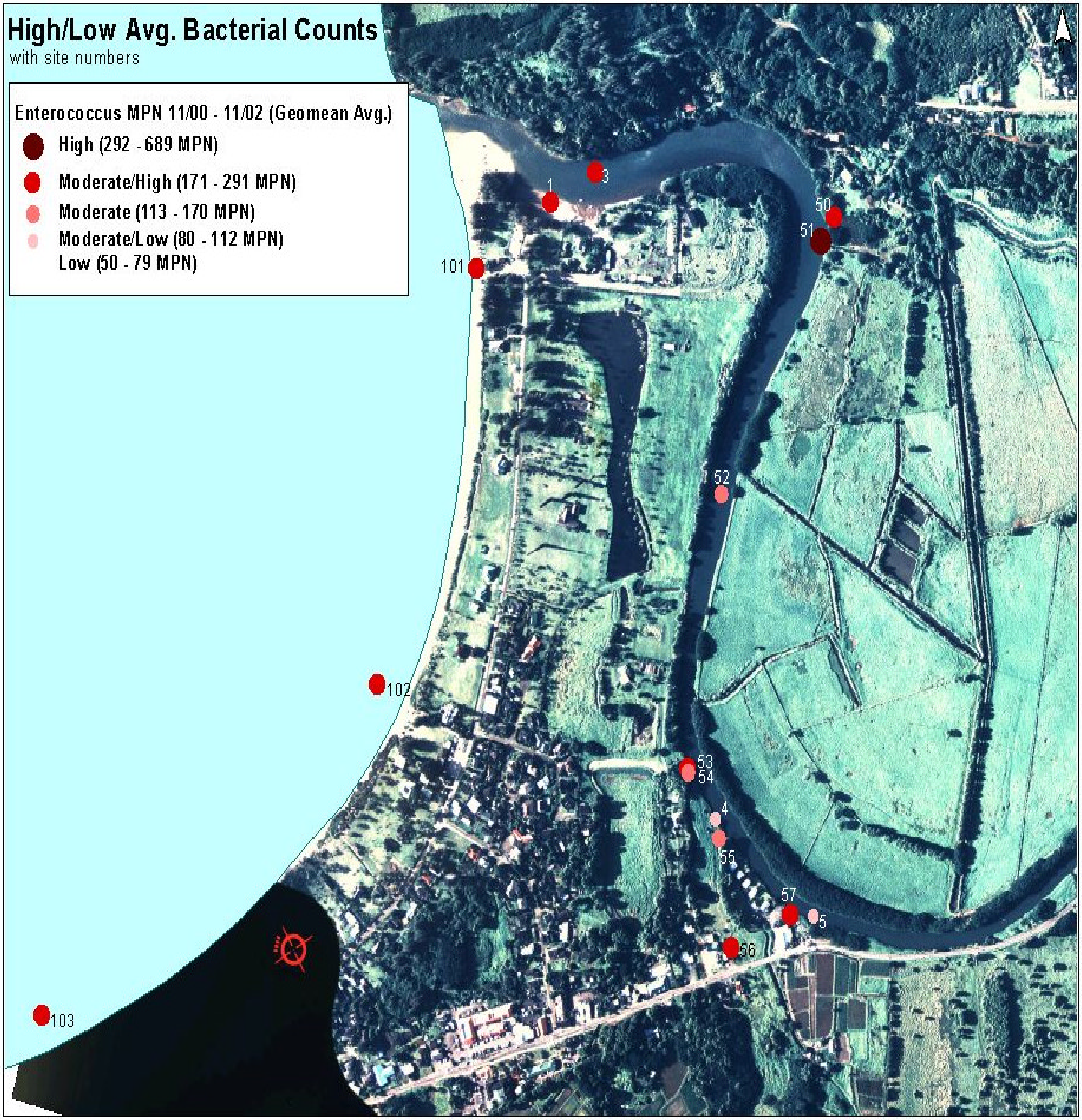


HANALEI
Archeological Sites
Princeville
Kalihikai
Hanalei Bay
Waikoko
Hanalei
Cement Foundations
Agricultural Terraces
Waipa
Waioli
Kalihiwai
Lumahai
Hanalei
Legend
Ahupua'a Boundary
Major Road
Rivers
Heiau
Archeological Areas
0 0.375 0.75 1.5 2.25 3
Miles

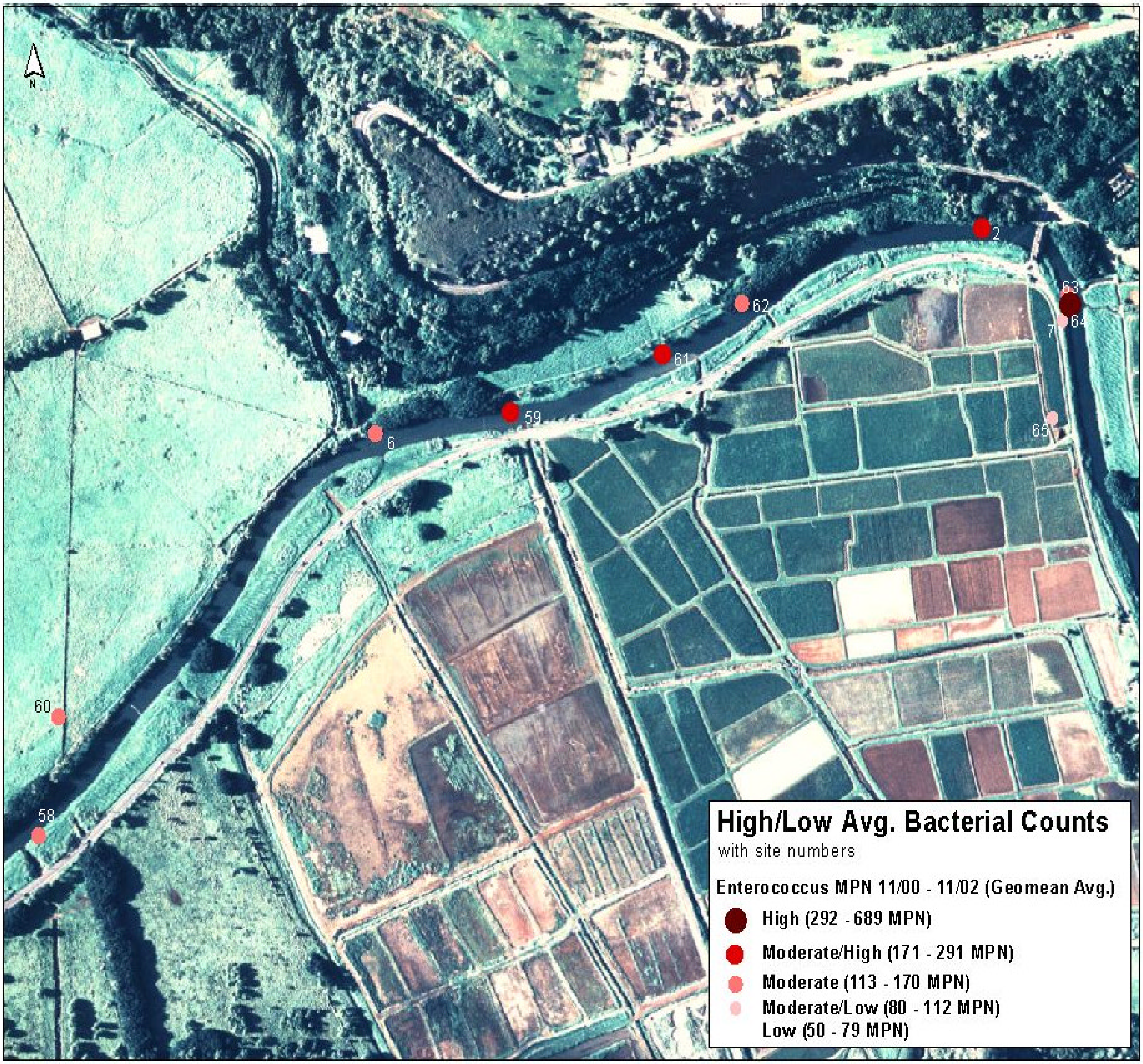
MAP B. 10.


Hanalei Bay
Hanalei River
Proposed Visitors Center
with shuttle to:
-Haraguchi Farm
-Ching-Young Shopping Center
-Kauai Kayaking
HANALEI
Proposed Tourism Additions
Legend
Proposed Shuttle Route
Proposed Conservation Easment Trust
USF&WS Refuge Boundary
0.5
0.25
0
0.5 Miles
N

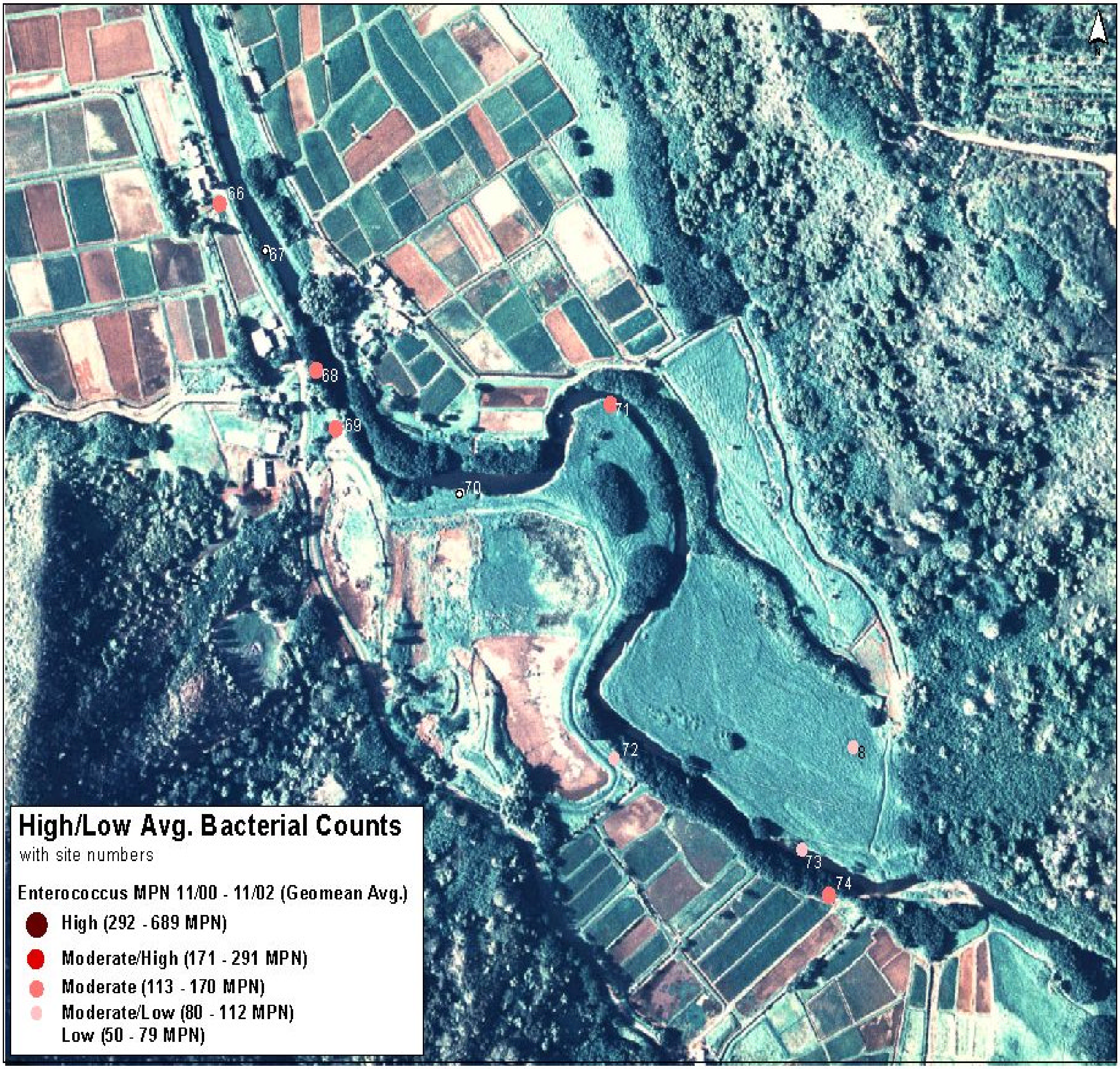
Map B. 11.


High/Low Avg. Bacterial Counts
with site numbers
Enterococcus MPN 11/00 - 11/02 (Geomean Avg.)
High (292 - 689 MPN)
Moderate/High (171 - 291 MPN)
Moderate (113 - 170 MPN)
Moderate/Low (80 - 112 MPN)
Low (50 - 79 MPN)
1
3
50
51
101
52
102
53
54
4
55
57
5
56
103

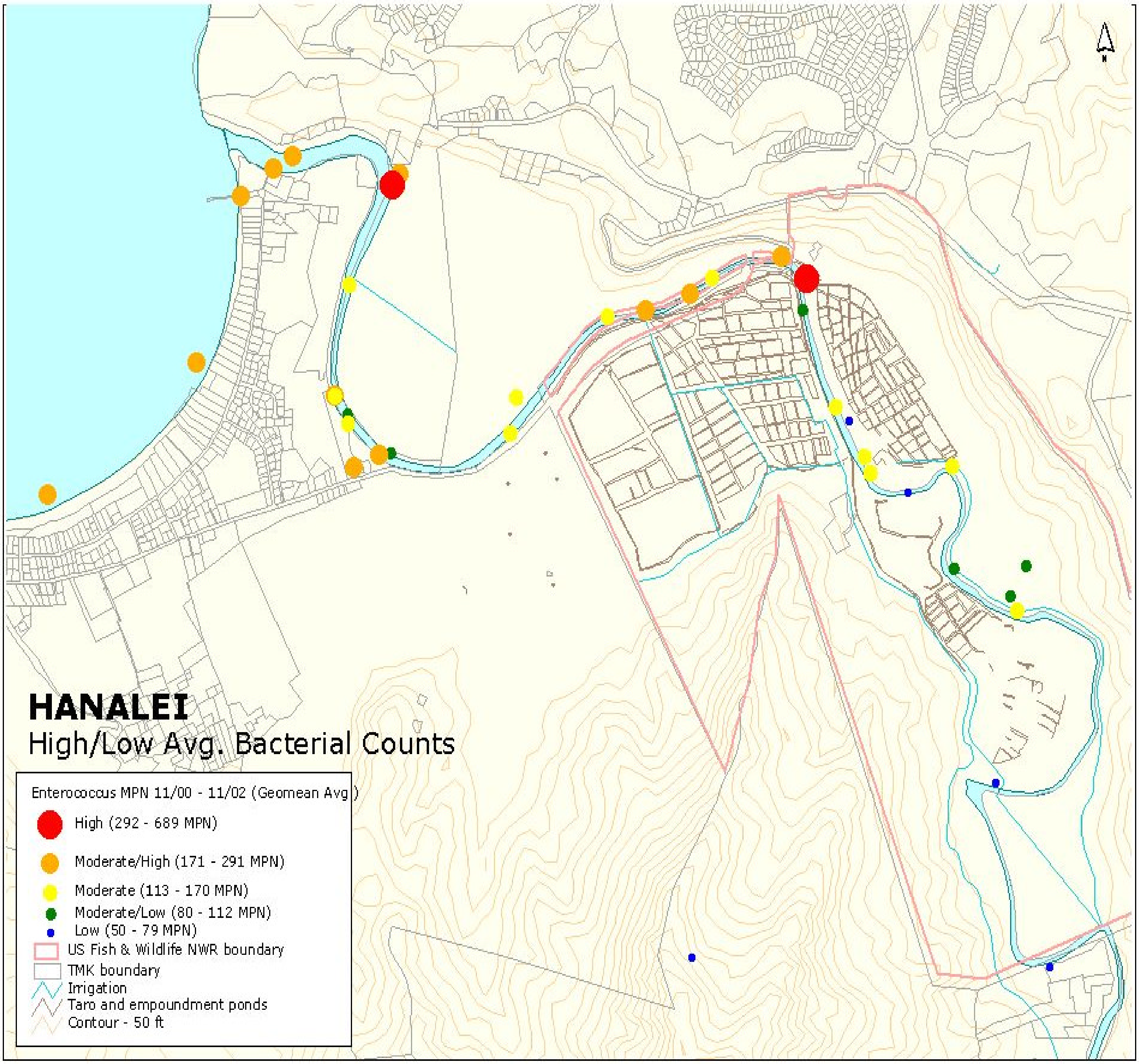
map B. 12.


N
2
63
64
7
62
61
59
6
65
60
58
High/Low Avg. Bacterial Counts
with site numbers
Enterococcus MPN 11/00 - 11/02 (Geomean Avg.)
High (292 - 689 MPN)
Moderate/High (171 - 291 MPN)
Moderate (113 - 170 MPN)
Moderate/Low (80 - 112 MPN)
Low (50 - 79 MPN)

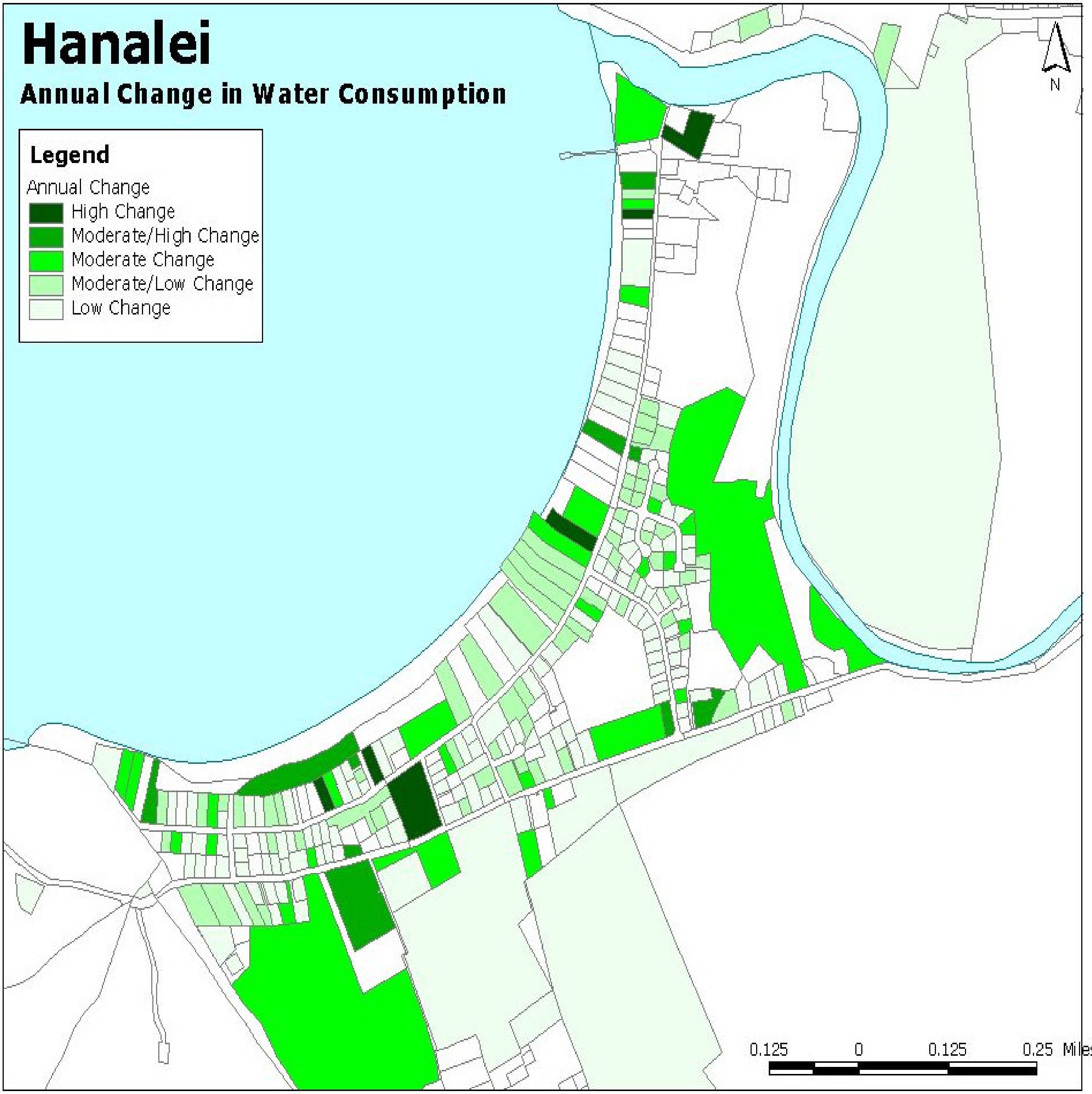
Map B. 13.


66
67
68
69
70
71
72
8
73
74
High/Low Avg. Bacterial Counts
with site numbers
Enterococcus MPN 11/00 - 11/02 (Geomean Avg.)
High (292 - 689 MPN)
Moderate/High (171 - 291 MPN)
Moderate (113 - 170 MPN)
Moderate/Low (80 - 112 MPN)
Low (50 - 79 MPN)

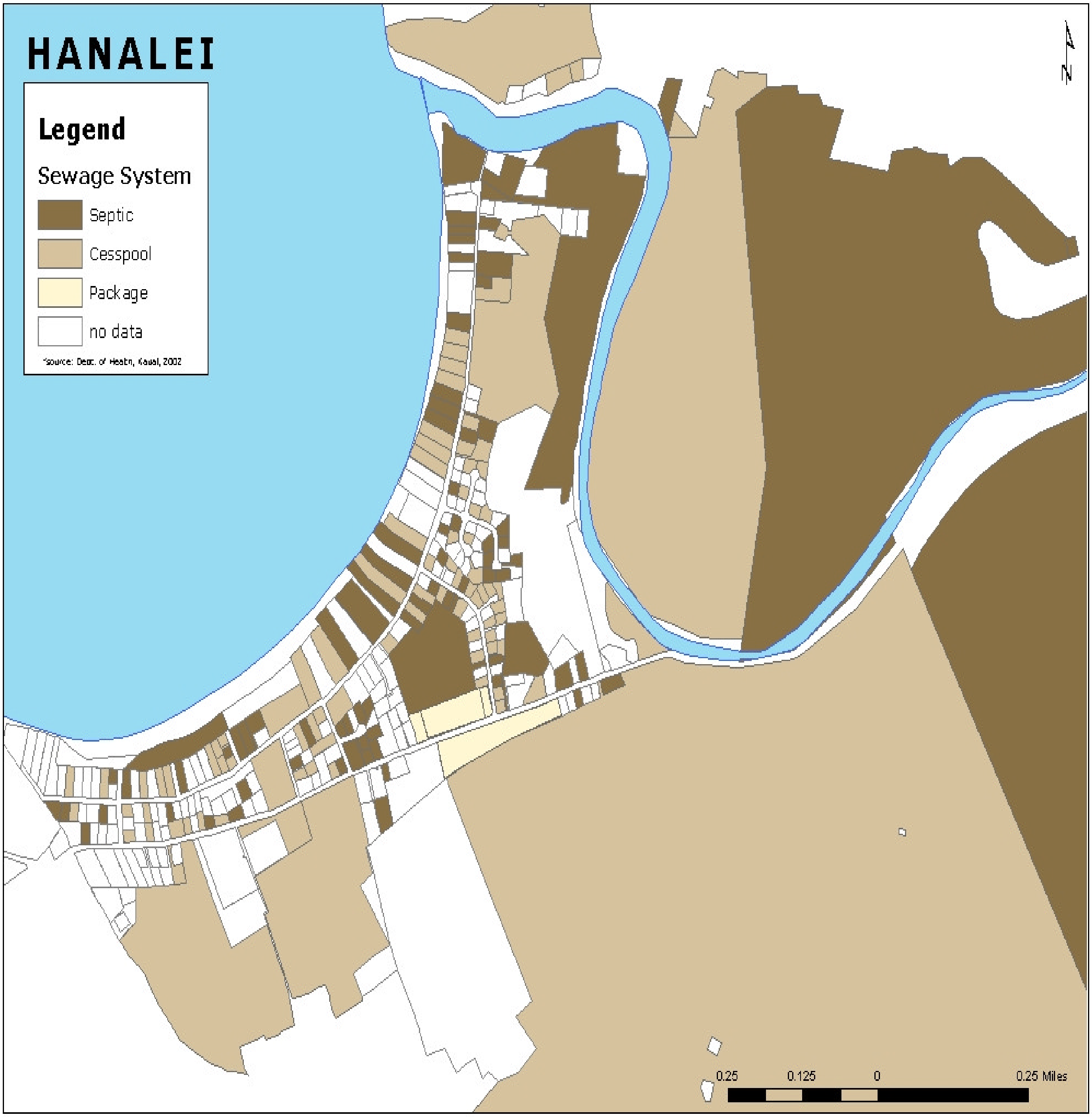
Map B. 14.


HANALEI
High/Low Avg. Bacterial Counts
Enterococcus MPN 11/00 - 11/02 (Geomean Avg.)
High (292 - 689 MPN)
Moderate/High (171 - 291 MPN)
Moderate (113 - 170 MPN)
Moderate/Low (80 - 112 MPN)
Low (50 - 79 MPN)
US Fish & Wildlife NWR boundary
TMK boundary
Irrigation
Taro and empoundment ponds
Contour - 50 ft

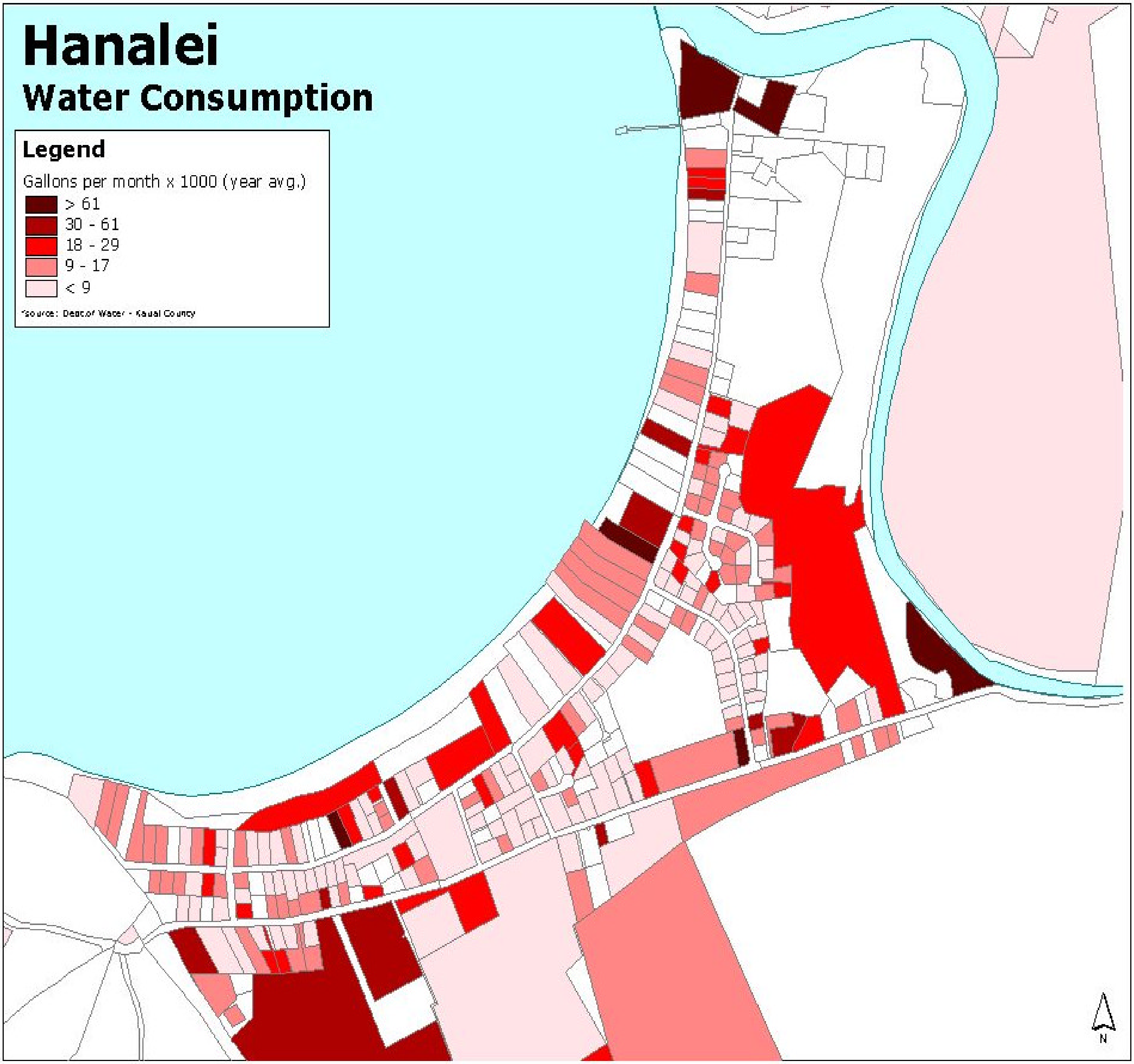
Map B. 15.


Hanalei
Annual Change in Water Consumption
Legend
Annual Change
High Change
Moderate/High Change
Moderate Change
Moderate/Low Change
Low Change
N
0.125 0 0.125 0.25 Miles

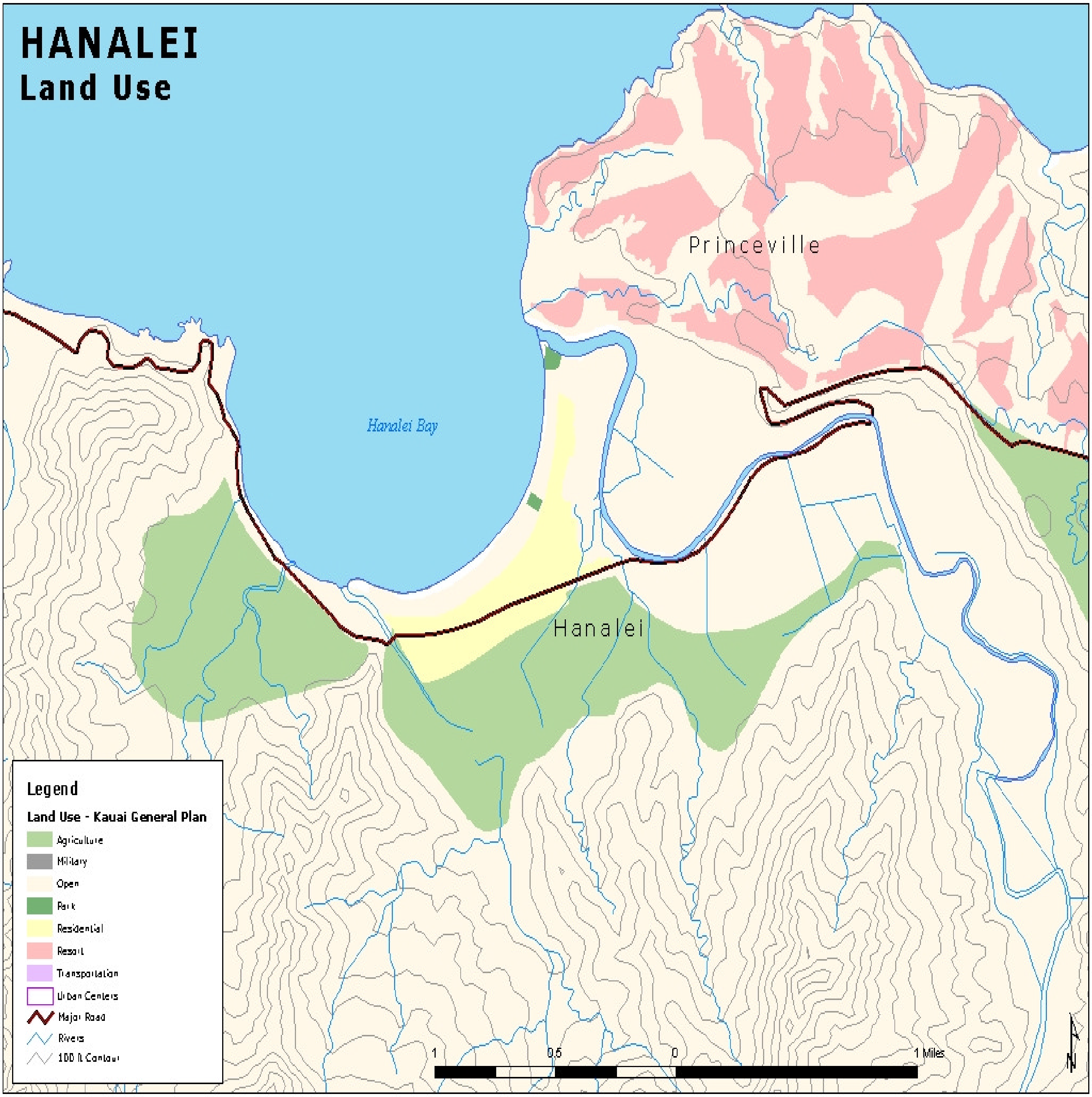
Map B. 16.


HANALEI
Legend
Sewage System
Septic
Cesspool
Package
no data
*Source: Dept. of Health, Kauai, 2002
N
0.25
0.125
0
0.25 Miles

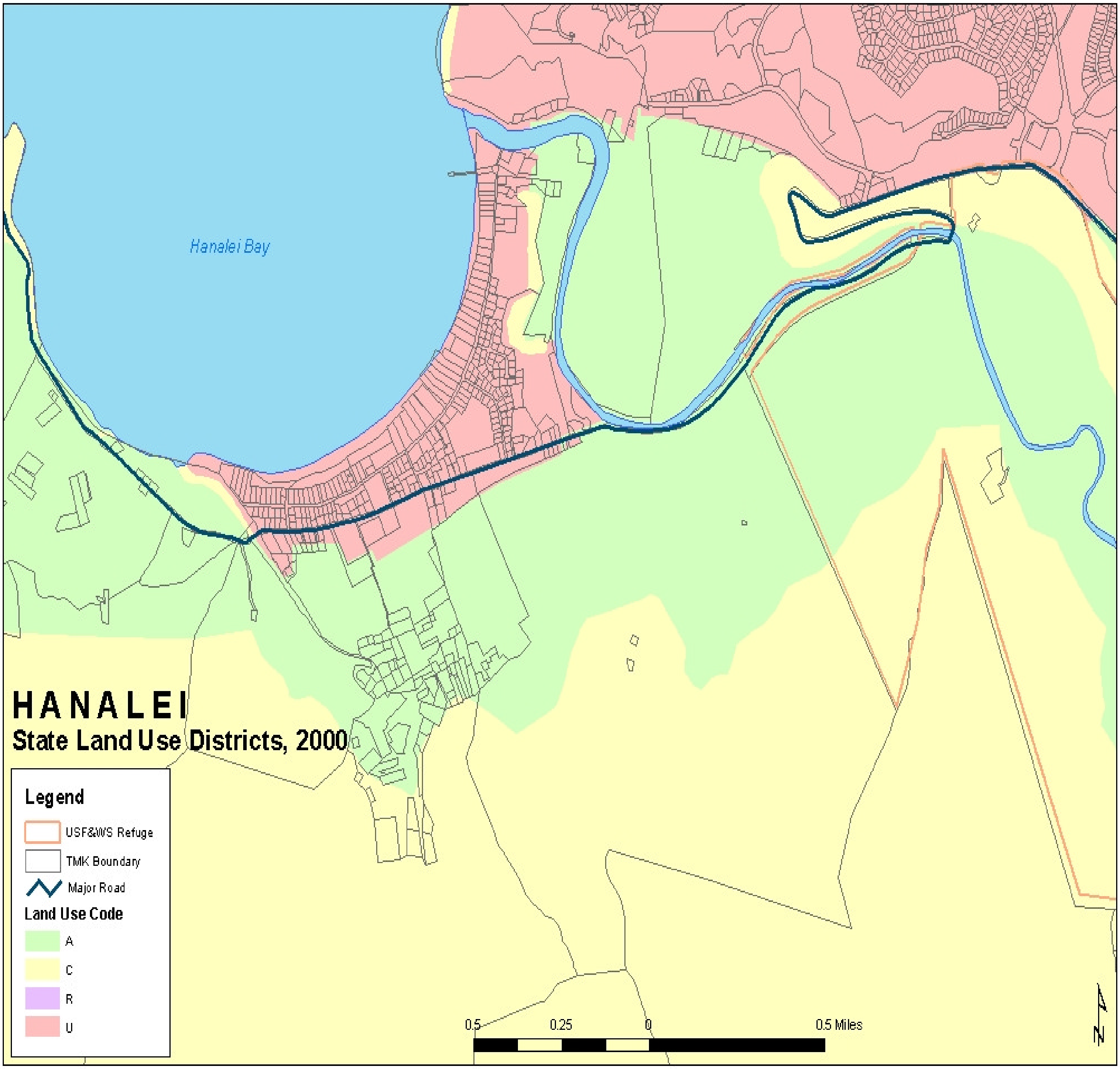
Map B. 17.


Hanalei
Water Consumption
Legend
Gallons per month x 1000 (year avg.)
> 61
30 - 61
18 - 29
9 - 17
< 9
*Source: Dept.of Water - Kauai County
N

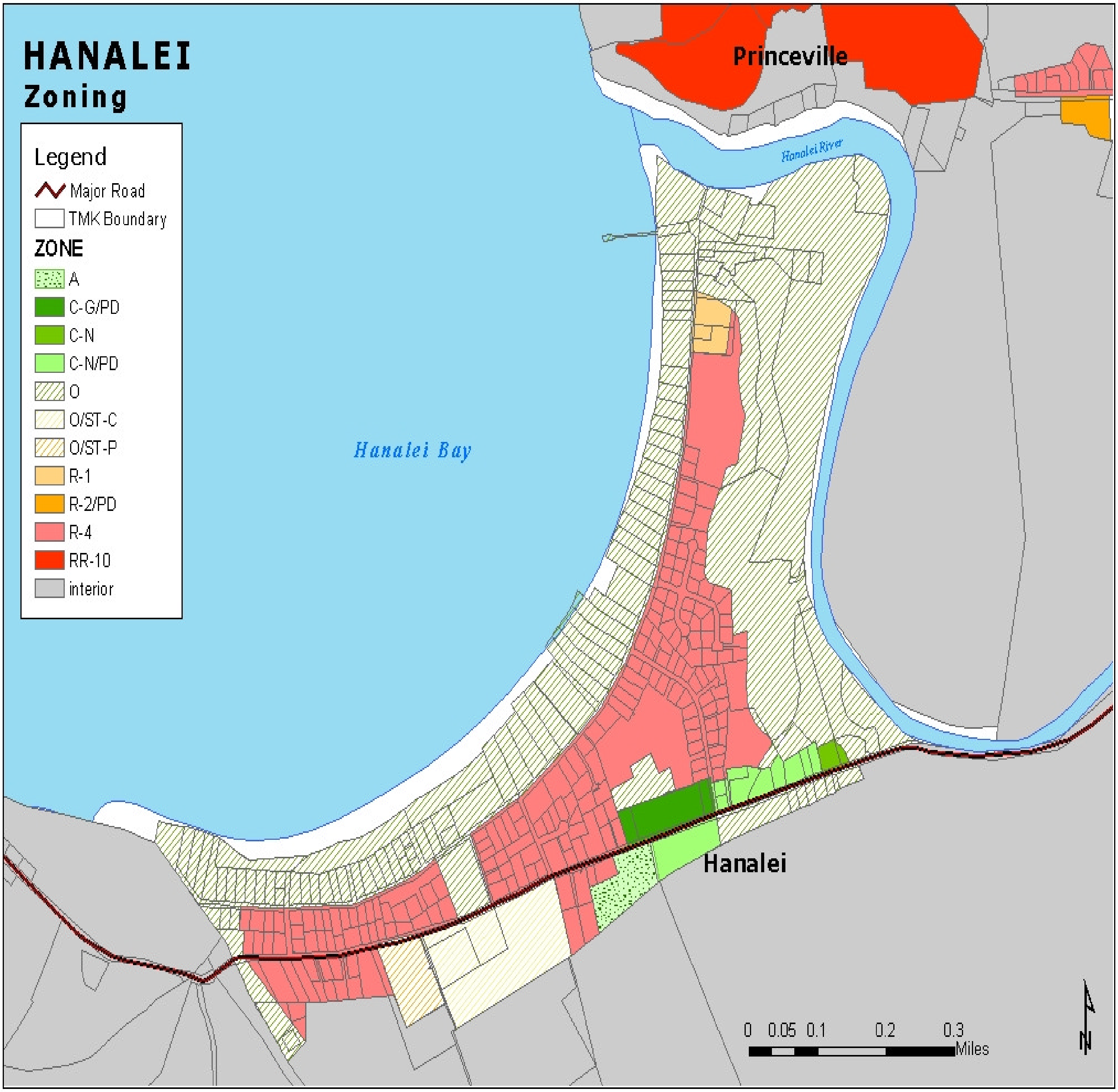
Map B. 18.


HANALEI
Land Use
Princeville
Hanalei Bay
Hanalei
Legend
Land Use - Kauai General Plan
Agriculture
Military
Open
Park
Residential
Resort
Transportation
Urban Centers
Major Road
Rivers
100 ft Contour
1
0.5
0
1 Miles
N

Map B. 19.


Hanalei Bay
HANALEI
State Land Use Districts, 2000
Legend
USF&WS Refuge
TMK Boundary
Major Road
Land Use Code
A
C
R
U
0.5
0.25
0
0.5 Miles
N

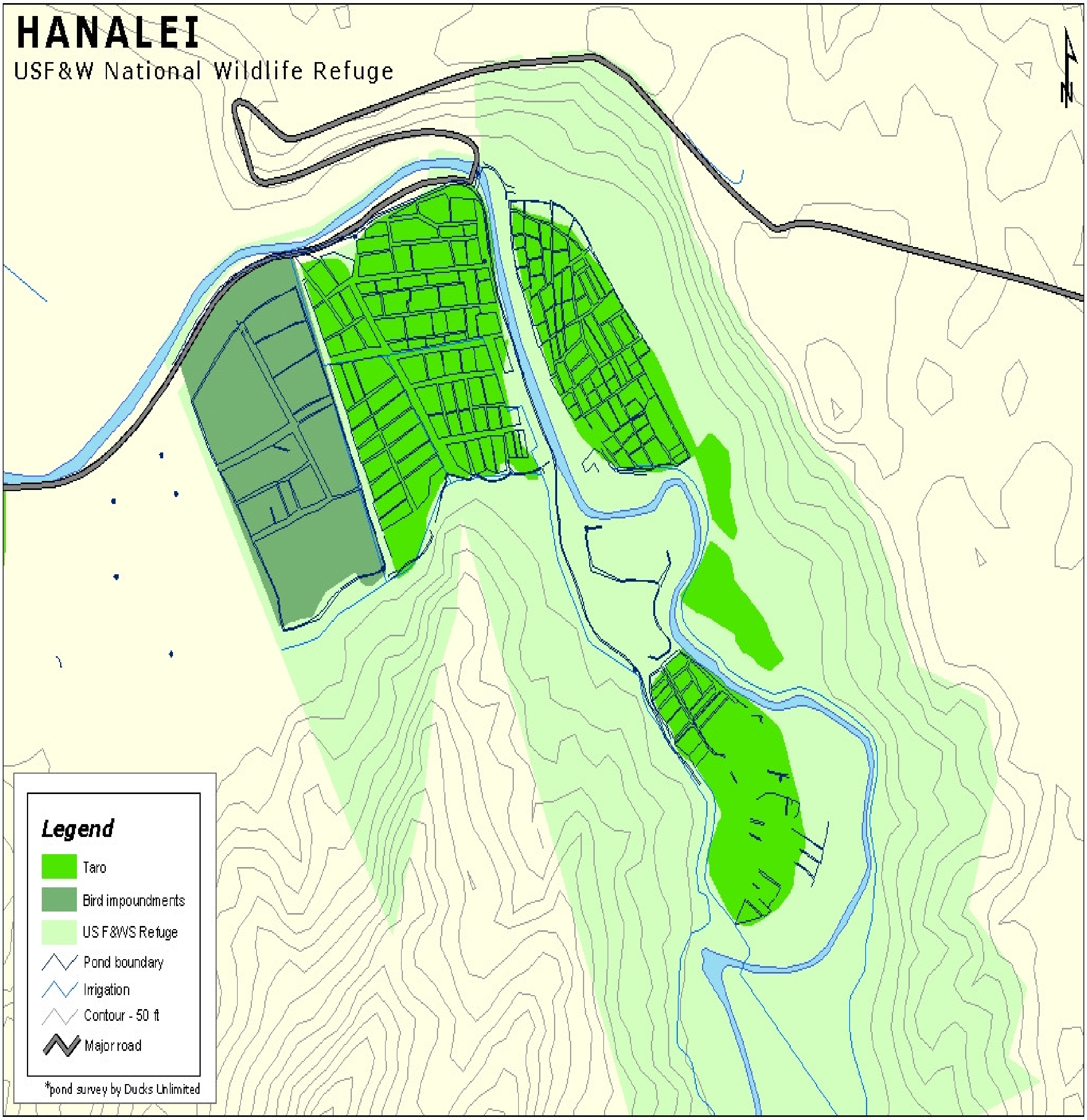
Map B. 20.


HANALEI
Zoning
Legend
Major Road
TMK Boundary
ZONE
A
C-G/PD
C-N
C-N/PD
O
O/ST-C
O/ST-P
R-1
R-2/PD
R-4
RR-10
interior
Princeville
Hanalei River
Hanalei Bay
Hanalei
0 0.05 0.1 0.2 0.3
Miles
N

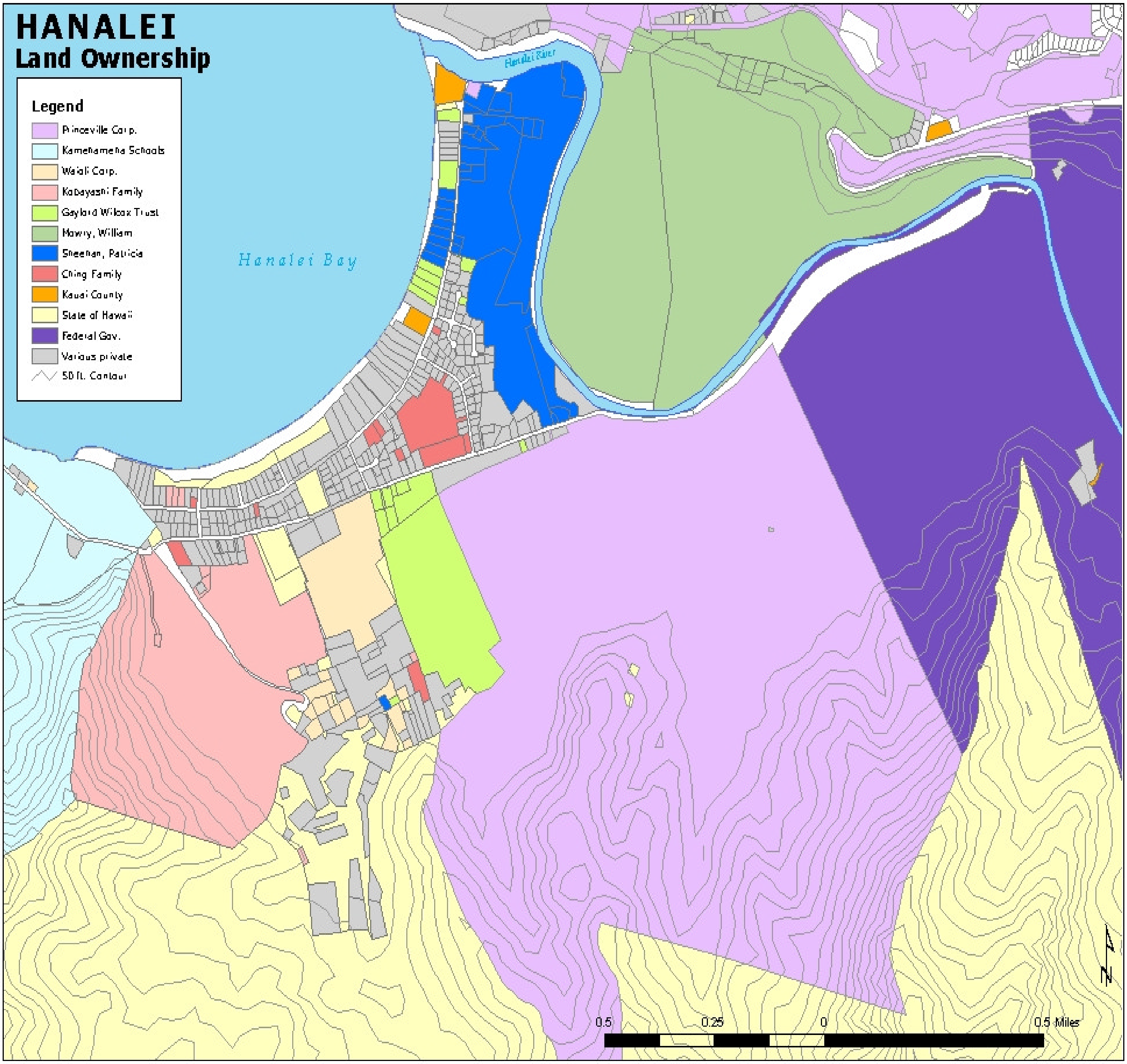
Map B. 21.


Hanalei
Wetlands
Hanalei Bay
Legend
Wetlands
Watershed Boundary
River
Major Road
N

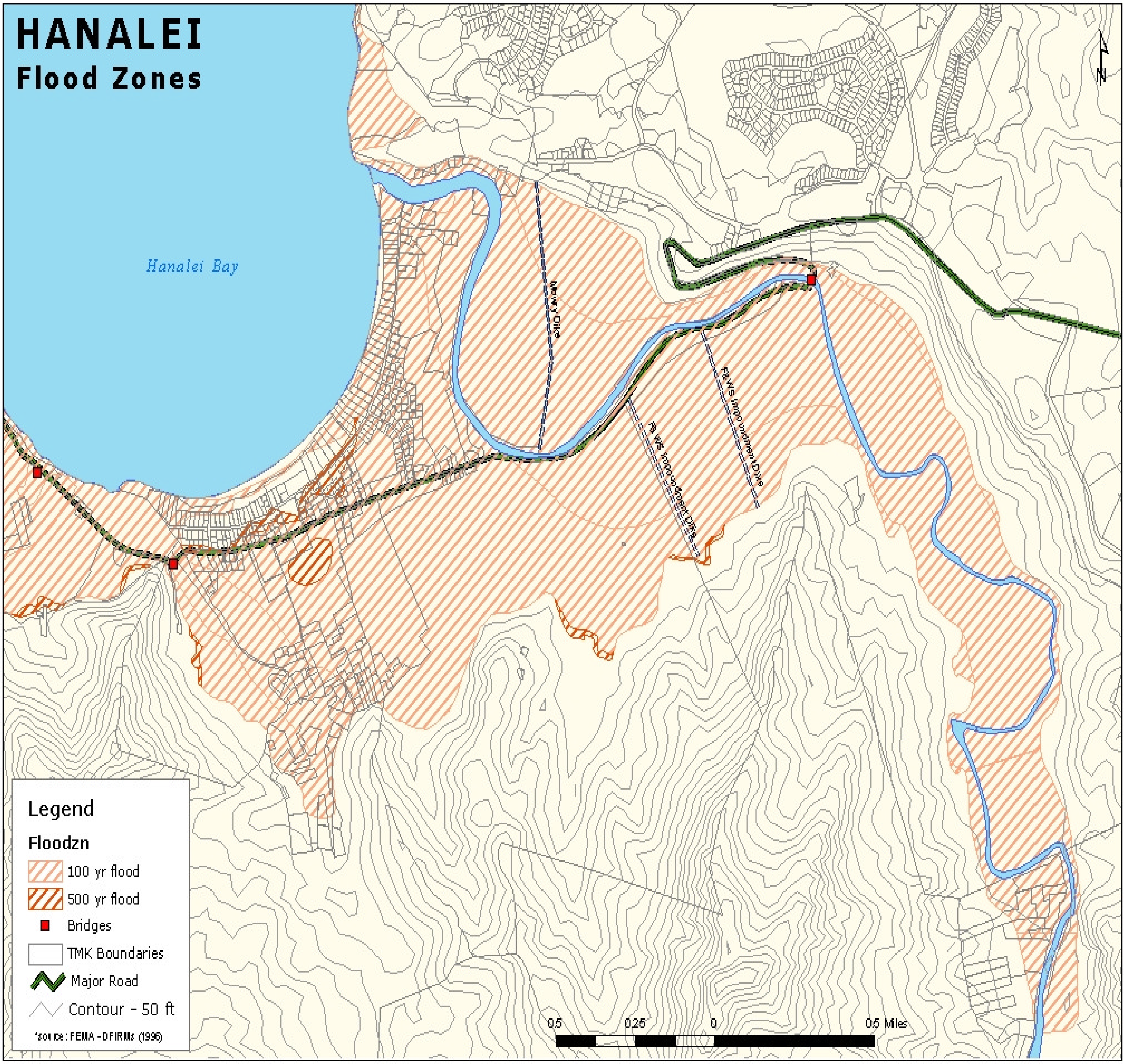
Map B. 22.


HANALEI
USF&W National Wildlife Refuge
N
Legend
Taro
Bird impoundments
US F&WS Refuge
Pond boundary
Irrigation
Contour - 50 ft
Major road
*pond survey by Ducks Unlimited

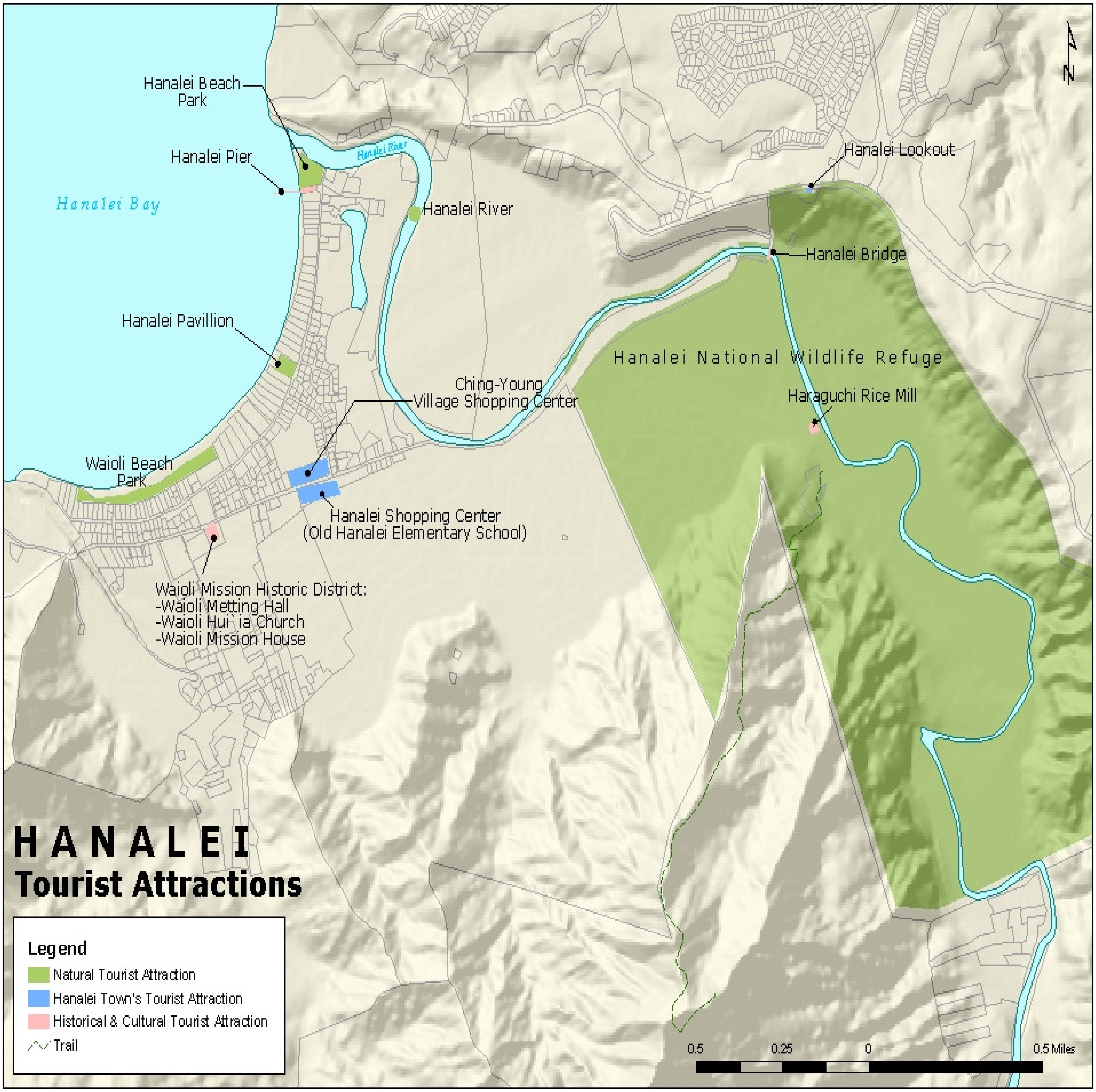
Map B. 23.


HANALEI
Land Ownership
Legend
Princeville Corp.
Kamehameha Schools
Waioli Corp.
Kobayashi Family
Gaylord Wilcox Trust
Mowry, William
Sheehan, Patricia
Ching Family
Kauai County
State of Hawaii
Federal Gov.
Various private
50 ft. Contour
Hanalei Bay
Hanalei River
0.5
0.25
0
0.5 Miles
N

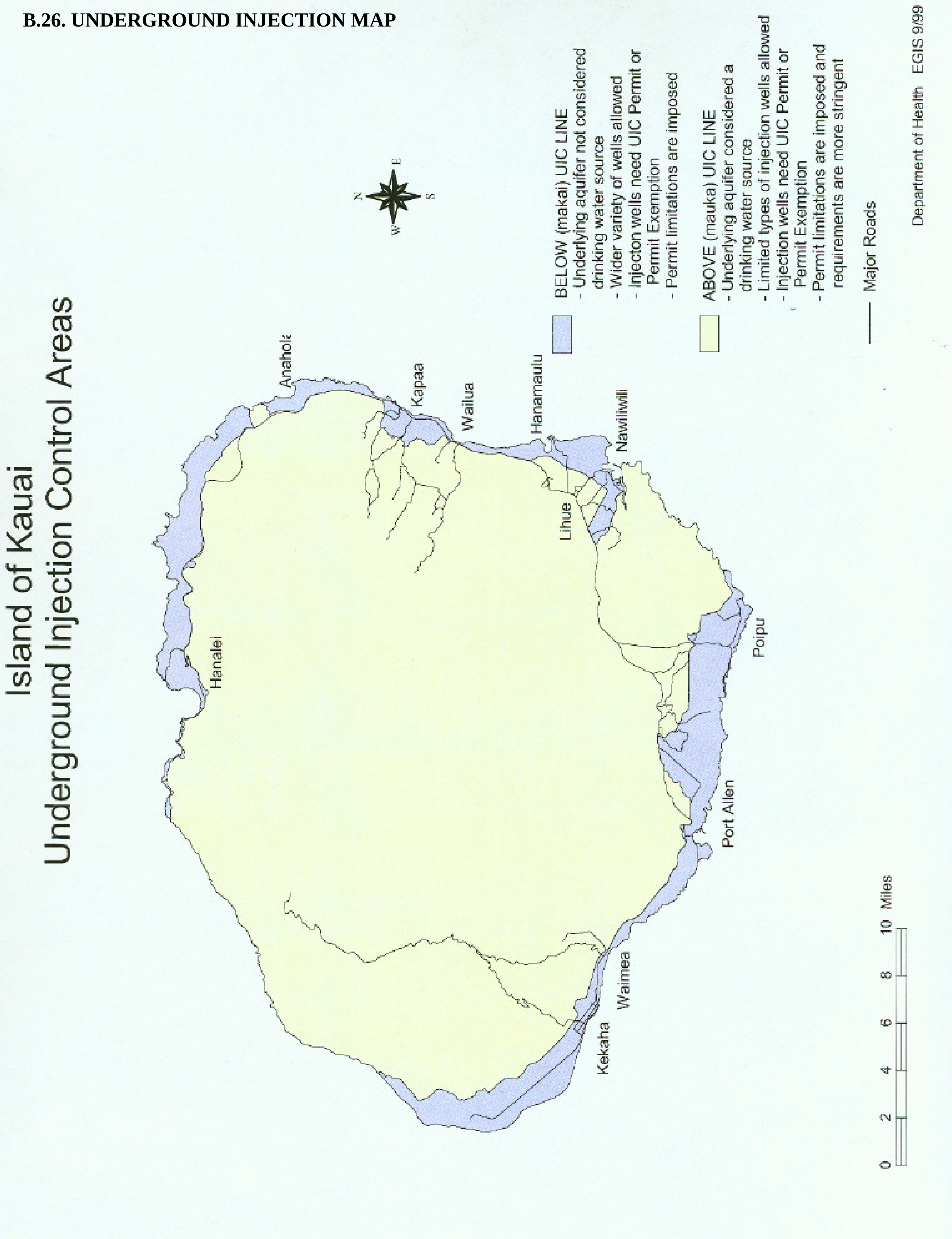
Map B. 24.


HANALEI
Flood Zones
Hanalei Bay
N
Legend
Floodzn
100 yr flood
500 yr flood
Bridges
TMK Boundaries
Major Road
Contour - 50 ft
*source: FEMA - DFIRMs (1996)
0.5
0.25
0
0.5 Miles

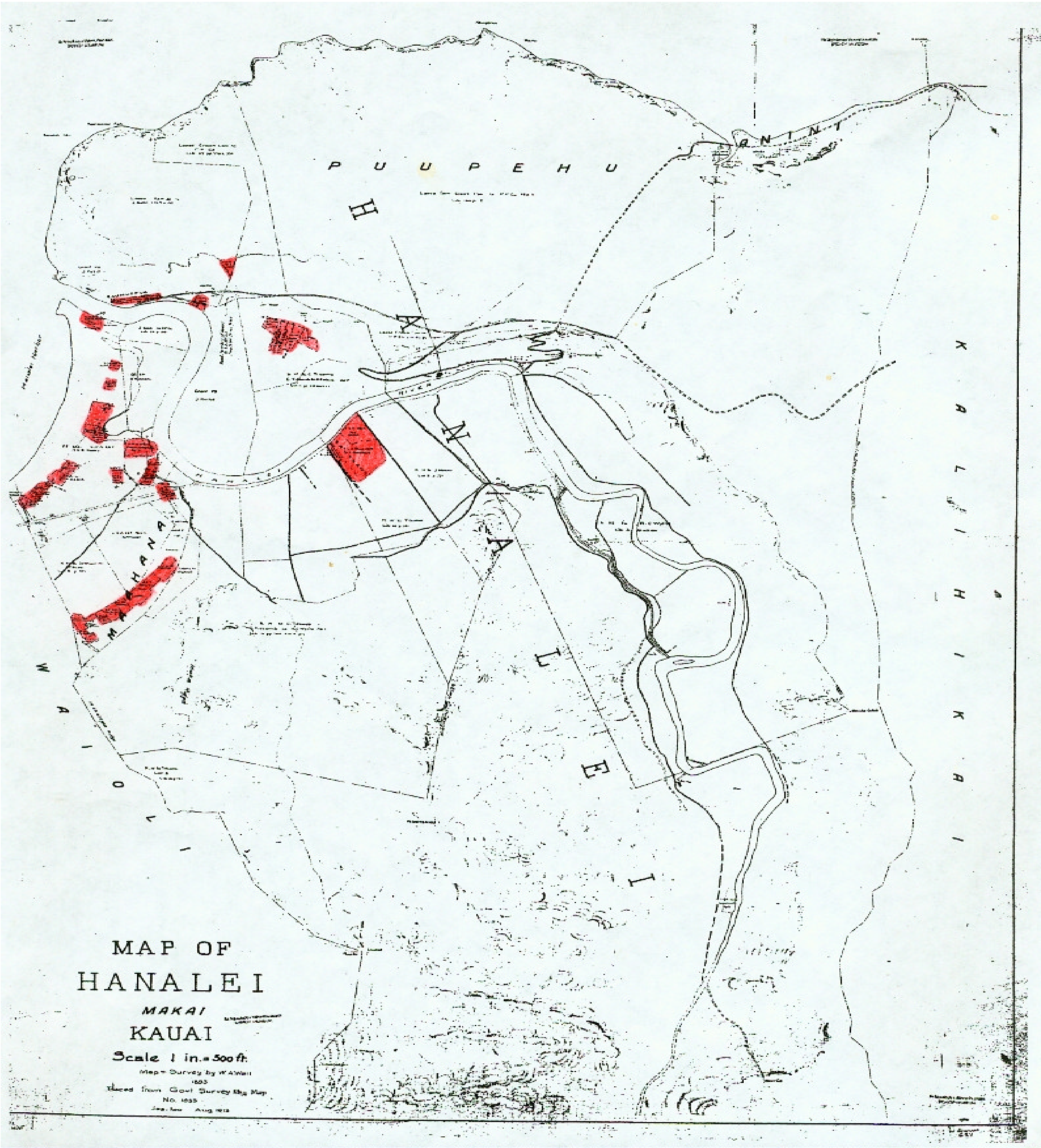
B.25.


Hanalei Beach Park
Hanalei Pier
Hanalei Bay
Hanalei River
Hanalei Lookout
Hanalei River
Hanalei Bridge
Hanalei Pavillion
Hanalei National Wildlife Refuge
Ching-Young Village Shopping Center
Haraguchi Rice Mill
Waioli Beach Park
Hanalei Shopping Center (Old Hanalei Elementary School)
Waioli Mission Historic District:
-Waioli Metting Hall
-Waioli Hui`ia Church
-Waioli Mission House
HANALEI
Tourist Attractions
Legend
Natural Tourist Attraction
Hanalei Town's Tourist Attraction
Historical & Cultural Tourist Attraction
Trail
0.5
0.25
0
0.5 Miles
N

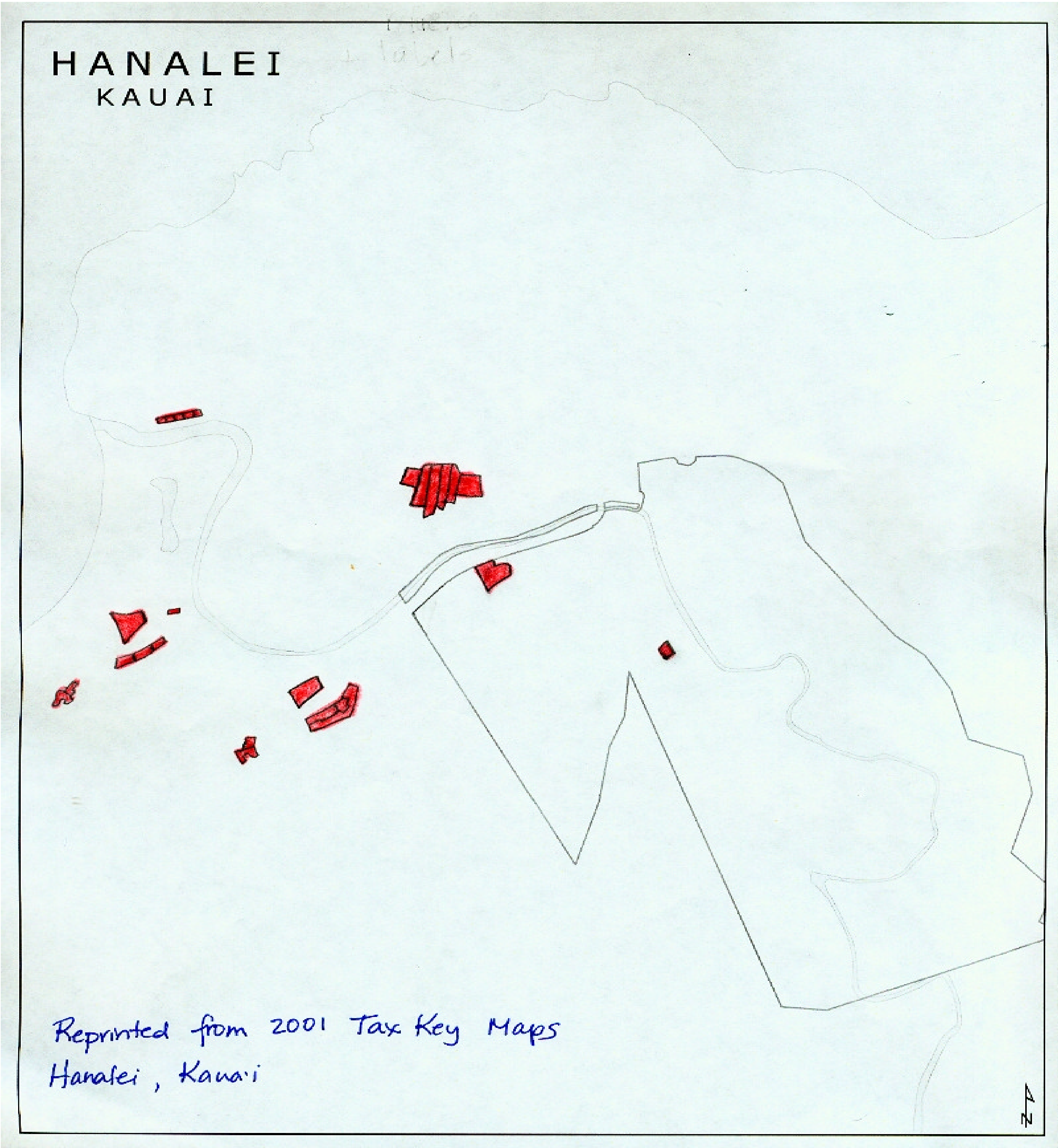
B.26. UNDERGROUND INJECTION MAP



MAP B. 27. LCA 1893



MAP B. 28. LCA 2001



APPENDIX C PRACTICUM EXERCISES

Appendix C.1
Wastewater Charette

The Practicum approached the charette with four considerations in mind:

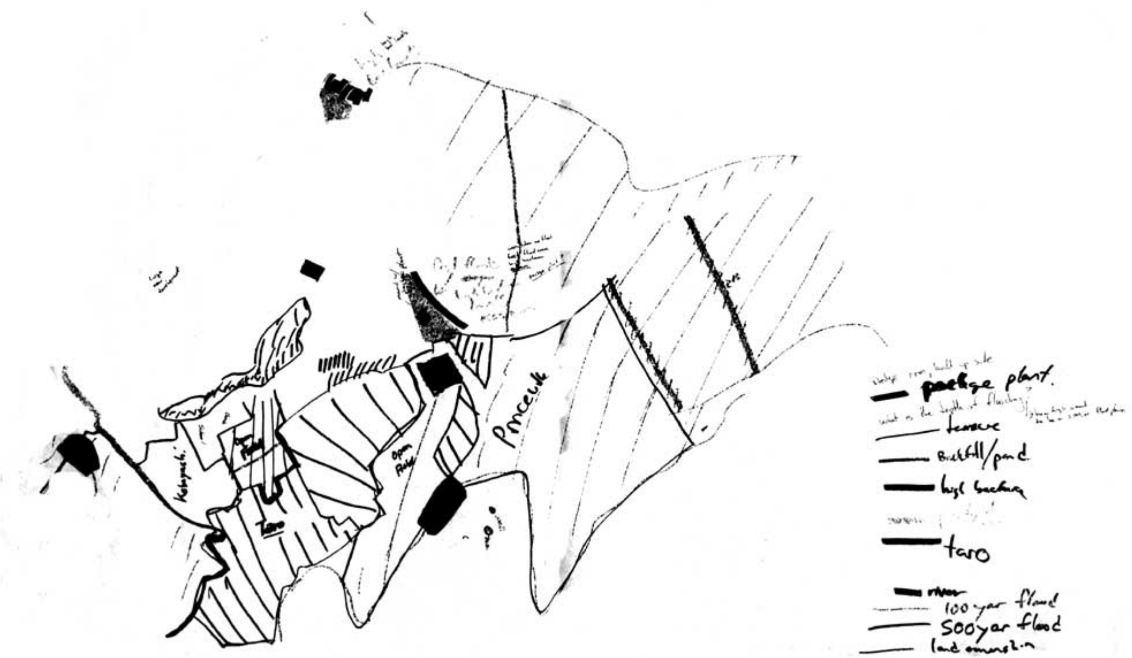
1. To consider all constraints in the planning and implementation of a wastewater treatment system in Hanalei.

2. Provide multiple location suggestions for wastewater treatment systems of varying size, configuration, and type.

3. The extremely high cost of installing infrastructure for a centralized system necessitates a phased system. Our general strategy is to eliminate the major sources of water contamination in the short term at a relatively low cost, and provide recommendations for a long term solution that may include a centralized wastewater facility and alternative in-ground infrastructure.

Provide multiple suggestions for infrastructure type, implementation, and phasing.

Team 1



Approach

- Team 1 recommends the use of STEP systems to pump effluent from existing septic systems to clustered or centralized constructed wetlands treatment or Living Machine.
- New development should be equipped with grinder pumps.
- The wastewater should be treated first in a sub-surface flow cell, then in a surface flow well.
- Treated wastewater should be disposed of using an injection well.

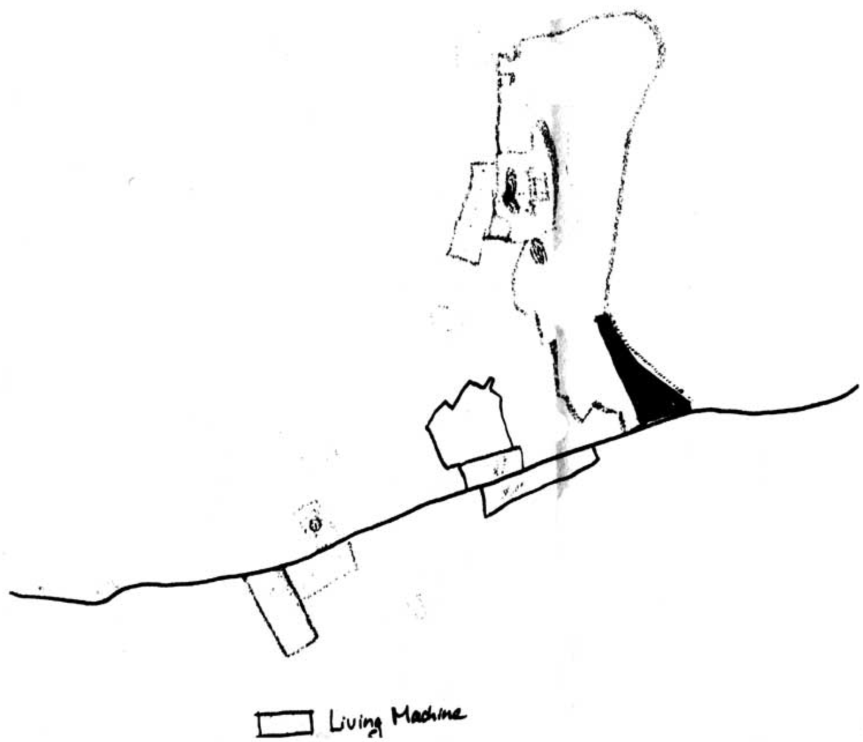
Location

- Terracing of State land in the conservation district.
- Consideration of locations immediately east and west of Hanalei (see map)

Phasing

- Provide immediate improvements in "high-risk" areas where high bacterial counts and flooding occur.
- Identify and replace remaining cesspools.
- Provide long term improvement in "medium-risk" areas – all land adjacent to a body of water where septic systems are potentially below tight-tide or over capacity.
- Leave septic systems where functional and appropriate.

Team 2



Approach

- We went along with the assumption that money was no object, since no cost was available for the options given.

Location

- Buying a section of Wai'oli land; felt this was a good location because it is in the middle of the housing development, yet on the other side of the road.
- Kamehameha lands
- Wanted to locate treatment facility on mauka side of road, away from houses and slightly higher in the floodplain
- Can the current package systems at the shopping centers be used by the neighboring houses? Understand that there are already problems with these, but can they be remedied?

Phasing

- Using the Wilcox fishpond as a discharge site that would at least service the Wilcox lands
- Constructing wetland on Wai'oli land. May also produce park-like setting for tourists.
- Please see our map for further clarification.

Appendix C.2
Community – Governance Planning Charette Exercise

In this exercise, the practicum members were divided into three groups, each looking at a different case. Group 1 focused on the taro farmers – USFWS relationship; Group 2 focused on Wastewater management, and Group 3 on Tourism and Historic Preservation. Each group started with discussing the basic concept of collaboration (see below) and was asked to apply the concept to their case. The outcome of the groups was visions and possible alternative actions corresponding to those visions that are believed to positively contribute to social harmony, understanding and integrated planning for Hanalei.

The Basic Concept: Collaboration

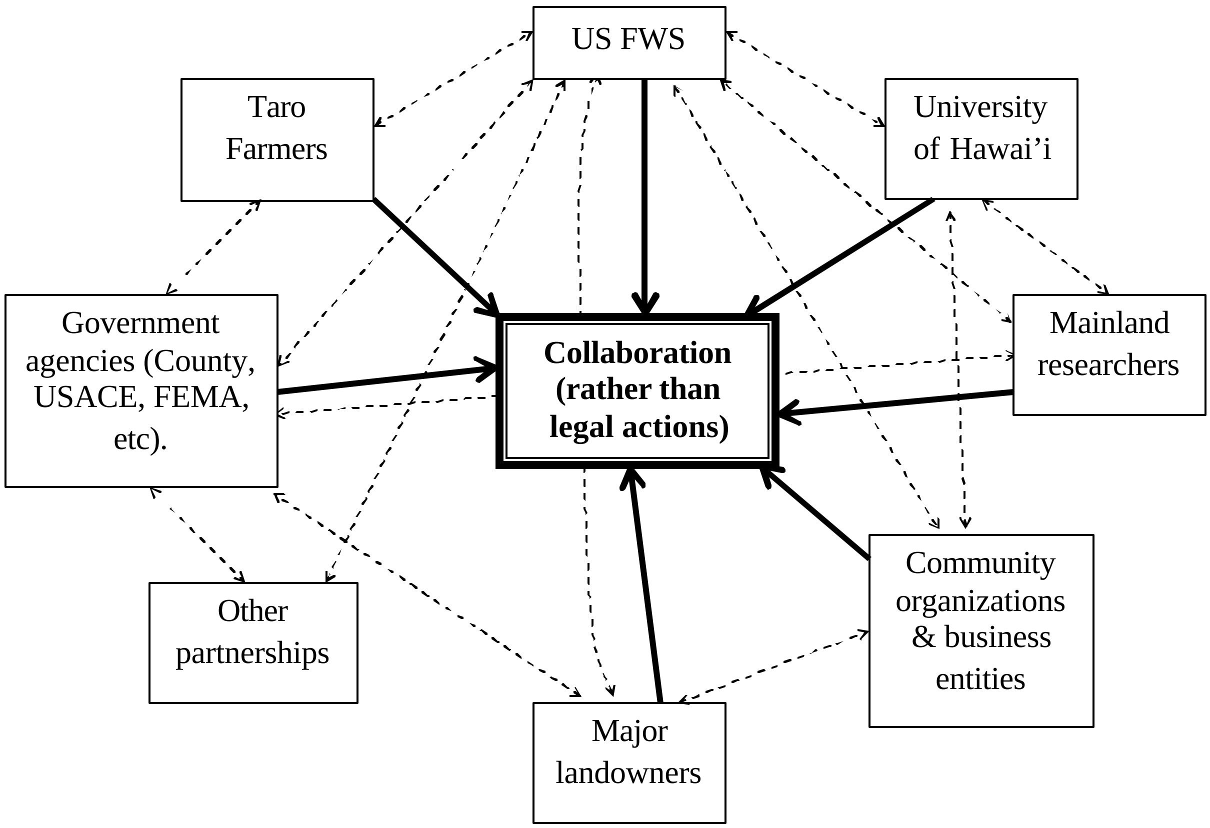
1. What does it encompass?
    - Inter – agency and stakeholders cooperation
    - Open communication
    - Common direction

2. Key Elements of Collaboration:
    - Participation
    - Networking
    - Communication
    - Identification of possible scenarios

3. Objectives:
    - To built trust in the community for one another
    - To achieve social harmony and cooperation

Group 1 Focus: Taro Farmer– USFWS Relationship

Result:
Collaboration Model of Interaction: "Behavior of Stakeholders in Collaboration Process"



Collaboration is the center and the spirit of inter-stakeholder behavior. In this process, each "player" needs to communicate and coordinate with related agencies or stakeholder.

Group 2 Focus: Alternative Wastewater Management Systems

Considering the technicalities involved in the wastewater alternative system analysis, Group 2 focuses in more detail on the aims, gap identification, and necessary steps to achieve those goals.

Result:

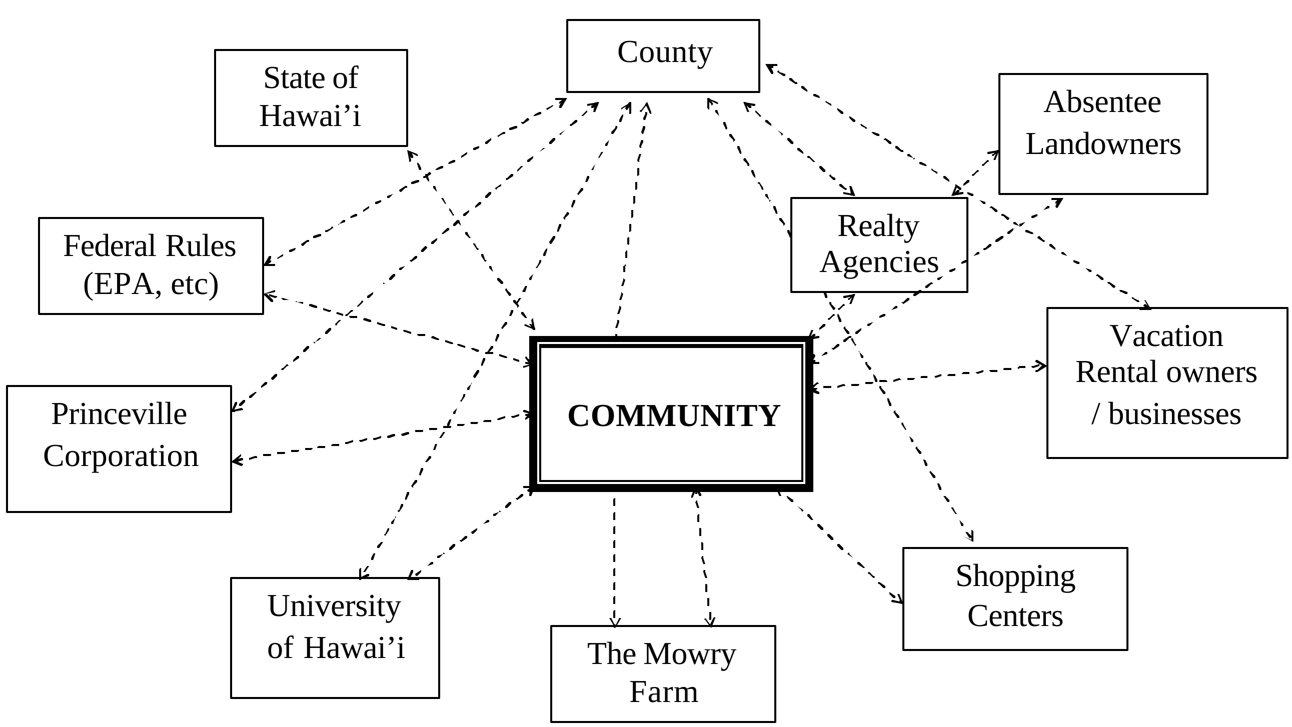
a. The community wants a wastewater disposal system that is
- Safe and effective
- Aesthetically pleasing
- Low cost
- Multifunctional (offers cleaning of water, is educational, can be used as community attraction)

b. The Vision:

Ecologically sound wastewater system of low cost and low impact on tourism and on visual landscape

c. Steps to get there:
- Community forum involving all stakeholders to address alternative systems, their implications and community concerns
- Education and information to build awareness in the community at large
- Pro-active facilitation by the county and community leaders

In addition, Group 2 also identified the following chart to identify roles and connections among agents for this issue, in which the community and the county government are identified as possessing the most lines of influential role and connection, justifying for those two entities to initiate dialog and facilitation to address the wastewater issue:



Group 3 Focus: Tourism and Historic Preservation

In exercising the charette, Group 3 identified visions of the stakeholders, aims and wants, and steps and stages to implement collaborative approach in the process. The results are presented in the following tables:

TOURISM		
Visions	Community / the HHR Hui:	- Benefits from tourism should be directed towards the community rather than to outside investors - Environmental concerns and local outflow
	KVB:	Promote tourism in the whole island
	Taro farmers:	- Sustaining the heritage of taro farmers - more value added for the taro produciton - higher wages for the agricultural sector so that it can compete with the tourism sector in attracting local workers
Aims and Wants	Community / the HHR Hui:	- Monitoring pollution in the river - Property tax assessment - Historic preservation (Bridge)
	KVB:	- Advertising / promotion - Encourage & include tourist flows, by promoting direct flights to Kauai
	Taro Farmers:	- Subsidy from the tourism industry - More variety of product diversification of taro products
Steps and Stages	Communication between those stakeholders Achieve agreement and common ground Mediation and facilitation Design and implementation of a Sustainable Development Plan	
HISTORIC PRESERVATION		
Visions	Community / the HHR Hui:	Historic preservation and cultural resources management
	Government:	Protection for rural and historic characters
	Developers:	Resort development
Aims and Wants	Community / the HHR Hui:	- Voice opinions, participate in preservation planning, and object adverse development projects - Lower property taxes for Hanalei residents
	Government:	- Planning and permits, zoning, grants, and tax incentives
	Developers:	- Properly purchase and develop new residential projects for resort accommodation
Steps and Stages	Dialogue among stakeholders Identify differences, concerns, and problems Mediate and negotiate to create a common goal Formulate policies and programs towards achieving the common goal Implement the policies and programs and evaluate the implementation	

Appendix C.3
Hanalei Community Survey: Quality of Life Assessment

Methodology:

A small representative of the Practicum 751 group participated at the Hanalei Annual Taro Festival on Saturday, October 19, 2002. They shared a table with the HUI, where two community interactive exercises were erected, aiming to obtain a small sample of taro festivals' participants views on (1) the things they value/don't value about Hanalei and (2) their visions for Hanalei. The latter attracted three responses, while the former received three pages of responses with ten respondents agreeing to fill out the related community profile survey. Only two people responded to the questions on what "works for Hanalei", "what does not work?", and "if they could change things how would they do it?"

The aim of the Quality of life Assessment was to ascertain the things about Hanalei that were of value, hence, important to Hanalei's continuity. A correlating map, where these values were marked, utilizing red and green dots, indicated the spatial distribution of these values throughout the most populated section of Hanalei. The "Visions" exercise hoped to ascertain the direction in which Festival participants wanted Hanalei to develop in the future.

Results of the Community Interactive Exercises:

1. Quality of Life Assessment

Participants were asked to give a list of things they value and/or do not value about Hanalei. The responses were categorized into the two fields, with responses numbering as many as the respondents could think of. No limitations were established for responses per person. For statements that were already listed, respondents either checked it off or wrote it again.

The responses were further classified into two values: negative and positive. These were colour-coded into red and green dots, with the red denoting negative, while the green denoted positive. After stating their responses, the respondents marked off these values onto a map of Hanalei. Some freely stuck their dots on the map, while others requested assistance from a practicum representative.

The complete responses, transcribed from the original statements are given in Table 1, below.

Table 1

Things You Value About Hanalei (+)	Things You Do Not Value About Hanalei (-)
✓ Black Pot Beach ✓ Hanalei Bay Area ✓ Doug and Sandy playing at sunset at the Bay ✓ Hanalei Bay – just as it is ✓ Local Farmers Market* ✓ Local old timers and families* ✓ Worship at Wai'oli Hui'ia United Church and Christian Education there ✓ Community involvement in beach and road clean-up ✓ Beach access ✓ Hawaiian loi be return to the natives ✓ The historic road system! ✓ One-lane bridges! * ✓ Cultural use and access* ✓ Flowers changing color 3x Daily. Hau ✓ Please maintain and paint the old bridges ✓ Wildlife Refuge-Native wildlife ✓ Taro ✓ Hanalei Bay Water quality (fishing and swimming) ✓ Hanalei Pier ✓ Sunset views ✓ Camping and pick-nicking ✓ Surfing hiking clean ocean sunsets ✓ Small town friendliness ✓ Good prices for healthy food ✓ Clean beaches ✓ Community involvement with clean beaches and roads ✓ Values of rural community and poi(?) and scale of life ✓ Open spaces ✓ Clean environment ✓ Clean beaches ✓ Bring awareness that most 'beach wash-up' and litter is poisonous cigarette butts	✓ Tourist related activities and excessive development ✓ (no hotels, tennis courts, swimming pool, parasailing) ✓ Building 4-lane highway ✓ Unchecked development ✓ Pollution (sewage in reefs)* ✓ Trash on the beach ✓ Land values keep escalating – locals lose land* ✓ Traffic ✓ High property taxes* ✓ Pollution in the ocean* ✓ Golf course at Princeville – pesticides* ✓ Vacation rentals ✓ Human health hazards (i.e strep staff, e.coli) ✓ Big buses ✓ Boating activity (excessive motor boating) ✓ Overdevelopment ✓ Trash on beach ✓ Commercial atmosphere ✓ Building on woods golf course (no way) ✓ Traffic – traffic into Hanalei should be controlled – maybe by the use of shuttle vans for visitors and residents alike ✓ Lack of enforcement of rules ✓ Too much traffic ✓ Too much development ✓ Too much emphasis / $ on promotion without presentation and planning – if just 25% of HUCB $ spent on above that would = BIG DIFFERENCE

The two fields can be further devolved into sub-categories:

- Environment
- Economic
- Cultural
- Social life
- Development

Based on the classification of participants' statements, the majority of statements referring to what is valued in Hanalei fall under the environment, cultural, and social life categories, specifically, clean environment and socio-cultural variables that render a sense of place and feelings of community for Hanalei. These generally point to clean beaches, maintaining the small scale of life, and historic landmarks that individuals feel make Hanalei what it is.

By comparison, statements pertaining to what are not valued in Hanalei predominantly fall under the categories environment, economic, social life, and development, referring to large-scale development, pollution, structures, and activities that threaten to force Hanalei to make the transition from small, rural town to large resort town.

The original map was, then, digitized to visually demonstrate the spatial distribution of participants' opinions by connecting them to some landmark on the map of Hanalei (see GIS value map). The distribution and location of red and green dots corroborate the statements, with green overwhelmingly represented on the beaches, the old section of town, agricultural land, the taro fields, the ocean, and the National Wildlife Refuge. The red dots were located in the water, indicating the de-valuation of pollution, the roads, the golf course, pending development in the woods in Princeville, and Princeville, itself, indicating excessive development.

1.1 Participant Profile

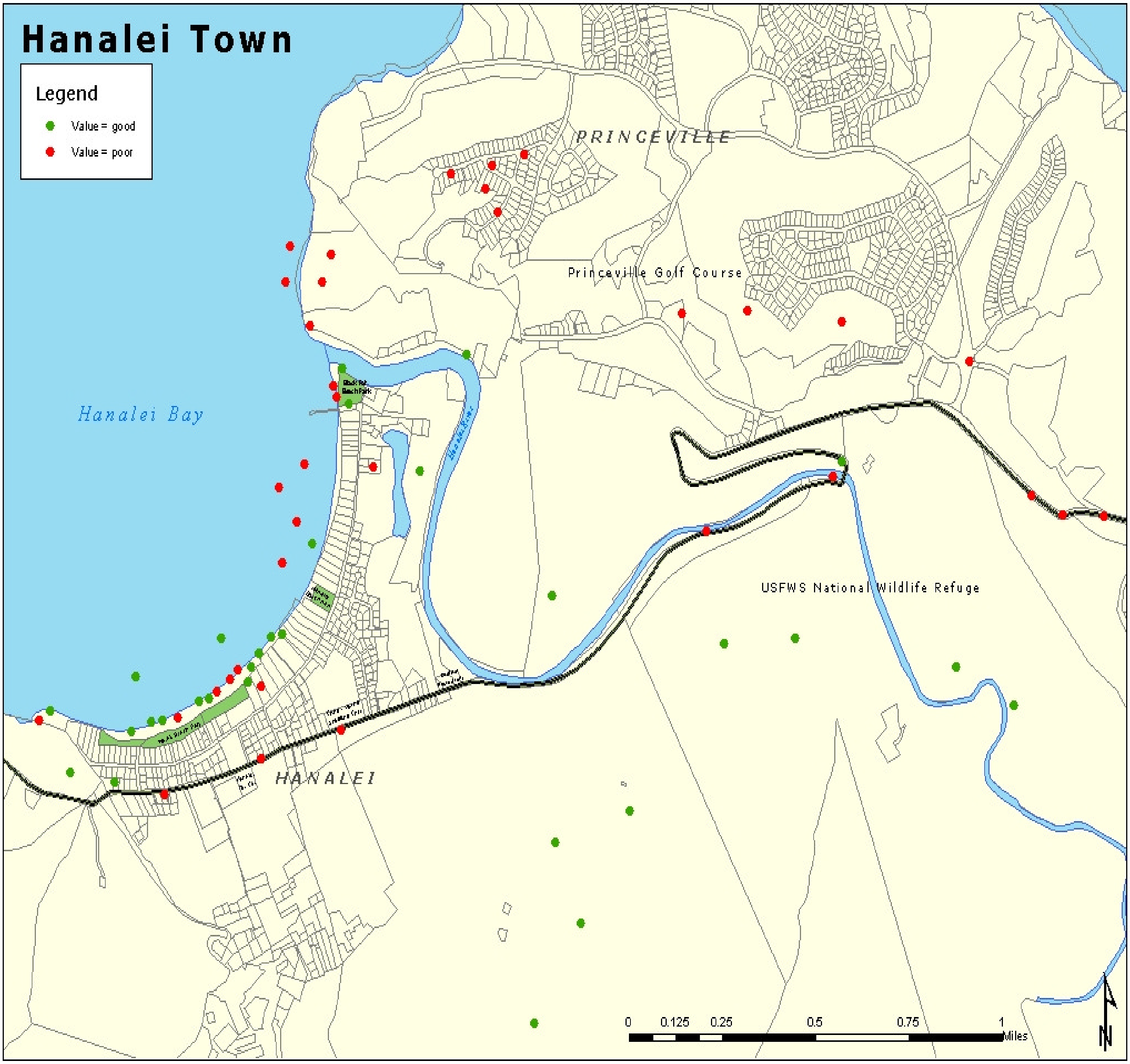
The number of people who filled out the supplementary "Profile" survey was 10, although the actual number fell between 10 and 20. The reason for this variance is due to the fact that several individuals declined to fill-out the participant profile, but at least 10 did, therefore, the exact number of participants in this exercise in unclear.

Because the small number of participants render a 32% sampling error, the results of the Quality of Life Assessment interactive exercise is not a good representation of Hanalei or the surrounding community. It, nevertheless, provides a good indice for gauging how some people feel about the quality of life in Hanalei today. It is also important to note that a higher number of participants would have produced a response profile much different from what was actually recorded.

The community profile, moreover, offers some insight on the type of individual who participated in this exercise. Based on the information given in the profiles, 70% (7) live in rural areas, but not necessarily in Hanalei. The remainder, 30% (3), come from urban areas (again, not necessarily from Hanalei). 100% of the respondents live full-time in their respective hometowns.

All the participants, save for 1, are members of a household. The average household size is 2.9. Household size ranged from 1 to 5. 70% were Caucasian mix, 10% listed him/herself as a "mix", while the remaining 20% did not give an ethnicity. For employment, 70% were professionals, 20% were homemakers, and 10% was a tradesman. 90% participate in local organizations, while only 10% (1) said "no".

GIS Value Map



Wildlife Refuge
- Native wildlife

Taro

Hanalei Bay water quality (fishing & swimming)

Hanalei Pier
- sunset views
- (camping & picknicking)

- SURFING
- HIKING
- CLEAN OCEAN
- SUNSETS

Small town friendliness
good prices for healthy food

✓ pollution in the ocean - too much run-off

✓ golf course at Princeville - pesticides

vacation rentals

human health hazards
- Strep, staff
- ecoli

Big buses

boating activity (excessive motorboating)

- OVERDEVELOPMENT
- TRASH ON BEACH
- Commercial atmosphere
- BUILDING ON WOODS GOLF COURSE (NO WAY)

BLACK POT

Hanalei Bay area
Doug & Sandy playing at sunset at the bay

Hanalei Bay - just like it is

Local Farmers Market *

Local old Timers *
+ Families

Worship at Waioli Huiia United Church
and Christian Education there

Community involvement in
Beach & Road clean-up.

BEACH ACCESS ✓

Hawaiian loi be return to the native's

the historic road system!
one lane bridges! ✓

Cultural use & access ✓

FLOWERS CHANGING COLOR 3X
DAILY · HAU.

Dogs unleashed at ~~Black Pot~~
Waioli Beach Park

Tourist related activities
+ excessive development
(no hotels, tennis courts,
swimming pools, parasailing)
Building 4-lane highway

(unchecked)
✓ Development

✓ Pollution (sewage in reefs)
TRASH ON the Beach

✓ land values
Keep escalating -
locals lose land

Please maintain
+ paint the old
bridges!

Traffic

✓ High Property Taxes

clean beaches

community
involvement with
cleaning of beaches
& roads.

values of rural
community pace + scale
of life

Open Spaces

- Clean Environment

- Clean beaches

Bring awareness that
Most "Beach washup"
and litter is
poisonous cigerrate
Butts.

Traffic - Traffic into
Hanalei should be
controlled - maybe by the
use of shuttle vans.
for visitors and resident
alike. -

lack of enforcement of rules
too much traffic
" development

Too much emphasis / $
on promotion w/out preserva-
tion
& planning - if just 25%
of HVCB $ spent on
above that would =
BIG DIFFERENCE

Appendix D Photographs

D.1. "Burning Sugar Cane, Hanalei, Kaua'i, Hawai'i, ca. 1890"
Source: Bishop Museum, Honolulu, Hawai'i
Photographer: G. Bertram

D.2. "Hanalei Valley, Kaua'i, Hawai'i, showing rice fields and old Princeville Plantation Buildings", pre-1900.
Source: Bishop Museum, Honolulu, Hawai'i

D.3. "Hanalei, Kaua'i Hawai'i", ca. 1890
Source: Bishop Museum, Honolulu, Hawai'i
Photographer: W.E.H Deverill

D.4. "Hanalei, Kaua'i, Hawai'i", ca. 1960.
Source: Bishop Museum, Honolulu, Hawai'i

D.5. "Hanalei, Kaua'i, Hawai'i", ca. 1950.
Source: Bishop Museum, Honolulu, Hawai'i
Photographer: Tai Sing Loo

D.6. "Hanalei Valley, Kaua'i, Hawai'i", n.d.
Source: Bishop Museum, Honolulu, Hawai'i

D.7. "Hanalei Bay, Kaua'i, Hawai'i", pre-1900
Source: W.T. Brigham Collections, Bishop Museum, Honolulu, Hawai'i

D.8. "Hanalei, Kaua'i, Hawai'i", ca. 1890
Source: Bishop Museum, Honolulu, Hawai'i
Photographer: W.E.T. Deverill

D. 9. "Hanalei, Kaua'i, Hawai'i", n.d.
Source: Bishop Museum, Honolulu, Hawai'i

D.10. "Hanalei, Kaua'i, Hawai'i", ca. 1890
Source: Bishop Museum, Honolulu, Hawai'i
Photographer: Bishop Museum

Ocean Arks International

176 Battery Street, Burlington. VT 05401
Tel: 802 860 0011 Fax: 802 860 0022
E-mail: info@oceanarks.org

DESIGN PARAMETERS FOR WASTEWATER TREATMENT

Date: __________________ Contact/Title: ________________________________

Company Name: _________________ Facility Name/Location ______________

Address: ____

Tel: _____________________________ Fax: ______________________________

----

1. Anticipated Flows and Loadings

What are the influent flows and loadings? Please fill in the attached influent data for those parameters that are available:

Influent Water Chemistry

Parameter	Minimum	Maximum	Average	Units
Flow Rate				
Chemical Oxygen Demand				
Biochemical Oxygen Demand				
Total Suspended Solids				
Ammonia				
Total Nitrogen				
Total Phosphorus				
Fats, Oils & Grease				
Temperature				
Others:				

If flow data and water chemistry are not available, what are the projected average, maximum and minimum numbers of people in building(s) for full build-out of the site? What are the specific uses in each building (e.g. offices, lodging, conference facilities)?

Will there be discharges from the building other than sewage (e.g. restaurants/cafeterias, laundry, laboratories)? If so, please describe wastewater characteristics.

What are the future expansion requirements in terms of the above, and the timing of this expansion?

2. Effluent Discharge Goals/Permit Limitations

Parameter	Minimum	Maximum	Average	Units
Flow Rate				
Chemical Oxygen Demand				
Biochemical Oxygen Demand				
Total Suspended Solids				
Ammonia				
Total Nitrogen				
Nitrate				
Fats, Oils & Grease				
Temperature				
Total Phosphorus				
pH				
Others:				

3. Existing Treatment and Disposal

Please describe any existing treatment/pretreatment of the wastewater.

Where is the treated effluent discharged to (leach field, surface water, municipal sewer, wetlands)?

How and where is sludge disposed of?

4. Constructed Wetlands and/or Living Machine™ Design Issues

Please describe seasonal high and low ambient air temperatures.

Please describe any space limitations, poor soil conditions or other potential design constraints.

Will the facility be included in a tour or otherwise open to the public?

Are there other aesthetic requirements of the project? If so, please describe.

Are there opportunities to re-use the treated water on-site (e.g. in toilets, for irrigation, for truck wash down, etc.?) If so, please describe desired re-use.

5. Cost Considerations

What is the annual operating cost of the existing wastewater treatment facility if it exists?

If discharging to the sewer, what are the average annual discharge fees?

What are the sludge disposal costs? If trucking is involved, what are the rates?

Are there any other significant costs associated with wastewater treatment? Please explain.

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2. Annual Change in Water Consumption
   Kaua'i Department of Water
   Kaua'i Tax Map Key – GDSI

3. Archaeological Sites
   Kaua'i General Plan
   United States Fish and Wildlife Service
   Virtual Taro Patch
<http://hawaiian.net/~cbokauai/ahupuaa.html>

4. High/Low Bacterial Counts (1-3)
   Imagery – NOAA, 20 April, 2000
   Bacteria data – Dr. Carl Berg, Hanalei HUI
   Kaua'i Tax Map Key – GDSI
   Pond Survey – Ducks Unlimited

5. Existing Berms
   Kaua'i Tax Map Key – GDSI

6. Coastal Zone Properties
   Kaua'i Tax Map Key – GDSI

7. Flood Zones
   FEMA – FIRM Data
   Contours – State of Hawai'i
   Kaua'i Department of Water
   Kaua'i Department of Health
   Hanalei HUI
   Kaua'i Tax Map Key – GDSI

8. High Risk Areas + Bacterial Sample Sites
   Kaua'i Department of Water
   Kaua'i Department of Health
   Hanalei HUI
   Kaua'i Tax Map Key – GDSI

9. Historic and Cultural Resources
   National and State Register of Historic Places
   <http://www.state.hi.us/dlnr/hpd/index.htm>
   Kaua'i State Map Key - GDSI

10. Land Use
    Kaua'i General Plan

11. Land Ownership
    Kaua'i Tax Map Key – GDSI

12. Parcels with Cesspools Using Greater than 30,000 GPM
    Kaua'i Department of Water
    Kaua'i Department of Health
    Kaua'i Tax Map Key – GDSI

13. Proposed Tourism
    Kaua'i Tax Map Key – GDSI

14. Sewage System
    Kaua'i Department of Health
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15. State Land Use Districts, 2000
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    Kaua'i Tax Map Key – GDSI

16. Soil Types
    National Resources Conservation Service (NRCS)

17. Tourist Attractions
    National and State Register of Historic Places
<http://www.state.hi.us/dlnr/npd/index.html>
    Kaua'i Tax Map Key – GDSI

18. United States Fish & Wildlife Refuge
    Hanalei HUI
    Pond Survey – Ducks Unlimited
    Contours – State of Hawai'i

19. Water Consumption
    Kaua'i Department of Water
    Kaua'i Tax Map Key – GDSI

20. Watershed Boundary
    State of Hawai'i

21. Wetlands
    State of Hawai'i

22. Structures. Year of Construction
    Real Property, Kaua'i
    Kaua'i Tax Map Key – GDSI

23. Zoning
    Kaua'i General Plan
    Kaua'i Tax Map Key - GDSI