DRAFT
ENVIRONMENTAL ASSESSMENT
FOR
REPAIR, RECONSTRUCTION, AND MAINTENANCE
OF
KAHINAPOHAKU FISHPOND
MOANUI AHUPUA'A
MOLOKA'I HAWAII (TMK 5-8-01:2)

Prepared for:

Aquaculture Development Program
Department of Land and Natural Resources

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January 1993

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PROJECT APPLICANT:

Aquaculture Development Program
Department of Land and Natural Resources
State of Hawaii

John S. Corbin, Manager

January 1993

ACCEPTING AUTHORITY:

Department of Land and Natural Resources

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SUMMARY

1.1 OBJECTIVE

The objective of the proposed action is the repair and reconstruction of Kahinapohaku Fishpond. It is intended that this restoration will serve as a model for restoration of other fishponds on Moloka'i and throughout Hawaii, and that it will facilitate the revitalization of community and *'ohana*-based traditional operation and management skills once associated with Hawaiian fishponds. The cultural and natural resource value of Kahinapohaku Fishpond to the Hawaiian community and the fishpond *'ohana* has been progressively lost as a result of structural damage to the fishpond wall by recent and historic tsunami and storm waves, regulatory obstacles, and general neglect of this unique coastal and cultural resource.

1.2 LOCATION

The proposed project site is identified as TMK 5-8-01:2, and is located in East Moloka'i, roughly halfway between Waialua and Halawa Valley (Exhibit 1). The fishpond is situated within the Moanui *ahupua'a* and lies immediately adjacent to and below State Highway 450. It is separated from the highway by an irregular embankment that has been reinforced by a seawall constructed of basalt boulders. The project site consists of a 4.0-acre (1.6 hectares [ha]) fishpond that is delineated on its *makai* (seaward) margin by a deteriorating 1200-foot-long (366 meter-long) wall constructed of basalt foundation boulders, and on its *mauka* (landward) margin by a rock seawall and Highway 450 (Exhibit 2).

1.3 THE PROPOSED ACTION

The proposed action involves the repair and reconstruction of the fishpond wall and at least one *makaha* (sluice gate); periodic post-construction maintenance of the fishpond wall and basin; and operation of the fishpond using traditional, culturally-based, management practices.

Repair and reconstruction will entail the following actions: 1) the physical movement, alignment, and retrieval of wall foundation boulders from within the pond basin using a tracked backhoe or loader/dozer; 2) the manual movement, manipulation, and temporary stockpiling of smaller *'ili'ili* (pebbles or rubble) within the fishpond basin; and 3) reconstruction of the pond wall using existing onsite rock, mechanized equipment, and *'ohana*-provided manual labor. Construction will take place in 1993 and is scheduled to occur between April and September when low to minus tides are common.

Periodic post-construction maintenance activities are required to facilitate the long-term use and management of the fishpond. These activities will include manual replacement of wall stones dislodged as a result of heavy surf action, and manual removal of wave-deposited sand and rock from the fishpond basin to maintain pond depths.

To the extent possible, fishpond use and management will follow traditional practices and methods, subject to existing State-regulated fishing methods, seasons, and catch limits. Marine organisms

cultured or harvested within the pond will be used for either subsistence purposes or as stocking materials for other Moloka'i fishponds.

Fishpond restoration expenses, based largely on heavy equipment rental and operation costs, are estimated at $22,267. Funding sources have, to date, not been identified but are expected to be derived from a combination of Federal, State, County, and private sources.

Existing Conditions

Water Quality. Kahinapohaku Fishpond demonstrates physical and chemical characteristics more or less typical of nearshore coastal waters with slight groundwater or surface water inputs. Overall water quality is generally high with no physical or chemical parameters likely to be limiting to marine organisms. The fishpond is subject to moderate siltation associated with discharges from Moanui Stream; these discharges may have a minor influence on coral growth and development.

Physical Environment. The underwater topography of the fishpond and adjacent nearshore areas consists of five physiographic zones: 1) a sandy, but somewhat silty, intertidal and nearshore subtidal zone; 2) a pond basin characterized by boulder- to cobble-sized basalt rock; 3) a broad zone of *'ili'ili*; 4) the structural remains of the fishpond wall; and 5) a wave-exposed seaward limestone reef flat platform.

Water currents within the fishpond are dominated by wave set-up on the seaward reef flat which produces a pronounced east-to-west flow during high to intermediate tides. During low tide periods, water currents are negligible because of the protection conferred by the existing wall, but wind influence may be considerable during low tide periods associated with prevailing tradewinds. Water quality studies indicated that oceanic conditions of temperature, salinity, and dissolved oxygen prevail in the pond.

Biological Environment. The beach strand habitat has been extensively modified as a result of road construction and periodic cutting.

Seven species of coral were recorded within the fishpond basin or in association with the structural remains of the fishpond wall. Coral zonation was not evident, suggesting storm-wave deposition. Because of their small size and prostrate growth forms, reef platform corals do not provide any significant habitat for fishes or invertebrates.

The macroalgal flora varied widely among the microhabitats of the fishpond. Brown algae dominated the fishpond basin, whereas articulated and non-articulated coralline red algae dominated the seaward reef flat platform.

The macroinvertebrate fauna of the fishpond basin demonstrated low diversity and was composed of common intertidal and subtidal mollusks, urchins, and crustaceans. The pond wall was dominated by sea cucumbers.

Fishes were, with few exceptions low in both diversity and abundance. Dominant species included *manini, kupipi,* and *mamo.*

Social/Cultural Environment. Kahinapohaku Fishpond, a *loko kuapa*,[1] is a State-registered historical site (State Site 50-60-05-228). It is regarded as being in "fair to poor" condition because of the largely submerged wall and shallow pond basin. Archaeological data collection and retrieval activities are deemed to be complete; thus it is not anticipated that any archaeological or cultural information will be jeopardized or lost as a result of the proposed action.

The proposed action is consistent with, and has the widespread support of, the Governor's Task Force on Moloka'i Fishpond Restoration (the Task Force), the Moloka'i community, and the respective pond *'ohana*.

Impacts

Land Use. The proposed action will not significantly change or modify existing use of the shoreline or submerged lands adjacent to, or associated with, the fishpond. The proposed action will allow the resumption of fishpond operation, management, and marine resource harvesting in a manner consistent with Hawaiian cultural and traditional values. Revitalization of the fishpond is expected to result in an increase in harvesting activities by the *'ohana* of the Moanui *ahupua'a*.

Water Quality. The proposed action will result in a small increase in water turbidity and elevated levels of suspended solids associated with the movement, stockpiling, and repositioning of wall foundation stones, smaller wall stones, and *'ili'ili*. Such changes would be short-term in nature and would not adversely affect marine organisms within the fishpond basin or in adjacent coastal waters. Because of the high interchange between fishpond waters and adjacent coastal waters, and tradewind influence, no diminution in dissolved oxygen levels are expected to occur as a result of wall reconstruction or subsequent operation of the fishpond.

Physical Environment. The proposed action will alter the physical topography of approximately 3.0 acres (1.2 ha) of the fishpond substratum as a result of the collection and repositioning of wall stones. The existing substratum will change from one dominated by stones, cobbles, and *'ili'ili*, to one of mixed cobble and sand. Water depths within the fishpond will increase by approximately 1 foot (ft; 0.3 meters [m]) as a result of rock removal. Vertical relief associated with the existing pond wall will be increased along an approximately 1200-ft-long (366-m-long) corridor as a result of the wall reconstruction. Water currents within the fishpond will decrease, although restoration of at least one *makaha* will ensure that adequate exchange is maintained with adjacent coastal waters. The ability to regulate tidal exchange and water currents is a desirable consequence of the proposed project since it will permit the biological productivity of the fishpond to increase in a manner consistent with Hawaiian aquacultural practices.

Biological Environment. The proposed action will result in no significant short- or long-term environmental impacts to the fishpond basin or adjacent marine communities. Minor impacts would accrue to an epibenthic macroalgae community that dominates most subtidal rocks in the fishpond basin as a result of rock removal, stockpiling, and wall reconstruction. Heavy equipment operations, rock repositioning, and other manual activities will result in the temporary relocation of some fishes. However, these fishes presently move between the fishpond basin and adjacent coastal waters as a

[1] "A fishpond of littoral water whose side or sides facing the sea consist of a stone or coral wall usually containing one or more sluice grates" (DHM 1989).

result of tidal fluctuations, thus such temporary dislocations are not expected to result in any adverse impacts to the affected species. Rock repositioning and wall construction may crush certain benthic invertebrates, however, these losses are expected to be minor.

Social/Cultural Environment. The proposed action will not adversely impact the archaeological or cultural integrity of the fishpond, inasmuch as data retrieval efforts are deemed complete. The action will, conversely, result in a revitalization of traditional fishpond technology and use. The proposed action is consistent with the goals and objectives of the Task Force and its Cultural Committee.

SECTION 2
PROJECT DESCRIPTION

2.1 PROJECT BACKGROUND

Hawaiian fishponds and fishtraps are a unique cultural resource and food production system developed and refined by pre-Western and post-Western contact Hawaiians. Fishponds have declined statewide in importance and value as result of many contributing factors. On Moloka'i, where approximately 70 known fishponds once flourished, the situation is particularly acute.

Among the factors accounting for the decline in Hawaiian fishpond use on Moloka'i are the following: 1) changing seafood markets and consumer demand; 2) infilling of ponds by silt as a result of agricultural runoff combined with poor soil and range management practices, and upland wind and water erosion exacerbated by overgrazing of domesticated and feral animals; 3) improperly designed stormwater and flood control channels; 4) destruction of fishpond walls by tsunami and regional tropical cyclonic storm events; 5) reclamation of ponds as a result of mangrove introduction and spreading; 6) changing land use practices; and 7) Federal, State, and County regulatory obstacles to fishpond reconstruction.

The Task Force was established in 1991 to reverse the loss of these important cultural and archaeological resources, and the impact of this loss on the traditions of the Hawaiian community. Among the objectives of the Task Force were a community-based fishpond restoration and revitalization targeted at selected ponds and fishtraps on Moloka'i. Kahinapohaku Fishpond was selected by the Task Force as one of two ancient ponds for community and *'ohana*-based reconstruction and revitalization. Selection of the Kahinapohaku Fishpond was based on its ownership by the State of Hawaii, regulatory agency support, small size, absence of significant archaeological constraints, lack of siltation, minimal environmental impact, public access considerations, and the strong support demonstrated by the Moloka'i community, the Kahinapohaku *'ohana*, and the Cultural Committee of the Task Force (Governor's Task Force on Moloka'i Fishpond Restoration 1992).

2.2 PROJECT PURPOSE

The purpose and objective of the proposed project is the repair and reconstruction of Kahinapohaku Fishpond. It is intended that this restoration will serve as a model for restoration of other fishponds on Moloka'i and throughout Hawaii, and that it will facilitate revitalization of community and *'ohana*-based traditional operation and management skills once associated with ancient Hawaiian fishponds. The cultural and natural resource value of the fishpond to the Hawaiian community and the fishtrap *'ohana* has been progressively lost as a result of structural damage to the fishpond wall caused by recent and historic tsunami and storm waves, regulatory obstacles, and general neglect of this unique coastal and cultural resource.

The proposed action is consistent with the goals and objectives of the Task Force and its Cultural Committee, and has the support of the Kahinapohaku *'ohana*. In addition, a majority of Moloka'i residents responding to a community-based questionnaire voiced their support of the project.

2.3 PROJECT LOCATION

The project site is located on submerged lands designated as TMK 5-8-01:2 in the Moanui *ahupua'a* of east Moloka'i, approximately 18 miles east of Kaunakakai (Exhibits 1 and 3). The fishpond abuts Highway 450 (Kamehameha V Highway) on its *mauka* margin and lies immediately southwest of the mouth of Moanui Stream, an intermittent stream which drains an estimated 3000 acres (1,214 ha) of East Moloka'i watershed, including State Forest Preserve. The fishpond's northeastern margin is located approximately 3,900 ft (1,200 m) southwest of Honouliwai Bay. The landward margin of most of the fishpond is dominated by a rock seawall that appears to have been constructed from foundation stones removed from the fishpond (as evidenced by their smooth, wave-worn, appearance and the absence of large wall foundation stones from the extreme southwest and northeast sectors of the nearshore pond wall) (Exhibit 2).

2.4 GENERAL DESCRIPTION OF PROJECT ACTION CHARACTERISTICS

The proposed action involves the repair and reconstruction of the fishpond wall and one pond wall opening (either a *makaha* [sluice gate] or unmodified entry lane; to be decided onsite by pond wall restorers); periodic post-construction maintenance of the fishpond wall and basin; and operation of the fishpond using traditional, culturally-based, management practices. The proposed project will produce a continuous fishpond wall approximately 1,200 feet (366 m) in total length; an average wall height ranging between 5 to 6 feet (1.5 to 1.8 m); a base width between 14 and 16 feet (4.3 to 4.9 m); and a wall crown width of between 4 to 6 feet (1.2 to 1.8 m). Onsite *'ili'ili* will be used as fill between interior and exterior walls. Cross-sectional diagrams and site plans are shown in Exhibit 4; quantity estimates of construction rock are shown in Exhibit 5.

Repair and reconstruction will involve the following actions: 1) the physical movement, alignment, and retrieval of large (up to 5-ft [1.5 m] diameter; ca. 4.1 tons) basalt wall foundation boulders using a tracked backhoe or loader/dozer; 2) the manual movement, manipulation, and temporary stockpiling of smaller stones, cobbles, and *'ili'ili*, within the fishpond basin; and 3) the reconstruction of the fishpond wall using existing onsite rock and *'ili'ili*, mechanized equipment, and *'ohana*-provided manual labor.

Heavy equipment will access the pond through an existing beach access road located between Moanui Stream and the northeastern side of the pond wall.

Reconstruction will take place in 1993 and is scheduled to occur between April and September when low to minus tides provide optimal conditions for equipment operations and manual labor. The majority of the wall stone is available onsite (within the fishpond basin, or immediately adjacent to the wall), although small quantities of wall stone may have to be collected from the adjacent intertidal reef flat.

Periodic post-construction maintenance activities are necessary to facilitate the long-term use and management of the fishpond. These activities will entail manual replacement of wall or entry lane stones dislodged as a result of storm-wave action, and occasional manual removal of wave-deposited sand and rock from the fishpond basin to maintain water depths.

Fishpond use and management will involve the manipulation of environmental conditions within the pond, and use of submerged net-pens and cages, nets, spears, or other devices in accordance with

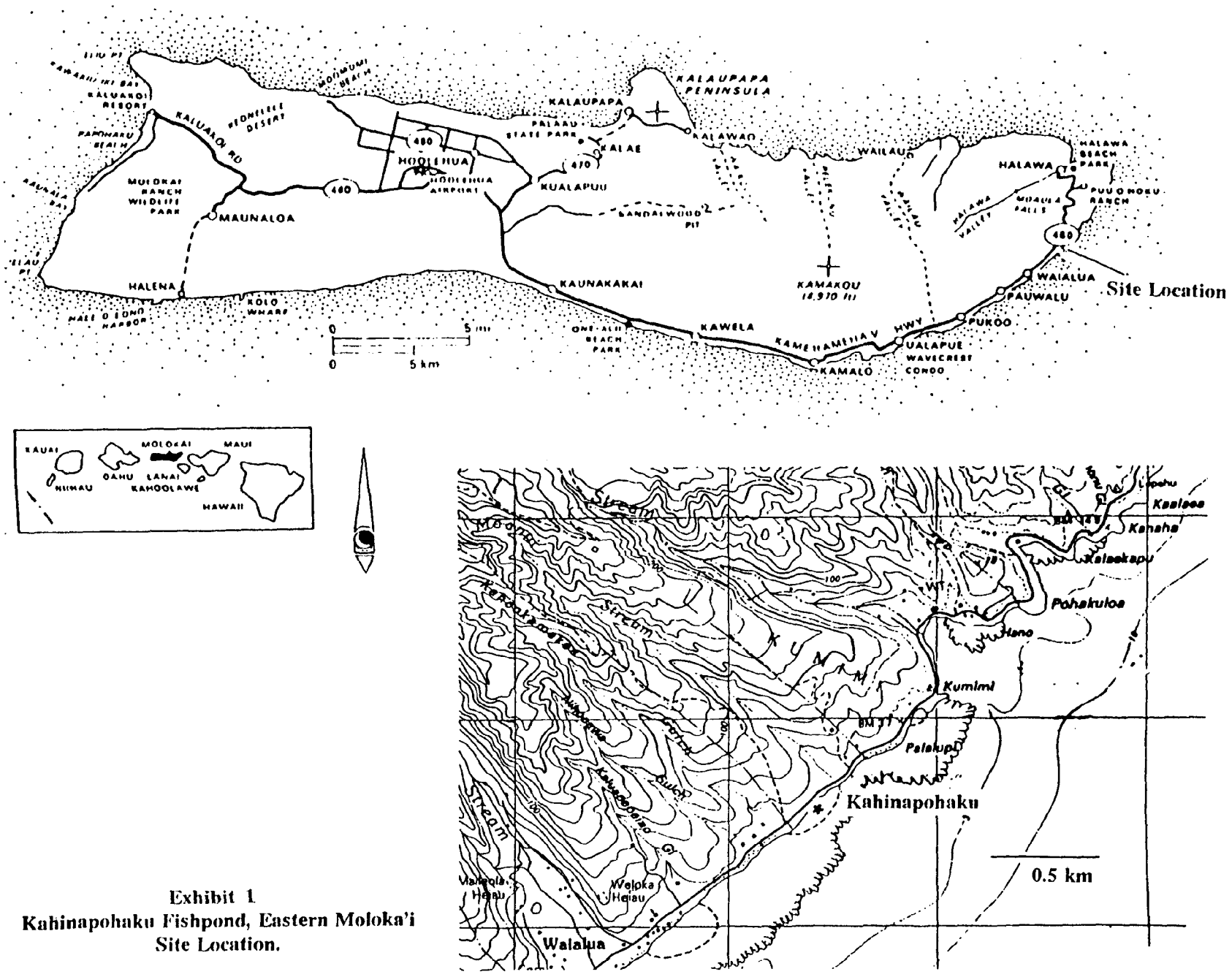


Exhibit 1
Kahinapohaku Fishpond, Eastern Moloka'i
Site Location.

EXHIBIT 2
KAHINAPOHAKU POND

Partial view of nearshore portion of pond, looking towards the southwest.

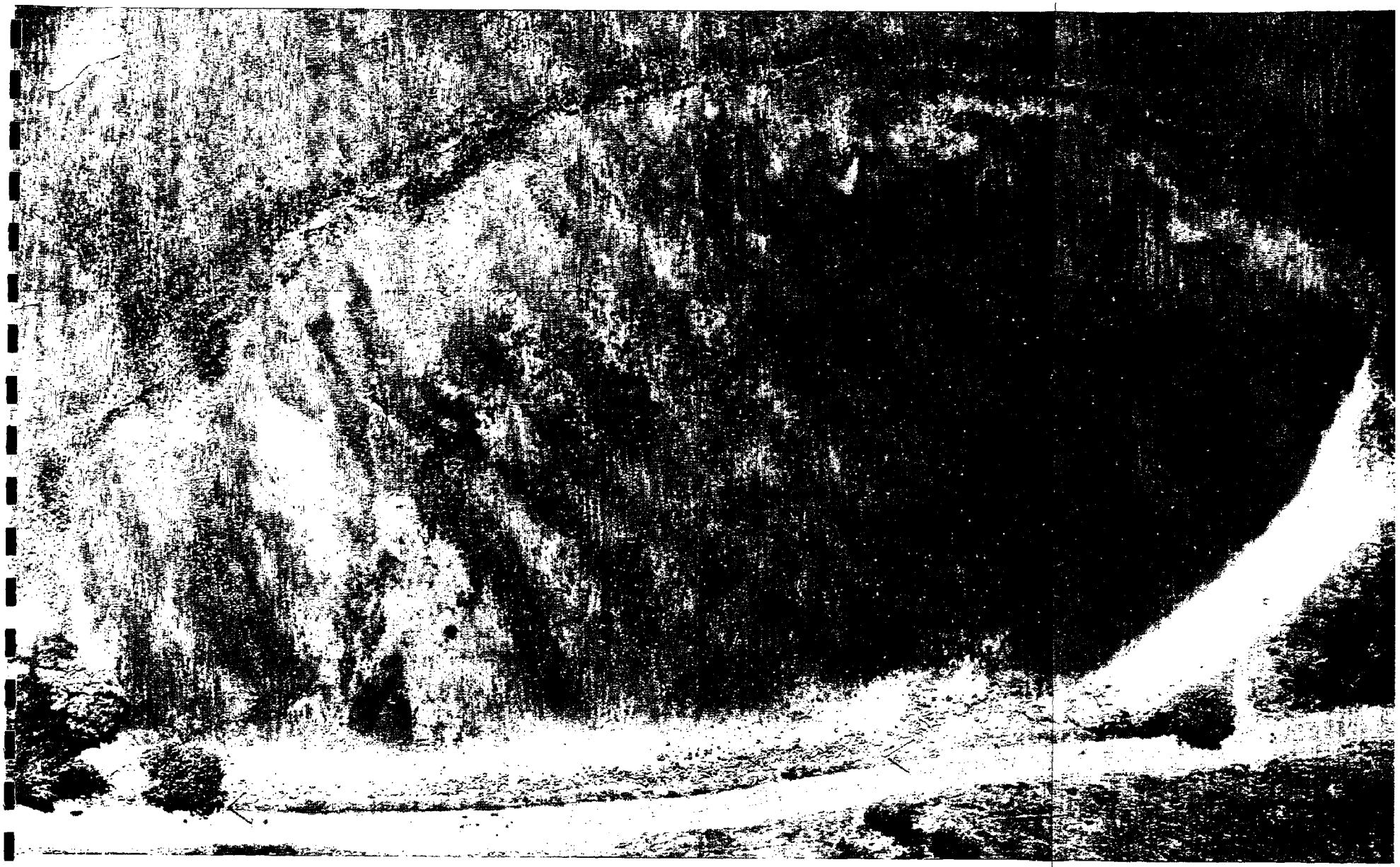
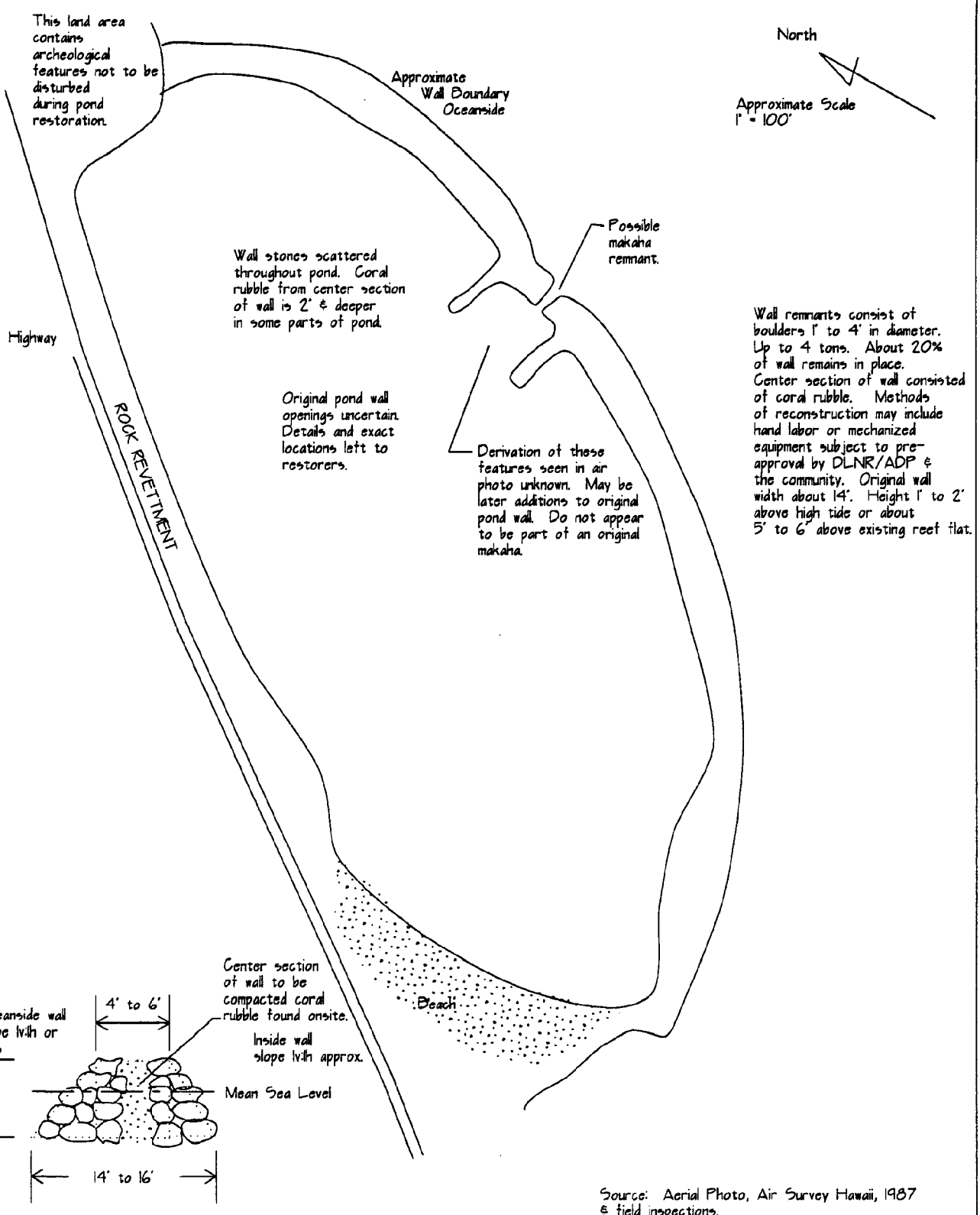


Photo Credit: Air Survey Hawaii (1987), Honolulu
Approximate scale 1 inch = 50 feet

Exhibit **3**
Kahinapohaku Fishpond
Moloka'i, Hawai'i



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KAHINAPOHAKU FISHPOND RESTORATION AQUACULTURE DEVELOPMENT PROGRAM STATE OF HAWAII

Exhibit 4

Exhibit 5: Kahinapohaku Restoration -- Material Requirements

Estimate of rock and coral rubble in Kahinapohaku Pond	
area of Kahinapohaku (acres)	4
area of Kahinapohaku (sq ft)	174240
rocks in Kahinapohaku (diameter, not piled up)	1
percent coverage	50%
volume of rocks (cu yd)	4840
coral rubble in Kahinapohaku (ft, depth of rubble)	1
percent coverage	50%
volume of coral rubble (cu yd)	3227

Estimate of rock in-place or adjacent to the original Kahinapohaku wall alignment	
wall length (ft)	1200
wall width at base	14
average height of in-place rock (ft)	2
volume of in-place rock (cu yd)	1244

Estimate of available rock: sum of rock in place and in pond	
total volume of rock (cu yd)	6084

Estimated rock required for Kahinapohaku	
total cross-section area (sq ft, see text)	60
less coral rubble (sq ft, see text)	(12)
net rock cross-section area (sq ft)	48
less in-place rock (sq ft)	(28)
net cross-section of rock to be restored (sq ft)	20
length of wall including 1 makaha (ft)	1200
volume of rock required (cu yd)	889

Estimated coral rubble required for Kahinapohaku	
total cross-section area (sq ft)	12
wall length (ft)	1200
volume of coral rubble required (cu yd)	533

Notes:

(1) Estimates of available rock and coral rubble are conservative.

(2) Estimates of required rock and coral rubble are based on tentative reconstruction dimensions.

existing State-regulated fishing methods, seasons, and catch limits. Marine organisms trapped, harvested, or cultured within the fishpond will be used for either local subsistence consumption by the *'ohana*, as stocking materials for other Moloka'i fishponds, or both.

Fishpond restoration expenses, based largely on heavy equipment rental and operation costs, are estimated at $22,267. Funding sources have, to date, not been identified but are expected to be derived from a combination of Federal, State, County, and private sources.

SECTION 3
DESCRIPTION OF THE ENVIRONMENT, IMPACTS, AND MITIGATION MEASURES

3.1 PHYSICAL ENVIRONMENT

3.1.1 LAND USE

Existing Conditions. Existing land use at the proposed project site is an inshore limestone reef flat platform that has been historically modified as a coastal fishpond. The project site presently consists of a deteriorated manmade fishpond wall, and a wall stone and *'ili'ili*-littered fishpond basin. Existing land use abutting the fishpond consists entirely of the Highway 450 corridor.

Impacts. The proposed project will change the land use at the project site from an infrequently used inshore fishing ground to that of a managed, operating Hawaiian fishpond. Adjacent land uses will not be affected.

Mitigation. Not applicable.

3.1.2 TOPOGRAPHY AND BATHYMETRY

Existing Conditions. The topography of the site is that of a gently sloping coastal plain which grades sharply to steep upland slopes on the *mauka* side of Highway 450. Elevations of 100 ft (30 m) occur within 328 ft (100 m) of Highway 450. Construction improvements to Highway 450 (ca. 1946 to 1947) altered the topography of the coastal lands fronting the fishpond and likely changed existing upland drainage patterns. The *mauka* side of the fishpond was also believed to have been significantly modified by highway improvements.

The bathymetry of the fishpond basin ranges from approximately 2 to 4 ft (0.6 to 1.2 m) as a function of tidal fluctuation. Topographic relief is limited and reflects the contours of a near confluent layer of boulder- to cobble-sized wall stones, and linear deposits of *'ili'ili* which litter the fishpond basin.

Impacts. The topography of upland areas adjacent to the proposed project site will not be affected. Collection and repositioning of the fishpond's wall stones and *'ili'ili* deposits will result in approximately a 1-ft (0.3 m) increase in mean fishpond depth.

Mitigation. Not applicable.

3.1.3 HYDROLOGY

Existing Conditions. Moanui Stream, which intermittently discharges into coastal waters within approximately 33 ft (10 m) of the northeast fishpond wall, exerts a periodic influence on water quality (salinity and turbidity) within the fishpond and adjacent coastal waters. Moanui Stream drains an estimated 3,000 acres (1,214 ha) of East Moloka'i watershed and grazing lands, including lands within the State Forest Reserve. Intermittent runoff from Kahookamakea, Nihooawa, and Kaluapepeiao gulches, located up to 1,000 ft (340 m) southwest of the fishpond may increase during periods of heavy or sustained rainfall. Discharge waters may periodically influence fishpond water quality.

Salinity measurements conducted during the October to November 1992 field surveys indicated the presence of slight freshwater influence within the fishpond.

Impacts. The proposed action will have no impact on hydrology, or upland or coastal drainage patterns, nor will it contribute to or exacerbate coastal flooding.

Mitigation. Not applicable.

3.1.4 SOILS

Existing Conditions. The submerged lands and coastal areas are comprised of Jaucas sand (0 to 15 percent slopes), representing the Jaucas series of excessively drained, calcareous soils that occur as narrow strips on coastal plains adjacent to the ocean, and manmade lands (fill used for the construction of Highway 450).

Impacts. The proposed project will not change or modify existing soils at the project site.

Mitigation. Not applicable.

3.1.5 NATURAL HAZARDS

Existing Conditions. The proposed project site is located within the Flood Emergency Management Agency (FEMA) hazard zone and within the Civil Defense Tsunami Inundation Zone. *Mauka* portions of the shoreline are subject to flash-flooding; the project site and adjacent shoreline areas are subject to storm wave and tsunami inundation. However, FEMA boundaries are of no relevance to the proposed action, because no temporary or permanent habitable facilities or structures are proposed.

Impacts. The proposed action will not exacerbate coastal flooding or tsunami inundation patterns. The proposed wall reconstruction will, instead, provide a high degree of storm wave protection to the shoreline and adjacent coastal highway. Shoreline erosion, which is particularly acute on the fishpond's southwestern side, will be curtailed.

Mitigation. Not applicable.

3.1.6 WATER QUALITY

Existing Conditions. With the exception of turbidity levels, water quality within Kahinapohaku Fishpond is generally high with nearshore oceanic conditions prevailing. Water quality sampling conducted during the October to November 1992 period showed water temperatures ranging from 26.2 to 27.6°C; salinity values of 33.0 to 35.0 parts per thousand (ppt); and dissolved oxygen values of 6.6 to 7.0 parts per million (ppm) in excess of saturation with respect to the prevailing temperatures and salinities. This finding is not unusual, given the degree of ocean surf influence within the pond and the extent of macroalgal coverage. Silty runoff from Moanui Stream contributes to chronically high turbidity levels within the fishpond, although aside from a silty veneer and reduced underwater visibility, there is no evidence of thick silt deposits within the fishpond.

Impacts. Nearshore water quality impacts associated with the proposed action are expected to be short-term in nature and largely confined to the immediate vicinity of the project site. Wall reconstruction activities such as rock collection, stockpiling, repositioning, and placement are expected to result in a short-term increase in the level of silt and suspended solids within the fishpond basin and adjacent reef flat waters. Increases in suspended solids will result from dislodged algae (both macroalgae and microscopic algae), suspension of organic detritus, and agitation of the silt deposits. However, increases in turbidity levels and suspended solids during wall reconstruction are not expected to approach levels which prevail during periods of heavy rainfall runoff.

The completion of wall restoration activities could result in a slight increase in ambient water temperatures within the fishpond basin. However, any such increases would be small and likely to occur only during low or minus tide conditions when basin waters would be shallow and water circulation reduced. Low or minus tide conditions, coupled with an absence of tradewinds, could exacerbate these conditions, but potential impacts to organisms which are judged to be minor, given the great range of physical and chemical environmental conditions within which such nearshore and intertidal organisms thrive.

Small quantities of hydrocarbons (oil, diesel fuel, or gasoline) may be inadvertently leaked into nearshore waters during heavy equipment operations. Any such leaks will be minor and subject to rapid dissipation through evaporative processes and dilution.

Dissolved inorganic nutrients and the levels of various organic materials may increase slightly with disturbance of rock and benthic deposits within the fishpond. Such impacts are judged to be minor, given the high degree of flushing that the fishpond will be subject to during all but the lowest tides. Increases in nutrient levels associated with low tide conditions may create conditions favoring rapid growth of microalgae, although the resident time of basin waters during low or minus tide periods may likely be too short to permit development of algal blooms.

Mitigation. Wall reconstruction activities will generally be confined to periods of low or minus spring tides when conditions are more favorable for both equipment operations and manual labor. Timing construction during low tide periods will ensure that project-related impacts are largely confined to the fishpond wall and basin area. The reconstruction of the wall will reduce, and possibly eliminate, the influx of silt-laden water from Moanui Stream. This action alone should enhance overall water quality within the fishpond.

3.1.7 WATER CURRENTS

Existing Conditions. The results of limited water current studies conducted during October and November 1992 indicated that prevailing currents flow lateral to the shoreline (northeast to southwest) within the fishpond at velocities averaging approximately 6.8 feet/minute (3.5 centimeters/second) during normal tradewind conditions. Wave surge creates localized zones of much greater velocities, but these zones are confined to the wall openings and channels along the western perimeter of the wall where wave influence is most pronounced. Casual observations made during an extremely low tide, and during an absence of tradewind conditions, suggests that water currents are minimal to non-existent during such periods. However, tradewinds are the norm for the eastern end of Moloka'i, thus during most low or minus tide conditions, wind is expected to have some influence on pond water currents and turnover.

Impacts. The proposed action will modify or attenuate water currents within the fishpond to some degree, although the reconstruction of a *makaha* or entry lane, and the degree of westerly wave exposure, will ensure that modest currents will continue to exist in the fishpond basin following wall reconstruction. The slight deepening of the fishpond resulting from repositioning of wall stones will also have a favorable impact on maintaining water currents within the fishpond. Tradewinds will also continue to exert an influence on water circulation during and following reconstruction of the wall.

Mitigation. The slight deepening of the fishpond, and the presence of at least one *makaha*, or entry lane, will ensure that wall construction will be self-mitigating with respect to water currents.

3.1.8 AIR QUALITY

Existing Conditions. Air quality in the vicinity of the project site is presumed to be high because of the low population density in the region. The major sources of air pollutants include light traffic on Highway 450, salt spray (originating from wave action), occasional outboard motor use, and periodic volcanic fog (vog) and smoke originating from a sustained volcanic eruption on the island of Hawaii.

Impacts. The proposed project would create a minor and temporary source of air pollution as a result of engine emissions from heavy equipment operations, and vehicles used by the wall restoration crew. These impacts are short-term in nature and would be limited to a no more than 3 to 6 month construction period.

Mitigation. Not applicable.

3.1.9 NOISE

Existing Conditions. The project site is situated away from noise-sensitive locations. Existing noise at the project site is the result of light vehicular traffic on Highway 450, an occasional outboard motor, and wind and wave action. Surf hitting the offshore reef and fishpond wall is, by far, the most noticeable noise source at the project site.

Impacts. Project-generated noise is not expected to be significant. Noise will be generated as a result of internal combustion engine operation and associated hydraulic accessories. Noise generation will be limited to daylight periods, and normally for intervals not exceeding six hours in total duration (low tide periods). Noises will also be associated with the mechanical repositioning of both foundation stones and smaller wall stones.

Mitigation. Not applicable.

3.2 BIOLOGICAL ENVIRONMENT

3.2.1 MARINE ENVIRONMENT

Existing Conditions. The results of baseline marine environmental surveys conducted during the October to November 1992 period (Appendix A) indicated that Kahinapohaku Fishpond presently supports a very modest assemblage of marine organisms. The fishpond appears to be functioning as a nursery for several species of reef fish of commercial and subsistence value. With few exceptions,

large or mature fishes were absent from the fishpond as were fishes normally associated with live coral reef habitats. The presence of two species of edible macroalgae (*limu*) in the pond is a positive indication that existing water quality conditions remain conducive to the growth of traditionally important seaweeds.

Algae. The marine algae, or seaweeds, constitute one of the most conspicuous groups of living organisms within and adjacent to Kahinapohaku Fishpond. The majority of the algae were attached to subtidal basaltic cobbles and boulders. Generally speaking, the algae associated with the fishpond basin were represented by species with a lax, upright habit, while the algae on the exposed boulders and seaward reef flat platform were either turf or mat-forming species, which are adapted to survival in a more exposed, high-energy environment. Acanthophora spicifera was the dominant macroalga throughout the fishpond basin, often forming uninterrupted, monotypic stands which completely covered most submerged rocks. Other less common species included Dictyota friabilis, Dictyosphaeria cavernosa, Galaxaura filamentosa, and Galaxaura fastigiata. In wave- and surge-prone areas, such as the pond wall, the coralline red algae Porolithon, Hydrolithon, Lithophyllum, Neogoniolithon, and Sporolithon were common. Most red corallines are normally found within high-energy wave environments, such as the seaward reef margin or reef crest. The fact that so many species of red coralline algae were found within the fishpond basin likely indicates strong wave influence, and possibly wave deposition, within the basin.

Non-coralline red algae were common, but less conspicuous than red coralline species. Of the fleshy red algae observed, two edible species were noteworthy: Gracilaria coronopifolia (*limu manauea*) and Asparagopsis taxiformis (*limu kohu*), both of which were infrequently observed in areas subject to moderate currents or wave action. Other red algae were common on the reef flat, and included both articulated and non-articulated coralline red algae.

Corals. A total of seven species of corals were recorded within or in association with the structural remains of the fishpond wall, basin, and on the adjacent reef flat. Represented species included various Porites, Pocillopora, Leptastrea, and Montipora. As is more or less typical of high energy wave environments, the represented colonies generally consisted of small nodular or low encrusting growth forms. There was no zonation pattern evident in the fishpond basin, suggesting that recruitment is largely a function of storm wave deposition of coral shards. This observation is further corroborated by the large number of unattached colonies that were evident throughout the fishpond.

Within the fishpond basin coral coverage is highest along the *makai* edge of the pond wall where wave surge and water currents appear strongest. Coverage in this zone averages approximately 5 percent, although in localized areas coverage may reach 20 percent in areas influenced by clean offshore waters.

Coral coverage within the fishpond basin averages less than 0.1 percent, despite the fact that live corals (mainly Pocillopora damicornis) occur to within 20 ft (6 m) of the shoreline.

Because of their small size and prostrate growth forms, the represented corals do not provide any significant habitat for nearshore fishes or invertebrates within the fishpond or on the adjacent seaward reef flat platform.

Fish. The fishpond is surprisingly low in both diversity and biomass of fishes (Appendix A). The majority of the observed species were restricted to the pond wall and areas of topographic relief

immediately adjacent to the wall both seaward and landward. The pond basin is almost entirely devoid of fish. The dominant fish species were Acanthurus triostegus (*manini*), Abudefduf sordidus (*kupipi*), and Abudefduf abdominalis (*mamo*). Other fishes included *kupipi, moa, 'ohua, moana, hilu pili-ko'a, 'alo-'ilo'i,* and *kikakapu.* The absence of suitable coral reef habitat resulted in the presence of relatively few "reef" fishes.

Macroinvertebrates. The macroinvertebrate fauna associated with exposed wall boulders was more or less typical of most semi-exposed to exposed rock shorelines throughout Moloka'i and the remainder of the State, although the density of many species was low. The rounded and smooth surfaces of the wave-worn basalt boulders do not provide an optimum substrate for the attachment of some organisms and may contribute to the low density of invertebrates observed. The largest and most conspicuous macroinvertebrates were the holothurians (sea cucumbers) which dominated the fishpond wall boulders, but were largely restricted to seaward, exposed parts of the wall. Intertidal boulders hosted an assortment of common gastropod mollusks and crustaceans, including *pipipi, pupu kolea,* false *opihi,* and *a'ama* crabs.

Impacts. Collection, temporary stockpiling, and repositioning of rock will result in the loss of portions of a dense, albeit largely monotypic, benthic algal community that presently dominates the fishpond basin. A loss of some benthic invertebrates is also expected to occur, but densities of these species are low and impacts will not be significant. Small quantities of silt and organic detritus are likely to be suspended from the fishpond bottom during rock repositioning but are unlikely to cause significant impact as they would be largely confined to the existing fishpond basin and adjacent nearshore waters. The fishpond basin is well flushed as a result of heavy wave action. Therefore, there is little potential for silt or detritus to accumulate in concentrations that would be harmful to corals or sedentary invertebrates. The marine community occurring in the pond appears to have adapted to the prevalent silty conditions.

Adverse impacts to the extant coral community will be limited because of the paucity of represented species and the low densities of coral associated with the fishpond basin and pond wall. Long-term benefits to the coral community may be expected from the reduction in silt loading to fishpond basin waters.

Impacts to the fish fauna are expected to be small and of no ecological consequence. Construction activities would cause the fishes to flee the construction site. Fishes routinely move between the fishtrap and adjacent waters through existing pond openings and this behavior would likely continue through the construction phase of the project.

Fishing opportunities in the fishpond will be curtailed during reconstruction activities. As a result, fishermen who routinely practice throw-net, spear, or surf fishing in the vicinity of the project site may have to find alternative fishing areas elsewhere on the seaward reef flat. However, most fishing in the area is conducted by residents of the Kahinapohaku *'ohana* who have expressed support for the proposed project.

Upon completion of wall construction, the increased vertical relief, together with the use of large foundation boulders and smaller stones, will provide a number of new protected microhabitats and niches for many marine organisms. Such protected habitats are presently few in number because of the limited topographic relief available in the fishpond. Epibenthic algae and invertebrates are expected to recolonize the repositioned pond boulders and stones. The collection of existing rock and

cobbles, now littering the pond basin, will result in a deepening of the fishpond which is expected to increase biodiversity over baseline conditions. Wall reconstruction is expected to result in an improvement in water quality, since silt-laden upland waters emanating from Moanui Stream will no longer have a significant influence on fishpond water quality.

Mitigation. Not Applicable.

3.2.2 TERRESTRIAL ENVIRONMENT

Existing Conditions.

Terrestrial Flora. The coastal strand has been almost entirely modified as a result of highway construction and maintenance (brush cutting). The beach vegetation adjacent to the fishpond was comprised of a limited number of coastal strand species including *koa haole, naupaka, milo, hau, kiawe*, and beach heliotrope.

Terrestrial Fauna. Birds associated with the coastal strand and beach slope included the common (Indian) mynah and the zebra dove. Various species of wading birds are likely to use the shoreline areas abutting the shoreline, although none was observed during October to November 1992 field surveys. Within the fishtrap's sandy intertidal zone, burrows possibly constructed by the ghost crab (*ohiki*) were evident in several isolated patches.

Impacts. Impacts to coastal strand plant communities will be minor and will result from heavy equipment ingress to and egress from the project site. Noise and activity associated with heavy equipment operations and manual labor may temporarily dislocate wading birds and exotic birds which may frequent the fishpond waters or adjacent disturbed strand and upland communities. Such temporary displacements are not regarded as significant.

No Federal or State-listed endangered or threatened plant or animal species or any designated critical habitat will be affected by the proposed project.

The reconstructed fishpond wall will likely create a permanent, and somewhat protected, resting or feeding habitat for indigenous wading birds. The deepening of the fishpond basin is also likely to increase biodiversity, resulting in improvements of the pond as a feeding site for indigenous seabirds and wading birds. The diversity and density of certain wading birds and seabirds may increase with the operation of the fishpond because of the greater abundance of fish biomass and forage fishes within the fishpond.

Mitigation. Not Applicable.

3.2.3 ENDANGERED AND THREATENED SPECIES

Existing Conditions. The federally-listed endangered Humpback whale is seasonally found in waters off the coast of Moloka'i. This endangered marine mammal performs breeding, calving, and nursing activities in Hawaiian waters between the months of November and April or May, particularly in the area bounded by Maui, Moloka'i, Lanai, and Kahoolawe.

The federally-listed endangered Green sea turtle is known to forage and rest in shallow waters around the Hawaiian Islands and may occur in the vicinity of the project site. The threatened Hawksbill turtle may also occasionally occur in the vicinity of the project site. Neither species was observed during October and November 1992 field surveys.

Impacts. Impacts to the Humpback whale are not expected since proposed wall reconstruction activities will take place between April and September when most breeding and calving have been completed. Because of the small size of the proposed project, no impacts on extant turtle populations is expected.

Mitigation. Construction activities would cease, should turtles be observed within the vicinity of the active construction site.

3.3 CULTURAL ENVIRONMENT

Existing Conditions. Kahinapohaku Fishpond, State Site 50-60-05-228, is a Class IIB fishpond,[2] and Type I in typology.[3]

An archaeological reconnaissance survey conducted on 30 November 1992 by the project's archaeologist and staff of the Historic Preservation Division, Department of Land and Natural Resources, revealed no new surface sites of historical or archaeological significance associated with the fishpond (Appendix B). Additional data collection or retrieval is not deemed necessary.

Impacts. The proposed project will result in the community and *'ohana*-based reconstruction and revitalization of an ancient Hawaiian fishpond. The fishpond wall will be reconstructed and maintained in a manner consistent with traditional fishpond operational and management practices, but is unlikely to replicate the original fishpond design and configuration as these details have been lost from the historical record. The project will, however, provide a model for community-based restoration, and thus provide unquantifiable social and cultural benefits for Moloka'i's native Hawaiian community and fishpond *'ohana*. Such positive impacts on the affected community are judged to greatly outweigh any negative impact associated with the proposed reconstruction of the wall in a manner that may differ somewhat from its historic condition.

Mitigation. The proposed project is believed to be self-mitigating since it would result in the restoration of a fishpond that is in an advanced stage of disrepair.

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[2] Wall in fair to poor condition, or submerged. Heavy siltation, or completely filled. Vegetation encroachment on most or all of fishpond. Three or less National Register criteria (DHM 1989).

[3] A *loko kuapa* is a fishpond of littoral water whose side or sides facing the sea consist of a stone or coral wall usually containing one or more sluice grates (Kikuchi 1973).

SECTION 4
PUBLIC FACILITIES, SERVICES, AND IMPACTS

The proposed action will not directly or indirectly impact any public facilities, services, or utilities. The proposed project may result in an expenditure of public funds from Federal, State, or County funding agencies. However, no such funding sources have, to date, been identified.

The entire project site is located on submerged lands owned by the State of Hawaii.

SECTION 5
SOCIAL AND ECONOMIC ENVIRONMENT

5.1 RECREATION

Existing Conditions. Recreational practices associated with the project site and environs consist primarily of sight-seeing and water-dependent activities including boating, fishing (nets, spears, and rod and reel), and swimming. Because of limited roadside public vehicular parking areas, most of these activities are believed to be conducted by members and guests of the Kahinapohaku *'ohana,* who can readily access the site from nearby residences.

Impacts. The proposed project will modify existing shoreline and water-dependent recreational opportunities within the Kahinapohaku Fishpond segment of the Moanui *ahupua'a.* This modification will result from a change in the physical character of the fishpond. The reconstructed wall will confer a more protected nearshore coastal setting, which may increase swimming and snorkeling opportunities within the fishpond basin. The reconstructed wall may also provide an excellent platform for net and rod and reel fishing, both within and outside the wall. As a function of the manner in which the fishpond is operated by *'ohana,* some change in marine resource harvesting practices and patterns may occur.

Mitigation. Swimming, snorkeling, and fishing opportunities are projected to increase within and adjacent to the fishpond as a result of wall reconstruction efforts.

5.2 AESTHETICS

Existing Conditions. The project site is located within a pristine coastal setting immediately adjacent to and abutting Highway 450. During low and intermediate tides the remnants of the existing fishpond wall are visible from Highway 450. During high tide periods, the existing pond wall is not visible from the highway.

Impacts. The proposed project will provide a permanent, but not prominent, enhancement of the viewscape. The reconstructed wall will attenuate the influence of silty runoff waters from Moanui Stream, thus resulting in an increase in the clarity of the fishpond water.

Mitigation. The proposed project would enhance the viewscape of the shoreline and improve water clarity.

5.3 AGRICULTURE

Existing Conditions. Other than upland cattle grazing, there is no agricultural activity conducted in the vicinity of the proposed project site.

Impacts. None.

Mitigation. Not applicable.

5.4 ECONOMICS

Existing Conditions. In its present deteriorated condition, Kahinapohaku Fishpond makes no measurable contribution to the economic base of Moloka'i, other than occasional recreational and subsistence marine resource harvesting, and as a scenic amenity to residents and visitors to Moloka'i.

Impacts. Because of the fishpond's small size, ocean exposure, and its mode of management, the reconstructed pond is not expected to yield resources or revenues that will have a significant impact on Moloka'i's economic environment. However, benefits of the proposed revitalization will be manifested in the increased harvest of marine resources or the use of harvested marine resources as seed stock for other ponds. Such harvests would have a positive and measurable benefit within the Kahinapohaku *'ohana*.

Mitigation. Not applicable.

SECTION 6
RELATIONSHIP TO STATE AND COUNTY PLANS, POLICIES, AND CONTROLS

6.1 THE HAWAII STATE PLAN

The *Hawaii State Plan* (Chapter 226, Hawaii Revised Statutes) represents a guide for the future of Hawaii by setting forth a broad range of goals, objectives, and policies to serve as guidelines for growth and development of the State. The proposed project is consistent with the *Plan.* The following are the Priority Guidelines identified in the *Plan* and the relationship between the Guidelines and the proposed action.

1) Direct future urban development away from critical environmental areas or impose mitigation measures so that negative impacts on the environment would be minimized.

Response: The proposed action will not stimulate urban development. The proposed project is self mitigating.

2) Identify critical environmental areas in Hawaii to include but not be limited to the following: watershed and recharge areas; wildlife habitats on land and in the ocean; areas with endangered species of plants and wildlife; natural streams and water bodies; scenic and recreational shoreline resources; open space and natural areas; historic and cultural sites; areas particularly sensitive to reduction in water and air quality; and scenic resources (emphasis added).

Response: The proposed project will preserve and enhance wildlife habitats in the ocean; improve scenic and recreational shoreline resources; promote open space and natural areas; restore and improve historical and cultural sites; and improve scenic resources.

3) Utilize Hawaii's limited land resources wisely, providing adequate land to accommodate projected population and economic growth needs while ensuring the protection of the environment and the availability of shoreline conservation lands, and other limited resources for future generations (emphasis added).

Response: The proposed project will not adversely affect environmental quality over the short- or long-term. The proposed project will ensure the availability of conservation lands and will protect and enhance cultural and archaeological resources for future generations.

4) Protect and enhance Hawaii's shoreline, open spaces, and scenic resources (emphasis added).

Response: The proposed project will protect and enhance shoreline areas, maintain open spaces, and enhance scenic resources.

The following are relevant objectives of the *Plan* that relate to the proposed project:

Section 226-5: Population

The restoration of the fishpond will provide expanded shoreline and water-dependent recreational opportunities for residents and visitors to Moloka'i.

Section 226-8: Visitor Industry

The proposed project will support the promotion of visitor attractions in the area by maintaining shoreline vistas and increasing the awareness of visitors to traditional food production practices of ancient Hawaiians as demonstrated by Hawaiian fishponds.

Section 226-11, 12, 13: Physical Environment

The proposed project will improve the area's physical environment by restoring the former productivity of the fishtrap and substantially increasing biological diversity. Scenic resources will be improved over baseline conditions.

Section 225-23: Socio-Cultural Advancement -- Leisure

The proposed project is consistent with the State's goal of assuring the availability of sufficient recreational resources.

The *State Conservation Lands Functional Plan*, developed as a corollary to the *Hawaii State Plan*, addresses a number of objectives, policies, and implementing actions concerning the conservation and management of lands within the State Conservation District as they relate to the proposed project. The following objectives, policies, and implementing actions are relevant to the proposed project.

Objective IIC: Enhancement of natural resources.
Implementing Action IIC(1)b: Develop fishery management areas and game fish populations and habitats.

Response: The proposed project will enhance marine habitats for nearshore game fish.

Objective IID: Appropriate development of natural resources.
Policy IID(3): Develop recreational and archaeological resources on the shoreline and mauka areas.
Implementing Action IID(3)a: Acquire and/or develop areas for historic preservation.

Response: The proposed project will involve the reconstruction and revitalization of a shoreline historical site.

Implementing Action IID(5)e: Determine mechanisms to authorize the use of ancient Hawaii fishponds for commercial aquaculture.

Response: The proposed project may serve as a model for possible future commercial aquaculture activities within ancient Hawaiian fishponds.

6.2 STATE LAND USE LAW

The proposed project site is situated within the Resource (R) subzone of the State Conservation District. Aquaculture is a permissible use within the Resource subzone of the State Conservation District.

6.3 COUNTY ZONING

Not applicable to project site.

6.4 COASTAL ZONE MANAGEMENT

The County-administered Special Management Area (SMA) extends from the upper wash of the waves to a point approximately 300 ft (TBS m) *mauka* of Highway 450. Except for the occasional ingress and egress of heavy equipment, there are no project-related actions that would fall within the purview of the county SMA ordinance.

6.5 PERMITS

The proposed action will require a Conservation District Use Permit from the Department of Land and Natural Resources, a General Permit (or Individual Permit) from the U.S. Army Corps of Engineers, a Coastal Zone Management Consistency Determination from the Hawaii Coastal Zone Management Office, and a Section 401 Certification (or waiver thereof) from the Department of Health.

6.6 SIGNIFICANCE CRITERIA

Chapter 200 (Environmental Impact Statement Rules) of Title 11, Administrative Rules of the Department of Health, specifies criteria for determining if an action may have a significant effect on the environment. The relationship of the proposed project to these criteria is discussed below.

1) *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource*

Kahinapohaku Fishpond has been extensively modified and nearly destroyed by tsunami, storm waves, adjacent highway construction, and general neglect. The proposed project will involve the reconstruction, repair, and maintenance of an important cultural and archaeological resource.

2) *Curtails the range of beneficial uses of the environment*

The proposed project will expand the range of beneficial uses of the environment and will result in the revitalization and use of an important cultural site.

3) *Conflicts with the State's long-term environmental policies or goals and guidelines as expressed in Chapter 344, Hawaii Revised Statutes, and any revisions thereof and amendments thereto, court decisions or executive orders*

The proposed project does not conflict with long-term State environmental policies or goals.

4) *Substantially affects the economic or social welfare of the community or State*

The proposed project will provide important social and economic benefits to the Moloka'i community and the *'ohana* of the Moanui *ahupua'a.*

5) *Substantially affects public health*

Public health is not threatened by existing facilities and functions at the site and there is no reason to expect that public health will be affected in the future by the revitalized fishpond.

6) *Involves substantial secondary impacts, such as population changes or effects on public facilities*

The proposed project does not involve secondary impacts such as population changes or effects on public facilities.

7) *Involves a substantial degradation of environmental quality*

Short-term environmental impacts will be limited to the fishpond and immediate nearshore waters. Overall environmental quality will be improved.

8) *Is individually limited but cumulatively has considerable effect upon the environment or involves a commitment for larger actions*

The proposed project does not involve a commitment for a larger action nor will it result in significant adverse effects to the environment.

9) *Substantially affects a rare, threatened or endangered species, or its habitat*

There are no rare, threatened, or endangered species (plants or animals) on the project site.

10) *Detrimentally affects air or water quality or ambient noise levels*

Impacts to air quality will be short-term only, therefore no violation of standards is expected to occur. Water quality impacts will be short-term, minor, and limited to the immediate project site. Noise impacts will be minimal and buffered by noises emanating from surf action on the reef flat.

11) *Affects an environmentally sensitive area such as a flood plain, tsunami zone, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters*

The project site is located in coastal waters and within a defined tsunami inundation zone. As no habitable structures are planned, the proposed project will not impact public safety. The action will serve to improve the habitat value of coastal waters for nearshore marine organisms.

For the reasons cited above, the proposed project will not have any significant effect in the context of Chapter 343, Hawaii Revised Statutes, and Section 11-200-12 of the State Administrative Rules.

SECTION 7
ALTERNATIVES TO THE PROPOSED PROJECT

7.1 GENERAL

There are no suitable alternative sites that will accomplish the objectives of the proposed project or result in less disturbance to the natural environment. The selection of Kahinapohaku Fishpond was based upon the absence of major natural resource constraints (wetlands and endangered species) and significant archaeological sites, and the fact that public access would not be an issue. Broad-based community support and consensus for the reconstruction and revitalization of Kahinapohaku Fishpond was received from the *'ohana* of the Moanui *ahupua'a* and the Task Force and its Cultural Committee. In addition, support for the project was also voiced by certain Moloka'i residents who participated in a community-based questionnaire survey.

7.2 THE NO-ACTION ALTERNATIVE

The no-action alternative will result in the continued deterioration of the fishpond wall and basin. Shoreline and water-dependent recreational activities will be further lost as storm wave action continues unabated and the fishpond wall further deteriorates. These actions will contribute to a continuing loss of the site's cultural and archaeological value. The integrity of the wall and basin will be progressively lost to future generations under the no-action alternative.

SECTION 8
LIST OF AGENCIES, ORGANIZATIONS, AND INDIVIDUALS CONSULTED

8.1 CONSULTED PARTIES

The following agencies, organizations, and individuals were consulted during the preparation of this document:

- William Paty, Chair, Board of Land and Natural Resources
- John Corbin, Manager, Aquaculture Development Program
- Donna Hanaike, Deputy Director, Department of Land and Natural Resources
- Roger Evans, Chief, Office of Conservation and Environmental Affairs
- Steve Chang, Department of Health
- Annie Griffin, State Historic Preservation Division
- Billy Kalipi, Snr., Fishpond Restorer
- Stanley Halama, Member, *'ohana* of the Honouliwai *ahupua'a*
- Lance "Kip" Dunbar, Operator, 'Ipuka'iole Fishpond
- Members of the Governor's Task Force on Moloka'i Fishpond Restoration
- Members of the Cultural Committee (under the Governor's Task Force on Moloka'i Fishpond Restoration)

In addition to the above parties, our appreciation is also extended to certain interested members of the Moloka'i community: the 12 residents who participated in a 15 October 1992 Cultural Committee meeting; and the 19 residents who participated in the 18 November 1992 community meeting on Moloka'i.

The feedback received from each of the above listed individuals or groups has served to define the issues and shape the content of this draft EA.

SECTION 9
LIST OF PREPARERS

The following firms or individuals were involved in the preparation of this environmental assessment:

MBA International
William A. Brewer
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Jacqueline Parnell, AICP

SECTION 10
LIST OF REFERENCES

DHM (DHM Planners, Inc. and Public Archaeology Section, Applied Research Group - Bishop Museum) 1989. *Hawaiian Fishpond Study; Islands of O'ahu, Moloka'i, and Hawai'i.* Report Prepared for the Hawaii Coastal Zone Management Program, Office of State Planning, Honolulu.

Governor's Task Force on Moloka'i Fishpond Restoration 1992. Minutes of meetings conducted on Moloka'i and Oahu, 28 January through 15 December 1992.

Kikuchi, William K. 1973. *Hawaiian Aquacultural System.* Doctoral Dissertation, University of Arizona.

APPENDIX A

BASELINE SURVEY
KAHINAPOHAKU FISHPOND

BASELINE MARINE ENVIRONMENTAL SURVEY
KAHINAPOHAKU FISHPOND, MOANUI AHUPUA'A
MOLOKA'I, HAWAII
(TMK 5-0-01:2)

TABLE OF CONTENTS

LIST OF EXHIBITS

SECTION 1
INTRODUCTION AND SCOPE OF SERVICES

The purpose of this study was to conduct a baseline evaluation of marine biological and coastal ecosystem resources of Kahinapohaku Fishpond, Moloka'i, to determine potential effects of proposed fishpond restoration. The scope of services for the present work included a review of existing literature pertaining to water quality, marine biology, and physical characteristics of East Moloka'i; field analysis of water quality; and preparation of a baseline marine environmental survey report.

SECTION 2
MATERIALS AND METHODS

All measurements and surveys were carried out during 16 October 1992 and 13 November 1992 at Kahinapohaku Fishpond. Brief, reconnaissance-level, observations (from the shore) were also made on 19 November 1992.

2.1 PHYSICAL-CHEMICAL MEASUREMENTS

Salinity and temperature measurements were made with a Yellow Springs Instrument Company (YSI) salinity-conductivity-temperature meter equipped with a YSI Model 3300 nickel-platinum conductivity and temperature probe. All measurements were based on *in situ* sampling. According to manufacturer-supplied specifications, maximum worst-case instrument and probe error is as follows: temperature +/-0.7 degrees Centigrade (°C); salinity, +/-0.2 parts per thousand (ppt). Dissolved oxygen measurements were made with a YSI Model 50 digital dissolved oxygen meter equipped with a YSI Model 5740-10 probe cable. According to manufacturer-supplied specifications, maximum worst-case instrument and probe error is as follows: dissolved oxygen, +/- 0.03 parts per million (ppm); temperature, +/- 0.1°C.

Water current analyses were conducted by observing drift rates of a neutrally-buoyant film container along a plastic surveyors tape. Three drift measurements were averaged and recorded at each of three representative sites within the pond.

2.2 BIOLOGICAL SURVEYS

All marine biological surveys were conducted with mask and snorkel apparatus. As the purpose of the survey was to establish only qualitative baseline data, the general physical features and biota within the pond and adjacent nearshore areas were defined through a series of more or less random snorkel traverses going from the shore to the outer (seaward) section of the pond wall; traversing the length of the pond wall's inner margin; random surveys across the reef flat seaward of the pond; and general reconnaissance of the pond's inner basin. The 16 October 1992 survey was timed to coincide with a +2.3 foot high tide to afford a greater opportunity to view resident species. The 13 November 1992 survey was timed to coincide with an intermediate tide.

Underwater survey data were recorded on Polypaper sheets. All zones were photographically documented utilizing a Nikonos V underwater camera and Kodak ASA 200-speed color print film.

SECTION 3
RESULTS

3.1 DESCRIPTION OF THE PROJECT SITE; GENERAL PHYSICAL CHARACTERISTICS OF KAHINAPOHAKU FISHPOND

Kahinapohaku Fishpond (Exhibit 3.1) is located in East Moloka'i, roughly halfway between Waialua and Halawa Valley (Exhibit 3.2). The pond lies immediately adjacent to and below State Highway 450 and is separated from the highway by an irregular embankment (3 to 6 feet [ft] or 1 to 2 meters [m] in height) that has been reinforced by a seawall constructed of massive basalt boulders. Presumably the seawall functions to retard shoreline erosion and undermining of the road during periods of high wave action. The absence of large boulders along portions of the extreme southwestern and northeastern sides of the pond wall suggests that boulders may have been retrieved from these sections of the pond wall to be used for construction of the seawall. Portions of the pond wall shows evidence of having collapsed, with both massive boulders and smaller, cobble-size stones, intruding into the pond a distance of at least 26 ft (8 m). Tree trunks, branches, tires, and flotsam and jetsam litter the shoreline along the southwestern side of the pond. Extensive (and recent) shoreline erosion is evidenced along the extreme southwestern side of the pond by the undermining of well-established stands of *naupaka* and large deposits of terrigenous soils in the intertidal zone.

The fishpond has a total reported surface area of 4 acres (1.62 hectares [ha]) and has a pond wall approximately 950 ft (290 m) in length. The pond is located approximately 3,900 ft (1,200 m) southwest of Honouliwai Bay (and Honouliwai Fishtrap).

The pond has no direct perennial source of surface waters, though Moanui Stream, an intermittent stream, drains into the ocean adjacent to the extreme northeastern corner of the pond during the rainy season and periods of rainfall runoff. Kahookamakea, Nihoawa, and Kaluapepeiao gulches drain to the shoreline within 2,600 ft (800 m) of the pond's southwestern flank and, as a function of water current patterns, may occasionally influence water quality within the pond. According to local informants, Kahinapohaku Pond is influenced by surface runoff which results in the pond demonstrating chronic high turbidity levels (William Kalipi, Sr., pers. comm., 1992). During the 16 October 1992 surveys, water visibility ranged from less than 0.9 ft (0.3 m) along the nearshore reaches of the pond to a maximum of approximately 7 ft (2.5 m) adjacent to the landward side of the pond wall. Underwater visibility on 13 November 1992 ranged from roughly 5.5 ft (2 m) along the shoreline to approximately 20 ft (7 m) along the margin of the inner pond wall. Runoff from Moanui Stream was contributing to pond siltation during both survey periods, with prevailing winds and water currents directing silty waters into the pond. The placement of the northeastern terminus of the pond wall directly adjacent to Moanui Stream may indicate that water from the stream may have once been used as a management tool to control pond salinity or nutrient levels.

The dominant features of the pond are the foundation stones of what appears to have once been a 15- to 20 ft-wide (4.6- to 6-m-wide) pond wall, and massive deposits of limestone *'ili'ili* stone (Exhibit 3.3) which form an often uninterrupted corridor, 13 - 33 ft (4 to 10 m) in width, immediately landward of the remnants of the pond wall. The pond wall was nearly completely submerged at high tide (+2.3 ft [0.7 m]) on 16 October 1992; about 70 percent of the pond wall (Exhibit 3.4) was exposed during an intermediate tide period on 13 November 1992. Larger boulders that once comprised the pond wall lie scattered along the landward side of the pond wall within a corridor that

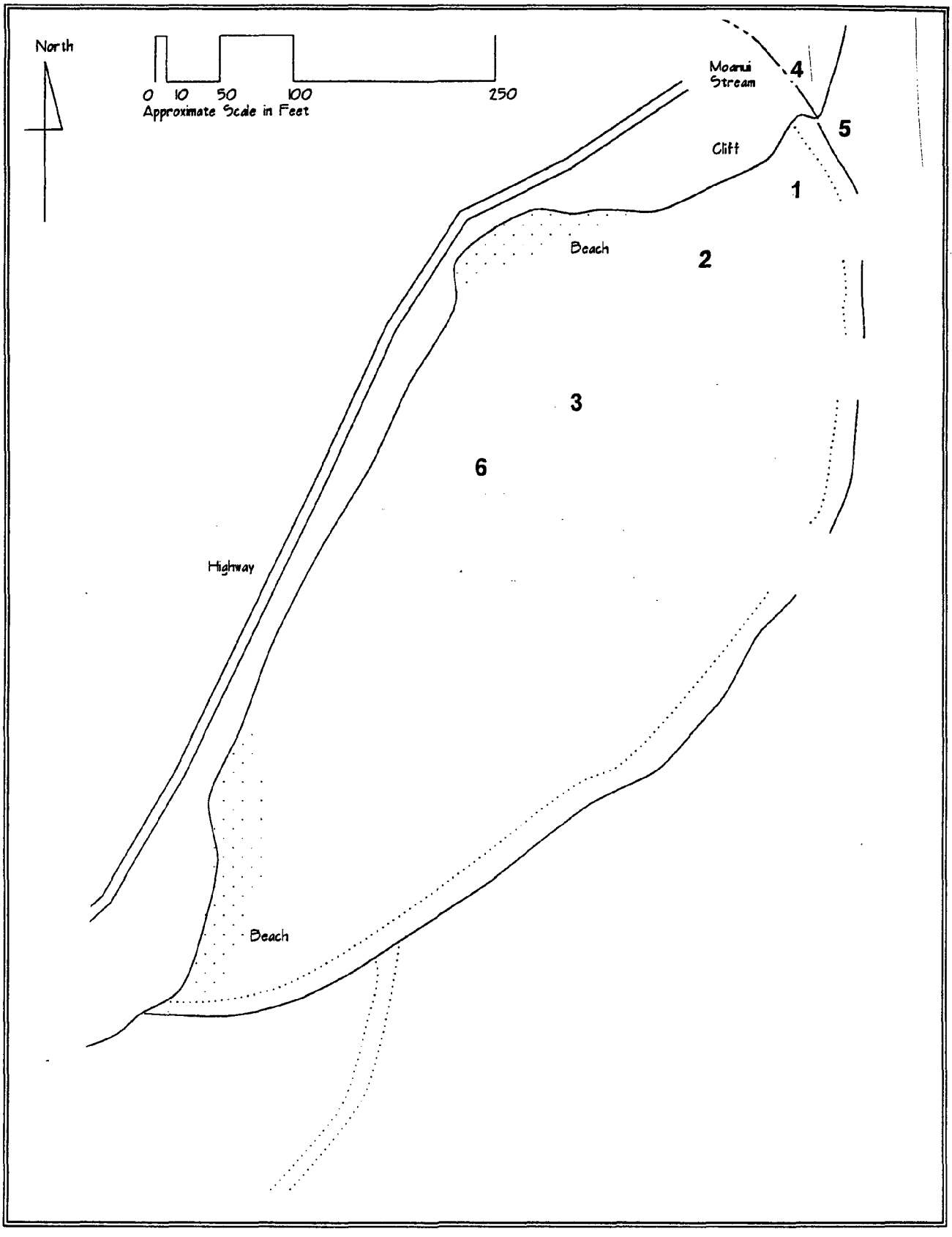

Exhibit 3.1 Kahinapohaku Fishpond, Eastern Moloka'i; Water Quality Station Locations (#1-6).

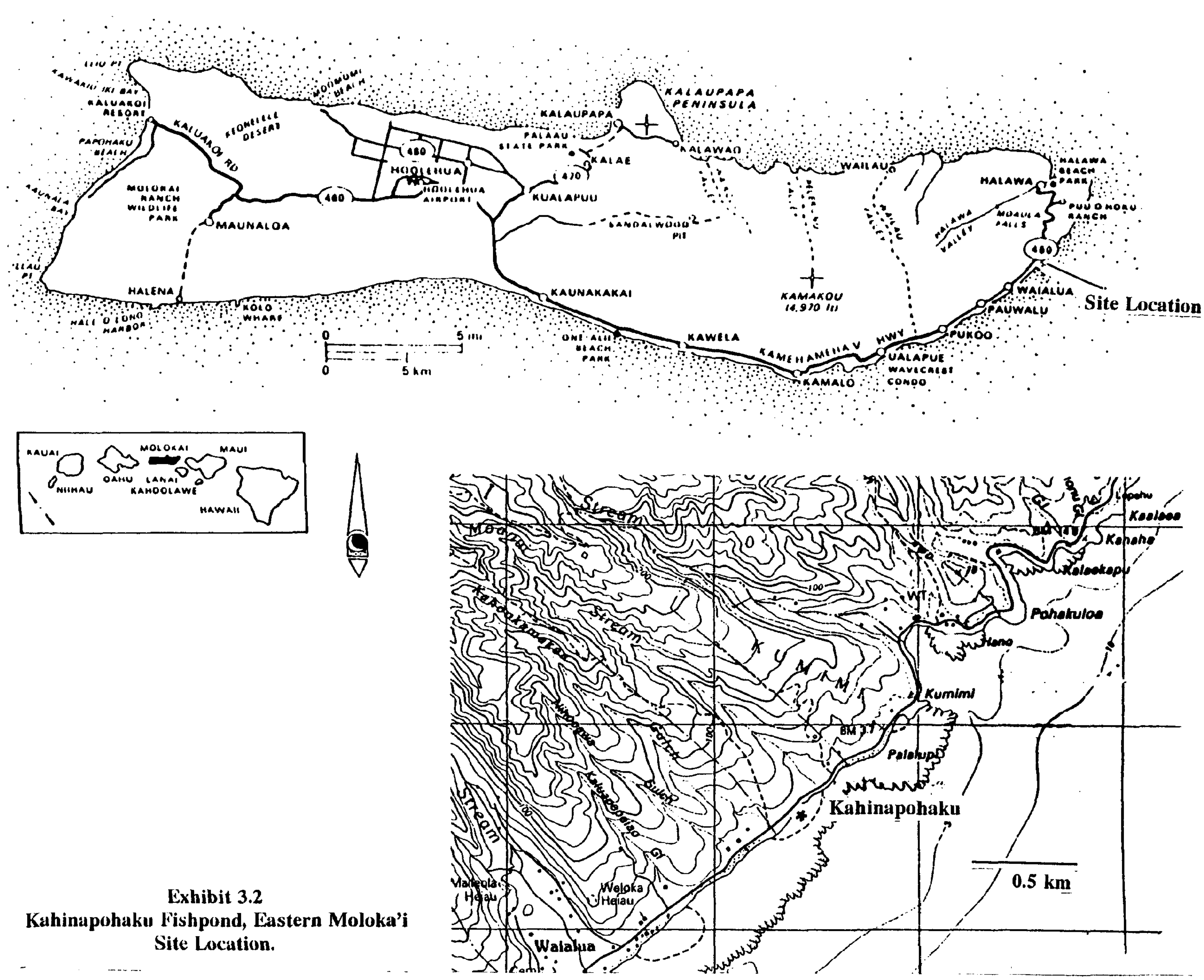

Exhibit 3.2
Kahinapohaku Fishpond, Eastern Moloka'i
Site Location.

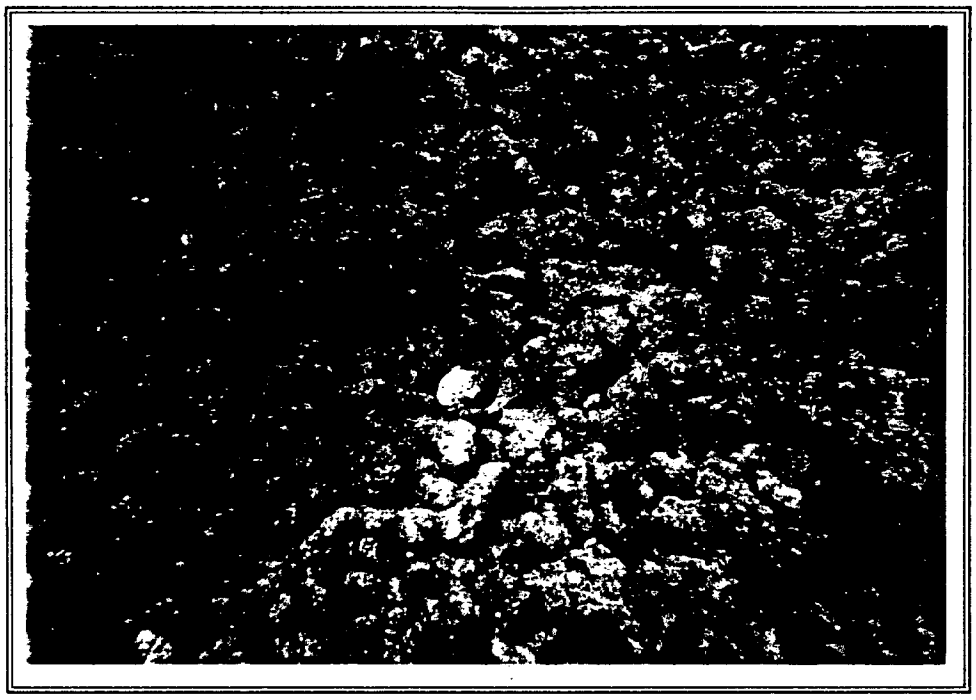

Exhibit 3.3 Kahinapohaku Pond. *'ili'ili* stone.

Exhibit 3.4 Kahinapohaku Pond. Large boulders dislocated from pond wall.

ranges up to 98 ft (30 m) in width; however, smaller stones and cobbles occur throughout the majority of the pond's subtidal basin. At least some of these smaller stones presumably originated from the pond wall, having been cast progressively landward during various storm wave or tsunami events.

The general underwater topography of the fishpond and adjacent nearshore areas can be described as consisting of five principal physiographic zones: 1) a sandy to muddy intertidal and nearshore subtidal zone; 2) a pond basin characterized by boulder- to cobble-sized basalt rock; 3) a broad zone of *'ili'ili* rock; 4) the structural remains of the pond wall; and 5) the natural reef platform (upon which are found the remnants of the pond wall). Three zones, other than the nearshore reef platform and the pond wall, displayed a silty veneer of terrigenous silt. With the exception of certain epibenthic marine algae, the majority of the pond's surface area displayed a very low diversity and abundance of marine organisms.

Tides and Water Currents

Tide charts for the survey periods are shown in Exhibit 3.5. As was earlier indicated, pond water currents were measured during a high tide period (+2.3 ft [0.7 m]) on 16 October 1992 and during an intermediate tide (+0.5 ft [0.15 m]) on 13 November 1992 in order to gather information under different tidal conditions. Light to moderate northeast tradewinds were evident during both surveys.

The results of water current measurements indicate that the majority of the pond basin is influenced almost entirely by the prevailing winds, resulting in a pronounced surface flow parallel to the shoreline in a southwesterly direction. Surface velocities averaged approximately 6.8 feet/min (ft/min; 3.5 centimeters/second [cm/sec]). There was no detectable water movement evident in the middle or lower portions of the water column at any measurement site within the pond basin. The absence of any significant water motion within most of the pond is supported by the presence of a sometimes thick silt veneer which covers the pond substratum. Silt deposits which are continually being resuspended by prevailing wind and water movement within the shallow reservoir undoubtedly cause the high turbidity levels evident in the pond.

Wave surge through pond wall openings results in complex water current patterns along the landward side of the pond wall; these patterns are further complicated during high tides by the action of waves breaking over the top of the pond wall. Water current measurements landward of the pond wall therefore did not yield any quantifiable information. Collectively, wave action and wave surge influence a zone up to about 30 ft (9 m) in width along the landward side of the pond wall. This zone of wave and wave surge influence is suggested by sometimes large deposits of coralline sands which overlie the natural reef flat substratum. The most expansive sand deposits within the pond appear to be located immediately landward of two major nearshore surge channels which dominate the outer reef flat seaward of the pond.

Water Quality

Exhibit 3.1 shows the locations where water quality measurements were taken. Water quality data are provided in Exhibit 3.6. The data indicate a mean pond temperature of 26.4°C and a mean salinity of 33.4 ppt on 16 October 1992. On 13 November 1992 water quality data showed a mean temperature of 27.4°C., a mean salinity of 34.8 ppt, and a mean dissolved oxygen level of 6.8 ppm. Sampling on both days showed evidence of some brackish water influence on pond salinity values. Lower salinity values during both sampling periods were recorded from the northeastern side of the

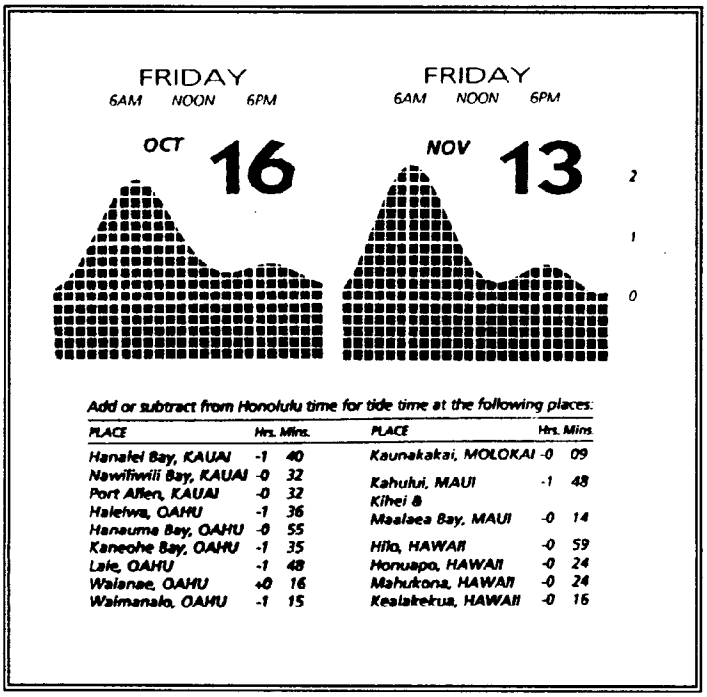

Exhibit 3.5 Tide Chart, 16 October and 13 November 1992.

EXHIBIT 3.6
WATER QUALITY DATA
KAHINAPOHAKU FISHPOND

Time	Location	Depth (m)	Temperature (°C)	Salinity (ppt)	Dissolved O_2 (ppm)
16 OCTOBER 1992					
0940	1	0.1	26.2	33.1	-
		0.5	26.3	33.2	-
0942	2	0.1	26.4	33.4	-
		0.5	26.4	33.0	-
0946	3	0.1	26.5	33.8	-
		0.5	26.5	33.8	-
13 NOVEMBER 1992					
1515	4	0.5	23.6	0.0	4.8
	5	0.5	25.9	21.0	6.8
1530	1	0.5	27.6	34.0	6.6
	2	0.5	27.3	35.0	7.0
	3	0.5	27.3	35.0	6.8
	6*	0.5	27.3	35.0	6.7

*pH = 8.0 to 8.5; $N(NH_4^+)$ = <2.0 ppm

pond, where influx of freshwater from Moanui Stream would have presumably had the greatest influence. All dissolved oxygen values recorded in the pond were in excess of saturation with respect to prevailing water temperature and salinity values.

3.2 BIOTA

3.2.1 Beach Strand

No natural beach strand habitat occurs over most of the pond's shoreline, inasmuch as a manmade boulder-filled shoreline seawall sharply grades to the shoreline highway. Stands of grasses and weedy vegetation occur on the seaward shoulder of the road; these are periodically mowed or cut as a part of road maintenance activities. A stand of Hibiscus tileaceus (*hau*) is found along the extreme northeast corner of the pond, along with occasional, widely scattered Tournefortia argentea (tree heliotrope), Prosopis pallida (*kiawe*), and Leucaena leucocephala (*koa haole, lilikoa*). Scaevola sericea (*naupaka*) occurs in large stands at the extreme northeast and southwest sides of the pond, and in occasional small patches along the pond shoreline.

There was no observed fauna or infauna observed in association with the pond's sandy to rocky intertidal zone, though burrows, possibly constructed by the ghost crab Ocypode ceratopthalmus (*ohiki*), were noted along sections of the northeastern beach.

3.2.2 Marine Habitat

Corals

A total of 7 species of corals were recorded within the pond basin or in association with the structural remains of the fishpond wall, and on the adjacent seaward reef flat. Represented species, listed in order of estimated abundance, included Porites lobata Dana (Exhibit 3.7), Pocillopora damicornis Linnaeus (Exhibit 3.8), Porites compressa Dana (Exhibit 3.9), Pocillopora meandrina Dana, Leptastrea purpurea Dana, Pocillopora eydouxi Milne-Edwards and Haime, and Montipora verrucosa Lamarck. All of the aforementioned species represent the more common nearshore corals that are found throughout most shallow water environments in Hawaii.

Except for corals occurring in high-energy environments immediately landward of the fishpond wall, or in prominent breaks in the wall, most of the represented colonies consisted of small nodular or low encrusting growth forms. Except for a prominent zone of corals immediately landward of certain sections of the pond wall, there was no particular zonation pattern evident within the pond. Live specimens of P. lobata and P. damicornis were, in fact, found within 26 ft (8 m) of the pond's landward shoreline. The absence of any obvious zonation pattern suggests that pond recruitment for most species is largely a function of storm wave deposition of coral shards originating from the pond wall or offshore areas than settlement of individual coral planulae (larvae). This conclusion is further corroborated by the observation that many of the corals occurring in the pond basin are not cemented to the substratum. Overall coral coverage within the majority of the pond basin is estimated at approximately 0.1 percent, with P. damicornis accounting for the majority of the coverage.

Because of their generally low nodular or prostrate growth forms, corals do not constitute a significant habitat for fishes or invertebrates within the pond. The relatively few species and small growth forms may, in part, result from the influence of silt and sediment discharges from Moanui

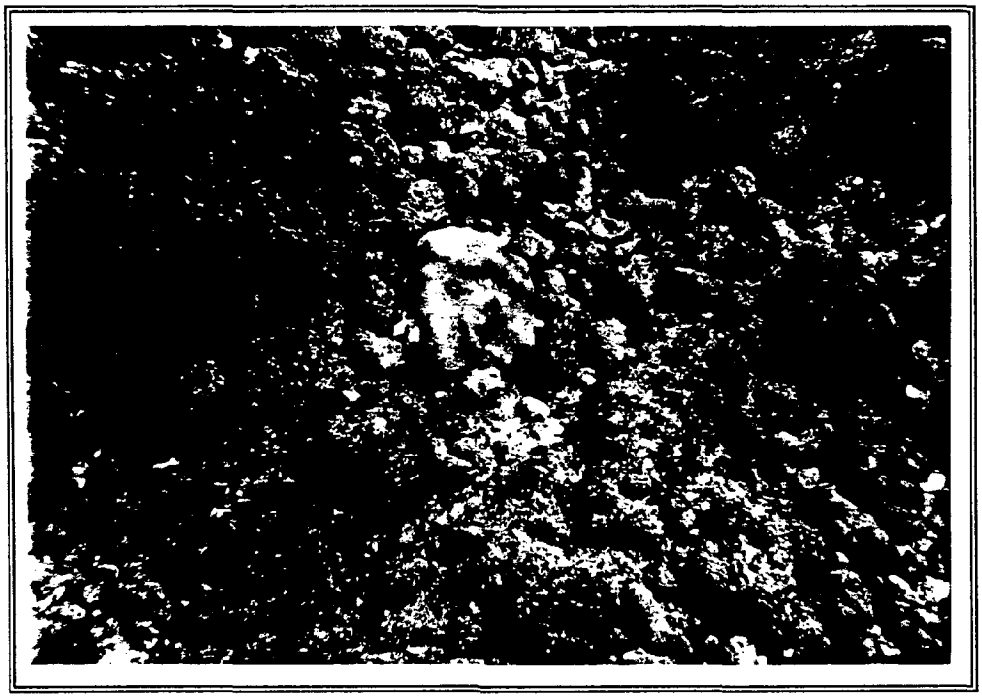

Exhibit 3.7 Kahinapohaku Pond. Porites lobata coral.

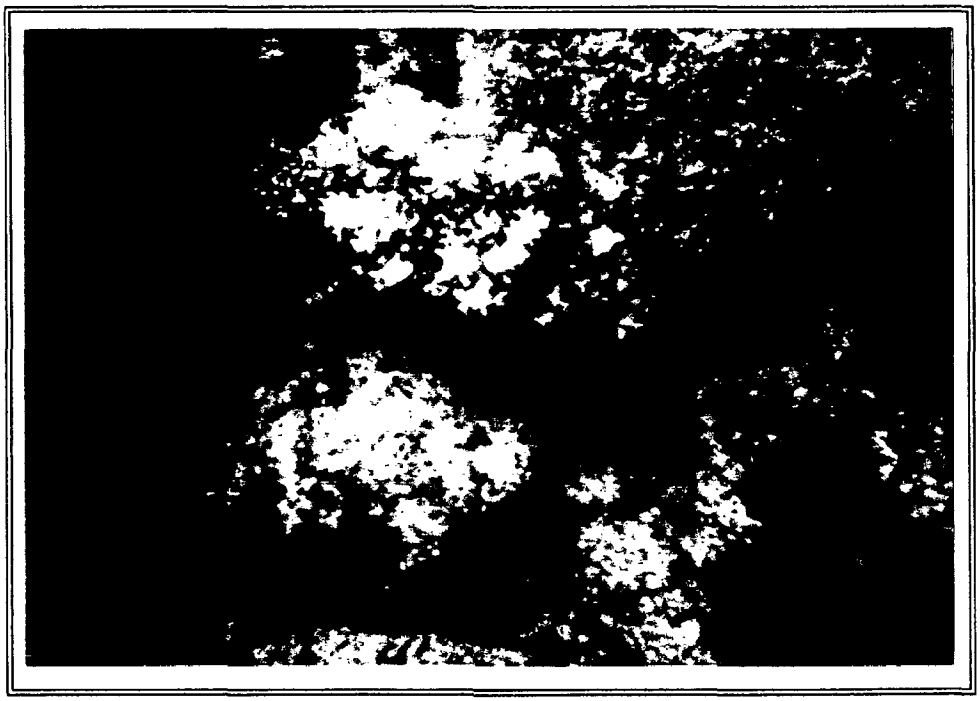

Exhibit 3.8 Kahinapohaku Pond. Pocillopora damicornis coral.

Exhibit 3.9 Kahinapohaku Pond. Porites compressa coral.

Exhibit 3.10 Kahinapohaku Pond. Various species of marine algae (*limu*).

Stream, which drains directly into the ocean immediately adjacent to the northeasterly terminus of the pond wall.

The zone of highest coral coverage is generally confined to the immediate interior of the pond wall where wave surge and water currents appear strongest. Coverage in this zone averages approximately 5 percent, though in localized areas coverage may extend up to 20 percent in areas influenced by offshore waters. P. lobata and P. compressa are the characteristic and dominant corals of this zone, though as in most other areas within the pond, colony size rarely exceeded 1 ft (0.3 m) in diameter. P. meandrina, L. purpurea, and M. verrucosa were also common in this zone with colony diameter exceeding that of individuals within the pond basin by a factor of 2 or 3.

Although not part of the live coral community, the zone of *'ili'ili* limestone is addressed here because of its size and influence on the physical character of the pond environment. *'Ili'ili* stone, largely composed of wave-worn Porites, constitutes an expansive zone within Kahinapohaku Fishpond. *'Ili'ili* forms an often uninterrupted, low-relief, "corridor" that dominates the pond's substratum along a large portion of the inner wall of the pond. Deposits of *'ili'ili* up to 30 ft (10 m) wide, and at least 1 ft (0.3 m) deep, run in lines along the landward side of the pond wall. This corridor is only occasionally interrupted by cobble- to boulder-sized basalt rocks, or, in wave-exposed areas where the pond wall is fully breached, by up to 1.5 ft (0.5 m) of wave-deposited coralline sand. Although small live coral shards and certain turf algae are occasionally observed within this zone, the *ili'ili* does not appear to provide any type of significant grazing habitat for fish or invertebrates.

Other Macroinvertebrates

The macroinvertebrate fauna associated with exposed wall boulders and rocks was more or less typical of most exposed to semi-exposed rock shorelines throughout the State. The upper intertidal portions of the pond wall and shoreline boulders (used as a seawall to protect the coastal highway) were characterized by the snails Nerita picea (*pipipi*) and Littorina sp. (*pupu kolea*), and occasional Siphonaria normalis (false *opihi*). The *a'ama* crab, Grapsus tenuicrustatus, was the largest invertebrate of the intertidal zone and was commonly observed atop large boulders in proximity to the shoreline on both sides of the pond.

Although no fauna or infauna was observed in the sandy intertidal zone fronting the pond, several burrows of the ghost crab Ocypode ceratopthalmus (*ohiki*) were observed along portions of the northeast sector of the pond's shoreline.

The largest and most conspicuous non-coral invertebrates observed in the pond or in association with the pond wall were holothurians. Actinopyga mauritiana was conspicuous on pond wall boulders in high energy environments on both the seaward and landward sides of the pond wall with densities ranging up to approximately 1 per 10 square feet (sq ft; 1 per square meter [sq m]). Holothuria atra (*loli*) was the dominant holothurian of the more protected reaches of the pond. The boring urchin Echinometra mathaei was routinely observed throughout the pond, though numbers were highest in the seaward half of the pond. A single brittle star (Ophiocoma sp.) was observed beneath one rock.

Mollusks were uncommon in the pond, though eroded shells of at least one species of bivalve were observed on several occasions. A large grouping (approximately 30) of an unidentified grey eolid nudibranch (possibly Spurilla sp.) was observed within a protected depression encompassing

approximately 100 sq ft (9 sq m) along the northeastern section of the pond. It was not observed elsewhere in the pond.

Ichthyofauna (Fishes)

Kahinapohaku Fishpond hosts a surprisingly low diversity of fishes with represented species exceptionally low in number and biomass. A total of approximately 15 species were observed and the majority of these were restricted to the pond wall and areas of topographic relief immediately adjacent (seaward and landward) to the wall. The pond basin, which comprises approximately 3.5 acres (8.6 ha) of the roughly 4.0-acre (9.8 ha) pond, is nearly devoid of fish. Following the surveys of 16 October 1992, the low number of fishes recorded was initially attributed to high pond turbidity which limited underwater visibility within all but the wave-exposed margins of the pond. However, underwater surveys conducted on 13 November 1992 yielded only 4 additional species, although underwater visibility was several times that of the earlier survey.

The dominant fish species were Acanthurus triostegus (*manini*), Abudefduf sordidus (*kupipi*), Abudefduf abdominalis (*mamo*), which dominated the wave-swept portions of the sea wall. Schools of juvenile Mulloides flavolineatus (*weke*) and juvenile Parupeneus multifasciatus (*moana*) dominated the landward margin of the pond wall. Other, less common species included Halichoeres ornatissimus (*'ohua*), Stegastes fasciolatus, and juveniles of the following species: Thalassoma ornatissimus (*'ohua*); Paracirrhites forsteri (*hilu pili-ko'a*); Pseudojuloides cerasinus; and Thalassoma duperrey (*hinalea lau-wili*).

Butterflyfishes (*kikakapu*) were restricted to widely scattered Chaetodon lineolatus and Chaetodon lunula.

Single individuals of Dascyllus albisella (*'alo-'ilo'i*) and the trunkfish Ostracion meleagris (*moa*) were also recorded in the pond, the former restricted to one of the larger P. meandrina coral heads found within the basin. On 16 October 1992, one of the members of the survey team (Mr. William Kalipi, Sr.) observed an unidentified red "dragon eel" (*puhi*) within the pond.

Algae

The marine algae constitute one of the most conspicuous groups of living organisms within and adjacent to Kahinapohaku fishpond (Exhibit 3.10). Some 19 distinct macroalgae species were identified during the survey. A number of additional species are no doubt present; however, the entire pond basin was covered with a silt "veneer" during both survey periods, and undoubtedly accounted for some smaller or less conspicuous species being overlooked and omitted from the record.

The pond was dominated by Acanthophora spicifera (Vahl) Boergesen, often forming thick monotypic stands which covered the majority of the pond's rocky basin. Both Dictyota friabilis Setchell and Dictyosphaeria cavernosa (Forskal) were occasionally observed in the mid-pond basin with the former often intermixing with A. spicifera. Both attached and unattached Galaxaura filamentosa Chou and Galaxaura fastigiata Decaisne were also frequently observed throughout the pond. The fact that both G. filamentosa and G. fastigiata were often found unattached to the substratum suggests recent storm wave influence.

In wave- and surge-prone areas, such as the pond wall, the coralline red algae Porolithon onkodes (Heydrich) Foslie, Porolithon gardineri (Heydrich) Foslie and Hydrolithon breviclavatum (Foslie) Foslie tended to dominate, with coverage accounting for upwards of 5 percent of the substratum. Less frequently observed were the following red coralline algae: Lithophyllum kotschyanum (Unger) Foslie, Neogoniolithon frutescens (Foslie) Setchell & Mason, Sporolithon erythraeum (Rothpletz) Kylin, Hydrolithon reinboldi (Weber-van Bosse & Foslie) Foslie, and Jania sp. S. erythraeum occurs in two distinct morphological forms; flat, crust-like growths and large, round, nodules. Most red corallines are normally found within high-energy wave environments, such as the seaward reef margin or reef crest. The fact that so many species of red coralline algae were found throughout the pond basin indicates wave influence, and possibly wave deposition. There was, in general, a pattern of higher coralline algal coverage in pond basin areas immediately adjacent to breaks or channels within the pond wall.

Non-coralline macroalgae were common, but less conspicuous, than red coralline species. Found throughout the subtidal reaches of the pond basin were Codium edule Silva, Dictyota acutiloba J. Agardh, and Amansia glomerata C. Agardh. A. glomerata often formed dense, bush-like "thickets" in areas of strong surges. Coverage in some of these areas often exceeded 50 percent in localized areas. Gracilaria coronopifolia C. Agardh (*manauea*) and Asparagopsis taxiformis (Delile) Collins & Hervey (*kohu*) were infrequently observed, and sometimes intermixed with stands of Acanthophora in areas subject to moderate currents or wave action. Both G. coronopifolia and A. taxiformis are highly prized edible seaweeds.

Giffordia breviarticulata (J. Agardh) Doty & Abbott was the common splash zone species of intertidal boulders and rocks.

SECTION 4
DISCUSSION

Kahinapohaku Fishpond (TMK 5-8-01:2) has been identified by Kikuchi (1973) as "Type I", a *loko kuapa*: "A fishpond of littoral water whose side or sides facing the sea consist of a stone or coral wall usually containing one or more sluice gates". It has been classified as a Class IIB structure, as follows:

> "Wall in fair to poor condition, or submerged. Heavy siltation, or completely filled. Vegetation encroachment on most or all of fishpond. Three or less National Register criteria (DHM Planners Inc. and Applied Research Group - Bishop Museum, 1989).

Although the Class IIB designation is in part correct, the pond presently shows no evidence of significant vegetation encroachment, except for the presence of a small stand of trees at its extreme northeast end. This stand is comprised of strand (shoreline) species and further encroachment into the pond is not likely to occur. The surveys also suggest that although the pond is characterized by chronic siltation, the existing deposits do not presently threaten the physical integrity of the pond, nor are they likely to result in any significant loss in pond depth. Although water current measurements did not show any demonstrable water currents within the main pond basin, storm wave action generated by regional cyclonic and local storm events are likely responsible for rather predictable flushing of accumulated silt and sediments from the pond.

The results of water quality studies indicate that the fishpond is dominated by waters of oceanic origin, with only minor influence of freshwater being detectable. The freshwater influx from Moanui Stream, though slight, appears to account for silt deposition in the pond. Shoreline erosion, particularly on the extreme southwest corner of the pond, may also contribute silt to the pond. The origin of the silt is likely through sheet flow from eroded upland areas presently used as grazing land. With the exception of silt loading during periods of heavy runoff, none of the chemical or physical environmental conditions encountered in the pond would be limiting to marine organisms.

The results of these surveys indicate that the fishpond presently supports a very modest assemblage of marine organisms. Furthermore, the surveys also indicated that Kahinapohaku Fishpond is presently functioning as a nursery for several species of reef fish of commercial and subsistence value. With few exceptions, large or mature fishes were absent from the pond. The presence of two species of edible macroalgae (*limu*) in the pond is a positive indication that existing water quality conditions remain conducive to the growth of traditionally important seaweeds.

A noteworthy finding was the near absence of epibenthic growth on the extensive deposits of *'ili'ili* stone which occur throughout the pond. Only rarely were corals, algae, or invertebrates found established on these often massive limestone deposits. The absence of epibenthic organisms in the *'ili'ili* zone is likely a result of continual movement and shifting of the stones, an action which would be inimical to most sedentary organisms. The absence of silt deposits on the *'ili'ili* also indicates the instability of this substrate. This finding suggests that future efforts directed at retrieving this material will not result in significant environmental disturbances to existing marine communities.

SECTION 5
LITERATURE CITED

DHM Planners, Inc. & Applied Research Group - Bishop Museum 1989. *Hawaiian Fishpond Study; Islands of O'ahu, Moloka'i, and Hawai'i.* Report Prepared for the Hawaii Coastal Zone Management Program, Office of State Planning.

Kikuchi, William K. 1973. *Hawaiian Aquacultural System.* Doctoral Thesis, University of Arizona.

APPENDIX B

ARCHAEOLOGICAL SURVEY
KAHINAPŌHAKU FISHPOND

CULTURAL RESOURCE MANAGEMENT
AKI SINOTO CONSULTING 2333 Kapiolani Blvd. No.2704 Honolulu, Hawai'i 96826 Tel/Fax (808) 941-9538

December 11, 1992

Mr. Eugene P. Dashiell
Eugene P. Dashiell AICP
Planning Services
1219 Keeaumoku Street, Suite 200
Honolulu, Hawai'i 96814-3132

Dear Gene:

Subject: Results of Onsite Inspection of Honoulivai and Kahinapohaku Fishponds, Honoulivai and Moanui, Moloka'i

On Monday, November 30, 1992, an onsite archaeological inspection of the two fishponds referenced above was conducted with Mrs. Annie Griffin from the Historic Preservation Division of the State Department of Land and Natural Resources. The purpose of this inspection was to determine specific attributes necessary for the proposed restoration of the ponds. The information obtained and relevant recommendations are presented below.

Honoulivai Pond - State Site 50-60-05-233:
The original wall width was determined to be c. 12 feet according to remnant basal stones. Based on our observations, no openings could be conclusively identified, although the deteriorated condition of the walls made such determinations difficult. Enough material appear to be scattered both inside and outside of the pond for use during wall restoration, however a paucity of smaller material was noted. The larger boulders that are still present above the waterline on the northwestern half of the pond wall probably represent the original height of the wall, c. 4-5 feet above sea bottom.

A hypothetical conclusion, based on the observations, regarding the construction of this pond wall, may have bearing on the lack of opening(s) and the paucity of smaller boulders and stones. Close inspection of the less-deteriorated northwestern wall section revealed the possibility of differential construction of the basal and upper wall portions. The lower portion of the wall, c. 1.8-2.0 feet high, is constructed of smaller boulders and stones with coral and basalt gravel fill. The boulders are placed more tightly together with interstices filled with smaller material. Overlying this basal construction is the upper wall portion consisting primarily of a single course (vertical) of 2-3 rows (horizontal) of larger boulders, ranging in diameter from 2 to 4 feet, placed together without any fill material in between.

The function of this fishtrap, as suggested by the construction, may not have required any openings, but rather operated on tidal changes. At high tide, fish could swim into the pond through the many spaces amongst the boulders. As the tide lowered, the fish would be trapped by the more tightly constructed basal portion of the wall. Although the large size of the boulders utilized for construction has been attributed to the location of this pond in a high energy wave zone, perhaps more than one factor was considered in utilizing the large boulders.

Battered walls (sloping rather than vertical) should improve the stability and help to maintain integrity of the wall. Generally such walls are easier to build when the wall consists of multiple vertical courses of stones, however, in the case of this pond, only a single course of large boulders is employed. Although several alternative methods to batter the wall can be employed, in terms of effective reinforcement while maintaining integrity of the original character of the pond, only one technique can be recommended. This would be the selection of naturally shaped boulders with the appropriate slope to be placed along the outer margins of the wall. The width of the wall should not exceed 12 feet including the batter. Also, the maneuvering of these large boulders may be facilitated if done during high tide, rather than at low tide.

Kahinapohaku Pond - State Site 50-60-05-228:
Informant data had indicated the presence of burials in the remnant dune at the northern end of this pond near the outlet of Moanui Stream. A probably articulated skeletal remains was found to be exposed in this locality during our field visit. Portions of a mandible, ribs, and vertebra, along with scattered teeth; representing a single individual was observed in a cut bank below the vegetation line, immediately inland of the northern terminus of the fishpond wall. Coral and basalt stones were used to cover the exposed remains. This area should be avoided during restoration activities, and protected from further erosion. A preservation plan should be formulated and submitted to HPD/DLNR for concurrence, prior to commencement of restoration activities.

The wall construction of this large pond is fairly typical of similar ponds along this coast. Again, the location of any former openings could not be determined through surface observation due to extensive deterioration of the wall. The width of the wall at its base is c. 14 feet as determined from two intact sections of the outer and inner alignments. Although no remnant segments of wall that suggest original height are present, 4-5 feet measured from sea bottom would be a reasonable finish height for the restoration. This would also be consistent with neighboring ponds. The wall construction, unlike that employed for Honoulivai Pond, is uniform from base to upper portions. It is similar to the double-faced, clinker filled, free-standing walls built on dry land. The wall consists of two parallel rows of stacked boulders with the central space filled with chunks, clinkers, gravel, and rubble primarily of coral and some basalt. The northeastern portions of the pond have been badly damaged while the southeastern to southern portions display some intact basal alignments. Boulders and stones tumbled from the wall are strewn mostly inside the pond, although some collapsed areas were evident outside the wall. The southern portion of the pond interior exhibits large deposits of coral rubble, presumably from the wall fill. The stones utilized for the highway revetment do not appear to have been robbed from the pond based on the differences in size.

Compared to others along this coastline, this pond is located in a relatively high energy wave zone due to the narrowness of the reef. Battering the outside edges of the wall may improve stability and reinforce against wave action.

General Comments:
Although both of these ponds have been severely damaged, their status as recorded archaeological sites need to be considered in planning for their

restoration. The currently definable dimensions and characteristics of the two ponds should be maintained along with the integrity of building materials and their intended functions.

Care should be exercised when using heavy equipment in and around the ponds during restoration activities to minimize adverse impacts to portions of both ponds as well as the marine environment in the vicinity. When possible, manual methods should be employed during restoration. Building material should be obtained as much as possible from the vicinity of each pond.

Continued coordination with knowledgeable individuals and the Historic Preservation Division of the State Department of Land and Natural Resources is recommended. Provisions for systematic documentation during restoration activities are also recommended.

Should you have any questions or comments, please contact me at 941-9538 by phone or FAX.

Sincerely,

Aki Sinoto