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GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

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FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
KAHOOLAWE ISLAND RESERVE COMMISSION
LAND
STATE PARKS

REF:OCCL:TM

FILE NO.: OA-3241

DEC 13 2005

MEMORANDUM

TO: Genevieve Salmonson, Director
Office of Environmental Quality Control

FROM: Samuel J. Lemmo, Administrator
Office of Conservation and Coastal Lands

SUBJECT: Final Environmental Assessment (FEA)/ Finding of No Significant Impact (FONSI) for the Hilton Corporation Duke Kahanamoku Lagoon Restoration Project Located at Waikiki, Oahu, Portions of TMK: (1) 2-3-037:012 & 021; (1) 2-6-009:002 & 010; and (1) 2-6-008:034

The Office of Conservation and Coastal Lands (OCCL) has reviewed the Final Environmental Assessment (FEA) for the Hilton Lagoon Restoration Project. The Draft Environmental Assessment (DEA) for this project was published in OEQC's August 23, 2005 Environmental Notice.

The FEA is being submitted to OEQC. We have determined that this project will not have significant environmental effects, and have therefore issued a FONSI. Please publish this notice in OEQC's upcoming December 23, 2005 Environmental Notice.

We have enclosed four copies of the FEA for the project along with the OEQC Bulletin Publication Form and Project Summary. Comments on the Draft Environmental Assessment were sought from relevant agencies and the public, and were included in the FEA.

Please contact Tiger Mills of our Office of Conservation and Coastal Lands staff at 587-0382 if you have any questions on this matter.

Attachments

2005-12-23-OA-FEA DUKE KAHANAMOKU LAGOON RESTORATION

Final Environmental Assessment &
Finding of No Significant Impact

DUKE KAHANAMOKU LAGOON RESTORATION PROJECT

WAIKĪKĪ BEACH AT THE HILTON HAWAIIAN VILLAGE,
HONOLULU, O'AHU

PREPARED FOR:
Hilton Hotels Corp.

PREPARED BY:
PLANNING SOLUTIONS

NOVEMBER 2005

Final Environmental Assessment &
Finding of No Significant Impact

DUKE KAHANAMOKU LAGOON RESTORATION PROJECT

WAIKĪKĪ BEACH AT THE HILTON HAWAIIAN VILLAGE,
HONOLULU, O'AHU

PREPARED FOR:
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PREPARED BY:
PLANNING SOLUTIONS

NOVEMBER 2005

PROJECT SUMMARY

Project:	Duke Kahanamoku Lagoon Restoration
Applicant	Hilton Hotels Corporation 2005 Kalia Road Honolulu, HI 96815 Contact: Mr. Gerhard Seibert Phone: (808) 949-4321
Approving Agency	Department of Land and Natural Resources State of Hawai'i P.O. Box 621 Honolulu, Hawaii 96809 Contact: Sam Lemmo Phone: (808) 587-0381
Location	Waikīkī Beach at the Hilton Hawaiian Village 2005 Kalia Road, Honolulu, Hawai'i, 96815 Waikīkī Beach, Island of O'ahu
Tax Map Keys	2-3-037:021, 2-6-009:001, 2-6-008:034, 2-6-009:010, 2-6-009:002, 2-3-037:012
State Land Use District	Urban, Conservation
County Zoning	WSDD Public Precinct, Resort Mixed Use Precinct
Special Districts	Special Management Area, Waikīkī Special District
Proposed Action	Restoring water quality and constructing public facilities in and around Duke Kahanamoku Lagoon for enhancing its recreational and scenic qualities.
Parties Consulted	State Dept. of Land and Natural Resources, City and County of Honolulu Dept. of Planning and Permitting, State Dept. of Health, Army Corps of Engineers
Possible Required Permits & Approvals	Conservation District Use Permit, NPDES Construction Permit, Department of the Army Individual Permit, Right of Entry to State land, Coastal Zone Management Consistency Determination, Section 401 Water Quality Certification, Community Noise Control (DOH), Major Special Management Area Use Permit, Grading, Grubbing, Excavation & Stockpiling Permit (DDC), Well Development Permit, NPDES Discharge Permit, Building Permit, Waikīkī Special Design District review, Planned Development-Resort (PD-R) review
Associated Actions Requiring Environmental Assessment	Use of State land, work within the Special Management Area, and work within the State Conservation District.
Determination	Finding of No Significant Impact
Consultant	Planning Solutions, Inc. 210 Ward Ave, Suite 330 Honolulu, HI 96814 Contact: Perry White (808) 550-4483

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1.0 PURPOSE AND NEED

1.1 INTRODUCTION AND OVERVIEW

The Hilton Hotels Corporation (HHC) has obtained a Special Management Area Use Permit (SMP) and Planned Development-Resort (PD-R) approval for construction of the new Waikikian Tower and associated facilities and landscaping on its Hilton Hawaiian Village (HHV) property in Waikīkī. Among other things, the SMP (File No. 2002/SDD-33) requires HHC to attain and maintain the water quality of the adjacent Duke Kahanamoku (Hilton) Lagoon at acceptable levels as specified by the State Department of Health. The PD-R (City Council Resolution No. 02-226, CD 1, FD 1) establishes requirements for recreational and public facilities around the lagoon that HHC must fulfill during the redevelopment of the property.

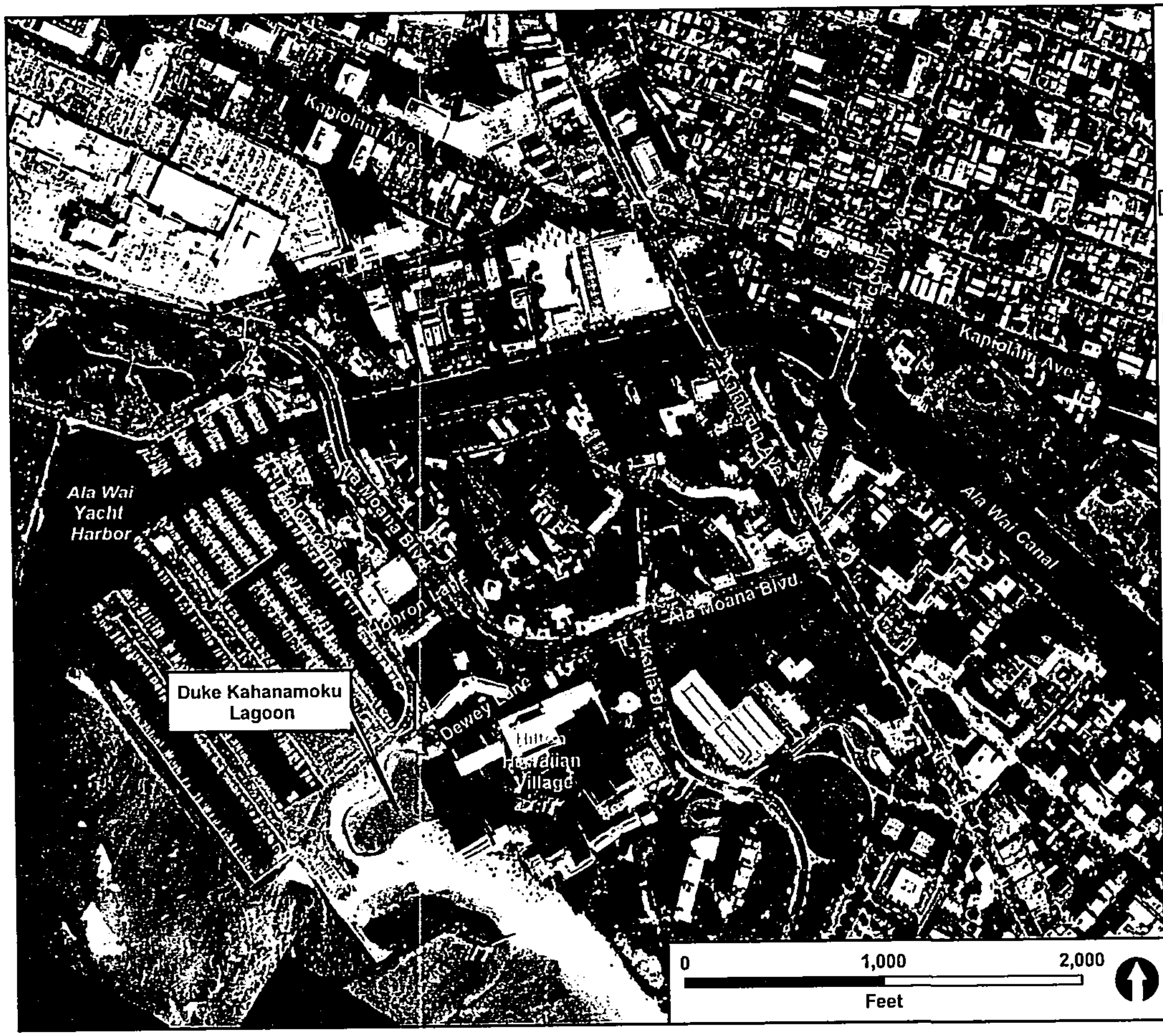
This EA covers the lagoon-related activities that Hilton Hotels Corporation is proposing in order to fulfill the conditions of its SMP and PD-R approvals for the Waikikian Project. Specifically, HHC is proposing to improve water quality in the lagoon by increasing the water turnover rate, reducing its volume, switching its source from ocean water to saline groundwater, and rerouting stormwater runoff away from the lagoon. It has also developed plans for extending the Waikīkī Promenade around the lagoon, adding landscaping, and installing public amenities (e.g., drinking fountains, benches) in accordance with the PD-R design program requirements. These actions entail work within the Conservation District and therefore will require HHC to obtain a Conservation District Use Permit. *In addition, the City and County Department of Planning and Permitting* has determined that a major SMP will be required.

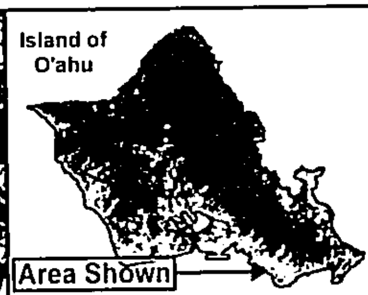
1.2 LOCATION AND EXISTING USE

The HHV is located at the western end of Waikīkī Beach (see Figure 1.1), and the Duke Kahanamoku Lagoon is situated adjacent to the southwestern boundary of the resort property. The lagoon is bordered by public beach to the east and south, by Ala Wai Harbor to the west, and by the HHV property on the northeast. The Duke Kahanamoku Lagoon was created by a combination of excavation and fill along the shoreline in 1956 when the Hilton Hawaiian Village was originally developed. The State of Hawai'i owns all of the property on which the 4.64-acre lagoon is located, but the terms of the September 22, 1955 Indenture and Deed from the Territory of Hawai'i gave the Hilton Hawaiian Village the right to construct and use (and the obligation to maintain) the lagoon.[1]

The lagoon's current uses are scenic and recreational, although recreational uses are limited by poor water quality and undesirable conditions within the lagoon and on the adjacent beach. The lagoon water is turbid and circulates slowly; the lagoon bottom is covered with soft, anaerobic sediment that emits an unpleasant odor when disturbed. The sand once covering the lagoon shore has eroded in many areas to expose hard coral and gravel substrate. No lights, benches, or other pedestrian amenities exist along the lagoon shore, in marked contrast to the Waikīkī Promenade to the east. Moreover, the lagoon is host to stinging jellyfish that have entered through the ocean intake pipes and now complete their entire life cycle within the lagoon. Thus, recreational uses are largely limited to pedestrians walking along the *makai* and 'Ewa shorelines of the lagoon. It is impossible to walk completely around the lagoon shoreline because the concrete retaining wall that supports the swimming pool on the *makai* side of the existing HHV Lagoon Tower extends into the water.

[1] Henry J. Kaiser constructed the lagoon in accordance with a design created by the (then) Territorial Harbors Commission. Lagoon construction was part of a littoral rights exchange between the abutting property owners (Kaiser and the Paoa Estate) and the Territory of Hawai'i. It was only a part of a planned significant enlargement of "Crescent Beach", but the other beach improvements were never made. Ownership of the lagoon passed to the Territory of Hawaii, under deed covenants specifying, for the Paoa property, that the Territory would preserve the lagoon as a "safe and sanitary" body of water and that Hilton maintain the lagoon for as long as economically practical. If HHC determines that this is impractical and notifies the State of its intent to discontinue maintenance of the lagoon, the State must fill the lagoon in to make a flat land area, provide an easement to Hilton, and create a "no buildings" zone.





Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Sources:

City & County of Honolulu GIS
Hilton Hotels Corporation

Figure 1-1:

Location Map

Hilton Hawaiian
Village Lagoon Restoration

Unlike conditions when it was first constructed, few people now use the lagoon shoreline for sunbathing or picnicking. People occasionally wade in the lagoon, but it is largely avoided by swimmers, who typically use the nearby ocean.

1.3 NEED FOR LAGOON RESTORATION

Both HHC and the City and County of Honolulu recognize that the lagoon has greater potential as a scenic and recreational resource than is currently being realized. HHC's approvals from the City for constructing the new Waikikian Tower within the HHV require that HHC propose and execute plans for restoration of the lagoon.[2] Moreover, the terms of the September 22, 1955 Indenture and Deed from the Territory of Hawai'i obligate the HHV to maintain water quality within the lagoon at a level that is better than now exists.

The approvals the City has granted require: (1) restoration of water quality within the lagoon to safe and sanitary conditions for recreation and (2) the addition of land-side amenities along the lagoon shore to encourage recreational use and integrate the lagoon area with the surrounding recreational area of Waikīkī. In developing the plan to address water quality issues, HHC examined the root causes of poor water quality and bottom conditions within the lagoon. Its findings are summarized in Section 1.3.1 and Section 1.3.2.

As discussed in Section 2.2.3 of this report, Condition C.1.c. of the Special Management Area permit for the Waikikian Project recognized that that restoration could prove to be infeasible and provided that if HHC determined this to be the case it prepare a detailed plan to DPP (including a timetable) for filling the lagoon and widening the beach. Because HHC determined that the plan described in this report is physically and economically feasible, it is not presently pursuing that alternative. DPP's October 2004 approval of the conceptual plan for the lagoon restoration reflects the same opinion. Should the City fail to grant the SMA permit, or should HHC be unable to obtain the other approvals that are required from State and Federal agencies, then HHC would be forced to prepare a detailed plan for filling the lagoon and seek the permits needed to implement that plan.

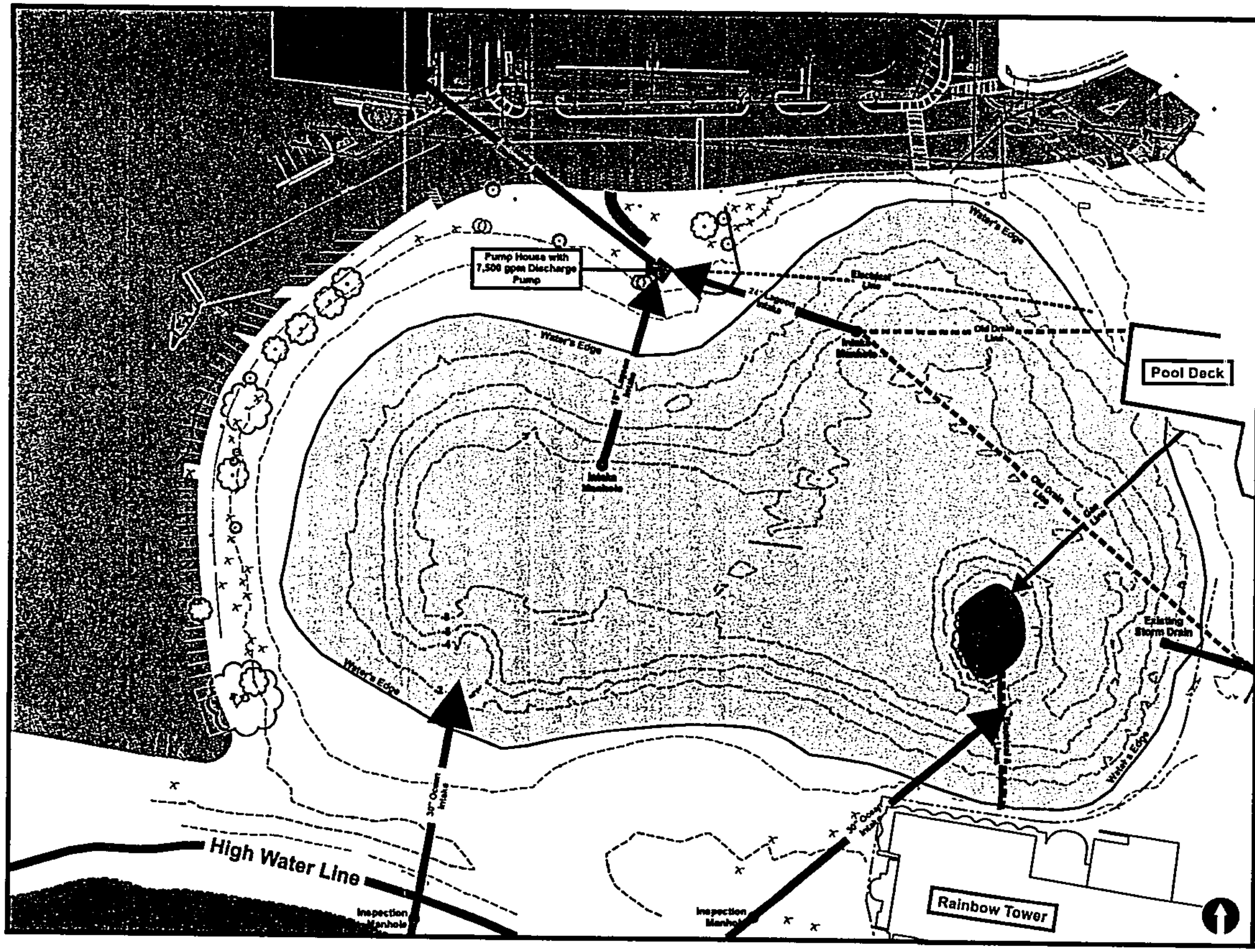
1.3.1 LAGOON WATER CIRCULATION

The lagoon's existing water circulation system as illustrated on Figure 1.2 consists of:

- Two 30-inch diameter corrugated-metal ocean-water intake pipes that originate in shallow water immediately *makai* of the lagoon, pass under the beach berm, and discharge into the lagoon.
- One 24-inch and one 18-inch diameter intake pipe in the lagoon that convey water from the lagoon to the pump house.
- A single 36-inch diameter discharge pipe that carries water from the pump house to the Ala Wai Harbor.
- A nominal 7,500 gpm discharge pump (now operating at about 5,300 gpm), which is located in a small pump house on the 'Ewa side of the lagoon.

By pumping water from the lagoon into the Ala Wai Harbor, the system lowers the water level in the lagoon below that in the adjacent ocean. The resulting difference in water surface elevation causes water to flow from the ocean into the lagoon at all times. However, because the head difference is a function of the level of the water in the ocean, which fluctuates with the tide, the rate of inflow varies over time, while the discharge into the harbor remains relatively constant. As a result, the water level

[2] If the restoration is determined infeasible, the terms of the indenture and deed under which the lagoon was constructed require the State (as successor to the Territory) to fill the Lagoon and beach to the elevation of the surrounding properties and to maintain them in open space. Both parties to the agreement prefer that this not occur. Instead, they wish the lagoon retained as a unique landmark and recreational resource.



Legend:

Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Source:

-Sea Engineering, Inc.
-RM Towill Corp.

Figure 1-2:

Existing Lagoon Features

Hilton Hawaiian Village Lagoon Restoration

in the lagoon rises and falls in response to the tide.[3] At various tidal phases, the water level in the lagoon can be 0.5 to 4.0 feet lower than the adjacent ocean. On average, it is about a foot lower.

The original pump capacity was selected to provide a lagoon turnover rate (i.e., the rate at which the complete volume of the lagoon is replaced) of one time per day, slower than the rate that is now considered good design practice, and too slow to support water quality appropriate for the desired recreational uses of the lagoon. Moreover, the pump is no longer operating at its original capacity. Finally, because the relative positioning of the pipes that supply and withdraw water from the lagoon leads to short-circuiting (i.e., relatively direct movement of water from the point at which it enters the lagoon through the ocean intake to the outlet pipe from which it is drawn into the pump house and then into the lagoon). Consequently, the average turnover rate in the entire lagoon is once every 1.5 to 2 days, and the water in many areas turns over far more slowly than that.

1.3.2 SOURCES OF LAGOON DEGRADATION

As shown on Figure 1.2, the lagoon is presently supplied with ocean water via two ocean intake pipes. These pipes draw relatively turbid water from the nearshore area into the lagoon. Once it is in the low-energy lagoon environment, sediment that was formerly kept in suspension by ocean waves settles out of the water column, accumulating on the bottom in the form of soft sediment. In the absence of wave energy to turn them over, the sediments have become anaerobic. In addition, a variety of marine organisms have entered the lagoon from the surrounding ocean environment and become established there. These include a number of marine fishes, but they also include stinging jellyfish which have compromised the lagoon's recreational value.

One other cause of poor water quality in the lagoon is the stormwater runoff from adjacent areas (including about half of the HHV property) that is currently discharged into it. Some tests of water samples taken from the lagoon show elevated concentrations of certain constituents in the portion of the lagoon closest to these stormwater discharges (see Section 3.5.1.1).

1.4 ORGANIZATION OF THE ENVIRONMENTAL ASSESSMENT

The remainder of this document is organized as follows:

- Chapter 2 describes the project objectives and the technical characteristics of the proposed action. It also summarizes the alternatives HHC considered (including "No Action"), and the reasons for including or excluding specific alternatives from detailed analysis in the EA.
- Chapter 3 introduces the environmental and social characteristics of the properties affected by the project, discusses the potential impacts of the project on those areas, and where applicable, details mitigation measures that will be used to minimize those impacts.
- Chapter 4 discusses the project's compliance with applicable laws and planning documents at county, state, and federal levels.
- Chapter 5 evaluates the project against the HRS Chapter 343 criteria for determining whether a project has significant environmental impacts.
- Chapter 6 and Chapter 7 list the parties and references consulted during the preparation of the EA, respectively. Chapter 6 also includes a list of agencies and individuals who were sent a copy of the Draft EA and a list of comments received on it. The comment letters and responses to them are reproduced at the end of Chapter 6.

[3] The timing of the rise and fall in the lagoon lags behind that of the ocean and is reduced in amplitude relative to it. The tidal lag is on the order of three to four hours and the tidal amplitude in the lagoon is about one-third of the ocean tide.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

This chapter describes the proposed action and the alternatives that were considered. Section 2.2 describes the framework within which alternatives (including HHC's proposed plan) were formulated and evaluated. Many of the alternatives considered affect both the water quality and land-side components of the project, and thus each alternative was evaluated in terms of maximizing the objectives specific to each component. The plan that is believed to represent the most balanced solution to the land side and water quality objectives is presented in Section 2.3. The alternatives that were considered but eliminated from detailed evaluation in this environmental assessment are described in Section 2.4. Section 2.4.4 discusses the implications of filling the lagoon and widening the beach as provided for in the 1955 Indenture and Deed if water quality restoration is not achieved. Finally, Section 2.5 addresses the alternative of "No Action" as required by HRS Chapter 343.

2.2 FRAMEWORK FOR CONSIDERATION OF ALTERNATIVES

This section outlines the process which HHC followed in identifying alternatives for inclusion in the EA. The process began with the identification of the general project objectives described in Section 2.2.1. Section 2.2.2 summarizes the regulatory guidelines for considering alternatives contained in Chapter 343 Hawai'i Revised Statutes that informed the definition of alternatives. Finally, the definition of alternatives adhered to the applicable requirements of HHC's SMA and PD-R approvals listed in Section 2.2.3.

2.2.1 PROJECT OBJECTIVES

HHC's primary objective for the project is to restore the lagoon to a condition appropriate for recreational use as mandated by the terms of the September 22, 1955 Indenture and Deed from the Territory of Hawai'i while also: (i) complying with all Special Management Permit (SMP) and Planned Development (PD-R) design program requirements and (ii) remaining compatible with HHC's vision for the Hilton Hawaiian Village. With this overall objective in mind, HHC developed the design objectives specific to the water quality and land side components of the project summarized in Section 2.2.1.1 and Section 2.2.1.2.

2.2.1.1 Water Quality Restoration

HHC's SMP requires that water quality within the lagoon be restored and maintained in accordance with State water quality standards. Based on the causes of poor water quality summarized in Section 1.3, HHC's consultants recommended this be accomplished by: 1) increasing the water turnover rate to at least four times per day; 2) providing a source of supply water with much lower suspended sediment levels than that of the existing source; 3) eliminating the silty organic layer on the lagoon bottom; 4) improving water circulation through better placement of intake and discharge structures; and 5) eliminating most stormwater inflow into the lagoon. Alternative ways of accomplishing these actions were identified and evaluated based on cost, feasibility, environmental impact, and compatibility with land side objectives outlined below.

2.2.1.2 Land Side Improvements

The PD-R requirements outlined in Section 2.2.3 below outline specific components that must be included in the land side improvement program. HHC elaborated on these criteria by specifying that the elements should be consistent with the aesthetic standards of the Hilton Hawaiian Village while remaining a clearly defined public use area distinct from the guest-oriented areas of the hotel itself.

2.2.2 REGULATORY GUIDANCE

Hawai'i Administrative Rules (HAR), §11-200-9 and §11-200-10 (sections in the Department of Health's Environmental Impact Statement Rules) provide the framework for considering alternatives. These sections do not prescribe the way in which alternatives must be selected for environmental assessments, but HAR §11-200-17 provides guidance useful in determining how to go about identifying alternatives for the purpose of environmental assessments. Specifically, §11-200-17(f) states:

> *(f) The draft EIS* [EA] *shall describe in a separate and distinct section alternatives <u>which could attain the objectives of the action</u>* (emphasis added), *regardless of cost, in sufficient detail to explain why they were rejected. The section shall include a rigorous exploration of the environmental impacts of all such alternative actions. Particular attention shall be given to alternatives that might enhance environmental quality or avoid, reduce, or minimize some or all of the adverse environmental effects, costs, or risks. Examples of alternatives include:*
>
> *(1) The alternative of no action;*
>
> *(2) Alternatives requiring actions of a significantly different nature which could provide similar benefits with different environmental impacts;*
>
> *(3) Alternatives related to different designs or details of the proposed action which would present different environmental impacts;*
>
> *(4) The alternative of postponing action pending further study; and*
>
> *(5) Alternative locations for the proposed project.*
>
> *In each case the analysis shall be sufficiently detailed to allow a comparative evaluation of the environmental benefits, costs, and risks of the proposed action and each reasonable alternative.*

HHC employed these guidelines and the SMA and PD-R conditions outlined in the following section in determining the range of alternatives to be evaluated and discussed in this EA.

2.2.3 APPLICABLE SMA AND PD-R REQUIREMENTS

The requirements of HHC's July 15, 2002 SMP relate to water quality improvements within the lagoon, while the August 7, 2002 PD-R requirements focus on land side improvements around the lagoon shore. The lagoon-related conditions of these approvals are reproduced below:

- <u>SMA-C.1.a.</u>. Within 2 years from the date of approval of this SMA permit, submit a detailed plan and timetable for the restoration of the lagoon to a safe and sanitary body of water.
- <u>SMA-C.1.b.</u> Within 2 years from the date of approval of this SMA permit, submit a detailed maintenance plan, to ensure that the lagoon will remain in compliance with State water quality requirements. Changes/additions to the piping/pumping system and/or other measures shall be proposed in order to restore and ensure continued maintenance of the lagoon water at a high quality level, in accordance with State standards.
- <u>SMA-C.1.c.</u> Within 2 years from the date of approval of this SMA permit, if restoration of the lagoon is determined to be infeasible, shall submit a detailed plan and proposal to the DPP (including a timetable) for filling the lagoon and widening the beach.
- <u>SMA-C.1.d</u>. Implement the approved plan within 3 years of the date of the approved lagoon restoration and maintenance plan. Implementation must be completed within 5 years of the date of approval of the SMA permit.

- PD-R-4 (part). The Applicant, at its own expense, shall construct, in coordination with and in compliance with the requirements of all applicable public agencies, the following: ...(4) pedestrian walkways and associated areas along Dewey Lane and around the Hilton Lagoon.
- PD-R-5 (part). The Applicant shall be responsible for the maintenance of all constructed improvements not otherwise accepted by the City/State for maintenance.
- PD-R-6.b. Prior to submitting any building permit applications, the Applicant shall submit Revised Plans for DPP review and approval, which include the following:

  b. Provide preliminary plans for an extension of the Waikīkī Promenade that encircles the Hilton Lagoon and connects the walkway of the Rainbow Tower to the Ala Wai Boat Harbor parking lot. (The promenade shall contain amenities, i.e., seating areas, drinking fountains, lighting, and landscaped planting strips with irrigation, shade trees, coconut palms, shrubs, and groundcover. The promenade also shall include, and the Applicant shall grant, public access to a restroom facility to be located at the swimming pool or restaurant area along the promenade.); and

  c. Provide preliminary plans for signage for public parking at reduced rates and public beach access fronting and along the Dewey Lane pedestrian walkway.

2.3 PROPOSED ACTION: HHV LAGOON RESTORATION PROJECT

Through analysis, review, and consultation with government agencies, HHC developed a plan for restoring the lagoon restoration which they believe best satisfies the objectives outlined in Section 2.1. The Department of Planning and Permitting has reviewed the plan and confirmed that it would satisfy the requirements of the SMA and PD-R approvals mentioned above. Consequently, it represents the action proposed in this EA. The following sections describe the proposed action in detail, separating the water quality restoration and land side improvements for convenience.

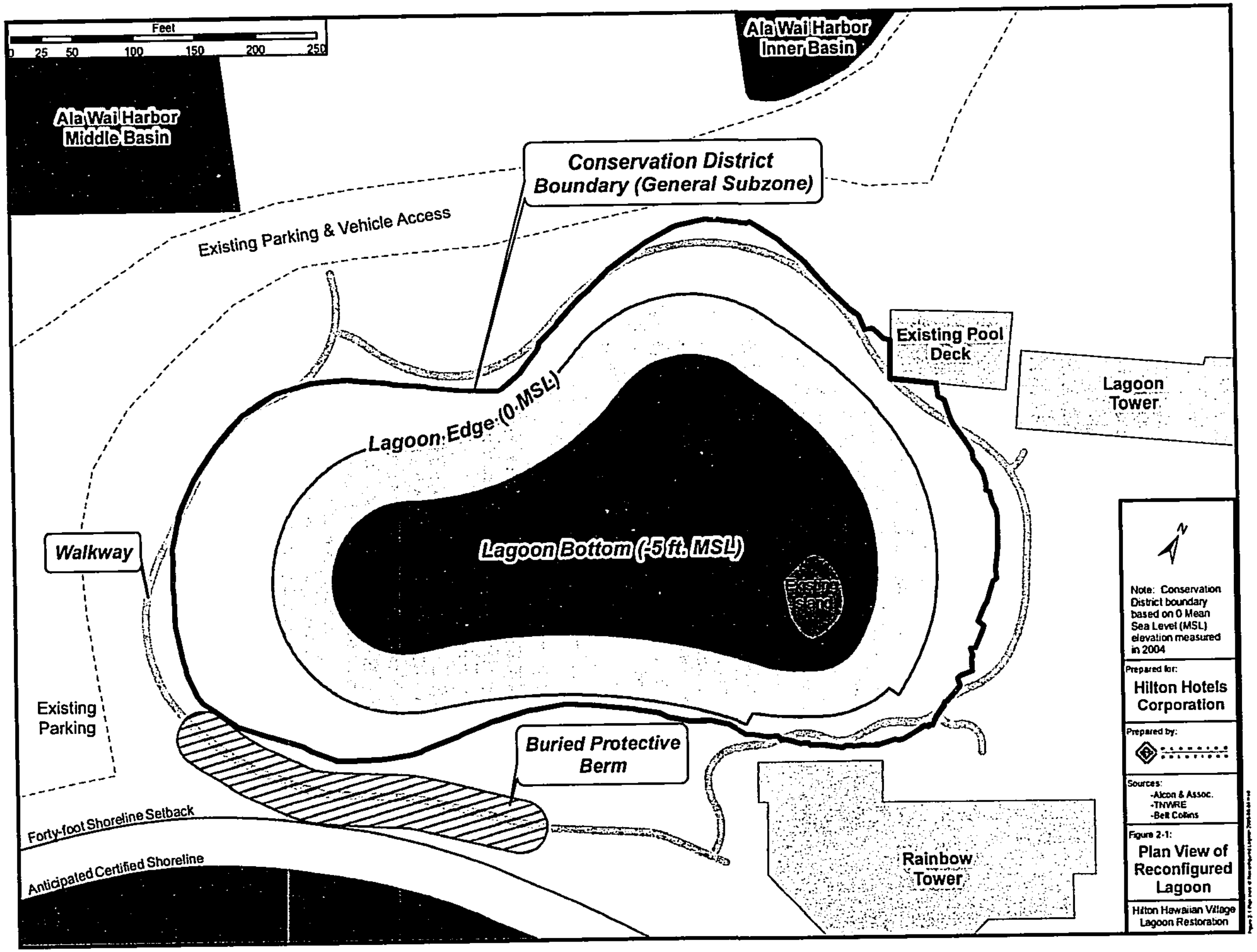
2.3.1 WATER QUALITY-RELATED IMPROVEMENTS

2.3.1.1 Description of the Proposed Improvements

The proposed plan for improving water quality in the Hilton Hawaiian Village consists of the following key components selected from the alternatives that were evaluated. The system is illustrated in Figure 2.1, Figure 2.2, and Figure 2.3.

- The volume of water in the lagoon will be reduced by about 50 percent. This will be achieved by reducing the maximum depth of the lagoon to 5.0 feet below mean sea level (MSL), creating gently sloping lagoon sides (1 foot vertical to 10 feet horizontal), and shrinking the surface area by about a quarter (from 4.64 acres to 3.43 acres). The soft, anaerobic bottom sediments would be sealed in place using an impermeable geotextile fabric covered by an overburden of 15,000-20,000 cubic yards of sand.[4] This will eliminate the need to remove and dispose of the bottom sediments. The sand will come from approved on-land sources. Figure 2.4 illustrates the manner in which the geotextile fabric will be secured along the side of the lagoon.
- HHC will seal the existing ocean intakes, eliminating the major source of the sediment that has accumulated in the lagoon and which contributes to its turbid appearance. Substituting the groundwater source for the existing ocean water source will also greatly reduce colonization by jellyfish and contamination by other pollutants found in nearshore waters.

[4] The geotextile layer provides separation between the very soft sediments and the sandy/gravelly fill above. This will prevent sand loss into the soft sediments and prevent the mud and fine soil particles from contaminating the sand fill.


Feet
0 25 50 100 150 200 250
Ala Wai Harbor Middle Basin
Ala Wai Harbor Inner Basin
Conservation District Boundary (General Subzone)
Existing Parking & Vehicle Access
Existing Pool Deck
Lagoon Tower
Lagoon Edge (0 MSL)
Lagoon Bottom (-5 ft. MSL)
Walkway
Existing Parking
Buried Protective Berm
Forty-foot Shoreline Setback
Anticipated Certified Shoreline
Rainbow Tower
N
Note: Conservation District boundary based on 0 Mean Sea Level (MSL) elevation measured in 2004
Prepared for:
Hilton Hotels Corporation
Prepared by:
Sources:
-Alcon & Assoc.
-TNWRE
-Belt Collins
Figure 2-1:
Plan View of Reconfigured Lagoon
Hilton Hawaiian Village Lagoon Restoration

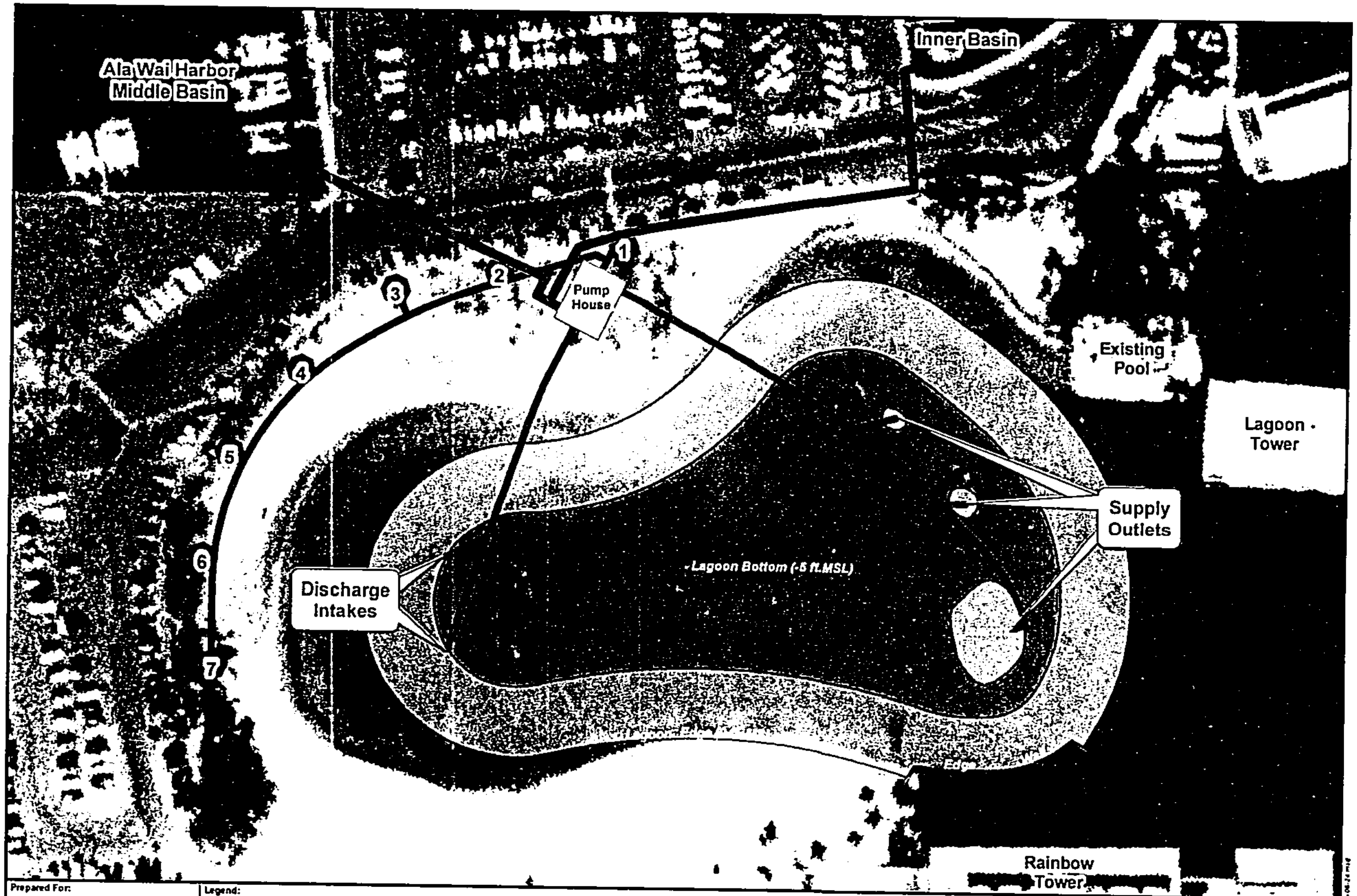
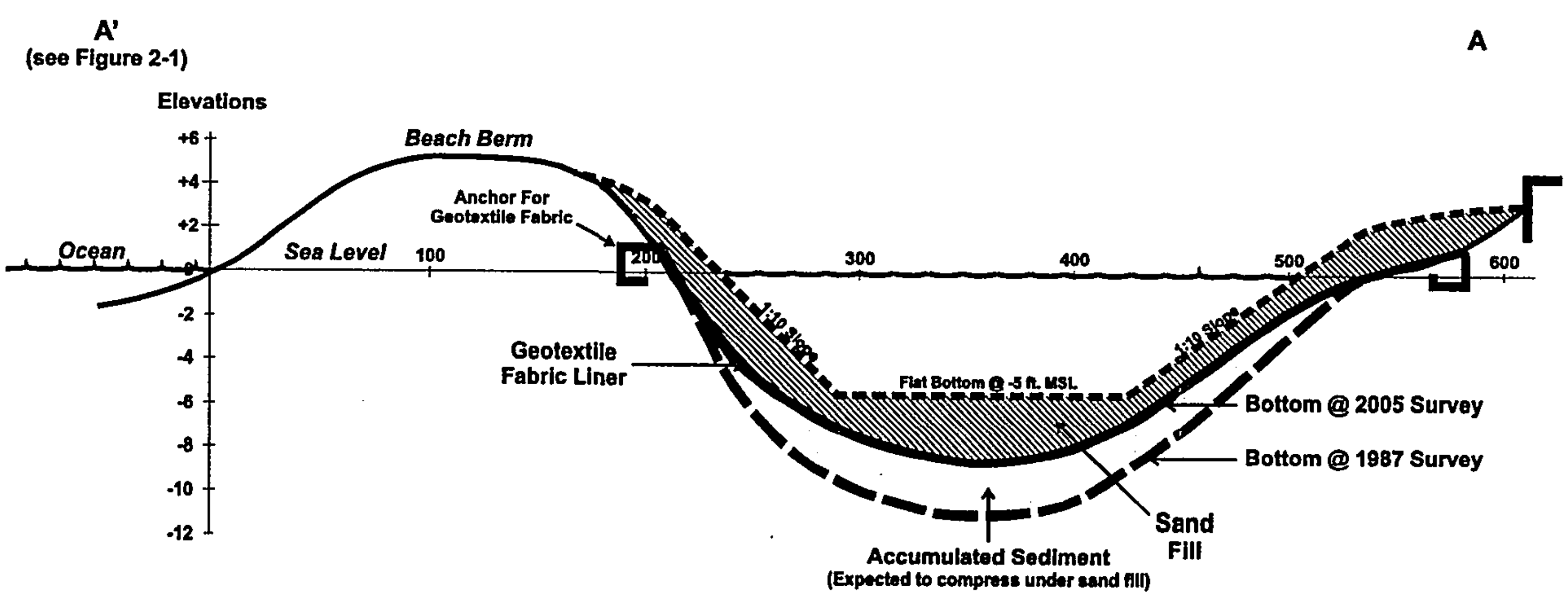


Figure 2-2:

Water Circulation System

Hilton Hawaiian Village Lagoon Restoration

Note: Vertical Exaggeration 10X



Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

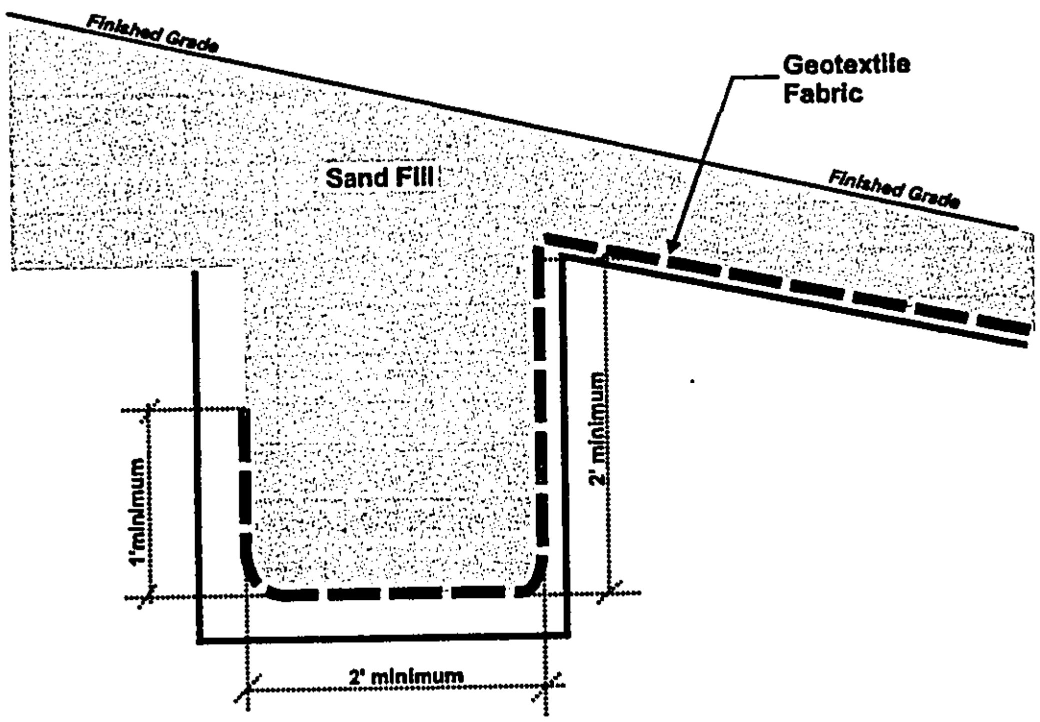
Source:

TNWRE

Figure 2-3:

Conceptual Lagoon Cross Section

Hilton Hawaiian Village Lagoon Restoration



Prepared For:
Hilton Hotels Corp.

Prepared By:
PLANNING SOLUTIONS

Source:
TNWRE

Legend:

Figure 2-4:

Schematic Diagram of Geotextile Fabric Anchoring System

Hilton Hawaiian Village
Lagoon Restoration

- HHC will develop the seven exploratory wells it has drilled alongside the northwestern side of the lagoon.[5] As constructed, the wells will draw saline groundwater from between 77 and 251 feet below sea level. Each well will have a capacity of at least 2,500 gallons per minute (gpm). Together, they will deliver a minimum of 15,000 gpm of water into the lagoon, about three times the present rate. Its first 82 to 97 feet consists of a 24-inch borehole, 14-inch diameter Schedule 80 solid PVC well casing, and a grout seal. The exact length of each well's upper section is shown in Table 2.1 below. Each was adjusted so that the bottom of the solid casing was in firm, non-caving material. Below the solid casing, each of the wells has 13-inch diameter open holes to depths between 194 and 250 feet below sea level. The specific depth for each well was varied to maximize the well's yield while producing water warm enough for comfortable swimming in the lagoon. This design avoids drawing the relatively poor quality shallow groundwater and it also avoids structural foundation problems that might be caused by dewatering the shallow groundwater. A prototype supply well was drilled and pump tested in 2003. Results showed that water could be drawn from the strata at depth without affecting the shallower, near surface groundwater.

Table 2.1. **Finished Dimensions of the Saltwater Supply Wells**

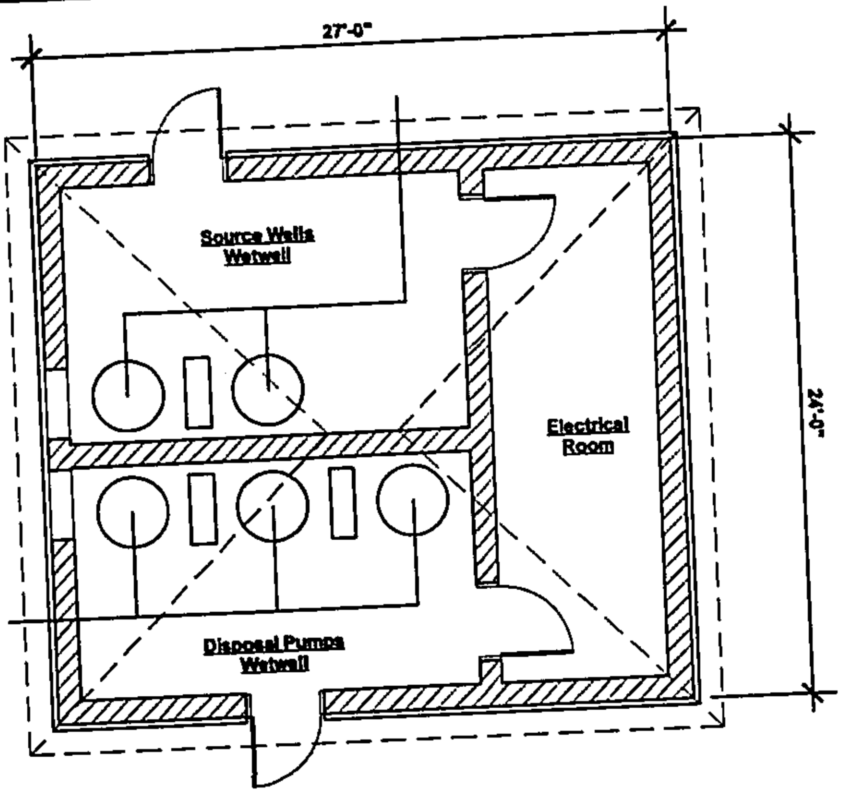
Well No.	*Ground Elevation (Feet MSL)*	*Length of Solid Casing (Feet)*	*Length of Open Hole (Feet)*	*Total Well Depth (Feet)*
1	5	87	107	194
2	5	83	165	248
3	5	97	153	250
4	3	83	172	255
5	2	83	159	242
6	2	82	123	205
7	2	82	164	246

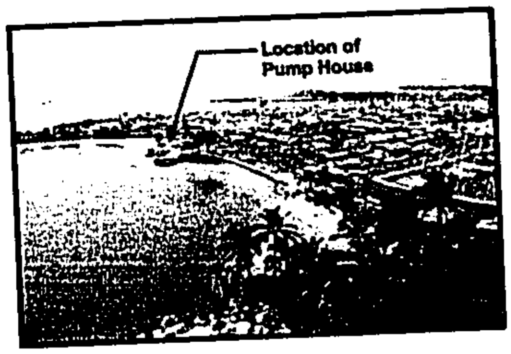
Note: All depths are relative to the existing ground as of April 22, 2005, the date that all seven wells were completed.

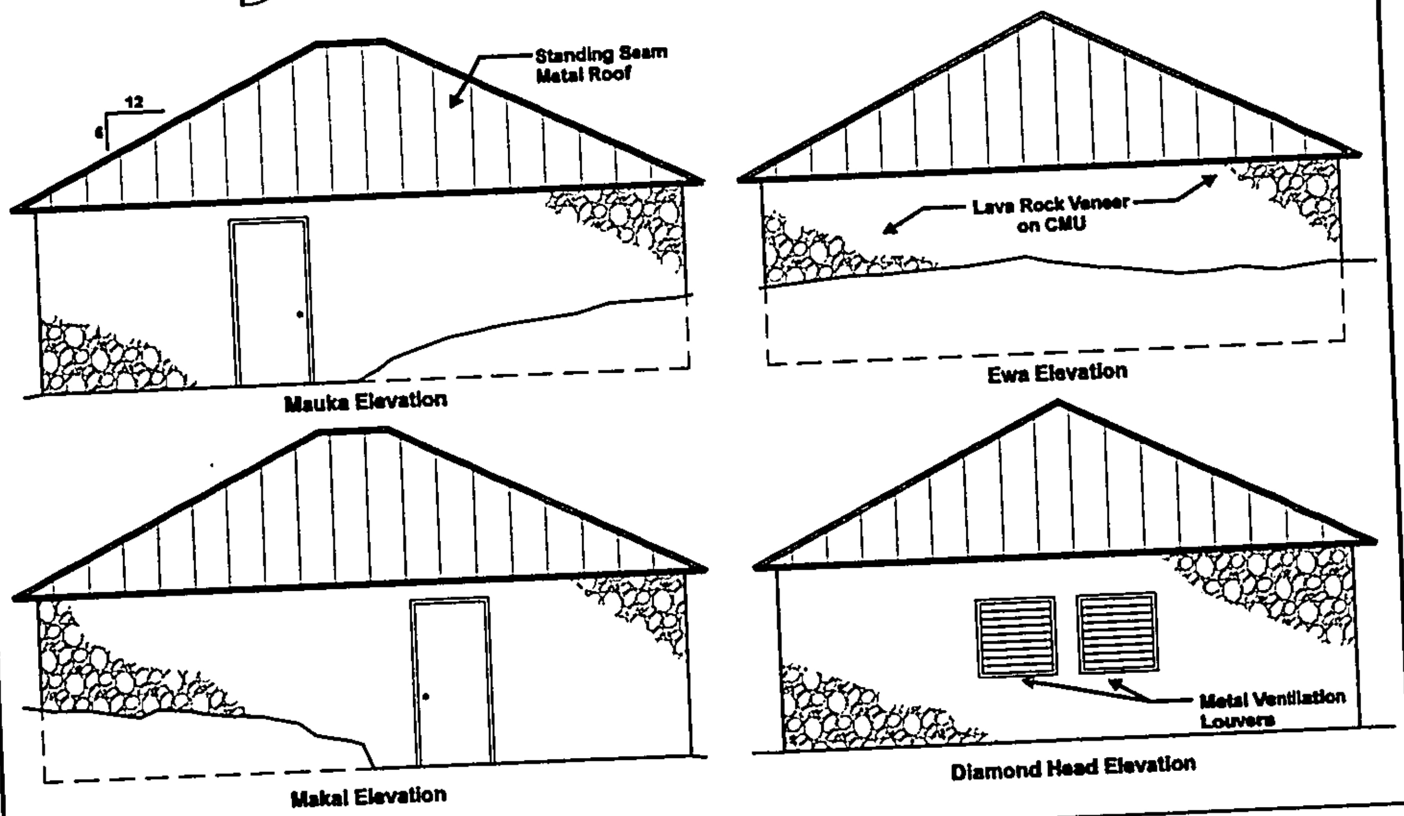
Source: Tom Nance Water Resource Engineering (2005).

- HHC will remove the existing 50 year-old pipes within the lagoon and replace them with a new circulation system within the lagoon for inflow and outflow. The circulation system will be located within a new pump house next to the existing one (which will be demolished). The proposed design of the new pump house is depicted in Figure 2.5. The existing lagoon water circulation system uses pumps only to discharge water from the lagoon into the Ala Wai Harbor. As a result, the inflow is only by gravity, and the resulting water level in the lagoon is below sea level. The proposed new system uses pumps for both the inflow and outflow from the lagoon. This gives operators much greater control over the system, and it also allows the average water level in the lagoon to remain closer to sea level.

[5] The bore holes for the wells were drilled and pump-tested during the first half of 2005 to determine their yield and operating characteristics and to confirm that the quality of the water that they would supply would be adequate for the proposed recreational use. The wells will be completed and the other equipment needed to complete the system installed if approvals are granted for the overall lagoon restoration program.







Prepared For:
Hilton Hotels Corp.

Prepared By:
PLANNING SOLUTIONS

Source:
RM Towill Corp.

Legend:

Figure 2-5:

Plan & Elevation Views of Pump House

Hilton Hawaiian Village
Lagoon Restoration

- The inflow (supply) system will consist of a manifold pipe that connects all seven new wells to a sump in the new pump house. The sump will be between 5 and 8.5 feet below mean sea level, allowing water to flow by gravity from the wells to it. From there, two 7,500 gallon per minute (gpm) pumps will deliver water (an average of 21.6 million gallons of water per day) through fusion-welded High-Density Polyethylene (HDPE) pipes laid beneath the lagoon's bottom to three discharge points situated toward the northeastern edge of the lagoon. Each pump will be driven by a 30 horsepower electric motor and will operate continuously. This delivery rate is equivalent to turning over the entire lagoon water volume approximately 5.5 times per day (i.e., once every four to five hours).
- The effluent pump sump will be located in the pump house adjacent to, but not connected with, the influent pump sump. It will house three 6,000 GPM pumps, each driven by a 15-horsepower electric motor. Water will be drawn into the sump from two intakes at the *makai* end of the lagoon and delivered to the inner and middle basins of Ala Wai Boat Harbor. Two of the pumps will operate continuously and the third will run for 12 hours each day. This means that for 12 hours each day, inflow to the lagoon will exceed the outflow by 3,000 GPM and for the other 12 hours, the outflow will be greater by 3,000 GPM. This inflow/outflow variation will create a daily lagoon water level variation of about two feet. The resulting lagoon level will vary from one foot above to one foot below sea level. The times of the high and low "tides" in the lagoon will be selected by *the start-stop settings for the effluent pumps.*
- The existing 36-inch diameter pipe which carries water from the existing pump house to a discharge point at the *mauka*-Diamond Head end of the Ala Wai Harbor's middle basin has sufficient capacity to accommodate the 15,000 gpm discharge rate. However, in response to a request from the Division of Boating and Outdoor Recreation (DOBOR) of the State Department of Land and Natural Resources, which operates the harbor, HHC has agreed to divert a portion of the water being discharged into the inner basin of the harbor. To accomplish this, it will install a new pipeline that will carry half of the outflow from the lagoon into the *makai*-Diamond Head corner of the inner harbor basin.
- Exceptionally high waves periodically cause the ocean to overtop the existing beach berm along the lagoon's southern shoreline, washing into the lagoon. The overtopping erodes the beach berm in the process. Consequently, HHC's preferred alternative includes the reinforcement of the berm as described in Section 2.3.2.4.2. This would reduce the possibility that high waves could wash out the sand or completely breach the lagoon/ocean separation.
- In addition to the improvements described above, the storm drains that presently send runoff from approximately half of the HHV property into the lagoon will be rerouted. The new system, which will include a filtration capability not present in the existing system, will divert stormwater runoff into the *mauka* basin of the Ala Wai Harbor adjacent to the existing discharge from the Dewey Lane stormwater drain. These improvements are discussed in detail in Section 2.3.1.3 below.

2.3.1.2 Performance, Operation and Maintenance of the Proposed System

2.3.1.2.1 Anticipated Performance of the System

The improvements described above will increase turnover in the lagoon from less than one time per day to approximately five times per day. Hence, the average residence time for water within the lagoon will drop from more than 24 hours to about five hours. In addition, because of the locations of the inlets and outlets, a positive turnover throughout the lagoon will be created. These improvements, plus the elimination of most stormwater runoff entering the lagoon as described in the following section, are expected to restore the lagoon's water quality to within safe recreational standards.

Unlike the present passive inlet system, operators will be able to control the rates of inflow and outflow from the lagoon. The system will be automated. For normal operations, it will be programmed to vary the water level in the lagoon, simulating tidal movement to avoid the bank erosion that could occur from wave action if the water were always at the same level. However, the system will allow operators to lower the water level in the lagoon as needed to facilitate maintenance.

The heart of the proposal is a source of clean saltwater drawn from the coral layers at depth, which will be free from the contaminants that are a problem with the existing ocean intakes. A test borehole was drilled and pump-tested late in 2003 near the northwest corner of the lagoon, on HHV property. The results demonstrate that it will be possible to provide the 15,000 gpm of water that is needed with the development of seven wells. Measurements made during the pump test showed that the dissolved oxygen content of the saline groundwater is low (less than 1.0 mg/l), but that it increased rapidly once discharged into the lagoon, reaching between 4 and 7 mg/l (55 to 95 percent saturation) within a few feet of the discharge. The extent to which additional aeration may be needed will be assessed during the detailed design phase of the facilities and appropriate measures used to assure that this occurs.

2.3.1.2.2 Operational Control and Maintenance

Hilton Hawaiian Village LLC will be responsible for the ongoing maintenance and operation of the system using trained personnel from its facilities maintenance staff with technical support from well and pump specialists. Because of the nature of the hotel operation, staff is onsite at all times so that these personnel can respond quickly in the event of a malfunction. One additional feature of the system is worth noting. It will have built-in redundant capacity (multiple well sources and multiple supply and discharge pumps) that will minimize the number of occasions when equipment malfunction results in a complete shutdown of the circulation system. Moreover, the nature of the lagoon ecosystem is such that it can tolerate reduced turnover rates for several days at a time without apparent harm.

Operation and maintenance of the system will entail the following activities:

- Daily visual inspection of the pump house to insure that equipment is in good working order. This would be supplemented with an automatic alarm system that would report a malfunction in the pumps to the maintenance personnel at the HHV so that they can undertake immediate corrective action.
- Daily visual inspection of the lagoon shoreline to look for signs of unusual biologic activity or foreign material.
- Weekly (or more frequent if needed) cleaning of the exposed portion of the beach sand and agitation of the lagoon bottom using a mechanical device.
- Periodic sampling and testing of the water from the lagoon in accordance with protocols acceptable to the State Department of Health.
- Annual (or more frequent) inspections of the accessible parts of the circulation system to determine their condition and to look for possible deterioration or blockages.
- The HHV will maintain the pumps, control systems, and other system components in accordance with the manufacturers' recommendations.

Periodic restoration of sand slopes using mechanical equipment if necessary.

2.3.1.3 Related Changes to Storm Drainage System

2.3.1.3.1 Existing Conditions

- Approximately 45 percent (10.2 acres) of the 23-acre HHV property presently discharges stormwater runoff into the lagoon. The size and peak runoff from the drainage areas which contribute runoff to the lagoon are shown in Table 2.2. Runoff from the Rainbow Tower Roof (Area 3) enters the Lagoon at several points along its Diamond Head side through downspouts along the northern face of Rainbow Tower.

- An underground drainage system carries stormwater runoff from the Rainbow Drive & Bazaar (Area 4) to a pump station located alongside the Tapa Tower Shops. It is then pumped to a transition drain box at the southwest corner of the Great Lawn from where the runoff sheet flows into the Lagoon.

Table 2.2 indicates that peak runoff entering the Lagoon from the HHV as the result of a storm with a 50-year recurrence interval is 38.3 cubic feet per second (cfs).

Alcon & Associates (personal communications dated April 22, 2005) report that the runoff enters the Lagoon from four distinct routes:

- Runoff from Lagoon Tower & Coral Ballroom/Parking Structure (Area 1) sheet flows down a paved service drive to the north of the HHV parking structure and Lagoon Tower and eventually enters an underground drainage system through an inlet at the northwest corner of Lagoon Tower.
- Runoff from Area 2 sheet flows across lawn between the Lagoon Tower and Rainbow Tower and discharges across the sandy shoreline directly into the Lagoon.
- Runoff from the Rainbow Tower Roof (Area 3) enters the Lagoon at several points along its Diamond Head side through downspouts along the northern face of Rainbow Tower.
- An underground drainage system carries stormwater runoff from the Rainbow Drive & Bazaar (Area 4) to a pump station located alongside the Tapa Tower Shops. It is then pumped to a transition drain box at the southwest corner of the Great Lawn from where the runoff sheet flows into the Lagoon.

Table 2.2 Stormwater Runoff Presently Draining into Lagoon.

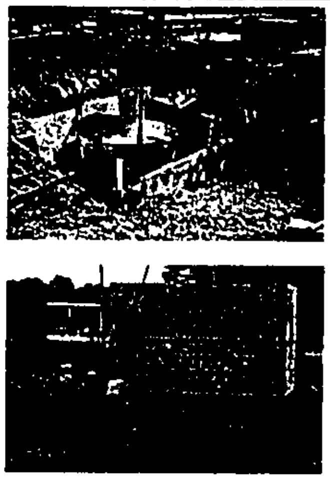
Area No.	*Description*	*Area (Ac)*	*Q (cfs)*
1	Lagoon Tower & Coral Ballroom/Parking Structure	3.2	13.7
2	Lagoon Lawn	1.0	1.5
3	Rainbow Tower Roof	0.3	1.4
4	Rainbow Drive & Bazaar	5.7	21.7
	Total	**10.2**	**38.3**

Note: "Q" represents the peak runoff discharge into the Lagoon under a 50-year storm recurrence interval per the current City and County Rules Relating to Storm Drainage Standards.

Source: Personal communications from Alcon & Associates, April 22, 2005.

Currently, HHV has a storm water quality management plan that consists of daily sweeping of all roadways and walks to minimize the quantity of leaves and other deleterious materials entering the onsite storm drain system. There are no special sediment traps, oil-water separators, or other pollution control devices in the system.

2.3.1.3.2 Proposed Drainage Improvements



As part of the effort to improve the water quality within the Lagoon, nearly all of the storm water runoff from the HHV currently entering the Lagoon will be redirected into the Ala Wai Boat Harbor.[6] The conceptual design of the proposed system is shown in Figure 2.6. The runoff will be diverted using two pump systems. One system will be located at the northeast corner of Lagoon Tower and will collect the runoff from Area 1. The second system will be located at the southwest corner of Lagoon Lawn, adjacent to a proposed loading dock for Rainbow Tower. This system will collect runoff from Areas 2, 3 and 4. These areas are also depicted in Figure 2.6.

Prior to entering the pump stations, all runoff will be treated using a "flow-through" storm water treatment system (one at each pump station) to supplement the daily sweeping currently performed by HHV (see Figure 2.7 and pictures immediately to the left for example of system). These treatment systems are designed to mechanically filter sediments at a relatively constant level of efficiency over the entire storm event for both high and low intensity storms. The rated removal rate is 80% of Total Suspended Solids (TSS) for 50-micron sediment particles.

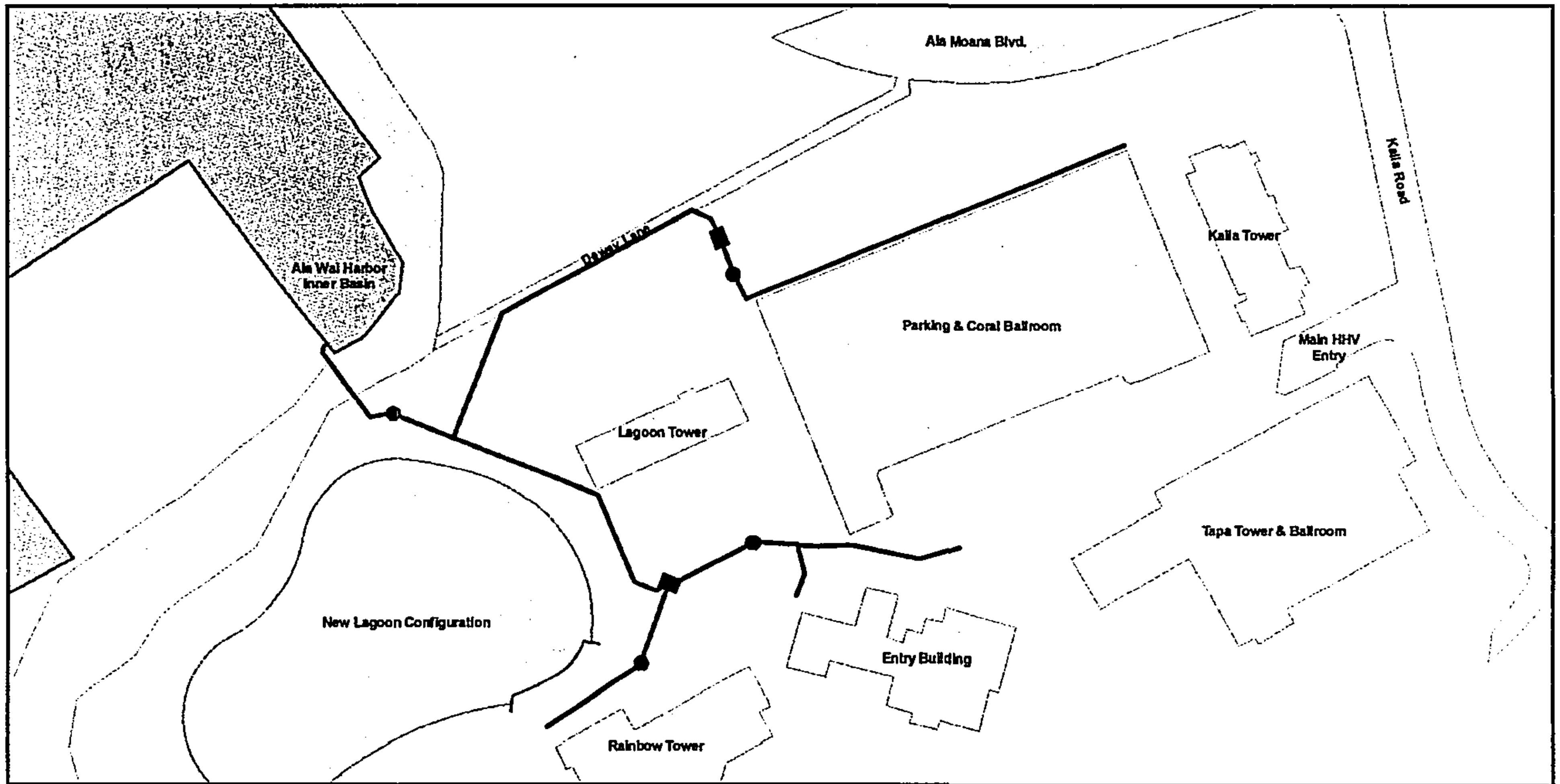
At present, most of the HHV's onsite rainfall-runoff enters the lagoon via two drain pipes, both of which discharge near the intake of one of the pump station's two inlet pipes. Except during severe storm events (when the runoff volume exceeds the amount captured by the pump intake), most of this runoff is pumped to the harbor's middle basin with little residence time and only a minimal removal rate in the lagoon itself.

The remainder of the rainfall-runoff that currently enters the lagoon consists primarily of runoff from the area around the lagoon's periphery. Owing to the lagoon's sluggish circulation and long residence time, virtually all suspended solids in this smaller fraction of the rainfall-runoff settle out. The dissolved inorganics in this fraction of the runoff are likely to be converted to organic forms, ultimately to settle, decay, and become a part of the layer of anaerobic mud on the lagoon bottom.

With the proposed improvements, rainfall-runoff now delivered to the lagoon in drain pipes would be collected and rerouted for pumped delivery to the harbor's inner basin. Because the filtration systems that will be installed as part of the new on-site drainage system will remove the majority of the suspended solids, the quality of the stormwater being discharged to the harbor from areas served by this system will actually be improved for this portion of the runoff.

Rainfall-runoff into the lagoon from the relatively small area around its periphery will still occur. However, with the much faster turnover rate that the proposed plan provides and the maintenance program to stir bottom sediments at regular (weekly or more often) intervals, most of this smaller fraction of the rainfall-runoff will probably be discharged to the harbor's inner and middle basins with little change in its chemistry.

[6] The only instances where runoff from the HHV would enter the Lagoon after the improvements are made are if the pump system failed or in instances where the runoff volume exceeds 50-year recurrence storm event used in the design. Under these conditions, overflow runoff would be diverted into a bypass line and released on Lagoon Lawn through a set of yard drains. Once released onto the lawn, the diverted runoff would sheet flow across the lawn, into the Lagoon. To minimize possible occurrence of a pump system failure, the pump stations are expected to be tri-plex pump systems with backup power generators to provide a high level of redundancy and minimize scheduled downtime.



Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Sources:

-City & County of Honolulu GIS
-Alcon Engineering, Inc.

Legend:

- New Storm Drains
- Treatment System
- Pump System

0 125 250 500
Feet

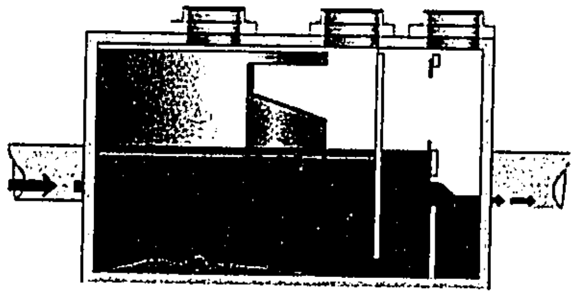
Figure 2-6:

Conceptual Layout of Proposed Storm Drainage System

Duke Kahanamoku Lagoon Restoration Project

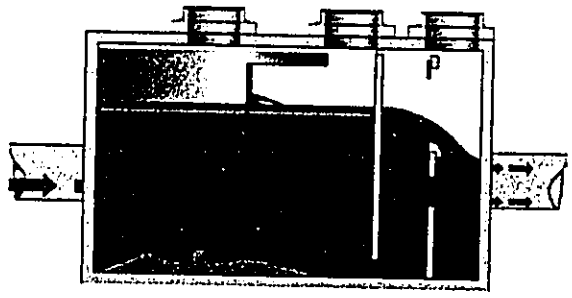
Figure 2.7. Stormwater Filtration System.

Low Intensity Storm



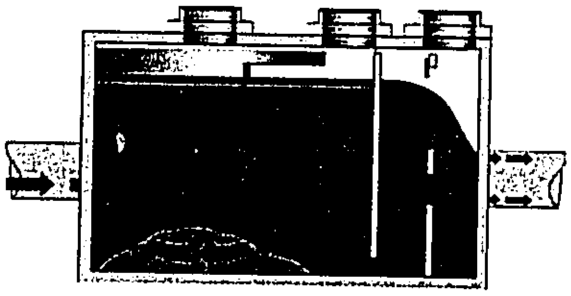
Most storm events (85 percent) do not exceed the two-month storm intensity. During this low intensity storm flow, the water level within the Vortechs* System will rise above the top of the inlet pipe, reducing inflow velocity and turbulence. Oil and fine sediments are usually washed off paved surfaces during these events, and the Vortechs* System treatment efficiencies are in the 80 to 90 percent range for typical urban runoff sediment.

Medium Intensity Storm



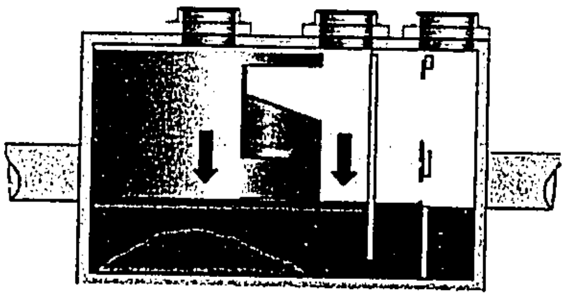
During a medium intensity storm, which occurs with a frequency of one to two years, remaining oil washes off pavement, and larger sediment particles and debris are now transported into the Vortechs* System. As flow increases, the water level rises above the low flow control and the tank begins to fill. With the inlet submerged, the oily layer is above the influent flow path, preventing *re-entrainment of floating pollutants. Swirling* action increases at this stage, which increases sediment removal rates.

High Intensity Storm



High intensity storms are infrequent, and storm flows have sufficient energy to wash off the largest sediment particles and pieces of debris. When the high flow control approaches full discharge within the Vortechs* System, storm drains are flowing at peak capacity. The Vortechs* System can accommodate flows up to the specified design storm (i.e. 10-year storm). Treatment efficiencies remain constant during this phase.

Storm Subsidence



Treated runoff is decanted out of the Vortechs* System at a controlled rate, restoring the water level to a low, dry-weather volume. This reveals a conical pile of accumulated sediment in the center of the grit chamber. Besides facilitating inspection and cleaning, the low water level significantly reduces maintenance costs by reducing pump-out volume.

Source: http://www.vortechnics.com/assets/VX%20General.pdf

2.3.2 LAND SIDE IMPROVEMENTS TO THE LAGOON SHORE

The proposed plans shown in Figure 2.8 and Figure 2.9 satisfy the conditions of the Planned Development Resort (PD-R) approval for the Waikikian project that pertain to the lagoon restoration. They include features derived from the Waikikian Schematic Design plan prepared by Wimberley Allison Tong & Goo that formed the basis for the City's approval of the Waikikian project. More specifically, the plans show:

- The pedestrian walkways and associated areas along the *makai* end of Dewey Lane and around the Hilton Lagoon that are required by Condition (4) of the PD-R-4.
- The extension of the Waikīkī Promenade that encircles the Hilton Lagoon and connects the walkway that now ends at the Rainbow Tower to the existing public walkway along the Diamond Head side of the Ala Wai Harbor parking lot [PD-R-6.b.].
- The amenities, i.e., seating areas, required drinking fountain, lighting, and landscaped planting strips with irrigation, shade trees, coconut palms, shrubs, and groundcover, that will be provided for public use [PD-R-6.b.].
- The shoreline native planting areas that will be provided along the proposed walkway.
- The relationship of the walkway to the Great Lawn.

The remainder of this chapter describes the major features of the plan. It focuses on the major concepts, but provides details where they are important to understanding the extent to which the proposed plan satisfies the requirements of the PD-R approval.

2.3.2.1 Overall Walkway Plan

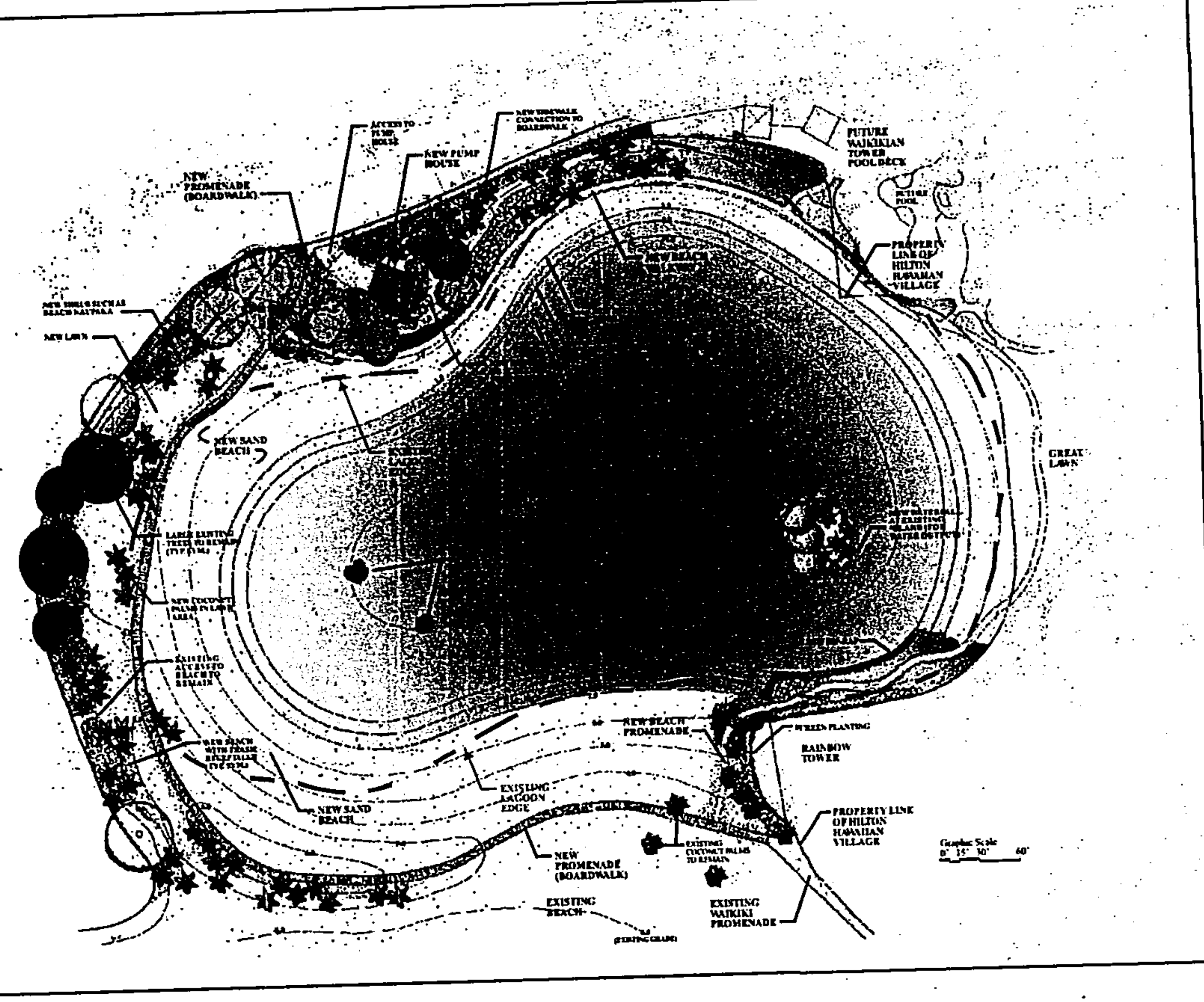
The proposed plan provides a public walkway that extends entirely around the lagoon. The primary route extends the Waikīkī Promenade from its present terminus in front of the Rainbow Tower around the *makai* side of the lagoon. Because it would carry the bulk of the pedestrian traffic along the Waikīkī shoreline and serve the expanded beach proposed along the *makai* edge of the lagoon, it is wide and equipped with nighttime lighting. The existing pool in front of the Lagoon Tower will be demolished to allow a secondary walkway to pass around the *mauka* side of the lagoon, completing the encirclement called for in the City's approvals of the Waikikian project. A portion of this path, which is intended to serve a smaller volume of traffic, is located on hotel property.

Section 2.3.2.2 describes the details of the proposed Waikīkī Promenade extension. Subsection 2.3.2.2.1 discusses the routing and Sections 2.3.2.2.2 and 2.3.2.2.3 cover the walkway design. Section 2.3.2.3 addresses the secondary walkways that will be provided around the *mauka* side of the lagoon. Finally, Section 2.3.2.4 describes the landscape design and amenities that will be provided adjacent to the walkways and the proposed berm stabilization approach.

2.3.2.2 Waikīkī Promenade Extension

2.3.2.2.1 Waikīkī Promenade Routing

The proposed route of the Waikīkī Promenade extension begins near the end of the existing walkway fronting the HHV's Rainbow Tower and connects to the existing sidewalk on the eastern side of Holomoana Street. The roadside walkway provides a way for pedestrians to access the Ilikai Hotel and Dewey Lane. Alternately, by crossing the street at the crosswalk situated near the base of the ramp that leads up to the recreational deck of the Ilikai, pedestrians can continue along the edge of the Ala Wai Harbor's innermost basin. Following this route, pedestrians can eventually reach the sidewalk along Ala Moana Boulevard just to the west of the Prince Hotel. Thus, the proposed route provides a way for pedestrians to reach Ala Moana Park largely along pathways removed from the noise and fumes associated with bus and car traffic. Only the last few hundred feet of the route directs them onto the Ala Moana Boulevard sidewalk so that they can cross the bridge over the Ala Wai Canal.



Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

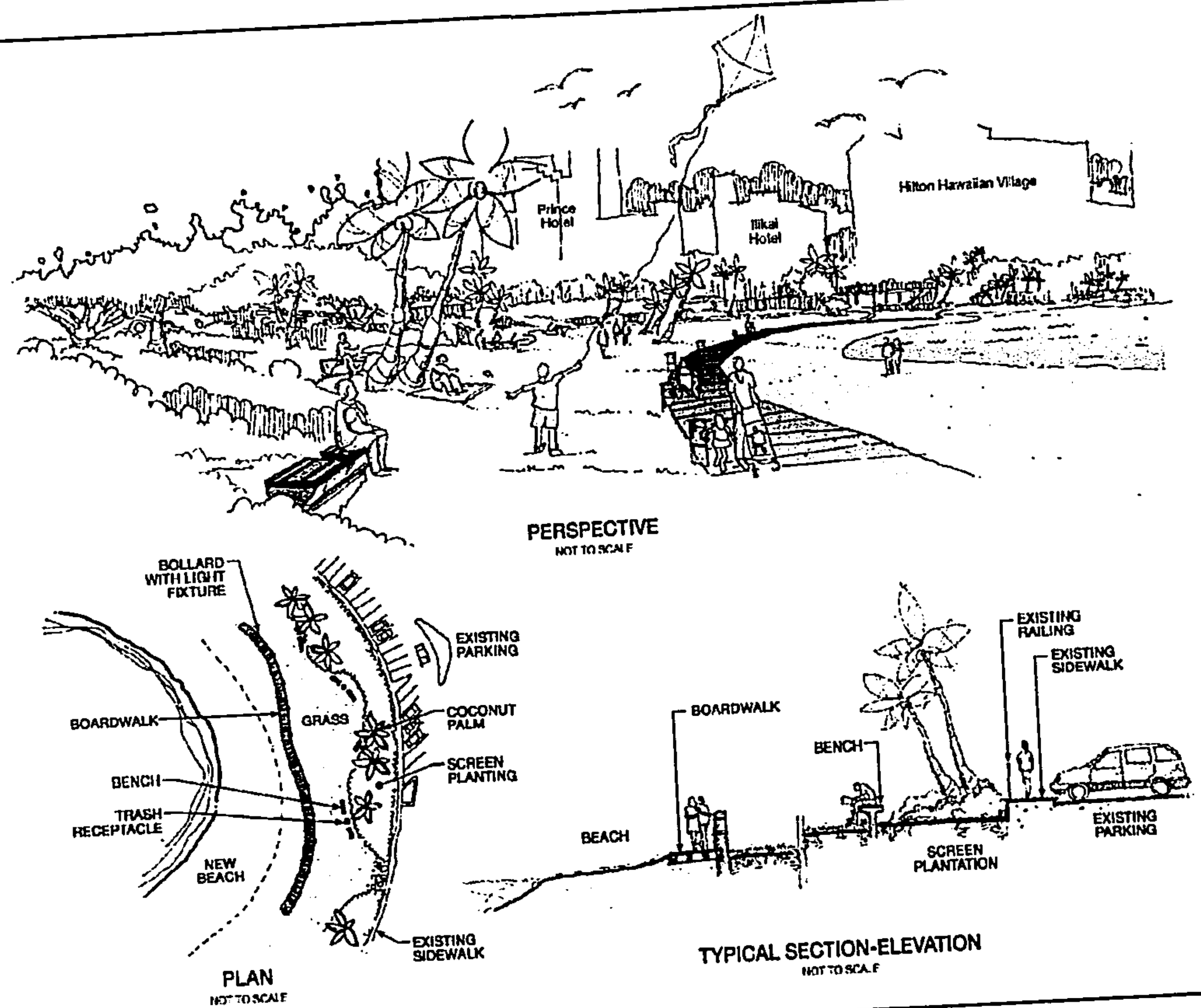
Source:

--City & County of Hawaii GIS
--Belt Collins Hawai'i

Figure 2-8:

Lagoon Landscape Concept

Hilton Hawaiian Village Lagoon Resoration



Prepared For:
Hilton Hotels Corp.

Prepared By:
PLANNING SOLUTIONS

Sources:
--City & County of Honolulu GIS
--Belt Collins Hawai'i

Figure 2-8:
Plan, Perspective, & Section Elevation

Hilton Hawaiian Village Lagoon Restoration

2.3.2.2.2 Waikīkī Promenade Design: General

After considering a range of options, including a continuation of the poured concrete walkway that is used for the Waikīkī Promenade along the Hilton Hawaiian Village's beach frontage and elsewhere, Hilton has concluded that a hybrid boardwalk design would provide the best combination of functionality and attractiveness. As sketched in Figure 2.10, the proposed design uses textured boards made of weather-resistant material as the walking surface. The walkway would be approximately eight feet wide, the same width as the existing concrete walkway fronting the Hilton Hawaiian Village. Bollards (posts on the order of 9 to 12 inches in diameter) would be located at 12-foot intervals along the ocean side of the boardwalk. In order to simplify construction and maintenance of the boardwalk, the design uses a series of short, straight sections between the anchoring posts to form a curved path.

2.3.2.2.3 Promenade Design: Shoreline Berm[7]

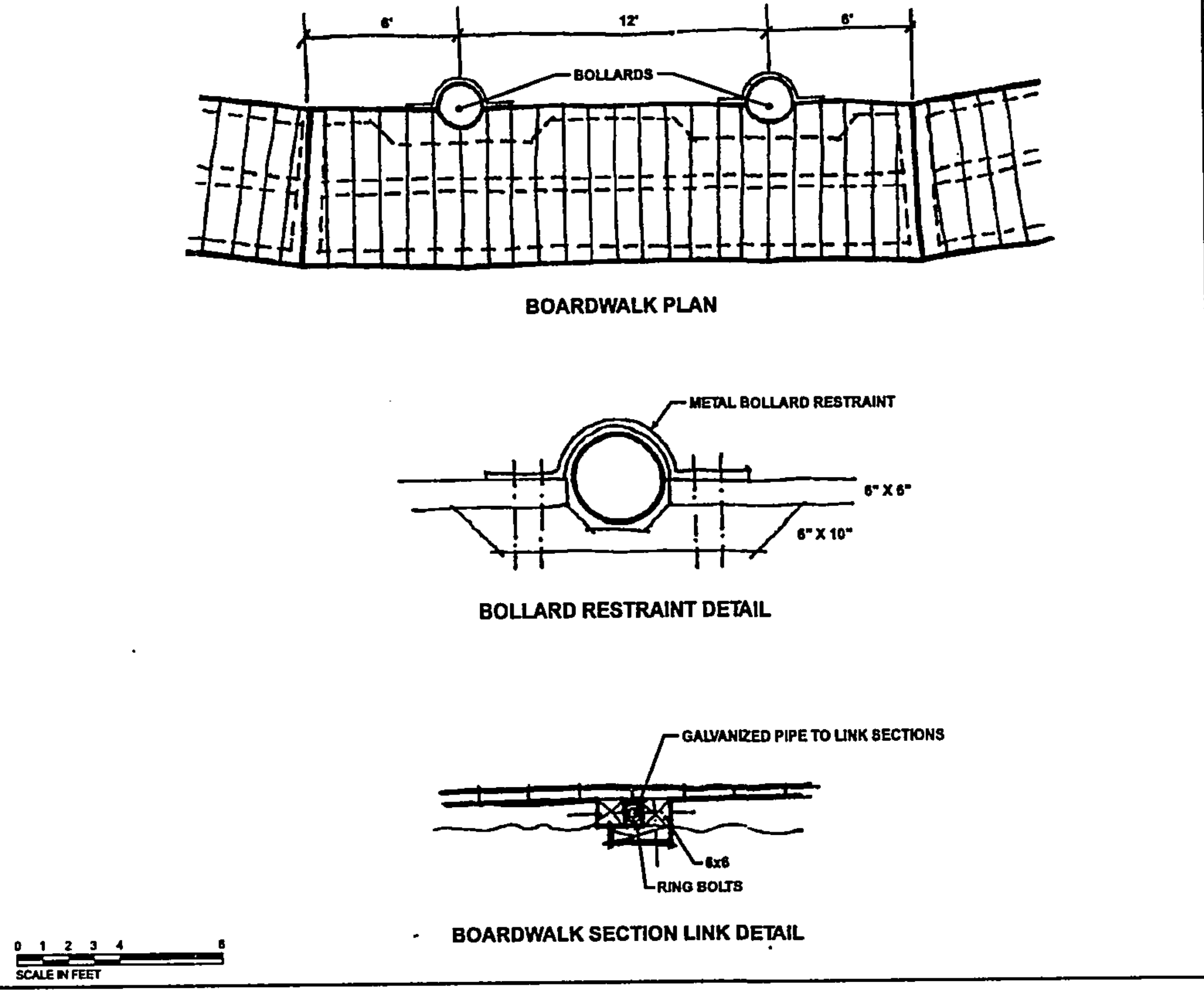
The easternmost 400 feet of the proposed Waikīkī Promenade extension would be situated atop the beach berm separating the lagoon basin from Kahanamoku Beach (see Figure 2.1). The berm is composed of a raised coral substrate with a thin veneer of sand. Once every year or two, on average, storm waves over-top the lowest portion of this berm, spilling ocean water into the lagoon. While the over-topping is infrequent and generally no more than a few inches deep, it is not so rare that it can be ignored. The need to accommodate this natural occurrence constrains the walkway design and has led HHC to establish the following design objectives for it:

- The boardwalk must accommodate movement in the sand under and adjacent to the boardwalk due to rain and wind.
- The portion of the boardwalk across the lowest-lying segment of the beach berm must be portable so that the walkway sections can be moved to higher ground when forecasts call for waves that have the potential to overtop the berm.
- The boardwalk and berm must be designed to minimize washout by relatively frequent storm waves and to be reinstalled quickly on the infrequent occasions when waves overtopping the berm cause some washout of the sand.
- The boardwalk must not form a tripping hazard. Therefore, it should stand out of the sand at least six inches (i.e., one step up).
- It must be possible to maintain low-intensity lighting along the boardwalk.

The proposed design achieves these objectives by anchoring the walkway using bollard posts grouted into holes bored into the coral. In this approach the boardwalk itself floats on top of the sand on two or three 6' x 6' stringer frames. These would be constructed in something like 6-foot increments. The stringer frames would be attached to the posts via brass slip rings similar to floating dock details. This arrangement would allow the boardwalk segments to move vertically to accommodate sand movement. If the stringers began to sink into the sand, four or five men could easily lift and re-level each stringer section. If particularly large waves are forecast, hotel staff will lift the boardwalk sections off the posts and place them on hotel property in areas that will not be affected by the waves.[8]

[7] Additional information on the berm design may be found in Section 2.3.2.4.2.

[8] While the design is expected to work effectively for most storm events, extreme events, such as waves and storm surge produced by Hurricane Iniki in September 1992, produce overtopping of such a magnitude that it is not practical to protect the walkway from damage during such infrequent occurrences. Hence, in all likelihood major portions of the walkway would need to be replaced following such an event.



Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Sources:

–City & County of Honolulu GIS
–Belt Collins Hawai'i

Figure 2-10:

Boardwalk Conceptual Details

Hilton Hawaiian Village Lagoon Restoration

2.3.2.3 Secondary Walkway

Details of the design concept for the walkway around the *mauka* side of the lagoon are shown in Figure 2.11 and Figure 2.12 below. Portions of this route are on hotel property and accommodate the internal circulation needs of hotel guests as well as the general public. This secondary walkway passes the Rainbow Tower, the Great Lawn, and the new pool facilities that are being developed to the west of the Lagoon Tower as part of the Waikikian project. In accordance with its different purpose and identity and the desire to have it look like an extension of the beach, a markedly different material would be used for this secondary walkway. The design has not been finalized, but present plans call for the use of concrete with a sand finish and/or a grass paving system.

The proposed landscaping along the western side of the lagoon is a continuation of the theme set adjacent to the Waikīkī Promenade. Beach Naupaka would be used along the entire street frontage to provide visual separation between the lagoon and the cars parked along the harbor road. Beach Morning Glory would be used in a few select areas where the beach width makes the shoreline unsuitable for sunbathing, and the walkway will pass through the center of this. The slight constraint is intended to emphasize the secondary nature of this route and encourage through-traffic to use the Waikīkī Promenade route along the *makai* side of the lagoon. Public restroom facilities for users of the secondary shoreline walkway and the Waikīkī Promenade will be located within the Waikikian Tower complex that HHC is planning to construct.

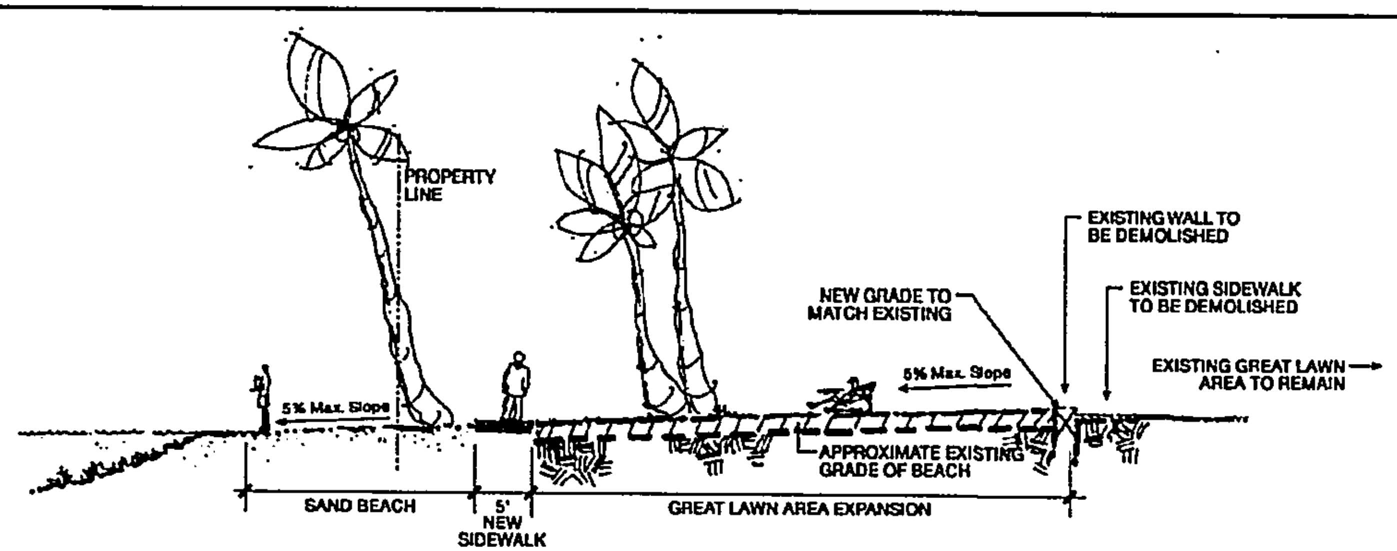
2.3.2.4 Landscaping and Beach Stabilization

2.3.2.4.1 Landscaping

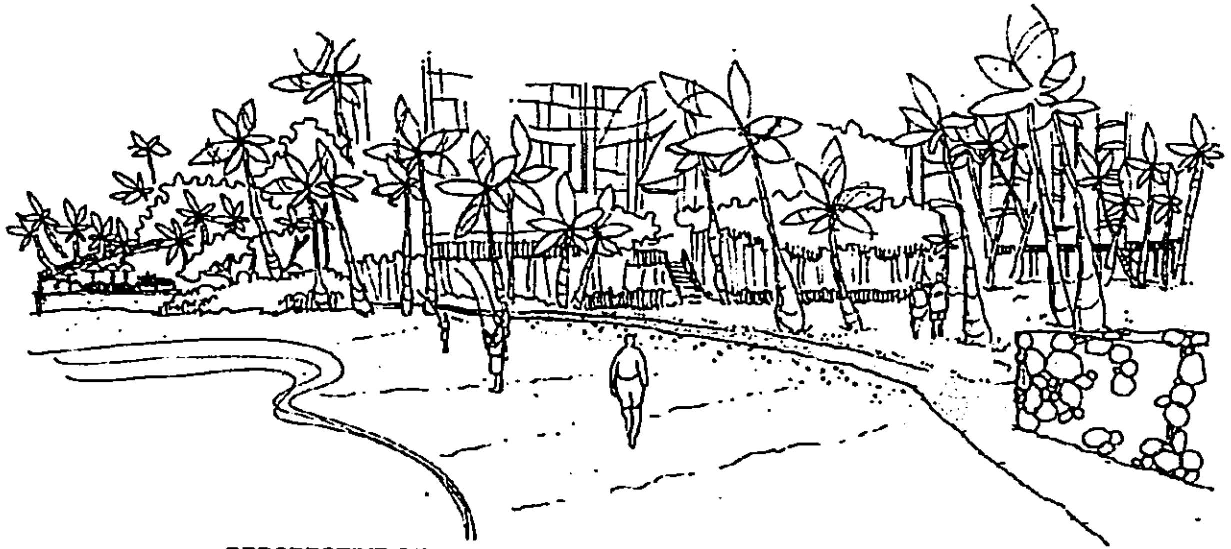
Figure 2.8 shows the location of the irrigated, landscaped planting strips, shade trees, coconut palms, shrubs, and groundcover that will be provided for public use as part of the lagoon restoration project. Additional detail is shown in Figure 2.9. These are situated principally along the southern and western sides of the lagoon. Little is proposed for the eastern side of the lagoon *makai* of the Rainbow Tower. This is because that stretch of the beach berm is subject to periodic over-topping by waves, and this makes it impossible to maintain landscaping and/or permanent facilities other than the proposed boardwalk. Similarly, the northern side of the lagoon adjacent to HHV is too confined to allow substantial new public amenities in that area, with the exception of a slight widening of the beach and the addition of the pedestrian walkway.

The proposed plan creates a broad sandy beach along the southwestern and western side of the lagoon. At present the shore is narrower and much of it consists of exposed limestone and beach rock and is little used. Equally important, the plan calls for creation of a landscaped area on the uphill side of the walkway that provides relief from the heat and high reflectivity of the sand and water. A portion of the landscaped area would be maintained as grass; the remainder would have sturdy shoreline plants. Up to 80 additional coconut palms would be planted around the lagoon to supplement those already present. Benches, such as the one shown in Figure 2.13, would be placed strategically under the palms where there is some shade.

Beach Naupaka (*Scaevola sericea Vahl*; naupaka kahakai in Hawaiian) would be used along the uphill side of the area and would separate the lagoon from the adjacent streets and parking areas. Naupaka has excellent salt, wind, and drought tolerance; it also requires relatively little maintenance,. Plants such as Beach Morning Glory (*Ipomoea imperati;* pohuehue in Hawaiian) would be used in areas where a low ground cover other than grass is desired. This includes the area at the northwest corner of the lagoon where the water nears the rock retaining wall that supports the harbor access road.



SECTION THROUGH BEACH AND GREAT LAWN
NOT TO SCALE



PERSPECTIVE OF BEACH AND GREAT LAWN EXPANSION AREA
NOT TO SCALE

Prepared For:
Hilton Hotels Corp.

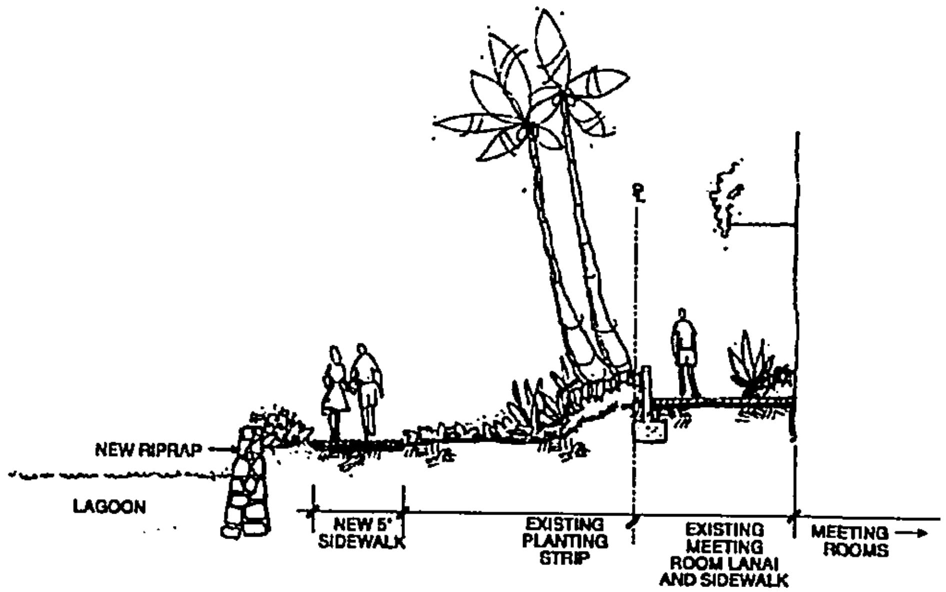
Prepared By:
PLANNING SOLUTIONS

Sources:
--City & County of Honolulu GIS
--Belt Collins Hawaii

Figure 2-11:

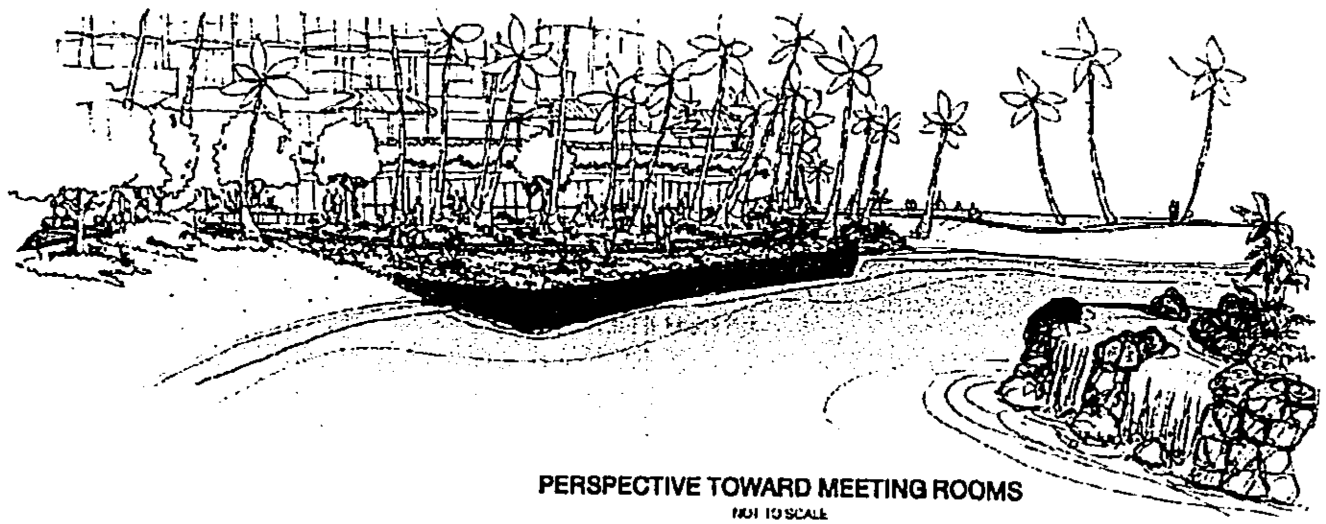
Secondary Walkway In Front Of Great Lawn

Hilton Hawaiian Village Lagoon Restoration



SECTION THROUGH BEACH AT MEETING ROOMS

NOT TO SCALE



PERSPECTIVE TOWARD MEETING ROOMS

NOT TO SCALE

Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

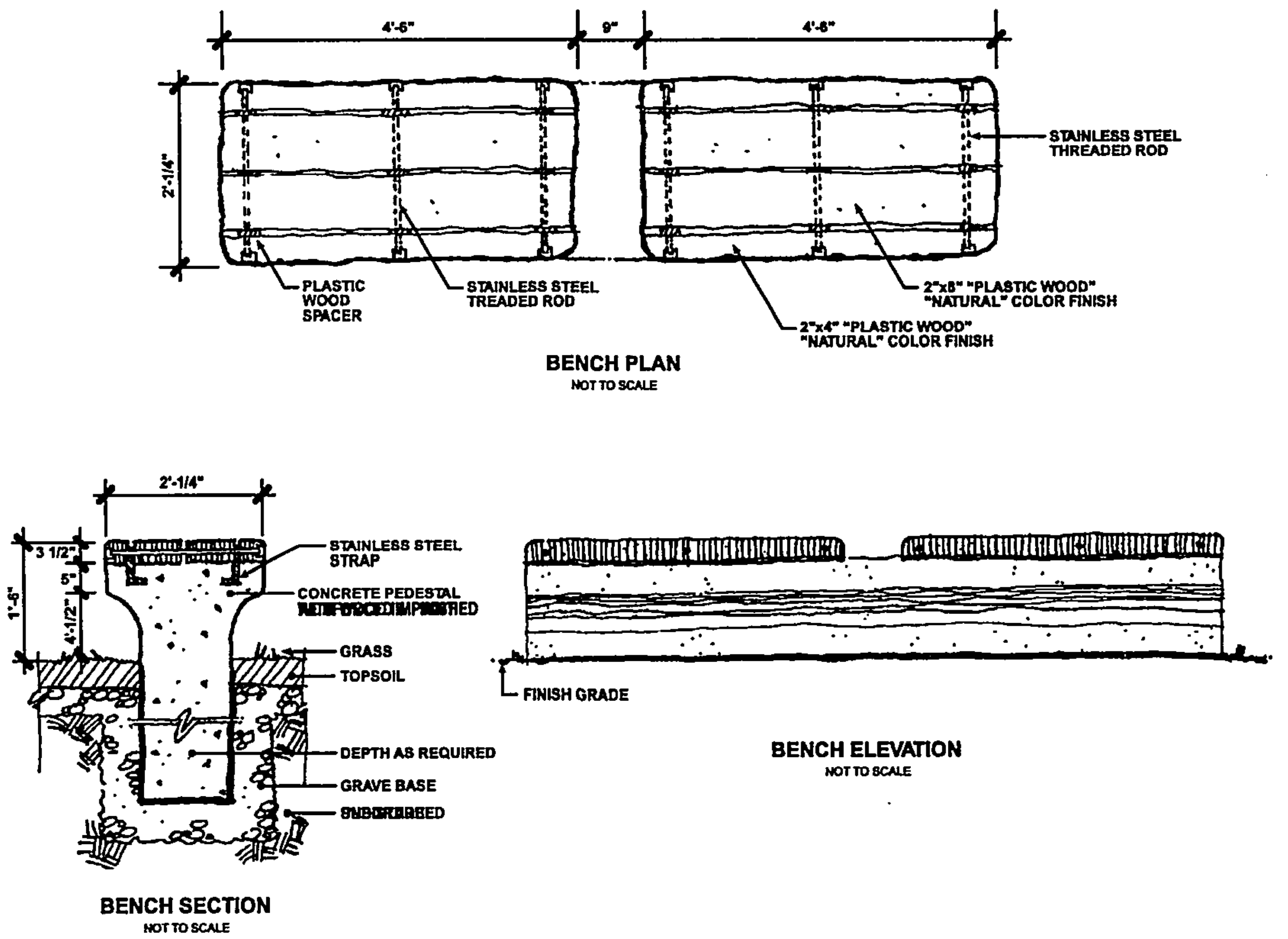
Sources:

–City & County of Honolulu GIS
–Belt Collins Hawaii

Figure 2-12:

Secondary Walkway In Front Of Meeting Rooms

Hilton Hawaiian Village Lagoon Restoration



Prepared For:
Hilton Hotels Corp.

Prepared By:
PLANNING SOLUTIONS

Source:
Belt Collins Hawai'i

Figure 2-13:

Typical Bench Details

Hilton Hawaiian Village Lagoon Restoration

2.3.2.4.2 Beach Stabilization

As previously noted, waves periodically overtop the shoreline berm that separates the lagoon from the ocean. The most severe example of this occurred during Hurricane Iniki, when the entire parking lot and shoreline berm were under water as a result of the wave setup from the storm. However, the over-topping occurs on a more limited basis once every few years. The water sweeping across the beach washes the lose sand on top of the berm into the lagoon, leaving only the relatively hard substrate. It also carries ocean organisms into the lagoon.

The use of the geotextile fabric to seal the existing lagoon sediments in place adds an additional concern to the over-topping. While the geotextile fabric would be well-secured, the anchoring could fail if the berm were overtopped by sufficiently energetic waves. Such a failure would expose the underlying sediment to wave action and could allow them to be spread within the lagoon, eventually settling on the bottom and degrading the recreational values that the lagoon restoration project is intended to promote.

To reduce the likelihood that this would occur, HHC proposes to emplace a buried rubble mound structure beneath the existing berm to increase its stability in the face of a large storm event. The conceptual design of the buried structure is depicted in Figure 2.13. Once constructed, the berm would be completely covered with sand and would blend in with the surrounding beach. The design shown is based on the following "conservative" design assumptions: (i) the use of basalt armor stones with a density of 150 pounds per cubic foot; (ii) all the sand that would normally bury the structure could be eroded by storm waves; and (iii) that a 6-foot design wave could break directly on the structure. These conservative assumptions would be refined in the final design process and could lead to a smaller structure than shown.

The proposed plan for the lagoon restoration calls for the shoreline sand berm to be +5- to +6-feet msl and to follow the alignment depicted in Figure 2.1. For the structure to provide the greatest protection for the lagoon but remain buried under normal conditions, the top of the stone structure would be set at an elevation of +4.5-feet msl. Putting the base of the structure 2.0 feet below sea level and selecting a 3:1 slope for the seaward (*makai*) side, the required armor stone size (assuming random placement of the stones) is nominally three feet or about 2,700 pounds per stone.[9] The crest would be at least three stones wide (or about 10 feet across) and, at 2:1, the slope of the shoreward (*mauka*) side would be slightly steeper. Under the proposed alignment the berm will more than 40 feet inland of the shoreline that DLNR has proposed for certification, and therefore entirely inland of the Shoreline Setback Area defined by the City and County of Honolulu.[10] If the shoreline that is eventually certified is substantially inland of the line for which certification has been requested, HHC will either shift the location of the berm inland sufficiently to keep work outside the 40-foot shoreline setback area or will submit a Shoreline Setback Variance application.

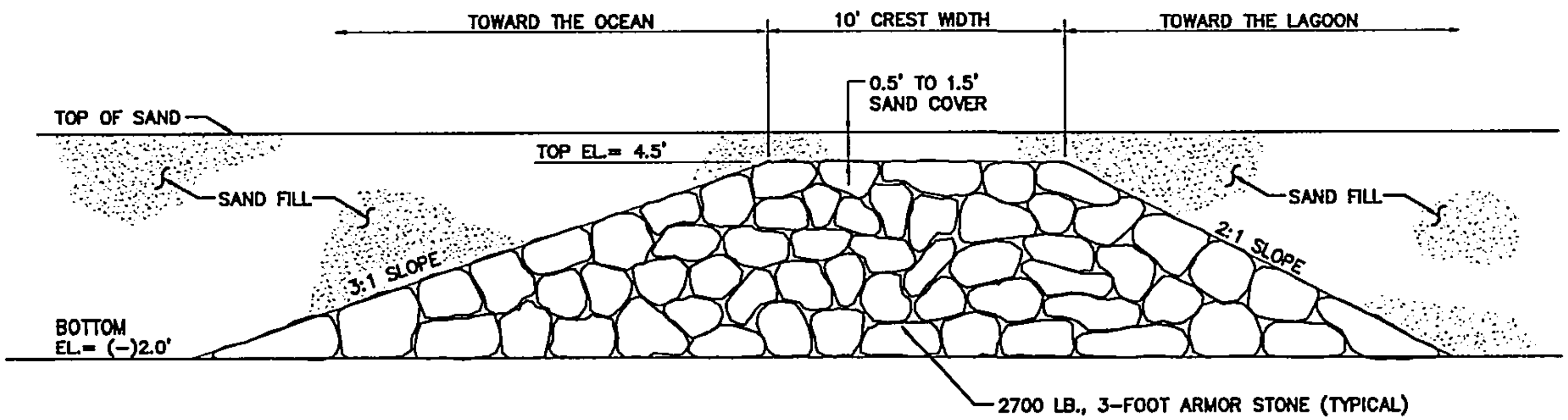
2.3.2.5 <u>Operation and Maintenance</u>

HHV is responsible for operating and maintaining the land-side improvements to the lagoon area for use by the public. HHV staff will be assigned to the task of ensuring that the landscaping public amenities around the lagoon are maintained. Their specific duties will involve:

- Daily security inspection of the lagoon public recreation area and walkway.
- Daily visual inspection of the walkway and associated amenities to identify any needed repairs and pick up debris and litter.

[9] Because the dimensions of the structure are relatively small compared to the size of the armor stone, creating a multi-layered structure with under-layers of smaller stone would not be appropriate. The entire structure would be comprised of similar-sized 2,700 pound stones.

[10] Notice of the proposed Shoreline Certification was published in the November 8. 2005 issue of OEQC's *Environmental Notice*. If no appeal is filed within 20 calendar days of the publication date, the proposed shoreline will be certified.



Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Source:

TNWRE

Figure 2-14:

Conceptual Design of Shoreline Berm Reinforcement

Duke Kahanamoku Lagoon
Restoration Project

- Weekly to monthly maintenance of the landscaping around the lagoon, including coconut removal, tree and shrub trimming, mowing grassy areas, weed removal, and watering.
- Periodic repairs or replacement of the boardwalk, drinking fountains, benches, and other amenities as needed.
- Regular inspection of the sand covering the buried shoreline berm to ensure that a minimum of one-half foot of sand cover remains in place on the top of the berm and one foot on the sloping sides of the berm. Should the cover fall below these minimums, HHC will push sand from adjacent areas back atop the berm.
- HHC will monitor any pipe that is left in place in the ocean to insure that it does not become exposed in the future. Should the monitoring indicate wave action is eroding the sand cover, HHC will initiate corrective action.

2.3.3 CONSTRUCTION SEQUENCE

Construction will proceed as follows:

- The new storm drain system and discharge pipes into the Ala Wai Harbor will be installed. This will involve installing the new storm drain pipes and pump stations situated on HHV property, extending the drain system by trenching across Holomoana Street from the southwestern corner of the HHV property to the *makai* corner of the inner basin of the Ala Wai Harbor, and constructing a new storm drain outlet into the harbor. Part of this work may involve passing under or through the decking around the swimming pool that fronts the Lagoon Tower. Construction fencing will be erected around localized work areas, but the lagoon itself and most of the surrounding area will remain open.
- Construction fencing will be erected around the entire lagoon.
- The lagoon will be hydrologically isolated from the ocean and the Ala Wai Harbor. This will be done by rerouting stormwater that now flows into the lagoon into the new storm drain system described above, sealing the ocean water intakes, and shutting down the discharge pump. When the pumping ceases, the water level will rise to that of sea level; this will decrease the groundwater inflow into the lagoon as well.
- The new intake and discharge pipes will be laid across the bottom of the lagoon as indicated on Figure 2.2. For the most part this can be done without trenching, but some excavation will be required in the places where the piping enters and leaves the lagoon. The vertical discharge and intake headers will be roughed into the lagoon at this time, as will the small pipes and conduits that provide water, electricity, and gas to the island. The piping and other material needed for this operation will be staged and partially assembled in the temporary work areas that will be created on the side of the lagoon.
- Once the piping is in place, geotextile fabric will be unrolled and the pieces sewn together to form long strips. Each strip will be floated across the surface of the lagoon and positioned using small boats, overlapped and sewn together with the adjacent strip, and then sunk into place on the bottom. The initial sinking will be facilitated by placing small amounts of sand on it at selected locations. The fabric will be anchored along the shoreline using a system such as that shown in Figure 2.4.
- Clean sand will be spread over the geotextile fabric to form the sandy beach areas shown in Figure 2.1. The fill will be thickest under the expanded beach area on the *makai* side of the lagoon and in deep pockets near its center.
- The new water supply and circulation system will be activated. The startup will occur gradually after a latent period to allow any sediments suspended during construction to settle. The gradual

startup will allow complete testing of the system. It will also ensure that changes in the portion of the Ala Wai Harbor that will be affected by the increased water flow occur slowly.

- As soon as the basic form of the lagoon and surrounding areas have been established, the contractor will begin work on the fine grading, landscaping (including irrigation system and lighting), and walkways.

2.3.4 PROJECT SCHEDULE

Major schedule milestones for the proposed project are as follows:

- Complete Chapter 343 Environmental Assessment Process – 4th Quarter 2005.
- Permits for Lagoon Circulation and Reshaping Completed – 2nd Quarter 2006.
- Lagoon and water circulation system substantially completed - 1st Quarter 2007.
- Landside Improvements and Amenities Substantially Completed – 2nd Quarter 2007.

2.3.5 ANTICIPATED COSTS

The estimated costs of the proposed improvements are summarized in Table 2.3.

Table 2.3. Estimated Costs

Item	*Order-of Magnitude Cost*
Lagoon Enhancements	$9,750,000
Site Enhancements / Promenade	$3,750,000M
Source: Hilton Hotels Corporation, 2005.	

2.4 ALTERNATIVES CONSIDERED AND ELIMINATED

HAR §11-200 requires *"consideration of Alternatives related to different designs or details of the proposed action which would present different environmental impacts."* It also requires the consideration of "reduced-scale" or delayed action. Hilton Hotels Corporation evaluated alternative ways of achieving the project objectives based on their ability to fulfill applicable requirements, cost, feasibility, environmental impact, and compatibility with the vision of HHV. These alternatives, and the reasons why they were eliminated from further consideration in this analysis, are outlined below.

2.4.1 ALTERNATIVES CONSIDERED IN THE 1980S AND 1990S

The need to take action to restore the lagoon has been recognized for a number of years, and a variety of approaches to this have been put forward and considered. The first, and most basic, was to dredge the lagoon, removing accumulated sediment without changing the water circulation system. In the late 1980s the U.S. Army Corps of Engineers issued a Department of the Army Permit for this. However, before this plan could be implemented a combination of a downturn in the economy and the advancement of the proposal described in the next bullet item led the HHC to shelve the concept.

In the mid-1990s, the Hilton Hawaiian Village Joint Venture and the EnterOcean Group, Inc. proposed and obtained all needed approvals for the construction and operation of a swim-through attraction. It would have consisted of a large tank holding approximately 2 million gallons of sea water occupying the *mauka* third of the existing lagoon. The plan called for the *makai* two-thirds of the lagoon to remain as a public amenity. The proposed design was physically separated from the public portion of the Kahanamoku Lagoon and had a water level several feet higher than that of the remainder. The approximately 15,000 gallons of sea water per minute needed for the proposed attraction was to have come from a new ocean intake extending to an area further seaward within the catamaran channel about 170 feet from the breakwater at the end of Kahanamoku Beach and 550 feet offshore. Water from the swim-through portion of the lagoon was to spill over into the public portion of the lagoon and from there to be pumped into the innermost basin of the Ala Wai Harbor. The EnterOcean concept called for the silt within the portion of the lagoon not used for the attraction to be removed using a suction dredge, dried, and trucked away. It acknowledged potential difficulties with the drying process, but concluded that these could be overcome. Problems with the financing for this project eventually led it to be abandoned. Elements of this proposal were reconsidered when approaches to lagoon restoration were evaluated again beginning in 2000.

2.4.2 APPROACHES EVALUATED AND REJECTED DURING 2000 - 2004

With the turn of the century and an improving economy, HHC turned its attention to the lagoon once again. Its overall goal was to achieve the water quality objectives at the lowest possible cost and with the least disruption to the surrounding area. Initially it considered simply resurrecting the plan to dredge the lagoon that had been approved more than a decade before. Analyses of the accumulated sediment on the lagoon bottom by MEC Analytical Systems, Inc. (May 2001) confirmed that the material is essentially free of measurable contaminants and *"...is likely suitable for either ocean disposal under a Tier 1 evaluation or upland landfill disposal on accordance with the requirements of the Hawai'i Department of Health Office of Solid Waste Management."*

However, dredging does not address the basic cause of poor water quality/rapid sediment accumulation in the lagoon (slow turnover rate and high turbidity in the source water). In fact, by increasing the volume of water in the lagoon, it would actually decrease the turnover rate. Consequently, it is not in and of itself a good solution to the problems in the lagoon. This led HHC to undertake a more comprehensive review that considered water quality, aesthetics, cost, and timing. The key findings of this review, the total of which led to the proposed design described in Section 2.3, are summarized below.

2.4.2.1 Different Pumping Rates

The proposed design calls for increasing the volume of water passed through the lagoon to 15,000 gpm, a two-fold increase over the 7,500 gallon per minute (gpm) design rate of the original lagoon, and nearly a three-fold increase over the rate at which the aged pumps currently in place are operating. The 15,000 gpm number is in line with previous recommendations.[11] Lower rates are possible, but would not meet the design goal of achieving an average turnover of at least four times per day. Increasing the supply water to more than 15,000 gpm was considered, but would be more costly to construct and operate, would begin to require placement of supply wells in less accessible locations, and would not provide any known benefits.

HHC also considered a lower pumping rate. With the proposed design, 12,000 gpm would be sufficient to provide four turnovers per day, the minimum design target. However, despite the improved placement of the discharge and intake points within the lagoon, at a 12,000 gpm rate some areas would experience a turnover rate of less than four times per day. Consequently, lower withdrawal rates were rejected.

2.4.2.2 Reversing the Flow in the Existing System

Engineers reviewing the system noted that the current system uses a pump on the discharge end of the circulation system; pumping water out of the lagoon lowers the water level in it below that of the ocean and below that of the surrounding groundwater table. This difference in water level causes water to enter the lagoon through the ocean intake, but it also causes shallow groundwater (and the pollutants which it contains) to flow enter the lagoon. If the pumps were moved to the supply (i.e., ocean) end of the system, they would raise the water level in the lagoon, greatly decreasing the rate of

[11] This rate is the same rate that had been adopted as the design target for the EnterOcean project previously described.

groundwater inflow. However, in order for this approach to work without providing pumps on the discharge end as well, the capacity of the pipes discharging into the Ala Wai Harbor would have to be increased. Further, such a system would increase the water level in the lagoon to the point where it would threaten the adjacent areas, such as the Rainbow Tower. This change in the system would not address the issues that stem from the quality of the existing source water itself. When all factors were considered, the approach was considered inferior to the proposed action and was eliminated from further consideration.

2.4.2.3 Using Ocean Water from Relocated Ocean Intakes

The two existing intake pipes draw water into the lagoon from a depression on the reef flat directly offshore. The reef flat *makai* of these inlets restricts water exchange between the inner reef area adjacent to the beach and the ocean. This, in turn, contributes to the elevated turbidity, nutrient, and bacterial levels. Water quality is better further offshore (e.g., in the catamaran channel that EnterOcean proposed as the source of water for the swim-through attraction described in Section 2.4.2). While using water from such an area would improve water quality within the lagoon and decrease the rate of sedimentation, the change would be only marginal. Moreover, by maintaining the link with the ocean, such an approach would leave open the route through which invasive species such as the stinging jellyfish enter and colonize the lagoon. Because of this, HHC eliminated it from consideration.

2.4.2.4 Installing Sand Filtration System on Ocean Intake

In some situations, filtration systems are effective means of removing the kinds of pollutants that are present in the ocean waters off the Duke Kahanamoku Lagoon. Two variants of such a system were evaluated, both of them using an in-place 0.5 millimeter sand filter on the water intake line. The first was designed to provide all water to the lagoon through an in-place sand filter (3,000 square foot) located in the catamaran channel off of Kahanamoku Beach.[12] The second variant combined a 7,500 gpm capacity in-place sand filter that would be used when conditions in the intake area are poor (i.e., storm conditions creating turbidity, movement of jellyfish toward shore) with a direct intake pipe in the catamaran channel that would provide 15,000 gpm when water quality conditions were judged acceptable. After considering the complexity of this system, as well as the fact that it would still allow considerable amounts of suspended sediments and undesirable biota to enter the lagoon, it was eliminated from further consideration.

2.4.2.5 Opening a Channel to the Ocean

Connecting the Duke Kahanamoku Lagoon directly to the ocean by constructing a channel between the ocean and the lagoon in the vicinity of the ocean intake pipes would not increase turnover or eliminate the need for mechanical pumping. An open channel has the potential to produce a more energetic condition in the lagoon if it were exposed to open coastal waters, but it would also provide a greater opportunity for suspended sediment to enter the lagoon. Moreover, the wave energy that it would introduce to the lagoon could adversely affect the stability of the shoreline. Because it appeared likely to introduce a new set of issues to the lagoon without solving the fundamental issue of sediment buildup, this alternative was eliminated from further consideration.

2.4.2.6 Biological Measures

HHC identified and briefly evaluated several biological approaches to improving the quality of the lagoon. These include constructed wetlands, floating islands of plants and associated organisms (Restorer® Technology), submerged biological filters, biological contactors, and bacterial suspensions. However, these systems are not well suited to the conditions and uses present in and around the lagoon and are no longer being considered.

[12] The size (100 feet by 300 feet) is based on a filter flow rate of 0.5 gallons per minute, per square foot, to provide 15,000 gallons per minute of acceptable quality seawater to the lagoon.

2.4.2.7 Alternate Methods of Disposing of Stormwater

The proposed plan calls for rerouting stormwater that presently discharges into the lagoon into the inner (*mauka*) basin of the Ala Wai Harbor. Injection wells and re-routing to other locations were considered as alternatives. However, calculations showed that on-site disposal could not provide the required capacity, and none of the alternate discharge locations offered clear advantages to the proposed plan.

2.4.2.8 Lagoon Configuration (Area, Depth, and Shape) Alternatives

The proposed design for the lagoon restored lagoon reduces both its depth and its surface area. Other things being equal, the resulting decrease in the volume of water in the lagoon increases the turnover rate. This, in turn, has a generally beneficial effect on water quality.

HHC considered retaining the existing lagoon surface area, but this would have decreased the turnover rate and lessened the amount of space available for land side recreational amenities. It would also have made it infeasible to leave the existing soft sediments in place on the lagoon bottom, securing them with a geotextile fabric and an overburden of sand. Instead, they would have to be dredged, dried, and trucked away for disposal. For this reason, HHC concluded that some reduction in the surface area was preferable.

The proposed plan calls for the beach on the *makai* side of the lagoon to be broader than the minimum needed to secure the geotextile fabric. HHC believes that the advantages that this provides in the way of increased water turnover rate and enhanced recreational opportunities on the land makes it preferable to a configuration that has more water surface area.

The proposed design provides a maximum water depth of between 5 and 6 feet at low water. The lesser depth (relative to existing) helps decrease the volume of water that must be turned over. It also leaves more of it in shallower water that can be agitated by wind-driven water movements. The existing water depth could be retained, but that would make it impossible to leave the existing sediment in place or to remove it and import fill material. In view of the fact that the water depth that is proposed is more than adequate for the intended recreational purposes, this alternative was eliminated from consideration.

2.4.2.9 Lagoon Bottom Restoration Alternatives

HHV identified eliminating the silty organic layer on the bottom of the lagoon as a key project objective for restoring the lagoon to acceptable recreational use (see Section 2.2.1.1). As an alternative to the proposed action of burying the sediment in place under geotextile fabric and selected sand fill, HHV considered removing the lagoon bottom sediments, disposing of them, and replacing them with selected granular fill. Geolabs, Inc. (2004) advised against the latter approach, citing greater environmental impacts and costs of implementation. Removing the lagoon bottom sediments would entail a significantly longer construction period with increased traffic and machinery. Moreover, the costs of excavating the material, hauling it off-site, and properly disposing of it are high compared to the preferred method of stabilizing the sediments with geotextile fabrics and covering them with clean fill. As such, this alternative was eliminated from further consideration in this EA.

2.4.2.10 Alternative Sand Sources

HHC considered several types and sources of sand for use on the lagoon bottom and for replenishing the lagoon shore. A study commissioned by HHC evaluated several potential land and offshore sand sources (Sea Engineering 2004). The study found that only one of the four offshore sites evaluated contained enough sand of suitable quality (i.e., with a grain size comparable to the existing beach sand at HHV) to be considered for mining. The deposit was found to have a shallow depth that would make dredging logistically difficult, and furthermore the dredging methods themselves have numerous inherent uncertainties and risks related to safety, efficiency, reliability, environmental impacts, and potential recreational conflicts. Thus, the study recommended obtaining sand from land-based sources rather than mining it from offshore. Suitable sources are available on O'ahu, making importation unnecessary.

2.4.3 DELAYED ACTION

The SMP and PD-R approvals for the new Waikikian Tower specify deadlines by which the lagoon-related conditions outlined in Section 2.2.3 must be fulfilled. Specifically, the SMP mandates that HHC implement its plan for the restoration of the lagoon to a safe and sanitary body of water within three years from the date of the plan's approval. The City and County Department of Planning and Permitting approved the proposed lagoon restoration plan and schedule in a letter dated October 8, 2004 (see Appendix A), making the deadline for implementation October of 2007. Likewise, the PD-R approval specified that a building permit for the Waikikian Tower must be obtained within five years of the approval, or by July of 2007. Construction plans for the land side improvements to the lagoon are required to be submitted as part of HHC's building permit application.

The proposed project schedule in Section 2.3.4 estimates that obtaining all of the necessary permits and completing the construction of the lagoon improvements will take at least a year. Thus, in order for HHC to remain in compliance with the conditions of its SMA and PD-R approvals, delaying the project is not a feasible alternative.

2.4.4 FILLING THE LAGOON

As discussed in Section 1.2, the Duke Kahanamoku Lagoon was created on State land that HHV is allowed to use under the terms of the 1955 Indenture and Deed from the Territory of Hawai'i. The Indenture and Deed provide that if it becomes impractical to maintain the lagoon, then the State may fill it. Condition C.1.c of the SMP for the Waikikian Tower also specifies that HHC provide plans for filling the lagoon within two years of the date of approval if the water quality restoration is determined infeasible. While filling it in would eliminate water quality as an issue, it would drastically alter the character of the environment and would not achieve the objectives of the proposed action as defined in Section 2.2.1. Consequently, it is not a viable alternative.

2.5 NO ACTION

HAR, §11-200-17(f)(1) requires an evaluation of "No Action". In the case of HHC's proposed lagoon restoration, "No Action" consists of retaining the lagoon as is. Water quality would continue to degrade as the pump wears out and more sediment enters through the ocean outlet. The lagoon would eventually become unsafe (rather than just undesirable) for recreational use, and would also become unsightly. Moreover, this alternative would mean non-compliance with the lagoon-related conditions of the SMA and PD-R approvals. Thus, the "No Action" alternative would not meet the objectives of the proposed action.

3.0 EXISTING ENVIRONMENT, POTENTIAL IMPACTS, & MITIGATION MEASURES

This chapter presents existing conditions within the area to be affected by the Duke Kahanamoku lagoon restoration project and identifies potential impacts of the project. Where the potential for negative impacts exists, it describes measures that will be taken to avoid, minimize, or mitigate those impacts. The affected area includes the following existing features and places within Waikīkī:

- The Duke Kahanamoku Lagoon itself and the land around its perimeter which would be filled and where the new pump house and amenities would be constructed;
- The existing public parking and beach areas *makai* of the lagoon;
- Portions of the Hilton Hawaiian Village immediately adjacent to the lagoon's north side (e.g., the Great Lawn, the proposed well sites, the existing pool, the Rainbow and Lagoon Towers) and along the route of the proposed stormwater drainage system;
- The Ala Wai Harbor where the new discharge pipes would be installed;
- Holomoana Lane *makai* of its intersection with Dewey Lane;
- The Pacific Ocean at the location of the existing intake pipes (seaward of the certified shoreline).

The chapter is organized by topic (e.g., topography, hydrology, sound levels, etc.). The scope of the discussion under each topic is adjusted to cover a localized area or a wider context, as appropriate.

3.1 PHYSIOGRAPHY, TOPOGRAPHY, & BATHYMETRY

3.1.1 EXISTING CONDITIONS

The area surrounding the lagoon and within the Hilton Hawaiian Village is flat to very gently sloping. A low (4 to 6 feet above mean sea level) berm separates the lagoon from the adjacent ocean. To the east of the lagoon is the crescent-shaped Duke Kahanamoku Beach, which is relatively flat. West and south of the lagoon is mostly paved, consisting of a public parking area, Holomoana Street, and walkways serving the Ala Wai Harbor; these are at an elevation of approximately 6 feet above sea level.

The hourglass shaped Duke Kahanamoku Lagoon is 675 feet long. At its widest, it is 420 feet across; at its narrowest (the neck of the hour glass), it is only 240 feet wide. The existing water surface area is about 4.6 acres; the small island in its southeast quadrant has an area of about 2,600 square feet (0.06 acre). At the deepest point in the lagoon the top of the sediment is about 8.5 feet below MSL; this is several feet less than when the lagoon was originally dredged.

3.1.2 POTENTIAL IMPACTS

The proposed action involves reducing the lagoon's surface area by approximately 25% and its volume by about 50% by placing clean sand fill in and around it. The modification would reduce its maximum depth to -5.0 feet MSL. Most of the land area that would be created is along the *makai* side of the lagoon, with small amounts being added around the remainder. As described in Section 2.3.1.1, the sand would be placed over a geotextile fabric that will nearly eliminate upward migration of silt into the sand. The fill will not significantly change the flat to gently sloping topography of the area, but it would substantially widen the level recreational area on the lagoon side of the existing parking area. The sealing and abandonment of the two existing intake pipes will not affect the bathymetry near them or produce other effects that could alter the ocean bottom. Similarly, installation and operation of the new discharge pipes into the Ala Wai Harbor will not affect the bathymetry there.

3.2 SOILS & SEDIMENTS

3.2.1 EXISTING CONDITIONS

3.2.1.1 Terrestrial Soils

The soil underlying most of the HHV property on the *mauka* side of the lagoon is classified as Jaucas Sand, 0 to 15 percent slopes. This series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean. They typically develop in wind and water deposited sand derived from coral and seashells. The soil is neutral to moderately alkaline throughout the profile. Permeability is rapid, and runoff is very slow to slow. The hazard of water erosion is slight, but the soil is susceptible to wind erosion where vegetation has been removed.

The area immediately around the lagoon, including the Ala Wai Harbor complex, is classified as mixed fill land (FL). This material was emplaced in the mid-1950s when Kaiser developed the Hawaiian Village. While detailed records are unavailable, it appears that most of the material that now makes up the banks of the lagoon originated from within it or from nearby ocean shoreline areas that were dredged when the Territory of Hawai'i constructed the "Crescent Beach" project. Kahanamoku Beach, the strip of beach fronting the HHV that was created at the same time as the lagoon, consists mainly of light-colored sands and larger material derived from coral and seashells. Much of the sand has eroded from the western end of the beach; what remains is exposed coral substrate, cemented sand, gravelly stones, and, in a few areas, a thin veneer of soil that has washed down from the surrounding landscaped areas.

3.2.1.2 Lagoon Bottom Sediments

As previously discussed, when ocean water enters the low-energy environment of the lagoon, most of the solids suspended in the water by wave action settle out. During the nearly 50 years since the lagoon was constructed, this has created a thick (1 to 6.5 feet) layer of very soft silty sediments over the loose coralline sand and gravel that formed the original lagoon bottom. Wind energy continually re-suspends this material into the water column and odors are released when anoxic bottom sediments are disturbed. Most of the sediment within the lagoon is anoxic silt and sand. Where sand is present, it is covered with a mat of fleshy algae (see Table 3.1). As shown by the data in Table 3.2, virtually all of the sediment grains are smaller than 2 mm in diameter and a large percentage smaller than 75 µm. Nearly all of the sediment consists of calcium carbonate, a strong indication that the material comprising the lagoon floor is of marine origin, with little terrestrial input.

When HHC was considering dredging as a means of restoring the Duke Kahanamoku Lagoon, it commissioned MEC Analytical Systems, Inc. (May 2001) (MEC) to conduct an in-depth evaluation of the quality of the bottom sediments. Its report presented the results of physical and chemical testing conducted on representative sediment collected from within the lagoon. In particular, the analysis focused on the environmental suitability of the dredged material for disposal at the South Oahu Ocean Dredged Material Disposal Site. MEC tested the material in accordance with procedures outlined in the Evaluation of Dredged Material Proposed for Ocean Disposal (the *Ocean Testing Manual*; United States Environmental Protection Agency (USEPA/USACE 1991) and the *Regional Implementation Manual* for the State of Hawai'i, dated January 1997 (USEPA Region IX and USACE Honolulu Engineer District 1997). To provide flexibility in the event offshore disposal was deemed impractical, MEC also assessed the material's suitability for upland disposal at a permitted landfill.[13]

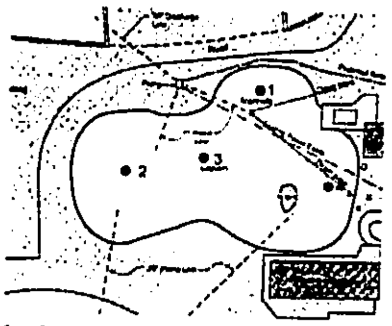
[13] Analysis for upland disposal of the material was conducted to conform to the requirements of one potential permitted landfill and in accordance with the requirements of the Hawai'i Department of Health Office of Solid Waste Management.

Table 3.1. Results of Sediment Analysis from Samples Collected in the Hilton Lagoon.

Station	*Distance from Shore*	*Date*	*Time*	*Conditions at Sampling Site*
1	60	9-Nov-2003	8:30	Anoxic muddy sand, with algal/grass masses
2	50	9-Nov-2003	9:00	Muddy sand, algal and grass masses
3	120	9-Nov-2003	8:45	similar to No 1
4	100	10-Nov-2003	8:15	Very turbid, anoxic mud, fleshy algae
5	100	9-Nov-2003	9:20	Anoxic muddy sand, with algal/grass masses
6	50	10-Nov-2003	9:10	Very turbid, anoxic muddy sand, fleshy algae
7	50	10-Nov-2003	9:20	Very turbid, anoxic muddy sand, fleshy algae
8	50	10-Nov-2003	8:50	Very turbid, H2S smell at shore, anoxic ooze, algae
9	100	10-Nov-2003	8:30	Very turbid, anoxic mud, fleshy algae
10	100	10-Nov-2003	9:35	low turbidity, fine sand, oxic, no algae, no grasses
Note: The sampling station locations are shown in Figure 3.1				
Source: Marine Research Consultants, April 24, 2004.				

Table 3.2. Station Percentage Size Fraction.

Station No.	*Station Percentage Size Fraction*			
	>2 mm	*<2mm*	*<75μm*	*TOTAL*
1	4.6	67.9	27.5	100.0
2	6.1	79.4	14.5	100.0
3	6.2	54.8	38.9	100.0
4	3.4	70.1	26.4	100.0
5	1.8	51.2	47.0	100.0
6	12.4	73.5	14.1	100.0
7	6.7	36.0	57.3	100.0
8	11.7	35.1	53.3	100.0
9	3.1	34.5	62.3	100.0
10	11.2	86.9	1.9	100.0
Source: Marine Research Consultants				



MEC combined samples taken from the four locations within the lagoon shown in the sketch at left for its testing. Information on the sample depths is summarized in Table 3.3. For the Tier I ocean disposal evaluation chemical analysis of the sediment included metals, pesticides, polychlorinated biphenyls [PCBs (as Aroclors)], organotins, and polycyclic aromatic hydrocarbons (PAHs). Conventional analyses included grain size, percent solids, percent volatile solids, total organic carbon (TOC), total and dissolved sulfides, oil and grease and total recoverable petroleum hydrocarbons (TRPH). Additional analysis performed for the evaluation of upland disposal included ignitability (EPA 1030); Toxicity Characteristic Leaching Procedure (TCLP) for metals; reactive and total cyanide; total petroleum hydrocarbons (TPH) as gasoline, diesel, and oil; benzene, toluene, ethylbenzene, xylene (BTEX); and volatile organic compounds (VOCs).

Table 3.3. Sample Depths for Sediments Cores.

Site	*Attempt*	*Depth feet (MSL)*	*Core Length feet*	*Penetration feet*	*Actual Depth Sampled feet (MSL)*	*Comments*
1	1 of 2	6' 10"	4' 6"	6' 10"	13' 0"	Refusal encountered, coral rubble in cutter head
1	2 of 2	6' 11"	4' 6"	5' 6"	12' 4"	Refusal encountered, coral rubble in cutter head:
2	1 of 2	7' 10"	-	1' 0"	-	Sample lost
2	2 of 2	7' 6"	2' 0"	2' 6"	10'	Refusal encountered, coral rubble in cutter head
3	1 of 1	7' 6"	2' 6"	4' 4"	11' 11"	Refusal encountered, coral rubble in cutter head.
4	1 of 1	7' 6"	3' 4"	4' 6"	12' 0"	Refusal encountered, coral rubble in cutter head
Note: Refusal (i.e., 1 inch penetration/minute) was encountered due to the presence of coral rubble that forms the base of this man-made lagoon						
Source: MEC Analytical Systems Inc (May 2001), Table 4.						

Based on its analyses, MEC Analytical Systems Inc. concluded that the bottom sediments in the Duke Kahanamoku Lagoon are essentially free of measurable contaminants and therefore likely suitable for either ocean disposal under a Tier 1 evaluation or upland landfill disposal in accordance with the requirements of the State of Hawai'i Department of Health Office of Solid Waste Management. Results of Tier I chemical analysis of sediments from the Hilton Lagoon revealed concentrations of metals below the conservative ER-L screening values of Long et al. (1995). All other analytes (PAHs, PCBs, pesticides, and organotins) were undetected. Additional analysis indicated nearly all measured analytes to be below reportable limits. The test for ignitability (EPA 1030) was negative.

3.2.2 POTENTIAL IMPACTS

As discussed in Section 2.3.1, the lagoon bottom sediments will be buried in place under a layer of geotextile fabric, and then covered with sand fill obtained from Mokulē'ia, O'ahu. The same sand will be used for filling around the lagoon and replenishing the beach. This will not change the soil classification of the filled area, which is classified as "Sandy Beach." No important agricultural or mineral resources will be affected by the project. The sand that will be used is virtually identical to the sand that is already present on the beach and has been used successfully in a number of previous Waikīkī beach replenishment projects. Some re-suspension of bottom sediments will undoubtedly occur during the placement of the geotextile fabric and other construction work within the lagoon.

However, in view of the absence of substantial wave energy and currents within the lagoon while the water circulations system is shut down and it is isolated from both the harbor and the ocean, nearly all of this will settle before the sand is emplaced. In view of the absence of contaminants, the small amounts that would remain in the water column and/or settle onto the clean ocean sand once it is in place on the lagoon bottom does not constitute a danger.

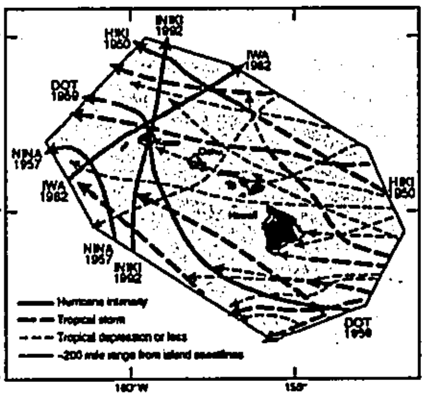
3.3 CLIMATE

3.3.1 EXISTING CONDITIONS

The Hawaiian Island chain is situated south of the large Eastern Pacific semi-permanent high-pressure cell, the dominant feature affecting air circulation in the region. Over the Hawaiian Islands, this high-pressure cell produces very persistent winds called the northeast trade winds. During the winter months, cold fronts sweep across the north central Pacific Ocean, bringing rain to the island chain and intermittently modifying the trade wind regime. Thunderstorms, which are rare but most frequent in the mountains, also contribute to annual precipitation.

Due to the tempering influence of the Pacific Ocean and their low-latitude location, the Hawaiian Islands experience extremely small daily and seasonal variations in ambient temperature. Average temperatures in the coolest and warmest months at Honolulu International Airport are 72.9° (January) and 81.4° (July), respectively. These temperature variations are quite modest compared to those that occur at inland continental locations. Additional temperature data from Honolulu International Airport are summarized in Table 3.4.

As noted above, the northeast trade winds predominate in the project area. Data from the Honolulu International Airport show that they are strongest and most persistent in the summer. During July, for example, winds from the northeast through east are present over 85 percent of the time and winds average just below 13 miles per hour. The trade winds become weaker and less persistent in the winter. During January, for example, winds from the northeast to east are present only 35 percent of the time and their average speed drops to a little over 10 miles per hour. The island is also influenced by occasional *kona* storms, which are intense low-pressure centers that pass near the island, bringing moderate to strong southerly winds and rain. When the trade winds or storms do not dominate the wind flows, the winds are typified by land/sea breezes and *kona* winds. Finally, while hurricanes are relatively rare events in the Hawaiian Islands, they do occur. The sketch to the right from *www.soest.hawaii.edu/MET/Faculty/businger/poster/hurricane* shows all tropical cyclone tracks passing within ~200 miles of the coast of the Islands of Hawai'i during the period 1949 to 1997.[14] Hurricane Iniki, the most recent of these, caused substantial flooding at the HHV. The danger from a possible recurrence of hurricane-related flooding is discussed in Section 3.6. **Error! Hyperlink reference not valid.**



The terrain on O'ahu is influential in determining the amount of rainfall. Annual rainfall at the project site averages only about 20 inches, an order-of-magnitude less than the nearly 250 inches of rain that falls each year near the top of the Ko'olau Range on the windward side of O'ahu. The wettest months in Waikīkī are December through March, when up to 5 inches can fall in a single month. From April through September rainfall averages 1 inch per month or less. Relative humidity in Honolulu typically ranges between 65-77%.

[14] The records prior to 1950 are sketchy, with only 19 tropical cyclones identified between 1832 and 1949 from scattered written records and ship reports.

Table 3.4. Average Monthly Temperature, Rainfall, and Humidity

Month	*Normal Ambient Temperature, °Fahrenheit*		*Average Monthly Rainfall (inches)*		
	Daily Minimum	*Daily Maximum*	*Monthly Minimum*	*Monthly Maximum*	*Average Relative Humidity (%)*
January	65.7	80.4	0.18	14.74	71
February	65.4	80.7	0.06	13.68	69
March	66.9	81.7	0.01	20.79	65
April	68.2	83.1	0.01	8.92	62.5
May	69.6	84.9	0.03	7.23	60.5
June	72.1	86.9	T	2.46	59
July	73.8	87.8	0.03	2.33	60
August	74.7	88.9	T	3.08	60
September	74.2	88.9	0.05	2.74	61.5
October	73.2	87.2	0.07	11.15	63.5
November	71.1	84.3	0.03	18.79	67
December	67.8	81.7	0.04	17.29	74.75
Note: "T" signifies a trace amount of rainfall (i.e., less than 0.01 inch).					
Source: DBEDT 2003 (Data from Honolulu International Airport).					

3.3.2 POTENTIAL IMPACTS

The proposed project does not involve activities that have the potential to alter the region's climate or weather patterns. The surface area of the lagoon will be reduced by about 25%, widening the beach along most of the lagoon shore. However, any localized temperature increases due to these changes are expected to be offset by the additional grass, trees, and landscaping HHC is providing around the lagoon (see Section 2.3.2.4.1). Moreover, any noticeable effect the project might have on the microclimate would be overwhelmed by the effect of the adjacent Pacific Ocean. Consequently, no mitigation measures are necessary. Issues related to weather-related natural hazards are discussed in Section 3.6.

3.4 AIR QUALITY

3.4.1 EXISTING CONDITIONS

The State of Hawai'i Department of Health monitors ambient air quality on O'ahu using a system of 9 monitoring sites. The primary purpose of the monitoring network is to measure ambient air concentrations of the six criteria pollutants regulated by the National Ambient Air Quality Standards, which are particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide (NO_2) sulfur dioxide (SO_2), carbon monoxide, and hydrogen sulfide. Data from the Waikīkī Air Quality Monitoring Station, which measures carbon monoxide, and the Honolulu Air Quality Monitoring Station, which monitors carbon monoxide, sulfur oxides, nitrogen oxide and particulates, indicate that the air quality in the project area is consistently within State and Federal regulatory limits. The major factor affecting air quality in the immediate project area is vehicular traffic along Ala Moana Boulevard and auxilliary streets.

3.4.2 PROBABLE IMPACTS

Construction activity in and around the lagoon will generate fugitive dust and other emissions in the immediate area. Measurable pollutants potentially generated by the project include particulate matter (e.g., dust generated during drilling, filling and grading), nitrogen oxide (NO_x) and carbon monoxide (CO) from construction vehicles.

All project actions will comply with DOH Rules Title 11, Chapter 59 and 60, regarding Air Pollution Control. For example, state air pollution control regulations require that there be no visible fugitive dust emissions at the construction site boundary. The lagoon and adjacent areas are immediately adjacent to the ongoing resort operations at the HHV. This makes the control of dust and other construction-related pollutants of particular concern to the owner. Consequently, it will require the contractor to prepare and implement a comprehensive dust control plan that meets or exceeds that required by State regulations. Fugitive dust control measures will include frequent watering of active work areas where fine particulate matter might become airborne, the use of dust screens, covering open-bodied trucks, and similar measures.[15] In addition, construction-related exhaust emissions will be mitigated by ensuring that project contractors properly maintain their internal combustion engines. The granular nature of the sand and soil at the site will limit the amount of airborne dust generated by the project. Once construction work has ended and the affected areas have been stabilized, the potential for dust will diminish. Over the longer term, the fact that irrigated landscaping will be installed over approximately the same amount of area as will be converted from water to land is likely to keep airborne particulate concentrations throughout the entire area at or about their existing levels despite the increase in land area that is proposed.

3.5 WATER QUALITY

3.5.1 EXISTING CONDITIONS

3.5.1.1 Duke Kahanamoku Lagoon

Because it is presently connected to the Pacific Ocean through two open inlet pipes, the State Department of Health considers the lagoon to have the same water quality classification as the adjacent ocean (Class A Open Coastal Waters). As such, it is subject to the Basic Water Quality Standards shown in Table 3.5 (which are applicable to all State Waters) and to the Class A Open Coastal Water Standards shown in Table 3.6.

In late 2003, water samples were collected from ten stations within the lagoon, the ocean near the two intake pipes, and from the Ala Wai Harbor near the point where water pumped from the lagoon is discharged. Figure 3.1 shows the location of the water sampling stations. Water was collected at two depths at each station; one within the top six inches of the air-water interface and a second within six inches of the lagoon or ocean floor. Water chemistry was evaluated by analysis of total nitrogen (TN), nitrate + nitrite nitrogen ($NO_3^- + NO_2^-$, henceforth referred to as NO_3^-), ammonium (NH_4^+), orthophosphate phosphorus (PO_4^{3-}), total phosphorus (TP), dissolved silica (Si), salinity, Chlorophyll a, turbidity and total suspended solids (TSS). In addition, continuous vertical profiles of salinity and temperature through the water column at each of the sampling sites were recorded to determine if density stratification exists and if it is a contributing factor to the lagoon's circulation patterns and water quality.

Table 3.7 and Table 3.8 show the results of water chemistry analyses for sample sets collected twice on October 6 and once on October 17, 2003. Table 3.9 presents data on fecal coliform testing within the lagoon.

[15] Most of the material that will be used in the lagoon restoration involves sand-size or larger material that typically does not become airborne, and recent experience with the exploratory wells along the banks of the lagoon indicates that work in that area can generally be conducted without watering. However, more active dust-control measures, including regular watering, will be needed during the placement of soil for the expanded landscaping areas. HHC's construction contract will require this, as well as wind speeds below 15 miles per hour during the placement of landscaping soil.

Table 3.5. Basic Water Quality Standards Applicable to All Waters

§11-54-4 Basic water quality criteria applicable to all waters.
(a) All waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including: (1) Materials that will settle to form objectionable sludge or bottom deposits; (2) Floating debris, oil, grease, scum, or other floating materials; (3) Substances in amounts sufficient to produce taste in the water or detectable off-flavor in the flesh of fish, or in amounts sufficient to produce objectionable color, turbidity or other conditions in the receiving waters; (4) High or low temperatures; biocides; pathogenic organisms; toxic, radioactive, corrosive, or other deleterious substances at levels or in combinations sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts sufficient to interfere with any beneficial use of the water; (5) Substances or conditions or combinations thereof in concentrations which produce undesirable aquatic life; and (6) Soil particles resulting from erosion on land involved in earthwork, such as the construction of public works; highways; subdivisions; recreational, commercial, or industrial developments; or the cultivation and management of agricultural lands.
§11-54-8 Specific criteria for recreational areas.
(a) In inland recreational waters: (1) Enterococcus content shall not exceed a geometric mean of 33 per one hundred milliliters in not less than five samples which shall be spaced to cover a period between 25 and 30 days. No single sample shall exceed the single sample maximum of 89 colony forming units (CFU) per 100 milliliters or the site-specific one-sided 82 per cent confidence limit. Inland recreational waters in which enterococcus content does not exceed the standard shall not be lowered in quality. (3) At locations where sampling is less frequent than five samples per twenty-five to thirty days, no single sample shall exceed the single sample maximum nor shall the geometric mean of these samples taken during the 30-day period exceed 33 CFU per 100 milliliters. (4) Raw or inadequately treated sewage, sewage for which the degree of treatment is unknown, or other pollutants of public health significance, as determined by the director of health, shall not be present in natural public swimming, bathing or wading areas. Warning signs shall be posted at locations where human sewage has been identified as temporarily contributing to the enterococcus count. (b) In marine recreational waters: (1) Within 300 meters (one thousand feet) of the shoreline, including natural public bathing or wading areas, enterococcus content shall not exceed a geometric mean of seven per one hundred milliliters in not less than five samples which shall be spaced to cover a period between twenty-five and thirty days. No single sample shall exceed the single sample maximum of 100 CFU per 100 milliliters or the site-specific one-sided 75 per cent confidence limit. Marine recreational waters along sections of coastline where enterococcus content does not exceed the standard, as shown by the geometric mean test described above, shall not be lowered in quality. (2) At locations where sampling is less frequent than five samples per twenty-five to thirty days, no single sample shall exceed the single sample maximum nor shall the geometric mean of these samples taken during the thirty-day period exceed 7 CFU per 100 milliliters. (3) Raw or inadequately treated sewage, sewage for which the degree of treatment is unknown, or other pollutants of public health significance, as determined by the director of health, shall not be present in natural public swimming, bathing or wading areas. Warning signs shall be posted at locations where human sewage has been identified as temporarily contributing to the enterococcus count.
Source: Hawai'i Administrative Rules §11-54 (as amended October 2, 2004).

Table 3.6. DOH Water Quality Standards for Class A Open Coastal Waters

Parameter	*Geometric mean not to exceed*	*Not to exceed more than 10% of the time*	*Not to exceed more than 2% of the time*
Total Nitrogen (µg N/L)	110.00*	180.00*	250.00*
Ammonia Nitrogen (µg NH_4 –N/L)	3.50*	10.00*	9.00*
Nitrate + Nitrite Nitrogen (µg [NO_3+NO_2] – N/L)	3.50*	10.00*	20.00*
Total Phosphorus (µg P/L)	16.00*	30.00*	45.00*
Light Extinction Coefficient (k units)	0.10*	0.30*	0.55*
Chlorophyll a (µg/L)	0.15*	0.50*	1.00*
Turbidity (N.T.U.)	0.20*	0.50*	1.00*

* "Dry" criteria apply when the open coastal waters receive less than three million gallons per day of fresh water discharge per shoreline mile.

Applicable to both "wet" and "dry" conditions:

pH Units - shall not deviate more than 0.5 units from a value of 8.1, except at coastal locations where and when freshwater from stream, storm drain or groundwater discharge may depress the pH to a *minimum level of 7.0.*

Dissolved Oxygen - Not less than seventy-five per cent saturation, determined as a function of ambient water temperature and salinity.

Temperature - Shall not vary more than one degree Celsius from ambient conditions.

Salinity - Shall not vary more than ten per cent from natural or seasonal changes considering hydrologic input and oceanographic factors.

k Units = the ratio of light measured at the water's surface to light measured at a particular depth.

Source: Hawai'i Administrative Rules, Title 11, Department of Health: Chapter 54, Water Quality Standards.

Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Sources:

--City & County of Hawaii GIS
--Environmental Assessment, LLC

Legend:

- Water Quality Stations
- Island
- Lagoon ca. 1987

0 125 250
Feet

Figure 3-1:

Lagoon Water Quality Monitoring Stations

Hilton Hawaiian Village
Lagoon Restoration

Table 3.7. Water Quality Test Results: October 6, 2003

SS#	Time	PO_4 µg/L	NO_3 µg/L	NH_4 µg/L	Silica µg/L	TOP µg/L	TON µg/L	TP µg/L	TN µg/L	Sal ‰	TSS mg/L	Turb ntu	Temp deg C	pH	DO % Sat	Chl a µg/L
1-s	am	4.96	1.40	2.80	281.84	8.99	92.54	13.95	96.74	34.68	94.80	5.88	27.55	8.14	99.17	0.39
1-s	pm	2.48	2.52	5.88	180.12	11.16	105.84	13.64	114.24	34.92	101.60	6.22	27.46	8.30	114.62	0.43
1-b	am	2.79	0.00	1.82	232.39	16.12	87.50	18.91	89.32	34.71	93.60	6.41	27.69	8.17	96.31	0.34
1-b	pm	2.17	2.52	4.34	178.44	11.47	102.06	13.64	108.92	34.96	94.40	6.39	28.49	8.30	119.43	0.35
1A-s	am	3.10	3.08	19.88	273.98	12.09	112.84	15.19	135.80	34.85	92.40	4.20	26.50	8.16	99.50	0.38
1A-s	pm	3.41	3.36	16.38	264.42	11.47	107.24	14.88	126.98	34.96	115.60	8.03	26.62	8.33	113.49	0.39
1A-b	am	2.17	1.40	0.70	247.28	12.40	113.54	14.57	115.64	34.62	100.80	3.76	27.96	8.18	96.52	0.16
1A-b	pm	6.51	2.66	6.16	233.79	10.85	109.06	17.36	117.88	34.94	92.80	7.71	28.44	8.32	115.11	0.18
2-s	am	2.48	0.70	5.74	248.97	16.74	91.98	19.22	98.42	34.69	89.20	4.93	26.47	8.13	92.09	0.22
2-s	pm	1.55	1.96	6.30	194.17	12.09	114.80	13.64	123.06	34.92	97.20	6.33	27.88	8.30	111.44	0.24
2-b	am	1.86	2.66	2.38	203.44	13.33	81.90	15.19	86.94	34.72	98.00	4.03	27.64	8.14	94.17	0.25
2-b	pm	3.72	9.80	7.14	78.40	9.92	98.28	13.64	115.22	35.07	140.80	3.47	28.35	8.32	119.70	0.07
3-s	am	4.03	0.84	6.86	247.00	10.85	92.54	14.88	100.24	34.73	84.80	3.79	26.97	8.17	95.11	0.30
3-s	pm	2.17	2.94	6.58	200.35	10.54	107.10	12.71	116.62	34.81	89.60	3.81	27.62	8.18	108.06	0.25
3-b	am	3.10	0.42	3.50	236.88	13.33	97.44	16.43	101.36	34.76	92.80	5.30	27.67	8.15	93.40	0.28
3-b	pm	1.55	2.66	8.12	189.68	11.16	109.34	12.71	120.12	34.83	108.00	6.05	28.34	8.17	113.81	0.30
4-s	am	3.72	3.22	0.14	241.94	9.30	92.68	13.02	96.04	34.75	84.00	3.80	26.57	8.16	97.86	0.28
4-s	pm	2.17	2.24	2.10	235.48	13.33	122.50	15.50	126.84	34.81	113.60	11.10	28.58	8.21	106.88	0.32
4-b	am	3.10	5.60	3.50	208.50	10.85	83.72	13.95	92.82	34.77	109.20	1.80	27.73	8.19	94.16	0.06
4-b	pm	1.55	2.94	10.08	189.39	12.09	114.80	13.64	127.82	34.87	120.40	2.76	28.47	8.23	114.73	0.06
5-s	am	3.72	2.66	7.84	245.59	17.36	95.62	21.08	106.12	34.78	110.40	1.23	27.72	8.21	100.09	0.05
5-s	pm	2.79	2.24	10.22	203.73	13.02	104.02	15.81	116.48	34.87	103.20	3.08	28.02	8.28	111.18	0.52
5-b	am	3.41	2.66	6.72	224.52	26.66	87.08	30.07	96.46	34.84	92.80	1.58	27.52	8.22	96.97	0.82
5-b	pm	3.72	2.24	23.24	185.18	11.78	111.16	15.50	136.64	34.91	111.60	3.06	28.45	8.29	118.11	0.59
6-s	am	3.41	2.38	9.94	228.45	11.16	85.26	14.57	97.58	34.78	119.60	8.50	27.91	8.22	100.36	0.41
6-s	pm	18.91	1.96	13.44	235.76	11.47	118.02	30.38	133.42	34.87	112.40	8.07	27.33	8.28	110.16	0.30
6-b	am	3.41	6.44	2.10	73.62	12.09	74.62	15.50	83.16	34.97	115.20	5.19	27.40	8.20	99.35	0.32
6-b	pm	7.75	2.38	18.62	225.64	13.33	145.74	21.08	166.74	34.91	88.40	1.41	28.40	8.27	116.88	0.34
7-s	am	4.34	9.10	5.88	535.59	15.81	91.70	20.15	106.68	34.07	100.80	4.69	27.78	8.20	95.67	2.59
7-s	pm	10.85	2.38	28.56	211.87	14.57	153.86	25.42	184.80	34.87	105.60	1.33	28.09	8.27	107.91	0.58
7-b	am	2.79	3.08	5.46	201.48	19.53	86.52	22.32	95.06	34.78	100.00	3.14	27.60	8.21	93.33	1.12
7-b	pm	3.41	2.66	14.70	194.73	12.71	129.92	16.12	147.28	34.92	109.20	1.15	28.38	8.29	117.15	3.13
8-s	am	5.58	5.60	25.62	255.43	17.36	87.36	22.94	118.58	34.42	114.80	12.40	27.72	8.20	97.72	2.25
8-s	pm	0.93	2.38	1.54	227.05	13.95	135.24	14.88	139.16	34.91	92.00	4.21	27.53	8.27	112.00	0.35
8-b	am	3.10	4.90	9.24	227.33	30.07	105.56	33.17	119.70	34.81	104.40	7.49	27.43	8.19	91.59	0.38
8-b	pm	3.10	3.22	7.42	207.38	14.57	103.60	17.67	114.24	34.93	112.88	3.46	28.44	8.28	115.79	0.39
9-s	am	2.17	4.20	4.20	245.59	12.09	94.36	14.26	102.76	34.81	112.96	3.75	26.58	8.23	100.12	0.14
9-s	pm	3.41	2.80	9.80	280.16	12.40	102.34	15.81	114.94	34.85	108.48	3.10	27.18	8.25	109.06	0.36
9-b	am	4.96	4.90	3.50	215.53	10.23	99.12	15.19	107.52	34.81	113.28	4.53	27.78	8.20	93.39	0.30
9-b	pm	2.79	4.06	6.30	243.91	12.40	99.40	15.19	109.76	34.92	84.80	4.50	28.43	8.26	115.48	0.37
10-s	am	1.24	2.66	0.42	51.99	9.92	78.68	11.16	81.76	34.73	87.60	5.31	27.25	8.06	97.03	0.23
10-b	am	1.24	1.54	0.00	39.06	10.54	96.88	11.78	98.42	34.83	54.40	3.80	26.99	8.04	90.94	0.36
11-s	am	1.55	1.96	0.14	43.84	9.92	78.26	11.47	80.36	34.88	56.88	2.81	26.69	8.07	98.35	0.23
11-b	am	2.48	2.52	2.94	33.44	9.92	76.44	12.40	81.90	34.89	49.60	3.87	27.12	8.07	96.80	0.54
12-s	am	5.89	7.98	21.42	275.94	12.09	95.20	17.98	124.60	34.79	56.08	6.23	27.28	8.20	97.77	0.34
12-b	am	4.96	9.94	13.02	236.04	11.78	89.60	16.74	112.56	34.86	37.60	4.35	27.67	8.20	95.94	0.29

Source: Marine Research Consultants.

SS# = Sampling Station Number

Note: Samples labeled "am" were collected at 0600-0800 low tide (+0.4 ft); samples labeled "pm" were collected at 1400-1600 at high tide (+2.0 ft). Concentrations of dissolved nutrients are shown in weight per volume units (µg/L). "s" indicates surface sample; "b" indicates bottom sample.

Table 3.8. Water Quality Test Results: October 17, 2003

SS#	*PO_4* *µg/L*	*NO_3* *µg/L*	*NH_4* *µg/L*	*Silica* *µg/L*	*TOP* *µg/L*	*TON* *µg/L*	*TP* *µg/L*	*TN* *µg/L*	*Sal* *‰*	*TSS* *mg/L*	*Turb* *ntu*	*CHL a* *µg/L*
1-s	7.13	5.18	1.40	286.34	11.16	137.34	18.29	143.92	34.96	30.40	1.82	0.25
1-b	2.79	2.80	0.14	260.21	14.88	144.06	17.67	147.00	35.03	54.40	3.91	0.26
2-s	2.48	5.18	3.36	279.60	13.64	152.32	16.12	160.86	34.95	39.60	2.22	0.24
2-b	1.86	4.76	0.14	261.05	13.64	119.14	15.50	124.04	34.99	18.40	1.99	0.24
3-s	4.03	4.76	0.84	237.16	12.09	112.98	16.12	118.58	35.04	24.00	1.61	0.24
3-b	3.41	4.34	1.12	244.47	12.40	119.00	15.81	124.46	35.05	36.00	1.53	0.18
4-s	3.10	5.46	0.56	278.75	11.16	116.20	14.26	122.22	34.98	28.40	1.60	0.21
4-b	2.79	4.62	4.48	248.12	14.57	112.98	17.36	122.08	35.03	50.40	3.02	0.19
5-s	1.55	8.54	3.92	433.58	14.26	115.78	15.81	128.24	34.77	27.60	1.70	0.40
5-b	2.48	6.30	4.62	265.83	11.47	99.68	13.95	110.60	35.10	24.40	2.02	0.23
6-s	5.27	11.76	25.48	321.75	12.09	97.86	17.36	135.10	35.02	23.60	1.62	0.24
6-b	1.86	5.18	5.04	129.54	10.85	79.52	12.71	89.74	35.18	24.80	1.30	0.15
7-s	1.55	6.30	9.38	289.15	12.71	106.54	14.26	122.22	34.58	28.80	1.30	0.24
7-b	3.41	6.44	10.78	236.32	10.85	91.28	14.26	108.50	35.05	29.60	1.88	0.20
8-s	2.17	7.14	6.86	262.45	11.78	104.16	13.95	118.16	34.99	26.80	1.83	0.23
8-b	3.10	6.16	7.14	234.64	12.09	118.30	15.19	131.60	35.06	30.40	2.07	0.20
9-s	3.10	6.72	5.88	248.40	11.47	104.58	14.57	117.18	35.03	27.20	2.04	0.25
9-b	3.41	7.56	7.84	233.23	10.85	107.52	14.26	122.92	35.06	37.60	2.76	0.16
1A-s	2.79	6.72	11.20	225.64	10.23	92.40	13.02	110.32	34.96	27.20	1.68	0.23
1A-b	3.41	5.88	9.24	228.45	11.47	122.22	14.88	137.34	35.00	37.20	2.43	0.06
10-s	1.24	1.96	6.44	91.89	10.85	99.68	12.09	108.08	35.21	31.60	1.10	0.07
10-b	2.17	1.82	0.70	71.37	9.61	115.36	11.78	117.88	35.23	33.20	1.07	0.08
11-s	1.86	2.80	0.70	82.33	10.85	133.70	12.71	137.20	35.22	6.40	1.11	0.08
11-b	0.07	0.00	0.06	2.50	0.32	8.91	0.39	8.97	35.27	26.00	1.78	0.09

Source: Marine Research Consultants.

SS# = Sampling Station Number. See Figure 3.1 for location.

Note: All samples were collected between 0600-0800 hrs at a flooding tide (+01.5 ft). Concentrations of dissolved nutrients are shown in weight per volume units (µg/L). "s" indicates surface sample and "b" a bottom sample.

Table 3.9. Fecal Coliform & Enterococcus Test Results: October 17, 2003

Sampling Station	*Fecal Coliform (MPN/100 ml)*	*Enterococcus (MF/100ml)*
#1 – *makai* end of lagoon (middle)	<20	11
#2 – *makai* end of lagoon (southernmost)	<20	10
#3 – *makai* end of lagoon (northernmost)	130	15
#4– middle of lagoon (northern)	130	41
#5 – middle end of lagoon (southern)	80	23
#6 – *mauka* end of lagoon (southernmost)	40	110
#7 – *mauka* end of lagoon (middle)	230	77
#8 – *mauka* end of lagoon (northernmost)	300	76
#9 – Near Intake of *easternmost* lagoon effluent pipe	170	16
#10 – Offshore Intake (Diamond Head)	<20	<1
#11 – Offshore Intake ('Ewa)	<20	<1
#12 - Middle Basin of Ala Wai Harbor near Lagoon Discharge	230	290
Notes: Water temperature was 22 degrees C; samples were collected by: S. Dollar on October 17, 2003.		
Source: Hawaii Food & Water Testing, Tested: 10-17-03; Completed: 10-20-03; HAR 11-54.		

The following generalizations about the lagoon can be made from the water quality data in Tables 3-7 through 3-9:

- Water temperature in the lagoon varies seasonally, as well as over the course of a day. During the fall and winter of 2003, it ranged from 80 to 84 degrees F. This was two to three degrees F warmer than the temperature in the ocean immediately adjacent to the lagoon.
- Concentrations of dissolved nutrients within the lagoon did not indicate any conditions that could be considered eutrophic. There was little variability between morning and late afternoon samples. The only significantly elevated nutrient levels occurred in the *mauka* end of the lagoon where a drain outlet discharges high-nutrient/high-bacteria fresh water into the lagoon on an almost continuous basis.
- Silica concentrations are consistently higher in the lagoon samples than in the ocean near the intakes. Silica was elevated by an order of magnitude in the sample collected near the drain outlet.
- Dissolved inorganic plant nutrients (NH_4^+, NO_3^-, PO_4^{3-}) show a pattern similar to that observed for silica. Concentrations throughout the lagoon are slightly elevated relative to intake water, while the sample near the drain outlet contained substantially higher concentrations. The greatest overall elevation in lagoon water relative to intake water occurred with NH_4^+. Such a result is not surprising as NH_4^+ is generated by organic degradation, an expected process in the lagoon.
- Values of Chlorophyll a showed surprisingly little variation between morning and afternoon samples or between intake water and lagoon water. The highest values of Chlorophyll a were in samples collected at Stations 7 and 8, located behind the island in the *mauka* corner of the lagoon, possibly because the limited circulation leads to high residence times in this area.
- Turbidity and TSS were elevated in the lagoon relative to intake water. This is probably the result of re-suspension of the fine-grained organic sediments throughout the lagoon bottom by wind energy. This is one of the primary causes of the unfavorable recreational conditions that presently characterize the lagoon. The accumulated bottom sediments are inconsistent with the intent of the criterion pertaining to objectionable bottom deposits (§11-54-04(1)).

- Water samples collected on October 17, 2003 were analyzed for the indicator bacteria, fecal coliform, and enterococcus (see Table 3.9). Results of these analyses showed substantial spatial variability throughout the lagoon, while the ocean water near the intake (Lagoon Stations 10 and 11) showed no detectable values for either indicator. Within the lagoon, the lowest counts occurred at Stations 1 and 2, where short-circuiting from the inflow to the pump discharge is a dominant factor. The highest counts of fecal coliform occurred at Stations 7-9 along the landward margin of the lagoon. The highest counts of enterococcus within the lagoon occurred at Stations 6-8. These patterns are the result of the essentially continuous discharge from the storm drain outlet located there.
- Throughout most of the lagoon, the vertical salinity and temperature profiles showed that there is no significant density stratification at high and low tides. The water column is apparently well-mixed through its full depth. The only exception to this is close to the drain outlet at the *mauka* end of the lagoon. Its fresh water discharge rises to form a lower-salinity surface layer about a foot thick.

3.5.1.2 Groundwater

Groundwater samples were taken during drilling for the seven exploratory wells that HHC has constructed to confirm the feasibility of the well supply system. Tests of the samples confirm that the water is saline (34.57 to 34.84 parts per thousand). Table 3.10 shows the salinity values and other water quality characteristics of the samples. Owing to their differences in hydraulic performance, the wells' individual contributions to the 15,000 GPM continuous discharge into the lagoon will vary between 1,150 and 3,170 GPM per well (see Table 3.11). Temperature and dissolved oxygen were continuously measured during the drilling pump tests. Both showed little variation; all temperatures recorded were between 75.54-76.32 degrees Fahrenheit. Dissolved oxygen ranged between 11.5 to 15.0% saturation. Tests of the well water showed that bacterial levels (*Clostridium perfringens* and *Enterococcus*) were below the detection limit of 1 MF/100 ml. Finally, tests of well water showed that the heavy metals and pesticides most likely to be present were all below detection limits.[16]

[16] The samples were tested for Lead, Iron, Mercury, Aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC (Lindane), 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Dieldrin, Endosulfan I, Endosulfan II, Endosulfan Sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, Toxaphene, alpha-Chlordane, and gamma-Chlordane.

Table 3.10. Groundwater Quality Data from Pump Tests During April, 2005.

Well No.	Temp °F	Dissolved O_2	Sal (o/oo)	Turb (ntu)	TSS (mg/l)	pH (rel)	Chl-a (µg/l)	NO_3 (µg/l)	NH_4 (µg/l)	TON (µg/l)	TN (µg/l)	PO_4 (µg/l)	TOP (µg/l)	TP (µg/l)	Si (µg/l)
1	76.15	13.7	36.068	0.17	3.20	7.61	BDL	42.56	15.26	131.74	189.56	24.18	4.34	28.52	113.8
2	76.32	11.5	34.808	0.31	0.70	7.70	0.031	40.74	2.8	65.66	109.2	22.94	0.62	23.56	125.6
3	75.54	14.0	34.774	1.62	7.85	7.65	0.021	45.08	4.48	73.5	123.06	24.8	0.31	25.11	122.2
4	76.19	15.0	34.756	0.76	4.10	7.66	0.010	48.44	6.3	93.66	148.4	24.18	4.96	29.14	116.3
5	76.22	14.5	34.798	0.16	0.65	7.60	0.010	43.54	4.06	83.3	130.9	22.94	1.24	24.18	129.2
6	76.01	15.0	34.773	0.34	2.30	7.67	BDL	44.94	5.18	67.62	117.74	24.8	0.31	25.11	122.9
7	76.07	14.3	34.845	1.25	5.65	7.67	0.010	39.9	1.12	78.96	119.98	26.04	0.31	26.35	127.2
Aggregate	76.08	14.0	34.760	0.59	3.19	7.65	0.011	43.80	5.88	85.86	135.54	24.05	1.82	25.87	122.5

Note 1: The concentrations in the row labeled "Aggregate" reflect the expected contribution of each well to the total based on the pump tests conducted in April, 2005. These are shown in the right-hand column of Table 3.11.

Note 2: BDL = Below Detection Limit of test.

Source: Tom Nance Water Resource Engineering.

Table 3.11. Basis for Aggregate Groundwater Quality Estimate.

Well No.	Expected Delivery Rate	
	GPM	% of Total
1	2,300	15.3
2	2,180	14.5
3	2,200	14.7
4	2,110	14.1
5	3,170	21.1
6	1,890	12.6
7	1,150	7.7
Totals	*15,000*	*100.0*

Source: Tom Nance Water Resource Engineering

3.5.1.3 Ala Wai Harbor, Ala Wai Canal, and Nearshore Ocean Waters

At present, the Duke Kahanamoku Lagoon is connected to the Ala Wai Harbor through the pump discharge system. Ala Wai Harbor is classified as a Class A marine embayment. The DOH-defined water quality standards for embayments are shown in Table 3.12. In addition, the applicable marine bottom types in the harbor are those defined in HAR § 11-54-7(d), and the uses to be protected in the harbor are "recreational" as defined in HAR § 11-54-8 (i.e., a Class 2 artificial basin to be protected "...for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping and navigation."

Table 3.12. DOH Water Quality Standards for Embayments.

Parameter	*Geometric mean not to exceed*	*Not to exceed more than 10% of the time*	*Not to exceed more than 2% of the time*
Total Nitrogen (μg N/L)	150.00*	250.00*	350.00*
Ammonia Nitrogen (μg NH_4–N/L)	3.50*	8.50*	15.00*
Nitrate + Nitrite Nitrogen (μg [NO_3+NO_2] – N/L)	5.00*	14.00*	25.00*
Total Phosphorus (μg P/L)	20.00*	40.00*	60.00*
Chlorophyll a (μg/L)	0.50*	1.50*	3.00*
Turbidity (N.T.U.)	0.40*	1.00*	1.50*

* "Dry" criteria apply when the average fresh water inflow from the land is less than one per cent of the embayment volume per day.

Applicable to both "wet" and "dry" conditions:

pH Units - shall not deviate more than 0.5 units from a value of 8.1, except at coastal locations where and when freshwater from stream, storm drain or groundwater discharge may depress the pH to a minimum level of 7.0.

Dissolved Oxygen - Not less than seventy-five per cent saturation, determined as a function of ambient water temperature and salinity.

Temperature - Shall not vary more than one degree Celsius from ambient conditions.

Salinity - Shall not vary more than ten per cent from natural or seasonal changes considering hydrologic input and oceanographic factors.

Source: Hawai'i Administrative Rules, Title 11, Department of Health: Chapter 54, Water Quality Standards.

The Ala Wai Harbor exchanges water with nearshore waters through its entrance channel.[17] Those waters are listed as "Honolulu Harbor and Shore Areas" on the Clean Water Act (CWA) §303(d) List of Impaired Waters. The listing covers the water out to a depth of 30 feet (shallower than the 600-foot depth that defines the boundary of "open coastal waters"). The applicable water quality standard criteria in this area are "basic" [HAR § 11-54-4] and "open coastal waters" [HAR § 11-54-6(b)] (see Table 3.6). The applicable marine bottom types are those defined in [HAR § 11-54-7(d)] and the uses to be supported are "recreational" (HAR § 11-54-8). To the extent that changes in harbor water quality affect the Honolulu Shore Area Waters, the standards that are applicable to them are relevant to the existing and proposed discharge of water from the lagoon.

The Ala Wai Harbor also exchanges water with the Ala Wai Canal, a two-mile-long artificial water body that begins at the Kalākaua Avenue Bridge and drains a 16 square-mile watershed. Between Kalākaua Avenue and its intersection with Mānoa-Pālolo Stream, the canal is defined as an "estuary. Above that point it is classified as "freshwater" in [salinity 0.05 ppt, HAR §11-54-1]. Water quality

[17] The *makai* embayment boundary is across the harbor entrance at "mean lower low water" [HAR § 11-54-6(a)(1)]; this estuary/embayment boundary is the 32 ppt salinity boundary between "brackish" and marine water (HAR § 11-54-1).

in the canal is relatively poor. This is a function of a number of factors, including erosion in the upper end of the watershed, the urban pollutants that run off into it, and poor mixing within the canal itself, particularly toward its upper end. As a result, water in the canal has consistently exceeded the State Water Quality standards, and the Department of Health has classified it as an impaired waterbody. Total Maximum Daily Loads (TMDLs) have been assigned to the canal to limit inputs of nitrogen and phosphorus. No separate TMDLs have been set for the Ala Wai Harbor, but the Department of Health's June 16, 2004, *Final List of Impaired Waters in Hawai'i,* identifies it as impaired for certain pollutants, which are *enterococci*, nitrogen, turbidity, Total P, and chlorophyll a. The report identified the priority for establishing TMDLs at this location as "low".

During preparation of this assessment, water quality was measured at the 26 sampling stations shown in Figure 3.2. These stations were selected to depict the water quality conditions in the waters that might be affected by the lagoon discharge. The station locations fall into three distinct groups:

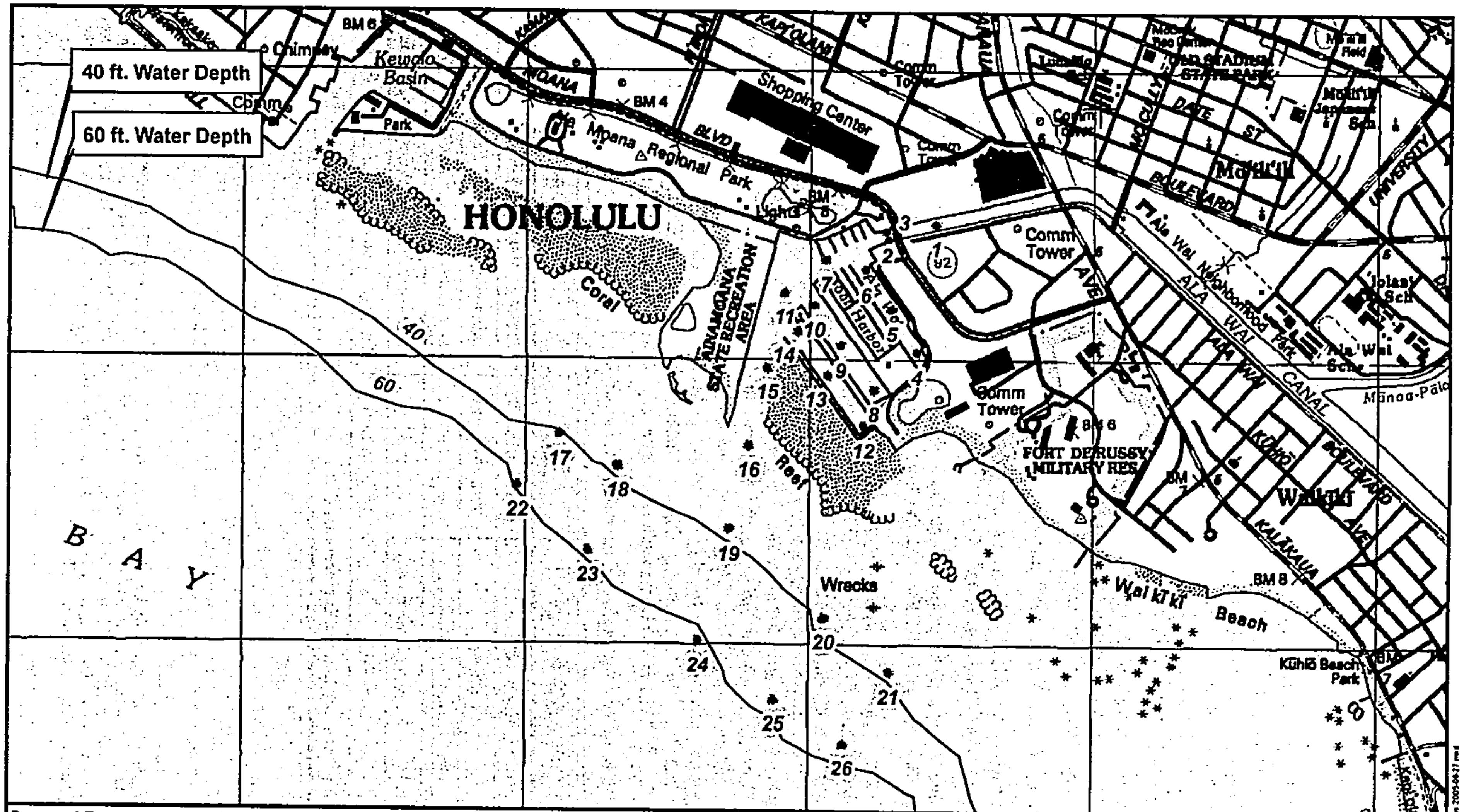
- Seven sites along the Ala Wai Canal's outlet channel: Station Nos. 1, 2, 3, 7, 11, 15, and 16.
- Three sites in each of the Ala Wai Harbor's three basins: (i) Inner Basin: Station Nos. 4, 5, and 6; (ii) Middle Basin: Station Nos. 8, 9, and 10, and (iii) Outer Basin: Station Nos. 12, 13, and 14.
- Offshore Marine Waters: (i) Five Sites Along the 30-Foot Depth Contour: Station Nos. 17 through 21and (ii) Five Sites Along the 55-Foot Depth Contour: Station Nos. 22 through 26.

In order to characterize existing water quality at these locations, samples were collected and tested on three separate dates. Sampling at each of the 26 sites consisted of continuous CTD *profiling* of salinity and temperature through the entire water column and collection of two discrete samples, one within a foot of the surface and the other just above the bottom. These samples were analyzed for all parameters with specific criteria listed in the State of Hawai'i Water Quality Standards (Hawai'i Administrative Rules §11-54) for embayments, estuaries and open coastal waters.[18] The dates, sampling times, and tidal conditions for the complete sampling events are shown in Table 3.13. Because the input of freshwater via the Ala Wai Canal is such a significant factor of the receiving water's quality, additional CTD profiling along a portion of the Ala Wai Canal's outlet channel (Station Nos. 1, 2, 3, 7, 11, and 15) was done on two other days as summarized in the same table.

Table 3.13. Summary of Sampling Events in March 2005.

Day	*Type of Sampling*	*Time of Sampling*	*Tidal Condition*
March 11	Complete	13:10 to 15:40	Midway through a 1.7-Foot Flood Tide
March 12	Complete	07:20 to 09:15	Midway through a 1.5-Foot Ebb Tide
March 24	CTD Canal Outlet Channel Only	06:30 to 07:00	Midway through a 1.7-Foot Ebb Tide
March 28	CTD Canal Outlet Channel Only	14:00 to 14:20	Midway through a 1.9-Foot Flood Tide
March 29	Complete	15:20 to 18:00	Midway through a 1.9-Foot Flood Tide
Source: Tom Nance Water Resource Engineering (2005)			

[18] Water quality constituents that were analyzed included dissolved silica (Si), total nitrogen (TN), nitrate + nitrite nitrogen (NO3- + NO2-, hereafter referred to as NO3-), ammonium nitrogen (NH4+), total phosphorus (TP), orthophosphate phosphorus (PO43-), chlorophyll a (Chl a), turbidity, and total suspended solids (TSS). All laboratory analyses were conducted by the University of Washington, School of Oceanography Marine Chemistry Laboratory, which possess the appropriate acceptability ratings from the U.S. EPA.



Prepared For:
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PLANNING SOLUTIONS

Sources:
–TNWRE
–USGS 7.5' Quad Map

Legend:

• Water Quality Sampling Stations

0 1,250 2,500 5,000
Feet

Figure 3-2:
Harbor & Offshore Water Quality Stations

Hilton Hawaiian Village Lagoon Restoration

Table 3.14. Fresh Water Input During the March 2005 Sampling Events.

Sampling Day	*Contribution from the Ala Wai's Inland Watershed*	*Local Rainfall-Runoff*	*Lagoon Discharge into the Middle Basin*
March 11	Significant Contribution on March 9 (Two Days Prior) but Low Flow on March 11	None	Pump Off
March 12	Slightly Above Average Inflow at the Time of Sampling	Substantial Rainfall-Runoff to Inner Harbor Basin	Pump Off
March 24	Sustained Low Flows from March 13 through March 24	None	Pump On
March 28	About Average Discharge at the Time of Sampling	None	Pump On
March 29	High Streamflow Substantially Greater than Previous Sampling Events	Some Rainfall-Runoff to the Inner Harbor Basin	Pump On

The fresh water input to the receiving waters during these five sampling days is an important aspect for the interpretation of the water quality results. Data from the USGS' website for the gauging station on Mānoa Stream at Kanewai Field (No. 2425) provide an indication of the relative fresh water contribution from the Ala Wai Canal's inland watershed. In addition, rainfall-runoff from the immediate vicinity of the Ala Wai Harbor was observed during the sampling events. The relative amounts of fresh water input during the five sampling days are as shown in Table 3.14.

The test results for March 11, 2005, are reproduced in Table 3.15. It represents a day when the pump discharging water from the lagoon into the middle basin of the Ala Wai Harbor was not operating and there was no stormwater runoff influencing the quality of the Ala Wai Harbor. Test results from samples collected on two other days during the same month are contained in Appendix B.

The following generalizations concerning the influence of different inputs can be drawn from this extensive data set. The data themselves, together with a more complete discussion of conditions during the sampling period, may be found in Appendix B.

- Ala Wai Harbor Middle Basin. The harbor's middle basin, into which water from the lagoon is presently discharged, is isolated from the Inner and Outer basins by earth filled groins. It presently receives the 5,300 GPM lagoon discharge (in the near vicinity of Station No. 8) when the pumps are operating; that input is absent when the pumps are turned off. On March 11th and 12th, when the lagoon pump was not running, there was a four- to five-foot thick upper layer throughout the basin. On March 29th, the wettest sampling day, the lagoon circulation pump was running. The data indicate that its discharge displaced the upper layer at the inland end of the basin (Station No. 8) but had little effect on the surface layer further from the discharge (Station Nos. 9 and 10).
- Ala Wai Harbor Outer Basin. There is no lagoon discharge and only minimal stormwater runoff into the harbor's outer basin. Its circulation results from tidal action, possibly from eddy currents produced by the passing Ala Wai Canal discharge, and from wave-driven water movement through its rubble mound outer breakwater. The profiles of May 11th and 12th depict a relatively saline upper layer (90 to 96 percent seawater) which is eight to 10 feet thick. On March 29th, the wettest sampling day, the upper layer was distinctly thinner and fresher (two to four feet thick and 78 to 90 percent seawater.
- Ala Wai Harbor Inner Basin. Circulation in the harbor's inner basin is relatively sluggish, driven primarily by tidal fluctuation, direct rainfall-runoff when it occurs, and lateral movement of Ala Wai Canal discharge into the harbor. The largest rainfall-runoff discharge enters the inner end of this basin via an existing culvert near Dewey Lane, but there are two other discharge points along the *mauka* side of the basin as well. Salinity profiles show a distinct surface layer on the order of two feet thick. The layer was substantially fresher on the wettest sampling days, March 12th and 29th.

Table 3.15. Existing Harbor and Ocean Water Quality on March 11, 2005.

		Stn.	Si (µg/L)	NO_3 (µg/L)	NH_4 (µg/L)	PO_4 (µg/L)	TN (µg/L)	TP (µg/L)	TON (µg/L)	TOP (µg/L)	CHL a (µg/L)	TURB (ntu)	TSS (mg/L)
Ala Wai Canal Outlet Channel		1S	2,384.71	451.56	128.52	7.45	1,024.6	33.84	444.58	26.38	7.09	1.80	9.82
		1B	179.74	19.16	42.45	9.96	302.90	15.78	241.29	5.81	1.15	3.60	11.63
		2S	1,349.79	260.20	63.57	11.79	706.49	24.15	382.72	12.36	4.06	2.65	8.40
		2B	307.27	38.67	24.14	10.32	411.41	21.24	348.60	10.93	2.27	4.70	12.55
		3S	1,370.57	275.72	76.52	9.57	747.20	22.55	394.97	12.97	3.66	2.12	8.40
		3B	317.20	47.83	12.37	6.28	401.14	14.38	340.93	8.10	1.54	1.75	9.45
		7S	1,432.70	302.51	32.59	11.54	733.11	26.20	398.01	14.66	4.23	1.68	6.95
		7B	193.51	23.06	5.89	6.05	308.06	11.57	279.11	5.52	0.94	1.75	8.60
		11S	1,413.17	283.45	41.53	9.58	664.02	23.10	339.05	13.51	3.33	1.74	9.10
		11B	183.01	12.82	4.01	4.08	271.97	9.82	255.14	5.74	0.52	1.24	10.65
		15S	1,314.32	276.87	50.16	9.54	588.94	21.04	261.91	11.50	2.78	1.88	9.55
		15B	127.56	11.95	0.84	3.29	282.87	8.82	270.07	5.53	0.39	0.85	11.55
		16S	561.03	110.65	37.61	7.97	225.64	11.90	77.39	3.92	0.72	0.60	9.43
		16B	69.08	8.70	0.38	2.81	133.76	5.91	124.68	3.10	0.18	0.45	10.45
Ala Wai Harbor	Inner Basin	4S	1,533.56	254.83	16.32	15.28	708.94	35.07	437.79	19.80	5.51	2.00	8.90
		4B	177.00	11.20	5.86	12.89	487.84	27.06	470.78	14.16	13.69	4.29	11.20
		5S	2,028.58	390.10	21.31	13.43	834.64	31.07	423.23	17.64	3.86	1.36	8.50
		5B	213.23	17.23	23.32	9.58	419.58	18.84	379.03	9.26	2.78	3.65	10.20
		6S	1,793.97	357.78	17.27	11.39	732.38	27.66	357.33	16.27	3.98	1.46	9.15
		6B	194.15	17.02	14.55	7.63	358.32	14.83	326.75	7.20	1.91	3.00	11.65
	Middle Basin	8S	412.03	77.19	30.17	10.32	393.90	18.74	286.55	8.42	0.94	1.23	10.55
		8B	187.59	22.85	10.99	8.20	393.76	16.13	359.93	7.93	0.93	1.60	7.45
		9S	561.79	115.61	26.24	9.19	460.61	16.68	318.77	7.49	1.21	1.26	10.00
		9B	168.48	10.12	34.28	13.38	325.50	23.70	281.10	10.32	2.86	9.65	21.65
		10S	862.03	191.66	21.01	7.61	546.32	17.33	333.65	9.73	2.07	1.42	10.00
		10B	146.71	8.86	13.02	5.76	254.24	11.57	232.37	5.81	1.04	2.40	20.90
	Outer Basin	12S	523.24	77.50	18.10	5.98	324.82	11.27	229.22	5.29	1.24	1.70	9.70
		12B	155.96	12.60	20.87	8.53	313.68	16.63	280.22	8.11	1.04	2.24	8.75
		13S	612.48	106.60	14.48	6.86	376.53	14.78	255.46	7.92	1.35	1.53	11.00
		13B	144.74	10.29	21.24	7.49	252.42	14.28	220.89	6.79	1.37	3.98	4.80
		14S	965.93	211.04	44.07	7.74	554.22	17.99	299.11	10.24	1.68	1.70	9.00
		14B	173.14	20.54	18.92	5.90	256.15	13.13	216.69	7.23	0.97	2.30	12.20
Offshore-30Ft.DepthContour		17S	76.66	5.45	0.45	2.15	152.62	5.86	146.72	3.71	0.18	0.42	10.80
		17B	47.24	2.75	0.10	2.04	259.46	5.81	256.62	3.77	0.11	0.40	11.80
		18S	118.29	19.90	3.52	2.75	154.34	6.21	130.93	3.46	0.24	0.23	10.70
		18B	43.90	3.02	BDL	2.09	172.20	5.71	169.15	3.62	0.12	0.22	11.40
		19S	46.20	1.86	2.70	1.80	321.03	6.11	316.48	4.31	0.12	0.51	7.40
		19B	37.92	1.75	BDL	1.50	125.94	4.41	124.22	2.90	0.11	0.88	6.00
		20S	45.51	2.69	0.25	1.30	188.79	5.26	185.85	3.96	0.12	0.46	8.00
		20B	37.23	1.53	BDL	2.02	161.65	4.91	160.02	2.89	0.12	0.65	10.60
		21S	39.53	1.41	BDL	1.26	201.51	4.86	200.02	3.60	0.11	0.33	9.15
		21B	39.18	3.40	0.16	2.35	212.37	6.61	208.81	4.26	0.18	0.65	9.10
Offshore-55Ft.DepthContour		22S	89.14	10.64	BDL	1.68	218.23	5.81	207.57	4.13	0.20	0.31	12.40
		22B	38.48	1.08	BDL	1.30	144.11	4.86	143.16	3.56	0.14	0.13	8.30
		23S	43.43	3.07	1.25	2.29	228.96	6.61	224.64	4.32	0.15	0.33	7.35
		23B	40.44	0.85	0.46	2.64	529.76	10.77	528.45	8.13	0.32	0.54	30.81
		24S	40.09	1.79	BDL	2.16	261.67	6.36	260.00	4.20	0.11	0.23	13.00
		24B	29.15	1.09	BDL	1.86	288.53	7.06	287.44	5.20	0.10	0.32	11.00
		25S	39.40	0.97	BDL	0.64	283.40	6.11	282.50	5.46	0.12	0.34	9.55
		25B	49.65	1.66	BDL	1.55	148.29	5.01	146.73	3.46	0.12	0.28	9.25
		26S	36.05	2.40	0.83	1.44	214.13	5.41	210.90	3.97	0.08	0.09	6.90
		26B	35.70	2.72	1.99	2.16	249.99	6.41	245.28	4.25	0.10	0.17	6.60

Note: "BDL" = Below Detection Limit of Test.

Source: Marine Research Consultants.

- Ala Wai Canal Outlet Channel. On the five days during which the CTD profiles were taken, the surface layer was typically between two and four feet thick. As expected, salinities were lowest on the two wettest days. The substantial range of salinity in the surface layer depends on the watershed's ongoing fresh water contribution. In all of the profiles, however, the salinity measurements show that there is a progressive mixing of the surface layer as it moves seaward so that it is substantially reduced in thickness and increased in salinity near the outer end of the outlet channel (Station No. 16 as shown on Figure 3.2).
- Offshore Along the 30-Foot Depth Contour. Salinity profiles at the sampling stations along the 30-foot depth contour portray a similar direction of flow from the Ala Wai Canal outlet channel into the offshore area. The fresher upper layer turned to the west and moved alongshore in that direction (from Station No. 19 toward Station Nos. 18 and 17).
- Offshore Along the 55-Foot Depth Contour. The same movement to the west of the Ala Wai Canal's discharge is also depicted in the sets of salinity profiles along the 55-foot depth contour. The salinity and thickness of the upper layer is inversely related to the canal's discharge at the time of sampling.

The results of water chemistry analyses of the top and bottom samples collected from the 26 sampling sites on March 11, 12, and 29, 2005, provide a good understanding of existing water quality within the harbor. The following generalizations can be drawn from the data.

- Ala Wai Canal Outlet Channel. The pattern of nutrient concentrations in the top and bottom samples from the Ala Wai Canal's outlet channel reflects the two-layered flow system and progressive mixing of the upper layer as the water moves down the channel toward its ocean discharge.
  - On all three sampling days, nutrient concentrations (silica, forms of nitrogen, and forms of phosphorus) were substantially higher in the upper surface layer than in the lower saline layer.
  - As a result of the progressive mixing of the surface layer as it moved downstream, nutrient concentrations were four to six times greater upstream (at Station No. 1) than downstream (at Station No. 16).
  - The fresher surface layer that resulted from the wetter conditions on March 12 and 29 did not universally translate to higher nutrient concentrations in comparison to the drier March 11th sampling event. This suggests that the nutrient concentrations in streamflow and urban rainfall-runoff may be lower at high rates of flow rather than essentially constant over a range of discharge rates.
- Ala Wai Harbor Inner Basin. Nutrient concentrations in the inner basin (Station Nos. 4, 5, and 6) were of approximately the same magnitude as those at the upstream sampling sites in the Ala Wai Canal's discharge channel (Station Nos. 1, 2, and 3). Levels were substantially higher in the fresher surface layer than at the bottom. Notably, these concentrations were not significantly higher on the day with substantial local input of rainfall-runoff into the inner basin (March 12th) than they were on the two sampling days with little or no local rainfall-runoff.
- Ala Wai Harbor Middle Basin. Normally, the middle basin receives a continuous 5,300 GPM discharge from the lagoon. However, the pump was off on the March 11 and 12 sampling days. The CTD profiles on these two days showed a poorly defined surface layer of comparable salinity and thickness on March 11 and 12. The nutrient concentrations in the Middle Basin on both these days were about the same and were significantly lower than in the inner basin. With the lagoon discharge pump running on March 29, the salinity profiles showed that the lagoon discharge completely displaced the upper layer at the inner end (Station No. 8 on Figure 3.2) but fresher water, presumably having entered from the Ala Wai Canal, had created a fresher and more distinct surface layer at the middle and outer stations (Nos. 9 and 10). Except for silica, however, the

nutrient concentrations were not elevated in the fresher upper layer of the two outer stations on March 29 in comparison to the two other sampling days.

- Ala Wai Harbor Outer Basin. The outer basin is physically isolated from the lagoon discharge into the middle basin and receives little local rainfall-runoff, a fact apparent from the salinity profiles on May 11th and 12th. On May 29th, the sampling day with the highest discharge in the Ala Wai Canal, some of the canal's water had moved into the outer basin to create a more distinct surface layer with progressively lower salinity with proximity to the canal's discharge channel. As in the other basins, and excepting silica, the fresher upper layer was not accompanied by elevated nutrient concentrations.
- Offshore Along the 30-Foot Depth Contour. As noted previously, the Ala Wai Canal's discharge turned to the west in the offshore area on all three sampling days. Nutrient levels generally depict this trend. The most obvious input of high nutrient water from Ala Wai Canal was found at Station No. 19 directly offshore of the canal's discharge on the day of its greatest discharge (May 29th at Station No. 19). "Upgradient" Station Nos. 20 and 21 along the 30-foot depth contour (i.e. to the east of the canal's outlet) reflect background concentrations not influenced by the canal's discharge.
- Offshore Along the 55-Foot Depth Contour. On the two wettest sampling days (March 12 and 29), the salinity profiles portrayed a less saline upper layer on the two stations to the west of the canal along the 55-foot depth contour. Except for silica concentrations at these two stations on May 29th, the pattern of nutrient concentrations does not track with the surface layer depicted by the salinity profiles. It appears, with the lack of significant differences in stations to the east and west of the canal's outlet, that nutrients were essentially diluted to background levels at this distance offshore.

3.5.2 POTENTIAL WATER QUALITY EFFECTS: CONSTRUCTION PERIOD

3.5.2.1 Ocean

Before beginning work within the lagoon, the existing ocean inlets will be permanently sealed. The slope of the ground is toward the lagoon, eliminating the potential for stormwater runoff from the construction area to flow *makai* toward the ocean. This will eliminate any potential for project-related construction-related activities to affect ocean water quality.[19] Similarly, the pump that removes water from the lagoon and delivers it into the middle basin of the Ala Wai Harbor will be shut down at the outset of construction. This will isolate the lagoon from the harbor and eliminate the potential for adverse effect on that water body during the course of lagoon restoration.

3.5.2.2 Lagoon

Construction within the lagoon will constantly disturb the lagoon bottom, resuspending sediment that previously settled there. That, together with the cessation of pumping will cause the quality of the lagoon to decrease for the duration of construction. The lagoon has previously experienced extended periods of no-pumping without causing undue effects once the pumping is restored, and this is expected to be the case in this instance. The fact that the lagoon will be lined with clean calcareous sand will help in this regard, and the design of the pump system is such that the water supply and circulation system can be re-started gradually after the work is completed if necessary. This will allow the water to be tested and the receiving waters to be acclimated to the resumption of pumping gradually should that appear to be appropriate.

As described elsewhere in this report, a variety of fishes and other marine organisms presently inhabit the lagoon. Many of these would be killed by the water quality and physical change that would occur within the existing lagoon during the course of the renovation. To limit potential water quality effects from this possibility, HHC is considering several mitigation measures. These include:

[19] This assumes that the existing above-ground manhole along the waters edge can be left in place.

- Lowering the water level in the lagoon prior to the start of the project and using staff and small equipment to remove algae and other biota from the exposed bottom prior to the start of construction. It has done this periodically over the years as a means of controlling aquatic growth within the lagoon.
- Arranging for the netting of the fish that presently inhabit the lagoon. This would decrease the biomass present and reduce the potential for fish kills.

3.5.2.3 Ala Wai Harbor

The proposed plan continues to use the existing discharge pipe into the middle basin of the Ala Wai Harbor.[20] Hence, except to remove internal algae growth, it will not be necessary to modify that existing discharge pipe. The decision to create a separate lagoon water discharge into the inner harbor to increase the turnover rate there and the re-routing of stormwater runoff away from the lagoon and into the harbor will require construction work in the harbor that has the potential to affect water quality there. Construction of the final few feet of these facilities will involve extending two pipes through the existing bulkhead so that they can discharge into the harbor. Creating these openings (one for the lagoon water discharge pipe and another for the stormwater discharge pipe) will require about a month of work along the land/harbor interface. If horizontal boring is used, the area of the bulkhead that will be penetrated will be approximately 50 square feet or less. If technical constraints require the use of open trenching for the pipes, a substantially larger penetration of the harbor bulkhead will be needed, perhaps three or four times the area needed for horizontal boring. Regardless of which technique is used, there is a possibility that some of the excavated material may inadvertently enter the harbor. Minimizing the extent to which this occurs will require the use of a silt fence, containment boom, or other similar technique. Assuming these pollution control measures are employed, the effect on water quality would be small in magnitude and of short duration.

3.5.3 POTENTIAL WATER QUALITY EFFECTS: OPERATIONAL PERIOD

Several aspects of the proposed action are expected to have long-term effects on water quality. They include increasing volume of water flowing through the lagoon, reducing the lagoon volume, substituting saline groundwater for the existing ocean water source, diverting a portion of the discharge from the lagoon into the inner basin of the Ala Wai Harbor, and changing the bottom of the lagoon from soft anaerobic silt to sand. Each of these is discussed in the subsections which follow. The assessments draw heavily on the water quality measurements described previously and on the results of a computer model that was used to forecast changes in water quality.

3.5.3.1 Forecast Changes in Lagoon Water Quality

Because of the short residence time in the lagoon, water in the lagoon will have essentially the same composition as supply water from the wells.[21] Comparing the results of the water quality testing in the Lagoon (Table 3.7 – Table 3.9) with the testing results for the supply wells (Table 3.10), we see that the major changes to water quality in the restored Lagoon will include:

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[20] The discharge pipe can accommodate the maximum planned discharge in its existing condition. However, the HHC may take this opportunity to remove algal growth from the pipe to restore it to its original capacity. Should it decide to do this, the last few tens of feet on the harbor end of the pipe would be cleaned. This would be done using hand-tools, pneumatically powered equipment, or high-pressure hydroblasting techniques. Most of the material that is removed could be retained, but some methods, particularly hydroblasting, could allow small amounts of the removed algae to enter the harbor. Because of the relatively short length of pipe that is involved (estimated at less than 50 feet), relatively little biomaterial would be affected. This, and the fact that the pieces of the algae that grow on the inside of the pipe already enter the harbor on a regular basis as they break off from the pipe walls limits the magnitude of the potential effect from this source.

[21] There are two exceptions to that generalization. First the water will warm by one or two degrees F. as it moves across the lagoon. Second, cascading water out of the supply structures will oxygenate it; that in turn will lead to the oxidation of reduced chemical species such as ammonium (NH_4^+).

- A seven-fold decrease in water turbidity, a fifteen-fold decrease in Chlorophyll a, and a 30-fold decrease in suspended sediments;
- A significant decrease in bacteria[22] and plankton abundance;
- A slight (2-5° F depending upon time of day and location within the lagoon) decrease in water temperature; and
- A marked increase in the concentrations of inorganic nutrients.[23]

Because of the short residence time of this water in the Lagoon, the increased nutrient levels will not lead to higher planktonic biomass as water will be completely exchanged at a rate that will prevent the growth of planktonic communities. Thus, water clarity in the restored Lagoon water will be much better than at present.

The anticipated higher nutrient levels in the water could, however, promote the growth of aquatic plants (i.e., macroalgae or *limu*). Assuming HHC implements a regular program of turning over the sandy bottom, this would be most likely to occur on to the hard-substrate surfaces within the lagoon. These consist of the supply outlets toward the *mauka* end of the lagoon, the discharge inlets toward the *makai* end of the lagoon, and the vertical walls around the island and along the Rainbow Tower shoreline. If algal growth on these structures becomes a problem, it will be necessary to implement a periodic maintenance program to keep such growth under control.

The near absence of bacteria and other pathogens in the supply water from the wells, together with the short residence time within the lagoon (resulting from the high turnover rate) will lead to much lower bacterial levels in the lagoon than are presently the case. Thus, the restored Lagoon will provide a good, safe site for water and beach recreational activities.

3.5.3.2 Changes in Ala Wai Harbor Water Quality

Two aspects of the proposed project have the potential to affect water quality in the Ala Wai Harbor. The first is the discharge of lagoon water into the inner and middle basins of the harbor. The second is the diversion into the inner basin of the Ala Wai Harbor of stormwater originating on the Hawaiian Village Resort property that now flows into the lagoon. The following subsections describe the approach used to predict the effect of these changes and the predicted water quality changes for dry and wet weather conditions.

3.5.3.2.1 Approach to Forecasting Effects

Computer modeling performed by EKNA Services (see Appendix C) was used to predict the effect that the change in the volume and nature of the lagoon water being discharged into the Ala Wai Harbor would have on water quality. CE-QUAL-W2, Version 3.2, a state-of-the-art hydrodynamic and water quality model developed by the U.S. Army Corps of Engineers (USACOE), was used for this evaluation. This is the same model used in previous studies of the Ala Wai Canal.[24] A complete description of the Application of the CE-QUAL-W2 model to the Harbor is presented in Appendix MM. The description includes physical model inputs such as bathymetry and the identification and physical characterization of the model boundary conditions. It also describes the way the model was applied to these specific circumstances.

The validated model was used to forecast water quality for key water quality parameters under two scenarios.

[22] Fecal coliform levels on October 17, 2003 ranged from a low of 20 MPN/100ml at the *makai* end of the lagoon to a high of 300 MPN/100 ml at its *mauka* end.

[23] Total organic nitrogen and ammonium would be about the same or slightly lower; total nitrogen would increase by about 20 percent, and; nitrate would increase by an order of magnitude. Phosphate and total organic phosphorous would increase to seven or eight times their present values, while total phosphorous would increase about 70 percent. Silica would increase about seven-fold.

[24] *Ala Wai Canal Improvement, Feasibility Report*, State of Hawaii, DLNR, October 1992.

- *Scenario 1: Dry Weather.* Proposed 15,000 gpm Lagoon outflow from the lagoon during a dry period having no stormwater discharge into the Ala Wai Harbor from the HHV and low flow in the Ala Wai Canal. The simulated conditions for March 11, 2005, were used as representative of dry weather.
- *Scenario 2: Wet Weather.* Proposed 15,000 gpm Lagoon outflow during rainfall that produces stormwater discharge from the new outlet that HHC is constructing to eliminate stormwater discharges into the Duke Kahanamoku Lagoon and moderate regional flow in the Ala Wai Canal. The simulated conditions of March 29, 2005, were used for this scenario.

The water quality parameters modeled were total suspended solids, Chlorophyll a, total nitrogen, ammonium, nitrate-nitrite, and total phosphorus. Data for numerous locations throughout the Harbor and in he Ala Wai Canal's discharge channel were tabulated for comparison with the modeled conditions of March 11 and 29, 2005.

3.5.3.2.2 *Effects During Dry Weather (Scenario 1)*

Scenario 1 models the effect that the proposed project would have on water quality in the Ala Wai Harbor during a typical dry period. It compares the water quality throughout the harbor on March 11, 2005, with the levels the model forecasts if the quantity and quality of water discharged from the lagoon are as proposed.

The results of this modeling are summarized in Table 3.16 and depicted graphically on Figure 3.3 and Figure 3.4. They predict the following effects of the proposed changes in lagoon discharge into the Ala Wai Harbor:

- As indicated by the fact that the surface and bottom values in the scenario are closer to one another than under baseline conditions, the increased discharge from the Lagoon into the harbor increases mixing within the harbor's basins.
- Residence times decrease throughout the harbor.
- Total Suspended Solids values decrease throughout the Inner and Middle Basins relative to existing conditions, particularly in bottom waters.
- Nitrogen species generally decrease in surface waters and increase in bottom waters in the Inner and Middle Basins close to where the discharge occurs, but these changes dissipate almost to the baseline values moving 'Ewa in the basins towards the main Ala Wai Canal outlet channel.
- Total phosphorus concentrations increase in the inner basins (surface and bottom waters) but also drop to near baseline values toward the main channel.
- Even though the proposed change produces higher modeled nutrient levels in the basins close to the lagoon discharge, the modeled Chlorophyll a values are the same or lower. This indicates that there would be no increased productivity.
- At the ocean outlet of the harbor, the modeled values for all parameters with the proposed discharge are practically indistinguishable from the baseline values.

Scenario 1	March 11 2005 With 15000 gpm Pumped Outflow from Hilton Lagoon Equally Divided Into Two Pipes Discharging to the Inner and Middle Basins																	
	Total Nitrogen			Ammonia Nitrogen			Nitrate-Nitrite Nitrogen			Total Phosphorus			Chlorophyll a			Total Suspended Solids		
	TN (ug/L)		Change	NH4 (ug/L)		Change	NO3 (ug/L)		Change	TP (ug/L)		Change	(ug/L)		Change	(ug/L)		Change
Channel	Baseline	Scenario	%	Baseline	Scenario	%	Baseline	Scenario	%	Baseline	Scenario	%	Baseline	Scenario	%	Baseline	Scenario	%
3 Top (Ala Wai)	302	321	6	25	24	-4	124	121	-2	25	26	4	4	4	0	8181	8168	0
3 Bottom (Ala Wai)	191	212	11	15	14	-7	55	63	15	20	22	10	2	2	0	10232	9230	-10
5 Top	279	290	4	18	17	-6	117	109	-7	24	26	8	4	4	0	7915	7903	0
5 Bottom	183	198	8	14	12	-14	50	58	16	19	20	5	2	2	0	10620	9484	-11
8 Top	205	213	4	12	12	0	74	69	-7	19	20	5	3	2	-33	9596	9276	-3
8 Bottom	133	141	6	4	5	25	23	26	13	13	14	8	0	1	100	11371	11258	-1
10 Top (Ocean)	212	215	1	13	13	0	77	74	-4	19	19	0	2	2	0	9706	9514	-2
10 Bottom (Ocean)	160	166	4	8	8	0	47	44	-6	15	15	0	1	1	0	11025	10993	0
Inner Basin																		
13 Top (DH)	303	277	-9	14	12	-14	116	132	14	24	43	79	5	3	-40	7329	6123	-16
13 Bottom (DH)	269	263	-2	11	11	0	96	117	22	24	41	71	4	3	-25	8000	6628	-17
17 Top	293	286	-2	14	13	-7	118	111	-6	24	28	17	5	4	-20	7310	7352	1
17 Bottom	201	228	13	14	15	7	56	67	20	22	26	18	3	3	0	9778	8695	-11
19 Top (Ewa)	286	286	0	16	14	-13	117	109	-7	24	27	13	4	4	0	7504	7537	0
19 Bottom (Ewa)	200	213	7	14	14	0	55	59	7	21	23	10	3	3	0	9988	9121	-9
Middle Basin																		
23 Top (DH)	264	223	-16	13	11	-15	104	80	-23	22	24	9	4	3	-25	7534	7035	-7
23 Bottom (DH)	152	218	43	15	14	-7	42	74	76	17	23	35	2	2	0	13126	7301	-44
26 Top	267	243	-9	13	12	-8	104	87	-16	22	23	5	4	3	-25	7722	7962	3
26 Bottom	173	220	27	14	14	0	55	76	38	18	23	28	2	2	0	11259	7469	-34
29 Top (Ewa)	263	243	-8	13	13	0	102	87	-15	22	23	5	4	3	-25	8259	8154	-1
29 Bottom (Ewa)	159	210	32	10	15	50	51	69	35	17	22	29	2	2	0	10463	8295	-21
Outer Basin																		
32 Top (DH)	235	238	1	15	14	-7	101	93	-8	20	20	0	3	3	0	8201	7979	-3
32 Bottom (DH)	133	155	17	14	16	14	25	33	32	16	17	6	1	1	0	9719	9207	-5
35 Top	238	235	-1	15	14	-7	102	91	-11	20	20	0	3	3	0	8384	8197	-2
35 Bottom	148	161	9	12	15	25	37	40	8	16	16	0	1	1	0	10045	9546	-5
38 Top (Ewa)	244	236	-3	15	14	-7	103	90	-13	20	20	0	3	3	0	8752	8503	-3
38 Bottom (Ewa)	156	168	8	9	10	11	46	46	0	15	16	7	1	1	0	10503	10259	-2

Baseline represents the existing conditions of March 11, 2005 as modeled at completion of model validation.

% Change = Scenario decrease (-) compared to Baseline

Table 3.16. Modeled Water Quality Changes in Ala Wai Harbor: Scenario 1.

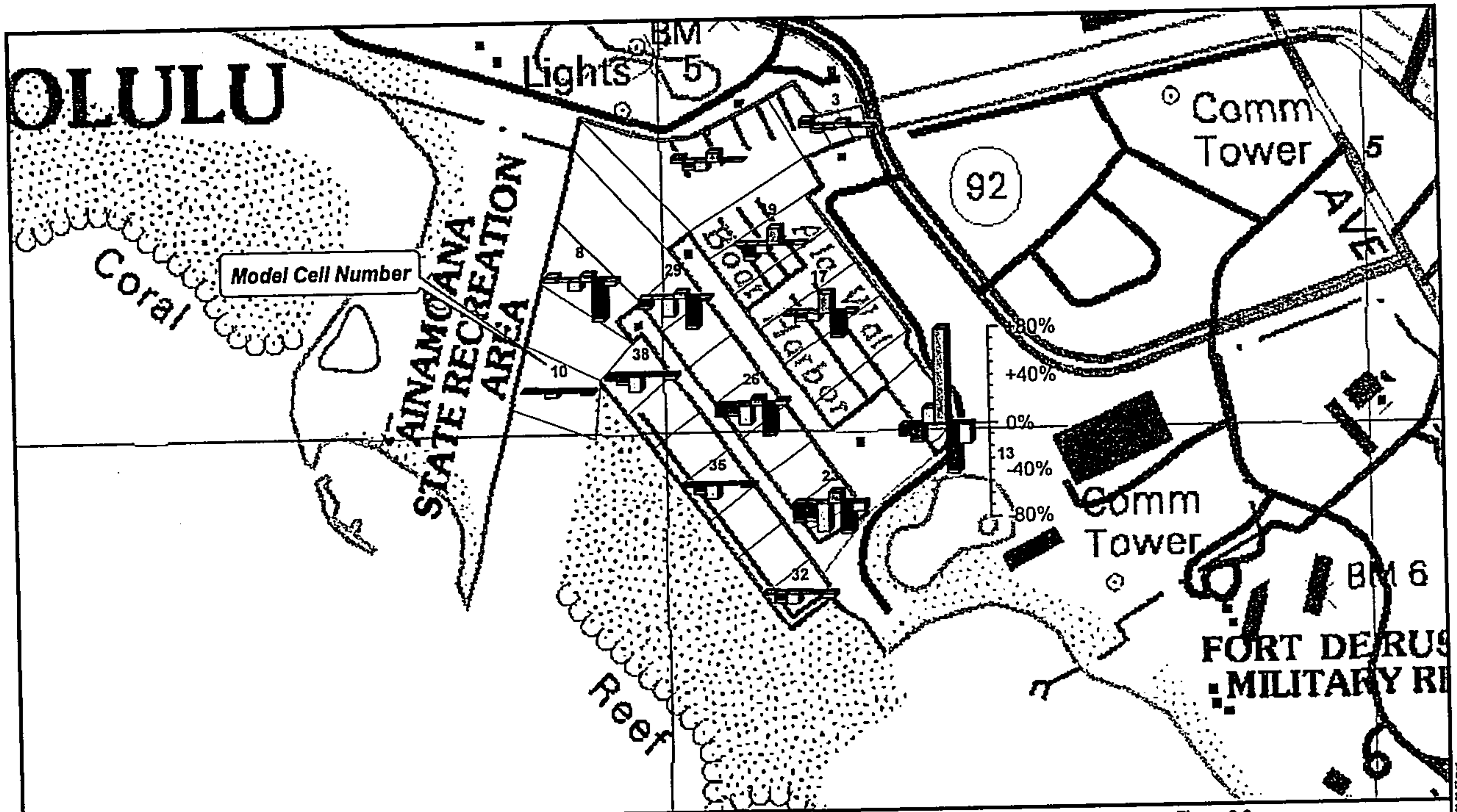


Figure 3-3:

Model Results: Percent Changes Scenario 1: Surface Water

Hilton Hawaiian Village Lagoon Restoration

Prepared For: Hilton Hotels Corp.

Prepared By: Planning Solutions

Sources:
- TNWRE
- Marine Research Consultants
- E.K. Noda & Associates, Inc.

Legend:
- Total Nitrogen
- Ammonium
- Nitrate/Nitrite
- Total Phosphorus
- Chlorophyll-a
- Total Suspended Sediments

Note: Bars denote estimated percent change of constituent levels.

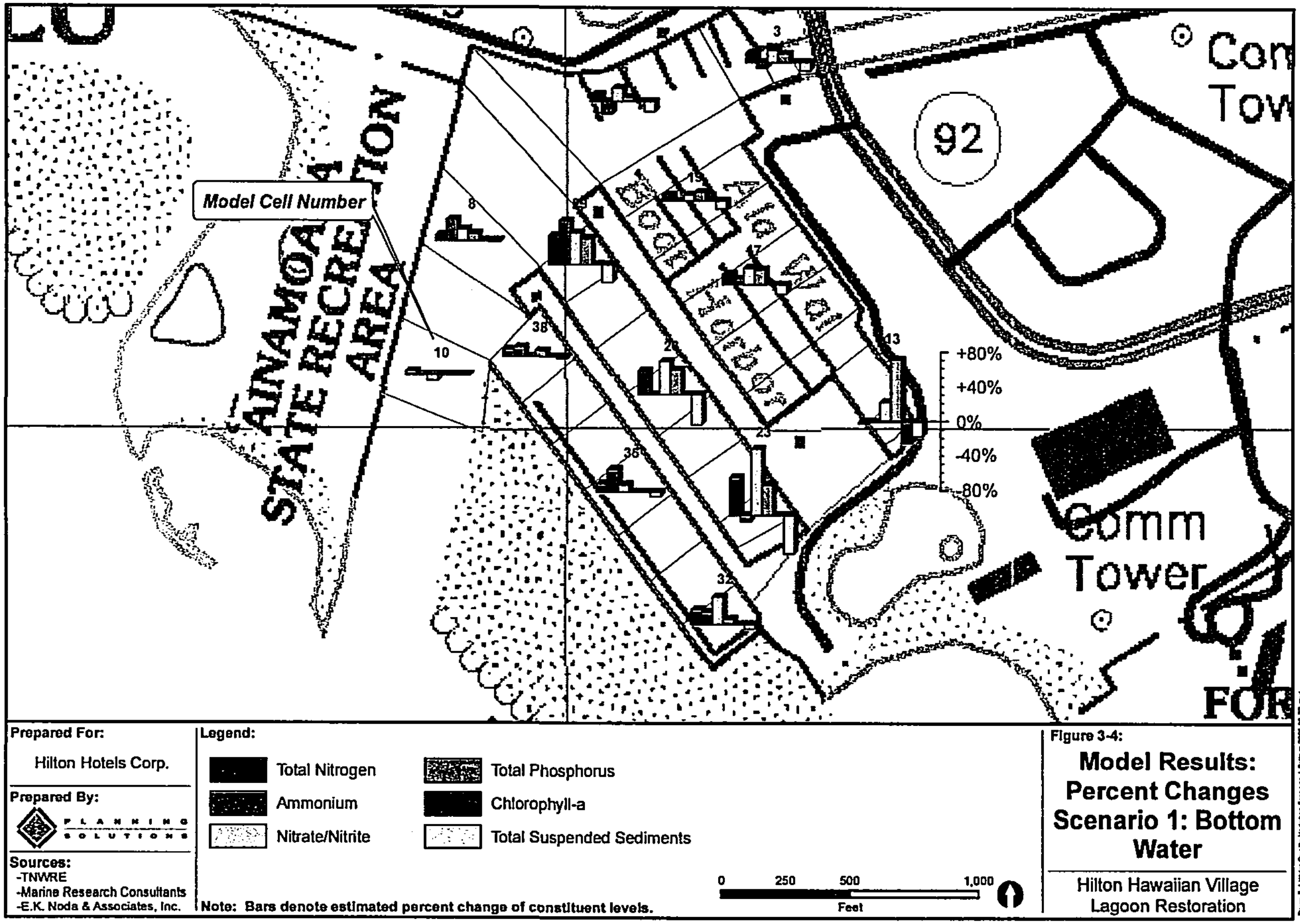


Figure 3-4:

Model Results: Percent Changes Scenario 1: Bottom Water

Hilton Hawaiian Village Lagoon Restoration

In summary, model results suggest that the proposed change has a generally positive effect on water quality within the harbor and essentially no effect on the quality of the water in the Ala Wai Canal's outlet channel and the marine waters offshore. Concentrations of several inorganic nutrients increase close to the discharge, but the increases do not produce a biological response in terms of plankton abundance. In addition, the increased nutrient concentrations return to background levels within the Ala Wai Harbor, resulting in no changes to ocean water. As such, there is no apparent effect of the lagoon discharge beyond the limit of the harbor.

3.5.3.2.3 Effects During Wet Weather (Scenario 2)

Scenario 2 modeled the effect that the proposed project would have on water quality in the Ala Wai Harbor during periods when rainfall is producing moderate runoff from the Ala Wai Watershed into the Ala Wai Canal and substantial runoff from the Hawaiian Village into the proposed new storm drain discharging into the inner basin of the Ala Wai Harbor. It compares the modeled baseline water quality throughout the harbor under the March 29, 2005, conditions with the levels the model forecasts if the quantity and quality of water discharged from the lagoon is as proposed.

The results of this modeling are summarized in Table 3.17 and depicted graphically on Figure 3.5 and Figure 3.6. They show the following effects of the proposed changes in lagoon discharge under these circumstances:

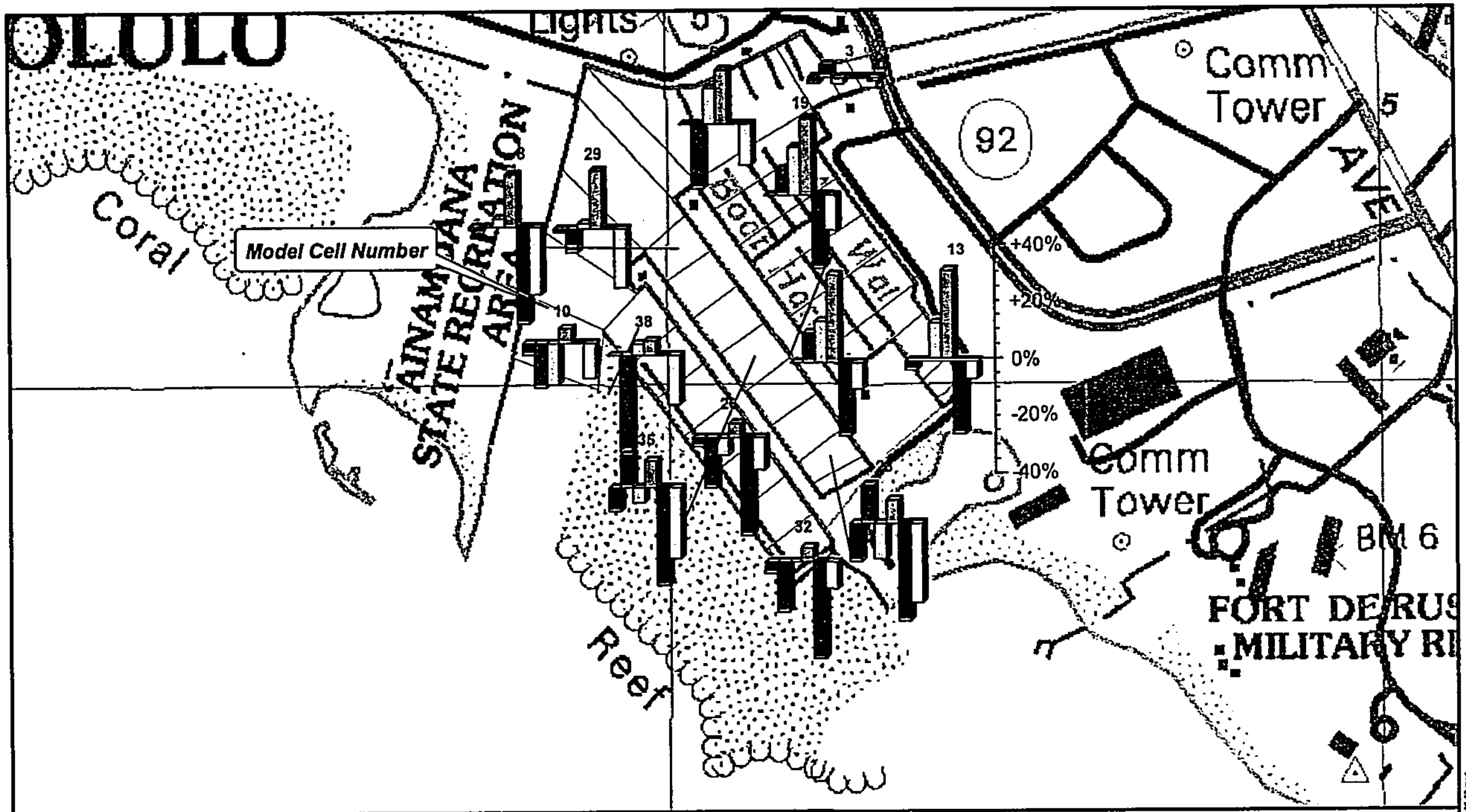
- As during dry conditions, mixing within the basins is increased relative to pre-project levels.
- Despite the fact that this scenario has stormwater discharge into the Inner Basin of the harbor, the modeled TSS values in it are much lower values throughout the Inner and Middle Basin compared to the modeled baseline (pre-project) condition.
- Predicted changes to nitrogen species are variable in the basins, though nitrate/nitrite generally increases in bottom water. The model predicts a small decrease in nitrogen concentrations at the mouth of the harbor, due to the dilution of the nutrient-rich Ala Wai Canal water with the lagoon discharges.
- Total phosphorus would increase in the basin surface and bottom waters and result in a small increase in phosphorus concentration in the surface water at the harbor mouth.
- Chlorophyll a values are the same or lower than the baseline values, a prediction that there would be no increased primary productivity.

In summary, the proposed change has a generally positive effect on water quality within the harbor by decreasing turbidity, suspended solids, and Chlorophyll a. Concentrations of several inorganic nutrients would increase close to the points of discharge, but the increases would not produce a biological response in terms of plankton abundance. The increased nutrient concentrations return to background levels within the Ala Wai Harbor; as such, there would be no apparent effect of the lagoon discharge beyond the limit of the harbor.

Scenario 2	March 29 2005 Ala Wai Canal Flow With 15000 gpm Pumped Outflow from Hilton Lagoon Equally Divided Into Two Pipes Discharging to the Inner and Middle Basins																	
	Total Nitrogen			Ammonia Nitrogen			Nitrate-Nitrite Nitrogen			Total Phosphorus			Chlorophyll a			Total Suspended Solids		
	TN (µg/L)		Chg.	NH4 (µg/L)		Chg.	NO3 (µg/L)		Chg.	TP (µg/L)		Chg.	(µg/L)		Chg.	(µg/L)		Chg.
Channel	Baseline	Scenario	%	Baseline	Scenario	%	Baseline	Scenario	%	Baseline	Scenario	%	Baseline	Scenario	%	Baseline	Scenario	%
3 Top (Ala Wai)	257	253	-2	25	26	4	104	102	-2	33	33	0	3	3	0	11229	11108	-1
3 Bottom (Ala Wai)	136	143	5	17	16	-6	18	29	61	18	23	28	1	1	0	16619	12687	-24
5 Top	218	218	0	18	14	-22	77	86	12	28	33	18	3	3	0	11506	9894	-14
5 Bottom	133	143	8	16	14	-13	18	29	61	17	22	29	1	1	0	17240	12206	-29
8 Top	163	161	-1	13	12	-8	48	49	2	20	24	20	2	2	0	12752	10243	-20
8 Bottom	133	124	-7	15	5	-67	22	14	-36	17	16	-6	1	1	0	14706	11546	-21
10 Top (Ocean)	158	152	-4	13	11	-15	50	43	-14	20	21	5	2	2	0	11788	10423	-12
10 Bottom (Ocean)	137	132	-4	10	7	-30	30	25	-17	17	17	0	1	1	0	11428	10760	-6
Inner Basin																		
13 Top (DH)	232	226	-3	11	11	0	88	99	13	29	38	31	4	3	-25	8085	7617	-6
13 Bottom (DH)	168	191	14	13	14	8	40	75	88	22	36	64	3	2	-33	11903	9065	-24
17 Top	215	214	0	10	11	10	76	87	14	27	35	30	4	3	-25	9389	8543	-9
17 Bottom	131	142	8	18	17	-6	14	26	86	18	23	28	1	1	0	16530	12765	-23
19 Top (Ewa)	213	213	0	11	12	9	74	86	16	27	34	26	4	3	-25	10135	8915	-12
19 Bottom (Ewa)	131	141	8	17	16	-6	14	26	86	17	23	35	1	1	0	16838	12715	-24
Middle Basin																		
23 Top (DH)	185	161	-13	8	9	13	58	51	-12	24	26	8	3	2	-33	11312	8302	-27
23 Bottom (DH)	118	143	21	15	15	0	10	32	220	15	23	53	1	1	0	36711	10397	-72
26 Top	179	164	-8	9	10	11	56	53	-5	23	25	9	3	2	-33	12233	9323	-24
26 Bottom	122	142	16	16	15	-6	13	32	146	16	23	44	1	1	0	29725	10540	-65
29 Top (Ewa)	176	174	-1	11	11	0	58	60	3	22	26	18	3	2	-33	12509	9579	-23
29 Bottom (Ewa)	128	137	7	16	15	-6	16	26	63	17	21	24	1	1	0	22061	11535	-48
Outer Basin																		
32 Top (DH)	166	159	-4	12	10	-17	46	46	0	21	22	5	3	2	-33	9903	8991	-9
32 Bottom (DH)	130	130	0	21	23	10	15	16	7	17	17	0	1	1	0	16232	14469	-11
35 Top	165	160	-3	12	10	-17	49	46	-6	21	22	5	3	2	-33	10250	9167	-11
35 Bottom	131	132	1	20	21	5	17	18	6	17	18	6	1	1	0	15976	13931	-13
38 Top (Ewa)	162	162	0	12	8	-33	45	47	4	21	22	5	3	3	0	11289	9365	-17
38 Bottom (Ewa)	134	135	1	18	16	-11	22	21	-5	17	18	6	1	1	0	15125	12867	-15

Baseline represents the existing conditions of March 29, 2005 as modeled at completion of model validation.

Table 3.17. Modeled Water Quality Changes in Ala Wai Harbor: Scenario 2.



Prepared For: Hilton Hotels Corp.

Prepared By: Planning Solutions

Sources:
- TNWRE
- Marine Research Consultants
- E.K. Noda & Associates, Inc.

Legend:

Total Nitrogen	Total Phosphorus
Ammonium	Chlorophyll-a
Nitrate/Nitrite	Total Suspended Sediments

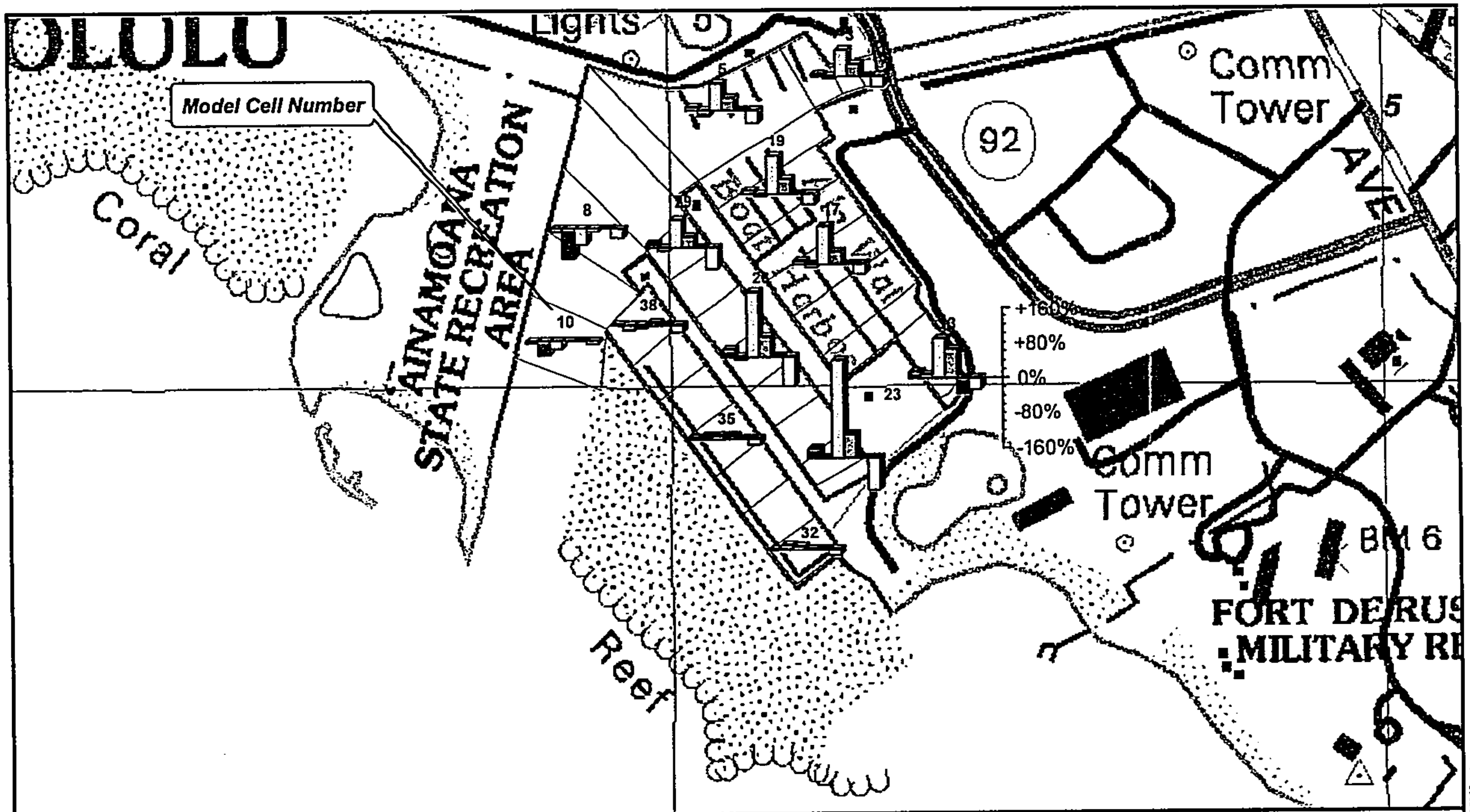
Note: Bars denote estimated percent change of constituent levels.

0 250 500 1,000
Feet

Figure 3-5:

Model Results: Percent Changes Scenario 2: Surface Water

Hilton Hawaiian Village Lagoon Restoration



Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Sources:
-TNWRE
-Marine Research Consultants
-E.K. Noda & Associates, Inc.

Legend:

- Total Nitrogen
- Ammonium
- Nitrate/Nitrite
- Total Phosphorus
- Chlorophyll-a
- Total Suspended Sediments

Note: Bars denote estimated percent change of constituent levels.

0 250 500 1,000 Feet

Figure 3-6:

Model Results: Percent Changes Scenario 2: Bottom Water

Hilton Hawaiian Village Lagoon Restoration

3.6 NATURAL HAZARDS

3.6.1 SUSCEPTIBILITY TO WIND DAMAGE

While other types of storms can produce winds that cause tree downings, only hurricane-force winds are capable of large-scale damage. Hurricane season begins in June and lasts through November in the Hawaiian Islands. Most Central Pacific hurricanes originate near the coasts of Central America or southern Mexico and typically subside when they move northwestward over cooler water or encounter unfavorable atmospheric conditions. In fact, while many hurricanes and tropical storms have passed near O'ahu during the last 50 years, only three have had direct impact. In all three cases, Kaua'i was the hardest hit, although O'ahu suffered significant damages as well. Hurricane 'Iniki in 1992 was by far the most destructive storm to strike Hawai'i in recorded history, with widespread wind and water damage exceeding $2.2 billion.

The new pump house, the boardwalk, and the landscaping are the only components of the proposed project that are susceptible to wind damage.[25] The O'ahu Civil Defense Agency estimates that the probability of hurricane force winds (i.e., winds in excess of 75 miles per hour) striking the island in any given year is one in 55. The probability of sustained winds in excess of 94 to 110 miles per hour is one in 320. The pump house, which is the only structure that is planned as part of the project, is being designed to withstand winds of up to 80 miles per hour, after which structural damage could begin to occur. The pumps would typically be shut down and the system de-electrified if a hurricane strike were expected. Destruction of the pump house would probably not affect the pumps themselves (though accompanying water damage would require cleaning and possible repairs), but a total collapse of the structure would seriously damage the electrical and control system, and this would take several months to repair. During that period the pumps would be inoperable and circulation within the lagoon would be greatly reduced. In view of the fact that a hurricane strike would have done substantial damage to the surrounding area, the temporary loss of the lagoon as a recreational amenity would be inconsequential.

Most of the landscaping that is proposed is low to the ground, but it would undoubtedly suffer damage as a result of hurricane force winds. The boardwalk is also susceptible to damage in the event it is thrown about by wind. However, the foundations are designed to secure it except in the areas where storm waves overtop the berm. In those areas, the planned removal based on storm warnings should be sufficient to avoid significant adverse effects.

3.6.2 SUSCEPTIBILITY TO DAMAGE FROM FLOODING AND TSUNAMI INUNDATION

3.6.2.1 Introduction

According to the Flood Insurance Rate Map (FIRM), all of the lagoon and the beach berm separating it from the ocean are in Zone AE, defined as an area with potential for flooding every 100 years. Holomoana Street is in Zone A, which signifies a 100-year flood zone where no base flood elevation has been established. The portion of the HHV that is adjacent to the lagoon is in Zone AO, which means that it is susceptible to sheet flows from an event with a recurrence interval of once in 100 years.

The proposed lagoon restoration entails very slight topographic alterations around the perimeter of the lagoon. Only one is of any note. It involves modifying the portion of the existing beach berm *makai* of the lagoon by adding sand to extend its highest point (about +6 feet msl) a short distance in the Diamond Head direction before tapering it down to meet the existing grade in front of the Rainbow Tower. The extent to which these would affect the area's susceptibility to damage is summarized below.

[25] The existing pump house and landscaping are at least as susceptible to damage as those that are proposed. Hence, the boardwalk is the only completely new element in the proposal.

3.6.2.2 Susceptibility to Flooding of the Pump House

After evaluating the requirements of the pump station equipment, the desire to blend the facility as much as possible into the existing environment, and the need to comply with the flood hazard regulations, the ground floor elevation of the pump house was set at +4 feet msl, one foot below the regulatory flood height of +5 feet msl. The pumps, electrical equipment, and all other sensitive items would be placed at +5 feet msl or above. The portion of the structure below that would be flood-proofed. Because this is not a habitable structure, the design complies with the City and County of Honolulu's flood hazard ordinance.

3.6.2.3 Susceptibility to Damage along the Shoreline Berm

Storm waves overtop the berm separating the lagoon from the ocean every few years, with the water over the top rarely exceeding a few inches. Because the area where this occurs will be close to its present elevation following the lagoon restoration, the periodic overtopping is expected to continue. During these events, little wave energy would enter the lagoon. Thus, potential damage to the walkway and the erosion of sand and its transport into the lagoon would be the principal concerns. As described in Section 2.3.2.2.3, the portion of the walkway that is most susceptible to wave action would be constructed in moveable segments. Storm waves are relatively predictable, and this would allow the HHC time to relocate the walkway elements to hotel property where they would be out of reach of the waves.

Extreme storm events, such as Hurricane Iniki, have the potential to create wave and ocean conditions that lead to extensive overtopping of the shoreline berm on the *makai* side of the lagoon. During the most severe part of Iniki, for example, the shoreline berm was completely submerged as a result of wave setup. Such extraordinary events expose the shoreline berm severe stress. Because a severe breaching of the berm would expose the anchoring of the geotextile fabric to wave energy that it is not designed to resist, HHC has proposed the buried reinforcement described in Section 2.3.2.4.2. If this aspect of the design is implemented, the geotextile fabric would resist damage from even extraordinary events. If it is not, the fabric could be damaged and the underlying sediment exposed to the force of the waves. This, in turn, could lead to the sediment being scattered across the sandy sides and bottom of the lagoon, degrading the improvement that the project is intended to secure.

Tsunamis have the potential to overtop the berm as well, though they have historically been infrequent along this shoreline. There is less advance warning of a tsunami that might strike the shoreline (typically a matter of a few hours) than there is for high storm waves. Consequently, there is less certainty that the boardwalk could be relocated out of harm's way. If the boardwalk sections could not be removed before a tsunami stuck, they could be washed into the lagoon. The chance that the boardwalk segments picked up by a tsunami could cause damage elsewhere is limited to the areas immediately adjacent to the lagoon, particularly the bottom level of the Rainbow Tower. A tsunami of sufficient size would damage the landscaped areas on other facilities that are proposed along the *makai* side of the lagoon, but these could easily be reconstructed.

3.6.3 SUSCEPTIBILITY TO SEISMIC DAMAGE

The Uniform Building Code (UBC) establishes minimum design criteria for structures to address the potential for damages due to seismic disturbances. The scale is from Seismic Zone 0 through Zone 4, with 0 the lowest level for potential seismic induced ground movement. Like all of O'ahu, the project area is designated Seismic Zone 2a (U. S. Geological Survey, 1997). All the structures planned as part of the project will conform to Seismic Zone 2a Building Standards, and will not increase the seismic vulnerability of the project area. It is more than likely that the wind loading (80 mph with Exposure D, coastal) rather than seismic forces will govern the design.

3.7 TERRESTRIAL BIOTA

3.7.1 EXISTING CONDITIONS

3.7.1.1 Terrestrial Flora

The project area consists largely of the lagoon and surrounding sandy beach; these have virtually no terrestrial vegetation. Only in the landscaped area around the *makai* and *makai*-'Ewa perimeter are significant numbers of plants found. Species in these areas are all exotic species planted after the fill was placed there in the mid-1950s. No terrestrial plant species on the proposed site are identified as either threatened or endangered, nor are any known to be candidates for such status.

3.7.1.2 Terrestrial Fauna

Terrestrial mammalian species found at the project site are limited to introduced species such as mice (*Mus domesticus*), rats (*Rattus r. rattus*, *Rattus norvegicus*, and possibly *Rattus exulans hawaiiensis*) and feral cats. Informal observation of avifaunal resources notes populations of barred doves (*Geopelia striata striata*), spotted doves (*Streptopelia chinensis*), rock doves (*Columba livia*), Red-crested Cardinal (*Paroaria coronata*), Northern Cardinal (*Cardinalis cardinalis*), and common mynah (*Acridotheres tristis tristis*) in the vicinity, none of which are threatened or native. All of the terrestrial mammal and bird species observed are considered alien to the Hawaiian Islands.

3.7.2 POTENTIAL IMPACTS

None of the plant or animal species observed in the project vicinity and that could be displaced by the proposed lagoon restoration are endangered, threatened or have been proposed for listing under the Endangered Species Act. Without exception, the project area and adjacent areas have been highly disturbed and subject to continuous intensive human use. Construction activities will temporarily displace common exotic vegetation and avifauna species; however the area will be replanted with species suitable for the expected conditions of the site upon completion of the project. As a result, there will be a net increase in terrestrial habitat and, in all likelihood, the number of species present.

The proposed plan calls for a substantial expansion of the landscaped area on the *makai* side of the lagoon. The landscaped area consists of grass and sturdy shoreline plants. Up to 80 additional coconut palms would be planted around the lagoon to supplement those already present. Beach Naupaka (*Scaevola sericea Vahl*; naupaka kahakai in Hawaiian) would be used along the uphill side of the area and would separate the lagoon from the adjacent streets and parking areas. It is one of the most common beach plants in Hawai'i and thrives in the kind of full-sun, sandy, high-pH environment found around the Duke Kahanamoku Lagoon. Naupaka has excellent salt, wind, and (once established) drought tolerance. Irrigation would be installed and maintained by HHC in support of the plantings. Other native plants, such as pohuehue (Beach Morning Glory/*Ipomoea imperati*) would be used in areas where a low ground cover other than grass is desired. This includes the area at the northwest corner of the lagoon where the water nears the rock retaining wall that supports the harbor access road. It is well-adapted to living in the hot sun and blowing sand.

3.8 MARINE BIOTA

3.8.1 EXISTING CONDITIONS

3.8.1.1 Duke Kahanamoku Lagoon

Appendix D lists the 68 species or taxa (species groups) that are known to be present in the lagoon. It includes the larger, visually apparent "macro" forms active during the daytime. Other small, cryptic species are likely to be present as well, but these do not make up a significant element of the biotic community. Most of the species found in the lagoon are believed to have entered it through the pipes connecting the lagoon to the ocean, but some were probably put there purposely by people or were introduced to it incidentally by human activity. The most dominant species seen from the shoreline is the tilapia (*Tilapia meoanotheron*). Once in the water, much of the floor of the lagoon is occupied by a mix of benthic jellyfish *Cassipoea*, the red algae *Gracilaria* and *Acanthophora,* and the sea grass *Halophila*. Thirteen of the 68 identified taxa (or 19%) are known to be recent, unintentional introductions to Hawai'i (i.e., are alien species). These common species are widely distributed in Hawai'i and elsewhere. None of the species identified are rare, threatened or endangered, or particularly unusual.

Because of their relatively large size, the upside-down jellyfish (*Cassipoea*) are readily recognizable in the lagoon. The species thrives in low-energy (wave-protected) waters such as the Hilton Lagoon. The full range in sizes of *Cassipoea* seen in the lagoon (disc diameters from 3 to more than 150 mm) indicates that it completes it entire life cycle here. These stinging creatures are an impediment to recreational use, and it would be virtually impossible to eliminate them from the lagoon permanently so long as the ocean intake pipes remain.

3.8.1.2 Ala Wai Harbor

The Ala Wai Harbor was first constructed by the U.S. Armed Forces in the early 1900s and has been periodically enlarged to where it presently provides The Ala Wai Harbor provides over 700 berthing and mooring spaces, one boat launch ramp, and 22 dry dock storage spaces. The harbor provides boating opportunities for the Hawai'i Yacht Club, Waikīkī Yacht Club, the Royal Hawaiian Ocean Racing Club, and other recreational boat owners. A channel originally connected the harbor to Fort DeRussy in Waikīkī, but was later filled in, and the Ala Wai Canal and harbor were connected.[26] The Ala Wai Boat Harbor is considered an embayment. Estuaries and embayments are important as habitat for larval and juvenile stages of some native species such as o'opu and 'ama'ama, or mullet.

Some indication of the biological array in Ala Wai Harbor is available from studies conducted in the Ala Wai Canal (Harris, 1975 & Miller, 1975). However, the harbor is characterized by deeper water and more marine, less brackish conditions and continuous boat traffic and related human usage. Consequently, the data from these studies is not directly applicable to the harbor. Coles et al. (June 1999) studied the non-indigenous marine species introduction in the harbors along the Southwest shores of O'ahu, including the Ala Wai Harbor, from 1997 to 1998. They sampled the benthic biota using a semi-quantitative technique and recorded observations of common macroinvertebrates and fish species. A gradient of biota types from coral reef-related organisms near harbor entrances to organisms adapted for eutrophic turbid conditions was noted. Amphipoda was the most diverse taxonomic group.

The results of these previous reviews and anecdotal information indicate that submerged piers, pilings and rock jetties within the Harbor are colonized by a wide variety of fouling organisms including stony and soft corals, sponges, hydrozoans, mollusks, echinoderms and ascidians. In addition, numerous species of reef fish inhabit the harbor. A complete inventory of marine organisms inhabiting the harbor is beyond the scope of this document. It is important, however, to note that none of the modeled changes to water chemistry discussed in Section 3.5 above are of a magnitude sufficient to alter biotic community structure. In fact, a potential effect of reducing concentrations of Chlorophyll a and total suspended material within the Harbor might be an increase in abundance of reef corals, which is generally considered a positive response.

[26] Hawai'i, State of, Department of Transportation. (1972). *The Environmental Impacts of the Proposed Construction (Phase I) for the Ala Wai Boat Harbor Final Environmental Statement.*

3.8.2 POTENTIAL IMPACTS & MITIGATION MEASURES: DUKE KAHANAMOKU LAGOON

3.8.2.1 Construction Period Impacts

Implementation of the proposed project will unavoidably kill the aquatic biota presently in the lagoon that are not first removed. None of the species is rare or endangered, and many are introduced varieties that are considered invasive or damaging to the indigenous biota. Consequently, their removal or elimination does not represent a significant loss from a biological standpoint. At the same time, the death and subsequent decomposition of the aquatic flora and fauna will result in decomposing organic matter beneath the liner. To minimize the amount of organic material under the geotextile liner, HHC will remove as much as is practicable before laying down the geotextile fabric and sand fill. In all likelihood it will do this by drawing down the level of the lagoon water as it has done in the past and manually removing aquatic biota from the exposed lagoon bottom. Nets can also be used to remove most of the larger fish from the portion of the lagoon that still has water in it. These measures will remove the bulk of the biomass from the lagoon.

3.8.2.2 Operational Impacts

Once the lagoon restoration is complete, it will be fed solely by groundwater from the new salt water wells. Because of the "sterile" nature of the deep groundwater, aquatic species will not be introduced into the lagoon with supply water. However, while there is not a direct pathway for aquatic species to enter the lagoon, it is highly likely that marine organisms will inevitably reappear through several inadvertent pathways. This is particularly true of very small organisms such as algal fragments which will be carried into the lagoon water on the bodies and/or clothing of people who have just been swimming in the ocean. Children may also catch fish in the ocean and bring them into the lagoon to play with. In other cases, birds may drop organisms into the lagoon that will reproduce. Finally, experience with other manmade water bodies suggests that fishermen and other people might intentionally introduce species into the lagoon. While such possibilities exist, it is impossible to predict which organisms will appear first, or of they will appear at all.

3.8.3 POTENTIAL IMPACTS & MITIGATION MEASURES: ALA WAI HARBOR

3.8.3.1 Short-Term Construction Period Impacts

The existing discharge from the lagoon into the middle basin of the Ala Wai Harbor will be stopped while the lagoon restoration is underway. The temporary cessation will reduce turnover in that arm of the harbor. Because the discharge from the lagoon into the harbor has been suspended for periods of time previously without apparent long-term effect on the biota that inhabit it, no persistent effect is anticipated as a result of this temporary halt to pumping from the lagoon.

The existing pipe discharging into the middle basin of the harbor may be cleaned as part of the project. This would consist of macroalgae that has grown on its interior near the harbor. Because the pipe serves largely as an extension of the harbor, the species present on the pipe and that might escape into the harbor during the cleaning are the same as those already present.

The installation of new pipes (one for lagoon water and one for stormwater) into the inner basin of the harbor will involve physical disturbance of a small portion of the harbor bulkhead. It is colonized by organisms typical of such hard substrate in protected harbor areas of leeward O'ahu, and these would be killed by the work. Their loss does not represent a significant adverse effect. The construction work would temporarily increase turbidity in the immediate vicinity of the outlet, but the increase in turbidity would be limited to the short construction period (a few weeks at most) and is expected to be of the same order of magnitude as that already experienced during heavy stormwater flows. Consequently, no significant construction-related effects are expected from this work.

3.8.3.2 Long-Term Operational Impacts on Biota in Ala Wai Harbor

As stated above, the only potential impact to biota in Ala Wai Harbor might be a slight increase in corals growing on piers, pilings and boulders owing to clearer water near the discharge points in the inner and middle basins of the harbor.

3.9 NOISE

3.9.1 EXISTING CONDITIONS

Properties adjacent to the project are in the State Urban District and are zoned by the City and County of Honolulu as "Public Precinct" and "Resort Mixed Use". The State Department of Health (HAR §11-46-3) limits noise levels in the Public Precinct to 55 dBA during the daytime and 45 dBA at night. Limits for the Resort Mixed Use zone are 60 dBA during the daytime and 50 dBA at night.

The most significant existing noise sources around the lagoon area are ocean waves, boat motors and horns in the Ala Wai Harbor, grounds maintenance and delivery activities in nearby areas of HHV and the Renaissance Ilikai hotel, and traffic entering the harbor and the public parking area adjacent to the lagoon on Holomoana Street. Traffic noise is also a factor at the end of Rainbow Drive, which is across the Great Lawn at the lagoon's north end. Traffic noise at both of these locations does not exceed 60 Ldn at 50 feet setback distance from the center line.

Inter-island jet aircraft from Honolulu International Airport can also be heard at the site, reaching maximum noise levels of 65-70 dBA. However, aircraft noise levels at the site are below 60 Ldn, which is the acceptable level for resorts as defined by the Hawai'i State Department of Transportation, Airports Division (Y.Ebisu & Associates 2001). Measurements of existing noise levels in the area are presented in Table 3.18.

Table 3.18. Existing Noise Levels

Location	*Leq*	*MinL*	*MaxL*	*MaxP*	*Start Time*
Beach on 'Ewa side of lagoon	51.3	69.3	59.3	88.4	8:30 am
Beach on 'Ewa side of lagoon	50.5	63.6	55.0	84.2	8:45 am
Walkway Adjacent to Rainbow Tower	51.3	66.1	56.6	89.5	9:10 am

Note: These variables are defined as follows:
- Equivalent Sound Level (Leq). This variable is the root-mean square (RMS) average of the time-varying sound energy measured during the 10-minute measurement interval. Leq correlates reasonably well with the effects of noise on people, even for wide variations in environmental sound levels and time patterns.
- Maximum Sound Level (Lmax). This is the maximum sound level (1-second integrated value) recorded during the measurement interval.
- Minimum Sound Level (Lmin). This is the minimum sound level (1-second integrated value) recorded during the measurement interval.

Maximum Peak Level (MaxP). This is the instantaneous maximum sound level measured during the measurement interval.

Source: Measurements collected by Planning Solutions, Inc. on 11/05/2003 using Brüel & Kjær Type 2239 Integrating Sound level Meter. Settings: Fast (1-sec. integration), A-weighted, 10-minute integration

3.9.2 POTENTIAL IMPACTS

3.9.2.1 Identification of Potential Noise Impacts

Noise-sensitive activities and facilities along the *mauka* side of the lagoon include the Rainbow Tower (particularly the ground-level conference rooms), the Lagoon Tower, and the Ilikai Hotel. The uses and activities within the Ala Wai Harbor and the nearby beaches on the 'Ewa and *makai* sides of the lagoon are less sensitive to temporarily elevated daytime noise levels of the sort that would occur during construction.

Because it will entail the delivery of substantial quantities of fill material and the operation of large, motorized equipment over an extended period of time, construction work related to the proposed restoration represents a substantial noise source. This noise is characterized in Section 3.9.2.2.

There are also few sources of ongoing (i.e., operational) noise associated with the proposed restoration of the lagoon. Most of the improvements (e.g., walkways, beach areas, landscaping, and irrigation systems) do not produce noise. The users of those facilities (e.g., pedestrians on the walkways, sunbathers on the expanded beach, picnickers in the expanded lawn area on the *makai* side of the lagoon) produce only modest noise levels, and the noise that they do cause tends to be confined to daytime hours and of a nature that it compatible with the existing uses in the area. Because of the low volume of additional vehicular traffic that the facilities would generate, vehicle-noise is not a significant concern. In view of this, only two sources of ongoing operational noise warrant additional discussion:

- The pumps in the new water circulation system, which will be driven by two 40 horsepower and three 25-horsepower electrical motors.
- Equipment used to maintain the lagoon and landscaping.

These are discussed in more detail in Section 3.9.2.3 below.

3.9.2.2 Construction Period Noise Impacts & Mitigation Measures

Earth-moving equipment, including diesel-powered trucks, bulldozers, backhoes, and front-end loaders, will be the noisiest equipment used during construction. Cranes and small boats will also be used during the placement of geotextile fabric in the lagoon. As indicated in Table 3.19, many of the types of construction equipment that would be used can generate noise levels in excess of the DOH noise limits. Because of this, HHC anticipates that the contractor will seek a construction noise permit from the State of Hawai'i Department of Health as provided for in Hawai'i Administrative Rules Title 11, Chapter 46 - Community Noise Control. Moreover, because HHC owns and operates the structures that will be most impacted by the noise, it intends to incorporate strict construction provisions in its construction contract that will minimize construction noise and the effect that it has on adjacent uses.

HHC's contract provisions will encourage or require the contractor to reduce the amount of noise that is being generated to the lowest level achievable with the kinds of equipment available on the island while containing construction cost. Because the nature of most of the work calls for it to be conducted outdoors and in set locations, much of the construction activity must be conducted in locations where it is impossible to provide acoustical screening, and some of it will necessarily be close to noise-sensitive uses. However, within those limits, HHC will require the construction contractor to:

- Situate noisy base facilities, stockpiling areas, fixed equipment, and support operations in locations as far as practicable from those who might be disturbed (i.e., away from the *mauka* end of the lagoon where the hotels and residential buildings are).

- Demonstrate that they have selected relatively quiet equipment for use on the project and maintain all mufflers and other sound attenuating devices in good working order throughout the construction period.
- Develop construction practices that minimize noise from backup alarms or other piercing signals.
- Restrict noisy construction activity to the hours between 9:00 am and 5:00 pm, Monday through Saturday. No work would be allowed on Sunday.
- Develop and implement an effective program for notifying residents of nearby buildings of the kinds of noise that they may expect on a day-by-day basis, of the steps that the contractor has taken to minimize noise, and of the way in which people may contact a representative of the contractor if they believe that the work is causing unnecessary noise.

Table 3.19. Noise Level Ranges for Construction Equipment

	Equipment	*dBA Range at 50 Feet*
Internal Combustion Powered Equipment	Front Loader	72-85
	Backhoe	70-88
	Trencher	70-80
	Scrapers, Graders, and Bulldozers	80-93
	Trucks	83-95
	Cranes (Moveable)	75-87
	Cranes (Derrick)	87-89
	Pumps	69-71
	Generators	71-82
Source: Y. Ebisu & Associates (2001).		

3.9.2.3 Operational Period Noise Impacts & Mitigation Measures

As noted above, most of the ongoing recreational activities that would take place around and in the lagoon are low-density/low-noise in nature. Because of the low volume of additional vehicular traffic that the facilities would generate, vehicle-noise is not a significant concern. The only mechanical equipment that would be used regularly during ongoing operations would be the pumps that drive the water circulation system and the equipment used to maintain the lagoon and landscaping.

The pump house would contain two 40 horsepower and three 25-horsepower electrical motors, and there are periods during which all might operate at once time. Assuming that the motors are comparable to the TEFC high thrust, premium efficiency, 460 volt/1,200 rpm motors sold by U.S. Motors, individual motors would produce a noise level of approximately 41 dB(A) at 50 feet.[27] When all five motors are operating at the same time, which will occur regularly, their combined noise level at a distance of 50 feet will be about 7 dB(A) higher, or 48 dB(A). This noise will be attenuated by the building walls. Depending upon the exact nature of the construction and the way ventilation openings are sized and baffled, the structure will provide an inside-to-outside noise reduction of at least 5 dB(A), and the reduction is likely to be much greater.

[27] This is based on manufacturer's data sheets that show a sound pressure at 3 feet of 65 dB(A). The sound pressure measurements on which they are based were made in accordance with IEEE 85, corrected to a free field under 60 Hz sine wave power at a reference level of 0.0002 $dyne/cm^2$.

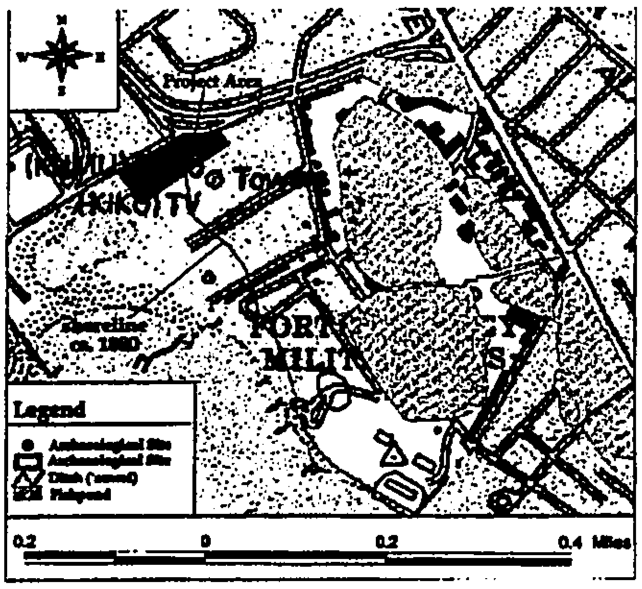
When all factors are taken into consideration, the noise level at a distance of 50 feet from the pump house will be 43 dBA or less. This is below the existing ambient noise level recorded during the morning, is lower than the noise produced by traffic on the nearby street, and is below the 45 dBA nighttime noise limit for the most stringent land use category.

Once the restoration is completed, increased recreational use of the lagoon and surrounding area may increase noise levels slightly. The noise levels sources would be voices, vehicles, and occasional music from beach-goers' radios. No motorized water sports or vehicles will be permitted within the lagoon.

3.10 ARCHAEOLOGICAL, HISTORIC, AND CULTURAL RESOURCES

3.10.1 ARCHAEOLOGICAL AND HISTORIC RESOURCES

3.10.1.1 Existing Conditions



Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted subsurface archaeological investigations for the Waikikian project. The study area extended as far south as the northwest lagoon shore, where the existing swimming pool juts into it. During the excavation work, no archaeological sites were identified. The only cultural materials encountered were recent cultural debris in secondary contexts, including wires, utility lines, tiles, and concrete fragments. Most of the identifiable debris was associated with a remnant trash pit attributed to the former Tahitian Lanai Restaurant.

As indicated by the map at left, the State Historic Preservation Division estimates that the shoreline prior to 1880 was located well inland of the lagoon. This is consistent with aerial photographs taken in the 1940s. Because all of the area where the lagoon restoration work would be undertaken consists of fill land or open water area, there is no potential that traditional cultural remains, including traditional Hawaiian burials, are present.

3.10.1.2 Potential Impacts and Mitigation Measures

The majority of the construction phase of the lagoon restoration project will involve placing pipe, geotextile fabric, and fill within areas that are now part of the lagoon water feature. Most of the remainder will involve placing imported sand on the portion of the lagoon banks that were created in 1956 when it was constructed. Both of these areas are manmade and consist of recently placed fill land, therefore no archaeological or historic resources would be impacted by the project.

3.10.2 CULTURAL RESOURCES AND TRADITIONAL CULTURAL PRACTICES

3.10.2.1 Background

Paul H. Rosendahl, Ph.D., Inc. (April 2001) summarized the cultural resources and cultural practices of the area as part of its work on the Waikikian project. The PHRI report noted that the project site is located within the *ahupua'a* of Waikīkī, once the favored spot for ruling chiefs of O'ahu. Relevant portions of the PHRI report are excerpted below.

Handy and Handy (1972:480) report that in the fourteenth century, "the new *ali'i nui,* Mailikukahi, transferred the seat of government to Waikīkī." Under his line, the area became rich and developed. Beckwith writes:

> *...with Mailikukahi, Waikīkī became the ruling seat of chiefs of Oahu. He carried out strict laws marked out land boundaries, and took the firstborn son of each family to be educated in his own household. He honored the priests, built heiaus, [sic] and discountenanced human sacrifice (Beckwith 1940: 383-384).*

Kamehameha I kept a residence in Waikīkī after he conquered O'ahu. John Papa I'i wrote:

> *This place had long been a residence of chiefs. It is said that it had been Kekuapoi's home, through her husband Kahahana, since the time of Kahekiki (I'i 1959:17).*

The inland areas of Waikīkī (between Moili'ili and Fort DeRussy) formerly contained numerous irrigated agricultural fields covered in taro *(kalo)* and fishponds. The Waikīkī area was noted for this intensive agriculture and aquaculture and was developed into a plantation-like region. Davis (1989:8) reported that in 1778 Waikīkī was one of the richest and most densely populated areas of O'ahu.

When Captain George Vancouver visited Waikīkī in 1792, he described it as follows:

> *... The situation occupied by us in this bay, which the natives call Whyteete [sic] seemed nearly as eligible as most of the anchoring places these islands are generally found to afford. On the shores, the vi llages appeared numerous, large, and in good repair; and the surrounding country pleasingly deep...with the plains near the sea-side, presented a high degree of cultivation and fertility. Several portions of land were planted with eddo or taro root, in different stages of inundation; none being perfectly dry, and some under three to six or seven inches under water... In this excursion we found the land in a high state of cultivation, mostly under immediate crops of taro; and abounding with a variety of wild fowl, chiefly of the duck kind. (Vancouver 1798: Vol. I 161-164)*

Andrew Bloxam described Waikīkī's fishponds as they appeared in 1825:

> *...The whole distance to the village of Whyteete [sic] is taken up with artificial fishponds extending a mile inland from the shore, in these fish taken by nets in the sea are put, and though most of the ponds are fresh water, yet the fish seem to thrive and fatten. Most of these fish belong to the chiefs, and are caught as wanted... (Bloxam 1925:35).*

Levi Chamberlain's 1828 description suggests that the fishponds and other water features were falling out of cultivation and into disrepair, quite possibly as a result of the depopulation being brought about by diseases that the foreigners introduced:

> *Our path led us along the borders of extensive plats of marshy ground, having raised banks on one or more sides, and which were once filled with water, and replenished abundantly with esculent fish; but now overgrown with tall rushes waving in the wind. The land all around for several miles has the appearance of having once been under cultivation. I entered into conversation with the natives respecting this present neglected state. They ascribed it to the decrease of population (Chamberlain 1957: 26).*

By the end of the 19th century, when the number of native Hawaiian was perhaps a tenth of what it had been a century earlier, the irrigation system was in complete disrepair and had become a possible health hazard. Act 61 of the 1896 session Laws required landowners of wetlands to create dry landscapes in the interest of public health (Simmons et al. 1995:6). The greatest change occurred between 1921 and 1929, when the Dillingham Construction Company carried out the Waikīkī Reclamation Project which consisted, among other things, in the dredging the entire length of the Ala

Wai Canal. The material dredged from the canal was then used to fill a large portion of Waikīkī, thus making the area useable to the United States Military (for Fort DeRussy) and to others for commercial use (Nakamura 1979). PHRI reports that available records indicate that the area in and immediately around the lagoon was not filled at this time. Instead, the existing shoreline was created in the mid-1950s as part of the overall development of the Hawaiian Village resort complex.

3.10.2.2 Potential Effects on Culture, and Traditional and Customary Rights

In its work for the Waikikian project, PHRI (April 2001) assessed the lagoon restoration's potential effects on Hawai'i's culture, and traditional and customary rights in compliance with the requirements of Chapter 343 (Haw. Rev. Stat.), as amended by Act 50 on April 26, 2000. Its report concluded that the fact that the historic shoreline was well inland of the lagoon together with the absence of any evidence that a fishpond was once present in the area now occupied by the lagoon indicates that the presence of traditional cultural properties or features in the affected area is highly unlikely. The report recognized the likelihood that the reef flat that formerly occupied the area was used for fishing. However, the fact that this had ceased more than a half-century ago together with the fact that long-time HHV staff report no ongoing cultural use of the lagoon strongly suggest that it is not associated with traditional cultural practices or beliefs.

There is no indication of any kind that the project area now has resources necessary to or currently being used by Native Hawaiian cultural practitioners exercising traditional and customary access and use rights for any purposes, or by individuals of any other cultural affiliation for any traditional cultural purposes except for coastal resources. The project would not curtail any modern uses of the site or limit access by Native Hawaiian cultural practitioners. Rather, it would support these uses by improving the scenic and recreational value of the lagoon.

3.11 RECREATION & PUBLIC SHORELINE ACCESS

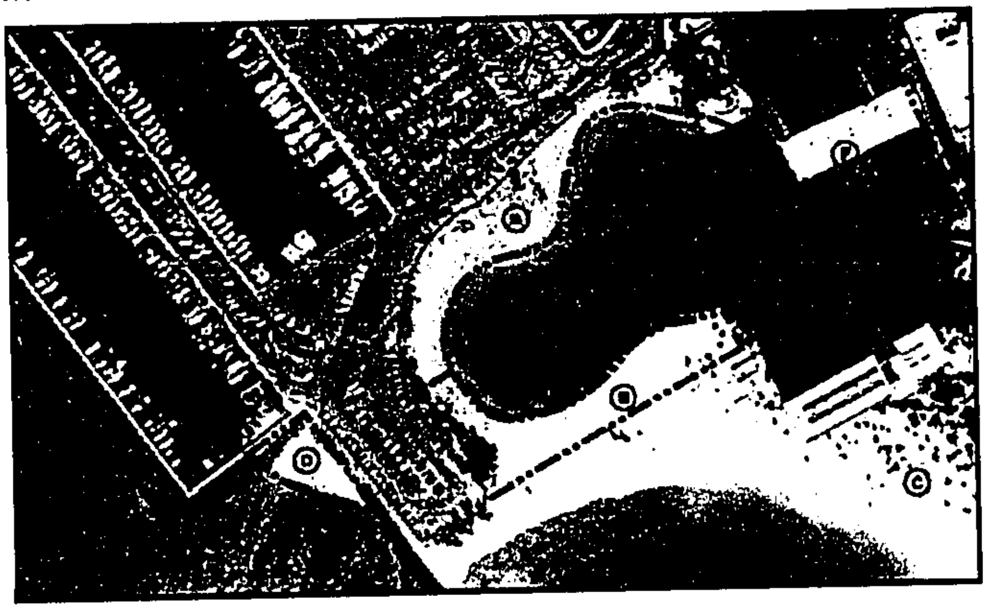
3.11.1 EXISTING CONDITIONS

The lagoon and the surrounding beaches, hotel and parking areas each have associated recreational activities, each with their own constituency. While there are not always hard and fast boundaries between the different areas, for the purposes of this discussion it is useful to divide the affected area into six distinct zones (Zones A through F), each of which is characterized by a particular set of activities and users. The boundaries of these areas are shown on Figure 3.7. The number of people observed in each area, during a survey conducted over the course of a single day, is shown in Table 3.20.

- ***Zone A*** consists of the 'Ewa bank of the lagoon between the lagoon water's edge and the roadways within the Ala Wai Harbor. Only rarely do people linger in this area; most frequently it is used as part of a pedestrian circuit by people en route to Zones B and C. As indicated by the data in Table 3.20, the area is most heavily used during the mid-morning. However, even then the intensity of use is modest. Few people use the area during mid-day, an indication of the extent to which its use is limited to pedestrians who are simply strolling through the area.
- ***Zone B*** includes the seaward bank of the lagoon. This raised strip of land separates the lagoon from the ocean; the upper portion of the bank closest to the lagoon has a small area of grass and palm trees together with a few benches and other recreational amenities. The public parking area that serves the entire area occupies the top and seaward side of the berm. During the mid-morning this zone is used in concert with Zone A as part of a walking circuit enjoyed by residents and visitors out for morning exercise.[28]

[28] Some homeless persons also use the lagoon-side bank of Zone B to sleep on at night and in the early morning. During a survey conducted beginning at 6:30 AM, on March 11, 2005, several individuals were still there.

Figure 3.7. Recreational Use Zones



- ***Zone C*** is Duke Kahanamoku Beach, the large crescent beach that begins seaward of the Rainbow Tower and extends eastward along the shoreline to Fort DeRussy. In the early morning before sunbathers are out, Zone C is used as part of the pedestrian course that includes Zones A and B. As the day progresses, hotel guests fill Zones C, spilling over into Zone B and the contiguous water. Duke Kahanamoku Beach is also occasionally used for large public events and gatherings.
- ***Zone D*** The focal point of this zone is the small sandy beach by the Ala Wai Harbor jetty, *makai* of the Duke Kahanamoku Lagoon. This beach is used largely as a staging area for surfers. However, homeless persons also frequent the area, taking advantage of the shade, the water fountain, and the outdoor shower. On the pier side of the beach, fishermen set up their gear and wait for their boats before going out.
- ***Zone E*** is the Duke Kahanamoku Lagoon itself. Because of the very soft bottom, there is very little recreational activity in the lagoon. While the water remains reasonably attractive, access to it entails wading several tens of feet across the gently sloping, mucky bottom. Its slimy texture, combined with the presence of stinging jelly fish, is enough to discourage all but the hardiest swimmers. Hence, the lagoon's principal recreational value is as a scenic backdrop for residents and visitors strolling through the area.
- ***Zone F*** includes the two small strips of sand between the *mauka* side of the lagoon and the HHV's Great Lawn and the Waikikian site. The two sand areas are separated by the existing Lagoon Tower pool area that juts out into the water, making it impossible to walk from one to the other. Currently there is very little use of the public beach area, either by sunbathers or pedestrians since the pedestrian route ends at the pool on the Diamond Head side and at a chain-link fence that extends down to the water line on the 'Ewa side.[29]

[29] Zone F does not include two adjacent areas which are also used for recreational purposes but which are on hotel property. The Great Lawn is frequently used for private and hotel-oriented special events and functions (e.g., weddings, banquets, and performances) but is not used for casual recreation. The pool adjacent to the Lagoon Tower is one of several pool areas within HHV and is reserved for guest use. Being smaller than the other pools and lacking some of the amenities (e.g., snack bar, towel service, etc.), it is the least used of HHV's pools, but is favored by guests of the Lagoon Tower.

Table 3.20. Recreational Usage by Area.

Time	*Zone A*	*Zone B*	*Zone C*	*Zone D*	*Zone E*	*Zone F*
7:00am	9	1	5	3	0	n.d.
8:00am	2	1	19	9	0	n.d.
9:00am	11	14	38	4	0	n.d.
10:00am	16	12	138	6	0	n.d.
11:00am	6	12	388	7	0	n.d.
12:00pm	4	19	400+	5	0	n.d.
1:00pm	2	20	400+	18	0	n.d.
2:00pm	10	25	366	20	0	n.d.
3:00pm	3	18	312	33	0	n.d.

Note: See Figure 3.7 for zone boundaries. Survey conducted on March 11, 2005 by Planning Solutions staff. Counts are approximate and were made by researcher walking through area and recording observations. Zone F was not surveyed.

Source: Planning Solutions, Inc.

3.11.2 POTENTIAL IMPACTS

As discussed in Chapter 1 of this report, the fundamental purpose of the proposed action is to restore and enhance the recreational and aesthetic value of the Duke Kahanamoku Lagoon. For reasons described below, HHC believes the planned design will accomplish this goal, producing a marked improvement in the lagoon's usability as a protected swimming area and family recreational area. In order to accomplish these goals, however, it will be necessary to restrict public access to the lagoon and surrounding area for a period of up to a year. This time is needed to seal the existing soft bottom sediments in place, install the new water circulation system, reconfigure the lagoon shoreline, and establish the new recreational facilities and landscaping. By making the area more attractive, the changes are likely to increase the number of people seeking to use the lagoon. In view of already heavy use of the existing parking areas near the lagoon, this additional use may increase the competition between the new and existing recreational users of the area for the limited available parking.

The remainder of this section discusses the kinds and magnitude of the effects on these recreational resources that could result from the lagoon restoration project. The discussion evaluates impacts to the general area as well as those specific to each recreational zone identified in Section 3.11.1 above.

- Section 3.11.2.1 addresses potential impacts to recreational use during construction. It also outlincs measures that would be taken to minimize or mitigate their occurrence.
- Section 3.11.2.2 discusses potential impacts to recreational usage and values once the lagoon restoration project is completed and operational.

3.11.2.1 Construction Period Impacts

There are five types of construction activities integral to the lagoon restoration process that have the potential to adversely affect recreational usage of the area.

- Construction Barriers and Fencing. One of the first steps in the restoration process will entail the erection of construction fencing around the entire lagoon, preventing physical access to the construction site and blocking normal view-paths. The fencing is needed to prevent the public from entering potentially dangerous construction areas. As illustrated in Figure 3.8, the fencing will encompass virtually all of Zones A, B, and E, and will block the most favored pedestrian route around the *makai* shoreline of the lagoon. HHC will require the contractor to delineate an alternate pedestrian route (see Figure 3.8).

- Construction Noise. The heavy equipment that will be used during some phases of the lagoon restoration will increase noise levels in nearby areas, making them less attractive from a recreational viewpoint for several months (see Section 3.9 for a further discussion of noise).
- Construction Traffic and Excavation within Harbor Access Road. Construction traffic can make the adjoining roadways more congested. The period of greatest concern is reconstruction of the beach when heavy trucks will be transporting large volumes of sand into the work area. Excavation across the harbor access road that may be needed to install the new lagoon water discharge pipe that the State Department of Land and Natural Resources has requested and the rerouted storm drainage pipe will also require special traffic controls. Section 3.15 discusses expected impacts on traffic.
- Visual Barriers. Construction fencing that will be erected around the construction site while work on the lagoon is underway. The barriers are intended to help mitigate visual impacts of the construction process and contain airborne matter from the construction site.
- Odor. Many of the sediments in the lagoon bottom are anaerobic. Because of this, there is the potential for them to release odors when disturbed by construction activities.

The extent to which each of these types of construction impacts is likely to occur within each of the geographic zones delineated above is discussed in subsections 3.11.2.1.1 through 3.11.2.1.6, below.

3.11.2.1.1 Construction Impacts on Recreational Use of Zone A ('Ewa Bank of the Lagoon)

Erection of the construction fencing at the outset of the project will cut off all public access to the pedestrian route along the 'Ewa bank of the lagoon for the duration of the restoration process, a period of approximately one year. Because the shoreline of the lagoon in this area consists largely of exposed coralline material with a sparse sand cover, there is little sunbathing or other activity in this area that would be displaced by making the beach area temporarily unusable. The contractor will establish and maintain an alternate pedestrian route at all times during the construction period. This will ensure that residents and visitors are able to skirt the construction area safely while they are exercising, preserving as much of the area's recreational value as possible.

Construction will cause some temporary inconveniences for users of the parking areas and the roadway within Zone A. The roadway and parking areas will remain open throughout construction. If it is practical, HHC will use horizontal boring for the proposed new lagoon water and stormwater discharge pipes into the inner basin of the Ala Wai Harbor, thereby eliminating the effect that trenching would have on traffic flow.[30] Because most users of the parking area and roadway do not linger there longer than a few minutes, construction noise and odor would not interfere with their normal use of the area. It is likely to be more disturbing to those who use it as a place to socialize.

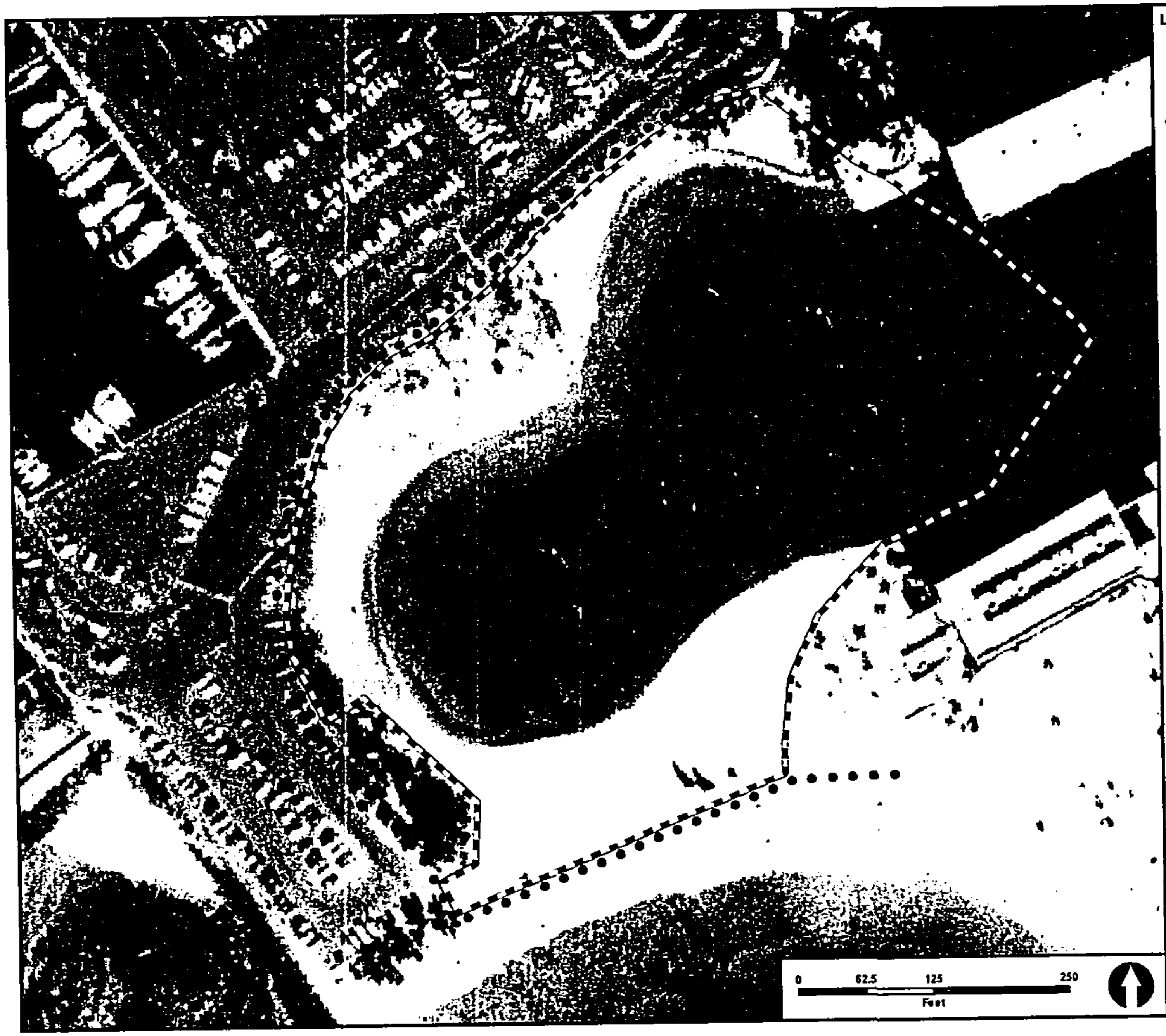
3.11.2.1.2 Construction Impacts on Recreational Use of Zone B (Seaward Bank of the Lagoon)

Construction activities would affect recreational use of Zone B in largely the same way as they would Zone A. However, because the slightly better quality of the sand in Zone B attracts more recreational users than Zone A, the effect of closing the area to public use for the duration of the construction work will temporarily displace a slightly greater number of users.

3.11.2.1.3 Construction Impacts on Recreational Use of Zone C (Duke Kahanamoku Beach)

This zone will not be fenced in and will be available for normal recreational use, with the exception of the one to several days when workmen are removing the above-ground concrete structure associated with the existing ocean intake. This is expected to take no more than a day or two, and temporary construction fencing will be erected around the work area to ensure the safety of persons in the area.

[30] If horizontal boring proves impractical, trenching would be needed, and this would necessitate lane closures for a period of up to four weeks. However, at least one lane would be kept open at all times, maintaining access to the harbor and parking areas.



Legend:

Construction Fence

Temporary Pedestrian Route

Prepared For:
Hilton Hotels Corp.

Prepared By:
PLANNING SOLUTIONS

Sources:
-City & County of Honolulu GIS
-Belt Collins Hawaii
-Tom Nance Water Resources

Figure 3-8:

Proposed Construction Fencing

Hilton Hawaiian Village Lagoon Restoration

Access to the beach from the parking areas *makai* of the lagoon and adjacent to the Ala Wai Harbor will be disrupted only for brief periods during construction and only when it is essential for safe operations. Alternate routes will be maintained at all times, but these will not be as aesthetically pleasing as the route along the edge of the lagoon. Beach space is available for the vendors of water toys and canoes which use this zone as a staging area to relocate further to the east temporarily, but both vendor and customer access to the area via roadways will be changed during construction. Finally, during some phases of the restoration process construction and machinery noise may also negatively impact recreational use.

3.11.2.1.4 Construction Impacts on Recreational Use of Zone D (Sandy Beach by the Ala Wai Harbor Jetty)

This area sees predominantly resident traffic, comprised of local surfers and fishermen. Vehicular access will be maintained during construction, although slight delays may occur during certain construction activities (such as when sand is being delivered for the beach). Construction workers will not be allowed to park vehicles in the regular public parking area adjacent to Zone D; instead, HHC will require the contractor to provide private parking for them. It may be necessary to block off a few parking stalls along the Holomoana Street near the existing pump house so that construction vehicles can enter and leave the work area. This was done during installation and testing of the exploratory wells, and did not appear to cause a hardship on users.

The preferred method of installing the additional lagoon water discharge pipe that will carry water from the pump house into the inner basin of the Ala Wai Harbor is horizontal boring. If this construction method can be used at reasonable cost, it will be selected for both that and for the re-routed storm water discharge pipe that is planned. The visual orientation of most users in this zone is towards the ocean, so any visual blockade of the lagoon will not represent a major impact, but at times construction noise may be loud enough to constitute a negative impact on recreational users.

3.11.2.1.5 Construction Impacts on Recreational Use of Zone E (Duke Kahanamoku Lagoon)

No recreational use of the lagoon will be possible during construction. The lagoon will be fenced off and access will not be permitted. HHV security will enforce the safety perimeter around the worksite and lagoon. As recreational use of the lagoon is currently very sparse, work in this area is not expected to impact a large number of people.

3.11.2.1.6 Construction Impacts on Recreational Use of Zone F (Mauka Shoreline of Lagoon)

As previously noted, there are virtually no public recreational activities in this zone that could be adversely affected. However, the adjacent area within the HHV is used for private functions that are reserved for hotel guests and persons paying to stage events there, and these will be negatively affected by construction activities. The Great Lawn and the existing pool adjacent to the Lagoon Tower will remain open for guest use throughout construction, but will temporarily be less pleasant for users due to blocked views, construction noise, reduced air circulation, and other factors. HHC will attempt to minimize these inconveniences to guests and visitors to HHV by ensuring that the barrier fencing is as attractive as possible and that noise is limited to appropriate hours.

3.11.2.2 <u>Operational Impacts of the Restored Duke Kahanamoku Lagoon</u>

3.11.2.2.1 General

The construction described above will substantially improve the lagoon and surrounding beach. Fresh sand will surround the new lagoon, replacing the hard coral substrate that now dominates in many areas. The Boardwalk around the *makai* side of the lagoon will extend the Waikīkī Promenade, making walking faster, cleaner and more convenient for pedestrians who do not enjoy walking on the sand. At the same time, the much improved sandy portions of the beach will enhance the experience for people who enjoy walking closer to the water. Water quality in the lagoon will be substantially improved and make the lagoon an inviting and sanitary place for bathers. Landscaping, trees along the *makai* waterline, and increased grassy areas will all offer a more pleasant and inviting environment for all recreational usages in the area. These improvements are expected to increase the number of people seeking to use the area. All of these are positive changes.

One potential drawback for existing users of the area could be increased competition of for parking spaces. There are generally enough parking stalls in the existing public parking areas to accommodate increased use during some periods of the day and under some surf conditions, however there are also busier periods when demand for parking stalls could exceed supply.

3.11.2.2.2 Operational Impacts on Recreational Use of Zones A and B ('Ewa and Seaward Bank of Lagoon)

The construction of a larger pump house to replace the existing one will slightly reduce the open space in Zone A, but the area is not heavily used at the present time. The beach area in Zones A and B will be expanded slightly, and a walkway connection will be created past the Lagoon Tower, a route that is now blocked where the swimming pool juts into the lagoon. The scenic value of Zones A and B will be significantly improved, both from a ground level perspective and for views from the surrounding parking areas and towers, and should invite new user groups to enjoy the lagoon. The *makai* portions of Zone A and B will form part of the greatly expanded and improved lagoon beach, and the lagoon adjacent to it will once again become an attractive swimming environment. Grass, landscaping, and other improvements on the upper portion of the lagoon sides will provide semi-shaded picnic areas. Additional palm trees planted along the path will guide pedestrians. The planting of additional grass and other landscaping between the parking area and the lagoon will also create an attractive recreational area that can better serve users.

3.11.2.2.3 Operational Impacts on Recreational Use of Zone C (Duke Kahanamoku Beach)

The proposed project will have only a minor effect on recreational use of Zone C, most of which lies to the east of the area that would be altered. The planned boardwalk extension of the Waikīkī Promenade will form the western end of this area, and the addition of improved beach sand will probably cause some beachgoers who now prefer Zone C to choose Zone B instead. To the extent that this occurs, the density of people on the beach in Zone C will decrease. By making most of the boardwalk along the western side of this area removable, the proposed plan will allow large events to continue to be staged there periodically.

3.11.2.2.4 Operational Impacts on Recreational Use of Zone D (Sandy Beach by the Ala Wai Harbor Jetty)

The orientation of this area is such that this user group will be unlikely to benefit significantly from the improvements to the Hilton Lagoon. Typical users (i.e., surfers, fishermen) face seaward and will not enjoy improved scenic resources to the extent which other user groups in other zones are expected to. Also, increased demands on roadways and parking in the area resulting from the lagoon restoration may cause a negative impact on existing recreational use in this area.

3.11.2.2.5 Operational Impacts on Recreational Use of Zone E (Duke Kahanamoku Lagoon)

The restoration will have a transformative effect on the lagoon itself. Currently, the lagoon is much underutilized. This is due to the poor quality of the beach sand, the turbid water, the mucky bottom, and the stinging jellyfish, all conditions that would change for the better with the proposed project. The restored lagoon will become an attraction for all who wish to swim in a calm, protected environment. Consequently, there is likely to be a sharp increase in the number of persons who wish to use it.

3.11.2.2.6 Operational Impacts on Recreational Use of Zone F (Mauka Shoreline of Lagoon)

At present, there is virtually no public recreational use of Zone F. Once the lagoon restoration and improvements are completed, it will be possible to walk entirely around the lagoon, something the public is not presently able to do. Because of the landscaping and other improvements that are planned, the walking experience will be improved as well. The additional beach area that will be created in this zone will provide additional sunbathing areas, and well as an inviting opportunity to enter and swim in the lagoon that does not presently exist.

3.12 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

3.12.1 EXISTING CONDITIONS

The project site is located near the western end of Waikīkī, the one square mile area that is O'ahu's main tourist destination. About 19,000 people reside in the district's 14,000 residential units, and on an average day the area is host to approximately 70,000 visitors (WBIDA 2002). Approximately 37,500 people are estimated to be employed in Waikīkī, and in 2002, approximately half of the state's visitor industry expenditures occurred there. This represented an estimated 13% ($5.2 billion) of the Gross State Product and supported 12% of all jobs in the state (WBIDA 2002).

Aside from restaurants and small retail businesses within the HHV itself, commercial uses immediately adjacent to the project area are limited to several small vendors who operate rental businesses along the shoreline in front of the hotel. There is no commercial use of the lagoon, though its presence undoubtedly adds to the attractiveness of the Hilton Hawaiian Village.

3.12.2 POTENTIAL IMPACTS

The most serious economic impact of the project will be to the HHV itself. The construction phase of the project will temporarily affect the experiences of guests and visitors to HHV by blocking views of the lagoon and creating noise (see Sections 3.9.2, 3.11.2, and 3.13.2 for details). As a result, the rates that the hotel may obtain for some of its rooms (particularly those on the western side of the Rainbow Tower and the eastern side of the Lagoon Tower) may be lower than would otherwise be the case. The disruption to hotel activities is likely to be sufficiently limited that the activity will not measurably reduce the number of guests present. Hence, the marginal reduction in room rates is not expected to be accompanied by a decrease in other visitor spending that could harm other businesses or the Island's economy.

Restoration of the lagoon will also entail temporary intrusions into areas that are presently used for the storage of water toys and canoes. However, there is sufficient space available to the east of the present locations to allow these operations to relocate their activities temporarily.

The proposed project would not impact the population or economy of Waikīkī adversely. The project is intended to revitalize the lagoon and surrounding area. It will be beneficial to residents and visitors alike. While it is expected that the project will have a positive impact on visitor experiences, the project in and of itself is expected to help maintain, rather than increase, the number of visitors. The project will have a positive effect on the value of homes with a view of the area by improving the appearance and utility of lagoon and its surroundings.

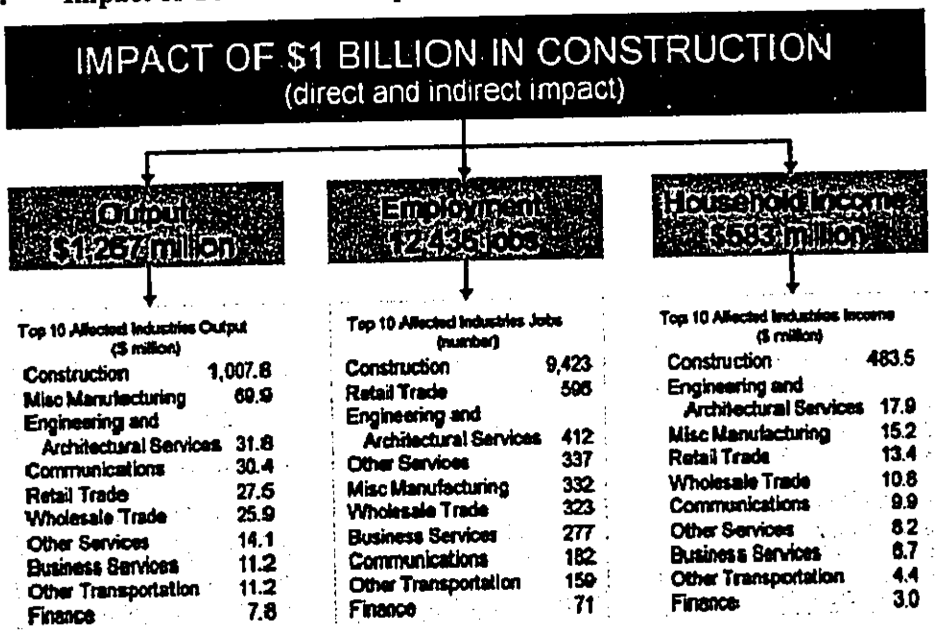
Based on the current construction plans, it is expected that the proposed improvements will cost at least $13,500,000. Maintenance will cost HHC at least $100,000 per year. Most of the construction work will be done using heavy equipment. Consequently, the number of jobs will be modest in comparison with buildings having similar construction budget. The maximum number of workers on-site at any one time is expected to be in the range of 20 to 30, but the average will be lower, probably about 15 to 20.

As part of its economic modeling program, the State of Hawaii Department of Business, Economic Development, and Tourism (DBEDT) has developed estimates of the impact construction expenditures have on other industries in the economy.[31] Figure 3.9 shows how money spent in construction expenditures creates *indirect* economic activity in addition to the *direct* economic activity in the construction industry itself. The table shows that, on average, a dollar in *direct* construction spending actually generates, about $1.30 of total output in the economy. Applying these

[31] The model used in this case is called the Hawai'i Input-Output Model, which measures the relationship of an industry in the local economy to every other industry.

factors to the proposed project expenditures of $13,500,000, more than 165 jobs and nearly $8,000,000 in household income in Hawaii.[32]

Figure 3.9. Impact of Construction Expenditures on Economy: 2000.



Source: Department of Business, Economic Development, and Tourism.

The lower boxes in Figure 3.9 show how this economic activity was distributed among the key industries that provide inputs into the construction sector. They show that most of the output, jobs, and income from construction spending generated is in the construction industry itself. But activity is also generated in related industries such as real estate, engineering and banking. Moreover, activity was also generated in industries seemingly unrelated to construction such as medical care, eating and drinking and retailing.

3.13 SCENIC AND AESTHETIC RESOURCES

3.13.1 EXISTING CONDITIONS

The lagoon and adjacent beach are visible from the surrounding shoreline, Holomoana Street, and the buildings that are adjacent to the Lagoon (Rainbow Tower, Lagoon Tower, and Ilikai Hotel). Those same buildings obstruct views of the lagoon from the remainder of the HHV and from areas *mauka* of Ala Moana Boulevard. The factors that have degraded the lagoon's recreational value have not had nearly as much effect on its aesthetic qualities. Only when one gets close to the lagoon does one notice the paucity of sand, the grayish tinge to the lagoon bottom that results from the anaerobic conditions in the sediment, and the odor that can arise when those sediments are disturbed. It is only a close look that reveals the deteriorated condition of the plantings along the *makai* and 'Ewa perimeters of the lagoon as well. From most areas it appears as an attractive water feature within a tropical beach setting.

[32] The output is defined as the value of sales for most industries and "trade margins" for a few industries such as retail and wholesale trade, which do not actually make the goods they sell.

3.13.2 POTENTIAL IMPACTS

Construction Period. Construction activities will result in temporary obstruction of ground-level views from all surrounding sites as a result of the planned construction fencing. The approximate location of the planned construction barriers is depicted in Figure 3.8. This may consist of standard plywood or similar fencing that will largely obscure views of the construction area. Different types of fencing may be used in selected areas, either to enhance the attractiveness of the fencing from selected locations or to allow a better view of the ongoing construction activity. In addition to being visible from a limited number of ground-level locations, the work area will be clearly visible from the upper floors of several neighboring buildings (Rainbow Tower, Lagoon Tower, and Ilikai, for example). Most of the rooms from which the lagoon work would be visible are occupied by visitors, but some are the homes of permanent residents.

Because water will be kept in the lagoon during construction, activity at any one time will be concentrated in a limited area, minimizing the extent of the disruption. If cranes or other particularly tall equipment is used, the tops will be visible from ground over the top of the fencing, but most will be completely screened at ground level. The grounds of the HHV will experience the greatest change during the construction period, with the openness of the Great Lawn being considerably reduced and the meeting rooms in the base of the Rainbow Tower deprived of their attractive views of the lagoon.

Operational Period. Following construction, there will be no significant impacts on views. The pump house is the only permanent above-ground structure being proposed, and it is sufficiently small that it can be camouflaged with landscaping so as not to detract from the lagoon's scenic value. Overall, the improved water clarity, landscaping and amenities proposed by the project are expected to increase the scenic value of the area substantially.

3.14 LAND OWNERSHIP

The great majority of the property on which work would take place is owned by the State; the remainder belongs to Hilton Hotels Corporation (see Table 3.21). HHC's existing agreement with the State gives HHC the right and obligation to maintain the lagoon until it is impractical to do so, at which time HHC has the authority to return the Lagoon to the State and the State is obliged to fill the lagoon. Should the State choose this course of action, HHC would retain a view and access easement across the area, and buildings would be prohibited on it.

If the proposed lagoon restoration plan is approved, HHC will obtain a right of entry from the State in order to construct the new facilities that are proposed on State-owned land, and will subsequently acquire an easement for the continued use of that land for lagoon-support purposes. The facilities that would be covered by the agreement include the new lagoon water supply and discharge equipment (e.g., pipes, pumps, pump house, control equipment, etc.), walkways, landscaping and landscape irrigation systems, and expanded beach.

Table 3.21. Land Ownership in the Lagoon Vicinity

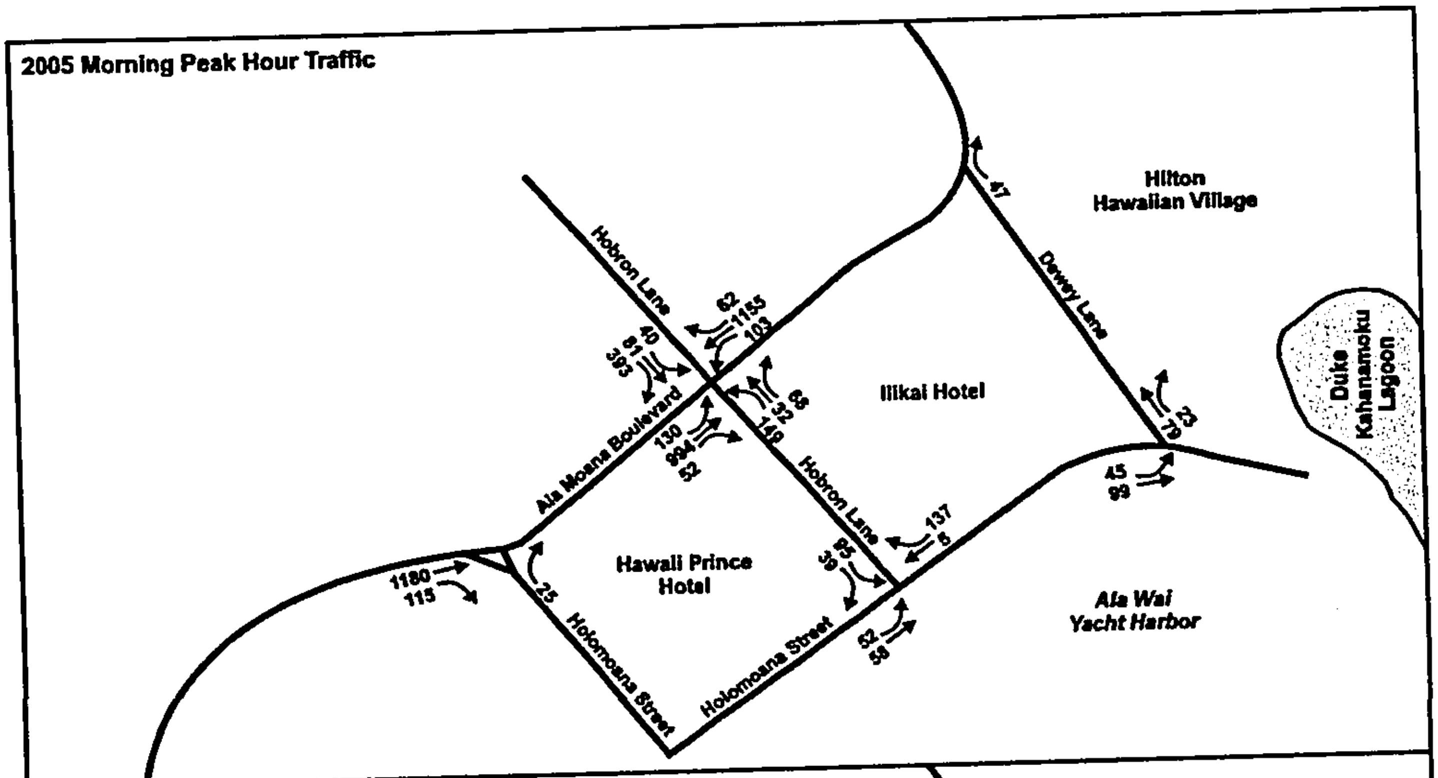
Portion of Affected Area	*TMK*	*Owner*
Entire Lagoon and Seaward Along Waikīkī Beach	2-3-037:021	State of Hawai'i
Ala Wai Harbor & Discharge Pipes	2-3-037:012	State of Hawai'i
Mauka HHV Hotel and Pool Areas	2-6-009:001, 2-6-009:002	HHC
Rainbow Tower/ East HHV Property	2-6-008:034	HHC
Proposed Well Sites	2-6-009:010	HHC
Source: Honolulu Land Information Systems (HOLIS), City and County of Honolulu, 2005.		

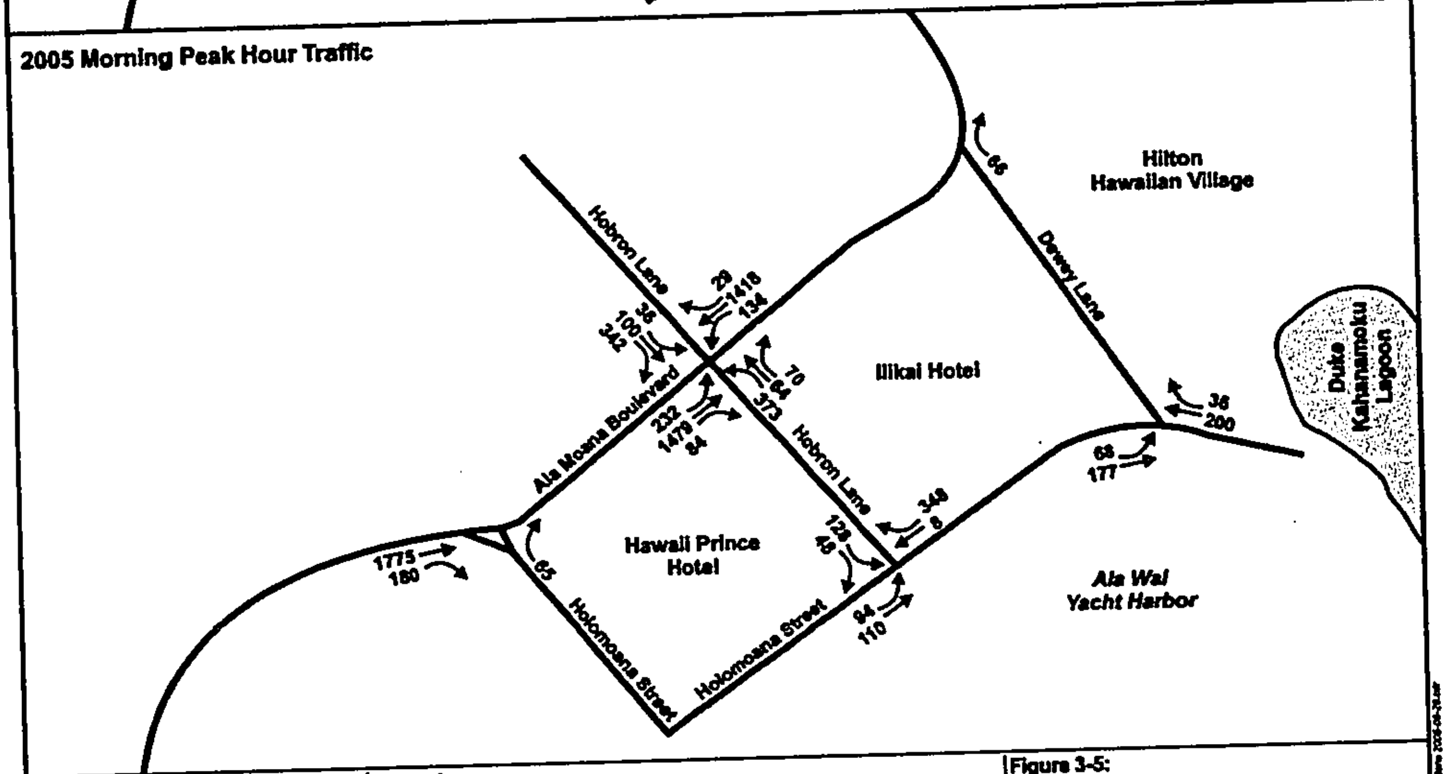
3.15 TRANSPORTATION FACILITIES

3.15.1 EXISTING CONDITIONS

As shown on **Error! Reference source not found.**, the following roadways are located near the project site and could be used by vehicles traveling to and from the Duke Kahanamoku Lagoon.

- Ala Moana Boulevard. All of the smaller roads discussed below that serve the project area connect to Ala Moana Boulevard. This State-owned highway links the Waikīkī area to the east with Ala Moana Center, Downtown Honolulu, Honolulu International Airport, and other points to the west. In the project area, Ala Moana Boulevard is a six-lane roadway with a median divider strip and with separate left turn lanes at major cross streets.
- Dewey Lane. This narrow (approximately 20-foot pavement width) two-way roadway runs from Ala Moana Boulevard to Holomoana Street, passing between the Ilikai Hotel and the 'Ewa boundary of the Hilton Hawaiian Village hotel. Because there are currently no improved pedestrian walkways along this roadway, pedestrians must share the pavement with vehicles. Large vehicles servicing the Ilikai use the roadway, and can completely block traffic when they are present. *Makai*-bound vehicles on Dewey Lane can turn right onto Hobron Lane or continue straight onto Holomoana Street; only right-turn in and right-turn-out movements are possible at Dewey Lane's intersection with Ala Moana Boulevard. It is presently the least used of the three routes for traffic coming into the outer harbor area.
- Hobron Lane. The one block stretch of Hobron Lane *makai* of Ala Moana Boulevard passes along the western side of the Ilikai Hotel. It serves the Ilikai Hotel, the Hawaii Prince Hotel, and the Ala Wai Harbor. This segment of Hobron Lane has two lanes in each direction. The signalized intersection of Hobron Lane and Ala Moana Boulevard is the primary route into the harbor area and the only roadway that allows vehicles to exit the Ala Wai Harbor complex in the west-bound direction. It is one of only three avenues of approach for traffic coming into the site.





Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Source:

Belt Collins Hawai'i

Legend:

Figure 3-5:

Existing Peak-Hour Traffic

Hilton Hawaiian Village
Lagoon Restoration

- Holomoana Street. This roadway intersects Ala Moana Boulevard west of the Hawai'i Prince Hotel. It is restricted to right-turn-in and right-turn-out movements only. In addition to serving the Hawai'i Prince Hotel, it is the major roadway within the Ala Wai Harbor and to the Duke Kahanamoku Lagoon. Most of Holomoana has two travel lanes in each direction. While the paved area remains wide to the roadways end near the ocean, the number of striped lanes is reduced to one in each direction past the *mauka* basin of the harbor. It is one of only three avenues of approach for traffic coming into the site.

Year 2005 peak-hour traffic volumes on Ala Moana Boulevard were reported in the environmental impact statement prepared for the Waikikian Project. Those estimates are reproduced in Figure 3.10. The analysis conducted for the same study estimated that peak-hour service levels at the three key intersections would be as follows:

Intersection	***Year 2005 Service Level***	
	AM Peak-Hour	*PM Peak-Hour*
Ala Moana Boulevard & Hobron Lane	D	D
Hobron Lane and Holomoana Street	A	B
Holomoana Street and Dewey Lane	A	B
Source: *Final Environmental Impact Statement: Waikikian Development Plan*		

The level of service at other times of day is equal or better than that shown in the tabulation.

3.15.2 POTENTIAL IMPACTS

Restoration of the Duke Kahanamoku Lagoon has the potential to affect transportation facilities and traffic flow in two fundamental ways. First, during construction it will generate construction-vehicle trips that will add to existing volumes on a few area roads; it will also entail brief periods during which construction activity will require temporary lane closures on Holomoana Street between its intersection with Hobron Lane and the parking area *makai* of the lagoon. Second, by making the lagoon and surrounding beach a more attractive recreational area, restoration of the lagoon will tend to increase the number of people trying to access the area, increasing traffic volume and the demand for parking.

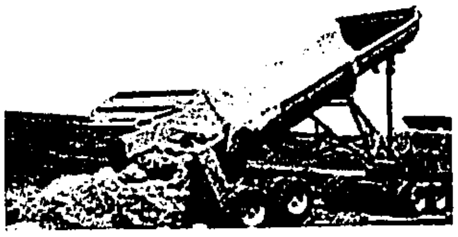
Because of the nature of the project, its effects on transportation facilities would be localized. Consequently, this assessment focuses on the roadways *makai* of Ala Moana Boulevard that vehicles traveling to and from the lagoon would use (Hobron Lane, Dewey Lane, and Holomoana Street, and their respective intersections with Ala Moana Boulevard). While vehicles traveling to and from the lagoon would also pass through more distant intersections, they would represent such a small proportion of the traffic at those intersections that extending the analysis to include them is unwarranted.

The following subsections discuss expected impacts to traffic and roadways that will occur during the lagoon restoration project. Section 3.15.2.1 discusses construction phase impacts and mitigation measures, and Section 3.15.2.2discusses impacts once the improvements are in place and the area is reopened to the public.

3.15.2.1 Construction Phase Impacts & Mitigation Measures

Material Transport. Earlier lagoon restoration proposals involved removing the accumulated sediments from the lagoon, drying them, and trucking them away for disposal. By leaving the sediment in place, the approach now being proposed eliminates a large number of truck-trips that would otherwise have been required for the restoration project.

Nonetheless, it will still be necessary to import up to 20,000 cubic yards of sand to replenish the floor and banks of the lagoon. This would be trucked to the site from Mokulē'ia on the north shore of O'ahu. This amount of material would require an estimated 625 truck-loads.[33] Assuming the contractor spreads the trips over a two-month period,[34] this would amount to an average of 14 truckloads per day, five days per week. Given the likely working hours, this would probably amount to 2 to 3 truckloads per hour over a 6-hour period during the middle of the day.



The trucks hauling the sand, as well as other large construction vehicles, would approach the work site traveling eastbound on Ala Moana Boulevard. They would turn into Dewey Lane or Hobron Lane and proceed to the work site. These vehicles will take 2-5 minutes to deposit their loads and then exit the area via Hobron Lane or Dewey Lane. If the rate of delivery is as estimated above, there would be one in-bound and one outbound trip every 20 to 30 minutes. Even if the sand transport were concentrated during a shorter period of time, it is unlikely that the number of trips per day would be more than twice that (one every 10 to 15 minutes. The change in the number of trips is a small fraction (well under a half percent) of the existing volume on Ala Moana Boulevard and would not measurably reduce the level of service for the brief period of time it occurs. Sufficient work space is available that it is unlikely that at this rate the entrance and exit to the worksite and surrounding parking would become congested.

Other materials needed for the planned restoration include geotextile fabric for lining the lagoon, boardwalk sections for the extension of the Waikīkī Promenade, stones for the rock work, landscape materials (soil, palm trees, shrubs, etc.), and the equipment and materials for the pump house and lagoon piping. These will be delivered to the site as needed. The quantities will be small compared to the sand, and the number of vehicle-trips needed to make the deliveries would be commensurate with that. The bridge over Hobron Lane is not low enough to obstruct even the largest of the heavy vehicles from exiting onto Ala Moana Boulevard.

Construction Worker Vehicle-Trips. Because most of the work would be done using heavy equipment, the number of construction workers on site at any one time would be small. HHV will provide parking for their vehicles within the lagoon work area and/or on it own property. It will include a clause in the construction contract requiring the contractor to provide private parking for its employees and suppliers.

Holomoana Street Piping. Current thinking is that the best way to construct the required pipelines beneath Holomoana Street from the Lagoon to the inner basin of the Ala Wai Harbor would be through horizontal or directional drilling. If this technique is used, there will be no effect on vehicular traffic. Even if this were found to be impractical, the trenching for the pipes would be done in such a way as to keep lanes open for traffic at all times. If trenching is necessary, some reduction in roadside parking in the vicinity of the pipeline crossing would probably be necessary. This would affect no more than a few stalls, however, and the restrictions on parking would be needed for no more than a few weeks.

3.15.2.2 Operational Impacts

The proposed project will not change the type of uses that will take place in the lagoon; they will remain recreational. However, it is likely that by making the area more attractive, they will increase

[33] This estimate assumes 20,000 cubic yards of sand will be needed, that the transport will be done using 40 cubic yard capacity truck/trailer combinations, and that the net load will be 80 percent of the capacity (i.e., 0.8*40 cubic yards, or 32 cubic yards).

[34] This preliminary discussions with contractors indicates that this rate is most reasonable in view of the sand quantities that are involved, the available trucking resources, the production capability of the quarry, the space limitations at the lagoon, and the anticipated rate at which the liner can be deployed.

the number of people who wish to use the area. Some of these people will be visitors and will arrive on foot. In fact, the preponderance of the people who will use the proposed boardwalk extension of the Waikīkī Promenade will be visitors staying at the HHV or elsewhere in Waikīkī.

A substantial proportion of the people who use, or wish to use, the lagoon itself are likely to be local residents, and many of them will arrive by car rather than on foot. As discussed above, the roadways leading to the lagoon are not congested, simplifying the task of reaching the restored resource. Parking availability is more limited. Consequently, the competition for parking may increase as a result of the proposed improvements.

3.16 POLICE, FIRE, DOCARE, & EMERGENCY MEDICAL SERVICES

3.16.1 EXISTING CONDITIONS

The Department of Land and Natural Resources Division of Conservation and Resources Enforcement (DOCARE) is responsible for enforcement activities on land controlled by the Department of Land and Natural Resources. The division, with full police powers, enforces all State laws and rules involving the Ala Wai Harbor. Typically, the Honolulu Police Department is called only if criminal activity is involved.

The nearest police station is a satellite office on Kalākaua Boulevard. Police headquarters is located on Beretania Street near its intersection with Ward Avenue. The three nearest Fire Stations are on Makaloa Street (approximately one mile from the lagoon), at the intersection of University and Date Street, and at the intersection of Kapahulu and Ala Wai Boulevard. The three hospitals nearest to the project site are Kapi'olani Women's and Children's on Punahou Street, Straub Hospital on King Street, and Queen's Hospital on Punchbowl Street. All three hospitals provide emergency medical services (EMS) to the area, as do the Fire Stations mentioned above.

3.16.2 POTENTIAL IMPACTS

The proposed project does not involve any activities that would permanently alter the need for, or ability to provide, emergency services. Police, Fire Department, and Emergency Medical Services will be informed of the project construction schedule and apprised of the emergency vehicle access routes to be used during construction. The contractor will be required to provide ample clearance to emergency vehicles at all times.

3.17 SEWER SYSTEM, UTILITIES & COMMUNICATION SYSTEMS

3.17.1 EXISTING CONDITIONS

The Duke Kahanamoku lagoon currently contains electrical, gas and water lines serving the ornamental island, and is traversed by submerged power cables running from the Lagoon Tower to the existing pump house. There is a public restroom located in the parking area of Ala Wai Harbor, but there are no sewer lines coming into, or out of, the project area. Electrical lines supplying power to the harbor run along the 'Ewa boundary of the work site.

3.17.2 POTENTIAL IMPACTS

Work on the lagoon is not expected to interfere with the operation or maintenance of any existing infrastructure. Local residents using the existing public restroom facilities in the harbor and/or the new restroom that HHC will construct along the *makai* end of Dewey Lane as part of the Waikikian project will increase the volume of wastewater entering the City sanitary sewer system. The change will be very small relative to the existing volume, however, and it does not have the potential to affect the performance of the system adversely.

Dramatically increasing the water circulation in the lagoon will increase the amount of electricity consumed by the pump system. Consequently, despite the low head that is involved in the system and the choice of high-efficiency pumps, engineers estimate that the system will consume approximately 800,000 kilowatt-hours per year of electricity. HHC will pay for the electricity needed to operate the pumps, a cost that is estimated to average approximately $10,000 per month at present electricity rates.

The existing electrical line into the harbor does not have sufficient excess capacity to accommodate the increased electrical draw. Consequently, HHC will install a new electrical line and telecommunications line) from a terminal point on the Waikikian Tower site to the pump house. The *mauka* end of the line will be situated on HHC property, but most of it will run within the Dewey Lane/Holomoana Street right-of-way. It will dedicate this line to the State once it is complete.

The additional plantings that are proposed are all drought-tolerant and require only modest irrigation. Nonetheless, landscape designers forecast that they will increase average daily water use by 10,000 to 12,000 gallons per day. To provide the water that will be needed, HHC will install a water line from the Waikikian site to the pump house, some of which will be within the State right-of-way. The irrigation system will connect to it at that point. The system will be metered, and HHC will be responsible for the cost of the water and for maintaining the system.

The lighting planned for installation as part of the lagoon restoration project will draw power from the Hilton Hawaiian Village facilities. The island within the lagoon will also continue to use gas for the tiki torches, water for plant irrigation, and electricity. The existing infrastructure for supplying utilities to the island within the lagoon will be demolished as part of the proposed action, but it will be replaced with comparable new facilities, and HHC will continue to operate and maintain these.

4.0 RELATIONSHIP TO RELEVANT PLANS, POLICIES, & CONTROLS

Table 4.1 lists the potential permits and approvals required for the project. The remainder of the chapter discusses the compliance and compatibility of the proposed improvements with pertinent plans, policies, and regulations at county, state, and federal levels.

Table 4.1. Required Permits and Approvals

Permit	*Issuing Authority*
Federal Government	
Department of the Army Permit (§10 of the Rivers & Harbors Act, §404 of the Clean Water Act)	Corps of Engineers
State of Hawai'i	
Right of Entry to State land	Board of Land & Natural Resources
Conservation District Use Permit	Board of Land & Natural Resources
Coastal Zone Management Act Consistency Determination	Coastal Zone Management Office, Department of Business, Economic Development, & Tourism
NPDES Discharge Permit	Department of Health, Clean Water Branch
Section 401 Water Quality Certification	Department of Health, Clean Water Branch
NPDES Stormwater Construction Permit (NOI-C)	Department of Health, Clean Water Branch
Community Noise Control	Department of Health, Noise & Radiation Branch
Well Construction Permit	Commission on Water Resource Management
City & County of Honolulu	
Major Special Management Area Use Permit	Department of Planning and Permitting (DPP)
Waikīkī Special Design District review	DPP
Planned Development-Resort (PD-R) review	DPP
Grading, Grubbing, Excavation, & Stockpiling Permit	DPP
Building Permit	DPP
Source: Compiled by Planning Solutions, Inc.	

4.1 CITY AND COUNTY OF HONOLULU

The proposed project's consistency with the policies and objectives of the O'ahu General Plan is discussed in Section 4.1.1 below. The project area is entirely within the Waikīkī Special District and the Special Management Area (SMA), and is consistent with the visions and design standards for both of these special districts (see Sections 4.1.2 and 4.1.3). The lagoon restoration project was designed to fulfill certain conditions of the Special Management Area Use Permit HHC obtained for its Waikikian Tower project, but DPP has determined that it will require a separate major SMP. The existing intake pipes to the lagoon are within the 40-foot shoreline setback area, but no work will take place within the SSA as part of the lagoon restoration project. The closing of the intake pipes will take place seaward of the shoreline and thus outside the City and County's jurisdiction. Finally, as discussed in Section 4.1.4, it is supportive of the Primary Urban Center Development Plan.

4.1.1 O'AHU GENERAL PLAN

The General Plan is the focal point of a comprehensive planning process that addresses physical, social, economic and environmental concerns affecting the City and County of Honolulu. It includes a comprehensive statement of objectives and policies which sets forth the long-range aspirations of O'ahu's residents and the strategies to achieve them. Several of these objectives and associated policies relate to the proposed lagoon restoration project. These are reproduced below, along with a brief discussion of the project's compatibility with them.

Objective: To maintain the viability of O'ahu's visitor industry.

Policy 2: Provide for a high quality and safe environment for visitors and residents in Waikīkī.

Policy 3: Encourage private participation in improvements to facilities in Waikīkī.

Policy 8: Preserve the well-known and widely publicized beauty of O'ahu for visitors as well as residents.

Discussion: The proposed project is intended to restore the lagoon to a safe and sanitary condition for recreational use by visitors and residents. HHC, a private entity, is funding the water quality restoration and providing for additional public amenities around the lagoon. The anticipated result is a lagoon with greatly enhanced scenic and recreational value.

Objective: To protect and preserve the natural environment.

Policy 1: Protect O'ahu's natural environment, especially the shoreline, valleys, and ridges, from incompatible development.

Policy 2: Seek the restoration of environmentally damaged areas and natural resources.

Policy 4: Require development projects to give due consideration to natural features such as slope, flood and erosi on hazards, water- recharge areas, distinctive land forms, and existing vegetation.

Discussion: The design for the lagoon restoration project presented in this EA is believed to represent an environmentally sound approach. As discussed in the impacts assessment included in Chapter 3, HHC took into account factors such as water quality, natural hazards, existing land forms, and the cultural and natural setting of Waikīkī in developing the lagoon restoration approach.

Objective: To preserve and enhance the natural monuments and scenic views of O'ahu for the benefit of both residents and visitors.

Policy 1: Protect the Island's well-known resources: its mountains and craters; forests and watershed areas; marshes, rivers, and streams; shoreline, fishponds, and bays; and r eefs and offshore islands.

Policy 2: Protect O'ahu's scenic views, especially those seen from highly developed and heavily traveled areas.

Policy 4: Provide opportunities for recreational and educational use and physical contact with O'ahu's natural environment.

Discussion: The lagoon is a well-known scenic resource. It is also a potentially valuable recreational resource. Restoring the lagoon will increase the diversity of outdoor recreational opportunities in Waikīkī and increase its value for residents and visitors alike.

4.1.2 CITY AND COUNTY LAND USE ORDINANCE/WAIKĪKĪ SPECIAL DESIGN DISTRICT [35]

All of the area affected by the proposed lagoon restoration project is within the boundaries of the Waikīkī Special Design District (WSDD). The lagoon itself and the State land that surrounds it on three sides (the west, south, and east) is in the "Public Precinct", while the HHV property to the north is in the Resort Mixed Use Precinct. The lagoon is being restored for use by the public, which makes it a permitted principal use in both Precincts.

The objectives of the Waikīkī Special Design District are outlined in the City and County of Honolulu Land Use Ordinance (LUO) §21-9.80-1. Several are relevant to the proposed lagoon restoration project. These are listed below, followed by a brief discussion of how the project satisfies them.

(b) Guide development and redevelopment in Waikīkī with due consideration to optimum community benefits. These shall include the preservation, restoration, maintenance, enhancement and creation of natural, recreational, educational, historic, cultural, community and scenic resources.

Discussion: The lagoon restoration project is being proposed in order to restore the lagoon's value as a scenic and recreational resource. It can be considered both a needed step toward improving the lagoon's water quality and an enhancement to the adjacent beach.

(d) Provide for a variety of compatible land uses which promote the unique character of Waikīkī, emphasizing mixed uses.

Discussion: Restoring the lagoon would add to the diversity of recreational opportunities available in Waikīkī, as well as ensuring the continued existence of the lagoon as a unique feature. The proposed extension of the Waikīkī Promenade is in accordance with City policies.

(j) Maintain, and improve where possible: mauka views from public viewing areas in Waikīkī, especially from public streets; and a visual relationship with the ocean, as experienced from Kalakaua Avenue, Kalia Road and Ala Moana Boulevard. In addition, improve pedestrian access, both perpendicular and lateral, to the beach and the Ala Wai Canal.

Discussion: The proposed lagoon restoration project provides for a pedestrian walkway and amenities to improve lateral beach movement and pedestrian access to the area. Because the lagoon is next to the ocean, its restoration will not affect *mauka* views from public streets. The project will also make it possible for pedestrians to walk entirely around the lagoon, something that is not possible at the present time.

(l) Emphasize a pedestrian-orientation in Waikīkī. Acknowledge, enhance and promote the pedestrian experience to benefit both commercial establishments and the community as a whole. Walkway systems shall be complemented by adjacent landscaping, open spaces, entryways, inviting uses at the ground level, street furniture, and human-scaled architectural details. Where appropriate, open spaces should be actively utilized to promote the pedestrian experience.

Discussion: The walkway, landscaping, and amenities planned around the lagoon, as well as the improved water clarity will make the lagoon a more inviting pedestrian experience.

(m) Provide people-oriented, interactive, landscaped open spaces to offset the high-density urban ambience. Open spaces are intended to serve a variety of objectives including visual relief, pedestrian orientation, social interaction, and fundamentally to promote a sense of "Hawaiianness" within the district. Open spaces, pedestrian pathways and other

[35] Chapter 21 of the Revised Ordinances of the City and County of Honolulu 1990.

ground level features should be generously supplemented with landscaping and water features to enhance their value, contribute to a lush, tropical setting and promote a Hawaiian sense of place.

Discussion: The Duke Kahanamoku Lagoon represents the largest water feature within Waikīkī. Project plans provide for a mosaic of uses and experiences around the lagoon, including open beach, shaded and grassy areas for picnicking, and a lighted and landscaped walkway for pedestrians. They also include plans for adding up to 80 additional coconut palms and other native vegetation around the lagoon to visually associate the area with the rest of Waikīkī. In addition, it should be noted that the City Council's approval of the Waikikian project included all of the features that are being proposed as part of the lagoon restoration project, including the pump house, walkways, and landscaping.

4.1.3 SPECIAL MANAGEMENT AREA REVIEW STANDARDS

The project will require a major Special Management Area Use Permit (SMP) to be issued by the City and County of Honolulu. HRS §205-A-26 and ROH §25-3.2 designate the specific guidelines used in reviewing developments proposed in the Special Management Area. The following subsections discuss the project's consistency with each of the guidelines. The text of each guideline is reproduced in italics before each discussion.

§25-3.2a(1) Adequate access, by dedication or other means, to publicly owned or used beaches, recreation areas and natural reserves is provided to the extent consistent with sound conservation principles;

Discussion: The lagoon restoration project will improve access to the lagoon and surrounding beach by providing an extension of the Waikīkī Promenade past the lagoon to the walkways within the Ala Wai Harbor. The landscaping and building materials to be used were chosen to be compatible with the natural environment and are consistent with conservation principles.

§25-3.2a (2): Adequate and properly located public recreation areas and wildlife preserves are reserved;

Discussion: The purpose of the lagoon restoration project is to provide for the continued existence of the lagoon and increase its value for public recreational use.

§25-3.2a (3): Provisions are made for solid and liquid waste treatment, disposition, and management which will minimize adverse effects upon special management area resources;...

Discussion: The project will not generate significant amounts of solid waste or sewage. Construction does not require permanent removal of sediments or demolition of existing structures, with the exception of the small existing pump house. The small amount of construction-generated waste will be disposed of properly at an approved off-site location. Operation of the proposed improvements will likewise generate only small quantities of solid waste, mostly from the increased number of people expected to use the area for recreation.

§25-3.2a(4) Alterations to existing land forms and vegetation; except crops, and construction of structures shall cause minimum adverse effect to water resources and scenic and recreational amenities and minimum danger of floods, landslides, erosion, siltation or failure in the event of earthquake.

Discussion: As discussed in Sections 3.5, 3.6, 3.11, and 3.13.2, the lagoon restoration project is not expected to have negative long-term effects on water resources or recreational and scenic amenities. Likewise, it will not exacerbate the dangers of flooding, landslides, or erosion that already exist in the area. The flood hazard zones in the project area are depicted on Figure 4.1.

Prepared For:

Hilton Hotels Corp.

Prepared By:

PLANNING SOLUTIONS

Sources:

--City & County of Hawaii GIS
--Environmental Assessment, LLC

Legend:

0 125 250
Feet

Figure 4-1:

Flood Hazard Zones

Hilton Hawaiian Village
Lagoon Restoration

§25-3.2b(1) The development will not have any substantial, adverse environmental or ecological effect except as such adverse effect is minimized to the extent practicable and clearly outweighed by public health and safety, or compelling public interest. Such adverse effect shall include, but not be limited to, the potential cumulative impact of individual developments, each one of which taken in itself might not have a substantial adverse effect and the elimination of planning options;

Discussion: Restoration of the Duke Kahanamoku lagoon will have temporary environmental impacts associated with its construction (e.g., noise, visual impacts, impaired access, water quality, etc.). However, over the long term the project is expected to have a significant net benefit to residents and visitors using the lagoon and surrounding area. It will greatly improve the lagoon's safety, water quality, attractiveness, and accessibility, and thus is considered in the public interest. Moreover, the project is not part of a larger plan for development that would incur additional environmental impacts or limit the scope of future planning options.

§25-3.2b(3) The development is consistent with the county general plan, development plans and zoning. Such a finding of consistency does not preclude concurrent processing where a development plan amendment or zone change may also be required.

Discussion: The project's consistency with the O'ahu General Plan, the Primary Urban Center Development Plan, and the Land Use Ordinance is discussed in Sections 4.1.1, 4.1.4, and 4.1.2, respectively.

§25-3.2c The council shall seek to minimize, where reasonable: (1) Dredging, filling or otherwise altering any bay, estuary, salt marsh, river mouth, slough or lagoon;

Discussion: The lagoon restoration project does involve filling that will alter the size of the Duke Kahanamoku lagoon. However, the restoration is taking place in accordance with a condition of the Special Management Area permit that the City approved for the Waikikian project. It is agreed among HHC, the City, and the State that alterations are needed restore the artificial lagoon to a condition appropriate for recreational use.

§25-3.2c The council shall seek to minimize, where reasonable: (2) Any development which would reduce the size of any beach or other area usable for public recreation;

Discussion: The lagoon restoration project would substantially increase the beach areas available for public recreation. It would reduce the size of the lagoon facilitate the achievement of the project's water quality objectives, but this would not decrease the recreational value of the lagoon itself. On the contrary, the improved character of the bottom, the enhanced surroundings, and the superior water quality would make it a much more attractive and usable recreational resource.

§25-3.2c The council shall seek to minimize, where reasonable: (3)Any development which would reduce or impose restrictions upon public access to tidal and submerged lands, beaches, portions of rivers and streams within the special management area and the mean high tide line where there is no beach;

Discussion: The project will not reduce or restrict public access to the shoreline except for a temporary period during construction. Once completed, public access to the lagoon area and shoreline will be improved by the addition of the walkway.

§25-3.2c The council shall seek to minimize, where reasonable: (4) Any development which would substantially interfere with or detract from the line of sight toward the sea from the state highway nearest the coast;

Discussion: The tallest structure proposed by the lagoon restoration project is the new pump house. It will extend less than 10 feet above ground and will be largely camouflaged by landscaping. It will not interfere with views toward the ocean. It would not be visible from vehicles traveling along Ala Moana Boulevard, the state highway nearest the coast.

§25-3.2c The council shall seek to minimize, where reasonable: (5) Any development which would adversely affect water quality, existing areas of open water free of visible structures, existing and potential fisheries and fishing grounds, wildlife habitats, or potential or existing agricultural uses of land.

Discussion: As discussed in Sections 2.3.1 and 3.5, the lagoon restoration project would greatly improve water quality within the lagoon over the long term. There will be no discharges into the Ala Wai Harbor during construction, and the water that the system will discharge into the harbor during operation will be of equal or better quality than the existing harbor water. Stormwater quality will be better following the proposed changes than it is at present. Finally, Sections 3.2.2, 3.7.2, and 3.10.2 confirm that the project will not affect important fisheries, wildlife habitats, or agricultural uses of land.

4.1.4 PRIMARY URBAN CENTER DEVELOPMENT PLAN

The Primary Urban Center (PUC) Development Plan presents a vision and a set of planning policies for Oahu's most diverse and populous region, an area extending from Kāhala to Pearl City across the valleys and coastline plains that characterize the island's southern coastline. Chapter 2 of this Development Plan outlines key elements of the vision for the PUC's future. The element of the Plan's vision that is most relevant to the lagoon restoration project is the need to protect and enhance Honolulu's natural, scenic, and cultural resources. This includes maintaining beaches and open spaces, providing adequate public shoreline access, preserving view corridors, and protecting culturally important landforms and sites. The lagoon restoration project is compatible with all of these goals, as discussed in Sections 3.10, 3.11, and 3.13.2 above.

4.2 STATE OF HAWAI'I LAWS AND REGULATIONS

4.2.1 HAWAII STATE PLANNING ACT

The Hawai'i State Planning Act (Chapter 226, Hawai'i Revised Statutes, as amended) outlines themes, goals, guidelines, and policies for statewide planning. The proposed project relates to the following objectives and policies:

§226-8(3) Improve the quality of existing visitor destination areas.

Discussion: The lagoon restoration project is designed to revitalize the lagoon and surrounding area's scenic and recreational qualities. This will contribute to improving Waikīkī as a visitor destination area.

§226-8(4) Encourage cooperation and coordination between the government and private sectors in developing and maintaining well-designed, adequately serviced visitor industry and related developments which are sensitive to neighboring communities and activities.

Discussion: HHC is designing and implementing the lagoon restoration project in close cooperation with the City and County of Honolulu Department of Planning and Permitting and the State Department of Land and Natural Resources to ensure that adequate amenities are provided and sensitive neighboring uses are protected.

§226-11(1) Prudent use of Hawaii's land-based, shoreline, and marine resources.

Discussion: The lagoon itself is considered a unique shoreline feature and landmark of Waikīkī. The restoration plan proposed in this EA is expected to have no significant adverse effects on land, shoreline, or marine resources and will enhance the recreational and scenic value of the area around the lagoon. Hence, restoration of the lagoon is a prudent and desirable way of revitalizing the Waikīkī area.

§226-12(a) Planning for the State's physical environment shall be directed towards achievement of the objective of enhancement of Hawaii's scenic assets, natural beauty, and multi-cultural/historical resources.

Discussion: While not yet considered a historic resource (the lagoon will be fifty years of age in 2006), the lagoon has great potential as a scenic asset of Waikīkī. The objective of the proposed lagoon restoration project is to enhance that potential.

§226-13(1) Maintenance and pursuit of improved quality in Hawaii's land, air, and water resources.

Discussion: Water quality improvement is an integral component of the lagoon restoration project. By re-configuring the inputs and outputs of the lagoon, water quality in the lagoon as well as the Ala Wai Harbor will improve from its current situation.

4.2.2 STATE LAND USE LAW

All of the facilities affected by the project are within the State Urban Land Use District, except the lagoon itself, which is in the Conservation District. Hawai'i Administrative Rule §15-15-18 characterizes the Urban district as exhibiting "city-like" concentrations of people, structures, streets, urban level of services and other related land uses. The small portion of the proposed project that entails work within the Urban District is consistent with the District's goals.

Duke Kahanamoku Lagoon is within the State Conservation District, and construction of the lagoon restoration project will require a Conservation District Use Permit (CDUP) as described in Hawai'i Revised Statutes §183C-6. This EA will be submitted to the State Department of Land and Natural Resources in support of HHC's CDUP application for the project.[36] The criteria that the LUC will use in evaluating the project are outlined in Hawai'i Administrative Rules, §13-5-30(c). Each criterion, followed by a discussion of how the proposed lagoon restoration project fulfills it, is reproduced in italics below.

(1) The proposed land use is consistent with the purpose of the conservation district;

Discussion: The purpose of the conservation district is to conserve, protect, and preserve the important natural resources of the State through appropriate management and use to promote their long-term sustainability and the public's health, safety, and welfare (HAR §13-5-1). As discussed throughout this EA, the lagoon restoration project is expected to have significant benefits in the way of public recreation, visual appreciation, safety, access, and sanitation. Thus, it is in keeping with the purpose of the conservation district.

(2) The proposed land use is consistent with the objectives of the subzone of the land on which the use will occur;

Discussion: The lagoon is in the General (G) subzone of the Conservation District. The objective of this subzone is to designate open space where specific conservation uses may not be defined, but where urban use would be premature (HAR §13-5-14(a)). The proposed lagoon restoration is considered an open space land use, defined in HAR §13-5-25 as *"Land uses promoting natural open space and scenic value including those with accessory structures; provided, however, that no new golf courses shall be developed in the conservation district."* Open space use is permitted in the conservation district with a Board permit, which HHC is seeking for the project.

[36] Note. The Duke Kahanamoku lagoon was constructed prior to the adoption of the State Land Use Law. When State Land Use Districts were designated in 1967, it was classified in conformity with the existing limits of the lagoon. The proposed restoration will reduce the perimeter the lagoon, and as a result the Conservation District boundary will extend beyond its intended limit (i.e., the shoreline of the lagoon). To avoid future confusion, if the restoration project is approved and implemented, HHC may seek a State Land Use Commission it may be necessary for HHC to seek a State Land Use District Boundary interpretation to bring the official map into agreement with the facts on the ground.

(3) *The proposed land use complies with provisions and guidelines contained in chapter 205A, HRS, entitled "Coastal Zone Management," where applicable;*

Discussion: The discussion in Section 4.3.5 below confirms the consistency of the project with the Coastal Zone Management Act and the objectives outlined in Chapter 205A, HRS.

(4) *The proposed land use will not cause substantial adverse impact to existing natural resources within the surrounding area, community or region;*

Discussion: As discussed in Chapter 3 of this report, the proposed project will enhance the lagoon environment without causing substantial adverse effects on the surrounding community. The temporary increases in noise and traffic that will occur during construction will be mitigated through measures that are part of the proposed project. Over the long term, the project will improve water quality in the lagoon and in the inner basin of the Ala Wai Harbor.

(5) *The proposed land use, including buildings, structures and facilities, shall be compatible with the locality and surrounding areas, appropriate to the physical conditions and capabilities of the specific parcel or parcels;*

Discussion: The proposed project consists principally of re-shaping the lagoon and dramatically enhancing its manmade water circulation system. The pump house would be almost completely screened by landscape vegetation, and the walkways are designed to blend into and enhance the existing beach setting.

(6) *The existing physical and environmental aspects of the land, such as natural beauty and open space characteristics, will be preserved or improved upon, whichever is applicable;*

Discussion: The overall goal of the project is to preserve and improve the open space environment around the lagoon. The beach areas are being improved, as are the landscaped areas on the water body's *makai* side.

(7) *Subdivision of land will not be utilized to increase the intensity of land uses in the conservation district;*

Discussion: No property subdivision is needed for the proposed project.

(8) *The proposed land use will not be materially detrimental to the public health, safety and welfare.*

Discussion: The proposed work in and around the lagoon is intended to improve public safety by enhancing water quality, removing stinging jellyfish from the lagoon, and enhancing the lighting and walkways in the area. Implementation of the plan will improve public welfare by improving the quality of the shoreline environment and the recreational resources that it provides.

4.3 FEDERAL ACTS AND LEGISLATION

4.3.1 ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACTS

As documented in Section 0, HHC has complied fully with the provisions of the Archaeological and Historic Preservation Act (16 U.S.C. § 469a-1) and the National Historic Preservation Act (16 U.S.C. § 470(f)).

4.3.2 CLEAN AIR ACT (42 U.S.C. § 7506(C))

The contractors will employ Best Management Practices (BMPs) to control fugitive dust emissions during the construction phase. Normal operation of the lagoon and related land side improvements will not produce on-site air emissions, will not alter air flow in the vicinity, and will have no other measurable effect on the area's micro-climate.

4.3.3 CLEAN WATER ACT SECTION 401 (33 U.S.C. §1341)

The Clean Water Act states:

> *Any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State...*

Operation of the proposed new lagoon circulation system will result in a discharge into the Ala Wai Harbor, requiring HHC to apply for a Water Quality Certification (WQC) from the State Department of Health. Section 3.5 of this report discusses the details of the anticipated discharge and the measures that will be taken to minimize and mitigate impacts on water quality. This EA will be submitted to DOH in support of a WQC application.

4.3.4 CLEAN WATER ACT SECTION 402 (33 U.S.C. § 1342)

Section 402 of the Clean Water Act establishes the National Pollutant Discharge Elimination System (NPDES) program. Under NPDES, all facilities which discharge pollutants from any point source into waters of the United States are required to obtain a permit. Construction of the lagoon restoration project will require an NPDES construction permit, as the affected area is larger than one acre. The contractor will minimize and treat runoff from the construction site by employing several Best Management Practices (BMPs), as described in the *Best Management Practices Manual for Construction Sites in the City and County of Honolulu* (1999). The proposed increase in the amount of lagoon water being discharged into the Ala Wai Harbor will require an NPDES permit from the State Department of Health as provided for in Hawai'i Administrative Rules (HAR) §11-55 (Water Pollution Control). Re-routing the stormwater that presently discharges into the lagoon into the inner basin of the Ala Wai Harbor will require coverage under an NPDES approval as well.

4.3.5 COASTAL ZONE MANAGEMENT ACT (16 U.S.C. § 1456(C) (1))

Enacted as Chapter 205A, HRS, the Hawai'i Coastal Zone Management (CZM) Program was promulgated in 1977 in response to the Federal Coastal Zone Management Act of 1972. The overall purpose of the CZM Program is to promote the protection and maintenance of valuable coastal resources.[37] Because HHC must obtain a Department of the Army permit for work in the lagoon, a CZM Consistency certification is required for the project. A general discussion of the lagoon restoration project's consistency with the objectives and policies of Hawai'i's CZM Program follows.

[37] The CZM area encompasses the entire state, including all marine waters seaward to the extent of the state's police power and management authority, as well as the 12-mile U.S. territorial sea and all archipelagic waters.

4.3.5.1 Recreational Resources

Objective: *Provide coastal recreational opportunities accessible to the public.*

Policies:

1. *Improve coordination and funding of coastal recreational planning and management; and*
2. *Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:*
   a. *Protecting coastal resources uniquely suitedfor recreational activities that cannot be provided in other areas;*
   b. *Requiring replacement of coastal resources having significant recreational value including, but not limited to, surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;*
   c. *Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;*
   d. *Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;*
   e. *Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;*
   f. *Adopting water quality standards and regulating point and nonpoint sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;*
   g. *Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and*
   h. *Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and county authorities; and crediting such dedication against the requirements of section 46-6.*

Discussion: Due to the degraded nature of the beach around the lagoon, the turbidity of its waters, and the accumulated soft sediments that give its bottom an undesirable feel, the Duke Kahanamoku Lagoon currently has very limited value for recreational use. Restoring it as described in this EA would expand the area of sandy beach open to the public, extend public access entirely around the lagoon, substantially expand the park-like area on the *makai* side of the lagoon, and re-establish the quality of the artificial lagoon that was created when the HHV was developed.

4.3.5.2 Historic Resources

Objective: *Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.*

Policies:

1. *Identify and analyze significant archaeological resources;*
2. *Maximize information retention through preservation of remains and artifacts or salvage operations; and*

3. *Support state goals for protection, restoration, interpretation, and display of historic resources.*

Discussion: As discussed in Section 3.10, the lagoon and surrounding area were created relatively recently and does not contain significant historic or archaeological sites.

4.3.5.3 Scenic and Open Space Resources

Objective: *Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources.*

Policies:

1. *Identify valued scenic resources in the coastal zone management area;*
2. *Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;*
3. *Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and*
4. *Encourage those developments that are not coastal dependent to locate in inland areas.*

Discussion: The proposed project is intended expressly to help restore and improve the quality of the open space around the Duke Kahanamoku Lagoon. It maintains the existing landforms and reintroduces vegetation that is native to O'ahu's shoreline.

4.3.5.4 Coastal Ecosystems

Objective: *Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.*

Policies:

1. *Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;*
2. *Improve the technical basis for natural resource management;*
3. *Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;*
4. *Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and*
5. *Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and nonpoint source water pollution control measures.*

Discussion: As discussed in Sections 3.1 and 3.8, the lagoon does not presently provide suitable habitat for corals or other biologically or economically important marine species. The proposed changes in the water circulation system and reduction in the volume of water in the lagoon will increase turnover in the lagoon to at least four times its present rate and will substitute higher quality saline groundwater for the turbid water that is presently used. Stormwater runoff will be rerouted from a recreational lagoon into a less sensitive harbor area, reducing the potential for adverse health effects.

4.3.5.5 Economic Uses

Objective: *Provide public or private facilities and improvements important to the State's economy in suitable locations.*

Policies:

1. *Concentrate coastal dependent development in appropriate areas;*
2. *Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and*
3. *Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:*
   a. *Use of presently designated locations is not feasible;*
   b. *Adverse environmental effects are minimized; and*
   c. *The development is important to the State's economy.*

Discussion: The lagoon has existed at its present location for almost fifty years. The proposed lagoon restoration project will enhance its suitability for public recreation while maintaining or enhancing other coastal values.

4.3.5.6 Coastal Hazards

Objective: *Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.*

Policies:

1. *Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and nonpoint source pollution hazards;*
2. *Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and nonpoint source pollution hazards;*
3. *Ensure that developments comply with requirements of the Federal Flood Insurance Program; and*
4. *Prevent coastal flooding from inland projects.*

Discussion: The lagoon and surrounding area is within a defined flood hazard zone and tsunami inundation area, as is the entire Waikīkī beachfront. The pumps and other equipment that will be installed in areas subject to flooding are being flood-proofed in compliance with applicable flood control regulations. During periodic storms, waves overtop the beach berm at the *makai* end of the lagoon. HHV has an emergency response plan for these types of situations, and will integrate procedures for notifying users of the lagoon area, removing portions of the walkway, and protecting other facilities into this plan.

4.3.5.7 Managing Development

Objective: *Improve the development review process, communication, and public participation in the management of coastal resources and hazards.*

Policies:

1. *Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;*

2. *Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and*
3. *Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.*

Discussion: HHC has consulted extensively with government agencies at the city, state, and federal level in designing the proposed lagoon improvements. It has obtained the City's approval for the plan (see Appendix A) and is now continuing public participation and comment with the submission of this EA. By working closely with the approving agencies HHC hopes to facilitate timely processing of the required permits and approvals.

4.3.5.8 Public Participation

Objective: *Stimulate public awareness, education, and participation in coastal management.*

Policies:

1. *Promote public involvement in coastal zone management processes;*
2. *Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and*
3. *Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.*

Discussion: Representatives of HHV have met with neighbors, the Waikīkī Neighborhood Board, the Makai Society, the Hawai'i Yacht Club, the Ilikai Apartment Owners' Association, and others to make them aware of its plans for the lagoon. The public will have an opportunity to review and comment on the EA, pursuant to the requirements of Hawai'i Administrative Rules §11-200. In addition, the public participation objective will be addressed during the processing of the Conservation District Use Permit, which will include public notification and a public hearing before the Board of Land and Natural Resources, and various Department of Health approvals.

4.3.5.9 Beach Protection

Objective: *Protect beaches for public use and recreation.*

Policies:

1. *Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;*
2. *Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and*
3. *Minimize the construction of public erosion-protection structures seaward of the shoreline.*

Discussion: The lagoon restoration project does not involve construction within the shoreline setback area. The proposed beach berm reinforcement will occur inland of the SSA (Figure 2.1). The improvements to the lagoon area will not interfere with shoreline processes or exacerbate erosion. The only activity to occur seaward of the shoreline will be the closing of the ocean intakes, which does not constitute an erosion-protection action and will not interfere with shoreline processes.

4.3.5.10 Marine Resources

Objective: *Promote the protection, use, and development of marine and coastal resources to assure their sustainability.*

Policies:

1. *Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;*
2. *Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;*
3. *Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone;*
4. *Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and*
5. *Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.*

Discussion: The design of the lagoon restoration project was arrived at through consideration of many environmental, economic, and social factors and through much consultation with various government agencies as well as experts in the biological and oceanographic sciences. It represents a solution that HHC believes is technically and economically feasible and that will ultimately enhance Waikīkī's scenic qualities and recreational appeal. A copy of this EA is being sent to the Office of Coastal Zone Management at the State of Hawai'i Department of Business, Economic Development, and Tourism, and HHC will seek a CZM Consistency certification as part of its overall permitting process.

4.3.6 ENDANGERED SPECIES ACT (16 U.S.C. 1536(A)(2) AND (4))

The Endangered Species Act (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the U.S. or elsewhere. The Act mandates that federal agencies seek to conserve endangered and threatened species and use their authorities in furtherance of the Act's purposes. It provides for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions. As discussed in Sections 3.7 and 3.8 of this report, there are no known rare or endangered species on or immediately adjacent to the project site that could be adversely affected by the proposed lagoon restoration project.

4.3.7 FLOODPLAIN MANAGEMENT (42 U.S.C. § 4321, EX. ORDER NO. 11988)

As described in Section 3.6.2, the project site lies within Flood Zones A, AE, and AO, which are all areas expected to be impacted by 100-year storms. The project does not call for the placement of any structures that would exacerbate existing flood hazards or substantially increase risk to life and property.

2. *Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and*
3. *Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.*

Discussion: HHC has consulted extensively with government agencies at the city, state, and federal level in designing the proposed lagoon improvements. It has obtained the City's approval for the plan (see Appendix A) and is now continuing public participation and comment with the submission of this EA. By working closely with the approving agencies HHC hopes to facilitate timely processing of the required permits and approvals.

4.3.5.8 Public Participation

Objective: *Stimulate public awareness, education, and participation in coastal management.*

Policies:

1. *Promote public involvement in coastal zone management processes;*
2. *Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and*
3. *Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.*

Discussion: Representatives of HHV have met with neighbors, the Waikīkī Neighborhood Board, the Makai Society, the Hawai'i Yacht Club, the Ilikai Apartment Owners' Association, and others to make them aware of its plans for the lagoon. The public will have an opportunity to review and comment on the EA, pursuant to the requirements of Hawai'i Administrative Rules §11-200. In addition, the public participation objective will be addressed during the processing of the Conservation District Use Permit, which will include public notification and a public hearing before the Board of Land and Natural Resources, and various Department of Health approvals.

4.3.5.9 Beach Protection

Objective: *Protect beaches for public use and recreation.*

Policies:

1. *Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;*
2. *Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and*
3. *Minimize the construction of public erosion-protection structures seaward of the shoreline.*

Discussion: The lagoon restoration project does not involve construction within the shoreline setback area. The proposed beach berm reinforcement will occur inland of the SSA (Figure 2.1). The improvements to the lagoon area will not interfere with shoreline processes or exacerbate erosion. The only activity to occur seaward of the shoreline will be the closing of the ocean intakes, which does not constitute an erosion-protection action and will not interfere with shoreline processes.

4.3.5.10 Marine Resources

Objective: *Promote the protection, use, and development of marine and coastal resources to assure their sustainability.*

Policies:

1. *Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;*
2. *Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;*
3. *Assert and articulate the interests of the State as a partner with federal agencies in the sound management of ocean resources within the United States exclusive economic zone;*
4. *Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and*
5. *Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources.*

Discussion: The design of the lagoon restoration project was arrived at through consideration of many environmental, economic, and social factors and through much consultation with various government agencies as well as experts in the biological and oceanographic sciences. It represents a solution that HHC believes is technically and economically feasible and that will ultimately enhance Waikīkī's scenic qualities and recreational appeal. A copy of this EA is being sent to the Office of Coastal Zone Management at the State of Hawai'i Department of Business, Economic Development, and Tourism, and HHC will seek a CZM Consistency certification as part of its overall permitting process.

4.3.6 ENDANGERED SPECIES ACT (16 U.S.C. 1536(A)(2) AND (4))

The Endangered Species Act (16 U.S.C. §§ 1531-1544, December 28, 1973, as amended 1976-1982, 1984 and 1988) provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the U.S. or elsewhere. The Act mandates that federal agencies seek to conserve endangered and threatened species and use their authorities in furtherance of the Act's purposes. It provides for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions. As discussed in Sections 3.7 and 3.8 of this report, there are no known rare or endangered species on or immediately adjacent to the project site that could be adversely affected by the proposed lagoon restoration project.

4.3.7 FLOODPLAIN MANAGEMENT (42 U.S.C. § 4321, EX. ORDER NO. 11988)

As described in Section 3.6.2, the project site lies within Flood Zones A, AE, and AO, which are all areas expected to be impacted by 100-year storms. The project does not call for the placement of any structures that would exacerbate existing flood hazards or substantially increase risk to life and property.

5.0 ANTICIPATED DETERMINATION

5.1 SIGNIFICANCE CRITERIA

Chapter 343, Hawai'i Revised Statutes (HRS), and Hawai'i Administrative Rules (HAR) §11-200 establish certain categories of action that require the agency processing an applicant's request for approval to prepare an environmental assessment. In this case, the following proposed actions require HHC to comply with Chapter 343: 1) use of state lands; 2) construction within the State Conservation District.

Hawai'i Administrative Rules §11-200-11.2 establishes procedures for determining if an environmental impact statement (EIS) should be prepared or if a Finding of No Significant Impact (FONSI) is warranted. §11-200-11.2 (1) provides that applicants should issue an environmental impact statement preparation notice (EISPN) for actions that it determines may have a significant effect on the environment. Hawai'i Administrative Rules §11-200-12 lists the following criteria to be used in making that determination:

In most instances, an action shall be determined to have a significant effect on the environment if it:

1. *Involves an irrevocable commitment to loss or destruction of any natural or cultural resource;*
2. *Curtails the range of beneficial uses of the environment;*
3. *Conflicts with the State's long-term environmental policies or goals as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders;*
4. *Substantially affects the economic or social welfare of the community or State;*
5. *Substantially affects public health;*
6. *Involves substantial secondary impacts, such as population changes or effects on public facilities;*
7. *Involves a substantial degradation of environmental quality;*
8. *Is individually limited but cumulatively has considerable effect on the environment or involves a commitment for larger actions;*
9. *Substantially affects a rare, threatened, or endangered species, or its habitat;*
10. *Detrimentally affects air or water quality or ambient noise levels;*
11. *Affects or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters;*
12. *Substantially affects scenic vistas and view planes identified in county or state plans or studies; or,*
13. *Requires substantial energy consumption.*

5.2 FINDINGS

During the preparation of this EA, the potential effects of the proposed project were evaluated using these significance criteria. The findings with respect to each criterion are summarized below:

5.2.1 IRREVOCABLE LOSS OR DESTRUCTION OF VALUABLE RESOURCE

No valuable natural or cultural resources have been found on the site, which has been in its present use since the mid-1950s. The proposed project is intended to enhance those existing resources by improving water quality, removing invasive species, and replacing beach sand that has eroded over the years. It has been designed to eliminate the need for off-site disposal of dredged spoils.

5.2.2 CURTAILS BENEFICIAL USES

As discussed in Section 3.16 the project is consistent with the planned land use for the area. It would enhance, rather than curtail, beneficial uses of the area.

5.2.3 CONFLICTS WITH LONG-TERM ENVIRONMENTAL POLICIES OR GOALS

As discussed in Sections 4.1.4 and 4.2.1, the proposed project is consistent with the *Primary Urban Center Development Plan* and the Hawai'i State Planning Act. The analysis conducted during preparation of this document indicates that it would not produce adverse effects that are inconsistent with long-term environmental policies or goals.

5.2.4 SUBSTANTIALLY AFFECTS ECONOMIC OR SOCIAL WELFARE

As discussed in Section 3.12, construction and operation of the proposed improvements will not substantially affect economic or social welfare on either a short-term or a long-term basis. While the construction of the project will provide some temporary employment, those jobs are not expected to affect the economic status or social welfare of the area in any substantial way.

5.2.5 PUBLIC HEALTH EFFECTS

The proposed project will not adversely affect air quality (see Section 3.4). Because of the vastly improved circulation within the lagoon and the near elimination of stormwater runoff into it, bacterial levels in the lagoon are expected to be substantially lower than they are at present (see Section 3.5.3.1. Construction noise has the potential to exceed noise standards at the property line, but the potential adverse effects of this will be mitigated by the noise abatement and attenuation measures that the construction contractor will employ to comply with DOH noise limits. For a complete discussion of noise impacts, see Section 3.9 of this EA.

5.2.6 PRODUCE SUBSTANTIAL SECONDARY IMPACTS

The proposed project will not produce substantial secondary impacts. Restoration of the lagoon is not designed to foster population growth. However, the improvement in water quality and the creation of an enhanced recreational beach immediately adjacent to the Hilton Hawaiian Village will make it a more attractive location for residents and visitors.

5.2.7 SUBSTANTIALLY DEGRADE ENVIRONMENTAL QUALITY

As discussed in Chapter 3.0 , the proposed project will not have substantial long-term environmental effects. Noise and fugitive dust from construction activities are the only impacts of note, and they will be of limited duration. So long as adequate measures are taken to control the timing and intensity of the construction noise and reduce the amount of airborne dust, effects on nearby residents will not be substantial.

5.2.8 CUMULATIVE EFFECTS OR COMMITMENT TO A LARGER ACTION

Development of the proposed drainage improvements is not a commitment to a larger action and will not promote substantial population growth. Fundamental aspects of the lagoon restoration project, including addressing the problems of accumulated silt and eroded sand, increasing the rate of water exchange, and decreasing the amount of sediments suspended in the water column, are independent of HHC's development of the Waikikian Tower. However, one of the conditions of the approvals for the Waikikian development was that Hilton prepare and implement a plan for improving water quality and other aspects of the lagoon environment.

5.2.9 EFFECTS ON RARE, THREATENED, OR ENDANGERED SPECIES

The proposed project will not utilize or adversely affect a resource needed for the protection of rare, threatened, or endangered species (see Section 3.8 for a complete discussion).

5.2.10 AFFECTS AIR OR WATER QUALITY OR AMBIENT NOISE LEVELS

As discussed in Section 3.4.2, construction and operation of the proposed improvements will not have a measurable long-term effect on air quality. Neither will it have a long-term effect on noise levels (see Section 3.9.2). The project does have the potential to increase noise levels temporarily during the construction phase. Adequate mitigation measures will be taken to minimize these effects. Similarly, adverse water quality effects during the construction period will be avoided by sealing the lagoon off from both the harbor and the ocean at the outset of construction, eliminating all potential for adverse effect during this period. Water quality sampling and modeling show that it would substantially reduce turbidity, suspended sediment, Chlorophyll a, and bacterial levels within the lagoon; this would substantially improve its recreational value. The proposed project would have a similar effect on the quality of water in the harbor close to the discharge points. Levels of some nutrients would rise in the lagoon and in portions of the harbor close to the discharge points, but the effect would rapidly disappear, returning to background levels before leaving the harbor.

5.2.11 ENVIRONMENTALLY SENSITIVE AREAS

The lagoon is located within the State Conservation District. However, it is a degraded manmade environment, not an environmentally sensitive area. The proposed action would improve virtually aspects of environmental quality within the affected area.

5.2.12 AFFECTS SCENIC VISTAS AND VIEWPLANES

The proposed project is not part of a designated scenic area. It will not alter views across it, but the proposed changes will make it a more attractive and scenic area (see Section 3.13.2).

5.2.13 REQUIRES SUBSTANTIAL ENERGY CONSUMPTION

Operation of the improvements will increase energy consumption roughly in proportion to the increase in the volume of water moving through the system, i.e., energy use will be about five times the present amount. This power, as well as the electricity needed for the walkway lighting, will be supplied by HHC at no expense to the public.

5.3 ANTICIPATED DETERMINATION

In view of the foregoing, the project should not have a significant adverse impact on the environment. Consequently, a Finding of No Significant Impact is anticipated for the proposed action.

6.0 CONSULTATION & DISTRIBUTION

As discussed at the beginning of this environmental assessment, the proposed lagoon restoration project is largely the result of extensive consultation that HHC has undertaken with government agencies and with neighbors. HHC distributed the DEA to the individuals and organizations listed in Table 6.1 and requested their comments on the project. The list of parties who submitted comments is included in Table 6.2. Their comment letters and HHC's responses to them are reproduced at the end of this Chapter.

Table 6.1. Draft EA Distribution List

State Agencies	***Libraries and Depositories***
Coastal Zone Management Program Planning Office (DBEDT)	Library, Honolulu Department of Customer Services
Department of Land and Natural Resources (5 copies)	Hawai'i State Library Hawaii Documents Center
Department of Health, Clean Water Branch (3 copies)	DBEDT Library
Office of Hawaiian Affairs	Waikiki-Kapahulu Public Library
Office of Environmental Quality Control (4 copies)	UH Hamilton Library
State Historic Preservation Division (DLNR)	Legislative Reference Bureau
Department of Transportation	
Department of Accounting and General Services	***Elected Officials***
	Honolulu City Council member Charles K. Djou
Federal Agencies	Neighborhood Board No.9 Chairperson Robert Finley
EPA – Pacific Islands Contact Office	State Senator Gordon Trimble
US Army Corps of Engineers, Honolulu District	State Representative Galen Fox
US Natural Resources Conservation Service	US Representative Neil Abercrombie
US Fish and Wildlife Service	US Senator Daniel Inouye
US National Marine Fisheries Service	US Senator Daniel Akaka
US Coast Guard	Mayor Mufi Hanneman
	Governor Linda Lingle
City and County of Honolulu	
Board of Water Supply	***Other Parties***
Department of Design and Construction	University of Hawai'i Environmental Center
Department of Environmental Services	University of Hawai'i Water Resources Research Center
Department of Facility Maintenance	Honolulu Advertiser
Department of Parks and Recreation	Honolulu Star Bulletin
Department of Planning & Permitting (5 copies)	Pacific Business News
Department of Transportation Services	Waikiki Improvement Association
Fire Department	Ilikai Apartment Owners Association
Police Department	Renaissance Ilikai Hotel
	Hawaii Prince Hotel
Utilities	Makai Society
Verizon	Hawaii Yacht Club
The Gas Company	
Hawaiian Electric Company, Inc.	
Source: Compiled by Planning Solutions, Inc.	

Table 6.2. Written Comments Received on the Draft EA

No.	*Name & Title of Commenter*	*Agency or Organizational Affiliation*
1	Laverne Higa, P.E., Director & Chief Engineer	Department of Facility Maintenance, City and County of Honolulu
2	Jill Lee, Manager – OSP Engineering	Hawaiian Telcom
3	Boisse P. Correa, Chief of Police	Honolulu Police Department, City and County of Honolulu
4	Ernest Y.W. Lau, Public Works Administrator	Department of Accounting and General Services, State of Hawai'i
5	Eric T. Hirano, Chief Engineer	Engineering Division, DLNR
6	Wayne M. Hashiro, P.E., Director	Department of Design & Construction, City & County of Honolulu
7	Senator Daniel K. Akaka	United States Senate
8	Attilio K. Leonardi, Fire Chief	Honolulu Fire Department, City and County of Honolulu
9	Keith S. Shida, Principal Executive	Board of Water Supply, City and County of Honolulu
10	Lester K.C. Chang, Director	Department of Parks & Recreation, City & County of Honolulu
11	Rodney K. Haraga, Director	Department of Transportation, State of Hawai'i
12	Charles E. Calvet, P.E. Manager	The Gas Company
13	Edward Y. Hirata, Director	Department of Transportation Services, City & County of Honolulu
14	Henry Eng, Director	Department of Planning & Permitting, City & County of Honolulu
15	Harold Lao, Acting Manager	Department of Health Environmental Planning Office, State of Hawai'i
16	John T. Harrison, Environmental Coordinator	University of Hawai'i Environmental Center
17	Genevieve Salmonson, Director	Office of Environmental Quality Control, State of Hawai'i Department of Health
18	Sam Lemmo, Administrator	Office of Conservation & Coastal Lands, State of Hawai'i Department of Land & Natural Resources

Source: Compiled by Planning Solutions, Inc.

DEPARTMENT OF FACILITY MAINTENANCE

CITY AND COUNTY OF HONOLULU

1000 ULUOHIA STREET, SUITE 215, KAPOLEI, HAWAII 96707

(1)

LAVERNE HIGA, P.E.
DIRECTOR AND CHIEF ENGINEER

IN REPLY REFER TO:
DRM 05-828

August 25, 2005

Mr. Perry White, President
Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: **Draft Environmental Assessment (DEA) for the Duke Kahanamoku Lagoon Restoration Project, Waikiki Beach at Hilton Hawaiian Village, O'ahu, Hawai'i (TMK's: 2-3-037:021, 2-6-009:001, 2-6-008:034, 2-6-009:010, 2-6-009:002 and 2-3-037:012)**

Thank you for giving us the opportunity to comment on the subject DEA. We have no comments since it appears that the project does not negatively impact any of our facilities or infrastructure that we are responsible for.

We are returning the DEA for your use.

Should you have any questions, please contact Larry Leopardi, Chief of the Division of Road Maintenance, at 484-7600.

Very truly yours,

LAVERNE HIGA, P.E.
Director and Chief Engineer

Attach.

PLANNING SOLUTIONS

August 25, 2005
2005-0001-001

Ms. Laverne Higa, P.E., Director and Chief Engineer
Department of Facility Maintenance
City and County of Honolulu
1000 Ulohia Street, Suite 215
Kapolei, HI 96707

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Ms. Higa:

Thank you for your August 25, 2005 letter concerning the *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the report and returning the document to us.

We are pleased to hear that the project will not negatively impact DFM's facilities or infrastructure. If you have any further questions concerning the project, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

(2)

August 24, 2005

Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814

Subject: Duke Kahanamoku Lagoon Restoration Project – Hilton Hotels Corp.

To Whom It May Concern::

Thank you for the opportunity to review the above project. We have the following comments to make:

- As far as Hawaiian Telcom, Inc. is concern, providing telephone service should not negatively impact the environment within the project area
- All electrical work shall conform to all electrical codes.
- Telephone service connection shall be determined once electrical drawings are submitted.

Should you have any questions, please call Noel Remigio at 840-5847.

Sincerely,

Jill Lee
Manager – OSP Engineering, East & West Oahu

C: File (Punahou)
N. Remigio

PLANNING SOLUTIONS

August 29, 2005
2005-0801-001

Ms. Jill Lee, Manager
OSP Engineering
Hawaiian Telcom
1177 Bishop Street
Honolulu, HI 96813

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikīkī Beach, O'ahu, Hawai'i

Dear Ms. Lee:

Thank you for your August 24, 2005 letter commenting on the *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document and providing written comments.

Thank you for confirming that providing telephone service will not adversely impact the environment in the project area. Hilton Hotels Corporation (HHC) will obtain a building permit for all of the electrical work associated with the project, and will ensure that it conforms to all pertinent codes. The project engineer will coordinate with Hawaiian Telcom with respect to telephone service connections.

Thank you again for your comments. If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC
Mr. Dean Alcon, Alcon & Associates

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU
801 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96813 · AREA CODE (808) 529-3111
http://www.honolulupd.org
www.honolulu.gov

(3)

BOISSE P. CORREA
CHIEF

BS-KP

August 18, 2005

Mr. Perry J. White, President
Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Thank you for the opportunity to review and comment on the Draft Environmental Assessment for the Duke Kahanamoku Restoration Project.

This project should have no significant impact on the facilities or operations of the Honolulu Police Department.

If there are any questions, please call Major Thomas Nitta of District 6 at 529-3351 or Mr. Brandon Stone of the Executive Bureau at 529-3644.

Sincerely,

BOISSE P. CORREA
Chief of Police

By [signature]
KARL GODSEY
Assistant Chief of Police
Support Services Bureau

Serving and Protecting with Aloha

PLANNING SOLUTIONS

August 31, 2005
2005-0001-001

Chief Boisse P. Correa
Police Department
City and County of Honolulu
801 South Beretania Street
Honolulu, Hawai'i 96813

**Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i**

Dear Chief Correa:

Thank you for your August 18, 2005 letter (your reference BS-KP) commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project.*

We appreciate the time you and your staff spent reviewing the document and we are pleased to hear that the project should have no significant impact on the facilities or operations of the Honolulu Police Department.

If you have any further questions, please call me at 550-4483.

Sincerely,

[signature]
Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

LINDA LINGLE
GOVERNOR

(4)

RUSS K. SAITO
COMPTROLLER
KATHERINE H. THOMASON
DEPUTY COMPTROLLER

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES
P.O. BOX 119, HONOLULU, HAWAII 96810

(P)1232.5

AUG 31 2005

Mr. Perry J. White, President
Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: Draft Environmental Assessment for the
Duke Kahanamoku Lagoon Restoration Project
Waikiki Beach at Hilton Hawaiian Village
Oahu, Hawaii
TMKs: 2-3-037:021, 2-6-009:001, 2-6-008:034, 2-6-009:010
2-6-009:002 and 2-3-037:012

Thank you for the opportunity to provide comments prior to the subject project's Draft Environmental Assessment. This project does not directly impact any of the Department of Accounting and General Services' projects or existing facilities and we have no comments to offer at this time.

If you have any questions, please have your staff call Mr. Bruce Bennett of the Planning Branch at 586-0491.

Sincerely,

ERNEST Y. W. LAU
Public Works Administrator

BB:mo
c: Ms. Genevieve Salmonson, OEQC

PLANNING SOLUTIONS

September 1, 2005
2005-0001-001

Ernest Y.W. Lau, Public Works Administrator
Department of Accounting and General Services
State of Hawai'i
P.O. Box 119
Honolulu, Hawai'i 96810

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Lau:

Thank you for your August 31, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment* (*DEA*): *Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document.

We are pleased that the project does not directly impact any of your Department's projects or existing facilities, and we understand that you have no comments on the project at this time. If, in the future, you have any questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Solbert, HHC

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

09/07/2005 10:07 FAX 8085873322 OCCL 004

DEPARTMENT OF LAND AND NATURAL RESOURCES
ENGINEERING DIVISION

Ref.: OCCL:TM / FILE NO.:OA 3241
Oahu.498

COMMENTS

(X) We confirm that the project site, according to the Flood Insurance Rate Map (FIRM), is located in Flood Zones A, AE and AO.

( ) Please take note that according to the Flood Insurance Rate Map (FIRM), the project site is located in Zone ___.

( ) Please note that the correct Flood Zone Designation for the project site according to the Flood Insurance Rate Map (FIRM) is ___.

(X) Please note that the project must comply with the rules and regulations of the National Flood Insurance Program (NFIP) presented in Title 44 of the Code of Federal Regulations (44CFR), whenever development within a Special Flood Hazard Area is undertaken. If there are any questions, please contact the State NFIP Coordinator, Ms. Carol Tyau-Beam, of the Department of Land and Natural Resources, Engineering Division at (808) 587-0267.

Please be advised that 44CFR indicates the minimum standards set forth by the NFIP. Your Community's local flood ordinance may prove to be more restrictive and thus take precedence over the minimum NFIP standards. If there are questions regarding the local flood ordinances, please contact the applicable County NFIP Coordinators below:

- (X) Mr. Robert Sumimoto at (808) 523-4254 or Mr. Mario Siu Li at (808) 523-4247 of the City and County of Honolulu, Department of Planning and Permitting.
- (X) Ms. Kelly Gomes at (808) 961-8327 (Hilo) or Mr. Kiran Emler at (808) 327-3530 (Kona) of the County of Hawaii, Department of Public Works.
- ( ) Mr. Francis Cerizo at (808) 270-7771 of the County of Maui, Department of Planning.
- ( ) Mr. Mario Antonio at (808) 241-6620 of the County of Kauai, Department of Public Works.

( ) The applicant should include project water demands and infrastructure required to meet water demands. Please note that the implementation of any State-sponsored projects requiring water service from the Honolulu Board of Water Supply system must first obtain water allocation credits from the Engineering Division before it can receive a building permit and/or water meter.

( ) The applicant should provide the water demands and calculations to the Engineering Division so it can be included in the State Water Projects Plan Update.

(X) Additional Comments: Draft Environmental Assessment - On page 3-32, Item 3.6.2.1, Introduction, first paragraph, second sentence, please indicate that Holomoana Street is also in Zone A (100-year flood zone), but no base flood elevation has been established.

( ) Other: ________________

Should you have any questions, please call Mr. Andrew Monden of the Planning Branch at 587-0229.

Signed: [signature]
for ERIC T. HIRANO, CHIEF ENGINEER

Date: 8/17/05

PLANNING SOLUTIONS

September 12, 2005
2005-0001-001

Mr. Eric T. Hirano, Chief Engineer
Engineering Division
Department of Land and Natural Resources
State of Hawai'i
1151 Punchbowl Street, Room 220
Honolulu, Hawai'i 96813

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Hirano:

Thank you for your comments on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project* (your reference OCCL:TM / FILE No.: OA 3241 Oahu.498). We appreciate the time you and your staff spent reviewing the document and providing written comments.

Item-by-item responses to your comments are provided below. The comments are reproduced for your convenience in italics before each response.

Comment 1:

We confirm that the project site, according to the Flood Insurance Rate Map (FIRM), is located in Flood Zones A, AE and AO.

Response: Thank you for confirming the flood zone designations within the project area. Our assessment (presented in Section 3.6.2 of the Draft EA) is consistent with your determination.

Comment 2:

Please note that the project must comply with the rules and regulations of the National Flood Insurance Program (NFIP) presented in Title 44 of the Code of Federal Regulations (44CFR), whenever development within a Special Flood Hazard Area is undertaken. If there are any questions, please contact the State NFIP Coordinator, Ms. Carol Tyau-Beam, of the Department of Land and Natural Resources, Engineering Division at (808) 587-0267.

Please be advised that 44CFR indicates the minimum standards set forth by the NFIP. Your Community's local flood ordinance may prove to be more restrictive and thus take precedence over the minimum NFIP standards.

Response: The project's design takes into consideration all applicable NFIP standards and local ordinances. Its consistency with flood hazard regulations is addressed in Section 3.6.2 of the Draft EA.

Comment 3:

Draft Environmental Assessment - On page 3-32, Item 3.6.2.1, Introduction, first paragraph, second sentence, please indicate that Holomoana Street is also in Zone A (100-year flood zone), but no base flood elevation has been established.

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

<u>Response:</u> Thank you for pointing out this omission. We will edit the text in that section to specify that Holomoana Street is in Flood Zone A.

Thank you again for your comments. If you have any further questions, please call me at 550-4483.

Sincerely,

Percy J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

DEPARTMENT OF DESIGN AND CONSTRUCTION
CITY AND COUNTY OF HONOLULU

September 6, 2005

Mr. Perry J. White, President
Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: Draft Environmental Assessment for the Duke Kahanamoku Lagoon Restoration Project, Waikiki Beach at Hilton Hawaiian Village, Oahu, Hawaii (TMKs: 2-3-037:021, 2-6-009:001, 2-6-008:034, 2-6-009:010, 2-6-009:002, and 2-3-037:012)

Thank you for inviting us to review the above Draft Environmental Assessment. The Department of Design and Construction does not have any comments to offer at this time.

Should you have any questions, please contact Eugene Lee, Deputy Director, at 523-4716.

Very truly yours,

WAYNE M. HASHIRO, P.E.
Director

WMH:k (116314)

PLANNING SOLUTIONS

September 12, 2005
2005-0001-001

Mr. Wayne M. Hashiro, P.E., Director
Department of Design and Construction
City and County of Honolulu
650 South King Street, 11th Floor
Honolulu, Hawai'i 96813

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikīkī Beach, O'ahu, Hawai'i

Dear Mr. Hashiro:

Thank you for your September 6, 2005 letter (your reference WMH:k (116314)) commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document and preparing your letter.

We understand that your Department has no comments to offer on the project at this time. If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

DANIEL K. AKAKA

United States Senate

WASHINGTON, DC 20510-1103

ARMED SERVICES
ENERGY AND NATURAL RESOURCES
HOMELAND SECURITY AND GOVERNMENTAL AFFAIRS
INDIAN AFFAIRS
VETERANS' AFFAIRS
SELECT COMMITTEE ON ETHICS

August 30, 2005

Mr. Perry J. White
1210 Auahi Street, #221
Honolulu, HI 96814

Dear Mr. White:

Thank you for providing me with a copy of the Draft Environmental Assessment for the proposed Duke Kahanamoku Lagoon Restoration Project.

I appreciate your keeping me apprised of this redevelopment project. Again, mahalo for contacting me on this matter.

Aloha pumehana,

DANIEL K. AKAKA
U.S. Senator

PRINTED ON RECYCLED PAPER

PLANNING SOLUTIONS

September 12, 2005
2005-0001-001

The Honorable Daniel K. Akaka
United States Senate
P.O. Box 50144
Honolulu, HI 96850

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Senator Akaka:

Thank you for your August 31, 2005 letter regarding Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project.*

We appreciate your interest in the project and will continue to keep you apprised of its development. We will provide your office with a copy of the *Final Environmental Assessment* for the project when it is completed.

In the meantime, if you have any questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

PLANNING SOLUTIONS

September 12, 2005
2005-0001-001

The Honorable Daniel K. Akaka
United States Senate
P.O. Box 50144
Honolulu, HI 96850

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikīkī Beach, O'ahu, Hawai'i

Dear Senator Akaka:

Thank you for your August 31, 2005 letter regarding Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project.*

We appreciate your interest in the project and will continue to keep you apprised of its development. We will provide your office with a copy of the *Final Environmental Assessment* for the project when it is completed.

In the meantime, if you have any questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU

ATTILIO K. LEONARDI
FIRE CHIEF

JOHN CLARK
DEPUTY FIRE CHIEF

September 8, 2005

Mr. Perry J. White, President
Planning Solutions, Inc.
Suite 330, Ward Plaza
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: Draft Environmental Assessment
Duke Kahanamoku Lagoon Restoration Project
Waikiki Beach at the Hilton Hawaiian Village
Honolulu, Oahu, Hawaii
Tax Map Keys: 2-3-037: 012 and 021
2-6-008: 034
2-6-009: 001, 002, and 010

We received your letter dated August 11, 2005, requesting our review and comments on the above-mentioned subject.

The Honolulu Fire Department requires that the following be complied with for the duration of the project:

1. Maintain fire apparatus access throughout the construction site.
2. Maintain access to fire hydrants. Notify the Fire Communication Center at 523-4411 regarding any interruption of the existing fire hydrant system.

Should you have any questions, please call Battalion Chief Lloyd Rogers of our Fire Prevention Bureau at 831-7778.

Sincerely,

ATTILIO K. LEONARDI
Fire Chief

AKL/SK:hh

PLANNING SOLUTIONS

September 12, 2005
2005-0001-001

Attilio K. Leonardi, Chief
Honolulu Fire Department
3375 Koapaka Street, Suite H425
Honolulu, HI 96819-1869

Subject: **Duke Kahanamoku Lagoon Restoration**
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Chief Leonardi:

Thank you for your September 8, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project.* We appreciate the time you and your staff spent reviewing the document and providing written comments.

The Hilton Hotel Corporation (HHC) understands that the Honolulu Fire Department requires that fire apparatus access throughout the construction site and access to fire hydrants be maintained for the duration of the project. It has indicated that it will make that a requirement of any construction contracts it awards for the project. HHC has also informed us that it will require contractors to notify the Fire Communications Center at 523-4411 regarding any interruption of the existing fire hydrant system.

If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

BOARD OF WATER SUPPLY

CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HI 96843

September 8, 2005

Mr. Perry J. White, President
Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: Your Letter of August 11, 2005, on the Draft Environmental assessment for the Duke Kahanamoku Lagoon Restoration Project at Hilton Hawaiian Village <u>TMKs: 2-3-37:21, 2-6-9:1, 2-6-8:34, 2-6-9:10, 2-6-9:2, and 2-3-37:12</u>

Thank you for the opportunity to comment on the subject document.

The existing water system is presently adequate to accommodate the proposed lagoon restoration.

The availability of water will be confirmed when the building permit is submitted for approval. When water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission, and daily storage.

The on-site fire protection requirements should be coordinated with the Fire Prevention Bureau of the Honolulu Fire Department.

The proposed project is subject to Board of Water Supply cross-connection control and backflow prevention requirements prior to issuance of the Building Permit Application.

If you have any questions, please contact Joseph Kaakua at 748-5442.

Very truly yours,

K. Shida

KEITH S. SHIDA
Principal Executive
Customer Care Division

Water for Life . Ka Wai Ola

PLANNING SOLUTIONS

September 12, 2005
2005-0001-001

Mr. Keith S. Shida, Principal Executive
Customer Care Division
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawai'i 96813

Subject: **Duke Kahanamoku Lagoon Restoration**
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Shida:

Thank you for your September 8, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project.* We appreciate the time you and your staff spent reviewing the document and providing written comments.

Item-by-item responses to your comments are provided below. The comments are reproduced for your convenience in italics before each response.

<u>*Comment 1:*</u>

The existing water system is presently adequate to accommodate the proposed lagoon restoration. The availability of water will be confirmed when the building permit is submitted for approval. When water is made available, the applicant will be required to pay our Water System Facilities Charges for resource development, transmission, and daily storage.

<u>Response:</u> Thank you for confirming that the existing water system is adequate to accommodate the proposed lagoon restoration project. HHC will pay all applicable charges once water is made available.

<u>*Comment 2:*</u>

The on-site fire protection requirements should be coordinated with the Fire Prevention Bureau of the Honolulu Fire Department.

<u>Response:</u> The Honolulu Fire Department was provided a copy of the Draft EA, and their comments will be reproduced in the Final EA. HHC will comply with all applicable fire safety regulations during construction and operation of the project.

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Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-h.com

<u>Comment 3:</u>

The proposed project is subject to Board of Water Supply cross-connection control and backflow prevention requirements prior to issuance of the Building Permit Application.

<u>Response:</u> Thank you for informing us of these requirements. We have passed this information on to the owner so that it will be sure to include this requirement in the construction documents.

Thank you again for your comments. If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Paul McElroy, Rider Hunt Levett & Bailey
Mr. Gerhard Seibert, HHC

DEPARTMENT OF PARKS AND RECREATION
CITY AND COUNTY OF HONOLULU

September 9, 2005

Mr. Perry J. White, President
Planning Solutions
210 Ward Avenue, Suite 330
Honolulu, Hawaii, 96814

Dear Mr. White:

Subject: Draft Environmental Assessment for the Duke Kahanamoku Lagoon Restoration Project, Waikiki Beach at Hilton Hawaiian Village, Oahu, Hawaii
TMKs: 2-3-037:021, 2-6-008:034, 2-6-009:010, 2-6-009:002 and 2-3-037:012

Thank you for the opportunity to review and comment on the Draft Environmental Assessment for the Duke Kahanamoku Lagoon Restoration Project at the Hilton Hawaiian Village.

The Department of Parks and Recreation has no comment on this project as it will not affect any program or facility of this department. You are invited to remove us as a consulted party to the balance of the EIS process.

Should you have any questions, please contact Mr. John Reid, Planner, at 692-5454.

Sincerely,

LESTER K. C. CHANG
Director

LKCC:mk
(116890)

PLANNING SOLUTIONS

September 13, 2005
2005-0001-001

Mr. Lester K.C. Chang, Director
Department of Parks and Recreation
City and County of Honolulu
1000 Uluohia Street, Suite 309
Kapolei, HI 96707

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Chang:

Thank you for your September 9, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment* (*DEA*): *Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document.

We are pleased to hear that the proposed project will not affect the facilities or programs of the Department of Parks and Recreation and understand that you have no further comments to offer on the project. In accordance with your request, we will remove your Department as a consulted party for the remainder of the environmental impact assessment process.

Should you have any questions in the future, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

LINDA LINGLE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

RODNEY K. HARAGA
DIRECTOR

IN REPLY REFER TO:
STP 8.1883

September 7, 2005

Mr. Perry J. White
President
Planning Solutions
210 Ward Avenue, Suite 330
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: Duke Kahanamoku Lagoon Restoration Project
Draft Environmental Assessment

Thank you for your transmittal requesting our review of the subject project. The applicant's proposal to restore water quality and constructing public facilities in and around the Duke Kahanamoku Lagoon for enhancing its recreational and scenic qualities will not impact our State highway facilities.

We appreciate the opportunity to provide comments.

Very truly yours,

RODNEY K. HARAGA
Director of Transportation

PLANNING SOLUTIONS

September 16, 2005
2003-0001-001

Mr. Rodney K. Haraga, Director
Department of Transportation
State of Hawai'i
869 Punchbowl Street
Honolulu, HI 96813-5097

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikīkī Beach, O'ahu, Hawai'i

Dear Mr. Haraga:

Thank you for your September 7, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document and we are pleased to hear that the project will not impact State highway facilities.

If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

(12)

GAS

P.O. Box 3000
Honolulu, Hawaii 96802-3000

September 13, 2005

Planning Solutions
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Attention: Mr. Perry J. White
President

Gentlemen:

Subject: Draft Environmental Assessment for the
Duke Kahanamoku Lagoon Restoration Project

Please be advised that The Gas Company, LLC maintains underground utility gas mains in the project vicinity, which serves commercial and residential customers in the area and is interconnected with the utility network in Waikiki. We would appreciate your consideration during the project planning and design process to minimize any potential conflicts with the existing gas facilities in the project area.

Thank you for the opportunity to comment on the Draft Environmental Assessment. Should there be any questions, or if additional information is desired, please call Mr. Chris Anderson at 594-5564.

Sincerely,

The Gas Company, LLC

Charles E. Calvet, P.E.
Manager, Engineering

CEC:ss
05-316

PLANNING SOLUTIONS

September 16, 2005
2005-0001-001

Mr. Charles E. Calvet, P.E.
Manager, Engineering
The Gas Company
P.O. Box 3000
Honolulu, HI 96802-3000

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Calvet:

Thank you for your September 13, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document and providing written comments. Our response follows.

Comment:

"Please be advised that The Gas Company, LLC maintains underground utility gas mains in the project vicinity, which serves commercial and residential customers in the area and is interconnected with the utility network in Waikiki. We would appreciate your consideration during the project planning and design process to minimize any potential conflicts with the existing gas facilities in the project area."

Response: Thank you for calling attention to the existing gas lines in the area. The construction plans and specifications note the presence of existing utilities and make it the responsibility of the construction contractor to contact The Gas Company, LLC before working in areas where these might be present.

If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC
Mr. Dean Alcon, Alcon & Associates

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU

September 15, 2005

TP8/05-116316R

Mr. Perry J. White, President
Planning Solutions, Inc.
Ward Plaza, Suite 330
210 Ward Avenue
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Subject: Duke Kahanamoku Lagoon Restoration Project

Thank you for your letter of August 11, 2005 requesting our review of and comments on the draft environmental assessment for the subject project. We reviewed the document and do not have any comments to submit for your consideration.

Should you have any questions regarding this matter, please contact Faith Miyamoto of the Transportation Planning Division at 527-6976.

Sincerely,

EDWARD Y. HIRATA
Director

PLANNING SOLUTIONS

September 21, 2005
2005-0001-001

Mr. Edward Y. Hirata, Director
Department of Transportation Services
City and County of Honolulu
650 South King Street, 3rd Floor
Honolulu, HI 96813

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Hirata:

Thank you for your September 15, 2005 letter (your reference TP8/05-116316R) commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document and preparing your letter.

We understand that your Department presently has no comments to offer on the proposed project. If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU

2005/ELOG-1908(cm)

September 20, 2005

Mr. Perry White, President
Planning Solutions
210 Ward Avenue Suite 330
Honolulu, Hawaii 96814-4012

Dear Mr. White:

Re: Draft Environmental Assessment
Duke Kahanamoku Lagoon Restoration Project
Hilton Hawaiian Village, Oahu
Tax Map Keys: 2-3-37:021, 2-6-8:034, 2-6-9:010, 2-6-9:002 and 2-3-37:012

We have reviewed the Draft Environmental Assessment (DEA) for Hilton Hawaiian Village's Duke Kahanamoku Lagoon Restoration Project and offer the following comments:

Project Summary – Possible Required Permits and Approvals

The portion of the table listing possible required permits and approvals should include a major Special Management Area Permit (SMP). The restoration of the lagoon is being undertaken in response to a condition of an earlier SMP (Res. 02-225, CD1) for the construction of a high rise tower and other improvements which required that the Hilton Hawaiian Village (HHV), within two (2) years, submit a detailed plan and timetable for the restoration of the lagoon and implement that plan within three (3) years, or, if that is found to be infeasible, submit a detailed plan and timetable for filling the lagoon and widening the beach. Although the restoration of the lagoon was identified as a priority in the former SMP, the details of the means and technology to be used were not addressed, and the restoration will require a major SMP.

Other county approvals may be required once special boundary or flood hazards are examined. A special district permit may be required for tree removal that was not previously considered by the Planned Development – Resort project approval (PDR), Res. 02-226, CD1, FD1.

Section 1.3 Need for Lagoon Restoration

The permit requirements associated with the development of the Waikikian Tower should be clarified as noted above. The DEA should also clarify that filling the lagoon and widening the beach was a possible alternative that would satisfy the 2002 SMP.

Section 2.3 Proposed Action: HHV Lagoon Restoration Project

Figure 2.1 illustrates that the proposed buried protective berm will be located just beyond the (forty) 40-foot shoreline setback established by an "anticipated" certified shoreline. The easternmost four hundred (400) feet of the proposed Waikiki Promenade extension would be situated atop the beach berm separating the lagoon basin from Kahanamoku Beach. Note that the berm and promenade may require a shoreline setback variance should the actual certified shoreline differ from the anticipated certified shoreline, or if the location of the berm or promenade is within the shoreline setback.

Section 2.3.1 Water Quality-Related Improvements

The proposed pump house will have an increased capacity. Since this may have some visual impacts on the lagoon, the document should provide more information on the proposed structure, such as size, height, and type of structure. It should also clarify its relationship to the special district and flood hazard districts.

Section 2.3.2 Land Side Improvements to the Lagoon Shore

A larger plan that shows the lagoon in relation to the HHV and abutting areas should be included, such as the parking lot, roadway, crosswalks, Lagoon Tower pool areas, Great Lawn, and Rainbow Tower.

Along the southern end of the promenade (parking lot), some coconut palm planting should occur on the lagoon side of the promenade to create a more interesting walking experience. Additional coconut palm planting should also be considered between the Rainbow Tower and State parking lot to provide some relief from the stark contrast between the grassy lawn areas, promenade, and sandy beach.

Clarify in the document that the existing concrete pool deck at the Lagoon Tower will be removed to allow a continuous access around the lagoon.

The special district precinct boundaries as well as the flood hazard district boundaries should be illustrated on a map with the proposed improvements. Any necessary county approvals triggered by such illustration should also be discussed.

There is mention in the DEA of planting eighty (80) additional coconut palms. The project description should clarify how much of the existing landscape, such as coconut palms, will be removed and/or retained. A special district permit may be required for tree removal that was not previously considered by the Planned Development – Resort project approval (PDR).

Section 2.3.4 Project Schedule

The schedule may require a change to reflect the major SMP subsequent to the completion of the Chapter 343 Environmental Assessment Process, since the major SMP cannot be processed until the Chapter 343 requirements are satisfied.

Section 4.0 Relationship to Relevant Plans, Policies and Controls

Table 4.1 lists only Grading, Grubbing, Excavation and Stockpiling as the applicable permit issued by the City and County of Honolulu required for the project. This table should be amended to include a major SMP.

The text within Section 4.1 states that the project does not require a separate SMP application. As noted previously, the restoration of the lagoon will require a major SMP.

As discussed earlier, once the special district precinct boundaries and the flood hazard district boundaries are included in the DEA, any necessary county approvals triggered by that examination should also be identified in Section 4.1.

There is mention in the DEA of planting eighty (80) additional coconut palms: The project description should clarify how much of the existing landscape, such as coconut palms, will be removed and/or retained. A special district permit may be required for tree removal that was not previously considered by the Planned Development – Resort project approval (PDR).

Finally, we reiterate that the proposed buried protective berm and the easternmost four hundred (400) feet of the proposed Waikiki Promenade extension may require a shoreline setback variance should the actual certified shoreline differ from the anticipated certified shoreline, or if the location of the berm or promenade is within the shoreline setback.

Should you have any questions on this matter, please contact Carrie McCabe of the Land Use Approvals Branch at 527-5349.

Very truly yours,

Henry Eng, FAICP, Director
Department of Planning and Permitting

HE:cs

[illegible]

PLANNING SOLUTIONS

November 22, 2005
2005-0001-001

Mr. Henry Eng, Director
Department of Planning and Permitting
City and County of Honolulu
650 South King Street
Honolulu, HI 96813

Subject: **Duke Kahanamoku Lagoon Restoration**
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Eng:

Thank you for your September 20, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document.

Responses to your comments follow below. To simplify your task, we have organized the responses according to the headings and paragraphs in your comment letter and have reproduced the text of each comment before our response. Where appropriate, we have indicated the changes that we will make to the report before submitting the Final Environmental Assessment to the Department of Land and Natural Resources.

PROJECT SUMMARY - POSSIBLE REQUIRED PERMITS AND APPROVALS

Comment 1

The portion of the table listing possible required permits and approvals should include a major Special Management Area Permit (SMP). The restoration of the lagoon is being undertaken in response to a condition of an earlier SMP (Res. 02-225, CD 1) for the construction of a high rise tower and other improvements which required that the Hilton Hawaiian Village (HHV), within two (2) years, submit a detailed plan and timetable for the restoration of the lagoon and implement that plan within three (3) years, or, if that is found to be infeasible, submit a detailed plan and timetable for filling the lagoon and widening the beach. Although the restoration of the lagoon was identified as a priority in the former SMP, the details of the means and technology to be used were not addressed, and the restoration will require a major SMP.

Response: The *Final Environmental Assessment* (*FEA*) for the project will reflect the requirement for a Major Special Management Area permit.

Comment 2

Other county approvals may be required once special boundary or flood hazards are examined. A special district permit may be required for tree removal that was not previously considered by the Planned Development - Resort project approval (PDR), Res. 02-226, CD 1, FD 1.

Response: Thank you for this information. The plans for the pump house have been modified so that they are consistent with the applicable flood regulations.

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawai'i 96814-4012
Phone: 808 550-4483 • Fax: 808 550 4549 • www.psi-hi.com

We believe the tree relocation that is shown on the attached landscape plan (Attachment 1) is consistent with the PD-R that was issued for the Waikikian project. In fact, the landscape architect for the work around the lagoon believes that it provides at least ten more trees than are required. We understand that the Department will evaluate this further as we complete the Chapter 343 process and will provide guidance so that we are able to submit all needed applications as soon as that process has ended.

SECTION 1.3 NEED FOR LAGOON RESTORATION

The permit requirements associated with the development of the Waikikian Tower should be clarified as noted above. The DEA should also clarify that filling the lagoon and widening the beach was a possible alternative that would satisfy the 2002 SMP.

Response: The *FEA* notes that the Department is requiring a second Special Management Area Permit. Further, the following paragraph has been included in Section 1.3 of the *FEA*:

As discussed in Section 2.2.3 of this report, Condition C.1.c. of the Special Management Area permit for the Waikikian Project recognized that restoration could prove to be infeasible and provided that if HHC determined this to be the case it would prepare a detailed plan (including a timetable) for filling the lagoon and widening the beach and submit it to DPP. Because HHC determined that the plan described in this report is physically and economically feasible, it is not presently pursuing that alternative. DPP's October 2004 approval of the conceptual plan for the lagoon restoration reflects the same opinion. Should the City fail to grant the SMA permit, or should HHC be unable to obtain the other approvals that are required from State and Federal agencies, then HHC would be required to prepare a detailed plan for filling the lagoon. Under the terms of its agreement with the State (as successor to the Territory of Hawai'i), once HHC notifies the State that it cannot obtain the permits needed to restore the lagoon to the condition mandated by the PDR, the State must fill in the lagoon to make a flat land area, provide an easement in favor of HHC, and create a "no buildings" zone.

SECTION 2.3 PROPOSED ACTION: HHV LAGOON RESTORATION PROJECT

Figure 2.1 illustrates that the proposed buried protective berm will be located just beyond the (forty) 40-foot shoreline setback established by an "anticipated" certified shoreline. The easternmost four hundred (400) feet of the proposed Waikiki Promenade extension would be situated atop the beach berm separating the lagoon basin from Kahanamoku Beach. Note that the berm and promenade may require a shoreline setback variance should the actual certified shoreline differ from the anticipated certified shoreline, or if the location of the berm or promenade is within the shoreline setback.

Response: The Final EA will note that a Shoreline Setback Variance would be required for the rock reinforcement if the approved shoreline certification should place it within 40 feet of the shoreline. This will be done by revising the last sentence in Section 2.3.2.A.2 to read as follows:

Under the proposed alignment the berm will be more than 40 feet inland of the shoreline that DLNR has proposed for certification, and therefore entirely inland of the Shoreline Setback Area defined by the City and County of Honolulu. If the shoreline that is eventually certified is substantially inland of the line for which certification has been requested, HHC will either shift the location of the berm inland sufficiently to keep work *outside the 40-foot shoreline setback area or will submit a Shoreline Setback Variance application.*

Section 2.3.1 Water Quality-Related Improvements

The proposed pump house will have an increased capacity. Since this may have some visual impacts on the lagoon, the document should provide more information on the proposed structure, such as size, height, and type of structure. It should also clarify its relationship to the special district and flood hazard districts.

Response: The *FEA* will include an elevation drawing that depicts the enlarged pump house. The pump house is in essentially the same location as the existing pump house and will be flood-proofed. Section 3.6.2.2 of the *DEA* discusses its relationship to the flood hazard district and the flood hazard districts. Plans for the pump house have been submitted to your Department for review. We believe that the plans for the pump house are now in accord with applicable flood regulations.

Section 2.3.2 Land Side Improvements to the Lagoon Shore

Comment 1

A larger plan that shows the lagoon in relation to the HHV and abutting areas should be included, such as the parking lot, roadway, crosswalks, Lagoon Tower, pool areas, Great Lawn, and Rainbow Tower.

Response: Figure 2-7 in the *DEA* depicts virtually all of the items mentioned in this comment. However, in order to provide the additional detail you have requested, the project planners prepared additional plans and reviewed these with your staff. A copy of that plan is attached to this letter (Attachment 2) and will be included in the *FEA*.

Comment 2

Along the southern end of the promenade (parking lot), some coconut palm planting should occur on the lagoon side of the promenade to create a more interesting walking experience. Additional coconut palm planting should also be considered between the Rainbow Tower and State parking lot to provide some relief from the stark contrast between the grassy lawn areas, promenade, and sandy beach.

Response: Subsequent to publication of the *DEA* the landscape architects provided the plan depicting the location of palm trees and other plantings proposed along the promenade to DPP (see Attachment 1). We understand that the Department will make a formal decision on this matter as part of its PDR and Special District review of the project.

Comment 3

Clarify in the document that the existing concrete pool deck at the Lagoon Tower will be removed to allow a continuous access around the lagoon.

Response: All of the plans included in the *DEA* show that the concrete pool deck in front of the Lagoon Tower will be demolished so that the walkway can extend entirely around the lagoon. In response to your comment, the first sentence in Section 2.3.2.1 has been revised so that in the *FEA* it reads: "*The proposed plan provides a public walkway that extends entirely around the lagoon*" [the

underlined words have been added]. In addition, the second-to-last sentence in that paragraph has been revised to read as follows. "*The existing pool in front of the Lagoon Tower will be demolished to allow a secondary walkway to pass around the mauka side of the lagoon, completing the encirclement called for in the City's approvals of the Waikikian project.*"

Comment 4

The special district precinct boundaries as well as the flood hazard district boundaries should be illustrated on a map with the proposed improvements. Any necessary county approvals triggered by such illustration should also be discussed.

Response: All of the lagoon and the beach area that is *makai* of it is public land that is in the Public Precinct as shown on the Waikiki Special Design District map. All of the property that is inland of that is in the Resort Mixed Use precinct.

The project's relationship to the flood hazard district boundaries is discussed above in our response to an earlier question. We have also included figures showing the flood hazard district boundaries, zoning, and Special District boundaries in Chapter 4 of the *FEA*. The project's compliance with the terms of the WSDD is discussed in Section 4.1.2 of the *FEA*.

Comment 5

There is mention in the DEA of planting eighty (80) additional coconut palms. The project description should clarify how much of the existing landscape, such as coconut palms, will be removed and/or retained. A special district permit may be required for tree removal that was not previously considered by the Planned Development - Resort project approval (PDR).

Response: The landscape plan included as Attachment 1 shows the location of existing and proposed coconut palms, including those planned to be relocated. We understand that the Department will make a formal decision on this matter as part of its PDR and Special District review of the project when HHC formally submits its plans.

Section 2.3.4 Project Schedule

Comment 1

The schedule may require a change to reflect the major SMP subsequent to the completion of the Chapter 343 Environmental Assessment Process, since the major SMP cannot be processed until the Chapter 343 requirements are satisfied.

Response: The schedule in the *FEA* reflects the extended time period needed now that the City has determined that a separate SMA permit is needed in order to implement improvements required by the SMP for the Waikikian project.

Section 4.0 Relationship to Relevant Plans, Policies and Controls

Comment 1

> *Table 4.1 lists only Grading, Grubbing, Excavation and Stockpiling as the applicable permit issued by the City and County of Honolulu required for the project. This table should be amended to include a major SMP.*

Response: We have revised the table to reflect the need for a major SMP, as well as a building permit.

Comment 2

> *The text within Section 4.1 states that the project does not require a separate SMP application. As noted previously, the restoration of the lagoon will require a major SMP.*

Response: We have revised the text in Section 4.1 to reflect the need for a major SMP.

Comment 3

> *As discussed earlier, once the special district precinct boundaries and the flood hazard district boundaries are included in the DEA, any necessary county approvals triggered by that examination should also be identified in Section 4.1.*

Response: HHC will formally submit detailed plans for the proposed improvements shortly. We understand that the Department will make a decision on this matter as part of its PDR and Special District review of the project. We will note that as a possibility in Section 4.1 and in the Project Summary.

Comment 4

> *There is mention in the DEA of planting eighty (80) additional coconut palms: The project description should clarify how much of the existing landscape, such as coconut palms, will be removed and/or retained. A special district permit may be required for tree removal that was not previously considered by the Planned Development -- Resort project approval (PDR).*

Response: The landscape plan included as Attachment 1 shows the location of existing and proposed coconut palms, including those planned to be relocated. We understand that the Department will make a formal decision on this matter as part of its PDR and Special District review of the project when HHC formally submits its plans.

Comment 5

> *Finally, we reiterate that the proposed buried protective berm and the easternmost four hundred (400) feet of the proposed Waikiki Promenade extension may require a shoreline setback variance should the actual certified shoreline differ from the anticipated certified shoreline, or if the location of the berm or promenade is within the shoreline setback.*

Response: Thank you for noting this requirement. The feature is inland of the shoreline that the State Surveyor has proposed for certification. Hence, unless an objection is filed by November 28, 2005, that eventually results in the shoreline being certified well inland of the location that the State

Surveyor has proposed, a setback variance will not be needed. If the certified shoreline is inland of the line that the State Surveyor has proposed for certification, the improvements will be shifted inland to remain outside the setback area or a shoreline setback variance will be sought.

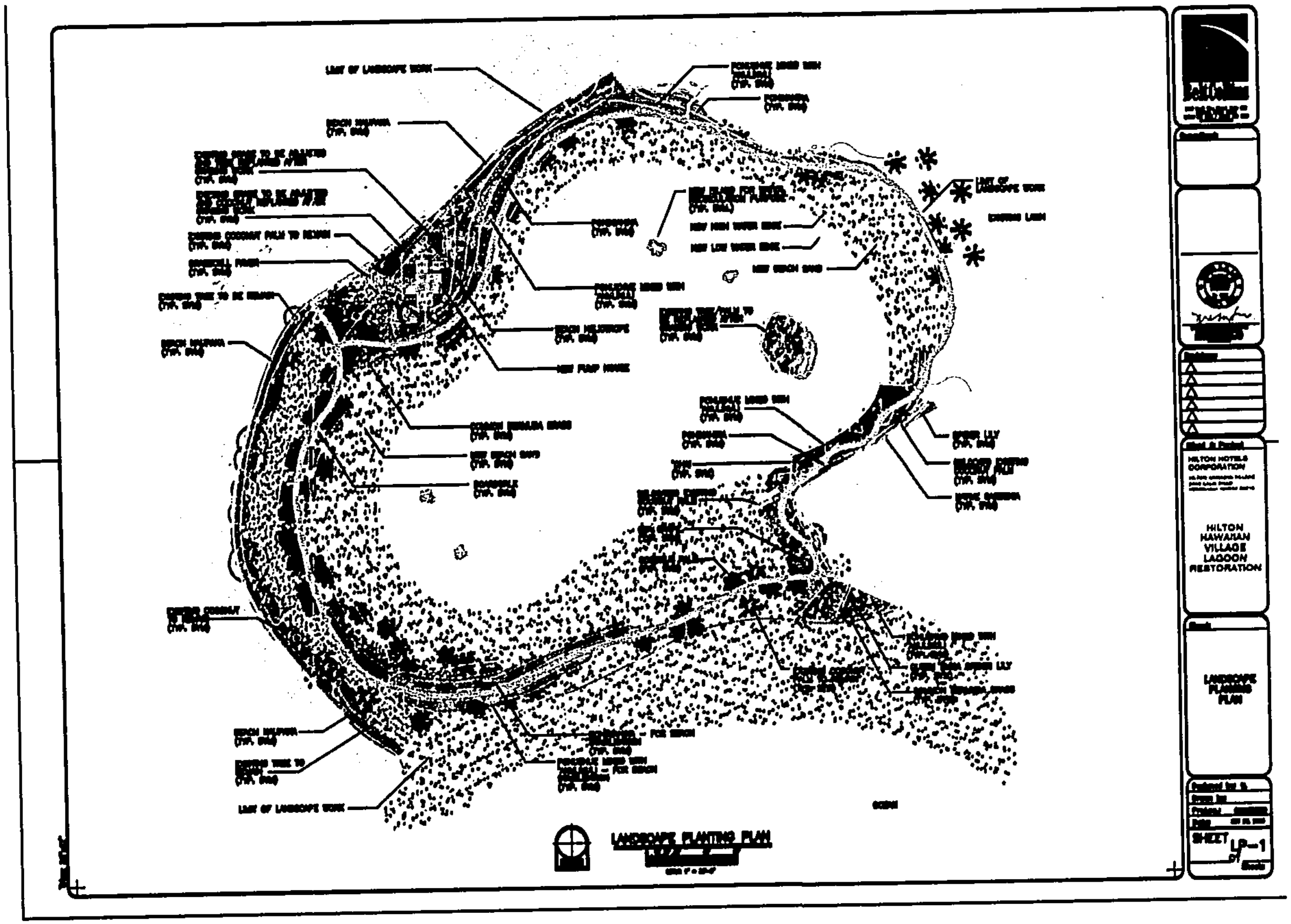
If you have any further questions, please call me at 550-4483.

Sincerely,

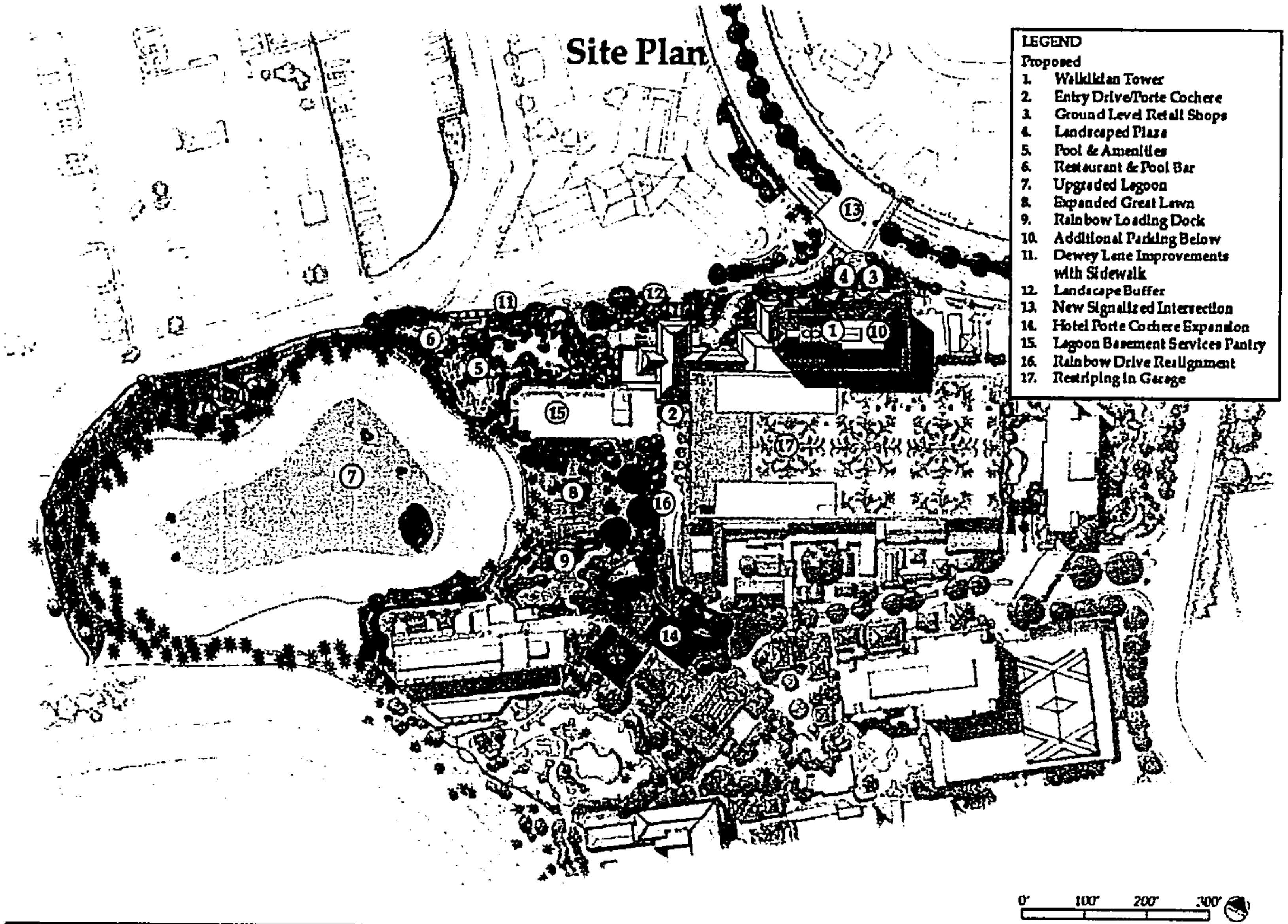
Perry J. White

Attachments:
(1) Landscape plan
(2) Site plan of lagoon and vicinity

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC


LIMIT OF LANDSCAPE WORK
BEACH NAUPAKA (TYP. SHS)
NEW PUMP HOUSE
NEW BEACH SAND
NEW HIGH WATER EDGE
NEW LOW WATER EDGE
EXISTING LAWN
SPIDER LILY (TYP. SHS)
LIMIT OF LANDSCAPE WORK
HILTON HOTELS CORPORATION
HILTON HAWAIIAN VILLAGE LAGOON RESTORATION
LANDSCAPE PLANTING PLAN
LANDSCAPE PLANTING PLAN
SHEET LP-1

Site Plan



Hilton Hawaiian Village
Waikikian Development

Exhibit "A"

GROUP 70 INTERNATIONAL
November 2005

STATE OF HAWAII
DEPARTMENT OF HEALTH

September 22, 2005

EPO-05-070

Mr. Perry White, President
Planning Solutions, Inc.
210 Ward Avenue, Suite 330
Honolulu, Hawaii 96814

Dear Mr. White:

SUBJECT: Environmental Review for Draft Environmental Assessment for the Duke Kahanamoku Lagoon Restoration Project, Waikiki Beach at Hilton Hawaiian Village, Oahu, Hawaii. TMK: 2-3-037:021, 2-6-009:001, 2-6-008:034, 2-6-009:010, 2-6-009:002, and 2-3-037:012

Thank you for allowing us to review and comment on the subject document. Our Total Maximum Daily Load (TMDL) program has provided the following comments listed below. Please also refer to our website for the Standard Comments (http://www.state.hi.us/health/environmental/env-planning/landuse/landuse.html). If there are any questions about these standard comments please contact Jiacai Liu with the Environmental Planning Office at 586-4346.

TMDL Program

General Comments

The information presented in the DEA suggests to us that the proposed restoration project would increase NO3 concentrations in the lagoon water column by an order of magnitude; similarly decrease TSS and bacterial indicator concentrations; increase TP concentrations; have less certain (and more variable) effects on NH4, TN, and Chl-a concentrations; and have no noticeable effect on salinity. We suspect that post-project pH changes would be significant but no pH data from the existing lagoon water column is presented in the DEA for comparison with pH of the proposed new groundwater source. The DEA projects a slight (2-5 °C) decrease in lagoon water temperature (p. 3-23), with aggregate groundwater temperature as much as 8 °C below maximum recorded values of lagoon water column and discharge temperature. Although "flow-through" treatment for removing TSS from stormwater is proposed, how the removal rate of this system compares with the removal rate of the existing lagoon is uncertain.

Coupled with the proposed decrease in lagoon storage volume (~50%); increased lagoon turnover rate (~500%) and discharge rate (~250%); diversion of 50% of lagoon discharge from

the middle Ala Wai Harbor basin to the inner basin; and the addition of stormwater discharge to the inner basin, this information suggests that:
(1) pollutant loading of the inner basin (all parameters) would increase;
(2) NO3 loading of the middle basin would increase;
(3) TSS and bacterial indicator loading of the middle basin would decrease; and
(4) overall NO3 loading of the Ala Wai Harbor would increase and overall TSS and bacterial indicator loading would decrease.
(5) biogeochemical processes affecting water quality in the lagoon and its receiving waters would change and the effects of these changes are uncertain.

Our review of the water quality modeling inputs, assumptions, and results is currently incomplete, and will be provided during the processing of required DOH applications. As noted in the DEA, TMDLs for the lagoon receiving waters have not been established by the State. As explained in our Standard Comments / Areas of Concern for environmental review (http://www.hawaii.gov/health/environmental/env-planning/wqm/landuse/EPO-standardcomment.pdf), where TMDLs are yet to be established and implemented, a first step in achieving TMDL objectives is to prevent any project-related increases in pollutant loads. While it is clear that there would be some increases in certain pollutant loads from the proposed project, our forthcoming evaluation of the modeling results will more directly address the overall impacts of the proposed project on receiving water quality and the potential achievement of water quality standards in these receiving waters.

Specific Comments

Page

1-5 "Some tests of water samples taken from the lagoon show elevated concentrations of certain constituents in the portion of the lagoon closest to these stormwater discharges." We suggest that the constituents with elevated concentrations be listed here, along with reference to the other pages of the DEA where they are presented and discussed.

2-1 "HHC's SMP requires that water quality within the lagoon be restored and maintained in accordance with State water quality standards." We suggest that the post-project lagoon waterbody type and class, as defined by Hawaii Administrative Rules Chapter 11-54, be specified here, along with the appropriate water quality criteria to be attained.

2-4 Figure 2-1 shows the Conservation District Boundary around the lagoon. We suggest that the Conservation District subzone designation be added to the label for this feature, as subzone designation is used to determine certain waterbody classes under Hawaii Administrative Rules Chapter 11-54.

2-10 We suggest that the second sentence under the first bullet in Section 2.3.1.3.1 (Existing Conditions) be rehabilitated.

2-12 We suggest that the removal rate of the existing lagoon be included in this discussion.

3-8 Page 3-7 refers to the lagoon as Open Coastal Waters. Thus we suggest that the specific criteria for recreational areas shown in Table 3.5 be changed to show part (b) of HAR 11-54-8 (In marine recreational areas rather than part (a) (In inland recreational areas).

3-11 In Table 3-7, we suggest that the title be modified to indicate that its presents Lagoon Water Quality Test Results; the note explaining SS# also include an explanation of -a and -b suffixes; and temperature, conductivity, dissolved oxygen, and pH results be added to the table if available.

3-12 We suggest that the Enterococcus results be added to Table 3.9, and that the fecal coliform results for stations #1, #2, #10, and #11 be corrected to conform with the lab sheet submitted to the DOH Clean Water Branch.

3-14 In Table 3.10, we suggest that the concentrations of NO3, NH4, TON, TN, PO4, TOP and TP entered in the row labeled "all" (Table 3.10) be corrected to microgram units. The current entries are lower than any of the concentrations entered for Wells 1-7 (and appear to be the micromolar values from Table 1. in Appendix A), thus they cannot reflect the expected contribution of each well to the total. We also suggest that temperature and dissolved oxygen results from Table 1. in Appendix A be added to this table.

3-15 We suggest that the final complete sentence on this page be modified to indicate that TMDLS have been assigned to the canal to limit inputs of nitrogen and phosphorous only (rather than "particularly").

3-16 We suggest that the first sentence on this page (beginning from page 3-15) be modified to indicate all of the pollutants listed as contributing to the impaired water quality of Ala Wai Canal and Harbor (rather than "including nutrients, turbidity, and suspended solids.").

3-28 We suggest that the first sentence on this page and the first sentence in the final paragraph on this page be modified to read "In summary, model results suggest that the proposed change ..."

Appendix B For ease of reading, we suggest enlarging Figures 1 and 3 and Tables 1-6 and rotating Figure 3.

Appendix C For ease of reference, we suggest page numbering throughout the appendix.

If there are any questions about these comments please contact David Penn with the Environmental Planning Office at 586-4339.

HAROLD LAO, ACTING MANAGER
Environmental Planning Office

c: Thomas E. Arizumi, EMD
Edward Chen, CWB
David Penn, TMDL, EPO
EPO

PLANNING SOLUTIONS

October 5, 2005
2005-0001-001

Mr. Harold Lao, Acting Manager
Environmental Planning Office
Department of Health
State of Hawai'i
P.O. Box 3378
Honolulu, HI 96801-3378

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Lao:

Thank you for your September 22, 2005 letter (your reference EPO 05-070) commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA). Duke Kahanamoku Lagoon Restoration Project.* We appreciate the time you and others at DOH spent reviewing the document. The remainder of this letter begins with a few remarks about your general comments. Item-by-item responses to your specific comments follow that.

GENERAL COMMENTS

Your general comments summarize major points that you have drawn from the material in the environmental assessment. With very minor exceptions (e.g., your reference to centigrade degrees rather than the Fahrenheit degrees used in the Draft EA and your omission of the 100% reduction in stormwater flow into the lagoon from the listing of changes), we agree with your summary.

We understand that your review of the water quality modeling inputs, assumptions, and results is currently incomplete and that the Environmental Planning Office will examine the situation more closely during the processing of applications for required DOH permits. We are pleased that your evaluation will consider the overall impacts of the proposed project on receiving water quality and the potential achievement of water quality standards in these receiving waters.

SPECIFIC COMMENTS

Comment 1:

Page 1-5: "Some tests of water samples taken from the lagoon show elevated concentrations of certain constituents in the portion of the lagoon closest to these stormwater discharges." We suggest that the constituents with elevated concentrations be listed here, along with reference to the other pages of the DEA where they are presented and discussed.

Response: This is an introductory paragraph intended only to indicate the kinds of issues that are present. We believe that expanding upon the discussion at this point would be distracting. However, in response to your suggestion, we will include a cross-reference pointing readers to the sections in the Final EA where this is discussed in more detail.

Comment 2:

Page 2-1: "HHC's SMP requires that water quality within the lagoon be restored and maintained in accordance with State water quality standards." We suggest that the post-project lagoon waterbody type and class, as defined by Hawai'i Administrative Rules Chapter 11-54, be specified here, along with the appropriate water quality criteria to be attained.

Response: The decision as to how to classify the restored lagoon is ultimately a decision that the Department of Health must make. However, we believe the restored lagoon (which will not have a direct connection with the Ocean or the Ala Wai Harbor) is most comparable to a "saline lake".

HAR §11-54-1 states:

> "*Saline lakes*" *means standing waters of salinities ranging from brackish to hypersaline, located in well-defined natural basins, and lacking a natural surface connection to the ocean. Saline lakes may be present as high island shoreline or near-shoreline features (e.g. Lake Nomilu, Kauai; Salt Lake, Oahu; Lake Kauhako, Molokai) or as low-island closed lagoons (Lake Laysan, Laysan). They are usually, but not always, fed by seawater seepage and may be diluted by rainwater, overland runoff, or ground water, or concentrated by evaporation.*

HAR §11-54-2 Classification of state waters states:

> *(b) Inland waters may be fresh, brackish, or saline.*
>
> *(2) All inland brackish or saline waters are classified as follows, based on their ecological characteristics and other natural criteria*
>
> *(A) Standing waters. (i) Anchialine pools; and (ii)* ***Saline lakes****.* [emphasis added]

HAR §11-54-5.1 identifies inland water areas to be protected. HAR §11-54-5.1(b) lists "Brackish or saline waters (anchialine pools, saline lakes, coastal wetlands, and estuaries) [*emphasis added*]." HAR §11-54-5.2(a) contains the criteria for springs and seeps, ditches and flumes, natural freshwater lakes, reservoirs, low wetlands, coastal wetlands, saline lakes, and anchialine pools. Only the basic criteria set forth in section 11-54-4 apply to springs and seeps, ditches and flumes, natural freshwater lakes, reservoirs, low wetlands, coastal wetlands, saline lakes, and anchialine pools. We have confirmed with the Department of Health that the lagoon is a "Beach Venue". HAR §11-10-1(5) specifically excludes beach venues from regulation under that Chapter.

As indicated in the Department of Health's September 30, 2004, letter to Mr. Eric Crispin (then the Director of the City and County of Honolulu Department of Planning and Permitting), in addition to maintaining adequate water quality in the lagoon, the proposed lagoon and re-routed storm water discharges into the Ala Wai Harbor must comply with the State Water Quality standards for that body of water. After the construction of the proposed improvements, the quality of waters pumped from the lagoon and discharged from the re-routed existing drain outlet are intended to be consistent with the "Class A, Marine waters" quality criteria established for "Embayments".

Comment 3:

Page 2-4: Figure 2-1 shows the Conservation District Boundary around the lagoon. We suggest that the Conservation District subzone designation be added to the label for this *feature, as subzone designation is used to determine certain waterbody classes under Hawai'i Administrative Rules Chapter 11.54.*

Response: This is a good suggestion. We have added the subzone designation to the figure in the Final EA.

Comment 4:

Page 2 10: We suggest that the second sentence under the first bullet in Section 2.3.1.3.1 (Existing Conditions) be rehabilitated.

Response: The sentence does require "rehabilitation". The problem resulted from the disappearance of a cross-reference to Table 2.2. In the FEA the bullet reads as follows:

Approximately 45 percent (10.2 acres) of the 23-acre HHV property presently discharges stormwater runoff into the lagoon. The size and peak runoff from the drainage areas which contribute runoff to the lagoon are shown in Table 2.2. Runoff from the Rainbow Tower Roof (Area 3) enters the Lagoon at several points along its Diamond Head side through downspouts along the northern face of Rainbow Tower.

Comment 5:

Page 2-12: We suggest that the removal rate of the existing lagoon be included in this discussion.

Response: At present, most of the HHV's onsite rainfall-runoff enters the lagoon in two drain pipes, both of which discharge near the intake of one of the pump station's two inlet pipes. Except during severe storm events, most of this runoff is pumped to the harbor's middle basin with little residence time and only a minimal removal rate in the lagoon itself. The remainder of the rainfall-runoff that enters the lagoon consists primarily of runoff from the area around the lagoon's periphery. Owing to the lagoon's sluggish circulation and long residence time, virtually all suspended solids in this smaller fraction of the rainfall-runoff settle out. The dissolved inorganics in this fraction of the runoff are likely to be converted to organic forms, ultimately to settle, decay, and become a part of the layer of anaerobic mud on the lagoon bottom.

With the proposed improvements, rainfall-runoff now delivered to the lagoon in drain pipes would be collected and rerouted for pumped delivery to the harbor's inner basin. As indicated on page 2-12 of the *DEA*, a substantial fraction (estimated at 80 percent) of the total suspended solids (for 50-micron and larger sediment particles) would be mechanically removed at the two drainage pump stations using a flow-through stormwater treatment system. Consequently, the quality of the stormwater being discharged to the harbor from areas served by this system would actually be improved for this portion of the runoff.

Rainfall-runoff into the lagoon from the relatively small area around its periphery will still occur. However, with the much faster turnover rate that the proposed plan provides and the maintenance program to stir bottom sediments at regular (weekly or more often) intervals, most of this smaller fraction of the rainfall-runoff will probably be discharged to the harbor's inner and middle basins with little change in its chemistry.

In response to your request, we have included a discussion of these points at the end of Section 2.3.1.3.2 in the *FEA*.

Comment 6:

Page 3-8: Page 3-7 refers to the lagoon as Open Coastal Waters. Thus we suggest that the specific criteria for recreational areas shown in Table 3.5 be changed to show part (b) of HAR 11-54-8 (in marine recreational areas rather then part (a) (in inland recreational areas).

Response: As noted above, we believe that if the lagoon is modified as proposed it will no longer be an Open Coastal Water but will instead be classified as inland waters. That is why Table 3.5 in the *DEA* appeared as it did. However, you are correct that the table should also list the standards for open coastal waters (which are applicable in its existing condition), and we have added part (b) of HAR 11-54-8 (marine recreational areas) to it.

Comment 7:

Page 3-11: In Table 3-7, we suggest that the title be modified to indicate that its presents Lagoon Water Quality Test Results; the note explaining SS# also include an explanation of -s and -b suffixes; and temperature, conductivity, dissolved oxygen, and pH results be added to the table if available.

Response: While most of the sample locations shown in the table are inside the lagoon, two are not. As can be seen in Figure 3-1 in the *DEA*, Stations 10 and 11 are in the ocean near the existing ocean intakes and Station 12 is in the middle basin of the Ala Wai Harbor approximately 50 feet from the existing lagoon water discharge pipe. Because of this, we have not renamed the table as you requested. We will add a note to explain the meaning of the suffixes (which indicate surface water (-s) and bottom-water (-b) sample collections. We will add available values of temperature and pH to the report.

Comment 8:

Page 3-12: We suggest that the Enterococcus results be added to Table 3.9, and that the fecal coliform results for stations #1, #2, #10, and #11 be corrected to conform with the lab sheet submitted to the DOH Clean Water Branch.

Response: Your suggestion is a good one. We had noted the error in the DEA's reporting of the fecal coliform results for stations #1, #2, #10, and #11 when we submitted the lab sheets to the Clean Water Branch. The errors were related to the detection limits of the tests that were conducted and did not affect the conclusions. The *FEA* contains the corrected numbers. At the CWB's request, we have also included the results for *Enterococcus* data that were not included in the *DEA*.

Comment 9:

Page 3-14: In Table 3.10, we suggest that the concentrations of NO3, NH4, TON, TN, PO4, TOP and TP entered in the row labeled "all" (Table 3.10) be corrected to microgram units. The current entries are lower than any of the concentrations entered for Wells 1-7 (and appear to be the micromolar values from Table 1, in Appendix A), thus they cannot reflect the expected contribution of each well to the total. We also suggest that temperature and dissolved oxygen results from Table 1 in Appendix A be added to this table.

Response: Thank you for identifying this typographical error in Table 3.10 of the *DEA*. You are correct that they represent the micromolar values as shown in Appendix A. The *FEA* contains the correct numbers. Finally, we have added the values for dissolved oxygen and temperature to the FEA as you requested.

__Comment 10:__

> *Page 3-15: We suggest that the final complete sentence on this page be modified to indicate that TMDLs have been assigned to the canal to limit inputs of nitrogen and phosphorus only (rather than "particularly").*

__Response:__ This is another good suggestion. The *FEA* states that TMDLs have been assigned to the canal to limit inputs of nitrogen and phosphorus only.

__Comment 11:__

> *Page 3-16: We suggest that the first sentence on this page (beginning from page 3-15) be modified to indicate all of the pollutants listed as contributing to the impaired water quality of Ala Wai Canal and Harbor (rather than "including nutrients, turbidity, and suspended solids.")*

__Response:__ This point was made generally, rather than by mentioning all of the pollutants by names because it was intended as an overview and because the TMDL discussion of the Ala Wai situation often does not do a particularly good job of distinguishing between the canal and the harbor. Nonetheless, in response to your comment, the *FEA* will note the specific pollutants as reported in the *Final 2004 List of Impaired Waters in Hawaii Prepared Under Clean Water Act §303(d)*. These are (as reported for the Ala Moana Bridge Station on the Ala Wai) *enterococci*, nitrogen, turbidity, Total P, and chlorophyll a. The priority at this location is "low".

__Comment 12:__

> *Page 3-28: We suggest that the first sentence on this page and the first sentence in the final paragraph on this page be modified to read "In summary, model results suggest that the proposed change..."*

__Response:__ This is a good suggestion. The *FEA* contains the change you suggested.

__Comment 13:__

> *Appendix B: For ease of reading, we suggest enlarging Figures 1 and 3 and Tables 1-6 and rotating Figure 3.*

__Response:__ The two figures you referred to are essentially the same as those in the main body of the *DEA*. To try to contain reproduction costs, we did not include a full page version of these two drawings in the *FEA*. In response to your desire for larger versions of the tables we have already provided you with a full-size version of the report reproduced in Appendix B.

__Comment 14:__

> *For ease of reference, we suggest page numbering throughout the appendix.*

__Response:__ Most of the pages in the appendices do have page numbers. The exceptions are certain drawings and plots. In almost all cases these have figure numbers and can be located quickly using those. The pages that do not have page numbers are produced by software that does not allow

automatic pagination, and we believe that the marginal increase in ease of use does not warrant the substantial additional expense associated with hand-numbering.

Thank you again for your comments. If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

UNIVERSITY OF HAWAI'I

Environmental Center

September 20, 2005
RE: 0319

Hilton Hawaiian Village LLC
Peter Schall
2005 Kalia Rd.
Honolulu, HI 96815

Dear Mr. Schall:

Draft Environmental Assessment
Duke Kahanamoku Lagoon Restoration Project
Waikiki Beach, Hilton Hawaiian Village
Honolulu, O'ahu

Hilton Hotels Corporation (HHC) has proposed restoring water quality and construction of public facilities in and around Duke Kahanamoku Lagoon located in the Hilton Hawaiian Village (HHV) in Waikiki. The proposed actions require use of State lands and work within the State Conservation District.

HHC has obtained a Special Management Area Use Permit (SMP) and Planned Development- Resort (PD-R) approval for construction of a new Tower and associated facilities and landscaping on its HHV property. In accordance with the requirements for the SMP (File No. 2002/SDD-33) approval, the HCC is required to attain and maintain the water quality of the adjacent Duke Kahanamoku Lagoon at acceptable levels as specified by the State Department of Health. The PD-R (City Council Resolution No. 02-226, CD 1, FD 1) establishes requirements for recreational and public facilities around the lagoon that HHC must fulfill during the redevelopment of the property.

This review was conducted with the assistance Paul Jokiel, Hawaii Institute of Marine Biology Coconut Island (HIMB); and Scott Burch and Amelia Hicks of the Environmental Center.

General Comment

The Draft Environmental Assessment (EA) for Duke Kahanamoku Lagoon Restoration Project in the HHV highlights many of the key concerns raised by the HHC

construction project; however our reviewers observed that some areas require further analysis and discussion.

The HHC is proposing restoration and construction activities in order to fulfill the conditions of its SMP and PD-R approvals. Specifically, HHC is proposing to improve water quality in the lagoon by increasing the water turnover rate, reducing its volume, switching its source from ocean water to saline groundwater, and rerouting storm water runoff away from the lagoon. HHC has also developed plans for extending the Waikiki Promenade around the lagoon, adding landscaping, and installing public amenities (e.g., drinking fountains, benches) in accordance with the PD-R design program requirements.

Our reviewers find it is generally a well thought out approach. At a cost of $14 million the Hilton will substantially upgrade the area into a much more attractive recreational area for the public and also will enhance the value of their adjacent property. Decreasing the lagoon depth to 5 feet, decreasing the size of the lagoon, sealing in the sediment and improving the circulation regime with rapid turnover makes a lot of sense. Enhancing the protective berm on the ocean side will provide needed protection from storm surf for the lagoon. There are several concerns that should be discussed further, and these concerns are addressed below.

Specific Comments

Water Quality

Salt water wells can produce water containing toxic hydrogen sulfide (rotten egg smell) as a result of anoxic conditions. Was hydrogen sulfide encountered in the test well?

The well water being used to flush the lagoon will be high in dissolved inorganic nutrients, particularly inorganic nitrogen, as well as being low in dissolved oxygen. Nutrient enrichment presents an ideal situation for rapid phytoplankton growth. The assumption is that the high flushing rate would remove the phytoplankton faster than they could grow. However, some algae have a doubling times of only a few hours.

Even if flushing rates successfully keep the phytoplankton under control, benthic algal mats may still be an issue. Shallow water, high sunlight penetration and high nutrient concentrations will promote growth of algal mats which will cover the sandy bottom. These mats tend to break away and float to the surface during times of peak photosynthesis due to bubble formation caused by high oxygen release during photosynthesis. Resultant surface detritus is likely to detract considerably from the aesthetic appeal of the lagoon. Will there be sufficient herbivorous fish in the lagoon to control the algae?

Mr. Peter Schall
September 21, 2005
p. 3

Organic detritus will build up in the lagoon as a result of biological reduction. Perhaps most of this will be consumed by herbivores or will be fine enough to remain suspended and flush out with the outflow. Otherwise, some form of regular suction maintenance (such as done in the large aquariums) might be needed to avoid another buildup of anoxic mud.

As stated in the Draft EA, the heart of the proposal is the pump-reliant well system. The Draft EA does list general procedures of pump operation and maintenance, but does not explain the effect of environmental forces on the pump system and the impacts of pump replacement when it is needed.

Cassiopia

The *Cassiopea sp* that occur in the lagoon do not depend on ocean input and will persist in a closed lagoon. Their life cycle is known to have an asexually reproducing polyp stage and a sexually reproducing medusa stage. The asexually reproducing stage is very small and can occur on a leaf or a small rock. Care must be taken to remove all of the life stages from the lagoon, and an ongoing program of surveillance and removal should be undertaken to completely eliminate or control this organism. This removal plan is key to the usefulness of the lagoon for recreation purposes yet the details of a removal plan are not discussed in the Draft EA.

Geotextile covering

The composition and stability of the geotextile fabric is not made clear in the Draft EA. Our reviewers have expressed concerns regarding effects on the fabric of overtopping into the lagoon of storm or seasonal waves. In the event the material is damaged, how will it be repaired, and what will be the impacts on the environment if such damage occurs?

Sediments and debris

HCC proposes to use a geotextile fabric in order to contain the anaerobic sediment presently at the bottom of the lagoon. Our reviewers have raised a concern over what will constitute future bottom lagoon sediments once both recreational use and addition of water low in DO ensues. Specifically, will another anaerobic community evolve, and if so, what remedial action will be taken? Last, how will the current bottom sediment be managed once the geotextile fabric is in place?

Beach stability

It is well documented that beach stabilization like that proposed in the project can affect sand deposition and erosion patterns at adjacent sites down beach from the stabilization structure. Our reviewers noted that the proposed construction activities and the structure itself may jeopardize the beach stabilization on the adjacent beach. Our

Mr. Peter Schall
September 21, 2005
p. 4

reviewers would like to see more discussion of effects on adjacent beach sites along Waikiki.

Thank you for the opportunity to review this Draft EA.

Sincerely,

John T. Harrison
Environmental Coordinator

cc. J. Moncur, Director, WRRC
OEQC
Sara Lemmo, DLNR
Perry White, Planning Solutions

PLANNING SOLUTIONS

October 5, 2005
2005-0001-001

Mr. John T. Harrison, Environmental Coordinator
Environmental Center
University of Hawai'i at Mānoa
Krauss Annex 19
Honolulu, HI 96822

Subject: **Duke Kahanamoku Lagoon Restoration**
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Harrison:

Thank you for your September 22, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document and providing written comments.

In response to your general comment, we are pleased that your reviewers find the proposed lagoon restoration project to be a generally well thought out approach and that they recognize the substantial recreational benefits that will result. We also appreciate your affirmation that the water circulation improvements and the reinforcement of the protective sand berm are appropriate and important to the restoration. Item-by-item responses to your specific comments are provided below. The comments are reproduced for your convenience in italics before each response.

<u>Comment 1:</u>

Salt water wells can produce water containing toxic hydrogen sulfide (rotten egg smell) as a result of anoxic conditions. Was hydrogen sulfide encountered in the test well?

<u>Response:</u> Hydrogen sulfide was <u>not</u> encountered in the test borehole or any of the seven production wells that have been completed.

<u>Comment 2:</u>

The well water being used to flush the lagoon will be high in dissolved inorganic nutrients, particularly inorganic nitrogen, as well as being low in dissolved oxygen. Nutrient enrichment presents an ideal situation for rapid phytoplankton growth. The assumption is that the high flushing rate would remove the phytoplankton faster than they could grow. However, some algae have a doubling times of only a few hours.

Even if flushing rates successfully keep the phytoplankton under control, benthic algal mats may still be an issue. Shallow water, high sunlight penetration and high nutrient concentrations will promote growth of algal mats which will cover the sandy bottom. These mats tend to break away and float to the surface during times of peak photosynthesis due to bubble formation caused by high oxygen release during photosynthesis. Resultant surface detritus is likely to detract considerably from the aesthetic appeal of the lagoon. Will there be sufficient herbivorous fish in the lagoon to control the algae?

Organic detritus will build up in the lagoon as a result of biological reduction. Perhaps most of this will be consumed by herbivores or will be fine enough to remain suspended and flush out with the outflow. Otherwise, some form of regular suction maintenance (such as done in the large aquariums) might be needed to avoid another buildup of anoxic mud.

<u>Response:</u> As discussed in the Draft EA, phytoplankton growth is not expected to be a problem. The average residence time in the lagoon is only 4.4 hours and the lagoon water circulation system (i.e., the points where water is introduced into and withdrawn from the lagoon) is laid out so as to minimize the possibility of areas having turnover rates significantly below the average. Even if some small areas were to have turnover rates only half the average of the entire lagoon, the exchange of water would still be so rapid that that even fast-growing algae would not have an opportunity to bloom. In addition, because all of the source water for the lagoon will be from saline wells and not the ocean, there will be minimal "seeding" of the lagoon with living phytoplankton.

The proposed system also takes into account your concern over the possible development of algal mats that could detract from the recreational value of the lagoon. As described in Section 2.3.1.2.2 of the *DEA*, HHC is committed to an active maintenance program in the lagoon. This work would include daily inspections to look for unusual biologic activity, weekly (or more frequent) cleaning of the exposed portion of the beach sand, and agitation of the lagoon bottom sand using a mechanical device. These measures will be designed to eliminate the development of algal mats. No decision has yet been made with respect to stocking the lagoon with herbivorous fish. However, this is certainly a possibility, and HHC would pursue this if needed to better manage algal growth in the lagoon.

The new water circulation system will turn over the water in the lagoon more than five times as fast as at present. Moreover, the proposed decrease in the volume of water in the lagoon will in itself decrease algal growth in absolute terms. Together, these changes, in combination with the regular mechanical disturbance of the bottom that will be done as part of the proposed lagoon maintenance program will prevent a substantial buildup of organic detritus in the lagoon.

<u>Comment 3:</u>

As stated in the Draft EA, the heart of the proposal is the pump-reliant well system. The Draft EA does list general procedures of pump operation and maintenance, but does not explain the effect of environmental forces on the pump system and the impacts of pump replacement when it is needed.

<u>Response:</u> The pump system is designed to work in the high-salt environment characteristic of the lagoon shoreline. The pumps and other equipment within the pump house are flood-proofed, and the control equipment is placed well above the regulatory flood level. The multiple-pump system is designed so that it will continue to circulate water through the lagoon (albeit at a reduced rate) when pumps are taken out of service for regular maintenance or repair. Even when it is operating at only half its rated capacity, the pump system will circulate water through the lagoon at nearly three times the present rate.

Comment 4:

The Cassiopea sp that occur in the lagoon do not depend on ocean input and will persist in a closed lagoon. Their life cycle is known to have an asexually reproducing polyp stage and a sexually reproducing medusa stage. The asexually reproducing stage is very small and can occur on a leaf or a small rock. Care must be taken to remove all of the life stages from the lagoon, and an ongoing program of surveillance and removal should be undertaken to completely eliminate or control this organism. This removal plan is key to the usefulness of the lagoon for recreation purposes yet the details of a removal plan are not discussed in the Draft EA.

Response: Thank you for the information you provided concerning *Cassiopea* spp. As noted in the *DEA*, this stinging jellyfish is an undesirable inhabitant of the existing lagoon. Unlike most jellyfish, which spend nearly all of their time floating in the water column, it spends much of its time resting on the flattened surface of its bell on the bottom. Native to the Philippines and other areas of the western Pacific, *Cassiopea* is believed to have been introduced to Hawai'i during World War II by ships arriving here from the South Pacific. It almost certainly entered the Duke Kahanamoku Lagoon through one of the existing intake pipes, quite possibly in its small polyp stage. Once in the sheltered lagoon environment, it has spread widely.

The exact construction methodology that will be used for the lagoon will not be known until after a construction contractor has been selected, something that will not occur until late this year. However, present thinking is that prior to the start of construction the water level in the lagoon will be lowered by continuing operation of the existing discharge pumps after placing a temporary seal in the intake pipes. This will allow the contractor to physically remove macrofauna, including adult *Cassiopea* from the exposed bottom. During the time the water level is lowered and the extent of the lagoon is reduced, nets may be used to capture fish and remove them from the lagoon. Many of the adult *Cassiopea* may be caught in the process, but the capture rate will be less than 100 percent, and so some will remain in the lagoon.

Restoration of the lagoon will involve installation of a geotextile fabric over the existing lagoon sediments and placement of a minimum of 2 feet of sand (and in almost all cases much more than that) over the fabric. This will bury everything that has been left on the bottom. It is unlikely that many of the *Cassiopea* will survive this treatment. However, should they do so, the regular maintenance of the lagoon that is planned is expected to make the future lagoon bottom a far different and less inviting place for the species to grow than is the low-energy/never-disturbed environment of the existing lagoon.

Comment 5:

The composition and stability of the geotextile fabric is not made clear in the Draft EA. Our reviewers have expressed concerns regarding effects on the fabric of overtopping into the lagoon of storm or tsunami waves. In the event the material is damaged, how will it be repaired, and what will be the impacts on the environment if such damage occurs?

Response: HHC has included the following specifications for the geotextile liner in its Request for proposals for the lagoon restoration:

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Mirafi Construction Products
365 South Holland Drive
Pendergrass, GA, USA 30567
1-888-795-0808
1-706-693-2226
1-706-693-2083, fax

2.2 MATERIALS

A. Geotextile

1. The geotextile shall be woven from high-tenacity polypropylene yarns. The yarns shall be woven to form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.
2. The geotextile shall meet the requirements in the table below. All numeric values in the table below except AOS represent MARV in the specified direction. Values of AOS represent maximum average roll values.

Properties	Test Method	Minimum Average Roll Value MD	Minimum Average Roll Value CD
Tensile Strength (at 5% strain) (lbs/ft)	ASTM D 4595	3600	3600
Tensile Strength (at 10% strain) (lbs/ft)	ASTM D 4595	6000	
Seam Strength (lbs/ft)	ASTM D 4884	3600 (Factory) 1920 (Field)	
Permittivity (sec^-1)	ASTM D 4491	0.27	
UV Resistance (at 500 hours) (% strength retained)	ASTM D 4355	70	
Puncture Strength (lbs)	ASTM D 3787	160	

MD – Machine, or roll direction
CD – Cross machine direction

The proposed design calls for the geotextile fabric to be secured around the perimeter. Figure 2-4 of the *DEA* shows the conceptual design for the anchoring. The buried stone reinforcement that is planned under the existing beach berm on the seaward side of the lagoon is shown in Figure 2-13 of the DEA. The stone would prevent the berm from washing away, and any water that comes over its top would have a relatively low velocity (and limited erosive force) as it flows down the inland side of the beach berm. Because of the substantial amount of sand fill that is being placed in this area (amounting to several feet of depth along most of this area), there is little chance that the water would reach the geotextile fabric anchor. Hence, the geotextile fabric is very unlikely to fail and release the sediment that is buried beneath it.

__*Comment 6:*__

HCC proposes to use a geotextile fabric in order to contain the anaerobic sediment presently at the bottom of the lagoon. Our reviewers have raised a concern over what will constitute future bottom lagoon sediments once both recreational use and addition of water low in DO ensues. Specifically, will another anaerobic community evolve, and if so, what remedial action will be taken? Last, how will the current bottom sediment be managed once the geotextile fabric is in place?

__Response:__ Your reviewers appear to have mistakenly assumed that the water in the lagoon would be low in dissolved oxygen (DO). This is not the case. While the groundwater source produces water that is initially low in dissolved oxygen, the proposed design of the circulation system includes substantial aeration of source water as it is cascaded into the lagoon. The exact level of oxygenation cannot be determined until a design is finalized, but it is expected to be at or near saturation. This aeration, together with the management measures described in the *DEA* and noted previously in this letter, will prevent the development of another anaerobic community in the lagoon. No management of the entrapped bottom sediment is needed or planned.

__*Comment 7:*__

It is well documented that beach stabilization like that proposed in the project can affect sand deposition and erosion patterns at adjacent sites down beach from the stabilization structure. Our reviewers noted that the proposed construction activities and the structure itself may jeopardize the beach stabilization on the adjacent beach. Our reviewers would like to see more discussion of effects on adjacent beach sites along Waikiki.

__Response:__ All of the work that is planned for the proposed project is inland of the 40-foot shoreline setback. The proposed design (which uses rocks placed below the existing grade of the berm) maintains the existing shape of the shoreline berm and is outside the area that is affected by normal shoreline processes. Consequently, it does not have the potential to affect adjacent beach sites.

Thank you again for your comments. If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Ms. Kimberly Mills, OCCL
Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC

LINDA LINGLE
GOVERNOR OF HAWAII

GENEVIEVE S. SALMONSON
DIRECTOR OF OEQC

STATE OF HAWAI'I
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
DEPARTMENT OF HEALTH
LEIOPAPA A KAMEHAMEHA
235 SOUTH BERETANIA STREET, SUITE 702
HONOLULU, HAWAI'I 96813
TELEPHONE (808) 586-4185

[illegible]

September 21, 2005

Mr. Gary Seibert
Hilton Hawaiian Village, LLC
2005 Kalia Road
Honolulu, HI 96815

Mr. Perry J. White
Planning Solutions, Inc.
210 Ward Avenue, Suite 330
Honolulu, HI 96813

Mr. Samuel J. Lemmo
Department of Land and Natural Resources
State of Hawai'i – Office of Conservation and Coastal Lands
1151 Punchbowl Street, Room 131
Honolulu, HI 96813

Dear Messrs. Seibert, Lemmo, and White:

The Office of Environmental Quality Control has reviewed the draft environmental assessment for the Duke Kahanamoku Lagoon Restoration Project, Tax Map Keys (1st): 2-3-37-21; 2-3-37-12; 2-6-08-34; 2-6-09-01; 2-6-09-2; and, 2-6-09-10, situated at Kalia in the district of Honolulu, and offers the following comments for your consideration and response.

1. **Section 3.10.2.2. Potential Effects on Culture, and Traditional and Customary Rights:** The draft environmental assessment, citing an April 2001, study for the Waikikian Project has an inset of a map indicating archaeological sites and fishponds. Please enlarge the map in the final environmental assessment so that pertinent details on the names of the fishponds and the historic shorelines.

Thank you the opportunity to comment, if you have any questions, please call Mr. Leslie Segundo, Environmental Health Specialist at (808) 586-4185.

Sincerely,

GENEVIEVE SALMONSON
Director

PLANNING SOLUTIONS

October 11, 2005
2005-0001-001

Ms. Genevieve Salmonson, Director
Office of Environmental Quality Control
Department of Health
State of Hawai'i
235 South Beretania Street, Suite 702
Honolulu, Hawai'i 96813

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Ms. Salmonson:

Thank you for your September 21, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project*. We appreciate the time you and your staff spent reviewing the document and providing written comments. Item-by-item responses to your comments are provided below. The comments, separated under the topic headings used in your letter, are reproduced for your convenience in italics before each response.

__Comment 1:__

> *Section 3.10.2.2. Potential Effects on Culture, Traditional and Customary Rights: The draft environmental assessment, citing an April 2001, study for the Waikikian Project has an inset of a map indicating archaeological sites and fishponds. Please enlarge the map in the final environmental assessment so that pertinent details on the names of the fishponds and the historic shorelines.*

__Response:__ The map included in the DEA was from the State Historic Preservation Division (2001). Its primary purpose was to demonstrate that the historic shoreline was well inland of the project site and to show that no archaeological sites or fishponds existed in the area to be affected by the project. The names of the sites and the fishponds were not provided on the map.

Figure 1 in Appendix A of the *Hilton Hawaiian Village Beach Resort and Spa Waikikian Development Plan Final Environmental Impact Statement* contains a larger map showing the fishponds in the area between Ala Moana Boulevard, Kalia Road, and Lewers Road (see Attachment 1). It does not identify the names of the fishponds, but it shows that the nearest fishpond is approximately one-quarter mile to the west of the nearest point on the existing lagoon. Because of this, we did not conduct the additional research that would be needed to name each of the fishponds shown on the drawing.

If you have any further questions, please call me at 550-4483.

Sincerely,

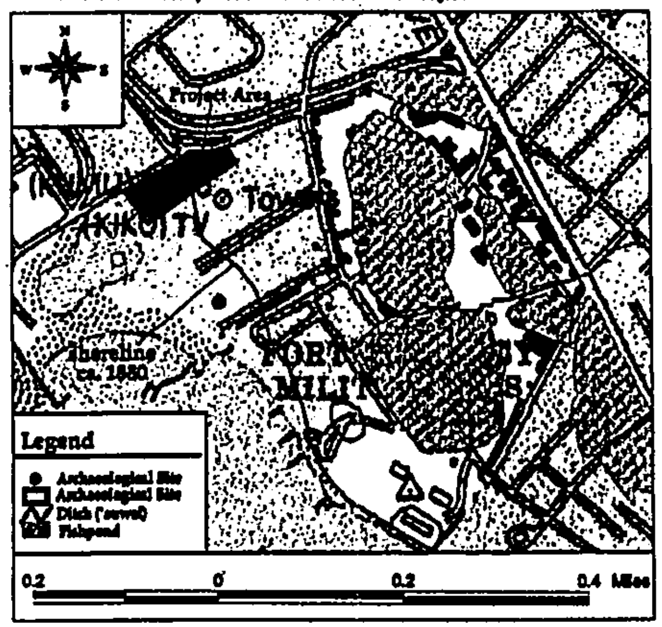
Perry J. White

Attachment

cc: Ms. Kimberly Mills, OCCL
Mr. Gerhard Seibert, HHC

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawai'i 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.ps-hi.com

Attachment 1. Location of Fishponds Nearest the Duke Kahanamoku Lagoon.



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
POST OFFICE BOX 621
HONOLULU, HAWAII 96809

REF:OCCL:CC

Perry White, President
Planning Solutions
210 Ward Avenue Suite 330
Honolulu, Hawaii 96814-4012

OCT - 4 2005

Dear Mr. White:

SUBJECT: Review of Draft Environmental Assessment for the Duke Kahanamoku Lagoon Restoration Project.

The State of Hawaii Department of Land and Natural Resources (DLNR) Office of Conservation and Coastal Lands (OCCL) has reviewed the July 2005 Draft Environmental Assessment (DEA) for restoration work at the Hilton Hawaiian Village (HHV) lagoon. The DEA describes the proposed actions, possible alternatives, current conditions, and potential impacts of restoration or alternatives.

Based on the Plan for Fulfilling Conditions Related to the Hawaiian Village Lagoon and the DEA for the Duke Kahanamoku Lagoon Restoration Project, the Department considers the proposed work, if conducted appropriately, an important improvement to the lagoon and recreational access to the shoreline area. The following are comments regarding the proposed project. These are reiterations of comments sent in the attached letter, dated September 21, 2004.

1. The Department still has concerns regarding the proposed "buried rubble mound structure" seaward of the lagoon, described in 2.3.2.4.2. The Department continues to recommend increasing dune height through dune restoration, or creation, as an environmentally responsible alternative to construction of a buried seawall. The Department understands that this is historically an engineered coastline, and will require continued maintenance. An alternative to a natural dune would be a hard structure that is continually covered in sand as part of the Operation and Maintenance (2.3.2.5) plan.

2. The Department requests removal of the existing intake pipes once the current circulation system is shut down. The Department would be satisfied with removal of all exposed intake pipe and capping the end of the shortened pipe. The Department also requests that continued monitoring, for any future exposed pipe removal, be included in the Operation and Maintenance (2.3.2.5) plan.

3. The Department recommends renourishment of a portion of the makai shoreline as part of the lagoon restoration activities. Specifically the makai-Ewa portion of the shoreline fronting the public parking lot inside the existing jetty. This area currently has minimal sand coverage and is a cobble and hard sand water entry. Since the nature of this project is restoring the lagoon and nearby environment for improved access and recreation, we believe renourishment of the connected beaches should be an essential step within the scope of the project.

We recommend that this project incorporate the dune restoration and beach renourishment suggested above to facilitate the preservation and maintenance of the current beach environment. We recommend the applicant

Perry White, President
Planning Solution

contact the OCCL to obtain the requirements for Small Scale Beach Nourishment (SSBN). The application can also be downloaded from the OCCL web site (http://www.hawaii.gov/dlnr/occl/documents.php).

Thank you for the opportunity to comment on this project. The Department will work directly with the applicant to provide guidance and review the project as it proceeds. If you should have any questions, please contact Sam Lemmo at 587-0381 or Chris Conger, Sea Grant Extension Agent at the OCCL at 587-0049.

Thank You,

Sam Lemmo, Administrator
DLNR, Office of Conservation and Coastal Lands

cc: Chairperson
ODLO
County of Honolulu, Department of Planning and Permitting

Attachment: Letter from Sam Lemmo to Eric Crispin, dated September 21, 2004.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
OFFICE OF CONSERVATION AND COASTAL LANDS

POST OFFICE BOX 621
HONOLULU, HAWAII 96809

Ref: OCCL: DE

Corr.: OA-05-75

September 21, 2004

Mr. Eric Crispin, Director
Attn: Eileen Mark
City and County of Honolulu
Department of Planning and Permitting
650 South King St
Honolulu, HI 96813

Subject: Review of Plan for Fulfilling Conditions Related to the Hawaiian Village Lagoon. SMA Permit (SMP) No. 2002/SMA-19

Dear Mr. Crispin:

The State of Hawaii Department of Land and Natural Resources (DLNR) Office of Conservation and Coastal Lands (OCCL) has reviewed the June 17, 2004 Plan for fulfilling Lagoon-related conditions for the Hilton Hawaiian Village lagoon. The document outlines a plan to restore and maintain the lagoon as well as constructing pedestrian improvements around the lagoon. Based on the information provided the Department is supportive of the project in concept.

Based on the information supplied, the Department considers the proposed work an important improvement to the lagoon and recreational access to the shoreline area. The following are some comments regarding the proposed project:

1. The Department has concerns regarding the proposed "buried cut-off wall" seaward of the lagoon mentioned on page 2-12 of the document. The Department will need more information on the design, location and intent of this proposed structure in order to better evaluate its' function. The Department

recommends increasing the dune height through dune restoration as an alternative to building a buried seawall.

2. We recommend removal of the exposed portions of the existing intake pipes once the system is shut down.

3. We recommend a minimum setback of 40 feet from the shoreline for the proposed boardwalk as well as increasing the dune height along the proposed boardwalk route to reduce wave overtopping problems.

In reviewing the project plan a few questions have arisen that will need to be answered as part of the Conservation District Use Application (CDUA).

1. How much sand will be placed in the proposed effort (cubic yards) and from what source? The proposed sand shall be of beach-quality (low silt content and free of organic material or debris) and free from any contaminants.

2. What type of equipment will be required to carry out this work?

3. Over what time period and areas of state jurisdiction will the work involve? The proposed work to place sand along the shoreline and in the lagoon may require a State of Hawaii Land Division right of entry.

4. A shoreline certification may be required for some of the proposed activities along the shoreline including the boardwalk, buried seawall and beach nourishment.

5. The Department would like to see a plan to renourish a portion of the makai shoreline as part of the lagoon restoration activities. Specifically the makai-Ewa portion of the shoreline fronting the public parking lot inside the existing jetty (Figure 1).

In order to further process this request and ensure the sand placement is done in accordance with established guidelines we do require additional information from the applicant. The Department requests that the applicant contact the Department of Land and Natural Resources, Office of Conservation and Coastal Lands (OCCL) for processing of a Conservation District Use Application (CDUA) for the proposed lagoon work.

Thank you for the opportunity to comment on this project. The Department will work directly with the applicant to provide guidance and review on the project as it proceeds. If you should have any questions, please contact Sam Lemmo at 587-0381 or Dolan Eversole, Sea Grant Extension Agent at the Office of Conservation and Coastal Lands at 587-0430.

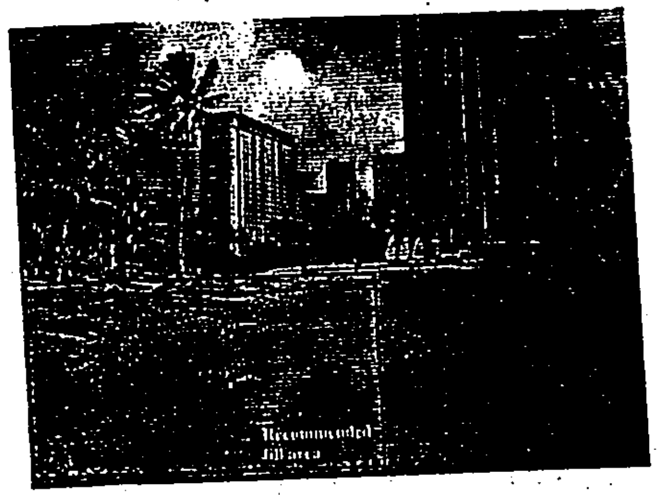
Thank You,

Sam Lemmo, Administrator
DLNR, Office of Conservation and Coastal Lands

Cc: Oahu Board Member
Oahu District Land Office
Chairperson's Office
USACOE/DOH
Planning Solutions, Inc. Ward Plaza Suite 330 210 Ward Ave Honolulu, HI 96814-4012

Figure 1.

Proposed Beach Nourishment Site



PLANNING SOLUTIONS

November 7, 2005
2005-0001-001

Mr. Sam Lemmo, Administrator
Office of Conservation and Coastal Lands
Department of Land and Natural Resources
State of Hawai'i
P.O. Box 621
Honolulu, HI 96809

Subject: Duke Kahanamoku Lagoon Restoration
Draft Environmental Assessment, Waikiki Beach, O'ahu, Hawai'i

Dear Mr. Lemmo:

Thank you for your October 4, 2005 letter commenting on Hilton Hotels Corporation's *Draft Environmental Assessment (DEA): Duke Kahanamoku Lagoon Restoration Project.* We appreciate the time you and your staff have spent assisting us in the preparation of the document, as well as reviewing it and providing us your written comments.

We are pleased to hear that the Department considers the proposed work, if conducted appropriately, an important improvement to the lagoon and recreational access to the shoreline area. Item-by-item responses to your specific comments are provided below. The comments, separated under the topic headings used in your letter, are reproduced for your convenience in italics before each response.

Comment 1:

The Department still has concerns regarding the proposed "buried rubble mound structure" seaward of the lagoon, described in 2.3.2.4.2. The Department continues to recommend increasing dune height through dune restoration, or creation, as an environmentally responsible alternative to construction of a buried seawall. The Department understands that this is historically an engineered coastline, and will require continued maintenance. An alternative to a natural dune would be a hard structure that is continually covered in sand as part of the Operation and Maintenance (2.3.2.5) plan.

Response: The proposed design for the shoreline berm shown in Figure 2-19 is the hard structure you suggested as an alternative. It consists of large (2,700 pound) armor stone located a minimum of 40 feet inland of the certified shoreline that will be continually buried under a sand cover. It is far inland from the active beach zone and does not constitute a buried seawall. HHC accepts that maintenance will be required to keep the sand cover in place, particularly on areas where the buried structure is closest to the surface, and agrees to assume responsibility for that maintenance. To clarify this, we will add the following bullet point to Section 2.3.2.5 dealing with operation and maintenance activities.

Regular inspection of the sand cover over the buried shoreline berm to ensure that a minimum of one-half foot of sand cover remains in place on the top of the berm and one foot on the sloping sides of the berm. Should the cover fall below these minimums, HHC will push sand from adjacent areas back atop the berm.

Comment 2:

The Department requests removal of the existing intake pipes once the current circulation system is shut down. The Department would be satisfied with removal of all exposed intake pipe and capping the end of the shortened pipe. The Department also requests that continued monitoring, for any future exposed pipe removal, be included in the Operation and Maintenance (2.3.2.5) plan.

Response: HHC's proposal is to remove the exposed end of the pipe and fill the remainder with concrete once the current circulation system is shut down. In response to your request we have added the following bullet item identifying continued monitoring and corrective action for any pipe that is left in place to Section 2.3.2.5 outlining the Operation and Maintenance plan.

HHC will monitor any pipe that is left in place in the ocean to insure that it does not become exposed in the future. Should the monitoring indicate wave action is eroding the sand cover, HHC will initiate corrective action.

Comment 3:

The Department recommends renourishment of a portion of the makai shoreline as part of the lagoon restoration activities. Specifically the makai-Ewa portion of the shoreline fronting the public parking lot inside the existing jetty. This area currently has minimal sand coverage and is a cobble and hard sand water entry. Since the nature of this project is restoring the lagoon and nearby environment for improved access and recreation, we believe renourishment of the connected beaches should be an essential step within the scope of the project.

Response: While we agree that the addition of sand to the *makai*-'Ewa portion of the shoreline fronting the public parking lot inside the existing jetty would improve the recreational value of the area, such improvements are outside the limits of the proposed project. In addition to increasing the cost of what is already an expensive restoration effort, it would require analyses and permits that would add uncertainty and demand additional time. Consequently, HHC respectfully asks that that it not be required to make ocean shoreline restoration part of its proposed action.

Thank you again for your comments. If you have any further questions, please call me at 550-4483.

Sincerely,

Perry J. White

cc: Office of Environmental Quality Control
Mr. Gerhard Seibert, HHC
Mr. Peter Schall
Mr. Tom Nance, TNWRE

7.0 REFERENCES

AECOS, Inc. 1981. Oahu Coastal Zone Atlas. Hawaii Coral Reef Inventory, Island of Oahu, Part C. Prep. for the U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter.

______ 1987. Second annual report on environmental monitoring activities for Marine Culture Enterprises, Kahuku Aquaculture Facility. Prep. for Marine Culture Enterprises, Kahuku. 65 p. plus appendices.

______. 1990. Environmental considerations for the Hilton (Kahanamoku Beach) Lagoon project, Waikiki, Oahu. AECOS No. 586: 11 p.

______. 1992. Measurement of the quality of the effluent from decorative salt water pond systems in Hawaii. AECOS, Inc., Kailua, Hawaii, Report No. 645: 19p.

______. 1989. Hydrodynamic Analysis of the Hilton Hawaiian Village Lagoon Pump System, Phase II, Results of Pipe Cleaning. Prepared for the Hilton Hawaiian Village Hotel.

______. 1987. Hydrodynamic Analysis of the Hilton Hawaiian Village Lagoon Pump System. Prepared for the Hilton Hawaiian Village Hotel.

Brock, Richard E. (2003). *Synopsis of Flora and Fauna of the Hilton Hawaiian Lagoon*. Prepared for Planning Solutions, Inc.

City & County of Honolulu (1987). *Coastal View Study*. Department of Land Utilization Draft Report, principal authors M.S. Chu and R.B. Jones. Honolulu: Author.

CFR (Code of Federal Regulations) (1981). Title 36 Part 60: *National Register of Historic Places*. (Including Part 60.4: Criteria for evaluation.)

CFR (Code of Federal Regulations) (1986). Title 36, Part 800: *Protection of Historic Properties*. (Including Part 800.9: Criteria of effect and adverse effect.)

Chave, K.E., R.J. Tait, J.S. Stimson, and E.H. Chave. 1973. Waikiki beach erosion project: Marine environment study. Univ. of Hawaii, Hawaii Inst. Geophysics, HIG-73-12: 67 p.

City and County of Honolulu Department of Planning and Permitting (2004). Honolulu Land Information Systems (HOLIS), http://www.honoluludpp.org/ResearchStats/.

City & County of Honolulu Department of Planning and Permitting (2000). *Rules Relating to Storm Drainage Standards*. Author. Honolulu.

CWRM (Commission on Water Resources Management). (2000). Ground Water Hydrologic Unit Map, Island of Oahu.

Coles, S. L., R. C. DeFelice, L. G. Eldredge, with the assistance of L. S. Godwin, R. L. Pyle, A. Suzumoto June 1999). Non-indigenous Marine Species Introductions In The Harbors of The South and West Shores of O'ahu, Hawai'i. Report prepared for the David and Lucile Packard Foundation. Bernice Pauahi Bishop Museum Hawaii Biological Survey. Bishop Museum Technical Report No. 15. Honolulu, Hawaii.

Cox, D.C. 1969. Estuarine pollution in the state of Hawaii. Univ. of Hawaii, Water Resources Research Center, Tech. Rept. 31.

Edward K. Noda and Associates, Inc. 1992. Job No. 31-OL-1, Ala Wai Canal improvement, Honolulu, Oahu, Hawaii. Prep. for Dept. of Land and Natural Resources, Div. of Water and Land Development, Honolulu. Rept. R-89a

Federal Register (1999a). Department of the Interior, Fish and Wildlife Service, *Endangered and Threatened Wildlife and Plants*. 50CFR 17:11 and 17:12 – December 3, 1999.

Federal Register (1999b). Department of the Interior, Fish and Wildlife Service, 50 CFR 17. *Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that are Candidates or Proposed for Listing as Endangered or Threatened.* Annual Notice of Findings on Recycled Petitions, and Annual Description of Progress on Listing Actions. Federal Register, 64 No. 205 (Monday, October 25, (1999): 57534-57547.

Foote, Donald E., Elmer L. Hill, Sakuichi Nakamura, and Floyd Stephens (1972). *Soil Survey of Islands of Kaua'i, O'ahu, Maui, Molokai, and Lanai, State of Hawai'i.* U.S. Department of Agriculture Soil Conservation Service in cooperation with the University of Hawai'i Agricultural Experiment Station. U.S. Government Printing Office. Washington, DC. 233 p.

Geolabs, Inc. (2004). *Geotechnical Engineering Exploration, Hilton Lagoon Improvements, Hilton Hawaiian Village, Waikīkī, O'ahu, Hawai'i.*

Gonzalez, F. I. 1971. Descriptive study of the physical oceanography of the Ala Wai Canal. Univ. of Hawaii, Hawaii Inst. Geophysics, HIG-71-7: 98 p.

Harrigan, I. F. 1991. Report on Water Quality. Volume I: Bacteriology - on the relationship between monitoring data and the marine recreational standard. Part B. Rationale for revision of the marine recreational waters standard - based on analysis of data from 11 monitoring stations on Oahu. State of Hawaii, Department of Health. November 1991: 33 p.

Hawai'i Administrative Rules (HAR) 11-54; Department of Health, 2000. State Water Quality Standards. Honolulu: Author.

Hawai'i, State of, Department of Transportation. (1972). *The Environmental Impacts of the Proposed Construction (Phase I) for the Ala Wai Boat Harbor Final Environmental Statement.* Honolulu: Author.

Krock, H. 1997. "Response to Nutrient Addition in Tropical Nearshore Waters, Bays, and Estuaries." In Proceedings of the Seventh (1997) International Offshore and Polar Engineering Conference, Honolulu, USA. International Society of Offshore and Polar Engineers. May 25-30, 1997.

Langenheim, V.A.M., and D.A. Clague (1987). Stratigraphic framework of volcanic rocks of the Hawaiian islands, in Decker, R.W., Wright, T.L., and Stauffer, P.H., eds., *Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350*, v. 1, p. 55- 84.

Macdonald, G.A., A.T. Abbott, and F.L. Peterson. (1983). *Volcanoes in the Sea: The Geology of Hawai'i. 2nd Edition.* Honolulu: University Press, 517 p.

MEC Analytical Systems, Inc (May 2001). *Hilton Hawaiian Village Lagoon Dredging, Dredged Material Characterization Tier I Report – Final.* Prepared for Belt Collins Hawaii, Ltd. Author: Carlsbad, California). 21 pages + app.

Nichols, W.D, P.J. Shade, and C.D. Hunt (1997). *Summary of the Oahu, Hawaii, regional aquifer system analysis.* USGS Professional Paper 1412-A. Washington, D.C. 61pp.

State of Hawai'i Office of Environmental Quality Control (1997). *Guidelines for Assessing Cultural Impacts.* Adopted by the Environmental Council; November 19, 1997. Honolulu: Author.

OCEES. 1990. Hilton Hawaiian Lagoon Water Intake System Preliminary Concept. Prepared for Coral World International. (See Appendix A)

______ 1989. Hilton Hawaiian Lagoon Field Investigation for a New Water Intake System. Prepared for Coral World International. (See Appendix A)

Parker, P.L., and T.F. King (1990). "Guidelines for Evaluating and Documenting Traditional Cultural Properties." *National Register Bulletin No. 38.* Washington, D.C.: U.S. Dept. Interior, National Park Service.

Planning Solutions, Inc. (2004). *Plan for Fulfilling Lagoon-Related Conditions, Hilton Hawaiian Village.* Prepared for Hilton Hotels Corporation.

Pukui, M. K., S. H. Elbert, and E. T. Mookini (1976). *Place Names of Hawaii.* University of Hawaii Press. Honolulu, Hawai'i. 289 pp.

Raymond, Lawrence P. (September 7, 1972). *The Environmental Impacts of the Proposed Construction (Phase I) for the Ala Wai Boat Harbor.* Prepared by Oceanic Institute for the State of Hawaii, Department of Transportation.

Rosendahl, Paul H., Ph.D. (2001). *Subsurface Archaeological Inventory Survey, Hilton Waikikian Property.* Report 2158-041801.

Rosendahl, Paul H., Ph.D. (2001). *Cultural Impact Assessment for Draft Environmental Impact Statement. Hilton Hawaiian Village Waikikian Project.* Report 2158-061201.

Sea Engineering, Inc. (2004). *Sand Source Investigations for the Hilton Hawaiian Village Lagoon Restoration Project.* Prepared for Planning Solutions, Inc.

State of Hawai'i (2002). Hawaii Statewide GIS Program. Hazard Layer. URL: http://www.state.hi.us/dbedt/gis/hazard.htm.

State of Hawaii Commission on Water Resource Management, and the National Park Service, Rivers and Trails Conservation Assistance Program. (1990). *Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources.* Honolulu: Author.

State of Hawai'i Department of Health, Environmental Planning Office (2002). *Final 2002 List of Impaired Waters in Hawai'i Prepared Under Clean Water Act §303(d).* Honolulu: Author.

State of Hawai'i Department of Health, Air Quality Branch (2003). *Hawai'i 2003 Air Quality Data Book.* Honolulu: Author.

State of Hawai'i Department of Business, Economic Development and Tourism (2003). *State of Hawai'i 2003 Data Book.* Honolulu: Author.

Sterling, Elspeth and Catherine C. Summers for Bishop Museum. (1978). *Sites of Oahu.* Honolulu: Bishop Museum Press.

U.S. Geological Survey (1997). *Volcanic and Seismic Hazards on the Islands of Hawaii.* http://pubs.usgs.gov/gip/earthquakes.html.

U.S. Geological Survey (1999). *Groundwater Atlas of the United States: Alaska, Hawaii, Puerto Rico and the U. S. Virgin Islands.* HA 730-N O'ahu Regional Aquifer System

U.S. Geological Survey (2000). *Water Resources Data, Hawaii and Other Pacific Areas, Water Years, 1999 and 2000.* Honolulu: Author.

WBIDA (Waikiki Business Improvement District Association) (2002). *Profile of Waikiki.* http://www.waikikibid.org/waikikiprofile.htm.

W. Dean Alcon & Associates, Inc. July 1998. Storm Water Quality Management Plan, Hilton Hawaiian Village. Prepared for Hilton Hawaiian Village/The EnterOcean Group.

Y. Ebisu & Associates. (2001). *Acoustic Study for the Waikikian Development Plan at the Hilton Hawaiian Village.* Prepared for Belt Collins Hawaii, Ltd.

APPENDIX A. CITY AND COUNTY APPROVAL OF LAGOON RESTORATION PLAN AND SCHEDULE

October 8, 2004

DEPARTMENT OF PLANNING AND PERMITTING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET • HONOLULU, HAWAII 96813
TELEPHONE: (808) 523-4414 • FAX: (808) 527-6743 • INTERNET: www.co.honolulu.hi.us

JEREMY HARRIS
MAYOR

ERIC G. CRISPIN, AIA
DIRECTOR

BARBARA KIM STANTON
DEPUTY DIRECTOR

2004/ELOG-1723 (eym)

October 8, 2004

Mr. Peter H. Schall
Senior Vice President & Managing Director
Hilton Hawaiian Village
Beach Resort & Spa
2005 Kalia Road
Honolulu, Hawaii 96815-1999

Dear Mr. Schall:

Plan for Fulfilling Conditions Relating to the Hawaiian Village Lagoon
Hilton Hawaiian Village - Waikikian Project
Special Management Area Permit (SMP) No. 2002/SMA-19

This is to confirm the Hilton Hawaiian Village's fulfillment of the requirements of Condition C of Resolution 02-225, CD1, the Special Management Area Permit for the Waikikian Project. Condition C requires, in part:

> "Within 2 years from the date of approval of this SMA permit, the Applicant shall submit a detailed plan and timetable for the restoration of the lagoon to a safe and sanitary body of water, and shall include a detailed maintenance plan, to ensure that the lagoon will remain in compliance with State water quality requirements."

Resolution 02-225, CD1 was adopted by the Honolulu City Council on August 7, 2002. The Department of Planning and Permitting (DPP) received review copies of the June 17, 2004 "Plan for Fulfilling Lagoon-Related Conditions" by Planning Solutions on July 27, 2004. The document describes the system proposed to be installed to upgrade the water quality of the lagoon, as well as the expected ongoing operation and maintenance program for the proposed system. A supplemental September 16, 2004 letter received on September 20, 2004 outlines an internal timeline for implementing the plan. As such, we confirm that Condition C of Resolution 02-225, CD1 has been fulfilled.

We are pleased to note that you have initiated consultation with the State Department of Land and Natural Resources (DLNR) prior to the submission of the lagoon improvement plan. In its September 21, 2004 letter, the Office of Conservation and Coastal Lands of the DLNR confirmed its intention to work directly with you to provide guidance and review on the project for purposes of processing the required Conservation District Use Application for the work.

We understand, through informal consultation with public agencies, that the project may be subject to other permit requirements, including additional DLNR permits administered by the Division of Aquatic Resources and Commission on Water Resource Management, as well as permits administered by the State Department of Health's Clean Water Branch and the Honolulu Engineer District of the Army Corps of Engineers. We encourage you to continue to work with these agencies to address relevant environmental issues and obtain all necessary permits to complete the upgrade of the lagoon in a timely manner.

We look forward to continuing to work with you on this important project. Should you have any questions, please feel free to contact me at 523-4432.

Sincerely yours,

ERIC G. CRISPIN, AIA
Director of Planning
and Permitting

EGC:cs

cc: DLNR/Office of Conservation and Coastal Lands

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APPENDIX B. WATER QUALITY DATA REPORT FOR THE HILTON HAWAIIAN VILLAGE LAGOON IMPROVEMENTS

Prepared by:

Tom Nance Water Resource Engineering

And

Marine Research Consultants

June 2005

Water Quality Data Report for the Hilton Hawaiian Village Lagoon Improvements

Prepared for:

Hilton Hotels Corporation
9336 Civic Center Drive
Beverly Hills, California 90210

Prepared by:

Tom Nance Water Resource Engineering
680 Ala Moana Boulevard - Suite 406
Honolulu, Hawaii 96813

and

Marine Research Consultants
1039 Waakaua Place
Honolulu, Hawaii 96822

June 2005

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INTRODUCTION

At present, circulation through the Hilton Hawaiian Village (HHV) saltwater lagoon is created by pumping from the lagoon into the middle basin of the Ala Wai Harbor (AWH). As the lagoon water is drawn down by this pumping, replacement water comes into the lagoon from the adjacent nearshore waters via two 30-inch intake pipes. Figure 1 shows the location of these features. The discharge pump operates continuously at about 5300 gallons per minute (GPM). Owing to the hydraulics of the pipes which bring water into the lagoon, the water level in the lagoon is typically one to two feet below the ocean level and its tidal variation is lagged and attenuated. The differences in the ocean and lagoon water levels and tidal fluctuations are illustrated on Figure 2.

The present pumping rate creates a nominal turnover time in the lagoon of between one and two days, too slow to achieve the aesthetics for swimming and other recreational activities. However, owing to the placement of the inflow and outflow pipes, the actual turnover rate is even slower. Most of the introduced water "short circuits" directly across the lagoon from the inflow pipe to the outlet pipe, creating a far longer actual residence time elsewhere in the lagoon. Other aspects of the lagoon's present configuration are problematic. The incoming water from the nearshore area brings suspended silt-sized particulates into the lagoon which settle as a thick layer of black mud on the lagoon floor. Rainfall-runoff from a substantial portion of the HHV complex drains into the lagoon and also contributes to this problem.

A major project will be undertaken to improve the lagoon's water quality. The basic elements of the project will include:

- Changing the source of water circulating through the lagoon from the problematic nearshore water to particulate-free, saline groundwater drawn from seven wells which tap the coral formation between 80 and 250 feet below sea level.
- Reducing the water volume in the lagoon by sealing the soft bottom sediments in place with geotextile fabric and then placing coraline sand on top of the fabric.
- Redirecting all HHV rainfall-runoff away from the lagoon and into the AWH.
- Creating a positive turnover throughout the entire lagoon by introducing the well water at its mauka end and drawing the water out at its makai end.
- Increasing the supply rate of "new" water into the lagoon from 5300 to 15,000 gallons per minute (GPM).

A new pump station, which will be built at the site of the existing one, will have two 7500 GPM well water supply pumps and three 6000 GPM effluent pumps. Fifteen thousand (15,000) GPM of well water will be delivered to the mauka end of the lagoon continuously. For 12 hours each day, water will be withdrawn from the makai end of the lagoon at 18,000 GPM. For the other 12 hours, it will be withdrawn at 12,000 GPM. These different pumping rates, together with a reduction in the lagoon's water volume,

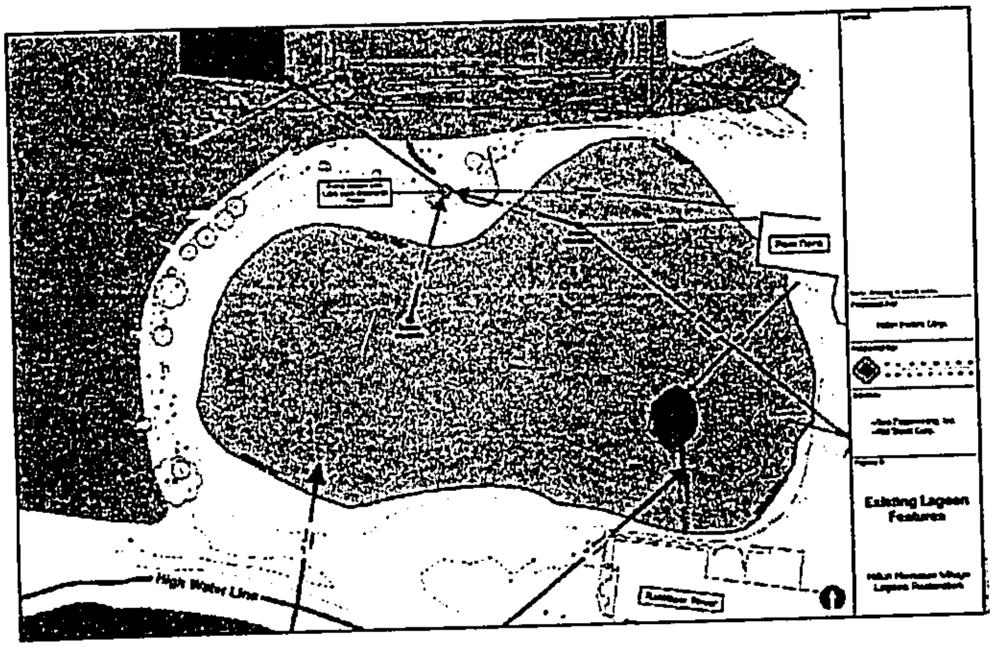
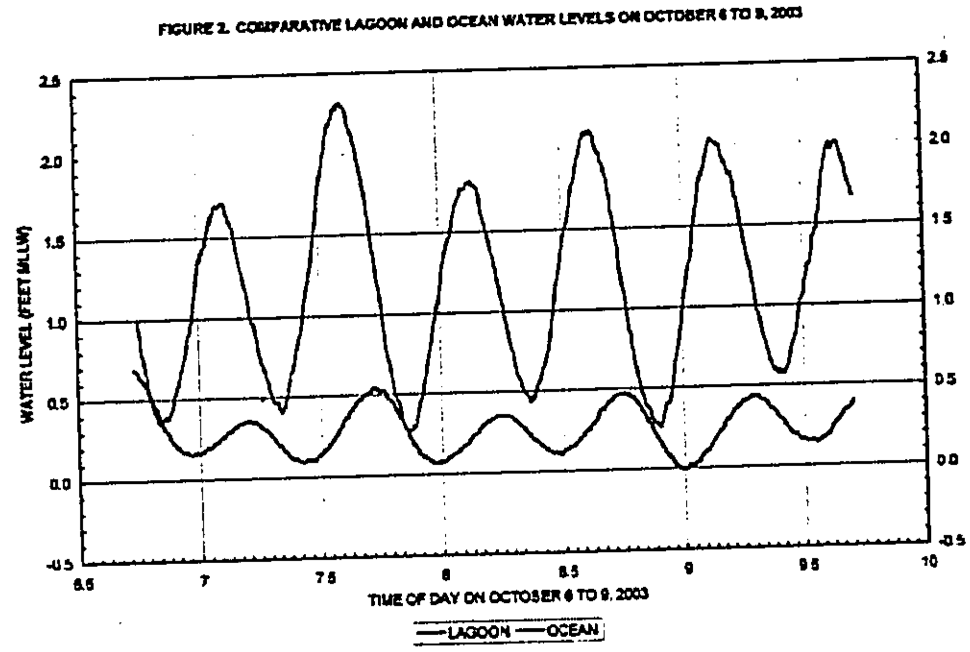


FIGURE 2. COMPARATIVE LAGOON AND OCEAN WATER LEVELS ON OCTOBER 6 TO 9, 2003



will create a 2-foot diurnal "tide" in the lagoon and turn its entire water volume over about four times a day.

Water pumped out of the lagoon at 12,000 and 18,000 GPM will be delivered to the adjacent AWH at two locations, the site of its present discharge into the middle basin and at a new site at the inner basin (Figure 3). The additional discharge location was requested by the State Department of Land and Natural Resources Division of Boating and Outdoor Recreation (DOBOR) to provide flushing of the inner basin. At present, the clarity throughout the water column in the inner basin is poor.

Changing the source of supply for the lagoon and increasing the rate of this supply about three times its present rate will require the approval of the State Department of Health (DOH). Adding a new point of discharge into the inner basin of the AWH will require DOH approval as well. Two studies have been undertaken to provide DOH with the information it will require to evaluate and ultimately approve the proposed circulation system. This report is a compilation of the water quality data of the seven saltwater supply wells and of the AWH, Ala Wai Canal, and offshore areas. A companion study by EKNA Services, Inc. provides a quantitative assessment of the proposed new circulation system utilizing hydraulic modeling and the water quality data presented in this report.

WATER QUALITY CHARACTERISTICS OF THE SEVEN SALTWATER SUPPLY WELLS

From March to April 2005, seven wells arrayed around the southwest perimeter of the lagoon were drilled, cased, and pump tested (their locations are shown on Figure 3). Owing to their differences in hydraulic performance (Figure 4), their individual contributions to the 15,000 GPM continuous discharge into the lagoon will vary between 1150 and 3170 GPM per well. Respective contributions are tallied below. Well 5 will be the most productive and Well 7 will be the least productive

Summary Characteristics of the Seven Saltwater Supply Wells

Well No.	Depths Below Sea Level from Which the Well Draws (Feet)	Expected Delivery Rate GPM	Expected Delivery Rate % of Total
1	81 to 188	2300	15.3
2	77 to 241	2180	14.5
3	91 to 244	2200	14.7
4	79 to 251	2110	14.1
5	80 to 230	3170	21.1
6	79 to 201	1890	12.6
7	79 to 243	1150	7.7
Totals		15,000	100.0

Several parameters (salinity, temperature, and dissolved oxygen) were monitored continuously during the pump tests and discrete samples were taken at the end of the tests for more complete analyses. Results of this water quality testing are compiled on Table 1. The continuous monitoring of salinity, temperature, and dissolved oxygen was done with an RBR Model XR-420 CTD which logged

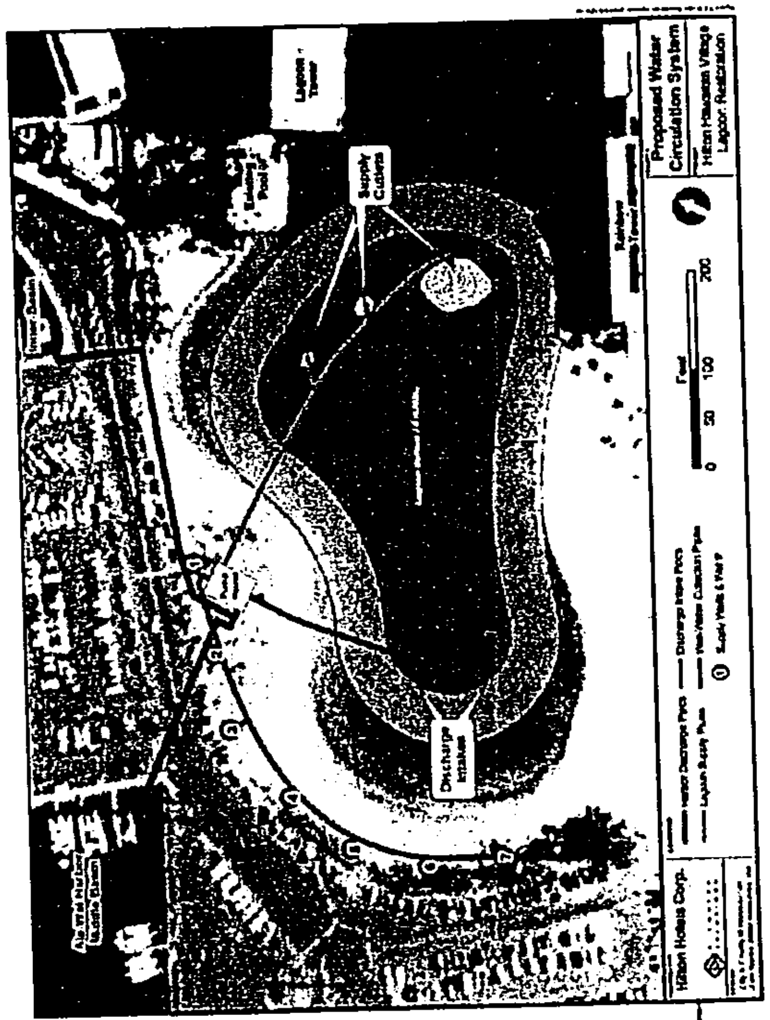


FIGURE 4. HYDRAULIC PERFORMANCE OF THE SEVEN SALTWATER SUPPLY WELLS

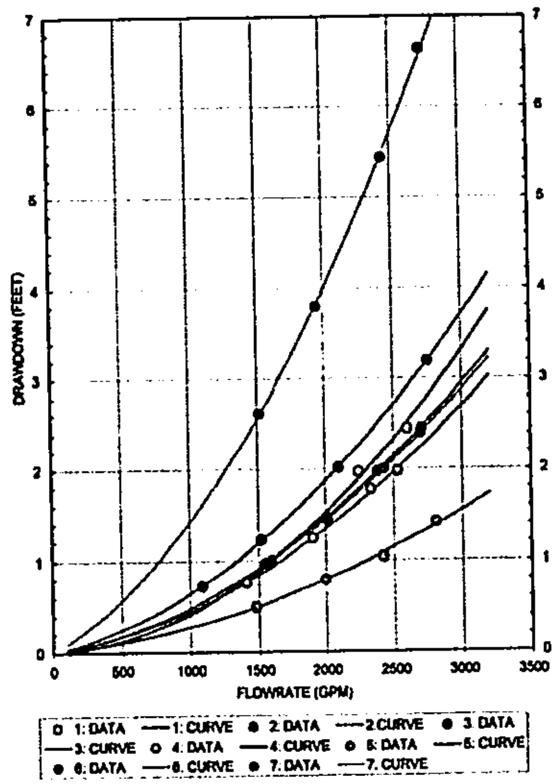


Table 1. Water Quality of the Seven Pelican Lagoon Saltwater Wells

Constituent	Units	Quality of the Wells Individually							Aggregate Well Water Quality	Present Lagoon Discharge
		Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Well 7		
Temperature	°F	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Salinity	PPT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dissolved Oxygen	% Saturation	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Turbidity	NTU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total Suspended Solids	mg/l	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
pH	pH Units	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chlorophyll-a	[illegible]	BCL	[illegible]	[illegible]	[illegible]	[illegible]	BCL	[illegible]	[illegible]	[illegible]
Nitrate	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ammonia	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dissolved Organic Nitrogen	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total Nitrogen	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Phosphate	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Dissolved Organic Phosphorus	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total Phosphorus	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Silica	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Clostridium Perfringens	MF/100 ml	<1	<1	<1	<1	<1	<1	<1	<1	
Enterococcus	MF/100 ml	<1	<1	<1	<1	<1	<1	<1	<1	
Lead	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Iron	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	[illegible]	BCL	
Mercury	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Aldrin	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
alpha-BHC	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
beta-BHC	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
delta-BHC	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
gamma-BHC (Lindane)	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
4,4'-DDD	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
4,4'-DDE	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
4,4'-DDT	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Dieldrin	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Endosulfan I	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Endosulfan II	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Endosulfan Sulfate	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Endrin	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Endrin Aldehyde	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Heptachlor	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Heptachlor Epoxide	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
Toxaphene	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
alpha-Chlordane	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	
gamma-Chlordane	[illegible]	BCL	BCL	BCL	BCL	BCL	BCL	BCL	BCL	

Notes:
1. Values of temperature, salinity, and dissolved oxygen of the well water reflect the average values recorded at [illegible]-minute intervals through the respective [illegible]-hour pump tests.
2. All other constituent values are analyses of discrete samples collected at the end of the respective [illegible]-hour pump tests.
3. The "Aggregate Well Water Quality" column of values is based on the [illegible] relative contributions of each of the seven wells to the total of all well water.
4. The "Present Lagoon Discharge" column of values reflects the average of three sampling events in October 2003.

these parameters in the pumped discharge at 6-minute intervals. Analyses of nutrients, TSS, turbidity, and chlorophyll were performed in the same manner as for the ocean samples (described in a subsequent section of this report). Analyses for indicator bacteria were performed by Hawaii Food and Water Testing. Clostridium perfringens were determined by the membrane filter renumeration method (Bisson and Cabelli, Appl. Environ. Micro 37:55-66, 1979) and EPA Method 1600 was used for enterococcus. Analyses of metals were performed by Severn Trent Laboratories (STL) in Seattle, Washington using EPA Method 6010 for lead and iron and EPA Method 7470 for mercury. STL also tested for the presence of organochlorine pesticides using EPA Method 608.

The aggregate well water quality (second to last column on the right of Table 1) assumes the relative contributions from the wells listed above. With the short residence time in the lagoon that the increased pumping rate will create (a little under six hours), the only expectable changes to the well water as it is discharged into the AWH's middle and inner basins will be an increase in dissolved oxygen (to full saturation based on measurements in the lagoon during pump testing) and a rise in temperature. The temperature increase is expected to be two to three degrees Fahrenheit at mid-day and less at other times based on the semi-diurnal temperature changes that now occur in the lagoon. All other aggregate water quality characteristics listed on Table 1 are not expected to change significantly as a result of the well water's relatively short travel time across the lagoon.

The last column on the right of Table 1 is the quality of the water now being pumped from the lagoon into the middle basin of the AWH based on three sampling events in October 2003. In comparison to the present discharge from the lagoon, the well water delivered to the AWH will be of essentially the same salinity and dissolved oxygen, two to three degrees Fahrenheit cooler, slightly higher in total nitrogen and total phosphorus (with more of these nutrients in inorganic rather than organic forms), and an order of magnitude higher in silica.

CHARACTERIZATION OF THE WATER QUALITY IN THE ALA WAI BOAT HARBOR, ALA WAI CANAL OUTLET CHANNEL, AND OFFSHORE MARINE WATERS

Selected Sampling Stations

Figure 5 identifies the 26 sampling stations that were selected to depict the water quality conditions in the waters that have the potential to be affected by the lagoon discharge. The station locations can be grouped as follows:

- Seven Sites Along the Ala Wai Canal's Outlet Channel: Station Nos. 1, 2, 3, 7, 11, 15, and 16
- Three Sites in each of the AWH's Three Basins:
  - Inner Basin: Station Nos. 4, 5, and 6
  - Middle Basin: Station Nos. 8, 9, and 10

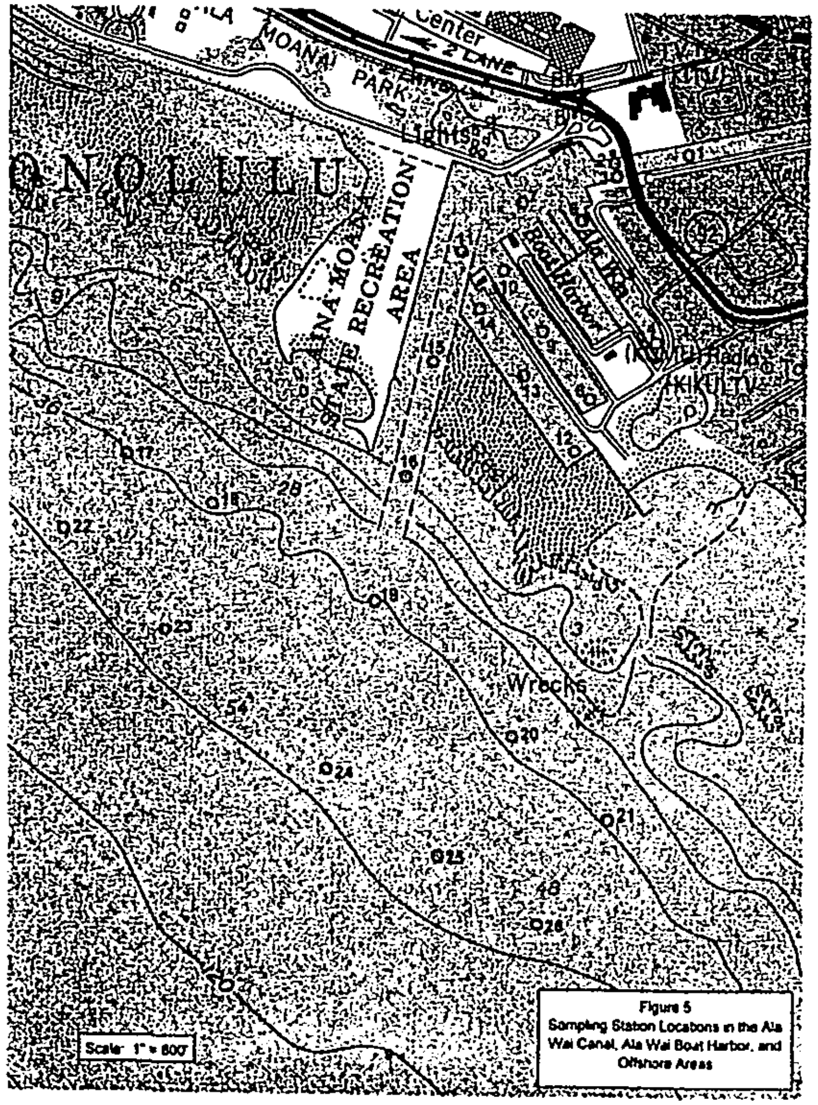


Figure 5
Sampling Station Locations in the Ala Wai Canal, Ala Wai Boat Harbor, and Offshore Areas

- Outer Basin. Station Nos. 12, 13, and 14
- Offshore Marine Waters
  - Five Sites Along the 30-Foot Depth Contour: Station Nos. 17 through 21
  - Five Sites Along the 55-Foot Depth Contour: Station Nos. 22 through 26

The selection of Site Nos. 2 and 3, which are adjacent to each other and immediately downstream of the Ala Moana Boulevard Bridge across the Ala Wai Canal, needs explanation. There is a continuous saline groundwater discharge of about 1100 GPM (as measured on March 11, 2005) from the Yacht Harbor Towers through the Ala Wai Canal's west wall about 200 feet upstream of the roadway bridge. It was thought that this discharge might be of sufficient magnitude to alter the layer of fresher water in the upper several feet of the Ala Wai Canal's water column. Site No. 2 on the west side of the channel would show the effect if it was occurring and Site No. 3 on the east side would be relatively undisturbed by the discharge. As it turned out, however, there was virtually no difference in the thickness or the salinity of the canal's surface layer at Site Nos. 2 and 3.

Sampling and Analytical Methods

Sampling at each of the 26 sites consisted of continuous profiling of salinity and temperature through the entire water column and collection of two discrete samples, one within a foot of the surface and the other just above the bottom. The continuous salinity and temperature profiles were done with an RBR Model XR-420 CTD. Surface samples were collected by opening 1-liter triple-rinsed polyethylene bottles over the side of the boat and filling with water. Bottom samples were collected using a Niskin-type oceanographic sampling bottle. The bottle was lowered to the desired sampling depth with spring-loaded endcaps held open so water passed freely through the bottle. At the desired sampling depth, a weighted messenger released from the surface triggered closure of the endcaps, isolating a volume of water. Upon retrieval, water from the Niskin bottle was poured into 1-liter triple-rinsed polyethylene bottles. Following collection, all water samples were immediately placed on ice and transported to the analytical laboratory.

Water quality constituents that were analyzed included dissolved silica (Si), total nitrogen (TN), nitrate + nitrite nitrogen (NO_3^- + NO_2^-, hereafter referred to as NO_3^-), ammonium nitrogen (NH_4^+), total phosphorus (TP), orthophosphate phosphorus (PO_4^{3-}), chlorophyll a (Chl a), turbidity, and total suspended solids (TSS). These constituents include all parameters with specific quality criteria in the DOH Chapter 11-54 water quality standards for embayments, estuaries, and open coastal waters. Analyses for NH_4^+, PO_4^{3-}, and NO_3^- were performed with a Technicon Autoanalyzer using standard methods for seawater analysis. TN and TP were analyzed in a similar manner following oxidative digestion. Total organic nitrogen (TON) and total organic phosphorus (TOP) were calculated as the

difference between TN and dissolved inorganic N and TP and dissolved inorganic P, respectively. Chl a was measured by filtering 300 ml of water through glass fiber filters. Pigments on filters were extracted in 90% acetone in the dark at 20° C for 12-24 hours. Fluorescence before and after acidification of the extract was measured with a Turner Designs fluorometer. TSS was measured gravimetrically on dried filtrate using a Cahn electrobalance. Turbidity was measured using a Monitek Model 21 nephelometer and reported in nephelometric turbidity units (NTU). All laboratory analyses were conducted by the University of Washington, School of Oceanography Marine Chemistry Laboratory, which possess the appropriate acceptability ratings from the U.S. EPA.

Sampling Events

Complete sets of CTD profiles and top and bottom water samples were collected on the following three days, times, and tidal conditions in March 2005:

Summary of the Complete Sampling Events in March 2005

Day	Time of Sampling	Tidal Condition
March 11	13:10 to 15:40	Midway through a 1.7-Foot Flood Tide
March 12	07:20 to 09:15	Midway through a 1.5-Foot Ebb Tide
March 29	15:20 to 18:00	Midway through a 1.9-Foot Flood Tide

Because the input of freshwater via the Ala Wai Canal is such a significant factor of the receiving water's quality, additional CTD profiling along a portion of the Ala Wai Canal's outlet channel (Station Nos. 1, 2, 3, 7, 11, and 15) was done on two other days:

Summary of the Additional CTD Profiling
In the Ala Wai Canal Outlet Channel in March 2005

Day	Time of CTD Profiling	Tidal Condition
March 24	06:30 to 07:00	Midway through a 1.7-Foot Ebb Tide
March 28	14:00 to 14:20	Midway through a 1.9-Foot Flood Tide

The fresh water input to the receiving waters during these five sampling days is an important aspect for the interpretation of the water quality results. Data from the USGS' website for the gaging station on Manoa Stream at Kanewai Field (No. 2425) provide an indication of the relative fresh water contribution from the Ala Wai Canal's inland watershed. In addition, rainfall-runoff from the immediate vicinity of the AWH was observed during the sampling events. Accordingly, the relative amounts of fresh water input during the five sampling days can be characterized as follows:

Characterization of the Fresh Water Input During the Five March 2005 Sampling Events

Sampling Day	Contribution from the Ala Wai's Inland Watershed	Local Rainfall-Runoff	Lagoon Discharge Into the Middle Berthing Slips
March 11	Significant Contribution on March 9 (Two Days Prior) but Low Flow on March 11	None	Pump Off
March 12	Slightly Above Average Inflow at the Time of Sampling	Substantial Rainfall-Runoff to Inner Harbor Basin	Pump Off
March 24	Sustained Low Flows from March 13 through March 24	None	Pump On
March 28	About Average Discharge at the Time of Sampling	None	Pump On
March 29	High Streamflow Substantially Greater than Previous Sampling Events	Some Rainfall-Runoff to the Inner Harbor Basin	Pump On

Salinity and Thickness of the Surface Layer throughout the Receiving Waters of the Proposed HHV Lagoon Discharge Based on the CTD Profiles

Ala Wai Canal Outlet Channel. Figures 8 through 10 illustrate the salinity and thickness of the surface layer in the Ala Wai Canal's outlet channel for the five days that CTD profiles were taken. The surface layer was typically between two and four feet thick. Expectedly, salinities were lowest on the two wettest days (March 12 and 29, 2005 on Figures 7 and 10). The substantial range of salinity in the surface layer depends on the watershed's ongoing fresh water contribution. In all of the profiles, however, there is a progressive mixing of the surface layer as it moves seaward so that it is substantially reduced in thickness and increased in salinity near the outer end of the outlet channel (Station No. 16).

Perhaps surprisingly, the temperature profiles do not provide as clear a depiction of the surface layer as the salinity profiles (Figures 11 and 12 are examples). Depending on the sampling event, the fresher surface layer was sometimes colder and at other times warmer than the saltwater layer below.

Ala Wai Boat Harbor Inner Basin. Circulation in the harbor's inner basin is relatively sluggish, driven primarily by tidal fluctuation direct rainfall-runoff when it occurs, and lateral movement of Ala Wai Canal discharge into the harbor. The largest rainfall-runoff discharge enters the inner end of the basin via an existing culvert near Dewey Lane, but there are two other discharge points along the mauka side of the basin as well. All three sets of the salinity profiles on Figures 13 to 15 show a distinct surface layer on the order of two feet thick. The layer was substantially fresher on the two wetter sampling days, March 12th and 29th (Figures 14 and 15)

Ala Wai Boat Harbor Middle Basin. The harbor's middle basin is isolated from the inner and Outer basins by earth filled groins. It presently receives the 5300 GPM lagoon discharge (in the near vicinity of Station No. 8). However, on March 11th and 12th, the lagoon circulation pump was not running

Figure 8. Salinity Along the Ala Wai Canal Outlet Channel on March 11, 2005 on a Flood Tide

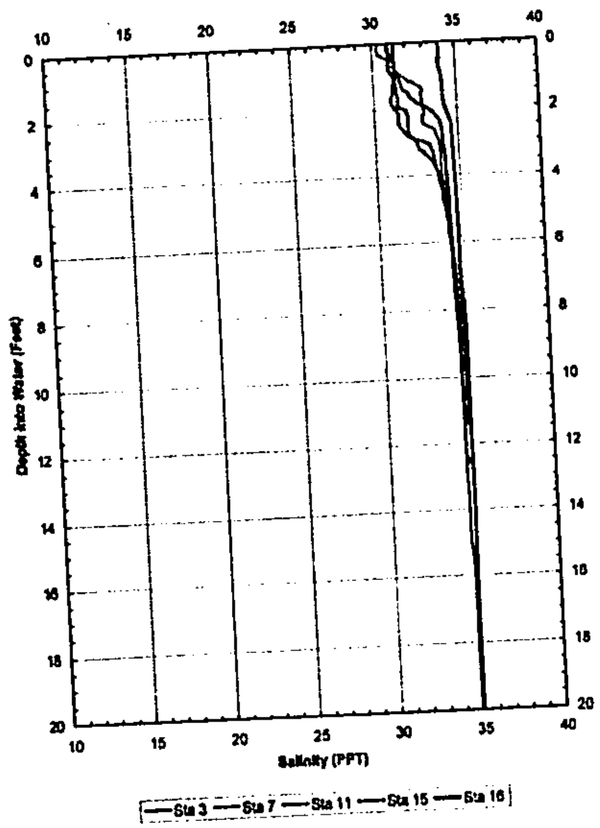


Figure 7. Salinity Along the Ala Wai Canal Outlet Channel on March 12, 2006 on an Ebb Tide

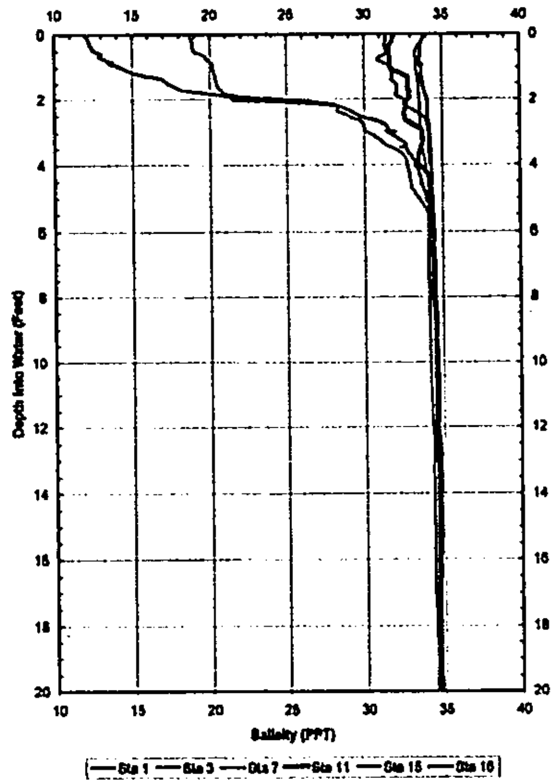


Figure 8. Salinity Along the Ala Wai Canal Outlet Channel on March 24, 2006 on an Ebb Tide

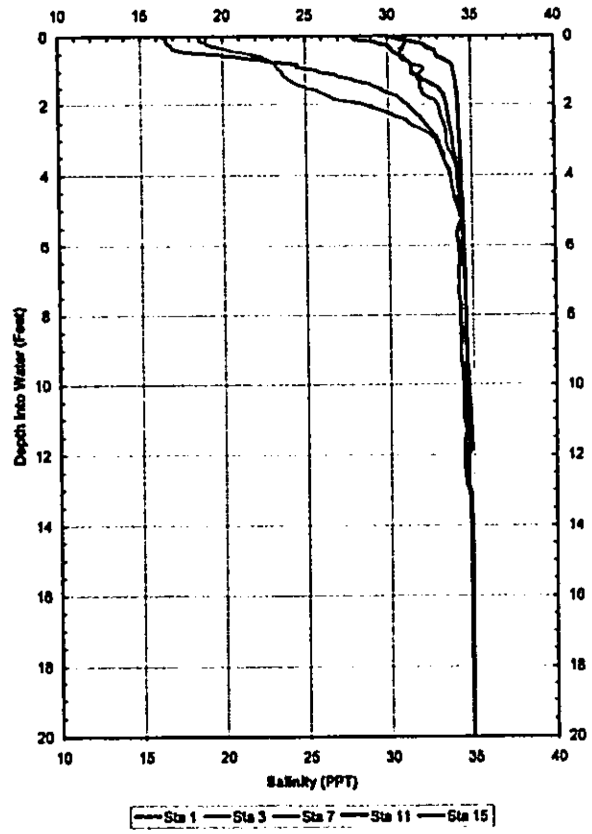


Figure 9. Salinity Along the Ala Wai Canal Outlet Channel on March 28, 2006 on a Flood Tide

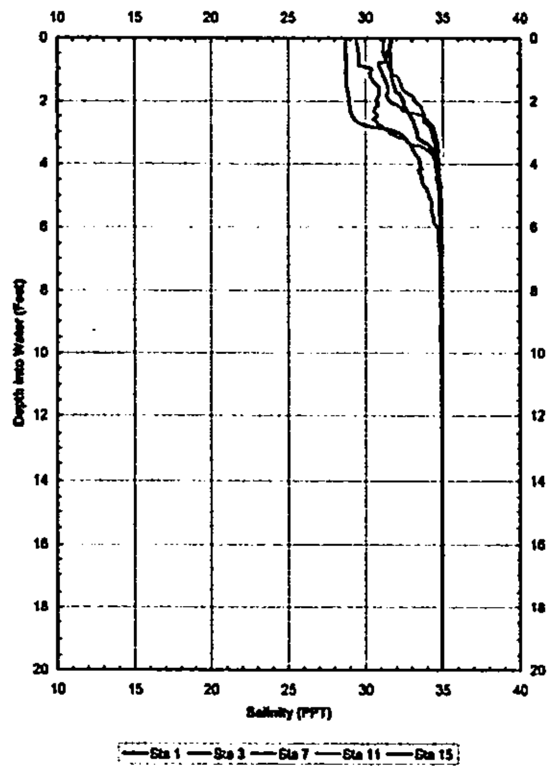


Figure 10. Salinity Along the Ala Wai Canal Outlet Channel on March 29, 2006 on a Flood Tide

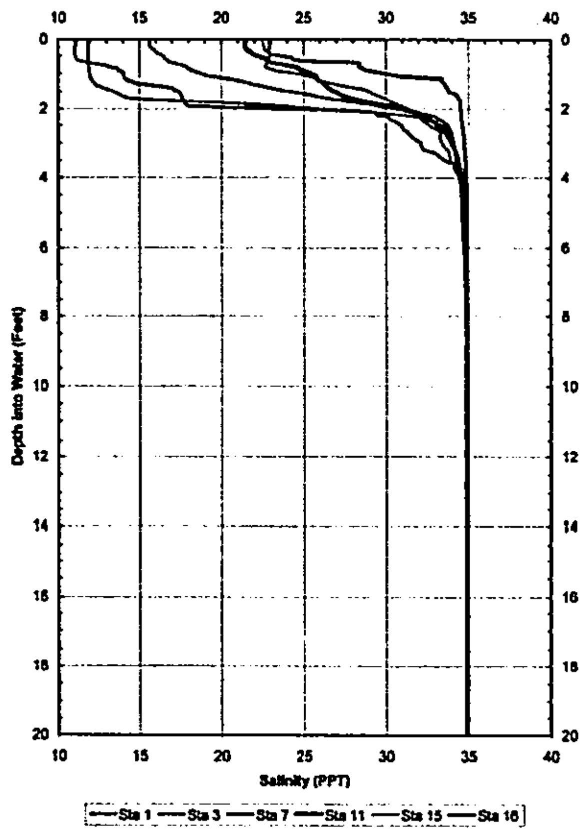


Figure 11. Temperatures in the Ala Wai Canal Outlet Channel on March 24, 2006 on an Ebb Tide

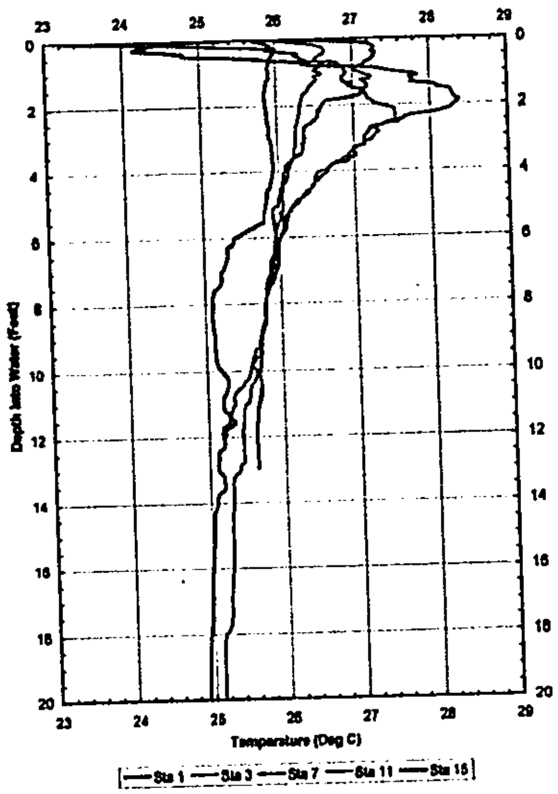


Figure 12. Temperatures in the Ala Wai Canal Outlet Channel on March 28, 2006 on a Flood Tide

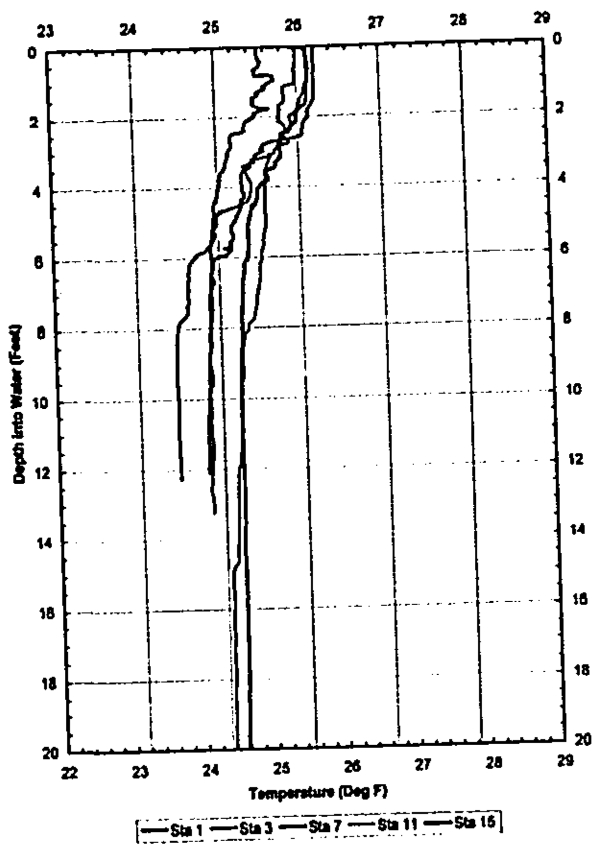


Figure 13. Salinity in the Ala Wai Harbor Inner Basin on March 11, 2006 on a Flood Tide

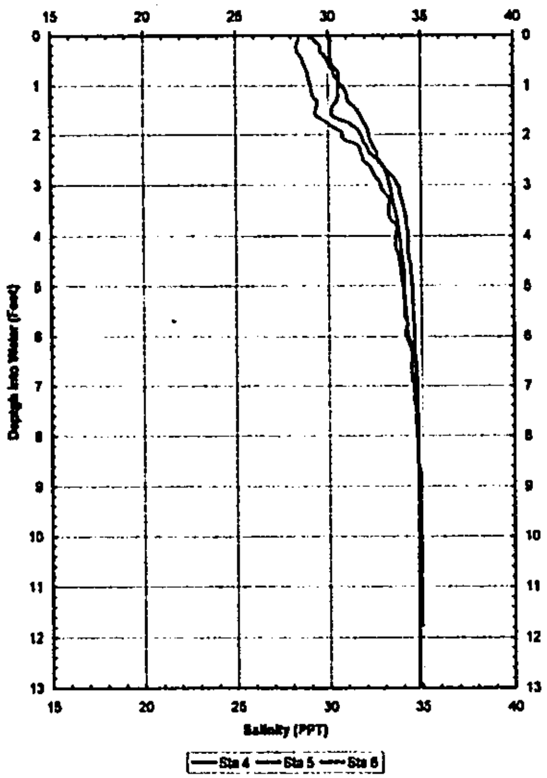


Figure 14. Salinity in the Ala Wai Harbor Inner Basin on March 12, 2006 on an Ebb Tide

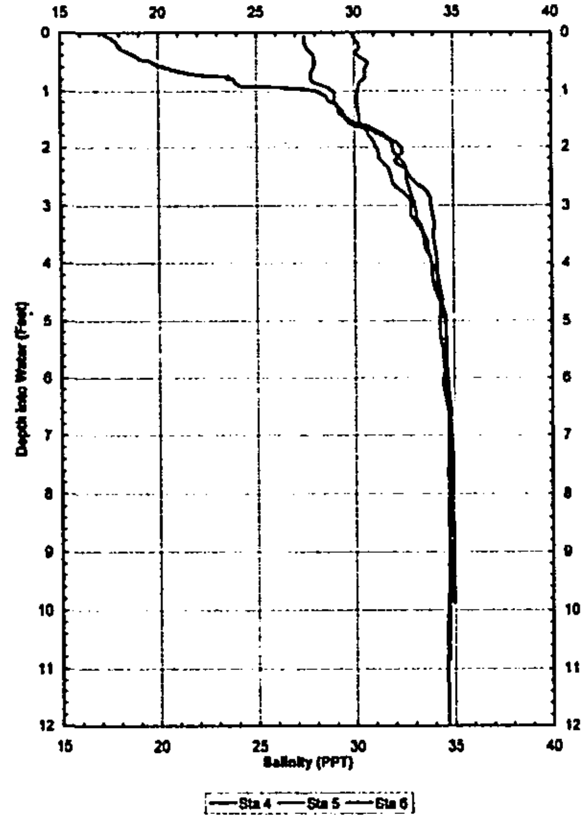
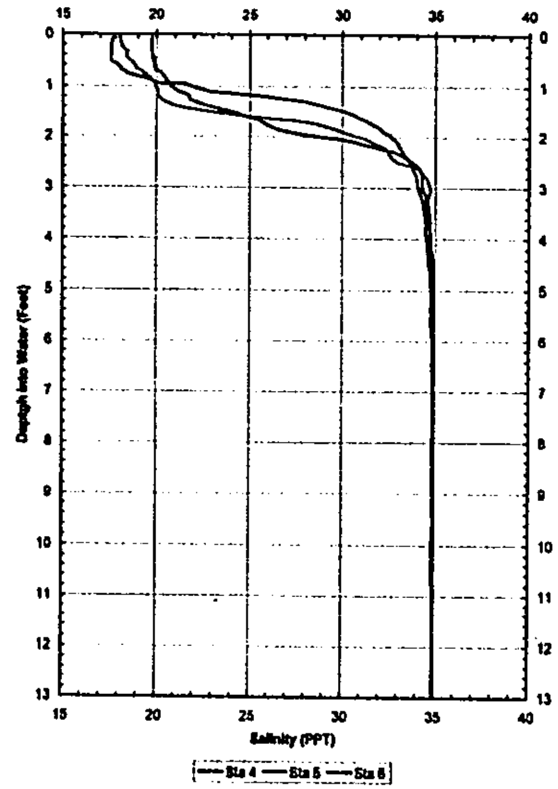


Figure 18. Salinity in the Ala Wai Harbor Inner Basin on March 29, 2005 on a Flood Tide



and there was a four- to five-foot thick upper layer throughout the basin (Figures 16 and 17). On March 29th, the wettest sampling day, the lagoon circulation pump was running. Its discharge displaced the upper layer at the inland end of the basin (Station No. 8) but appeared to have little effect on the surface layer further from the lagoon's discharge (Station Nos. 9 and 10 on Figure 18).

Ala Wai Harbor Outer Basin. There is no lagoon discharge and only minimal stormwater runoff into the harbor's outer basin. Its circulation results from tidal action, possibly from eddy currents produced by the passing Ala Wai Canal discharge, and from wave-driven water movement through its rubble mound outer breakwater. The profiles of May 11th and 12th depict a relatively saline upper layer (90 to 96 percent seawater) which is eight to 10 feet thick (Figures 19 and 20). On March 29th, the wettest sampling day, the upper layer was distinctly thinner and fresher (two to four feet thick and 78 to 90 percent seawater on Figure 21).

Offshore Along the 30-Foot Depth Contour. All three sets of salinity profiles on Figures 22 to 24 portray a similar direction of flow from the Ala Wai Canal outlet channel into the offshore area. The fresher upper layer turned to the west and moved alongshore in that direction (from Station No. 19 toward Station Nos. 18 and 17).

Offshore Along the 55-Foot Depth Contour. The same movement to the west of the Ala Wai Canal's discharge is also depicted in the sets of salinity profiles along the 55-foot depth contour, with the salinity and thickness of the upper layer reflecting the relative magnitudes of the canal's discharge at the time of sampling (Figures 25 to 27).

Water Quality Results in the Ala Wai Canal, Ala Wai Boat Harbor, and Offshore Areas

Tables 2 through 7 present the results of water chemistry analyses of the top and bottom samples collected from the 20 sampling sites on March 11, 12, and 29, 2005. Tables 2, 3, and 4 show the constituent concentrations in micromolar (µM) units. Tables 5, 6, and 7 show these same results in units of micrograms per liter (µg/l). The results are characterized in the paragraphs following.

Ala Wai Canal Outlet Channel. The pattern of nutrient concentrations in the top and bottom samples from the Ala Wai Canal's outlet channel reflects the two-layered flow system and progressive mixing of the upper layer as the water moves down the channel toward its ocean discharge.

- On all three sampling days, nutrient concentrations (silica, forms of nitrogen, and forms of phosphorus) were substantially higher in the upper surface layer than in the lower saline layer.

Figure 16. Salinity in the Ala Wai Harbor Middle Basin
on March 11, 2005 on a Flood Tide

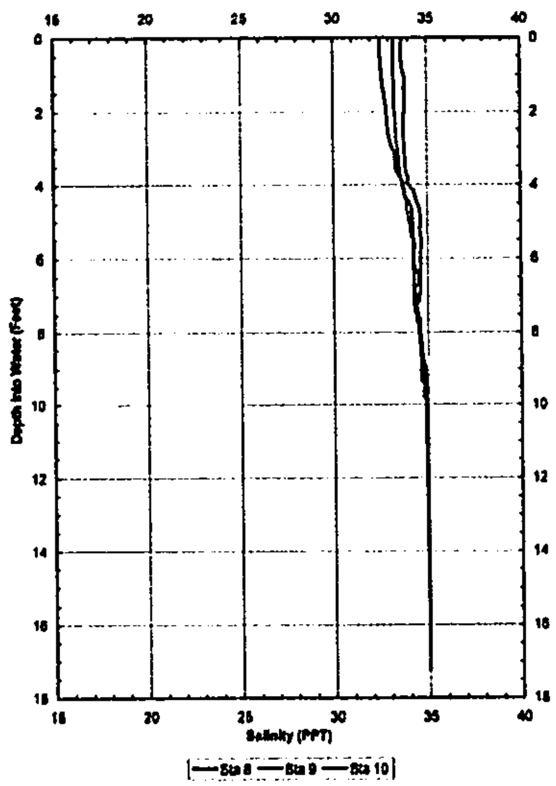


Figure 17. Salinity in the Ala Wai Harbor Middle Basin
on March 12, 2005 on an Ebb Tide

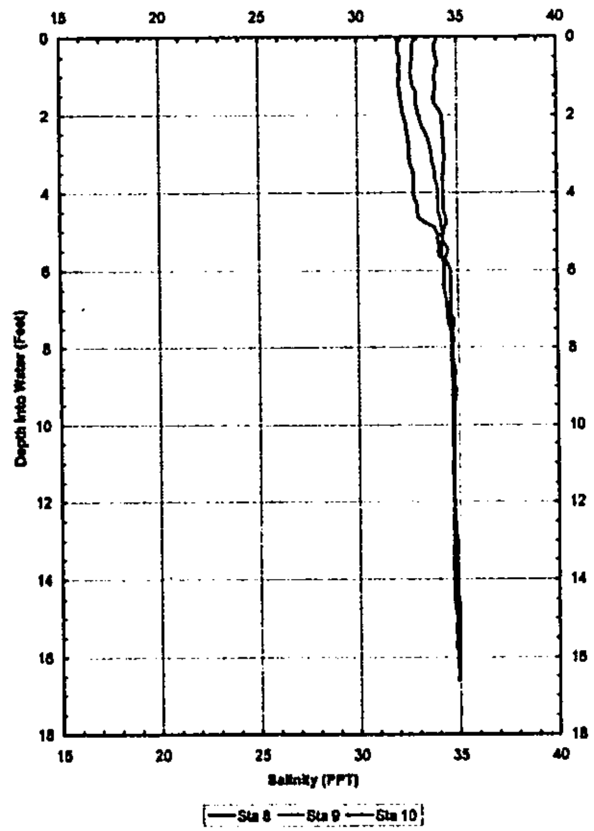


Figure 18. Salinity in the Ala Wai Harbor Middle Basin on March 29, 2006 on a Flood Tide

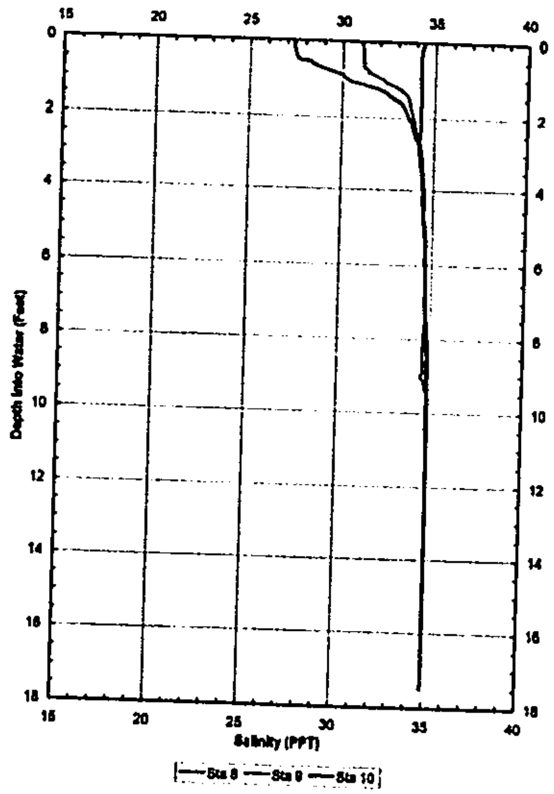


Figure 19. Salinity in the Ala Wai Harbor Outer Basin on March 11, 2006 on a Flood Tide

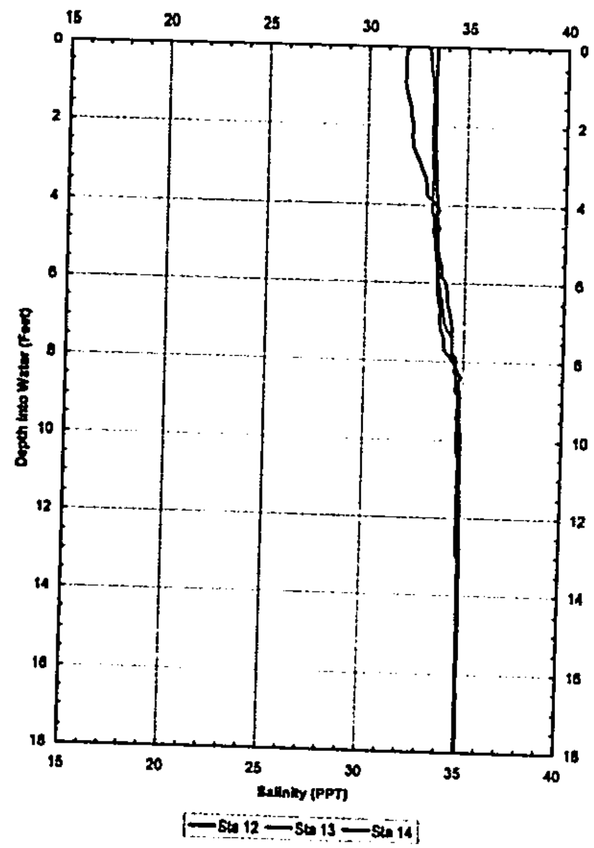


Figure 20. Salinity in the Ala Wai Harbor Outer Basin on March 12, 2006 on an Ebb Tide

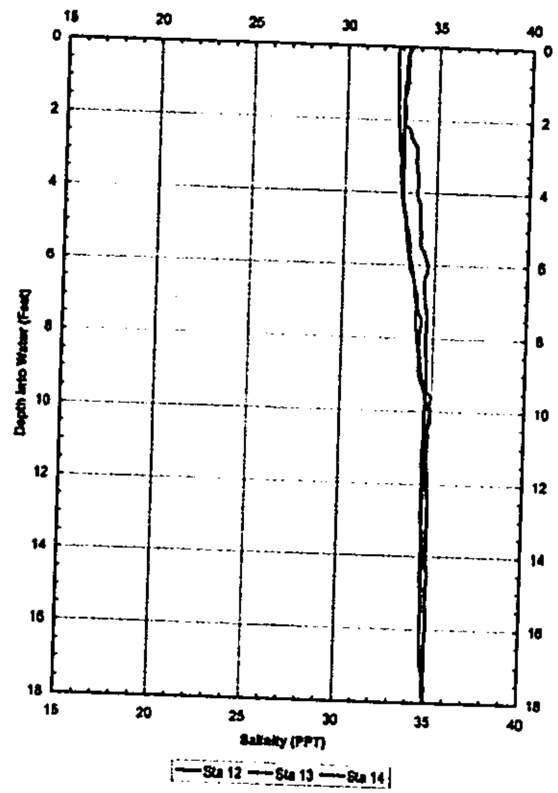


Figure 21. Salinity in the Ala Wai Harbor Outer Basin on March 29, 2006 on a Flood Tide

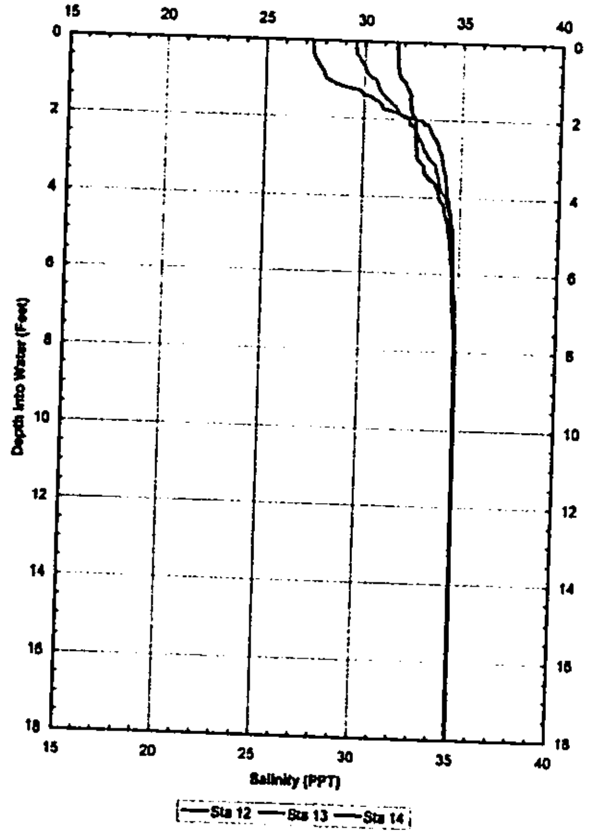


Figure 22. Salinity Along the 30-Foot Depth Contour Offshore on March 11, 2005 on a Flood Tide

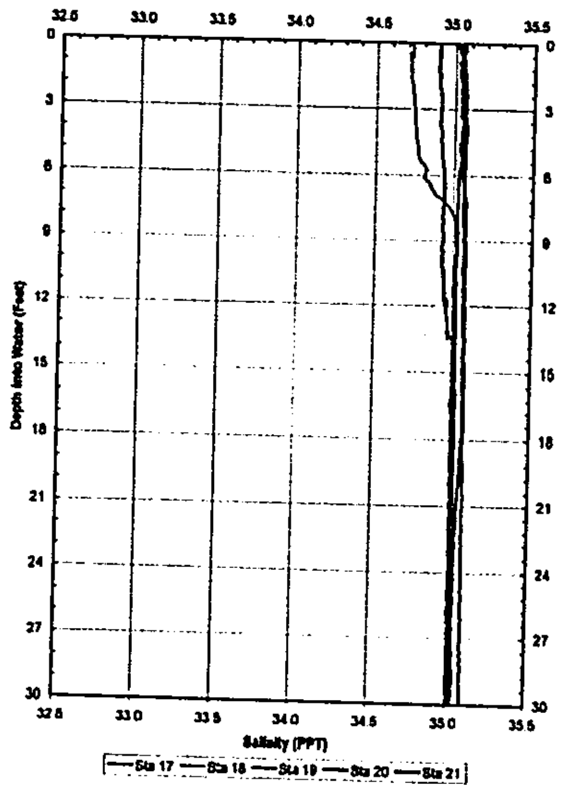


Figure 23. Salinity Along the 30-Foot Depth Contour Offshore on March 12, 2005 on an Ebb Tide

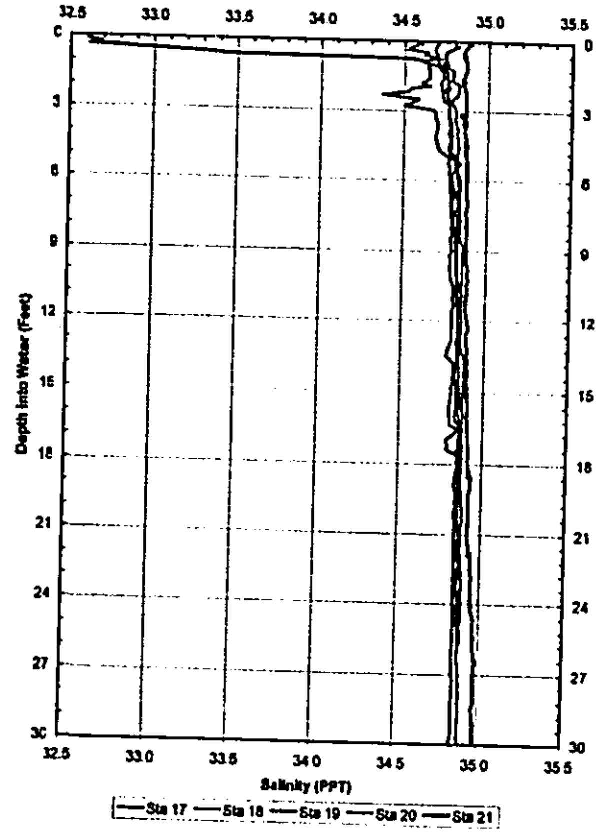


Figure 24. Salinity Along the 30-Foot Depth Contour Offshore on March 29, 2006 on a Flood Tide

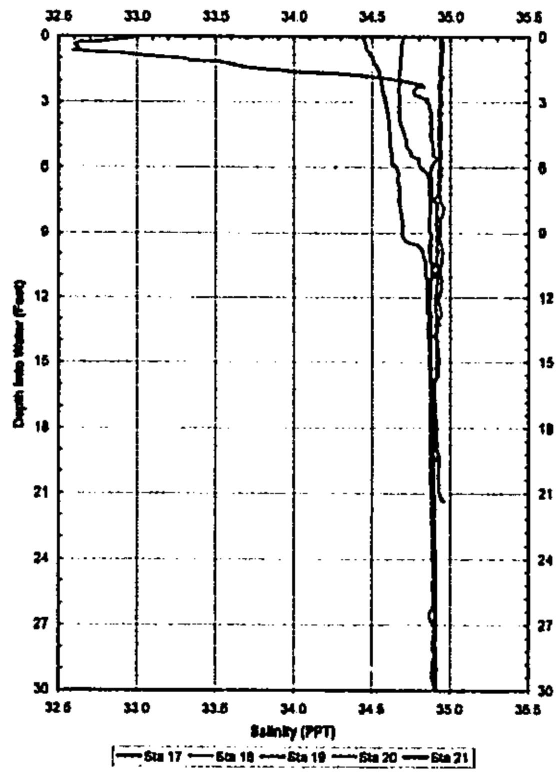


Figure 25. Salinity Along the 55-Foot Depth Contour Offshore on March 11, 2006 on a Flood Tide

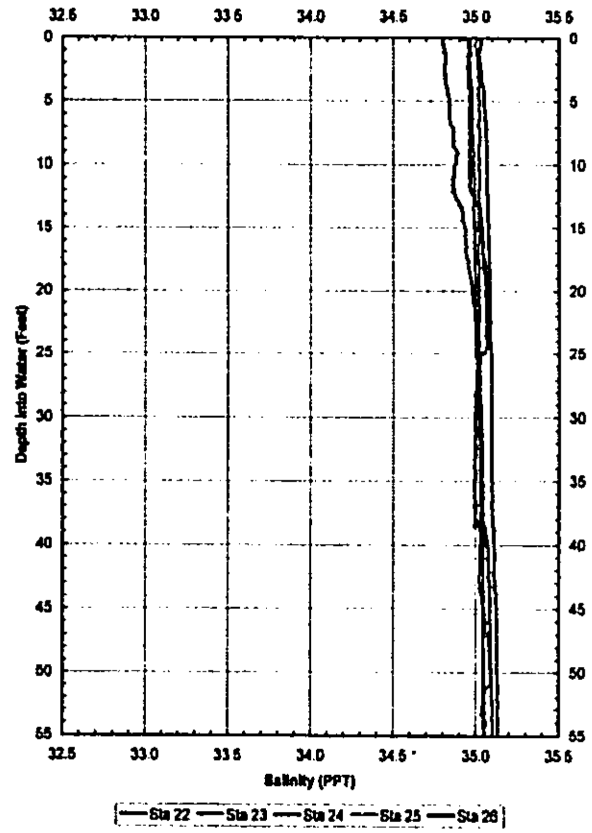


Figure 26. Salinity Along the 55-Foot Depth Contour Offshore on March 12, 2006 on an Ebb Tide

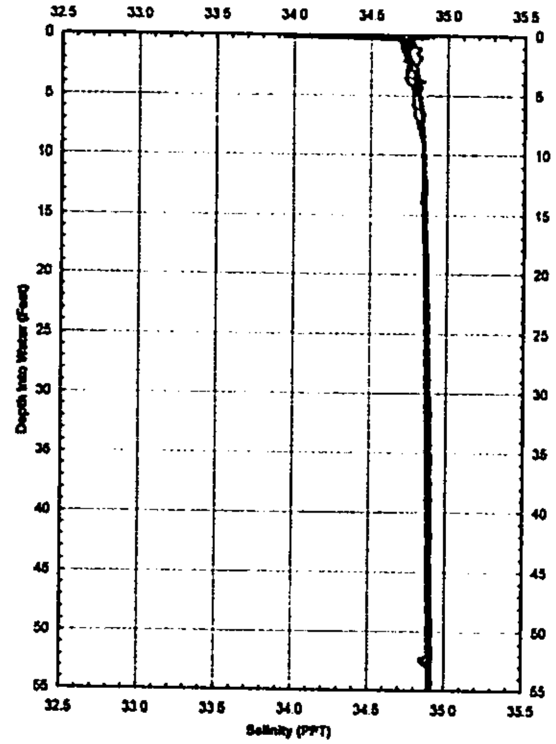


Figure 27. Salinity Along the 55-Foot Depth Contour Offshore on March 29, 2006 on a Flood Tide

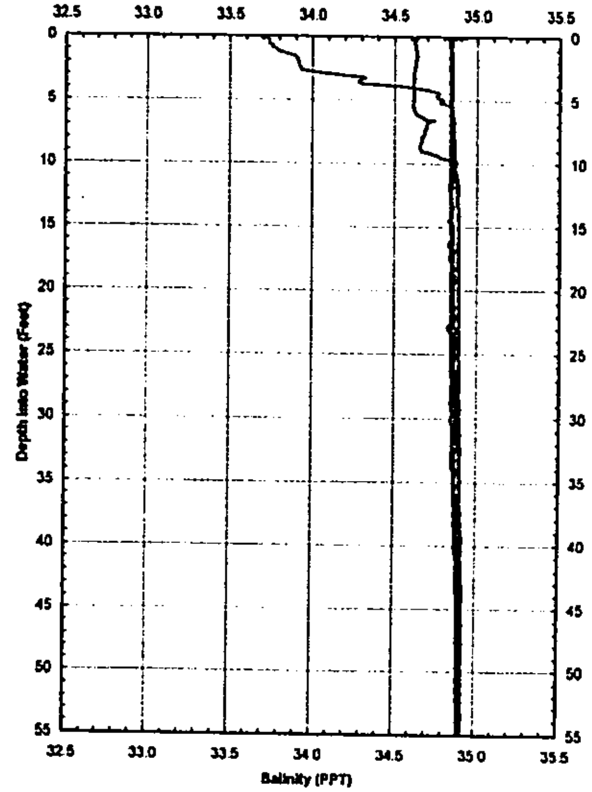


TABLE 2. Water Quality Results in Units of Micromolar for the March 11, 2005 Samples
Abbreviations as follows: S = surface water; B = bottom water; "bd" = below detection limit. Concentrations of nutrients are shown in micromolar units (µM). For locations of sampling sites, see Figure 5.

LOCATION	STA NO.	Si (µM)	NO_3 (µM)	NH_4 (µM)	PO_4 (µM)	TN (µM)	TP (µM)	TON (µM)	TOP (µM)	Chl a (µg/l)	TURB (ntu)	TSS (mg/l)
ALA WAI CANAL OUTLET CHANNEL	1S	54.87	16.07	4.37	0.27	36.46	1.30	15.82	0.94	7.09	1.80	9.82
	1B	6.40	0.66	1.51	0.35	10.78	0.56	8.59	0.21	1.15	3.60	11.63
	2S	48.04	9.28	2.26	0.42	25.14	0.86	13.62	0.44	4.06	2.45	8.40
	2B	10.93	1.38	0.86	0.37	14.64	0.76	12.41	0.39	2.37	4.70	12.55
	3S	48.77	9.81	2.72	0.34	26.59	0.80	14.06	0.46	3.44	2.12	8.40
	3B	11.29	1.70	0.44	0.22	14.28	0.51	12.13	0.29	1.54	1.75	9.45
	7S	50.99	10.77	1.16	0.41	26.39	0.93	14.16	0.52	4.23	1.48	6.95
	7B	6.89	0.82	0.21	0.22	10.96	0.41	9.93	0.20	0.94	1.75	8.60
	11S	50.29	10.09	1.48	0.34	23.63	0.82	12.07	0.48	3.33	1.74	9.10
	11B	6.51	0.46	0.14	0.15	9.68	0.35	9.08	0.20	0.52	1.24	10.65
	15S	46.77	9.85	1.39	0.34	20.96	0.75	9.32	0.41	2.78	1.88	9.55
	15B	4.54	0.43	0.03	0.12	10.07	0.31	9.61	0.20	0.37	0.83	11.55
	16S	19.97	3.94	1.34	0.28	8.03	0.42	2.75	0.14	0.72	0.60	9.43
	16B	2.49	0.31	0.01	0.10	4.76	0.21	4.44	0.11	0.18	0.45	10.15
ALA WAI HARBOR INNER BASIN	4S	54.58	9.07	0.58	0.54	25.23	1.25	15.58	0.70	5.51	2.00	8.90
	4B	6.30	0.43	0.21	0.46	17.36	0.96	16.75	0.50	13.69	4.29	11.20
	5S	72.19	12.85	0.76	0.48	29.70	1.31	15.06	0.63	3.86	1.36	8.50
	5B	7.59	0.61	0.83	0.34	14.93	0.67	13.49	0.33	2.78	3.65	10.20
	6S	63.64	12.73	0.61	0.41	26.06	0.98	12.72	0.50	3.98	1.46	9.15
	6B	4.91	0.41	0.53	0.27	12.75	0.53	11.63	0.26	1.91	3.00	11.65
ALA WAI HARBOR MIDDLE BASIN	8S	14.66	2.75	1.07	0.37	14.02	0.47	10.20	0.30	0.94	1.23	10.55
	8B	4.68	0.81	0.39	0.29	14.01	0.57	12.81	0.25	0.93	1.60	7.45
	9S	19.94	4.11	0.93	0.31	16.39	0.59	11.34	0.27	1.21	1.24	10.30
	9B	6.10	0.36	1.22	0.43	11.58	0.84	10.00	0.37	2.86	9.45	21.65
	10S	30.68	6.82	0.75	0.27	19.44	0.67	11.87	0.35	2.07	1.42	10.00
	10B	5.72	0.32	0.46	0.70	9.05	0.41	8.27	0.21	1.04	7.40	20.90
ALA WAI HARBOR OUTER BASIN	12S	18.62	2.76	0.84	0.21	11.56	0.40	8.16	0.19	1.34	1.70	9.70
	12B	5.55	0.45	0.74	0.30	11.16	0.29	9.97	0.29	1.04	2.24	8.75
	13S	21.80	3.79	0.52	0.24	13.40	0.53	9.09	0.78	1.35	1.53	11.00
	13B	5.15	0.27	0.76	0.27	8.98	0.51	7.86	0.24	1.37	3.98	4.80
	14S	34.37	7.51	1.57	0.28	19.72	0.64	10.64	0.34	1.68	1.70	9.00
	14B	6.16	0.73	0.67	0.21	9.12	0.47	7.71	0.26	0.97	2.30	12.20
OFFSHORE - 15 FT DEPTH CONTOUR	17S	2.73	0.19	0.02	0.08	5.43	0.21	5.22	0.13	0.18	0.47	10.80
	17B	1.48	0.10	0.00	0.07	9.23	0.21	9.13	0.13	0.11	0.40	11.80
	18S	4.21	0.71	0.13	0.13	5.49	0.27	4.66	0.12	0.24	0.23	10.70
	18B	1.56	0.11	bd	0.07	4.13	0.20	4.02	0.13	0.12	0.22	11.40
	19S	1.64	0.07	0.10	0.06	11.42	0.22	11.26	0.15	0.12	0.51	7.40
	19B	1.35	0.06	bd	0.05	4.48	0.16	4.42	0.10	0.11	0.89	6.00
	20S	1.62	0.10	0.01	0.05	6.72	0.19	6.61	0.14	0.12	0.46	8.00
	20B	1.22	0.05	bd	0.07	5.75	0.17	5.69	0.10	0.12	0.65	10.60
	21S	1.61	0.05	bd	0.04	7.17	0.17	7.12	0.13	0.11	0.23	9.15
	21B	1.39	0.12	0.01	0.08	7.56	0.24	7.43	0.15	0.18	0.65	9.10
OFFSHORE - 30 FT DEPTH CONTOUR	22S	3.17	0.38	bd	0.06	7.77	0.21	7.39	0.15	0.20	0.31	12.60
	22B	1.37	0.04	bd	0.05	5.13	0.17	5.09	0.13	0.14	0.13	8.30
	23S	1.55	0.11	0.04	0.08	8.15	0.26	7.99	0.15	0.15	0.33	7.35
	23B	1.44	0.03	0.02	0.09	18.85	0.38	18.81	0.29	0.32	0.34	20.81
	24S	1.43	0.06	bd	0.08	9.31	0.23	9.25	0.15	0.11	0.23	13.00
	24B	1.04	0.04	bd	0.07	10.27	0.25	10.23	0.18	0.10	0.32	11.00
	25S	1.40	0.03	bd	0.07	10.09	0.22	10.05	0.19	0.12	0.34	9.55
	25B	1.77	0.06	bd	0.06	5.28	0.18	5.22	0.12	0.12	0.28	9.25
	26S	1.28	0.09	0.03	0.05	7.62	0.19	7.51	0.14	0.08	0.09	6.90
	26B	1.27	0.10	0.07	0.08	8.90	0.23	8.73	0.15	0.10	0.17	4.60

TABLE 3. Water Quality Results in Units of Micromolar for the March 12, 2005 Samples
Abbreviations as follows: S = surface water; B = bottom water; "bd" = below detection limit. Concentrations of nutrients are shown in micromolar units (µM). "Pipe" indicates water draining into the Ala Wai Canal from Yacht Harbor Towers. For locations of sampling sites, see Figure 5.

LOCATION	STA NO.	Si (µM)	NO_3 (µM)	NH_4 (µM)	PO_4 (µM)	TN (µM)	TP (µM)	TON (µM)	TOP (µM)	Chl a (µg/l)	TURB (ntu)	TSS (mg/l)
ALA WAI CANAL OUTLET CHANNEL	1S	69.30	14.85	3.02	3.35	47.16	5.94	15.82	0.94	2.47	28.00	23.80
	1B	40.50	9.89	6.39	1.19	31.49	2.40	8.59	0.21	8.18	12.00	24.11
	2S	93.30	19.46	1.78	1.63	39.52	3.30	13.62	0.44	3.05	14.50	17.09
	2B	35.97	8.27	5.06	0.73	26.85	1.79	12.41	0.39	7.11	6.00	15.05
	3S	116.88	23.99	2.74	1.66	43.46	3.35	14.06	0.46	2.95	15.30	14.15
	3B	21.80	4.32	4.22	0.42	15.89	1.32	12.13	0.29	5.72	6.20	13.35
	7S	40.78	7.67	6.81	0.73	25.20	1.47	14.16	0.52	5.57	4.20	16.10
	7B	8.13	0.94	1.69	0.43	6.31	0.63	9.93	0.20	1.25	3.85	16.60
	11S	36.66	6.05	1.97	0.43	13.20	0.95	12.07	0.46	1.15	6.55	9.70
	11B	7.48	0.71	2.32	0.47	16.37	0.93	9.08	0.20	2.02	2.25	12.70
	15S	14.06	2.04	0.80	0.23	7.39	0.59	9.32	0.41	1.36	1.30	16.60
	15B	5.50	0.48	1.14	0.27	11.91	0.62	9.61	0.20	0.91	2.60	19.70
	16S	11.80	1.89	0.60	0.22	13.12	0.51	2.75	0.14	0.87	2.93	20.20
	16B	5.25	0.49	0.57	0.19	11.30	0.60	4.44	0.11	0.52	0.31	12.15
ALA WAI HARBOR INNER BASIN	4S	68.92	9.85	5.17	2.14	34.10	3.84	15.58	0.70	2.08	23.90	25.55
	4B	9.97	0.95	1.20	0.63	11.62	1.30	16.75	0.50	7.31	3.83	9.95
	5S	43.67	7.28	2.20	0.73	22.47	1.40	15.06	0.63	3.65	2.85	4.70
	5B	7.01	0.65	1.19	0.43	6.10	0.89	13.49	0.33	2.44	2.30	4.55
	6S	42.03	11.00	3.90	0.87	24.21	1.60	12.72	0.58	3.25	5.67	18.00
	6B	8.76	0.43	0.96	0.45	7.02	0.92	11.63	0.26	3.95	3.55	16.05
ALA WAI HARBOR MIDDLE BASIN	8S	19.47	3.66	1.89	0.39	12.67	0.74	10.20	0.30	0.94	1.05	10.10
	8B	7.29	1.03	1.65	0.43	8.83	0.84	12.81	0.28	0.74	1.55	13.10
	9S	21.21	3.74	1.81	0.39	13.83	0.75	11.34	0.27	1.42	1.16	10.65
	9B	7.04	0.88	1.73	0.36	11.64	0.84	10.00	0.37	0.82	1.70	13.55
	10S	15.20	2.72	1.29	0.37	13.52	0.73	11.87	0.35	2.07	1.20	8.95
	10B	6.11	0.70	1.26	0.33	5.91	0.66	8.27	0.21	1.03	1.93	10.75
ALA WAI HARBOR OUTER BASIN	12S	17.72	3.35	1.33	0.36	15.33	0.67	8.16	0.19	1.33	0.88	13.05
	12B	5.69	0.72	1.28	0.47	13.16	0.76	9.97	0.79	0.76	7.15	13.90
	13S	18.70	3.39	1.27	0.31	13.91	0.64	9.09	0.28	1.30	0.90	17.05
	13B	8.49	1.30	1.14	0.29	7.64	0.67	7.86	0.24	0.87	1.82	114.55
	14S	15.38	2.75	1.17	0.27	14.05	0.63	10.64	0.36	0.96	0.97	13.65
	14B	5.85	0.74	0.72	0.22	11.34	0.54	7.71	0.26	0.67	2.00	20.60
OFFSHORE - 15 FT DEPTH CONTOUR	17S	1.74	0.12	0.04	0.13	8.10	0.37	5.22	0.13	0.09	1.09	6.75
	17B	1.47	0.11	0.06	0.13	8.91	0.41	9.13	0.13	0.21	0.52	12.25
	18S	1.20	0.09	0.04	0.13	8.74	0.37	4.66	0.12	bd	0.60	11.95
	18B	1.41	0.09	0.04	0.14	9.13	0.36	4.02	0.13	bd	0.51	12.70
	19S	1.33	0.06	0.03	0.13	9.55	0.36	11.26	0.15	0.12	0.61	12.00
	19B	1.64	0.08	0.07	0.16	7.51	0.46	4.47	0.10	0.13	0.33	12.60
	20S	3.77	0.41	0.15	0.13	9.63	0.34	6.61	0.14	0.25	0.65	10.65
	20B	1.67	0.11	bd	0.12	8.34	0.29	5.69	0.10	0.17	0.26	9.30
	21S	1.31	0.07	0.05	0.13	8.12	0.33	7.12	0.13	0.08	0.26	11.90
	21B	1.33	0.07	0.02	0.12	9.01	0.32	7.43	0.15	0.11	0.35	8.45
OFFSHORE - 30 FT DEPTH CONTOUR	22S	1.25	0.07	0.04	0.12	8.16	0.29	7.39	0.15	0.11	0.72	6.30
	22B	1.27	0.07	bd	0.11	7.73	0.26	5.09	0.13	0.10	0.22	8.85
	23S	1.28	0.07	0.05	0.12	9.86	0.31	7.99	0.15	0.11	0.32	10.65
	23B	1.30	0.07	0.05	0.12	9.97	0.30	18.81	0.79	0.10	0.33	11.70
	24S	1.32	0.04	0.02	0.12	10.71	0.27	9.25	0.15	0.09	0.41	8.15
	24B	1.34	0.06	0.04	0.12	6.37	0.26	10.23	0.18	0.14	0.40	9.15
	25S	1.45	0.07	bd	0.05	10.32	0.23	10.05	0.19	0.10	0.26	7.75
	25B	1.47	0.06	0.01	0.11	9.61	0.27	5.22	0.12	0.09	0.24	10.20
	26S	1.39	0.06	0.04	0.11	4.59	0.23	7.51	0.14	0.06	0.20	13.20
	26B	1.50	0.06	0.01	0.11	8.93	0.26	8.73	0.15	0.09	0.20	12.65

TABLE 4. Water Quality Results in Units of Micromolar for the March 23, 2005 Samples. Abbreviations as follows: S = surface water, B = bottom water; "bdl" = below detection limit. Concentrations of nutrients are shown in micromolar units (µM). "Pod" indicates water draining into the Ala Wai Canal from Yacht Harbor Towers. For locations of sampling sites, see Figure 5.

LOCATION	STA. NO	Si (µM)	NO3 (µM)	NH4 (µM)	PO4 (µM)	TN (µM)	TP (µM)	TON (µM)	TOP (µM)	Chl a (µg/l)	TURB (NTU)	TSS (mg/l)
ALA WAI CANAL OUTLET CHANNEL	1S	128.25	3.45	2.84	0.89	22.19	1.54	10.83	0.68	3.43	4.00	16.18
	1B	34.37	2.44	0.73	0.42	12.14	0.77	8.75	0.36	4.01	1.70	14.67
	2S	130.65	8.86	2.94	0.87	21.96	1.63	10.17	0.76	3.02	3.40	10.09
	2B	11.84	1.39	3.11	0.53	12.79	0.76	6.29	0.23	2.02	2.00	13.60
	3S	127.87	8.17	2.14	0.79	17.07	1.51	8.74	0.72	3.15	3.20	10.84
	3B	8.16	0.84	0.38	0.35	9.96	0.50	8.74	0.15	2.35	1.80	15.82
	7S	123.01	8.30	2.80	0.80	22.66	1.40	11.56	0.66	3.04	4.20	7.78
	7B	3.77	0.23	0.02	0.20	8.69	0.34	8.47	0.16	0.47	0.60	11.85
	11S	83.99	4.41	1.73	0.61	17.94	0.98	9.77	0.37	3.35	2.30	10.21
	11B	5.10	0.43	0.32	0.25	7.70	0.33	6.95	0.08	0.52	0.80	14.42
	15S	72.61	6.16	1.29	0.53	16.10	0.99	10.65	0.46	2.32	3.00	4.96
	15B	3.65	0.26	bdl	0.18	9.01	0.31	8.75	0.13	0.19	0.60	11.09
	16S	71.70	4.85	1.27	0.37	21.34	0.92	13.22	0.55	1.60	1.50	8.43
	16B	7.94	0.19	0.06	0.15	7.51	0.30	7.26	0.15	0.10	0.30	11.37
ALA WAI HARBOR INNER BASIN	4S	123.64	12.84	3.47	0.67	27.87	1.26	11.56	0.59	2.60	2.70	7.14
	4B	9.35	0.19	0.48	0.46	10.06	0.79	9.40	0.33	6.07	3.00	12.82
	5S	117.79	12.48	2.29	0.63	22.91	1.26	8.14	0.41	1.94	7.50	12.36
	5B	6.60	0.19	0.36	0.32	12.82	0.62	12.27	0.30	4.47	1.00	13.18
	6S	116.15	11.07	1.85	0.62	22.95	1.17	10.03	0.55	1.85	2.00	8.59
	6B	7.49	0.55	1.36	0.50	11.77	0.82	9.84	0.32	4.25	0.60	16.89
ALA WAI HARBOR MIDDLE BASIN	8S	18.15	2.32	1.04	0.21	12.84	0.51	9.48	0.28	3.16	0.80	11.17
	8B	8.13	0.78	1.34	0.32	10.36	0.51	8.23	0.19	1.16	1.90	15.45
	9S	36.58	4.62	0.54	0.29	10.10	0.62	4.95	0.36	5.00	0.50	7.71
	9B	5.59	4.15	0.78	0.34	10.35	0.47	5.42	0.13	1.42	1.30	12.63
	10S	58.22	6.05	1.15	0.41	12.29	0.74	5.10	0.32	2.25	0.90	8.89
	10B	3.04	0.31	0.09	0.19	6.11	0.34	5.70	0.14	0.52	1.20	12.67
ALA WAI HARBOR OUTER BASIN	12S	30.90	3.96	1.23	0.27	17.43	0.53	12.20	0.26	3.19	1.00	12.87
	12B	6.63	0.44	1.70	0.51	16.08	0.83	13.95	0.32	2.38	4.70	14.44
	13S	46.47	5.37	0.68	0.31	16.91	0.64	10.89	0.34	2.89	0.60	12.21
	13B	5.97	0.44	1.54	0.41	13.30	0.71	11.32	0.30	2.25	3.20	14.32
	14S	54.07	5.96	0.86	0.35	16.95	0.68	10.14	0.33	2.65	1.10	9.09
	14B	3.87	0.44	0.16	0.23	9.93	0.35	9.37	0.11	0.55	0.70	13.42
OFFSHORE - 30 FT DEPTH CONTOUR	17S	2.93	0.12	0.14	0.13	8.58	0.26	8.32	0.13	0.10	0.20	7.39
	17B	2.47	0.09	0.04	0.13	7.44	0.24	7.31	0.11	0.10	0.20	9.59
	18S	3.19	0.16	0.06	0.11	9.01	0.23	8.80	0.12	0.12	0.20	6.49
	18B	2.28	0.19	0.16	0.13	9.11	0.27	8.75	0.14	0.10	0.30	14.72
	19S	19.13	1.76	0.61	0.17	13.22	0.44	10.85	0.28	0.56	0.60	11.32
	19B	2.35	0.09	bdl	0.13	9.02	0.26	8.93	0.14	0.11	0.20	13.24
	20S	2.26	0.16	0.37	0.11	8.90	0.18	8.37	0.07	0.09	0.30	23.84
	20B	2.07	0.03	bdl	0.11	7.65	0.25	7.62	0.15	0.10	0.10	6.06
	21S	1.98	0.09	0.04	0.12	7.47	0.25	7.34	0.13	0.10	0.50	26.92
	21B	1.95	0.20	0.07	0.11	8.05	0.21	7.84	0.10	0.11	0.20	16.69
OFFSHORE - 15 FT DEPTH CONTOUR	22S	3.60	0.16	0.15	0.11	9.63	0.25	9.29	0.14	0.12	0.20	9.25
	22B	1.96	0.06	bdl	0.15	6.61	0.18	6.55	0.03	0.21	0.20	6.92
	23S	8.24	0.68	0.14	0.13	6.99	0.35	6.17	0.22	0.26	0.40	6.47
	23B	1.91	0.05	bdl	0.10	8.46	0.26	8.41	0.16	0.10	0.10	7.58
	24S	2.22	0.10	0.42	0.10	14.80	0.28	14.28	0.17	0.20	0.30	7.59
	24B	1.76	0.06	0.05	0.15	5.44	0.30	5.33	0.15	0.17	0.70	7.71
	25S	1.54	0.06	0.34	0.18	11.75	0.35	11.35	0.17	0.22	0.20	9.79
	25B	1.93	0.06	0.01	0.12	12.63	0.44	12.55	0.31	0.10	0.40	7.44
	26S	2.19	0.06	0.15	0.11	8.56	0.27	8.37	0.16	0.06	0.30	8.71
	26B	1.63	0.03	0.02	0.11	8.44	0.25	8.39	0.14	0.12	0.10	8.08

TABLE 5. Water Quality Results in Units of Micrograms per Liter for the March 11, 2005 Samples. Abbreviations as follows: S = surface water, B = bottom water; "bdl" = below detection limit. Concentrations of nutrients are shown in units of micrograms per liter (µg/l). For locations of sampling sites, see Figure 5.

LOCATION	STA. NO	Si (µg/l)	NO3 (µg/l)	NH4 (µg/l)	PO4 (µg/l)	TN (µg/l)	TP (µg/l)	TON (µg/l)	TOP (µg/l)	Chl a (µg/l)	TURB (NTU)	TSS (mg/l)
ALA WAI CANAL OUTLET CHANNEL	1S	2,384.71	451.55	126.52	7.45	1,021.65	33.84	444.36	26.38	7.09	1.80	9.82
	1B	179.34	19.16	42.45	9.96	302.90	15.78	241.29	5.81	1.15	3.60	11.63
	2S	1,349.79	260.20	63.57	11.79	706.49	24.15	382.72	12.36	4.06	7.45	8.40
	2B	307.27	38.67	24.14	10.32	411.41	21.24	348.60	10.93	2.27	4.70	12.55
	3S	1,370.57	275.72	76.52	9.57	747.23	22.55	394.97	12.97	3.64	2.12	8.40
	3B	317.20	47.83	12.37	6.28	401.14	14.38	340.93	8.10	1.54	1.75	9.45
	7S	1,432.70	302.51	32.59	11.54	733.11	25.20	398.01	14.66	4.23	1.68	6.95
	7B	193.51	23.06	5.87	6.05	308.06	11.57	279.11	5.52	0.94	1.75	8.60
	11S	1,413.17	283.45	41.53	9.58	664.02	23.10	339.05	13.51	3.31	1.74	9.10
	11B	183.01	12.82	4.01	4.08	271.97	9.82	255.14	5.74	0.52	1.24	10.65
	15S	1,314.27	276.87	30.16	9.54	588.94	21.04	261.91	11.50	2.78	1.88	9.55
	15B	127.56	11.95	0.84	3.29	282.87	9.87	270.07	5.53	0.37	0.65	11.55
	16S	561.53	110.65	37.61	7.97	225.64	11.90	77.39	3.92	0.72	0.60	9.43
	16B	69.78	8.73	0.38	2.81	133.76	5.91	124.68	3.10	0.15	0.45	10.45
ALA WAI HARBOR INNER BASIN	4S	1,533.54	254.83	16.32	15.28	708.94	35.07	437.79	19.80	5.51	2.00	8.90
	4B	177.00	11.20	5.86	12.89	487.84	27.06	470.78	14.16	13.69	4.29	11.20
	5S	2,028.58	290.10	21.31	13.43	834.64	31.07	423.23	17.64	3.86	1.36	8.50
	5B	213.23	17.23	23.32	9.58	417.58	15.84	379.03	9.26	2.78	3.65	10.20
	6S	1,792.17	357.78	17.27	11.39	732.34	27.66	357.33	16.27	3.98	1.46	9.15
	6B	194.75	17.02	16.55	7.63	359.32	14.83	376.75	7.20	1.91	3.00	11.65
ALA WAI HARBOR MIDDLE BASIN	8S	412.63	77.19	30.17	10.32	393.90	18.74	286.55	6.42	0.94	1.23	10.55
	8B	187.59	22.85	10.99	8.20	393.76	16.13	359.93	7.93	0.93	1.63	7.45
	9S	561.79	115.61	26.24	9.19	460.61	16.68	318.77	7.49	1.21	1.26	10.00
	9B	168.48	10.17	34.28	13.38	375.50	23.70	281.10	10.37	2.86	9.65	21.65
	10S	857.03	191.66	31.01	7.81	546.32	17.33	333.65	9.73	2.07	1.42	10.00
	10B	146.71	8.66	13.02	5.76	234.24	11.57	212.37	5.81	1.04	2.43	20.90
ALA WAI HARBOR OUTER BASIN	12S	323.24	77.50	18.10	5.98	324.82	11.27	229.22	5.27	1.34	1.73	9.70
	12B	155.96	12.60	20.87	8.53	313.68	16.63	280.22	8.11	1.04	2.24	8.75
	13S	612.48	106.60	14.48	6.84	376.53	14.78	255.46	7.92	1.35	1.53	11.00
	13B	144.74	13.29	21.24	7.49	252.42	14.28	220.89	6.79	1.37	3.98	4.80
	14S	965.93	211.04	44.07	7.74	554.22	17.99	299.11	10.24	1.68	1.70	9.00
	14B	173.14	23.54	18.92	5.90	254.15	13.13	214.69	7.23	0.97	2.33	12.20
OFFSHORE - 30 FT DEPTH CONTOUR	17S	76.66	5.45	0.45	2.15	152.62	5.86	146.72	3.71	0.18	0.42	10.80
	17B	47.34	2.75	0.10	2.04	257.45	5.81	256.62	3.77	0.11	0.63	11.80
	18S	118.29	19.90	3.42	2.75	156.34	6.21	130.93	3.46	0.24	0.22	10.70
	18B	43.50	3.02	bdl	2.09	172.20	5.71	169.15	3.62	0.12	0.22	11.40
	19S	46.20	1.86	2.70	1.80	321.03	6.11	316.48	4.31	0.12	0.51	7.40
	19B	37.97	1.75	bdl	1.50	125.94	4.41	124.77	2.90	0.11	0.64	6.00
	20S	45.51	2.69	0.25	1.30	168.79	5.26	185.85	3.96	0.12	0.46	8.00
	20B	37.23	1.53	bdl	2.02	161.65	4.91	160.02	2.89	0.17	0.65	10.60
	21S	39.53	1.41	bdl	1.26	201.51	4.66	200.02	3.60	0.11	0.33	9.15
	21B	39.16	1.63	0.16	2.35	212.37	6.61	208.81	4.76	0.15	0.65	9.10
OFFSHORE - 15 FT DEPTH CONTOUR	22S	89.14	10.64	bdl	1.68	219.23	5.81	207.57	4.13	0.20	0.31	12.40
	22B	38.48	1.08	bdl	1.30	144.11	4.86	143.16	3.54	0.14	0.13	8.30
	23S	43.43	3.07	1.25	2.29	228.96	6.61	224.64	4.32	0.15	0.33	7.35
	23B	40.44	0.85	0.44	2.64	529.76	10.77	528.45	8.13	0.32	0.54	20.81
	24S	40.09	1.79	bdl	2.16	261.67	8.36	260.00	4.20	0.11	0.23	13.00
	24B	29.15	1.09	bdl	1.85	298.53	7.06	287.44	5.20	0.10	0.37	11.00
	25S	39.40	0.97	bdl	0.64	283.43	6.11	282.50	5.46	0.12	0.31	9.55
	25B	49.65	1.66	bdl	1.55	148.29	5.01	146.73	3.48	0.12	0.28	9.25
	26S	36.05	2.43	0.82	1.44	214.13	5.41	210.90	3.97	0.08	0.09	6.90
	26B	35.20	2.72	1.99	2.16	249.99	6.41	245.28	4.75	0.10	0.17	6.60

TABLE 6. Water Quality Results in Units of Micromolar for the March 12, 2005 Samples
Abbreviations as follows: S=surface water; B=bottom water; "bdl"=below detection limit. Concentrations of nutrients are shown in units of micrograms per liter (µg/l). "Pyd" indicates water drawing into the Ala Wai Canal from Yacht Harbor Towers. For locations of sampling sites, see Figure 5.

LOCATION	STA NO	Si (µg/l)	NO3 (µg/l)	NH4 (µg/l)	PO4 (µg/l)	TN (µg/l)	TP (µg/l)	TON (µg/l)	TOP (µg/l)	CHL a (µg/l)	TURB (ntu)	TSS (mg/l)
ALA WAI CANAL	1S	1,947.22	207.93	43.24	100.90	660.24	184.07	221.50	29.11	2.47	28.00	23.80
	1B	1,138.11	138.43	89.50	36.84	443.67	74.38	125.21	6.41	0.18	12.00	24.11
	2S	2,421.82	272.49	24.99	50.53	553.24	102.38	193.68	13.64	3.05	14.30	17.09
	2B	1,010.63	115.84	70.91	22.71	373.89	55.47	173.64	12.06	7.11	6.00	15.09
	3S	2,284.29	233.86	36.38	51.51	608.49	103.83	196.78	14.31	2.95	15.30	14.15
	3B	612.54	60.50	59.09	19.18	272.43	40.78	169.86	8.94	3.22	6.20	13.35
	7S	1,145.92	107.44	95.77	21.66	352.82	45.47	190.30	14.18	5.57	4.20	16.10
	7B	228.46	13.17	23.49	13.42	88.30	25.83	137.06	6.10	1.25	3.85	16.60
ALA WAI BOAT HARBOR	4S	1,938.65	137.94	72.43	46.42	477.45	119.53	218.12	21.84	2.08	23.90	25.55
	4B	290.14	13.32	16.84	19.34	162.62	40.23	231.55	15.62	7.71	3.83	9.95
	5S	1,227.19	101.98	30.77	22.43	314.53	43.36	210.86	19.46	3.65	3.85	4.70
	5B	197.18	9.16	16.66	12.49	85.38	24.93	185.86	10.21	2.44	2.30	4.55
	6S	1,743.17	154.07	54.64	27.41	338.90	49.45	178.03	17.95	3.25	5.62	18.00
	6B	189.83	6.07	13.43	17.55	98.29	28.53	162.79	7.94	3.95	3.55	16.05
	8S	547.11	51.26	26.40	12.19	177.44	23.48	142.76	9.78	0.94	1.05	10.10
	8B	707.70	14.37	23.09	13.34	123.63	26.61	179.32	6.75	0.74	1.55	13.10
	9S	596.12	52.42	25.31	12.15	193.85	23.27	158.82	8.26	1.42	1.16	10.63
	9B	197.76	12.36	17.27	11.23	162.96	26.73	140.05	11.38	0.82	1.70	13.55
	10S	476.98	28.08	18.13	11.61	189.33	22.73	166.23	10.73	2.07	1.20	8.95
	10B	171.69	9.82	17.69	10.18	82.71	20.55	115.77	6.41	1.03	1.93	10.75
	11S	1,030.15	84.65	27.62	13.48	184.81	29.48	168.92	14.91	1.15	6.55	9.70
	11B	219.18	9.95	33.31	14.57	229.12	26.79	127.11	4.33	2.62	2.25	12.70
	12S	698.07	46.83	18.65	11.13	214.66	20.51	124.30	5.84	1.37	0.86	13.05
	12B	159.98	10.08	17.93	12.92	184.29	23.60	139.61	8.94	0.76	2.15	12.90
	13S	525.46	47.46	17.76	9.67	194.70	19.93	127.27	8.73	1.30	0.30	17.05
	13B	238.63	18.20	15.96	9.05	107.01	20.76	110.05	7.49	0.87	1.82	114.55
	14S	432.12	38.51	14.45	8.52	196.66	19.38	149.03	11.30	0.96	0.97	13.65
	14B	164.39	10.34	10.03	6.79	158.78	16.71	107.96	7.98	0.67	2.00	20.60
ENTRANCE CHANNEL	15S	395.22	28.50	11.76	7.37	103.47	18.18	130.49	12.69	1.36	1.30	16.60
	15B	154.54	6.74	15.99	8.44	166.72	19.15	134.56	6.10	0.11	2.60	19.70
	16S	331.62	26.49	8.37	6.72	183.63	15.81	38.56	4.31	0.87	2.93	20.20
	16B	167.39	6.08	8.04	6.00	158.21	18.60	62.12	3.42	0.52	0.11	13.15
OPEN COASTAL OCEAN	17S	46.89	1.76	0.58	4.18	113.36	11.45	73.10	4.09	0.09	1.09	6.75
	17B	41.36	1.52	0.90	4.03	124.80	17.56	127.85	4.16	0.21	0.22	12.25
	18S	33.84	1.34	0.62	4.01	122.39	11.49	65.23	3.81	bdl	0.60	11.95
	18B	39.87	1.21	0.55	4.19	127.76	11.21	84.28	2.99	bdl	0.51	12.70
	19S	37.49	0.87	0.38	4.17	133.71	11.19	157.68	4.76	0.12	0.61	12.00
	19B	45.98	1.14	0.97	4.95	133.20	14.31	61.89	3.30	0.13	0.35	12.60
	20S	91.79	6.75	2.16	3.97	134.68	10.64	92.58	4.37	0.25	0.65	10.65
	20B	44.95	1.50	bdl	3.59	116.73	9.13	79.72	3.19	0.17	0.26	9.30
	21S	34.12	1.03	0.68	4.07	113.72	10.26	99.63	3.97	0.08	0.76	11.90
	21B	37.27	0.99	0.29	3.85	126.15	9.91	104.03	4.70	0.11	0.35	8.45
	22S	35.18	0.96	0.50	3.83	114.18	8.89	103.43	4.55	0.11	0.72	8.30
	22B	35.31	0.92	bdl	3.50	108.19	8.20	71.32	3.93	0.10	0.27	8.83
	23S	36.08	0.95	0.64	3.68	138.06	9.50	111.92	4.77	0.11	0.32	10.65
	23B	36.57	0.94	0.63	3.76	139.51	9.32	263.28	8.97	0.10	0.31	11.70
	24S	37.26	0.81	0.74	3.63	143.00	8.96	129.54	4.63	0.09	0.41	8.15
	24B	37.54	0.78	0.31	3.71	89.19	7.94	143.31	5.73	0.14	0.42	9.15
	25S	40.68	0.92	bdl	1.66	164.66	7.09	140.75	6.03	0.10	0.26	7.25
	25B	41.17	0.83	0.16	3.46	134.48	8.39	73.10	3.87	0.09	0.24	10.30
	26S	39.20	0.85	0.59	3.41	84.23	7.21	105.08	4.38	0.06	0.20	13.20
	26B	47.14	0.82	0.70	3.42	126.96	8.01	123.79	4.69	0.09	0.70	12.65

TABLE 7. Water Quality Results in Units of Micromolar for the March 29, 2005 Samples
Abbreviations as follows: S=surface water; B=bottom water; "bdl"=below detection limit. Concentrations of nutrients are shown in units of micrograms per liter (µg/l). "Pyd" indicates water drawing into the Ala Wai Canal from Yacht Harbor Towers. For locations of sampling sites, see Figure 5.

LOCATION	STA NO	Si (µg/l)	NO3 (µg/l)	NH4 (µg/l)	PO4 (µg/l)	TN (µg/l)	TP (µg/l)	TON (µg/l)	TOP (µg/l)	CHL a (µg/l)	TURB (ntu)	TSS (mg/l)
ALA WAI CANAL OUTLET CHANNEL	1S	3,241.80	118.30	45.35	27.56	316.59	48.53	151.95	20.94	3.43	4.00	16.18
	1B	965.87	37.72	10.22	12.87	169.93	23.93	122.50	11.04	4.01	1.70	14.87
	2S	3,879.15	123.98	41.18	27.00	307.31	50.62	142.34	23.67	3.02	3.60	10.09
	2B	337.74	19.40	43.54	16.35	151.03	22.61	68.09	7.26	2.02	2.00	13.40
	3S	3,619.30	114.36	30.00	24.38	267.02	46.71	122.65	22.33	3.15	3.20	10.84
	3B	277.41	11.79	5.76	10.83	139.43	15.37	122.39	4.54	2.35	1.80	15.32
	7S	3,456.45	116.19	39.27	24.83	317.30	45.77	161.90	20.94	3.04	6.20	7.78
	7B	105.89	3.26	0.42	6.11	121.60	11.16	117.92	5.05	0.47	0.60	11.85
	11S	2,360.20	90.18	24.20	18.98	251.21	30.31	136.83	11.32	3.35	2.30	10.21
	11B	143.20	6.09	4.49	7.81	107.01	10.17	97.23	2.36	0.52	0.80	14.42
	15S	2,045.22	84.20	18.10	16.49	253.45	30.64	149.15	14.15	2.32	3.00	6.98
	15B	108.32	3.67	bdl	5.65	126.17	9.74	122.50	4.11	0.19	0.60	11.09
	16S	2,014.69	95.87	17.74	11.48	298.71	28.47	185.10	16.94	1.60	1.50	8.43
	16B	92.50	2.70	0.86	4.69	105.14	9.34	101.58	4.65	0.10	0.30	11.37
ALA WAI HARBOR INNER BASIN	4S	3,474.16	179.79	48.53	20.83	390.12	37.00	161.80	18.17	2.60	2.20	7.14
	4B	252.68	2.43	6.69	14.20	140.90	24.57	131.59	10.37	4.07	3.00	12.82
	5S	3,309.81	174.78	32.02	19.55	320.74	38.47	113.95	18.93	1.94	2.50	12.36
	5B	185.44	2.67	5.05	9.92	179.47	19.08	121.76	9.16	4.47	1.00	13.18
	6S	3,261.95	154.95	25.89	19.09	321.30	34.76	140.47	17.17	1.85	2.00	8.59
	6B	216.10	7.82	18.72	15.35	161.83	25.37	138.30	9.97	4.75	0.60	16.89
ALA WAI HARBOR MIDDLE BASIN	8S	510.02	32.42	14.62	7.12	177.81	15.76	132.77	8.64	3.16	0.80	11.17
	8B	278.59	10.95	18.83	9.89	144.97	15.92	115.18	4.03	1.16	1.90	15.45
	9S	1,027.86	64.68	7.49	8.93	141.45	19.35	69.28	10.42	5.00	0.50	7.71
	9B	154.96	58.06	11.03	10.46	144.92	14.44	75.83	3.98	1.42	1.30	12.63
	10S	1,635.92	84.69	16.06	12.82	172.11	22.85	71.34	10.03	2.25	0.90	8.89
	10B	85.56	4.29	1.33	5.97	85.58	10.43	79.86	4.46	0.52	1.20	12.67
ALA WAI HARBOR OUTER BASIN	12S	658.26	55.48	17.27	8.31	243.56	16.36	170.82	8.04	3.19	1.00	12.87
	12B	186.13	6.10	23.78	15.77	225.16	23.61	195.76	9.84	2.38	4.70	14.44
	13S	1,305.75	75.12	12.35	9.54	237.13	19.95	149.64	10.41	2.89	0.60	12.21
	13B	167.78	6.11	21.55	12.75	186.17	22.12	158.51	9.37	2.25	2.20	14.32
	14S	1,517.98	83.37	11.99	10.98	237.38	21.22	142.02	10.24	2.65	1.10	9.09
	14B	108.73	6.11	2.25	7.23	139.60	10.71	131.22	3.45	0.55	0.70	13.42
OFFSHORE - [illegible] DEPTH CONTOUR	17S	82.31	1.73	1.96	3.95	120.17	8.13	116.46	4.18	0.10	0.20	7.29
	17B	69.43	1.25	0.53	3.92	104.18	7.44	102.40	3.51	0.10	0.20	9.59
	18S	89.53	2.73	0.78	3.40	126.20	7.07	123.19	3.68	0.12	0.20	6.49
	18B	63.99	2.73	2.29	4.01	137.55	8.40	122.53	4.38	0.10	0.30	14.73
	19S	537.53	24.69	8.58	5.36	185.15	14.16	151.88	8.80	0.54	0.60	11.32
	19B	64.16	1.78	bdl	3.99	126.78	8.19	125.01	4.20	0.11	0.20	13.74
	20S	63.45	2.26	5.21	3.35	124.59	5.60	117.12	2.25	0.09	0.20	23.84
	20B	58.61	0.43	bdl	3.39	107.10	7.89	106.66	4.51	0.10	0.10	6.06
	21S	55.68	1.29	0.63	3.75	104.65	7.46	102.72	3.91	0.10	0.50	24.92
	21B	55.51	2.76	0.21	3.47	117.68	6.15	109.71	3.07	0.11	0.20	16.69
OFFSHORE - [illegible] DEPTH CONTOUR	22S	103.32	2.28	2.09	3.41	134.80	7.88	130.03	4.47	0.12	0.20	9.25
	22B	55.16	0.83	bdl	4.64	92.56	5.61	91.73	0.94	0.21	0.20	6.92
	23S	231.59	9.57	1.92	3.91	97.86	10.73	86.38	6.82	0.26	0.40	6.67
	23B	53.76	0.42	bdl	2.97	118.22	8.05	117.80	5.08	0.10	0.10	7.58
	24S	62.37	1.33	5.93	3.16	207.15	8.57	199.89	5.41	0.20	0.30	7.59
	24B	49.59	0.86	0.73	4.63	76.22	9.36	74.64	4.76	0.12	0.20	7.71
	25S	54.66	0.87	4.74	5.67	164.54	10.90	158.93	5.23	0.22	0.20	9.79
	25B	54.28	0.88	0.70	3.86	174.83	13.60	175.75	9.73	0.10	0.40	7.44
	26S	61.66	0.88	2.07	3.43	120.09	8.67	117.14	5.05	0.06	0.30	8.71
	26B	51.47	0.41	0.31	3.31	118.09	7.44	117.35	4.37	0.12	0.10	8.05

- As a result of the progressive mixing of the surface layer as it moved downstream, nutrient concentrations were four to six times greater upstream (at Station No. 1) than downstream (at Station No. 18).
- The fresher surface layer that resulted from the wetter conditions on March 12 and 29 did not universally translate to higher nutrient concentrations in comparison to the drier March 11th sampling event. This suggests that the nutrient concentrations in streamflow and urban rainfall-runoff may be lower at high rates of flow rather than essentially constant over a range of discharge rates.

Ala Wai Harbor Inner Basin. Nutrient concentrations in the AWH's inner basin (Station Nos. 4, 5, and 6) were of approximately the same magnitude as those at the upstream sampling sites in the Ala Wai Canal's discharge channel (Station Nos. 1, 2, and 3). Levels were substantially higher in the fresher surface layer than at the bottom. Notably, these concentrations were not significantly higher on the day with substantial local input of rainfall-runoff (March 12th) in comparison to the two other sampling days with little or no local rainfall-runoff.

Ala Wai Harbor Middle Basin. Normally, the middle basin receives a continuous 5300 GPM discharge from the lagoon, However, the pump was off on the March 11 and 12 sampling days. The CTD profiles on these two days showed a poorly defined surface layer of comparable salinity and thickness on March 11 and 12 (Figures 16 and 17). The nutrient concentrations were comparable on both these days and were significantly lower than in the inner basin. With the lagoon discharge pump on running on March 29, the salinity profiles showed that the lagoon discharge completely displaced the upper layer at the inner end (Station No. 8 on Figure 18) but fresher water, presumably having entered from the Ala Wai Canal, had created a fresher and more distinct surface layer at the middle and outer stations (Nos. 9 and 10 on Figure 18). Except for silica, however, the nutrient concentrations were not elevated in the fresher upper layer of the two outer stations on March 29 in comparison to the two other sampling days.

Ala Wai Harbor Outer Basin. The outer basin is physically isolated from the lagoon discharge into the middle basin. It receives only a negligible amount of local rainfall-runoff, a fact reflected in the salinity profiles on May 11th and 12th (Figures 19 and 20). On May 29th, the sampling day with the highest discharge in Ala Wai Canal, some of the canal's water had moved into the outer basin to create a more distinct surface layer with progressively lower salinity with proximity to the canal's discharge channel (Figure 21). As in the other basins and with the exception of silica, nutrient concentrations were not elevated in response to a fresher upper layer.

Offshore Along the 30-Foot Depth Contour. As noted previously, the salinity profiles illustrate that the Ala Wai Canal's discharge turned to the west in the offshore area on all three sampling days (Station Nos. 17, 18, and 19 on Figures 22, 23, and 24). Nutrient levels generally depict this trend. The most obvious input of high nutrient water from Ala Wai Canal was found at Station No. 19 directly offshore of the canal's discharge on the day of its greatest discharge (May 29th at Station No. 19 on Tables 4 and 7). "Upgradient" Station Nos. 20 and 21 along the 30-foot depth contour (ie. to the east of the canal's outlet) reflect background concentrations not influenced by the canal's discharge.

Offshore Along the 55-Foot Depth Contour. On the two wetter days, March 12 and 29, the salinity profiles portrayed a less saline upper layer on the two stations to the west of the canal along the 55-foot depth contour (Station Nos. 22 and 23 on Figures 26 and 27). Except for silica concentrations at these two stations on May 29th, the pattern of nutrient concentrations does not track with the surface layer depicted by the salinity profiles. It appears, with the lack of significant differences in stations to the east and west of the canal's outlet, that nutrients were essentially diluted to background levels at this distance offshore.

APPENDIX C. WATER QUALITY MODELING OF DISCHARGES FROM THE HILTON HAWAIIAN VILLAGE LAGOON INTO THE ALA WAI SMALL BOAT HARBOR (USING CE-QUAL-W2 VERSION 3.2)

Prepared by EKNA Services Inc.

June 2005

Water Quality Modeling of Discharges From the Hilton Hawaiian Village Lagoon Into the Ala Wai Small Boat Harbor (Using CE-QUAL-W2 Version 3.2)

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EXECUTIVE SUMMARY

The Hilton Hotel Corporation is proposing to undertake work intended to improve water quality and other recreational values of the Duke Kahanamoku Lagoon (also known as the Hilton Hawaiian Village Lagoon). It would accomplish this by substituting saline groundwater for the existing ocean water source, tripling the water flow through the lagoon, decreasing the volume of water in the lagoon, diverting stormwater runoff that now enters the lagoon into the Ala Wai Small Boat Harbor ("Harbor"), and restoring the surrounding sandy beach. The changes will increase the rate of turnover within the lagoon from less than one time per day to more than five times per day, substantially improving water quality within the lagoon and greatly reducing the buildup of soft, anaerobic sediment on the lagoon bottom. The proposed changes will increase the amount of lagoon water being discharged into the Harbor (which is classified as a Class A embayment under HAR 11-54-6), directing half of it into the poorly mixed inner basin of the harbor with the goal of improving water quality there.

The objective of this study is to determine water quality changes to the Harbor and to the marine waters with which it is connected due to changes in discharges from the Hilton Hawaiian Village Lagoon. Based on previous studies on the Ala Wai Canal[1], a state-of-the-art hydrodynamic and water quality model CE-QUAL-W2, Version 3.2 developed by the U.S. Army Corps of Engineers (USACOE) was used for this evaluation.

Application of the CE-QUAL-W2 model to the Harbor involved the acquisition of physical model inputs including bathymetry, and the identification and physical characterization of the model boundary conditions. Before utilizing the model to evaluate the changes to the discharges to the Harbor, the model was calibrated and validated for the existing physical and water quality conditions closely matching the measured water mass properties of salinity, temperature and density through calibration of the physical properties controlling the hydrodynamics of the system. Following validation of the hydrodynamics, a similar methodology was utilized to validate the model using the measured water quality parameters.

The validated model was then utilized to forecast water quality under the following scenarios.

Scenario 1: Proposed 15000 gpm Lagoon Outflow During March 11, 2005, "Dry Event" (Low Flow from the Ala Wai Canal).

Scenario 2: Proposed 15000 gpm Lagoon Outflow During March 29, 2005, "Wet Event".

[1] Ala Wai Canal Improvement, Feasibility Report, State of Hawaii, DLNR, October 1992.

The model was utilized to evaluate these scenarios and the effect on the water quality parameters of Total Nitrogen, Ammonium, Nitrate-Nitrite, Total Phosphorus, Chlorophyll a, and Total Suspended Solids. Data for certain locations throughout the Harbor were tabulated for comparison with the modeled existing condition.

Because of the complex circulation within the harbor due to the vertically stratified flows within the channel and basins, there is much variability of the nutrient levels throughout the harbor and throughout the day (due to the tidal influences on circulation). Results from the model were tabulated at intervals throughout a tidal cycle to show this variability.

Within the harbor for the scenarios with the 15000 gpm lagoon discharge, the Chlorophyll a levels were consistently low and comparable to or better than the existing condition. TSS levels were also lower than the modeled existing condition. Residence times within each segment were output from the model for the scenarios and show that the 15000 gpm flow from the Hilton Lagoon reduces the residence times throughout the harbor. At the ocean boundary, nutrient levels were comparable to or lower than the existing levels.

1.0 Introduction and Objectives

The Hilton Hotel Corporation is proposing to undertake work intended to improve water quality and other recreational values of the Duke Kahanamoku Lagoon (also known as the Hilton Hawaiian Village Lagoon). It would accomplish this by substituting saline groundwater for the existing ocean water source, tripling the water flow through the lagoon, decreasing the volume of water in the lagoon, diverting stormwater runoff that now enters the lagoon into the Ala Wai Small Boat Harbor (Harbor), and restoring the surrounding sandy beach. The changes will increase the rate of turnover within the lagoon from less than one time per day to more than five times per day, substantially improving water quality within the lagoon and greatly reducing the buildup of soft, anaerobic sediment on the lagoon bottom. The proposed changes will increase the amount of lagoon water being discharged into the Harbor (which is classified as a Class A embayment under HAR 11-54-6), directing half of it into the poorly mixed inner basin of the harbor with the goal of improving water quality there.

The increased inflow into the lagoon will result in a corresponding increase in the discharge from the lagoon to the Harbor. The objective of this study is to determine water quality changes to the Harbor and the adjoining marine waters due to changes in discharges from the Hilton Hawaiian Village Lagoon. These changes include replacing water from the two existing nearshore ocean intakes with water from seven new salt water wells, re-positioning the pipes supplying and withdrawing water from the lagoon to eliminate areas of poor circulation, increasing the throughput from approximately 5,300 gallons per minute to 15,000 gallons per minute, diverting the storm runoff that now enters the lagoon into the inner basin of the Harbor, and installing a new pipe between the lagoon and the Harbor so that half of the lagoon discharge (7,500 gpm) is into the inner basin of the harbor (the remaining 7,500 gpm would be discharged through the existing pipe into the middle basin of the harbor).

A state-of-the-art hydrodynamic and water quality model CE-QUAL-W2, Version 3.2 developed by the U.S. Army Corps of Engineers (USACOE) was used to quantitatively evaluate the effect that the proposed change in discharge would have on water quality within the Harbor and the Ala Wai Canal discharge channel.

Application of the CE-QUAL-W2 model to the Harbor involved the acquisition of physical model inputs including bathymetry, and the identification and physical characterization of the model boundary conditions. Before using the model to evaluate the changes to the discharges to the Harbor, the model was calibrated/validated to the existing physical and water quality conditions. This was done by first validating the hydrodynamics of the model by closely matching the measured water mass properties of salinity, temperature and density through calibration of the physical properties controlling the hydrodynamics of the system. Following validation of the hydrodynamics a similar methodology was used to validate the model to the measured water quality parameters.

The validated model was then used to evaluate the following scenarios.

Scenario 1: Proposed 15000 gpm Lagoon Outflow During March 11, 2005, "Dry Event" (Low Flow from the Ala Wai Canal).

Scenario 2: Proposed 15000 gpm Lagoon Outflow During March 29, 2005, "Wet Event".

Model results of the water quality parameters of Total Nitrogen, Ammonium, Nitrate-Nitrite, Total Phosphorus, Chlorophyll a, and Total Suspended Solids were used to compare each scenario to a modeled existing condition event.

2.0 Baseline Data Collection for Model Development

Bathymetry

Bathymetry is one of the most important requirements of the model. It defines the geometry of the model. Since the Harbor is a dredged harbor, the bathymetry in the main channel and the basins is well defined and fairly uniform. The bathymetry from the earlier Ala Wai Canal Study (October 1992), was used as the baseline for the modeling effort. This data was augmented by a lead-line bathymetry survey on March 8, 2005, which confirmed that the depths were consistent with the previous modeling effort.

Boundary Conditions

The external boundaries of the model were defined at the ocean boundary of the main channel (seaward of the Harbor breakwater), the upstream open end of the channel (at the Ala Moana Bridge), the Diamond Head end of each of the three harbor basins, the harbor water surface and the harbor bottom (Figure 1). The hydrodynamic conditions at these boundaries were defined as a water surface elevation fluctuation due to tides at the ocean boundary of the main channel, a downstream flow fluctuation out of the Ala Wai Canal, a constant flow condition out of the discharge pipe for the Hilton lagoon in the Middle Basin and runoff and freshwater discharge to the Diamond Head end of the Inner Basin. The harbor water surface is affected by the local wind conditions and weather.

In order to define these boundary conditions, measurements are usually obtained over a defined period of at least a year. However due to time constraints, data were obtained over a one month period. The modeling effort also relied on information from the 1992 modeling effort for the Ala Wai Canal. The baseline measurement period for this Harbor model development was the period from March 10, 2005 to April 1, 2005.

Tide data define the water surface fluctuations at the open ocean end of the main channel. These data during the baseline measurement period were obtained from the National Oceanographic and Atmospheric Association (NOAA) gage located in Honolulu Harbor (Station 1612340). The previous October 1992 study had shown that data from this gage were identical to that obtained from a temporary gage that was located in the Outer Basin during that study. These data were also compared to measurements from a water level gage installed by the United State Geological Survey (USGS), located adjacent to the Ala Moana Boulevard Bridge and found to agree as well. A plot of the tidal elevations over the measurement period is provided in Appendix B.

In order to define the flow conditions out of the Ala Wai Canal into the Harbor, current measurements were obtained utilizing an RD Instruments Acoustic Doppler Current Profiler (ADCP). This instrument was moored on the bottom just ocean-side of the Ala

Moana Boulevard Bridge, and was programmed to measure a vertical profile of the currents from the instrument to the water surface every six minutes during the deployment period. The instrument was deployed at this location from March 10 to April 1, 2005. Measurements by this gage showed both upstream and downstream flows, depending on the location in the water column and the tidal stage. The data measured by this gage were used to determine flow input to the model by averaging the measurements in the water column. This was accomplished by first defining upstream/downstream directions of flow. Each measured profile layer (ADCP Bin) is assigned either an upstream or downstream vector, and an average vector is computed by vector-averaging the measured values for all layers in the profile. This value is then used to define the measured flow for that profile time in the model. The computed flow data used in the model are presented in Appendix B. Measurements from the ADCP were augmented with stream discharge data obtained from the USGS Manoa Stream discharge gage located at Kanewai Field at the mouth of Manoa Valley. Plots of this information over the measurement period are provided in Appendix B.

Typically the discharge from the lagoon is a constant pumped discharge at 5300 gallons per minute (gpm). Prior to March 11 this pump was turned off and was turned back on from March 24 through the remaining duration of the measurement period.

Stormwater runoff from some roadways and properties adjacent to the Hilton Hawaiian Village is currently discharged via a submerged box culvert into the Inner Basin of the Harbor. In order to estimate this discharge during the March 10 to April 1 measurement period, weather records were obtained from the National Weather Service Branch of NOAA which included hourly rainfall totals for Stations at the Honolulu International Airport and at the Aloha Tower in downtown Honolulu. These measurements in conjunction with known drainage areas were used to determine discharge during the rainfall events that occurred during the measurement period. A simple estimate was used assuming all of the rainfall would end up as runoff. This is a very conservative assumption, yet is still a small quantity compared to the overall volume of the harbor. It was used to determine if this discharge would have any influence in the modeling of the harbor hydrodynamics.

Wind speed and direction data were obtained from the National Weather Service for Honolulu International Airport (WBAN Station 22521). These values were assumed relevant for this location and were utilized directly in the model.

Other Physical Water Parameters

Besides the requirements for the boundary conditions, it is necessary to obtain characteristics of the water body for validation of the model. Physical characteristics of the water mass are usually defined by water temperature, salinity and density. Measurements of these values were provided by Tom Nance Water Resource Engineering (TNWRE). Conductivity, temperature and depth measurements (CTD) were provided for three measurement dates (March 11, 12 and 29, 2005) throughout the entire Harbor and on two other occasions (March 24 and 28, 2005) in the channel alone. The measurement dates and times corresponded to tidal ebb flow conditions on March 12 and 24 and tidal flood flow on March 11, 28, and 29. The profiles used in the modeling effort are provided in Appendix B.

Water quality measurements were also provided by TNWRE throughout the Harbor on March 11, 12 and 29, 2005. These included measurements of PO_4, $Si(OH)_4$, NO_3, NH_4, Total Phosphorus, Total Nitrogen, Chlorophyll a, Total Suspended Solids and Turbidity. The measured values used in the modeling effort are provided in Appendix B.

3.0 CE-QUAL-W2 Model Development

3.1 Description

CE-QUAL-W2 is a two-dimensional (longitudinal/vertical) hydrodynamic and water quality model. It has been under continuous development since 1975. The original model was known as LARM (Laterally Averaged Reservoir Model) developed by Edinger and Buchak (1975). Improvements to the model to include estuarine conditions and multiple branches resulted in the modeling program called GLVHT (Generalized Longitudinal-Vertical Hydrodynamics and Transport Model). With the addition of water quality algorithms by the Water Quality Modeling Group at the US Army Engineer Waterways Experiment Station (WES), the program CE-QUAL-W2 Version 1.0 was developed (Environmental and Hydraulics Laboratory, 1986). Modifications to the code in order to improve the mathematical description of the prototype and increase computational accuracy and efficiency occurred in Version 2.0. Version 3.2 incorporates additional improvements to the numerical solution scheme and the water quality algorithms. A full evolution of the program to its current form is described in the CE-QUAL-W2 User Manual (Cole, T.M. and Coles, S.A., 2002).

3.2 Capabilities and Limitations of the Model

3.2.1 Hydrodynamics

The hydrodynamic portion of the model predicts water surface elevations, velocities, and temperatures. Although temperature is a physical property it is included in the hydrodynamic portion of the program as it affects water density. The hydrodynamic limitations of the model arise from the lateral and layer averaging of the governing equations. Lateral averaging assumes that variations across a section width in velocities, temperature and constituents are negligible and is usually true for narrow waterways and basins. Eddy coefficients are used to model turbulence and the user is left to decide the most appropriate vertical turbulence schemes for the type of waterbody being simulated. The equations used to describe the fluid motion are written in the conservative form using Boussinesq and hydrostatic approximations. Vertical momentum is not included in the equations and consequentially, if there is significant vertical accelerations, the model may provide inaccurate results.

3.2.2 Water Quality

A modular water quality algorithm allows any combination of constituents to be included/excluded from a simulation. Total dissolved solids or salinity effects on density and thereby hydrodynamics are included only if they are simulated in the water quality module. The following water quality variables are currently included in the model.

- any number of generic constituents (conservative tracers, hydraulic residence times, coliform bacteria, or contaminants) as defined by:

    - Zero order decay rate
    - First order decay rate
    - Settling velocity
    - Arrhenius temperature rate multiplier

- any number of inorganic suspended solids groups
- any number of phytoplankton groups
- any number of epiphyton groups
- any number of CBOD groups
- ammonium
- nitrate-nitrite
- bio-available phosphorus
- labile dissolved organic matter
- refractory dissolved organic matter
- labile particulate organic matter
- refractory particulate organic matter
- total inorganic carbon
- alkalinity
- total iron
- dissolved oxygen
- organic sediments
- gas entrainment

In addition, over 60 derived variables including pH, total organic carbon (TOC), dissolved organic carbon (DOC), total organic nitrogen (TON), total organic phosphorus (TOP), etc can be computed internally from the state variables and output for comparison to measured data.

Compared to the complexity of the aquatic ecosystem, water quality interactions in the model are of necessity simplified. As better means of mathematically describing the aquatic ecosystem have become available, they have been included in the model revisions. In the current version, the major assumptions in the water quality algorithms include:

- No zooplankton and their effects on phytoplankton or recycling nutrients
- No macrophytes and their effects on hydrodynamics or water quality
- A simplistic sediment oxygen demand. This places a limitation on the long-term prediction of the water quality portion of the model when the kinetics of the sediment and the sediment-water interface are of concern.

3.2.3 Numerical Transport

Three different numerical transport schemes for temperature and constituents are available in the model.

- Upwind Difference. This introduces numerical diffusion often larger than the physical diffusion.
- QUICKEST (Leonard, 1979). This reduces the numerical diffusion, but in areas of high gradients it will generate overshoots and undershoots which may generate small negative concentrations.
- ULTIMATE (Leonard, 1991). This is Leonard□s solution to the overshoot/undershoot problem.

The first two schemes are included to be compatible with early versions cf the model. ULTIMATE is the current recommended schem e and was used in the current modeling effort.

Discretization errors are introduced in the numerical transport scheme as the finite difference cell dimensions or the time step increases. This limitation becomes important in comparing the model results (spatial and temporally averaged) with measured observed data usually taken at discrete points in time and space.

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4.0 Model Implementation for Ala Wai Small Boat Harbor

There are three basic geographic components to the model: water bodies, branches and tributaries. Each water body is broken into one or more branches with each branch broken down into segments and layers. Each segment has a width (Δy) and length (Δx) and each layer has a thickness (Δz). There are boundary conditions for the upstream and downstream end of each branch defining inflows/outflows (e.g. streams) or water surface elevation variations (e.g. tide elevations). Tributaries are used to define inflows into the model within a branch such as pipe or stream inflow. Tributary inflow can only occur into a single segment (cannot have more than one tributary entering one segment).

The Ala Wai Small Boat Harbor was modeled as a single water body composed of four branches. Each branch was divided into segments with additional zero dimensioned segments added at the boundaries of each branch. A total of 39 segments were created with segment lengths varying from 90 to 700 feet. All segment layers were defined as 2 feet thick, equating to up to 17 layers for a segment where the maximum depth is 34 feet. The number of layers in a segment was depth dependent. Branch 1 was assigned to the Channel from the Ala Wai Canal entrance to the open ocean boundary, Branch 2 as the Inner Basin, Branch 3 as the Middle Basin and Branch 4 as the Outer Basin. (Figure 1)

The width of each segment was computed by constructing a volume-area-elevation table for each segment from the available bathymetry. The volume of each 2 foot thick layer was calculated and the representative segment width for this layer was obtained by dividing the layer volume by the assigned length and thickness.

Segment orientation with respect to north was determined from the geometry and each segment was assigned an elevation of zero indicating sea level. A shading value of 1.0 was utilized indicating no shading on any segment. Shading is a factor in determining the amount of solar radiation reaching the water surface. The bottom friction was assigned a Manning value of 0.03 representing a dredged earth channel (Brater, E.F. and King H.W., 1982). Sensitiv ity analysis of the model to the Manning value found a variation from 0.03 to 0.001 had little effect on the model results.

Inflows from the Ala Wai Canal, the submerged storm drain in the Inner Basin and the present lagoon discharge were specified in the model as Tributaries and not as end boundary conditions. This provided the model with more flexible inflow conditions such as specifying the layers at which the inflow enters a system branch. This would not be possible if a Branch End Boundary Condition was utilized. The tributaries were specified to enter at model segments 2, 13 and 23 respectively. No additional inflow was specified in the Outer Basin.

5.0 Model Calibration/Validation

5.1 Temperature/Salinity/Density Validation

Calibration/validation of the hydrodynamics was accomplished over the measuring period by comparison of the measured temperature, salinity and density data to model results. Measured CTD profile data provided by TNWRE were used for comparison to the model predictions. Model profile data were extracted at the model dates corresponding to the CTD measurement periods and compared to the field measured values. The absolute mean error (AME) and the root mean square error (RMS) were computed for each profile. Typically these two statistics have been used for evaluating model results. The AME provides the best indication of the model performance since it is directly interpretable. For example, an AME of 0.5° C means that the model results are, on the average, within ±0.5° C of the observed data. The RMS value is an indicator of a relative goodness of fit and more broadly defines the fit of the predicted to observed data.

$$AME = \frac{\sum |predicted - observed|}{number of\ observations}$$

$$RMS = \sqrt{\frac{\sum (predicted - observed)^2}{number of\ observations}}$$

Numerous model runs were done before reaching the best fit case. In each run, a model parameter would be changed to determine its effect on the temperature, salinity and density (sigma t) results with the objective to reduce the AME values. The boundary conditions at the Ocean entrance to the Harbor and the discharge pipe from the Hilton Lagoon were well defined and were not adjusted in the model. Also any flow into the Outer Basin was assumed to be zero in the model and was not changed. The areas subject to adjustment were the discharge into the Inner Basin from rainfall runoff and the discharge from the Ala Wai Canal.

The boundary condition at the Ala Wai Canal entrance is represented in the model as a simple non-stratified flow condition. In reality, this boundary has both a water level fluctuation and a stratified variable flow. However, the model is not capable of accommodating this type of boundary. The current profiler measurements made in the channel just oceanside of the Ala Moana Bridge were used to convert this stratified flow condition to an average flow input for the model. Additionally, the input constituents of temperature and salinity for this average flow were determined by mixing a cooler salty bottom water with a warmer fresher surface flow in proportions determined by the

upstream and downstream current profiler measurements. Values of salinity and temperature for these two water masses used in the calculation of a combined water mass were obtained from the CTD measurements made on March 11, 12, 24, 28 and 29 near Segment 2. The salinity, temperature and flow values at this boundary were subject to adjustments in the model. Based on the variability of the discharges from the Ala Wai Canal, adjustments were made to raise or lower salinity and temperature values in the model.

The boundary condition at the Diamond Head end of the Inner Basin was also not well defined. The only known discharge into this basin is the submerged culvert currently draining areas of Dewey Lane and Ala Moana Boulevard. The discharge was estimated from the rainfall events that occurred during the measurement period. For this discharge, values of salinity were initially estimated to be near zero and temperatures were initially set equal to atmospheric temperatures. Salinity, temperature and flow values at this boundary were subject to adjustments in the model.

Other discharges into the harbor that were not accounted for in the model boundary conditions are from the boats in the harbor. There are approximately 800 boats moored in the harbor, and the quantity and quality of their discharges are not accounted for in the model. Discharges from the boats probably have more effect on the water quality constituents than on the hydrodynamics.

Initial model runs showed that the predicted salinity values in all segments were very low compared to measured values. This indicated that the flow and the associated salinity and temperature values from the Ala Wai Canal were not properly input to the model. Adjustments were made to the temperature and salinity values of the input flow from the Ala Wai Canal, with the model still predicting lower than measured values in most of the segments. In order to obtain a better fit with the measured values of temperature, salinity and density values, it was found that the calculated flow values used for input to the model had to be reduced to nearly 10% of the net measured flow values. These values were adjusted lower because the measured values obtained in the middle of the channel over estimated the flow in a channel segment. The initial flow calculations assumed the measured peak flow values to be constant throughout the segment cross-section and used them to represent the flows from the Ala Wai Canal. In reality, this peak flow only occurs in the channel proper of the segment and does not take into account the non-permanent features of the harbor (boats and piers on piles) within the segment. These features obstruct the flow outside of the navigation channel and will tend to "funnel" the Ala Wai Canal flow compared to the model boundary conditions. Since the model does not accommodate this directly, adjustment to the inflow value was necessary. Second, the flow calculation assumes that the ADCP data only measured upstream and downstream values. Actually it measures currents in all directions, but the simplified flow calculation makes the determination of upstream or downstream flow based on the general direction of the flow measurement in a layer. Although this is not a large error, it will also overestimate the flow values.

The validated hydrodynamic model results as compared with the measured data are provided in Appendix A. Figures A1 to A9 in Appendix A plot the final model validation results with the field measurement data for each profile location and date. The computed AME and RMS values are provided on Table 1. The model profiles compared favorably to the measured data.

The March 11 model results have consistently lower than measured values for salinity in the upper portions of the profile but good fit in the lower part of the profile near bottom. Temperature measurements match well except at the DH end of the Inner Basin. The March 12 results match well and do not have the lower salinity values shown in the March 11 plots except at the Ewa end of the Middle Basin. The March 29 results match well in temperature, but again show lower salinity values in the upper portions of the profiles but better fit in the lower part of the profile. Overall these results indicated a general good fit of the modeled data to the measured data.

The validated hydrodynamic model was used to obtain horizontal current vectors for ebb and flood conditions on March 11, 2005 at 0700, 0900 and 1500 HST. These current vectors were plotted for every segment and layer in the model (Figures 2, 3 and 4). The plots show that the circulation patterns in the channel and basins are complex and multi-layered and vary considerably during a tidal stage.

Table 1. Computed Error Values

	March 11 2005		March 12 2005		March 29 2005	
	Temperature		Temperature		Temperature	
Segment	AME	RMS	AME	RMS	AME	RMS
3	0.18	0.21	0.51	0.75	0.23	0.27
5	0.26	0.32	0.18	0.24	0.30	0.39
8	0.17	0.22	0.17	0.20	0.30	0.40
10	0.09	0.13	0.36	0.39	0.27	0.38
13	1.58	1.65	1.01	1.08	1.41	1.46
17	0.54	0.71	0.57	0.75	0.63	0.84
19	0.30	0.40	0.49	0.56	0.50	0.67
23	0.78	0.94	0.58	0.75	0.84	1.10
26	0.77	0.91	0.62	0.80	0.87	1.03
29	0.43	0.56	0.41	0.54	0.69	0.81
32	0.51	0.58	0.38	0.48	0.81	1.05
35	0.53	0.62	0.44	0.60	0.70	0.88
38	0.43	0.57	0.51	0.68	0.49	0.64
	Salinity		Salinity		Salinity	
Segment	AME	RMS	AME	RMS	AME	RMS
3	2.19	3.15	1.93	2.78	2.27	3.18
5	2.11	2.74	1.97	2.69	1.86	2.58
8	0.51	0.79	0.61	0.78	0.68	1.06
10	0.20	0.34	0.36	0.39	0.45	0.73
13	3.05	3.19	3.21	3.30	2.97	3.27
17	1.68	2.14	1.76	2.31	1.92	2.58
19	1.93	2.51	1.89	2.50	2.22	2.86
23	1.21	1.43	0.83	1.17	1.34	1.58
26	1.29	1.43	1.23	1.43	1.51	1.69
29	1.16	1.35	1.40	1.72	1.42	1.69
32	0.33	0.47	0.32	0.49	0.63	0.82
35	0.40	0.60	0.38	0.54	0.74	0.94
38	0.59	0.79	0.56	0.75	0.78	0.98
	Sigma T		Sigma T		Sigma T	
Segment	AME	RMS	AME	RMS	AME	RMS
3	1.63	2.41	1.35	2.01	1.69	2.41
5	1.52	2.03	1.47	2.02	1.32	1.88
8	0.37	0.57	0.46	0.57	0.50	0.75
10	0.13	0.23	0.27	0.31	0.34	0.58
13	1.83	1.92	2.18	2.25	2.02	2.15
17	1.10	1.42	1.28	1.65	1.25	1.69
19	1.36	1.79	1.41	1.85	1.53	1.98
23	0.68	0.82	0.55	0.72	0.76	0.88
26	0.74	0.83	0.82	0.92	0.88	0.97
29	0.75	0.87	0.96	1.22	0.86	1.04
32	0.17	0.21	0.21	0.29	0.36	0.50
35	0.24	0.31	0.20	0.30	0.44	0.58
38	0.37	0.46	0.41	0.51	0.47	0.58

5.2 Water Quality Calibration/Validation

Validating the water quality parameters in the model is a complex task. Each water quality parameter may have more than one internal source and sink. Also many parameters are interrelated. Table 2 excerpted from the CE-QUAL-W2 users manual, shows the various interactions between constituents. The measured water quality parameters that will be validated here include Total Phosphorus, Total Nitrogen, Nitrate-Nitrites, Ammonium and Chlorophyll a. In addition to these values which are important as Class A water quality indicators, several other constituents were used to validate the model water quality. These included Si(OH)4, PO3, Total Organic Phosphorus, Total Organic Nitrogen and Total Suspended Solids.

Each constituent that is to be evaluated requires several rate constants and multipliers in order to account for the sinks and sources for that parameter as outlined in Table 2. Table 3 provides the various rate multipliers and coefficients used in the validation runs.

At the start of the model, each segment and layer must have an initial constituent value. The measured data from March 11 was used to initialize the model. Measured station locations were assigned to each segment and the data for the surface and bottom were linearly interpolated to obtain values for layer input. Also for each active boundary, constituent input values are required. At the ocean entrance (Segment 10), constituent values are available from the three water quality measurements obtained on March 11, 12 and 29 with additional CTD data on March 24 and 28. For values between these dates, the stream flow gage information was used to assign similar profiles.

Similar data are available at the Ala Wai Canal Entrance (Segment 2). The model is left to linearly interpolate constituent input values between these dates. This is a potential weakness in the modeling effort. If the input values fluctuate at a faster rate than between measurement periods then the model does not account for this. More frequent measurements at the boundaries would improve the model results.

The input to the middle basin from the existing discharge from the lagoon is assumed to be a constant flow with constant constituent values represented by the average values for the lagoon provided by TNWRE (Appendix B). This is input in the model as a tributary flow into Segment 23 for the period when flow occurred.

Table 2. CE-QUAL-W2 V3.2 Water Quality State Variables

Constituent	Internal Source	Internal Sink
• Total dissolved solids		
• generic constituent, no interactions with other state variables • bacteria • tracer • water age • contaminants	• 0 order decay	• settling • 0 and 1st order decay
• inorganic suspended solids		• sedimentation
• bio-available P measured as one of the following • ortho-P • dissolved P • SRP	• algal/epiphyton respiration • labile/refractory particulate/dissolved organic matter • sediment release • CBOD decay	• algal/epiphyton growth • adsorption onto inorganic suspended solids
• ammonium	• sediment release • algal/epiphyton excretion • labile/refractory dissolved/particulate organic matter decay • CBOD decay	• algal/epiphyton growth • nitrification
• nitrate-nitrite	• nitrification	• denitrification • algal/epiphyton growth
• dissolved silica	• anoxic sediment release • particulate biogenic silica decay	• algal/epiphyton growth • adsorption onto suspended solids
• particulate biogenic silica	• algal/epiphyton mortality	• settling • decay
• iron	• anoxic sediment release	• oxic water column settling
• labile dissolved organic matter	• algal/epiphyton • mortality • excretion	• decay
• refractory dissolved organic matter	• labile dissolved organic matter decay	• decay
• labile particulate organic matter	• algal/epiphyton mortality	• settling • decay
• refractory particulate organic matter	• labile particulate organic matter decay	• settling • decay
• CBOD		• decay
• algae	• algal growth	• respiration • excretion • mortality • settling
• epiphyton	• epiphyton growth	• respiration • excretion • mortality • settling
• dissolved oxygen	• surface exchange • algal/epiphyton growth	• surface exchange • algal/epiphyton respiration • nitrification • CBOD decay • 0 and 1st order BOD • labile/refractory dissolved/particulate organic matte decay
• total inorganic carbon	• labile/refractory dissolved/particulate organic matter decay • sediment release • surface exchange • algal respiration	• surface exchange • algal/epiphyton growth • CBOD decay
• alkalinity		

Table 3. Rate Multipliers and Coefficients for Validation Run

Extinction Coefficient of Water	EXH2O	1.01
Frac of Solar Radiation Absorbed @ Water Sfc	BETA	0.61
Algae #1	EXA1	0.2
Generic Q10	C_ARBQ10	0.0
Generic Zero Order decay Rate, mg/l/day	CG0DK	0.0
Generic 1st Order Decay Rate, 1/day	CG1DK	0.0
Generic Settling Rate, m/day	CGS	0.0
Suspended Solids Settling Rate, m/day	SSS	1.0
Sediment Resuspension Control	SEDRC	ON
Critical Shear Velocity for Resuspension, m/s	TAUCR	0.00001
Algal Growth Rate, 1/day	AG	2
Algal Dark Respiration Rate,1/day	AR	0.04
Algal Excretion Rate,1/day	AE	0.04
Algal Mortality Rate,1/day	AM	0.1
Algal Settling Rate, 1/day	AS	0.1
Algal half saturation P	AHSP	0.003
Algal half saturation N	AHSN	0.014
Algal half saturation SI	AHSSI	0
Algal light Saturation W/m^2	ASAT	75
Lower Temperature for Algal Growth	AT1	10
Lower Temperature for max. algal growth	AT2	25
Upper Temperature for max. algal growth	AT3	28
Upper Temperature for algal growth	AT4	35
Fraction of algal growth rate at AT1	AK1	0.1
Fraction of max. algal growth rate at AT2	AK2	0.95
Fraction of max. algal growth rate at AT3	AK3	0.98
Fraction of algal growth rate at AT4	AK4	0.1
Algal Fraction P	ALGP	0.005
Algal Fraction N	ALGN	0.08
Algal Fraction C	ALGC	0.45
Algal Fraction SI	ALGSI	0.18
Chlorophyll-algae ratio	ACHLA	145
Frac Algae lost by mortality to POM	ALPOM	0.8
Ammonia Preference Factor Equation 1 or 2	ANEQN	2
Ammonia Half Sat Coef. for Ammonia-Nitrate P	ANPR	0.001
Oxygen equiv. for organic matter for algae growth	O2AR	1.1
Oxygen equiv. for organic matter for algae resp.	O2AG	1.4
Labile DOM decay rate, 1/day	LDOMDK	0.1
Labile to refractory decay rate, 1/day	RDOMDK	0.001
Max refractory decay rate, 1/day	LRDDK	0.01
Labile POM decay rate, 1/day	LPOMDK	0.08
Labile to refractory decay rate, 1/day	RPOMDK	0.001
Max refractory decay rate, 1/day	LRPDK	0.01
Settling rate, m/day	POMS	1
Organic Matter Stoich Fraction P	ORGP	0.005
Organic Matter Stoich Fraction N	ORGN	0.06
Organic Matter Stoich Fraction C	ORGC	0.45
Organic Matter Stoich Fraction SI	ORGSI	0.18
Lower temp. for OM decay	OMT1	0
Upper temp. for OM decay	OMT2	30
Fraction of OM decay rate at OMT1	OMK1	0.1
Fraction of OM decay rate at OMT2	OMK2	0.99
Phosphorus Sediment Release Rate	PO4R	0.01
Partitioning Coef. for Suspended Solids	PARTP	0
Ammonium Sediment Release Rate	NH4R	0.001
Ammonium Decay rate, 1/day	NH4DK	0.15
Lower Temp for Amm. Decay	NH4T1	5
Upper Temp for Amm. Decay	NH4T2	30
Frac of Nitrification rate at NH4T1	NH4K1	0.1
Frac of Nitrification rat at NH4T2	NH4k2	0.99
Nitrate Decay Rate	NO3DK	0.05
Nitrate Sediment diffusion rate	NO3S	1
Lower Temp for Nitrate Decay	NO3T1	2
Upper Temp for Nitrate Decay	NO3T2	25
Frac of Denitrification rate at NO3T1	NO3K1	0.1
Frac of Denitrification rate at NO3T2	NO3K2	0.98
Dissolved Silica release rate	DSIR	0.1
Particulate Silica settling velocity	PSIS	1
Particulate Silica decay, 1/day	PSIDK	0.3
Silica Partitioning coef.	PARTSI	0
Sediment decay rate, 1/day	SEDK	0.05

The input from existing runoff of the offsite property due to localized rainfall enters the model through a submerged culvert at Segment 13 in the model. No measurements of flow or water quality parameters are available for this culvert. For use in the model, hourly flow values were computed based on the drainage areas that feed this culvert and the hourly measured rainfall from the Aloha Tower and Honolulu International Airport. This is assumed to be a freshwater flow with water temperature values equal to the current air temperature. The water quality constituents for this flow were assumed equal to the measured surface water quality values of March 12 2005 at TNWRE measuring Station 4. These values are mixed discharge and basin values and may not be exactly representative of the constituents from the drainage basin. Any additional contributions to discharges from this culvert are not accounted for in this modeling effort. Also, discharges from the boats in the harbor are not accounted for in the model input.

Direct precipitation/evaporation on the modeling water surface was not accounted for in the model. The water surface area of the model is as large as the drainage area for the offsite drainage. On a heavy rainfall event, this could have a significant effect on the basin surface areas. This was not implemented in the current modeling effort.

The model constituent inputs are not identical to the measured data values. For example the model requires input values for algal mass, whereas the measured water quality parameter representing algal mass is Chlorophyll a. In order to obtain a value for algal mass to be used as input into the model, this quantity had to be calculated from the Chlorophyll a value using a chlorophyll-algae ratio. The model recommended value for this quantity as shown in Table 3 was 145. This was applied to the measured Chlorophyll a values to provide algal constituent input where appropriate.

Another model input requirement is Dissolved Organic Matter (DOM). In the model, this quantity is used to determine the derived values of Total Organic Nitrogen (TON) and Total Organic Phosphorus (TOP). In the measured data, these values are determined by subtracting the measured inorganic nitrogen in the form of Nitrates-Nitrates and Ammonium from the measured Total Nitrogen, and the measured inorganic phosphates from measured Total Phosphates. To determine DOM for input in the model, a value was calculated using the Organic Matter Stoichiometry values in the model of Fraction P (ORGP) and Fraction N (ORGN). These are the multipliers used in the model to derive the TON and TOP quantities as a fractional part of the DOM. The DOM values used as boundary input were computed by applying ORGN to the measured TON values. This is a good estimate for the starting values as it is the larger of the two DOM components.

To validate the model for the water quality data, the model was run with the validated hydrodynamics. No changes were made to flow rates or water surface elevations that could alter the validated hydrodynamics of the system during the water quality validation runs. To evaluate the goodness of fit of the predicted to the measured data, AME and RMS values could not be used. The measured water quality data existed only at two points in the water column (near surface and near bottom), and two points are not adequate to do a statistical comparison. Graphical comparisons of the predicted profile and the measured data points at thirteen measured locations were used to validate the water quality portion of the model. Plots of the model versus measured data for the validation are presented on Figures A10 to A39 in Appendix A.

On March 11 the validation plots show good match in all parameters in the Channel, Middle and Outer Basins. In the Inner Basin, NH4 in slightly higher than measured, low values for Total Organic Nitrogen (TON) and Total Organic Phosphorus (TOP)in the DH end, but overall a good fit to the measured data.

On March 12 the validation plots show good match in all parameters in the Middle and Outer Basin. In the Channel there is good match in the outer channel segments, but in the inner segments, NH4, Total Phosphorus (TP), TSS, and TOP are lower than measured in the near surface values. These are consistent with lower values for these parameters in the Inner Basin. Segment 5 is where the Inner Basin connects to the Channel in the model scheme and the lower surface values here reflect water coming out of the Inner Basin. These values are probably reflecting the deficiency in the model due to the lack of measured data for the flows and constituents entering the Inner Basin on a rainfall event.

On March 29 the validation plots show a good match in all parameters in the Channel except for TN, NH4, TON and TOP in Segment 5 where they are lower than measured near the surface. The Inner Basin shows the same 4 parameters with low surface values. The Middle Basin shows good match with all parameters at the surface and bottom except for the TSS value which shows a high values in the middle of the water column. In the Outer Basin the model showed lower values of TN and TON in the near

surface values. Overall, the fit of the model water quality predictions to that of the measured data is very good.

6.0 CE-QUAL-W2 Model Runs

After completion of validation, the model was used to test modifications to the existing system and quantitatively evaluate the results. The proposed modifications were applied during the modeled data period and the results were compared to the validated model results for similar times. The results from each of the scenario runs are presented in a table along with the baseline run that represents the modeled existing conditions for comparison. The table presents the averaged results for the top and bottom portions of the model profile at each reported segment, and the percent change from the baseline case. A negative percent value indicates that the scenario value is less than the modeled existing value (e.g. a reduction in the water quality constituent). Results are tabulated for the standard water quality parameters plus Total Suspended Solids (TSS). Since the model does not compute Turbidity, TSS is used here as an indication of the water clarity in conjunction with the Chlorophyll a value.

6.1 Scenario 1: Proposed 15000 gpm Lagoon Outflow During March 11, 2005, "Dry Event" (Low Flow from the Ala Wai Canal).

This scenario is designed to reflect changes due to the increased pumping from the Hilton Lagoon in a dry period such as was measured on March 11, 2005.

The results in Table 4 show that the new pumped discharge would increase the mixing within the harbor basins as the surface and bottom values in the scenario are closer in value than the baseline values. There is an increase in Nitrate-Nitrite Nitrogen and Total Phosphorus in the Inner and Middle Basins where the lagoon water will be discharged, but these values dissipate to the baseline values in each basin by the time the water reaches the Ala Wai Canal channel. Even though the nutrient values are higher at the inner ends of these two harbor basins, the Chlorophyll a values are the same or lower indicating there would be no increase in productivity. The proposed discharge would reduce the TSS values throughout the Inner and Middle Basins. At the ocean outlet of the harbor (Segment 10), constituent values are the same or slightly better (lower) than without the pumped discharge..

6.2 Scenario 2: Proposed 15000 gpm Lagoon Outflow During March 29, 2005, "Wet Event".

This scenario was simulated to reflect changes due to the new pumped discharge during higher than average discharge from the Ala Wai Canal. The simulation compares the conditions on March 29, 2005 with and without the proposed15000 gpm discharge.

The results in Table 5 show increases of Nitrate-Nitrite Nitrogen and Total Phosphorus values in the Inner and Middle Basins as in Scenario 1. However, they continue to dissipate as water moves out these basins and into the channel. As with Scenario 1, the Chlorophyll a values are the same or lower with the 15000 gpm discharge,

indicating no increased productivity. The TSS values are much lower throughout the Inner and Middle Basins with this discharge, and the low values continue into the channel. Constituent values at the ocean outlet of the harbor are the same or lower than without the proposed discharge.

TABLE 4: Simulation of March 11, 2005 (Dry Event) Conditions With and Without the Proposed 15,000 GPM Discharge from the Hilton Lagoon (Scenario 1)

	Total Nitrogen			Ammonia Nitrogen			Nitrate-Nitrite Nitrogen			Total Phosphorus			Chlorophyll a			Total Suspended Solids		
Channel	TN (ug/L) Baseline	Scenario	Change %	NH4 (ug/L) Baseline	Scenario	Change %	NO3 (ug/L) Baseline	Scenario	Change %	TP (ug/L) Baseline	Scenario	Change %	(ug/L) Baseline	Scenario	Change %	(ug/L) Baseline	Scenario	Change %
3 Top (Ala Wai)	302	321	6	25	24	-4	124	121	-2	25	26	4	4	4	0	8181	8168	0
3 Bottom (Ala Wai)	191	212	11	15	14	-7	55	63	15	20	22	10	2	2	0	10232	9230	-10
Top 5 279	290	4	18	17	-8	117	109	-7	24	26	8	4	4	0		7915	7903	0
5 Bottom	183	198	8	14	12	-14	50	58	16	19	20	5	2	2	0	10620	9484	-11
8 Top	205	213	4	12	12	0	74	69	-7	19	20	5	3	2	-33	9596	9276	-3
8 Bottom	133	141	6	4	5	25	23	26	13	13	14	8	0	1	100	11371	11258	-1
10 Top (Ocean)	212	215	1	13	13	0	77	74	-4	19	19	0	2	2	0	9706	9514	-2
10 Bottom (Ocean)	160	166	4	8	8	0	47	44	-6	15	15	0	1	1	0	11025	10993	0
Inner Basin																		
13 Top (DH)	303	277	-9	14	12	-14	116	132	14	24	43	79	5	3	-40	7329	6123	-16
13 Bottom (DH)	269	263	-2	11	11	0	96	117	22	24	41	71	4	3	-25	8000	6628	-17
17 Top	293	286	-2	14	13	-7	118	111	-6	24	28	17	5	4	-20	7310	7352	1
17 Bottom	201	228	13	14	15	7	56	67	20	22	26	18	3	3	0	9778	8695	-11
19 Top (Ewa)	286	286	0	16	14	-13	117	109	-7	24	27	13	4	4	0	7504	7537	0
19 Bottom (Ewa)	200	213	7	14	14	0	55	59	7	21	23	10	3	3	0	9988	9121	-9
Middle Basin																		
23 Top (DH)	264	223	-16	13	11	-15	104	80	-23	22	24	9	4	3	-25	7534	7035	-7
23 Bottom (DH)	152	218	43	15	14	-7	42	74	76	17	23	35	2	2	0	13126	7301	-44
26 Top	267	243	-9	13	12	-8	104	87	-16	22	23	5	4	3	-25	7722	7962	3
26 Bottom	173	220	27	14	14	0	55	76	38	18	23	28	2	2	0	11258	7489	-34
29 Top (Ewa)	263	243	-8	13	13	0	102	87	-15	22	23	5	4	3	-25	8259	8154	-1
29 Bottom (Ewa)	159	210	32	10	15	50	51	69	35	17	22	29	2	2	0	10463	8295	-21
Outer Basin																		
32 Top (DH)	235	238	1	15	14	-7	101	93	-8	20	20	0	3	3	0	8201	7979	-3
32 Bottom (DH)	133	155	17	14	16	14	25	33	32	16	17	6	1	1	0	9719	9207	-5
Top 35 238	235	-1	15	14	-7	102	91	-11	20	20	0	3	3	0		8384	8197	-2
148	161	9	12	15	25	37	40	8	16			0	1	1	0	10045	9546	-5
38 Top (Ewa)	244	236	-3	15	14	-7	103	90	-13	20	20	0	3	3	0	8752	8503	-3
38 Bottom (Ewa)	156	168	8	9	10	11	46	46	0	15	16	7	1	1	0	10503	10259	-2

Notes: 1. "Baseline" results in the table refers to the March 11, 2005 simulation without the pumped discharge.
"Scenario" results are the same simulation with the 15,000 GPM discharge split equally between the harbor's inner and middle basins.
2. % Change = Scenario decrease (-) compared to Baseline

TABLE 5: Simulation of March 29, 2005 (Wet Event) Conditions With and Without the Proposed 15,000 GPM Discharge From the Hilton Lagoon (Scenario 2)

	Total Nitrogen			Ammonia Nitrogen			Nitrate-Nitrite Nitrogen			Total Phosphorus			Chlorophyll a			Total Suspended Solids		
Channel	TN (ug/L) Baseline	Scenario	Change %	NH4 (ug/L) Baseline	Scenario	Change %	NO3 (ug/L) Baseline	Scenario	Change %	TP (ug/L) Baseline	Scenario	Change %	(ug/L) Baseline	Scenario	Change %	(ug/L) Baseline	Scenario	Change %
3 Top (Ala Wai)	257	253	-2	25	26	4	104	102	-2	33	33	0	3	3	0	11229	11108	-1
3 Bottom (Ala Wai)	136	143	5	17	16	-6	18	29	61	18	23	28	1	1	0	16619	12687	-24
5 Top	218	218	0	18	14	-22	77	86	12	28	33	18	3	3	0	11506	9894	-14
5 Bottom	133	143	8	16	14	-13	18	29	61	17	22	29	1	1	0	17240	12206	-29
8 Top	163	161	-1	13	12	-8	48	49	2	20	24	20	2	2	0	12752	10243	-20
8 Bottom	133	124	-7	15	5	-67	22	14	-36	17	16	-6	1	1	0	14706	11548	-21
10 Top (Ocean)	158	152	-4	13	11	-15	50	43	-14	20	21	5	2	2	0	11788	10423	-12
10 Bottom (Ocean)	137	132	-4	10	7	-30	30	25	-17	17	17	0	1	1	0	11428	10760	-6
Inner Basin																		
13 Top (DH)	232	226	-3	11	11	0	88	99	13	29	38	31	4	3	-25	8085	7617	-6
13 Bottom (DH)	168	191	14	13	14	8	40	75	88	22	36	64	3	2	-33	11903	9065	-24
17 Top	215	214	0	10	11	10	76	87	14	27	35	30	4	3	-25	9389	8543	-9
17 Bottom	131	142	8	18	17	-6	14	26	86	18	23	28	1	1	0	16530	12785	-23
19 Top (Ewa)	213	213	0	11	12	9	74	86	16	27	34	26	4	3	-25	10135	8915	-12
19 Bottom (Ewa)	131	141	8	17	16	-6	14	26	86	17	23	35	1	1	0	16838	12715	-24
Middle Basin																		
23 Top (DH)	185	161	-13	8	9	13	58	51	-12	24	26	8	3	2	-33	11312	8302	-27
23 Bottom (DH)	118	143	21	15	15	0	10	32	220	15	23	53	1	1	0	36711	10387	-72
26 Top	179	164	-8	9	10	11	56	53	-5	23	25	9	3	2	-33	12233	9323	-24
26 Bottom	122	142	16	16	15	-6	13	32	146	16	23	44	1	1	0	29725	10540	-65
29 Top (Ewa)	176	174	-1	11	11	0	58	60	3	22	26	18	3	2	-33	12509	9579	-23
29 Bottom (Ewa)	128	137	7	16	15	-6	16	26	63	17	21	24	1	1	0	22061	11535	-48
Outer Basin																		
32 Top (DH)	166	159	-4	12	10	-17	46	46	0	21	22	5	3	2	-33	9803	8891	-9
32 Bottom (DH)	130	130	0	21	23	10	15	16	7	17	17	0	1	1	0	16232	14489	-11
35 Top	165	160	-3	12	10	-17	49	46	-6	21	22	5	3	2	-33	10250	9167	-11
35 Bottom	131	132	1	20	21	5	17	18	6	17	18	6	1	1	0	15976	13931	-13
38 Top (Ewa)	162	162	0	12	8	-33	45	47	4	21	22	5	3	3	0	11289	9365	-17
38 Bottom (Ewa)	134	135	1	18	16	-11	22	21	-5	17	18	6	1	1	0	15125	12867	-15

Notes: 1. "Baseline" results in the table refers to the March 29, 2005 simulation with the existing 5300 GPM discharge to the harbor's middle basin.
"Scenario" results are the same simulation except replacing existing discharge with the 15,000 GPM discharge split equally between the harbor's inner and middle basins.
2. % Change = Scenario decrease (-) compared to Baseline

7.0 Discussion

The two dimensional water quality model CE-QUAL-W2 V3.2 was implemented for the Ala Wai Small Boat Harbor in order to evaluate the results of increasing discharge from the Hilton Hawaiian Village Lagoon. The model was successfully validated using data collected during a one month field measurement program in March 2005. Field measurements included tidal water surface elevations, current profile information, weather data, CTD and water quality measurements.

Two scenarios were run with the validated model reflecting existing baseline conditions and the proposed discharge changes.

The model results show that the proposed increased discharges from the lagoon into the harbor result in elevated levels of some nutrients at the inner ends of the inner and middle harbor basins. (The seawater from the deep wells that will be used as the source water for the lagoon are higher in nutrients than the water that is currently pumped from the lagoon into the harbor.) Because of the complex circulation within the harbor due to the vertically stratified flows within the channel and basins, there is much variability of the nutrient levels throughout the harbor and throughout the day (due to the tidal influences on circulation). To evaluate this variability, the model was set up to obtain nutrient values every two hours using the validation run for March 11 and again for Scenario 1. Results from the model were tabulated at two hour intervals throughout a tidal cycle on March 11 to show this variability (Tables 6 to 11). These tables present averaged results for the top and bottom portions of the model profile for each reported segment and the computed variation equal to the difference between the minimum and maximum values reported over the tidal cycle.

Despite the elevated nutrient levels in the proposed 15000 gpm lagoon discharge, the Chlorophyll a levels are consistently low and comparable or better (lower) than the existing condition. The residence times within each segment were output from the model for the March 29, 2005 Ala Wai Canal flow, with and without the proposed 15,000 gpm discharge from the Hilton Lagoon. Figures 5, 6, 7 and 8 show the results for selected segments, where the time to 50% concentration (and 25% concentration) are given for the upper half of the water column and the lower half of the water column. The results show that with the proposed 15,000 gpm discharge the residence times decrease throughout the harbor. The residence times to 50% concentration are less than 2 days in the upper half of the water column, and about one day or less in the lower half of the water column. This may explain the low Chlorophyll a levels despite the relatively high nutrients.

Table 6. Variation Of Total Nitrogen Over a Tidal Cycle
TN (ug/l)

	March 11 Baseline						Scenario 1					
Time of Day	0700	0900	1100	1300	1500	Variation	0700	0900	1100	1300	1500	Variation
Channel												
3 Top (Ala Wai)	288	323	344	351	311	65	284	321	342	351	313	68
3 Bottom (Ala Wai)	196	215	228	212	194	34	189	213	230	225	201	41
5 Top	296	309	321	322	288	34	296	308	319	318	285	34
5 Bottom	196	214	232	213	186	46	193	219	235	214	188	47
8 Top	224	230	244	236	219	25	232	234	245	239	216	28
8 Bottom	137	141	146	143	136	10	138	144	158	139	136	22
10 Top (Ocean)	217	226	239	231	219	22	220	229	240	232	217	23
10 Bottom (Ocean)	166	155	153	170	168	17	161	158	156	167	167	11
Inner Basin												
13 Top (DH)	323	328	322	314	311	17	320	327	323	316	311	17
13 Bottom (DH)	273	319	325	260	279	65	277	308	312	267	283	45
17 Top	314	325	325	315	304	21	311	323	323	313	300	24
17 Bottom	218	238	247	207	223	40	222	234	246	211	227	35
19 Top (Ewa)	312	321	324	318	294	30	310	318	322	315	292	30
19 Bottom (Ewa)	205	226	242	204	210	38	206	225	244	219	215	38
Middle Basin												
23 Top (DH)	273	263	284	277	266	21	277	275	284	279	271	12
23 Bottom (DH)	159	150	209	222	161	72	216	201	235	245	213	44
26 Top	276	268	277	279	270	11	275	275	277	278	271	7
26 Bottom	178	163	196	210	167	47	192	182	223	230	185	48
29 Top (Ewa)	271	271	266	275	264	11	272	271	268	269	259	13
29 Bottom (Ewa)	178	177	189	206	174	32	180	184	209	233	175	58
Outer Basin												
32 Top (DH)	249	241	262	259	236	26	247	242	258	257	235	23
32 Bottom (DH)	144	143	179	163	138	41	145	142	181	159	138	43
35 Top	244	241	256	261	241	20	241	243	255	260	240	20
35 Bottom	159	149	163	181	149	32	162	149	166	174	147	26
38 Top (Ewa)	229	244	251	255	247	26	229	242	251	257	247	28
38 Bottom (Ewa)	164	156	161	180	159	24	159	156	161	174	157	18

Variation = (Maximum Value - Minimum Value) Over the Tidal Cycle

Table 7. Variation Of Ammonia Nitrogen Over a Tidal Cycle
NH4 (ug/l)

Time of Day	March 11 Baseline 0700	0900	1100	1300	1500	Variation	Scenario 1 0700	0900	1100	1300	1500	Variation
Channel												
3 Top (Ala Wai)	22	29	31	31	23	9	22	28	31	31	22	9
3 Bottom (Ala Wai)	15	15	16	14	14	2	14	15	15	14	13	2
5 Top	22	23	21	19	16	7	21	23	22	20	16	7
5 Bottom	14	16	16	14	13	3	13	15	15	14	13	3
8 Top	16	17	18	14	11	7	17	17	17	14	11	7
8 Bottom	4	6	9	6	4	5	5	7	10	5	4	5
10 Top (Ocean)	16	17	18	15	12	6	16	17	18	15	11	7
10 Bottom (Ocean)	8	7	9	9	9	2	7	8	10	9	9	2
Inner Basin												
13 Top (DH)	22	21	21	18	11	11	23	24	22	18	11	14
13 Bottom (DH)	16	20	20	14	10	10	13	19	19	11	8	11
17 Top	21	23	22	17	12	11	21	24	22	17	13	11
17 Bottom	16	17	17	15	13	4	15	15	16	14	13	3
19 Top (Ewa)	22	23	21	17	14	9	22	23	22	17	14	10
19 Bottom (Ewa)	15	17	16	14	14	3	15	15	16	14	14	2
Middle Basin												
23 Top (DH)	21	19	16	14	12	9	21	19	16	14	12	9
23 Bottom (DH)	14	13	16	15	14	3	13	11	15	14	12	4
26 Top	21	20	17	14	12	9	21	20	17	14	11	10
26 Bottom	14	13	16	15	12	4	13	12	15	15	12	4
29 Top (Ewa)	21	20	17	15	12	9	21	19	17	15	11	10
29 Bottom (Ewa)	12	13	15	14	10	5	12	13	14	15	9	6
Outer Basin												
32 Top (DH)	21	19	18	16	14	7	20	20	17	15	14	6
32 Bottom (DH)	14	13	15	14	13	2	14	13	15	14	13	2
35 Top	20	19	17	16	14	6	20	19	17	16	14	6
35 Bottom	13	12	14	15	10	5	14	11	14	14	10	4
38 Top (Ewa)	19	19	18	16	14	5	19	18	18	16	14	5
38 Bottom (Ewa)	11	9	13	13	8	5	10	10	14	12	8	6

Variation = (Maximum Value - Minimum Value) Over the Tidal Cycle

Table 8. Variation Of Nitrate-Nitrite Nitrogen Over a Tidal Cycle
NO3 (ug/l)

Time of Day	March 11 Baseline 0700	0900	1100	1300	1500	Variation	Scenario 1 0700	0900	1100	1300	1500	Variation
Channel												
3 Top (Ala Wai)	103	120	128	132	113	29	103	121	130	133	116	30
3 Bottom (Ala Wai)	52	63	69	58	49	20	50	66	78	73	59	26
5 Top	110	116	122	122	105	17	114	119	125	124	106	19
5 Bottom	54	59	69	63	45	24	54	66	78	70	52	26
8 Top	74	76	90	81	71	19	80	80	94	86	72	22
8 Bottom	24	26	27	27	23	4	25	28	38	25	24	14
72	81	91	83	75	19	74	83	93	85	75		
10 Bottom (Ocean)	45	36	33	48	46	15	41	38	36	45	46	10
Inner Basin												
13 Top (DH)	127	132	123	116	117	16	129	124	121	123	122	8
13 Bottom (DH)	83	124	125	79	94	46	153	142	136	143	150	18
17 Top	120	127	125	119	113	14	127	127	123	123	118	10
17 Bottom	54	67	72	48	60	24	61	78	86	62	75	24
19 Top (Ewa)	119	123	125	121	108	17	123	125	125	125	111	14
19 Bottom (Ewa)	51	61	71	52	54	20	53	69	86	71	66	33
Middle Basin												
23 Top (DH)	103	98	109	108	99	11	107	105	108	107	105	3
23 Bottom (DH)	33	28	66	72	35	44	105	100	102	113	110	13
26 Top	105	100	105	107	102	7	105	105	105	108	104	4
26 Bottom	46	37	58	65	41	28	68	64	91	92	64	29
29 Top (Ewa)	102	102	101	103	98	5	102	103	104	103	97	7
29 Bottom (Ewa)	48	45	53	64	46	19	53	55	81	85	48	37
Outer Basin												
32 Top (DH)	102	96	110	107	92	18	101	98	106	104	90	15
32 Bottom (DH)	25	25	52	40	22	30	25	24	53	37	22	31
35 Top	99	96	104	108	95	13	96	96	103	107	94	13
35 Bottom	38	31	41	53	32	22	40	31	43	48	31	17
38 Top (Ewa)	87	95	102	103	99	16	86	93	102	105	98	19
38 Bottom (Ewa)	42	37	39	54	40	17	39	37	40	49	38	13

Variation = (Maximum Value - Minimum Value) Over the Tidal Cycle

Table 9. Variation Of Total Phosphorus Over a Tidal Cycle
TP (ug/l)

	March 11 Baseline						Scenario 1					
Time of Day	0700	0900	1100	1300	1500	Variation	0700	0900	1100	1300	1500	Variation
Channel												
3 Top (Ala Wai)	23	24	25	25	24	2	25	26	26	26	26	1
3 Bottom (Ala Wai)	19	20	21	20	19	2	20	22	25	26	25	6
5 Top	24	24	25	25	23	2	27	27	27	28	25	2
5 Bottom	19	21	22	20	18	3	20	24	26	26	23	6
8 Top	19	20	20	20	19	2	21	22	23	23	20	3
8 Bottom	14	14	15	14	13	1	14	15	19	14	14	6
10 Top (Ocean)	18	19	20	19	18	1	19	20	21	21	19	2
10 Bottom (Ocean)	15	15	15	15	15	1	15	15	16	16	15	2
Inner Basin												
13 Top (DH)	26	25	25	24	24	1	26	20	24	27	28	8
13 Bottom (DH)	26	26	25	24	24	2	56	38	34	54	52	22
17 Top	25	25	25	24	24	1	30	26	25	28	28	5
17 Bottom	22	23	23	21	22	2	26	30	30	27	30	4
19 Top (Ewa)	25	25	25	25	23	2	29	28	26	28	26	3
19 Bottom (Ewa)	20	22	23	20	21	3	23	27	30	28	27	8
Middle Basin												
23 Top (DH)	22	22	23	22	22	1	23	24	24	24	25	2
23 Bottom (DH)	17	16	19	20	17	4	48	50	36	41	51	15
26 Top	23	22	22	22	22	1	23	24	24	24	24	0
26 Bottom	18	17	19	19	16	3	31	31	34	33	29	5
29 Top (Ewa)	22	22	21	22	22	1	23	23	23	24	23	1
29 Bottom (Ewa)	17	17	18	19	16	3	21	22	33	26	18	15
Outer Basin												
32 Top (DH)	20	19	20	20	19	1	20	20	21	21	20	1
32 Bottom (DH)	16	16	17	16	15	2	17	16	17	16	15	2
35 Top	20	19	20	20	20	1	20	20	21	21	20	1
35 Bottom	16	15	16	17	15	2	16	15	17	17	15	2
38 Top (Ewa)	19	20	20	20	20	1	19	20	20	21	20	2
38 Bottom (Ewa)	16	15	16	17	15	2	15	15	16	16	15	2

Variation = (Maximum Value - Minimum Value) Over the Tidal Cycle

Table 10. Variation Of Chlorophyll a Over a Tidal Cycle
(ug/l)

	March 11 Baseline						Scenario 1					
Time of Day	0700	0900	1100	1300	1500	Variation	0700	0900	1100	1300	1500	Variation
Channel												
3 Top (Ala Wai)	3	3	4	4	4	1	3	3	4	4	4	1
3 Bottom (Ala Wai)	2	2	3	3	2	1	2	2	3	3	2	1
Top 5 3	4	4	4	4	1	3	3	4	4	4	1	
5 Bottom	2	2	3	2	2	1	2	2	3	2	2	1
Top 8 2	2	3	3	2	1	2	2	3	3	2	1	
8 Bottom	1	1	1	1	1	0	1	1	1	1	1	0
10 Top (Ocean)	2	2	2	3	2	1	2	2	2	3	2	1
10 Bottom (Ocean)	1	1	1	1	1	0	1	1	1	1	1	0
Inner Basin												
13 Top (DH)	4	4	4	4	5	1	3	4	4	4	5	1
13 Bottom (DH)	4	4	4	4	5	1	2	3	3	2	3	2
Top 17 4	4	4	4	5	1	3	4	4	4	4	1	
17 Bottom	3	3	3	3	3	1	3	3	3	2	3	0
19 Top (Ewa)	4	4	4	4	4	1	3	4	4	4	4	1
19 Bottom (Ewa)	2	3	3	2	3	1	2	2	3	2	3	0
Middle Basin												
23 Top (DH)	3	3	4	4	4	1	3	3	3	4	4	1
23 Bottom (DH)	1	1	2	2	1	1	1	1	2	2	1	1
Top 26 3	3	3	4	4	1	3	3	3	4	4	1	
26 Bottom	1	1	2	2	1	1	1	1	2	2	1	1
29 Top (Ewa)	3	3	3	4	4	1	3	3	3	3	3	1
29 Bottom (Ewa)	1	1	2	2	1	1	1	1	2	2	1	1
Outer Basin												
32 Top (DH)	2	2	3	3	3	1	2	2	3	3	3	1
32 Bottom (DH)	1	1	2	1	1	1	1	1	2	1	1	1
Top 35 2	2	3	3	3	1	2	2	3	3	3	1	
35 Bottom	1	1	1	2	1	1	1	1	1	2	1	1
38 Top (Ewa)	2	2	3	3	3	1	2	2	3	3	3	1
38 Bottom (Ewa)	1	1	1	2	1	0	1	1	1	1	1	0

Variation = (Maximum Value - Minimum Value) Over the Tidal Cycle

Table 11. Variation Of Total Suspended Solids Over a Tidal Cycle TSS (ug/l)												
	March 11 Baseline						Scenario 1					
Time of Day	0700	0900	1100	1300	1500	Variation	0700	0900	1100	1300	1500	Variation
Channel												
3 Top (Ala Wai)	9177	8820	8717	8409	8503	768	8997	8685	8594	8383	8189	808
3 Bottom (Ala Wai)	10566	9973	9553	10141	10442	1013	10108	9528	8968	8937	9165	1172
5 Top	8433	8236	7926	7743	8304	690	8167	8037	7792	7535	8021	632
5 Bottom	10514	10093	9524	10258	10645	1121	10084	9385	8807	9026	9497	1277
8 Top	9830	9518	9694	9430	9641	400	9375	9058	9152	8786	9394	608
8 Bottom	11342	11271	11480	11205	11504	299	11322	11118	10462	11282	11476	1014
10 Top (Ocean)	9806	9587	9854	9532	9754	322	9560	9293	9552	9063	9547	497
10 Bottom (Ocean)	11029	11093	11063	10955	11333	378	11090	10964	10656	10879	11323	667
Inner Basin												
13 Top (DH)	7111	6296	6809	7131	7368	1072	6989	6589	6778	6800	7016	427
13 Bottom (DH)	9203	6890	6680	8595	8040	2523	5649	5841	6146	5554	5700	592
17 Top	7561	7083	7324	7273	7646	563	7102	7062	7394	6981	7394	413
17 Bottom	10221	9621	9094	10402	9560	1308	9386	8587	8055	8807	8249	1331
19 Top (Ewa)	7702	7606	7568	7300	7958	658	7440	7474	7544	7125	7664	539
19 Bottom (Ewa)	10428	9879	9298	10332	9944	1130	9611	9049	8218	8738	8742	1593
Middle Basin												
23 Top (DH)	8106	8598	7033	7206	8029	1565	7539	7475	6973	7039	7418	566
23 Bottom (DH)	17461	16154	11803	10634	13365	6827	7486	7546	7676	6948	6845	831
26 Top	8030	8253	7592	7869	7872	661	7877	7685	7605	7733	7588	289
26 Bottom	13588	13846	12485	11230	11620	2616	9285	9302	8205	7933	9157	1369
29 Top (Ewa)	8461	8171	8551	8375	8243	380	8287	8007	8316	8217	8128	308
29 Bottom (Ewa)	11514	11721	12431	10607	10648	1824	10068	9884	8594	8505	10221	1716
Outer Basin												
32 Top (DH)	8402	8304	7806	8123	8285	596	8325	8209	7740	7995	8203	585
32 Bottom (DH)	9434	9592	9149	9389	9934	785	9351	9644	9174	9534	9985	811
35 Top	8527	8366	8441	8652	8411	286	8462	8268	8354	8446	8324	194
35 Bottom	9730	10144	9521	9200	10532	1332	9621	10178	9501	9335	10515	1181
38 Top (Ewa)	8682	8592	9118	8835	8669	526	8680	8509	8968	8659	8473	495
38 Bottom (Ewa)	10251	10580	9858	9624	10898	1274	10454	10536	9708	9858	10891	1184

Variation = (Maximum Value - Minimum Value) Over the Tidal Cycle

REFERENCES

State of Hawaii, Department of Land and Natural Resources, Division of Water and Land Development.,(1992). Ala Wai Canal Improvement, Honolulu, Oahu, Hawaii, Feasibility Report, Report R-89b.

Edinger, J. E. and Buchak, E.M., (1975). A Hydrodynamic, Two-Dimensional Reservoir Model: The Computational Basis. Prepared for the US Army Engineer Division, Ohio River, Cincinnati, Ohio.

Cole, T.M. and Wells, S.A., (2002). CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 3.1. User Manual. Prepared for U.S. Army Corps of Engineers, Washington. D.C.

Leonard, B.P. (1979). A Stable and Accurate Convective Modeling Procedure Based on Upstream Interpolation. Computer Methods in Applied Mechanics and Engineering, Vol 19, pp 59-98.

Leonard, B. P. (1991). The ULTIMATE Cons ervative Difference Scheme Applied to Unsteady, One-Dimensional Advection, Com puter Methods in Applied Mechanics and Engineering, Vol 88, pp 17-74.

Brater, E.F. and King, H.W.. (1982). H andbook of Hydraulics for the Solution of Hydraulic Engineering Problems, Sixth Edition, McGraw Hill Book Company, New York

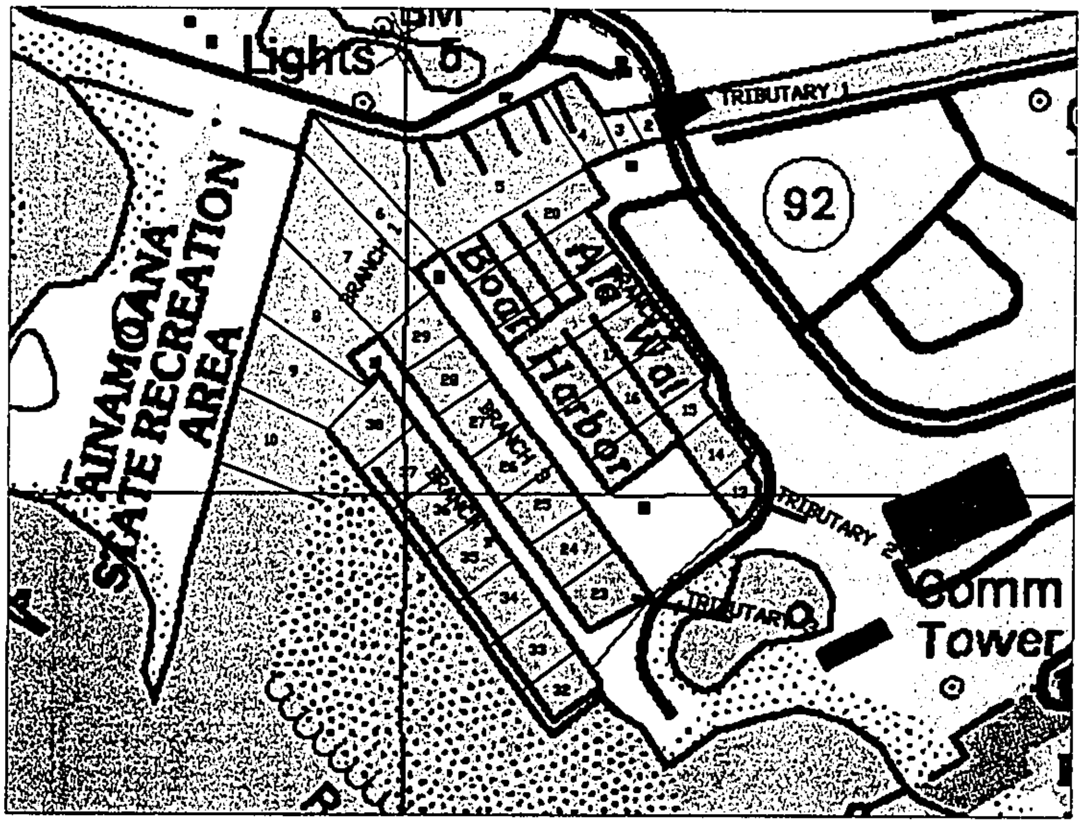


FIGURE 1. CE-QUAL-W2 ALA WAI SMALL BOAT HARBOR GEOMETRY

FIGURES

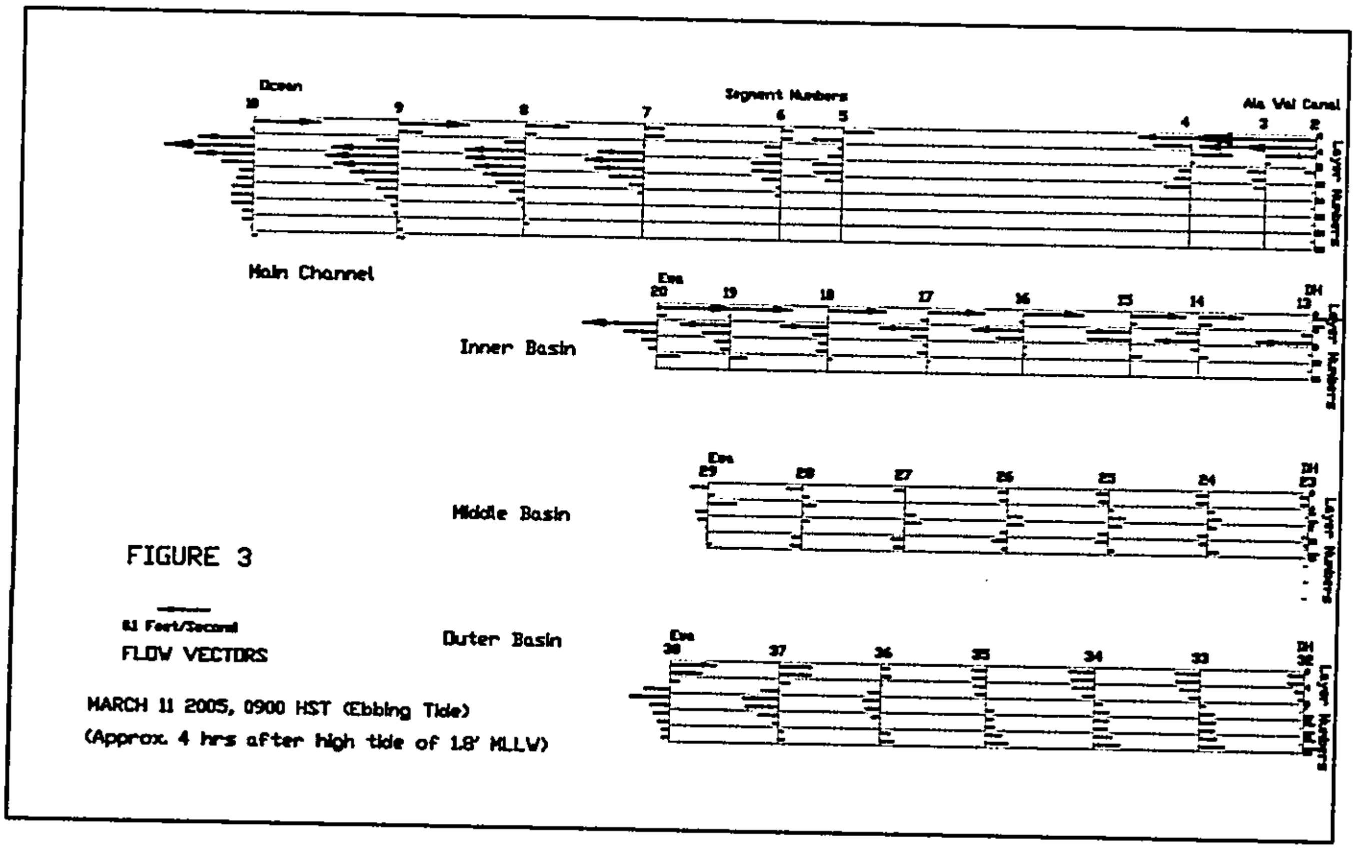


FIGURE 3

FLOW VECTORS

MARCH 11 2005, 0900 HST (Ebbing Tide)
(Approx. 4 hrs after high tide of 1.8' MLLW)

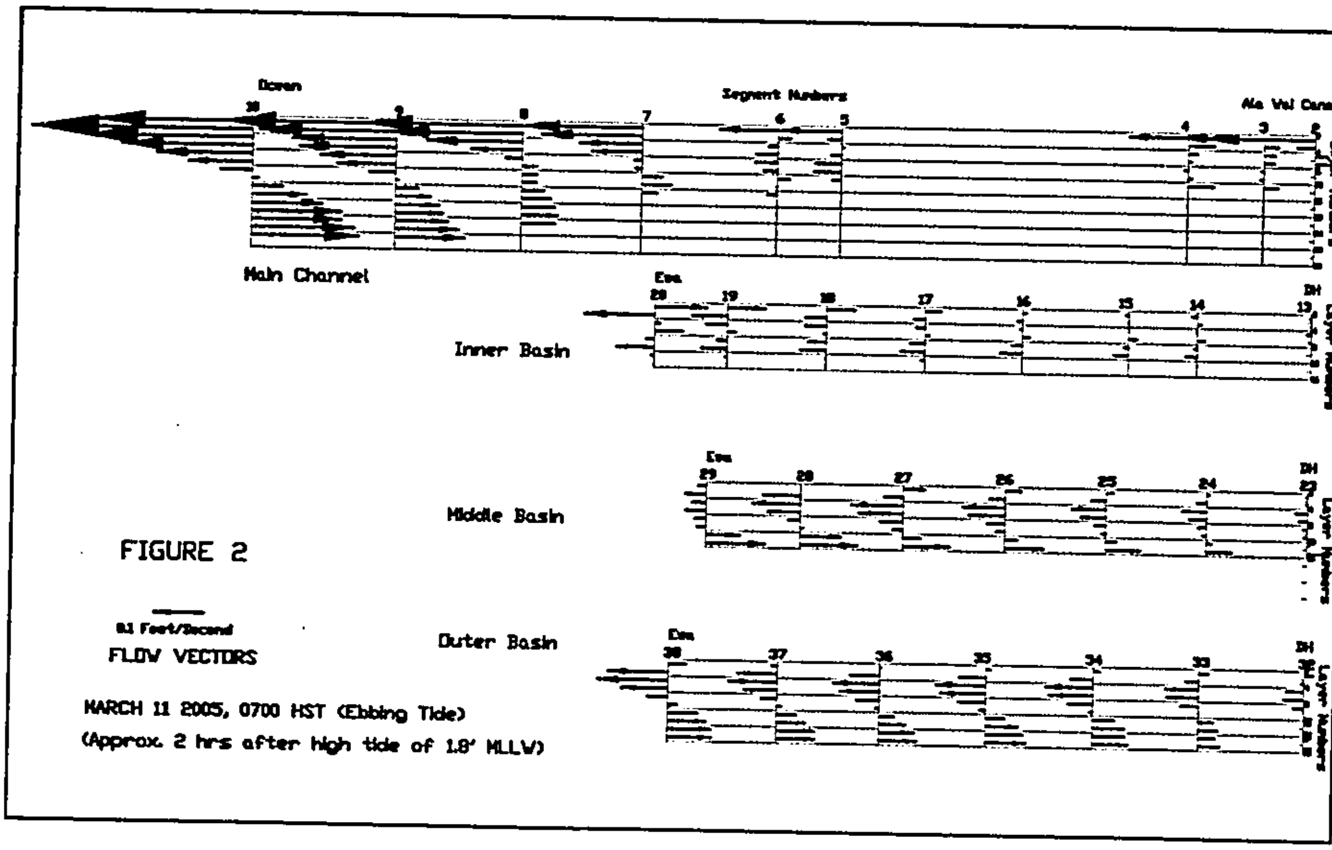


FIGURE 2

FLOW VECTORS

MARCH 11 2005, 0700 HST (Ebbing Tide)
(Approx. 2 hrs after high tide of 1.8' MLLW)

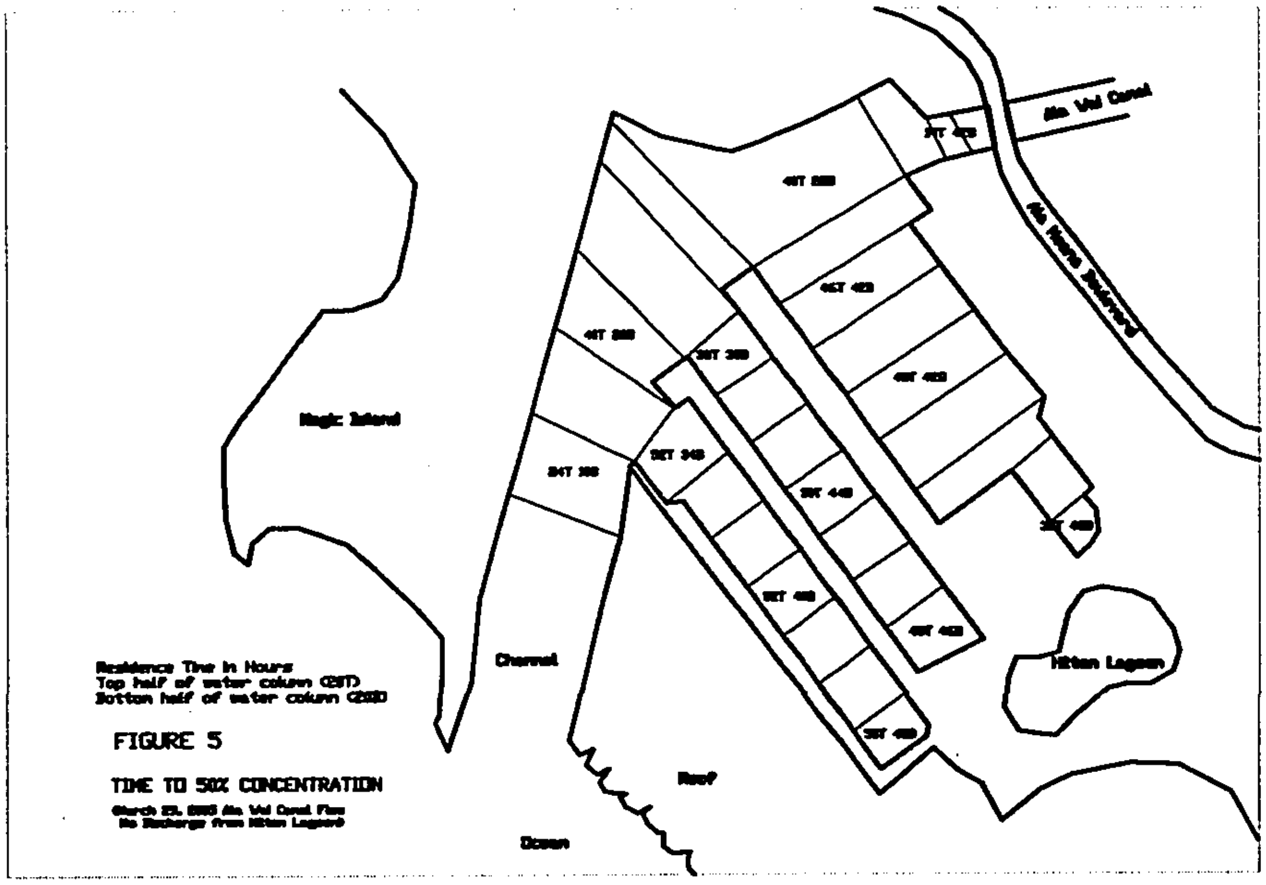


FIGURE 5

TIME TO 50% CONCENTRATION

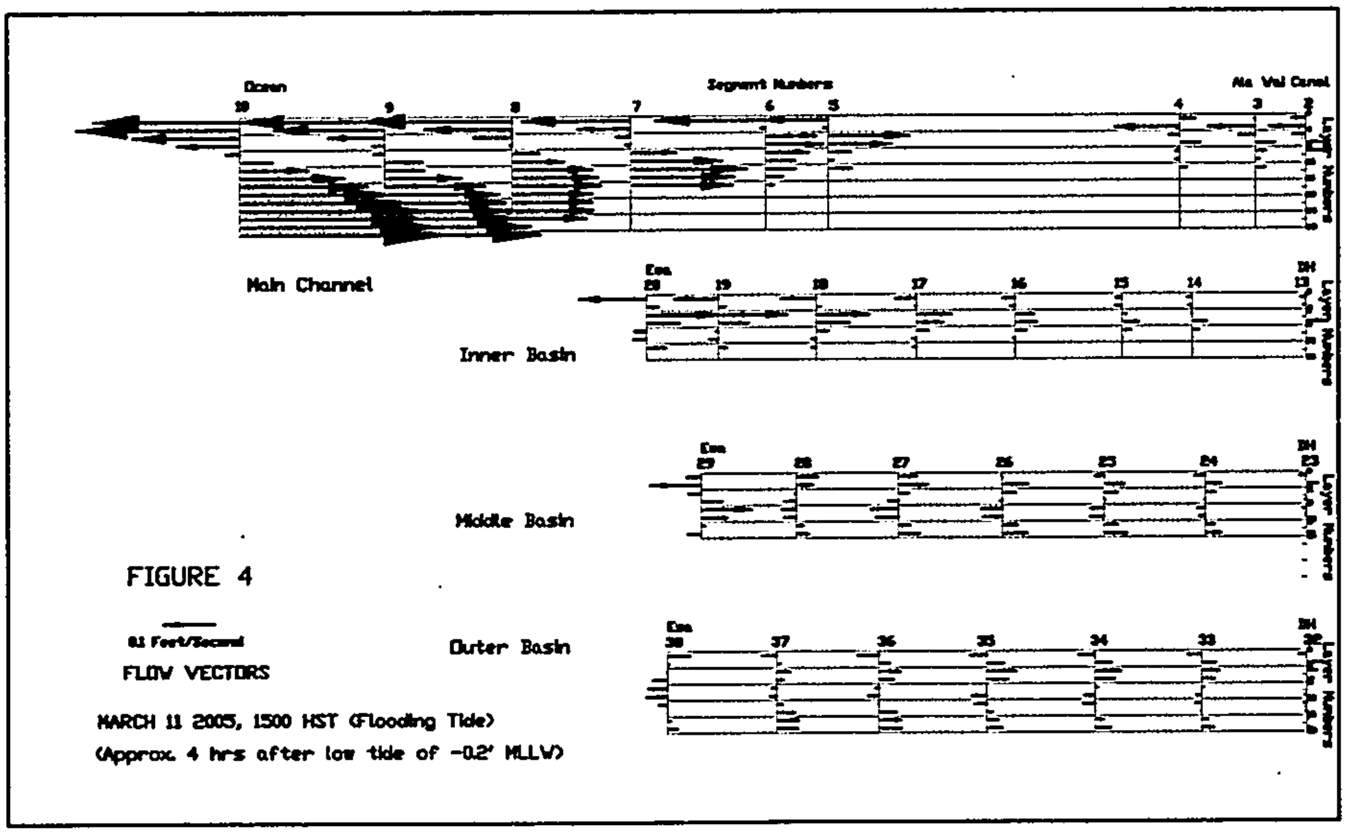
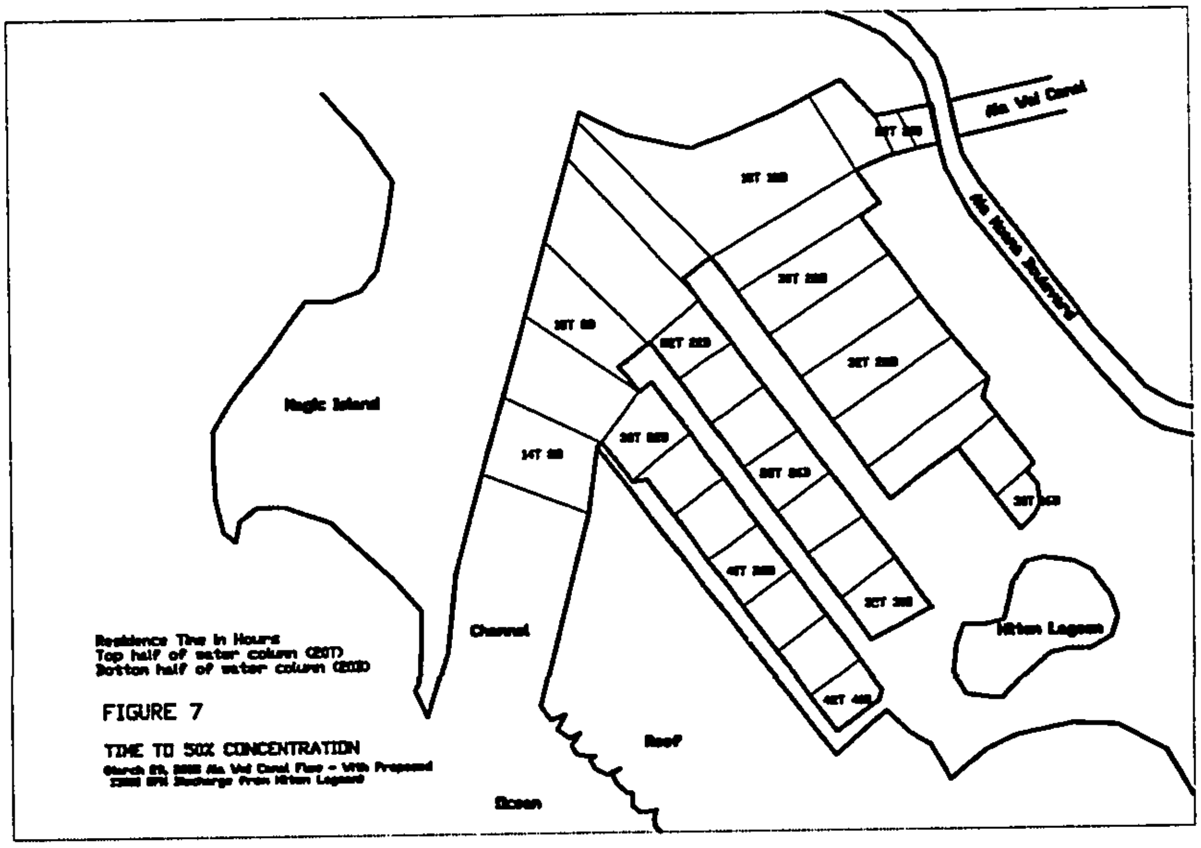


FIGURE 4

FLOW VECTORS

MARCH 11 2005, 1500 HST (Flooding Tide)

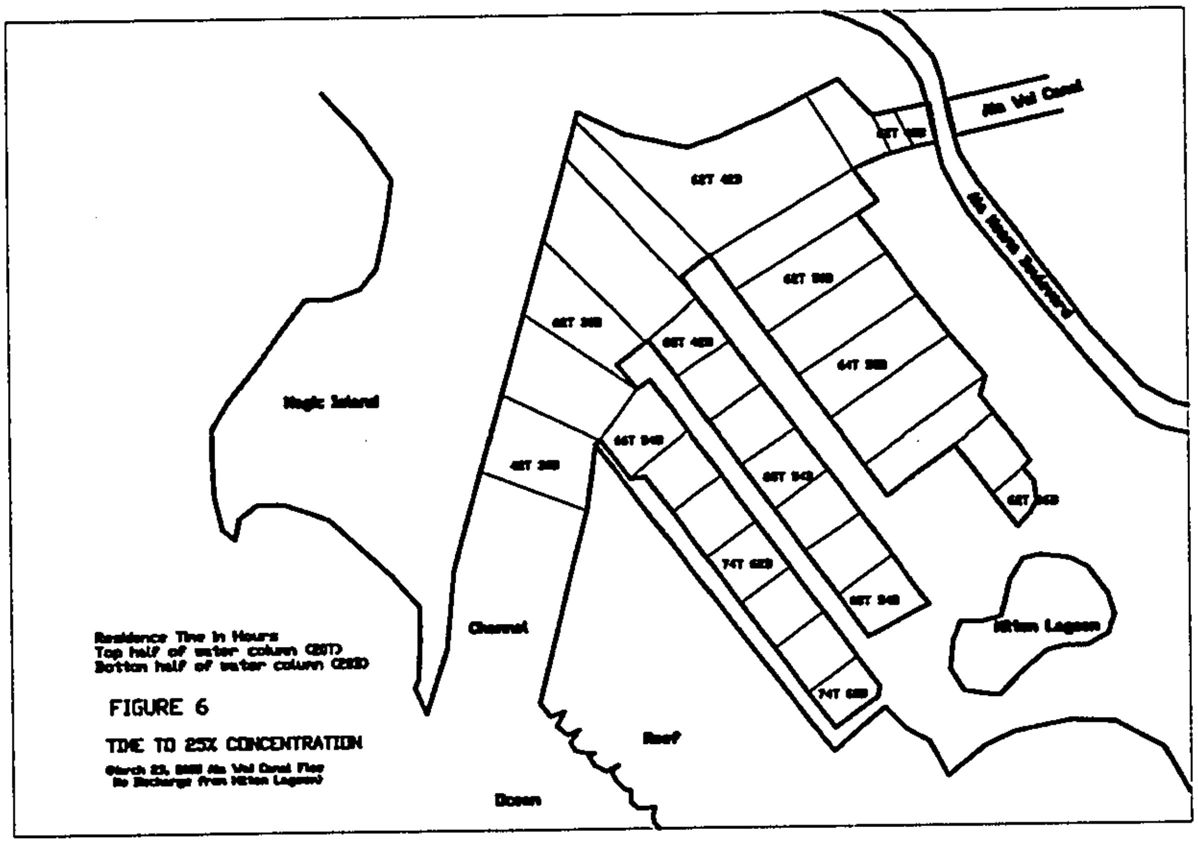
(Approx. 4 hrs after low tide of -0.2' MLLW)



Residence Time in Hours
Top half of water column (20T)
Bottom half of water column (20B)

FIGURE 7

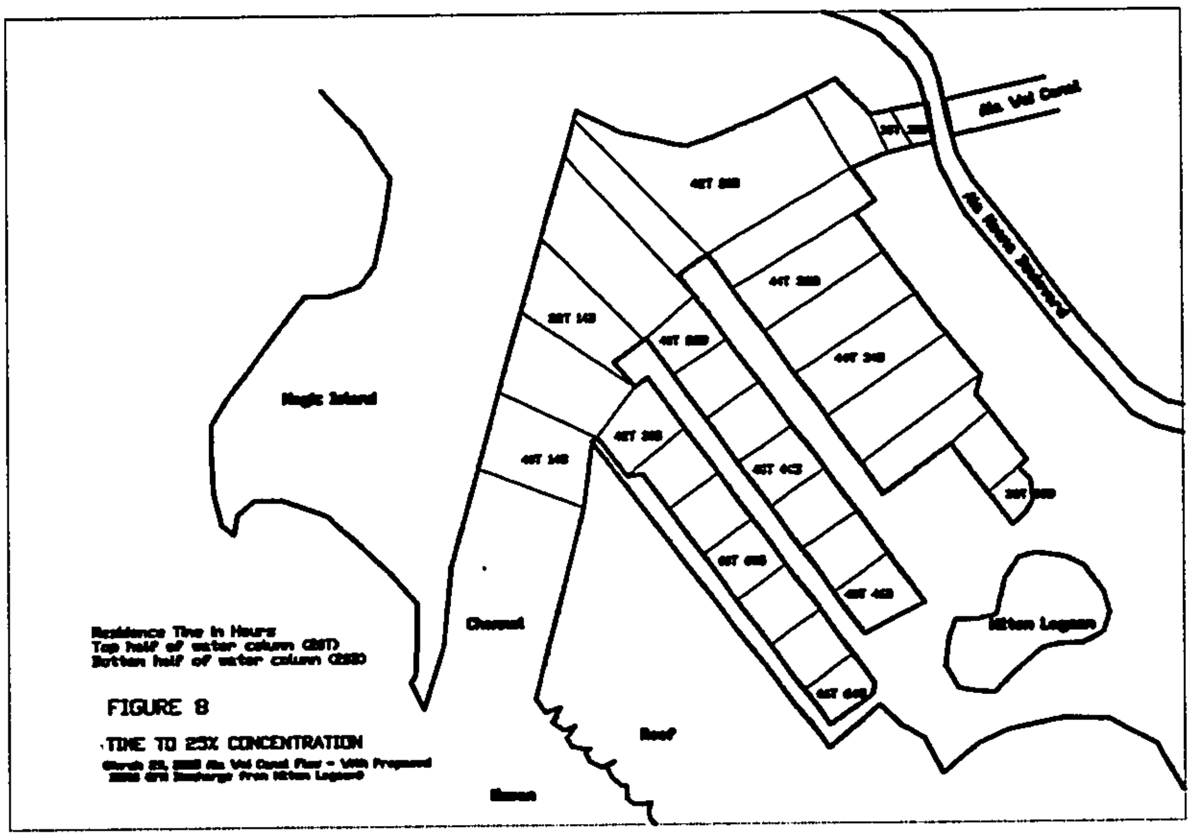
TIME TO 50% CONCENTRATION



Residence Time in Hours
Top half of water column (20T)
Bottom half of water column (20B)

FIGURE 6

TIME TO 25% CONCENTRATION



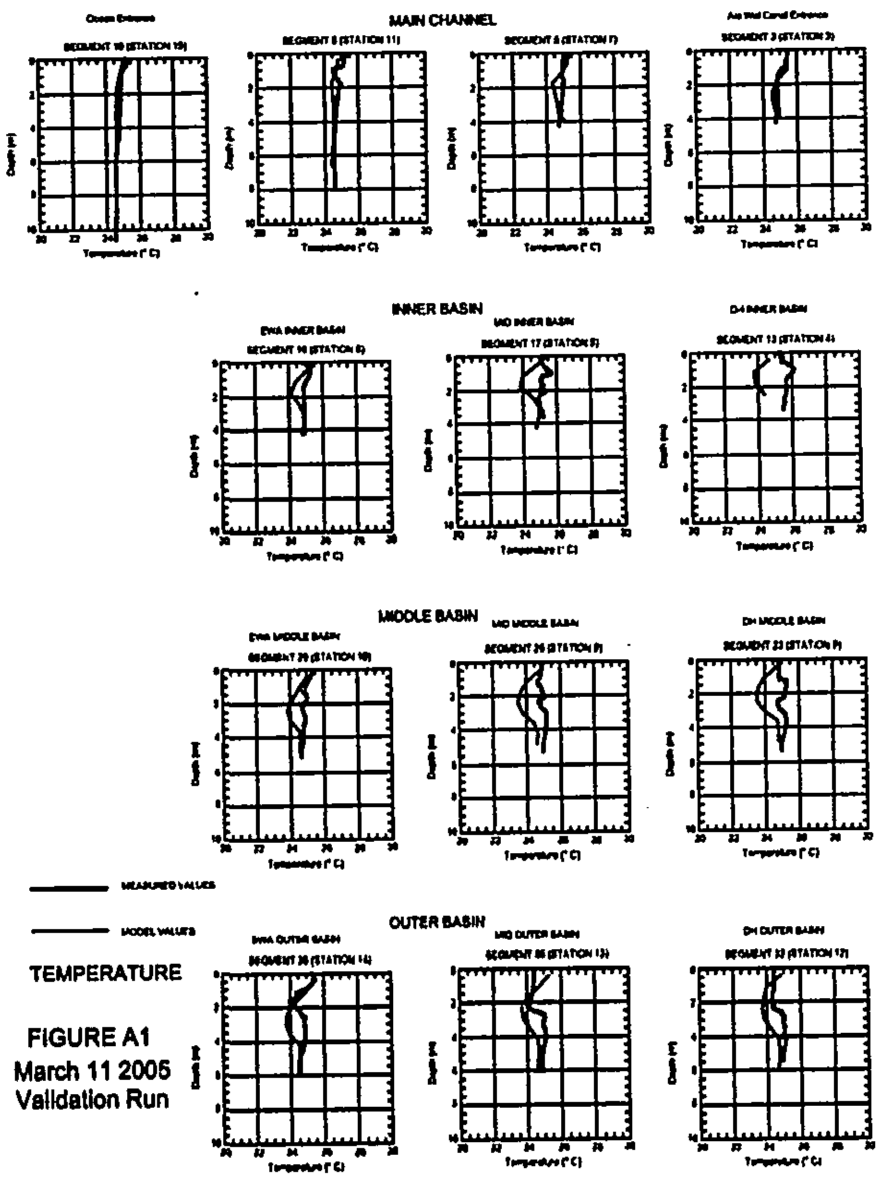
Residence Time in Hours
Top half of water column (XXT)
Bottom half of water column (XXB)

FIGURE 8

TIME TO 25% CONCENTRATION

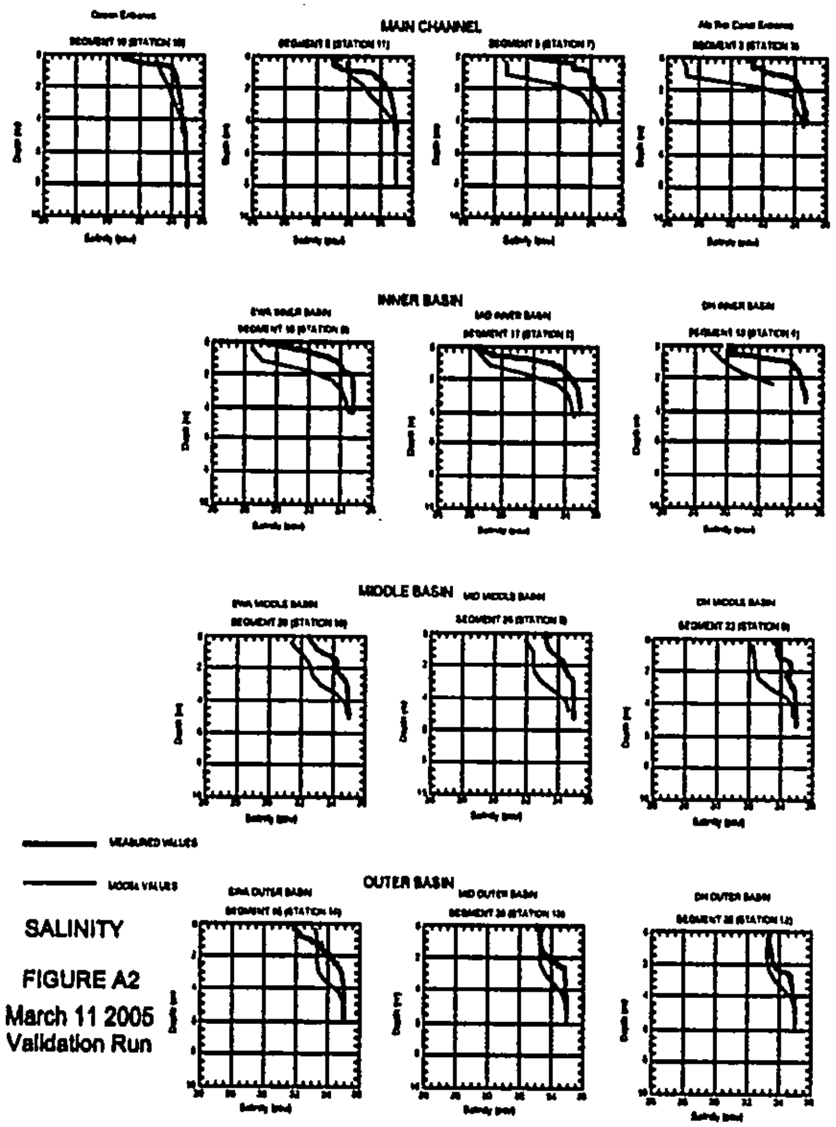
APPENDIX A

Model Validation Plots



TEMPERATURE

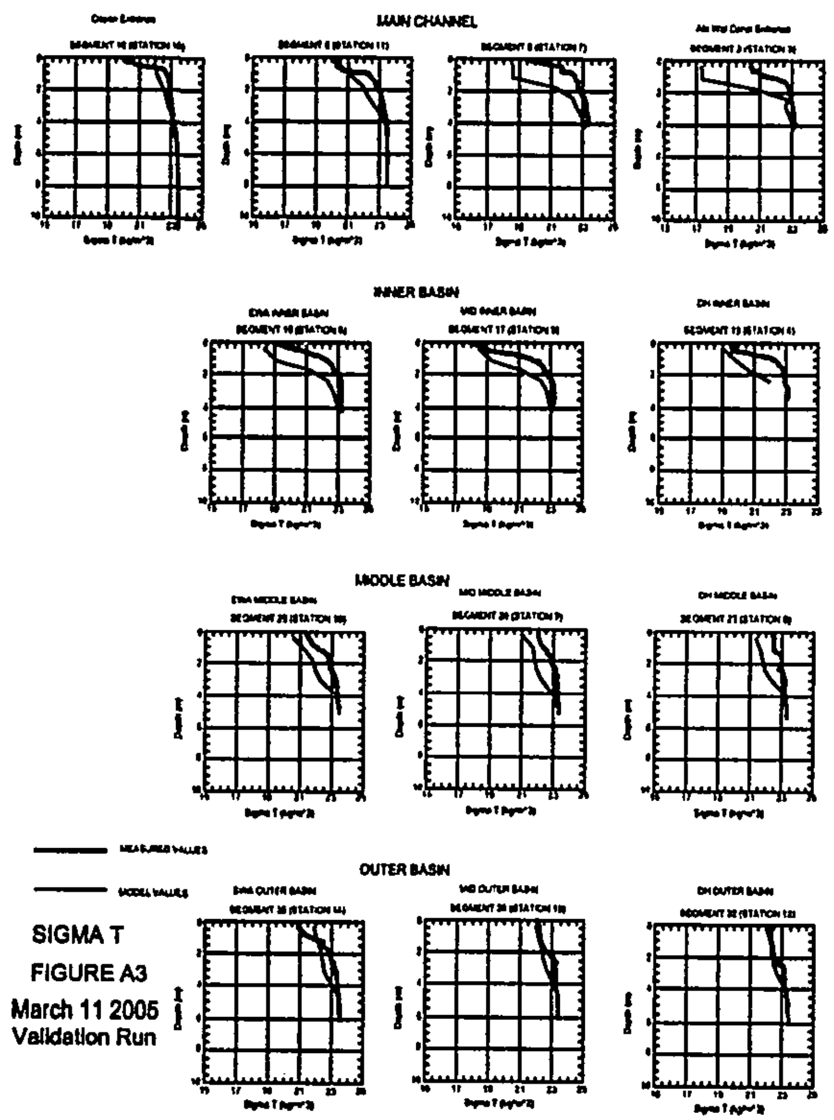
FIGURE A1
March 11 2005
Validation Run



SALINITY

FIGURE A2

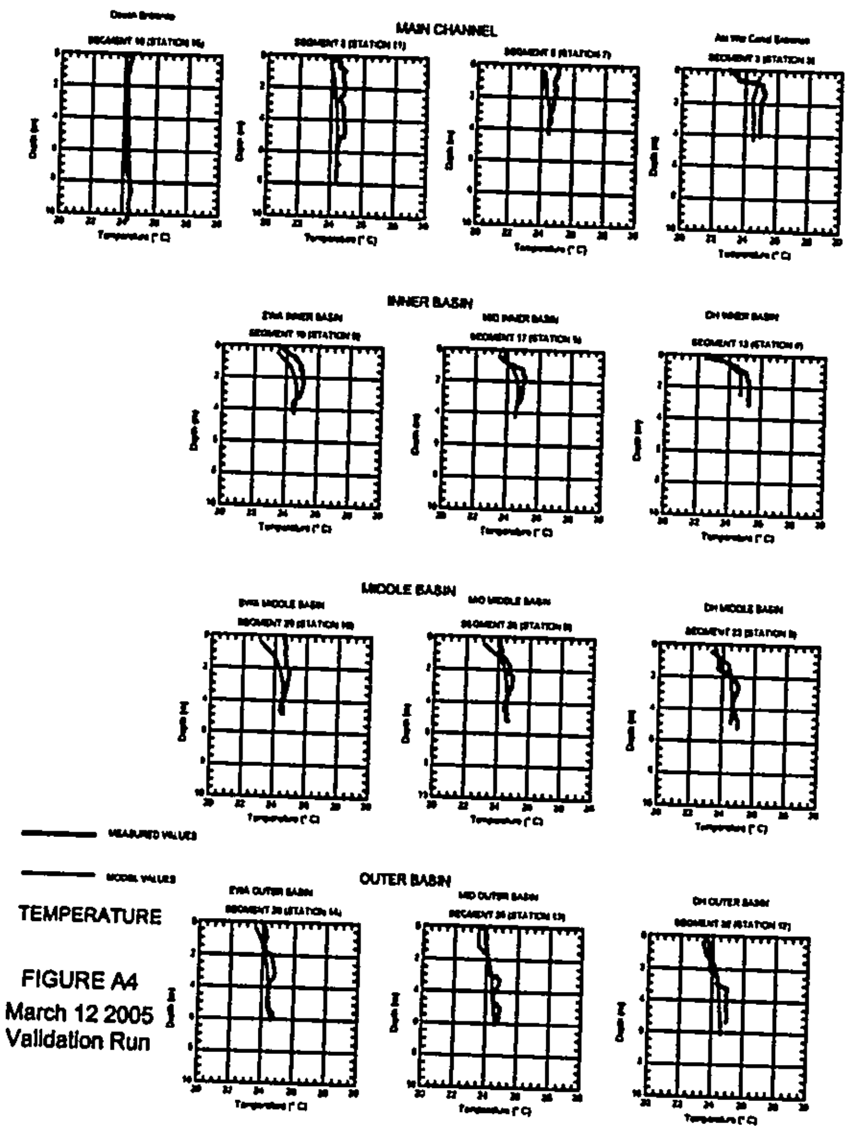
March 11 2005
Validation Run



SIGMA T

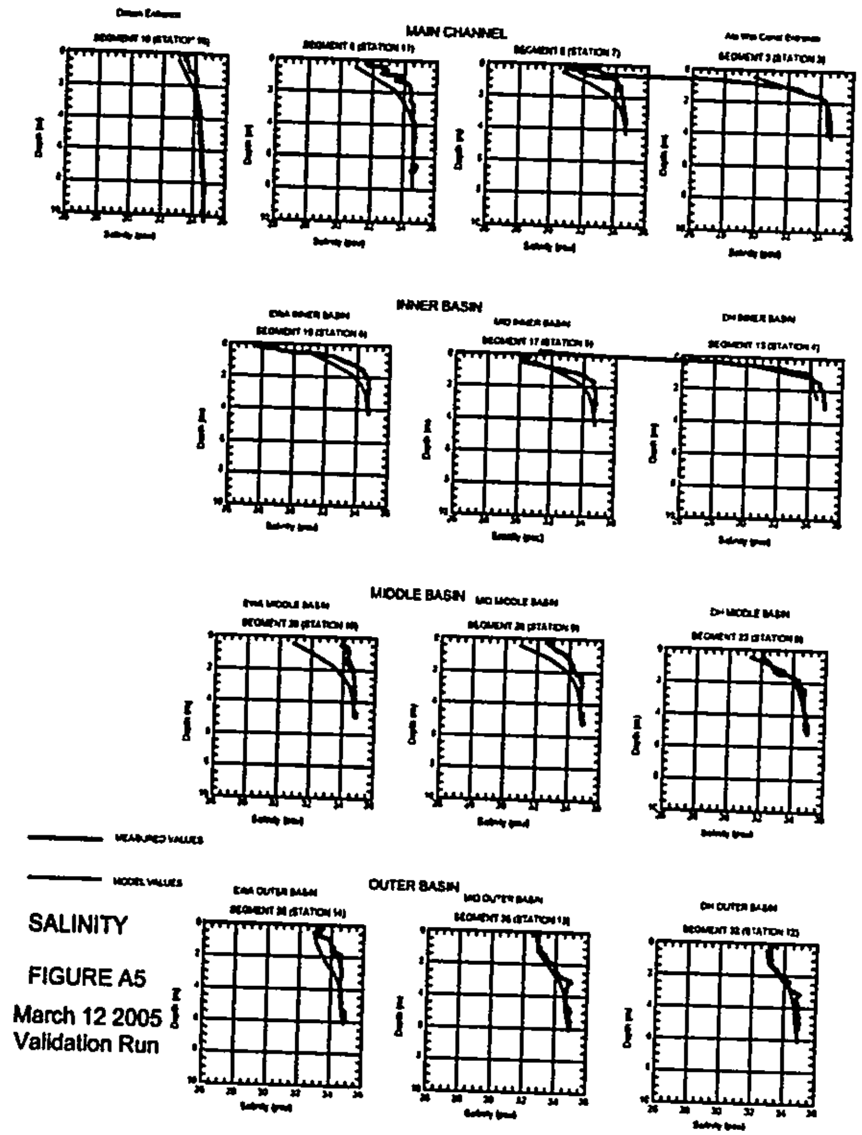
FIGURE A3

March 11 2005
Validation Run



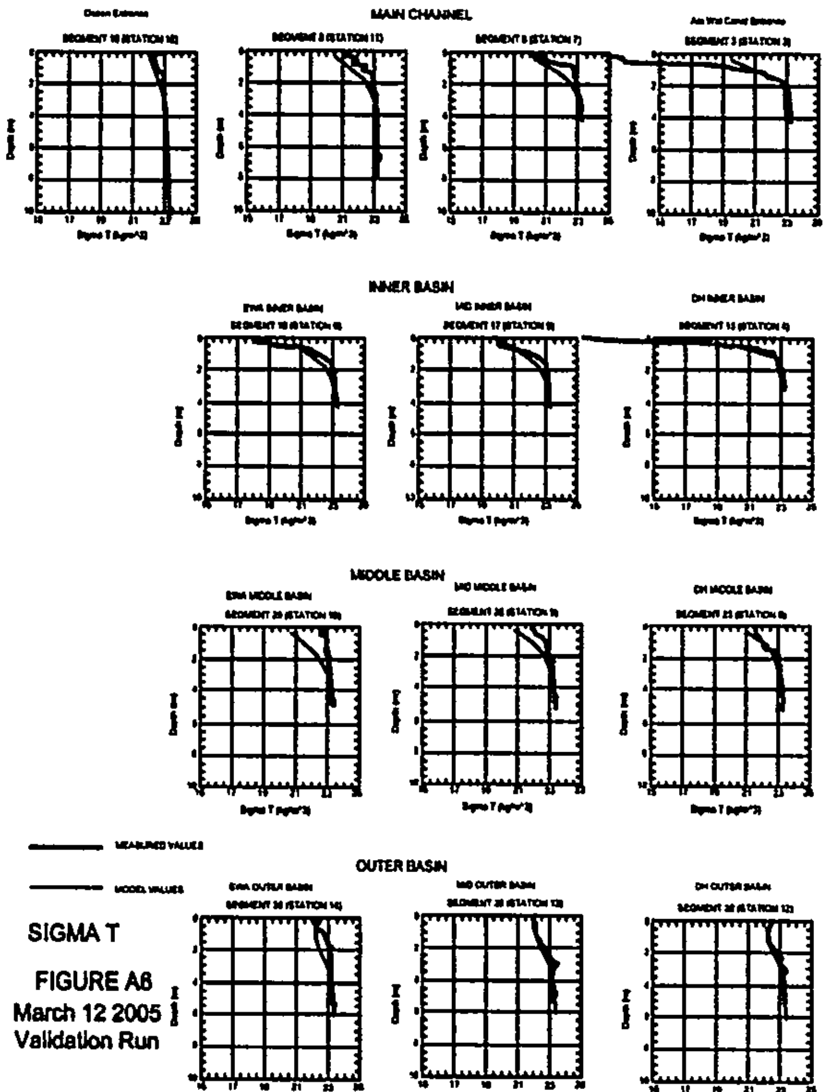
TEMPERATURE

FIGURE A4
March 12 2005
Validation Run



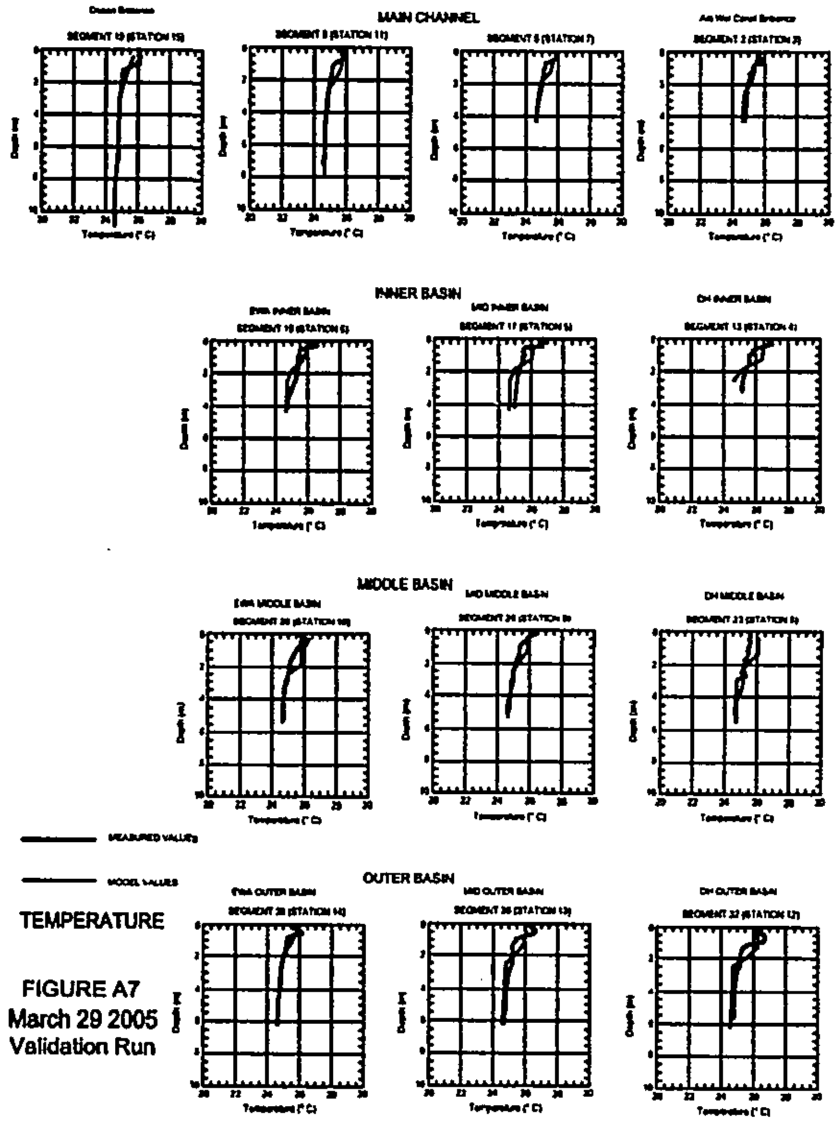
SALINITY

FIGURE A5
March 12 2005
Validation Run



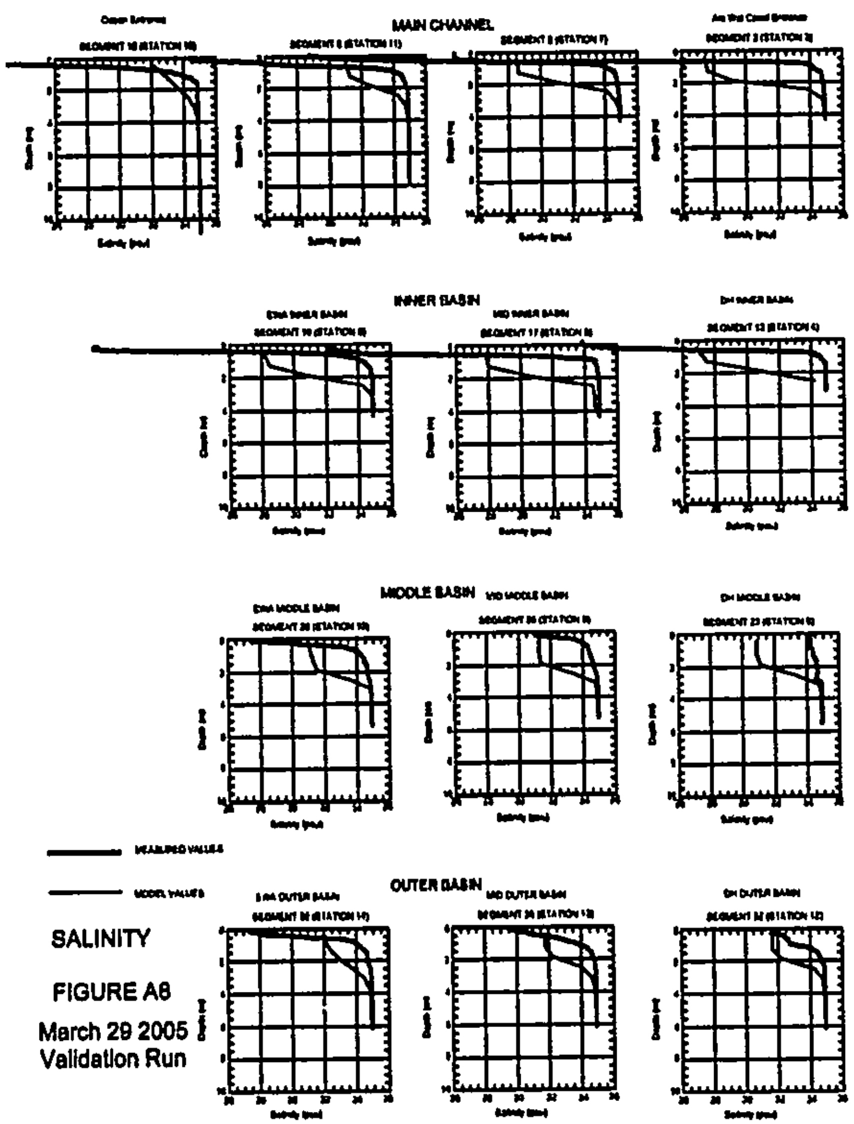
SIGMA T

FIGURE A8
March 12 2005
Validation Run



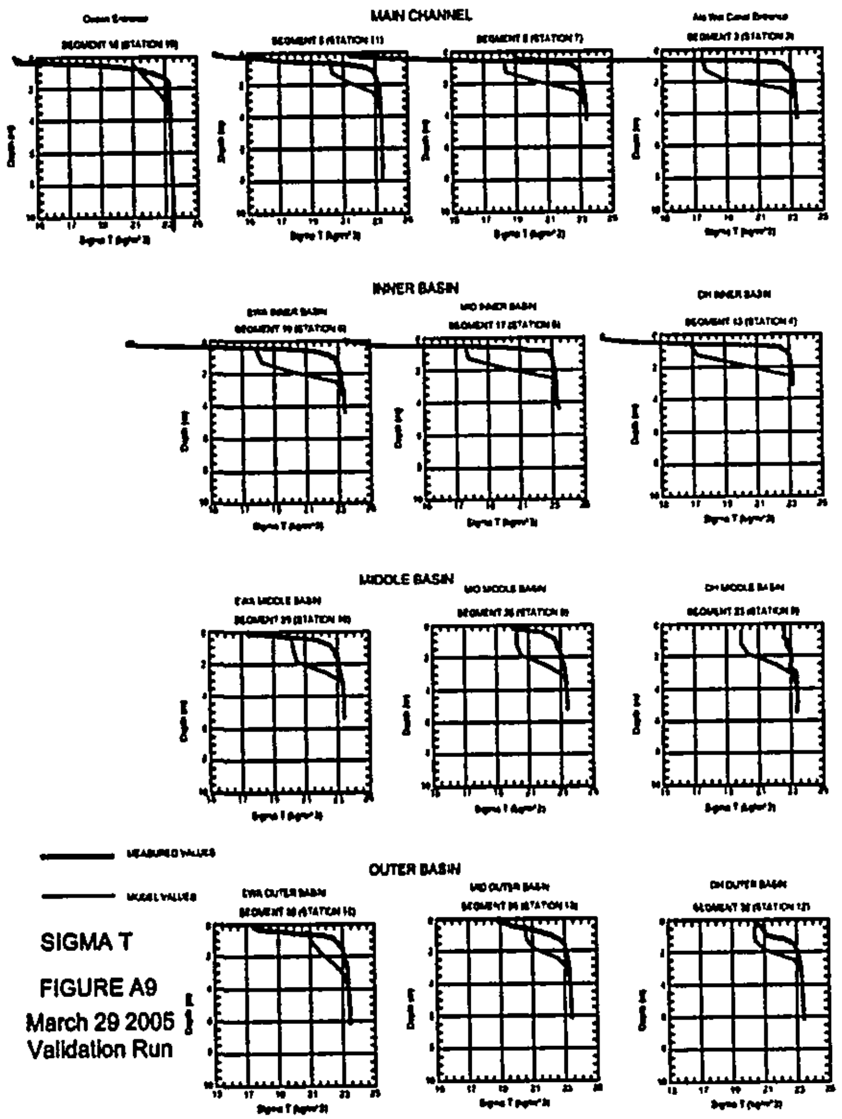
TEMPERATURE

FIGURE A7
March 29 2005
Validation Run



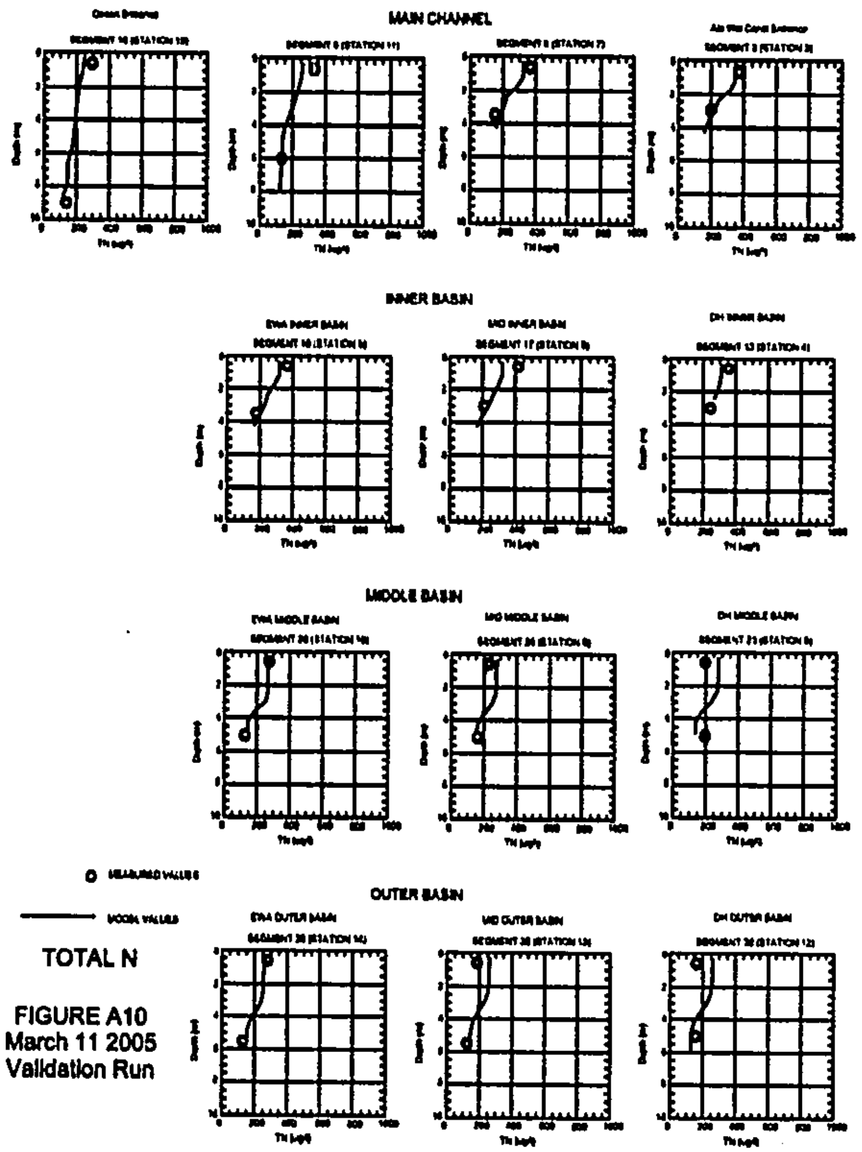
SALINITY

FIGURE A8
March 29 2005
Validation Run



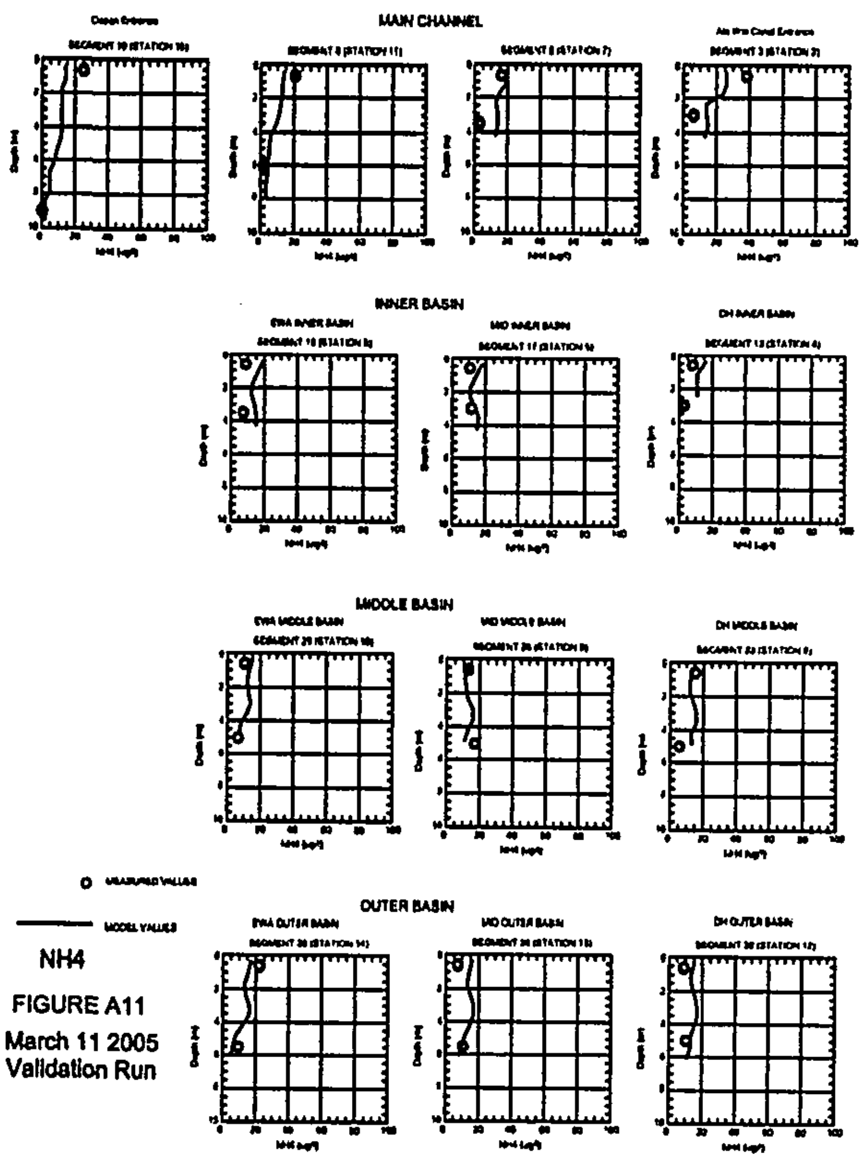
SIGMA T

FIGURE A9
March 29 2005
Validation Run



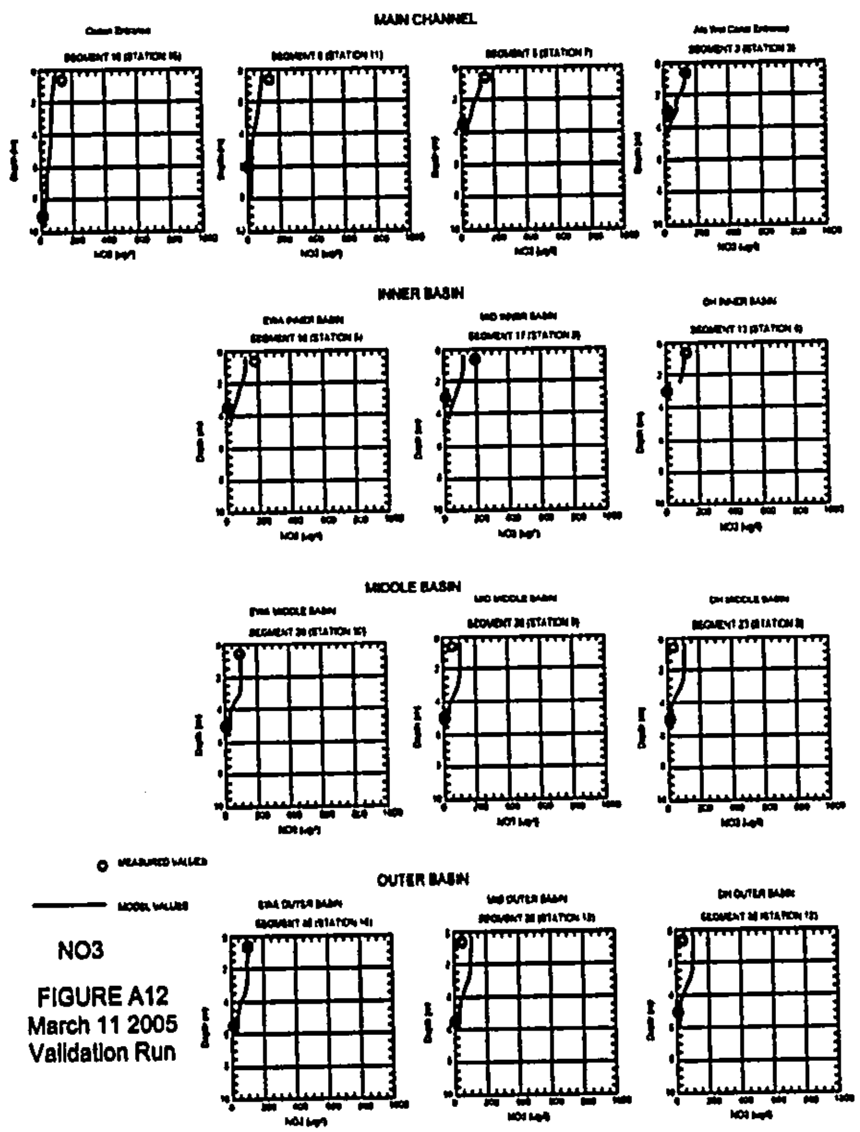
TOTAL N

FIGURE A10
March 11 2005
Validation Run



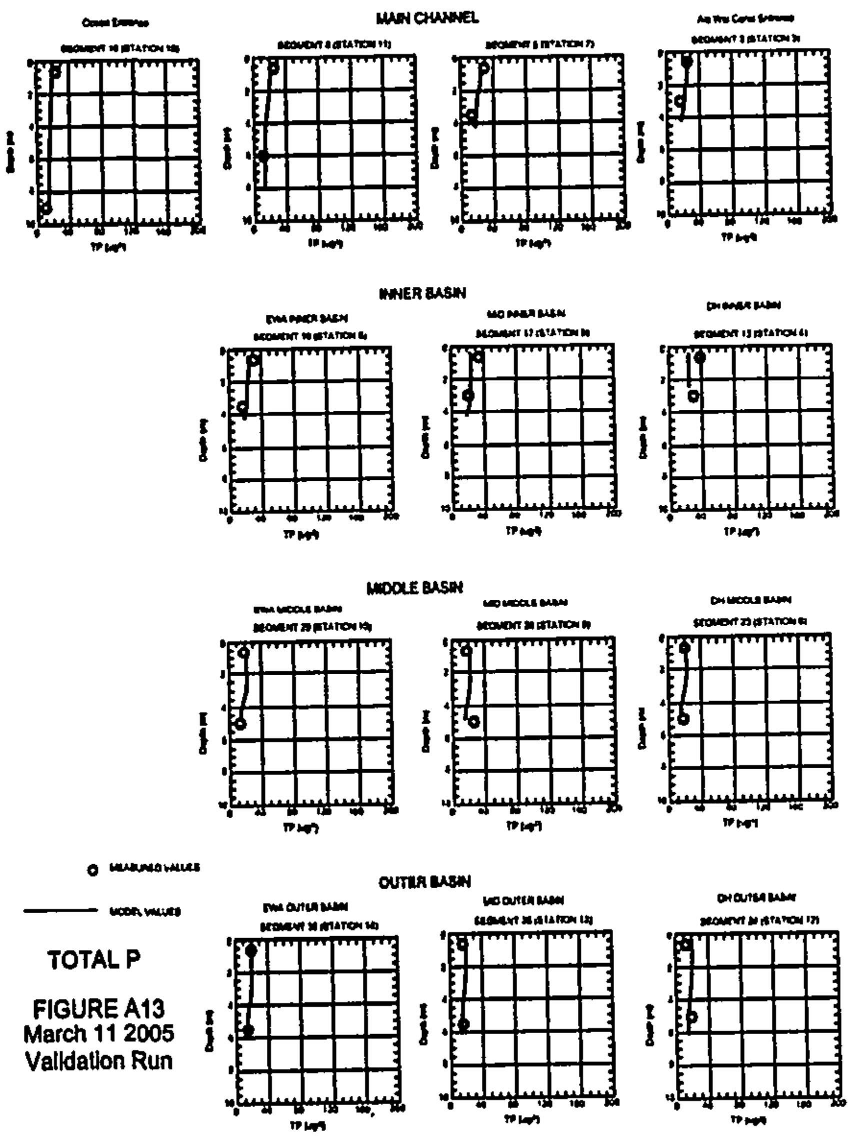
NH4

FIGURE A11
March 11 2005
Validation Run



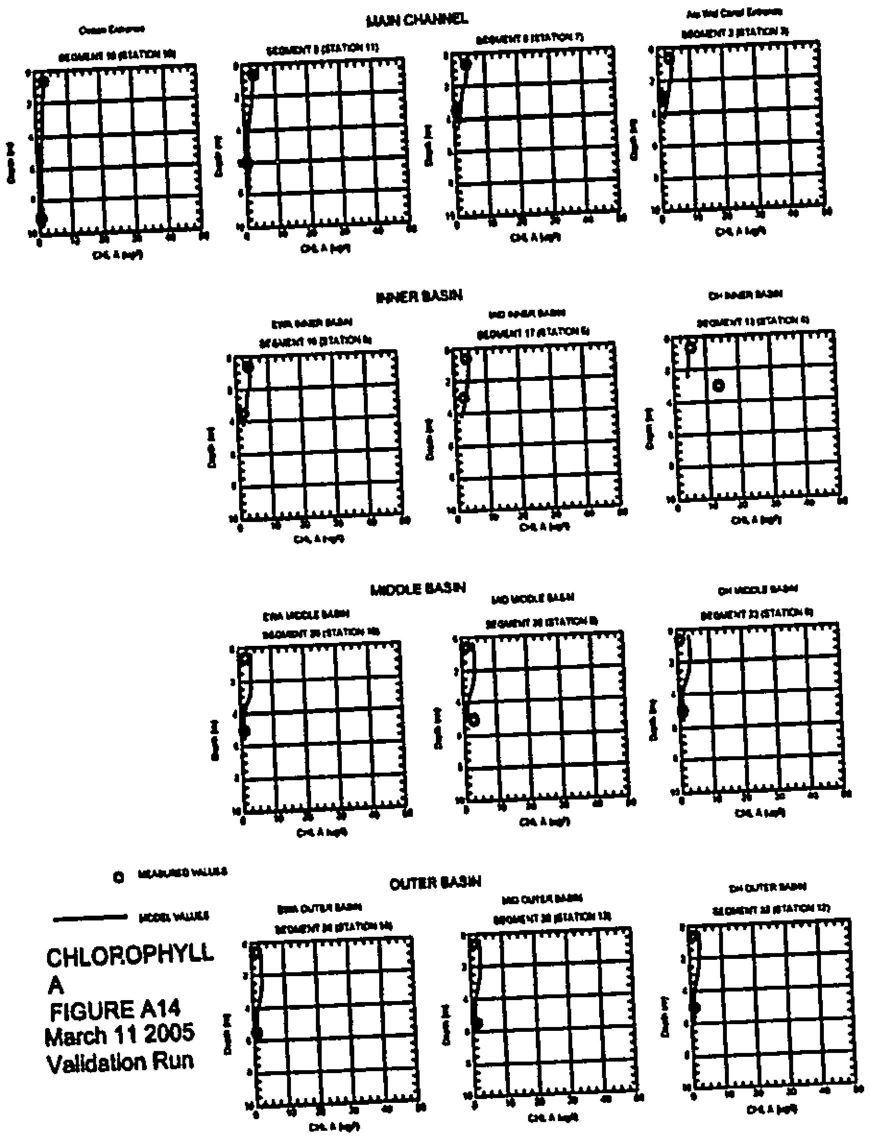
NO3

FIGURE A12
March 11 2005
Validation Run

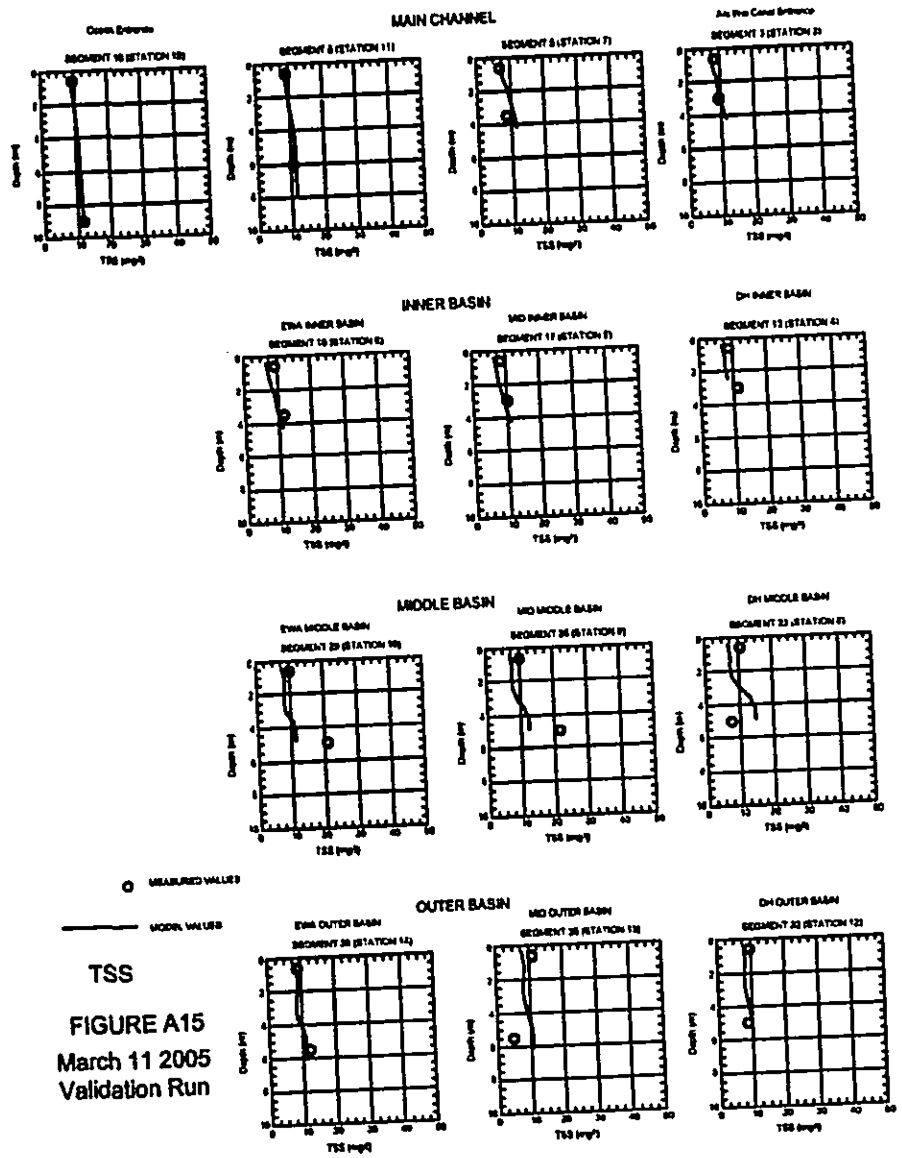


TOTAL P

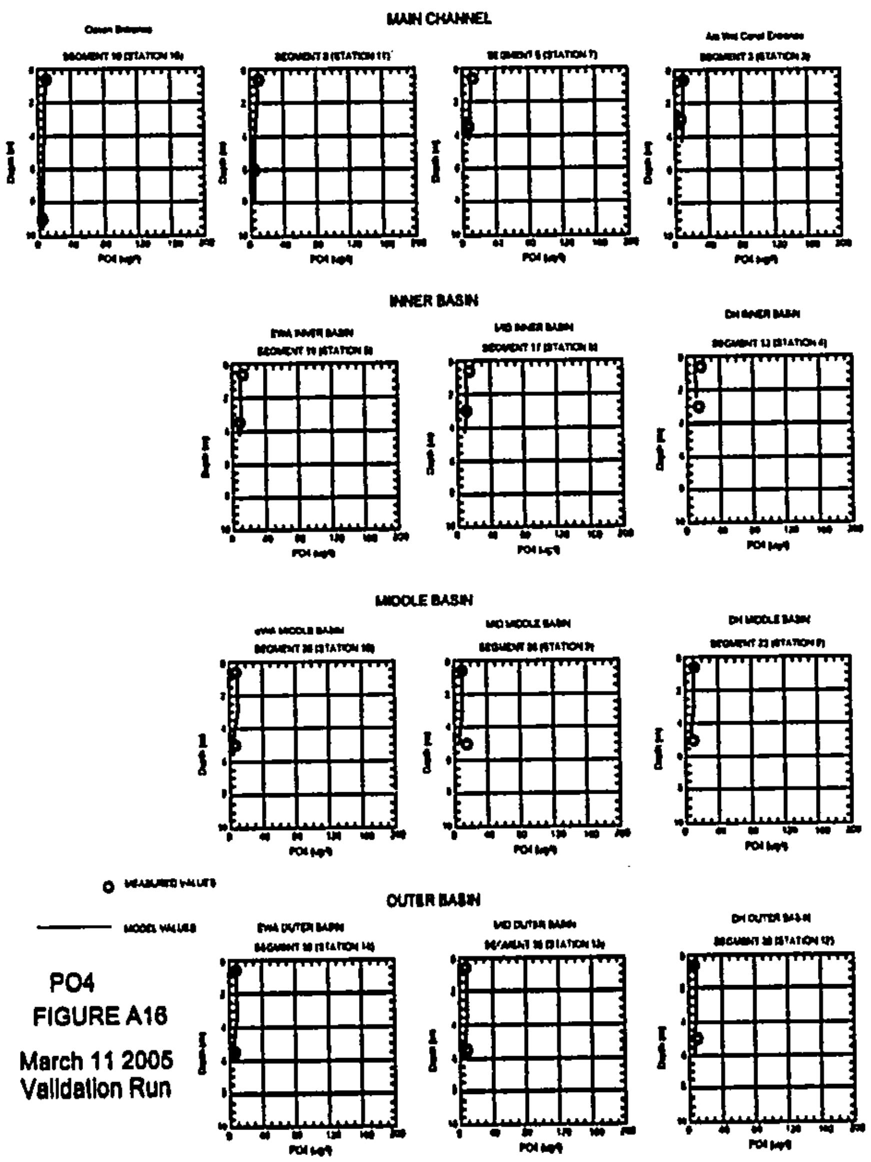
FIGURE A13
March 11 2005
Validation Run



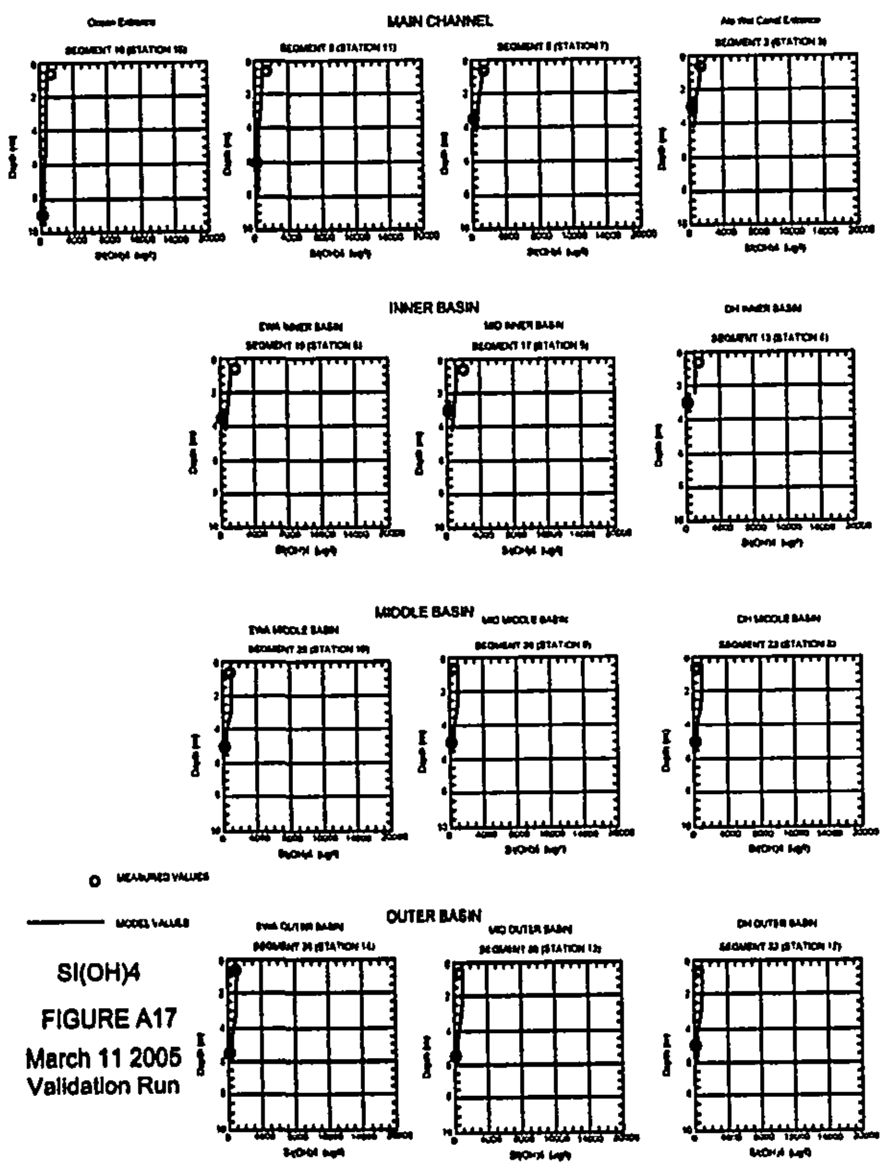
CHLOROPHYLL A
FIGURE A14
March 11 2005
Validation Run



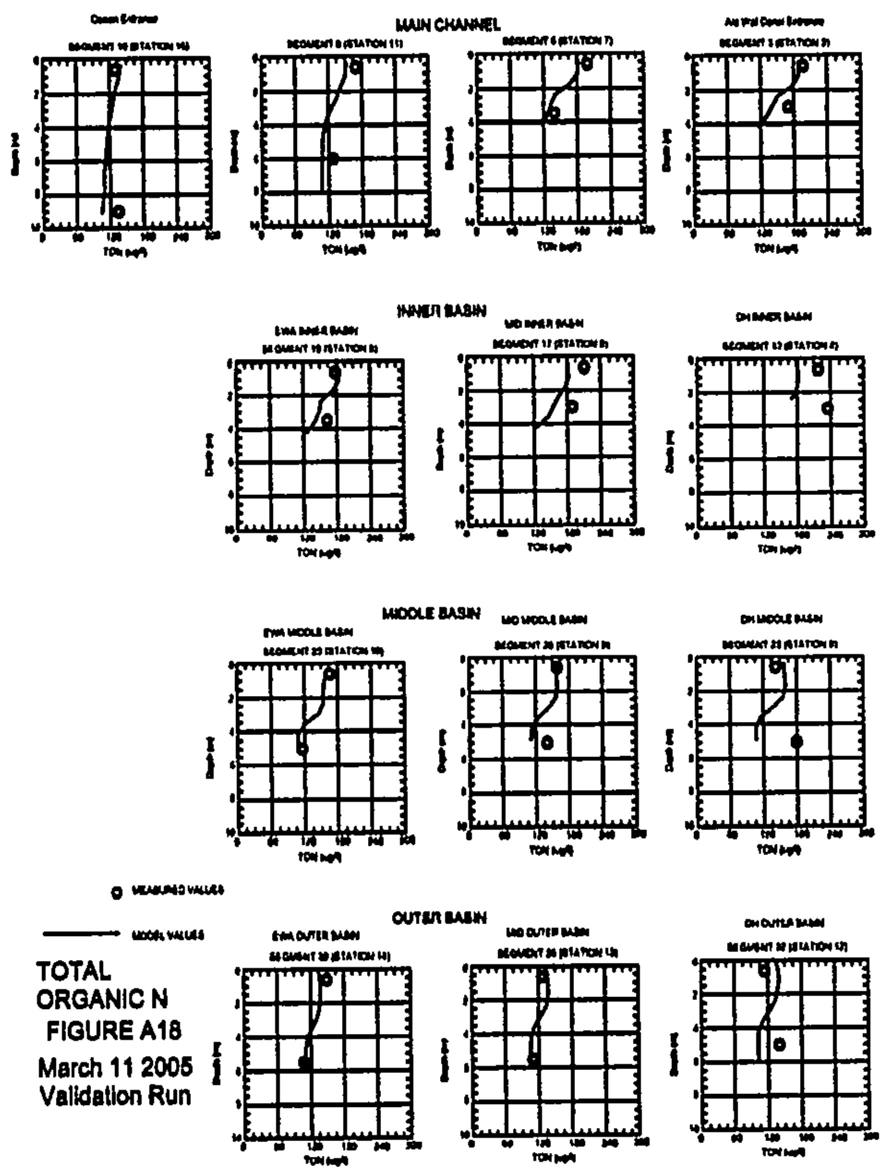
TSS
FIGURE A15
March 11 2005
Validation Run



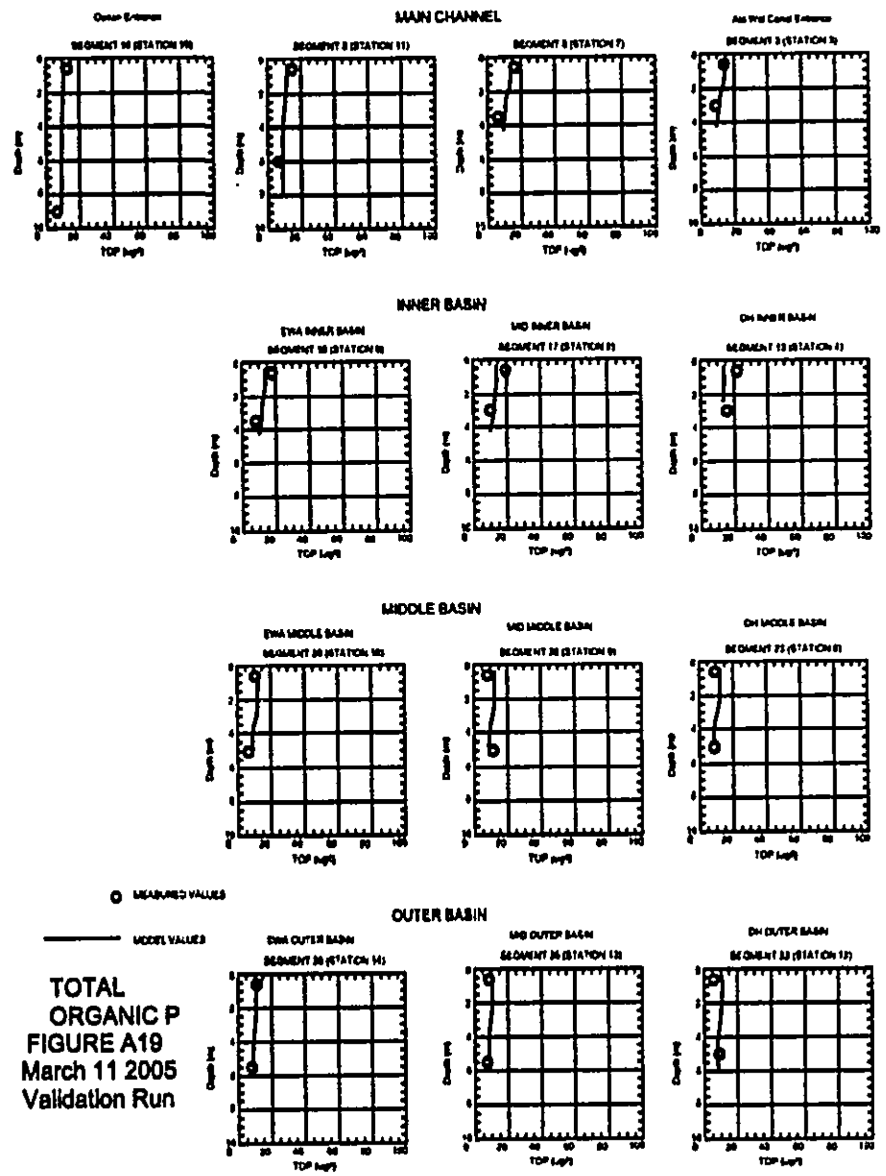
PO4
FIGURE A16
March 11 2005
Validation Run



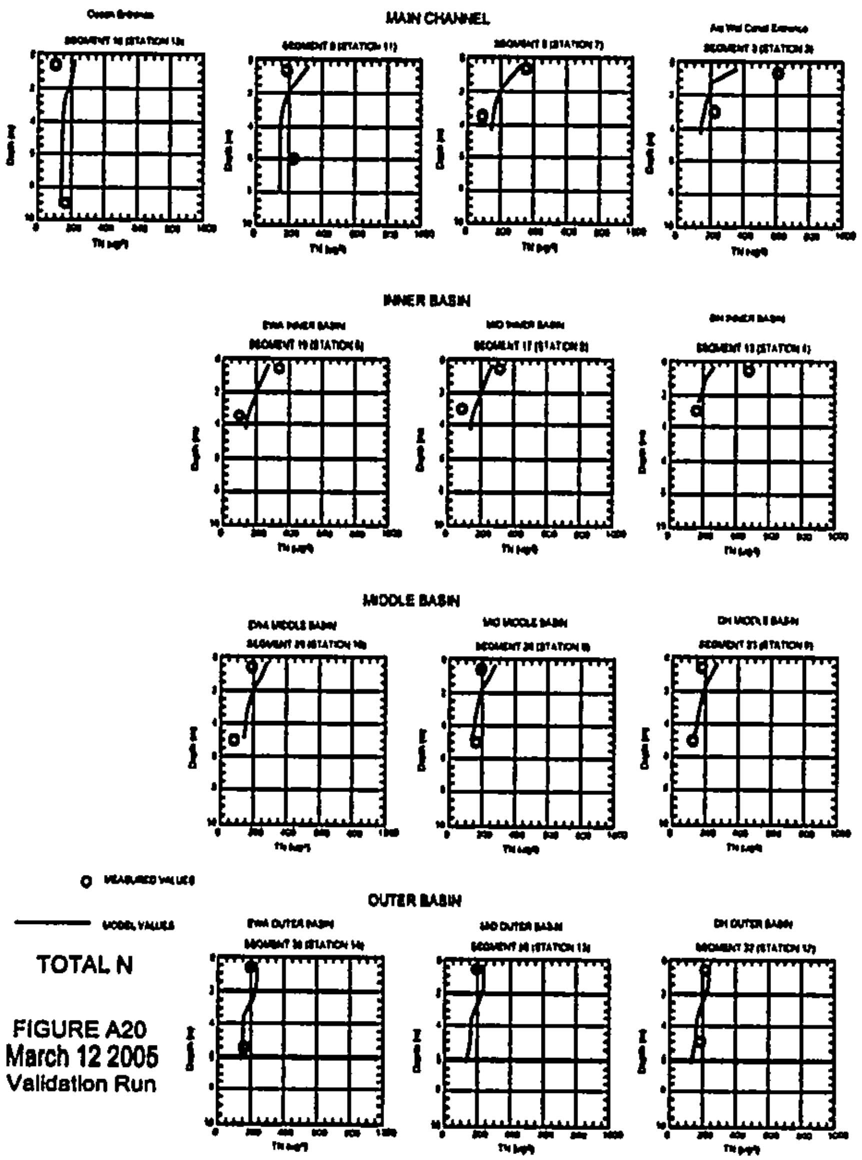
SI(OH)4
FIGURE A17
March 11 2005
Validation Run



TOTAL
ORGANIC N
FIGURE A18
March 11 2005
Validation Run

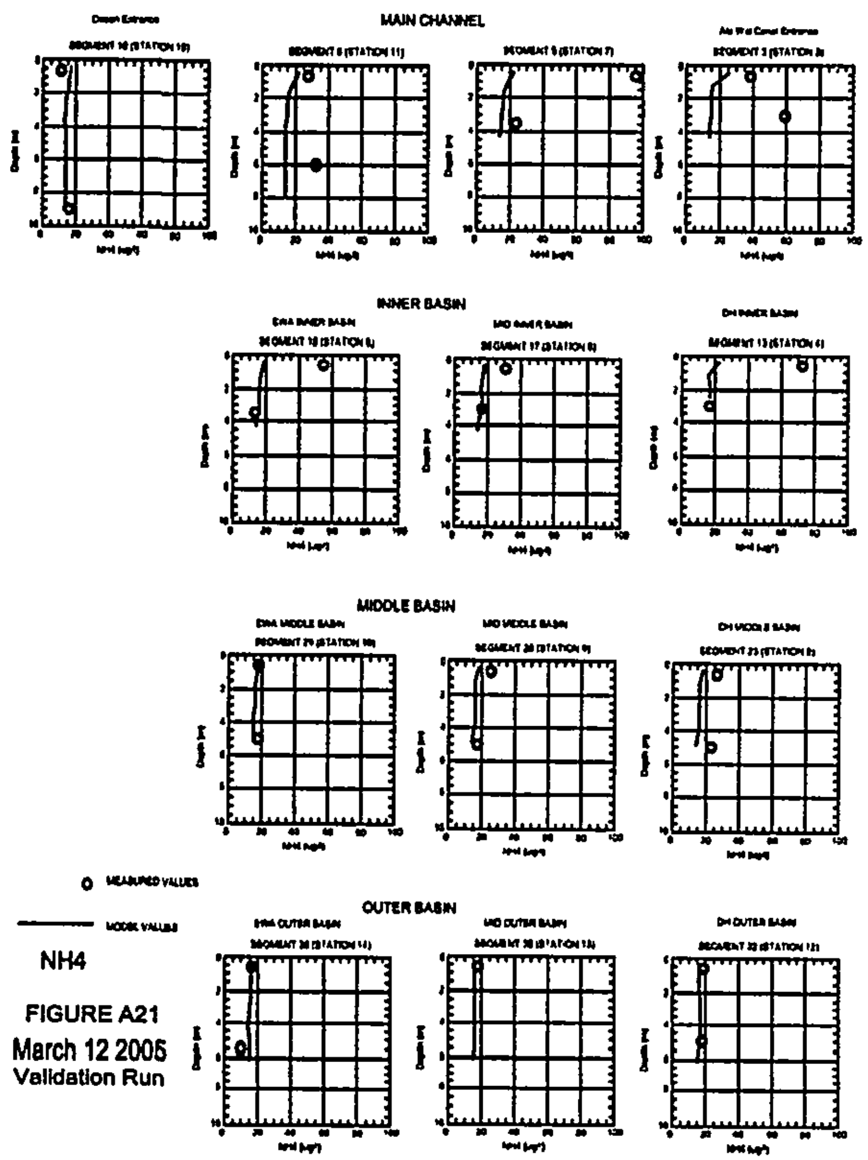


TOTAL
ORGANIC P
FIGURE A19
March 11 2005
Validation Run



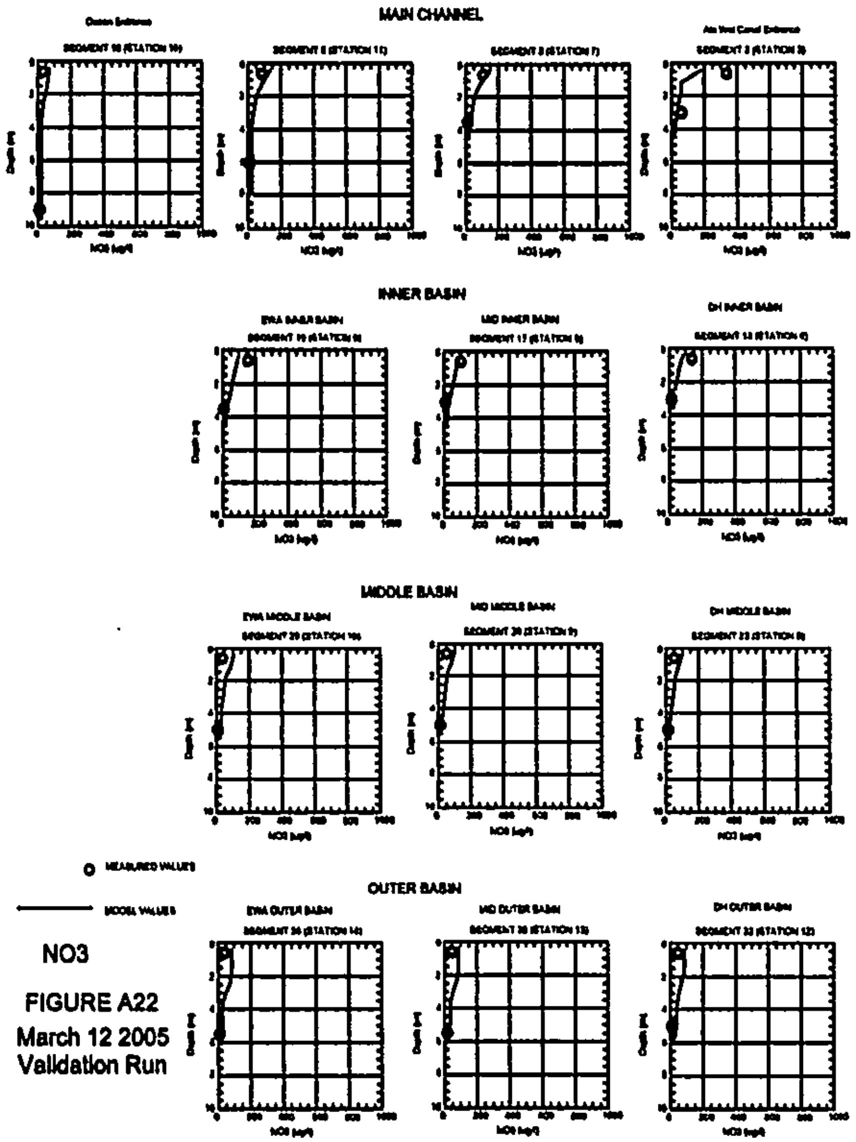
TOTAL N

FIGURE A20
March 12 2005
Validation Run



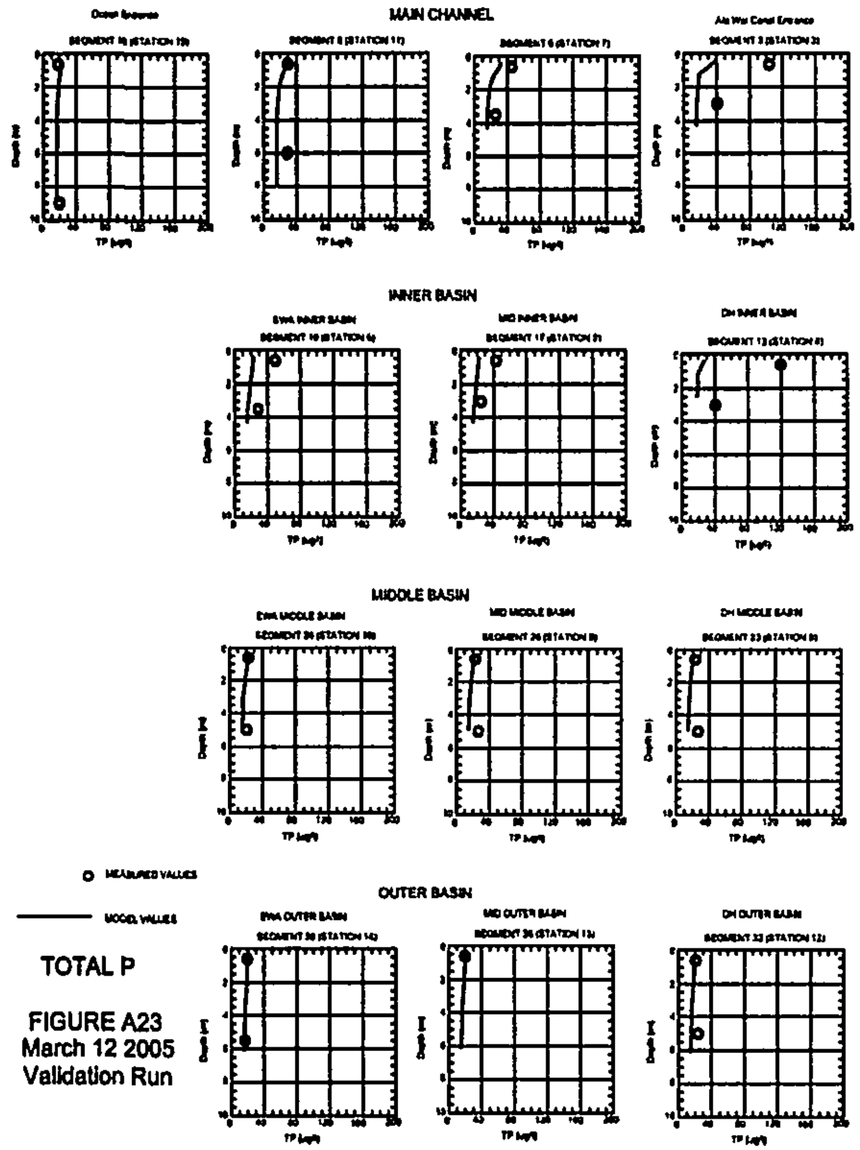
NH4

FIGURE A21
March 12 2005
Validation Run



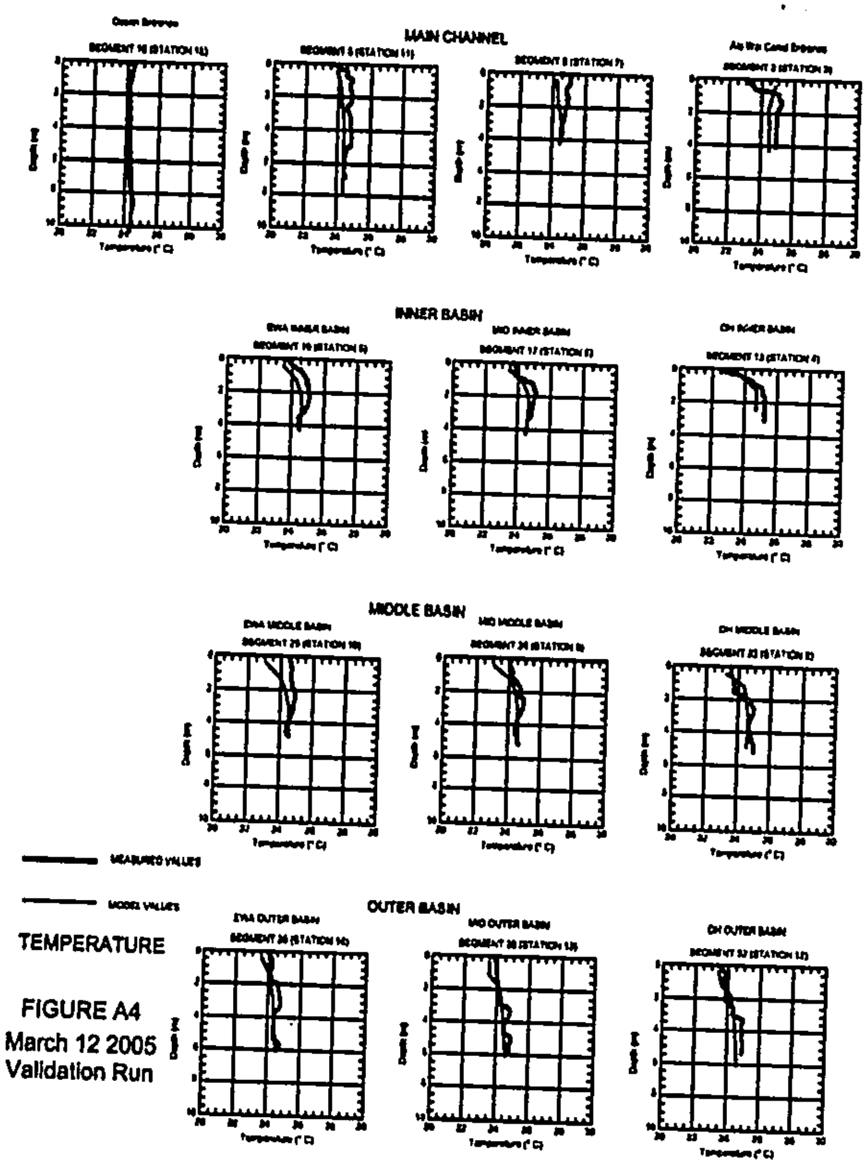
NO3

FIGURE A22
March 12 2005
Validation Run



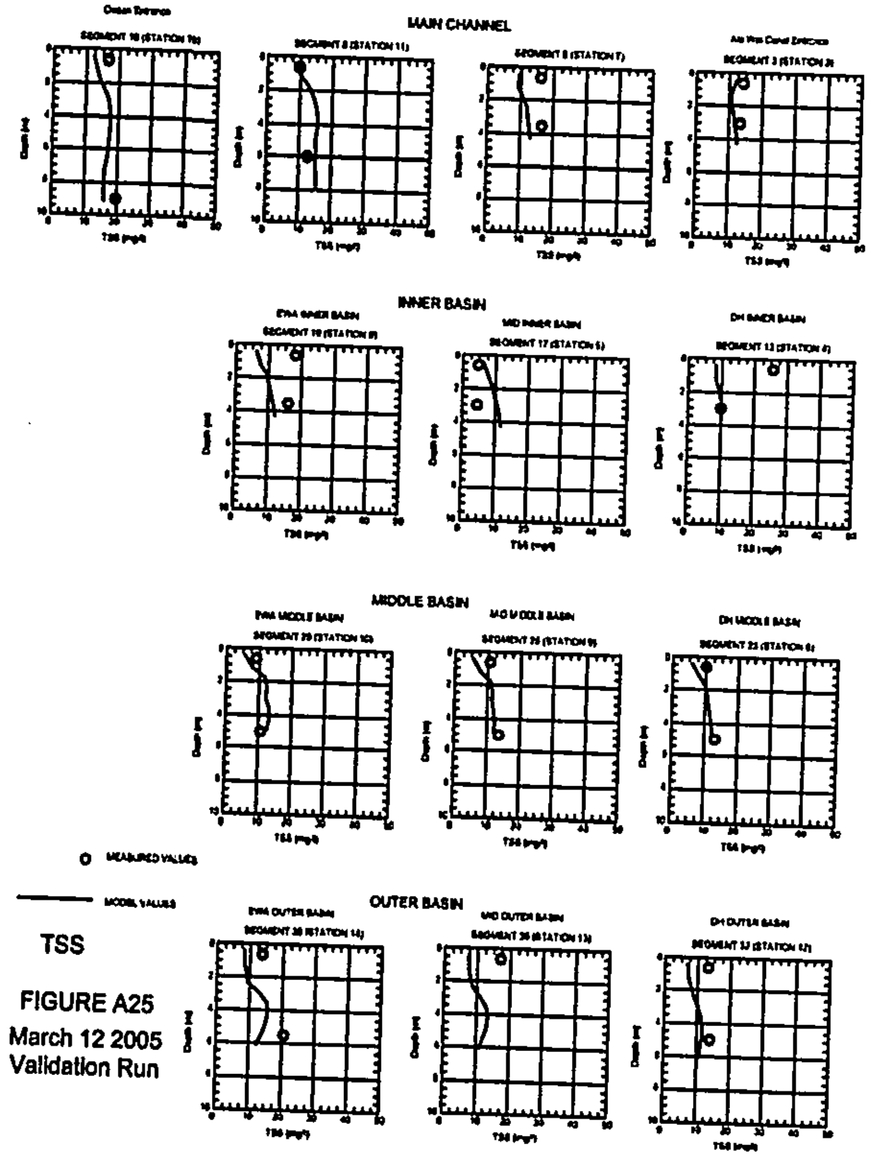
TOTAL P

FIGURE A23
March 12 2005
Validation Run



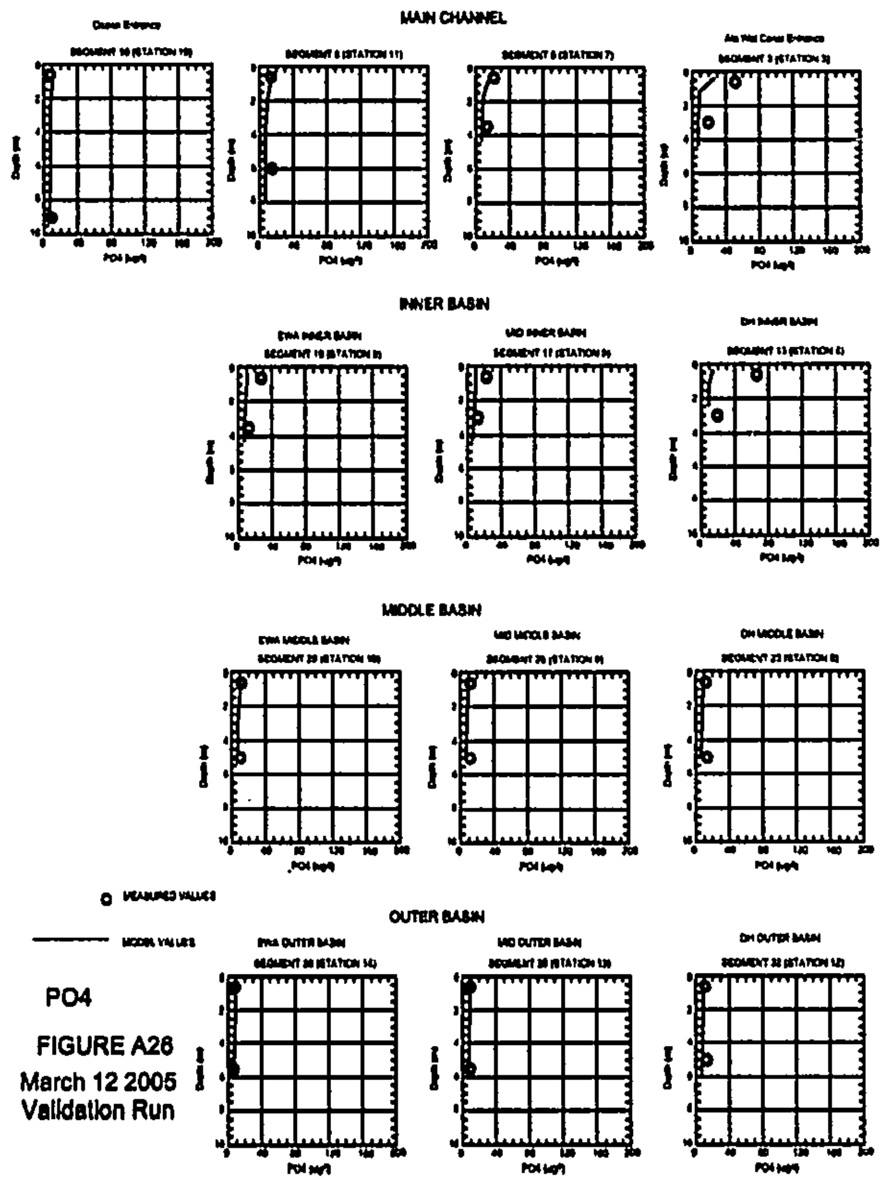
TEMPERATURE

FIGURE A4
March 12 2005
Validation Run



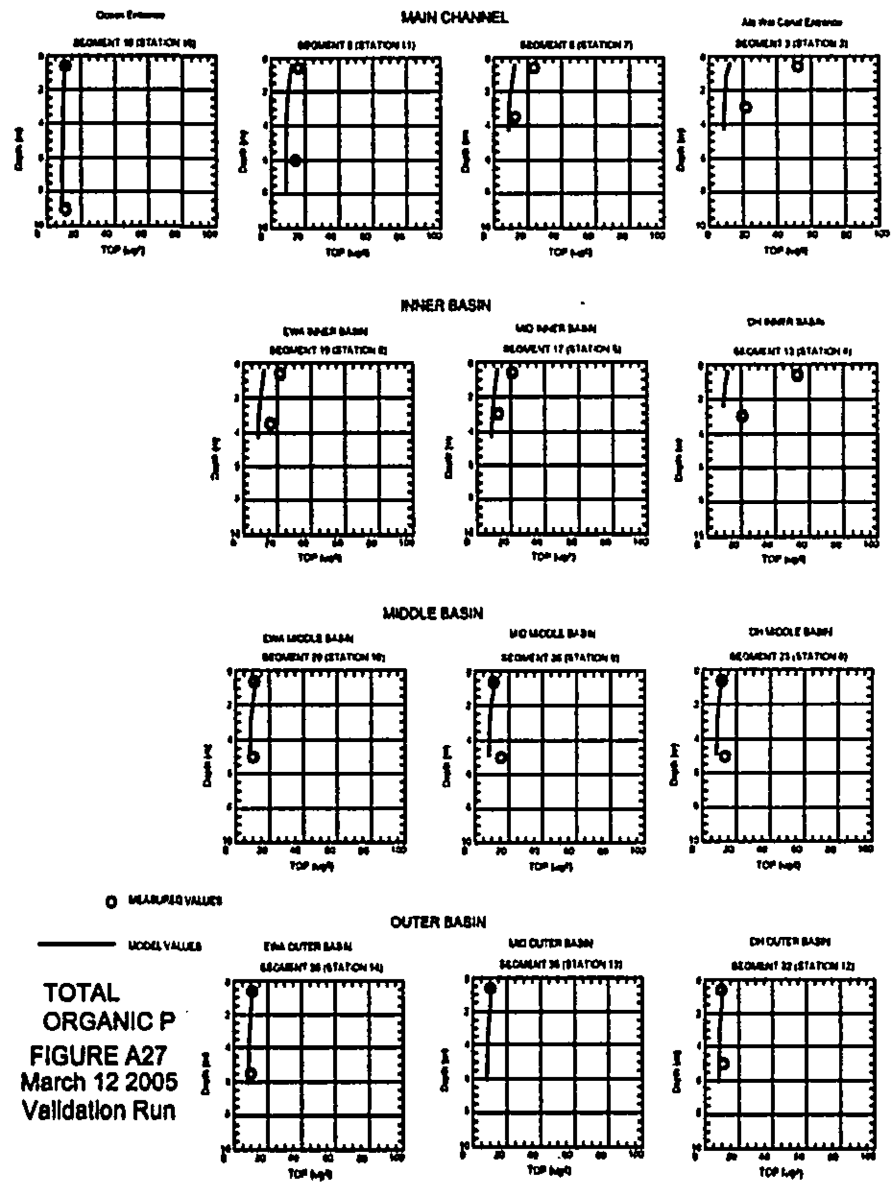
TSS

FIGURE A25
March 12 2005
Validation Run



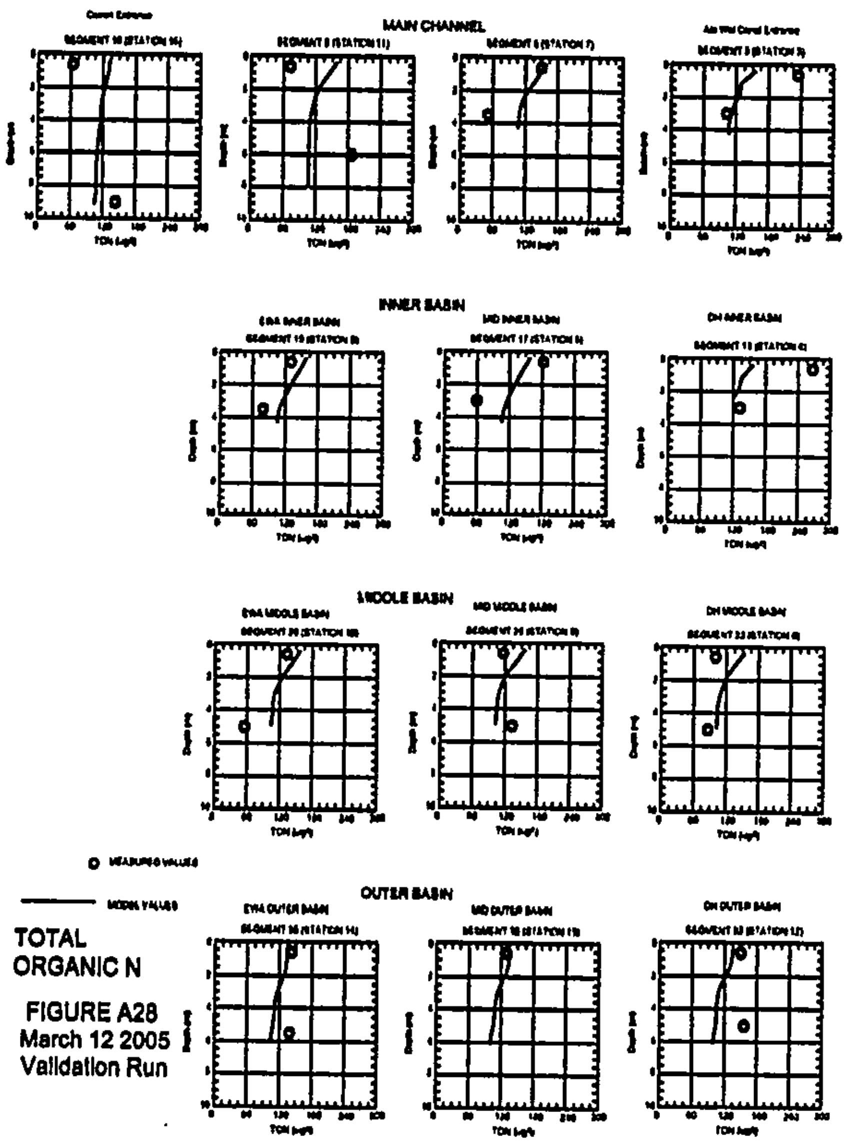
PO4

FIGURE A28
March 12 2005
Validation Run



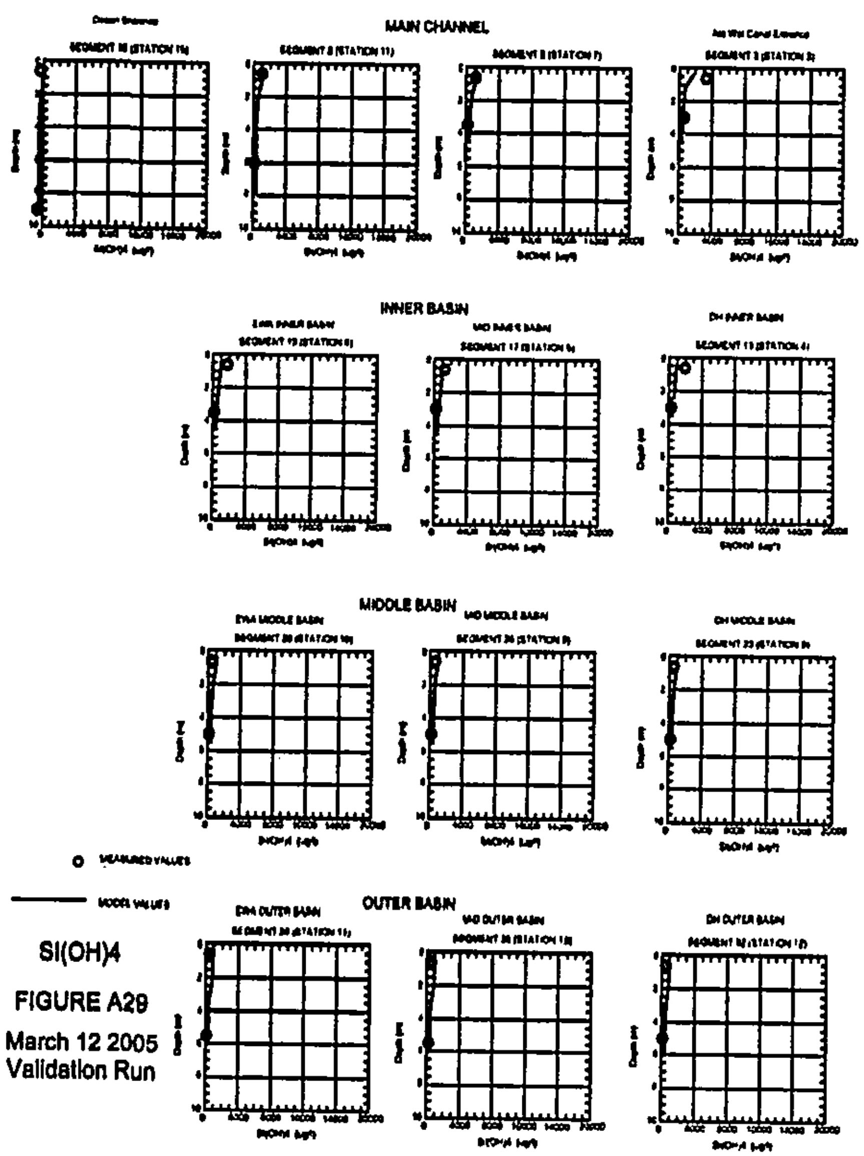
TOTAL
ORGANIC P

FIGURE A27
March 12 2005
Validation Run



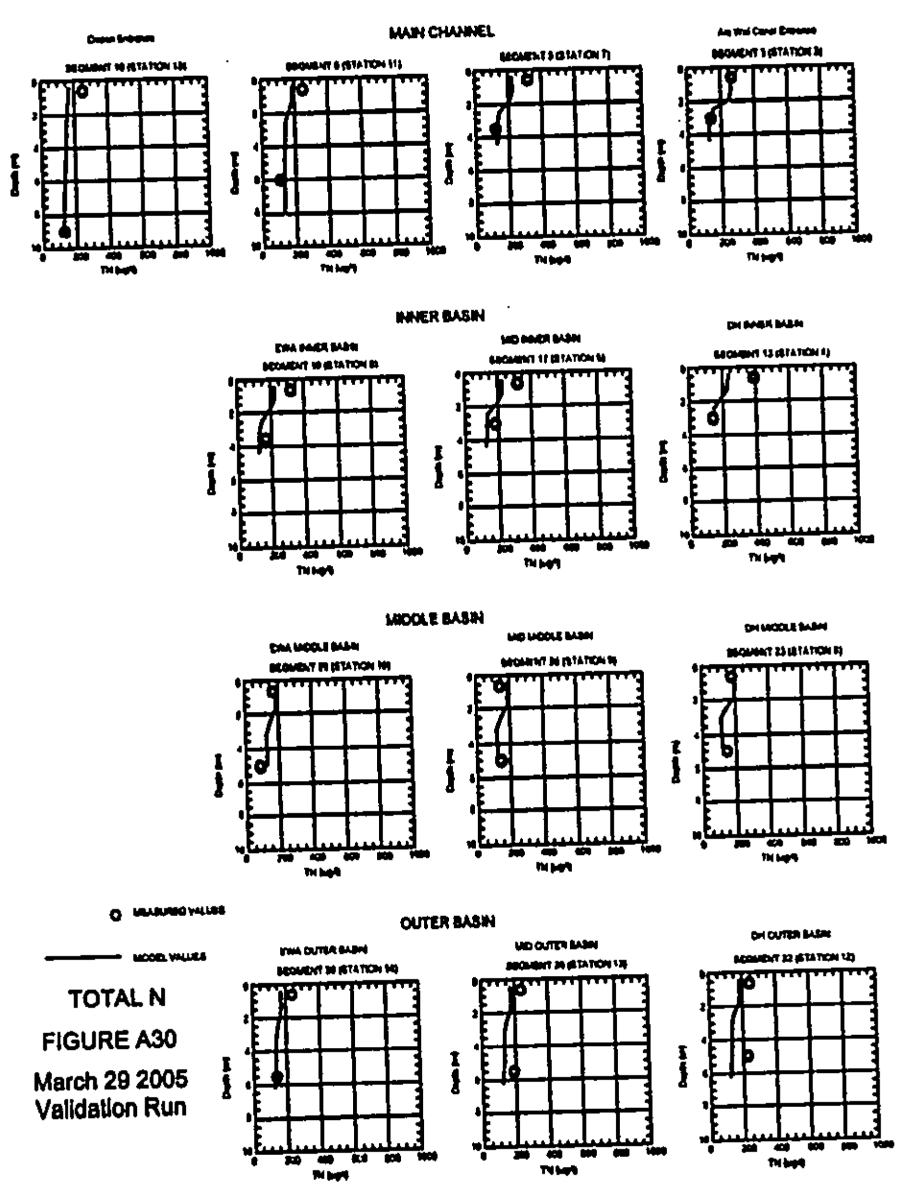
TOTAL ORGANIC N

FIGURE A28
March 12 2005
Validation Run



SI(OH)4

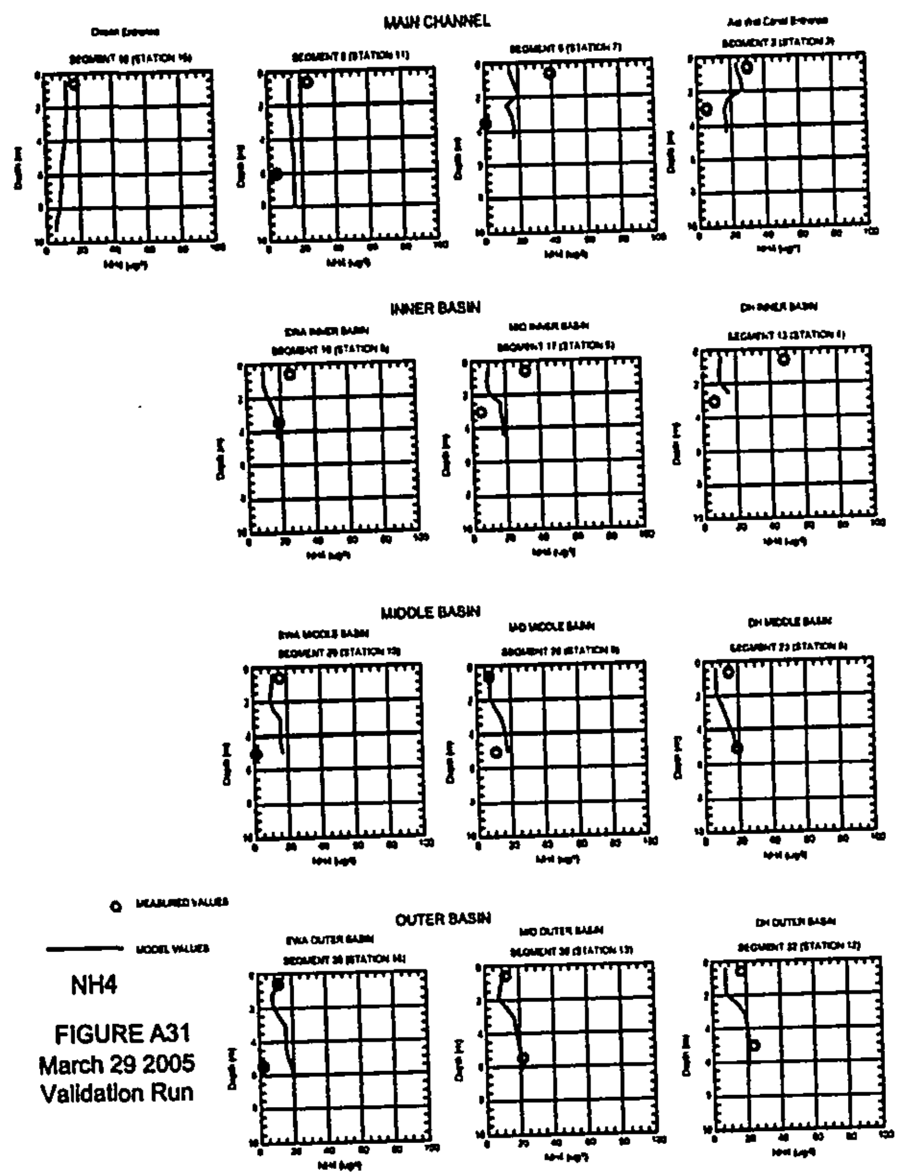
FIGURE A29
March 12 2005
Validation Run



TOTAL N

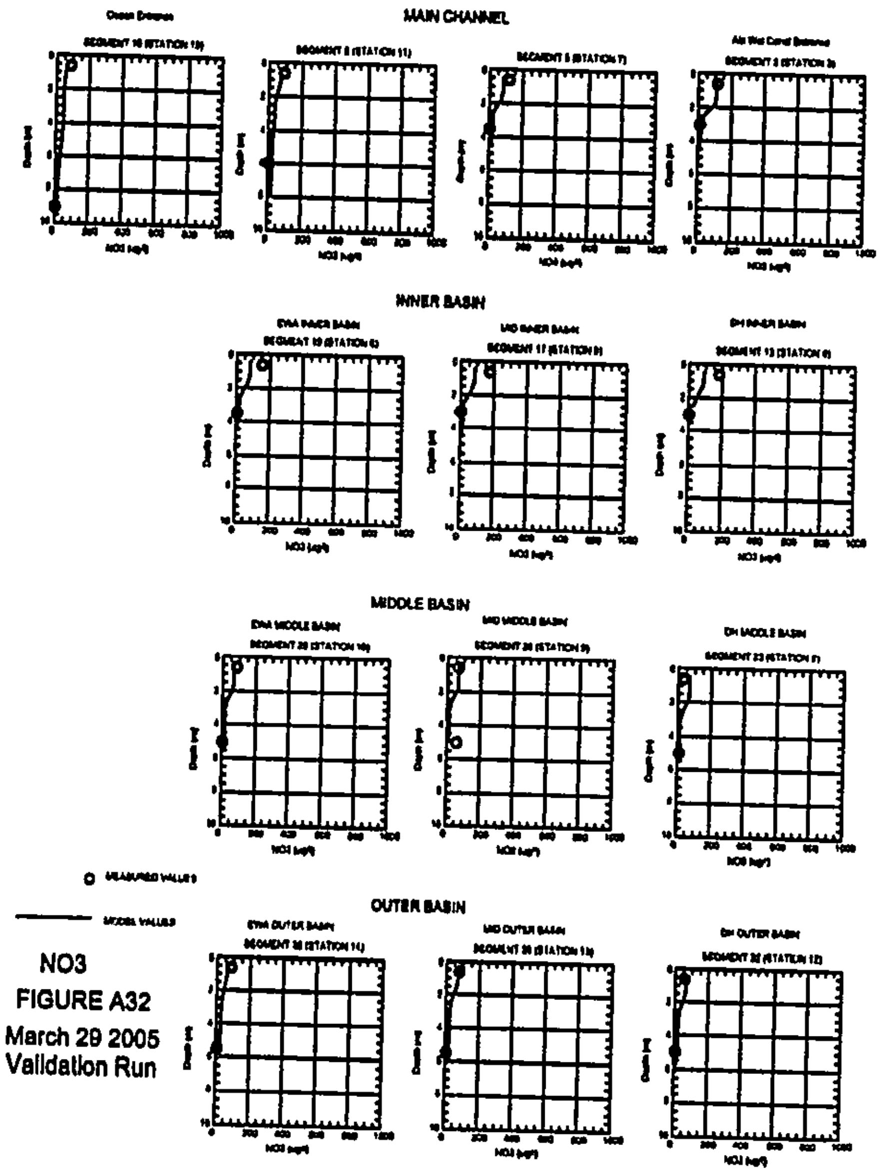
FIGURE A30

March 29 2005
Validation Run

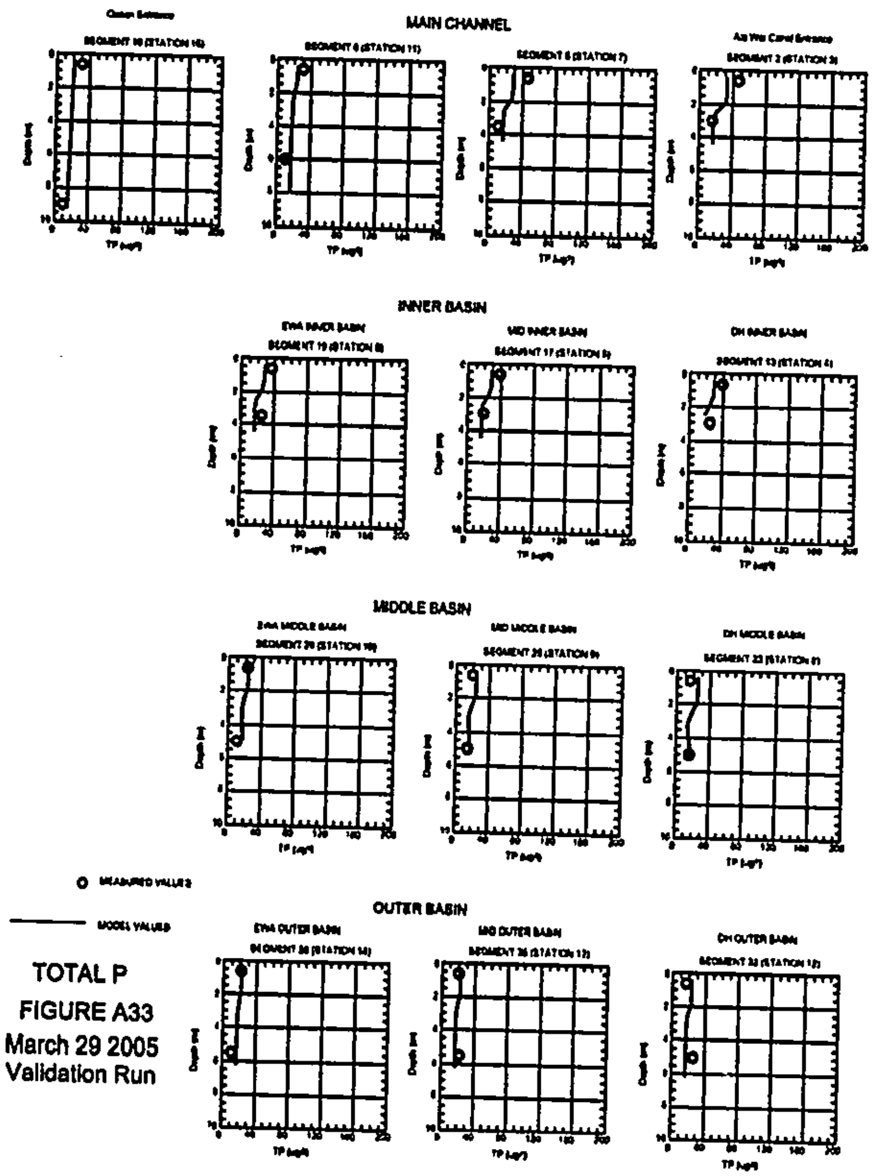


NH4

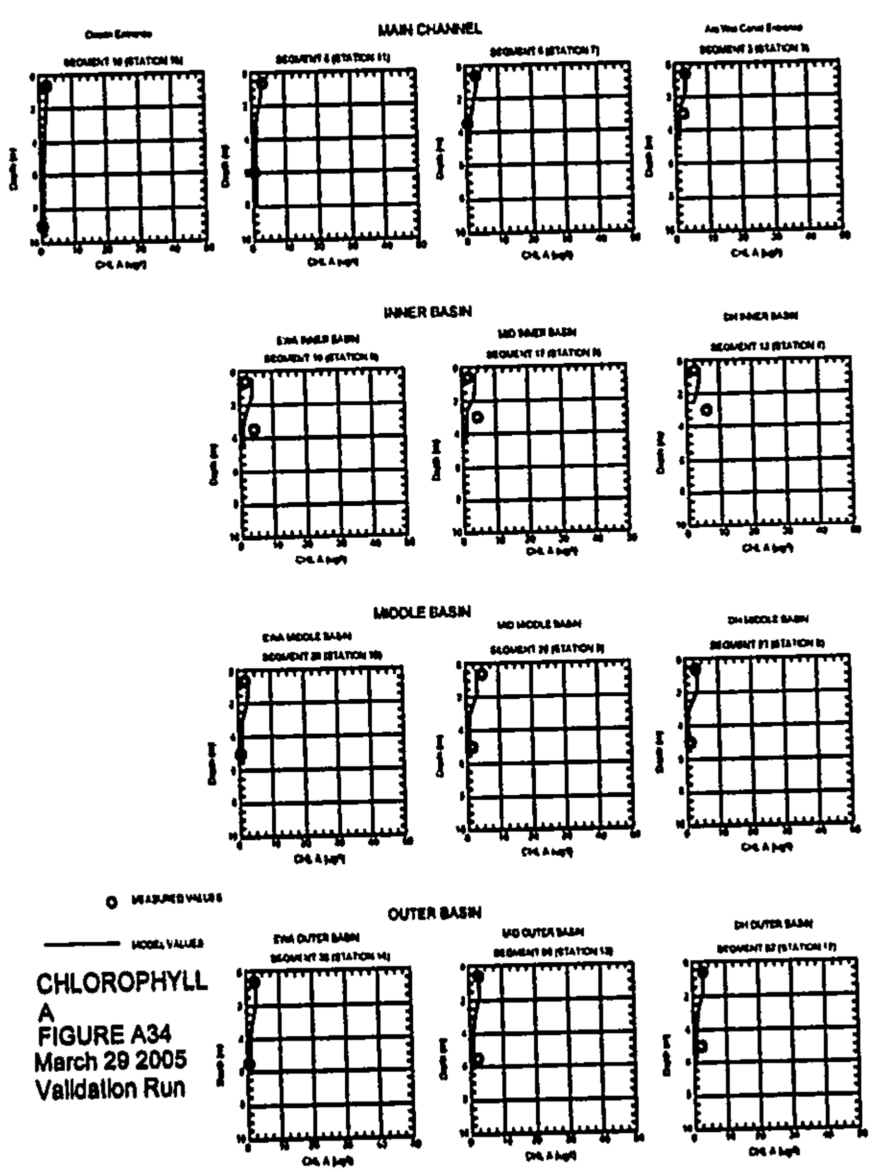
FIGURE A31
March 29 2005
Validation Run



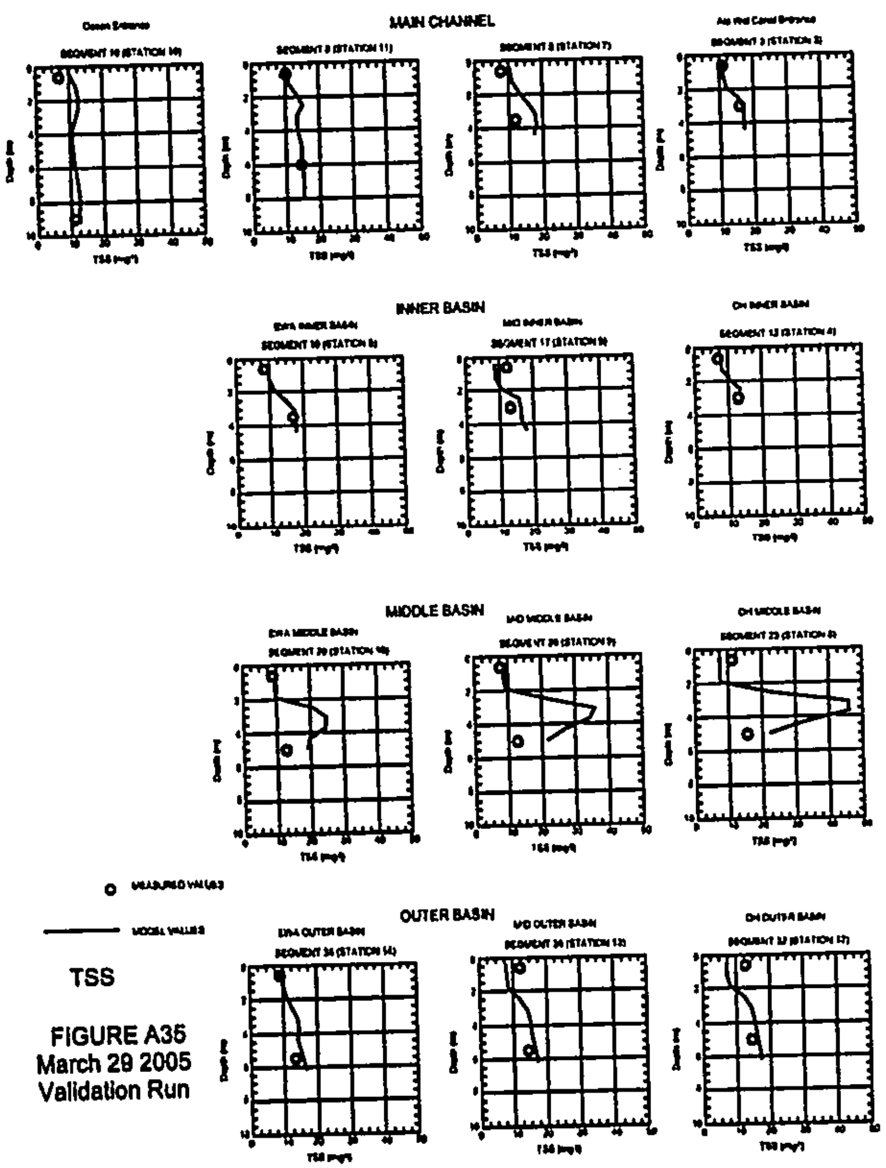
NO3
FIGURE A32
March 29 2005
Validation Run



TOTAL P
FIGURE A33
March 29 2005
Validation Run

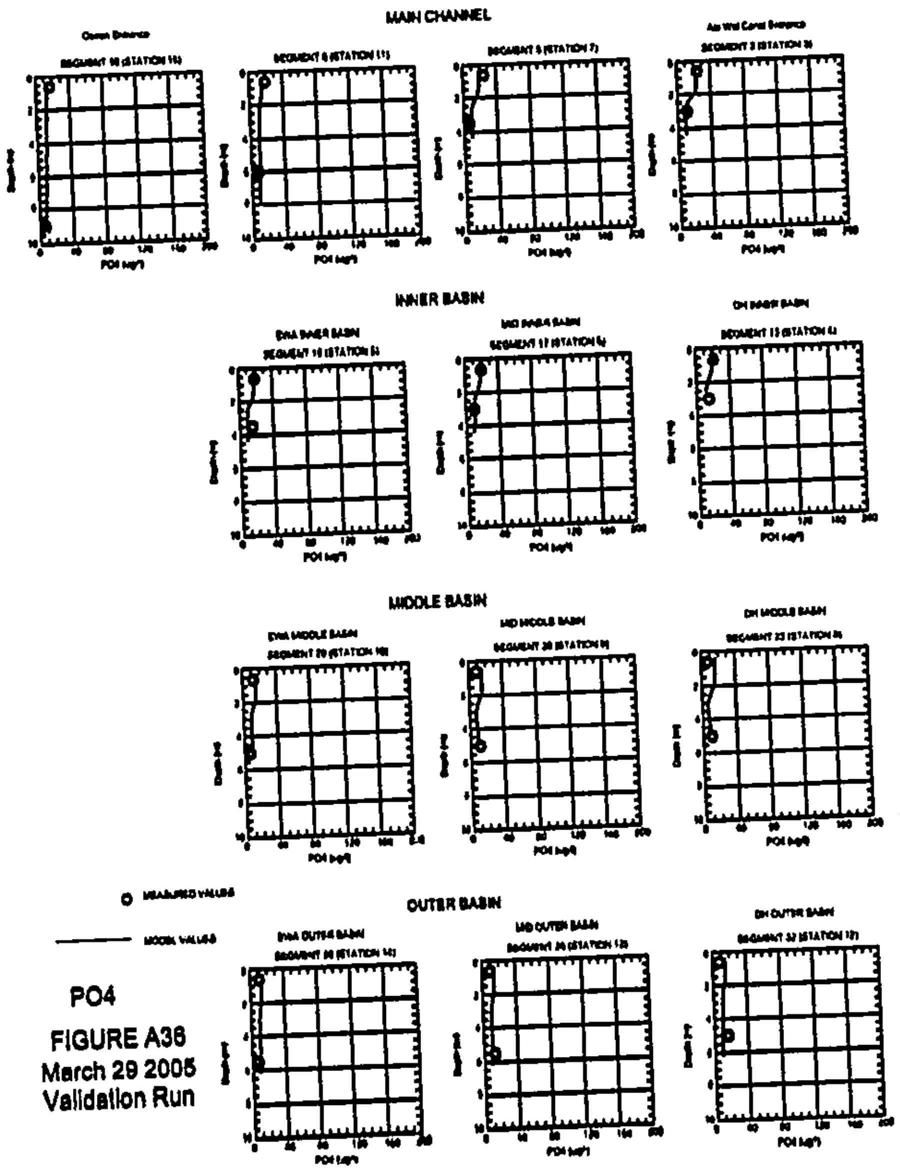


CHLOROPHYLL A
FIGURE A34
March 29 2005
Validation Run



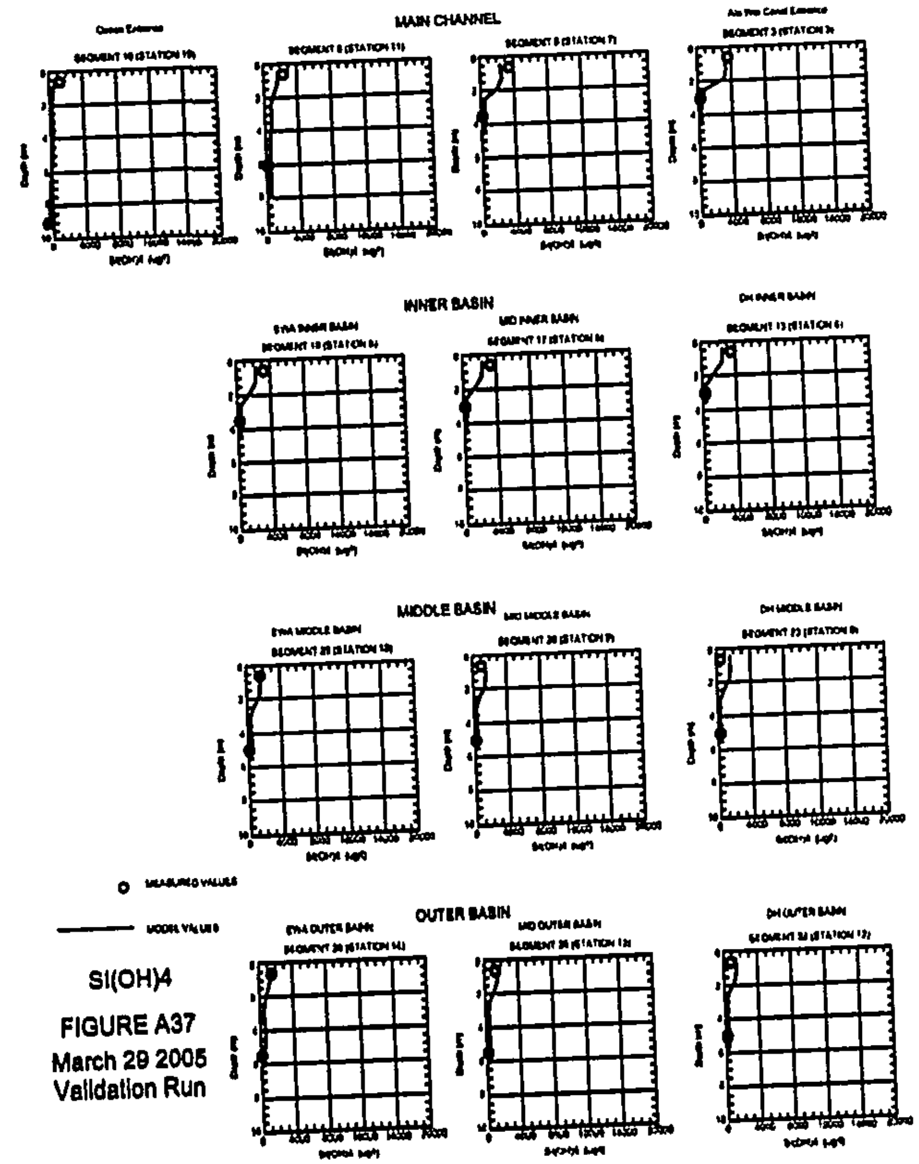
TSS

FIGURE A35
March 29 2005
Validation Run



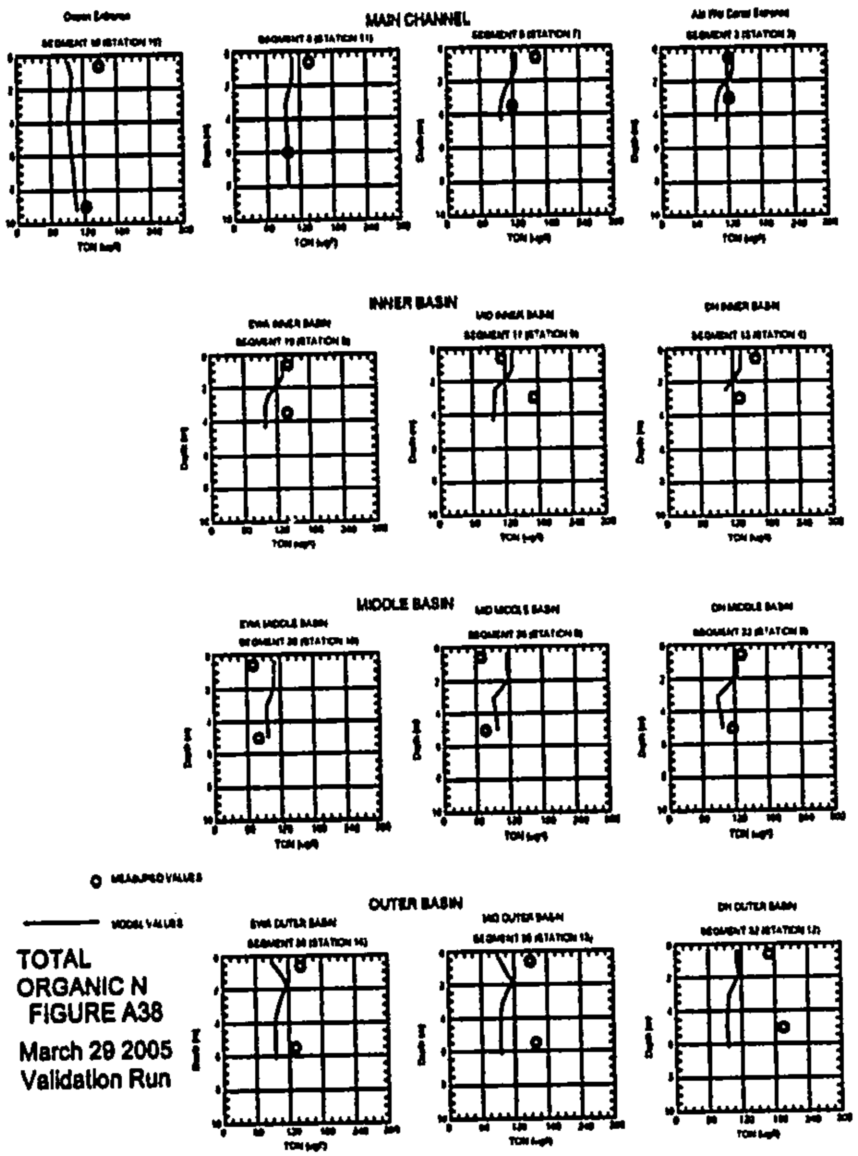
PO4

FIGURE A36
March 29 2005
Validation Run

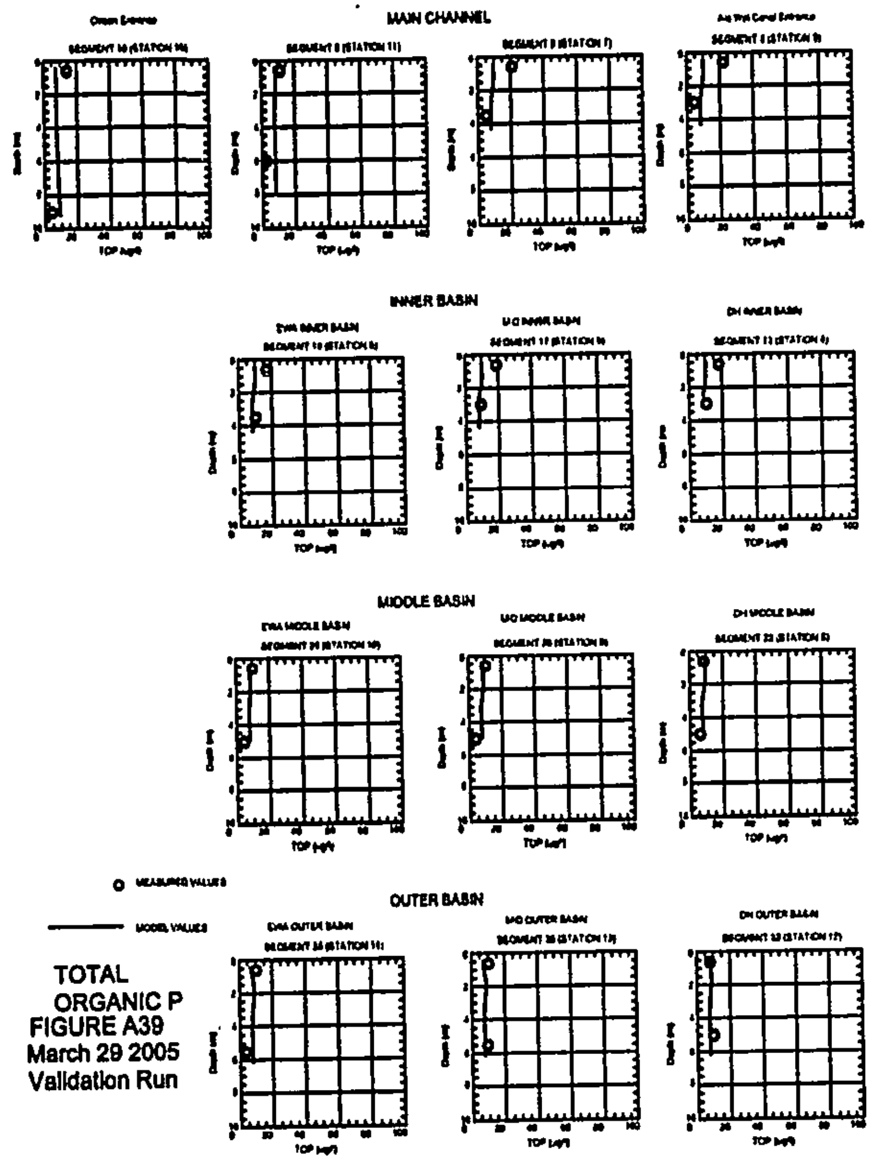


SI(OH)4

FIGURE A37
March 29 2005
Validation Run

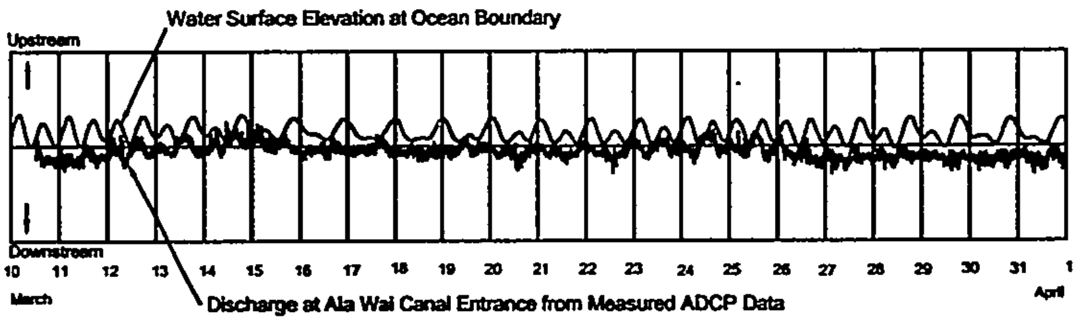


TOTAL
ORGANIC N
FIGURE A38
March 29 2005
Validation Run

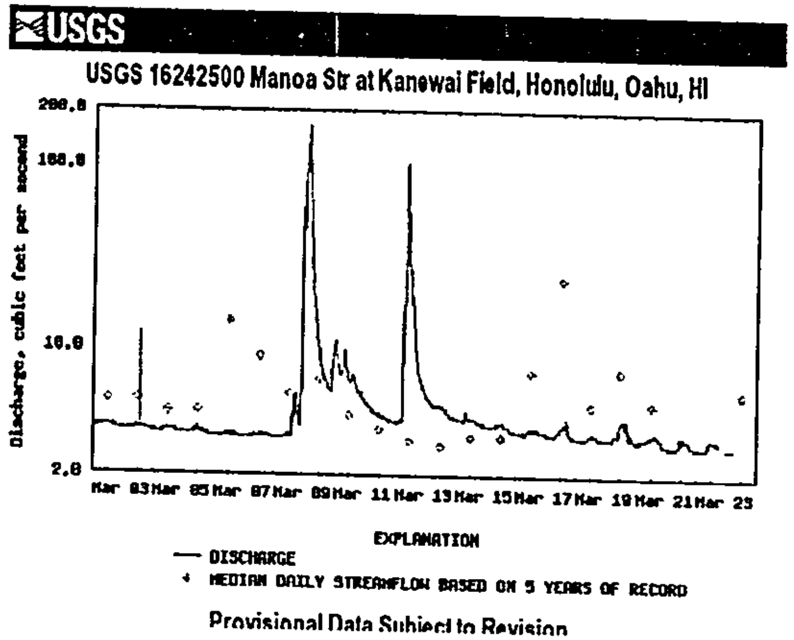


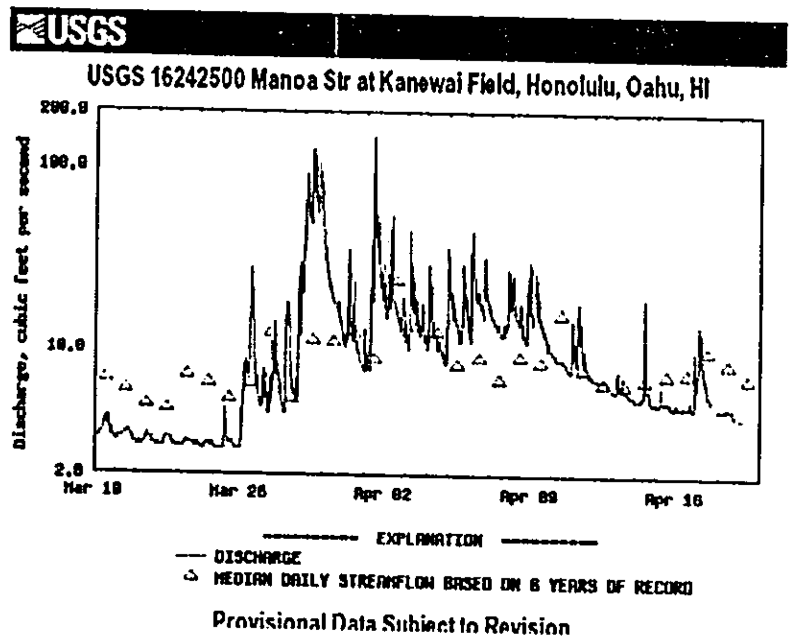
TOTAL
ORGANIC P
FIGURE A39
March 29 2005
Validation Run

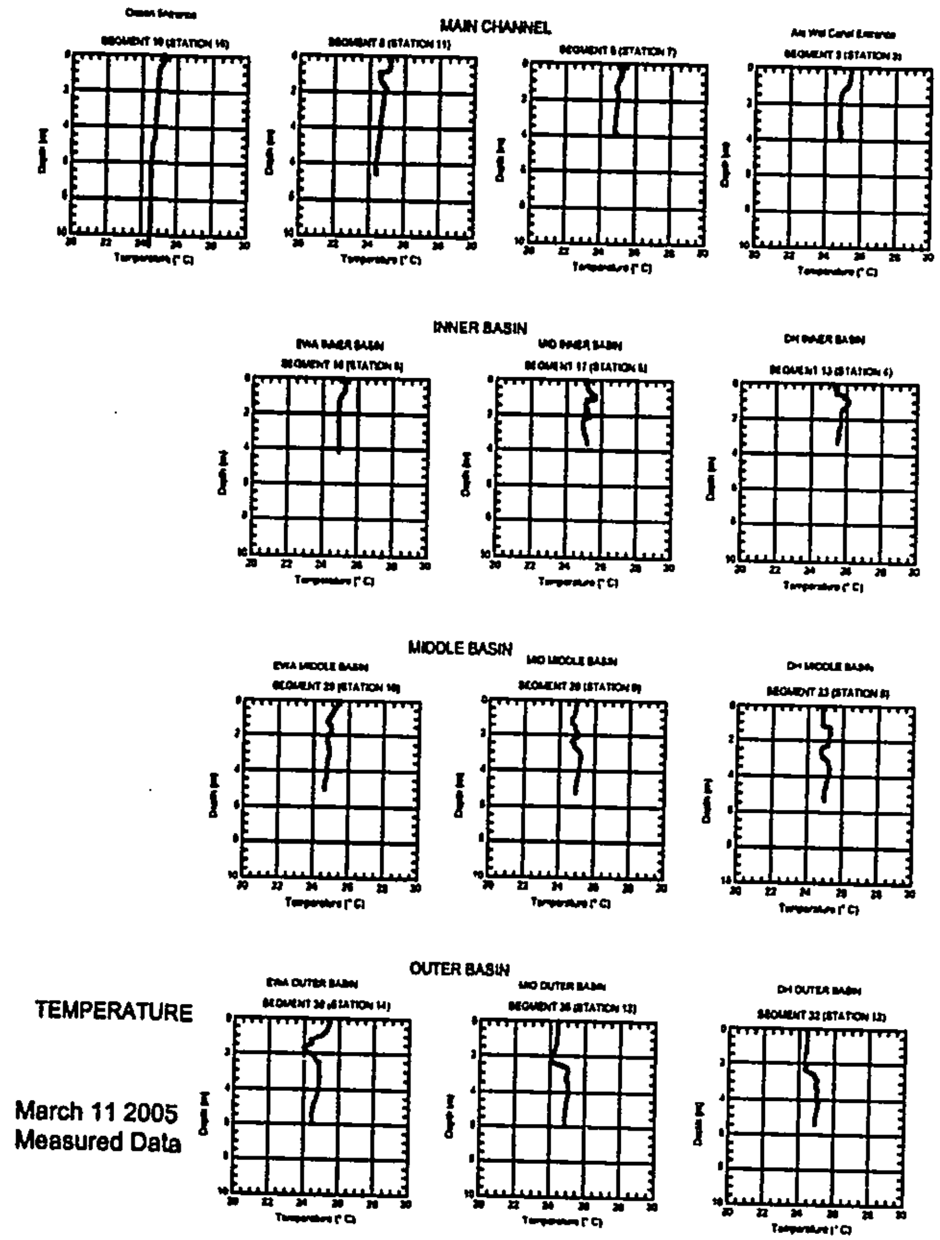
Input Model Data from Tides and Current Measurements

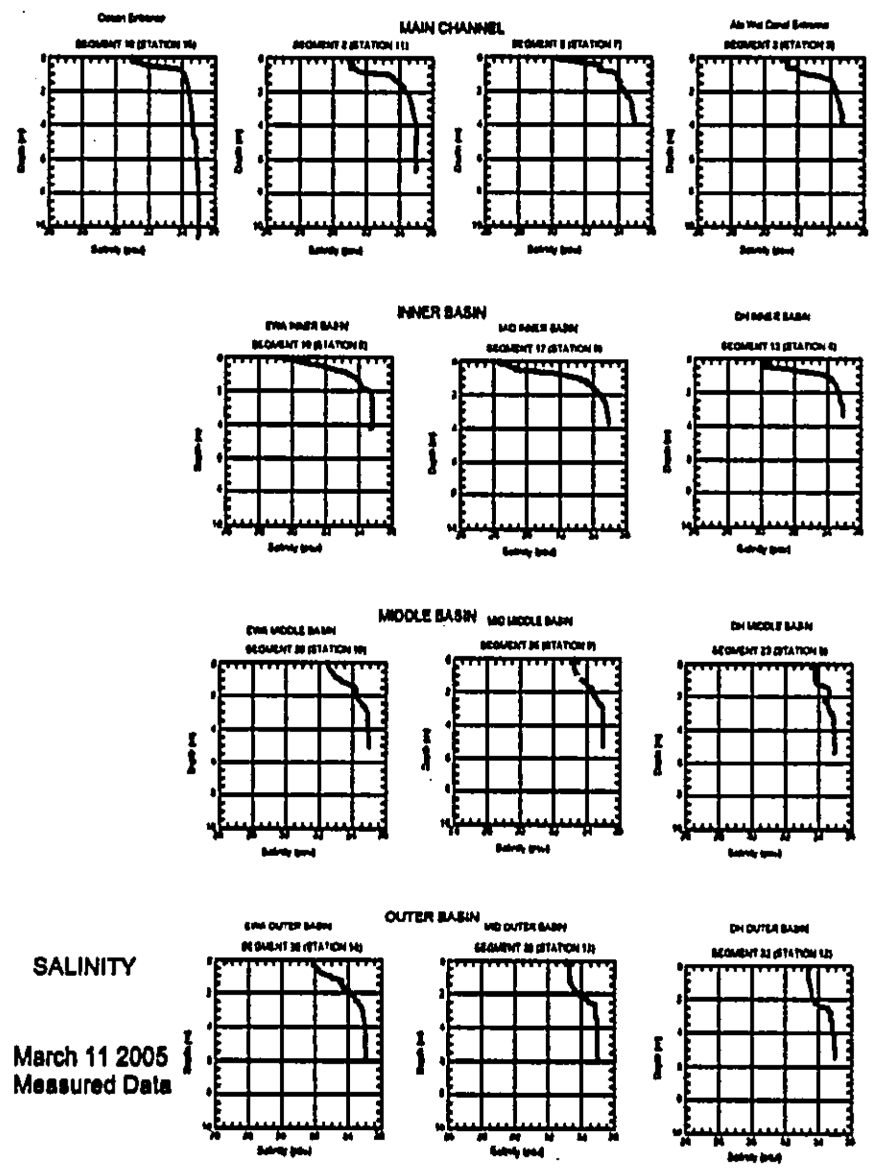


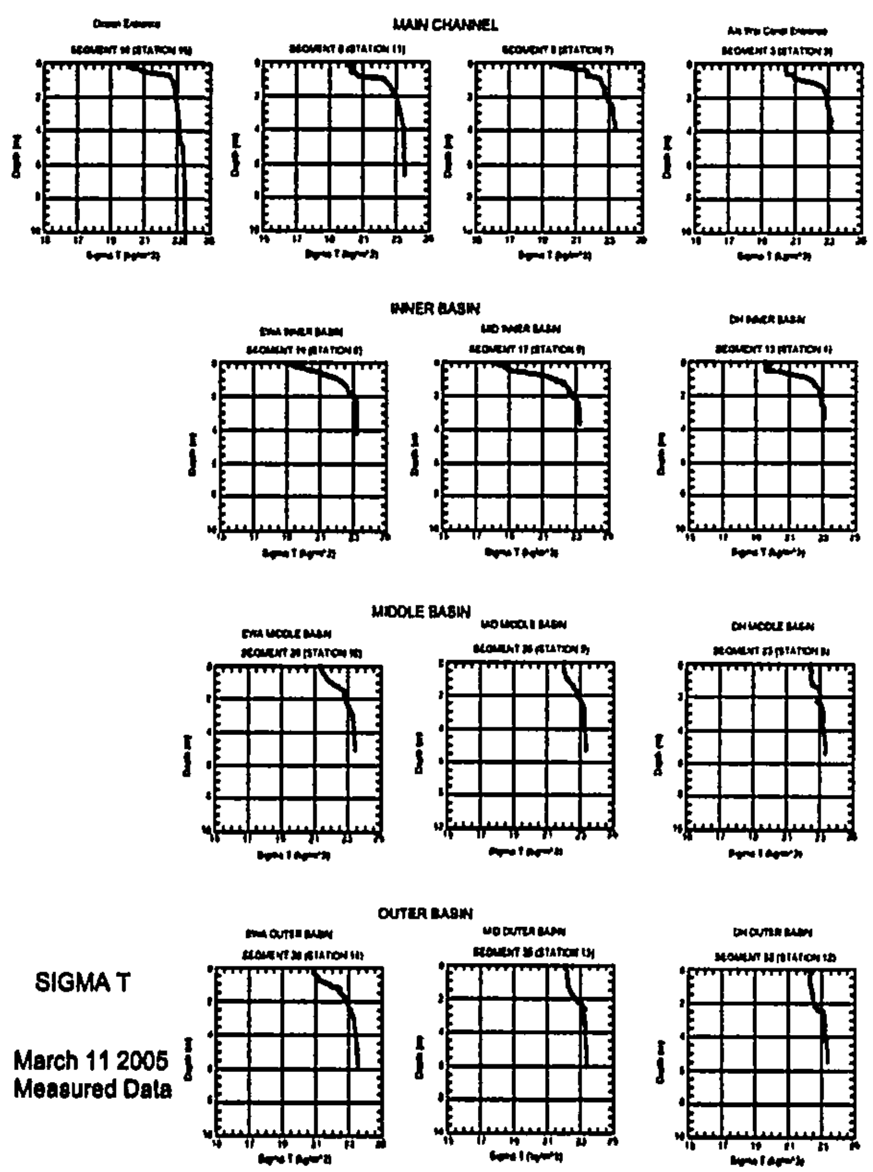
VERTICAL SCALE
- 0.5 meter Water Elevation
- 50 m^3/sec Discharge

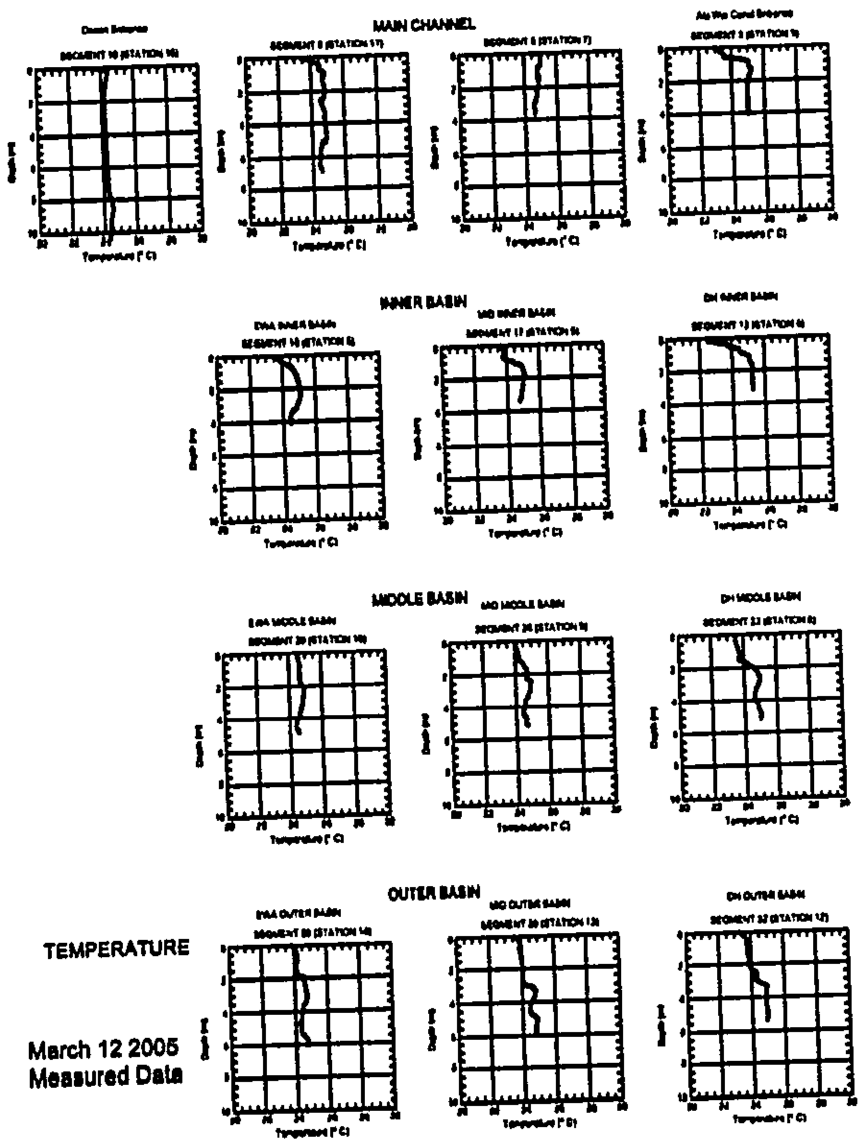

USGS
USGS 16242500 Manoa Str at Kanewai Field, Honolulu, Oahu, HI
Discharge, cubic feet per second
EXPLANATION
DISCHARGE
MEDIAN DAILY STREAMFLOW BASED ON 5 YEARS OF RECORD
Provisional Data Subject to Revision


USGS
USGS 16242500 Manoa Str at Kanewai Field, Honolulu, Oahu, HI
Discharge, cubic feet per second
EXPLANATION
DISCHARGE
MEDIAN DAILY STREAMFLOW BASED ON 6 YEARS OF RECORD
Provisional Data Subject to Revision


MAIN CHANNEL
INNER BASIN
MIDDLE BASIN
OUTER BASIN
TEMPERATURE
March 11 2005
Measured Data

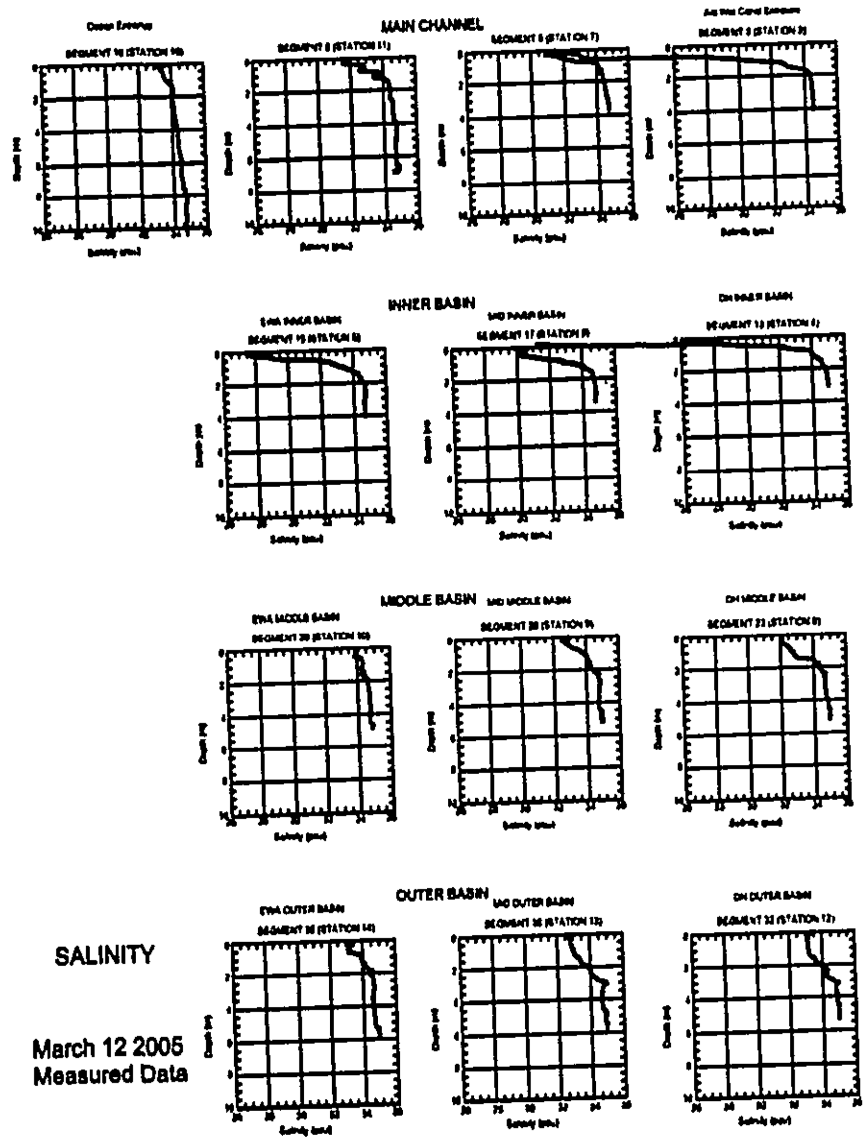

MAIN CHANNEL
INNER BASIN
MIDDLE BASIN
OUTER BASIN
SALINITY
March 11 2005
Measured Data


MAIN CHANNEL
INNER BASIN
MIDDLE BASIN
OUTER BASIN
SIGMA T
March 11 2005
Measured Data



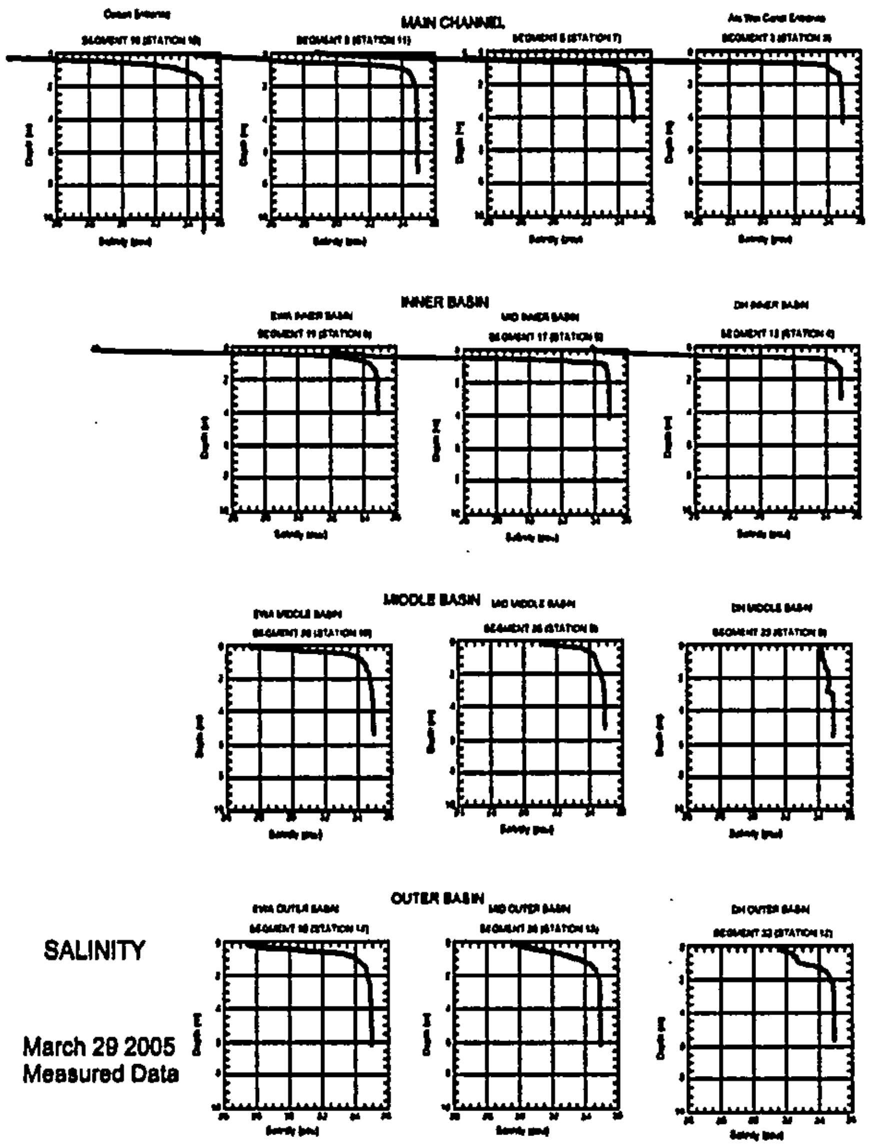
TEMPERATURE

March 12 2005
Measured Data



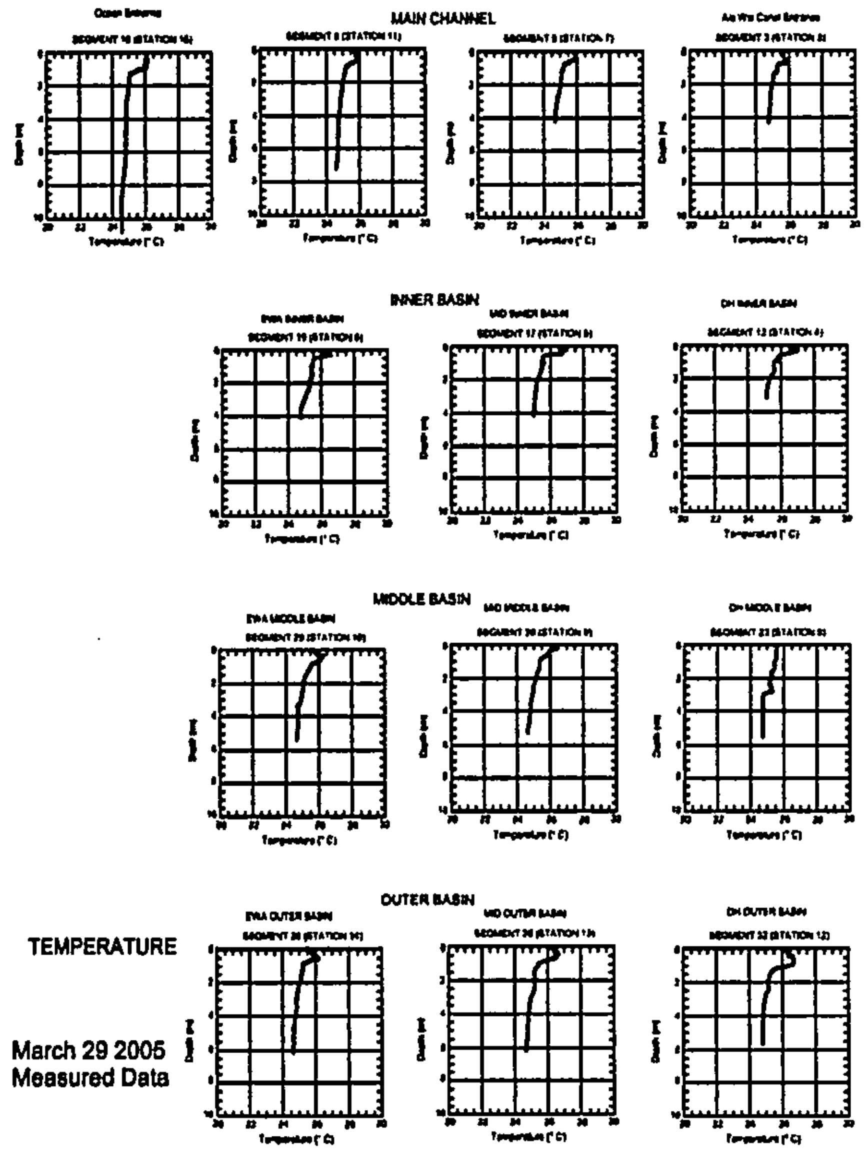
SALINITY

March 12 2005
Measured Data



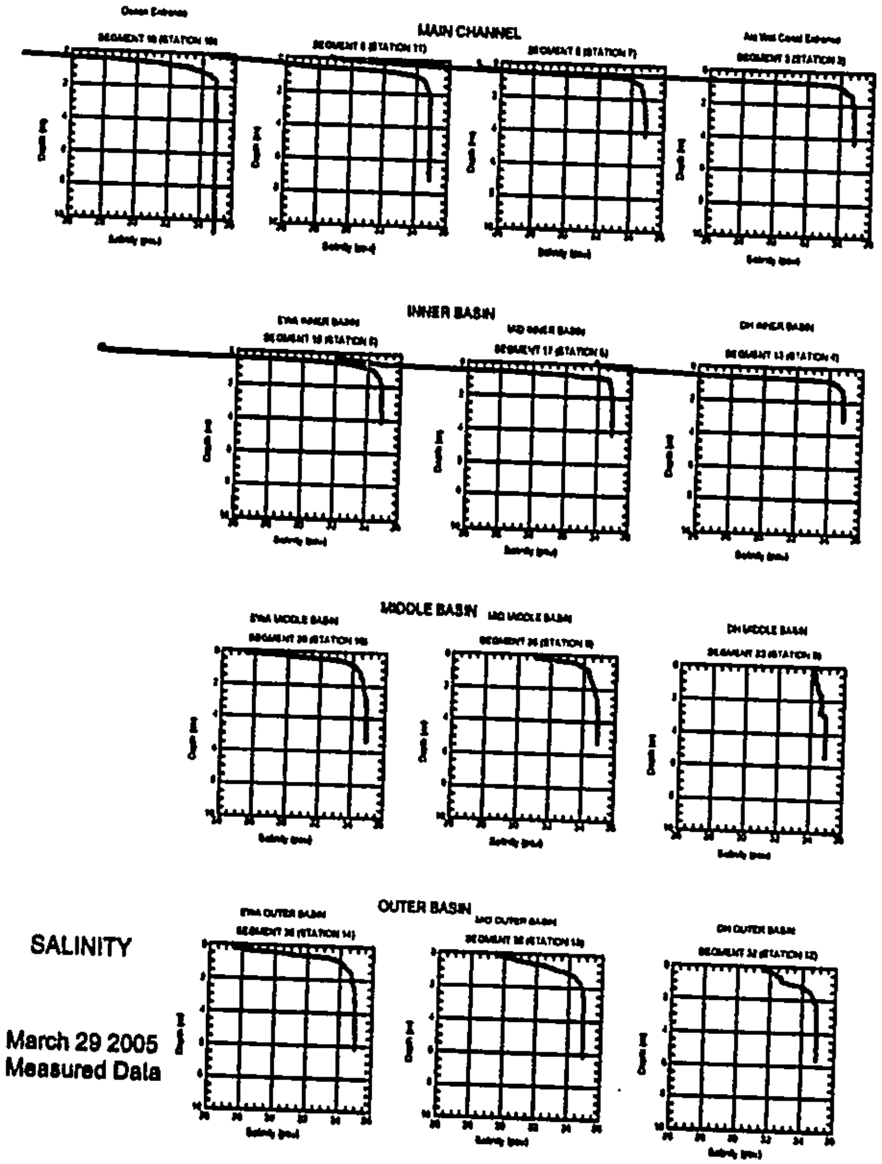
SALINITY

March 29 2005
Measured Data



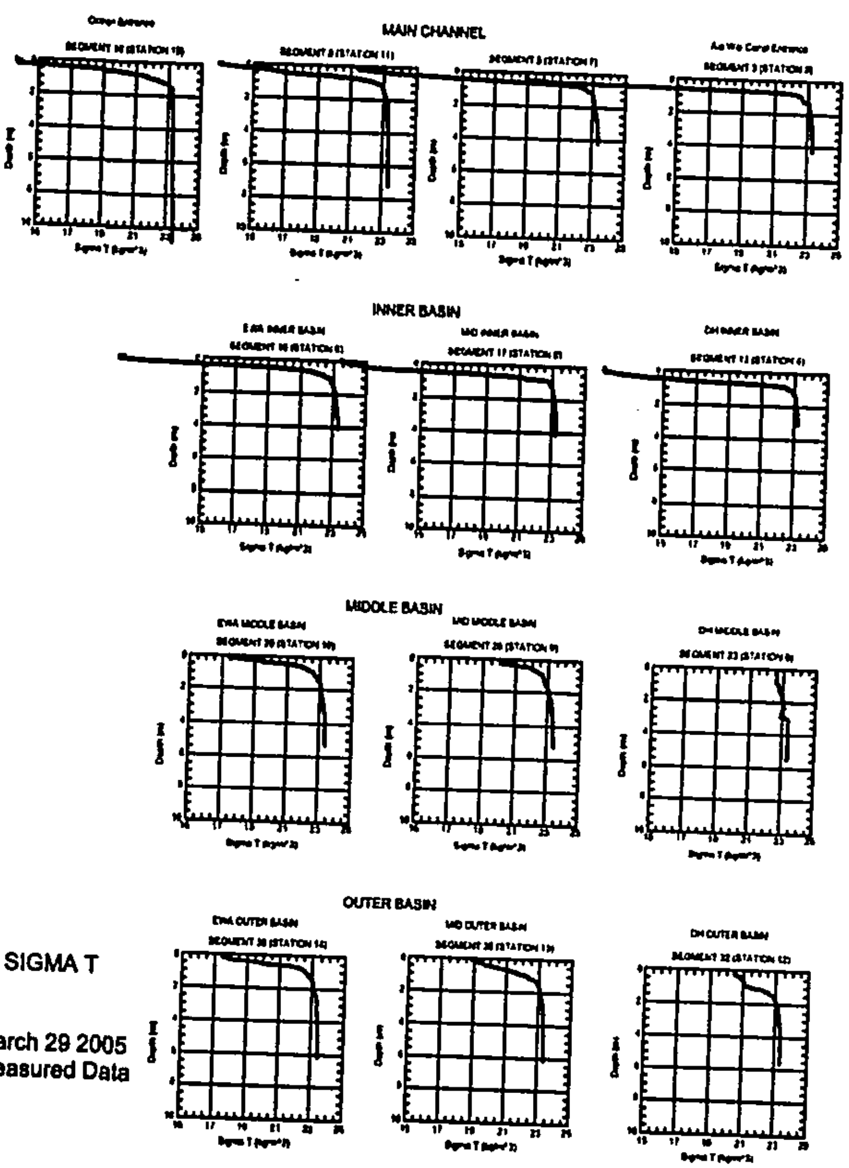
TEMPERATURE

March 29 2005
Measured Data



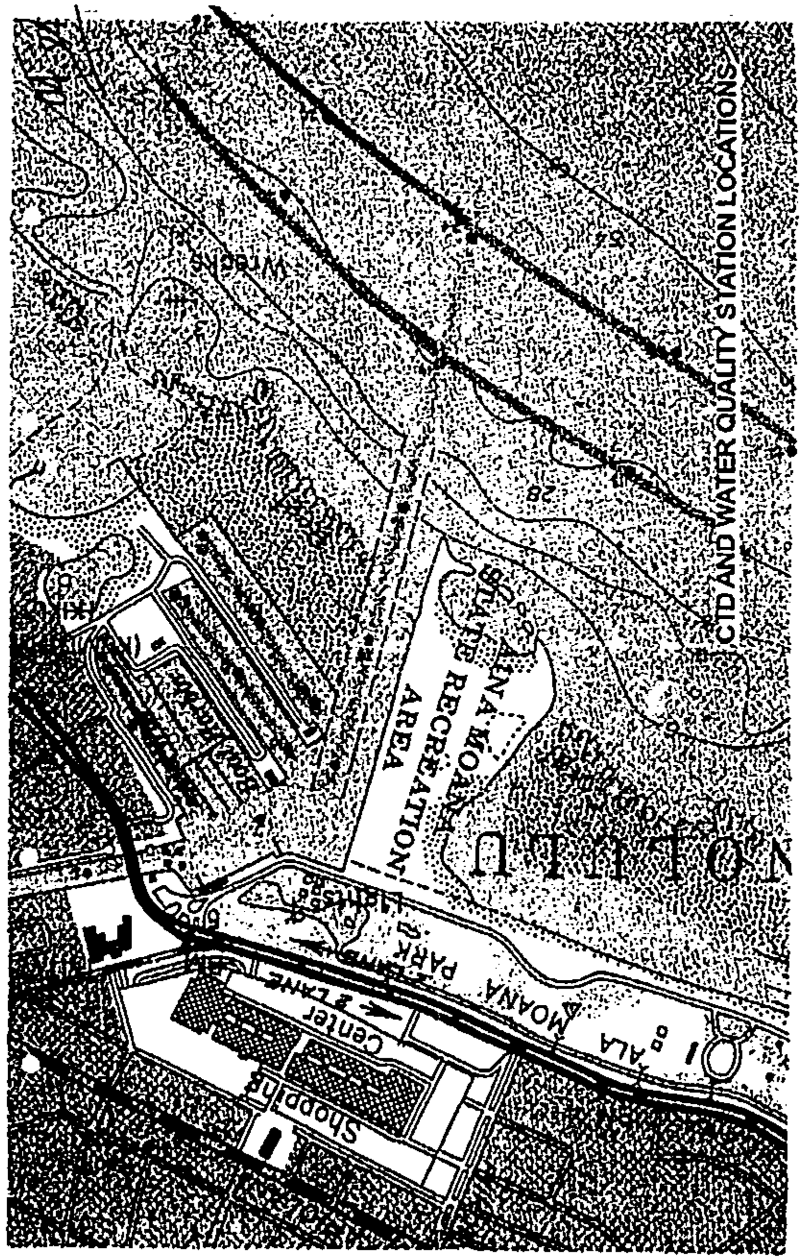
SALINITY

March 29 2005
Measured Data



SIGMA T

March 29 2005
Measured Data



ALA WAI WATER CHEMISTRY - MARCH 11, 2005

STATION	Bottle#	(µM) [PO₄]	(µM) [Si(OH)4]	(µM) [NO₃]	(µM) [NH₄]	(µM) [TP]	(µM) [TN]	(µM) [TOP]	(µM) [TON]	(µg/l) Chlorophyll	(mg/l) TSS	(ntu) TURBIDITY
CANAL-CHANNEL												
1S	1	0.27	64.87	18.07	4.57	1.20	38.48	0.94	15.82	7.087	9.82	1.80
1B	2	0.38	6.40	0.68	1.81	0.58	10.78	0.21	8.59	1.154	11.63	3.60
2S	3	0.42	48.04	9.26	2.28	0.86	25.14	0.44	13.62	4.062	8.40	2.65
2B	4	0.37	10.93	1.38	0.86	0.76	14.64	0.39	12.41	2.274	12.55	4.70
3S	5	0.34	48.77	9.81	2.72	0.80	26.58	0.46	14.06	3.664	8.40	2.12
3B	6	0.22	11.29	1.70	0.44	0.51	14.28	0.29	12.13	1.538	9.46	1.75
7S	13	0.41	50.99	10.77	1.18	0.93	28.09	0.52	14.18	4.231	8.96	1.66
7B	14	0.22	8.80	0.82	0.21	0.41	10.96	0.20	9.93	0.938	8.60	1.75
11S	21	0.34	50.29	10.09	1.48	0.82	23.63	0.48	12.07	3.334	9.10	1.74
11B	22	0.15	8.51	0.46	0.14	0.35	9.68	0.20	9.08	0.518	10.65	1.24
15S	29	0.34	46.77	9.85	1.79	0.75	20.96	0.41	9.32	2.782	8.55	1.86
15B	30	0.12	4.54	0.43	0.03	0.31	10.07	0.20	9.61	0.394	11.56	0.85
16S	31	0.28	19.97	3.94	1.34	0.42	8.03	0.14	2.75	0.721	9.43	0.60
16B	32	0.10	2.46	0.31	0.01	0.21	4.76	0.11	4.44	0.184	10.45	0.48
19S	37	0.06	1.64	0.07	0.10	0.22	11.42	0.16	11.26	0.122	7.40	0.61
19B	38	0.05	1.35	0.06	0.00	0.16	4.48	0.10	4.42	0.114	8.00	0.84
24S	47	0.06	1.43	0.06	0.00	0.23	9.31	0.15	9.25	0.110	13.00	0.23
24B	48	0.07	1.04	0.04	0.00	0.25	10.27	0.18	10.23	0.099	11.00	0.32
INNER MARINA												
4S	7	0.54	54.58	9.07	0.58	1.25	25.23	0.70	15.58	5.506	8.90	2.00
4B	8	0.46	6.30	0.40	0.21	0.96	17.36	0.50	16.75	13.687	11.20	4.29
5S	9	0.48	72.19	13.88	0.76	1.11	29.70	0.63	15.06	3.858	8.80	1.36
5B	10	0.34	7.69	0.81	0.83	0.67	14.93	0.33	13.49	2.778	10.20	3.65
6S	11	0.41	63.64	12.73	0.81	0.98	26.06	0.58	12.72	3.975	8.15	1.46
6B	12	0.27	6.91	0.61	0.52	0.33	12.75	0.26	11.63	1.908	11.45	3.00
MID MARINA												
8S	15	0.37	14.86	2.75	1.07	0.87	14.02	0.30	10.20	0.939	10.55	1.23
8B	16	0.29	6.58	0.81	0.39	0.57	14.01	0.28	12.81	0.930	7.45	1.60
9S	17	0.33	19.99	4.11	0.93	0.59	16.39	0.27	11.34	1.214	10.00	1.26
9B	18	0.48	6.00	0.36	1.22	0.84	11.58	0.37	10.00	2.660	21.65	9.65
10S	19	0.27	30.58	6.62	0.75	0.62	19.44	0.35	11.87	2.074	10.00	1.42
10B	20	0.20	5.22	0.32	0.48	0.41	9.05	0.21	8.27	1.036	20.60	2.40
OUTER MARINA												
12S	23	0.21	18.62	2.78	0.64	0.40	11.58	0.19	8.16	1.241	9.70	1.70
12B	24	0.30	5.55	0.45	0.74	0.59	11.16	0.29	9.97	1.037	6.75	2.24
13S	25	0.24	21.60	3.79	0.62	0.53	13.40	0.28	9.09	1.345	11.00	1.83
13B	26	0.27	8.15	0.37	0.78	0.51	8.94	0.24	7.86	1.370	4.80	3.84
14S	27	0.28	34.37	7.61	1.57	0.64	19.72	0.38	10.64	1.676	8.00	1.70
14B	28	0.21	8.16	0.73	0.87	0.47	8.12	0.26	7.71	0.967	12.20	2.30
OCEAN WEST INSIDE												
18S	37	0.06	1.64	0.07	0.10	0.22	11.42	0.16	11.26	0.122	7.40	0.61
18B	38	0.05	1.38	0.06	0.00	0.16	4.48	0.10	4.42	0.114	8.00	0.84
18S	35	0.10	4.21	0.71	0.13	0.22	5.49	0.12	4.68	0.236	10.70	0.23
18B	36	0.07	1.66	0.11	0.00	0.20	8.13	0.13	8.02	0.121	11.40	0.22
17S	33	0.06	2.73	0.19	0.02	0.21	6.43	0.13	5.72	0.177	10.80	0.42
17B	34	0.07	1.68	0.10	0.00	0.21	9.23	0.13	9.13	0.107	11.80	0.40
OCEAN WEST OUTSIDE												
24S	47	0.06	1.43	0.06	0.00	0.23	9.31	0.15	9.25	0.110	13.00	0.23
24B	48	0.07	1.04	0.04	0.00	0.25	10.27	0.18	10.23	0.099	11.00	0.32
23S	45	0.08	1.85	0.11	0.04	0.24	8.15	0.15	7.99	0.147	7.35	0.33
23B	46	0.09	1.44	0.03	0.02	0.38	18.65	0.29	18.81	0.324	30.81	0.54
22S	43	0.06	3.17	0.38	0.00	0.21	7.77	0.15	7.39	0.196	12.40	0.31
22B	44	0.05	1.37	0.04	0.00	0.17	5.13	0.13	5.09	0.144	8.30	0.13
OCEAN EAST INSIDE												
19S	37	0.06	1.64	0.07	0.10	0.22	11.42	0.15	11.26	0.122	7.40	0.61
19B	38	0.05	1.35	0.06	0.00	0.16	4.48	0.10	4.42	0.114	8.00	0.84
20S	39	0.06	1.82	0.10	0.01	0.19	6.72	0.14	6.61	0.120	8.00	0.48
20B	40	0.07	1.32	0.05	0.00	0.17	5.76	0.10	5.69	0.124	10.80	0.65
21S	41	0.04	1.41	0.05	0.00	0.17	7.17	0.13	7.12	0.106	9.15	0.33
21B	42	0.06	1.39	0.12	0.01	0.24	7.86	0.18	7.43	0.178	9.10	0.66
OCEAN EAST OUTSIDE												
24S	47	0.06	1.43	0.06	0.00	0.23	9.31	0.15	9.25	0.110	13.00	0.23
24B	48	0.07	1.04	0.04	0.00	0.25	10.27	0.18	10.23	0.099	11.00	0.32
25S	49	0.02	1.40	0.03	0.00	0.22	10.09	0.16	10.06	0.121	9.65	0.34
25B	50	0.06	1.77	0.06	0.00	0.18	5.28	0.12	5.22	0.123	9.28	0.28
26S	51	0.06	1.28	0.09	0.03	0.19	7.62	0.14	7.61	0.083	6.90	0.09
26B	52	0.06	1.27	0.10	0.07	0.23	8.90	0.16	8.73	0.103	8.80	0.17

ALA WAI WATER CHEMISTRY - MARCH 12, 2005

STATION	Bottle#	(µM) [PO$_4$]	(µM) [Si(OH)4]	(µM) [NO$_3$]	(µM) [NH$_4$]	(µM) [TP]	(µM) [TN]	(µM) [TOP]	(µM) [TON]	(µg/l) Chlorophyll	(mg/l) TSS	(ntu) TURBIDITY
CANAL-CHANNEL												
1B	1	3.34	66.30	14.88	9.02	8.84	47.16	2.90	29.20	2.411	22.80	28.0
1B	2	1.19	40.80	9.80	8.39	3.40	31.09	1.21	18.41	8.181	24.11	12.0
2B	3	1.83	83.30	18.48	1.78	3.30	39.82	1.67	18.28	3.048	17.09	14.2
2B	4	0.73	35.07	8.27	5.06	1.79	26.48	1.08	13.81	7.108	16.06	8.80
3B	5	1.86	116.88	23.90	2.74	3.34	43.48	1.86	16.73	2.960	14.15	18.3
3B	6	0.82	21.80	4.32	4.23	1.32	15.80	0.70	7.38	8.218	13.38	6.38
7B	13	0.70	40.78	7.87	6.84	1.47	25.20	0.77	10.58	6.874	16.18	4.20
7B	14	0.43	8.15	0.94	1.60	0.83	8.31	0.40	3.67	1.251	16.80	3.85
11B	21	0.43	30.66	8.06	1.87	0.96	13.20	0.82	6.18	1.182	9.70	6.84
11B	22	0.47	7.48	0.71	2.32	0.93	18.37	0.48	13.33	2.072	12.70	2.25
15B	29	0.23	14.06	2.04	0.80	0.89	7.38	0.35	4.88	1.362	14.80	1.38
15B	30	0.27	8.50	0.46	1.14	0.82	11.91	0.34	10.29	0.913	10.70	2.80
16B	31	0.22	11.80	1.80	0.60	0.81	13.12	0.29	10.83	0.873	20.30	2.83
16B	32	0.19	8.25	0.40	0.87	0.80	11.30	0.41	10.24	0.816	13.18	0.31
19B	37	0.13	1.33	0.06	0.03	0.36	9.88	0.23	9.48	0.121	13.00	0.61
19B	38	0.10	1.64	0.08	0.07	0.44	9.61	0.30	9.36	0.132	12.09	0.35
24B	47	0.12	1.33	0.08	0.03	0.29	10.31	0.17	10.14	0.094	8.15	0.41
24B	48	0.13	1.34	0.08	0.04	0.24	8.37	0.14	8.20	0.130	9.18	0.40
INNER MARINA												
4B	7	2.14	66.92	8.85	8.17	2.86	34.10	1.71	19.08	2.079	29.14	23.9
4B	8	0.63	8.67	0.56	1.30	1.30	11.62	0.67	8.46	7.714	8.96	3.83
6B	9	0.73	43.87	7.26	2.20	1.40	22.47	0.87	12.94	3.888	4.70	3.86
6B	10	0.40	7.01	0.65	1.18	0.80	8.10	0.40	4.28	2.441	4.86	2.30
6B	11	0.68	62.03	11.00	3.80	1.60	24.21	0.70	8.30	3.254	18.80	1.82
6B	12	0.40	8.78	0.43	0.98	0.92	7.02	0.83	8.83	3.964	18.86	3.55
MID MARINA												
8B	15	0.38	19.47	3.66	1.89	0.78	12.87	0.36	7.13	0.943	10.10	1.06
8B	16	0.43	7.38	1.03	1.88	0.86	8.83	0.43	8.18	0.742	13.10	1.56
8B	17	0.38	21.21	3.74	1.81	0.78	13.88	0.36	8.29	1.819	10.58	1.16
9B	18	0.36	7.04	0.88	1.23	0.84	11.64	0.40	8.82	0.834	13.86	1.78
10B	19	0.37	18.20	2.72	1.29	0.73	13.82	0.38	9.51	2.068	8.06	1.20
10B	20	0.33	8.11	0.70	1.28	0.86	8.81	0.33	3.94	1.034	16.78	1.83
OUTER MARINA												
12B	23	0.38	17.72	3.38	1.33	0.67	18.33	0.31	10.88	1.329	13.06	0.88
12B	24	0.42	8.80	0.73	1.28	0.78	13.18	0.34	11.16	0.763	13.80	2.18
13B	25	0.31	16.70	3.30	1.27	0.64	13.91	0.34	9.28	1.302	17.08	0.90
13B	26	0.29	8.49	1.30	1.16	0.87	7.84	0.38	8.20	0.870	114.80	1.82
14B	27	0.37	18.38	3.78	1.17	0.63	14.08	0.35	10.12	0.980	13.65	0.97
14B	28	0.22	8.88	0.74	0.72	0.64	11.34	0.32	9.80	0.887	20.80	3.00
OCEAN WEST INSIDE												
19B	37	0.13	1.33	0.06	0.03	0.36	9.86	0.23	9.48	0.121	12.80	0.81
19B	38	0.18	1.64	0.08	0.07	0.44	9.81	0.30	9.36	0.132	12.80	0.36
18B	35	0.13	1.20	0.06	0.04	0.37	8.74	0.34	8.80	Lost	11.86	0.60
18B	36	0.14	1.41	0.09	0.04	0.38	9.13	0.23	9.00	Lost	12.70	0.81
17B	33	0.13	1.74	0.12	0.04	0.27	8.10	0.24	7.93	0.094	8.73	1.00
17B	34	0.12	1.47	0.11	0.06	0.41	8.01	0.28	8.74	0.206	12.28	0.22
OCEAN WEST OUTSIDE												
24B	47	0.12	1.32	0.08	0.02	0.29	10.21	0.17	10.14	0.094	8.18	0.41
24B	48	0.12	1.34	0.06	0.04	0.26	8.37	0.14	8.23	0.130	9.18	0.40
23B	45	0.12	1.28	0.07	0.06	0.31	9.86	0.11	9.78	0.107	10.06	0.22
23B	46	0.12	1.30	0.07	0.06	0.30	8.07	0.15	8.85	0.106	11.70	0.33
22B	43	0.12	1.25	0.07	0.04	0.28	8.16	0.16	8.00	0.112	6.30	0.72
22B	44	0.11	1.27	0.07	0.00	0.28	7.73	0.15	7.86	0.101	8.86	0.22
OCEAN EAST INSIDE												
19B	37	0.13	1.33	0.06	0.03	0.36	9.86	0.23	9.44	0.121	12.80	0.61
19B	38	0.18	1.64	0.06	0.07	0.44	9.81	0.30	9.36	0.132	12.80	0.38
20B	39	0.13	3.27	0.41	0.18	0.34	9.82	0.22	9.06	0.247	10.86	0.65
20B	40	0.12	1.87	0.11	0.00	0.29	8.34	0.18	8.22	0.186	9.30	0.24
21B	41	0.13	1.21	0.07	0.06	0.33	9.12	0.20	9.00	0.083	11.80	0.29
21B	42	0.12	1.33	0.07	0.02	0.32	8.81	0.20	8.82	0.110	8.40	0.35
OCEAN EAST OUTSIDE												
24B	47	0.13	1.32	0.06	0.02	0.29	10.21	0.17	10.14	0.094	8.18	0.41
24B	48	0.12	1.34	0.08	0.04	0.26	8.37	0.14	8.28	0.130	9.15	0.40
25B	49	0.05	1.48	0.07	0.00	0.23	10.32	0.18	10.25	0.104	7.29	0.20
25B	50	0.11	1.47	0.06	0.01	0.27	9.81	0.16	9.83	0.087	10.30	0.24
26B	51	0.11	1.30	0.06	0.04	0.23	4.80	0.12	4.48	0.062	13.20	0.20
26B	52	0.11	1.60	0.06	0.01	0.26	9.83	0.18	9.66	0.090	12.65	0.20

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STATION	Bottle#	(µM) [PO$_4$]	(µM) [Si(OH)4]	(µM) [NO$_3$]	(µM) [NH$_4$]	(µM) [TP]	(µM) [TN]	(µM) [TOP]	(µM) [TON]	(µg/l) Chlorophyll	(mg/l) TSS	(ntu) TURBIDITY
CANAL-CHANNEL												
1B	1	0.88	138.26	8.48	2.84	1.56	22.18	0.68	10.86	3.433	18.18	4.0
1B	2	0.42	34.37	2.80	0.73	0.77	12.14	0.38	8.78	4.011	14.67	1.7
2B	3	0.87	136.06	8.86	2.94	1.63	21.98	0.76	10.17	3.022	10.08	3.8
2B	4	0.83	11.84	1.30	3.11	0.78	10.79	0.23	8.29	2.021	13.60	2.0
3B	5	0.79	129.87	8.17	2.14	1.61	19.07	0.72	8.78	3.182	10.84	3.2
3B	6	0.36	8.16	0.84	0.38	0.50	9.06	0.18	8.74	2.362	10.67	1.8
7B	13	0.80	123.01	8.30	2.80	1.44	22.86	0.68	11.80	3.041	7.78	8.2
7B	14	0.20	3.77	0.23	0.03	0.36	8.80	0.18	8.43	0.469	11.86	0.8
11B	21	0.81	83.96	8.44	1.73	0.98	17.84	0.37	8.77	3.355	10.21	2.3
11B	22	0.26	8.10	0.43	0.32	0.33	7.70	0.08	8.95	0.821	14.42	0.8
15B	29	0.83	72.81	8.18	1.29	0.98	18.10	0.44	10.85	2.319	8.96	3.0
15B	30	0.18	3.88	0.28	0.00	0.31	8.01	0.13	8.78	0.186	11.09	0.6
16B	31	0.37	71.70	8.86	1.37	0.92	21.34	0.68	13.22	1.806	8.43	1.8
16B	32	0.18	2.94	0.18	0.06	0.30	7.61	0.18	7.28	0.100	11.17	0.3
19B	37	0.17	18.13	1.78	0.81	0.48	13.22	0.28	10.83	0.863	11.32	0.8
19B	38	0.13	2.38	0.00	0.00	0.28	9.02	0.14	8.93	0.110	13.34	0.2
24B	47	0.10	2.22	0.10	0.43	0.28	14.80	0.17	14.28	0.208	7.80	0.3
24B	48	0.18	1.76	0.06	0.06	0.30	8.44	0.18	8.33	0.117	7.71	0.2
INNER MARINA												
4B	7	0.61	122.84	12.84	3.47	1.29	27.47	0.89	11.88	7.801	7.14	2.2
4B	8	0.40	8.35	0.16	0.44	0.78	10.06	0.33	9.40	6.087	12.82	3.0
6B	9	0.83	117.78	12.48	2.29	1.24	22.81	0.81	8.14	1.840	12.34	2.5
6B	10	0.32	8.80	0.19	0.38	0.82	12.82	0.30	12.27	4.468	13.18	1.0
6B	11	0.62	116.18	11.07	1.86	1.17	22.06	0.86	10.03	1.854	8.90	2.0
6B	12	0.60	7.88	0.58	1.34	0.82	11.77	0.32	9.84	4.244	16.80	0.8
MID MARINA												
8B	15	0.23	18.16	2.32	1.04	0.81	12.84	0.29	9.48	3.158	11.17	0.8
8B	16	0.32	8.13	0.78	1.34	0.61	10.36	0.18	8.23	1.161	18.45	1.8
8B	17	0.29	38.56	4.82	0.64	0.62	10.10	0.34	4.95	4.995	7.71	0.6
9B	18	0.34	8.89	4.18	0.79	0.47	10.38	0.13	8.42	1.623	12.63	1.3
10B	19	0.41	64.22	8.06	1.15	0.74	17.29	0.32	8.10	2.251	8.88	0.8
10B	20	0.18	3.04	0.31	0.09	0.34	8.11	0.14	8.70	0.826	12.67	1.2
OUTER MARINA												
12B	23	0.27	30.90	3.90	1.33	0.83	17.40	0.29	12.20	3.182	12.87	1.0
12B	24	0.81	6.82	0.44	1.70	0.83	14.08	0.32	13.95	2.341	14.44	4.7
13B	25	0.31	46.47	6.37	0.88	0.84	16.94	0.34	10.90	2.890	12.21	0.8
13B	26	0.41	8.97	0.44	1.54	0.71	13.30	0.30	11.32	2.248	14.32	3.2
14B	27	0.33	64.02	8.90	0.86	0.68	16.96	0.33	10.14	2.846	9.08	1.1
14B	28	0.23	3.87	0.44	0.18	0.35	9.87	0.11	9.37	0.854	13.43	0.7
OCEAN WEST INSIDE												
19B	37	0.17	18.13	1.78	0.81	0.46	13.22	0.28	10.86	0.842	11.32	0.8
19B	38	0.13	2.35	0.09	0.00	0.28	9.03	0.14	8.93	0.110	13.24	0.2
18B	35	0.11	3.19	0.18	0.08	0.23	8.01	0.12	8.80	0.117	6.88	0.2
18B	36	0.13	2.28	0.18	0.18	0.27	9.11	0.14	8.78	0.109	14.73	0.3
17B	33	0.13	2.83	0.12	0.14	0.28	8.84	0.13	8.32	0.102	7.38	0.2
17B	34	0.13	2.47	0.08	0.04	0.34	7.44	0.11	7.31	0.101	9.88	0.2
OCEAN WEST OUTSIDE												
24B	47	0.10	2.22	0.10	0.42	0.28	14.80	0.17	14.28	0.205	7.80	0.3
24B	48	0.15	1.78	0.08	0.05	0.30	8.44	0.15	8.33	0.117	7.71	0.2
23B	45	0.13	8.24	0.68	0.14	0.35	8.89	0.22	8.17	0.255	8.47	0.4
23B	46	0.10	1.81	0.03	0.00	0.20	8.44	0.18	8.41	0.104	7.98	0.1
22B	43	0.11	3.98	0.18	0.18	0.25	9.80	0.14	9.29	0.124	8.25	0.2
22B	44	0.18	1.96	0.06	0.00	0.18	8.61	0.03	8.55	0.214	8.92	0.2
OCEAN EAST INSIDE												
19B	37	0.17	19.13	1.78	0.81	0.46	13.22	0.28	10.85	0.842	11.32	0.6
19B	38	0.13	2.35	0.09	0.00	0.29	9.02	0.14	8.93	0.110	13.24	0.2
20B	39	0.11	2.28	0.16	0.37	0.18	8.90	0.07	8.37	0.093	23.84	0.3
20B	40	0.11	2.08	0.03	0.00	0.25	7.68	0.18	7.82	0.102	8.08	0.1
21B	41	0.12	1.98	0.09	0.04	0.25	7.47	0.13	7.34	0.101	28.92	0.5
21B	42	0.11	1.08	0.20	0.02	0.21	8.05	0.10	7.84	0.108	18.88	0.2
OCEAN EAST OUTSIDE												
24B	47	0.10	2.22	0.10	0.42	0.28	14.80	0.17	14.28	0.205	7.80	0.3
24B	48	0.18	1.78	0.08	0.05	0.50	8.44	0.15	8.33	0.117	7.71	0.2
25B	49	0.18	1.94	0.08	0.34	0.36	11.78	0.17	11.35	0.218	9.79	0.2
25B	50	0.12	1.83	0.08	0.01	0.44	12.83	0.31	12.84	0.100	7.44	0.4
26B	51	0.11	2.18	0.08	0.15	0.27	8.68	0.18	8.37	0.080	8.71	0.3
26B	52	0.11	1.83	0.03	0.02	0.25	8.44	0.14	8.38	0.118	8.08	0.1

Ala Wai Flow Constituents

March 10 1318 to March 12 0006, March 13 0006 to March 25 0006

Salinity	Varies	ppt	Varies	ppt	
TSS	8.4	mg/l	8.4	mg/l	
PO4	0.34	uM	0.01055	g/m^3	
NH4	2.72	uM	0.03814	g/m^3	
NO3	9.81	uM	0.13743	g/m^3	
Si(OH)4	48.77	uM	1.36986	g/m^3	
TON	14.06	uM	2.4609	g/m^3	Expressed as LDOM = (TON)/0.08
CHL a	3.664	ug/L	0.5313	g/m^3	Expresses as Algal Mass Algal mass to CHL a ratio =145
DO	6	g/m^3	6	g/m^3	

March 12 0006 to March 13 0006, March 25 0006 to March 28 0006, March 30 0006 to March 31 0006

Salinity	Varies	ppt	Varies	ppt	
TSS	14.15	mg/l	14.15	mg/l	
PO4	1.66	uM	0.0515	g/m^3	
NH4	2.74	uM	0.0384	g/m^3	
NO3	23.99	uM	0.336	g/m^3	
Si(OH)4	116.88	uM	3.2826	g/m^3	
TOP	0.38	uM			
TON	7.35	uM	2.9296	g/m^3	Expressed as LDOM = (TON)/0.08
CHL a	5.218	ug/L	0.4277	g/m^3	Expresses as Algal Mass Algal mass to CHL a ratio =145
DO	6	g/m^3	6	g/m^3	

March 28 0006 to March 30 0006, March 31 0006 to end

Salinity	Varies	ppt	Varies	ppt	
TSS	10.84	mg/l	10.8407	mg/l	
PO4	0.79	uM	0.0244	g/m^3	
NH4	2.14	uM	0.03	g/m^3	
NO3	8.17	uM	0.1144	g/m^3	
Si(OH)4	129.87	uM	3.6474	g/m^3	
TOP	0.38	uM			
TON	8.76	uM	1.5339	g/m^3	Expressed as LDOM = (TON)/0.08
CHL a	3.152	ug/L	0.457	g/m^3	Expresses as Algal Mass Algal mass to CHL a ratio =145
DO	6	g/m^3	6	g/m^3	

Salinity varies from 23 to 34.5 ppt based on calculation from ADCP data of upstream (34.5) and downstream(23) water volumes
Temperature varies from 24.8 to 25.5 C based on calculation from ADCP data of upstream (24.8) and downstream(25.5) water volumes
Discharge is calculated by computing average velocity from an ADCP profile

Proposed Hilton Lagoon Discharge Pipe Flow
15000 gpm = 0.9464 m^3/sec split to inner and outer basin
Temperature step function with values:

1000-1759 HST = 26.1°C
1800-0959 HST = 24.5°C

Constituents used:

	Provided Values		Values in Model		
Salinity	35	ppt	35	ppt	
TSS	3.49	mg/l	3.49	mg/l	
PO4	0.78	uM	0.02425	g/m^3	
NH4	0.4	uM	0.0056	g/m^3	
NO3	3.11	uM	0.04362	g/m^3	
Si(OH)4	122.48	uM	3.44	g/m^3	
TON	6.07	uM	1.063	g/m^3	Expressed as LDOM = (TON)/0.08
CHL a	0.02	ug/L	0.0029	g/m^3	Expresses as Algal Mass Algal mass to CHL a ratio =145
DO	6	g/m^3	6	g/m^3	

Existing Hilton Lagoon Discharge Pipe Flow Constant Temperature = 25.5°C
5300 gpm = 0.334 m^3/sec

Salinity	34.89	ppt	34.89	ppt	
TSS	76.63	mg/l	76.63	mg/l	
PO4	0.1	uM	0.0031	g/m^3	
NH4	0.38	uM	0.0053	g/m^3	
NO3	0.28	uM	0.0039	g/m^3	
Si(OH)4	8.37	uM	0.2344	g/m^3	
TON	7.62	uM	1.484	g/m^3	Expressed as LDOM = (TON)/0.08
CHL a	0.26	ug/L	0.0377	g/m^3	Expresses as Algal Mass Algal mass to CHL a ratio =145
DO	6	g/m^3	6	g/m^3	

APPENDIX D. LIST OF SPECIES PRESENT IN THE LAGOON

Species	Substrate	Species	Substrate
Algae/Seagrasses			
*Acanthophora spicifera**	occupies soft substratum	*Halophila decipiens**	occupies soft substratum
*Gracilaria salcornia**	occupies soft substratum	*Coelothrix irregularis*	occupies soft substratum
Lyngbya majuscula	occupies soft substratum	*Tolypiocladia sp.*	occupies soft substratum
Bryopsis hypnoides	occupies soft substratum		
Sponges			
*Gelliodes fibrosa**	occupies hard substratum	*Haliochondria coerulea**	occupies hard substratum
*Suberites zeteki**	occupies hard substratum	*Dysudea avara**	occupies hard substratum
*Mycale armata**	occupies hard substratum	*Chondrosia* sp. (tentative)	occupies soft substratum
Jellyfish			
*Cassipoea andromeda**	occupies soft substratum		
Anemones			
Aptasia pulchella	occupies hard substratum		
Corals			
Cyphastrea ocellina	occupies hard substratum		
Polychaetes			
*Sabellastarte spectabilis**	occupies hard substratum	*Chaetopteris variopedatus**	occupies soft substratum
Eurythoe complanata (fireworm)	occupies hard substratum	*Salmacina* sp.*	occupies hard substratum
Neodexiospira steueri	occupies hard substratum	Unidentified *nereids*	found in association w/ algae
Exogene sp.	found in association with algae	Unidentified *syllids*	found in association with alga
Sphaerosyllis sp.	found in association with algae	Unidentified *dorvilleids*	found in association w/ algae
Acorn Worms			
Ptychodera flava	occupies soft substratum		
Mollusks			
Isognomon perna	occupies hard substratum	*Tellina palatam* (clam)	occupies soft substratum
Isognomon californicum	occupies hard substratum	*Macoma dispar* (clam)	occupies soft substratum
Ostrea sandvicensis	occupies hard substratum	*Chromodoris decora* (nudibranch)	found in association w/ algae
Bryozoans			
*Amathia distans**	occupies hard substratum		
Arthropods			
*Chthamalus proteus** (barnacle-all dead)	occupies hard substratum	*Thalamita edwardsi* (sm. swimming crab)	occupies soft substratum
Leptochelia dubia (amphipod)	found in association with algae	*Thalamita integra* (blue-pincher crab)	occupies soft substratum
Palaemon debilis (opae)	occupies soft substratum w/	Unidentified copepods	found in association w/ algae
Paribacus antarcticus (ula'papa)	occupies hard substratum	Unidentified gammarid amphipods	found in association w/ algae
Pilodius areolatus (chocolate claw crab)	occupies hard substratum	Unidentified cumaceans	found in association w/ algae
Echinoderms			
Opiocoma savigayi (brittlestar)	found in association with algae	*Holothuria hilla* (sea cucumber)	occupies hard substratum
Opiocoma dentata (brittlestar)	found in association with algae	*Holothuria impatiens* (sea cucumber)	found in association with algae
Holothuria parvula (sea cucumber)	found in association with algae	*Opheodesoma spectabilis*	occupies mix of substratum types
Tunicates			
*Ascidia sydneiensis**	occupies mix of substratum types	*Phallusia nigra**	occupies hard substratum

Species	*Substrate*	*Species*	*Substrate*
Ascidia nigra	occupies mix of substratum types	*Botryllus* sp.	occupies hard substratum
Ascidia sp.	occupies hard substratum		
Fishes			
Psilogobius mainlandi (goby)	occupies soft substratum	*Dascyllus albisella* ('alo'ilo'a)	occupies hard substratum
Bathygobius fuscus (goby)	occupies soft substratum	*Abudefduf abdominalis* (mamo)	occupies hard substratum
Gnatholepis anjerensis (goby)	occupies soft substratum	*Saurida gracilis* (lizardfish)	occupies soft substratum
Arothron hispidus (smooth puffer)	occupies mix of substratum types	Kuhlia sandvicensis (aholehole)	occupies hard substratum
Diodon holocanthus (spiny puffer)	occupies hard substratum	Pranesus insularum ('iao – tentative ID)	In water column
Diodon hystrix (spiny puffer)	occupies hard substratum	*Tilapia meoanotheron** (silver tilapia)	in water column
Asterropteryx semipunctatus (eleotrid)	occupies hard substratum		

Notes: Survey conducted on 10 December 2003. Also given is the habitat (i.e., hard or soft substratum or algae) that each species is usually found. An asterisk following a specific name denotes species that are known to be alien (recent introductions).

Source: Dr. Richard Brock