PRELIMINARY
ENGINEERING REPORT
FOR
NEW POTABLE WATER SOURCES

AGRICULTURAL SUBDIVISION WATER SYSTEM
HUEHUE RANCH DEVELOPMENT
KAILUA-KONA, HAWAII
WELL HR-3 (STATE WELL 4558-01)
T.M.K. 7-2-04:07

DECEMBER 1991

PREPARED FOR:
HUEHUE RANCH ASSOCIATES, L.P.
75-5722 KUAKINI HIGHWAY, SUITE #107
KAILUA-KONA, HAWAII 96740

BY:
AKINAKA & ASSOCIATES, LTD.
250 NORTH BERETANIA STREET, SUITE 300
HONOLULU, HAWAII 96817-4716

AND
WAIMEA WATER SERVICES
P.O. BOX 326
KAMUELA, HAWAII 96743
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I. INTRODUCTION

This report is prepared pursuant to Chapter 20 of Title 11, "Potable Water Systems," of the Public Health Regulations, which requires submittal of preliminary drawings and supporting data to the State Department of Health when a new source of water supply is developed.

The new source of water supply, Well HR-3 (State Well No. 4558-01) located on the lower slopes of Hualalai Volcano in the North Kona District, Island of Hawaii, will serve the Huehue Ranch Development located as shown on EXHIBIT 1: ISLAND MAP.

This report follows the format of "Guidelines for Preparation of Preliminary Engineering Reports for New Potable Water Sources", Drinking Water Program, State Department of Health. The information it contains has been gathered from various project reports and documents as listed below. As appropriate in this report, they will be referenced by their listed letter designation.

The firms of Akinaka & Associates, Ltd. and Waimea Water Services prepared this report. Waimea Water Services provided the hydro-geologic sections of this report. As referenced, the planning data for the Huehue Development was obtained from PBR Hawaii. Section VII "Proposed Treatment Work" is an insert prepared by Sam O. Hirota & Associates.

REFERENCES FOR WELL HR-3


I. Keahole to Kailua Development Plan, County of Hawaii, November 1990.
II. GENERAL INFORMATION

A. Project Description and Location

1. Development Description

On the lands of Kukio (See EXHIBIT 2: LOCATION MAP) Huehue Ranch Associates, L.P. is proposing to develop a 187 lot (more or less) agricultural subdivision with recreational amenities which will include an 18 hole golf course with clubhouse, tennis center, equestrian center, and a sales and administrative facility on the mauka portion of its lands, specifically on TMK's 7-2-04:07, 7-2-06:09 and 7-2-07:01. These lands, which comprise approximately 1,736 acres on either side of the Mamalahoa Highway are located about 12 miles north of Kailua-Kona and 32 miles south of Waimea.

On the makai portion of the property (TMK's 7-2-04:05 and 16), the proposal is to develop a resort hotel complex, multi-family and single family residential units, an 18 hole golf course, other recreational facilities, and a village commercial area. This portion of the development is located on approximately 675 acres in the North Kona District on either side of the Queen Kaahumanu Highway about six miles north of the Keahole Airport and one mile south of the Kona Village Resort. EXHIBIT 3: VICINITY PLAN locates the project described above.

Phase I will take place in 1991 through 1993. Components of Phase I will include the development of the 187 mauka agricultural lots and facilities, 350 hotel units, 71 to 114 multi-family units and 120 to 179 single family units in the makai portion of the property. Phase II includes an additional 102 to 170 multi-family units and 119 to 184 single family units which will be developed during 1993 - 1996. Phase III will take place from 1997 to 1999 and include 194 to 317 multi-family units and 53 to 73 single family units.

2. Water System (Off-site)

The Huehue Ranch Associates, L.P. proposes to construct well pump facilities at the existing Well HR-3 which will serve the
Huehue Ranch Development. This off-site water system (See EXHIBIT 4: OFF-SITE WATER SYSTEM) will consist of:

a. Installation of well pump with submersible motor, pump control piping and appurtenances at the well site.

b. Construction of a motor control center, telemetering equipment, flow recorder, water level recorder, and chlorination system. New buildings will be constructed to house these equipment and the control system.

c. Construction of water treatment works utilizing water softening and activated treatment with optional ozone injection will be included.

d. Installation of ductile iron pipeline system with booster pump stations connecting the wells and the Huehue Ranch Reservoirs. Miscellaneous piping for pump control discharge, system pressure control, compressed air line and chlorine solution are included.

e. Site work to include grading, asphalt concrete access road and site preparation for the control building.

B. Owner and Operator of the Project:

The Huehue Ranch Associates, L.P. will own, and initially construct and maintain the proposed well pump systems. It is anticipated that the water system (including wells, treatment plants, pumps, and reservoirs) will be maintained as an independent private system and require no public monies for operation or maintenance.

In July 1991 Huehue Ranch Associates, L.P. (HRA) sold the upper portion of the development area, consisting of the 1,736 acres on either side of Mamalahoa Highway, to Makalei Hawaii Corp. HRA retained ownership of the lower development on either side of Queen Kaahumanu Highway and the water resources situated within the upper development. The water utility to service both the upper and lower developments will be operated by HRA as a single, private utility. The planned land uses and populations served by the utility, as summarized below, remain unchanged.
III. PHYSICAL AND HYDROLOGICAL CHARACTERISTICS OF THE AREA

A. Location:

The Huehue Ranch Development is approximately 12 miles north of Kailua-Kona and 32 miles south of Waimea. The off-site water system will be constructed in vicinity of Mamalahoa Highway between elevation 1600' and 2850'. Well HR-3 site is located at the 1600' level.

B. Climate:

The mauka lands are located in the lee of the mountains so are buffered from gusty tradewinds. Predominant wind patterns come from the convectional processes occurring from the daily heating and cooling of the land. Temperatures in the winter months range from 60 degrees to 75 degrees Fahrenheit. In the summer months temperatures range from 70 to 85 degrees Fahrenheit. Rainfall is closely linked to the elevations of the parcels and the season. Parcels in the 700' - 1,175' elevation receive approximately 20 - 25 inches annually, while those in the 1,200' - 3,000' elevation receive approximately 25 - 50 inches annually as shown in EXHIBIT 5: RAINFALL MAP. Maximum precipitation occurs in the period from May through September.

The environmental conditions at the makai Kukio lands are similar to those along the rest of the North Kona and South Kohala coast. Temperatures vary between 75 and 85 degrees Fahrenheit. Cooler temperatures are experienced inland at higher elevations. The subject property is south of the strong wind line in South Kohala so is not subjected to the intense winds that buffet Waikoloa and Kawaihae. Winds at Kukio are usually light and variable, often blowing offshore in the morning and onshore later in the afternoon. Rainfall on the makai lands averages only 7 to 8 inches annually.

C. Topography:

Land slopes in the off-site water system area averages 14 percent. The slopes at the well sites are approximately 12 percent while the pipeline to the reservoirs will range up to 20 percent. The gradient direction is consistent in the westerly direction.
D. **Geology:**

The surface geology of Hualalai Volcano was described by Stearns and MacDonald (1946) in **EXHIBIT 6 & 7**, is the published map from the Stearns report. A thin soil layer overlies basaltic rocks of the Hualalai Volcanic series (Qhl). In general, these volcanic rocks comprise all the lava flows, intrusive rocks and pyroclastic rocks of Hualalai. In areas where soil is non-existent, both pahoehoe and a’a forms of basalt are evidenced at the site. Relative ages of separate lava flows can generally be distinguished by variations in color and vegetation, with younger flows appearing darker and less vegetated.


As shown in **EXHIBIT 7**, the well field for the domestic and potable water supply straddles the north west rift zone of Hualalai. Geologic description in this section was first begun at Huehue with the drilling of well HR-1 (State Well No. 4559-01). Similar geologic conditions were discovered at Well HR-3 and are illustrated in **EXHIBIT 8: WELL SECTION HR-3**.

Major discoveries of massive trachyte lava flows have been confirmed in HR-1 and HR-3 wells more than 800 feet below the surface. These massive flows were absent in HR-2 well. Lavas in the upper 800 feet of the Huehue Ranch consist largely of thin bedded pahoehoe and a’a flows interspersed with occasional clinker beds. In addition to the geologic description of materials encountered during drilling of the wells, continuous television logs have been retained for wells HR-2 and HR-3.

As evidenced during the drilling of HR-1 and HR-2, dense, non-porous a’a lava is found between the elevations of about 200 feet +/- 50 feet to elevation -15 to 20 feet. In both wells, the first water entered the bores between -15 and -20 feet and rose to elevation +7 feet.

The northwest rift zone of Hualalai has erupted as recently as 1801. Water quality in HR-1 clearly confirms the presence of hydrothermal alteration. New geologic information will be available in the future as drilling progresses.
E. Earthquake Consideration and Design Parameters:

The island of Hawaii is seismically active and is in Seismic Zone III of the Uniform Building Code. Although the most recent large earthquakes have taken place under the southern part of the island, a large earthquake offshore from Kealakekua Bay, roughly 20 miles south of the site, occurred on August 21, 1951. Its magnitude was between 6.75 and 7.0, and its Modified Mercalli intensity at the site was estimated to be IV. This intensity level corresponds to nondestructive ground motion felt by many people indoors.

The closest large earthquake to the site probably was the magnitude 6.5 event on October 6, 1929, centered under Hualalai Volcano. Assuming a distance between 10 and 15 miles from the 1929 earthquake, Modified Mercalli intensities at the site of VII to VIII would have resulted. This corresponds to ground motion causing damage ranging between negligible to slight in well-built structures and slight to considerable damage in ordinary substantial buildings.

The project will conform with standards for Earthquake Zone III in the Uniform Building Code to minimize risks from earthquake activity. Further geotechnical surveys will be conducted to determine the presence of lava tubes and subsurface cavities that could pose a hazard to construction workers and require special design considerations.

F. Groundwater Conditions:

The complete well field (consisting initially of HR-1, HR-2 and HR-3) will straddle the northwest rift zone of Hualalai volcano. As indicated in the Section III.D, "Geology," the geology of the area is unique in terms of water. Because of very dense a'a lavas located near and just below sea level (SEE EXHIBIT 8: WELL SECTION HR-3) the groundwater in the vicinity of HR-1 and HR-2 is considered semi-artesian. Regardless, it is presently assumed that the groundwater occurs as a basal lens. Water level measurements made since 1985 indicate that the water level stands from 7 to 10 feet above sea level, depending on the season.

Based on studies performed since 1981 for this water development program, the water level contours shown in EXHIBIT 9: GROUNDWATER MAP are representative. The average gradient is
about 2.5 feet per mile based on data available presently. It is not yet known how the rift zone influences groundwater flow laterally.

Assuming a water level fluctuation of +7 to +10 feet, it is estimated that the minimum thickness of fresh water is about 287 feet and the transition zone (brackish) has a thickness of about 120 feet. Well HR-2 and HR-3 penetrates to about elevation -80 feet.

Well spacing and pumping rates have been based on estimates of groundwater flows of 2 to 4 mgd per mile of aquifer width. The relatively thin lens and low yields caused by dense lava at sea level tend to promote the use of smaller capacity (350 gpm to 500 gpm) pumps and widely spaced wells (about 2000 feet between producing wells).

G. Flood Problems:

Due to low rainfall and highly porous ground conditions, natural runoff from seasonal rainfall is very limited and flood hazards remote. What little surface runoff that occurs during storm events is predominantly carried as sheet flow before percolating to the groundwater table.

Flood Insurance Maps do not cover project site.

H. Conformance with local Land Use Planning and Zoning Regulations:

The land use in the area of the Huehue Ranch is characterized by extensive agricultural use, with some small areas of residential development. The area to the north of the resort development is also classified and in use as resorts, namely the Kona Village and Kaupulehu developments. The area to the south is open at this time.

Huehue Ranch is presently used for agricultural purposes with initial construction phases of the 18-hole mauka golf course. Proposed development will conform to State and County land use and zoning regulations as shown on EXHIBIT 10: STATE LAND USE and EXHIBIT 11: GENERAL PLAN.
Discussion of Water Rights and Future Uses:

The water wells will be developed primarily to serve the water requirements for the Huehue Ranch Development. Future considerations include construction of Hawaii County Department of Water Supply's 300,000 gallon tank at Elevation 2060 connected to the transmission main between Reservoir #2 and #3. The Huehue Ranch wells will serve as an emergency resource to the County of Hawaii, Department of Water Supply's North Kona Water System through this reservoir.
IV. **EXTENT OF WATERWORKS SYSTEM**

A. **Description of the nature and extent of the existing area and future area to be served:**

The total development area consists of approximately 2,411 acres. 1,736 acres are located at the upper elevations, on either side of the Mamalahoa Highway. These lands are generally slightly sloped with relatively level "benches" crossing the property, particularly in the mauka portions. Slopes generally range from 10 to 20 percent. There are no streams or major gulches. There are five soil types on the subject parcels ranging from Punalu'u extremely rocky peat, Kaimu extremely stony peat, Aa lava flows, pahoehoe lava flows and cinder lands. The Detailed Classification - Island of Hawaii classifies the lands with suitability ratings of 'D' and 'E', which are characterized as having "poor productivity" and "very poor productivity," respectively.

The flora in the area consists of natural vegetation - a mixture of shrubs, trees and fountain grass - and pasture land which is planted with kikuyu, green panic, buffel and guinnea grasses. Fauna consists of mongoose, feral goats and pigs, and various birds. No rare or endangered species have been identified as habitating within the subject area.

The 675 acres located on either side of the Queen Kaahumanu Highway, and comprising the makai portion of the proposed development are characterized by rough lava which supports a minimum of dry land vegetation. The coastal area is characterized by several stretches of white sand beach backed by a low lying sand dune, coconut grove, anchialine ponds and a dense thicket of kiawe. Slopes range from 10 to 20 percent or less. The area from sea level to the highway, which is approximately 200' above sea level is relatively flat. Mauka of the highway there is gentle sloping to a maximum elevation of 680' at the Muheenui cinder cone. The predominant flora in the area is fountain grass and kiawe trees. There are palms, coconuts, hala, and other native plants around and makai of the pond complex. There are no rare or endangered plant species on the site. Animal life includes a variety of feral rodents and dryland birds, with several species of water fowl visiting the pond complex. Within the ponds themselves are opae'ula, several varieties of crustaceans, worms, and exotic fish.

The total project area is not anticipated to increase in size.
B. Description of population served and land use data.

The agricultural subdivision in the mauka ranch lands is expected to contain approximately 183 new single residences. An additional four single family residents, already in existence, will also be served by the water system. In addition to single family residences dependent upon the new water source, there will be a sales office and an administrative office which will have a combined number of employees equalling about 35, and four units comprising the ranch headquarters. Other uses will include the ranch golf clubhouse, tennis facilities, sewage treatment plant (STP), and the equestrian center.

In terms of acres devoted to a specific land use, the ranch portion of the development can be broken down as follows:

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential lots</td>
<td>219.4</td>
</tr>
<tr>
<td>Ranch headquarters</td>
<td>167.5</td>
</tr>
<tr>
<td>Cowboy residences</td>
<td>5.0</td>
</tr>
<tr>
<td>Golf course</td>
<td>300.0</td>
</tr>
<tr>
<td>Golf maintenance/STP</td>
<td>3.5</td>
</tr>
<tr>
<td>Clubhouse/tennis center</td>
<td>15.0</td>
</tr>
<tr>
<td>Equestrian center</td>
<td>19.0</td>
</tr>
<tr>
<td>Sales/administration</td>
<td>5.0</td>
</tr>
<tr>
<td>Pasture</td>
<td>1,038.4</td>
</tr>
<tr>
<td>Conservation</td>
<td>25.0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,797.8</strong> acres</td>
</tr>
</tbody>
</table>

The beach development will comprise a resort hotel of 350 units with related restaurant facilities, health spa, golf course and clubhouse, tennis center, parks, and both multi-family and single family units. There will be approximately 661 to 1,037 residential units at build-out.
In terms of acres devoted to a specific land use, the beach portion of the development can be broken down as follows:

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel site</td>
<td>51.7</td>
</tr>
<tr>
<td>Golf course</td>
<td>241.7</td>
</tr>
<tr>
<td>Commercial</td>
<td>6.5</td>
</tr>
<tr>
<td>Roadways</td>
<td>33.0</td>
</tr>
<tr>
<td>Parks</td>
<td>12.4</td>
</tr>
<tr>
<td>Maintenance center</td>
<td>2.5</td>
</tr>
<tr>
<td>Sewage treatment plant</td>
<td>3.7</td>
</tr>
<tr>
<td>Community/tennis center</td>
<td>3.0</td>
</tr>
<tr>
<td>Miscellaneous open</td>
<td>29.6</td>
</tr>
<tr>
<td>Residential multi-family</td>
<td>65.8</td>
</tr>
<tr>
<td>Residential single family</td>
<td>225.7</td>
</tr>
</tbody>
</table>

TOTAL 675.6 acres

C. Appraisal of future requirements for service, including existing and potential residential, commercial, resort and other water supply needs:

There is not expected to be any further expansion beyond that discussed in Section IV.B above.

D. Provisions for extending waterworks system.

Additional water sources are planned for the Huehue Ranch Development. Future wells are planned along the 1600' contour: HR-4 between HR-1 and HR-2, and HR-5 north of HR-3. These wells are located on EXHIBIT 7: GEOLOGIC MAP - DETAIL.

Extending the water system as an emergency resource for the Department of Water Supply is discussed in Section III.I. No other extensions beyond the limits of the development are planned.

E. Fire protection and pressure requirements:

The water system's design follows the Hawaii County Department of Water Supply standards for storage, transmission and distribution. All applicable fire flow and pressure requirements will be met.
F. Alternate solution considered and supporting data for recommended plan:

Other ways to meet the projected water demand are to develop a substantial rainfall catchment system or to desalinize brackish water from shoreline wells. Both of these alternatives are not economically comparable to the proposed wells and would involve other environmental impacts as well. Water from existing Hawaii County, Department of Water Supply and Huehue Ranch wells cannot meet the development's demand.

G. Environmental and Economic Impact:

The impact that the proposed off-site water system will have on the environment can be broken down into two categories: primary impacts, which are associated with the construction and initial operation of the water system; and secondary or long-term impacts which may or may not become apparent after several years of continuous functioning. Because of their particular importance, impacts on ground water resources in the areas are discussed separately.

1. Primary Impacts:

During the construction phase of the project, it is expected that some volume of dust and noise will be produced. In an agricultural area this will only be a minor inconvenience. The nearest house is approximately 0.5 miles from the site. Construction will occur only during specific daylight hours and dust prevention measures; such as, dampening the ground with a minimum amount of water, will be implemented.

Site work at the well sites will permanently transform the landscape in the immediate area. Excavation and trenching surface shall be restored to its original condition. Installation of a pump with submersible motor will assure quiet pump operations and eliminate motor noise intrusion into the natural landscape.

Environmental impacts due to the water supply system are negligible.
2. Secondary Impacts:

The installation of the proposed water supply improves the climate for development, but will not in itself result in a sudden movement towards further urbanization. Several requirements must be satisfied for residential development to proceed successfully: land must be available, public service facilities must be able to handle greater numbers of people and the public must be in favor of such projects.

3. Economic Impacts:

The primary economic impact of the agricultural lot subdivision will be the generation of significantly increased real property tax revenues for the County, once the lots are improved. There will be some increase in employment related to the upper development, namely a sales force of up to eight and the requisite personnel for the golf, tennis, and equestrian recreational amenities.

The resort development will have a more significant economic impact, being both larger in scale and more land use intensive. The resort itself will generate direct, indirect and induced visitor expenditures. Direct visitor expenditures are estimated to amount to $51 - 74 million at completion of the resort. Indirect and induced expenditures could generate an additional $48 - 69 million (in 1985 dollars).

The planned development will also generate both short-term and long-term increases to employment. The direct construction employment could generate a total demand for 2,400 to 3,200 person years for the entire project. The operational employment is estimated to be between 840 and 1,320 full-time equivalent positions at completion of the resort.

In terms of increased revenues to the County of Hawaii, the project could be expected to generate between $3.5 and $5.0 million at completion. An analysis comparing projected public revenues to public expenditures indicates that additional County
revenues will be 3.0 to 3.1 times the expenditures incurred by the County. Increased revenues to the state, through the general excise tax, income tax, and other state taxes could range between $4.2 and $6.1 million per year at completion (in 1985 dollars). The expected revenue/expenditure ratio for the state would be in the range of 2.8 to 3.5 more revenues than expenditures.

The above stated economic impact figures were derived from projections made by John Child & Company, Inc. as part of the Environmental Impact Statement prepared for Huehue Ranch for the Kukio Beach Resort and submitted to the Planning Department, County of Hawaii in 1986.
V. POTENTIAL SOURCES OF CONTAMINATION

A. Description of Well Site:

1. Coordinates:

Well HR-3 (State Well 4558-01) has the following coordinates:

6479.67N
9110.47W

Coordinates above are based on Trig Station: Moanuiahea

2. Topography and Land Surface Elevation:

The well is located approximately 4.6 miles from the shoreline at elevation 1510. Ground slopes of approximately 10 percent are typical at the well sites. No major gullies or craters are located in the near vicinity.

3. Size and Topography of Catchment Area

The well sites will provide virtually no surface catchment of water so surface drainage will not be a problem. The precise areal size of the catchment area is not known. In general, the recharge area for groundwater flowing to the well sites is inland and upslope of the well on the western slopes of Hualalai volcano.

4. General Summary of Soil and Substrata:

The well site contain a thin layer of soil (ash & cinders) underlain by basaltic rocks of the Hualalai Volcanic Series (Qhl). Both pahoehoe and a'a types of basaltic rocks are represented at the site as evidenced by the well boring logs shown on EXHIBIT 8.

10/01/91
5. Well depth, depth to ground water and design well draft.

a. **STATE WELL NO. 4559-01 (EXHIBIT 8: WELL SECTION HR-3)**

Ground El. = 1518 Ft.
Q = 550 GPM
Hp = 300 Hp
Static Head = 1590 Ft.
TDH - 1613 Ft.
Casing = 18 inches (inside diameter) to 498' depth
14 inches (inside diameter) to 1445' depth
W.S. El. = 7 Ft.

TDH = Total Dynamic Head

B. **Water Quality:**

The following tables are results of samples analyzed by Brewer Analytical Laboratory. Per laboratory remarks, the samples were analyzed according to "Methods for Chemical Analysis of Water and Wastes" U.S.E.P.A., March 1976, and/or "Microbiological Methods for Monitoring the Environment", U.S.E.P.A., August 1978.
LABORATORY ANALYSIS REPORT (1)

TO: HUE HUE RANCH  
ADDRESS: 75-5722 KUAKINI HWY, SUITE 107  
ADDRESS: KAILUA-KONA, HAWAII 96740  
SAMPLES OF: POTABLE WATER

DATE SAMPLE ANALYZED: 08/05-09/11
TIME SAMPLE ANALYZED: 
SAMPLE TYPE
SAMPLE DESCRIPTION

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<td>FLUORIDE</td>
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</table>

**LABORATORY ANALYSIS REPORT (1)**

**TO:** HUEHUE RANCH  
**ATTN:** MR. STEPHEN BOWLES

**ADDRESS:** 75-5722 KUAKINI HWY, SUITE 107  
**KAILUA-KONA, HAWAII 96740**

**SAMPLES OF:** POTABLE WATER

**SAMPLES BY:** CLIENT  
**SAMPLING DATE:**  
**RECEIPT DATE:** 08/02/91  
**TIME:** 0930

**DATE SAMPLE ANALYZED:** 08/02-12/91  
**TIME SAMPLE ANALYZED:**

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<td>IRON</td>
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<td>POTASSIUM</td>
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<td>CALCIUM</td>
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<td>CHLORIDES</td>
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<td>SULFIDES</td>
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<tr>
<td>TOTAL DISSOLVED</td>
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<td>840</td>
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</table>

**SOLIDS**

<table>
<thead>
<tr>
<th>pH</th>
<th>units</th>
<th>8.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALKALINITY</td>
<td>meq CaCO₃/l</td>
<td>318</td>
</tr>
<tr>
<td>TOTAL HARDNESS</td>
<td>meq CaCO₃/l</td>
<td>334</td>
</tr>
<tr>
<td>SILICA</td>
<td>mg/l</td>
<td>64</td>
</tr>
<tr>
<td>CONDUCTIVITY</td>
<td>umhos/cm</td>
<td>967</td>
</tr>
</tbody>
</table>


_Signed_ [Signature]

[End of Document]
## INORGANICS ANALYSIS

<table>
<thead>
<tr>
<th>Compound</th>
<th>Method</th>
<th>Date Analyzed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluoride</td>
<td>340.2</td>
<td>09/30/91</td>
</tr>
</tbody>
</table>

**Client Sample ID**: 2  
**PNELI Sample ID**: 3590A-02  
**Sample Matrix**: Water  
**Date Sample Received**: 09/25/91  
**Units of Measure**: mg/l
C. **Land Use Classification of Surrounding Area:**

The surrounding area is classified Extensive Agriculture (EA) in the County General Plan and Agriculture in the State Land Use Plan as shown in EXHIBIT 11: GENERAL PLAN and EXHIBIT 10: STATE LAND USE.

D. **Potential Sources of Contamination In the Recharge Area:**

The wells are located in a remote area. The Huehue Ranch and nearby residences are the only active land uses. Potential sources of contamination are limited to cesspool effluent from individual residential units and the wastes of the ranch's cattle. Neither pose a health risk but chlorination will be provided to ensure that bacterial contamination is not a problem.

Future residential use of the surrounding area will be completely sewered. No solid waste or industrial facilities will be constructed in the development. Fertilizers and herbicides used to maintain the golf course is a potential source of contamination. Considering the depth to ground water (1600'), and stringent adherences to application instructions, contamination from the fertilizers and herbicides are remote.

The chemicals and fertilizers expected to be used on the golf course are:

- **Herbicides** - MCPP / 2-4 D / Round-up
- **Fungicides** - Subdue and/or Banner
- **Insecticides** - Dersban
- **Fertilizers** - 9-25-5 Starter Fertilizer
  - 5-10-15 Fertilizer
  - Ammonia Nitrate
  - Ammonia Sulfate

The Developer will establish a groundwater monitoring plan for approval by the State Department of Health in conformance to the "Eight (8) conditions Applicable to This New Golf Course Development" of April 1990 (version 3). The plan will include adequate employee education and a golf course operation and maintenance plan for use of fertilizers and biocides.
E. Approximate Groundwater Contours:

EXHIBIT 9: GROUNDWATER MAP provides approximate groundwater contours in the North Kona District. The map was based on Reference C: "Domestic Water Supply for the Proposed Subdivision at Huehue Ranch, North Kona, Hawaii; Island Resources, Ltd; September 1981" with contours revised in the area of the Huehue Development due to water surface elevations found at the new wells.
VI. SOURCES OF WATER SUPPLY

A. Nature of soil and stratum within and overlaying the water source:

The upper soil layers are typically a few inches to a few feet thick of volcanic ash and cinders overlaying layers of lava flows from the Hualalai volcano. Lava flows are both aa and pahoehoe types.

B. The probability and effect of surface drainage or contaminated underground water entering the subject water source:

1. Contamination from surface drainage will be prevented by designing the facilities to control local rainfall runoff.

2. Probability that contaminated underground water will enter the water source is decreased by grouting the upper 500' of the well.

C. Depth to water table, location and lay of wells in vicinity in use and/or abandoned:

1. Depth to water table for the well is approximately:

\[
\begin{align*}
\text{Land surface elevation} & = 1520' \\
\text{Water surface elevation} & = 7' \\
\text{Depth to water table} & = 1513' \text{ say } 1510' 
\end{align*}
\]

2. The following wells are planned for development in the vicinity of well HR-3 and shown on EXHIBIT 13: ADJACENT WELLS.

<table>
<thead>
<tr>
<th>WELL NAME</th>
<th>STATE NO.</th>
<th>DIST FROM HR-1</th>
<th>DRAW</th>
<th>RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nansay Hawaii</td>
<td>Kohanaiki 1</td>
<td>4458-01</td>
<td>4,000' So.</td>
<td>1.0 mgd</td>
</tr>
<tr>
<td>Nansay Hawaii</td>
<td>Kohanaiki 2</td>
<td>4458-02</td>
<td>5,000' So.</td>
<td>0.6 mgd</td>
</tr>
<tr>
<td>Kaupulehu Dev.</td>
<td>Kaupulehu 3</td>
<td>4658-03</td>
<td>7,000' No.</td>
<td>0.7 mgd</td>
</tr>
<tr>
<td>Kaupulehu Dev.</td>
<td>Kaupulehu 4</td>
<td>4658-04</td>
<td>6,000' No.</td>
<td>0.5 mgd</td>
</tr>
</tbody>
</table>
D. Slope of Water Table:

As discussed in the Section III.F "Groundwater Conditions", the slope of the water table in the project area is about 2.5 feet per mile.

E. Flooding and/or earthquake risk:

No flooding problems are anticipated. Potential seismic activity will be mitigated in the design of all structures.

F. Quality and Quantity of source waters:

Water quality data for HR-3 is tabulated in Section V.B herein. Samples were obtained on August 1, 1991 during the pump test period with the aquifer under stress conditions.

Pump testing for HR-3 started 8:00 am July 29, 1991 and continued to 10:00 pm August 1, 1991 in four 16-hour pumping increments. During that period, pumpage was approximately 580 gpm, which approximates the selected pumping rate of 500 gpm. No effects on the quality and quantity of source water is expected during stress periods of drought or heavy precipitation.

G. Significant factors having potential for contaminating the water source:

1. Urban development - limited risk
2. Golf Course area - limited risk
3. Pasture lands - limited risk
4. Sanitary landfills - none
5. Subsurface disposal units - none

H. Control Measures:

Potential contamination from herbicides and fertilizers can be reduced by adhering strictly to label instructions and the golf course operation and maintenance plan as discussed in Section V.F. All facilities will be sewered and wastewater treated to meet current health standards.
The well water quality will be monitored using chemical and biological analysis in conformance with State Safe Drinking Water quality requirements to assure maintenance of high quality water. Output from the wells will be treated as discussed in the following sections and chlorinated.

I. Summary:

The quality of water from Well HR-3 are within the limits for potable waters and the State Department of Health, Safe Drinking Water Program regulates compliance with the standards of the Safe Drinking Water Act and other State Department of Health Regulations. The water quality will be monitored on a regular basis.
VII. PROPOSED TREATMENT WORKS

The water drawn from the wells will be treated by an activated carbon treatment process. This treated water will be pumped into the existing storage tank effluent line to be mixed with the treated waters from HR-1 and HR-2 then distributed to the consumers or directed to the tank dependent on pressure levels.

Technical and operational analysis are included in Appendix A Section VII: "Proposed Treatment Works" by Sam O. Hirota & Associates.
VIII. PUMPING FACILITIES

A. Purpose of Service:

The well pumps and booster pumps will serve the Huehue Ranch Development consisting of the Agricultural Subdivision and Regent Kona Coast Resort as described in earlier section of this report.

B. Pumping Layout and Sizing of Connection Main:

A "Pump Installation Permit" for Well HR-3 was issued on April 2, 1991 by the Commission on Water Resource Management. The permit designated the installation of a 500 gallon per minute capacity pump in the well. Well pump station piping, valves and controllers are shown on EXHIBIT 13: WELL PUMP STATION HR-3. The well station is designed as an outdoor facility with submersible pump for quieter operations. To prevent backflow into the wells, a check valve will be installed upstream of the pump. Instruments and electrical controls will be housed in outdoor waterproof cabinets.

EXHIBIT 14: BOOSTER PUMP STATION show the typical booster pump station piping, valves and appurtenances. The booster stations are designed as an outdoor facility with instruments housed in waterproof cabinets. For emergency conditions, a by-pass system will allow upper reservoirs to back feed to the lower reservoirs. Each booster station includes a stand-by pump and provisions for future demands.

Connecting mains will be ductile iron pipe with push-on or mechanical joints. Flanged end pipe and fittings will be used for above ground piping. Main size between wells and elevation 1815' will be 8, 12, & 16-inches. Pipeline size will be 8-inch diameter between elevation 1815' and 2720' and within the subdivisions. Pipeline size will be 12-inch between elevations 2720' and 2850'.
C. Design Flow Requirements for Phase I Construction:

<table>
<thead>
<tr>
<th>SERVICE LEVEL</th>
<th>RESERVOIR NO.</th>
<th>AVERAGE DAY FLOW (GAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0’ to 120’**</td>
<td>220’ @ 1.0 MG</td>
<td>475,400</td>
</tr>
<tr>
<td>120’ to 450’*</td>
<td>550’ @ 1.0 MG</td>
<td>223,600</td>
</tr>
<tr>
<td>450’ to 650’*</td>
<td>750’ @ 0.2 MG</td>
<td>175,000</td>
</tr>
<tr>
<td>1450’ to 1715’</td>
<td>No. 1 @ 1.0 MG</td>
<td>37,500</td>
</tr>
<tr>
<td>1715’ to 1930’</td>
<td>No. 2 @ 0.1 MG</td>
<td>58,510</td>
</tr>
<tr>
<td>1930’ to 2220’</td>
<td>No. 3 @ 0.1 MG</td>
<td>42,100</td>
</tr>
<tr>
<td>2220’ to 2470’</td>
<td>No. 4 @ 0.1 MG</td>
<td>102,400</td>
</tr>
<tr>
<td>2470’ to 2750’</td>
<td>No. 5 @ 0.2 MG</td>
<td>288,450</td>
</tr>
</tbody>
</table>

Subtotal Regent Beach Water*: 874,000
Subtotal Agricultural Subdivision: 528,960
Total Water Demand: 1,402,960

AVERAGE DAY DEMAND = 1,400,000 gals

D. Liquid Characteristics:

The water characteristics are tabulated in Section V.B.

E. Electric Power:

Electric power supplied by Hawaii Electric Light Company is available at the site or will be available at the site. Electrical services will be provided from a temporary overhead connection to the existing power line that serves the Huehue Ranch Permanent power connection will be underground from the planned service line to the agricultural subdivision.

F. Pumping Arrangement:

Pumping arrangement is shown in EXHIBIT 13: WELL PUMPING STATION. Submersible pumps will be controlled by reservoir mounted
floats for activating pump start and pump stop sequences. A compressed air line in the well will monitor water levels.

G. Pump Selection:

HR-3 well pump will be multi-staged centrifugal pump Model SB520 by Standard Pumps, Inc. with 35 stages. A 300 hp submersible Hitachi Electric Motor will provide power at 3550 rpm.

Pump capacity must meet average day demand with an operating time of 16 hours with the larger unit on standby and not contributing to the flow requirements. Using HR-2 (See Section IV.D) as the designated standby, the pump calculations are:

\[
\begin{align*}
\text{HR-1: } & \quad 350 \text{ gpm} \times 60 \text{ min/hr} \times 16 \text{ hr} = 336,000 \\
\text{HR-3: } & \quad 500 \text{ gpm} \times 60 \text{ min/hr} \times 16 \text{ hr} = 480,000 \\
\text{Total} & \quad = 816,000 \text{ gal}
\end{align*}
\]

Total capacity is below requirement of 1,400,000 (Section VIII.6) Additional wells are required prior to completion of Phase I.

H. Buildings and Other Structural Improvements:

The well pumping station will be designed as an exposed outdoor facility. Electrical equipment and instrumentation will be housed in weather proof cabinets.

I. Water Hammer Consideration:

Water hammer is controlled during pump start-up and shut-down by the correct sequencing of the pump, the pump control valve and the check valve. Reservoirs will serve as pressure controlling stations along the water transmission main.

J. Essential Features of Construction and Operation:

The well pumps will be automatically controlled by reservoir mounted floats. Pump and motor protection will be provided by pressure and flow switches.
K. Electrical System provisions for power failure:

The pump motor requires a 460 volts, 3 phase, 60 hertz power source which will be supplied by Hawaii Electric Light Company. Stand by power will not be provided.
IX. FINISHED WATER STORAGE

Eight water service levels have been designated for the Huehue Ranch Development. These service levels and supply reservoirs are discussed in Section VIII.C "Design Flow Requirements."

In the Regent Beach (makai) System, three 50,000 gallon tanks will be constructed to reduce pressures. These pressure breaker tanks will be located between the 1000' and 1550' elevation. There will be no draw points in this section of the water system.

Source and control reservoirs will be constructed in vicinity of the wells and water treatment plant. Reservoirs A & B were sized at 500,000 gallons to receive the well flows, supply the treatment plant and store the treated water prior to distribution.

Reservoir locations and elevations are shown on EXHIBIT 4: OFFSITE WATER SYSTEM. Reinforced concrete is recommended for the storage tank material of construction. Reinforced concrete meets the requirements of the Hawaii County Department of Water Supply. It also requires the least maintenance and is the least susceptible to vandalism.

Service reservoirs in the Agricultural Subdivision system will include water level indicators, recorders, controllers and transmitters. The indicator will provide conditions within the tank and can furnish high and low level alarm signals. The controller and transmitter are linked to the booster pump station for flow supply. Additionally, altitude valves will allow back feeding during emergency and power outage conditions.

Reservoirs in the Regent Beach System will be controlled by altitude valves. Pressure reducing valves will be installed to protect the altitude valves from surges. The system will operate entirely on gravity.
X. WATER DISTRIBUTION SYSTEMS

A. General Layout:

The water system service area is shown on EXHIBIT 4. Schematic profiles for the Agricultural Subdivision and Regent Beach systems are shown on EXHIBITS 15 & 16. Pipe sizes are subject for review during the design process. In general, the off-site pipelines fall in the following categories:

1. Source to storage (wells to reservoirs)
2. Storage to storage (reservoir to reservoir)
3. Storage to user (reservoir to subdivision)

Source to storage lines are pressurized by the well pumps. These lines are relatively short (300' + ), mainly within well and reservoir sites, and will not be subjected to high pressures.

Storage to storage lines are pressurized by booster pumps at the lower reservoir. These pipelines will be aligned along paved access roads with gradients between 10 - 18 percent. Design pressures will be less than 150 psi. Gate valves will be included to isolate selected sections of the pipelines.

Storage to user lines are located in each service level. System pressures are based on the relative reservoir elevation and will be designed below 80 psi. These lines are relatively short and in general are 8-inch in diameter.

B. Water System Materials:

The system will follow the County of Hawaii, Department of Water Supply's standards for construction materials for pipeline, valves, fittings and miscellaneous appurtenances.

C. Proximity to Other Utilities:

There are no other utilities except for the overhead power line serving the pump stations and treatment plant, and sewer lines which require crossing at few locations.
D. Increments of Phased Construction:

Well HR-3 has been drilled and tested. The deepwell submersible pump and motor has been delivered to the site and is ready for installation.

Drilling of two additional two deepwells (HR-4 and HR-5) is expected to provide adequate water supply for the future Regent Kona Coast Resort development. Well drilling and well pump installation permit applications have been approved by the State Water Commission.

Well pump stations, booster pump stations, reservoirs, pipelines and appurtenances discussed herein will be installed as a single construction increment. Additions to the systems will be made as needed.

E. Data Affecting Installation of the Distribution System:

Pipe cover, location and other installation details will conform to the Department of Water Supply standards. Lava rock in the trench sections will require gravel pipe bedding for uniform and continuous support.
XI. **FINANCING**  

A. **Estimated costs of installation.**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Deepwell drilling, casing, and testing</td>
<td>$ 555,000.00</td>
</tr>
<tr>
<td>2. Deepwell pump and motor (1-500 gpm, 300 hp)</td>
<td>$ 250,000.00</td>
</tr>
<tr>
<td>3. Deepwell pump controller, piping, valves, etc.</td>
<td>$ 15,000.00</td>
</tr>
<tr>
<td>4. Sitework at Well HR-3, incl. access road</td>
<td>$ 50,000.00</td>
</tr>
<tr>
<td>5. Telemetering system, Electrical Work</td>
<td>$ 20,000.00</td>
</tr>
<tr>
<td>6. 8&quot; pipe from Well No. HR-3 to Pressure Breaker Tank then to Reservoirs A&amp;B (5000')</td>
<td>$ 300,000.00</td>
</tr>
<tr>
<td>7. Pressure Breaker Tank, 1 - 50,000 gal.</td>
<td>$ 100,000.00</td>
</tr>
<tr>
<td>8. Site work at Pressure Breaker Tank incl. access road</td>
<td>$ 50,000.00</td>
</tr>
<tr>
<td>9. Instrument House</td>
<td>$ 20,000.00</td>
</tr>
</tbody>
</table>

$1,360,000.00
Phasing:

Development phasing is shown on EXHIBIT 4. Proposed schedule for the development phasing is:

- Phase I: 1991 - 1993
- Phase II: 1993 - 1996
- Phase III: 1997 - 1999

C. Operation and Maintenance:

It is anticipated that the water system will be maintained as an independent private system and require no public monies for operation or maintenance.
SECTION VII "PROPOSED TREATMENT WORKS"

PREPARED FOR:
HUEHUE RANCH ASSOCIATES, L.P.
75-5722 KUAKINI HIGHWAY, SUITE #107
KAILUA-KONA, HAWAII 96740

BY:
SAM O. HIROTA, INC.
864 BERETANIA STREET
HONOLULU, HAWAII 96814

APPENDIX 'A'
VII. PROPOSED TREATMENT WORKS:

BACKGROUND:

Water from Well numbered HR-3 is characterized as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Hardness</td>
<td>400 mg/L</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>700 mg/L</td>
</tr>
<tr>
<td>pH</td>
<td>7.5</td>
</tr>
<tr>
<td>Taste &amp; Odor</td>
<td>Hydrogen Sulfide</td>
</tr>
<tr>
<td>Temperature</td>
<td>70°F</td>
</tr>
</tbody>
</table>

TREATMENT PROCESS:

The water drawn from Well HR-3 will be stored in a raw water reservoir; and processed by the water treatment plant on demand from the treated effluent storage reservoir that services the Huehue Ranch Off-Site Water System.

The raw water will first pass through a water softener to reduce the total harness to 100 mg/L. A potassium form of cationic resin will be contained in appropriately sized softeners that will alternately process 500 gpm for HR-3. The softeners will regenerate on demand after 400,000 gallons throughout. Potassium chloride salt will be used to regenerate the softener resin to avoid the health concerns associated with high levels of sodium in soft potable waters. (Refer to Appendix I for resin description.) Softeners will be backwashed at a rate of 140 gpm for HR-3 for a total regeneration time of approximately 10 minutes each. Spent backwash water will be stored in a containment pond.

An option to inject ozone will be provided downstream of the water softeners. The anticipated ozone dosage will vary from 1.0 to 1.5 lbs. per day. Ozone will provide sanitizing of the water without forming THMs normally associated with chlorine. Ozone generation will be accomplished via carona discharge system and air dryer.

Treated water will next pass through activated carbon columns. The activated carbon will provide absorption of materials that cause taste and odor problems. Periodic backwashing of the granulated activated carbon media is required to eliminate accumulated suspended matter and regrade the bed. (Refer to Appendix II for GAC
Description.) Automatic backwashing is initiated by a loss of head assembly. Spent backwash water will be stored in a containment pond.

Treated effluent will meet or exceed the standards established by Environmental Protection Agency or the Hawaii State Health Department for potable water. This comprehensive approach to clarifying this water source is capable of producing potable water of the very highest quality.
APPENDIX I

CATIONIC EXCHANGE RESIN (POTASSIUM FORM)

PHYSICAL FORM: Sulfonated copolymer of styrene and divinylbenzene. Hard attrition-resistant, special beads, shipped in a moist completely swollen condition.

Sphericity: 92% Typical
Effective Size: 0.47 to 0.62
Uniformity Coefficient: 1.6 to 1.8 maximum
Standard Screen Size: 16 to 50 mesh (wt.)
On 16 Mesh: 15% Maximum
Through 40 Mesh: 6% Maximum
Through 50 Mesh: 0.7% Maximum
 Void Volume: 25% to 40% (determined experimentally with water)
Moisture Content: 44% to 47%
Color Throw: APHA number 40 maximum
Odor: None
Minimum Total Capacity: meg/g dry resin 4.5
meg/ml wet resin 2.0
kgr/cu.ft. as CaCO3 43.5
SHIPPING WEIGHT: 51 to 53 lbs. per cubic feet
APPENDIX II

ACTIVATED CARBON: (G.A.C.)

------------------------------------------------------------------------------------------------------------------

PHYSICAL FORM: Granulated Activated Carbon formed from select grades of bituminous coal at elevated temperatures. Each granule must be abrasion resistant and have maximum inner surface porosity.
------------------------------------------------------------------------------------------------------------------

U.S. Standard Series Sieve Size: 8 X 30
Greater than number 8: 15% Maximum
Less than No. 30: 5% Maximum
Iodine Number - mg/g: 900 Minimum
Abrasion number (Ro-Tap): 70 Minimum
Mean Particle Diameter - mm: 1.5 to 1.7
Moisture (as packed): 2.0% Maximum
Total Surface Area (N2BET Method): 900 -1000 m2/g
Apparent Density (bulk dense pack): 32 lbs/ft3 (0.51 g/ml)
Backwashed & Drained Density: 28 lbs/ft3 (0.45 g/ml)
Effective Size: 0.85 mm
Particle Density Wetted H2O: 1.35 g/ml
Uniformity Coefficient: 2.0
Ignition Temperature: 480 C to 520 C
ISLAND OF HAWAII

HUEHUE DEVELOPMENT PROJECT
KAILUA-KONA, HAWAII

ISLAND MAP

EXHIBIT 1
SUMMARY
SOURCE AND CONTROL RESERVOIRS
1 - 50,000
2 - 500,000
TOTAL = 1,050,000 GALS.

ULTURAL SUBDIVISION

RESERVOIR NO. 5
1 - 200,000 GAL
SPILLWAY = 2850'

RANCH RESERVOIRS
1 - 200,000
3 - 100,000
1 - 1,000,000
TOTAL = 1,500,000 GALS

REGENT RESERVOIRS
3 - 50,000
1 - 200,000
2 - 1,000,000
TOTAL = 2,350,000 GALS

GRAND TOTAL = 3,850,000 GALS

RESERVOIR NO. 4
1 - 100,000 GAL
SPILLWAY = 2570'

RESERVOIR NO. 3
1 - 100,000 GAL
SPILLWAY = 2320'

RESERVOIR NO. 2
1 - 100,000 GAL
SPILLWAY = 2030'

AKINAKA & ASSOCIATES, LTD.
HUEHUE DEVELOPMENT PROJECT
KAILUA-KONA, HAWAI'I
OFFSITE WATER SYSTEM

EXHIBIT 4
-30- AVE. ANNUAL RAINFALL IN INCHES

HUALALAI, HAWAII

Prepared by the U.S. Geological Survey for publication by the Defense Mapping Agency Hydrographic/Topographic Center, Washington, D.C.

MAP INFORMATION AS OF 1982

AKINAKA & ASSOCIATES, LTD.
HUEHUE DEVELOPMENT PROJECT
KAILUA-KONA, HAWAII

RAINFALL MAP

EXHIBIT 5
Figure 20.5.—Generalized geologic map of Hualalai Volcano showing age distribution of lava and locations of vents. Not all smaller vents are shown. Map by USGS.

Modified from Moore, R.B., et al; 1987, USGS Professional Paper 1350
Modified from Moore, R.B., et al; 1987, USGS Professional Paper 1350

AKINAKA & ASSOCIATES, LTD.
HUEHUE DEVELOPMENT PROJECT
KAILUA-KONA, HAWAII

GEOLOGIC MAP-DETAIL

EXHIBIT 7
WATER LEVEL IN FEET ABOVE MSL

GROUNDWATER MAP

EXHIBIT 9