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Hawaii Natural Energy Institute
Holmes Hall 246 • 2540 Dole Street • Honolulu, Hawaii 96822

DEPT. OF WATER &
LAND DEVELOPMENT

7 March 1989

Department of Land and
Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96809

RE: Drilling Permit Applications
Scientific Observation Hole Program

Gentlemen:

Enclosed are six Drilling Permit Applications for the Scientific Observation Hole Program to cover the drilling of four holes on the island of Hawaii and two holes on the island of Maui.

A blanket bond in the amount of \$250,000 or in the amount set by the Board and meeting the requirements of Title 13-183-68 will be submitted to the Chairman within ten calendar days after notification that the applications have been approved.

It is the firm intention of the applicant to perform the work outlined in the applications, and thereafter to operate the drilling activities and maintain the Scientific Observation Holes in accordance with the rules in Title 13, Department of Land and Natural Resources, Sub-Title 7, Water and Land Development, Chapter 183, Rules on Leasing and Drilling of Geothermal Resources, and all other federal, state, and county requirements.

Sincerely,

Harry J. Olson
Principal Investigator
Scientific Observation
Hole Program

HJO:klcm

enclosures

23 February 1989

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State of Hawaii
Department of Land and Natural Resources
Kalanimoku Bldg.
1151 Punchbowl Street
Honolulu, Hawaii 96809


DIV. OF WATER &
LAND DEVELOPMENT

Re: Scientific Observation Hole Program
(SOH-5m)
Drilling Permit Application

In accordance with the Department of Land and Natural Resources Administrative Rules, Title 13, Sub-Title 7, Chapter 183-65, application is herewith made for a drilling permit to drill Scientific Observation Hole (SOH) to confirm geothermal resources and stimulate development of the resource on the islands of Hawaii and Maui.

1. APPLICANTS:

Research Corporation of the University of
Hawaii (RCUH) / Hawaii Natural Energy
Institute (HNEI)
University of Hawaii at Manoa
2540 Dole Street, Holmes Hall #246
Honolulu, Hawaii 96822



Harry J. Olson, Principal Investigator

a) Owner of Mining Rights:

SOH 5m - State of Hawaii

b) Land Owner:

SOH 5m - State of Hawaii

c) Lessee of Mineral Rights:

SOH 5m - State of Hawaii

2. WELL DESIGNATION:

SOH 5m

3. PLOT PLANS:

The tax map key for the hole location is attached as Exhibit A. Hole location will be surveyed by a Hawaii licensed surveyor, if required, after completion of drilling operations and removal of the drill rig.

a) Geothermal Resource Subzone:

SOH 5m Haleakala Southwest Rift Zone, Island of Maui

b) Hole Elevation:

Approximate Elevation above Mean Sea Level in Feet

SOH 5m = 860

4. PURPOSE AND EXTENT OF DRILLING:

Scientific Observation Hole SOH-5m is one hole in a six hole program, funded by the State to assess Hawaii's geothermal potential and to stimulate development of the resource by private producers. The purpose of the Scientific Observation Holes is for scientific observation only. The holes will not be flow tested or produced. The information to be gained from the SOHs will provide an assessment of subsurface geological conditions, ground water level and composition, temperature, drilling conditions, an inventory of possible mineral and geothermal resources, and an eruptive history of the island to the depth drilled. The SOHs, in combination with existing geothermal wells or geothermal wells to be drilled by producers in the future, can be instrumented to provide data relating to reservoir productivity. By injecting water into the holes, estimates can be made as to possible reservoir conditions and productivity.

The SOHs will be drilled in areas not tested by deep drilling, so it is not possible to predict conditions at depth. The SOHs will be drilled to a nominal depth of approximately 4,000 feet, which is about the top of the geothermal reservoir in the vicinity of the HGP-A well. The holes are scheduled to be drilled to or through possible geothermal cap rocks and into fractures connecting with the reservoir. As such, the holes may be drilled to shallower or deeper depths than 4,000 feet. The drill rigs contracted to do the drilling will have the capability of drilling to depths of approximately 6,500 feet.

5. DRILLING PLAN:

The following drill plan is the same for each of the six Scientific Observation Holes to be drilled on the islands of Hawaii and Maui. The plan is generic and may be modified to meet specific drilling conditions or to reflect experience from previous holes.

The holes are designed for observation and reservoir analysis purposes only, and not for the discharge of geothermal fluids. A combination of cable tool, rotary, and core drilling methods will be used to provide the maximum flexibility to handle the variety of anticipated drilling conditions. Casing and cementing programs, and the Blowout Prevention (BOP) equipment to be used will provide protection from any potential overpressured zones and allow the hole to be shut in at any stage during the drilling after the upper 100 feet of surface casing is cemented in place.

SOH 5 is located adjacent to an existing road, and the drill pad will be constructed next to the road. The drill pad will be approximately 80 x 120 feet, and will be located to minimize grading and environmental impact.

a) Cable Drilling Operations:

- 1) Move in cable drilling rig, rig up and drill 16 inch diameter hole from surface to 100 feet. Hole may be deepened if competent formation is not encountered by 100 feet.
- 2) Set 10 x 10.5 inch casing from surface to total depth (TD).
- 3) Cement annulus from surface to TD with approximately 115 cubic feet of 7-sack Redimix concrete (7 sacks Portland cement per cubic yard with 1 inch minus gravel).
- 4) Rig down and move cable drilling rig off location and to next location if applicable.

b) Rotary/Core Drilling Operations:

- 1) Move in Universal 5000 rotary/core rig, rig up over hole on 11 foot (or higher) substructure.
- 2) Install BOP consisting of an 11 inch wellhead flange and 11 inch 3M "LWS" hydraulic double-gate with pipe and blind rams. Wellhead flange will have valved, 2 inch choke-kill lines connected to the mud pump. The BOP will conform to or exceed specifications in Title 13, Chapter 183-74.
- 3) Test BOP to 200 psi for 20 minutes. Repeat test for both pipe and blind rams.
- 4) Core drill from casing shoe to approximately 1,000 feet with 134 mm (5.28 inch) core using a bentonite drilling fluid. Drilling fluids will be contained in above ground tanks.

- 5) Condition hole, pull out of hole (POH) and standby for geophysical logging. Mud-out temperature will be continuously monitored during drilling operations. Deviation surveys will be taken every 100 feet or at applicable intervals. Bottom hole temperatures will be recorded during deviation surveys.
- 6) Run in Hole (RIH) and open to 9-7/8 inches from casing shoe to TD using rotary hole opener.
- 7) Condition hole, POH and rig down rotary tools.
- 8) Run 4 x 4.5 inch J-55 casing with centralizers and cementing shoe from surface to TD.
- 9) Cement through casing using Class G high temperature cement.
- 10) If cement does not return to surface, complete cementing of annulus using a 1.5 inch "spaghetti string" pipe to cement back to surface.
- 11) Rig down Universal 5000 rig if applicable, and move to next scheduled site location.

c) Alternative Plan:

If hole conditions do not permit completion of 9-7/8 inch hole to 1,000 feet, an intermediate string of 6 x 6-5/8 casing will be cemented. The hole will then be completed by core drilling a 134 mm hole and running 4 x 4.5 inch casing inside the drill rods prior to pulling out of hole. Cementing will be completed as described above, except the use of a spaghetti string would not be possible.

d) Core Drilling:

- 1) Continue coring with Universal 5000 rig, or move in Universal 1500 drilling rig over hole, rig up, and continue coring operations.
- 2) Remove 11 inch BOP.
- 3) Weld steel ring plate between 4.5 inch and 10.5 casing and install BOP consisting of an 11 x 7 inch reducing spool on 11 inch wellhead flange. Install 7-1/16 inch 3M "LWP" hydraulic double gate unit with 3-1/2 inch and CSO rams. Install 4 inch Regan 500 PSI hydraulic annular unit. Install high speed rotating head with seals for CHD-134, HMQ, and NCQ drill rods. The BOP will conform

to or exceed specifications in Title 13, Chapter 183-74.

- 4) Test pipe and CSO rams to minimum of 1,000 psi for 20 minutes each. Test Regan unit to 500 psi for 20 minutes.
- 5) RIH, core drill from casing shoe to 4,000 - 6,500 feet, drilling HMQ (3.85 Inch), or equivalent, hole.
- 6) If drilling conditions warrant, hole size will be reduced to 76 mm (3 inches) using the CHD-101 drill rods as temporary casing to the point of hole reduction.
- 7) POH, standby for geophysical logging.
- 8) Remove BOP, and hang tubing from wellhead spool. Install gate valve on tubing and rig down.

e) Drilling Fluids Program:

Details of the drilling fluids program will be adjusted as drilling conditions change. The general program will be as follows:

- 1) 100 - 1,000 Feet:

Use extra high yield bentonite for viscosity. Maintain weight at 8.5+ lbs/gal and viscosity at 40 - 50 seconds. Loss of circulation will be controlled, if possible, with the use of fibrous materials such as cottonseed hulls, Multi-Seal, sawdust, or locally available materials. Spot cementing may be necessary in severe loss circulation intervals. If circulation cannot be maintained, the hole will be deepened by "blind" drilling.

- 2) 1,000 Feet to TD, mud temperatures <300°F:

Use extra high yield bentonite and liquid polymer for viscosity. Control loss circulation with fibrous materials or spot cementing.

Concentrations:	Bentonite	5 - 10 lbs/bbl
	Liquid Polymer	0.2 - 0.5 lbs/bbl
	Rings Out	0.1 - 0.2 lbs/bbl
	(or equivalent)	

- 3) 1,000 Feet to TD, mud temperatures 300°F - 450°F

Use small quantities of sepiolite with additions of Aquatex (or similar polymer) for yield point control and a drilling mud surfactant (DMS) to aid even flow

properties and reduce rod vibration. Control loss of circulation with fibrous materials or spot cementing.

Concentrations:	Sepiolite	2 - 5 lbs/bbl
	Aquatex	2 - 4 lbs/bbl
	DMS	1 - 2 lbs/bbl
	Oxygen	0.25 - 1 lbs/bbl
	Scavenger	(>400°F)

4) 1,000 Feet to TD, mud temperatures 450°F - 600°F:

Use high temperature polymer and oxygen scavenger. As temperature increases, viscosity becomes more difficult to maintain. Control loss of circulation with fibrous materials or spot cementing.

Concentrations:	High Temp Polymer	1.5 - 4 lbs/bbl
	Oxygen Scavenger	0.25 - 1 lbs/bbl

Note: Mud temperatures reflect drilling fluid temperatures in hole, and not ambient rock formation or geothermal fluid temperatures.

f) Monitoring:

1) Temperature:

Drilling fluid return temperatures will be made with a continuous recording thermograph. During bit changes and core runs, bottom hole temperatures will be measured using a number of maximum recording thermometers lowered to the bottom of the hole.

2) Hydrogen Sulfide:

Although dangerous levels of hydrogen sulfide gases are not likely, a H₂S safety system will be employed. A detector will be located at the base of the wellhead, and a second detector near the fluid discharge line will sound visual and audio alarms if H₂S gas is emitted from the well. Three Scott Air Packs will be kept on site for use by personnel if dangerous concentrations of H₂S occur.

g) Completion:

The hole will be completed with 2.0 inch steel tubing, or if completion size will not permit, with 1.5 inch tubing that is crimped on the bottom and/or slotted in the lower

portions. The tubing will allow long term access to the hole for various surveys and testing. If, at some future time it is decided to abandon the hole, the tubing will be utilized to cement in and around the tubing, or to stage cement in the hole while pulling the tubing.

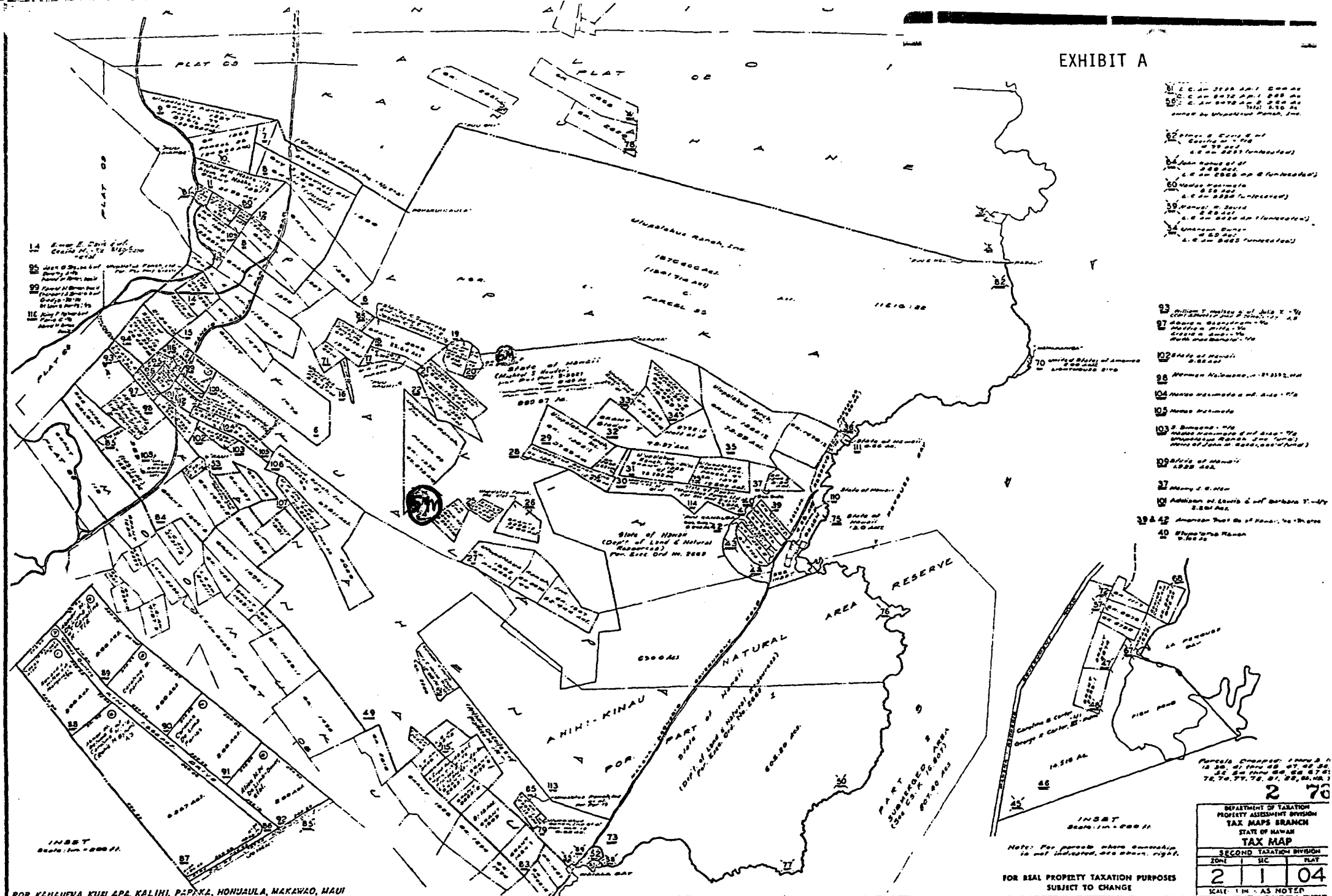
6. BONDS:

A bond meeting the requirements of Title 13 Chapter 183-65 will be submitted to the Chairperson of the Department of Land and Natural Resources Board within ten calendar days after notification that this application has been approved.

7. CONFORMANCE WITH REGULATIONS:

The applicant will perform the work described above, and will thereafter operate and maintain the Scientific Observation Holes in accordance with the rules in Title 13 Chapter 183-65 and all other federal, state, and county requirements.

EXHIBIT A



- 14 E. E. Clark & Co. Certificate of Title
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INSET
Scale: 1 in. = 500 ft.

INSET
Scale: 1 in. = 500 ft.

Note: For parcels shown ownership to not indicated, see above, right.

FOR REAL PROPERTY TAXATION PURPOSES
SUBJECT TO CHANGE

Parcels Shaded: 1000, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200

DEPARTMENT OF TAXATION		
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SCALE: 1 IN. = AS NOTED		