

GEO-North

Statement of Work1.0 Introduction

The Cascade volcanic region has long been suspected to contain considerable geothermal potential, as evidenced by recent volcanism and other thermal expressions. There are few known surface manifestations of geothermal energy in spite of the obvious occurrence of heat sources. One possible explanation is that the downward percolation of the extensive regional cold ground-water system suppresses surface evidence of underlying hydrothermal systems. However, there have been few wells drilled in the Cascades region to a sufficient depth to properly evaluate the temperature and hydrological conditions beneath the cold water zone. There is a great need for characterization identification of the deeper hydrothermal regime in order to more conclusively define the geothermal potential of the Cascades volcanic environment.

2.0 Scope

DOE's primary objectives for this cost-shared drilling project are to obtain and release to the public subsurface information, to include but not limited to the following:

- o rock samples (core and/or drill chips),
- o equilibrium temperature profiles,
- o uncontaminated fluid samples,
- o evidence for the existence and depth of potentially producible aquifers,
- o geophysical well logs, and
- o information on drilling conditions and problems in the Cascades environment.

The Participant will drill a deep thermal gradient hole to a depth of 4000 feet located 4,100 feet north and 500 feet east of the southwest corner of section 24, T20S, R12E, Deschutes County, Oregon. The Participant will perform data collection both during and subsequent to drilling. The Participant will maintain the hole and allow DOE access to the hole to collect data. The Participant will be responsible for obtaining any permits or approvals required by government regulatory agencies in the performance of this project. The Participant will provide all data and information gathered under this project to DOE.

3.0 Applicable Documents

Work performed by the Participant will be in compliance with all Federal, State, and local laws, rules and regulations, and agency orders and guidelines.

4.0 Technical Tasks

4.1 Project Management

- A. The Participant will prepare and obtain DOE approval of a Project Management Plan within 30 days after award of this agreement. The plan will include a work breakdown structure and a list of deliverables by task, identify the individuals and subcontractors responsible for each task, discuss the management techniques to be used, and include a schedule that shows the period for performance of each subtask and identifies principal milestones and decision points for each. The plan will also designate an individual or individuals who will act as principal points of contact with DOE on behalf of the Participant.
- B. The Participant will perform project management in accordance with the approved Project Management Plan. In addition to close general coordination with DOE, immediate and full disclosure of any project problem areas to DOE is required, so that timely corrective action may be taken with DOE technical support, if necessary.

Deliverable: Approved Project Management Plan

4.2 Permitting and Environmental Reporting

- A. The Participant will submit and obtain DOE approval of a Project Institutional Plan prior to initiation of site preparation. The plan will identify items required by governmental regulatory agencies for the performance of this work, the agency whose requirement the item fulfills, and the actual or projected submittal and agency approval dates. The plan will also discuss any legal, social or institutional problems anticipated during performance of the project and planned solution.
- B. The Participant will prepare, submit and obtain approval of any documentation required by governmental regulatory agencies for the performance of this work. The Participant will provide a copy of all documentation provided to any governmental agency and pertinent to this project to DOE for information.

- C. An approved environmental document is required for this project prior to any ground disturbance. It is anticipated that an environmental assessment will be prepared by the Bureau of Land Management for this project. This environmental assessment may satisfy DOE's environmental reporting requirements. If DOE determines that an Environmental Evaluation Report is required prior to any ground disruptive activity, DOE will notify the Participant in writing. In that event, the Participant will prepare the Environmental Evaluation Report in accordance with DOE Environmental Guidelines. If a DOE Environmental Assessment is required, the Participant will provide information to DOE as required for DOE's preparation of the Environmental Assessment.

Deliverables: Approved Project Institutional Plan, Regulatory Documentation, Approved Environmental Document

4.3 Drilling

- A. The Participant will prepare and obtain DOE approval of a Project Drilling Plan prior to drilling. The plan shall describe:
- o Surface and subsurface conditions anticipated to be encountered during drilling, including configuration of the resource.
 - o Site access.
 - o Site preparation.
 - o Hole design including hole size, casing size, cementing, etc.
 - o Rig and equipment specifications.
 - o Well containment during and after drilling (including applicable regulatory requirements).
 - o Drilling fluids and disposal method.
 - o Hole completion.
 - o Plugging and abandonment.
 - o Site restoration.
 - o Anticipated hole problems, if any, and proposed solutions.
 - o Health, safety and environmental considerations.
 - o Site facilities, if any.

- o Drilling schedule including major activities and estimated duration.
 - o On-site supervision to be used during drilling, including drilling supervisor(s) and geologist(s).
- B. The Participant will prepare a drill site and drill a deep thermal gradient hole in accordance with the approved Project Drilling Plan. The Participant shall report on drilling status daily to the designated DOE representative, so that decisions concerning the drilling operation can be made in a timely manner.

Deliverable: Approved Project Drilling Plan

4.4 Data Collection

- A. The Participant will prepare and obtain DOE approval of a Project Data Collection Plan prior to drilling. This plan will address data collection both during drilling and after drilling. The plan will identify the types of data to be collected, the depth(s) at which each type of data will be collected, the timing of collection, and the method by which the Participant plans to collect each type of data (including type of instrument and planned calibration, where appropriate). The plan will specifically identify all logs, samples of rock and fluid and other data that are to be collected.
- B. The Participant will collect the following data as a minimum in accordance with the approved Project Data Collection Plan. These samples and data shall be provided to DOE by the Participant as soon as possible after collection. The Participant will incorporate its analysis and interpretation of the data collected as part of the final project report.

Rock Sampling. Cuttings will be collected at ¹⁰~~15~~-foot intervals in the section of the hole to be rotary drilled. Four (4) splits of cutting samples of each sampled interval will be provided to DOE. The remainder of the hole will be continuously cored. The Participant will warehouse the core and cuttings in Bend and make them available to DOE. DOE will provide procedures for identification and splitting of core and cuttings. The Participant will make thin sections of selected core samples and complete a petrographic study of these sections. The Participant will also select core samples for age dating. The results of these studies will be made available to DOE.

Drilling Records. Logs describing primary lithology and secondary mineral content and mud return temperatures will be kept during the tricore drilling and core portion of the

hole, copies of which will be provided to DOE. These logs will also include information on lost circulation amounts, times and depths and/or the location of water entries.

Temperature. The bottomhole temperature shall be recorded at a minimum of 100 ft. intervals during drilling and preferably at least every other change of core barrel. One objective of these measurements will be to obtain a useable temperature profile in the event a subsequent equilibrium temperature profile cannot be obtained. The measurements shall be made using calibrated thermometers.

Hydraulic head. At the start of daily drilling, or whenever the drilling operation will allow, measurements of the hydraulic head or depth to fluid surface in the hole will be made.

Drilling fluid samples. An appropriate number of sets of one-liter samples of drilling fluid will be collected every trip for bit during drilling. Additional fluid samples will be collected when warranted by geologic conditions. One set will be delivered to DOE for possible analysis. If the Participant analyzes samples, copies of the results will be given to DOE.

Aquifer fluid samples. If artesian flow is encountered during drilling, representative samples of uncontaminated aquifer fluid will be collected in accordance with procedures outlined in the approved Data Collection Plan. If no artesian flow is encountered, the Participant will still endeavor to collect samples of uncontaminated aquifer fluids at locations in the hole at which fluid production would be anticipated on the basis of lost circulation, indications of fracturing in the core or chips, geophysical well logs or other standard indicators. Potential methods for collection of these samples include swabbing, bailing, airlift, drill stem tests and pumping. The Participants will examine these and/or other fluid sampling techniques and address collection of these samples in the Project Data Collection Plan.

Geophysical well logging. Temperature, caliper, resistivity and self-potential logs will be run in the interval between the surface pipe and total depth.

Density and sonic velocity logs will also be run if tools are available which can operate in the conditions encountered in the hole. The temperature tool capable of 0.01°F precision in measurement will be used to measure the geothermal gradient. One set of field prints will be sent to DOE as soon as available.

Detailed Mercury (Hg) Survey. A comprehensive 3-D analysis of Hg distribution at Newberry Volcano will be conducted analyzing Hg at 10 foot intervals throughout the corehole and the results compared with the published Hg soil survey of Hadden, et al. (1982, DOGAMI-BPA Coop. Agr. DE-AC79-82BP36734). The proposed study will be used to establish the theoretical basis for Hg surveys in geothermal exploration, provide data pertaining to the reliability, limitations, and general utility of such surveys, and provide insight into the relationship among fracture permeability, mercury distribution, magma bodies, and geothermal reservoirs.

A byproduct of the proposed Hg study will be "splits" of the samples for which Hg has been analyzed. These "splits" will be made available to DOE for analysis of other elements. Analyses and interpretation of these data will be conducted.

Deliverables: Approved Data Collection Plan, Data and Samples

4.5 Hole Completion and Maintenance

- A. Upon satisfactory completion of openhole geophysical logging and sampling, standard black pipe, 2" ID, with a knockout plug at the bottom, will be run by the Participant from surface to total depth, filled with fresh water and capped. After allowing sufficient time for thermal equilibration to occur, the Participant will run a temperature log and derive a geothermal gradient.
- B. Upon completion of the hole, DOE and the Participant shall review and discuss the data. The Participant will obtain the Project Manager's agreement prior to releasing the rig.
- C. The Participant shall provide to DOE within 15 days of completion of the hole a schematic of the actual completed hole configuration.
- D. The Participant shall maintain the hole and site facilities for 12 months after hole completion in accordance with the approved Project Drilling Plan. The hole and site facilities shall be made available to DOE during this period for DOE's scientific use. The Participant may also collect data during this period at its own expense and on a non-interference basis.

Deliverable: Completed Hole Configuration Schematic

4.6 Abandonment

The Participant will plug and abandon the hole in accordance with U.S. Bureau of Land Management requirements (Form 3200-9, #5) and other applicable regulations within the one month subsequent to the end of the DOE access period. The Participant shall provide

DOE with a copy of the plug and abandonment plan as approved by the Bureau of Land Management. If for any reason the hole is not plugged and abandoned by the end of the period of the agreement, the hole becomes the legal and financial responsibility solely of the Participant. DOE will not cost-share costs incurred after the project period of this agreement.

Deliverable: Approved P&A Plan

4.7 Site Restoration

The Participant will clear the site, fill the pits, and restore the site in accordance with applicable state and federal regulation and as outlined in the approved Project Drilling Plan. The Participant shall provide DOE with confirmation of restoration activities and Bureau of Land Management or Forest Service approval.

5.0 Reports, Data and Other Deliverables

- A. The Project Drilling Plan as required by Subtask 4.3.A.
- B. The Project Data Collection Plan as required by Subtask 4.4.A.
- C. The Project Management Plan as required by Subtask 4.1.A.
- D. The Project Institutional Plan as required by subtask 4.2.A.
- E. All data collected by the Participant under Task 4.4.
- F. Regulatory documentation and approved environmental document under Subtasks 4.2.B and 4.2.C.
- G. Completed hole completion schematic as required by Subtask 4.5.C.
- H. Approved plug and abandonment plan as required by Task 4.6.
- I. Project status and management reports as identified on DOE Form CR-537, Reporting Requirements Checklist. The described final technical report shall include a summary of drilling and completion and a section describing data collected along with a discussion of analysis and interpretation.



GEO Operator Corporation
A Subsidiary of Geothermal Resources International, Inc.

May 21, 1986

Noble H. Larsen, President
Tonto Drilling Services
#200-3920 Norland Ave.
Burnaby, B.C., Canada V5G 4K7

Dear Noble:

I am writing to inform you that we would like to commence our corehole drilling activities at site GEO N-3, Newberry volcano, Oregon, on May 29, 1986.

Danny Ellis of your organization has already been shown where to obtain his water. There is a 25 ton limit for travel along Knott Road so if you need a variance, we will be happy to assist you in obtaining it. I have attached an internal memorandum which summarizes the concerns voiced to us by the USFS and BLM during our site inspection. Please be sure that Danny has a copy.

Corehole N-3 will be cost shared with the US Department of Energy so we will need the same billing procedures that we used last year for corehole GEO N-1 (i.e., separate billing if we drill below 4,000 feet, etc.).

The following GEOOC persons have authority to represent the Company during the 1986 drilling operations:

1. Chandler A. Swanberg, Vice President-Project Manager
2. Walter Randall, Vice President-Chief Geologist
3. Any officer of GEOOC or its parent company, Geothermal Resources International, Inc.

The following persons will be periodically/episodically on site but do not have the authority to represent GEOOC on matters pertaining to the 1986 GEOOC/Tonto Drilling program:

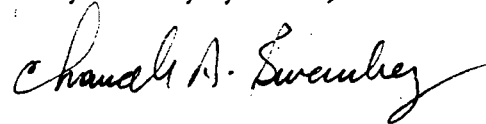
1. Bruce Sibbett, University of Utah Research Institute
2. Dennis Nielson, University of Utah Research Institute
3. Susan Prestwich, U.S. Department of Energy
4. Ron King, U.S. Department of Energy
5. William C. Walkey, GEOOC Geologic Field Technician
6. Michael S. Woodruff, GEOOC Geologic Field Technician
7. William Dansart, GEOOC Geologic Field Technician

Noble H. Larsen
May 21, 1986
Page 2

In addition, there may be various researchers requesting access to the drill site. Such persons will have such access only with the approval of and upon the presence the GE00C authorized representative on site.

We look forward to another successful drilling season.

Very truly yours,



Chandler A. Swanberg
Vice President
Non-Geysers Project Manager

CAS:yts
Enclosure

cc: Ron King - DOE
Susan Prestwich - DOE
Bruce Sibbett - UURI
Dennis Nielson - UURI
Jim Combs
Walter Randall
Rosemary Sprong

M E M O R A N D U M

TO: C. Swanberg

FROM: M.J.C.

DATE: May 20, 1988

RE: GEO-Newberry Field Operations

The following are punch list items requested by the U.S.F.S. for the 1988 field year:

1. If trees are to be used for guide wire support tonto must provide protection from wire damage. This can be accomplished with 2x4's or similar devices that provide adequate padding from tension devices. Additionally any tree to be used must be located at such a point that it could not fall onto the site or equipment.
2. Prior to any water extraction from Paulina Creek there will be a site visit with the truck(s) operator(s), U.S.F.S., rig supervisor, and GEO. The site visit will establish limits for the water truck(s) to prevent encroachment into sensitive areas.
3. Guide wires used for rigging up at the N-3 location shall not cross road 1810.
4. Under no circumstances shall orange banded tress be used for any purpose.
5. All fire tool boxes shall be provided lids.

Any questions regarding forest service operations shall be directed to:

Donna Owens
Fort Rock Ranger District
1648 Highway 20E
Bend, OR
(803) 388-5677



GEO Operator Corporation
A Subsidiary of Geothermal Resources International, Inc.

May 12, 1986

Ronald A. King
U. S. Department of Energy
Idaho Operations Office
550 Second Street, Room 119
Idaho Falls, Idaho 83401

Dear Ron:

Due to the success of last year's drilling of corehole N-1, we do not plan to modify our drilling program for this year's drilling of corehole N-3. Therefore, our project drilling plan for corehole N-3 (SCAP DE-FC07-85ID12613) will be identical to that approved by DOE for corehole N-1 (SCAP DE-FC07-85ID12612). Similarly, we plan no changes in the project management plan, the project institutional plan, the project data collection plan, or the project P&A plan. We plan to use the same drilling company (Tonto Drilling Services) who has given us the same field crew. The only scheduled difference in operations for the drilling of corehole N-3 is that we will be using a different well site geologist who will replace Mike Johnson, who has resigned from the Company. I will forward to you the resume of the new geologist as soon as one is assigned to the Newberry project. We have attached a schedule for the drilling of corehole N-3 and subsequent activities. We plan to relog corehole N-1 as soon as the snows permit access--perhaps the first week in June.

We look forward to working with you during the upcoming field season.

Very truly yours,

Chandler A. Swanberg
Vice President
Non-Geysers Project Manager

CAS:yts
Enclosure

cc: Jim Combs
Susan Prestwick
Bruce Sibbett

545 Middle Road, Suite 200, Menlo Park, CA 94025 (415) 321-5662

SCHEDULE N-3

PHASE I - DRILLING

05/27/1986	Spud Corehole N-3	6/3/86
07/27/1986	Release Rig	
09/15/1986	Final Billing from Contractor	
10/01/1986	End Phase I	

PHASE II - DOE ACCESS PERIOD

07/27/1986	Begin DOE Access Period	
07/27/1986 ⁷	End DOE Access Period	
07/27/1986 ⁷	Begin Plug and Abandonment Operations	
08/03/1986 ⁷	End Plug and Abandonment Operations	

PHASE III - TECHNOLOGY TRANSFER

07/27/1986	Begin Preparation of an Requisite Documents	
07/27/1986	Submission of All Requisite Documents	

M I L E S T O N E S - GEO North

Phase I ---Drilling

8/19/85 Spud Corehole
 10/ 7/85 Release Rig
 11/ 1/85 Final Billing from Contractor
 11/15/85 End Phase I

Phase II --Evaluation, DOE Access Period

Phase III--Technology Transfer

MILESTONE DELIVERABLE

<u>DATE</u>	<u>MILESTONE</u>	<u>DELIVERABLES</u>
8/15/85	Letter Agreement	<ul style="list-style-type: none"> * Project Drilling Plan * Project Data Collection Plan * Project Management Plan * Project Institutional Plan * Regulatory Documentation * Environmental Document * Proof of Site Access * GEO AFE Documents * GEO Procurement Procedures * Documentation for Additional (Hg) Studies * Breakdown of Cost According to Milestones and deliverables * Other Information as Required
9/1/85	Contract Award	N/A
11/15/85	Phase I-Drilling	Geophysical Logs Temperature Logs Lithologic Log Drillers Log Hole Completion Schematic Temperatures Measured during Drilling Hydraulic Head Data taken during Drilling Other Data Collected during Phase I

* No DOE Funds Requested

11/15/86 Phase 11 Evaluation

6/15/86

- Geochemical Data-fluids
- Geochemical Data-rocks
- Age Dates
- Petrographic Analysis
- Mercury Survey
- Splits of core, cuttings, fluids, etc.
- Final Temperature Log
- Plug and Abandonment Plan
- Project Status and Management Reports
- Other Reports as required
- Other Data collected during Phase 11
- All reports written during Phase 11
- DOE access to Site

11/15/87 Phase 111
Technology Transfer

1/15/87

- Final Project report
- Project Status and Management reports
- Other reports as required
- Other remaining Data and miscellaneous items

COST BREAKDOWN

<u>COSTS ACCRUED</u>	<u>PHASE</u>			<u>TOTAL</u>
	1	11	111	
1. Direct material				
a. Purchased parts, maps, etc.	8,000	-0-	-0-	8,000
b. Subcontracted items				
Environmental	-0-	-0-	-0-	-0-
Archeology	5,000	-0-	-0-	5,000
Drilling	260,000	≈ 65/ft -0-	-0-	260,000
Geophysical logging	25,000	5,000	-0-	30,000
Geochemical analysis	-0-	10,000	-0-	10,000
2. Material Overhead	-0-	-0-	-0-	-0-
3. Direct Labor				
Environmental coordinator	3,443 (75%)	-0-	1,148 (25%)	4,591
Geologist-supervision corehole	7,128	-0-	-0-	7,128
Geologist-analysis of core	2,851 (40%)	2,851 (40%)	1,426 (20%)	7,128
Geologist-evaluation of logs	-0-	3,564	-0-	3,564
Geologist-evaluation	-0-	5,346 (75%)	1,782 (25%)	7,128
Project Management	2,596 (40%)	1,299 (20%)	2,596 (40%)	6,491

COSTS ACCRUED

	<u>PHASE</u>			<u>TOTAL</u>
	1	11	111	
4. Labor Overhead, payroll taxes Insurance(@ 25.48%)	4,081	3,328	1,771	9,180
5. Special testing-mercury survey	-0-	6,150	-0-	6,150
6. Special equipment	-0-	-0-	-0-	-0-
7. Travel	9,000	1,000	-0-	10,000
8. Consultants	-0-	-0-	-0-	-0-
9. Other Direct costs				
Site preparation	5,000	-0-	-0-	5,000
Hole maintenance	-0-	7,000	-0-	7,000
Abandonment	-0-	-0-	5,000	5,000
Technology transfer	2,000	2,000	6,000	10,000
10. Total Direct cost & overhead	334,099	47,538	19,723	401,360
11. General and administrative expense @ 7% of 1,3,4,5,7,9	23,387	3,328	1,380	28,095
12. TOTAL ESTIMATED COST	357,486	50,866	21,103	429,455