IDAHO DEPARTMENT OF WATER RESOURCES Proof Report

Water Permit 43-7199

Owner Type	Name and Address
Current Owner	GEO ENERGY CORP
	, ZZ

Status: Cancelled

 Source
 Tributary

 Beneficial Use
 From
 To
 Diversion Rate
 Volume

 Source and Point(s) of Diversion
 Image: Conditions of Approval:
 Image: Comments:
 Image: Comments:</td

Dates and Other Information Water District Number: TBD Mitigation Plan: False

Combined Use Limits

SubCase: N/A

<u>Water Supply Bank:</u> N/A 6/8/2020

INTER-DEPARTMENT MEMO ----- 1

FROM Sharla

RECEIVED DATE 2/25/86 FEB 27 1986

Department of Water Resources /

Southern District Office

TO Southern

SUBJECT

Please send file \$3-7199 to us since it has been worded (see attached order) so it can be filmed and destroyed. sharks

SIGNATURE

BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE

STATE OF IDAHO

Dapertment or Water

Southern Risiday Entry

Rurber

IN THE MATTER OF WATER RIGHT APPLICATION NO. 43-7199 AND GEOTHERMAL APPLICATIONS NOS. 43-GR-1, 2, 3, 4 AND 5 IN THE NAME OF GEO ENERGY CORPORATION

This matter having come before the Department of Water Resources (Department) as a result of the applicant's failure to supply required information on water right application, the Department finds as follows:

FINDINGS OF FACT

On July 14, 1983 Geo Energy Corporation submitted five 1. geothermal applications (3 production and 2 injection) to the Department for development of the geothermal resource in the Raft River Geothermal Resource Area.

On that same day the Department advised the applicant 2. by phone of the deficiencies of the applications.

On July 28, 1983 Geo Energy Corporation filed Water 3. Right Application 43-7199 for power production in connection with the geothermal wells.

On August 16, 1983 the applicant was again notified by 4. the Department of the deficiencies on the geothermal applications.

On September 26, 1983 a protest was received against 5. Water Right Application 43-7199.

6. On September 30, 1983 the applicant contacted the Department in regard to the bonding requirements and appeared to be making progress in fulfilling these requirements.

7. On November 23, 1983 the applicant amended the place of use of the water right application.

8. On December 13, 1983 the Department advised the applicant of the withdrawal of the protest on the water right and requested the submittal of additional information to satisfy the requirement of Sections 42-205 and 206 of the <u>Idaho</u> Code.

9. On July 15, 1985 the Department advised the applicant by certified mail of the deficiencies of the geothermal applications so that processing of the applications could be completed.

10. No response was received and the letter was returned to the Department marked "No Forwarding Address".

11. On October 30, 1985 an order to show cause why Water Right Application 43-7199 and Geothermal Applications 43-GR-1, 2, 3, 4 and 5 should not be voided for failure to provide the requested information was sent by regular and certified mail to Lee Albright and Lou Esposito the two remaining Corporation officials of Geo Energy Corporation.

12. No response was received to the Order to Show Cause within the thirty days specified.

CONCLUSIONS OF LAW

1. Section 42-204, <u>Idaho Code</u>, provides 30 days for submission of the requested information on the water right application or the Department may void said record. 2. More than thirty days have passed since the additional information was requested for water right application 43-7199.

3. Geothermal Applications 43-GR-1, 2, 3, 4 and 5 are not complete and do not comply with the requirements of the law.

IT IS HEREBY ORDERED that Water Right Application 43-7199 and Geothermal Applications 43-GR-1 through 5 are voided.

DATED this day of JANCEARY 1986.

NORMAN C. YOUNG, Administrator Resources Administration Division



STATE OF IDAHO DEPARTMENT OF

SOUTHERN REGION

WATER RESOURCES

SOUTH

1041 Blue Lakes Blvd. North Twin Falls, Idaho 83301 (208) 734-3578

John V. Evans Governor

C. Stephen Allred Director

July 26, 1983

TO: Times News

South Idaho Press

FROM: Loren O. Holmes Southern Region Supervisor

RE: GEOTHERMAL APPLICATIONS FILED IN RAFT RIVER VALLEY

NEWS RELEASE

Geo Energy Corporation, 3766 Stone Creek Way, Boise, Idaho, has filed 5 applications for permit with the Department of Water Resources to drill for geothermal resources in the Raft River Valley near Bridge, Idaho.

In its applications, the company proposes to drill 5 wells to depths of 1300 to 1600 feet to tap geothermal waters.

After energy has been extracted from the water, the applicant proposes to inject the used water into the ground at depths of 500 to 1300 feet. Copies of the applications are on file in the Southern Region office of the Idaho Department of Water Resources, 1041 Blue Lakes Blvd. North, Twin Falls, Idaho, 83301.

Public comments of objections to the proposed permits should be filed with the Department of Water Resources by August 15, 1983.

INTER-DEPARTMENT MEMO ----- 1 REGENTEN DATE 7/15/83 FROM John Beal JUL 19 1988 To Loven Holnes Department to Water Comment Sauthers District Office SUBJECT 43-6R-4, 5 Since these Are injection wells they will require press release per Waste Disposal Rule 6.1 Paragraph Please make release AS 1. 500~ As possible Och EBeensure



State of Idaho DEPARTMENT OF WATER RESOURCES

REGEN

JUL IS

Department of Water Resources Southant Diastict Office

STATE OFFICE, 450 W. State Street, Boise, Idaho

JOHN V. EVANS Governor

A. KENNETH DUNN Director

July 15, 1983

Mailing address: Statehouse Boise, Idaho 83720 (208) 334-4440

Loren Holmes IDWR - Southern Region

RE: 43-GR-1, 43-GR-2, 43-GR-3, 43-GR-4 & 43-GR-5

Dear Loren:

Attached for your review and comment are applications for permit to drill 3 production wells and 2 injection wells at Raft River, Idaho, submitted by Geo Energy Corporation.

Please submit your comments to me by August 4, 1983.

Sincerely,

JOHN E. BEAL, Supervisor Construction Permits Section

JEB:1dt

Enclosures

Geothermal Application No. 43-6-8-1

Form 4003-1 5/78

STATE OF IDAHO DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

	Nan	ne of applicant Geo Energy Corporation
	Post	t office address 3766 Stone Creek Way, Boise, Idaho 83703
	part nam	artnership, joint-venture, association, or unincorporated group, attach names and places of domicile of tners or persons. If corporation, attach list of corporate offices and their place of domicile, and the nes and place of domicile of any person owning thirty percent (30%) or greater interest in the corpo- on. Also give:
	a.	Place of incorporation and dateJune 28, 1983
		Secretary of State's Office, Boise, Idaho
	b.	Principal place of businessBoise, Idaho
	c.	Location of home office3766 Stone Creek Way
		Boise, Idaho 83703
	d.	Is applicant making application as an agent for another person, corporation or entity? If so, state name, address, and interest of your principal. Jerry R. Kirkman, President, Geo Energy Corporation,
		3766 Stone Creek Way, Boise, Idaho 83703
		Designation of agent residing in the State of Idaho Rick Tremblay, Vice President,
_	е.	Geo Energy Corporation
2.		ation of proposed well Raft River, Idaho
	11	W ¼ – ¼, Section 23 , Township <u>158</u> , Range <u>26E</u> , B.M.
	Wel	I number or well nameShaun #1
3.	Түр	be of well: \Box Exploration \boxtimes Production $\#1$ \Box Injection
4.	Wel	l construction:
	tior pro	cribe specifically or attach information pertinent to the proposed casing program, and well construc- n including casing size, thickness, length of conductor, surface and production pipes; proposed grouting cedures, safety devices, valving, and other measures designed to conserve and protect the geothermal purce and ground water of the state. 20" hole drilled to 18' depth.
	16-	-3/4" Casing set at 18' depth, (2' above land surface) with annular space cemented
	sol	lid to surface.
	14'	'Hole drilled from 18' depth to 1,400' depth.
		-3/4" Casing set from surface to 1,400' depth with annular space cemented solid
		curface
	1.21	'Hele drilled from 1 400' depth to 1 600' depth
		'Hole drilled from 1,400' depth to 1,600' depth. 5/8" Screen or perforated casing installed with lead swedge and set open hole
	T L C	om 1,400' depth to 1,600' depth. All casing standard wall 3/16".

If the proposed well is for exploration or production, explain the means by which you expect to contain and control the resource. (Use additional sheets if necessary.) Standard surface valving procedures with remote control extension devices. Cement, casing, surface valving, and drilling program is based on USGS drilling reports for Raft River site where no high temperatures or high pressures are known to exist at drilled depths of over 6,000'.

6. What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc. <u>Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well</u>" and

"The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink or USDOE Raft River

Geoscience Case Study.

7. Is this application a part of a program for exploration or development of an already explored geothermal resource?

Development of an already explored geothermal resource.

- 8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project.
 \$70,000: Niagra-Mohawk Power Co. HydraCo Joint Venture
- 9. If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?

Geothermal power production use

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10. List in detail the applicant's previous experience in geothermal resource development.

Rick Tremblay, Vice President, Geo Energy Corporation formerly project director

of Capitol Mall Geothermal Project and L. L. "Roy" Mink, Consultant to Geo Energy

Corporation and former USDOE Geothermal Energy Branch Chief.

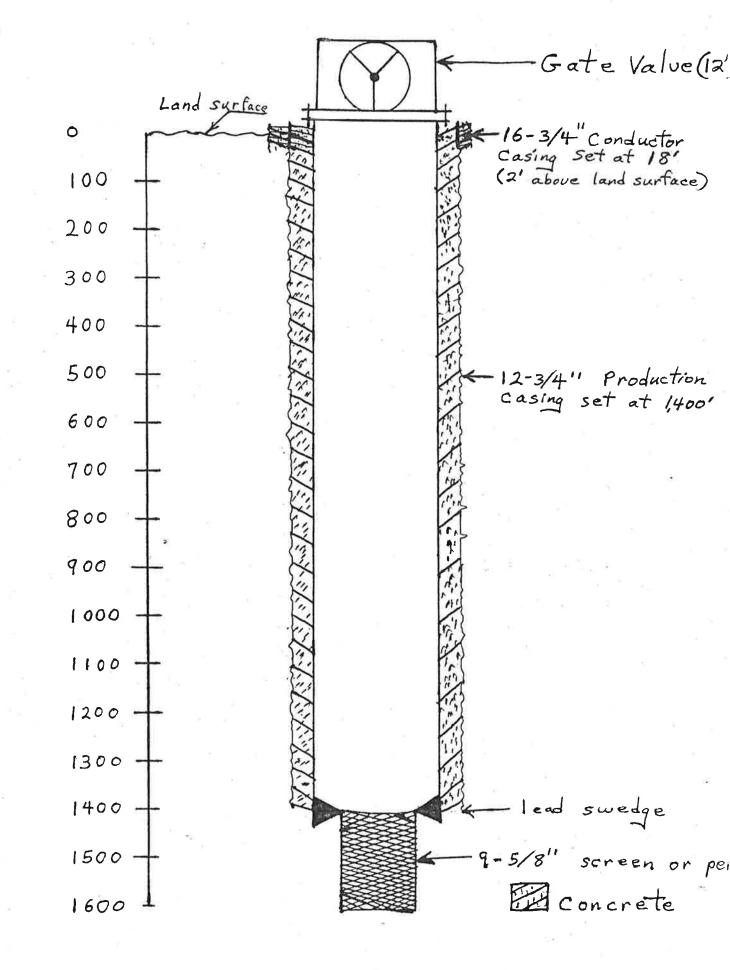
11. What does the applicant intend to do with waste products, brine or water from the well?

Reinjection into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than \$10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees. <u>A Surety Bond will be</u>

provided to the IDWR in the forthcoming drilling prospectus.

application ignature for



Muo to 1,400' - WATER 1,400' - 1,600'

IVAN DARRINGTON WELL #4 155 26E 24DOC1 IVAN DARRINGTON WELL #3 155 26E 230001 15S 165 15S REID STEWART WELL MORRIS MITCHELL WELL #2 155-21E 250001 HAROLD WARD WELL J1 145 Z7E 18CCC1 FRAZIER H S WELL 155 26E 2388C1 HAROLD WARD WELL #2 ISS 24E 2200 HARRIAT ORANK WELL 155 26E 2300C1 5/18/72 SEARS IVAN DARRINGTON 15S 81 122 HAROLD WIGHT Y GRIFFETH-WIGHT Spring or Well Identification Number and Name 3 SPRI 26E 26E 26E 26E 25E 220001 25 ACA 1 IZVOCI 2900C1 190022 268V1 RING 68081S MACE. WELL #1 20 212 2 10/ 3/28/75 1/14/75 1/29/75 7/24/75 7/30/75 5/18/72 8/ 7/25/72 9/22/17 7/24/75 6/14/77 Sample Collection Date 6/74 5/74 7/76 ৎ 5/75 0 ð 2 З 5 ដ 8 3 8 82 8 8 9 6 24 ង 77 Measured Surface Temperature ^OC 8 1982. 165. 126. 152. ٩ 0 • • °, 0 0 Reported Well Depth below Land Surface 0 0 • • • 0, 3399. 3399. 151. (mators) 3399. 227. ZZ0. 8 189. 378. 378. 662. 15. ٩ 58. ۰ Discharge (I/min) • 0 140 37 86 S 47 ü 97 80 5 68 68 * 28 90 38 64 22 S11ica (Si0₂) 0_001 140-0 130.0 300.0 28.0 35.0 88.0 53.0 43.0 0.95 37.0 55.0 29.0 3.6 2.0 1.0 5-0 Calcium (Ca) 0.40 9.00 7.10 3.90 6.30 8,30 0.40 12.00 0.50 0.10 1.40 0.10 9.30 0.20 1.8 2.20 7.50 Magnesium (Mg) 1110 1300 240 370 Ä 2000 \$0 380 260 8 Ξ 120 170 170 70 Sodium (Na) ¥ 5 13.00 270.00 ¥ ĩ6**.** 16. 19. 3 57. 14. 22 3.10 8 3.40 2.90 3.30 2.50 8 8 8 8 1.80 Potassium (K) 8 8 8 8 00 138. 176. 161. 177. 174. 26 55. 6 ĉ 169 230. 131. 240. 58. 65. 116. 120. Bicarbonate (HCO3) 2 124.00 0.0 0.0 0.0 0.0 0.0 0.0 8 36.00 0.0 0.0 0.0 0.0 0_0 0.0 0.0 Carbonate 8 8 (003) 44.00 65.00 61.00 32. 52. 69 57.00 40.00 52.00 45.00 40.00 녆 2 C 27. X Cassia ō Sulfate (504) 8 8 8 8 8 8 8 8 8 0.0 0.0 0.0 0.0 0.0 0.01 0.0 0.0 0.0 0.0 0.0 0-03 0 0.0 0.0 0.01 0.0 County Phosphate 02 (PU4) 380.0 570.0 650.0 1900.0 2000.0 3900.0 560.0 B20.0 0.006 680.0 300.0 82.0 80.0 17.0 62.0 72.0 0.61 Chloride (Cl) (cont'd.) 14.00 2.30 4_40 2.80 2.50 1. 8 9,10 5.70 5.00 1.10 7.30 0.40 3.90 7.60 2.90 2.40 0.0 Flouride (F) 0.0 0.0 0.0 0.0 1.10 0.57 0.54 0.0 0.0 0.0 0_0 0.56 0.03 0.50 0.0 1.20 0.0 Nitrate (NO3) 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 1.00 0.0 Boron (8) 0.14 0.21 0.0 0.0 0.0 0.0 0.0 0.0 0.04 0.88 0.0 0.0 0.08 0.0 0.08 0.0 0.0 Ammonia (NH3) 1539 2179 1949 1839 2459 6089 10000 6609 3049 1879 866 540 606 475 960 600 Specific 270 Conductance 6.8 7.7 7.5 7.3 7_0 (fleid) 7.7 7.4 8.1 8.0 7.8 6.9 7.4 8.7 5.6 8.4 8.2 7.6 pH (field) 1199 1222 838 1353 1648 3365 853 1715 138: 3514 376 282 515 306 734 368 165 Total Dissolved Solids (TDS) 182. 249. 275. 103 38. 326. 134. н. 142. 754. 151. 146. 103. 62. 9 ŝ ۲ Carbonate 241. 117. 130. 296. • 69 707. 89 60. 0 90 • 0 • 39. • • ŝ Non-Carbonate 113. 132. 145. 144. 143. 87. 138. 207. ŏ. 45. 107. 257. 302. Alkalinity 52. 48. 52 86 as CaCOi 72.5 84.6 73.3 73.6 70.6 86.7 88.3 B4.6 94.7 79.8 95.0 53,1 96.9 66.8 98.1 51.9 23.3 Percent Sodium (\$Na) 15.8 10.0 26,7 21.1 7.7 9.4 10.0 15.5 47.3 31.7 17.0 20.6 40.6 2.7 Sodium Absorption Ratio (SAR) 6.1 0.8 0.6 -2.119 0.971 1.293 -0.596 0,265 -0.474 -2--1.377 -2.673 -0.457 -3.683 -62.093 0.762 0.365 1.B40 .427 381 365 Cation-Anion Balance N ö Ň 0 Data Reference

Basic Data Table Chemical Analyses 0f Thermal Water from Selected Springs and Wells ĥ (continued)

Idaho

Hardness

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Geothermal Application No. 4/3 - GR-2

Form 4003-1 5/78

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STATE OF IDAHO DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

Name of applicant Geo Energy Corporation

Post office address 3766 Stone Creek Way, Boise, Idaho 83703

If partnership; joint-venture, association, or unincorporated group, attach names and places of domicile of partners or persons. If corporation, attach list of corporate offices and their place of domicile, and the names and place of domicile of any person owning thirty percent (30%) or greater interest in the corporation. Also give:

a. Place of incorporation and date June 28, 1983

Secretary of State's Office, Boise, Idaho

b. Principal place of business Boise, Idaho

c. Location of home office 3766 Stone Creek Way

Boise, Idaho 83703

d. Is applicant making application as an agent for another person, corporation or entity? If so, state name, address, and interest of your principal.

Jerry R. Kirkman, President, Geo Energy Corporation,_____

3766 Stone Creek Way, Boise, Idaho 83703

e. Designation of agent residing in the State of Idaho Rick Tremblay, Vice President, Geo Energy Corporation

2. Location of proposed well Raft River, Idaho

W 1/2 SE %, Section 22 , Township 158 , Range 26E , B.M.

Well number or well name <u>Heather #2</u>

3. Type of well: '□ Exploration 🛛 🖾 Production #2 □ Injection

4. Well construction

Describe specifically or attach information pertinent to the proposed casing program, and well construction including casing size, thickness, length of conductor, surface and production pipes; proposed grouting procedures, safety devices, valving, and other measures designed to conserve and protect the geothermal resource and ground water of the state.

ground water of the state. 20" hole drilled to 18' depth.

16-3/4" Casing set at 18' depth, (2' above land surface) with annular space cemented

solid to surface.

14" Hole drilled from 18' depth to 1,400' depth.

12-3/4" Casing set from surface to 1,400' depth with annular space cemented solid

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12" Hole drilled from 1,400' depth to 1,600' depth.

9-5/8" Screen or perforated casing installed with lead swedge and set open hole

from 1,400' depth to 1,600' depth. All casing standard wall 3/16".

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6. What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc.
Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well!" and

"The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink or USDOE Raft River

Geoscience Case Study.

5

 Is this application a part of a program for exploration or development of an already explored geothermal resource? Development of an already explored geothermal resource.

8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project.

\$70,000: Niagra-Mohawk Power Co. - HydraCo Joint Venture
9. If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?

Geothermal power production use

10. List in detail the applicant's previous experience in geothermal resource development.

Rick Tremblay, Vice President, Geo Energy Corporation formerly project director

of Capitol Mall Geothermal Project and L. L. "Roy" Mink, Consultant to Geo Energy

Corporation and former USDOE Geothermal Energy Branch Chief.

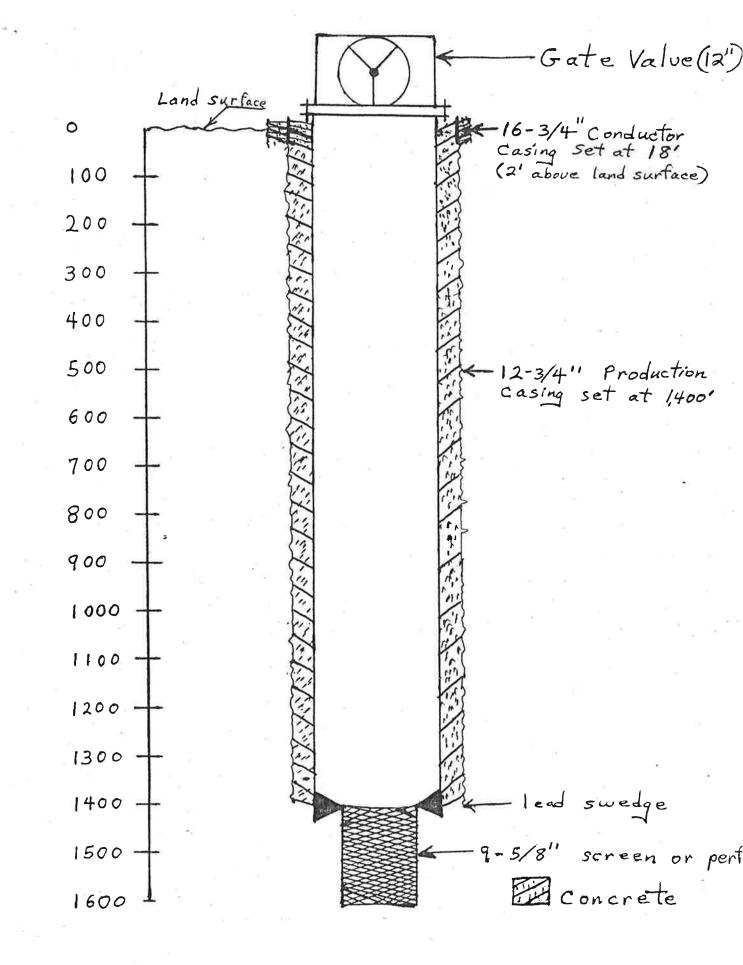
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Reinjection_into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than \$10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees. A Surety Bond will be

provided to the IDWR in the forthcoming drilling prospectus.

for applicat



General Production Well' Const. MUD to 1,400! - WATER 1,400'-1,600'

BLM 165 26E 58BA1 3/28/75 40 0. 151. 37	BLM 155 26E 25ACA1 1/14/75 30 0. 83. 88	IVAN DARFINGTON WELL /4 155 26E 2400C1 7/29/75 31 0. 3399. 55	REID STEWART WELL 155 26E 248ADI 7/24/75 32 0. 3399. 47	I VAN DARRINGTON WELL #3 155 26E 230001 7/30/75 33 0. 0. 53	HARRIAT ORAMY WELL 155 26E 2000C1 5/18/72 90 165. 227. 97	FRAZIER H S WELL 155 26E 2388C1 5/18/72 95 126. 220. 90	IVAN DARRINGTON WELL #1 155 26E 23AAA1 10/23/75 85 0. 15. 140	8LM 155 26E 220001 12/ 6/74 82 0. 189. 56	BLM 155 26E 12AQCI 12/ 5/74 26 0. 0. 88	^т ВLM 155 25E 290001 10/ 7/76 60 0. 0. 68	HAROLD MARD WELL /2 135 24E 220081 7/25/72 38 152. 378. 44	MORRIS MITCHELL MELL //Z 135 21E ZDOC1 9/22/77 46 0. 38, 2	HAROLD MARD MELL #1 145 27E 180001 7/24/75 24 0. 3399. 9	HAROLD WIGHT WELL 145 26E 100A1 6/14/77 63 0. 0. 8	GRIFFETH-WIGHT WELL 145 26E 18001 0/0/0 77 1982. 378. 6	SEARS SPRING 145 25E 688815 8/ 5/75 28 0. 662. 2		Number ing and anti- ic q Name Sample Collection Date Measured Surtace Temperature CC Reported Well Depth below Land Surface (meters) Discharge (1/min)
58.0	3 35.0	5 89.0	7 100.0	5 140-0	7 130-0	0 53.0	0 43.0	5 56.0	8 300.0	8 3. 6	4 37.0	28 2.0	90 55.0	83 1.9	64 5.0	22 29.0	5	Silica (Sł0 ₂) Calcium
9.00	3.90	7.10	6.30	B.30	0.40	0.40	1.00	0.50	1.40	0.10	9,30	0.10	2.20	0.20	0 12.00	0 7.50		(Ca) Magnesium
240	370	340	380	450	1110	560	400	1300	2000	120	0 70	0 110	0 170	0 170	0 14	0 15		(Mg) Sodlum
13.00	34-00	16.00	16,00	19.00	35,00	22.00	37.00	14.00	270.00	3.40	3,10	1.80	29.00	2.90	2.50	3. 30		(Na) Potassium
138.	176.	161.	177.	174.	ж.	-55.	63.	63.	58,	65.	0 169.	0 230.	ه ۱ <u>۶۱</u>	0 240.	0 116.	0 120.		(K) Bicarbonate
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	. 20,00	. 0.0	. 11.00	•	. 36.00	• 124.00	. 0.0		(HCO3) Carbonate (CO3)
44.00	32.00	52,00	65.00	69.00	61.00	57.00	40.00	52.00	45.00	40_00	33.00	21.00	23.00	0,25,00	0 27.00	10.00	Cassia	Sulfate (SO4)
0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.03	0.02	0.0	0.0	0.01	0.0		Phosphate
360.0	570.0	560.0	650.0	820.0	1900.0	0.006	680_0	2000.0	0-0065	82.0	B0.0	17.0	300.0	72.0	62.0	- 19.0	County ((PU4) Chloride (Cl)
4.40	2.80	2,50	1.90	2.30	14.00	5.70	9.10	5.00	3,90	7.60	2_90	2.40	1.10	7.30	0.0	0.40	(cont'	Flouride
0.0	0.0	0.0	0.0	1.10	0.57	0.54	0.0	0_0	0-0	0.0	0.56	0.03	0,0	0.50	1.20	0.0	d.)	(F) Nitrate
0.0	0.0	0.0	0.0	0_0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0		(NO3) Baron
0.14	0.21	0.0	0.0	0.0	0.0	0.0	0.0	0_04	0.88	0.0	0-0	0.08	0.0	0.08	0.0	0.0		(B) Ammonila
1539	1949	1839	2179	2459	6089	3049	1879	6609	866	540	606	475	960	600	10000	270		(NHz) Specific
6_8	7.7	7.5	7.3	7.0	7.7	7.4	8.1	9 8 .0	3 7.8	6.9	5 7.4	5 8,7	0 7.6	0 9.3	0 8.4	0 8.2		Conductance (fleid) pH
853	1222	1199	1353	1648	3365	1715	1381	3514	66.36	376	362	306	734	515	368	165		(field) Total Dissolved
182.	103.	249.	275.	363.	5 326.	5 134.	H.	4 142.	5 754.	9.	2 151.	5. 6	4 146.	ч С	8 62.	5 103.		Solids (TDS)
69	0.	117.	130.	241.	296.	69.	60.	8	707.	0	•	0	. 39.	•	•	5		Carbonate Tanga Non-Carbonate V
113.	144.	132.	145.	143.	30.	45.	52.	52.	48.	87.	138.	207.	. 107.	. 257.	. 302.	. 98.		Alkalinity as CaCO3
72.5	84_6	73.3	73.6	70.6	B6.7	88.3	84.6	94.7	79_8	95.0	53.1	6.96	66.8	98.1	. 51.9	. 23.3		Percent Sodium (\$Na)
7.7	15.8	9.4	10.0	10.0	æ.,1	21-1	15-5	47.5	31.7	17_0	2.7	20.6	6.1	40.6	0.8	0.6		Sodium Absorption Ratio (SAR)
0.971	-2.119	1.293	-0,596	0.265	-0.474	-0.381	-2.265	0.762	-1.427	1.840	ه 1.377	-2.673	-0.457	-3.683	-62.093	0.365	18	Cation-Anion Balance
ø	Ŷ	ø	e va	12	u.	3	v	9	v	ø	u	10	s	12	10	v		Data Reference#

Basic Data Table 1. Chemical Analyses of Thermal Water from Selected Springs and Wells in Idaho (continued)

Geothermal Application No. 43-6R-3

Form 4003-1 5/78

1

STATE OF IDAHO DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

ł	Nam	e of applicant Geo Energy Corporation
	Post	office address 3766 Stone Creek Way, Boise, Idaho 83703
	part nam	artnership, joint-venture, association, or unincorporated group, attach names and places of domicile of ners or persons. If corporation, attach list of corporate offices and their place of domicile, and the les and place of domicile of any person owning thirty percent (30%) or greater interest in the corpo
	ratio	on. Also give:
	a.	Place of incorporation and dateJune 28, 1983
	1	Secretary of State's Office, Boise, Idaho
	b.	Principal place of businessBoise, Idaho
	c.	Location of home office 3766 Stone Creek Way
		Boise, Idaho 83703
	d.	ls applicant making application as an agent for another person, corporation or entity? If so, state name, address, and interest of your principal. Jerry R. Kirkman, President, Geo Energy Corporation,
		3766 Stone Creek Way, Boise, Idaho 83703
	е.	Designation of agent residing in the State of Idaho Rick Tremblay, Vice President, Geo Energy Corporation
2.	Loc	cation of proposed well Raft River, Idaho
	-	NW 1/2 1/2, Section 22 , Township 155 , Range 26E , B.M.
	We	Il number or well name Bryce #3
3.	Τvi	pe of well: 🖆 Exploration 🛛 🖾 Production #3 🗂 Injection
8	,,	
4.		Il construction:
	tio	scribe specifically or attach information pertinent to the proposed casing program, and well construct in including casing size, thickness, length of conductor, surface and production pipes; proposed grouting ocedures, safety devices, valving, and other measures designed to conserve and protect the geothermal
	res	ource and ground water of the state. 20" hole drilled to 18' depth.
	16	-3/4" Casing set at 18' depth, (2' above land surface) with annular space cemented
	50	lid to surface.
	14	"Hole drilled from 18' depth to 1,400' depth.
1	12	-3/4" Casing set from surface to 1,400' depth with annular space cemented solid
	to	surface.
	. *	

12" Hole drilled from 1,400' depth to 1,600' depth.

9-5/8" Screen or perforated casing installed with lead swedge and set open hole from 1,400' depth to 1,600' depth. All casing standard wall 3/16".

If the proposed well is for exploration or production, explain the means by which you expect to contain and control the resource. (Use additional sheets if necessary.) Standard surface valving procedures

with remote control extension devices. Cement, casing, surface valving, and drilling program is based on USGS drilling reports for Raft River site where no high temp-

6. What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc. Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well" and

"The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink or USDOE Raft River

Geoscience Case Study.

7. Is this application a part of a program for exploration or development of an already explored geothermal resource?

Development of an already explored geothermal resource.

- 8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project. \$70,000: Niagra-Mohawk Power Co. - HydraCo Joint Venture
- If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?

Geothermal power production use

10. List in detail the applicant's previous experience in geothermal resource development.

Rick Tremblay, Vice President, Geo Energy Corporation formerly project director

of Capitol Mall Geothermal Project and L. L. "Roy" Mink, Consultant to Geo Energy

Corporation and former USDOE Geothermal Energy Branch Chief.

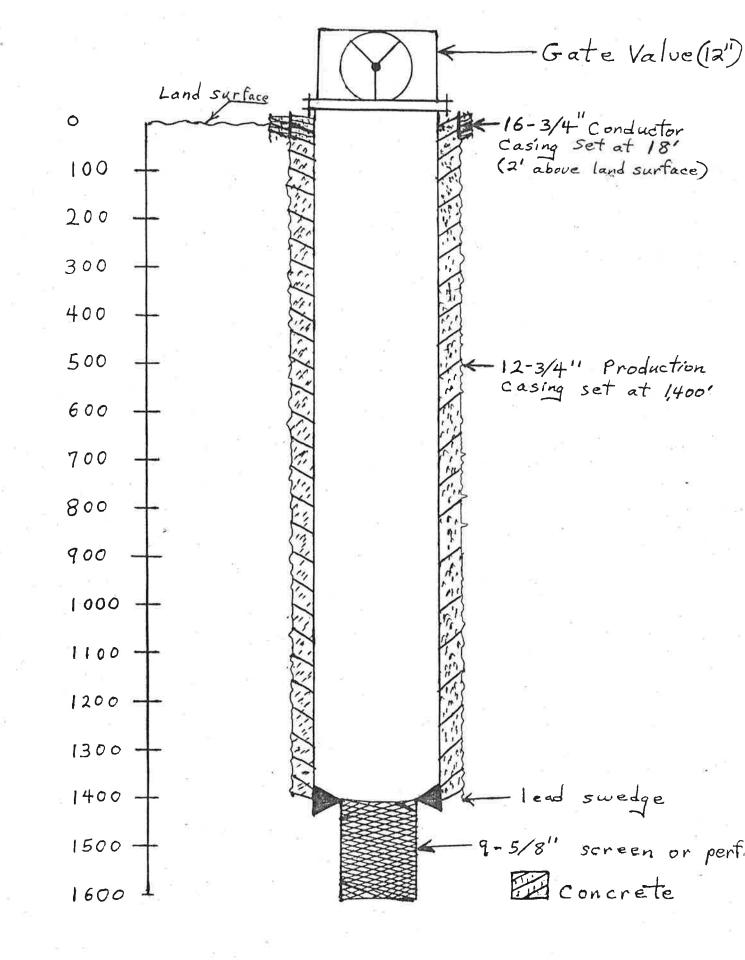
11. What does the applicant intend to do with waste products, brine or water from the well?

Reinjection into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than \$10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees. A Surety Bond will be

provided to the IDWR in the forthcoming drilling prospectus.

complex naturé for application



Muo to 1,400: - WATER 1,400'-1,600'

IVAN DARRINGTON WELL #4 155 26E 24DCC1 IVAN DARFINGTON WELL #3 155 26E 230001 165 I 55 REID STEWART WELL 155 26E 248AD1 MORRIS MITCHELL WELL #2 155 ZIE 250CC1 HARRIAT FRAZIER HAROLD WARD WELL #2 155 24€ 220081 BLM 155 BLM 155 HAROLD WARD WELL_#1 14S 27E 18CCC1 IVAN DARRINGTON 155 155 SEARS SPRING 145 Z5E 680015 HAROLD WIGHT W GRIFFETH-WIGHT 145 26E 18001 Spring or Well IdentIfication Number and Name 26E 26E 26E 26E 25E 2388C1 23DDC1 25 ACA I 220001 Z9CDC1 1 VBPG 120001 WELL MELL 0/ 1/ WELL #1 2 3/28/75 2 10/ 1/14/75 7/29/75 7/24/75 7/30/75 5/18/72 1/25/12 9/22/77 6/14/77 8/ 7/24/75 18/72 Sample 6/74 5/74 ৎ 7/76 5/75 Collection 0 Date 10 20 3 32 3 8 35 80 82 Я 8 8 46 24 c, Measured Surface Temperature ^oC 77 8 165. 126. 1982. 152. Reported Well Depth below Land Surface (meters) ۰ 0 0 0 0 0 ° 0 ۰ 0 0 0 0 3399. 3399. 151. 3399. 662. 83 227. 220. .681 378. 378. 5 0 38 Discharge (1/min) • • 0 140 33 88 S 47 č 97 90 26 88 68 44 28 90 83 64 Silica (510₂) 22 100.0 140.0 58.0 88.0 130.0 300.0 35.0 53.0 43.0 37.0 56.0 55.0 3.6 29.0 2.0 5.0 •0 Calcium (Ca) 00.6 7.10 6.30 3.90 8.30 0.40 12.00 0.40 1.00 0,50 0 0 1.40 9.30 N 0 7.50 Magnesium (Mg) õ 3 8 8 1110 1300 240 370 340 080 450 260 400 2000 120 5 170 170 70 4 3 Sodium (Na) 270 13.00 5 16 16.00 14.00 19 ы 22 37 8 3.40 3-10 1.80 2.90 2.50 3.30 8 8 80 8 Potassium 8 8 8 00 (K) 138. 176. 161. 177. 174. 230. 116. 63. 169. 131. 240. 120. 36. 55 63. -85 65. Blcarbonate (HC03) 124.00 20.00 11.00 0.0 0.0 0.0 8 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0_0 Carbonate (CO₃) 8 44.00 52.00 65.00 69 32 6 57 40.00 52.00 45.00 40 N 5 С Х 27 10.00 Cassia Sulfate (SO₄) 8 80 8 8 -00 8 8 8 -00 00 0.0 0.0 0.0 0.0 0.0 0.0 0.01 0,0 0.0 0.0 0.02 0.01 0.0 0.03 0.0 0.0 0.0 County Phosphate (PO₄) 1900_0 3900.0 380.0 570.0 2000.0 560.0 820. 650.0 0.006 680.0 82.0 80.0 300-0 62.0 17.0 72.0 0.61 Chloride ò (cont'd.) (CI) 4.40 4 2.80 2, 50 1.90 2.30 5.70 9.10 5.00 3.90 7.60 0.40 2.90 2.40 7.30 0.0 1.10 8 Flouride (F) 0.0 0.0 0.0 0.54 0.0 0.0 1.10 0.57 0.0 0.0 0.0 0,56 0.03 0.0 0.50 0.0 1.20 Nitrate (NO3) 0.0 0.0 0.0 •• 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0_0 0.0 0.0 0_0 1.00 Boron (B) 0.14 0,21 0.0 0.0 0.0 0.0 0.0 0.04 0.88 0.0 0.0 0.08 0.0 0.0 0.08 0.0 0.0 Ammonila (NH-5) 1539 2179 10000 1949 2459 6809 6609 6591 3049 1879 866 Specific Conductance (fleId) 540 606 475 960 600 270 6.8 7.7 7.5 7.3 7.0 7.7 7.4 8. 8.0 7.8 8.9 7.4 8.7 7.6 9.J 8.4 8 * 2 pH [[leid] 6611 853 1222 1353 1648 66.36 3365 1715 138: 3514 376 36 2 306 734 515 368 165 Total Dissolved Solids (TDS) 182. 103 249. 275. 383. 326 134. 111. 754. 142. 151. 146. 103, 62. 9 \$ 4 Carbonate 117. 241. 69. 130 296. 707. 69. • 60. •06 39. 0 • <u>,</u> • 0 \$ Non-Carbonate 113. 132. 44. 145. 143. 257. 207 107. 302. Alkalinity 45 48. 138. 30 52. 52. 87. 98. as CaCO₃ 7.2.5 84.6 73.3 73.6 86.7 88.3 84.6 79.8 70.6 94.7 95.0 53.1 96-9 66.8 98.1 9°1۶ 23.3 Percent Sodium (\$Na) 15.8 21 - 1 10.0 10.0 ж, 7 31.7 7.7 47.3 9_4 ۰.5 17.0 20.6 40.6 · - 7 6.1 0.8 0.6 Sodium Absorption Ratio (SAR) -2.119 146*0 -0.596 -0.474 -0.381 -1.427 -62.093 1.293 0.265 -0.457 0.762 1.840 -2.673 -3.683 0.365 .265 .377 Cation-Anion Balance ١Z ō 2 õ Data Reference* 9

Basic Data Table .-Chemical Analyses of Thermal Water from Selected Springs and Wells 5 I daho (continued)

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Geothermal Application No. 43-6-8-4

Form 4003-1 5/78

STATE OF IDAHO DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

1	Nan	ne of applicant Geo Energy Corporation
¥7	Pos	t office address 3766 Stone Creek Way, Boise, Idaho 83703
	part nam	artnership, joint-venture, association, or unincorporated group, attach names and places of domi- mers or persons. If corporation, attach list of corporate offices and their place of domicile, and mes and place of domicile of any person owning thirty percent (30%) or greater interest in the con. Also give:
	a.	Place of incorporation and dateSecretary of State's Office, Boise, Idaho
		June 28, 1983
	b.	Principal place of business <u>Boise, Idaho</u>
	c.	Location of home office 3766 Stone Creek Way
	0.	Boise, Idaho 83703
L	d.	Is applicant making application as an agent for another person, corporation or entity? If so name, address, and interest of your principal. Jerry R. Kirkman, President, Geo Energy Corporation
		3766 Stone Creek WAy, Boise, Idaho 83703
	e.	Designation of agent residing in the State of Idaho <u>Rick Tremblay</u> , <u>Vice President</u> , Geo Energy Corporation
2.		ation of proposed well <u>Raft River</u> , Idaho
	N	W ¼ – ¼, Section 23 , Township <u>155</u> , Range <u>26E</u> , B.M.
	We	I number or well name Sonja #4
3.	Typ	be of well: Exploration Production Injection #1
4.	We	Il construction:
	tio pro	scribe specifically or attach information pertinent to the proposed casing program, and well con n including casing size, thickness, length of conductor, surface and production pipes; proposed g produres, safety devices, valving, and other measures designed to conserve and protect the geof ource and ground water of the state.
	162	16" Hole Drilled to 18' depth.
	12	-3/4" Casing set at 18' depth, (2' above land surface) with annular
	sp	ace cemented solid to surface.
	12	" Hole drilled from 18' depth to 500' depth.
	9-	5/8" Casing set from surface to 500' depth with annular space cemented
	SC	lid to surface.
	<u>9'</u>	Hole drilled from 500' depth to 1,300' depth.
	8'	'Slotted injection pipe set from 500' depth to 1,300' depth.
	A1	l casing standard 3/16" wall.

If the proposed well is for exploration or production, explain the means by which you expect to rintain and control the resource. (Use additional sheets it necessary.)

Standard surface valving procedures with remote control extension devices. Grouting, casing, valving, and drilling program is based on USGS drilling reports for Raft River Site where no high temperatures or high pressures are known to exist at drilled depths of over 6,000'.

6 What is the character and composition of the material you expect to derive from the well? Include parameters such as phase, estimated temperatures, etc. Refer to attached "Chemical Analysis of Thermal Water - H. S. Frazier Well" and

"The Raft River, Idaho 5 MW Binary Project" report by L. L. Mink, or USDOE Raft

River Geoscience Case Study.

7. Is this application a part of a program for exploration or development of an already explored geothermal resource?

Development of a thoroughly explored geothermal resource.

- 8. What is the estimated cost of the construction of the well and related uses? Provide a validated financial statement showing the applicant has sufficient financial resources to complete the project. \$65,000: Niagra-Mohawk Power Co.HydraCo. Joint Venture
- 9. If the proposed development will involve the use of water for purposes other than geothermal uses, has the applicant applied for a permit to appropriate water as prescribed in Chapter 2, Title 42, Idaho Code?

Geothermal injection use

10. List in detail the applicant's previous experience in geothermal resource development.

Rick Tremblay, Vice President, Geo Energy Corporation, formerly Project Director

of Capitol Mall Geothermal Project, and L. L. "Roy" Mink, Consultant to Geo Energy

Corporation and former USDOE Geothermal Energy Branch Chief.

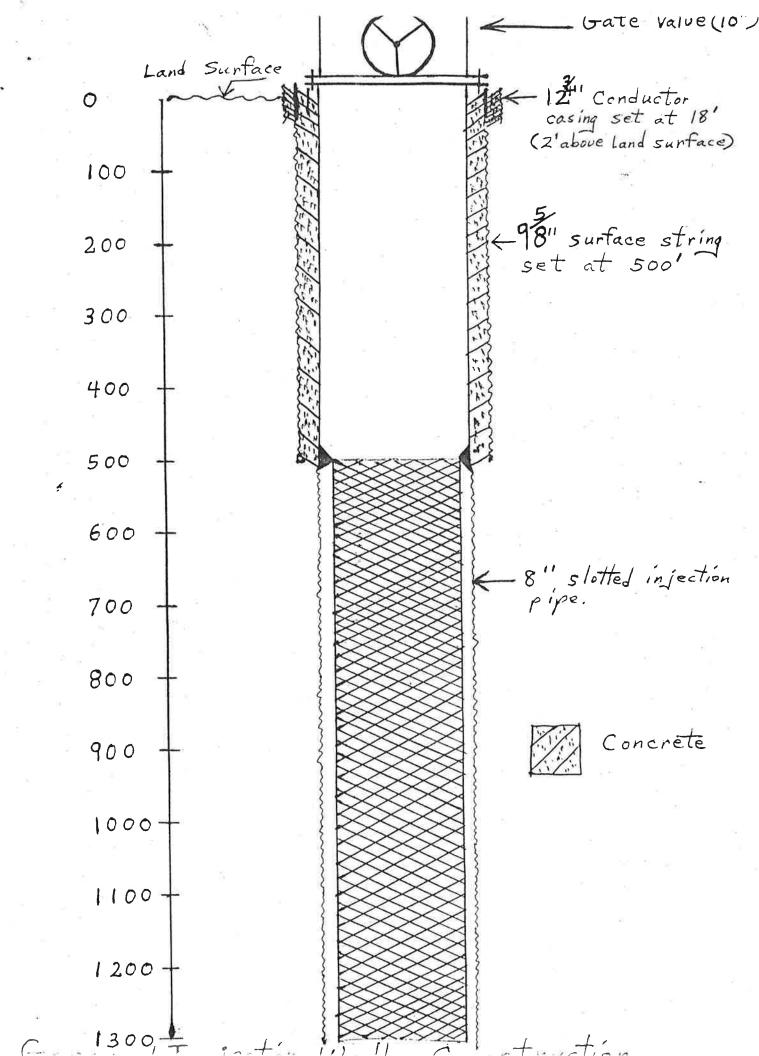
11a What does the applicant intend to do with waste products, brine or water from the well?

Reinjection into thief zone 500' to 1,300' depth.

12. Idaho law requires that a bond be filed with the Department indemnifying the State of Idaho, conditional upon the performance of the duties required by the Idaho Geothermal Resources Act and the proper abandonment of any well covered by permit of not less than \$10,000 per well, the actual amount set as a condition of the permit. Identify the company that will underwrite your bond and provide confirmation that they will issue such bond upon payment of the necessary fees.

A Surety Bond will be provided to the IDWR inthe forthcoming drilling prospectus.

cent Signature for application



165 26E 58841 3/28/75 40 0. 151. 37 58.0 9.00 240 13.00 138. 6 1/6*0 L'L 5'ZL 'SIL '69 'ZBL 558 8*9 6251 11*0 0*0 0*0 280*0 4*40 0*0 44*00 0*0 MJ8 122 SEE SEVENT 611°Z-8"\$1 9"#8 "##1 "0 "\$01 2221 05 51/21/1 L*L 6761 12*0 0*0 0.0 570°0 2.80 0*0 00°75 0.0 0 83 88 35.0 3.90 570 54.00 176. **N**18 1*563 122 SEE SUDCCI 1839 1.5 1199 249. 117. 132. 73.5 9.4 "191 00"91 0¥\$ 01"L 0"88 \$\$ "66\$\$ "0 15 51/62/1 0*0 25*00 0*0 0*0 0.0 20010 5120 0.0 ₩ 113A NOLDNING NYAL 122 SEE 248VD1 0°0 5116 1°2 1322 512 130° 172° 130° *221 00 91 085 05*9 1/54/12 25 . 0° 2266° 41 100°0 965*0-0*0 0*0 06*1 0*059 0*0 00°59 0*0 BEID STEWART WELL ZL \$92*0 127 SE 20001 1/20/12 392 551 1648 383* 241* 143* 10*0 10*0 00*69 0*0 0" 22 140"0 ۰۵ 5420 100 0*0 0.0 01-1 820°0 5°20 0*0 S# 113M NOTON LARN DARRINGTON ç \$1\$.0-.00 6089 7.7 3365 326. 296. 2°* 86"1 20" 0*0 25*0 00*71 0*0061 10*0 00*19 0*0 122 See S200C1 2/18/12 30 102* 551* 31 120*0 0*40 1110 22*00 20* HARRINT ORANK WELL ٤ 195*0-1"17 5"99 * 5 1 122 See Steeci 2/18/12 95 126. 220. *69 *PSI SILL ▶°L 6005 0.0 0.0 **bC ***O 0/°C 0°006 0.0 00*15 0*0 *CC 00*77 096 01*0 0"55 06 LEVICES H 2 MER 59Z*Z-6 5" 8" 8 19" 09 122 SEE 52 VVV1 10/52/12 82 111 1961 1.8 9781 0 15, 140 43.0 1.00 400 57.00 63. 0.0 0*0 0.0 01*6 0*089 0*0 0*0 40*00 IA MADARINGTON WELL #1 291.0 5° L> L°>6 "ZS 0°04 6609 8.0 3514 142. 90. 122 See 220001 12/ 6/74 82 00*11 0051 05*0 0*95 95 *681 *0 0*0 n°n 00*5 0*0002 0*0 00*25 0*0 • 29 RLM 6 120-1-L*15 8*6/ *8# */0/ **</ 9599 122 SEE 15VCC1 15/ 2/14 SE 9°L 966 89*0 0.0 0*0 06'5 0'0065 0'0 00"50 000 °85 1**0 2000 210*00 0.007 86 .00.0 *0 H18 0"11 0"56 945 122 S2E S6COC1 10/ 1/10 P0 0125 00'00 150 3'40 65' 50'00 40'00 *0 010 0.0 0.0 09*/ 0*79 0.0 9"6 89 "0 MJ8 £ 0" 128" 23"1 5" -1"211 151 295 \$°L 909 0"0 22"00 0"02 80"0 5"60 122 54E 550081 1/52/15 28 125" 318" 44 21'0 6"20 10 2"10 166" 0"0 95*0 0.0 2/ 113A ORAN QJOFAH 10 \$19"2-9°0Z 6°96 *L0Z °0 ۰с 122 SIE S20CCI 0/55/11 40 905 L.8 214 80.0 0.0 0' 28' 58' 5'0 0'10 119 1'80 520' 11'00 51'00 0'05 11'0 5'*0 0'02 Z# 113A MORRIS MITCHELL 90"8 101 .62 124 146" - 6 150-0-1.0 9*4 096 0*0 0*0 0*0 0* 32365* 60 25:50 110 56:00 131* 0*0 52:00 0*0 200*0 1*10 142 51E 180001 1/54/12 54 L# 1134 URAN ULORANH 21 589*5-9"0* 1"86 "152 "0 •5 515 72.0 7.30 0.50 0"20 110 2"80 240" 2000 22"00 0"0 £°6 009 80*0 0.0 0.1 0' 82 •0 59 LL/01/9 IVODI 392 501 HAROLD WIGHT WELL 01 5'20 110" 154"00 51"00 0"01 05"0 0"0 *205 •Z9 890 00001 0*0 00°1 02*1 21 00°Z1 0°C GRIFFETH-WIGHT WELL GRIFFETH-WIGHT WELL \$95*0 9°0 5°52 '86 ٠ς °£01 \$91 2°8 012 0°0 0*0 0* 662* 22 29.0 7.50 15 3.50 120* 0.0 10.00 0.0 19.0 0.40 0.0 8Z 52/5 /8 518889 35Z 501 SEMRS SPRING ("p,quos) hqunog eisseg

Data Reference*	Catlon-Anion Balance	Sodium Absorptic Ratio (SAR)	Percent Sodium	Alkatinity as CaCO3	Non-Carbonate	Carbonate	Total Dissolved Solids (TDS)	 Specific Conductance (fleld)	Annonia (NH3)	Boron (8)	Nitrate (NO3)	Flourida (F)	Chlorlde (Cl)	Phosphate (PUg)	Suitate (SO4)	Carbonate (CO ₃)	Bicarbonate (HCO3)	Potassium (K)	Sodium (Na)	Magnesium (Mg)	Calcium (Ca)	Silica (SiO ₂)	Discharge (1/min)	Reported Well De below Land Surf (meters)	Measured Surface Temperature ^O C	Sample Collection Date	Spring or Well Spring or Well Number and Name
		S S			ssau	Hard																0		р†ћ асв	ľ		1

Basic Data Table 1. Chemical Analyses of Thermal Water from Selected Springs and Wells in Idaho (continued)

Geothermal Application No. 43. 6 8-5

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/78	

1.

STATE OF IDAHO DEPARTMENT OF WATER RESOURCES

APPLICATION FOR PERMIT TO DRILL FOR GEOTHERMAL RESOURCES

Name of applicant	Geo Energy Corporation	
	3766 Stope Creek Way Boise, Idaho 83703	

Post office address

If partnership, joint-venture, association, or unincorporated group, attach names and places of domu partners or persons. If corporation, attach list of corporate offices and their place of domicile names and place of domicile of any person owning thirty percent (30%) or greater interest in the ration. Also give:

Place of incorporation and date Secretary of State's Office, Boise, Idaho 8.

June 28, 1983

- Principal place of business _____Boise, Idaho_____ b.
- с.

Location of home office ______3766 Stone Creek Way Boise, Idaho 83703

Is applicant making application as an agent for another person, corporation or entity? If so d., name, address, and interest of your principal. Jerry R. Kirkman, President, Geo Energy Corporation

3766 Stone Creek WAy, Boise, Idaho 83703

Designation of agent residing in the State of Idaho Rick Tremblay, Vice President, Geo Energy Corporation

Location of proposed well _____ Raft River, Idaho 2.

N $\frac{1}{2}$ NW %, Section 27 , Township 15S , Range 26E , B.M.

Well number or well name ______Michelle #5_____

Type of well: 🗆 Exploration 🛛 Production ☑ Injection #2 3.

Well construction: 4

> Describe specifically or attach information pertinent to the proposed casing program, and well co tion including casing size, thickness, length of conductor, surface and production pipes; proposed q procedures, safety devices, valving, and other measures designed to conserve and protect the geo resource and ground water of the state.

16" Hole Drilled to 18' depth.

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space cemented solid to surface.

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9-5/8" Casing set from surface to 500' depth with annular space cemented

solid to surface.

9" Hole drilled from 500' depth to 1,300' depth.

8" Slotted injection pipe set from 500' depth to 1,300' depth.

All casing standard 3/16" wall.

5. If the proposed well is for exploration or production, explain the means by which you expect to contain and control the resource. (Use additional sheets if necessary.)

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River Geoscience Case Study.

6

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Development of a thoroughly explored geothermal resource.

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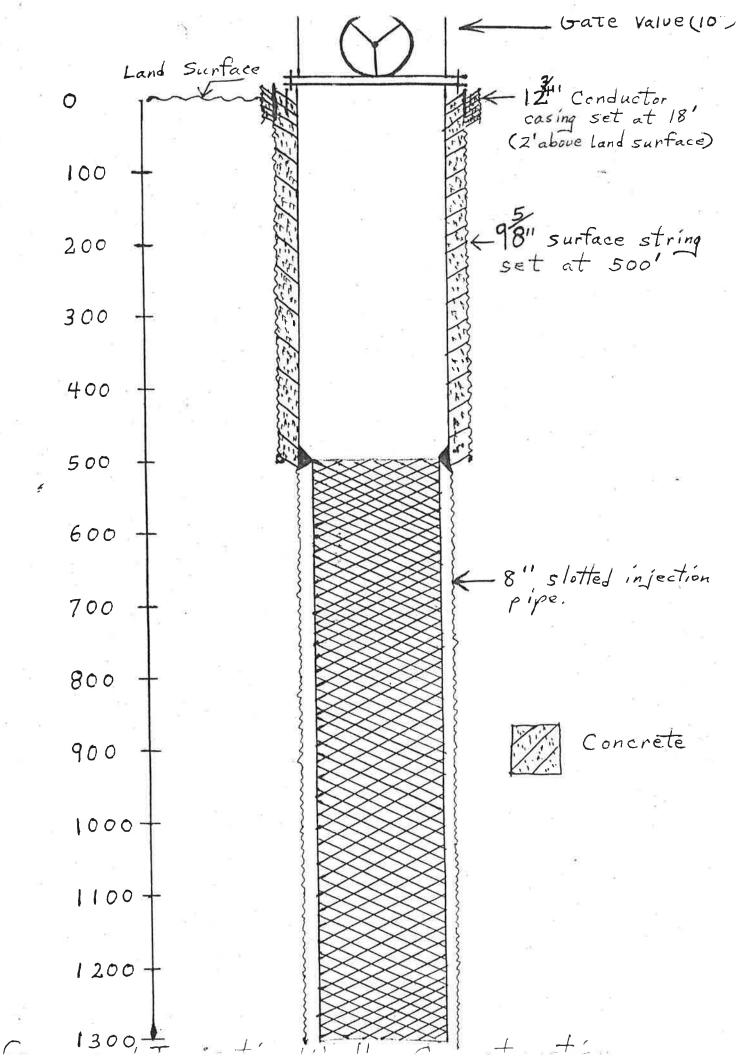
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A Surety Bond will be provided to the IDWR inthe forthcoming drilling prospectus.

Signature for application



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Data Reference* Cation-Anion Balance Chlori (CI) 8 Aumber and Name Sulfate (SO4) (Magnes Total Di Sollds (B) (Calici (NO3) noifeolilinebi (F) (PO4) (HC03) (NH) ŝŝ tassium (K) ILIAN TO POILIDE a 90 ium Absor Ratio (SAR) (SN S de -bonate ate ų, Sod (TDS) ity and 3 106 5 phlor Dep sseupler

Basic Data Table 1. Chemical Analyses of Thermal Water from Selected Springs and Wells in Idaho (continued)

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PAPER H8

International Conference on

geothermal energy

Florence, Italy: May 11-14, 1982

THE RAFT RIVER, IDAHO 5MW(e) BINARY PROJECT

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Summary

The Raft River Geothermal project, located in southern Idaho, U.S.A., has involved nearly eight years of geothermal research activities in both electric and nonelectric geothermal applications.

The geothermal resource supplying the facility is located in a fracture system found at the Contact Metamorphic Zone near the intersection of the Narrows Zone and the Bridge Fault Zone. 130°C to 145°C fluids are produced from four 1,500/2,000 m production wells and disposed of in two 1,200 m injection wells. Reservoir testing indicates the field is anisotrophic, with the major axis of hydraulic conductivity coincidental to the Bridge Fault Zone. Injected fluids will not interfere with the geothermal resource although injection over long periods of time at high pressure could affect the shallow ground water system. Further analyses of the production and injection data during plant operation will provide greater insight into this complex reservoir.

The facilities at the Raft River Site include a 60 KW(e) prototype power plant, a 5MW(e) power plant, and facilities for various types of direct applications research. These facilities are used for heat exchanger evaluations, space conditioning experiments, heat pump investigations, agriculture and aquaculture experiments, materials testing, and other miscellaneous geothermal related research.

A preliminary analysis was made of the initial start-up data taken between October 20 and November 2, 1981, for the 5MW(e) Pilot Geothermal Power Plant. This plant utilizes a dual-boiling isobutane binary cycle. Two test conditions were selected for analysis: (1) a thermal loop test with 94% of the design geofluid flow, and (2) a test at about three-fourths of the design geofluid flow in which one megawatt was generated from working fluid flow through the low-pressure stage of the turbine.

Component and system energy balances were made from initial startup data. Except for a malfunction in the high pressure turbine throttle valve system, the plant performed generally as predicted, and the testing was judged to be successful.

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1. INTRODUCTION

The Raft River Idaho 5MW(e) binary plant is the culmination of almost eight years of research activities in both geoscience and engineering. The Raft River geothermal project was initiated in 1973 with the U.S. Department of Energy and the U.S. Geological Survey performing an integrated geologic, geophysical, and hydrological exploration program to assist in location of the first exploration well. Since that time, seven wells have been drilled to supply and dispose of water for a 5MW(e) binary system and associated geothermal research projects. The project has been funded by the U.S. Department of Energy with EG&G Idaho, Inc., performing the research and development functions at the facility.

The Raft River Geothermal Area lies in South Central Idaho (Fig. 1) in a north trending geologic basin bounded on three sides by mountains. The valley opens to the north into the Snake River Plain. The Known Geothermal Resource Area (KGRA) is located in the south end of the valley near the Idaho-Utah border.

2. GEOLOGY

The Raft River Valley is a down-dropped sedimentary basin composed principally of tertiary siltstones, tuffaceous sandstone, and conglomerates of the Salt Lake Formation derived from the surrounding mountains. This material is overlain by several hundred meters of Quaternary alluvium and lacustrine sediments of the Pleistocene Raft Formation.

Faults in the valley are steeply dipping normal faults along range fronts and are described as having occurred as late as several hundred thousand years ago. The Bridge Fault, a principal fault lying in a north trending zone on the west side of the valley, is the principal structure thought to control the up-welling of geothermal fluids (Fig. 2). This fault was originally described as having a dip of 60-70° continuing to depth (Mabey, (1978)). Later interpretations indicate a shallowing of dip with depth flattening to nearly horizontal with no displacement of the basement (Covington (1980)) (Fig. 3). The Bridge Fault terminates north of the Raft River by an inferred basement shear structure called the Narrows Zone.

3. RESOURCE CHARACTERISTICS

The Raft River Geothermal field includes five 1,500 - 2,000 m production wells and two 1,100 - 1,200 m injection wells. Drilling was initiated in 1975 with a 1,521m deep exploration well. This well proved the existence of a 144°C resource at a depth of 1,500 m.

With the confirmation of resource availability, plans were initiated for a binary pilot power plant to research power production at these medium temperatures. Production wells RRGE2, RRGE3, RRGP4, and RRGP5 were drilled from 1975 to 1978. Two intermediate depth injection wells RRGI6 and RRGI7, were completed in 1978 to complete the field for the 5MW(e) binary pilot plant (Table 1). One well, RRGP4, was classed as a nonproducer and is being used as a monitor well at the present time. Seven shallow monitoring wells (MW-1 through MW-7), drilled in 1978, are located near the Geothermal Injection Wells. The depth and location of each well were designed to detect any migration of injected geothermal fluids into shallow aquifers used for irrigation and drinking water supplies.

The geothermal reservoir at Raft River is a fracture dominated system. The hydraulic conductivity, coincidental with the northeast-southwest direction of the Bridge Fault Zone, is two times greater than the orthogonal direction. Tritium data indicates the fluid age is very young at sixty to seventy years old.

The fluid chemistry indicates the deep geothermal system is composed of sodium chloride type waters. Total specific conductance ranges from 2,500-2,800 uS for wells RRGE1, RRGE2, and RRGP5 to 10,800-12,000 uS for Wells RRGI6 and RRGI7. RRGE3 water quality is mid-range between the deep production wells and the intermediate depth injection wells at 8,000 uS. Fluoride is the major environmentally sensitive element with concentrations in excess of 7 mg/l in the three production wells.

The chemistry of the Raft River geothermal water suggests the existence of two waters, one of high dissolved solids moving in from the southeast at a depth of 1,200-1,600 m and one of lower dissolved solids moving in from the northwest (Figure 4). Water chemistry also indicates the deep geothermal system is hydraulically connected with the shallow ground water system of the Raft River Valley. Since the injection wells are located in the zone of higher dissolved solids, there is concern injection may cause a migration of this water into the shallower potable ground water system. Injection testing and monitoring is being conducted in conjunction with plant start-up to determine if this will occur.

4. 5MW(e) GENERAL PLANT DESCRIPTION

4.1 Plant facilities

The 5MW(e) Raft River Pilot Plant (RRPP) is a geothermal power plant designed and constructed to demonstrate the feasibility of electric power generation using moderate temperature liquid dominated geothermal resources. The plant utilizes an organic Rankine cycle method of operation. Isobutane, the working fluid, conveys the heat energy of the geothermal liquid to a turbine-generator which converts the thermal energy to mechanical and electrical energy to generate 5MW gross electric power.

The plant is composed of a tank farm, process area, pond area, and office buildings (Figure 5). The process area contains the 5MW(e) power plant including the isobutane and geothermal fluid systems. The tank farm contains the storage tanks for isobutane, propane, and nitrogen. The pond area has sludge holding ponds, a brine pond, and the isobutane flare pit. The facility offices and plant control buildings include many of the plant support systems, e.g., cooling water system, fire protection system, and plant air system.

4.2 Plant operations

The operating crew consists of a 5MW(e) plant operating crew, geothermal well operating crew, maintenance crew, and support personnel (chemists, administration, engineering, etc.). The entire crew for a three-shift, seven-day operation is approximately 50 to 55 personnel with eight to ten people on each operating crew.

4.3 Geothermal fluid supply and injection system

The supply and injection system supplies geothermal water from the production wells to the 5MW(e) plant Geothermal Fluid System and then injects the fluid into intermediate depth injection wells. The supply wells contain line shaft pumps capable of producing 32 to 70 l/s of fluid each. The exact flow rate is dependent on the drawdown characteristics of the individual wells. The injection pumps are also line shaft pumps each capable of injecting 70 l/s. The injection pumps take suction from holding ponds where the geothermal return water lines from the 5MW(e) plant terminate. These ponds act as surge vessels to relieve pressure and flow transients on the suction side of the injection pumps. All pipe for the supply and injection system is transite (asbestos cement).

The Geothermal Fluid System in the process area consists of a filter, two booster pumps, four heat exchangers, control valves, instruments, and associated piping. The primary function of the system is to transfer geothermal heat to the isobutane working fluid. The heated fluid is then converted to vapor to turn the turbine_driven generator. Secondarily, the Geothermal Fluid System is tapped for makeup cooling water, for cooling tower water basin and water tank freeze protection and to furnish building heat.

During steady-state operation, the geothermal fluid is at a flow rate of 142 1/s, a temperature of 140°C, and a pressure of 1,172 kPa at the high-pressure boiler inlet. Under steady-state conditions, the temperature at the high-pressure boiler geothermal fluid inlet is the maximum geothermal fluid temperature. However, this temperature can be regulated from the control room by means of automatic controls. The automatic control valves in the recirculation line to the suction side of the booster pumps are temperature actuated to divert cool geothermal fluid back through

the heat exchanger loop to adjust system temperature.

4.4 Isobutane system

Isobutane is the primary working fluid used in a dual boiling Rankine cycle for the 5MW(e) Raft River Pilot Plant. The Isobutane System consists of two basic parts, the isobutane storage area and the process loop. The process loop is designed to extract 44MW of energy from the geothermal liquid and is capable of generating 5MW of electrical power. The isobutane flow is split at the exit of the low-pressure preheater. Approximately 34 percent of the flow is channeled to the low-pressure boiler, and the remaining 66 percent flows through the high-pressure preheater and then into the high-pressure boiler. The flow of vaporized isobutane from both boilers is directed through the turbine where thermal energy is converted to mechanical energy.

At 100 percent capacity, isobutane flow of 246 1/s is provided through two feed pumps and is maintained by an automatic control valve. Liquid isobutane is preheated in the low- and high-pressure preheaters and vaporized in the low- and high-pressure boilers. The low-pressure boiler operates at 1,393 kPa and 82°C; the high-pressure boiler operates at 2,620 kPa and 129°C. The turbine exhaust flows into the condenser where it is condensed and slightly subcooled by releasing its heat to the Cooling Water System. The liquid isobutane, at 455 kPa and 38°C, then drops into the storage tank.

4.5 Turbine generator

The turbine generator consists of a turbine, gear reducer, generator, piping, and control instrumentation. The turbine has high-pressure and low-pressure radial inflow units. The unit is designed to expand the isobutane to drive a generator that produces 5 megawatts (gross) of power and operates with exhaust pressures up to 1,586 kPa.

The isobutane is supplied to the dual pressure turbine through a 35.6 cm highpressure header and a 30.5 cm low-pressure header that are equipped with individual throttle stop valves and flow meters. Flow control is regulated by the turbine governor. The turbine back pressure is governed by the amount of condenser pressure. The generated power of 4,160V, 1,110A ties to the 3-phase 25 KV Raft River commercial primary power lines. When the plant's turbine generator is operating, it supplies power for facility operation and delivers the surplus power to the commercial grid via a 5,000 KVA transformer substation installed at the site. When the turbinegenerator is not operating, power is supplied to the site facilities from the commercial grid.

4.6 Cooling water treatment system

The Water Treatment System removes biological and chemical scale-forming impurities from geothermal water that is used as makeup feed for the Cooling Water System. Since the 5MW(e) power plant is located in a region where ground water is not readily available, cooled geothermal water is used as the makeup supply for the evaporative cooling tower. About 20% of the geothermal fluid is taken from the Geothermal Supply after passing through the plant and prior to reaching the injection system. This water is supplied to the Water Treatment System where it is initially pretreated to reduce hardness and remove silica. The water is then treated for pH, algae, corrosion, and scale control.

4.7 Data acquisition and controls

The 5MW(e) Raft River Pilot Plant is equipped with a complete system of data acquisition and process controls consisting of four major subsystems, the Process Control Subsystem, the Process Instrumentation Subsystem, the Data Acquisition and Recording Subsystems, and the Automatic Calibration Subsystem. The function of the controls and instruments is to permit the operation and monitoring of the plant under all conditions from the control room using existing state-of-art components.

5. 5MW(e) PILOT PLANT START-UP

5.1 High geofluid flow test evaluation

System start-up testing of the Raft River 5MW(e) Pilot Geothermal Power Plant occurred between October 20 and November 2, 1981. The plant was run for two periods (October 20 through October 23; and October 28 through November 2). These tests culminated with a test in which the plant was run as a thermal loop with 94 percent of design geofluid flow and one in which the low-pressure stage of the turbine generated one megawatt of electrical power with a lower geofluid flow. The primary purpose of this testing was to check out the system and its individual components. The only significant component which did not function was the throttle valve and its control system on the high-pressure turbine stage. For this reason, the highpressure stage could not be loaded during the power production test. Further engineering performance tests are scheduled to be performed in the spring and summer of 1982.

The High Geofluid Flow Rate Test afforded the best opportunity to establish the plant performance. During this test, the plant was operating nearest its design point. All major components except the turbine were functioning during this test.

Eight sets of complete data were taken over the time span of the test. Since variation of all important values during this time was quite small, the average measurements over this time interval were taken as the steady-state values.

Figure 6 shows a schematic of the 5MW(e) plant with various points numbered to correspond with values in Table 2. All values which were deemed to be recorded correctly are presented, although there is disagreement among several measurements. Certain redundant measurements were ignored, others were averaged, and heat balances were made for the system and individual components.

5.2 Basic data analysis

Table 2 gives the experimental values of the measurements which are used in the energy balances. The state point numbers correspond to Figure 5. For the geofluid data, the mass flow rate was taken as the averages of the two experimental measurements. The same procedure was used for all but the two lowest temperatures. For those temperatures, the lower measurement gave more consistent results. There was no redundancy in measurements for the cooling water, so the individual measurements were used. In the isobutane loop, the liquid flow rates into the boilers were taken as the best working fluid flow-rate measurements. These were used together with the preheater inlet flows to determine a consistent set of isobutane flows. The fact that the high preheater inlet flow was approximately equal to the high boiler inlet flow indicates no bypass around that preheater.

An energy balance using experimental temperature data indicated an 8.7 percent bypass. Later results indicate that the low preheater outlet temperature may be high causing the energy balance to yield a value which is too large. Temperatures were averaged utilizing the assumption that there is no bypass around the high preheater so that state points 10 and 11 are the same. Boiler and condenser pressures were derived from pressure and temperature measurements around the components.

Energy balances were calculated for each of the heat exchangers. For these calculations, both geofluid and cooling water were assumed to have the proportion of pure water as given in the steam tables (Keenan, 1969), and the isobutane proportions were taken from Starling (1973). Table 3 gives the results of these calculations. The individual differences ranged between 6.4 and 8.5 percent. An overall system energy balance is given in Table 4. The pump work is estimated from the pump characteristics knowing the flow through the pumps. The percentage difference in closure of the heat balance is smaller than that of the heat balances for the individual components.

6. BENEFICIAL USE EXPERIMENTS

Experiments related to the application of geothermal fluids, either directly from wells or after primary heat extraction from electric power generation or industrial processing, have been performed at Raft River. Uses for these fluids can impact overall economics in combined geothermal use scenarios or can influence future activities around geothermal sites such as aquaculture and agriculture. These experiments also contribute to understanding the environmental implications of geothermal development activities.

A three-year irrigation/agriculture experiment is being conducted at Raft River by the University of Idaho and the U.S. Department of Agriculture. This experiment is successfully contributing to understanding how to use geothermal fluids in cropraising activities. A highly successful aquaculture experiment was completed at the Raft River Site. Several aquatic species were raised directly in geothermal waters with the conclusion that disease problems all but disappear and growth rates are remarkably accelerated. An alternative water disposal system, geothermal wetlands, has been exténsively studied at the site. This ecosystem utilized aquatic plants as bioaccumulators for water purification and the creation of waterfowl/aqua specie habitat. Successful experiments raising catfish, carp, and shrimp in geothermal water were also completed.

Several development and testing studies have been performed on equipment potentially useful in geothermal applications. The first U.S. Residential-Sized Geothermal Air Conditioner (LithiuBromide, 3-ton Arkla Unit) cooled one of the Raft River buildings.

A fluidized bed dryer was in operation for about a year, drying samples of biomass potato waste from the secondary treatment step of a local processing plant. Potato peel materials were also processed and dried. Other hardware experiments involved fluidized bed space heaters for geothermal waters that may be corrosive or have a high dissolved solids content.

A number of studies were also completed and some portions implemented for facility use at Raft River. These included integrated use/Industrial Park Geothermal complexes for Raft River or elsewhere; advanced district heating systems; advanced air conditioning using geothermal water (ammonia absorption and diaphragm); and geothermally assisted biomass-to-liquid fuel. The first geothermal powered still for fuel alcohol was successfully tested at Raft River.

7. CONCLUSIONS

The Raft River 5MW(e) Power Plant is the culmination of almost eight years of Geothermal research activities. A vast amount of knowledge has been obtained on the characteristics of a fracture-controlled geothermal system, both with respect to production and injection. Experimental data has also been collected on nonelectric experiments relating to use of geothermal fluid as the energy source. Successful experiments include agriculture, aquaculture, biomass production, wetland studies, and space conditioning.

Data on the 5MW(e) power plant was collected at the time of start-up testing during the fall of 1981. These tests indicated all components of the plant performed as predicted except the high-pressure turbine-throttle valve system. Further testing of the power plant and associated components, together with further reservoir testing, is scheduled to occur during the spring of 1982.

8. ACKNOWLEDGMENTS

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Well	Well Depth (m)	Casing Depth (m)	Well Head Temperature (°C)	Pumping/Injection Rate (1/s)	Specific Conductivity (uS)
Geothermal					
RRGE-1	1521	1105	137	66	2 800
RRGE-2	1994	1289	139	40	2 500
RRGE-3	1789	1293	144	40	8 000
RRGP-4	1654	1054	N/A	Nonproductive	4 050
RRGP-5	1497	1039	129	41	2 700
RRGI-6	-1176	509	N/A	70	10 800
RRG I – 7	1185	623	N/A	70	12 000

TABLE 1 - Selected Data From Raft River Wells

TABLE 2 = Experimental Values From 5MW(e) Plant Start-Up

Geofluid		State <u>Point</u>			Experimental Value
Mass Flow Rate (Kg/hr x 10 ⁻⁶)		2 8			.4439
Temperature (°C)		4 5 6 7 8	۰.		138.7 114.9 98.8 81.3 58.0
Cooling Water Mass Flow Rate (Kg/hr x 10 ⁻⁶)	c;	40		u x	2.826
Temperature (°C)		40 41			18.4 30.8
Isobutane			×		
Mass Flow Rate (Kg/hr x 10 ⁻⁶)		13 14 29 19 22 31		5	.3948 .3680 .1381 .2567 .2567 .1381
_Temperature (°C) Pressure (kPa)		13 14 18,29 21,22 36 37 24 31 36			36.3 82.6 77.4 113.2 75.8 34.2 2321. 1246. 403.

TABLE 3 - Component Heat Balances Using Experimental Values

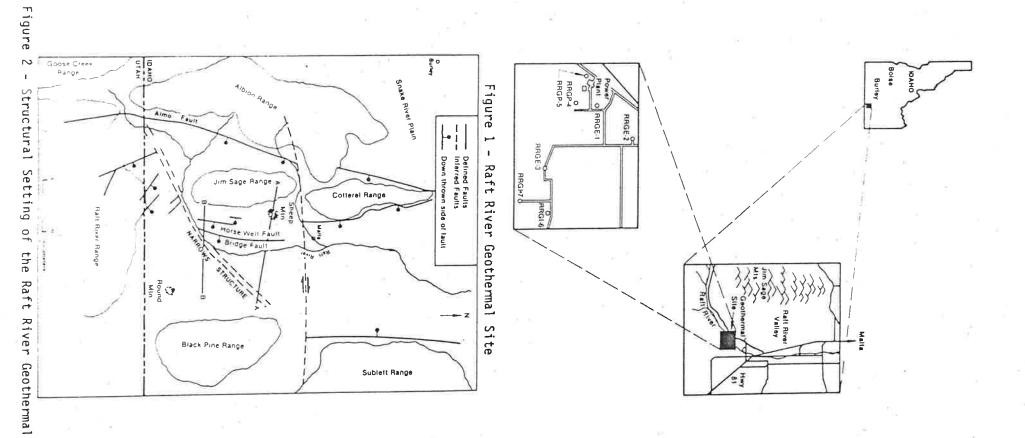
Component

Heat Transfer Rate (Btu/hr x 10^{-7})

	Into Component	Out of Component	Average	Percent Difference
Low Preheater	4.004	4.300	4.109	7.0
Low Boiler	3,195	3.432	3.314	7.2
High Preheater	2.865	3.119	2.992	8.5
High Boiler	4,267	4.002	4.135	6.4
Condenser	14.960	13.886	14.430	7.4

TABLE 4 - System Energy Balance

Rate of Heat Transfer from Geofluid Power Input to Isobutane Feed Pump Rate of Energy Flow to System Rate of Heat Transfer for Cooling Water	=	43.32MW(e)
Difference	=	1.04MW(e) 2.4%



Area

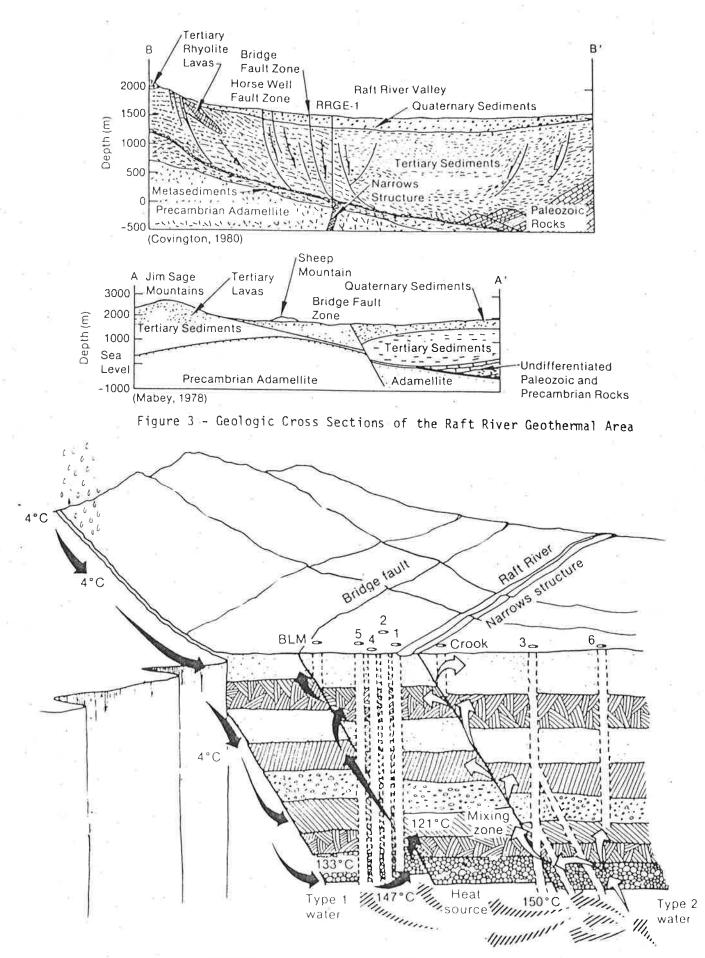
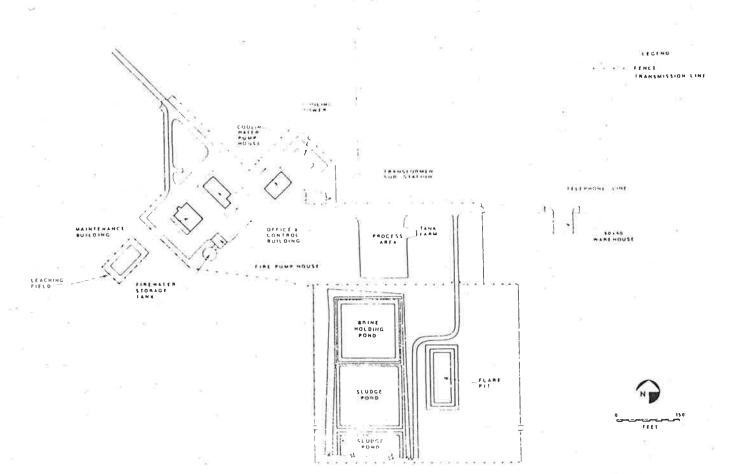
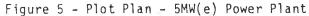


Figure 4 - Conceptual Model for Raft River Geothermal System





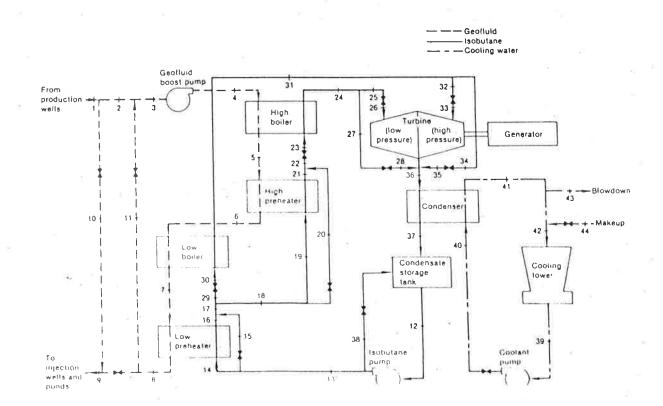


Figure 6 - Schematic Diagram of the Raft River 5MW(e) Geothermal Power Plant