STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO.: F41689-81-R-0061-0004
2. EFFECTIVE DATE: 81 Oct 27
3. REQUISITION/PURCHASE REQUEST NO.:
4. PROJECT NO. *(If applicable)*:

5. ISSUED BY — CODE
3303 Contracting Squadron/LGCTM
Randolph AFB, Texas 78150
(512) 652-2304

6. ADMINISTERED BY *(If other than block 5)* — CODE

7. CONTRACTOR NAME AND ADDRESS — CODE — FACILITY CODE
(Street, city, county, state, and ZIP Code)

8.
[X] AMENDMENT OF SOLICITATION NO. F41689-81-R-0061
DATED 81 Aug 14 *(See block 9)*
[ ] MODIFICATION OF CONTRACT/ORDER NO. ______
DATED ______ *(See block 11)*

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers [ ] is extended, [X] is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning 1 copies of this amendment, (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA *(If required)*

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) [ ] This Change Order is issued pursuant to ______
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) [ ] The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) [ ] This Supplemental Agreement is entered into pursuant to authority of ______
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

The ranking of evaluation factors set forth in Section IV, para 3c (ref. Amendment 0003), is further amplified as follows:

a. The first three factors pertain to cost and are of significantly greater importance than the remaining technical factors.

b. Technical proposals will be evaluated by a panel of knowledgeable individuals convened specifically for that purpose. Similarly, business proposals will be evaluated separately by a designated panel.

c. Upon completion of the separate evaluations, selection will be made of that offer considered most advantageous to the Government, price and other factors considered.

d. The right is reserved to accept other than the lowest offer and to reject any or all offers.

e. The Government may award a contract, based on initial offers received, without discussion of such offers.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. [ ] CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT [ ] CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN ______ COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR
BY ______
(Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY ______
(Signature of Contracting Officer)

15. NAME OF TITLE OF SIGNER *(Type or print)*

16. DATE SIGNED

18. NAME OF CONTRACTING OFFICER *(Type or print)*

19. DATE SIGNED

OPTION TO SF 30, APPROVED BY NARS 5/79

STANDARD FORM 30, JULY 1966
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.101

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO.: F41689-81-R-0061-0003
2. EFFECTIVE DATE: 81 Oct 23
3. REQUISITION/PURCHASE REQUEST NO.:
4. PROJECT NO. (If applicable):

5. ISSUED BY — CODE:
F3303 Contracting Sq/LGCTM
Randolph AFB TX 78150
(512) 652-2304

6. ADMINISTERED BY (If other than block 5) — CODE:

7. CONTRACTOR NAME AND ADDRESS — CODE: — FACILITY CODE:
(Street, city, county, state, and ZIP Code)

8. [X] AMENDMENT OF SOLICITATION NO. F41689-81-R-0061
DATED 81 Aug 14 (See block 9)

[ ] MODIFICATION OF CONTRACT/ORDER NO. ____
DATED ____ (See block 11)

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers [ ] is extended, [X] is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning 1 copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) [ ] This Change Order is issued pursuant to ____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) [ ] The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) [ ] This Supplemental Agreement is entered into pursuant to authority of ____
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

a. Add the following to the General Provisions as Reference No 63:

63. 7-603.60 Affirmative Action Compliance Requirements for Construction (with changes shown on Atch 1). 1978 Sep

b. Delete Para 4 ("Availability of Funds") of the Additional General Provisions.

c. The additional general provision incorrectly numbered as "86" is deleted in its entirety and the revised provision (correctly numbered as 5) contained at Atch 1 is substituted therefor.

d. Para 4b of the General Information section of the specs package (page ii) is revised to read as follows:

"Contract to be awarded will cover both Phases I and II, with Phase I accomplished on a cost-sharing basis and Phase II accomplished at no capital cost to the Government."

e. In Para 17 of the General Information section (Page iv), line 3, the word "or" is changed to "and/or."

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. [ ] CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT [ ] CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN ____ COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR
BY ____
(Signature of person authorized to sign)

17. UNITED STATES OF AMERICA
BY ____
(Signature of Contracting Officer)

15. NAME OF TITLE OF SIGNER (Type or print)

16. DATE SIGNED

18. NAME OF CONTRACTING OFFICER (Type or print)

19. DATE SIGNED

f. In Para 5 of Section I (Page 1), line 7, delete the words "and the Department of Energy."

g. In Para 4e of Section II (Page 10), line 3, the word "expected" is changed to "excepted."

h. Add the following to Para 2c of Section II (Page 7):

"Sale of utilities to off-base customers shall not be permitted unless the contractor also has a long-term utility contract to furnish energy for Williams AFB."

i. Add the following new subpara f to Para 2 of Section II (Page 7):

"f. Plant ownership will remain with the contractor after the expiration of the 30-year utility contract. If subsequent utility contracts to supply energy to Williams AFB are not negotiated with the contractor after the initial 30-year contract, the contractor may dispose of plant equipment and facilities. The contractor shall not have access to operate the plant unless he has an energy contact with Williams AFB."

j. Add the following new subpara f to Para 3 of Section III (Page 12):

"f. Should the Phase I development prove to be successful as defined by the cost-share plan parameters, and should the Government still elect not to proceed with Phase II, the Government's total liability shall be the maximum Government portion of the cost share plan, actual resource quality notwithstanding, not to exceed $1,000,000.

k. Add the following new subpara c to Para 3 of Section IV (Page 23):

"c. Ranking of Evaluation Factors. In evaluating proposals, the Government will consider the above criteria in the following order of importance:

(Criterion 9)	(1)	Utility Life Cycle Cost, Phase II, Business Proposal
(Criterion 8)	(2)	Variable Cost-Share Plan, Phase I, Business Propsoal
(Criterion 7)	(3)	Confirmation Program Cost Summary, Phase I, Business Proposal
(Criterion 1)	(4)	Technical Feasibility, Phase I, Technical Proposal
(Criterion 4)	(5)	Technical Feasibility, Phase II, Technical Proposal
(Criterion 2)	(6)	Project Management, Phase I, Technical Proposal
(Criterion 5)	(7)	Project Management, Phase II, Technical Proposal
(Criterion 3)	(8)	Institutional Considerations, Phase I, Technical Proposal
(Criterion 6)	(9)	Institutional Considerations, Phase II, Technical Proposal

l. In Para 3 of Section VII (Page 30), lines 3 and 4, the words "to reflect the percent change in accordance with" are changed to "by an amount not to exceed the percent change specified in."

1. Reference Block 12, Para a:

DAR 7-603.60 - Make the following changes to the clause:

Delete the words "and time tables" from (c), (h), and (j) of the clause.

Delete the existing paragraph (d) and substitute the following:

(d) The contractor shall implement the specific affirmative action standards provided in subparagraphs (g)(1) through (16) of this clause. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. If the contractor performs construction work (whether or not it is Federal or Federally assisted) in a geographical area located outside of the covered area, it shall apply the goals established for the geographical area where such work is actually performed. The contractor is expected to make substantially uniform progress toward its goals in each craft.

2. Reference Block 12, Para c:

5. NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY (1981 MAR).

(a) The Offeror's or Bidder's attention is called to the "Equal Opportunity" and the "Affirmative Action Compliance Requirements for Construction" clauses set forth herein.

(b) The goals for minority and female participation, expressed in percentage terms for the contractor's aggregate work force in each trade on all construction work in the covered area, are as follows:

Goals for minority participation for each trade	Goals for female participation in each trade
6.9%	15.8%

These goals are applicable to all the contractor's construction work (whether or not it is Federal or Federally assisted) performed in the covered area. If the contractor performs construction work (whether or not it is Federal or Federally assisted) in a geographical area located outside of the covered area, it shall apply the goals established for the geographical area where such work is actually performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs (OFCCP) office. The contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity clause, specific affirmative action obligations required by the clause entitled Affirmative Action Compliance Requirements for Construction and its efforts to meet prescribed goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from contractor to contractor or from project to project for the sole purpose of meeting the contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

(c) The contractor shall provide written notification to the Director, OFCCP within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

(d) As used in this Notice, and in the contract resulting from this solicitation, the "covered area" is:

Maricopa County, Arizona

STANDARD FORM 20
JANUARY 1961 EDITION
GENERAL SERVICES ADMINISTRATION
FED. PROC. REG. (41 CFR) 1-16.401

REQUEST FOR PROPOSAL
(CONSTRUCTION CONTRACT)

REFERENCE
REQUEST FOR PROPOSAL NO. F41689-81-R-0061

DATE
81 Aug 14

NAME AND LOCATION OF PROJECT
Geothermal Energy Development
Williams AFB AZ

DEPARTMENT OR AGENCY
UNITED STATES AIR FORCE
3303 Contracting Squadron/LGCTM
Randolph AFB TX 78150

BY (Issuing office) 3303 Contracting Sqdn/LGCTM
Randolph AFB TX 78150

Prospective bidders may submit inquiries by writing or calling (collect calls not accepted) Don Norville, (512)652-2304.

Proposals in original and three copies for the work described herein will be received until

4:00 P.M., C.T., 6 Oct 81

at the 3303 Contracting Sqdn/LGCTM, Randolph AFB TX 78150.
(Hand- Carried Bids Must Be Deposited at the contracting officer's desk on the second floor of Bldg 955, Randolph AFB TX.

A. SPECIAL INFORMATION: This is a negotiated procurement, therefore all reference to "Invitation for Bids or IFB" and "Bidder" shall be construed to mean "Request for Proposal or RFP" or "Proposal" and "Offeror".

B. INFORMATION REGARDING BIDDING MATERIAL, BID GUARANTEE AND BONDS
See page ii of the Specifications Package.

C. DESCRIPTION OF WORK:

Drilling of a test geothermal well on or near Williams AFB AZ (Phase I). Construction of a geothermal plant and distribution system at no capital cost to the Air Force (Phase II).

D. EQUAL OPPORTUNITY NOTICES:

I. NOTE THE AFFIRMATIVE ACTION REQUIREMENT ON THE EQUAL OPPORTUNITY CLAUSE WHICH MAY APPLY TO THE CONTRACT RESULTING FROM THIS SOLICITATION.

II. NOTE THE CERTIFICATION OF NONSEGREGATED FACILITIES IN THIS SOLICITATION. Bidders, offerors and applicants are cautioned to note the "Certification of Nonsegregated Facilities" in the solicitation. Failure of a bidder or offeror to agree to the certification will render his bid or offer nonresponsive to the terms of solicitations involving awards of contracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity Clause (1975 OCT).

[illegible] ESTIMATED COST OF THE PROPOSED CONSTRUCTION IS over $10,000,000

READ THE FOLLOWING IN CONJUNCTION WITH THE INSTRUCTIONS TO BIDDERS, STANDARD FORM 22:

F. PURCHASE REQUEST: DE 0012

(NOTE: See attached Continuation Sheets, Pages 1 through 3, for additional information concerning this IFB)

G. RATED OR AUTHORIZED CONTROLLED MATERIAL ORDERS (1974 APR)

Contracts or purchase orders to be awarded as a result of this solicitation shall be assigned a ( ) DX rating; (X) DO C-2 rating; ( ) DMS allotment number ______ In accordance with the provisions of DPS Regulation 1 and/or DMS Regulation.

H. CONTRACT AUTHORITY: Any contract resulting from the Invitation for Bids will be awarded pursuant to the authority of 10 U.S.C. 2304(a) (10).

I. THIS INVITATION FOR BIDS CONSISTS OF THE FOLLOWING:

1. Standard Form 20, INVITATION FOR BIDS (Construction Contract), pages 1 and 2
2. Continuation Sheet to Standard Form 20, pages 1 thru 4.
3. Standard Form 21, BID FORM(Construction Contract), pages 1 and 2
4. Continuation Sheet to Standard Form 21, pages 1, 2 and 3
5. Standard Form 19-B, REPRESENTATIONS AND CERTIFICATIONS, pages 1 and 2
6. Alterations Sheet to Standard Form 22, INSTRUCTIONS TO BIDDERS(Construction Contract) 1 page
7. Standard Form 22, INSTRUCTIONS TO BIDDERS (Construction Contract), pages 1 and 2
8. Standard Form 23, CONSTRUCTION CONTRACT, pages 1 and 2
9. Not Used
10. Not Used
11. GENERAL PROVISIONS, 3 pages
12. ADDITIONAL GENERAL PROVISIONS, 2 pages
13. Schedule "A" - Rates of Wages, Decision No. AZ81-5124, dated 29 May 81, with Modification #1, dated 12 Jun 81, Modification #2, dated 19 Jun 81, Modification #3, dated 6 Jul 81, and Modification #4, dated 24 Jul 81, 19 pages.
14. Schedule "B" - Schedule of Drawings, 1 page
15. Schedule "C" - Not used
16. Schedule "D" - not used
17. Schedule "E" - not used
18. Specifications Package, 97 pages
19. Drawing - Geothermal Energy Development Project, 6 pages
20. BID SET: TO BE RETURNED BY BIDDERS! Items 1-3, 4, & 5 above and Item 1-15 when used.

SPECIFICATIONS PACKAGE

TABLE OF CONTENTS

GENERAL INFORMATION

1. Proposals for development of possible geothermal resource at Williams AFB AZ, and conversion to supply base-wide electric power and/or central chilled water for air conditioning in accordance with this Request for Proposals (RFP) will be received at 3303rd Contracting Squadron/LGCTM, Randolph AFB TX 78148 until 4:00 PM, 6 Oct 81.

2. A preproposal conference will be held at 9:00 a.m., 10 Sep 81, at Bldg. 505 Williams AFB for all prospective proposers. It is requested that a representative of each proposer attend the pre-proposal conference. Names of individuals from each company that will attend the conference should reach the above address no later than 7 Sep 81. Due to the limited space available, each principal planning to send representatives to the pre-proposal conference should limit the number of representatives to a total of not over three. Replies by the Government to proposers' questions concerning any aspect of this Request for Proposals will be recognized as official only if the proposer submits the question in writing, and he is provided a written reply by the Contracting Officer. This rule includes, but is not limited to, the Pre-proposal Conference activities embracing the conference session and the site visit. Proposers are specifically cautioned that verbal discussions, questions and replies thereto shall not have the effect of changing the provisions of the written Request for Proposals. Proposers are encouraged to submit written questions to:

3303rd Contracting Sq
LGCTM
Randolph AFB TX 78148

in sufficient time for receipt at least ten days in advance of the conference date and replies thereto will be provided during or subsequent to the conference.

3. SITE VISIT. Proposers or quoters are urged and expected to inspect the site where services are to be performed and to satisfy themselves as to all general and local conditions that may affect the performance of the contract, to the extent such information is reasonably obtainable. In no event will a failure to inspect the site constitute grounds for a claim after award of the contract. A physical inspection of the project site may be arranged by contacting the base civil engineer, Williams AFB AZ.

4. METHOD OF ACQUISITION.

a. One step acquisition will be used, consisting of solicitation, submission, and evaluation of proposals. The basis of the Air Force's contract award will be the technical quality of the proposal, business proposal (financial plan), the cost/share plan, and the offeror's proposed life cycle cost of energy. Details concerning criteria for evaluating proposals are contained in Section IV, Evaluation Factors for Award. Energy costs will be evaluated based on the proposed 30-year life cycle cost of geothermally produced power consumed by

Williams AFB at the designated delivery point(s) shown on the attached drawings. Chilled water costs will be evaluated based on a factor of 0.94 KW of electricity input per ton of refrigeration. Delivered energy at each designated delivery point must meet the total electrical and/or air conditioning load at each point, except that family housing areas will not be provided with chilled water. The life cycle costs of energy, either air conditioning, chilled water, electricity, or a combination thereof shall not exceed the 30-year life cycle energy cost ceiling as defined in Appendix B.

b. Contract to be awarded will be a cost-sharing type contract covering Phases I and II. See also para 17 below.

5. BONDS. The successful Contractor will be required to furnish a BOND in the penal sum of $100,000.00 conditioned on compliance with the Geothermal Resources Operational Order No. 3, "Plugging and Abandonment of Wells." The bond of any surety company holding a certificate of authority from the Secretary of the Treasury as an acceptable surety on Federal bonds will be accepted.

6. INSURANCE. Within 15 days after the award of this contract, the Contractor shall furnish the Contracting Officer a certificate of Insurance as evidence of the existence of the following insurance coverage in amounts not less than the amounts specified below.

	COVERAGE		
	PER PERSON	PER ACCIDENT	PROPERTY
a. Comprehensive General Liability		$300,000	
b. Automobile Liability	$100,000	$300,000	$10,000
c. Workmen's Compensation	AS REQUIRED BY STATE LAW WITH MINIMUM OF $100,000 EMPLOYER'S LIABILITY		

The Certificate of Insurance shall further provide for thirty days written notice to the Contracting Officer by the insurance company prior to cancellation or material change in policy coverage.

7. SUBMISSION OF PROPOSALS. Proposers are required to submit their proposal in response to this Request for Proposals to the address and marked as indicated in

Paragraph 1. Technical Proposals shall include complete information to establish the proposer's understanding and capability for accomplishment of the total project to provide services as outlined herein within the parameters set forth. Technical Proposals shall include the information contained in paras 5 and 6, Section III and in Section IV.

8. Proposers are advised to submit proposals which are fully and clearly acceptable without additional explanation or information, since the Government may make a final determination as to whether a proposal is acceptable or unacceptable solely on the basis of the proposal as submitted and proceed without requesting further information from any offeror. However, the Government may discuss, clarify or obtain additional information on any aspect of the proposal with the concern submitting the proposal.

9. MULTIPLE TECHNICAL PROPOSALS. Proposers are authorized and encouraged to submit multiple technical proposals presenting different basic approaches. Each technical proposal submitted will be separately evaluated.

10. CLARIFICATION OF THE PROVISIONS OF THIS REQUEST. Any explanation desired by a proposer regarding the meaning or interpretation of the Request for Proposals must be requested in writing and with sufficient time allowed for a reply to reach proposers before the submission of their proposals.

11. UNNECESSARILY ELABORATE CONTRACTOR'S PROPOSALS. Unnecessarily elaborate brochures or other presentations beyond that sufficient to present complete and effective proposals are not desired and may be construed as an indication of the offeror's or quoter's lack of cost consciousness. Elaborate art work, expensive paper and bindings and expensive visual or other presentation aids are neither necessary nor wanted.

12. MODIFICATION OF PROPOSALS. Modifications of proposals already submitted will be considered if received at the office designated in this request by the time set for receipt of proposals. Modifications received after the designated time will not be considered (subject to the provisions of the "Late Proposals" clause) unless specifically requested by the Air Force.

13. NONCONFORMING PROPOSALS. Any proposal may be construed as a nonconforming proposal and ineligible for consideration if a proposer does not comply with the requirements of this Request for Proposals. The failure to comply with the technical features or to acknowledge receipt of amendments are common causes for holding proposals nonconforming.

14. RESTRICTIONS ON DISCLOSURE AND USE OF DATA IN PROPOSALS AND QUOTATIONS. A proposal, whether solicited or unsolicited, may include data, such as a technical designs, concepts, financing and management plans, which the offeror does not want disclosed to the public for any purpose or used by the Government for any

purpose other than evaluation of the proposal. If an offeror wishes so to restrict his proposal, he shall mark the title page with the following legend:

THIS DATA, FURNISHED IN CONNECTION WITH REQUEST FOR PROPOSALS NO. F41689-81-R-0061. SHALL NOT BE DISCLOSED OUTSIDE THE GOVERNMENT AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED IN WHOLE OR IN PART FOR ANY PURPOSE OTHER THAN TO EVALUATE THE PROPOSAL: PROVIDED, THAT IF A CONTRACT IS AWARDED TO THIS OFFEROR AS A RESULT OF OR IN CONNECTION WITH THE SUBMISSION OF THIS DATA, THE GOVERNMENT SHALL HAVE THE RIGHT TO DUPLICATE, USE, OR DISCLOSE THE DATA TO THE EXTENT PROVIDED IN THE CONTRACT. THIS RESTRICTION DOES NOT LIMIT THE GOVERNMENT'S RIGHT TO USE INFORMATION CONTAINED IN THE DATA IF IT IS OBTAINED FROM ANOTHER SOURCE WITHOUT RESTRICTION. THE DATA SUBJECT TO THIS RESTRICTION IS CONTAINED IN SHEETS __________.

The offeror shall mark each sheet of data which he wishes to restrict with the following legend:

USE OR DISCLOSURE OF PROPOSAL DATA IS SUBJECT TO THE RESTRICTION ON THE TITLE PAGE OF THIS PROPOSAL.

15. ALTERNATE PROPOSALS. Proposals for utilizing geothermal energy other than through on-base wells supplying base-wide electric power and/or chilled water for air conditioning as described in this RFP will be entertained. Proposals based on supplying energy to off-base customers during times when the on-base demand is below peak will also be entertained.

16. EVALUATION FACTORS FOR AWARD. Proposals will be evaluated in accordance with Section IV, Evaluation Factor for Award. Posposals will be scored consistent with these evaluation factors.

17. UTILITY SERVICE CONTRACT. Upon completion of performance of Phase II under this contract, the contractor agrees to enter into a utility service contract with the Government to provide air conditioning chilled water or electrical power, as appropriate, to Williams AFB AZ at rates not in excess of those contained herein, with escalation as specified in Section VII and Appendix B.

I. PROJECT DESCRIPTION

1. The objective of this project is to have private industry develop the geothermal resource beneath Williams AFB AZ and sell energy to the United States Air Force.

2. The goal of the Air Force in pursuing this project is to reduce its total cost of energy over the life of the project.

3. The proposed development will result in geothermal production wells, a geothermal energy plant, a distribution system, and reinjection wells located on or near Williams AFB AZ. Development is to proceed in two phases. The first phase will be evaluation of the resource including drilling to completion of a single production well (completion is defined in Section II, Specifications). The Air Force will share the cost of phase one with the developer. Phase two will consist of drilling of additional production wells and injection wells, and construction of a geothermal plant and distribution system. Phase two will be at NO CAPITAL COST TO THE AIR FORCE.

4. The type of plant to be constructed will depend on the quality of the resource. The first priority is for base-wide air conditioning chilled water (less family housing) and the second priority is for base-wide electrical power (including family housing). If the resource proves to be of exceptionally high quality, proposals will be entertained for co-generation of air conditioning chill water and electricity, or even co-generation of ethanol and chill water or electricity.

5. The basis for award will be quality scoring of the proposal in accordance with the Evaluation Factors for Award, Section IV, and the offeror's proposed cost of energy over the life of the project, utilizing life cycle costing techniques described in Appendix B. The Air Force expects to purchase energy from the plant for an anticipated period of 30 years. The contract will contain a negotiated a cost-share plan for phase one which has been determined acceptable to the Air Force and the Department of Energy. This plan must define levels of resource quality for the first well and identify associated costs-shares.

6. If the first production well is successful, as defined by the cost-share plan, the Air Force will pay up to 10 percent of the cost of the well. The contractor will bear the remaining costs and in no case will the government reimburse the contractor for more than the actual cost of the well.

7. If the first production well is unsuccessful, as defined by the cost-share plan, the Air Force will pay up to $1,000,000 toward the cost of the well as determined by the cost-share plan. The contractor will bear the remaining costs and in no case will the contractor be reimbursed by the government for more than the cost of the first well. The developer may drill additional wells at his own expense; without benefit of the cost-share plan.

II. SPECIFICATIONS

1. Phase I. After contract award, the successful proposer (contractor) must conduct a resource evaluation program during Phase I. If drill sites outside of Williams AFB are to be used, this evaluation program is to include exploration to determine a specific drill site. Drilling and testing of a single production well will be included in Phase I regardless of drill site location. Accordingly, each offeror must submit a proposed Exploration Plan, Drilling Plan, and Test Plan. In addition, offerors must submit proposed cost-share plans for Phase I in accordance with Section III, cost-share quidelines. Plans will be evaluated as specified in Section IV.

a. Exploration Program. The contract will contain the negotiated, Government-approved Exploration Plan for drill sites outside of Williams AFB. The plan must define a schedule and method of exploration, and criteria to be used in establishing the site for the first well. Exploration may take place on Williams AFB, on a not to interfere with operations basis, or in the Williams AFB vicinity. It may consist of a review of existing data, the conduct of surface testing, drilling of test holes, and/or logging and testing of existing wells. It is the responsibility of the offeror to identify and justify in its preliminary plan the method of exploration and drill site locations. Furthermore, it is the contractor's responsibility to obtain all permits, accesses, right-of-ways, etc. required for the conduct of the exploration program. The Air Force's responsibility in this area will be limited to granting of access to Air Force property for the purposes of exploration and well siting.

(1) If the contractor lacks adequate in-house expertise in exploration, he should retain the services of a competent consultant or contractor. Consulting and subcontracting costs are items that the Air Force will cost-share if an award is made. The contractor should be careful to select consultants or contractors who have a broad range of exploration experience and expertise to ensure that an appropriately balanced exploration plan is developed.

(2) It is the offeror's responsibility to specify the analysis and data interpretation technique to be used in identifying locations of possible drill sites from the exploration program data. Once a final site is chosen, it is the contractor's responsibility to obtain permits, right-of-ways, leases, etc., for drilling of the well. The Air Force's responsibility will be limited to reviewing of the decision with the contractor and to granting of a permit to drill on Air Force property once all applicable prerequisite requirements are satisfied. On-base drill sites are limited to the areas indicated on the drawings, Appendix F.

b. Well Drilling.

(1) It will be the responsibility of the contractor to drill a resource confirmation well to completion. Completion is defined as being either location of a resource that satisfies intended use, or drilling to a minimum depth of 10,000 feet. Each offeror must develop a Drilling Plan which provides a schedule for drilling, and identifies the major elements of the drilling program such as

the proposed drilling rig, hole depth and diameter, intended drilling fluids, proposed drill casings, intended cementing program, the well logging program, and method of discharging geothermal fluids.

(2) It will be the responsibility of the contractor to acquire all necessary support for drilling and testing of the well. If the drill site is located on the base, the Air Force will sell the contractor electrical power, gas and water. Electrical power, gas and water will be supplied from the sewage treatment plant located to the west of the area to be turned over for development. The billing rate for electrical power will be approximately $.062 per kwhr, the rate for gas will be approximately $.2977 per therm, and the rate for water will be approximately $.5486 per thousand gallons. The rates stated above apply only to utilities used by the contractor during Phase I.

(3) It will be the responsibility of the contractor to insure that adequate provisions for the disposal of geothermal fluids are made so that test/production wells can flow adequately to prevent well damage. It is recommended that an injection well be drilled prior to drilling the production well to insure adequate disposal of geothermal fluids without interrupting flow.

c. Test Plan.

(1) Each offeror must submit a proposed Test Plan which identifies a schedule and the tests to be conducted during drilling and subsequent reservoir evaluation test to be conducted after drilling is completed. The test plan should identify the physical and hydrologic data to be collected during drilling, the method to be used in collecting this data, the reduction and analysis techniques to be employed, and the intended uses of the information. The preliminary test plan must also address the objectives and procedures to be used in evaluating the completed well's performance under sustained withdrawals. The offeror must put forth a plan that will adequately test at a minimum the major parameters of flow rate, fluid (potentionmetric) levels and temperature. The plan will include provisions for making continuing seismic measurements which are required throughout both drilling and production phases (Phases I and II). The suggested duration and method of testing proposed must be of sufficient duration and scope to permit a reasonably confident prediction of the reservoirs behavior over the life of intended use.

(2) It will be the responsibility of the contractor to update the test plan if test data/conditions indicate a change is necessary. Revisions to government approved procedures must also be approved by a designated government representative. The government will provide a method for rapid concurrence of proposed changes.

(3) It will be the responsibility of the contractor to obtain all required approval, permits, right-of-ways, etc., for the conduct of well testing. The Air Force's responsibility in this matter will be limited to the granting of approval for the testing of a well drilled on the base provided all prerequisite requirements are satisfied.

d. Cost-Share Plan. The contractor will be required to adhere to the approved Cost-Share Plan (reference Section IV, Evaluation Factors for Award). The plan will include considerations for exploration and drilling. However, it can only be related to the degree of success as defined by the well test results. The cost-share plan will be in accordance with section III, Cost-Share Guidelines. In developing the cost-share plan, the offeror should also keep in mind the cost stipulations of Section I, Project Description. The cost-share plan must be in terms of quantifiable well parameters that can be measured. An example is shown in Figure 1, Section III, Cost-Share Guidelines. The plan may include multiple schedules to take into account various baseline conditions.

e. Schedule/Decision Points. Throughout and at the conclusion of Phase I, the contractor will be expected to confer with the government on various program decisions. An example of a program flow chart with decision points is provided by Figure 1, Phase I, Sample Flow Chart. The contractor will be required to develop for the government's approval an overall Phase I schedule containing program decision points where the contractor and government representative will be required to confer and agree to a follow-on course of action. The total duration of the schedule for completion of work to be performed in Phase I shall be no more than 12 months from the receipt of the notice to proceed. It will be the responsibility of the contractor to notify the Air Force of any unforeseen delays, which cannot be overcome by the contractor exercising due diligence.

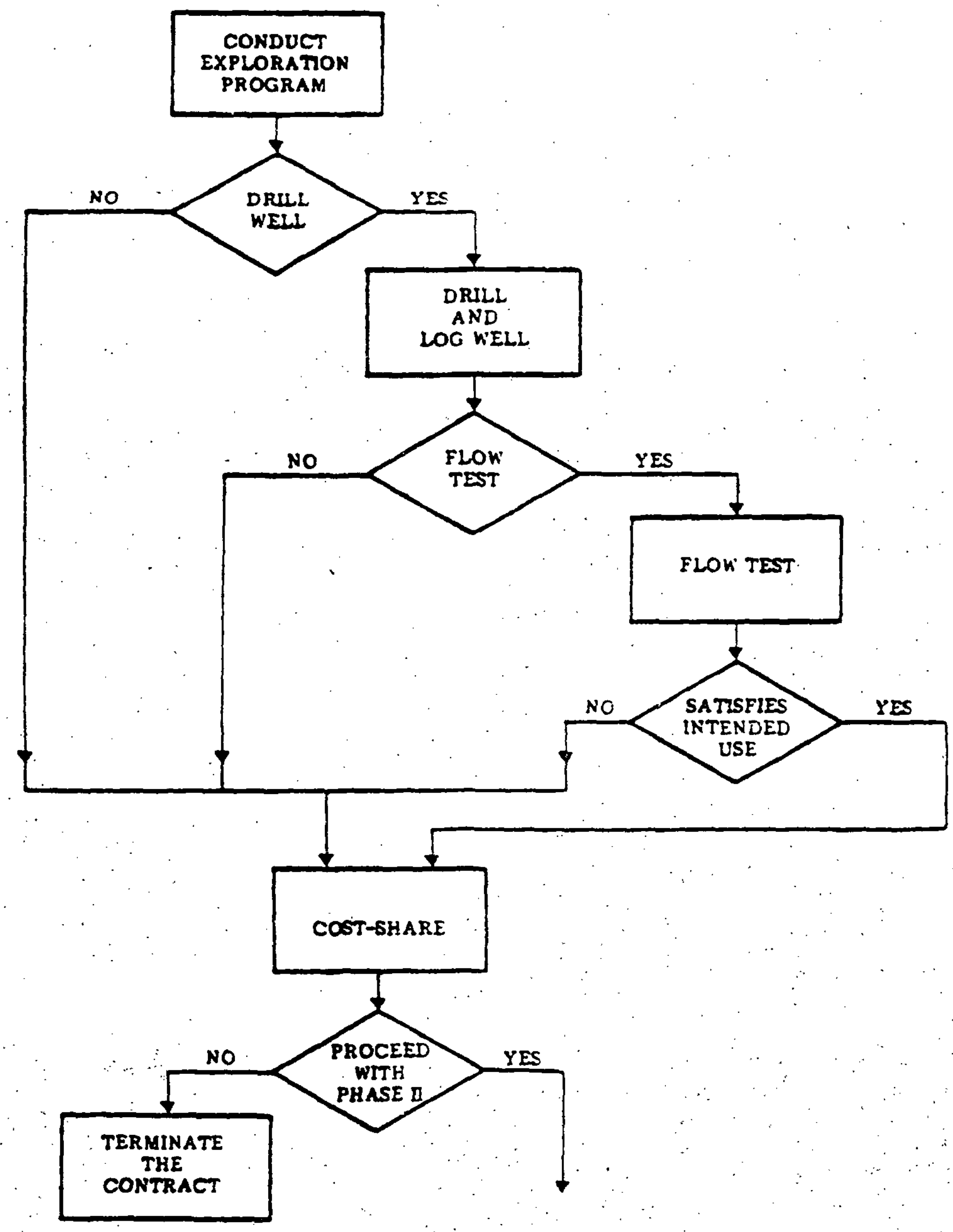

Figure 1. Phase I Sample Flow Chart

f. Success Definition. At the conclusion of well drilling to a minimum depth of 10,000 ft, logging and flow tests, the project will be considered successful if final utility contract negotiations result in plant and distribution system construction at no capital cost to the government, and a finalized utility contract which will result in a 30-year life cycle energy cost not in excess of the Life Cycle Energy Cost Ceiling defined in Appendix B, within the environmental constraints of this RFP.

2. Phase II. The contractor will be required to construct and operate a geothermal energy plant during Phase II. Construction of the plant will include drilling additional supply and injection wells as required, construction of transmission corridors, and making connections to existing Air Force facilities all at NO CAPITAL COST TO THE AIR FORCE, and plant ownership will remain with the contractor. The Air Force will grant the contractor a license to enter and use the sites designated on the drawings in order to operate and maintain plants and systems until the contract is terminated. The contractor will be responsible for all phases of design, construction, start-up and testing, and operation and maintenance of the Energy Supply System and plants. The contractor will be responsible for obtaining all permits, right-of-ways, approvals, etc., for all activities associated with Phase II. The contractor will be responsible for repair of Air Force property damaged in the course of construction, and operation and maintenance of the plant. Repairs shall be in accordance with the Corps of Engineer Guide Specifications and Air Force Manual 88-15. The Air Force's responsibility will be purchasing of the utility and granting access, right-of-ways, permits, etc. for construction, and operation on Air Force property. In order to grant the necessary permission to construct and operate the Energy Supply System and plants on Air Force property, it will be necessary for the Air Force to review and approve the contractor plans for the system.

a. If the contractor proposes to construct an air conditioning chilled water plant, he will be required to provide all fluid pipelines, flow control devices, flow metering devices, interconnections and modifications to existing facilities, and provide an emergency shutdown system acceptable to the Air Force. Attached drawings, Appendix F, show connection points and suggested on-base plant location, well locations, transmission corridors etc. Pipelines must be run underground, parallel to the streets instead of under streets. The plant must be designed to provide for maintenance without interruption of service. The design must provide spare chiller capacity and a fossil fueled back-up heat source. Loss of service will be permissable only for power outages. The operation and maintenance contractor for the plant will be responsible for the entire facility including wells, plant and chilled water supply, and return headers up to the five foot line outside of each building served. The chilled water lines will be metered and the Air Force will pay for utility used and not for plant capacity. For a facility located on the base the contractor will furnish meters and connection to the Air Force electric distribution or in-building cooling systems in accordance with the attached drawings, Appendix F. For conventional utilities to serve the contractor's plant, the contractor will be responsible for making the necessary hook-ups, and the Air Force will bill the contractor for utilities at the average rate schedule current at the time of utility use, taking Air Force capital, operating and maintenance costs into consideration. All base utilities, including water, will be made available to the contractor only after all Air Force utility demands are satisfied.

b. If the contractor proposes to construct an electric power plant, he will provide associated controls, electric power lines, switch gear, transformers, meters and other equipment associated with the electrical interconnected. Interconnection with the existing supply system will be required. However, regulations prohibit the sale of on-base generated electricity off-base. Therefore, if the facility is built on-base, it will be the contractor's responsibility to arrange for interconnection with the existing utility in a manner which precludes the transmission of power off-base into the utilities grid. The contractor will provide metering and bill the Air Force for power used. The Air Force will not pay for unused capacity. The attached drawings, Appendix F, show the connection points and suggested on-base plant location, well locations, transmission corridors, etc. For conventional utilities to serve the contractor's plant, the contractor will be responsible for necessary hookups, and the Air Force will bill the contractor as described in para 2a above. All base utilities, including water, will be made available to the contractor only after all Air Force utility demands are satisfied.

c. Offerors may propose to construct a plant with the intention of selling energy to off-base customers during off peak base condition provided all Air Force energy needs are met first.

d. If the offeror proposes to construct a plant for co-generation of chilled water and electricity the stipulations of the preceding paragraphs apply. Proposals for co-generation of ethanol to be sold off-base with one or more of the above utilities may be proposed. The previously mentioned conditions for utility connections, metering and rate structures will apply.

e. The schedule for completion of work in Phase II is a maximum of 48 months after notice to proceed with Phase II. This is in addition to the 12 months allowed for Phase I. It will be the responsibility of the contractor to notify the Air Force of any unforeseen delays, such as regulatory agency approvals, that are encountered which cannot be overcome by the parties exercising due diligence.

3. Capacity. The Phase II construction program must result in the contractor providing to Williams either 3320 tons of refrigerator capacity as chilled water, or up to 12.3 MW of electrical power at 12KV, 3-phase, 60 Hz, or a combination of 3320 tons of refrigeration and 9.2 MW of electrical power.

4. General Conditions.

a. Road Maintenance. Existing Air Force roads on or servicing the area under this contract shall not be impaired by the contractor. Road maintenance required based on contractor's damage will be the responsibility of the contractor, and will be accomplished in accordance with the Corps of Engineer Guide Specifications and Air Force Manual 88-15.

b. GRO Orders. All work under the contract shall be performed in accordance with AFM 88-15, as amended; GRO Orders, and other regulations as listed in Section VI, Constraints, except where the contract specifies differently. The following GRO Orders substitutions of terminology, however, will apply to the work done under this contract on Air Force property: the Terms "Area Geothermal Supervisor", "Supervisor", "US Geological Survey Geothermal District Office", "Secretary" or "Director" are to mean the Air Force. If repairs of contractor's damage are made by the Air Force, the contractor will be responsible for reimbursing the Air Force accordingly. "Lessee" or "operator" are to mean the contractor; and "lease" is to mean the Entry Permit. The GRO Orders make reference to Chapter II of Title 30, the Code of Federal Regulations. Where applicable, the modifications to the language and intent of the original regulations, as noted above, shall apply to this contract. Plans and reporting requirements identified in this contract shall meet the contractor's obligation provided that where data is requested by GRO Orders or the regulations and not in this contract, such data shall be provided by the contractor.

c. Protection and Closing of Wells. If work under this contract is terminated, the following conditions of completed or unfinished wells or borings will apply:

(1) Any casing or plugs set into the well shall remain in place, and title to such items located on Air Force property will automatically pass to the Government upon the decision to terminate.

(2) All nonproductive wells will be capped and abandoned if directed by the Air Force in accordance with the GRO Order No 3 prior to final abandonment of the project.

(3) Any producing well will be fitted with a valving or regulating mechanism to allow either a complete shutdown of the well or withdrawal of the geothermal resource in a regulated and controlled manner as specified in GRO Order No 2, para 5B.

d. Reporting Requirements.

(1) Phase I reporting requirements will be as follows:

(a) Project Status Reports. Status Reports shall be provided to the Air Force monthly. This report will communicate to the Air Force an assessment of the contract status, to explain variance and problems, and to discuss any areas of concern or achievements. Included will be a Contract Management Summary Report which is to be a one page presentation of cost, major milestones and manpower for rapid visual analysis and trend forecasting.

(b) Technical Progress Report. A formal structured technical report shall be required after completion of milestones for exploration, well drilling and logging, and flow testing. A Final Technical Report shall be required reporting on the results of the Resource Confirmation Program.

(c) Exploration Data. A copy of the exploration data and the analysis of this data is to be provided to the Air Force during the exploration period. The Air Force will use this data for an independent evaluation of possible drill site locations.

(d) Drilling Data:

1. Daily Drilling Reports. A daily record shall be kept on the IADC Official Standard Daily Drilling report or other form standard to the drilling industry. The general remarks section shall contain an accurate record of hold conditions and work performed and time required for all work to the nearest quarter hour. A copy of the Daily Drilling report shall be provided. Daily verbal communication may be required to transmit this information. An additional daily record form shall be required for transmittal.

2. Well Cuttings. Three sample bags (3" x 5") of well cuttings will be collected as required by the Air Force. The cuttings will be filed and available to the public after well completion.

3. Logs. A copy of all logs is to be transmitted to the Air Force as available.

4. Fluid Samples. As required by the Air Force

5. Seismic Recordings.

(e) Flow Test Data. A copy of flow test data and of the analysis of this data is to be provided to the Air Force for reservoir assessment. The government will use this data for an independent evaluation to determine the government cost-share.

(f) Final Cost Report. A cost report submitted at program completion summarizing estimated and actual costs. This report will show the Air Force share as evaluated by the previously negotiated variable-cost-share formula criteria.

(g) Conference Records. Documentation of the contractor's understanding of significant decisions, direction, or redirection or required actions resulting from any meetings with Air Force representative.

(2) The Air Force will have the right to data obtained by the contractor during the term of the Phase I contract from geologic studies, exploratory wells and development wells. The data may be used by the Air Force in conducting an independent evaluation of the resource.

(3) Phase II reporting requirements will be as follows:

(a) Project Status Reports. Status Reports shall be provided to the Air Force semi-annually to communicate an assessment of the progress toward completion of the facility.

(b) In the status reports, or as a minimum, six months prior to the plant becoming operational, the contractor shall advise the Air Force in writing of any modifications of his plan for the plant design. If any modifications have impact on either the capacity of the plant or the location of the designated delivery points or the characteristics of the utility to be delivered to the Air Force, the contractor shall advise the Air Force in writing within seven days of the time the contractor is aware of the modification, which shall be subject to Air Force approval.

e. Field Closure. During field closure, the facilities shall be removed, wells abandoned and capped as appropriate if directed by the Air Force, and the premises restored to their original condition, ordinary wear and tear expected, by the contractor at his expense within a reasonable time after termination of the contract.

5. Document Submittals. Once approved by the government, the documents described under Section IV, para 2, Evaluation Factors for Award, will become part of this specification.

III. COST-SHARE GUIDELINES

1. INTRODUCTION

The purpose of COST-SHARE GUIDELINES is to provide an indication of what kind of geothermal development might be expected in terms of well parameters and to provide cost-share criteria for preparation of proposers' cost-share plan. The cost-share plan should be based on the paramters of temperature, flow rates and fluid chemistry. These guidelines assume that the chemistry of the resource is acceptable and are therefore given in terms of temperature and flow rates. In addition, assumptions are made on a per well basis and all wells will have the same performance. Chemical treatment of the resource will be costed out in the proposer's life cycle cost of utilities.

2. RESOURCE QUALITY GUIDELINES

Resource quality must be evaluated in terms of the ability to produce an adequate utility given certain well parameters. The utilities to be considered are either air conditioning chill water or electricity, or co-generation of both.

a. Air conditioning chill water. Air conditioning chill water can be produced with state-of-the-art equipment using the geothermal resource either as hot water or steam. Units are available that operate at temperatures of 170°F and above. However, they are inefficient at lower end of their temperature range and would require large amounts of brine to produce sufficient chill water to meet the need at Williams. Rather than attempt to address the entire range of possibilities, it is assumed that the temperature of the resource under Williams AFB will average about 360°F. Given a resource temperature of 360°F, the required resource flow rate needed to produce chill water at 40°F is estimated to be on the order of 600,000 lbm/hr (1200 gpm). At well flow rate of about 500,000 lb/hr, for a good well, it would require little more than one well to support a 3320 ton air conditioning chill water plant under these conditions. Therefore, a proposal that suggests an air conditioning chill water plant to operate from a resource with an average temperature of 360°F flowing at about 600,000 lbm/hr should be given further consideration. Proposals for other conditions must demonstrate similar thermodynamic balance. Air conditioning loads shown on the drawings must be met.

b. Electricity. Electricity, like air conditioning, can be generated with state-of-the-art equipment using the geothermal source as either hot water (binary systems) or as steam. Binary systems in principle can produce electrical power at lower temperatures than steam systems. However, rather than pursue all possible combinations it will be assumed that the resource will have an average temperature of 360°F. Given an average temperature of 360°F, the required flow rate to generate electricity using a flashed steam system is about 210 lbm/kw-hr. (Reference: Electricity Power Research Institute Report EPRI ER-301 of November 1976). Therefore, the total flow required to produce 12 MW(e) would be 2,520,000 lbm/hr (5100 gpm). This would require at least five wells flowing at a rate of 500,000 lbm/hr. Studies of binary systems (same reference) indicate about 75 percent of this flow rate would be required to support a binary system (1,875,000 lbm/hr). Therefore, a proposal that suggests an electric power plant to operate from a resource of an average temperature of 360°F at about 210 lbm/kw-hr for steam or about 160 lbm/kw-hr for binary should be given further consideration.

c. Co-generation. A proposal which suggests co-generation should take into consideration the reduction of electrical load utilized in producing chill water. Based on 0.94 kw of electricity consumed per ton of central air conditioning plant, a reduction of 3 MW(e) in the power plant requirements is implied. Therefore, co-generated proposals, which suggest air conditioning chill water and 9.2 MW of electrical power, may be considered. The geothermal brine requirements will be the sum of the requirements for air conditioning chill water and 9.2 MW of electricity.

3. COST-SHARE PLAN

a. The COST-SHARE PLAN must be based on the economics and process energy requirements of the proposed plant.

b. The COST-SHARE PLAN should be presented in table form as shown in Figure 1. Each table shall show the well-head temperature on the verticle axis and the well flow rate on the horizontal axis, furthermore each table shall have a specified range of water quality for which that table applies. If only one table is presented, the proposer must specify the range in water quality (in ppm TDS) for which this table applies.

c. The values that appear on the proposers COST-SHARE PLAN shall range from 10 percent to 90 percent and apply to the percentage to be paid by the proposer of the Phase I project costs.

d. The range of possible flow test parameters and baseline conditions for the COST-SHARE PLAN should be reasonable estimates for the geothermal reservoir in question. The engineering and economic calculations utilized to justify the COST-SHARE PLAN must be included in the proposal to provide the rationale for the plan.

e. The number of parameters and baseline conditions considered in the establishment of the cost share should be minimized to the extent practical.

FLOW RATES IN GPM (PER WELL)

$T = {}^{o}F$	<300 gpm	300-450	450-600	600-750	750-900	900-1000	>1000	
<200	10%	10%	10%	10%	10%	10%	10%	Region I
200-250	10%	10%	10%	50	50	50	50	Region II
251-300	50	50	50	50	50	50	50	
301-350	50	50	50	90	90	90	90	
351-400	50	50	90	90	90	90	90	Region III
>400	50	90	90	90	90	90	90	

Water Quality $\leq$50,000 ppm TDS

Figure 1. Proposer's Cost Share in % for Conditions Shown.

Note: This example is for a proposed chill water and electric power co-generation plant where Region I is unsuccessful, Region II is chill water only and Region III is both chill water and electrical generation available.

IV. EVALUATION FACTORS FOR AWARD

1. GENERAL CONDITIONS

The proposals submitted in response to this RFP will be evaluated in accordance with the criteria set forth in paragraph 2 of this section. In conducting this evaluation, the Air Force may utilize the assistance and advice of qualified personnel from other agencies of Government and Air Force contractor consultants. All proposers will be notified in writing of the action taken on their proposal. The status of any proposal during the evaluation process will not be discussed with proposers. Prior to making a comprehensive evaluation of the proposal, a preliminary review will be made to determine if the proposal meets the qualification criteria listed below.

a. The proposal must contain a plan and schedule for resource confirmation.

b. The proposal must contain a plan for resource confirmation cost-shares.

c. The proposal must contain a plan and schedule for construction and operation of a plant.

d. The proposal must contain a utility pricing plan that will permit the Air Force to purhcase refrigeration chill water and/or electricity at a net savings in utility cost over the anticipated life of the plant.

e. The proposer must not be a government agency and/or laboratory owned, operated, or under the cognizance of the government.

Proposals which pass the preliminary review will undergo a comprehensive technical and business evaluation in accordance with the criteria of paragraph 3 of this section. The evaluation criteria parallel the RFP format requirements, paragraph 2 of this section.

2. TECHNICAL AND BUSINESS PROPOSAL REQUIREMENTS

Each submission in response to the RFP should be prepared in two separate and detached volumes: Volume I - Technical Proposal, and Volume II - Business Proposal. To facilitate an orderly and expedient review of proposals, proposers are requested to follow the format given below for Volumes I and II. Each volume should be written as a "stand-alone" document. Separate teams of reviewers may review each volume and all pertinent information to make each volume entirely understandable without reference to the other volume should be included. It is recommended that the total number of pages for the two volumes not exceed 200 pages. Proposals should be as short and concise as possible consistent with being complete. At the end of this section, a checklist is provided to assist in verifying proposal completeness.

a. VOLUME I - TECHNICAL PROPOSAL

(1) General Requirements

(a) Title Page - The title page should contain, in addition to the title, the name and address of the company or companies submitting the proposal.

(b) Table of Contents - Include a Table of Contents to facilitate locating the elements outlined in these guidelines (include page numbers).

(2) Phase I - Resource Confirmations

Provide information concerning the technical feasibility of the proposed resource confirmation effort. Includes as a minimum the following:

(a) A brief summary of the resource confirmation program.

(b) A Proposed Plan and Schedule for Resource Confirmation which provides considerations and rationale for an Exploration Plan, a Preliminary Drilling Plan, a Preliminary Test Plan, identifies program decision points, and a Project Management Plan as follows:

1. Exploration Plan - The exploration program has the basic goal of selecting drill sites. If the on-base site shown on the drawings, Appendix F, is to be used, the contractor shall so state, and no exploration plan will be required. Collection, analysis and interpretaion of geological, geochemical, geophysical and hydrological data (as applicable) should form the exploration program. Drilling for the purpose of determining temperature and thermal gradient is acceptable if applicable. Each technique applied should contribute to a better understanding and evaluation of the target concept and to the selection of the drill site. Anticipated methods to be used in analysis and interpretation of the exploration data should be detailed or referenced in the open literature. The exploration program should be kept as modest as possible consistent with developing enough data for good drill site selection. Exploration is not restricted to Williams AFB, but is restricted to the vicinity. Therefore, the proposer must define the exploration boundaries. Within the boundaries of Williams AFB, the drill site should conform to the limitations indicated on the attached drawings.

2. Preliminary Drilling Plan - The purpose of the drilling program is to intersect the resource by utilizing good geothermal drilling practices. Consideration should be given to the use of drilling fluids that minimize or eliminate formation damage, i.e., drilling with air, water or high temperature drilling fluid systems. The proposed drilling program should give anticipated rig type well depth, well diameter, casing schedule, drilling fluid, logging plan, method of discharging geothermal fluids, etc. Anticipated drilling safety problems and planned mitigating measures (such as blowout prevention equipment) should be described. Completion and abandonment plans should be indicated; these plans must comply with Federal, State and/or local requirements.

3. Preliminary Test Plan - The purpose of testing is to prove the existence of an adequate geothermal resource. Consideration should be given to testing during drilling and reservoir testing after drilling. The proposal shall address the method and value information collection on the physical and hydrologic characteristics of the well during drilling. Reservoir testing once drilling is completed is required to evaluate critical parameters such as temper-

ature, discharge rate and fluid (potentiometric) level. Results should be analyzed to predict reservoir behavior over the life of the project. The proposal should specify in detail the plans for testing, including: (a) test and data analysis procedures; (b) type of instrumentation and its accuracy, and (c) any other information relevant to demonstrating the proposer's understanding of well testing. The Air Force and/or its contractors will monitor this phase for concurrence for determination of the degree of success, and may perform an independent assessment of all testing.

4. Program Decision - During the resource confirmation phase of the project the Air Force will be sharing the risk with the contractor. It will be necessary for the contractor to confer with the Air Force at key points to reach a consensus on follow-on courses of action. The proposal should specify where these program decision points should occur and address the alternatives to be considered at each point. This section should address the proposers criteria for levels of success if a usable resource is found.

5. Program Management - Provide, as a minimum, the following Phase I information:

a. Describe the planned organizational elements showing the reporting relationships of key personnel and list all key personnel who will be involved in the project. If the project is to be accomplished by a team effort, identify each of the participating organizations and/or individuals and include a project organization chart. If the proposer is a team of organizations, one member organization must be designated as the principal participant and an individual must be designated Project Manager. The relationship of all parties who work on the project with respect to one another must be clear.

b. Identify all consultants and subcontractors where possible. Clearly explain the nature and extent of their efforts in support of the proposed project. If all consultants and subcontractors are not yet identified, describe how they will be selected.

c. Provide a work schedule for the project. This schedule should indicate the phasing and interrelationship of the various tasks as defined by the Statement of Work. The schedule should also identify key milestones and decision points through testing and well competition. The schedule shall be based on a time line from receipt of notice-to-proceed and not based on calendar dates. The decision point or milestone chart should define the data to be delivered at each stage of the program.

d. Discuss personnel and organization experience. Include, as a minimum, the following:

1) Describe any relevant experience or related capabilities of the proposing organization and consultants that lend strength to the proposed project. Proposals should include a complete description of previous

experience that would demonstrate ability to plan and manage projects of similar magnitude.

2) Provide resumes of the Project Manager and key personnel to indicate competence and experience in geothermal development or related technologies.

(c) Institutional Considerations - Discuss any Phase I institutional considerations. Include, as a minimum, the following.

1. Site and Access: Provide a legal description of the site proposed for exploration, drilling, testing, and power plant siting if other than on Williams AFB. Provide the following evidence to the best of your abilities:

a. Right of access, leases and/or ownership to the property, and

b. Right to the use of the water/geothermal/mineral resource for the proposed application.

2. ENVIRONMENTAL MANAGEMENT PLAN. The offeror shall, in his proposal, indicate how the Environmental Management Plan will be prepared for each phase of development and what its content will include. This plan is closely related to the prepared Environmental Assessment (EA) and shall also address itself to the following items:

a. Adherence to mitigating procedures proposed in the EA.

b. Compliance with monitoring operation and maintenance programs required by the various permits.

c. Coordination procedures with the Air Force.

d. Field closure and necessary remedial measures.

e. Protection and preservation of natural and cultural resources.

f. Disposal of geothermal fluids (reinjection well).

g. Fluid disposal during and after drilling.

h. Drill site restoration.

i. Completion and/or abandonment procedures.

j. Technical competence. Offeror's proposal shall include a section describing environmental management capabilities and/or discussion of environmental engineering consulting firms that have capabilities to fulfill the above responsibilities.

3. Safety: The proposer should discuss potential safety problems and practices during drilling and testing.

4. Describe any legal, social or institutional issues or problems associated with the project. Describe intended solutions to the issues or problems anticipated.

(3) Phase II - Plant Construction and Operation. Provide information concerning the technical feasibility of the plant construction and operation program. Provide as a minimum the following:

(a) A brief summary of the construction and operation program.

(b) A thorough discussion of the technical aspect of a plant construction and operation program. Included should be consideration for preliminary designs, requirements for and method of construction, preliminary tests and start-up, operation and maintenance which include, but are not limited to, the following:

1. Design

a. Proposed design schematics of the process(es) which identify temperatures (°F), flow rates (gpm) and other pertinent design information.

b. Energy requirements (BTU/hr) for the process(es). The energy requirements should be shown as a Process Energy Requirements Plot of temperature (°F) versus hydrothermal fluid flow (gpm). Clearly describe the minimum acceptable resource requirements (flow rates, temperatures and other parameters that may limit the project) needed to meet the intended application.

c. Predicted utilization factor.

d. Predicted average gross annual energy consumption (BTU/yr) that will be met through the use of hydrothermal energy.

e. Brief description of major energy system components.

f. Description of the intended fluid disposal system design.

2. Construction

a. Knowledge of requirements for construction on Williams AFB.

b. Requirements for drilling of additional wells.

c. Requirements for transmission systems for utility and resource pipelines.

d. Requirements for the hook-up of utility to existing system(s).

e. Requirements for personnel facilities and control room(s).

f. Requirements metering and safety features.

3. Plant Test and Start-Up

a. Requirements for testing of the facility to demonstrate it meets design requirements.

b. Requirements for start-up and orderly transition of the base facilities to use of the plant utility.

4. Operation and Maintenance

a. Proposed method of providing for operation and maintenance, i.e., proposer personnel or a subcontractor.

b. Level of automation of plant and the number of personnel required for operation and maintenance.

c. Demonstrate knowledge of the requirements for operating a plant on base and how the requirements are considered in the design.

d. Describe the features, including conducting of preventive maintenance, which are intended to provide for uninterrupted service.

(c) Project Management - Provide, as a minimum, the following Phase II information:

1. Describe the planned organizational elements showing the reporting relationships of key personnel and list all key personnel who will be involved in the project. If the project is to be accomplished by a team effort, identify each of the participating organizations and/or individuals and include a project organization chart. If the proposer is a team of organizations, one member organization must be designated as the principal participant and an individual must be designated Project Manager. The relationship of all parties who work on the project with respect to one another must be clear.

2. Identify all consultants and subcontractors where possible. Clearly explain the nature and extent of their efforts in support of the proposed project. If all consultants and subcontractors are not yet identified, describe how they will be selected.

3. Provide a work schedule for the project. This schedule should indicate the phasing and interrelationship of the various tasks as defined by the Statement of Work. The schedule should also identify key milestones through testing and completion. The schedule shall be based on a time line from date of agreement award and not based on calendar dates.

4. Discuss personnel and organization experience. Include, as a minimum, the following:

a. Describe any relevant experience or related capabilities of the proposing organization and consultants that lend strength to the proposed project. Proposals should include a complete description of previous experience that would demonstrate ability to plan and management projects of similar magnitude.

b. Provide resume of the Project Manager and key personnel to indicate competence and experience in geothermal development or related technologies.

(d) *Institutional Considerations* - Discuss any Phase II institutional considerations which differ from those of Phase I. Include as a minimum:

1. Site and access.

2. Safety.

3. Legal or social issues.

b. VOLUME II - BUSINESS PROPOSAL

(1) General Requirements

(a) Title Page - The title page should contain, in addition to the title, the name and address of the company or companies submitting the proposal and the name(s) and position(s) of the individuals authorized to negotiate a contract.

(b) Table of Contents - Include a Table of Contents to facilitate locating the elements outlined in these guidelines (include page numbers).

(c) Summary of proposed costs:

1. A proposed cost and cost-shares plan for Phase I.

2. A proposed cost plan for the utility or utilities for Phase II, indicating the total 30-year life cycle cost to the government of geothermally produced utilities and the estimated quantities of these utilities.

(d) Organizational Information - The following organizational information should be provided:

1. A brief description of the proposing entity including size, type of business, history and discussion of ownership and/or controlling interest.

2. A listing of current or recent (within the last two years) Government contracts or other contracts by the proposer(s) in this or related fields. Include the name of the sponsoring agency of firm, contract number, amount of contract, subject area of contract, name and phone number of Contract-

ing Officer for any Government contracts cited. Also, provide information concerning cost and schedule performance. If necessary for evaluation, the Air Force may solicit experience data concerning proposer's past performance.

3. Provide financial data on the proposer(s) and the proposer's available financial resources. An annual financial statement (balance sheet and income and expense statement) for the past three years should be attached for proposers and major proposed subcontractors and consulting firms.

(2) Phase I. The following information should be provided for Phase I of the proposed project:

(a) Provide cost data for the project broken down into costs for the key tasks. The cost data should be submitted on DD Form 633. Append as many schedules as required to detail fully the cost of the project. Describe the method of computation and application of labor overhead and general and administrative overhead. Any cost escalation factors utilized in determining the cost estimates should be clearly defined. Subcontract costs should be summarized separately.

(b) Describe the amount and method of financing proposed for the non-Government share of the cost of the project. Assume a completely successful well.

(c) Provide a detailed variable cost-share plan and the rationale for this plan. The engineering and economic calculations used to determine the cost-share should be included in the proposal to aid the Air Force in evaluating the adequacy of the cost-share plan. The proposed cost-share must be related to the degree of resource quality as defined by the well test results.

(3) Phase II. The following information should be provided for Phase II of the proposed project:

(a) Provide a detailed utility pricing plan over the life of the plant and indicate how this plan proposes to provide utilities to the Air Force at a net savings over the life. Assume in this plan that the Air Force will purchase the utility for a period of 30 years.

(b) Provide sufficient information to justify the numbers involved in estimating the construction and life cycle operating cost of the plant. This information should include estimated construction costs, method and terms of financing, test and start-up costs, and annual operation and maintenance. Escalation factors used in estimating costs should be clearly identified and defined. (Reference Appendix B, Life Cycle Energy Cost Ceiling.)

3. TECHNICAL AND BUSINESS PROPOSAL EVALUATION CRITERIA

a. VOLUME I - TECHNICAL PROPOSALS.

(1) PHASE I - TECHNICAL PROPOSALS.

(a) Criterion 1: Technical Feasibility -The following factors will be considered in evaluating the technical feasibility of the proposal for Phase I:

1. Does the proposal present a knowledgeable and realistic approach to confirming the existence of a viable resource under Williams AFB.

2. Does the proposal present credible levels of success predictions for a located resource.

(b) Criterion 2: Project Management - The following factors will be considered in evaluating the project management proposal of Phase I:

1. Project Management Plan

a. Completeness and adequacy of the comprehensive project description, discussion of individual responsibilities and task assignments of each project participant, estimates of personnel effort for each of the tasks, discussion of manpower availability to satisfy task requirements, and management techniques.

b. Completeness and adequacy of the detailed schedule including sequence of project tasks, principal milestones and decision points.

c. Adequacy of participant/team commitments to assure completion of the project in a timely manner.

2. Organization and Management Team - will be evaluated for:

a. Qualifications, capabilities and experience of key personnel with projects of comparable scope, i.e., in geothermal, petroleum, hyrdrology or related technologies.

b. Qualifications, capabilities and experience of all participating organizations.

(c) Criterion 3: Institutional Considerations - The institutional considerations will be evaluated according to their potential impact on the success of the project and the likelihood of satisfactory solution of the following items:

1. Right of access, leases and/or ownership and right to the use of the water/geothermal/mineral resources, if on land other than Williams AFB.

2. Known and potential environmental issues.

3. Relevant legal, social or institutional problems.

4. Potential safety problems and practices.

(2) PHASE II - TECHNICAL PROPOSALS

(a) Criterion 4: Technical Feasibility - The following factors will be considered in evaluating the technical feasibility of the proposal for Phase II:

1. Feasibility of the proposed plant(s) design based on the indicated resource.

2. Feasibility of constructing, operating and maintaining a facility that will deliver the utility at the required quality and quantity.

3. Feasibility of Phase II based on identified problem areas and proposed methods of solution.

(b) Criterion 5: Project Management - The Phase II proposal will be evaluated for Project Management feasibility in accordance with the considerations of Criterion 2.

(c) Criterion 6: Institutional Considerations - The Phase II proposal will be evaluated for Institutional considerations in accordance with the considerations of Criterion 3.

b. VOLUME II - BUSINESS PROPOSAL

(1) PHASE I - BUSINESS PROPOSAL

(a) Criterion 7: Confirmation Program Cost Summary - The project cost budget summary will be evaluated to determine the reasonableness of costs and time proposed for functional tasks and adequacy of cost breakdown by tasks.

(b) Criterion 8: Variable Cost-Share Plan - The variable cost-share plan, as based on the degree of resource quality, will be evaluated for adequacy and fairness between the Air Force and the proposer.

(2) PHASE II - BUSINESS PROPOSAL

(a) Criterion 9: Utility Price - The proposal will be evaluated to assess the ability to deliver the utility to the Air Force at a net savings over the anticipated purchase period.

4. EVALUATION FACTORS FOR AWARD CHECKLIST. Proposers should use this checklist to assure that your proposal is complete.

a. VOLUME 1 - TECHNICAL PROPOSAL

(1) Is there a table of contents?

(2) Phase I - Resource Confirmation.

(a) Is there a summary of your resources confirmation program?

(b) Does your Exploration Plan define your exploration boundaries, methods and rationale for well site selection?

(c) Does your Preliminary Drilling Plan anticipate the following:

1. Rig type?

2. Well depth?

3. Well diameter?

4. Casing schedule?

5. Drilling fluid?

6. Logging plan?

7. Blow out prevention and other safety considerations?

8. Completion and abandonment plans?

9. Seismic measurements?

10. Disposal of Geothermal Fluids (reinjection well).

(d) Does your test plan include consideration of testing during drilling?

(e) Does your test plan identify the procedures to be used to establish reservoir temperature, discharge rate, fluid level and resource chemistry?

(f) Does your proposal contain a discussion of program decision?

(g) Does your Phase I management plan include:

1. The organizational elements of your project team?

2. A work schedule?

3. Description of relevant experience?

4. Resumes of the project manager and key personnel?

(h) Have you addressed institutional considerations such as site and access rights, water rights, mineral rights; environmental considerations such as fluid disposal during and after testing; and drill site restoration?

(3) Phase II - Plant Construction and Operation.

(a) Have you provided a summary of your planned construction and operation program?

(b) Does your plant design proposal include schematics which identify flow rates, temperatures and other pertinent information?

(c) Have you discussed your intended construction techniques?

(d) Does your proposal contain a plant test and start-up program that provides for orderly and timely transition of the base facilities to use of the plant utility?

(e) Does your operation and maintenance plan identify the features designed to ensure an uninterrupted supply of energy?

(f) Is Seismic measurement during Phase II indicated?

(g) Does your Phase II management plan include those items listed in Item a(2)(g) of this checklist?

(4) Can this volume be completely reviewed without reference to the other volume?

b. VOLUME II - BUSINESS PROPOSAL

(1) Does the title page identify the individual(s) by name and title who are authorized to negotiate a contract?

(2) Is there a table of contents?

(3) Is there a summary of proposed costs for Phase I and Phase II?

(4) Phase I - Resource Confirmation

(a) Have you included estimated cost data on a properly executed DD Form 633?

(b) Have you identified your proposed method of financing the non-Government share of the cost of the project?

(c) Have you included a proposed cost-share plan for Phase I?

(5) Phase II - Plant Construction and Operation

(a) Have you provided a detailed utility pricing plan that will result in a net savings to the Air Force over the anticipated period of purchase?

(b) Have you provided a justifiable estimate of the construction and life cycle operating costs for the plant?

(6) Can this volume be reviewed without reference to the other volume?

V. ENVIRONMENTAL PROTECTION PROGRAMS

1. GENERAL. The United States Air Force has the major responsibility for carrying out the environmental and cultural resources protection programs in a manner that will ensure smooth operation during all phases of the development without any conflicts. The Air Force has the final review and approval authority on all aspects of the environmental and cultural resources protection programs. The Contractor shall maintain close coordination with the Air Force in order to ensure that Williams AFB can carry out its mission and responsibilities without any conflict with the environmental and cultural resources protection requirements. The Air Force has prepared an Environmental Assessment that will fulfill the initial requirements and provide general environmental management guidelines. The environmental protection programs shall ensure compliance with all applicable laws and regulations which include, but are not limited to, the following Federal and State requirements:

a. Resource Conservation and Recovery Act (RCRA) of 1976 (Public Law 94-580). Establishes criteria for management of solid waste and waste products.

b. Clean Water Act (Public Law 92-500 as Amended by Public Law 95-217). Establishes policy of protection of ground or surface water resources by enabling the promulgation of regulations for and participation in the National Pollutant Discharge Elimination System (NPDES).

c. Safe Drinking Water Act (Public Law 93-523 as Amended by Public Law 95-190). Establishes framework for promulgation of regulations to ensure safe drinking water sources, including provisions for the Underground Injection Control (UIC) Program.

d. Clean Air Act (Public Law 91-604 and Subsequent Amendments). Establishes Federal policy for the protection of the quality of the air. The law requires each state to prepare an implementation plan which describes how that state will ensure compliance with the National Ambient Air Quality Standards (NAAQS).

e. Endangered Species Act of 1973 (Public Law 93-205 as Amended by Public Law 94-32 and 94-539). Provides a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, and provides a program for the conservation of such endangered or threatened species. Section seven of this act requires all Federal departments and agencies to avoid actions authorized, funded or carried out by them from destroying or adversely modifying critical habitats.

f. Soil and Water Resources Conservation Act of 1977 (Public Law 95-192). Establishes the policy that Federal programs shall be responsive to the long-term requirements of land and water conservation.

g. Noise Control Act of 1972 (Public Law 92-574 as Amended by Public Law 94-301). Vests primary control of noise with state and local governments, but retains Federal regulatory control over noise production for construction, electronic, and transportation equipment, and motors and engines. It also provides noise control requirements for geothermal operations.

h. Toxic Substances Control Act (Public Law 94-469). Establishes the authority to regulate chemical substances which may present an unreasonable risk of injury or health.

i. Historical and Antiquities Act (Public Law 93-291) and the Archaeological Resource Protection Act of 1979 (Public Law 96-95). Provides for the protection and preservation of historical and archaeological data which may be lost or destroyed as a result of a Federal or private action.

j. Arizona Revised Statutes, Section 2, Title 27; and Article 4, Section 27-651 through 27-666. Establishes the Oil and Gas Conservation Commission, which controls the drilling of all oil, gas and geothermal wells in the state.

k. Oil and Gas Conservation Commission, Rules and Regulations (1972 and Subsequent Amendments). Provides for the regulation of activities associated with the drilling of geothermal wells, as well as monitoring of construction and operation of facilities.

l. Arizona Department of Health Services, Division of Environmental Health Services, Bureau of Air Quality Control, Air Pollution Control Regulations. Establishes requirements for the permitting of pollutant emitting activities and the control of criteria pollutants.

m. Arizona Department of Health Services, Division of Health Services, Bureau of Water Quality Control, Water Quality Standards for Surface Waters (1980). Establishes criteria standards for surface water discharge pursuant to the Clean Water Act, and will eventually provide for the regulation of surface and subsurface discharges associated with geothermal development.

2. PERMIT REQUIREMENTS FOR ENVIRONMENTAL ENHANCEMENT. The Contractor will be responsible for obtaining all necessary approvals, permits, etc, at his expense including, but not limited to, those for wastewater discharges, air pollution control and solid waste disposal associated with operation of the various developments. An outline of a program to obtain all required permits shall therefore be included in the offeror's proposal. The outline should demonstrate knowledge in dealing with the various permitting agencies and familiarity with recent changes in Federal, State and local laws. It also shall identify how permit coordination will be maintained with the Air Force.

3. CONTINGENCY PLANS. Contingency plans shall be prepared containing plans for immediate implementation of corrective actions in case of emergency situations resulting from operational or equipment failure causing hazardous conditions (for example: blow-outs, wastewater spills, excessive emissions to the atmosphere, fire and safety hazards, etc).

VI. CONSTRAINTS

1. It shall be the responsibility of the Contractor to conform to and abide by all applicable laws; ordinances; rules; regulations; and permit, approval, and easement requirements relating to the development of the geothermal resource, access to and from the general sites, and construction on and use of Air Force property. In addition to the laws and regulations identified in Environmental Protection Plan, Section V, and the General Provisions to the Contract, the Proposer is referred to the Geothermal Resources Operational Orders as published by the Geological Survey; the Geothermal Steam Act; the Geothermal Energy Research, Development and Demonstration Act; the Federal Land Planning and Management Act; the Defense Withdrawal Act of 1958 (P.L. 85-337); Title 30, the Code of Federal Regulations; and the Occupational Safety and Health Act, or any successor statutes thereto, all as from time to time amended. Unless specifically advised by the Contracting Officer to the contrary, the Contractor shall meet the applicable requirements of all State and Local Laws and Regulations. This list is not all inclusive and it is the sole responsibility of the Contractor to acquaint himself with all applicable laws, regulations, and other legal constraints or requirements. Because of the nature of the Williams AFB mission, the Air Force has placed certain constraints on geothermal operations within the boundaries of Williams AFB. These constraints ensure the safe and economical development and production of those geothermal resources within the base boundary and ensure that any exploration development, or production does not conflict with the mission of Williams AFB. All on-site and other inspections performed by the Air Force will be at Air Force's cost.

a. Environmental. All vehicular traffic shall be limited to routes approved by the Air Force. The Air Force will retain the right to suspend any operation judged by the Air Force to present an imminent threat to the environment. During all operations, all Federal, State and local environmental requirements shall be rigorously observed. The Air Force shall have the right to impose emission standards required to protect the mission of Williams AFB.

b. Sites and Routes. Energy plant sites, drill pad sites and pipeline routes will be selected subject to Air Force approval to ensure such sites will have a minimum impact on Williams AFB operations. All site plans shall be submitted to the Air Force for approval. Routes to and from work areas will be approved by the Air Force.

c. Radioactive Sources. No radioactive sources shall be brought onto Williams AFB until appropriate Air Force permits have been obtained. These permits will be issued upon the Air Force verifying the license of the operator to be valid for the proposed effort, and the Air Force approving a standard operating procedure for dealing with lost sources and handling damaged sources.

d. Injuries and Accidents. All disabling injuries occurring on Williams AFB land will be reported within 24 hours to the Air Force. The Air Force will retain the right to suspend any operation judged by the Air Force to present an imminent danger to people or to government property.

e. Electronic Radiation. No electronic radiation will be permitted on Williams AFB until a permit is obtained which certifies this emission will not interfere with the Williams AFB mission. The Air Force may, at times, require electronic emission silence for up to four hours.

f. Public Release of Information. There shall be no public release of information or photographs concerning the aspects of this contract or other documents resulting therefrom without prior written approval of the Air Force contracting officer.

g. Blow-out Contingency Plan. Prior to the commencement of any drilling into the geothermal reservoir, the Contractor shall prepare a contingency plan acceptable to the Air Force for use in the event of a blow-out of a geothermal well.

h. Geothermal Resources Operational (GRO) Orders. The GRO Orders, as published by the United States Department of Interior, Geological Survey, Conservation Division, Office of the Area Geothermal Supervisor, and Title 30, Chapter II of the Code of Federal Regulations, shall be adhered to subject to certain interpretations that are discussed in more detail under Specifications, Section II.

i. Right of Inspection. The Air Force shall have the right of inspection to ensure and verify compliance with these constraints.

VII. PRICING, ESCALATION AND PAYMENTS

1. GENERAL

a. The Air Force will accept from the Contractor energy service for loads listed in Appendix "E." The Air Force will pay the Contractor on a monthly basis for delivery of such energy as metered at the designated delivery points. Payments will be made solely for energy consumed by the Government as recorded on a watt-hour or BTU meter at the designated delivery points, and not for energy that is available to the Government but not actually consumed. The pricing must be such that it represents a total cost to the Government for energy service to Williams AFB designated delivery points.

b. It is understood that the Air Force loads listed in Appendix "E" are presently being serviced by a utility company under contract to the US Air Force. It is agreed that the successful contractor will pay for any costs of termination involved in such existing contracts, and that the sole payment by the Air Force under this contract is for the negotiated utility contract price. Similarly, the Air Force will not make payment for any additional items of cost including, but not limited to, wheeling, banking, standby, emergency, backup, line transmission loss, metering loss, transformer loss, power factor, demand, termination charges, and the like.

2. POWER AVAILABILITY. Service shall be available at the designated delivery points which the Contractor has agreed to serve 100% of the time subject to force majeure. The Contractor shall use reasonable diligence to provide a regular and uninterrupted supply of service at the service locations, but shall not be liable to the Government for damages, breach of contract, or otherwise, for failure, suspension, diminution, or other variations of service occasioned by any beyond the control and without the fault or negligence of the Contractor.

3. PRICE ESCALATION. Commencing 1 year after initial energy production start-up and effective each year thereafter, the contract unit price will be adjusted for the following twelve month period to reflect the percent change in accordance with the contractor's Business Proposal, Volume II.

APPENDIX A

WILLIAMS AIR FORCE BASE
FEE OWNED LANDS AVAILABLE
FOR GEOTHERMAL DEVELOPMENT

DESCRIPTION

STATE OF ARIZONA
GILA AND SALT RIVER MERIDIAN

TS2, R7E

N½ of the N½ of Section 2

containing 176 acres more or less.

APPENDIX B
LIFE CYCLE ENERGY COST CEILING

1. Table II, Appendix E, contains the total electric demand and usage for Williams AFB from October 1974 through June 1980. Attached are rate schedules and monthly entitlements from the United States Department of the Interior Bureau of Reclamation and Salt River Project Improvement and Power District. On this basis, the average cost of electricity at Williams AFB was $.0310/KWH for October 1979 through September 1980.

2. The life cycle energy cost ceiling will be computed based on the following:

A. The total annual electric demand and usage will be the same as the last recorded year shown in Table II. No increases in demand or usage will be assumed during the life cycle period. The air conditioning demand will be assumed to be a peak value of 3320-tons. The air conditioning demand and usage will be assumed to be proportional to the electric demand and usage throughout the year.

B. Life cycle cost will be computed for supplying energy for 30-years and will be based on the attached economic analysis data using a 7% discount factor to allow for general inflation and a 7% differential escalation for electricity usage and demand charge to allow for inflation above the general inflation rate. Present values will be used in accordance with the attached economic analysis data.

C. The electrical rate indicated in paragraph 1 above will be escalated to the proposed plant start-up date to arrive at the initial rate for the 30-year analysis.

D. Chilled water energy will be numerically converted to electrical energy for comparison purposes, using a conversion factor of 0.94 KW of electrical power input for each ton of refrigeration at the designated delivery point.

E. Differences in distribution and generating (or chilling) maintenance costs will not be considered since they will be internal contractor expenses in both existing electrical and future Geothermal contracts.

6 Atch
1. Salt River Project Schedule E-5
2. US Dept of Interior Bureau of Reclamation Schedule UC-F2
3. US Dept of Interior Bureau of Reclamation Schedule UC-FP2
4. Western Power Administration Exhibit A (Rev-1)
5. Economic Analysis Data 0%/7%
6. Economic Analysis Data 7%/7%

SALT RIVER PROJECT AGRICULTURAL IMPROVEMENT AND POWER DISTRICT

ELECTRIC RATE SCHEDULE E-35

GENERAL SERVICE

Effective: March 1, 1981
Supersedes: March 1, 1980

AVAILABILITY:
Where facilities of adequate capacity are available.

APPLICABILITY:
To electric service supplied at one point of delivery and measured through one meter. This schedule is applicable to any service for which no other standard schedule is available.

CHARACTER OF SERVICE:
Sixty hertz alternating current, three phase or single phase, at one standard voltage of approximately 120/240, 480, 2300/4000 or 7200/12,000 volts, where, and to the extent available, at the option of the District.

MONTHLY BILL PER METER:
Rate

MAY 15-OCTOBER 14

Customer Charge
$5.00/Month

Service Charge	
No Charge	First 10 KW
$3.05/KW	Next 220 KW
2.00/KW	All Additional KW

Energy Charge	
$0.0877/KWH	First 400 KWH
0.0677/KWH	Next 3600 KWH
0.0626/KWH	Next 100 KWH/KW of billing demand or if no billing demand, all additional KWH
0.0471/KWH	Next 50,000 KWH
0.0341/KWH	All Additional KWH

OCTOBER 15-MAY 14

Customer Charge
$5.00/Month

Service Charge	
No Charge	First 10 KW
$2.60/KW	Next 220 KW
1.00/KW	All Additional KW

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Energy Charge

$0.0744/KWH	First 400 KWH
0.0558	Next 3600 KWH
0.0538/KWH	Next 100 KWH/KW of billing demand or if no billing demand all additional KWH
0.0385/KWH	Next 50,000 KWH
0.0299/KWH	All Additional KWH

Minimum

The minimum bill shall be the greater of:

A. $8.50

B. The minimum monthly dollar amount as specified in the service agreement.

Adjustments

A. The energy rate is subject to an increase or decrease based on changes in the weighted average cost of fuel and purchased power. Excluded from the average cost are the demand portion of firm purchases and certain other fixed or otherwise predictable, recurring expenses predominantly associated with fuel handling. The fuel adjustment shall be determined prior to the beginning of each winter and summer season (or at any other time as required) by dividing the estimated cost of fuel and purchased power (net of exclusions) plus any variance between estimated and actual cost of fuel carried forward from the preceding adjustment period, by the applicable kilowatt-hours.

B. Monthly rate and minimum bill are subject to increase for the applicable proportionate part of any taxes or governmental impositions which are assessed on the basis of gross revenues of the District and/or the price or revenue from the electric energy or service sold and/or the volume of energy generated or purchased for sale and/or sold hereunder.

C. Subject to adjustment of kilowatt-hour use based on power factor in the following manner. In the event that the power factor falls below eighty-five percent lagging during any billing period, the kilowatt-hours during this period shall be adjusted at District's option, to equal kilovolt-ampere hours times .85 for billing purposes.

D. Subject to adjustment for customer's lack of polyphase current balance. If, at any time, the current in any phase shall exceed the average of the currents in the three-phase by more than five percent, the amount to be paid for by the customer for the period during which the imbalance occurs will be increased, at District's option, by a percentage equal to that of the imbalance.

Terms of Payment

All bills are due as of the date rendered and are delinquent 15 days thereafter.

DETERMINATION OF DEMAND IN KILOWATTS:

A. The billing demand, when applicable, shall be the maximum number of kilowatts measured by meter during the billing cycle.

B. A customer using 2,500 KWH per billing cycle or more may have demand metering supplied.

C. The District reserves the right to require demand metering for any service.

RULES AND REGULATIONS:

Service under this schedule is subject to the Rules and Regulations of the District governing Electric Service as of the effective date hereof and as they may be amended or supplemented by the Board of Directors of the District.

Special Conditions

Industrial customers contracting and paying for not less than 5,000 kilowatts of firm power and energy may be eligible to contract for interruptible power to the extent of the District in its normal operations may from time to time have such power available. Details of this service are available in the Interruptible Power Service Rider.

Schedule SP-F1
(Supersedes Schedule UC-F2)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Colorado River Storage Project

SCHEDULE OF RATES FOR WHOLESALE FIRM POWER SERVICE

Effective:

The first day of the first full billing period beginning on or after January 23, 1981.

Available:

In the area served by the Colorado River Storage Project.

Applicable:

To wholesale power customers for general power service supplied through one meter at one point of delivery.

Character and Conditions of Service:

Alternating current, sixty hertz, three-phase, delivered and metered at the voltages and points established by contract.

Monthly Rate:

CAPACITY CHARGE: $1.655 per kilowatt of billing demand.

ENERGY CHARGE: 4.0 mills per kilowatt-hour for all energy use up to, but not in excess of, the delivery obligation under the power sales contract.

BILLING DEMAND: The billing demand will the be greater of (1) the highest 30-minute integrated demand established during the month up to, but not in excess of, the delivery obligation under the power sales contract, or (2) the contract rate of delivery.

Billing for Unauthorized Overruns:

For each billing period in which there is a contract violation involving an unauthorized overrun of the contractural firm power and/or energy obligations, such overrun shall be billed at ten times the above rate.

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Adjustments:

For transformer losses:

If delivery is made at transmission voltage but metered on the low-voltage side of the substation, the meter readings will be increased two percent to compensate for transformer losses.

For power factor:

None. The customer will normally be required to maintain a power factor at the point of delivery of between 95 percent lagging and 95 percent leading.

Schedule SP-FP1
(Supersedes Schedule UC-FP2)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Colorado River Storage Project

SCHEDULE OF RATES FOR PEAKING POWER SERVICE

Effective:

The first full day of the first full billing period beginning on or after January 23, 1981.

Available:

Within and adjacent to the marketing area of the Colorado River Storage Project.

Applicable:

To wholesale power customers purchasing such service under long-term contracts. Because of the nature of this class of service, it is applicable only to customers with other resources enabling them to utilize it.

Character and Conditions of Service:

As specifically established by contract. Delivery will be made from the transmission system of the United States at transmission voltage, and normally only during peakhours of the purchaser's load. Return of all energy furnished shall normally be required.

Monthly Rate:

CAPACITY CHARGE: $1.655 per kilowatt of the effective Contract Rate of Delivery for Peaking Power or the maximum amount scheduled, whichever is the greater.

ENERGY CHARGE: 4.0 mills per kilowatt-hour for all energy scheduled for delivery without return.

Billing for Unauthorized Overruns:

For each billing period in which there is a contract violation involving an unauthorized overrun of the contractural obligation for peaking capacity and/or energy, such overrun shall be billed at ten (10) times the above rate.

Adjustments:

For power factor:

None. The customer will normally be required to maintain a power factor at the point of delivery of between 95 percent lagging and 95 percent leading.

MONTHLY CAPACITY AND ENERGY ENTITLEMENTS,
MAXIMUM ALLOWABLE RATES OF DELIVERY AT POINT(S) OF DELIVERY
AND
DELIVERY CONDITIONS

1. This EXHIBIT A, made this 24th day of November, 1980, to be effective under and as part of Memorandum No. DE-MS65-80WP39045, dated April 9, 1980, hereinafter called "Memorandum," shall become effective October 1, 1980, and supersedes Exhibit A, dated May 12, 1980. This Exhibit A shall remain in effect until superseded by another Exhibit A in accordance with the provisions of the Memorandum; provided that this Exhibit A or any superseding Exhibit A shall be terminated by the termination of the Memorandum.

2. MAXIMUM SEASONAL CAPACITY ENTITLEMENT FOR PEAKING POWER. On and after the effective date of initial service hereunder, peaking power will be delivered up to the maximum seasonal capacity entitlements of:

a. 790 kilowatts in each summer season; and

b. 256 kilowatts in each winter season.

3. a. ADDITIONAL ENERGY OBLIGATION FOR SUMMER SEASON. On and after the effective date of this Exhibit A, the obligation of the United States to deliver energy to the Contractor in excess of the established limit set forth in Article 11.c. of the Memorandum shall be:

Summer Season Additional Energy

Obligation = 0 kWh

b. ADDITIONAL ENERGY OBLIGATION FOR WINTER SEASON. On and after the effective date of this Exhibit A, the obligation of the United States to deliver energy to the Contractor in excess of the established limit set forth in Article 11.c. of the Memorandum shall be:

Winter Season Additional Energy

Obligation = 0 kWh

4. a. MONTHLY CAPACITY ENTITLEMENTS AT POINT(S) OF RECEIPT FOR SUMMER SEASON. On and after the effective date of this Exhibit A, the monthly capacity entitlements to the Contractor at Point(s) of Receipt for the period of April 1980 through September 1980 shall be:

Month	Firm		Short-Term Firm		Peaking	Total Firm and Peaking Capacity	
	Max. (kW)	Min. (kW)	Max. (kW)	Min. (kW)		Max. (kW)	Min. (kW)
April	1621	840	0	0	533	2154	840
May	2026				667	2693	
June	2307				759	3066	
July	2400				790	3190	
August	2369				780	3149	
September	2338				770	3108	

b. MONTHLY ENERGY ENTITLEMENTS AT POINT(S) OF RECEIPT FOR SUMMER SEASON. On and after the effective date of this Exhibit A, the Contractor's energy entitlement at Point(s) of Receipt by months, for the period of April 1980 through September 1980 shall be:

Month	Firm (kWh)	Additional Energy (kWh)	Short-Term Firm (kWh)	Total Energy (kWh)
April	676,355	0	0	676,355
May	880,665			880,665
June	1,094,816			1,094,816
July	1,198,885			1,198,885
August	1,165,532			1,165,532
September	1,103,747			1,103,747
Total	6,120,000			6,120,000

5. MONTHLY CAPACITY ENTITLEMENTS AT POINT(S) OF RECEIPT FOR WINTER SEASON. On and after the effective date of this Exhibit A, the monthly capacity entitlements to the Contractor at Point(s) of Receipt shall be:

a. WINTER SEASON CAPACITY (OCTOBER 1980 - MARCH 1981):

Month/Year	Firm		Short-Term Firm		Peaking	Total Firm and Peaking Capacity	
	Max. (kW)	Min. (kW)	Max. (kW)	Min. (kW)	(kW)	Max. (kW)	Min. (kW)
October	650	228	0	0	256	906	228
November	557				219	776	"
December	530				209	739	"
January	560				221	781	"
February	555				219	774	"
March	550				217	767	"

b. WINTER SEASON ENERGY (OCTOBER 1980 - MARCH 1981):

Month/Year	Firm (kWh)	Additional Energy (kWh)	Short-Term Firm (kWh)	Total Energy (kWh)
October	290,324	0	0	290,324
November	270,874			270,874
December	265,395			265,395
January	270,189			270,189
February	269,504			269,504
March	291,214			291,214
Total	1,657,500	0	0	1,657,500

6. a. DELIVERY OPTIONS. On and after the effective date of this Exhibit A, the Point(s) of Receipt and voltage(s) and measurement Point(s) and voltage(s) shall be:

Pinnacle Peak 230 kV and/or Mesa 230 kV.

7. The Provisions of this Exhibit A may be modified by the parties and such modification shall occur upon execution of a superseding Exhibit A to the Memorandum.

THE UNITED STATES OF AMERICA

By R. A. Olson

Title Area Manager

Address Western Area Power Administration
Boulder City Area
P. O. Box 200
Boulder City, Nevada 89005

DEPARTMENT OF DEFENSE
WILLIAMS AIR FORCE BASE

By E. H. Ferguson

Title Contracting Officer

Address Base Contracting Office
Bldg 323
Williams AFB AZ 85224

Attest:

____

____

Signature Clause

ECONOMIC ANALYSIS DATA
DIFFERENTIAL INFLATION RATE = 0%*
DISCOUNT RATE = 7%

ECONOMIC LIFE YEARS	ONE TIME COST FACTORS	RECURRING BENEFITS/COSTS FACTORS
1	0.935	0.935
2	0.874	1.809
3	0.817	2.626
4	0.764	3.390
5	0.714	4.104
6	0.667	4.771
7	0.623	5.394
8	0.582	5.976
9	0.544	6.520
10	0.508	7.028
11	0.475	7.503
12	0.444	7.947
13	0.415	8.362
14	0.388	8.750
15	0.363	9.113
16	0.339	9.452
17	0.317	9.765
18	0.296	10.065
19	0.277	10.342
20	0.259	10.601
21	0.242	10.843
22	0.226	11.069
23	0.211	11.280
24	0.197	11.477
25	0.184	11.661
26	0.172	11.833
27	0.161	11.994
28	0.150	12.144
29	0.140	12.284
30	0.131	12.415

*These factors are to be applied to cost elements which are anticipated to escalate at the same rate as the general price level.

ECONOMIC ANALYSIS DATA
DIFFERENTIAL INFLATION RATE = 7%
DISCOUNT RATE = 7%

ECONOMIC LIFE YEARS	ONE TIME COST FACTORS	RECURRING BENEFITS/COSTS FACTORS
1	1.0	1.0
2	1.0	2.0
3	1.0	3.0
4	1.0	4.0
5	1.0	5.0
6	1.0	6.0
7	1.0	7.0
8	1.0	8.0
9	1.0	9.0
10	1.0	10.0
11	1.0	11.0
12	1.0	12.0
13	1.0	13.0
14	1.0	14.0
15	1.0	15.0
16	1.0	16.0
17	1.0	17.0
18	1.0	18.0
19	1.0	19.0
20	1.0	20.0
21	1.0	21.0
22	1.0	22.0
23	1.0	23.0
24	1.0	24.0
25	1.0	25.0
26	1.0	26.0
27	1.0	27.0
28	1.0	28.0
29	1.0	29.0
30	1.0	30.0

APPENDIX C

EVALUATION OF THE
GEOLOGY, GEOCHEMISTRY, GEOPHYSICS
AND POSSIBLE GEOTHERMAL RESOURCES
OF WILLIAMS AIR FORCE BASE AND VICINITY
MARICOPA COUNTY, ARIZONA

NOTICE

OVERVIEW

The published and unpublished geologic, geochemical and geophysical data, available for the Higley basin within which Williams Air Force Base is located, has been reviewed by Cascadia Exploration Corporation. Mr. Richard W. Hahman of the Arizona Bureau of Geology & Mineral Technology prepared an excellent summary of the geology and the geothermal energy potential of the Williams Air Force Base (Hahman, 1979 & E.G. & G. Idaho, Inc., 1979). Mr. Hahman graciously allowed Cascadia Exploration access to his files and provided many hours of discussion regarding the geology and geothermal information available for the Williams Air Force Base project. Virtually all the available information regarding the potential geothermal resources at Williams Air Force Base results from the exploration efforts of Geothermal Kinetics, Inc. Mr. Mike O'Donnell allowed access to the data from the Geothermal Kinetics Powers Ranch #1 and #2 wells, and the geologic, geochemical and geophysical information for the Higley basin developed by Geothermal Kinetics and its subsidiary, Group Seven, Inc. Geothermal Kinetics, Inc. was allowed to review this report and delete any information which they desired remain confidential.

Williams Air Force Base is located in the southeastern portion of Maricopa County, Arizona, east of the town of Higley and approximately 30 miles southeast of Phoenix. The potential geothermal reservoir is located within the Higley basin, a northwest trending basin approximately 30 miles long and 15 miles wide. The basin is bounded on the north by the Usery and Goldfield mountains; on the south by the Santan mountains; on the east by the Superstition mountains; and on the west by the South mountains. The upper portion of the Higley basin is filled with continental deposits which are in part an evaporite sequence. The continental deposits overlie a volcanic sequence believed to be correlative with the Superstition volcanic complex. Group Seven (1979) picked the top of the volcanic sequence at a depth of approximately 5,000 feet. Hahman (1979) prepared an independent lithologic log of the Powers Ranch wells and picked the top of the volcanic sequence as being in excess of 6,600 ft. The Higley basin can be defined on the basis of gravity (Peterson, 1968) and magnetic studies (Sauck & Sumner, 1970).

Evidence for the presence of geothermal resources in the Higley basin consists primarily of the information provided by Geothermal Kinetics for the two

Powers Ranch wells. Group Seven (1979) indicated a maximum temperature of 196°C (385°F) at 9,000 ft. Hahman (1979) and E.G. & G. Idaho, Inc. (1979) indicated from a study of temperature data furnished by Geothermal Kinetics, Inc. that temperatures in excess of 100°C (212°F) can be expected below depths of 7,000 ft. and that temperatures in excess of 150°C (302°F) may be expected below 9,000 ft. These reports went on to state that temperatures approaching 200°C (392°F) might be expected at depths of 10,000 to 11,000 ft.

Subsequent to the drilling of the Powers Ranch wells, Group Seven, Inc. conducted additional exploration studies in the Higley basin. These studies which included electrical surveys, water geochemistry, mercury soil geochemistry, and evaluation of existing gravity and magnetic data all indicated the presence of anomalous conditions centered to the south of Williams Air Force Base. The anomalies developed by the various surveys are approximately coincident upon the same area and these anomalies could reflect a possible geothermal reservoir. It is also possible that the anomalies are the result of some condition or conditions other than the presence of a geothermal reservoir. The presence of geothermal conditions within the two Powers Ranch wells and the coincident geophysical and geochemical anomalies south of the Williams Air Force Base indicate that exploration for geothermal resources in the area is justified.

REGIONAL GEOLOGY

The Higley basin is located at the eastern edge of the Southern Basin and Range physiographic province. To the east and northeast of the Higley basin, the Colorado Plateau physiographic province adjoins the Southern Basin and Range province. Separating these two physiographic divisions is a northwest trending mountainous transition zone. A discussion of the geologic history in the Higley basin area can begin at the end of the Laramide orogeny. The geology germane to an understanding of the Higley basin and its geothermal resources began to evolve at the beginning of the Tertiary. The Laramide orogeny between 75 and 50 m.y. ago was a period of uplift, volcanism, intense compressive deformation, and plutonism - in that order (Shafiqullah, et. al., 1980). The magmatism and deformation of the Laramide orogeny was followed by a period of quiescence that lasted from 50 to 30 m.y. ago. This was primarily a period of erosion and/or nondeposition throughout much of Arizona. The resulting Eocene erosion surface created an unconformity between the Tertiary and older rocks throughout Arizona. The rocks representative of this period in Arizona include fluviatile and lacustrine sediments. Some of the earliest middle Tertiary volcanic rocks were extruded prior to 30 m.y. ago, but the end of the Eocene period of quiescence and the beginning of the middle Tertiary orogeny is approximately defined at 30 m.y. ago. The middle Tertiary orogeny was a period of crustal melting, plutonism, uplift, extrusion of voluminous lavas of a wide range in composition, deformation in metamorphic core complexes, thin-skinned tectonics and deposition of continental sediments in nearby basins. The mid-Tertiary orogeny was described by Shafiqullah, et. al., (1980) as occurring in three stages. Stage one was the mid-Tertiary orogenic regime (36-24 m.y.) Stage two (24-12 m.y.) was a transition time between the middle Tertiary orogeny and the later Basin and Range disturbance regime. Stage three (12-0 m.y.) is the Basin and Range disturbance regime, which was most active between 14 and 8 m.y. ago. One of the oldest dated units for the mid-Tertiary orogeny is the 39.4 m.y. old andesite flow dated at a depth of 2,720 meters in one of the Geothermal Kinetics Powers Ranch wells (Shafiqullah, et. al., 1980). The peak of mid-Tertiary magmatism drifted across Arizona from east to west so that magmatic activity was at its height in western New Mexico, approximately 32 m.y. ago and in the eastern mountain region of Arizona approximately 26 m.y. ago, and in the Sonoran Desert at 21 m.y. ago. This implies a westward drift for the axis of volcanism. Two explanations were offered for this phenomena. Coney and Reynolds (1977) suggested that the locus of volcanism was a function of the dip of the Benioff zone. They suggested decelerating plate convergence and attendant increasing dip during the middle Tertiary orogeny returned magmatism to Arizona after the post-Laramide quiescence. Shafiqullah, et. al. (1980) suggest the shifting locus of volcanism may be due to more rapid fusion of the hotter basaltic superstratum of the subducting, newly created, thin oceanic plate as the spreading center approached the trench, resulting in the volcanic axis moving closer to the trench.

In the vicinity of the Higley basin, the middle Tertiary orogeny was manifested by the Superstition - Superior volcanic field, a rhyolite ash-flow cauldron complex (Stuckless & Sheridan, 1971 and Sheridan, 1978). At least three calderas were active in this volcanic field at different times during the period between 22 and 15 m.y. ago with the most intense volcanism occurring between 21 and 18 m.y. ago. A poorly welded tuff encountered at a depth of 2,400 meters in one of the Powers Ranch wells was dated at 19.4 m.y. (Shafiqullah, et. al., 1980) and is correlated with the Superstition volcanic field. Similar dacite tuff exposed in the Santan mountains on the south side of the Higley basin has been correlated with Superstition volcanic tuff on the other side of the basin. The inference is that the 19.4 m.y. old tuff at 2,400 meters in the Geothermal Kinetics wells correlates with the tuff exposed in the Santan mountains to the south and the Superstition volcanic field to the north and east. To accomplish this correlation the tuff must have been emplaced on a relatively level surface approximately 19.4 m.y. ago and subsequent subsidence in the Higley basin has displaced the tuff in the Powers Ranch wells 3,000 meters lower than exposures in the Santan mountains and the Superstition volcanic field (Shafiqullah, et. al., 1980).

The older middle Tertiary rocks are usually tilted with respect to the younger Tertiary and Quaternary rocks in Arizona. The tilting has created a regional unconformity which Damon, et. al. (1973) suggest was created at different times between 17 and 12 m.y. ago. Eberly and Stanley (1978) described the presence of this unconformity in many of the Arizona basins as a result of refraction profiling. These authors suggested that the unconformity was created in a relatively short period between 13 and 12 m.y. ago. Eberly and Stanley mentioned that the seismic data below the unconformity is very poor and therefore this limits the seismic technique to the interpretation of rocks younger than the unconformity.

Approximately 12 m.y. B.P. the Basin and Range disturbance succeeded the mid-Tertiary orogeny. The Basin and Range disturbance broke the crust along steeply dipping normal faults into a series of horsts and grabens that formed the present day mountains and basins of the Arizona Sonoran desert region. Erosion has modified the original fault blocks so that the mountain fronts have retreated back from the bounding faults, now located some distance out from the mountain front beneath the basins. In the Higley basin, subsidence of the basin must have began sometime after the 19.4 m.y. age of the tuff correlated with the Superstition volcanic field. Basin subsidence was most active during the period 14 to 8 m.y. ago, and subsidence probably has continued into the present time (Shafiqullah, et. al., 1980). As basin subsidence occurred, continental sediments deposited in the basins. Many of the basins in central Arizona, including the Higley basin, contain thick redbed and evaporite sequences. Shafiqullah, et. al. (1980) on the basis of a 10.5 m.y. old basalt flow near the top of the Luke Salt have suggested that evaporite accumulation ended in most basins sometime after 10 m.y. B.P. Sedimentation subsequent to the deposition of the evaporite and redbed sequence has consisted of sandstone and pebble conglomerate.

The stratigraphic section, revealed in the Powers Ranch wells for the Higley basin, suggests that the oldest sequence of rocks penetrated are related to the earlier phases of the mid-Tertiary orogeny. Volcanism continued from about 39.4 m.y. until 19.4 m.y. with the youngest volcanic rocks being correlated with the Superstition - Superior volcanic field. These mid-Tertiary volcanic rocks are probably separated by a regional angular unconformity from the overlying sedimentary section which started to accumulate as basin subsidence began probably approximately 14 m.y. ago. A sequence comprised predominantly of redbeds and evaporite deposits accumulated until approximately 10 m.y. ago. The final episode of sedimentation in the Higley basin has consisted of interbedded sandstone and pebble conglomerate beds which have continued to accumulate up until the present time.

Two pulses of very late Mesozoic and Cenozoic magmatism have occurred in Arizona. The first pulse was the Laramide orogeny between 75 and 50 m.y. B.P. Following a 20 m.y. quiescence period, a second orogeny occurred in the mid-Tertiary. This second mid-Tertiary orogeny extended from approximately 39 m.y. until 15 m.y. B.P. Rehrig and Heidrick (1976) described the stress relationships which have produced the resultant late Mesozoic and Cenozoic structural fabric of Arizona. During the Laramide the tectonic stress orientations resulted in differential vertical uplift and weak lateral compression. Following a 20 m.y. period of quiescence the tectonic stress orientations changed to east-west to southwest - northeast directed crustal extension which has been the predominant stress orientation to the present time. The initial Laramide stress patterns resulted from Arizona's position on the leading edge of a convergent plate boundary. The intersection of the American plate with the East Pacific Rise during the mid-Tertiary resulted in a cessation of plate convergence and a release of the east-northeast directed compressive stress. The release of compressive stress resulted in west-southwest and east-northeast directed extension with accompanying magmatism.

GEOLOGY, GEOPHYSICS & GEOCHEMISTRY OF THE HIGLEY BASIN

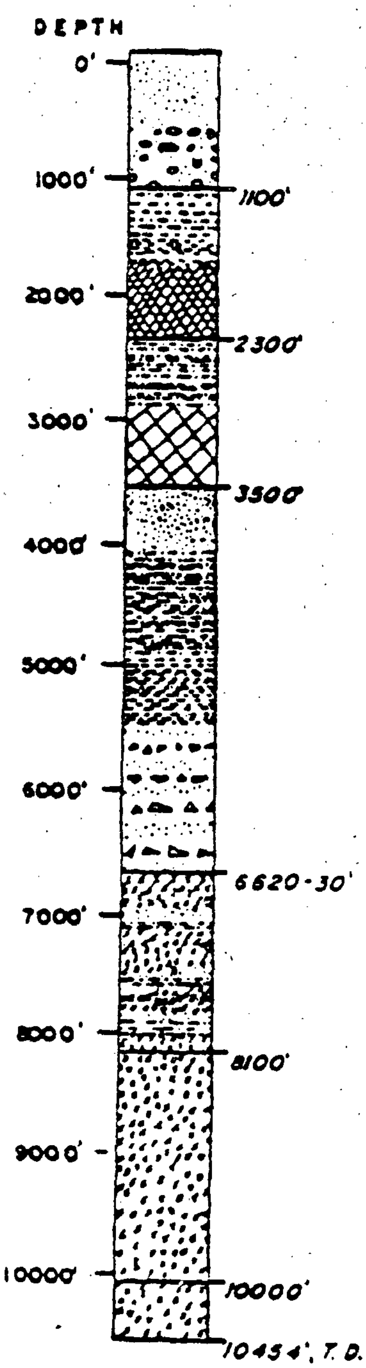
The subsurface geology of the Higley basin in the vicinity of Williams Air

Force Base is known from the logs of the geothermal wells drilled by Geothermal Kinetics, Inc. Figure 1 (Hahman, 1979 & E.G.&G. Idaho, Inc., 1979) is a generalized stratigraphic log which is Hahman's interpretation of the lithology. Figure 2 shows generalized lithologic logs of the Powers #1 and Powers #2 wells prepared by Geothermal Kinetics, Inc. The individual lithologic breaks on these two logs are different, but the overall gross lithologies are similar. In addition to the generalized logs, Geothermal Kinetics, Inc. also provided access to the original stratigraphic log prepared during the drilling of each well. From the surface to a depth of approximately 1100 ft. the lithology is sandstone interbedded with pebble conglomerate. From 1100 to 2300 ft. the section is light brown claystone and siltstone with interbedded anhydrite. From a depth of 2300 ft. to a depth of approximately 3500 to 4000 ft. the lithology is anhydrite interbedded with brown siltstone and claystone. The lower part of this interval shows a gradual change with anhydrite decreasing and sandstone, siltstone and claystone increasing. The interval 4000 to 6000 ft. is brown and red claystone, siltstone and sandstone with minor anhydrite beds in the upper portion of this section and tuff beds in the lower part of this section. The section gradually becomes more tuffaceous toward the bottom and the top of the Superstition volcanics - probably occurs between 6600 and 6650 ft. From 6600 to 8100 ft. the predominant lithology is tuff interbedded with reddish brown siltstone, sandstone, and shale. Hahman (1973) described the tuff as being primarily a gray dacite. The lithologic logs prepared at the time of drilling only describe the volcanic rocks as tuff and do not attempt to classify the composition of the tuff units. From 8100 ft. to the bottom of the deepest hole, which is 10,454 ft., the lithology is all dacite according to Hahman and the Geothermal Kinetics generalized log. The lithologic log prepared at the time of drilling indicated the interval from 10,050 to 10,440 ft. was a conglomerate and sandstone interval. Hahman relogged this interval and interpreted the lithology to be altered dacite with intense propylitic and weak to possibly strong argillic alteration, with some silicification. The temperatures encountered in the wells would indicated that propylitic, argillic and silicification types of alteration would be likely to occur in the lower portions of the wells.

Core was taken at 9,207 ft. in the #1 well and from the interval 7,890 to 7,920 ft. in #2 well. Sections cut from these cores were studied and the following results were obtained. Mr. P.R.L. Browne of the Department of Scientific & Industrial Research, New Zealand Geological Survey states that the mineralogical assemblage found in the cores from the Powers wells could have formed at temperatures

GENERALIZED STRATIGRAPHIC LOG: WILLIAMS A.F.B. MARICOPA COUNTY, ARIZONA

BY W. RICHARD HAHMAN, SR.



Sandstone, conglomerate

Brown claystone with minor siltstone and anhydrite

Brown siltstone
Brown and white anhydrite

Red and brown claystone
Siltstone and sandstone with minor anhydrite in the upper part of section and tuff beds in the lower part of the section

Top of Superstition (?) volcanic complex

Interbedded red-brown and gray dacite with minor red and brown sandstone and siltstone

Dacite

Superstition Dacite
Gray and gray brown

Dacite - intense propylitic and weak (?) argillic alteration to T.D.

FIGURE 1

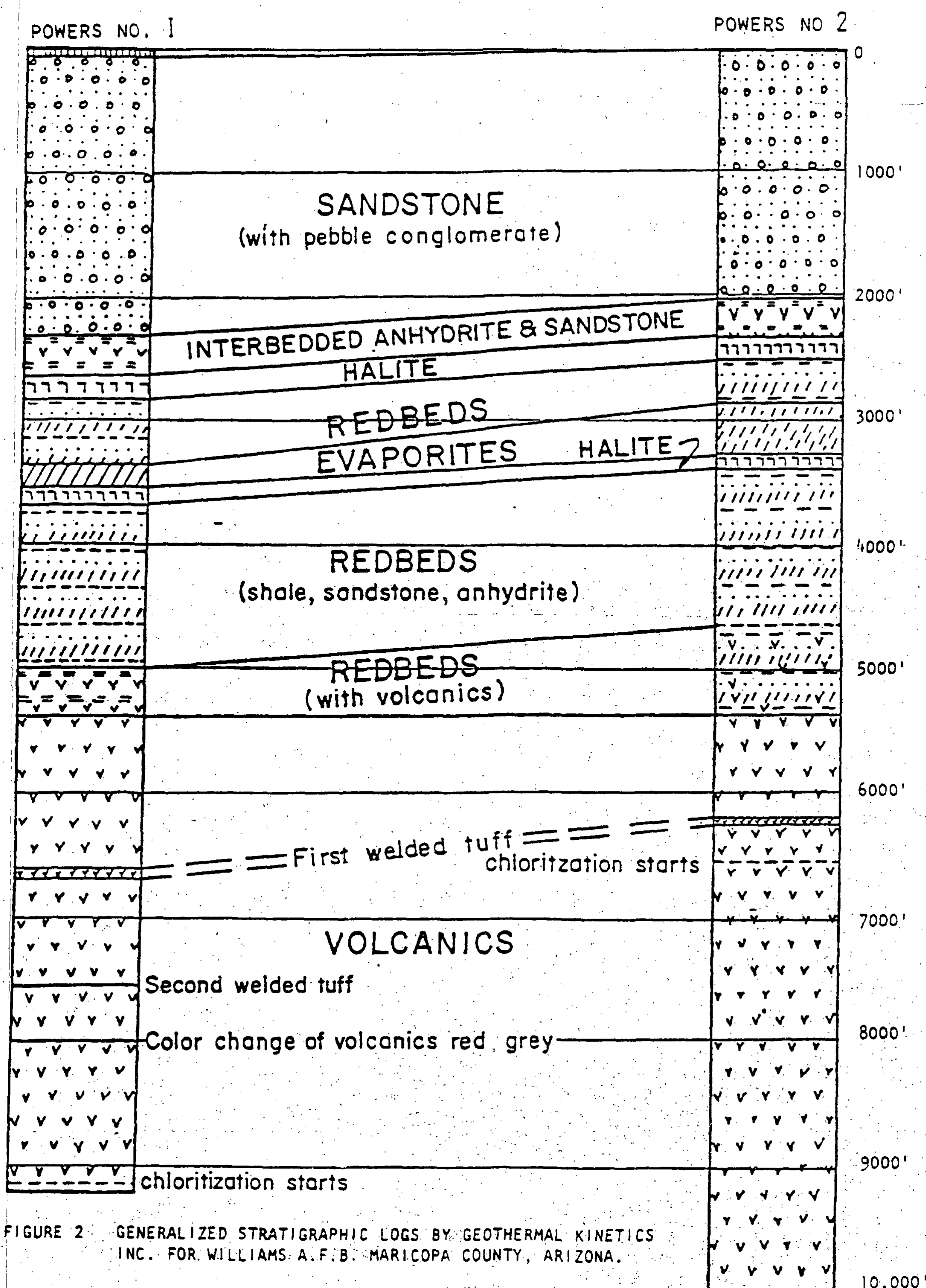


FIGURE 2 GENERALIZED STRATIGRAPHIC LOGS BY GEOTHERMAL KINETICS INC. FOR WILLIAMS A.F.B. MARICOPA COUNTY, ARIZONA.

between 150°C (302°F) and 220°C (428°F). Dr. Jerry Hoffer of the University of Texas at El Paso, using Xray techniques, analyzed an iron chlorite mineral from the #1 core at 9,207 ft. His conclusion, "Based upon the association of calcite with a chlorite mineral, it is estimated that they formed in a hydrothermal environment of approximately 350°C (662°F) to 400°C (752°F)."

GRAVITY

Group Seven, Inc. (1979) used the available gravity data (Peterson, 1968) to interpret the structural setting of the Higley basin. Proceeding across Arizona from the Basin and Range physiographic province across the transition zone and into the Colorado Plateau, there is an abrupt thickening of the crust beneath the Colorado Plateau so that the thin crust of the Basin and Range thickens steeply across the transition zone and into the Colorado Plateau. Williams Air Force Base lies near the beginning of the transition zone on the edge of the Basin and Range. Peterson's (1968) gravity map of the area shows the crustal thickening along with local gravity anomalies associated with the Basin and Range geologic structures. The dominant northwest - southeast direction of the gravity contours is parallel to the general strike of the boundary between the Basin and Range and the Colorado Plateau physiographic provinces. The most prominent gravity feature in the vicinity of Williams Air Force Base is a large gravity gradient which runs north-south, west of Chandler and bends abruptly to the east continuing along the north edge of the Santan mountains to the south of Williams Air Force Base. Local gravity highs are seen in the Santan, Goldfield and Superstition mountains.

The boundary between the Basin and Range and Colorado Plateau provinces is interpreted to be a step-like thickening of the crust abruptly in the transition zone located to the northwest of Williams Air Force Base. Group Seven interpreted the abrupt step-like thickening to be on the order of approximately 3 miles at the step-like transition.

A residual gravity map was prepared by Group Seven (1979) from the Bouguer Gravity Map (Peterson, 1968). One of the major features of this map is a large east-west striking gravity gradient extending from the Santan mountains northward to Williams Air Force Base. There is a gravity high to the south located over the Santan mountains and a gravity low in the vicinity of Williams Air Force Base and to the west which reflects the thick basin fill of sediments, evaporites and volcanic rocks. The large gravity gradient extending to the north from the Santan mountains is interpreted to be the result of multiple faults dipping steeply to the north and progressively down dropping the Precambrian basement rocks in a step-like fashion to the north and thus creating the Higley basin. The step down faulting of the Precambrian rocks probably results in a fault contact between Precambrian rocks and the volcanic rocks in the lower portion of the Higley basin. There is also gravity evidence for a cross fault extending from the northwest side of the Santan mountains through the center of Williams Air Force Base and dipping steeply to the northwest. Displacement along this fault would also be a step down on the northwest side of the fault.

The area of Williams Air Force Base and extending southward to the Santan mountains can thus be interpreted as a series of northward down stepping fault blocks bounded by east-west striking faults. A northeast trending fault extending from the northwest side of the Santan mountains to the center of Williams Air Force Base crosscut the east-west striking fault blocks and down drops the fault blocks on the west relative to those on the east. This results in the deepest portion of the Higley basin being located in an area west of Williams Air Force Base and with the least amount of downward displacement to the south of the base in the Santan mountains where the Precambrian rocks are exposed at the surface.

MAGNETICS

The Aeromagnetic Map of Arizona prepared by Sauck and Sumner (1970) was interpreted by Group Seven (1979) for the Higley basin area. On the basis of the aeromagnetic data, Group Seven interpreted the Higley basin as being located within a large caldera-like feature about 50 miles in diameter and lying between the Basin and Range and the Colorado Plateau physiographic provinces. The magnetic data suggested to Group Seven that the large caldera-like feature contains a cluster of resurgent calderas which are draped with their own ejecta. A possible master ring fracture zone is intermittently defined by the aeromagnetic data and includes parallel faults which pass through the area immediately south of Williams Air Force Base on the north side of the Santan mountains. Williams Air Force Base, therefore, would lie within the caldera-like feature and be located close to the southwest edge of the ring fracture system. A broad east-west trending magnetic high occupies the elliptical shaped caldera-like feature which Group Seven interpreted to be defined by faults passing near the Superstition, Queen Creek, Santan, South, Salt River, and Goldfield mountains. These faults are indicated by the gravity high and the magnetic gradients which outline the anomaly. Group Seven interpreted the probable source for the magnetic high to be volcanic tuff deposited in a closed fault bounded structural depression.

Within the broad magnetic high of the caldera-like feature are two small areas containing smaller local anomalies. A closed magnetic high is located about 7 miles northeast of Williams Air Force Base and a second small high is located 10 to 15 miles northwest of Williams Air Force Base. Group Seven suggests igneous intrusion as the cause for both of these magnetic highs. In summary the large magnetic high is interpreted as being caused by volcanic tuffs which fill the basin. Smaller magnetic anomalies caused by intrusions are superimposed on the tuff related high. The volume of buried volcanic rocks was interpreted to be on the order of 170 cubic miles.

The model for a large cauldron type structure proposed by Group Seven on the basis of magnetic data must be considered a hypothesis until additional data is obtained to support this proposed model. Geological studies in the Superstition - Superior volcanic field (Stuckless & Sheridan, 1971; Stuckless & O'Neil, 1973 and Sheridan, 1978) show the area to be characterized by clusters of calderas and cauldrons, some of which are nested one within the other. It is therefore possible that a large cauldron-like feature or volcano - tectonic depression could occur within the area occupied by the Higley basin.

ELECTRICAL GEOPHYSICS

Group Seven (1979) originally conducted a resistivity survey over the Higley basin. Subsequent to that survey, it was found that in certain cases, resistivity data presented as apparent conductances was sometimes more diagnostic than were the apparent resistivity maps. The data was therefore presented as contours of apparent conductances. The results of this survey were to define an area of high conductance centered to the south and southeast of Williams Air Force Base.

120 Time - Domain Electromagnetic (TDEM) soundings were carried out from two sources in order to tie the geoelectric section of the Powers #1 and #2 wells with the rest of the area. The volcanic unit in the bottom of the Powers wells, which may be a geothermal reservoir, has electrical characteristics that differ from the resistive basement below and the units above the volcanic horizon. Using TDEM soundings, Group Seven believes it has laterally traced the volcanic layer.

The TDEM survey attempted to map the lateral extent and thickness of this volcanic unit and the change in resistivity within it.

From the TDEM soundings, a map of the depth to the electrical basement was prepared. A principal feature of the map is a deep basin centered on Powers Road and it can be seen that the Powers wells were drilled on the north flank of the basin. The basin is terminated abruptly to the south by a fault running mainly east-west almost coincident with Ocotillo Road. The throw on the fault is greater than 2000 meters and south of the Ocotillo Road Fault, the conductive section thins until it is probably no more than a few hundred feet thick and lies on top of the basement. The deepest portion of the basin shows an electrical basement at 5,750 meters and the depth shallows markedly to all sides from this deep point.

Within the volcanic unit the lowest resistivity values occur along the Ocotillo Road Fault and the interpretation of Group Seven was that higher permeability along the fault was responsible for the lower resistivity values which resulted from hot water or brine permeated along the fault surface. The resistivity anomaly occurs centered along the Ocotillo Road Fault and immediately to the north of this fault in an area southwest of the Williams Air Force Base.

WATER GEOCHEMISTRY

Group Seven (1979) sampled 18 irrigation wells in the Higley basin and the water chemistry was analyzed using the Na-K-Ca method of Fournier and Truesdell (1974) to estimate the reservoir temperature. The estimated reservoir temperatures range from 199°C to greater than 240°C with the highest temperatures existing immediately southeast of the Powers wells. The Group Seven report provided no data regarding the depth of the wells sampled nor the assumption made regarding mixing effects of deeper geothermal fluids with shallower ground water. The depth of the geothermal resources within the Higley basin, the lithologies of the rock units which fill the basin and the probable complex ground water movements within the basin all should make interpretation of water geochemical data a difficult task.

MERCURY SOIL GEOCHEMISTRY

Mercury soil samples were collected on a 1 mile grid spacing within the Higleg basin. The mercury values were then contoured to produce a map of mercury concentration. The principal feature is an area of high concentration up to 3000 ppb situated in the southern part of the prospect immediately south of Ocotillo Road.

Around this major essentially linear high is another area of elevated mercury content outlined by the 200 ppb contour which extends to the north to a point 3 miles north of Williams Air Force Base. Outside the 200 ppb contour the mercury values drop off to a background level close to 100 ppb. The high mercury concentration and its linear east-west configuration along the Ocotillo Road suggests mercury is produced as a result of the leakage of geothermal fluids along the Ocotillo Road Fault. The area within the 200 ppb contour may outline the broader area of the geothermal anomaly.

GEOTHERMAL WELLS

In 1973 Geothermal Kinetics, Inc. drilled 2 geothermal exploratory wells immediately southwest of Williams Air Force Base. The wells, Powers #1 and #2, were drilled to total depths of 9,207 and 10,454 ft. respectively. The Powers #1 well is cased with 7" casing to a depth of 9,065 ft. The #2 well is cased with 9 5/8" casing to a depth of 5,400 ft.

Hahman (1979) reported temperatures in excess of 150°C (302°F) could be expected below 9,000 ft. and that temperatures approaching 200°C (392°F) might be expected at depths of 10,000 to 11,000 ft. The report by Group Seven (1979) reports a temperature of 196°C (385°F) at 9,000 ft. in the Powers #1 well. An Agnew & Sweet Subsurface Temperature Survey on July 20, 1973 in the Powers #1 well showed a temperature of 128°C (262°F) at a depth of 9,050 ft. A Dresser Atlas Subsurface Temperature Survey on November 20, 1973 in the Powers #2 well showed a bottom hole temperature of 178°C (352°F) at a depth of 10,454 ft. Graphs of the subsurface temperature surveys show the temperature to be continuing to increase with depth in both the Powers #1 and #2 wells. Continued deepening of these holes would probably have achieved higher temperatures in the potential geothermal reservoir.

The mineral assemblages present in the lower portions of the Powers wells indicate that high temperature geothermal conditions presently exist or existed in the past near the bottom of these wells. The silicification, propylitic and argillic alteration on the bottom of the Powers Ranch wells would tend to decrease and possibly completely seal off any effective porosity the volcanic rocks may have originally contained. Geothermal Kinetics believes the wells have an average porosity of 20% and occasionally the porosity is locally 30%. This information was obtained from dual induction and neutron logs. There may be no effective porosity in the volcanic rocks due either to the nature of the primary porosity or to post depositional metamorphic changes. Water is probably present in the volcanic reservoir rocks, but it may be necessary to penetrate a fracture interval to demonstrate the presence of an economic geothermal reservoir. Additionally, the hydrothermal alteration might also serve to seal off any preexisting microfractures. It is therefore likely that any permeability present in the reservoir rocks would result from recent and possibly continuing fracturing of the volcanic rocks.

The Powers Ranch wells have encountered high bottom hole temperatures but the wells have not proven to be capable of production. Mike O'Donnell (oral communication), of Geothermal Kinetics, Inc., has suggested that completion operations during the drilling of the Powers Ranch wells may have sealed the well bore either with cement or drilling mud and this has decreased the fluid entry into the hole. It is also possible that the Powers wells have not as yet encountered a major fracture zone and that the presence of a fluid thermal reservoir is not as yet demonstrated.

The hydrothermal alteration mineral assemblage present near the bottom of the Powers Ranch wells is liable to have decreased or eliminated any effective porosity in the reservoir rocks. The type of geothermal reservoir likely to be encountered is a fracture reservoir. Further exploration in the Higley basin will require test wells to penetrate a fault zone at sufficient depth where the temperature of contained fluids will be hot enough to constitute a geothermal resource. At present there are no exploration methods capable of accurately locating fault zones in the deeper portion of the Higley basin. The only available exploration method is to drill and hope that a fracture zone bearing geothermal fluids will be penetrated by the well bore.

SUMMARY

The Powers wells have demonstrated the presence of high temperatures within the Higley basin. Temperatures in excess of 150°C (302°F) may be expected below 9,000 ft. and drilling to greater depths may demonstrate the presence of even higher temperatures. Geologic and geophysical evidence indicate that the Higley basin has undergone subsidence of 5,000 ft. or more in the last 14 m.y. Williams Air Force Base is located near the approximate center of the basin which is defined by a series of step-like faults down dropped toward the center of the basin.

Group Seven has suggested that the Higley basin is part of a large cauldron-like feature related to the Superstition - Superior volcanic field. The heat source responsible for the high temperatures within the Higley basin is unknown and could be due either to deep circulation of ground waters along fault zones or residual magmatic heat possibly related to the volcanic activity in the Superstition - Superior volcanic field. Group Seven has suggested that magnetic highs located to the northeast and northwest of Williams Air Force Base are the result of igneous intrusion. It is possible that intrusive activity is present or was present in the recent geologic past at depth beneath the Higley basin area. The location of the Higley basin near the boundary between the Basin and Range and Colorado Plateau physiographic provinces would be an area favorable for the presence of intrusive igneous activity. Geophysical and geochemical surveys conducted in the Higley basin indicate the possible presence of geothermal resources associated with the movement of geothermal fluids along fault zones located to the south of Williams Air Force Base. The geologic, geophysical and geochemical data, as well as the information from the Powers Ranch wells, all indicated further geothermal exploration of the Higley basin is justified. Group Seven's investigations would indicate a possible geothermal anomaly is centered south of the Williams Air Force Base but the presence of geothermal resources extending northward beneath the base cannot be ruled out.

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NOTICE

APPENDIX D

WATER RESOURCES FOR THE WILLIAMS AFB GEOTHERMAL PROJECT

1.0 PURPOSE

The Air Force desires to develop the geothermal resource beneath Williams AFB, Arizona. Several modes of development are under consideration, including the following:

a. An air conditioning chilled water plant.

b. An electric power plant.

c. A chilled water electricity co-generation plant.

d. An ethanol and chilled water or electricity co-generation plant.

One of the main factors in deciding on the method of development is the availability of a dependable and adequate quantity of essentially potable water for the various process cycles, particularly for cooling. The purpose of this report is to identify the various sources and potential amounts of water available from each source, to provide an estimate of the amount of water required in developing and operating a geothermal plant, and to recommend methods of acquiring the required amounts of water.

2.0 WATER SOURCES

Several possible sources from which the required water may be obtained will be discussed in the following sections. The quality of each of these source waters is such as to be essentially, if not really, potable. Therefore, water quality will not be considered when discussing water resource availability since each is equally suitable. The possible water sources are:

a. Irrigation water from the Roosevelt Water Conservation District Canal (Roosevelt Canal).

b. Central Arizona Project Water.

c. Groundwater supplied through existing and new wells at the Williams AFB.

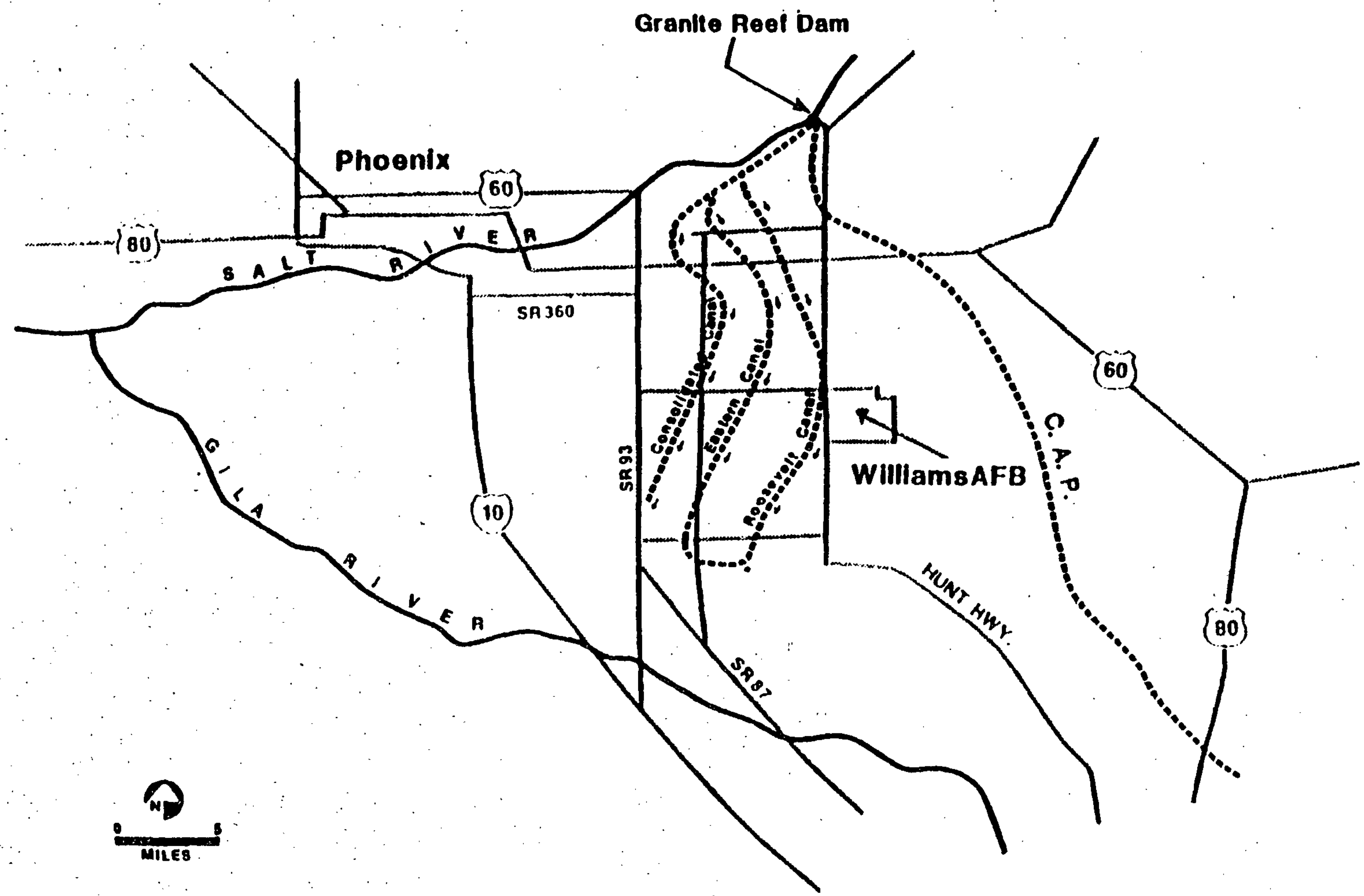
d. Effluent from the Williams AFB sewage treatment plant.

e. Other sources, including condensate, agricultural tailwater, treated geothermal brine, and deactivated cooling towers.

2.1 Irrigation Water from the Roosevelt Water Conservation District Canal (Roosevelt Canal)

Irrigation water is brought to the cultivated lands west of Williams AFB from reservoirs located on the Salt and Verde Rivers. Water is diverted into the Southern Canal at Granite Reef Dam on the Salt River, and then into the Roosevelt Water Conservation District Canal (RWCD) and two other canals farther to the west. The RWCD canal borders the northwest corner of the Air Force Base, as shown on Figure 1. Surface water from the Salt River allocated to cropland irrigation is approximately 670,000 acre-feet. This water generally contains less than 500 mg/l total dissolved solids. When surface water supplies are inadequate to meet irrigation demands, the RWCD augments their water supply with water from wells. Irrigation tailwater discharges to the Gila River approximately 50 miles downstream from the Buttes Dam of the Central Arizona Project.

All current surface water supplies of the RWCD are allocated to specified uses. According to Mr. Grant Ward, General Manager of RWCD, water is not currently available to Williams AFB from RWCD; deliveries cannot be made outside the district boundaries (telephone conversation of August 13, 1980). Mr. Ward indicated that the RWCD may be interested in taking over the complete water system of the AFB and would thus be able to deliver water when it became available, possibly by purchase from an existing water right holder (or CAP water, below). However, recent legislation (ARS 45-494) may restrict use of AFB groundwater use on the AFB. Similarly, under



SOURCE: U.S. Department of Agriculture, 1978.

Location of the Roosevelt Canal and the Central Arizona Project (CAP)

FIGURE 1

the same statutory section the RWCD may not be allowed to deliver groundwater to Williams AFB (Ward, personal communication). Groundwater delivery from the RWCD would also be restricted by the non-irrigation use proposed as stipulated in the new Groundwater Management Act (ARS 45-461 to 45-482 and 45-541 to 45-545).

2.2 Central Arizona Project Water

The Central Arizona Project will convey an estimated 1.2 million acre-feet of Colorado River water to central Arizona. It is stipulated in the Colorado River Basin Project Act (1968) that when

> there is insufficient mainstream Colorado River water available for release to satisfy annual consumptive use of seven million, five hundred thousand acre feet in Arizona, California, and Nevada, diversions from the mainstream for the Central Arizona Project shall be so limited as to assure the availability of water in quantities sufficient to provide for the aggregate annual consumptive use by holders of present perfected rights, by other users in the State of California served under existing contracts with the United States by diversion works heretofore constructed, and by other existing Federal reservations in that state, of four million four hundred thousand acre feet of mainstream water, and by users of the same character in Arizona and Nevada (43 USC 1521(b), 1970).

However, this limitation "shall not apply so long as the Secretary (of the Interior) shall determine and proclaim that means are available and in operation which augment the water supply of the Colorado River system in such quantity as to make sufficient mainstream water available for release to satisfy annual consumptive use of seven million five hundred thousand acre feet in Arizona, California, and Nevada" (43 USC 1521(c), 1970). In other words, CAP water may not always be available. Of the total allotment, Williams AFB has been tentatively allocated 1200 acre-feet. The allocation will be made definite if the water is put to beneficial use (Mr. Jim Freeman, 82nd Civil Engineering Squadron, personal communication). The CAP allocation may be necessary to meet groundwater conservation measures of the anticipated management plan for the Phoenix Active Management Area in which Williams AFB is located. However, there currently is no method conveying the water from the Central Arizona Project to Williams AFB. CAP suppies will contain 600-900 mg/l total desolved solids.

Two possible means of conveying CAP water to Williams AFB are apparent (see Figure 1). The first would be to acquire a right-of-way and construct a pipeline or canal from a diversion point on the CAP aqueduct. This pipeline would have to be at least 6.5 miles long. The other possibility would be to use the existing RWCD canal as the transportation medium from which the CAP water could then be transferred to Williams AFB.

The RWCD canal frequently flows at its maximum capacity, particularly during the summer months (Ward, personal communication). This is also the time during which the maximum per day water requirement for the geothermal project would occur. Therefore, even with the approval of the RWCD Board of Directors, extra water made available by CAP cannot be physically conveyed by this means under the existing canal characteristics. However, with approval of the RWCD Board of Directors and appropriate state agencies, the capacity of the northern approximately 15 miles of the canal could be increased. Thus, either of the two possible conveyance means will require a large capital outlay.

2.3 Groundwater Supplied Through Existing and New Wells

Groundwater has been historically (and is presently) pumped in quantities exceeding safe yield from the Salt River groundwater basin (the Phoenix Active Management Area). This means that the amount being withdrawn exceeds the amount recharged either naturally or artificially to the aquifer. As a consequence of this overdraft on the aquifer, depth to groundwater has increased since 1930 and land subsidence has occurred. Figures 2, 3, and 4 show groundwater conditions in the Williams AFB area. Figure 5 shows areas of areal land subsidence in the Williams AFB area for the period 1948-1967. Because of these conditions and similar conditions elsewhere in Arizona, the state legislature recently provided a groundwater management act which includes many provisions for diminishing the total groundwater pumpage in order to achieve safe yield by 2025 in the Phoenix AMA.

Eight wells are recorded as having been drilled at Williams Air Force Base (USGS, Water Resources Division, 1978). The location of these wells, corresponding well numbers and the total well depths are shown on Figure 6. Three of the wells are used to provide water for the various onbase water demands. Ranges of groundwater production from the wells is listed in Table 1. The other five wells were abandoned more than twenty years ago and are not capable of future production. It is believed that deeper drilling of these five wells would not allow water production (Cannon, 1980). The three wells in use occasionally are pumped to the maximum flow capacity to serve the AFB water needs. Therefore, if additional groundwater is required, it will be necessary to drill a new well subject to regulations to be adopted by the Director of DWR (ARS 45-591 to 45-604). Because of the high productivity of the onsite water supply wells, it will be assumed for this discussion that any new wells would have similar high productivity. The groundwater at the base contains 300-600 mg/l total dissolved solids.

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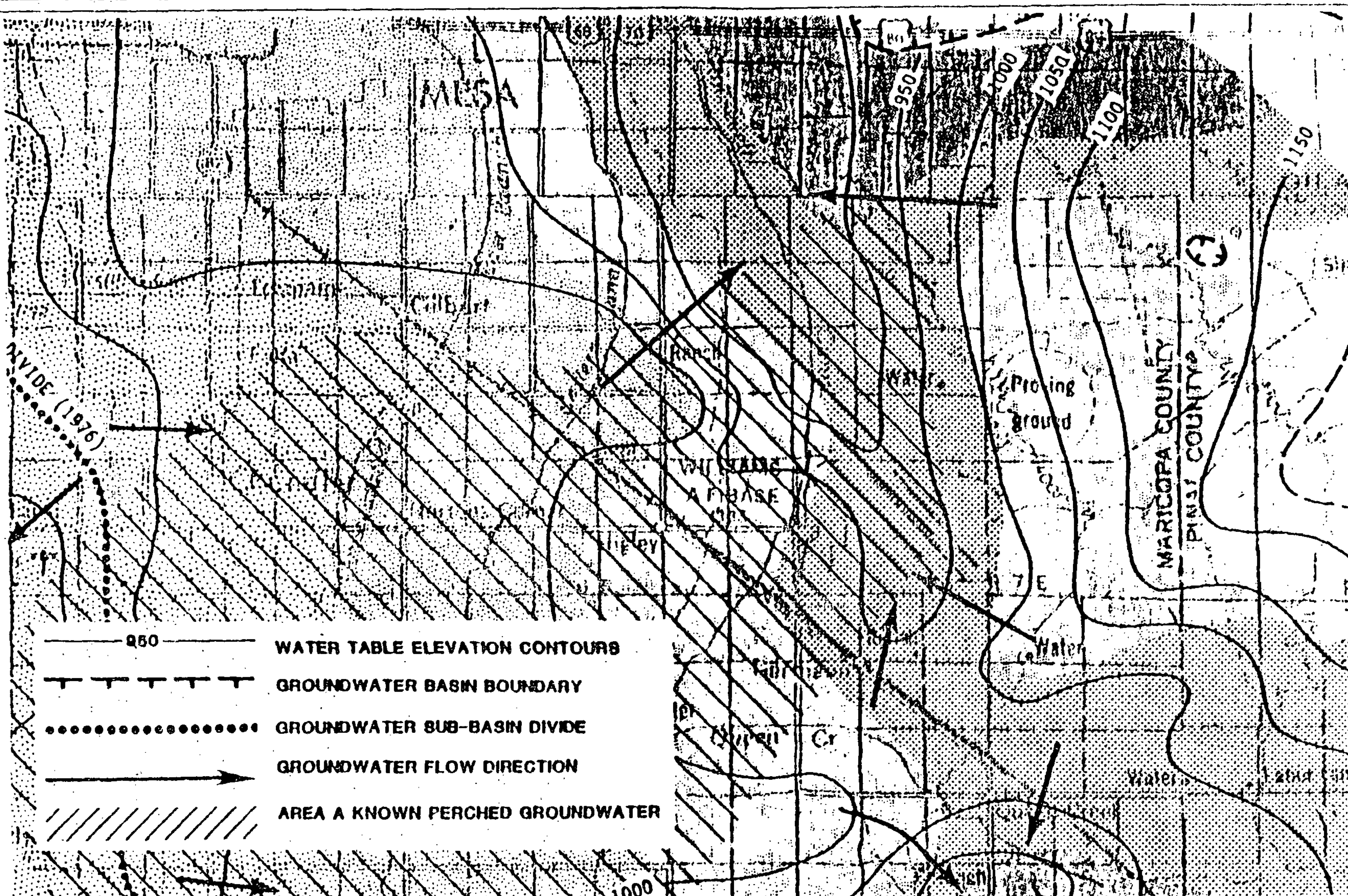
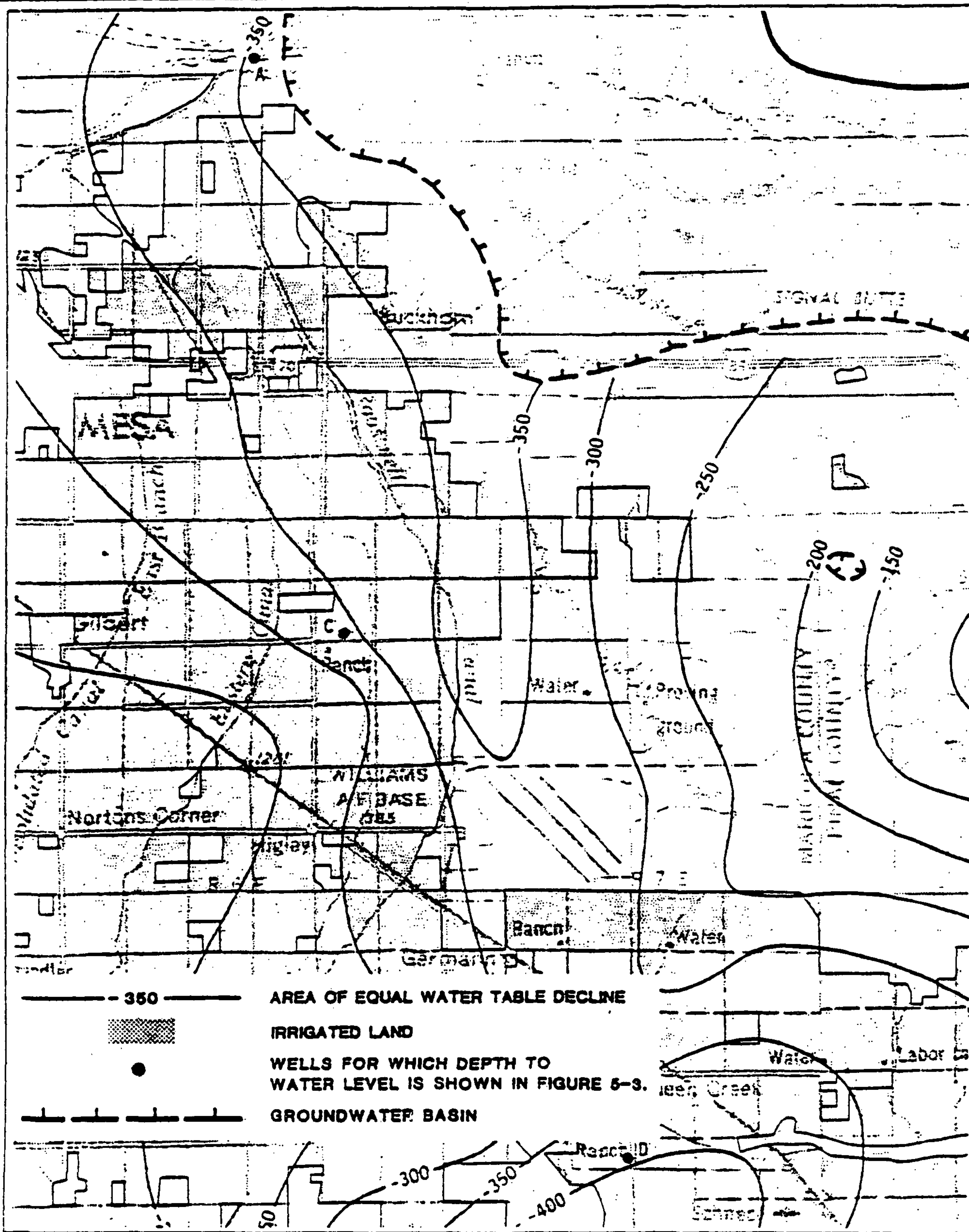


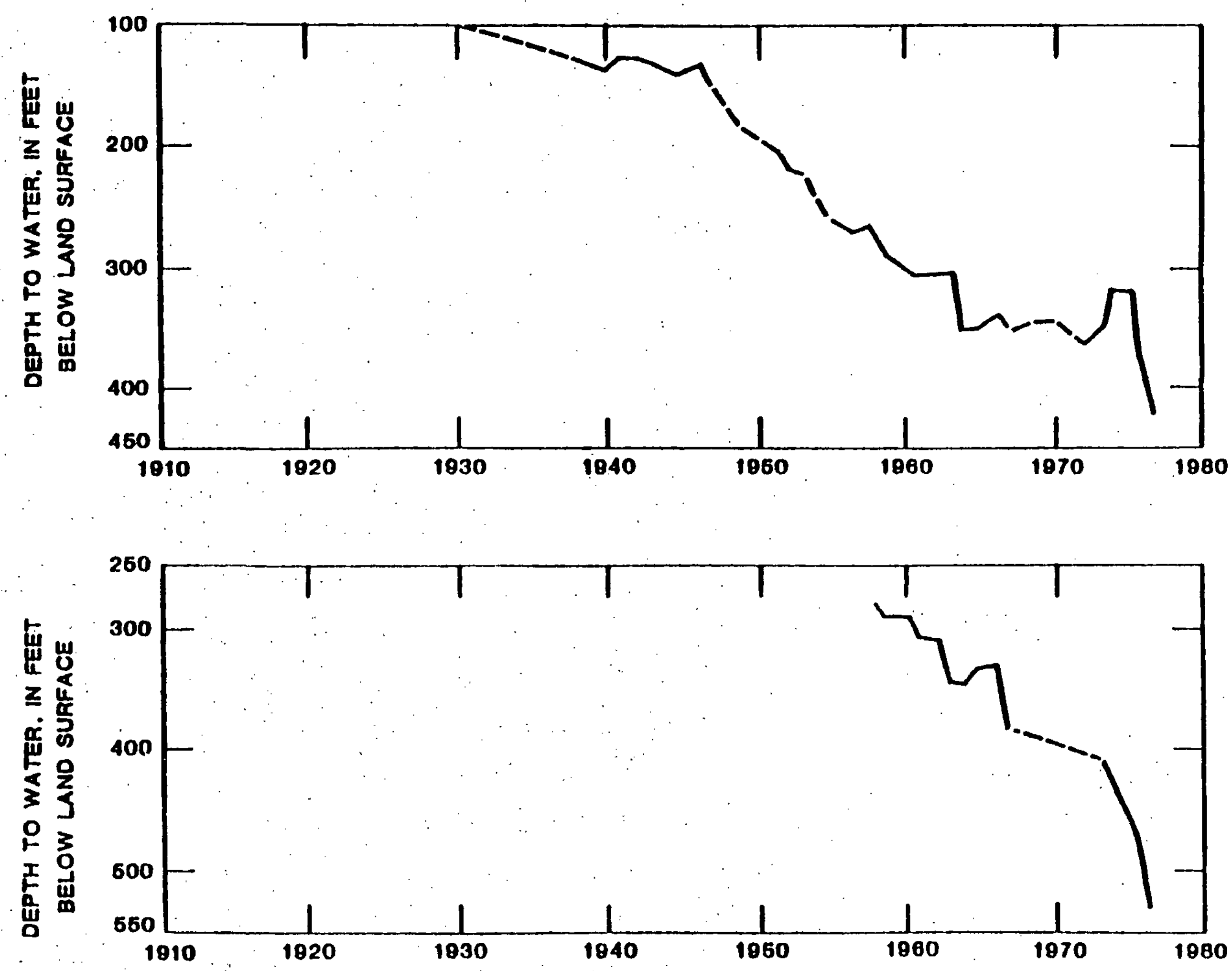
Groundwater Conditions in the Williams AFB Area, 1976

FIGURE 2



Map Showing Decline in Water Table 1930–1976, Williams AFB Area.

FIGURE 3



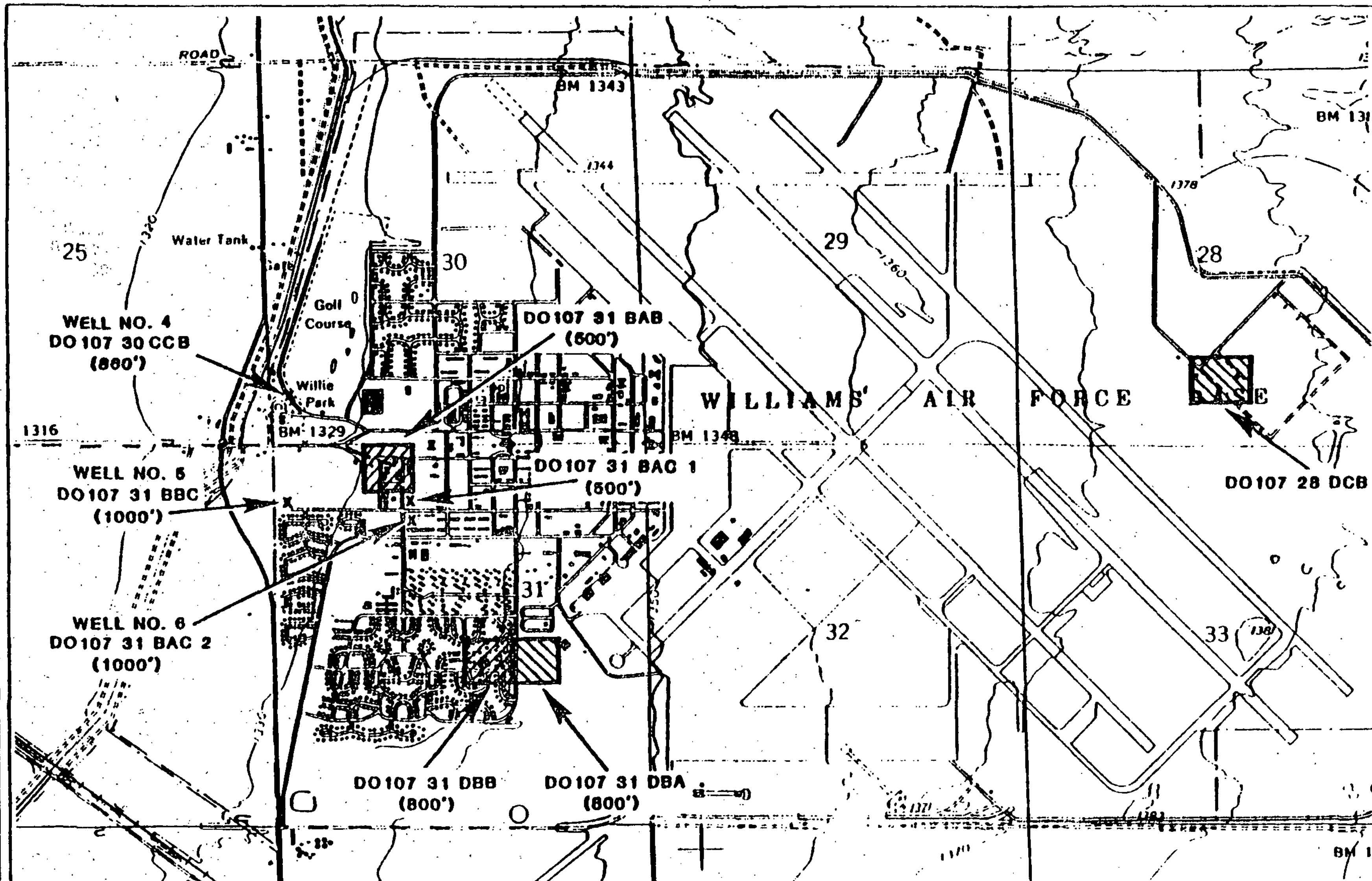
Depth to Water Since 1930 for Wells C and D shown on Figure 5-2

FIGURE 4

WESTEC Services, Inc.

Land Subsidence and Earth Fissures in the Williams AFB Area.

FIGURE 5



Topographic Map of the Williams AFB Showing Locations of Wells, Well Number and Total Well Depth.

FIGURE 6

Table 1

RANGES OF GROUNDWATER PRODUCTION FROM WILLIAMS AIR FORCE BASE WELLS

Well	4	5	6
Well Number	D010730CCB	D010731BBC	D010731BAC2
Average Production	748,000 G/D (837.9 ac-ft/yr)	755,000 G/D (845.8 ac-ft/yr)	689,000 G/D (771.8 ac-ft/yr)
Maximum Production	1,545,000 G/D (1730.7 ac-ft/yr)	1,483,000 G/D (1661.3 ac-ft/yr)	1,441,000 G/D (1614.2 ac-ft/yr)
Minimum Production	218,000 G/D (244.2 ac-ft/yr)	229,000 G/D (256.5 ac-ft/yr)	128,000 G/D (143.4 ac-ft/yr)

Groundwater use is controlled by state law, according to the United States Supreme Court, (California-Oregon Power Company vs. Beaver Portland Cement Co.) The Arizona Revised Statutes provide different regulations for use of groundwater by persons or by city, towns, or private water companies. It is not clear if an Air Force Base is legally considered a person or a city or town (295 U.S. 142, 1935). ARS Section 45-402 includes the United States, any State, Territory or County or a governmental entity (or) political subdivision in the definition of person. ARS Section 45-451 states "in an Active Management Area a person may withdraw and use groundwater only in accordance with provisions of Articles 5 through 12 of this chapter."

However, if Williams AFB constitutes a city or town, or if the water distribution system controlling authority on the base constitutes a private water company, then the base "shall have the right to withdraw and transport groundwater within its service area for the benefit of landowners and residents within its service area, and the landowners and residents are entitled to use the groundwater delivered, subject to: ...conservation requirements developed by the Director" (of the Arizona Department of

Water Resources) (ARS 45-492). A conservation program "...shall require reasonable reduction in per capita use..." (ARS 45-564 A2). The requirement of "reasonable reduction in per capita use" almost negates the possibility of using groundwater for the geothermal project, since water consumption would increase substantially with geothermal development. Groundwater may be available in spite of conservation requirements, either by approval of the Director of Water Resources or by purchasing a grandfathered, or previously established, right to groundwater sufficient to meet the demand.

Under Section 27-667, if the geothermal resource is naturally comingled underground with surface waters or groundwaters, the resource would also be subject to control by Arizona's water laws. The above statute does not state whether comingling of the geothermal resource with the groundwater must be proven or disproven. It should be noted that few hydrothermal convection systems are isolated from the normal hydrologic cycle and that groundwater geochemical interpretations by Geothermal Kinetics, Inc. (1979) imply a mixing of deeper geothermal fluids with shallower groundwater.

2.4 Effluent from the Williams AFB Sewage Treatment Plant

Domestic wastewater from the Williams Air Force Base is treated in an onsite sewage treatment plant. All of the effluent from this plant is presently used to irrigate the base's golf course. This water contains 600 to 1200 mg/l total dissolved solids. Average wastewater flow is 567,000 gallons per day (635.2 ac-ft/yr), while summer flow is 633,000 gallons per day (709.1 ac-ft/yr) and winter flow is 447,000 gallons per day (500.7 ac-ft/yr). By reducing the amount of water used by the golf course, some of this water could be used for geothermal development.

2.5 Other Water Sources

Four other potential sources of water may be available to provide a portion of the water requirements of the geothermal project. Condensate produced during the operation of flash steam type utility generation plant would be available. This should be adequate to satisfy all water needs under normal operating conditions. However, a reserve water supply would be needed.

Agricultural tailwater may be available but would have to be pumped up-gradient from wherever sufficient supply was available. However, such a supply of tailwater may not be available when irrigation water conservation measures are established (ARS 45-564 to 45-568). Under the same statutes, municipal water conservation techniques established for the AFB may not be able to provide water for the project.

The third potential source is treated geothermal water. Geothermal brine can be treated with a combination of chemical and filtration process that will reduce its TDS content to allow its use as cooling water.

Another potential source might be deactivated cooling towers. Many of the existing refrigeration systems at Williams AFB use cooling towers to condense the freon refrigerant. If the existing freon refrigeration systems are deactivated upon installation of a central chill water plant, the makeup water to these systems can be used as makeup to the central system.

3.0 WATER REQUIREMENTS

Estimates of the amounts of water required for drilling a well and operating a geothermal utility plant are as follows:

a. Well drilling will require an average of 3000 gallons per day over a 50 day period for a total of 150,000 gallons.

b. Cooling water make up requirements during operation of a utility plant are estimated to be as follows:

(1) For air conditioning chill water the requirement is estimated to be about 9.5 acre-ft/year per 1000 ton.

(2) For electrical power generation the requirement is estimated to be about 115 acre-ft/year per MW for a flash steam system and about 89 acre-ft/year per MW for a binary system. (Electrical Power Research Institute Report ER-301 of November 1976.)

4.0 RECOMMENDATIONS

a. Providing water at a rate of 3000 G/D for drilling a well will represent a very small percentage of the average daily production of 2,192,000 G/D from wells 4, 5, and 6. Therefore it is recommended well drilling needs be supplied from normal sources.

b. Air conditioning chill water plant requirements are considered to be at most about 30.4 acre-ft/year. This amount can be reduced by using a flash steam cycle which utilizes condensate as cooling water make-up. Seventy-five percent make-up from condensate is within the state-of-the-art. The net requirement then would be on the order of 7.6 acre-ft/year. This amount is less than 1/10 of 1 percent of annual production of wells 4, 5, and 6. In addition, installation of central chill water will permit deactivation of several existing cooling towers that are presently being cooled by water from wells 4, 5, and 6. It is therefore recommended that air conditioning chill water plant requirements be provided by only permitting construction of a flash steam system that uses condensate as a make-up source of cooling water. The remaining cooling water requirements should be supplied from normal supplies.

b. Electrical power plant requirements are considered to be on the order of 1380 acre-ft/year for a 12 MW(e) net flash steam plant and 1068 acre-ft/year for a binary system. These requirements can be reduced to an approximate net of 345 acre-ft/year by restricting the plant to a flash steam system and use the condensate as make-up cooling water. However, this still represents over one half of the total production of the sewer treatment plant or 14 percent of the production of wells 4, 5 and 6. It is therefore recommended that a new groundwater well be drilled to support the plant. The 1200 acre-ft of CAP water allocated to Williams can be used as "trading material" in negotiating if needed.

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NOTICE

APPENDIX E

ONSITE SURVEY REPORT AND ENERGY USE SURVEY

1. INTRODUCTION. An onsite survey was made for the proposed project site at Williams AFB by Westek Services, Inc as a consultant to the Air Force. Data contained in this survey report is furnished as information only except for specific references listed in other sections of the RFP.

a. Energy use survey of the base facilities to determine the specifics of:

(1) Electrical usage requirements--daily and seasonal demand, voltages and special requirements.

(2) Chilled water requirements--for present and planned centralized facilities.

b. Site inspection to identify, from a technical standpoint, acceptable drillsites, plant sites, pipelines and transmission corridors, and locations for electrical substations.

c. Inspection of existing facilities and plans to identify points of connection of utilities, including modifications necessary to make such connections.

This report also addresses the various options for the generation of electrical power or the production of chilled water based upon the available information regarding the prospective geothermal resource.

2. ENERGY USE SURVEY. A survey of energy use at Williams AFB has been made to determine the electric power requirement of the base and the amount of refrigeration required to cool the major buildings used for central base activities. The results of these surveys are discussed in the following sections.

a. Central Air Conditioning System. Refrigeration for space cooling is the major energy consumer at Williams AFB. The use of geothermal energy to operate a central refrigeration system would significantly reduce the use of fossil fuels. It is planned that the system would refrigerate the main buildings at the air base but would not supply the smaller offices and residences at the base. The criteria for inclusion in the central system were a refrigeration requirement of not less than 12 tons and a location close to the chilled water headers. The buildings being considered for this refrigeration system are listed on Table 1. The total refrigeration load for these buildings is 3321 tons. The temperature of the chilled water supply was set at $40^{o}F$ and a $10^{o}F$ temperature rise was allowed. The quantity of refrigerated water flowing to the individual buildings is shown in Table 1.

b. Electrical Power Requirement.

(1) The total Main Base electrical power demand and usage at Williams AFB are shown in Table II, from October 1974 to June 1980.

(2) Electric power demand has reached values as high as 12.3 MW several times in this period. It is predicted that the power requirement of the base will not greatly exceed the amounts shown in Table II in the future, since power consumption at the base can be regulated and no major power consuming additions are presently under consideration.

3. SITE LOCATIONS. The locations of the new facilities discussed in this section will be dependent on the location and condition of the local geothermal resource. Preliminary evidence indicates that a geothermal resource might be developed at the southwest corner of the air base, but further exploration will be necessary to confirm that this resource can be developed. The areas south of

the base and north of the base may prove to be good geothermal resources, in which case, plant site selection will be selected to take advantage of specific geothermal well locations.

a. Geothermal Wells.

(1) Production Wells. The southwest corner of the base is presently available for the development of a geothermal resource. One or more wells could be drilled in this area. Sufficient area is available for the development of a flashed steam facility to operate a central refrigeration system or a geothermal power plant. If numerous geothermal wells are required, the wells would probably extend into the area immediately south of the base.

(2) Reinjection Wells.

(a) A plan for disposal of the geothermal brine cannot be developed until the properties of the brine are known. If the brine has a low salinity, it could be used for cooling water or for industrial purposes. If it has high salinity, it would need to be reinjected into the ground. Normally the reinjected wells are shallower than the production wells and are located one to two miles from the production wells.

(b) Williams AFB required 1,000 feet of horizontal clearance plus 7 feet for every foot of vertical height for structures which might interfere with planes using the base runways. Drilling rigs capable of drilling to 10,000 feet would have an approximate height of 150 feet. Such a rig could be located within 2,050 feet of the existing runways. Drawings No 2 and No 5 show reinjection wells located in the southeast portion of the base located 2,050 feet from the nearest runway. Reinjection wells could be located in the shaded area at sites which are not archeologically significant.

b. Central Refrigeration Plant. Two absorption systems were considered for this service--a lithium bromide system and an ammonia system. The ammonia system was rejected because of the undesirable characteristics of the refrigerant gas. The lithium bromide refrigeration unit uses water as a refrigerant and employs lithium bromide solution as the absorbent.

(1) Description of a Typical Plant.

(a) The lithium bromide solution is heated by low pressure steam produced by flashing the geothermal brine or by direct exchange with the geothermal brine. The steam flash facility would be located adjacent to the producing well. The flashed steam or the geothermal brine would be transported to the refrigeration plant in an underground pipeline.

(b) A 3,000 square foot prefabricated steel building houses the refrigeration units, the expansion tank, chilled water circulating pumps and the motor control center. A cooling tower and cooling water pumps complete the supportive equipment. Overall plot requirements are about 60 feet by 170 feet. The plant has a spare absorption chiller to assure continuity of operation. A fossil fuel boiler provides a backup source of heat to operate the system when the geothermal well is not operating. Interruption of chilled water service is not permissible except in the case of an electrical power outage.

(2) Location of Refrigeration Facilities.

(a) The buildings that will be cooled by the central refrigeration system form a loop around the central section of the air base as shown in Drawing No 3. This drawing shows the permissible corridors for the chilled water piping.

(b) The refrigeration load has been roughly balanced to give two separate loops--an east and a west loop with Fourth Street the dividing line.

The refrigeration plant and supporting equipment is located at the intersection of Fourth and "G" Streets. The west loop follows "G" Street westward to the Hospital, where it turns south to the Chapel. At the Chapel, it turns east and follows "C" Street to Fourth Street where it turns north and returns to the refrigeration plant.

(c) The second loop follows "G" Street east to the Flight Line buildings, turns south to "D" Street and follows the extension of "C" Street to Fourth. At Fourth Street, the loop turns north and returns to the refrigeration plant. The entire loop system and building service lines are installed below grade. Both the chilled water supply header and the return header are progressively reduced in size as the load decreases to arrive at the lowest installed costs.

c. Geothermal Electric Power Plant

(1) Drawing No 5 shows the proposed location of the geothermal electric power plant in the southwest corner of the air base. This location is close to the potential geothermal resource and the land is available for this purpose. The site is sufficiently far from the runways that well drilling and construction in this area will not interfere with flight operations.

(2) If detectable amounts of hydrogen sulfide are found to be present in the geothermal brine, facilities to absorb the hydrogen sulfide will have to be provided at the same site. Any gases released from the power plant would have to comply with local Air Pollution Control Regulations.

4. EXISTING FACILITIES

a. Chilled Water System

(1) Table I indicates the type of refrigeration system in each building as follows:

(a) CW---Chilled Water

(b) DX---Direct Expansion

(c) Abs---Absorption Refrigeration

(2) The direct expansion refrigeration units at the base use compressed freon as a refrigerant. The condensing coils of these units are not compatible with chilled water and must be replaced. The air circulation systems in the buildings are suitable for the new system. The only major change that must be made is the replacement of the freon condensing coil with a chilled water/air exchanger. The freon refrigeration systems would then become surplus.

(3) The chilled water refrigeration units and the absorption unit circulate chilled water to water/air exchangers which provide space cooling. These units can be tied into the central refrigeration system with a system of valves as shown in Drawing No 4. The existing refrigeration systems can then be used as a backup (spare) for the central system, or they can be removed and used at some other location.

(4) In some cases, a group of buildings is supplied with refrigerated water from a common refrigeration source. The following buildings use this system:

(a) Building 323 supplies chilled water to 320 and 321

(b) Building 570 supplies chilled water to 477, 560, 568 and 571

(c) Building 643 supplies chilled water to 633

(d) Building 785 supplies chilled water to 786

A single tie-in point at each refrigeration source would be sufficient to supply chilled water to these systems.

(5) Buildings 237, 425, 558, 785 and 790 are major users of refrigerated water. Meters should be provided at these buildings to measure the heat load at each building.

b. Electric Power System

(1) Electric power is presently supplied to the base by the Salt River Project Agricultural Improvement and Power District at 69,000 volts. The power is reduced to 12,000 volts at a substation within the base. This substation is owned by the Salt River Project. If the contractor chooses to generate electric power, the Salt River Project power lines and substation will be retained as a backup for the geothermal power plant.

(2) The simplest installation to provide power to the base from a geothermal power plant would consist of a new 12 KV line from the plant to the existing substation. A new circuit breaker would be required in the power line. The 12 KV power would be distributed to the base through the existing 12 KV lines.

(3) Figure 6 is a single-line diagram of a typical geothermal power plant designed to produce 10 MW power at 12,000 volts. A plant of this type would be suitable for installation at Williams AFB.

Table I

BUILDINGS TO BE INCLUDED IN
CENTRAL REFRIGERATION SYSTEM

BLDG. NO.	NAME	TYPE*	TONS REFRIG-ERATION	CW FLOW GPM**
01	Base Headquarters	DX	3,321	90
09	Personnel	CW	50	120
15	T-38 Flight Ops	CW	60	144
19	Base Operations	DX	40	96
26	Military Personnel	DX	50	120
41	Flight Line	CW	35	84
45	Flight Line	DX	60	144
72	Headquarter Ops	CW	50	120
75	Armament	CW	15	36
88	Chapel	CW	75	180
104	Youth Center	CW	16	38
105	Child Care Center	CW	80	200
234	Physical Training	CW	34	82
237	Hospital	CW/Abs	250/150	996
300	Officer's Club	DX	78	188
323, 321, 322	Procurement	DX	20	48
324	Officers' Quarters	CW	25	60
326	Officers' Quarters	CW	25	60
334	Officers' Quarters	CW	25	53
344	Officers' Quarters	CW	22	53
354	Officers' Quarters	CW	28	68
390	Bowling Alley	DX	20	48
425	Instrument Flight Simulator	CW	469	1,125
426	Parachute Shop	CW	12	29
480	Field Training	CW	40	96
500	Service Club	DX	30	72
505	NCO Club	CW	75	180
558	Science Laboratory	CW	260	624
570, 571, 477, 560, 568	Flight Simulator Training	CW	225	540
628	Supply UNIVAC Computer	DX	50	120
632	Airmans' Dorm	CW	44	106
640	Airmans' Dorm	CW	50	120
643-633	Airmans' Dorm	CW	137	330
664	Airmans' Dining Hall	DX	120	288
672	Airmans' Dorm	CW	44	106
753	Data Automation	DX/CW	20/18	92
762	Telecommunications	DX	20	48
775	TLF Complex	CW	80	200
785, 786	BX, Sales, Cafe	CW	209	502
790	Commissary	CW	120	288
795	Theater	DX	38	92
		TOTAL	3,321	

* CW = Chilled Water
DX = Direct Expansion
Abs = Absorption

** Based on 40°F water with a 10°F temperature rise

TABLE 11

WILLIAMS AIR FORCE BASE

TOTAL BASE ELECTRIC DEMAND AND USAGE

	1974-1975		1975-1976		1976-1977		1977-1978		1978-1979		1979-1980	
MONTH	KW DEMAND	MWH USAGE	KW DEMAND	MWH USAGE	KW DEMAND	MWH USAGE	KW DEMAND	MWH USAGE	KW DEMAND	MWH USAGE	KW DEMAND	MWH USAGE
OCTOBER	8,845	3,430	7,720	2,960	7,565	3,255	9,760	4,278	10,560	4,666	10,560	4,174
NOVEMBER	5,639	2,701	6,114	2,647	5,930	2.665	6,560	3,044	8,000	3,179	6,560	2,918
DECEMBER	5,156	2,464	5,315	2,418	4,810	2,677	5,920	2,768	6,720	3,144	6,240	2,967
JANUARY	5,311	2.674	4,990	2,738	5,285	2,596	6,240	3,047	6,400	3,132	6,240	3,192
FEBRUARY	5,153	2,423	5,000	2,331	5,281	2,475	6,240	2,939	6,240	2,794	6,240	2,763
MARCH	5,313	2,722	5,472	2,624	5,440	2,798	6,720	3,144	5,920	3,060	6,400	3,178
APRIL	5,958	2,663	6,433	2,651	8,480	3,296	8,320	3,329	8,320	3,246	8,800	3,469
MAY	8,523	3,734	9,313	3,958	9,760	3,427	10,400	4,313	10,400	4,263	10,720	4,428
JUNE	9,480	4,376	10,603	4,589	11,040	5,151	11,520	5,104	12,320	5,415	11,660	5,400
JULY	10,125	5,340	10,764	5,880	11,520	5,893	12,320	6,239	12,160	5,798		
AUGUST	9,963	5,268	10,444	5,312	11,680	6,085	11,840	6,079	11,840	5,402		
SEPTEMBER	9,805	4,288	9,962	4,454	11,200	4,904	12,000	4,901	12,000	5,418		
AVG. DEMAND	7,439		7,677		8,165		8,986		9,240			
TOTAL		42,083		42,562		45,222		49,185		49,517		

CONTRACT DATA REQUIREMENTS LIST

ATCH NR ______ TO EXHIBIT ______

TO CONTRACT/PR ______

CATEGORY ______

SYSTEM/ITEM Geothermal Energy Development, Williams AFB AZ

CONTRACTOR ______

1. Sequence Number	2. Title or Description of Data / 3. Subtitle	4. Authority (Data Item Number)	5. Contract Reference	6. Technical Office	7. DD250 REQ	8. App Code (A)	9. Input to IAC (X)	10. Frequency	11. As of Date	12. Date of 1st Submission	13. Date of Subsequent Subm/Event ID	14. Distribution and Addressees (Addressee—Regular Copies/Repro Copies)	15. Total	16. Remarks
001	Project Status Report / Contract Management Summary	DE 1	Para 4d(1)(a) Sect II, RFP	ATC/DEE	N/A			Monthly	Notice to Proceed	1 mo after notice to proceed	Monthly	ATC/DEE 1/3; ATC/LGCTM 0/3; 82 ABG/DEE 0/3	1/9	
002	Technical Progress Report / Resource Confirmation Program	DE 2	Para 4d(1)(b), Sect II, RFP	ATC/DEE	N/A			After ea mile-stone	Current	After Exploration	After well drill-ing, flow testing, re-source con-firmation	ATC/DEE 1/3; ATC/LGCTM 0/3; 82 ABG/DEE 0/3	1/9	
003	Exploration Data / Analysis of Exploration Data	DE 3	Para 4d(1)(c), Sect II, RFP	ATC/DEE	N/A			After Explora-tion	Current	After Exploration	None	ATC/DEE 1/3; ATC/LGCTM 0/3; 82 ABG/DEE 0/3	1/9	
004	Drilling Data / Drilling Rpts, Logs, Seismic Recordings/ Flow Test Data	DE 4	Para 4d(1)(d), Sect II, RFP	ATC/DEE	N/A			Daily	Start of drill-ing	1 Day after drill-ing start	Daily	ATC/DEE 1/3; ATC/LGCTM 0/3; 82 ABG/DEE 0/3	1/9	

PREPARED BY: [signature] RICHARD M. STEEDE, HQ ATC/DEEEM, Randolph AFB TX 78150

DATE: 24 Jul 81

APPROVED BY: ______ DATE: ______

DD FORM 1423

CONTRACT DATA REQUIREMENTS LIST

ATCH NR ____ TO EXHIBIT ____

TO CONTRACT/PR ____

CATEGORY ____

SYSTEM/ITEM Geothermal Energy Development,

CONTRACTOR Williams AFB AZ

1. Sequence Number	2. Title or Description of Data / 3. Subtitle	4. Authority (Data Item Number)	5. Contract Reference	6. Technical Office	7. DD250 Req	8. App Code (A)	9. Input to IAC (X)	10. Frequency	11. As of Date	12. Date of 1st Submission	13. Date of Subsequent Subm/Event ID	14. Distribution and Addressees (Addressee – Regular Copies/Repro Copies) 2/0	15. Total	16. Remarks
005	Phase II, Project Status Report	DE 5	Para 4d(3), Sect II, RFP	ATC/DEE	N/A			Semi-annually	Current	6 mo after PH II NTP	Semi-annually	ATC/DEE 1/3; ATC/LGCTM 0/3; 82 ABG/DEE 0/3	1/9	
006	Blow-Out Contingency Plan	DE 6	Para 1h, Sect II, RFP	ATC/DEE	N/A			One Time	Current	Prior to Drilling	None	ATC/DEE 1/3; ATC/LGCTM 0/3; 82 ABG/DEE 0/3	1/9	

PREPARED BY RICHARD M. STEEDE, HQ ATC/DEEEM, Randolph AFB TX 78150

DATE 24 JUL 81

APPROVED BY

DATE

DD FORM 1 JAN 78 1423

PAGE 2 OF 2 PAGES

DATA ITEM DESCRIPTION	2. IDENTIFICATION NO(S).	
	AGENCY	NUMBER
1. TITLE Periodic Status Report - Study/Services Contract	NSA	A-5028

3. DESCRIPTION/PURPOSE	
Evaluation of contractor progress toward contract objectives.	4. APPROVAL DATE 1 October 1967
	5. OFFICE OF PRIMARY RESPONSIBILITY N
	6. DDC REQUIRED N/A
7. APPLICATION/INTERRELATIONSHIP	8. APPROVAL LIMITATION
	9. REFERENCES (Mandatory as cited in block 10)
	MCSL NUMBER(S)

10. PREPARATION INSTRUCTIONS

1. The contractor shall furnish periodic status reports in conformance with the schedule established in the DD Form 1423, Contract Data Requirements List. The reports shall include, but need not be limited to the following:

a. Brief summary highlighting any significant technical activities and developments occuring during the reporting period.

b. Listing of titles of all reports issued during the reporting period.

c. Concise statement of the month's activities on each assigned task, including successes obtained and difficulties encountered and their effect on the overall work effort.

d. Charts showing by task, anticipated reporting schedules.

e. Tabulation of all direct charge personnel, showing number of hours each spent on assigned tasks.

f. Tabulation of all visitors to the project, giving individual's name, organization, and date and purpose of the trip.

2. The report and any attachments shall be typewritten or otherwise clearly lettered, as appropriate, and shall be duplicated in non-fading ink. Textual data shall be prepared on letter size paper (8"x10½" or 8½"x11"). Attachments are to be folded to letter size, and fully identified and referenced in the text of the report.

3. A title page shall be included which identifies the report with the task and the contract, and indicates type of report, purchase description title, contract number, and dates of the reporting period.

4. Security classification and distribution limitation markings shall be applied in accordance with instructions contained in the purchase description, security requirements checklist, and contract document, as applicable.

DATA ITEM DESCRIPTION	2. IDENTIFICATION NO(S). AGENCY	NUMBER
1. TITLE Technical Report - Study/Services Contract	NSA	A-5029

3. DESCRIPTION/PURPOSE Documentation of studies or analysis conducted by the contractor.	4. APPROVAL DATE 1 October 1967 5. OFFICE OF PRIMARY RESPONSIBILITY N 6. DDC REQUIRED N/A 8. APPROVAL LIMITATION
7. APPLICATION/INTERRELATIONSHIP	9. REFERENCES (Mandatory as cited in block 10) MCSL NUMBER(S)

10. PREPARATION INSTRUCTIONS

1. The contractor shall provide technical reports, as directed by the procuring activity, which fully document results of all studies or analyses conducted. The reports shall be prepared in accordance with the format and general instructions as indicated below:

a. Format

(1) Title Page - Identifying the report by providing contract number, project name or purchase description title, task number, and reporting period.

(2) Table of Contents

(3) Section I - Including the following:

(a) Introduction

(b) Summary - i.e., a brief statement of results obtained from the analytic effort.

(c) Conclusions and a condensed technical substantiation therefor.

(4) Section II - Including a complete and detailed description of the analytic results which led to the conclusions included in Section I above.

b. General Instructions

(1) The report and all attachments shall be typewritten or otherwise clearly lettered and shall be duplicated using non-fading

DD FORM 1 JUN 68 1664

ink.

(2) Text shall be prepared on standard letter size paper (8"x10½" or 8½"x11").

(3) When attachments are included, they shall be fully identified, referenced in the text, and folded to conform to the size paper used in the report.

(4) Security classification and distribution markings shall conform to the requirements of the contract, purchase description and security requirements checklist, as applicable.

DEEE

12 NOV 1981

Proposal for Geothermal Energy Development, Williams AFB AZ

Department of Energy (Ms Susan Prestwich)

1. Reference 10 Nov 81 telephone conversation between our Mr. Richard Steede and your Ms Susan Prestwich.

2. Attached for your preliminary review is the proposal for this project received from Geothermal Kinetics, Inc (GKI). You will be contacted subsequently regarding procedures for formal evaluation.

FOR THE COMMANDER

WALTER A. ARNOLD, Capt, USAF
Acting Chief, Engineering Division
Engineering & Construction Dir
DCS/Engineering & Services

1 Atch
Proposal

Cy to: 3303 Contracting Sqn wo Atch

November 3, 1981

United States Air Force
3303 Contracting Squadron/LGCTM
Randolph Air Force Base
Texas 78150

RE: Request For Proposal #F41689-81-R-0061
Geothermal Energy Development
Williams Air Force Base, Arizona

Dear Sir:

Submitted herewith are an original and three copies each of Volume I, Technical Proposal and Volume II, Business Proposal, in response to the above subject Request For Proposal.

We are submitting an Alternate Proposal to provide power from off site of Williams Air Force Base as provided for by Article 15, of General Information per the RFP.

We believe the approach to the project that we have proposed will be a necessary and effective means by which the interests of Williams Air Force Base and Geothermal Kinetics, Inc. can best be served.

We look forward to the opportunity of working with the Air Force on this project, and we will welcome the opportunity to negotiate the implementation of the overall project.

Very truly yours,

James T. Kuwada
Vice President Engineering

JTK:a

GEOTHERMAL KINETICS INC.
Three Embarcadero Center, Suite 2045 • San Francisco, California 94111 • Telephone (415) 434-4717

VOLUME I
TECHNICAL PROPOSAL

For

GEOTHERMAL ENERGY DEVELOPMENT
WILLIAMS A.F.B., ARIZONA

SUBMITTED in RESPONSE to

RFP No. F41689-81-R-0061
UNITED STATES AIR FORCE
3303 CONTRACTING SQUADRON/LGCTM
RANDOLPH AFB, TX 78150

By

GEOTHERMAL KINETICS, INC.
THREE EMBARCADERO CENTER
SUITE 2045
SAN FRANCISCO, CALIFORNIA 94111

3 NOVEMBER 1981

GEOTHERMAL KINETICS INC.
Three Embarcadero Center, Suite 2045 • San Francisco, California 94111 • Telephone (415) 434-4717

VOLUME I

TABLE OF CONTENTS

I. PROJECT OVERVIEW & APPROACH

The subject RFP requests, as a first priority, the supply of geothermal heat to provide the energy needs for an absorption refrigeration system. This system will supplant the existing mechanical refrigeration system which is providing base-wide chilled water air conditioning. The peak demand is 3320 tons of refrigeration.

Based on the stated power conversion rate of 0.94 KW/ton, the peak refrigeration demand is equivalent to 3,120 KW or 2250 MWh/month usage. However, even this usage rate exists for only half the year. Therefore, the first priority requirement of this RFP provides little capacity incentive for a geothermal development company to do the resource exploration work, let alone the exploratory drilling and resource confirmation testing.

There are substantial front-end costs associated with geothermal resource exploration, to identify exploratory drilling sites, in drilling exploratory wells, in flow testing these wells to assess well productivity and resource characteristics. Therefore, a developer must foresee a substantial utilization of the discovered resource, over which he can spread the development costs, in order to justify the resource confirmation effort.

Geothermal Kinetics, Inc. must look upon the second priority of the RFP as its first priority, i.e., of providing a peak demand of 12.3 MW of electric power. When one examines the demand vs. usage for Williams Air Force Base, the data shows that a power plant built to supply that quantity of power will be operating at a capacity factor of 63% during maximum usage, and as low as 32% during the winter months.

In order to make the power plant project economic, the developer must operate the plant at the highest capacity factor possible. Geothermal power plants operate at capacity factors in the range of 80-85%.

The subject RFP allows the sale of excess capacity to public utilities, and indeed, the developer must do so in order to structure an economic venture. As long as the developer determines that he must sell excess capacity, the logical question arises as to whether he, the developer, should not build an even larger plant, so he can enjoy the economies of size in constructing the power plant.

One economic factor inhibiting the push towards the construction of a larger plant, in a new geothermal resource area, is the greater commitment of time and money required to confirm the size of the resource (reservoir) which will be necessary to sustain the larger plant over the life of the project.

The number of production wells required will depend on the resource temperature, brine quality, and well productivity as a function of wellhead pressure. Assuming a double-flash steam power plant of 25 MW_e capacity, the number of wells required may be on the order of eight production wells and four reinjection wells (plus spares) for a 400°F resource of average productivity.

More than one exploratory (resource confirmation) well will be required in order to develop the data necessary to make a reservoir assessment of an areal extent sufficient to support the 25 MW_e plant. This would hold true even for a 12 MW_e plant.

Considering the capacity to risk ratio, the cost-share formula proposed in the RFP, to share in the cost of drilling one well for purposes of resource confirmation, is not a very persuasive inducement. To drill a 10,000 foot production well and a 6,000$^{\pm}$ foot reinjection well on base; to purchase, install and operate the test facility to determine resource potential, will cost approximately $3.5 million. If successful, the developer will receive 10% ($350,000) in cost-share contribution; an amount which would leave very little for the physical execution of the project after the paper costs for additional reporting are deducted. If unsuccessful, the cost-share contribution is not $3.15 million (90%), but $1 million leaving the developer with a short fall of $2.15 million.

The "User-Coupled Well Confirmation Drilling Program" and the "Geothermal Loan Guarantee Program" sponsored by the US Department of Energy were available at the time the proposed project was initially being considered. In discussions with the DOE at the time, the DOE suggested GKI respond to the Williams AFB project directly, rather than through the User-Coupled program because the User-Coupled program intended to contribute a portion of its funds towards the Williams AFB project. Unfortunately, in the interim period, while the RFP was being prepared, the DOE dropped these two programs in its budget cutting efforts. These programs which were established to aid industry to finance geothermal development projects are no longer available as a source or vehicle for project financing.

In view of the present situation and the differing priority needs for the project from the viewpoint of the developer and Williams AFB, Geothermal Kinetics, Inc. proposes the following Alternate Proposal for Resource Confirmation (Phase I) and Plant Construction and Operation (Phase II). GKI will not drill the resource confirmation well on Williams AFB, but rather, will deepen its Powers Ranch No. 1 well to a depth of 12,000 feet. The rationale for taking this approach is discussed in the body of our proposal, but basically, reworking Powers Ranch No. 1 well and testing to confirm the resource will cost less than half as much as it would to do so on the Base. The location, by virtue of the wells that exist on the property, also provides greater confidence that exploitable geothermal energy will be found on the Powers Ranch than on the Base.

If Phase I, Resource Confirmation, is successfully concluded, GKI will construct and operate a power plant to supply 12.3 MW_e to Williams AFB through a 12 KV tie-line. Any excess power over the needs of Williams AFB will be sold to the local utilities at their "Avoided Costs". Therefore, the same costs will be charged for power delivered to the Base. The "Avoided Costs" will exclude the transmission and distribution costs, so the power costs to the Base should be lower by this amount.

Because Williams AFB will pay "avoided costs" for its electric power over the life of the project, under GKI's proposed plan, GKI believes that the Air Force should contribute the entire \$1 million towards the Resource Confirmation effort. GKI for its part will, with due diligence, undertake to confirm the resource, and pay from its own account the Phase I program costs in excess of the \$1 million Air Force contribution.

If this approach or a variation thereof, is of interest to the Air Force, Geothermal Kinetics, Inc. will be pleased to enter into negotiations with Williams Air Force Base to arrive at a mutually acceptable agreement.

2. PHASE I - RESOURCE CONFIRMATION

2.1. Exploration Plan

Geothermal Kinetics, Inc. proposes to rework its Powers Ranch wells in order to provide geothermal energy to Williams Air Force Base. An extensive amount of data was gathered and evaluated concerning the geology, geophysics and geochemistry in the Higley Basin prior to the siting and drilling of the Powers Ranch wells by Geothermal Kinetics, Inc. in 1973.

To quote from the "Overview" in Appendix C of this Request For Proposal, "Virtually all the available information regarding the potential geothermal resources at Williams AFB results from the exploration efforts of Geothermal Kinetics; Powers Ranch #1 and #2 wells." The citations in Appendix C clearly establish the potential for geothermal energy development in the Higley Basin within which Williams Air Force Base is located.

GKI's proposed use of its existing Powers Ranch wells, therefore, eliminates the need for an exploration plan.

2.2. Preliminary Drilling Plan - Background

GKI drilled the Power Ranch No. 1 well to a depth of 9,207 feet in 1973. The well was completed by running 7" casing to a depth of 9,065 feet and cementing to surface. Likely production zones were identified from the Dual Induction and Neutron Logs, which were run prior to casing the well. The production casing, opposite these zones of production, was perforated with detonating jet charges. This well completion practice was typical for an oil or gas well, but unfortunately, it was not appropriate for a geothermal well from which an order-of-magnitude more fluid production must be obtained in order to have, what would be regarded as, a commercial geothermal well. After perforating the casing, drill-stem tests were conducted. Additional casing perforations were made to increase fluid production. A Reda pump was installed in the wellbore to physically pump the well. At a shallow pump setting the pumping rate exceeded the well drawdown, and the pump cavitated. At a deep pump setting the pump capacity was diminished by the requirement for a higher pumping head. Consequently, Powers Ranch No. 1 did not produce commercial flow rates.

Below 7,000 feet the formation is a dense welded tuff. Permeability will be through fractures, so both drilling techniques and well completion practices must minimize the possibilities of blinding off the fractures. The cement sheath around the 7" casing in PR No. 1 well and the mudding-off and cement-squeeze job in PR No. 2 well are considered to have caused severe "skin damage" to the production intervals in both wells.

After perforating the casing in PR No. 1 well, the perforated zone should have been pressurized to breakoff pressure to verify that the perforating job was successfully completed. However, this verification was not made before drill-stem and pump tests were conducted, so there remains an uncertainty as to whether the formation fracture permeability, or inadequate casing perforations, is the limiting factor governing well production.

2.3. Preliminary Drilling Plan - Workover

In laying out the drilling (workover) program for Powers Ranch No. 1 well, GKI weighed the following considerations in developing its proposed drilling program.

2.3.1 "Skin Damage" to the formaton in the existing well is probably so severe that side-tracking of the well is most likely the only practical way to restore permeability in the existing production intervals (zones).

2.3.2 Cutting A Window in the casing at about 6,000 feet and side-tracking the well to a depth of 10,000 feet will be more costly than deepening the existing well to 12,000 feet. Other disadvantages of side-tracking are that the procedure will increase the risk of a "lost hole", and it will not provide any higher temperature than those measured or projected for that depth.

2.3.3 Deepening Powers Ranch No. 1 Well from 9,207 feet to a maximum depth of 12,000 feet will require drilling less hole and in a less expensive manner. Deepening the hole will expose new horizons in which fractures are expected to exist. If these fractures are water filled, we can expect temperatures in the range of 425°F at 12,000 feet, compared to about 360°F at 9,000 feet, assuming the measured temperature gradient prevails.

2.3.4 While the Power Ranch Wells may have been the deepest geothermal wells drilled at the time, GKI recently has successfully completed geothermal wells in the Imperial Valley to depths of 13,000 feet, in a brine reservoir at 520°F.

GKI, therefore, feels confident in its abilities to drill deep geothermal wells. While it was thought at one time that commercial geothermal reservoirs could not exist at great depths owing to the loss in matrix permeability due to compression, we now recognize that geothermal reservoirs can and do exist in deep formations, controlled by fracture permeability.

2.3.5 A Geothermal Resource at 425°F would require 15% less production and reinjection wells and associated facilities than would a resource at 360°F. The higher temperature also may provide the flash-lifting capability to produce commercial flow rates without mechanical pumping. Elimination of the well pumps would significantly increase reliabilty and reduce capital and O & M costs.

2.3.6 Deepening Powers Ranch No. 1 through the 7" casing will reduce wellbore size; however, if the fractured reservoir is determined to be competent, the well may be completed "barefoot." A barefoot completion will provide the least resistance to flow; however, the well flow rate is generally limited by the wellbore diameter at the top and not at the bottom of the well.

2.3.7 The rationale for deepening PR No. 1 Well rather than PR No. 2 is that PR No. 2 is already drilled to 10,454 feet. PR No. 1 will provide 1,200 feet more of new hole in drilling to a total depth of 12,000 feet.

In view of the considerations set forth above, GKI proposes to deepen Powers Ranch No. 1 Well to a depth of 12,000 feet, unless a good production interval is found before achieving that depth.

Loss circulation zones, fluid losses, penetration rate and roughness of drilling, will be monitored. A mud logger will be on hand to take cutting samples and monitor gas make and composition. Temperature surveys will be made at appropriate intervals. When a suitable production zone appears to have been reached, the well will be lanced (unloaded) with nitrogen to stimulate flow. A short term flow test to the pit will be conducted to assure adequate production before the drilling rig is released.

2.4. Preliminary Test Plan - Well Flow Test

After the drilling rig is released, the test separator installation will be completed. The test separator will have the capabilities to measure flash steam flow rate and separator liquid flow rate. Sample connections will be provided for sampling steam to determine non-condensible gas content and composition; liquid samples for determining brine composition, total hardness, and pH.

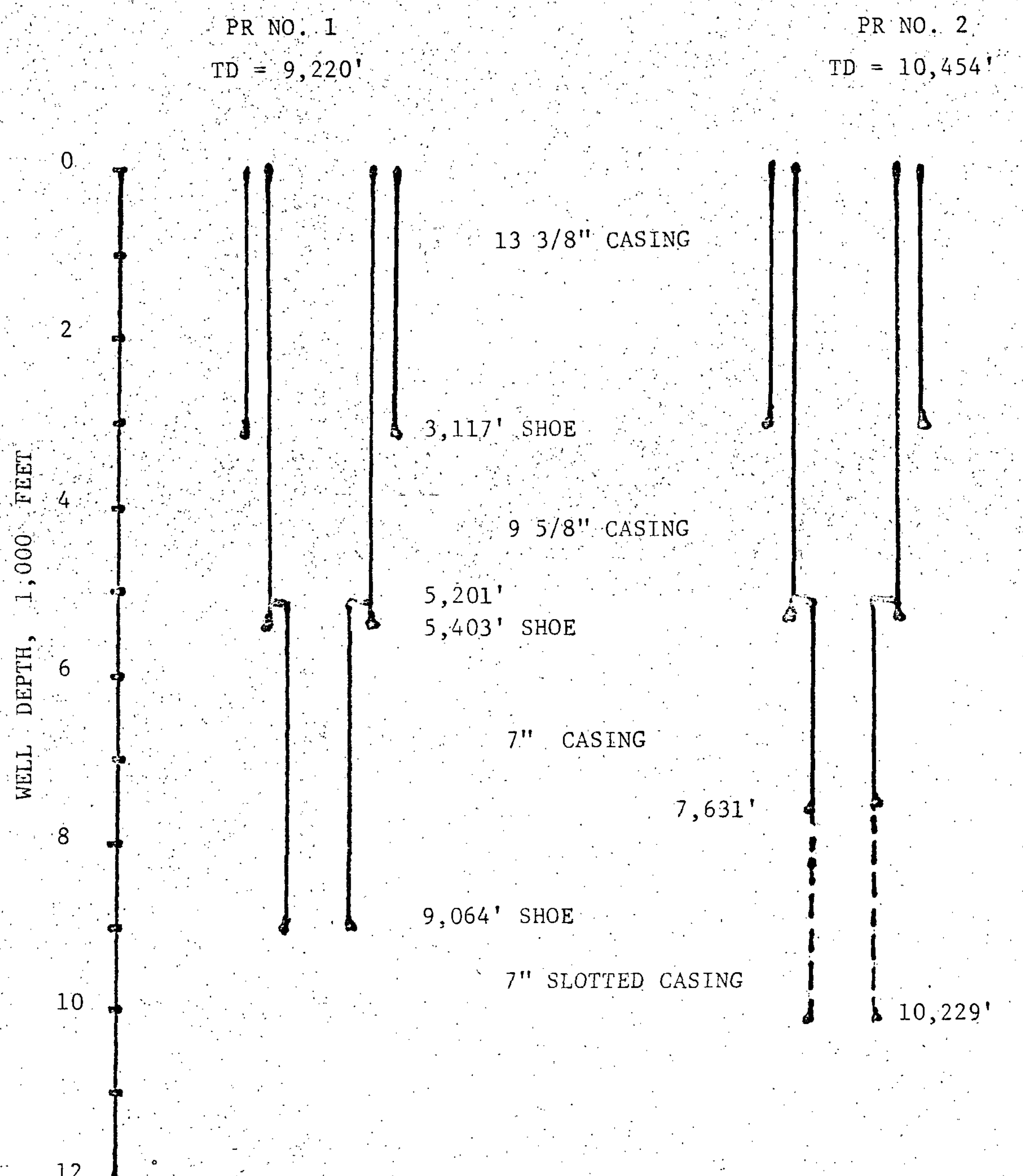
The test facility will be sized and pressure rated so that the well flow rate may be determined over a range of wellhead pressures and temperatures. Tests will be conducted at a minimum of four different wellhead pressures so that well productivity can be determined by plotting flow rate vs. wellhead pressure.

Downhole pressure and temperature surveys will be made at the four flow rates to determine well drawdown pressures. A pressure-temperature traverse will be made under flowing conditions to establish the gas bubble point or flash point pressure in the wellbore. This information will be used to corroborate the noncondensable gas content determined by steam sample analysis.

GEOTHERMAL KINETICS INC.

SUBJECT: WILLIAMS AIR FORCE BASE PROPOSAL
POWERS RANCH WELLS NO. 1 & NO. 2
CASING PROFILES

SHEET NO. .... OF ....
JOB NO. ....
BY .... DATE 10/24/81
CHKD. BY .... DATE ....



2.4.1 Reservoir Assessment

At the conclusion of the flow test the well will be shut in, and pressure buildup data will be taken at the bottom of the well. This data will be used to calculate the permeability - thickness of the production zone.

In order to make a reservoir assessment, additional wells will have to be drilled and tested. Well production data and pressure interference data from a number of wells are necessary to provide the spatial characterization of the reservoir.

2.4.2 Waste Water Disposal

Chemical analysis of the geothermal brine, from Powers Ranch No. 1 did not show concentrations of heavy metals that could form high temperature precipitates. Therefore, hot reinjection of the liquid flow from the flash steam separator into Powers Ranch No. 2 appears feasible. A standy reinjection pump will be provided in case PR No. 2 requires more than the separator pressure to reinject the waste brine. This condition is likely to occur when the wellhead pressure is lowered to obtain maximum flow rates from the well.

2.4.3 Institutional Considerations

The Powers Ranch wells are located about a quarter mile from Williams Air Force Base. The legal description is as follows:

Powers Ranch #1 Well - NE1/4, SE1/4, Section 1, T2S, R6E
Gila and Salt River Base, Maricopa County, Arizona

Powers Ranch #2 Well - SE1/4, NE1/4, Section 1, T2S, R6E
Gila and Salt River Base, Maricopa County, Arizona

GKI has the right of access to this property and has maintained its lease to the geothermal rights. The County will be contacted at an appropriate point in the project to obtain easement for running a 12KV power line from the power plant to the Base substation.

2.4.4 Environmental Management Plan

Geothermal Kinetics, Inc. has been actively involved in geothermal energy development for the past decade, so it is knowledgeable of the environmental and safety requirements for drilling and producing geothermal wells. GKI will adhere to mitigating procedures proposed in the Environmental Assessment. Air quality standards for H_2S will be complied with. If necessary, the vented steam will be scrubbed to remove the H_2S to a level sufficient to bring the discharge into compliance with the standards. To cite a specific example, GKI's plans for H_2S Abatement at the Geysers in Northern California has been accepted by the Sonoma County APCD.

The waste brines will be disposed of in a reinjection well. The disposal of drilling fluids, restoration of the drillsite, completion and/or abandonment of the well will be in accordance with the requirements of the Oil & Gas Conservation Commission.

2.4.5 Drilling Permits

The Powers Ranch wells are in a state of "Temporary Abandonment". As such, these wells may be reentered after due notification to the Oil & Gas Conversation Commission. A new drilling permit will not be required.

2.4.6 Safety

With respect to protection of geothermal wells against blowout, a blowout preventor stack will be installed, consisting of pipe and blind rams actuated by an accumulator, operated at 1,000 psig minimum pressure. The blowout preventor is tested on a regular basis. In the state of Arizona the blowout preventors must be tested once every 24 hours at a minimum of 1,000 psig.

2.5 Project Management

The project organization is shown in Figure 1. The Project Manager for GKI will be James T. Kuwada. Mr. Kuwada has over 20 years experience in engineering and management of refinery, chemical and geothermal projects. During the past 10 years he has directed a variety of geothermal exploration, well drilling and testing, and power plant projects both here and abroad. These projects include geothermal exploration and drilling in Costa Rica, workover and testing of a geothermal well in Hawaii, 30 MW to 100 MW geothermal power plant projects in the Geysers, Philippines and Iceland. He has the knowledge, background and experience to relate effectively to all requirements of this project.

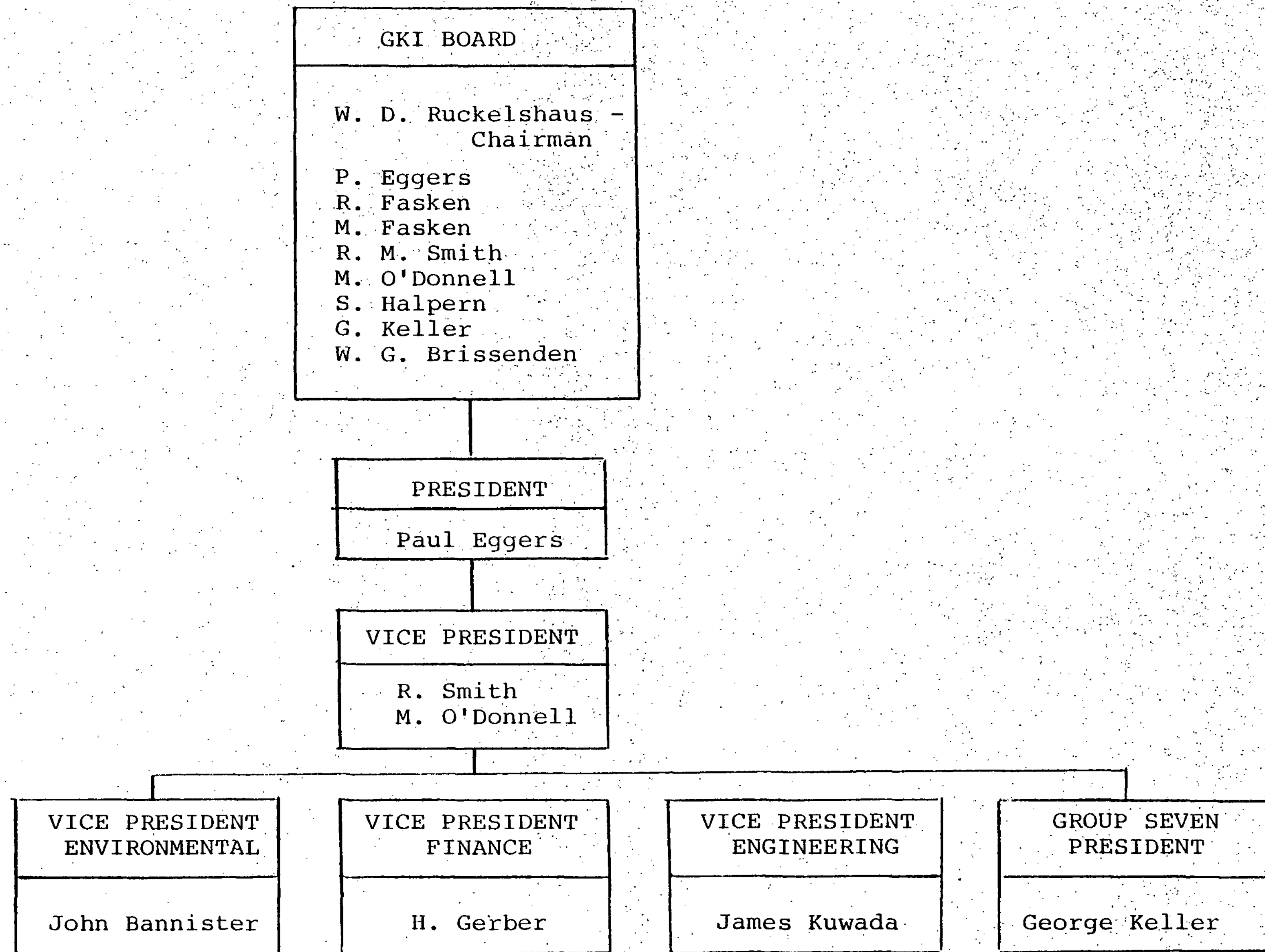
Daily drilling supervision of the well workover program will be under the direction of Mr. Bert McComack. Mr. McComack has supervised the drilling of many geothermal wells for GKI. He has also been loaned to other companies such as Phillips Petroleum Co. and the Department of Energy to supervise the drilling of wells for these organizations. The requirements of this well workover program will present no new departures to Mr. McComack's 30 years of drilling experience.

The Mud Logging Service will be subcontracted to a competent company which GKI has employed on past drilling projects, or which GKI knows to be knowledgeable.

The Geothermal Well Testing, Chemical Sampling and Analysis will be provided under a subcontract to one of a select group of qualified companies engaged in geothermal well testing service. However, the GKI Project Manager will define the test program, test procedures, data collection and sample analysis.

Reservoir Engineering Service will be provided by Berkeley Group, Inc. under the direction of Mr. Ron Schroeder. He has provided similar service to GKI, and he has demonstrated a thorough knowledge and capability in geothermal reservoir engineering. BGI provides its own downhole instrumentation so that they can control the quality of the subsurface measurements taken by instruments which they know to be correctly calibrated, maintained and operated.

ORGANIZATION OF GKI CORPORATION

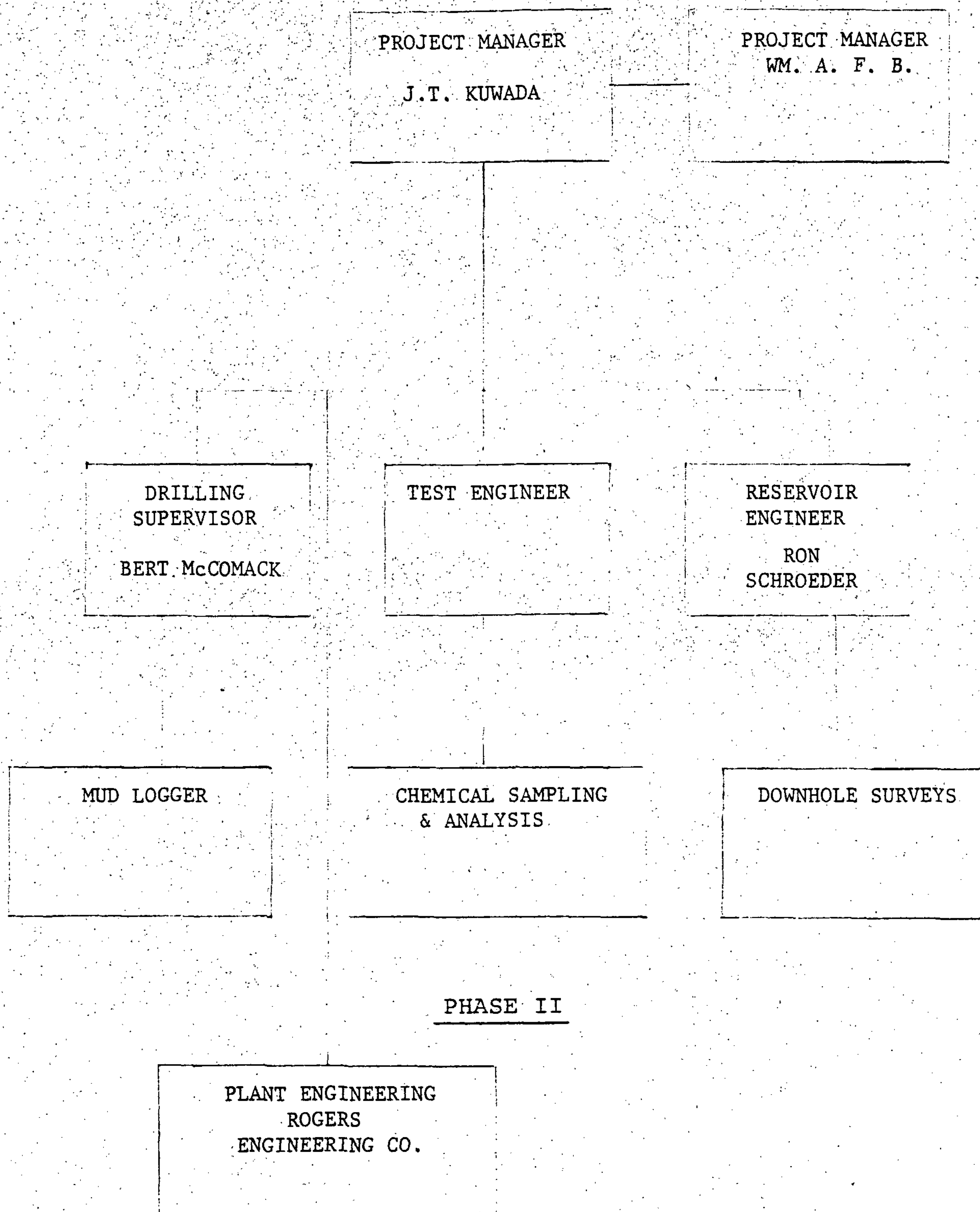


GEOTHERMAL KINETICS INC.

FIGURE 1

SUBJECT WILLIAMS AIR FORCE BASE PROPOSAL
PROJECT ORGANIZATION
PHASE I

SHEET NO. 1 OF
JOB NO.
BY DATE
CHKD. BY DATE



2.5.1 Company History

Geothermal Kinetics Inc. (GKI), a wholly-owned subsidiary of United Siscoe Mines, Inc., was incorporated in Nevada in 1970. Since inception, GKI and its subsidiaries have been engaged in the exploration and development of geothermal resources for utilization in power generation.

Exploration and property evaluation are conducted by Group Seven Inc., a wholly owned subsidiary, who developed geophysical methods for delineating potential geothermal reserves.

Development operations are conducted through Geo Mac, Inc. and United Geothermal Geysers, Inc., both wholly owned subsidiaries.

2.5.2 Management

Paul W. Eggers, 62, an attorney and senior partner of Eggers and Greene, attorneys in Dallas, Texas, has served as President since 1973. He also serves as a Director of United Siscoe Mines, Inc. During 1969 and 1970, Mr. Eggers served as General Counsel for the U.S. Treasury Department. He has many years of experience in energy and related businesses.

Mike O'Donnell, 57, co-founder of GKI, Executive Vice President and General Manager since 1971 has been engaged in oil and gas, and geothermal exploration and production operations since 1949.

James T. Kuwada, 50, a graduate of the University of California with a BSc. in Chemical Engineering, joined GKI as Vice President of Engineering in 1980. With over twenty years experience in engineering and management of refining, chemical and geothermal projects, Mr. Kuwada is a leader in the geothermal industry. His geothermal experience includes geothermal development, gathering systems and power plant design, engineering and construction management, well and plant testing and plant startup as well as environmental control systems in Hawaii, Iran, Iceland, Costa Rica, Philippines, Turkey and the United States.

Prior to joining GKI, Mr. Kuwada was a Vice President with Rogers Engineering and prior to that was with Bechtel Corporation, both headquartered in San Francisco.

Dr. George V. Keller, 53, is one of the founders of Group Seven Inc. in 1969 and has served as President since that time. Dr. Keller is currently Chairman of the Geophysical Department and has been Professor of Geophysics at the Colorado School of Mines since 1965. He is a leading authority in geophysics, including advanced electrical prospecting techniques, in oil and gas, geothermal and other minerals throughout the world. Dr. Keller has served as a consultant to various government agencies and major international energy companies. He has authored over 80 technical papers and several books.

Dr. Norman Harthill, 44, Executive Vice President of Group Seven Inc. is a co-founder of that company. He has received degrees from the University College of Wales and advanced degrees from the Colorado School of Mines in geology. Dr. Harthill has had extensive experience in geothermal exploration in the United States as well as in foreign countries.

John Bannister, 60, joined GKI as Vice President-Production in 1979. Prior to that, Mr. Bannister headed the Arizona Oil and Gas Commission for 15 years and directed the formulation, implementation and enforcement of the various oil and gas regulations.

Harold D. Gerber, 50, joined GKI as Vice President-Finance in January 1981. Mr. Gerber, a certified public accountant has over 20 years of extensive U.S. and international financial, administrative and operational experience at various levels, particularly in oil and gas, mining and public utilities, including 10 years with Arthur Young & Co.

Bert McComack, 63, has been Drilling Superintendent for GKI since 1971. Before joining GKI, Mr. McComack operated his own drilling company for a number of years; and prior to that, served in various positions with contract drillers. His experience is extensive in both oil and gas and geothermal drilling in the western United States.

Peat, Marwick, Mitchell & Co.

Certified Public Accountants

100 West Clarendon
Phoenix, Arizona 85013

The Board of Directors
Geothermal Kinetics Inc.:

We have examined the consolidated balance sheets of Geothermal Kinetics Inc. and subsidiaries (companies in the development stage) as of December 31, 1980 and 1979 and the related consolidated statements of earnings and retained earnings, changes in common stock and additional paid-in capital and changes in financial position for each of the years in the three-year period ended December 31, 1980 and the period from inception (June 29, 1971) to December 31, 1980. Our examinations were made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances. We did not examine the financial statements of the CU I Venture in 1980 nor the CU I Venture, Roosevelt Hot Springs Master Venture, and Fisher Master Venture in 1979. The statements of these unincorporated joint ventures in which the Company participates reflect total assets constituting 12% and 14% in 1980 and 1979, respectively, of the related consolidated total. These statements were examined by other auditors whose reports thereon have been furnished to us and our opinion expressed herein, insofar as it relates to the amounts included for the CU I Venture, Roosevelt Hot Springs Master Venture, and Fisher Master Venture for such periods, is based solely upon the reports of the other auditors.

In our opinion, based upon our examinations and the reports of other auditors, the aforementioned consolidated financial statements present fairly the financial position of Geothermal Kinetics Inc. and subsidiaries at December 31, 1980 and 1979 and the results of their operations and the changes in their financial position for each of the years in the three-year period ended December 31, 1980 and for the period from inception (June 29, 1971) to December 31, 1980, in conformity with generally accepted accounting principles consistently applied during the period except for the change, with which we concur, in the method of accounting for interest costs as described in note 4 to the financial statements.

Peat, Marwick, Mitchell & Co.

April 30, 1981, except for
note 19 which is as of May 7,
1981

GEOTHERMAL KINETICS INC. AND SUBSIDIARIES
(Companies in the Development Stage)

Consolidated Statements of Earnings and Retained Earnings

Years ended December 31, 1980, 1979 and 1978, and the period from inception (June 29, 1971) to December 31, 1980

	Year ended December 31, 1980	1979	1978	Inception (June 29, 1971) to December 31, 1980
Revenues:				
Drilling and consulting fees	$ 12,203	75,967	110,079	717,576
Gain on sale of equipment	-	-	-	172,995
Interest	13,749	9,721	6,580	86,621
Gain on exchange of prospect (note 15)	13,405,918	-	-	13,405,918
Total revenues	13,431,870	85,688	116,659	14,383,110
Costs and expenses:				
Drilling costs	-	-	-	361,212
General and administrative expense	1,173,840	758,865	753,303	4,096,885
Interest expense (note 4)	-	308,314	139,690	505,463
Abandoned prospects and dry hole expenses (note 4)	565,582	1,309,933	99,391	3,543,241
Total costs and expenses	1,739,422	2,377,112	992,384	8,506,801
Earnings (loss) before income taxes and extraordinary item	11,692,448	(2,291,424)	(875,725)	5,876,309
Income taxes (note 11)	3,730,000	-	-	3,730,000
Earnings (loss) before extraordinary item	7,962,448	(2,291,424)	(875,725)	2,146,309

(Continued)

GEOTHERMAL KINETICS INC. AND SUBSIDIARIES
(Companies in the Development Stage)

Consolidated Balance Sheets

December 31, 1980 and 1979

Assets	December 31, 1980	1979
Current assets:		
Cash	$ 336,914	501,931
Receivables:		
Note and interest, officers (note 2)	60,537	122,775
Co-venturer	-	19,782
Others	19,360	33,737
Marketable equity securities at cost (notes 5, 12 and 18)	13,582,000	-
Prepaid expenses and deposits	77,169	28,319
Total current assets	14,075,980	706,544
Interest receivable from officers and directors (note 2)	67,339	35,016
Casing pipe	703,734	-
Furniture and equipment, net (note 3)	292,383	245,986
Prospect costs (note 4)	10,990,201	8,199,594
Deferred exploration costs	389,997	-
Other assets, at cost	65,632	65,514
	$ 26,585,266	9,252,654

Liabilities and Stockholders' Equity	December 31, 1980	1979
Current liabilities:		
Accounts payable	$ 675,278	89,222
Accrued expenses and other liabilities	5,847	31,809
Advance and interest payable to parent (notes 10 and 12)	3,837,057	-
Payable to co-venturer	416,618	-
Current obligations under capital leases (note 13)	26,869	23,049
Deferred income taxes (note 11)	2,335,000	-
Total current liabilities	7,296,669	144,080
Long-term notes and interest payable to co-venturer (note 7)	-	1,173,454
Note payable to bank (note 7)	2,898,152	908,500
Obligations under capital leases (note 13)	103,080	129,949
Deferred income (note 2)	68,262	35,016
Stockholders' equity (notes 8, 9, 10 and 12):		
Common stock of 1¢ par value per share. Authorized 10,000,000 shares; issued 6,514,614 shares	65,146	65,146
Additional paid-in capital	13,041,935	13,041,935
Notes receivable from officers and directors (note 2)	(461,750)	(461,750)
Retained earnings (deficit) accumulated during the development stage	3,573,772	(5,783,676)
Total stockholders' equity	16,219,103	6,861,655
Commitments and contingencies (notes 7, 9, 13, 14, 16, 17 and 18)		
	$ 26,585,266	9,252,654

See accompanying notes to consolidated financial statements.

GEOTHERMAL KINETICS INC. AND SUBSIDIARIES
(Companies in the Development Stage)

Consolidated Statements of Earnings and Retained Earnings, Continued

	Year ended December 31, 1980	1979	1978	Inception (June 29, 1971) to December 31, 1980
Extraordinary item - reduction of income taxes arising from carryforward of prior years' net operating losses (note 11)	$ 1,395,000	-	-	1,395,000
Net earnings (loss)	9,357,448	(2,291,424)	(875,725)	3,541,309
Deficit at beginning of period	(5,783,676)	(3,492,252)	(2,616,527)	-
Adjustment - retained earnings of pooled company (note 8)	-	-	-	32,463
Retained earnings (deficit) at end of period	$ 3,573,772	(5,783,676)	(3,492,252)	3,573,772

See accompanying notes to consolidated financial statements.

2.6. Measure of Success

Phase I, Resource Confirmation, will be judged a success, if through a combination of reservoir temperature and well flow rate, the well, Powers Ranch No. 1, is capable of producing the equivalent of at least 3 MW_e.

However, Reservoir Capacity Confirmation still remains to be accomplished before GKI can prudently embark upon Phase II, Plant Construction and Operation. At least one or two additional wells should be drilled and tested, depending on the size of the power plant that will be constructed.

The multiple wells completed will provide the information necessary to make an adequate reservoir assessment to determine that the reservoir capacity will support the project over its lifetime.

GKI has made inquiries in the capital market, and it believes that project financing can be secured to complete reservoir assessment and Part II, providing Part I is successfully demonstrated.

The Air Force can assist GKI in implementing Phase I by contributing the $1 million towards the project. For sharing in the risk, GKI proposes to sell to Williams AFB any power generated, up to 12.3 MW_e at 12KV, at a price equal to the "Avoided Costs" for the Salt River Project Agricultural Improvement & Power District.

Recent discussions with the Rate Department of Salt River Project indicates that the "avoided costs" will be about 10% less than the amount that Williams AFB pays for its power, $.031/Kwh. Adjusting for price escalation over the life of the project, the incremental difference in selling price should prevail to the advantage of Williams AFB.

There are many milestones to accomplish prior to that time, and there will be a need to update data and costs as the project progresses. Therefore, definitive commitments can not be made at this time, but we believe there are reasonable basis on which to negotiate an agreement of intent and understanding so that Part I may proceed.

3. PHASE II - PLANT CONSTRUCTION AND OPERATION

Upon successful completion of Part I and Reservoir Confirmation, Geothermal Kinetics, Inc. will construct a power plant to provide Williams AFB with 12.3 MW_e of power, delivered at 12KV.

The power plant will be of the flash steam type, single or double flash, rather than a binary fluid cycle power plant. The very low power rates paid by Williams AFB requires that the lower capital cost flash steam power with its years of proven reliability, be selected over the binary cycle plant, in order to generate competitive power rates.

The choice of a single flash or double flash steam power cycle will be determined by plant size, which in turn will depend on marketing strategy. The double flash steam plant will enjoy a higher resource utilization efficiency and lower unit costs. Therefore, double flash cycle is the preferred cycle; however, the plant size would have to be at least 25MW_e. Capital requirements would be greater, so the final decision as to type of plant will be deferred until the resource is confirmed and marketing studies are finalized.

3.1. Project Management

3.1.1 Field Production Drilling

The Phase I Project Management team will continue to direct the field development activities in Phase II. Additional production wells will be drilled and tested until sufficient steam production is secured to supply the power plant requirements.

The wells will be drilled on 20 acre centers. The production from each well will be piped to a central flash steam station where the steam will be separated from the brine. The steam will be piped to the power plant, while the brine will be piped to the reinjection wells for disposal.

The steam gathering system will be equipped with automatic controls and a steam venting station to protect the system in the event there is an emergency shutdown of the power plant and a sudden over pressure of the steam system.

3.1.2 Power Plant Construction and Operation

Geothermal Kinetics, Inc. plans to retain the services of Rogers Engineering Co., Inc. of San Francisco to provide engineering, procurement and construction management services required for construction of the power plant. Rogers Engineering Co. has provided similar services on about a third of the world's installed and operating geothermal power plant capacity. This is a record of accomplishment shared by no other engineering firm in the United States. Rogers will prepare a construction bid package, so the plant construction may be obtained on a competitive bid basis. Once the contractor is selected and construction begins, Rogers will provide construction management services as liaison between the contractor and GKI.

GKI will add engineering personnel to its project management. This staff of engineers will monitor the design, engineering and construction phases of the power plant project. They will prepare the operating and maintenance manuals and become the plant operating staff when the plant is completed and ready for start-up.

3.2. Project Schedule

The RFP stipulates that Phase I shall be completed in 12 months and Phase II in 48 months. Geothermal power plants can be completed in 30 months, including two months for plant start-up.

Phase I, resource confirmation, can be easily accomplished in 12 months because GKI will be deepening Powers Ranch No. 1 well rather than drilling a new well for production and reinjection.

The longest time requirement is the ordering and delivering of the well flow test separator. Current quotations state about 20 weeks for delivery. Allowing 9 months for completion of Phase I and 30 months for completion of Phase II allows 21 months for drilling additional wells for reservoir assessment. The 21 months should provide sufficient time to arrange financing and perform the reservoir assessment.

The 60 months allowed for the overall project, therefore, appears adequate.

Rogers

PROPOSAL

FOR

GEOTHERMAL ENERGY DEVELOPMENT

AT

WILLIAMS AIR FORCE BASE, ARIZONA

PHASE II
GEOTHERMAL POWER PLANT
DESIGN AND CONSTRUCTION

Prepared for

GEOTHERMAL KINETICS, INCORPORATED

In response to

UNITED STATES AIR FORCE BASE REQUEST
FOR
PROPOSAL NO. F41689-81-R-0061

OCTOBER 30, 1981

Z-81003-27

Rogers

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Rogers

2.0 INTRODUCTION

2.0.1 Objectives

The goal of this proposal work is to provide cost-competitive electrical energy to Williams Air Force Base through the utilization of nearby geothermal resources. The proposed geothermal power plant will provide all electrical needs for the base at a reasonable cost, and with high reliability, since the geothermal energy is indigenous and essentially noninterruptable.

To meet this goal, the proposed work is based on the following objectives. Rogers Engineering will design, manage the installation of, and complete the startup of a geothermal power plant with an approximate installed gross capacity of 25 MWe. This represents Phase II of the project described in the U. S. Air Force RFP No. F41689-81-R-0061. It is understood that Phase II will proceed only with the successful completion of Phase I, which is designed to provide a realistic assessment of the geothermal resource potential. As a result, funding is not requested for Phase II at this time. Information provided herein is intended to briefly establish the methodology to be used if Phase II proceeds, and to present the experience and qualifications of Rogers Engineering.

2.0.2 Study Approach

Rogers Engineering Co., Inc. is organized on the Project Management concept. All projects are assigned to a Project Manager whose responsibility it is to see that a project is completed on schedule and within budget, utilizing the best possible talent. This project management approach involves task definitions and budget and time allocations for each task to insure that the objectives of that project are attained. Periodic reviews are carried out to insure that each task is proceeding with other tasks. These reviews are also designed to assure real time responsiveness to the specific needs of the Client.

The use of this project management system has contributed to the successful completion of a number of geothermal power plants by Rogers Engineering, including units at the Geysers in California, Hawaii, Krafla in Iceland, and Brawley in the Imperial Valley of California. By the end of 1980, Rogers Engineering had been associated with the installation of over one-third of the capacity of the world's geothermal power plants. All of this experience can be brought to bear to assure the successful completion of a power plant at Williams AFB.

Rogers

2.1 Power Plant Design and Installation

Assuming successful completion of Phase I, this work would entail the following activities in a nearly sequential fashion: conceptual design of the power plant and fluid gathering and injection system based upon reservoir characteristics identified in Phase I, detailed design, specification and procurement of all equipment and materials, management of the construction of the power plant and fluid gathering and injection system, plant startup and testing, and operator training. Interconnection of electrical lines into the base's system is within the scope of this effort.

2.1.1 Plant Description

This power plant will be designed to provide for the entire electrical load of the base, including refrigeration. Excess capacity will be sold to other customers. As stated earlier, this plant would have a gross capacity of 25 MWe and an approximate net capacity of 22 MWe.

There exist three basic types of geothermal power plants: direct steam, flashed steam, and binary fluid cycle. Direct steam plants utilize dry steam produced directly from geothermal wells, and produce electricity with a generator coupled to a low pressure expansion turbine. Direct steam represents a high quality and scarce resource. The Geysers area in northern California is the only known geothermal resource in the U. S. that currently produces dry steam. The flashed steam plant is similar to the direct steam design, except that it utilizes steam flashed and separated from hot water (or a water-steam mixture). This type of plant is often more costly than the direct steam type, since it usually dictates higher well flow rates and lower turbine inlet pressures. The third type of plant is the binary fluid cycle. In this plant, thermal energy from the geothermal fluid (liquid and/or vapor) is transferred to a secondary working fluid in a series of heat exchangers. This secondary fluid is vaporized and subsequently expanded through a turbine coupled to a generator. Secondary fluid from the turbine is condensed and returned to the heat exchangers. The binary plant is normally only considered for lower temperature resources and for those geothermal fluids that are too corrosive to come into contact with power generation equipment.

Although the geothermal resource potential beneath William AFB remains to be assessed, it is probable that the type of power plant to be used in this case will be of the flashed steam design. The reasons for this are as follows: There no indication that a dry steam reservoir exists, ruling out a direct steam design. Secondly, a power plant can not be economically constructed unless the resource temperature is at or above 400°F. Above this temperature, flashed steam plants are usually less expensive than binary plant designs.

For these reasons, the following discussions on power plant design and installation are based upon a flashed steam type of plant. It should be noted, however, that this does not represent a preferred plant type. This decision cannot be made until the resource is evaluated, the needs of the AFB are fully known, and the cash flow analyses have been completed.

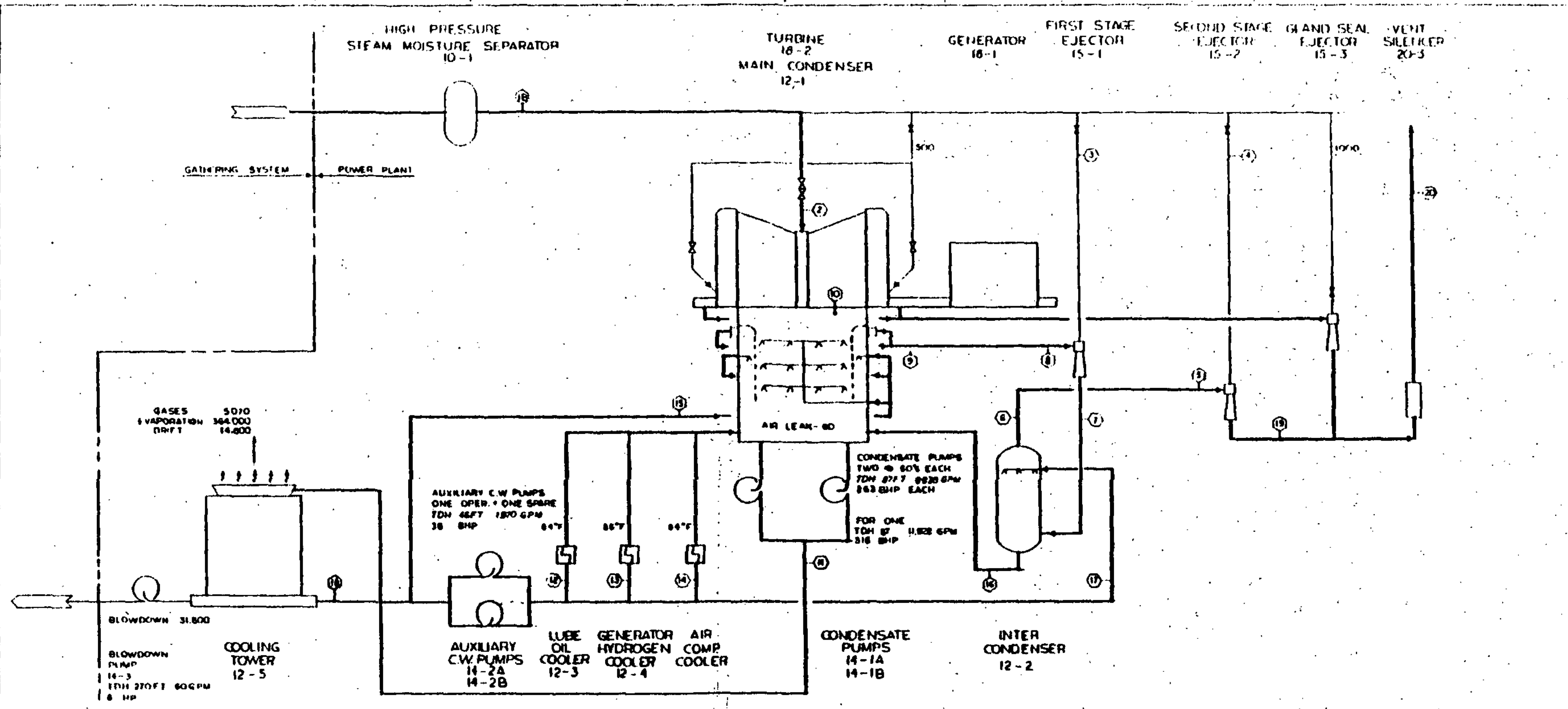
A schematic of a typical geothermal power plant using the flashed steam design is shown in Figure 2.1. Steam that has already been separated from the hot geothermal liquids is shown entering in the upper left hand corner. Primary power plant components and typical flows, temperatures and pressures are shown. The following features should be noted.

A. The steam is at a higher temperature and pressure in this design than expected at the AFB. Lower steam pressures will result in higher steam flow rates for the same power output.

B. The steam turbine shown is a single entry turbine, and accepts steam at one pressure only. Under certain thermodynamic and capacity conditions, it may be economic to generate steam at two different pressures and then inject these steam flows into different sections of the turbine. The decision on a single- or double-flash design cannot be made without additional resource data.

C. The steam condenser shown is a direct contact condenser which mixes exhaust steam with cooling water for condensation. A second major type of condenser is the shell and tube type which separates the cooling water and condensate flow streams. The latter type will most likely be utilized in this design to allow greater control over gaseous emissions from the cooling tower.

D. The plant shown in the schematic is designed for 24 MWe gross generation, and approximately 20 MWE net capacity. It is expected that the proposed unit can probably achieve a 22 MWe net capacity with a gross generation of 25 MWe. The design on the schematic involved several high pressure injection pumps, not expected to be needed in this application.



STREAM No	MOL WT	1B	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
FLOWS IN LB/HR																					
STEAM		424,000	397,300	13,700	11,500	800	800	17,100	3,300	3,300	387,300									12,300	13,800
NONCONDENSABLE GAS		13,520	12,670	440	370	8,040	8,040	8,040	7,600	7,600	12,670	5,070								8,400	8,450
AIR						60	60	60	60	60	60									60	60
CONDENSATE												410,200					18,200				
COOLING WATER												3,519,800	175,000	140,000	20,000	8,538,000	438,980	478,800	9,519,800		
TOTAL		437,520	409,970	14,140	11,870	8,900	8,900	25,100	10,960	10,960	410,030	3,935,070	175,000	140,000	20,000	8,538,000	456,000	478,800	9,519,800	20,770	22,310
TEMPERATURE °F		347.7	347.7	347.7	347.7	100	100		100	100		88.2				80	120.0		80.0		
PRESSURE PSIA		105	96	100	100	47	48	50	1.76	1.86	1.96										
PRESSURE INCH H_g Abs											4.0										
DENSITY LB/FT³												61.7				62.2	61.7				
TOTAL MOLS/HR																					
ENTHALPHY BTU LB		1192	1192	1192	1192						994.4										

[redacted]

FIG. 2.1

20 MW GEOTHERMAL POWER PLANT
POWER PLANT PROCESS FLOW DIAGRAM

E-02-101

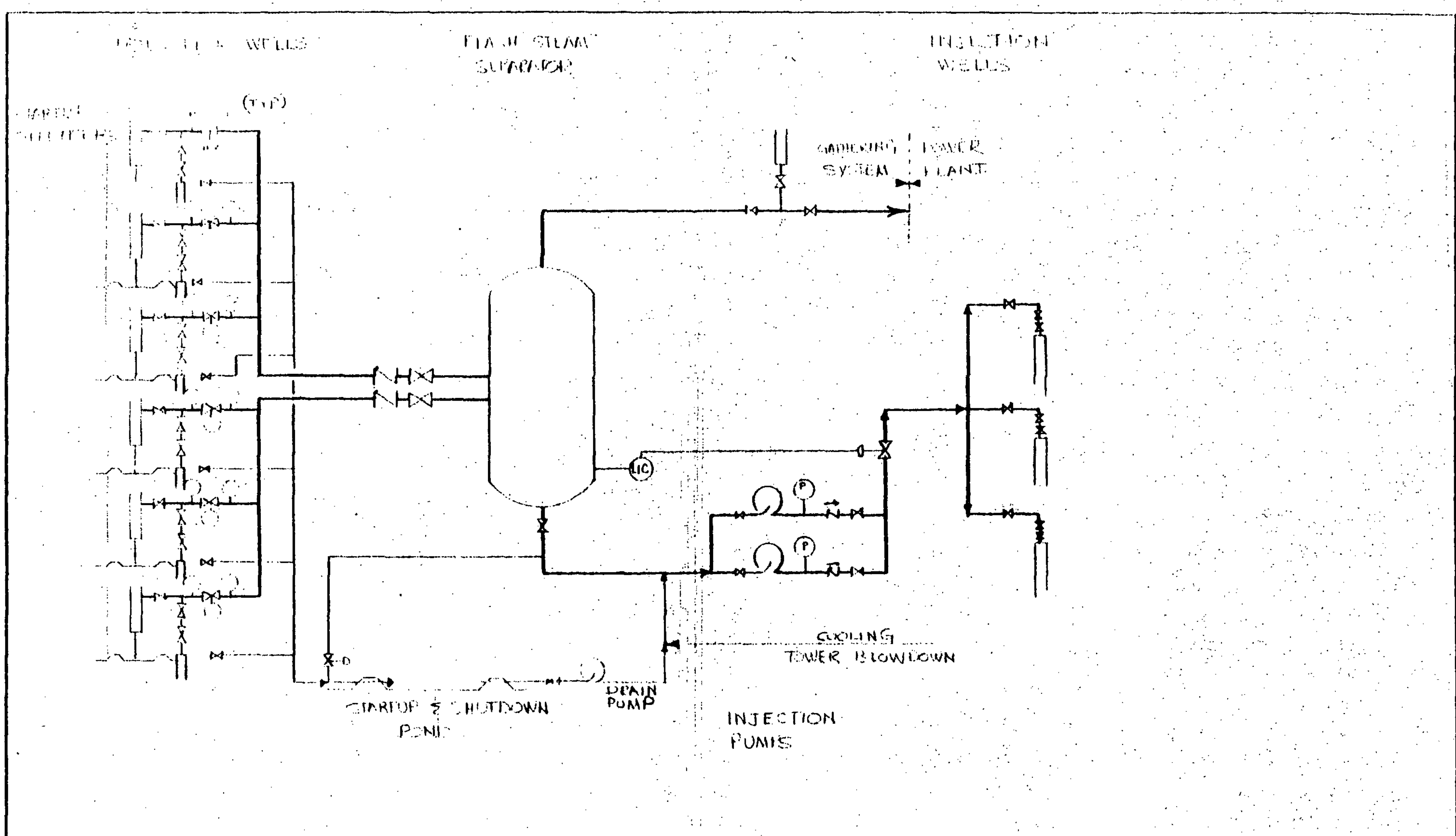
Rogers

Figure 2.2 depicts a typical geothermal fluid gathering and injection system. Water and steam from production wells is gathered in a piping network which leads to a steam separator. The steam from the separator is sent to the power plant and the waste liquids are pumped into injection wells, as shown. Flow silencers and ponds are also indicated for disposal of fluids during startup and shutdown.

The power plant and gathering and injection system involve a large number of subsystems that must be integrated from conceptual design all the way through startup and testing. In Phase II of this project, Rogers will develop these subsystems from concept through to testing and startup. Major subsystems are listed below.

Power Plant

- Steam turbine with steam valving and controls, lubricating oil and gland seal system, turning gear and instrumentation.
- Generator with excitation and voltage regulation system, hydrogen generator cooler, electric tachometer, temperature detectors, current transformers, surge protection equipment, space heaters and a seal oil system.
- Steam cleanup system including moisture separators and steam strainers.
- Steam condenser and noncondensable gas ejectors with intercondenser, aftercondenser and vent silencer.
- Cooling tower including fans and fan drives and water distribution equipment.
- Main and auxiliary cooling water pumps.
- Instrument air compressor.
- H_2S abatement systems
- Fire control systems
- Plant instrumentation
- Power plant building including control room and operating areas.
- Electrical substation and interconnections to AFB station.



ROGERS ENGINEERING CO., INC. ENGINEERS & ARCHITECTS 111 PINE STREET, SAN FRANCISCO, CALIF. 94111	GATHERING & INJECTION SYSTEM FLOW DIAGRAM		
SCALE: DATE	APPROVED: DATE	JOB. NO.	REV.
DR. CHK. ENG. APPROVED:		FIGURE 22	

REV. DATE REVISION DR. CHK.

Rogers

Gathering and Injection System

- Piping and valving for gathering of production fluids.
- Vent silencing equipment and fluid disposal ponds for each production well.
- Flashed steam separation vessel(s) and control systems.
- Main startup and bypass ponds.
- Steam pre-treatment system (if required)
- Fluid treatment system prior to inejction for silica control.
- Injection pumping system
- Piping and valving to injection wells.
- Instrumentation

2.1.2 Schedule

The overall Phase II schedule is based upon a 36 month design, procurement and construction schedule. The 36 month schedule is an appropriate length of time permitting several manufacturers capable of supplying new turbine-generators of geothermal desigh to quote. This schedule represents a shorter time span than stated in the RFP (48 month). A brief milestone log is included at the end of this section, along with the Schedule in Figure 2.3.

Design:

The schedule allows 4 1/2 months to finalize the process flow diagrams which are the basis for preparation of specifications for purchase of major power plant equipment. The total design period required will be 18 months. Preparation and finalizing of process and instrumentation diagrams and the electrical single line diagram will continue throughout the design period.

Procurement:

Twenty-three months have been allowed for bid, bid evaluation, award and delivery of Owner supplied power plant equipment and material. This length of time is dictated by the delivery schedule for the

Rogers

turbine-generator. Three months have been allowed for bid and award of the turbine-generator contract. Twenty months have been allowed for delivery of the unit. All other major power plant equipment including the condensers, cooling tower, gathering and injection system piping and material, and electrical switchgear and power transformers can be bid, awarded and delivered in this length of time.

Construction:

Construction will begin with site preparation, 10 months after start of work, and continue through commercial operation at the end of 36 months.

Sixteen months have been allowed for site preparation, major foundation construction and building construction. Installation of the cooling tower and condenser will start near the end of the building construction period and continue for three months. During the following six months the construction activities will involve the installation of the turbine-generator and power plant auxiliary systems.

Eight months has been allowed for installation and testing of the gathering and injection system.

Start-up and Testing:

Three months has been allowed for start-up and testing of the power plant electrical, mechanical and process systems.

Rogers

MILESTONE LOG

DESIGN/PROCUREMENT

Month	
1	Start Project
2	Complete Preliminary Design
6	Finalize Process Flow Diagrams
10	Completion of Major Equipment Specifications
18	Complete P&ID and Electrical Single Line
19	Complete Construction Drawings (Power Plant and Gathering and Injection Systems)

CONSTRUCTION

Month	
10	Start Site Preparation
14	Complete Site Preparation
19	Complete Major Foundations
22	Start Installation of Gathering and Injection System
26	Complete Building Enclosure
28	Complete Installation of Condenser and Cooling Tower
30	Complete Installation of Gathering and Injection System
31	Turbine-Generator Delivered to Site
35	Complete Installation of Turbine-Generator
35	Start-up System Checkout and Test
36	Complete Installation of Power Plant Auxiliary Systems and Building Construction
36	Commercial Operation

ROGERS ENGINEERING CO., INC.
ENGINEERS & ARCHITECTS
111 PINE STREET
SAN FRANCISCO, CALIF. 94111

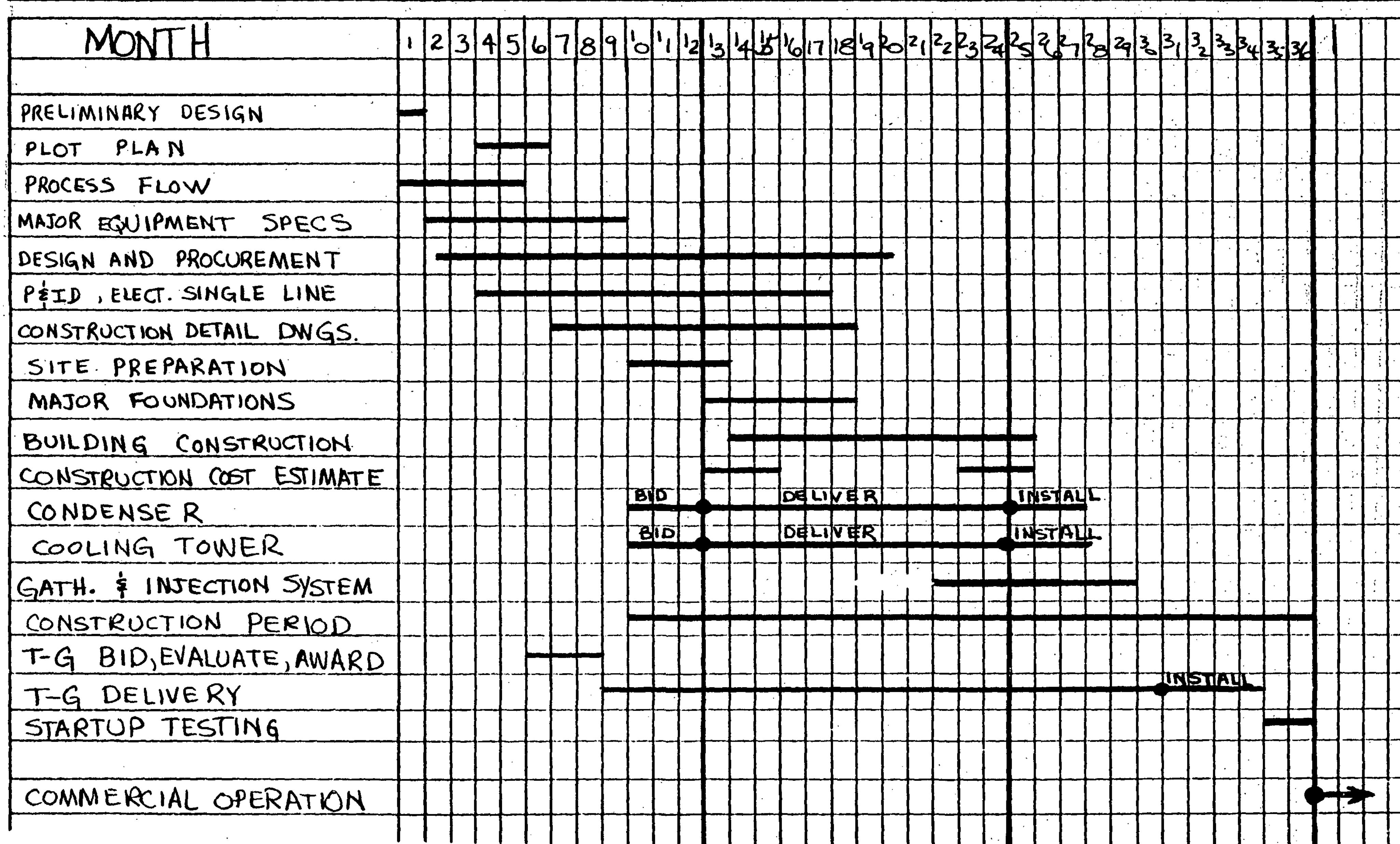
Z-81063-27

FIG. 2.3

PRELIMINARY SCHEDULE

PROJECT: PHASE II - 25 MWe GEOTHERMAL ELECTRICAL GEN. PLANT

WILLIAMS AIR FORCE BASE - GEOTHERMAL POWER PLANT



Rogers

2.1.3 Approximate Costs

This section is included to provide approximate costs for a typical geothermal power plant. It is based upon the power plant and gathering and injection system depicted in Figures 2.1 and 2.2, and assumes startup of work in January 1983 and commercial operation in January 1986. The cost of drilling and completing production and injection wells is not included. Interest and inflation rates are assumed to be 7% per annum. A number of factors may increase or decrease these figures and they should be treated as working numbers only.

	Power Plant	Gathering and Injection System
Construction Cost (1/83)	$16,770,000	$5,200,000
Escalation	2,300,000	710,000
	$19,070,000	$5,910,000
Interest during Construction	1,350,000	$ 415,000
	$20,420,000	$6,325,000
Professional Services (1/83)	2,400,000	$ 415,000
	$22,820,000	$6,740,000

Total Cost (w/o wells) = $29,560,000

or $1,232/kWe gross

Rogers

2.2 Rogers Qualifications and Experience

2.2.1 General

This proposal offers a capable and experienced team of geothermal engineers to assist Geothermal Kinetics and the Williams Air Force Base in developing a promising geothermal resource and installing a reliable and cost competitive source of electric power. Rogers Engineering feels that good power plant design which results in reliable power generation doesn't just happen; it is the cumulative result of firsthand knowledge of the geothermal resource, sound engineering practice, and experience developed from other similar projects.

Rogers Engineering has been in the geothermal business since 1961. They designed the following operating geothermal power plants: Krafla in Iceland, Southern California Edison plant at Brawley, the HGP-A Wellhead generator on Hawaii, the first two 110 MW power plants in the Philippines (preliminary design), The Geysers Units 5 and 6 (partial design) and 7 and 8. They have conducted resource exploration, reservoir development and power plant design studies at Tiwi and Los Banos in the Republic of the Philippines, Costa Rica, El Salvador, Iran, Turkey and at numerous U. S. locations such as Roosevelt Hot Springs, the Salton Sea, and Marysville, Montana. In fact, by the end of 1980, Rogers had been associated with the installation of over one-third of the capacity of the world's geothermal power plants. Activities of Rogers Engineering in the above projects have included not only engineering design but also equipment procurement, construction management, operator training, start up, and supervision.

Rogers has also had considerable experience in working on or near military bases. Their familiarity with military standards and protocol will aid in achieving an efficiently managed project.

Examples of geothermal power plant projects and projects on military bases are listed in the next subsection to provide an overview of Rogers' experience and qualifications. This section is followed by a number of resumés of key personnel.

Rogers

2.2.2 Descriptions of Completed Projects

Geothermal Experience

Iceland - Krafla
Brawley
Hawaii
Philippines - Tiwi and Los Banos
The Geysers - Units 5 and 6
The Geysers - Units 7 and 8
Costa Rica - Miravalles
Iran
Turkey - Kizildere
Roosevelt Hot Springs
Magmamax Power Plant

Projects on Military Bases

Mare Island Naval Shipyard
U. S. Naval Base, Subic Bay, Philippines
Naval Air Station, Alameda, California
Clark Air Force Base. Philippines
Anderson Air Force Base, Guam

Rogers

PROJECT

Krafla Geothermal Project
Krafla Executive Committee
Appointed by the Iceland Government
Ministry of Industries
Akureyri, Iceland

Description

The Krafla Geothermal Electric Power Plant Project is the first commercial electric power plant in Iceland using geothermal fluids for the steam supply. A joint venture was formed between Rogers Engineering Co., Inc. and an Icelandic consulting engineering firm to provide the design, equipment and contractor procurement, construction management, and start-up services.

The process characteristics of the power plant are:

- Two 30 MW turbine generator units
- Double flash of geothermal fluid
- Two inlet steam pressures to turbine

Rogers' background of having already designed operating geothermal plants in the United States was helpful to the successful completion of the Krafla power plant. Rogers responsibilities for this project included development of the major power plant equipment specifications, bid evaluations and recommendations, process design, mechanical equipment layout and piping, instrumentation, electrical substation, station service and control supplies, assistance during construction for design interpretation, on site start-up engineers, and preparation of operations manuals.

The project was built on a very short schedule in spite of two national strikes, a volcanic eruption, and Icelandic winters. The project started in November 1974, and commercial power from the first unit came on line in February 1978.

The National Energy Authority (NEA) of Iceland undertook the drilling, steam procurement, and design and construction of the gathering system to the power plant building. The State Electric Power Works (RARIK) planned for, designed and built the power transmission lines to the substation.

Construction Cost

$30,000,000

Rogers

PROJECT: BRAWLEY 10 MW GEOTHERMAL POWER PLANT
Imperial Valley, California
Southern California Edison Company
Rosemead, California

Description: This geothermal power plant is a prototype 10 MW geothermal power plant designed to generate electric power on a commercial basis from the highly saline geothermal reservoir in the Imperial Valley in southern California. The steam supply to the plant is produced by Union Oil Company of California by flashing the hydrothermal resource in a proprietary process to provide steam of a quality acceptable for use in a conventional geothermal steam turbine. The electric power generated by the plant is marketed by the plant owner, Southern California Edison Company.

The power plant is a single nominal 10 MW turbine generator condensing unit having a single steam inlet and top exhaust to a grade level surface type condenser. Noncondensable gases contained in the steam are extracted from the main condenser by a first stage steam ejector condenser system followed by a second stage vacuum pump system discharging to atmosphere through vent silencers. All condensate generated by the plant is returned to the steam supplier. Cooling water make-up for main steam condenser and other auxiliary cooling requirements is supplied by the Imperial Irrigation District from selected locations in its irrigating canal system. Steam quality monitoring stations and revenue metering stations are provided to ensure steam supply contract compliance. Electric power generated by the plant is connected into the Imperial Irrigation Districts transmission system at the plant switchyard.

Services provided by Rogers Engineering for this plant included: critical path scheduling of all design and procurement activities; preparation of preliminary and final design, construction drawings and specifications for the complete power plant; and development of process plant layout and site preparation; buildings and structures for turbine-generator, control room, offices, laboratory and maintenance shop, tool room and spare parts storage; cooling tower; cooling water make up pipe lines and all on-site steam, condensate, cooling water, fire protection, drainage and utility piping; and electric switchyard. In addition, Rogers prepared the specifications for purchase of major equipment and all other Owner-furnished materials and equipment, and performed the complete procurement services including purchase order preparation, associated expediting, cost control scheduling and disbursement of funds to all contractors and suppliers.

Rogers

BRAWLEY 10 MW GEOTHERMAL POWER PLANT (Cont'd)

Rogers also initiated an operator training program and performed the start-up of the unit for turnover to the Client for commercial operation.

This project was designed, constructed and put in operation in a period of 23 months from date of authorization to proceed and is the first commercial electric power generation obtained from the extensive geothermal reservoir in the Imperial Valley.

Construction Cost: $8,000,000 (rounded)

Rogers

PROJECT:	HGP-A Wellhead Generator Proof of Feasibility The Research Corporation of the University of Hawaii

Description

The HGP-A Wellhead Generator Proof of Feasibility Project was established to demonstrate that a geothermal hydrothermal resource in Hawaii can be utilized to generate reliable electric power. The project utilizes an existing geothermal well in the Puna District on the Island of Hawaii.

The well has a nominal flow sufficient to supply a 3 MW plant which is the basis for the plant design. The plant includes a unique H_2S abatement system for control of the H_2S emissions content in the noncondensable gases. The turbine-generator unit features a single pressure, single flow condensing turbine. Construction has now been completed and start up tests are now underway.

Rogers' responsibilities for this project include preliminary design; preparation of major power plant equipment specifications, bid evaluations and recommended manufacturer; process design; mechanical equipment layout and piping; all electrical systems design for substation, station service and control supplies; preparation of construction contract documents, bid solicitation and recommendations for contract award; construction surveillance services; on site start-up engineering services, preparation of operations manuals; and a training program for operating personnel. The consulting engineering services for the site development and civil/structural design were provided by a local Hawaiian firm under subcontract to Rogers.

Construction Cost: $7,500,000

Rogers

Project	Preliminary Design of Philippines Geothermal Power Plants Tiwi and Los Banos, Philippines National Power Corporation Manila, Republic of Philippines
Description	Rogers Enginerring completed the preliminary design, construction cost estimate, and economic analysis for two 100 MWe electric power plants in the Philippines, one at Tiwi and the other at Los Banos. Each 100 MWe plant consisted of two 50 MWe units, powered by geothermal steam obtained from hot water wells. A double-flash system design was used with dual entry turbines. Final design and construction were completed by Mitsubishi Heavy Industries.
Construction Cost	U. S. $66,000,000

Rogers

PROJECT — The Geysers Geothermal Project - Units 5 and 6
The Geysers, Sonoma County, California
Pacific Gas and Electric Company
San Francisco, California

Description — Rogers Engineering Co., Inc. was retained to provide the architectural, civil, structural, design and construction drawings for the geothermal power plant known as "Units 5 and 6." In addition, we provided for this project the mechanical and electrical design drawings relating to the power plant building facilities.

The work performed by Rogers Engineering was basically a support service to the Engineering Department of Pacific Gas and Electric Company, and was originated in view of the large design load of the power company and the short time requirements for producing the construction and bid documents for this project.

The project involved development of complete construction drawings, survey data reduction, project control, design of structural elements, as well as architectural requirements for the building. The site grading for this project was of major importance due to the location of this plant on what had been a mountainous ridge which had to be graded level so that there was sufficient room, not only for the power plant and its cooling tower basin, but also an access road.

This plant, at the time of its design, was the largest geothermal plant to be designed and built, in the world, and was the predecessor for Units 7 and 8, and 9 and 10, which have been subsequently designed and built.

Construction Cost — $12,000,000

Rogers

PROJECT	The Geysers Geothermal Project - Units 7 and 8 The Geysers, Sonoma County, California Pacific Gas and Electric Company San Francisco, California
Description	Units 7 and 8 generate a gross electric power of 110 megawatts. This plant is one of the largest geothermal generating plants in the world. Rogers Engineering Company, Inc. was retained to provide the complete design for the construction and installation of the two 55 MW units (Units 7 and 8). Some of the specific elements performed by Rogers Engineering included: site studies and final siting of the powerhouse, cooling tower, step-up transformer substation and other site related equipment based on economic earthwork analysis, optimum access approach analyses and topography data obtained from the site; preparation of design and construction drawings and specifications for: all foundations, structures, powerhouse building, cooling tower basin and equipment foundations and supports; piping systems for steam, cooling water, lubrication, fire protection, etc., including thermal and seismic piping stress analysis and location and design of required system anchors and restraints; complete interior and exterior electrical power distribution, supervisory control and lighting systems, building mechanical systems; and general plant instrumentation and control systems including interfacing with vendor supplied control packages. After construction contracts were awarded, Rogers provided consulting services in interpretation of plans and preparation of field sketches required to accommodate to field conditions, reviewed and evaluated Contractor- and Owner-generated construction change orders to provide the client with construction cost control.
Construction Cost	$12,000,000

Rogers

PROJECT Miravalles Geothermal Project
Guanacaste Province, Costa Rica, Central America
Instituto Costarricense de Electricidad (ICE)
San Jose, Costa Rica

Description The Miravalles Project consisted of the first three phases of geothermal development directed at installing the first geothermal electric power plant in Costa Rica. The project included an evaluation of all scientific data on geothermal resources collected by ICE in the Pailas-Hornillas Zone of the Cordillera Volcanica de Guanacaste, which is in the Northwestern part of Costa Rica, not far from the border of Nicaragua. This zone has active surface manifestations which indicate a prime geothermal resource. Following the data evaluation, geologic and geophysical surveys were conducted by ICE with Rogers' assistance, with the objective of locating the sites for exploratory wells to be drilled in the next phase of work. The second phase of the project was the drilling and testing of three production sized exploratory wells, and the reservoir assessment. The third phase was a feasibility study for the installation of a geothermal electric power plant.

As managers of this project, Rogers engaged specialists to assist in implementing the first-phase exploration effort in geology, geophysics, geohydrology and geochemistry. All work was accomplished by combining the efforts of Rogers, the geotechnical consultants and ICE's own scientists. A prefeasibility report that designated the optimum test well sites concluded this phase.

During the second or test well drilling phase, Rogers provided detailed consultation on design of drill sites, drilling specifications, solicitation and award of drilling contract, purchase of materials, and during actual drilling, furnished a resident drilling supervisor. Three successful hydrothermal wells were drilled out of three sites tested. Rogers designed and purchased a custom steam separator well test system, then provided a resident well test engineer to supervise testing of the wells. A reservoir assessment of available steam reserves concluded the second phase.

The feasibility study (third phase) included: (1) analysis of the chemical and thermodynamic characteristics of the geothermal resource; (2) preliminary design and cost estimate of the power generation equipment, power plant building geothermal well field, steam gathering system, waste fluid reinjection system and power distribution system; (3) projection of Costa Rica's power demand growth; and (4) economic analysis of the optimum rate of integration of geothermal power development with future hydro power development potential.

Rogers

Project	Iranian Geothermal Study Northwestern Iran - Sabalan, Sahand, Damavand, Khoy, Maku Ministry of Energy Imperial Government of Iran
Description	Rogers Engineering and GeothermEx Company conducted a resource exploration program including geological, geohydrological and geochemical studies. The project was intended to proceed through drilling and testing exploratory wells, reservoir assessment, feasibility studies, and design and construction of a power plant. Project operations were suspended as of May, 1979 due to internal problems in the country.
Construction Cost	Not Available

Rogers

PROJECT — Kizildere Geothermal Power Plant Feasibility
Menderes River Valley, Western Anatolia, Turkey
United Nations Development Programme (Special Fund)

Description

The United Nations Development Programme (Special Fund) has agreed to assist the Turkish government, in a survey of the geothermal energy potential in West Anatolia. Jointly with the staff of Maden Tetkik ve Arama Enstitüsü they have developed the Kizildere Field in the Menderes River valley, which has proved to be a significant geothermal area. Currently, the wells installed and tested are capable of flash flowing sufficient hot water to generate about 30 MW of electric power

Rogers' project scope included a feasibility study on generation of electricity, technical field assistance with well testing programs, and evaluation of test results.

Analysis and evaluation of well tests and geothermal hot water chemical composition brought about normal geothermal technical considerations which were developed: calcite deposition, well plugging, hot water flashing and hot water disposal.

Two geothermal alternatives were studied: a flashed steam system and a closed geothermal cycle (binary cycle generation). Consideration was given to the environment and the geothermal characteristics in the recommendation of a binary cycle for this project.

Rogers prepared complete plot plans, process flow diagrams, electrical single line diagrams, and architectural rendering of the completed plan. Preparation of capital costs, operating and maintenance cost was made to evaluate alternatives. An economic analysis was provided which from capital and operating costs showed its benefit/cost ratios in relation to generation costs from conventional power generating facilities.

The feasibility study report depicted the technical facets of the consideration as well as a summary and recommendation.

Construction Cost - Subject to approval of client

Rogers

Project	50 MWe Geothermal Power Plant Roosevelt Hot Springs Milford, Utah Utah Power and Light Company
Description	Rogers Engineering conducted power plant optimization studies based upon known resource characteristics to develop a preliminary design of the power plant. Cost comparisons were made with other types of electric generation plants.
Construction Cost	Not Available

Rogers

PROJECT — Magmamax Power Plant Feasibility Study
Magma Energy, Inc.
Los Angeles, California

Description — This project involved a comprehensive engineering study and the development of a preliminary design complete with a construction cost estimate and economic analysis for a nominal 10 MW prototype electric generating plant utilizing a geothermal energy source through a binary heat exchange cycle. The initial design concept was performed by J. Hilbert Anderson for Magma Energy Inc. and essentially considers a dual heat cycle employing isobutane as the working fluid utilizing heat from pumped hot geothermal well water through a heat exchange system.

Services provided included materials selection based on field test data, heat balance calculations, complete preliminary plant design, development of equipment purchase specifications, and economic evaluation for feasibility analysis.

Estimated
Construction Cost - $3,000,000

Rogers

PROJECT	Electrical Distribution System Improvements - Final Design U. S. Navy Mare Island Naval Shipyard Vallejo, California
Description	The existing 12 kV distribution system lacked capacity to meet a planned expansion program. Also, the system needed improvements in reliability to meet the Shipyard's needs and requirements. Based on engineering and economic studies a new system with improved reliability was designed for a five year period for an increase in load from 25 MW's to 39 mva. System modifications consisted of: (1) Three new substations, (2) modifications to sixteen existing substations, (3) three new 12 kV primary network loops, (4) twenty-eight new 12 kV power circuit breakers, (5) new pilot wire and directional relays, (6) new supervisory control and indication system from one master station with sixteen remotes. The supervisory system included 99 control points, 79 telemetering points, and 217 scanned points, (7) prototype design of pier 8000 ampere terminal hoods which are the point of connection of the 480 volt power from shore to ship. These terminal hoods also contain control facilities for local control and on-board control of breakers which are located in transportable unit substations. Services provided included design preparation of construction drawings and specifications, protection and coordination studies with recommended relay settings.
Construction Cost	$1,960,000

Rogers

PROJECT	Electric Distribution System Improvements Naval Facilities Engineering Command United States Naval Base Subic Bay, Philippines
Description	Installation of 69 kV system tie between Subic Bay Naval Base system and the National Power Corporation including a 40 mva substation, and tie-line load control for use with an existing 26 MW diesel plant, supervisory control and associated system protection. The work also included improvements of the 13.8 kV distribution system to improve reliability and provide capacity for the planned 40 megawatt system. Engineering services included the preparation of construction drawings, specifications, cost estimates and aid during construction.
Approximate Construction Cost	$1,500,000

Rogers

PROJECT Electric Distribution System Improvement
Naval Air Station
Alameda, California

Description Replace six utility feeders with one new incoming main substation service. Superimpose two 12 kv network distribution system son an existing 4 kv system and relocate existing 12 - 4 kv transformation to the load centers of the 4 kv system. Convert the largest building (over 900,000 sq. ft.) from a 4 kv to 12 kv primary distribution system and install 12 kv system on Pier 3. Construct supervisory system and telemetering.

The project included 63 cubicles of 12 kv switchgear, 11 unit substations and 117,000 linear feet of 15 kv cable.

Services provided included design and the preparation of construction drawings and specifications for the project.

Construction Cost $4,284,630

PROJECT Power System Study
Naval Air Rework Facility Building Low Voltage Systems
Naval Air Station
Alameda, California

Description Field investigation of the low voltage electric systems in a large aircraft rework building (over 900,000 sq. ft.) including survey of existing equipment and power loads to determine the adequacy of the existing system to meet future planned expansion and the new interrupting duties imposed by the new 12 kv primary distribution being planned for the building.

Engineering services included the field investigation, system and load analyses, preparation of drawings defining the existing low voltage systems, and preparation of a report summarizing system modification recommendations and cost estimates.

Rogers

PROJECT	Power System Expansion U. S. Air Force Clark Air Base, Philippines
Description	Comprehensive power system study and detailed design planning for 100% system expansion (from 20 to 40 MW) including commercial power tie and control provisions and final engineering, design, and installation supervision of a generating plant with eight 1,000 kV diesel electric units.
Construction Cost Approximately	$5,000,000

Gas Turbine-Driven Electric Power Generator
U. S. Air Force - Clark Air Base
Pampanga, Philippines

The project involved engineering and design for the installation of one 10,000 kW diesel-fueled gas turbine-driven electric generating unit, which utilized an aircraft type Pratt & Whitney gas turbine engine. This generating unit was installed as an addition to the existing diesel engine-driven electric power plant at the base and is complete with interconnections with the Air Base system and the utility.

Rogers Engineering Co., Inc. prepared equipment purchase specifications and all necessary construction drawings and specifications for the installation of the unit.

Construction Cost: $1,200,000

Rogers

Air Base Hydrant Refueling Projects
USAF, Anderson AFB, Guam, M. I.
USN, Naha Air Base, Okinawa, R. I.

Complete design of 3-product, semi-underground, high-pressure terminal, tank farm, and pumping station survey, evaluation, reloading, and redesign of 15 miles of 14-inch and 8-inch product lines; review and revision of pipeline control and communication system; design of electric power system; inspection of construction.

Design of underground storage tanks, 19 miles of 6-inch product transfer pipeline, double truck loading facility, manifolding for 4-product transfer pumping station, electric power for the facilities and inspection of construction.

Design modifications for POL storage, transfer and dispensing facilities including redesign and relocation of 20 miles of 8-inch product and water pipelines, dockside tanker unloading facilities (4-product), design of a pipeline control and communications system and electric power supply. Work included inspection of construction.

Design of 7-product undersea tanker unloading facility, including connection of island-wide grid, undersea POL lines, tanker moorings, undersea ship-shore communications system and inspection of construction.

Design of five 2-product unloading storage and truck loading facilities including POL transfer lines from tankage to pier, pier to unloading points, design of tankage, truck loading and drum-filling facilities.

Design of 7-product, ship-unloading booster station including semi-underground pump-house, machinery and manifolding; connecting pipeline to shore valve-box, engine auxiliary piping, sanitary plumbing and electrical facilities.

Rogers

Resumés

Rogers Engineering Co., Inc.

Herbert Rogers, Jr.
Fred D. Dunn
Ronald A. Walter
H. I. Rogers
John H. G. Stuart
Bruce Fraser
William W. Lindsay
Frank Prendergast
Winston F. Bott
Donald R. Brewer

Rogers

HERBERT ROGERS, JR.

POSITION

Chairman of the Board and President

EXPERIENCE

Mr. Rogers, as President, is responsible for overall administration of both the overseas and domestic operations for Rogers Engineering Co., Inc. In this capacity, he actively supervises the planning of projects, with particular attention to contract negotiations and project financing arrangements with financial institutions, both local and international.

Since founding his firm in 1946, Mr. Rogers has maintained a keen interest in the solution of special problems and new technology areas where the state-of-the-art is not yet clearly defined or well developed. This has resulted in the growth of a nucleus of highly skilled and creative engineers within the firm, which has been responsible for the successful completion of a number of unusual projects.

ROGERS entered the geothermal resource field in 1961, when it was in its infancy and sophisticated methods of utilization were being developed. Some nineteen years later, ROGERS has participated in, and is continuing in, the development and utilization of geothermal resources at locations in the United States, Iceland, Costa Rica, Iran, Turkey, the Republic of the Philippines and Hawaii.

By the end of 1980, ROGERS had participated in the engineering of over one-third of the capacity of the world's geothermal-electric generating plants. ROGERS engineers have developed a system for controlling the deposition of solids from highly mineralized geothermal fluids. This research resulted in U. S. Patent No. 3,782,468, "Geothermal Hot Water Recovery Process and System".

Mr. Rogers participated in the preparation of a portion of the Hickel Geothermal Report as Co-Chairman of the Geothermal Utilization Panel. He is a former member of the Board of Directors of the Geothermal Resources Council.

Under the direction of Mr. Rogers, the firm has successfully completed a diversity of projects for major industrial firms on the West Coast, all branches of the armed forces, U. S. Government Agencies, and the governments of the Philippines, Thailand, and Guam.

Rogers

HERBERT ROGERS, JR. (Page 2)

EXPERIENCE

Power systems projects, under Mr. Roger's direction, have included design and supervision of the installation for geothermal, thermal-electric, diesel-electric and hydroelectric generating plants, both in the United States and overseas. The engineering of the associated electrical transmission and distribution systems has also been a major part of the firm's operations, including the design of several hundred step-down substations ranging in voltage from 220 kV to 4.16 kV.

Rogers Engineering, under the supervision of Mr. Rogers, has actively participated in the engineering design for petroleum and chemical processing facilities; and also for bulk handling systems for asphalt and petroleum, including military and commercial airport hydrant refueling systems.

EDUCATION

Polytechnic College of Engineering, Bachelor of Science in Electrical Engineering, 1937

REGISTRATION

Registered Electrical Engineer, California

MEMBERSHIPS

The Engineers Club of San Francisco, Institute of Electrical and Electronic Engineers, Illuminating Engineering Society, The World Trade Club, Geothermal Resources Council

Rogers

FRED D. DUNN

POSITION Vice President

EXPERIENCE

Mr. Dunn has over thirty-five years of experience in all phases of engineering design and project management of electric power, industrial, and process facilities for public utilities, industrial complexes and government installations, in both domestic and international applications.

As a firm principal in charge he has been responsible for the supervision of the preparation of feasibility studies, economic analyses, and conceptual, preliminary, and final design for a multitude of projects in the fields of electric power generation and distribution, steam generation and distribution systems, petroleum products storage and transfer facilities, and miscellaneous chemical process and industrial manufacturing plants.

On electric power generating projects Mr. Dunn has performed as firm principal and/or engineer in charge for preparation of design and construction drawings for (a) four hydroelectric power plants (120 MW each); (b) a major heavy fuel-fired total energy diesel-electric plant (50 MW); (c) several geothermal electric power generating plants including a single wellhead unit (3 MW) in Hawaii, a two unit (30 MW each) 60 MW plant in Iceland, a single unit 10 MW plant in California's Imperial Valley, two 2-unit (55 MW each) 110 MW plants at PGandE's Geysers geothermal power plants in California; and (d) a number of small diesel-electric stations (5 MW +) and standby and emergency power installations for utilities and government installations.

In the geothermal field, Mr. Dunn has been directly involved in the performance of a geothermal well testing and report program for a geothermal well in California's Imperial Valley; preparation of well drilling contracts and procurement of drilling accessories and tools for a well drilling program in the Philippines; preparation of numerous studies and publications on geothermal conversion systems and gathering and injection systems analyses and evaluations; and in development of feasibility studies, preliminary designs and cost estimates for numerous geothermal power generating plants.

Mr. Dunn's background also includes environmental engineering and pollution abatement studies and projects for H_2S abatement at geothermal power plants, solid and gaseous waste incineration, industrial fume control and chemical and industrial waste treatment facilities.

EDUCATION University of Nevada, Bachelor of Science, Mechanical Engineering

REGISTRATION Professional Mechanical Engineer, California, Nevada, Arizona and Montana

MEMBERSHIP Consulting Engineers Association of California

Rogers

RONALD A. WALTER

POSITION

Senior Mechanical Engineer

EXPERIENCE

Mr. Walter has ten years of experience in the conduct of research, development and engineering studies associated with energy resource utilization. In eight of these years, work has been primarily in the development of geothermal energy resources. Activities and responsibilities in geothermal energy have included:

- program manager at a National laboratory responsible for geothermal energy research projects in resource exploration, power plant design, production economics, environmental impacts, geochemical interactions and reservoir engineering.

- project manager for development of a computer model simulating the operation of a geothermal power plant. This model includes thermodynamic, mechanical, chemical and financial considerations. Direct steam, flashed steam, binary fluid cycle and total flow plant designs were modeled.

- conducted power plant optimization studies for a variety of geothermal power plant design and operating conditions.

- studied environmental impacts associated with geothermal energy development, including gaseous effluents, liquid and solid waste disposal, subsidence and induced seismicity.

- developed monitoring instrumentation systems for binary fluid cycle power plants designed to detect adverse chemical and material performance changes.

Mr. Walter's experience in other energy technology projects include the development of improved methods for mechanical transport of solid materials at high pressures during coal gasification processes, development of a laser doppler velocimeter, design of a self-contained instrument for detection of rock movement in underground mines, and the design and testing of a high speed non-contact examination system for detecting flaws in ammunition casings. He worked for two years on the development of improved dry and wet/dry cooling tower designs for nuclear and fossil-fuel power plants. In this project, Mr. Walter conducted comparison studies on advanced extended surface designs for heat rejection, developed advanced wet/dry cooling tower designs, designed and managed the installation of a Water Augmentation Test facility to test advanced wet/dry designs, and conducted optimization studies on a variety of wet, wet/dry, and dry heat rejection systems.

Rogers

RONALD A. WALTER (Cont'd)

EDUCATION	M. S. Degree in Mechanical Engineering, Oregon State University, 1976 B. S. Degree in Mechanical Engineering, University of Nebraska, 1971
REGISTRATION	Engineer-In-Training Certificate - Mechanical Engineering, State of Nebraska
MEMBERSHIPS	American Society for Mechanical Engineers Geothermal Resources Council International Society for Geothermal Engineering

Rogers

H. I. ROGERS

POSITION

Senior Electrical Engineer
Vice President

EXPERIENCE

Mr. Rogers has had extensive experience in the electric utility and computer applications fields. He has professional experience in planning, engineering design, economics, systems analysis, management of projects, and construction management.

Geothermal experience includes: project management, construction management, specifications, design criteria, capital and operating cost determinations, cost of electric power, project financing and overall economic analysis.

Electric Utility experience has been gained in consulting to and being an employee of investor owned, municipal and government owned systems. He has conducted and participated in field investigations, technical studies, and implemented electric system improvements and expansion projects to meet existing and future system load requirements. In planning the system requirements, his experience has included the total utility electrical situation from load development through transmission line design, routing and planning; economic evaluation of generation methods resources to coordinate with load characteristics and demand. Electric utility technical analysis includes: load flow, short circuit, and transient stability studies. Distribution work has been in operations, planning and design.

Economic Study experience includes: power supply contracts, wheeling agreements, rate structures, engineering economic alternatives, generation operating cost alternative comparisons, utility plant appraisal, project capital costs, cost of power and international project financing.

Computer Applications experience includes: system analysis and program writing in electrical and mechanical engineering, economics, business accounting, finance, public utility technical studies and critical path project scheduling.

Legal Research in the utility field relating to administrative and statute law of government power projects, regulatory commissions (FPC, CPUC, CERDC), and contractual regulations. This information was utilized in engineering and economic work.

Rogers

EDUCATION	Whitman College 1959-62, Walla Walla, Washington Arizona State University, BSE 1964, Tempe, Arizona University of Santa Clara, MSEE 1970, Santa Clara, California Stanford University, 1976, Utility Economics, Stanford, California
REGISTRATION	Professional Electrical Engineer, California
MEMBERSHIP	Institute of Electrical and Electronic Engineers - Power Society Consulting Engineers Association of California Geothermal Resources Council

Rogers

JOHN H. G. STUART

POSITION

Senior Staff
Mechanical Engineer

EXPERIENCE

Mr. Stuart's professional career embraces more than thirty-five years experience in the operation, maintenance and design of geothermal and fossil fuel electric generation plants, marine propulsion equipment and aerospace test facilities.

He was Lead Start Up Engineer and Project Manager for the start up and commissioning of the Brawley 10 MW Geothermal Power Plant (owned by Southern California Edison Co.) in Imperial County, California. He was responsible for the training of the plant operating personnel.

Mr. Stuart's experience in geothermal power plant design covers the evaluation of conversion of Pacific Gas and Electric Co.'s Unit 1 thru 12 conversion to comply with the California environmental requirements; the bid evaluation for the Heber, Imperial County's 50 MW geothermal power plant (Southern California Edison Co.) turbine-generator and brine flasher units; design of steam flasher test facility in Costa Rica; and Project Manager for the Salton Sea 10 MW geothermal power plant, Feasibility Report (Southern California Edison Co.) in Imperial County, California.

For the Krafla Geothermal Power Plant in Northern Iceland, Mr. Stuart served as project engineer, and in this capacity developed the design and carried it through to completion. His work included preparation of specifications and procurement documents, evaluation of bids, monitoring vendor submittals and progress and providing support to the construction effort, both from the home office and through considerable time spent at the project site. Additionally, Mr. Stuart was in residence at the site throughout the start-up period and made significant contributions to this phase of the project as well as training of the permanent operating staff. The Krafla project consists of two 30 MW steam turbine-generators with turbines of the double flow mixed pressure condensing type.

Mr. Stuart was mechanical discipline engineer for the preliminary design of the Tiwi 110 MW geothermal power plant in the Philippines and was involved in the specification preparation, and bid evaluations covering the main and auxiliary equipment.

Mr. Stuart was successively senior construction engineer, facility design engineer, supervisor of facility design and construction, and senior research engineer with Lockheed Missile and Space Co., Sunnyvale, California, and was responsible for the design, installation and test of several facilities for aerospace vehicle, ocean vehicle and missile development. Test facilities included very high pressure-high flow gas and hydraulic equipment, cryogenic, vacuum, power equipment, and high pressure/temperature deep sea simulator. Project work included development work on DSRV high pressure joints and development work on "clean sweep" oil suck recovery equipment for ocean systems.

Prior to joining Lockheed, Mr. Stuart was technical assistant, mechanical, with Pacific Gas and Electric Co. and was responsible for planning and economic analysis for the turbine-generator and boiler overhaul and maintenance program for the entire Pacific Gas and Electric system of seven million kilowatts installed capacity.

His experience includes service with the Calcutta Electric Supply Corp. in India as boiler and turbine house superintendent in three steam-electric power plants where he was responsible for operation, maintenance and construction for over five years.

Mr. Stuart's professional career began with seven years service in the Royal Navy with assignments including chief engineer officer and inspector of naval machinery.

EDUCATION

University of Dublin, Trinity College
B. S. Mechanical Engineering
M. S. Mechanical Engineering

University of London, Imperial College
Diploma in Generation, Distribution and Utilization of Electric Power

Hartnell College, Salinas
Industrial Electronics

REGISTRATION

Chartered Mechanical Engineer
Great Britain

MEMBERSHIPS

Member, Institution of Mechanical Engineers
Electrical Power Engineers Association
American Society for Metals
American Vacuum Society

Rogers

BRUCE FRASER

POSITION: Chief, Chemical & Process Department

EXPERIENCE: Mr. Fraser has over forty years experience in all phases of process and power plant design, construction, start-up, production operations, process improvements, and air and water pollution abatement.

He is responsible for process engineering in the design of geothermal power production facilities including standards for well testing and evaluation; heat and materials balance for power cycle diagrams and process flow diagrams; evaluation of turbine condensers and noncondensable gas removal systems; application and evaluation of environment abatement processes applicable to the disposal of geothermal waste water and noncondensable gas including H_2S; and application of Rogers' process system for handling calciting geothermal waters.

He is also responsible for evaluation of turbine condenser heat sink systems including: dry cooling systems (radiators), mechanical draft cooling water towers, cooling ponds and canals, river, lake and sea water circulation.

Mr. Fraser provided process engineering services on the Geysers Units 7 and 8 and the Krafla, Iceland 60 MW geothermal power plant. Most recently, he has directed or performed process design for 10 MW and 3 MW geothermal power plants including H_2S abatement for the latter.

His experience in pollution abatement projects includes:

Removal of chlorine, sulfur chlorides and sulfenyl chloride from the exhaust air system of a semi-works fungicide plant and from a similar full-scale fungicide manufacturing facility, plus additional disposal of liquid chlorinated sulfur compounds via dual liquid gas incineration and a flue gas scrubbing unit.

A field survey and plan to handle industrial wastes at Sharpe Army Depot, involving degreasing, chromate stripping and solvent removal units, and a similar, but more comprehensive plan for the Riverbank Army Ammunition Depot including waste water clarification, sludge dewatering and disposal and thermal reduction.

The collection and disposal of relief vent gases from petroleum processing which included a liquid interceptor and vent stack with smokeless flare.

Design of a process to remove H_2S from turbine exhaust steam at PGandE's Geysers' Power Plant.

Rogers

BRUCE FRASER (Cont'd)

Mr. Fraser was the technical adviser for a coal gasification conceptual design program for Lawrence Livermore Laboratory (LLL). This project involved process engineering consulting services for optimum system control design to provide maximum safety for equipment and personnel during the operation of LLL's steam/oxygen injection test for in-situ coal gasification experiment at the Hoe Creek, Wyoming test site.

EDUCATION B. S. in Chemical Engineering, University of California

REGISTRATION Professional Chemical Engineer, California

MEMBERSHIPS American Chemical Society
Instrument Society of America

Rogers

WILLIAM W. LINDSAY

POSITION — Senior Staff Electrical Engineer

EXPERIENCE — Over twenty-seven years of professional experience in electrical engineering has provided Mr. Lindsay with a background in planning, design and project management for power systems for public and private utilities and industrial firms both in the United States and abroad. Over thirteen years of experience has been in the Philippines, Thailand, Laos and Iceland.

Mr. Lindsay performed as a resident construction advisor and the electrical start-up engineer for the 60 MW Krafla geothermal plant in Iceland requiring his presence at the project site for extended periods of time. He performed similar construction and start-up services for a 10 MW geothermal plant located at Brawley, California.

Mr. Lindsay's experience in geothermal design includes, in addition to the above, responsibility for the design of the electrical systems relating to the steam supply and treatment system for the 10 MW geothermal power plant at Brawley. He also had design responsibility for the electrical systems for a 3 MW wellhead geothermal power generating plant on the island of Hawaii including on site supervision and start-up operations.

As Chief Electrical Engineer in Rogers' Manila office, Mr. Lindsay was responsible for field investigation, design, preparation of specifications and purchase orders, contract negotiations and field inspection for industrial and marine facilities, power plants, overhead and underground distribution, substations and high voltage transmission in the Philippines.

As project engineer for Rogers in Thailand, he conducted field surveys and prepared feasibility studies for rehabilitation and extension of distribution systems in Northern Thailand. He was also engaged in sub-transmission and distribution system planning and design for the power system in the City of Bangkok, including preparation of procurement specifications and evaluation of equipment bids. Also included in his responsibilities were supervision of electrical design, equipment procurement and construction supervision for a 10 MW diesel plant and a 12.5 MW steam electric generating plant, together with related 69 kV transmission and substation facilities.

Rogers

WILLIAM W. LINDSAY (Cont'd)

Mr. Lindsay has designed electrical power and control systems for a roofing plant and airport fueling and lighting systems. Additionally, he has spent over five years in planning, design supervision, preparation of specifications and purchase orders, and bid analyses for industrial power and control systems for various petrochemical facilities in California, Texas, Louisiana, British Columbia, and Australia. His experience also includes design of hydroelectric power plants and high voltage substations.

EDUCATION B. S. in Electrical Engineering, University of California

REGISTRATION Professional Electrical Engineer, California

MEMBERSHIP Institute of Electrical and Electronic Engineers

Rogers

FRANK PRENDERGAST, AIA

POSITION

Assistant Vice President
and Project Manager, Architecture

EXPERIENCE

Mr. Prendergast has had a wide range of experience in the design of industrial, commercial, and residential buildings. He is responsible for the architectural design of major building structures for the firm. Recent design work has included programs for geothermal power plants in California and Hawaii.

Project architect assignments for Rogers have included diverse development programs, namely: A major research and development center for Del Monte Corporation, Walnut Creek, California; a bag manufacturing plant and regional office for St. Regis Paper Co., Union City, California; various industrial and maintenance buildings at military installations throughout California; a complex facility for the United States Navy at Pearl Harbor; several structures for Pacific Gas and Electric Company; a 50 MW diesel generation power plant for Anamax Mining Co., Sahuarita, Arizona; and geothermal power plants for Pacific Gas and Electric Company, and National Power Corporation, Tiwi, the Philippines.

As Project Manager he was responsible for a maintenance area planning and development study for the Golden Gate Bridge and Highway District; a headquarters fire station and sheriff's substation for valley of the Moon Fire Protection District; a bag manufacturing plant for Bemis Company, Union City, California, an enological research center for United Vintners, Inc., and an industrial plating shop for the U. S. Army Corps of Engineers.

Prior to his association with Rogers, Mr. Prendergast was engaged in the design of bank buildings for the Royal Bank of Canada and the Bank of America. For the Royal Bank of Canada, Montreal, he was assistant to the Chief Architect and had overall project responsibility from design concepts through preparation of drawings, coordination with associated engineers, site supervision of construction and final responsibility for the interior furnishings. He was also employed by a large architectural firm in the Bay Area involved primarily in the design of apartment buildings, townhouses, office buildings and custom residential work. This assignment covered full responsibility in all planning, design and construction phases, including major apartment and townhouse complexes and design essays in environmental planning.

EDUCATION	University of London, Sir John Cass School of Art, and University of Cambridge, Department of Estate Management
REGISTRATION	Registered Architect, California, Hawaii
MEMBERSHIP	American Institute of Architects

Rogers

WINSTON F. BOTT

POSITION

Geothermal Development - Well Drilling Advisor
- Project Manager

EXPERIENCE

Thirty-two years diversified professional experience with principal emphasis in the energy field starting as a designer with successive assignments as field engineer, construction superintendent, drilling manager, exploration manager and project manager.

In April, 1980, Mr. Bott rejoined the staff of Rogers Engineering Co., Inc. and since then has served as Project Coordinator for the Costa Rica geothermal program. This work included the final reporting of the successful exploration and test well drilling phase, and the preliminary planning and feasibility study for development drilling, gathering system and reinjection well system.

During 1979-80 Mr. Bott served as Project Coordinator on the staff of PB-KBB, Inc., consulting specialists in the field of solution mining and construction of underground storage caverns by the solution-mining process. Mr. Bott coordinated projects including: drilling wells for solution mining of salt in bedded salt and shale formations; hydraulic fracturing of bedded salts; a report detailing the state-of-the-art in the field of feedwater treatment with additives to effect the in-situ (underground) purification of the solution-mined salt product; a proposal to DOE for a research program to develop a variety of stimulation techniques for the in-situ production of natural gas from coal deposits.

During 1977-78 Mr. Bott was designated as Drilling Supervisor for the Instituto Costarricense de Electricidad for their geothermal exploration program. He furnished guidance and advice on drilling specifications, drill site engineering, contractor solicitation and selection, drill rig inspection and mobilization, and contract administration.

Concurrently with the above assignment during 1977-78 Mr. Bott was Project Manager for geothermal exploration for the Ministry of Energy of Iran. Mr. Bott performed contract administration at the home office and in Iran, and coordinated the work of scientific subcontractors in the fields of geochemistry, geology, volcanology and photo-geology.

Rogers

WINSTON F. BOTT (Cont'd)

Mr. Bott managed the drilling of an exploratory well for the Marysville Geothermal Project, sponsored by the National Science Foundation, which was completed in 1974. On this project, Mr. Bott handled all local, state and federal government agency contracts and supervised drafting of an environmental impact report. He also supervised the preparation of contracts and specifications for the deep-hole drilling and for all site preparation. As drilling manager, he had full charge of drilling strategy and drilling supervision, and administered all contracts.

Mr. Bott has maintained a close contact with the drilling industry through the years as the inventor of a specialized safety device for which he holds a patent, and which is used by major oil well drillers throughout the world.

Prior experience has included: seismic exploration with a major oil company; construction supervision of refinery projects; area engineer on the construction management staff of a nuclear project; and other civil, process, and industrial projects.

EDUCATION	University of Missouri, Bachelor of Science in Civil Engineering Tau Beta Phi and Phi Kappa Phi Member
REGISTRATION	State of Texas, Civil Engineer State of California, Civil Engineer

Rogers

DONALD R. BREWER

POSITION Senior Control Systems Engineer

EXPERIENCE Mr. Brewer has over thirty years of experience in the analysis, design and application of instrumentation and control systems for the process, industrial, transportation, and food processing industries.

His experience in design of instrumentation and control systems includes analyses of AC and DC power systems and subsequent design and application of controls for transportation systems, design and application of control devices and systems for machine tools and hydraulic presses, injection molding machines, and aluminum extrusion presses. He also designed systems and controls for completely automated fluid product handling systems for the dairy, food, beverage and pharmaceutical industries.

As control systems engineer for the Rogers' Krafla Geothermal Electric Project in Iceland, Mr. Brewer designed the instrumentation and control system, prepared instrument specifications, evaluated quotations and recommended suppliers, and provided supervision for the preparation of installation drawings. He provided on-site supervision of the installation of the system and served as control system start up engineer including training of operating staff.

In Rogers' capacity as consultant to PGandE, Mr. Brewer prepared basic instrumentation and control philosophy for the major systems in Geysers Units 16 and 17. His most recent assignments have been as control systems project engineer for the Brawley geothermal power plant now in operation in southern California and the HGP-A Geothermal project in Hawaii. Rogers has design, procurement, operator training, construction management and start up responsibilities for both of these plants.

Mr. Brewer assisted in the preparation of instruction manuals, the training of operators and maintenance men and start-up supervision in these plants.

EDUCATION B. S. in Electrical Engineering, University of Wisconsin

REGISTRATION Registered Control Systems Engineer, California
Registered Professional Engineer, New York State

Because Williams AFB will pay "avoided costs" for its electric power over the life of the project, under GKI's proposed plan, GKI believes that the Air Force should contribute the entire $1 million towards the Resource Confirmation effort. GKI for its part will, with due diligence, undertake to confirm the resource, and pay from its own account the Phase I program costs in excess of the $1 million Air Force contribution.

If this approach or a variation thereof, is of interest to the Air Force, Geothermal Kinetics, Inc. will be pleased to enter into negotiations with Williams Air Force Base to arrive at a mutually acceptable agreement.

1.1 Summary Of Proposed Costs

1.1.1 Phase I - Resource Confirmation

Geothermal Kinetics, Inc. estimates the following costs for the Phase I Program which will include: deepening the Powers Ranch No. 1 Well from its present depth of 9,220' to a total depth of 12,000', performing downhole temperature and pressure measurements, and flow testing the well in order to determine well productivity and the physical and chemical attributes of the geothermal fluids. Powers Ranch No. 2 Well will be used as the reinjection well to dispose of the well fluids produced during the flow test.

ACTIVITY	ESTIMATED COST ($Thousands)
Well Workover	
Mob & Demobilization	300
Rig Costs	270
Fuel & Rentals	90
Drill Bits	100
Drill Mud	100
Slotted Liner & Hanger	62
Drilling Supervision	35
Well Logs and Surveys	10
Subtotal Workover	967

ACTIVITY	ESTIMATED COSTS ($Thousands)
Well Testing	
Test Equipment	200
Power Supply	30
Piping	70
Reinjection Pump	15
Test Personnel	70
Engineering	35
Well Surveys	45
Chemical Analysis	15
Subtotal Well Testing	480
Grand Total	1,447

1.1.2 Phase II - Plant Construction & Operation

Upon resource and reservoir confirmation GKI will construct and operate a flash steam geothermal power plant of a capacity sufficient to supply 12.3 MW_e of power to Williams Air Force Base.

Excess capacity will be sold to the local utility company at its "avoided costs." This same rate will be charged to Williams AFB.

The "avoided costs" exclude transmission and distribution costs, so the cost of power to the Base will be about 10% less than the purchase price of power.