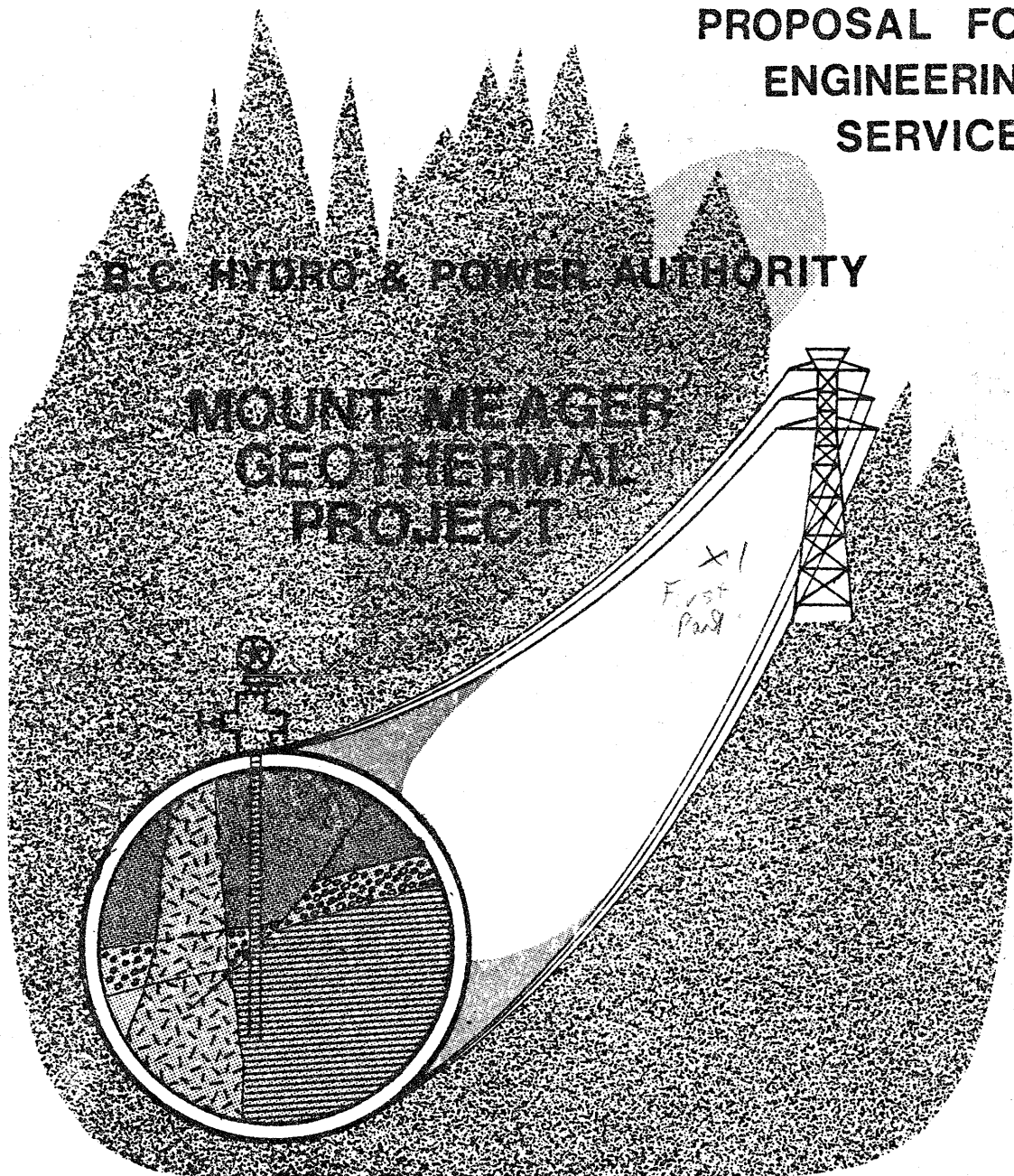


PROPOSAL FOR
ENGINEERING
SERVICES

B.C. HYDRO & POWER AUTHORITY

MOUNT MEAGER
GEOTHERMAL
PROJECT



(EDITED)

RECEIVED

OCT 15 1985

Prepared by

REID, CROWTHER & PARTNERS LIMITED

PETROLEUM RESOURCES
DIVISION

ROGERS ENGINEERING CO., INC.

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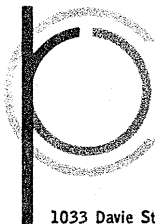
MOUNT MEAGER
GEOTHERMAL PROJECT
PROPOSAL FOR
ENGINEERING SERVICES

October 1979

Submitted to
B.C. HYDRO AND POWER AUTHORITY

by

REID, CROWTHER & PARTNERS LIMITED
in Association with
ROGERS ENGINEERING COMPANY INC.



Reid, Crowther & Partners Limited

1033 Davie Street, Vancouver, B.C., Canada V6E 1M7, Telex 04-507875, Telephone (604) 688-2451

PLEASE REFER TO FILE NO.

X1967

October 5, 1979

Mr. H.J. Goldie
Manager, Systems Engineering Division
B.C. Hydro and Power Authority
Box 12121, 24th Floor
555 West Hastings Street
Vancouver, B.C. V6B 4T6

Dear Mr. Goldie:

Re: Mount Meager Geothermal Project

We attach herewith a proposal for engineering services related to your geothermal project at Mount Meager. This is offered on an unsolicited basis as a result of our present involvement in the geothermal project and the experience of our associated company.

The study proposed would be performed jointly by Reid, Crowther & Partners Limited and Rogers Engineering Company Inc., who have formed an association specifically for this project.

We believe that within the next year you will require pertinent project development information to guide additional work for your geothermal program.

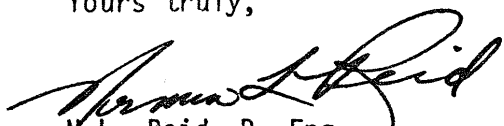
This proposal outlines the study which would generate this information.


The association of the two firms brings together the experience of over 70 years of engineering design experience in Canada, familiarity and involvement in the current Mount Meager development and the design of generation facilities in the Geysers, Imperial Valley, Utah, Iceland, Costa Rica and the Philippines.

We would be pleased to discuss this proposal further with you and your colleagues and would respectfully request the opportunity to do so.

Thank you for your time and attention.

Yours truly,


M.L. Reid, P. Eng.
Chairman of the Board


R.K. Sayer, P. Eng.
Study Director

RKS:pk1

Encl.

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EXECUTIVE SUMMARY

The transition from exploration to development in the Mount Meager geothermal program could result in unnecessary expenditures of millions of dollars if the correct field development program is not followed at this time. Conversely, a proper development program could be exploited to provide significant savings.

Reid, Crowther & Partners Limited and Rogers Engineering Company Inc. have formed an association for the specific purpose of providing the necessary expertise to assist B.C. Hydro and Power Authority to develop the plans and programs for resource utilization.

At this time we believe that a study is required to address:

- a) A Field Development Program - timing schedule of activities, requirements and decisions leading to resource utilization.
- b) A Pilot Plant Concept - general arrangement of a pilot plant and all ancillary components, and process flow diagram.
- c) Cost Estimate - fiscal planning guide of capital costs for study events.

This proposal outlines the study objectives, study areas, identifies study participants, and provides qualifications. The study cost is estimated to be \$97,000.

The undertaking of the work at this time will enable B.C. Hydro and Power Authority to identify the needs for design and the requirements of pre-design testing programs which are crucial to proper resource utilization.

SECTION 1

INTRODUCTION

The transition from exploration to development in a geothermal program could result in unnecessary expenditures of millions of dollars if the correct development programs are not followed at this time. The exploration program in the area of Mount Meager is approaching the point of transition where activities could bring a hot water and/or steam resource to the surface. Prior to this occurrence we believe that experienced input to the project would greatly assist with the project development.

The association of Reid, Crowther & Partners Ltd. and Rogers Engineering Company Inc. will provide B.C. Hydro and Power Authority with access to a geothermal development design group. Initially we believe that two specific areas of study should be undertaken at the present time, as follows and discussed below:

- a) Field Development Program
- b) Pilot Plant Concept

These studies would assist B.C. Hydro and Power Authority to achieve the transition from exploration to development of a utilization facility, in both the immediate and long term programs, and assist in the areas of fiscal planning.

The study would focus upon the Mount Meager geothermal area which is currently understood to encompass two potential reservoirs; the South Reservoir in Meager Creek and the possible North Reservoir in the Lillooet River Valley.

1.1 Field Development Program

The formulation of a field development program would outline the decision network and criteria necessary to take a geothermal resource from initial planning through all testing and data gathering to the selection of a utilization plant. This field development program would assist B.C. Hydro and Power Authority to determine data requirements and project direction.

This study would also assemble the development steps on a progress evaluation basis with estimated timing and costs. B.C. Hydro and Power Authority could then use this information in ongoing budget planning.

1.2 Pilot Plant Concept

The pilot concept would provide B.C. Hydro and Power Authority with a graphic overview of a possible 55 MW pilot plant for the Mount Meager geothermal project and would assist in the development of the land areas of the Meager Creek basin.

As with many "alternative energy sources", the public often lacks a realistic perception and understanding of the particular resource utilization facility. The pilot plant concept will provide a basis for this understanding.

The framework of study for the pilot plant concept would also include the construction costs for roads, on plot and off plot services, water sourcing and distribution (potable and/or process), utilities such as sewer and storm water, housing and office facilities.

1.3 Development Advisory Design Group

The study as outlined within this proposal, uses an advisory design group, oriented toward resource utilization, would assist in the evaluation of development data. This ongoing support group would be made up of personnel from within the two companies to deal with the requirements of any particular event. Additionally, the immediate availability of knowledgeable personnel could provide the guidance at various decision points for the on-going drilling exploration program.

These services would be provided on a time and material basis, per event and as requested. Changes for personnelk would be per the fee basis described within section 4.1.

1.4 Permits

Because the permitting regulations have not been clearly defined at this time, this activity has been excluded from the scope of this study.

SECTION 2

STUDY OUTLINE

2.1 Field Development Program

The escalation of activity and costs associated with future steps dictate that a comprehensive development program be utilized.

An assessment of the geothermal reservoir potential of a field requires the analysis of the test results from several wells which have been drilled into a common zone of productivity. This information will provide the basis for planning the development strategy on well spacing and plant installation arrangement and capabilities.

To insure all necessary steps have been taken in the data gathering process, the field development program would itemize these necessary steps and indicate what information is necessary to attain the various decision levels. B.C. Hydro and Power Authority could be more assured that evaluations at the various decision steps would have sufficient basis in fact, for further direction of effort.

The field development program would enable an assessment of the current activities and program, and assist in problem solving.

Many items of data gathering such as well testing and analysis, fluid flow analysis, non-condensable gas evaluation, various sampling techniques, require special equipment. In view of the long lead time for some of this equipment, the development program would set out construction and procurement schedules to minimize the time period.

Once a geothermal reservoir is located by the exploration program, a test well is drilled. This well is subject to tests run to evaluate the characteristics of the resource. In fact, the initial well testing program may involve three or four wells since one well may not demonstrate the complete situation. Assuming that these well tests verify a commercially down-hole viable resource, at least two additional production wells are usually drilled in the same reservoir to provide adequate data for a reservoir assessment. This assessment will provide information on the characteristics of the reservoir and reservoir fluids for evaluating producing capacity, optimum well siting, well design and probable life.

To adequately facilitate reproducible test results there are a number of requirements pertaining to the well specifications, instrumentation, supervision and procedures. This study would direct the methodology to obtain this important information, and outline pitfalls.

Upon completion of the well flow tests and analysis of the geothermal fluids, the field development plan would then provide the critical guidelines by which methods, end uses and economies of scale of the geothermal resource and utilization facility could be determined.

2.2 Pilot Plant Concept

Within this section of the study, the utilization facility together with all services and access would be reviewed on the basis of a selected pilot generation plant of 55 megawatts. Other service facilities would be assembled and costed to compliment this plant. Electric power transmission and transmission corridor and connection to power plant are beyond the confines of this study.

The data reviewed would allow preliminary selection of building structures, road construction and upgrading, stream crossings and site utilities. Further, the review of the access corridor would assist in the planning of the overall resource utilization.

A perspective drawing would be prepared showing the pilot plant located within a geographical framework related to the Mount Meager development area together with a general description of the process.

Included in the cost estimate and construction schedule would be plant and plant facilities, roads, support utilities, resource gathering system, reinjection and pollution abatement equipment.

2.3 Cost Estimate

Firm liaison with B.C. Hydro would be necessary to ensure schedules of field development and plant construction will operate within reasonable time frames and within generation requirements. The costs of the works are extremely time dependent and are predicated by the construction season. It would be necessary to set out construction decision points to operate within chosen phases of development.

SECTION 3

ORGANIZATION

3.1 Study Responsibilities

Reid, Crowther & Partners Limited would act as the project managers, with Mr. N.L. Reid, Chairman of the Board, as Principal-in-Charge, and Mr. R.K. Sayer as the Study Director.

The activities of Rogers Engineering Co. Inc. would be the responsibility of Mr. Herb Rogers, Jr., President of this firm. Mr. H.I. Rogers would manage the project work. The responsibility for input of technical information related directly to the requirements of a field development program and a geothermal generation plant and its development would be shared by Mr. J. Kuwada, Mr. Herb Rogers, Jr. and other experienced on-staff members of Rogers Engineering Co. Inc.

Engineering related to Canadian practices, various structural and off-plot requirements would be provided by Reid, Crowther & Partners Limited.

The two study items would be coordinated by Mr. H.I. Rogers and Mr. R.K. Sayer. The study organization is shown in Figure 1.

3.2 The principal study participants are identified below:

Mr. N.L. Reid is Chairman of the Board of Directors of Reid, Crowther & Partners Limited and has been active within the

company for 28 years. Included in his experience of major industrial development is the management of thermal power generation projects. He would act as the Principal-in-Charge for this study.

Mr. R.K. Sayer has carried out design, contract preparation and contract administration in industrial process engineering over some 13 years. In addition, he has acted and continues to act as Project Manager on several projects within the office. Mr. Sayer will be able to devote much of his time to the study outlined within this proposal.

Mr. J.T. Kuwada is currently Vice-President and Director of Advanced Technology for Rogers Engineering Company Inc.. He has 19 years of experience in process design, engineering and management of projects including geothermal development.

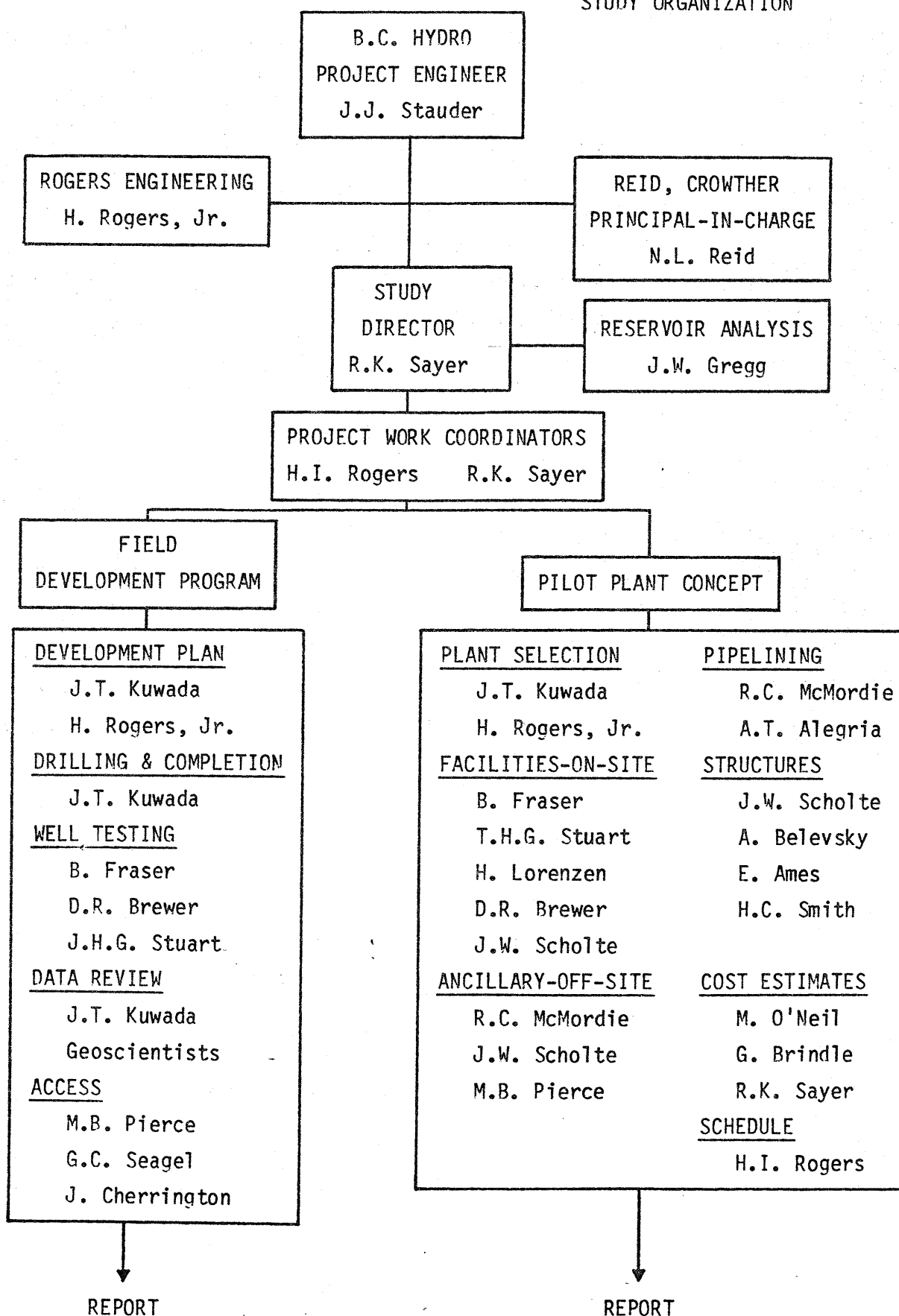
Mr. Herb Rogers, Jr. is Chairman of the Board and President of Rogers Engineering Company Inc.. He has been actively involved in the development of geothermal resources, in locations around the world, since 1961.

Mr. H.I. Rogers is currently Vice-President of Rogers Engineering Company Inc.. He has extensive experience in planning, engineering design, economics, system analysis and management of projects, including geothermal development.

3.3 Qualifications

The absence of engineering experience in geothermal generation design in Canada required the input of such expertise from outside Canada. Rogers Engineering Company Inc. have been

FIGURE 1
STUDY ORGANIZATION



involved in the design of geothermal facilities related to electrical generation for about 18 years; in such locations as the Geysers and Imperial Valley of California, the Roosevelt field in Utah, Costa Rica, Iceland and the Philippines. As consultants their experience in this field is unsurpassed.

Reid, Crowther & Partners Limited, whose origins extend back to 1905 in Western Canada, became involved in the geothermal project at Mount Meager through involvement in the current environmental studies. The exposure undertaken to this concept of energy production has provided the firm's engineers with an understanding of the process. In addition, Reid, Crowther & Partners Limited have provided design services for recreation facilities at Radium and Banff using geothermal fluids. In the oil and gas industry, Reid, Crowther & Partners Limited has been retained by most major oil companies and financial houses for geophysical and reservoir analysis, investigations and reports. The extensive Canadian engineering experience in disciplines which are related to geothermal provides this firm with a background to assist Rogers Engineering Co. Inc.. This experience will be placed in the context of the Mount Meager Geothermal Project.

Personal resumes of proposed study members are enclosed within the proposal for review.

For your reference the qualifications of these firms are presented in Appendix A (Reid, Crowther & Partners Limited) and Appendix B (Rogers Engineering Company Inc.).