

**A PRECONCEPTUAL ASSESSMENT
OF FIELD DEVELOPMENT
AT THE MEAGER CREEK
GEOTHERMAL SITE**

**Prepared for
B.C. HYDRO & POWER AUTHORITY**



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A Pre-Conceptual Assessment of the

Meager Creek Geothermal Project

Phase I

Field Development

by

NEVIN SADLIER-BROWN GOODBRAND LTD.

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1.0 INTRODUCTION

1.1 Terms of Reference and Scope of Study

This report is intended as a brief summary of progress to date at Meager Creek and a set of short and long term recommendations respecting drilling and drill related activities. It comprises the initial phase of a two part pre-conceptual study which is described in proposals presented to B.C. Hydro and Power Authority (B.C.H.P.A.) September 29th and then October 15th, 1980 and is carried out under the authority of B.C.H.P.A. Purchase Order # 951 691 dated October 17, 1980. The study will evaluate the project and set forth its requirements through the exploration and confirmation stages. The critical aspect of the confirmation phase is the design and programming of the initial deep test well. Section 4.0 summarizes these activities and they are covered in detail by R.W. Nicholson of Well Production Testing Inc. in his report dated February 1981 which is submitted in its entirety as Appendix I of this document. The second phase of the study consists of a pre-conceptual power plant design and surface facility and is the contribution of Bechtel International Inc. Input variables include field observations where available but necessarily rely substantially upon conceptual data derived from related experience elsewhere.

Section 2.0 of this report is intended as a brief update on progress to date at Meager Creek. We consider this useful, if not necessary, for an understanding of the problems at hand. Work in a variety of disciplines has been carried out and is continuing. Some methods are proven; others are more esoteric and are tried with the full appreciation of the possibilities that they might not necessarily

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be applicable. In total they have brought the project to the discovery stage at a cost which compares very favourably with similar undertakings elsewhere. The objective now is to outline the steps necessary to develop the potential geothermal resources to the point where electric power can be brought on line. For purposes of this report the target is a geothermal resource capable of sustaining a 55 MW generating facility.

1.2 Location, Access, and Logistical Considerations

The project area is located 160 kilometres north-northwest of Vancouver and approximately 60 kilometres northwest of the community of Pemberton, B.C. The area of geothermal interest is the Meager Creek Volcanic Complex which lies between the Lillooet River and its tributary Meager Creek. Known temperature anomalies occur in the South Reservoir area, located on the north side of Meager Creek, and the North Reservoir area in the Upper Lillooet Valley.

Access to the project is via paved highway from Vancouver to about 20 kilometres northwest of Pemberton, continuing on good gravel surface forestry development and private logging roads an additional 40 kilometres to the site.

Work is presently being conducted from a base camp operated by B.C.H.P.A. and located in the Lillooet Valley about one kilometre upstream from the mouth of Meager Creek. The base camp is equipped to accommodate a crew of up to 25 men and contains a drill maintenance facility and covered storage space for equipment, drill rods, and core.

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The geothermal site is situated in mountainous terrain between the elevations of about 700 and 2000 metres above sea level. All drilling carried out to date has been done in the valleys of Meager Creek and the Lillooet River in areas of interest designated the Meager or South Reservoir and the Lillooet, or North Reservoir respectively. Target areas beneath the slopes of the volcanic complex itself have been identified but have yet to be tested.

1.3 Geological Setting

The Meager Creek geothermal area is defined by a volcanic centre active through Quaternary to Recent time. The area of interest covers about 300 square kilometres centered on the volcanic edifice between Meager Creek and the Lillooet River. Rock types consist principally of dacitic flows and fragmental deposits cut by hypabyssal dikes and sills. The volcanic sequence rests on a basement of crystalline metamorphic and intrusive rocks made up of greenstones, amphibolites, and gneisses intruded by Coast Range diorites and quartz diorites ranging in age from Triassic to lower Cretaceous. In the Lillooet Valley and on the north slope of the range which includes Meager, Job and the other volcanic peaks, the basement rocks are intruded by a complex quartz monzonite--alaskite body of Miocene age. Known as the Fall Creek Stock it is contemporaneous with volcanic activity which occurred along the Pemberton Volcanic Belt, an older zone of volcanism which generally lies to the east of and sub-parallel to the Garibaldi Group.

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Fall Creek originates in a poorly developed cirque on the northeast flank of Plinth Peak. The "cirque" may be a breached crater and is the source of the youngest volcanic unit thus far identified in the complex. This is the Fall Creek flow, a dacitic lava and welded tuff which overlies the older rhyodacite flows and young fragmental deposits considered contemporaneous with the Bridge River Ash. The fragmental deposits have been dated at 2460 ± 60 years BP and 2490 ± 50 years BP using radio carbon methods.

The valleys adjacent the volcanic edifice are host to a number of thermal springs of which the Meager Creek Hotsprings are the best known. They are also unquestionably the first observed evidence of a potential geothermal resource in the area. The springs issue from gravel overburden near the confluence of Meager and Hotsprings Creeks and are the hottest and most substantial of several springs which lie in the Meager Creek Valley. The Pebble Creek hotspring empties into the Lillooet River on the north side of the complex opposite the mouth of Fall Creek, the type area for the Fall Creek Stock mentioned above. Chemical data indicates that the thermal waters of the Pebble Creek spring are derived from a different reservoir than those at Meager Creek.

Geothermal fluids ranging in temperature from marginally above ambient surface temperatures to over 200°C have been encountered in fracture system within the crystalline basement rocks. They are interpreted to have derived their heat from a high temperature source beneath the volcanic center. The exploration program now underway is intended to define, within economic reach of the surface, a zone of geothermal fluid heated and driven by this source.

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2.0 PREVIOUS WORK AND PRESENT STATUS OF THE PROJECT

The existence of thermal springs in the Meager Creek and Lillooet Valleys has been known to trappers, hunters, prospectors, and geologists for many decades. The first geothermal investigations in this area were carried out in 1973 by the Geological Survey of Canada. Also in that year the Meager Creek area was selected as a first order geothermal target by NSBG on behalf of B.C. Hydro and Power Authority. Selection was on the basis of geology and spring water geochemistry carried out during the course of a regional reconnaissance survey performed for B.C.H.P.A. In 1973 and subsequent years a number of exploration techniques were applied in efforts to identify and define the geothermal resource. Chief among these are geological mapping, resistivity surveys, and drilling. These and a number of other methods which were tried are outlined briefly below.

2.1 Geology

The Meager Creek Geothermal Area was mapped at reconnaissance scale by Nevin Sadlier-Brown Goodbrand Ltd. in 1973 and 1974. Detailed mapping was done at a scale of 1:10 000 by P.B. Read in 1978 (GSC O.F. 603). Read's mapping has since been augmented by data from recent drilling and by surface mapping and fracture studies by NSBG personnel in the reservoir areas.

2.2 Resistivity

A total of 26 square kilometres in the valleys of Meager Creek and the Lillooet River and the lower slopes of the volcanic edifice have now been mapped by resistivity. This geophysical method provides data on electrical properties of the subsurface and is used to identify

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areas that may be underlain by hot conductive fluids. Drill testing of anomalies discovered to date suggests that the method is generally an effective one but sensitive to different interpretations and limited by terrain to the valleys and lower slopes.

2.3 Drilling and Well Site Engineering

Drilling began in the Meager Creek area in 1973 with two diamond drill holes put down by Energy Mines and Resources near Meager Creek Hotspring. The first drilling by B.C.H.P.A. was done further up the Meager Creek Valley late in 1974. To date a total of 17 diamond drill holes and 12 percussion holes have been drilled in both reservoir areas.

The percussion drilling was undertaken during the 1978 field season for the purpose of gathering near surface geothermal gradient data. Shallow diamond drilling was carried out in 1975 for the same purpose but both of these methods were suspended in favour of intermediate depth (200 m to 1000 m) diamond drilling which has been found to provide substantially more meaningful data.

During the course of both percussion and diamond drilling, lithological and downhole temperature logs were maintained. The temperature logging methods include maximum registering mercury thermometers, thermistor probes, and self-contained oil field wireline tools. In 1980, Schlumberger Downhole Services was retained to carry out a pilot program of downhole geophysics on hole M9-80D. The resulting information was used to provide a basis for comparison between data obtained from direct observation of the

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drill core and indirect data from selected logging tools. In general terms it was found that interpreted features such as porosity, permeability, and a fracture density correlate well with those observed in the core. The comparison suggests that the methods tested should provide reliable data for holes from which no core is available.

The table below summarizes diamond drilling results to date. Hole numbers indicate the reservoir area (M for Meager, L for Lillilooet), the approximate sequence, the year, and finally the type of hole (D for diamond drill, P for percussion).

<u>Hole and Year Started</u>	<u>Location</u>	<u>Depth (metres)</u>	<u>Maximum Temperature (°C)</u>
EMR 301-1 (1973)	Meager Hotsprings	45	60
EMR 301-2 (1973)	" "	118	33
M1-74D	Meager Valley	347	68.9
M2-75D	South Reservoir	91	15.4
M3-75D	" "	87	35.0
M4-75D	" "	60	20.8
M5-78D	" "	250	103.7
L1-78D	North Reservoir	603	102.8
M6-79D	South Reservoir	321	140.8
M7-79D	" "	367	202.2
M8-79D	" "	497	55.0
M9-80D	" "	1142	99.0
M10-80D*	" "	323	158.3
M11-80D	" "	559.4	55.0
M12-80D	South Fork Area	605	47.8
M13-81D*	South Reservoir	403	82.0
L2-80D	North Reservoir	595.4	42.5
L3-80D**	" "	256	15.2

* Drilling in Progress

** Drilling Suspended--to be completed later.

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Holes M6-79D, M7-79D and M10-80D have intersected a plume of hot geothermal water at temperatures in excess of 140°C. Hole M5-78D and probably Hole M13-81D also appear to lie within this plume which is presently considered a first order target for a moderate to high temperature geothermal resource.

Hole L1-78D on the north side of the volcanic complex intersected water at temperatures in excess of 100°C. Gradients in holes L2-80D and L3-80D are consistent with the presence of an undefined geothermal resource at depth.

2.4 Refraction Seismic Surveys

Several seismic profiles have been run to test overburden depths in the vicinity of proposed drill sites. The method works well and provides information invaluable in well site selection and design.

2.5 Self Potential

This geophysical method was carried out in conjunction with part of the resistivity program. Several anomalies have been identified but additional field work and interpretation will be required to ascertain their significance.

2.6 Magneto-Telluric

The Earth Physics Branch of Energy, Mines and Resources have conducted two magneto-telluric surveys over the Meager Complex. These are large scale surveys which measure the conductivity of

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the earth's crust to depths of around 40 kilometres. The presence of a low conductivity zone approximately 10 kilometres deep has been established. This zone may represent a deep magma (molten rock) chamber under the existing volcano.

2.7 Passive Seismic

Micro-earthquake activity has been associated with the existence of certain geothermal fields around the world. During the winter of 1974-75, high frequency, low amplitude seismic noises were monitored at one station at Meager Creek. Several events were recorded but they were too infrequent and indistinct to provide meaningful interpretations. As the general effectiveness of the method is still open to debate no further attempt to monitor microseismic has been made.

2.8 Radiation Surveys

In 1978, a survey employing radon cup detectors to identify radon and mercury isotopes was undertaken as a pilot project. The gases present in soil have been correlated with the presence of thermal water below the surface. The study performed around the Meager Creek hotsprings vent delineated the vent locations but the results suggest that this technique will not prove particularly useful in the Meager area.

2.9 Geochemical Studies/Isotope Studies

Geochemical studies of all flowing thermal waters discovered in the Meager area have been carried out. Analytical results provide estimates of previous temperatures attained by the water

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and permit evaluation of water quality. Detailed geochemistry of the hot spring water was studied by Hammerstrom and Brown of the University of British Columbia in 1977.

Isotope studies performed by the University of Waterloo personnel have been used to determine the residence time of groundwater and also temperatures attained by this water.

A mercury soil survey was carried out over part of the South Reservoir. The resulting data was of limited value (see Section 3.5 for further discussion).

2.10 Infra-red Scanning

During the fall of 1973 a low level airborne infra-red scanning survey of the Meager Creek was carried out. The method was found to be effective for locating hot or warm surface waters and may have some application on surveys done at a regional scale. It is, however, considered to be of limited use in reservoir exploration and evaluation which is the nature of the work being done at Meager Creek.

3.0 FIELD DEVELOPMENT PROGRAM; EXPLORATION PHASE

The objective of this section is to outline the steps necessary for the continued orderly exploration of the resource at Meager Creek. The exploration program should result in the definition of target zones for the siting of production scale wells using the methods considered in Section 4.0.

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As in the past the work will have to advance on more than one front. An exploration success, for instance, will mean the initiation of confirmation work and should insure that the exploration phase of the project continues. This principle is illustrated on the flow diagram (Figure 3). Exploration phase tasks to be considered are as follows:

- Drilling
- Geology and Engineering
- Geophysics
- Fluid Geochemistry
- Trace Element Studies

3.1 Drilling

Exploration drilling should continue to be a major component of the Meager Creek site investigation at least for the near term future. We anticipate that it would be terminated by either of two events: a marked increase in reservoir data which would permit the project to proceed with production/injection scale drilling or; lack of success in both exploration and confirmation drilling stages forcing discontinuation of the project.

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Present plans calls for continued diamond drilling by three rigs capable of attaining depths up to about 1500 m. We feel that it would be in the interest of the project to modify this plan in two ways. The first would be to augment it through the use of a fast penetration truck-mounted rotary rig to drill the upper part of selected holes to depths required to penetrate overburden and/or incompetent volcanic rocks say about 200 or 300 m. On the basis of several inquiries local availability of this equipment appears good. An estimate of the operating cost of this drilling (as of October 1980) is about \$70 per metre in overburden (including casing) and \$66 per metre in bedrock (uncased) excluding fuel, crew accommodation, and mobilization charges. Recent contract diamond drilling costs for comparable work are to the order of \$140 per metre.

The second modification is provision of a light helicopter portable drill as both the North and South Reservoirs, as presently understood, lie partly in mountainous terrain which presents serious surface access problems. For the exploration phase of the work at least, these problems can be overcome by using helicopters. As the program continues, however, extensive testing of these parts of the presumed reservoir may become necessary and consideration will have to be given to drilling from sites accessed by roads or to directional drilling from accessible pads. With increasing emphasis on confirmation work we anticipate that diamond drilling will be used primarily in areas where access is difficult. For the next two field seasons, however, diamond drills will be the dominant exploration tools.

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We estimate that testing the presently inferred area of the South Reservoir will require about 9 holes totalling 7,000 metres of diamond drilling in addition to the 11 holes which have been drilled to date.

Testing of other nearby targets inferred from resistivity and geology will require an additional 4 holes totalling about 3,000 metres of drilling.

The first priority area of the North Reservoir could be tested by drilling about 5 holes for a total of 4,000 metres. Resistivity surveys and geological mapping also suggest a second priority North Reservoir area target which could be tested by 2 holes or about 1,500 metres of drilling. An allowance should be made for testing of areas for which no exploration data is presently available. These might include the Capricorn Creek area, Job Glacier or Nunatak area and the Mosaic-Affliction Creek area. Provision for about 5,000 metres of exploration drilling in 5 holes is considered appropriate for this purpose.

The accumulating body of data on the South Reservoir appears to favour the likelihood that the higher temperatures lie to the north, beneath the volcanic edifice and in mountainous terrain. The problem of drill access in this area should be addressed and a strategy involving the three options outlined above should be developed. We recommend that initially two helicopter accessed holes be planned. The report on the 1980 field work by NSBG (in preparation) will address this question

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in more detail after an analysis of the 1980 drill and resistivity results has been completed.

Access problems could also result in the need for helicopter supported drill holes in the North Reservoir area and we recommend that provision be made for one in the 1981 field season and possibly an additional two in 1982.

Step out drill sites should be selected on the basis of geological and geophysical data as has been the case in the past. Interpreting this data will be aided in the future through the use of a three dimensional model (now under construction) which incorporates all available surface and subsurface data. Discovery of a high temperature feature or geothermal gradient anomaly could result in modification of the drill plan by closing up of the hole spacing and drilling to identify and define the feature or by advancing rapidly to the confirmation drilling phase which would involve the use of rotary equipment.

It has been the policy of the technical consultants to measure bottom hole temperature at regular intervals during the course of the drilling as well as to run post drilling temperature profiles. We feel that this procedure has several advantages but it does adversely effect drilling progress as the rig is required to sit idle for up to 8 hours prior to each measurement. E.V. Ciancanelli¹ has questioned the worth of this method in light of slow drilling progress and states

¹E.V. Ciancanelli: Private Report October 1980.

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that the project would be better served if drilling were done on a 24 hour basis with bottom hole temperatures taken only when the procedure will not interfere with the drilling. We find considerable merit in these remarks but recognize that, in our experience, bottom hole temperature measurements provide certain structural information, more accurate gradient information, and could serve as an early warning of any dramatic or potentially dangerous increase in temperatures. These data are all considered valuable particularly in the early stages of any exploration program. As experience is gained in the area, however, a reduction in the frequency of bottom hole temperature measurements would be justified.

3.2 Geology and Engineering

We recommend that geological investigations continue at an accelerated pace. The work should include detailed mapping with emphasis on fracture and alteration studies with the objective in mind being to determine the exact nature of the control or controls over the occurrence of geothermal fluids and to define their locations as accurately as possible.

The preponderance of the geological studies to date have been concentrated in the Meager and Lillooet Valleys, and on the slopes of the volcanic edifice between them. We now consider it worthwhile, however, to expand upon the limited information presently available from elsewhere in the general locality. Reconnaissance geological studies of such areas is the South Fork of Meager Creek. The Meager-Elaho divide area and the Salal and Pebble Creek areas are proposed for the 1981 field

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season. These areas have been examined in the past but without the benefit of both recent developments at the site and in the science of geothermal exploration in general.

3.3 Geophysics

Experience at Meager Creek suggests that resistivity survey work has produced results which correlate reasonably well with subsequent drill hole temperature studies at the South Reservoir area. Applicability of the resistivity method at other geothermal sites has not yet been demonstrated and in some cases interpretation may be difficult and results ambiguous. We feel that it is nevertheless a useful guide in the Meager Creek context and recommend that it and accompanying SP surveys be continued in the remaining accessible areas. Their continued employment should, however be subject to review from time to time.

Refraction seismic is a geophysical tool which has been employed to profile the bedrock surface beneath the overburden as an aid to drill site selection and may provide lithological and structural information as well. We recommend that the refraction seismic be used more extensively with the ultimate objective being the preparation of a bedrock surface map of both the Lillooet and Meager Valleys. We estimate that approximately 15 additional line kilometres of survey work will be required to attain this objective.

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3.4 Fluid Geochemistry

Geochemical studies will continue to be a significant aspect of the exploration program at Meager Creek. Emphasis will shift from acquisition of surface data to sampling and analysis of geothermal fluids (including water, steam, and gas) obtained from wells. Data will be used in reservoir engineering studies and the design of production, abatement, and disposal systems. Procedures should be developed and refined to permit sampling of water, steam, and gas from future immediate depth gradient holes as well as confirmation, delineation, and development wells. Acquisition or design and fabrication of sampling equipment should be undertaken promptly.

3.5 Trace Element Studies

Geochemical sampling of soils and rock in the project area has been carried out on a number of occasions since the inception of the study. Radon and mercury have been considered potentially useful indicator elements and previous programs were designed to delineate their distribution as a guide to identification of near surface geothermal features or geological controls over such features. The work to date has been inconclusive but it has been recommended by E.V. Ciancanelli that mercury soil sampling be tried again with certain modifications. In his report¹ on the project he states that:

"A new survey should be conducted because this method may be useful for defining the geothermal fracture reservoir zone beneath Meager Mountain. The method might also show an anomaly over the zone of upwelling. East-west sample lines might show the possible north-south belt of faults beneath the mountain. North-south sample lines could show a high Hg concentration over the zone of upwelling. This is often a very effective exploration tool which is relatively inexpensive to apply. It should be used to assist with locating temperature gradient holes."

¹ E.V. Ciancanelli; Private Report October 1980

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We concur with this suggestion and recommend that an orientation survey be designed and carried out along these lines during the 1981 field season. If successful, the work might be expanded to include other parts of the project site such as the North Reservoir.

4.0 FIELD DEVELOPMENT PROGRAM; CONFIRMATION PHASE

4.1 General Statement

The deep test well planned for the 1981 field season at Meager Creek South Reservoir is considered, for purposes of this report, the initial hole of the confirmation phase of the project. Confirmation is intended to mean the production of a geothermal fluid having temperature and flow rates consistent with use as a steam source for electrical generation. The parameters of such a geothermal resource are variable and interdependent. The production rate, for instance, which would be necessary to sustain say a 55 MW generating plant operating on dry steam would be substantially lower than that for a similar plant operating on hot water from a reservoir at the same temperature.

These variations in the resource parameters mean that no single set of values can be used to describe a potentially exploitable geothermal fluid. For purposes of comparison however, industry experience suggests that production of one MW requires a steam flow to the order of 8,000 Kg/hr at temperatures in excess of 200°C. A production well would produce 50,000 to 80,000 Kg/hr or the equivalent of 6 to 10 MW. Equivalent power productions from hot water would require higher flow rates these being inversely proportional to the fraction of water flashed to steam.

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Discovery of a geothermal source conforming with the foregoing description might reasonably be considered to have fulfilled the requirements for the confirmation phase of the project. Subsequent drilling will be intended to delineate the resource and further evaluate its characteristics.

The following sections outline the design and programming of the initial confirmation test well. Subsequent wells may be expected to be drilled along similar lines although subject to modifications suggested by project experience.

4.2 Summary of Drilling Program and Well Design

The initial confirmation test well in the Meager Creek Geothermal area, designated MCG #1, is planned to be drilled at the north side of the Meager Creek valley in the area east of No Good Creek and west of hole M10-80D during the 1981 field season. The program calls for rotary oil-field equipment capable of drilling to a maximum depth to the order of 3600 m. Planned depth of the hole is to the order of 2300 m. In the appended report R.W. Nicholson recommends an initial vertical hole. Interpretation of geophysical and geological work performed subsequent to his review of the data suggests, however, that the hole should be directionally drilled towards the north. This approach would provide for a more effective penetration of the resource and is endorsed for purposes of this report.

The project will comprise a number of different but related tasks which will be carried out by several different contractors, consulting firms, and by B.C.H.P.A. staff members. The work will be coordinated by B.C.H.P.A. and its consultants in communication with a project advisory group drawn from B.C.H.P.A., project consultants, and outside experts.

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The tasks to be performed in approximate chronological sequence are as follows:

1. Selection of drill site.
2. Preparation of well specifications and tender forms.
3. Procurement of required approvals.
4. Selection of successful bidders.
 - Drilling contractor
 - Cement contractor
 - Drilling fluid (Mud) supplies and Engineering
 - Mud Logger
 - Drilling Engineer
 - Directional Drilling Contractor
 - Down Hole Electric Logger
 - Testing and Reservoir Engineering.
5. Assuring procurement of:
 - Bits and drill string
 - Casing
 - BOP
 - Well head
 - Crew Accommodation
 - Mud cooling system
 - Storage facilities.
6. Site Preparation:
 - Access
 - Clearing
 - Pad and pit excavation; pit lining
 - Well Cellar Construction/Installation
 - Conductor and Rathole drilling
 - Set Conductor
7. Water Supply and Storage

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8. Mobilization
9. Rig up and Camp Construction
10. Operating
11. Logging and Testing

The preceeding tasks are discussed in detail in Appendix I, a report by R.W. Nicholson of Well Production Testing Inc. entitled Deep Exploratory Drilling and Cost Estimate for the Meager Creek Geothermal Area. The reports sets forth drilling procedures, equipment specifications, and an estimate of costs based upon certain assumed reservoir and geological conditions. Information is provided for both production and injection wells although, at the present level of development at Meager Creek only production drilling is under consideration.

The cost of drilling the well as outlined above to a depth of 2300 m is estimated by Nicholson to be \$1,795,500.

4.3 Logging and Testing

The logging and testing phase of the project includes four rather diversified activities which will begin with the initiation of drilling and end, if the hole is successful, some time well after completion. The four types of work would normally be carried out by specialists in the particular field and include the following procedures:

1. Mud logging
2. Lithological/Geological logging
3. Down hole electric logging
4. Fluid testing

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Mud logging would be performed by a Mud Logging Contractor, probably from an oilfield centre such as Calgary or Fort St. John. Logging would begin with the drilling and in the case of the geothermal hole would involve the continuous monitoring of a number of characteristics of the drilling fluid or mud. These would normally include:

1. mud temperature in/out
2. CO₂ content
3. H₂S content
4. hydrocarbon gas content
5. rock bulk density
6. mud resistivity in/out
7. mud flow
8. mud pit level
9. drilling rate

In addition to the foregoing the mud logger would normally supply H₂S detecting equipment and alarm and safety equipment such as self contained breathing apparatus. Logging is normally carried out from a trailer equipped with the appropriate instrumentation and set up at the drill site for the duration of the drilling.

Lithological/Geological logging is carried out continuously for the duration of the drilling activity. It involves the lithological examination of rock cuttings taken from the return mud flow. Samples are examined for purposes of determining rock type and identification of precipitates and alteration products. Chemical analysis may be carried out on selected samples. This work should be performed by a geologist with experience in crystalline lithology and alteration product identification.

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Downhole electric logging is carried out by a number of contract logging firms in Canada. They operate from oil field centres and are normally on call at short notice to carry out downhole logging runs which may be necessary at several points during the drilling of a well. The drilling plan at Meager Creek calls for three such runs, each of which would involve a separate trip from the logging company's centre of operation. High temperature logging tools are expected to be required in all cases.

The initial run called for in the drilling plan would be carried out when the hole is at an approximate depth of 1000 feet. Recommended tools are:

1. DIL/GR/SP (Dual Induction-Log/Gamma Ray/Spontaneous Potential).
2. FDC/CNL (Formation Density Log/Compensated Neutron Log)
3. Sonic
4. Caliper
5. Temperature

The second logging run would be performed when the hole is at a depth of approximately 5200 feet and would consist of a test of the interval between 1000 and 5200 using the following tools:

1. FDC/CNL
2. DIL/GR/SP
3. Sonic
4. Caliper
5. CBL (in 13-3/8" casing) (Cement Bond Log)
6. Temperature
7. Spinner

. . .

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The third logging run would be carried out when the hole has reached its total depth and would cover the interval between 5200 feet and total depth, ostensibly 7500 feet in this case.

Recommended tools are:

1. FDC/CNL
2. Sonic
3. DIL/GR/SP
4. Temperature
5. CBL (9-5/8" casing)
6. Spinner (as required)

The downhole electric logs are used to provide geological and lithological information as well as engineering data for use in the drilling itself. Electric log interpretation is expected to be the leading method of locating and defining the permeability which might constitute a geothermal reservoir. A test carried out during the 1980 field season using slim hole tools produced an excellent correlation between observed fracture permeability and permeability interpreted from the Neutron Gamma Ray, Natural Gamma Ray, and sonic logs in diamond drill hole M9-80D.

The fourth activity fluid testing consists of a) testing of pressures, temperatures, flow rates, and b) the sampling and chemical analysis of the produced fluid. These activities would normally be carried out by specialists in reservoir engineering and testing. They might be initiated while the rig is still on the hole and continued for some time after installation of the well head.

. . .

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Instrumentation and testing equipment would be provided by a testing and reservoir engineering contractor. It would include devices such as nitrogen tube pressure monitors and downhole pressure/time and temperature/time recorders such as the Kuster instruments presently in use at the site. Flows would be measured by crifice metres, or in the case of brine, by weirs or simple volumetric calculations from fluid discharge to the pit.

The testing sequence would be initiated by inducing fluid to flow from the completed hole. Tests would be conducted at high pressure and low flow rate, relative to the hole's productive capacity, to insure, if possible, that parameters being measured were for single liquid phase only: then flashing can only occur at the surface exhaust. The initial work is termed pulse testing. It would involve flowing the well at various rates for durations of 6 to 12 hours with equal shut-in intervals. The bottom and hole surface pressures, temperatures, and surface flow rates would be monitored continuously while the well was flowing. The downhole pressures and temperatures would be monitored during the shut-in intervals. Long term testing, normally carried out over a duration of 21 days, would be performed upon completion of the pulse tests.

The data obtained from these tests would permit calculations of values for a/ intrinsic transmissivity (kh), a measure of the fluid production capability of the rock, b/ porosity compressibility factor (ϕch), the fluid storing ability of the rock; and c/ well bore efficiency (where ϕ = porosity, c = compressibility, h = reservoir thickness). From these a value can be derived for what is perhaps the single most important well parameter--the productive capacity of the well. This value would be given in units of power such as BTU's per hour, or, for purposes of this study, in megawatts.

. . .

5.0 FIELD DEVELOPMENT PROGRAM; DELINEATION PHASE

5.1 General Statement

The goal of the testing program outlined in Section 4.3 is to confirm the existence of a geothermal resource. Given a successful outcome for this phase of the work the project would move into its third phase, delineation of the resource. This would involve the drilling of production holes in sufficient quantity to sustain the required flow of geothermal fluid to the power plant. A plant such as the 55 megawatt installation discussed in Phase II of this report would require a steam flow rate to the order of 400,000 Kg/hr. Experience elsewhere suggests that such a flow could be sustained by between 6 and 9 producing wells.

Another consideration for the delineation phase of the project is the disposal of waste fluid from the turbine condenser. The generally recommended and acceptable procedure is reinjection into the ground through the use of injection wells. These would be either dry holes with sufficient permeability or holes drilled for the sole purpose of reinjection.

5.2 Drilling

The level of effort required for the delineation drilling phase of the project is presently impossible to predict with precision. Given a continuing flow of valid data from exploration drilling, however, a reasonable minimum might be to the order of 8 holes drilled over a duration of 26-28 months by a single rig.

. . . .

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(assuming a mid summer 1981 start-up and mid winter shut downs). These assumptions are incorporated into the development calendar (Figure 4) which suggests that, barring severe drilling problems, resources consistent with the 55 megawatt plant might be proven up by late 1983. The economic advantage of adding another rig could be investigated when the delineation drilling is well underway. For purposes of this report however the time frame is considered sufficiently short to permit an economically effective program using one drilling rig.

6.0 CONCEPTUAL DEVELOPMENT SCHEDULE

6.1 Timetable

The schedule presented here assumes continued exploration at approximately the level of activity set out in Section 3 of this report. Such exploration emphasis varies from contemporary practice in the United States but is, we feel, well suited to the situation at Meager Creek. We suggest that continued use of light drilling equipment as an aid in defining deep test sites is efficient here both in terms of cost and time. We assume, in addition, that cost effective use of a large rotary rig will mean drilling year round with perhaps a short midwinter break when access is liable to be most severely impaired.

Estimates of drilling time vary widely. R.W. Nicholson in the appended report allows 49 days. Personal communication from oilfield engineers with Canadian experience suggests that, taking into account remoteness of the site from supply centres such as Calgary, Edmonton, and Fort St. John, substantially more time will

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be required, perhaps up to 120 days. Nicholson's estimate, however, is based on experience with crystalline rocks and anticipated good drillability with rates to the order of 3 m/hr. Western Canadian rotary drilling on the otherhand is almost invariably in sedimentary rocks which provide poor grounds for comparison with the anticipated circumstances at Meager Creek. As drilling depths themselves are presently only assumptions the durations used in Figure 4, the Conceptual Development Calendar, represent a range of 70 to 90 days.

6.2 Personnel Requirements

As presently envisioned the exploration and confirmation work to be done during 1981 and subsequent seasons will require a staff of varying size but averaging about 30 persons. A breakdown by work phases and specialization is as follows:

Permanent Staff: Exploration Phase

(assumes average of 3 drill rigs operating on a 2 shift basis).

Camp Manager	1
Drilling & Construction Coordinator	1
Drillers	6
Drill Helpers	6
Drill Foreman	1
Truck Driver	1
Geologists	5
Technicians	2
Clerk/draftsman/expediter	1
Kitchen staff	3
subtotal	27

...

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Temporary Staff: Exploration Phase

Geophysical Contractors	6
Environmental Consultant	2
Construction Crew	<u>2</u>
subtotal	<u>10</u>
Exploration Phase TOTAL	37

Current expansion of the main B.C. Hydro camp at the Meager Creek site will provide accommodation for the staff listed above in addition to the 3 man engineering and geological staff on the rotary project. The B.C. Hydro camp then should accommodate about 40 staff people plus visitors while the rotary site camp should provide for about 26 people as listed below.

Staff Requirements: Rotary Drilling

Drill Superintendent	1
Drilling Crew:	
Driller	1
Derrickman	1
Motorman	1
Floorhands	<u>2</u>
subtotal	5 x 2 shifts 10
Cementing Crew (part-time)	2
Mud Engineer	1
Mud Loggers	2
Down Hole Electric Loggers (part-time)	5
Engineering Staff	2
Geologist	1
Kitchen Staff	<u>2</u>
subtotal	26

...

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6.3 Cost Estimates

An estimate of 1981 dollars of the cost of the project from exploration, through delineation drilling consistent with a 55 MW generating plant is as follows:

1981/82

Exploration Phase:

Drilling	\$ 1,050,000
Engineering/Geology	470,000
Geophysics/Misc-Technical Surveys	100,000
Environmental Studies	200,000
Support Facilities/Meals, Accom.	<u>680,000</u>
Subtotal	\$ 2,500,000

Confirmation Phase:

Rotary Drilling-Related Tasks (2 holes)	\$ 2,400,000
Engineering, Supervision, Testing	<u>700,000</u>
Subtotal	\$ 3,100,000
TOTAL	<u>\$ 5,600,000</u>

1982/83

Exploration Phase	\$ 2,200,000
Confirmation & Delineation Drilling	<u>8,000,000</u>
TOTAL	<u>\$10,200,000</u>

1983/84

Exploration & Development Combined	<u>\$11,500,000</u>
Allowance for Contingencies	<u>\$ 400,000</u>

Total 1981 through 1983	<u>\$27,700,000</u>
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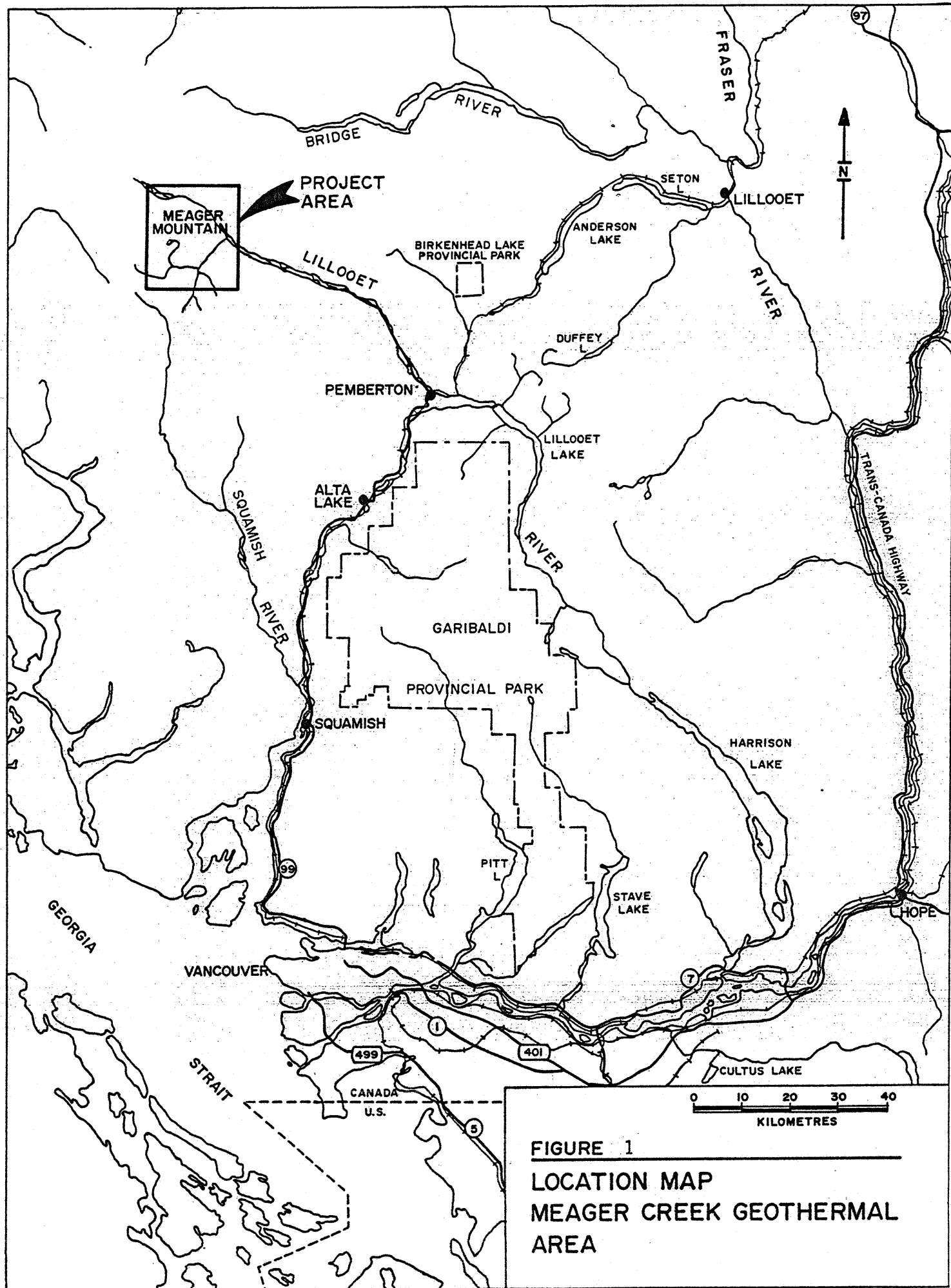
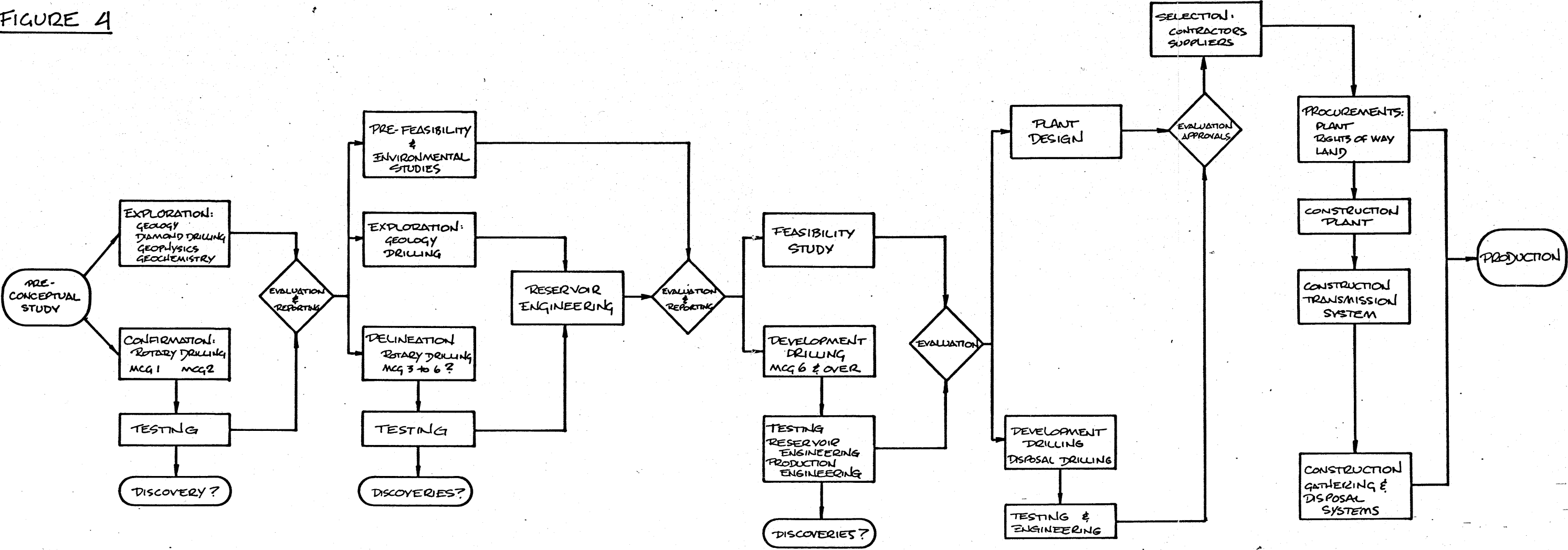




Figure 2 Proposed Deep Test Well Location
South Reservoir, Meager Creek Area.

FIGURE 4



APPENDIX A

Report on

DEEP EXPLORATORY DRILLING
PROGRAM AND COST ESTIMATE FOR THE
MEAGER CREEK GEOTHERMAL AREA

Prepared by

DR. R.W. Nicholson

REPORT

DEEP EXPLORATORY DRILLING
PROGRAM AND COST ESTIMATE FOR THE
MEAGER CREEK GEOTHERMAL AREA

PREPARED BY
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SIGNATURE:

Robert W. Nicholson

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1.0 ABSTRACT

Geologic investigation in the Meager Creek Geothermal Area, Upper Lillooet River, British Columbia have determined that potentially significant geothermal energy reserves may exist. Deep drilling is required to confirm and test the potential of the area. A deep production well drilling program and the estimated costs for this program are contained in this report.

In addition, to adequately test the reservoir to determine the potential of the production well, an injection well will be required. A drilling program for the injection well and the estimated costs for this program are also contained in this report.

Recommendations for the type of drilling equipment needed to accomplish the drilling are included in this report. There is a myriad of various configurations for drilling rigs and their associated equipment. Thus, the actual drilling equipment which will be used to drill these MCGA wells will be determined by selection of the drilling contractor.

The estimated drilling costs for the production and injection wells are \$1,795,500 and \$787,000 respectively. The remoteness of the area, anticipated difficult drilling and the unknown well depth contribute to these costs which are higher than comparable oil or gas wells. Future cost estimates can be more accurate after drilling these initial wells. There is not an estimate for contingency funds. However, some contingency funds must be available. Wells drilled in a new, unknown, area often run into drilling problems and additional funding must be available to accomplish the objectives of the project.

2.0 INTRODUCTION

The initial phases of exploration work in the Meager Creek Geothermal Area (MCGA) have determined that potentially lucrative geothermal energy may exist. A deep exploratory production well which can be adequately tested is needed to prove the prospect.

The technical and economic success of a project of this magnitude is highly dependent upon the technical and managerial expertise of the field operator. The MCGA is located in an area remote to experienced deep drilling personnel and to needed drilling services. In addition, although considerable technically competent exploration geology has been done in the area, little is known about what conditions will be encountered as the bit penetrates to depth. The operator must have highly trained technical personnel supervising all aspects of the operations to handle the many unanticipated conditions which may occur. Such conditions could easily lead to the technical or economic failure of the project.

The personnel who manage the field development program must be thoroughly capable of initiating and developing the entire field production program to the point of supplying the future power plant with the required geothermal fluid. It is important to have such an organization because a geothermal power plant and the reservoir are an integral unit. Thus, because power plant design and ultimate power output of the plant are highly dependent upon the reservoir, great care must be taken from the very outset to obtain all the possible data needed for the power plant. Yet it is also critical that the reservoir be properly developed through competent drilling and production planning and operations.

In this report we suggest a drilling strategy which would economically allow the MCGA to be proven and developed. Each geothermal area is unique and the drilling strategy and wells must be designed for that area. The MCGA has several unique aspects which must be considered when planning a deep well drilling and testing program.

The remoteness of the area from deep well drilling equipment is a prime consideration. Project costs can be significantly reduced by planning maximum utilization of personnel and equipment.

In addition, in such a remote area, extra expenditures are needed to insure against major problems while drilling. Considerable savings can be realized by being prepared for certain problems. Herein we recommend expenditures for material, equipment and personnel which would not normally occur if this drilling area were not remote from drilling support services.

The MCGA is only recently discovered with minimal knowledge about the subsurface formations and fluids. Thus, to design a well, to recommend equipment and material, and to estimate the costs for the drilling project, a number of assumptions must be made. Herein we discuss these

assumptions. We also, described the assumptions we have made in developing the drilling program and in preparing the corresponding well cost estimates.

In the concluding section of this report, we discuss the suggested drilling equipment requirements. These are only suggestions, since the actual equipment which will be used is highly dependent on that which is available.

2.1 INITIAL DRILLING AND TESTING STRATEGY

There are several strategies to the deep drilling and production testing of an exploratory geothermal prospect. Basically, one must drill the hole and while drilling evaluate whether the hole justifies completion. If the hole justifies completion, then preliminary testing must be carried out to determine if the well can be sufficiently productive to be economical. This means that initial "pit testing" must be done. If these initial tests indicate that further development is warranted, an injection well must be drilled to conduct long term testing. This is required to evaluate the reservoir, the fluids, and make preliminary plans for future fluid utilization, i.e. a power plant.

There are three approaches to consider here to satisfy the requirements for exploration and evaluation of the productivity of the reservoir. The first is to drill an exploratory well from one pad (i.e. well location) and an injection well dedicated to injection on another pad. A second approach is to drill the injection well on another pad with the idea that it will be deepened to become a producer to help define the extent of the reservoir. A third approach, which is the one we would recommend if more were known about drilling in the granite is to drill the production and injection wells from the same drill site. The production well would be vertical and the injection well would be deviated. There are several advantages and disadvantages to this approach. The advantages are:

1. The rig can be easily "skidded" to drill and injection well. Thus, costs for moving and rigging up the drilling equipment will be reduced.
2. Only one drill pad needs to be built. However, this one pad must be larger than a pad for a single well.
3. Piping for long term production testing and the associated brine reinjection will be much less costly.
4. Activities during initial long term testing are much easier to coordinate and less costly at a single site.

However, there are some definite disadvantages to using a single site for the production and injection wells. These are:

1. The injection well would be directionally drilled which is more expensive than a vertical well.
2. If the injection well is deepened for conversion into a producer, additional knowledge about the areal extent of the reservoir will not be gained.

Because of the nature of the terrain in the MCGA it may be that all development should be from multi-well pads. This will reduce the costs of roads, drill sites and pipelines (or gathering systems). The gathering systems are quite costly (several millions of dollars) and drilling from pads may be very cost advantageous. Additional analyses of drilling from pads should be made in the future for development drilling after the reservoir has been defined.

Above it is considered that the injection wells will be completed in zones shallower than the production zone. This certainly may not be the case at all. There are a number of technical, economic and institutional aspects which must be considered prior to making this decision. However, from the limited amount of data available at this time, shallower injection appears feasible. Shallow reinjection of course reduces the costs for drilling the injection wells.

2.2. BASES USED FOR THE WELL PROGRAM AND ASSOCIATED COSTS

At the time of this report only shallow gradient holes have been drilled in the Meager Creek Geothermal Area (MCGA). These holes have penetrated to a maximum depth of approximately 1000 m (3280 feet). Although this depth is greater than usually drilled for gradient hole geothermal exploration work, it is not known at what depth a suitable productive reservoir will be intersected. Furthermore, the fracture trends in the MCGA have not yet been defined. Thus, a number of assumptions will be required to plan a deep production well and an injection well. These assumptions are based upon this author's knowledge and experience in other geothermal areas. A summary of the assumptions made for the (MCGA) well planning is contained in TABLE 1.

2.2.1 WELL DEPTHS

The projected drilling depth influences the well costs and the required drilling equipment more than any other aspect of the project. In the case of the MCGA drilling the actual depths of the production wells may vary considerably over the areal extent of the reservoir because of subsurface geologic conditions and also because of the relief of the surface terrain.

The reservoir encountered may be either steam or liquid dominated. Since a "seal" has not yet been encountered it may be presently assumed that a "hot water" (i.e. liquid dominated) reservoir will be encountered.

The initial casing programs and cost estimates will assume that a 2155 m (7,500 feet) deep well may be required. Although a suitable reservoir could be penetrated at much shallower depths, because of the large costs involved in mobilization and de-mobilization, the operator should be prepared to drill and case to this depth. If the reservoir is found at a lesser depth, then less costly drilling equipment which has been sized for that depth can be used for future drilling programs. The injection well must be completed over an interval which can be economically injected into. That is, the formation must have sufficient injectivity (defined as BBL/DAY/PSI or $\text{lb}_m/\text{HR}/\text{PSI}$) to handle the injection rates at minimal surface pressure. Also, the zones into which the heat depleted brine is disposed must be isolated from the fresh surface waters. We assume that if injection is below 300 m (1000 feet) then surface waters will not be contaminated. In addition, we assume that injection zones must be opened down to 1000 m (3500 feet) so that the injection well will have desired injectivity.

2.2.2 PRESSURES AND TEMPERATURES

The expected bottom hole temperature and flowing surface temperature, along with the corresponding bottom hole pressures and flowing surface pressures, must be presently assumed. At 367 m (1204 feet) a temperature of 202.2°C (396°F) has been encountered. The maximum temperatures in other wells have been generally much less. Also, the temperature gradient has not been consistent. Thus, predictions of reservoir temperatures at this time cannot be made with any degree of accuracy. For design of this production well a maximum bottom hole temperature of 315°C (600°F) and a maximum surface temperature of 288°C (550°F) will be assumed.

All subsurface formation pressures will be assumed to be hydrostatic. (That is, the static pressure gradient in the well will be 0.433 psi/ft.) Also, it will be assumed that there will not be any artesian pressure. Although artesian pressures have not been encountered, they could definitely be encountered in this drilling program. However, for surface equipment, well head equipment and downhole equipment designs, it will be assumed that the static pressure gradient is hydrostatic. Thus, it is assumed that a maximum surface pressure which occurs just after the production well is "shut-in" will not exceed 1,030 psi (see TABLE 2). Thus, 600 # pound ANSI equipment is required for the well head to safely handle this pressure (see TABLE 2).

It is assumed that the maximum surface pressure required at the injection well head will be 500 psig. Thus, 300 lb. ANSI equipment can be used for the injection wellhead.

2.2.3 PRODUCTION AND INJECTION RATES

Geothermal wells must flow high rates as compared to oil wells, for a geothermal prospect to be economical. For example, at today's prices it can be assumed that the cost of one megawatt of geothermal power is

equivalent to the cost of between 25 BPD to 40 BPD of oil. This, of course, depends upon many factors which go into producing the one MW of geothermal power. It is generally found that between 16 lb_m and 27 lb_m of "steam" are required to generate one kw of electricity. Thus, assuming 20 lb_m per kw, a well must flow 20,000 lb_m per hour steam for one megawatt. A "good" well can produce ten megawatts (i.e. 200,000 lb_m per hour steam). The total well flowrate then must be 1.0×10^6 lb_m/hr if we assume a 20% steam flash. This is approximately equivalent to 2000 gpm if all the fluid in the wellbore remains in the liquid state.

Fractured type reservoirs can produce this 1.0×10^6 lb_m/hr. Thus, we assume that successful wells in the MCGA will have such a potential production rate. This rate assumption is required to propose an adequate well casing diameter.

Further, the expected temperature in the reservoir precludes the need for downhole pumping equipment. There are advantages and disadvantages of pumping geothermal wells. These details are far too involved to be discussed here. However, it is assumed that the wells will self flow after the flow is initiated by some artificial means such as gas lift. It is doubtful that the wells would have any artesian pressure. This presumption is based on the presently little known geology. However, the possibility of artesian pressure does exist.

Disposal of the heat depleted brine is a major problem for geothermal projects. This is true in countries where the people are environmentally conscious as the people are in the U.S. and Canada. Thus, the fluid must be disposed of in an environmentally acceptable manner.

To dispose of the fluid in the MCGA an injection well will be required. The well should be designed to handle the fluid from several wells. It is assumed that the injection well will handle 4500 gpm. Thus, the casing diameter will be designed accordingly. There are other influencing factors on the selection of the casing design discussed later in this report.

3.0 DRILLING PROGRAM FOR THE EXPLORATORY MCGA PRODUCTION WELL

The drilling program presented in Appendix A is only a recommendation. Many of the details may be changed at the time of actual equipment ordering because of (a) new information, (b) equipment availability, or (c) the particular desires of the drilling supervisory personnel. This drilling program should allow sufficient flexibility to successfully drill, complete and test the first deep well in the MCGA.

Figure 1A depicts the well designed and costed for the deep production well.

The first consideration for developing a drilling program is to decide upon the type of completion. Geothermal wells have been completed with several types of wellbore/casing configuration. Some of these are shown in Figure 1. Using the assumptions for the anticipated well conditions it is recommended that the first well be completed with a long casing string and a liner as shown in Figure 1A.

3.1 DRILLING HAZARDS

Drilling of geothermal wells can be difficult because of the number of problems inherent to this type of geology. Tables 3 through 7 indicate the many problems. All of these problems can well be expected in the drilling of the MCGA. In addition, the shallow drilling will be difficult because of the presence of boulders in the unconsolidated overburden. The 20" conductor pipe should be set through this section. However, in some of MCGA this section is quite deep and will cause problems until the 13-3/8" surface casing is in place.

3.2 ASPECTS OF THE DRILLING PROGRAM

The drilling program in Appendix A is self contained. However, brief explanations of certain aspects of the program are warranted.

3.2.1 TOTAL WELL DEPTH

The program and costs are for a 7500' well. However, if an adequate reservoir is encountered at a shallower depth, the program can be altered to accommodate this by easily changing the casing setting depths. After a short test at 7500', it may be determined that the well needs to be deepened. If the well is deepened prior to running the 7" liner, then some additional 7" liner may be required. This size casing is very common and short sections (i.e. 1000' to 2000') can be acquired in time not to delay the project.

3.2.2 LOCATION AND ELEVATION

The surface drilling location is not yet specified, thus, the site elevation is yet to be determined. Since the country is mountainous and the depth

of the rubble overburden varies, the consideration of site selection may reduce costs and problems of drilling.

Movement of equipment, site ingress and egress, and access to and from temporary storage areas should be considered in site selection so as not to permit interruption, or delays, of drilling activities and supplies movements. Also, as stated above, site selection should take into consideration the potential drilling hazards of drilling and casing off the shallow rubble zones.

Water for the drilling operations does not seem to be a problem. Fresh, uncontaminated surface water appears to be in adequate supply for drilling activities. The chemistry of the waters should be analyzed for possible contaminants, especially for those which may affect cementing operations.

3.2.3 CASING/HOLE SIZE PROGRAM

The casing/hole size program recommended here should be flexible enough to accomplish the goals for deep drilling. This type of casing program may not be optimum for full field development, however, after the first well, this program can be adjusted. This type program has been used to drill to depths of 25,000 feet with appropriate changes in the casing weight and grades.

These sizes are common to the petroleum industry; therefore, there is a wide range of downhole equipment readily available. This is an important consideration if problems occur.

3.2.4 CEMENTING PROGRAM

The cementing program in Appendix A has been found satisfactory for geothermal wells. However, placement is a primary problem. Extreme care and attention to minute detail should be given to the cementing of the casing. The volumes should be recalculated on site according to caliper information and the slurry volumes adjusted accordingly.

Since downhole temperatures are not yet known, retarders should be available to mix with the mixing water prior to cementing. It is recommended that the water/retarder be pre-mixed and a consistometer test be made prior to cementing the casing. This will require surface storage of the water.

It is recommended that an extra 1000 sacks of cement be on location in the event severe lost circulation problems are encountered. It is recommended that this be class G neat which can be "tailored" to fit the situation. This is recommended because of the remoteness of the area and is cheap insurance. If the cement is maintained and not used, the service company will probably take it back and credit the account.

It is recommended that a cementing unit be on site at all times. It may not be necessary to keep a cementing equipment operator at the site. This would depend on how quickly operators can be moved to the site. The cement pumping equipment is also insurance against unforeseen serious drilling problems.

3.2.5 CASING

The casing and casing equipment are presented in Appendix A. Casing is a big expense and a well cased hole is extremely important to the success of any drilling project. There are many considerations which must be given to the casing, and running the casing, to ensure a good casing job. All these details must be attended to by the operator and the on-site representative.

It is recommended that all API required casing reports of inspections are obtained with the purchase of the casing. In addition, an independent inspection should be made on the casing (i.e. wall thickness, drift, special end area plus threads). Needless to say, a casing failure is catastrophic to a project and where a critical well is being drilled, such as is the first MCGA production well. All reasonable care should be taken to adequately case the well.

3.2.6 WELLHEAD

The recommended wellhead equipment is adequately described in Appendix A. The bases for this rating have been discussed earlier in this report. There is one note of caution; that is, extra sets of seals should be at the site and re-use of the old seals should be avoided. Special treatment of the metal for H₂S service has not been recommended. However, if damaging concentrations of H₂S are encountered, then the wellhead (as well as other materials) must have to be redesigned for such service.

3.2.7 DRILLING FLUID PROGRAM

The drilling fluid program is thoroughly presented in Appendix A. In addition to the 1000 sacks of barite recommended for safety, a supply of lost circulation materials should also be available. The drilling fluid supplier should be able to recommend the types of material which should include cottonseed hulls, fine and course ground walnut hulls and cellulose.

3.2.8 BOPE REQUIREMENTS

The BOPE requirements are thoroughly described in Appendix A along with supplemental information in Appendix B. Thorough discussion of this equipment should be held with the drilling contractor to insure that the rig substructure can accommodate the stack and wellhead height requirements.

3.2.9 DIRECTIONAL PROGRAM

The hole should be drilled vertically. However, in drilling through volcanics this is often difficult. The drillstring should be well stabilized. This means that several stabilizers should be on site because the formations will quickly wear the stabilizers to be under gauge. Also, if the drill bits are worn under gauge, reamers should be used just above the bit.

4.0 COST ESTIMATES FOR THE MCGA EXPLORATORY PRODUCTION WELL

The major factors which cause the cost of the first MCGA to be high are (a) remoteness to drilling services, (b) the formations, and (c) the yet unknown subsurface drilling conditions. In Appendix D the production well cost estimate is presented. An explanation of the cost details are also given along with a description of the cost categories for making well cost estimates.

Suppliers were contacted for the prices being charged at the time of preparation of this report. Costs will vary slightly among the various suppliers. However, these costs are sufficiently accurate for planning purposes. These prices are given in Canadian dollars except for the tangibles. Price adjustments for importation may be required. However, it is considered that all equipment and materials can be acquired in Canada.

Exact costs are not known for the services which can be found locally in the MCGA. For example, the cost of building and maintaining the location is not precisely known. For these costs we estimate the costs based on past experiences. In general, the cost estimates herein are conservative. However, major drilling problems can cause these cost estimates to be very inaccurate.

5.0 SUGGESTED DRILLING EQUIPMENT

The drilling equipment needed to drill the MCGA wells falls into two categories. That is, equipment is provided by the drilling contractor and some equipment is supplied by the operator. It is generally to the advantage to the operator to have the drilling contractor supply as much equipment as possible except for permanent well equipment.

However, the operator must be careful not to require special equipment not in the drilling contractor's inventory. When such equipment is required it is usually more cost effective to rent this equipment from a supplier.

Appendix E contains a hypothetical International Association of Drilling Contractors (IADC) dayrate drilling contract. Which of the drilling equipment suggested in Appendix E is to be supplied by either the contractor or the operator is negotiable. The operator should shop around the rig equipment market and select the rig with the equipment meeting the requirements suggested in Appendix E.

The IADC form in Appendix E is a U.S. type contract. However, Canadian forms can be obtained from the Canadian Association of Oilwell Drillers in Calgary.

6.0 INJECTION WELL PROGRAM AND COSTS

After drilling short term pit testing and completing the MCGA production well, longer term production testing will be required to determine the reservoir potential. Long term testing (30 days or more) will require an environmentally acceptable method of fluid disposal. Thus, an injection well will be required.

Reservoir management during the life of the reservoir may dictate any number of fluid disposal or fluid reinjection schemes. However, during the early stages of reservoir and fluid characterizations, shallow reinjection is recommended. This will significantly reduce costs. The well design presented here offers several advantages:

1. Casings are the same as recommended for the production well. Thus, there is flexibility in use of equipment.
2. The well can be easily deepened and converted to a producer. This is done by pulling the 9 5/8" slotted liner, deepening and then completing the same as the MCGA producer.
3. The reinjection well program is very simple. Thus, the drilling risks are significantly reduced.
4. Minimal reinjection pump horsepower will be needed to overcome frictional pressure losses in the casing because of the length and size of the casing (150 psi maximum at 4500 GPM).

A primary concern with the shallow injection well proposed here is the possibility of the reinjection zones communicating with the shallow fresh ground water or surface waters. If such communication exists, than potentially hazardous geothermal fluids could contaminate the fresh waters. A hydrology and geology program should be carried out to make such a determination. The possibility of such communication is not remote in volcanic areas where fractures in the rock may extend from the surface to considerable depths.

6.1 INJECTION WELL PROGRAM

The injection well program is given in Appendix B. The program is similar to the production well program described in detail in Section 3.0 and Appendix A. The primary difference is that prior to running the 9 5/8" slotted liner, an injectivity test must be done. If insufficient injectivity is found in the 1000' to 3500' interval, it may be necessary to deepen the well. During injectivity testing, if there are nearby gradient holes, these should be monitored for evidence of communication between the shallow ground water and the reinjection zones.

6.2 INJECTION WELL COSTS

Costs for the injection well program in Appendix B are contained in Appendix F. The costs were derived essentially in the same manner as the costs for the production well. The primary difference is that \$20,000.00 are allocated for the rig move from the production well site to the injection well site. The costs for demobilization of the rig are included in the production well costs.

TABLE 1

SUMMARY OF ASSUMED
RESERVOIR AND GEOLOGIC CONDITIONS
FOR THE DESIGN OF
THE MCGA PRODUCTION AND INJECTION WELLS

PRODUCTION WELL

Bottom of Reservoir (depth)	3050 meters (10,000 ft)
Top of Reservoir (depth)	2590 Meters (8,500 ft)
Average Reservoir Temperature	315°C (600°F)
Maximum Surface Temperature	288°C (550°F)
Static Reservoir Pressure Gradient	0.433 psi/ft.
Average Reservoir Pressure	4330 psi
Maximum Surface Pressure	1030 psi
Maximum Producing Rate	1.0 x 10 ⁶ lbm/hr.
	(2000 GPM Equiv.)
Thickness of Overburden	25 meters (82 ft)
Granitic Formations	25 meters to 3050 meters
	(25 ft. to 10,000 ft)

75?

INJECTION WELL

Bottom of Injection Zone	1006 meters (3,500 ft)
Top of Injection Zone	287 meters (1,000 ft)
Thickness of Overburden	25 meters (75 ft)
Average Temperature of Injection Zone	150°C (302°F)
Maximum Injection Pressure	1000 psi
Maximum Injection Rate	4500 GPM
Granitic Formations	25 meters to 1006 meters)
	(75 ft to 3500 ft)

TABLE 2

FLANGE AND VALVE
PRESSURE-TEMPERATURE RATING

TEMPERATURE (F)	WATER VAPOR PRESSURE (psig)	VALVE RATING	
		#400 ANSI (psig)	600# ANSI (psig)
500	665	835	1,250
525	833	812	1,215
550	1,030	790	1,180
575	1,260	765	1,155

UNIQUE ASPECTS OF GEOHERMAL DRILLING

TABLE 3

FORMATION ROCK

HIGH TEMPERATURE

HIGH PRODUCTION RATES

COMPLEX FLUID CHEMISTRY

GEOHERMAL FORMATION ROCK VOLCANICS AND METAMORPHOSED

TABLE 4

HARD

ABRASIVE

HIGHLY FRACTURED

LOW FORMATION PRESSURE

HIGHLY STRESSED UNSTABLE

HIGH TEMPERATURE CAUSES PROBLEMS WITH:

TABLE 5

COMPLETION EQUIPMENT

DRILLING EQUIPMENT

FORMATION EVALUATION TOOLS

PRODUCTION LOGGING TOOLS

DRILLING FLUIDS

DIRECTIONAL DRILLING

COMPLEX FLUID CHEMISTRY

TABLE 6

CORROSIVE GASES

SCALE FORMING MINERALS

CONCENTRATED BRINES

DRILLING AND COMPLETION PROBLEMS

TABLE 7

LOST CIRCULATION

HOLE STABILITY

DIFFICULT FISHING OPERATION

LIMITED ELECTRIC LOGGING CAPABILITY

DRILLING FLUID PROBLEMS

CASING PROBLEMS

DRILLING AND COMPLETION PROBLEMS (CONT.)

TABLE 7 (CONT.)

CEMENTING

BIT LIFE SHORTENED

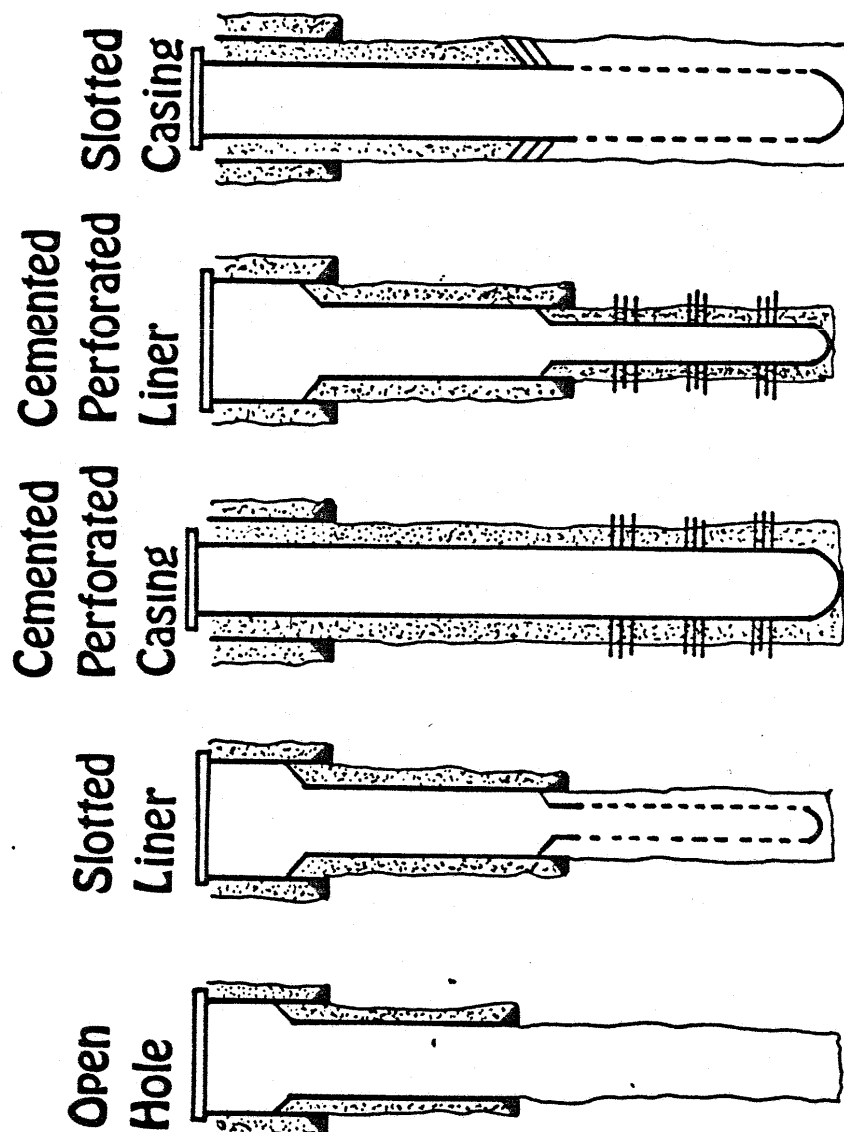
DRILL STRING WEAR

DIRECTIONAL DRILLING LIMITATIONS

CORING

TYPES OF GEOTHERMAL WELL COMPLETIONS

FIGURE 1



APPENDIX A

DRILLING PROGRAM FOR THE MCGA

PRODUCTION WELL

DRILLING PROGRAM FOR THE MCGA PRODUCTION WELL

February, 1981

Procedure to Drill a Deep Geothermal Production Well in the MCGA

Upper Lillooet River, British Columbia

Vertically drilled production well scheduled to drill to 7500'±.

(All measurements refer to K.B. (MSL elevation depends on location) approximately 17 feet above ground level. Depths refer to measured depths unless specified.

Total Depth:

7500' ± MD

Location:

Bottom hole location:
(To be specified by geologists)

Surface location:
(Approximate location size shown on Figure 2A actual location to be determined)

Elevation:

(See Figure 3A - Ground Level Elevation Depends upon Location)

Casing/Hole Size Program: (see Figure 1A)

<u>Casing</u>	<u>Hole Size</u>	<u>Depth</u>
20" conductor	26"	80' to 100' (depends on unconsolidated overburden)
13-3/8"	17-1/2"	800' to 1000'
9-5/8"	12-1/4"	5200'
7"	8-1/2"	5000' to 7500'

Procedure to Drill MCGA Production Well

Cementing Program:

20" conductor pipe:

Cemented to surface with portland cement

Volume:

(100% excess)

26" x 20" - 100 feet = 150 CF

260 sacks Portland Neat Cement w/100% excess

13-3/8" Surface Casing:

Cemented through shoe with inner string cementing method:

Volume:

17-1/2" x 13-3/8" - 1000 feet = 695 CF

(25% excess)

339 sacks of 1:1 API class G to Perlite + 3% gel + 40% Silica flour + 0.5% CFR-2 mixed with 1.42 CF of water per sack.

Tail end with 100 sacks of class G neat pre-mixed with 35% Silica flour and 0.5% CFR-2 with 0.87 CF of water per sack.

Note: Liquid retarder should be available in the event bottom hole temperatures from the logs indicate the need for retarder.

9-5/8" Production Casing

Cemented conventionally from bottom to surface.

Volume:

9-5/8" x 13-3/8" Casing - 1000' - 363 CF

9-5/8" x 12-1/4" Hole - 4200' - 1315 CF

2 Jts between shoe and float collar (80') - 34 CF

Total Volume 1712 CF

(15% Excess)

720 sacks of 1:1 API class G to Perlite + 3% gel + 40% Silica flour + 0.5% CFR-2 mixed with 1.42 CF of water per sack.

Tail end with 100 sacks of class G neat pre-mixed with 35% Silica flour and 0.5% CFR-2 with 0.87 CF of water per sack.

Note: Liquid retarder should be available to use in the mixing water. The amount of retarder will be determined after the bottom hole temperatures are found from the logs.

Procedure to Drill MCGA Production Well

Slurry Properties:

	<u>Weight</u>	<u>Yield</u>	<u>Water</u>	<u>Strength</u>
Perlite	- 12.7 PPG	2.22 CF/SX	1.42 CF/SX	405 PSI (8 hr.)
Tail Slurry	- 15.6 PPG	1.50 CF/SX	0.87 CF/SX	1300 PSI (8 hr.)

Properties of Casing:

		<u>Burst (PSI)</u>	<u>Tension (KIPS)</u>	<u>Collapse (PSI)</u>
13-3/8"	- (54.5-K)	2730	1038	1130
9-5/8"	- (40.5 PPF-K)	3950	843	2570
7"	- (26 PPF-K)	7240	667	5410

All safety factors are better than: 1.68 Joint Tension, 1.25 Body
Tension, 1.25 Burst, 1.15 Collapse.

Tubular Goods Required:

Casing:

100' - 20" conductor
1000' - 13-3/8" - 54.4 #/ft, K-55, Buttress
5200' - 9-5/8" - 40.5 #/ft, K-55 Buttress
2500' - 7" - 26 #/ft, K-55 Buttress (slotted 0.25" 16 row)

Casing Equipment Required:

13-3/8":

- 1) Float shoe (stab-in), wash down type
- 2) 5 13-3/8" centralizers

9-5/8":

- 1) 9-5/8" differential fill-up Float Collar for 9-5/8" 40 #/ft.
- 2) 9-5/8" Guide shoe-wash down type with side ports
- 3) 30 9-5/8" Centralizers
- 4) 2 9-5/8" Buttress Collars

Procedure to Drill MCGA Production Well

Note: The collars on the bottom two joints of the 9-5/8" are to be carefully cut off. New collars are to be put on with Baker-Loc or equivalent.

7" liner:

- 1) Liner Hanger simple mechanical type w/lead seal on top
- 2) 5 - 7" centralizers
- 3) Orange Peel shoe with bailing plate

Wellhead:

13-3/8" S.O.W. x 12", 600# RTJ starting head with two 3" flanged side outlets (600# ANSI), 9-5/8" expansion spool with two 3" 600# ANSI flanged side outlets and 12" - 600# RTJ flange down and 10" - 600# RTJ flange up. 10" master valve and fittings per Figure 3A. Side outlets to be equipped with two, 600# RTJ flanged gate valves on each side of the expansion spool.

Drilling Fluid Program:

From surface to 1000' use lightweight, low solids fresh water clay base mud treated with lignite, caustic and bicarbonate of soda for cement contamination, and bit lube as required.

From 1000' to 7500' use lightweight, lignosulfonate thinned sepiolite mud with caustic soda.

Below 5200' one 1-liter sample of drilling fluid and one 1-liter sample of make-up water are to be taken every 12 hours while drilling or circulating.

Notes: Fresh water may be used without gel. Slugs of gelled water should be used occasionally to clean the hole. This should be determined by the drilling conditions.

Lost circulation may be very severe. Air compressors may be required for injecting air into the stand pipe so that drilling may safely proceed. Proper surface handling equipment (air compressors and mud-gas separators and rotating head) should be available.

A cooling tower should be installed in the mud system and the mud pumped through the cooling tower when the mud return temperature exceeds 160°F (71°C).

Procedure to Drill MCGA Production Well

Fluid density should be kept to a minimum unless drilling conditions require the density to be increased.

Because of the remoteness of the location, 1000 sacks of barite should be on site in the event abnormally high subsurface pressures are encountered.

BOPE Requirements:

Surface to 1000' - no BOPE requirement. Numerous exploratory holes in the area indicate subnormal pressures to 1000 feet.

1000' to 7500' - install 12" class II BOPE on 13-3/8" wellhead. (see Figures 4A and Figure 5A) Choke and kill lines to be hooked up to wellhead valves.

Fill-up line is to be installed above the preventer. A lower kelly cock and a standpipe valve will be installed. A full opening safety valve and an inside preventer shall be maintained on the floor. Crossover subs will be available and readily accessible on the floor for all connections in the drill string.

Hydraulic BOPE control stations shall be equipped with dual controls, one at the rig floor and one 50' from the wellhead. Accumulator capacity will be at least 80 gals. Mud flow line, flow rate and pit level will be monitored continuously. A pit level warning device shall be installed. While drilling below 1000 feet, a pit drill will be conducted daily. All procedures in Appendix C (Blowout Contingency Plan) shall be strictly adhered to.

In the event air assist is needed for controlling lost circulation, a rotating head will be installed above the rams and a blow down line will be installed from below the rotating head to a mud gas separator.

Hydraulics Program:

Below 13-3/8" casing shoe, keep annular velocities and viscosities around the drill collars so as not to cause transition to turbulent flow. Estimate pipe running speeds which will not produce more than 200 psi surge and/or swab pressures above the bottom hole pressure.

Directional Program:

Drift dogleg severity will be allowed with combined angle and directional changes of no greater than 3.5°/100 feet. Angle surveys will be taken according to:

Procedure to Drill MCGA Production Well

<u>Interval</u>	<u>Frequency</u>	<u>Maximual Deviation from Vertical</u>
0 - 500'	Every 60 feet	5°
500'- 1000'	Every 120 feet	5°
1000'- 7500'	Every 240 feet	5°

Note: If directional control cannot maintain the tolerances, then angle and azimuth surveys shall be taken. This requires a monel drill collar and associated equipment.

Drilling Procedure:

- 1) Conductor should be set with a crane or conductor setting rig prior to moving in the drilling rig. Several attempts to drilling and setting the conductor may be required because of boulders in the shallow overburden.

If this in not feasible, then the drilling rig will be required to drill the 26" hole and set the conductor. Several attempts may be required.

In the areas where the overburden is less than 100', the 20" conductor should be set to the base of the overburden.

- 2) Move in drilling rig and rig up over 20" conductor hole. (Assumes conductor already set.)
- 3) Make up 17-1/2" bit and drill collars. Install mud loggers and drill to 1000' using fresh water and gel mud system as outlined in the mud program.
- 4) Pull out and run IES, DIL, FDC/CNL, sonic and caliper logs. Run maximum recording thermometers on all logging runs. Run temperature surveys as required.
- 5) Make conditioning trip after logging.
- 6) Run 1000' of 13-3/8" 54.4 #/ft buttress casing. Install stab-in cementing shoe on bottom of casing. Pipe lock the shoe and bottom five joints. Put turbolizer (centralizer) at shoe and remaining centralizers on each collar above shoe.
- 7) Center casing in rotary table. Make-up cementing stab-in assembly and run inside casing and stab into shoe. Establish circulation and circulate at least one casing/hole annular volume. Cement (see cementing program above) casing at as high a rate as possible. Continue cementing until good cement comes to the

Procedure to Drill MCGA Production Well

surface. Displace cement out of drill pipe and pull out. Wait on cement (WOC) 8 hours.

- 8) If cement fails to circulate to the surface, run one inch macaroni tubing down annulus and cement to surface using same slurry as above.
- 9) After WOC for 8 hours, cut off 13-3/8" casing and weld on slip-on wellhead. Install BOPE in accordance with Figure 4A.
- 10) Test blowout preventers to 1000 psi, hold pressure for 30 minutes. Report any bleed off.

Note: Burst of 13-3/8" 54.5 lb/ft casing is 2730 psi. Pressure internal at 1000 feet with 9.0 ppg fluid in the casing is 1468 psi.

- 11) Drill out of 13-3/8" casing with 12-1/4" bit with as light bit weight as possible to keep hole straight. Monitor mud temperature and record every 30 feet. (Mud logger should do this.) When return mud temperature reaches 160°F (71°C). pump mud through cooling tower. Perform a pressure test on the shoe after drilling 5 feet of formation below the shoe. Record the results. Be prepared to squeeze cement if the shoe will not hold 9.0 ppg equivalent hydrostatic.
- 12) Maintain directional control as specified above and drill to 5200 feet.
- 13) Run FDC/CNL with a GR plus sonic and caliper logs in the open hole. Run CBL in 13-3/8" casing. Run temperature surveys as required.
- 14) Make conditioning trip.
- 15) Run 9-5/8" casing. Install guide shoe, 2 joints of casing, float shoe and pipe lock bottom 5 collars. Use new collars on bottom 2 joints and pipe lock both sides. Install centralizers just above shoe and the remaining centralizers on each of the collars above the shoe.
- 16) Cement casing with slurry specified above. Note that retarder needs to be added according to temperatures measured during logging.
- 17) WOC 8 hours. Install expansion spool and nipple up BOPE as shown in Figure 5A.

Procedure to Drill MCGA Production Well

- 18) Lay down big collars and pick-up 8-1/2" drilling assembly. Run in hole.
- 19) Drill out 5 feet of new formation below the 9-5/8" casing shoe and pressure test to 9.0 ppg equivalent as minimum. Be prepared to squeeze shoe.
- 20) Drill to 7500' in accordance with directional and fluid programs specified above.
- 21) Log hole with FDC/CNL, sonic, GR and temperature surveys. Run CBL in the 9-5/8" casing.
- 22) If logs indicate and formations are sufficiently competent, an open hole flow test should be made.
 - 22.1 Run in hole with drill pipe and displace out drilling fluid with fresh water.
 - 22.2 POH and stand back drill pipe.
 - 22.3 Set 9-5/8" bridge plug 100' below surface.
 - 22.4 Nipple down BOPE and nipple up wellhead as shown in Figure 3A.
 - 22.5 Rig up nitrogen and gas lift well.
 - 22.6 Flow well through energy dissipator and pump fluid into pit.
 - 22.7 Record flow rates, collect fluid samples and measure all pressures and temperatures.
- 23) If the well does not have sufficient rate or temperature, rig down test equipment. Nipple up BOPE and drill deeper.
- 24) If well is adequate, kill well, set bridge plug, install rams and trip in hole with drill pipe clean out to bottom. Run 7" slotted liner and hang at 5000 feet. Move rig.
- 25) Upon completion of preliminary testing, transmit history and results to operator. Dependent upon results of initial testing specifications for additional testing will be issued.

Procedure to Drill MCGA Production Well

General Instructions

1. Keep hole full at all times.
 - a) While pulling out of hole, fill hole every 10 stands. Check fill-up volume to verify that hole is taking proper amount of fluid.
 - b) It is the responsibility of each driller to record on his tour report the amount of fluid lost or gained on all trips or each tour.
2. Contract drilling foremen are to conduct kick control drills and be confident that drillers and crew men understand their responsibility during a Well Kick or fire.
3. The daylight Tour driller will log three reduced pumps rates (strokes) and pressures each day when drilling below surface pipe.
4. Function test all Rams once every 24 hours. Log all tests on Tour report. Test all BOPE and Kill system equipment every 7 days to 1000 psi (except the annular preventer-test to 500 psi).
5. It is the responsibility of each driller and the drilling foremen to be confident that there is no well flow or fluid loss, at all times. Driller has the authority to shut down drilling operations and check hole at any time, especially after drilling rate increases, high gas reading, flow rate increases, abnormal salt increase, unusual increase in viscosity, or any time he is unsure of conditions. Driller may also shut in well and immediately notify drilling foremen and tool pusher.
6. Keep all safety valves clean, in working order, and on drilling rig floor at all times.
7. Drill pipe will be reciprocated or rotated at all times. Repairs will be made with drill pipe in casing. We will never shut down with everything out of hole, except during logging operations.
8. No smoking or fires at any time on rig or in cellar. There are designated smoking areas. Fires, welding, or hot work will be done in special areas.

Procedure to Drill MCGA Production Well

9. All new employees will be instructed of their duties during Kick control and fire emergency. This information must be kept posted on the rig or on the crew change house.
10. Keep all solids control equipment in working order at all times.
11. Tour reports must be made out complete and time must be kept to the closest half ($\frac{1}{2}$) hours.
12. No alcoholic beverages are allowed on the drill site.

FIGURE 1 A

SCHEMATIC CROSS SECTION
OF CASING/HOLE SIZE PROGRAM FOR
MCGA PRODUCTION WELL

NOTE: CASINGS FULLY
CEMENTED FROM SHOE
TO SURFACE

NOTE: FINAL SETTING
DEPTHS TO BE
DETERMINED DURING
DRILLING

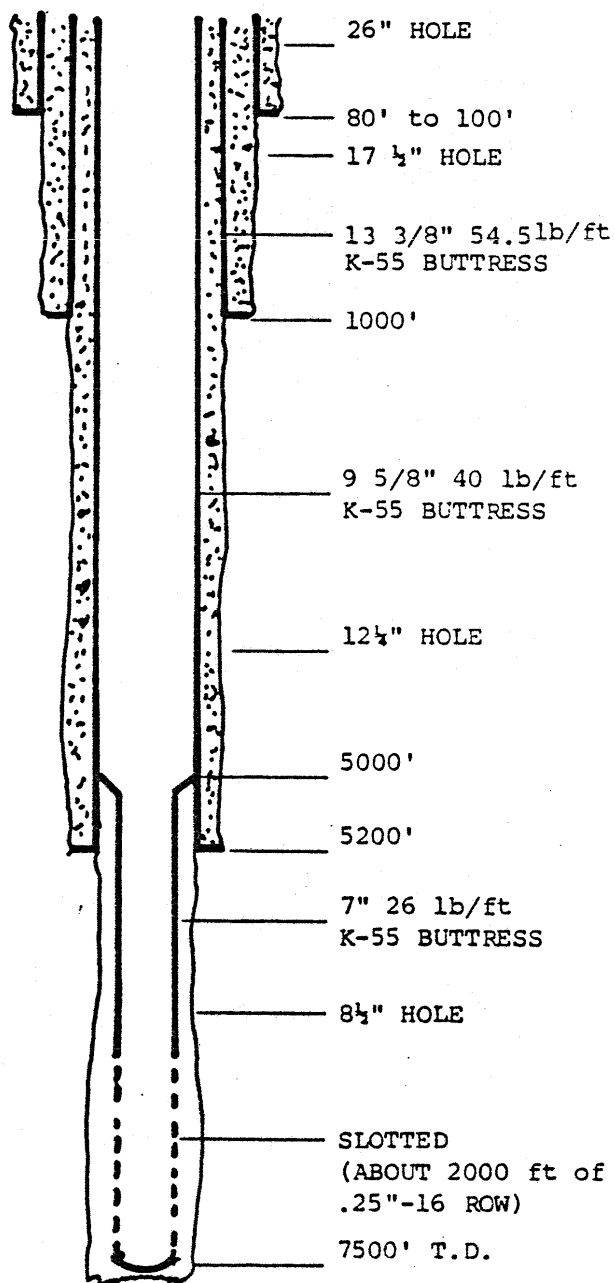


FIGURE 2A
TYPICAL DRILLING PAD
FOR 10,000' RIG

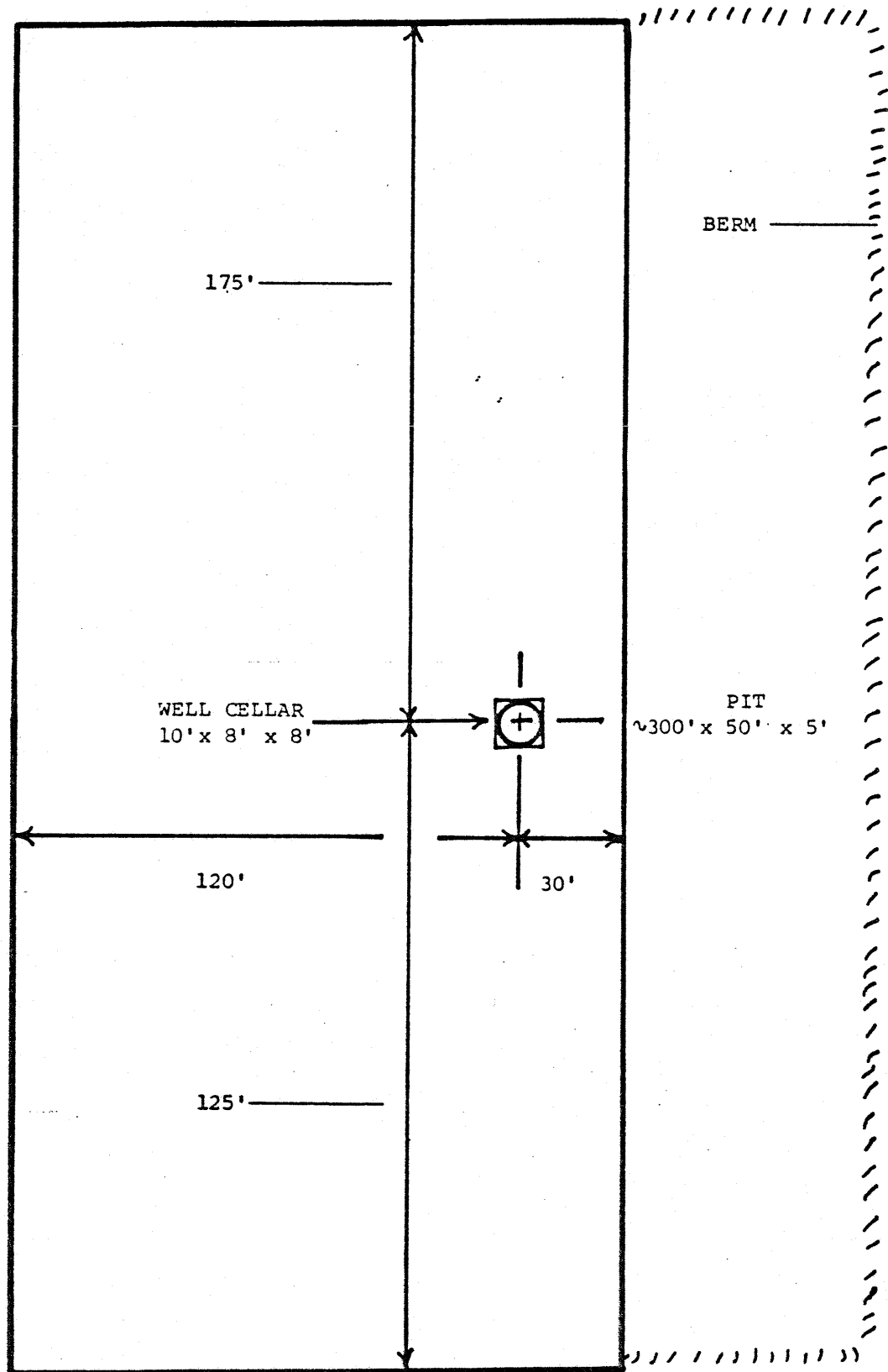


FIGURE 3A
MEAGER CREEK
PRODUCTION WELL WELLHEAD

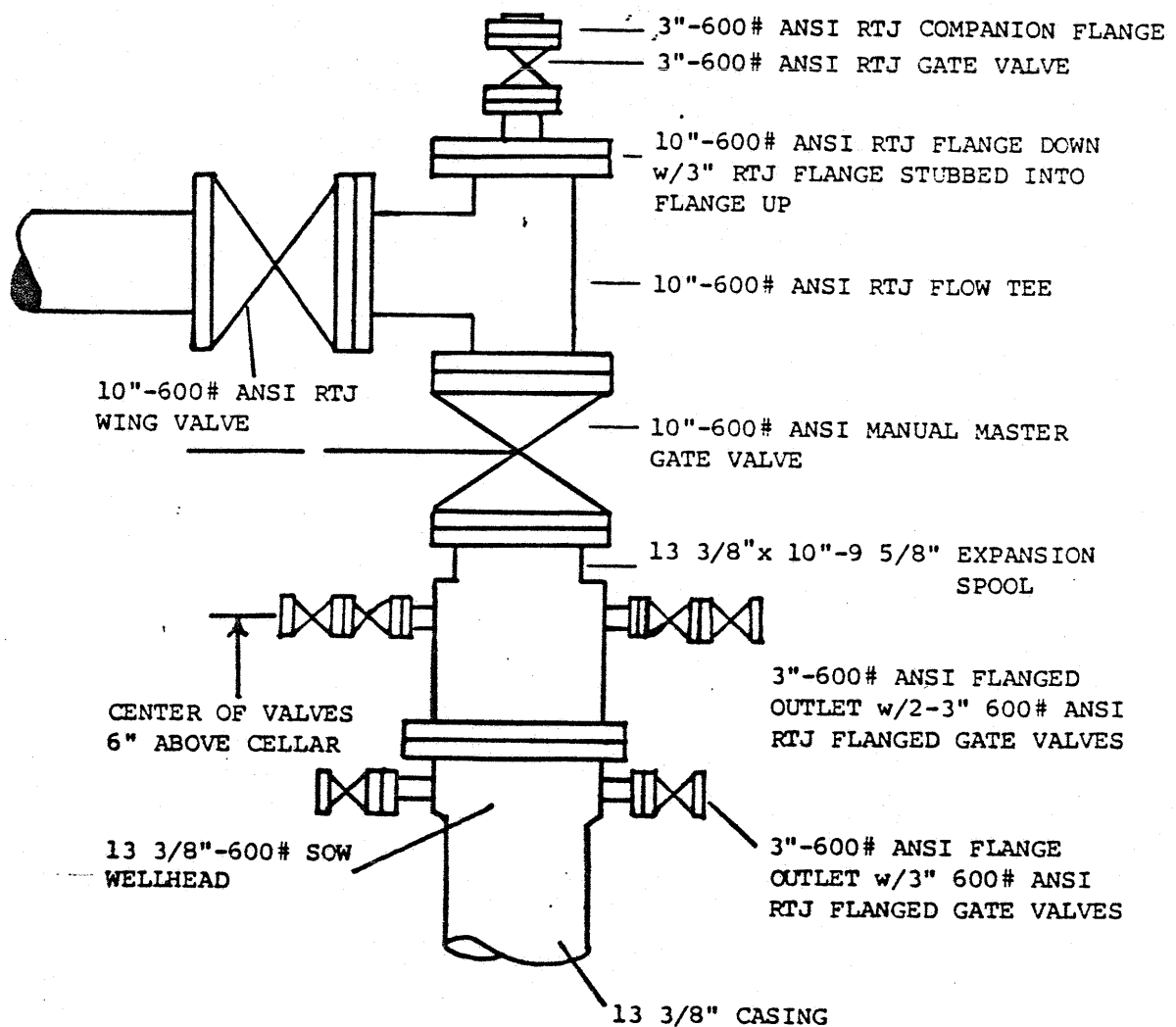


FIGURE 4A

BLOWOUT PREVENTER EQUIPMENT
FOR DRILLING BELOW 13 3/8" CASING

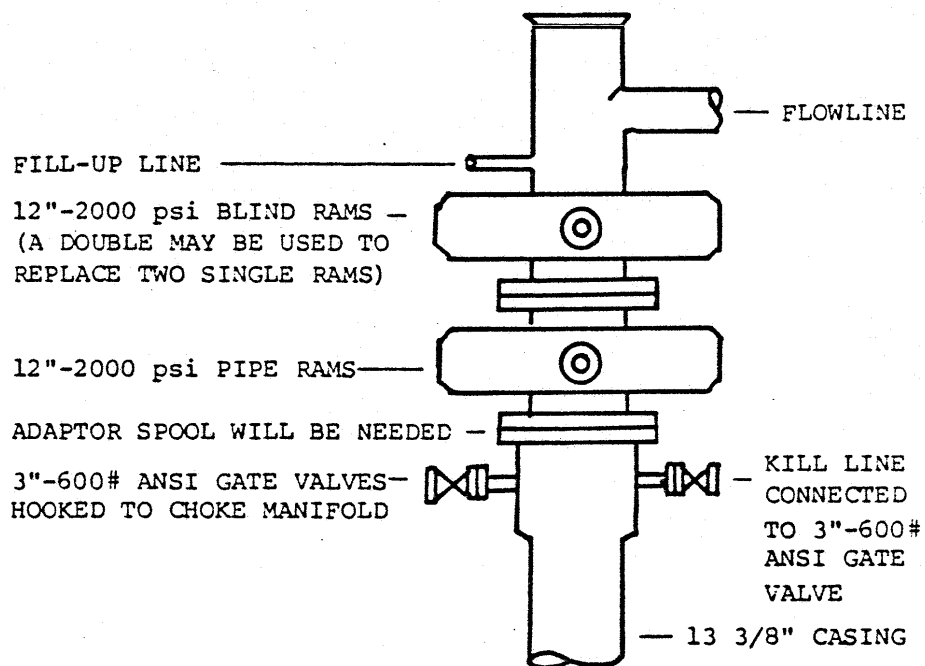
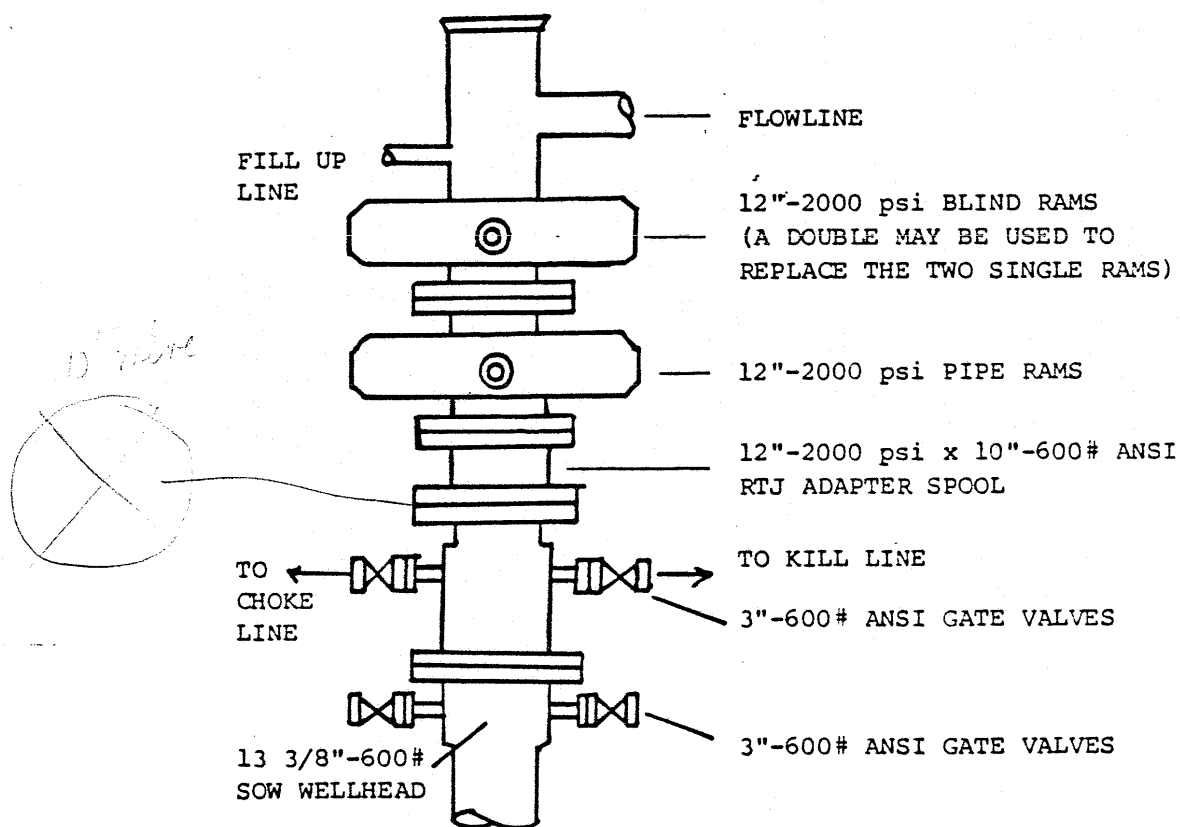


FIGURE 5A

BLOWOUT PREVENTER EQUIPMENT
FOR DRILLING BELOW 9 5/8" CASING



- NOTES:
- (1) VERTICAL DIMENSIONS OF BOPE MUST BE COMPATIBLE WITH SUBSTRUCTURE OF DRILLING RIG.
 - (2) 12" BOPE FOR DRILLING BELOW 9 5/8" CASING IS THE SAME AS THAT FOR DRILLING BELOW 13 3/8" CASING.
 - (3) ROTATING HEAD MAY BE REQUIRED IF AIR IS NEEDED TO COMBAT LOST CIRCULATION PROBLEMS.

APPENDIX B

DRILLING PROGRAM FOR THE MCGA
INJECTION WELL

DRILLING PROGRAM FOR THE MCGA INJECTION WELL

February, 1981

Procedure to Drill Geothermal Fluid Injection Well in the MCGA
Upper Lillooet River, British Columbia

Vertically drilled injection well scheduled to drill to 3,500'±.

(All measurements refer to K.B. (MSL elevation depends on location) approximately 17 feet above ground level. Depths refer to measured depths unless specified.

Total Depth:

3500' ± MD

Location:

Bottom hole location:
(To be specified by geologists)

Surface location:
(Approximate location size shown on Figure 2B actual location to be determined)

Elevation:

(See Figure 3B - Ground Level Elevation Depends upon Location)

Casing/Hole Size Program: (See Figure 1B)

<u>Casing</u>	<u>Hole Size</u>	<u>Depth</u>
20" conductor	26"	80' to 100' (depends on unconsolidated overburden)
13-3/8"	17-1/2"	1000'
9-5/8"	12-1/4"	800' to 3500'

Procedure to Drill MCGA Injection Well

Cementing Program:

20" conductor pipe:

Cemented to surface with portland cement

Volume:

(100% excess)

26" x 20" - 100 feet = 150 CF

260 sacks Portland Neat Cement w/100% excess

13-3/8" Surface Casing:

Cemented through shoe with inner string cementing method:

Volume:

17-1/2" x 13-3/8" - 1000 feet = 695 CF

(25% excess)

339 sacks of 1:1 API class G to Perlite + 3% gel + 40% Silica flour + 0.5% CFR-2 mixed with 1.42 CF of water per sack.

Tail end with 100 sacks of class G Neat pre-mixed with 35% Silica flour and 0.5% CFR-2 with 0.87 CF of water per sack.

Note: Liquid retarder should be available in the event bottom hole temperatures from the logs indicate the need for retarder.

Slurry Properties:

	<u>Weight</u>	<u>Yield</u>	<u>Water</u>	<u>Strength</u>
Perlite	- 12.7 PPG	2.22 CF/SX	1.42 CF/SX	405 PSI (8 hr)
Tail Slurry	- 15.6 PPG	1.50 CF/SX	0.87 CF/SX	1300 PSI (8 hr)

Properties of Casing:

	<u>Burst (PSI)</u>	<u>Tension (KIPS)</u>	<u>Collapse (PSI)</u>
13-3/8" - (54.5-K)	2730	1038	1130
9-5/8" - (40.5 PPF-K)	3950	843	2570

All safety factors are better than: 1.68 Joint Tension, 1.25 Body Tension, 1.25 Burst, 1.15 Collapse.

Tubular Goods Required:

Casing:

100' - 20" conductor

1000' - 13-3/8" - 54.4 #/ft, K55, Buttress

2700' - 9-5/8" - 40.5 #/ft, K-55 Buttress (slotted 0.25" - 16 row)

Procedure to Drill MCGA Injection Well

Casing Equipment Required:

13-3/8":

- 1) Float shoe (stab-in), wash down type
- 2) 5 13-3/8" centralizers

9-5/8" liner:

- 1) Liner Hanger simple mechanical type w/lead seal on top
- 2) 5 9-5/8" centralizers
- 3) Orange Peel shoe with bailing plate

Wellhead:

13-3/8" S.O.W. x 12", 400# RTJ starting head with two 3" flanged side outlets (600# ANSI). 12" master valve, flow tee, and fittings per Figure 3D. Side outlets to be equipped with 600# RTJ flanged gate valves on each side of the expansion spool.

Drilling Fluid Program:

From surface to 1000' use lightweight, low solids fresh water clay base mud treated with lignite, caustic and bicarbonate of soda for cement contamination, and bit lube as required.

From 1000' to 3500' use lightweight, lignosulfonate thinned sepiolite mud with caustic soda.

Notes: Fresh water may be used without gel. Slugs of gelled water should be used occasionally to clean the hole. This should be determined by the drilling conditions.

Lost circulation may be very severe. Air compressors may be required for injecting air into the stand pipe so that drilling may safely procede. Proper surface handling equipment (air compressors and mud-gas separators and rotating head) should be available.

A cooling tower should be installed in the mud system and the mud pumped through the cooling tower when the mud return temperature exceeds 160°F (71°C).

Procedure to Drill MCGA Injection Well

Fluid density should be kept to a minimum unless drilling conditions require the density to be increased.

Because of the remoteness of the location, 1000 sacks of barite should be on site in the event abnormally high subsurface pressures are encountered.

BOPE Requirements:

Surface to 1000' - no BOPE requirement. Numerous exploratory holes in the area indicate subnormal pressures to 1000 feet.

1000' to 3500' - install 12" class II BOPE on 13-3/8" wellhead. (see Figure 4B) Choke and kill lines to be hooked up to wellhead valves.

Fill-up line is to be installed above the preventer. A lower kelly cock and a standpipe valve will be installed. A full opening safety valve and an inside preventer shall be maintained on the floor. Crossover subs will be available and readily accessible on the floor for all connections in the drill string.

Hydraulic BOPE control stations shall be equipped with dual controls, one at the rig floor and one 50' from the wellhead. Accumulator capacity will be at least 80 gals. Mud flow line, flow rate and pit level will be monitored continuously. A pit level warning device shall be installed. While drilling below 1000 feet, a pit drill will be conducted daily. All procedures in Appendix C (Blowout Contingency Plan) shall be strictly adhered to.

In the event air assist is needed for controlling lost circulation, a rotating head will be installed above the rams and a blow down line will be installed from below the rotating head to a mud gas separator.

Hydraulics Program:

Below 13-3/8" casing shoe, keep annular velocities and viscosities around the drill collars so as not to cause transition to turbulent flow. Estimate pipe running speeds which will not produce more than 200 psi surge and/or swab pressures above the bottom hole pressure.

Directional Program:

Drift dogleg severity will be allowed with combined angle and directional changes of no greater than 3.5°/100 feet. Angle surveys will be taken according to:

Procedure to Drill MCGA Injection Well

surface. Displace cement out of drill pipe and pull out. Wait on cement (WOC) 8 hours.

- 8) If cement fails to circulate to the surface, run one inch macaroni tubing down annulus and cement to surface using same slurry as above.
- 9) After WOC for 8 hours, cut off 13-3/8" casing and weld on slip-on wellhead. Install BOPE in accordance with Figure 4B.
- 10) Test blowout preventers to 1000 psi, hold pressure for 30 minutes. Report any bleed off.

Note: Burst of 13-3/8" 54.5 lb/ft casing is 2730 psi. Pressure internal at 1000 feet with 9.0 ppg fluid in the casing is 1468 psi.

- 11) Drill out of 13-3/8" casing with 12-1/4" bit with as light bit weight as possible to keep hole straight. Monitor mud temperature and record every 30 feet. (Mud logger should do this.) When return mud temperature reaches 160°F (71°C) pump mud through cooling tower. Perform a pressure test on the shoe after drilling 5 feet of formation below the shoe. Record the results. Be prepared to squeeze cement if the shoe will not hold 9.0 ppg equivalent hydrostatic.
- 12) Maintain directional control as specified above and drill to 3500 feet.
- 13) Run FDC/CNL with a GR plus sonic and caliper logs in the open hole. Run CBL in 13-3/8" casing. Run temperature surveys as required.
- 14) Make conditioning trip. Displace with fresh water and run injection test. If injection is adequate, complete well.
- 15) Run 9-5/8" casing and hang at 800'. Install centralizers just above shoe and the remaining centralizers on each of the collars above the shoe.
- 16) RIH with open ended drill pipe. If well flows, kill well with weighted salt water.
- 17) POH Lay down drill pipe and move rig.

13 3/8"-54.5 lb/ft
K-55 BUTRESS

12 1/4" HOLE

20" CASING
26" HOLE
80' to 100'
17 1/2" HOLE
800'
1000'
9 5/8"-36 lb/ft
K-55 BUTRESS
SLOTS -0.25" 16
ROW

FIGURE 2 B
TYPICAL DRILLING PAD
FOR 10,000' RIG

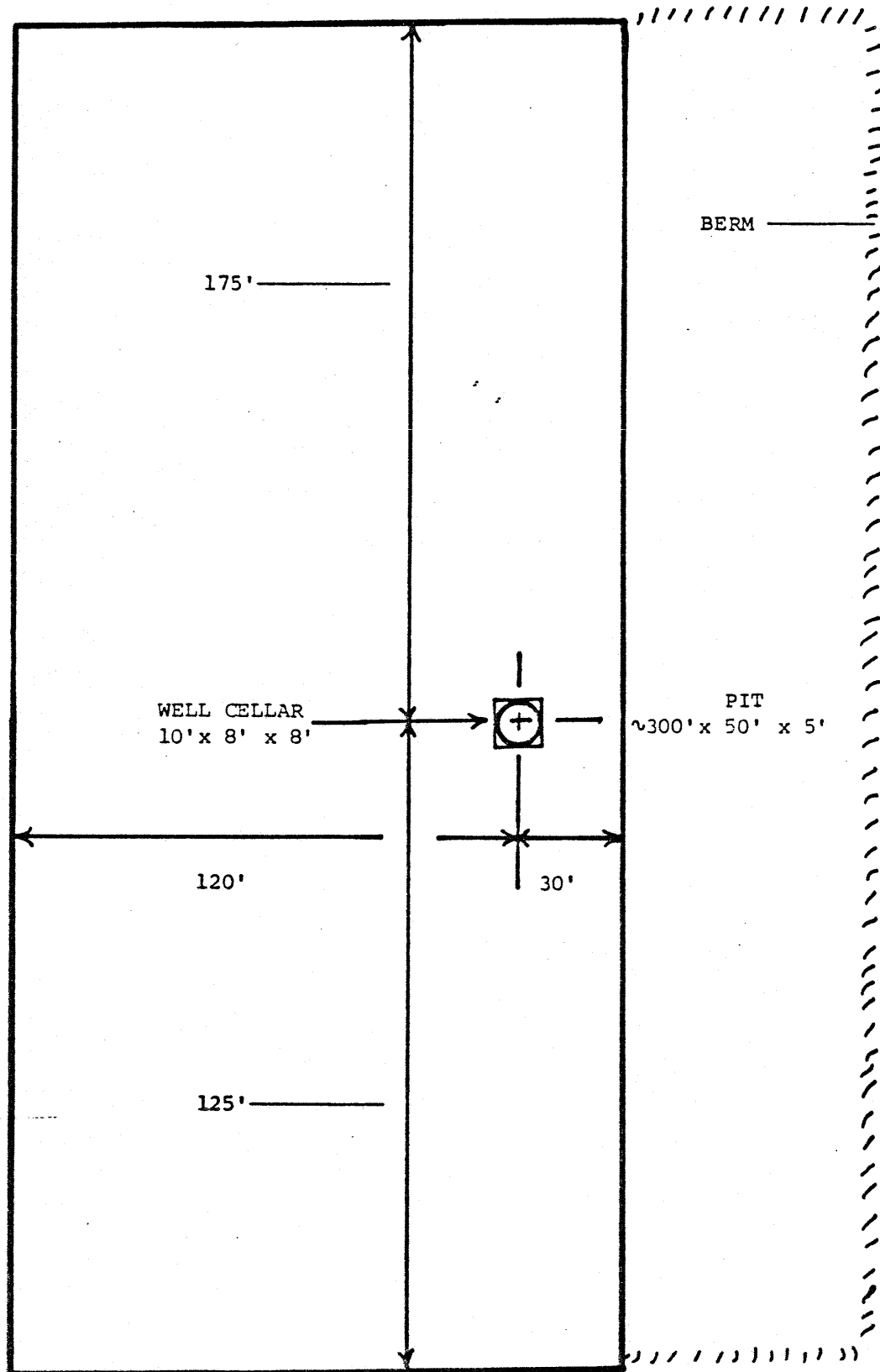


FIGURE 3B

MEAGER CREEK

INJECTION WELL WELLHEAD

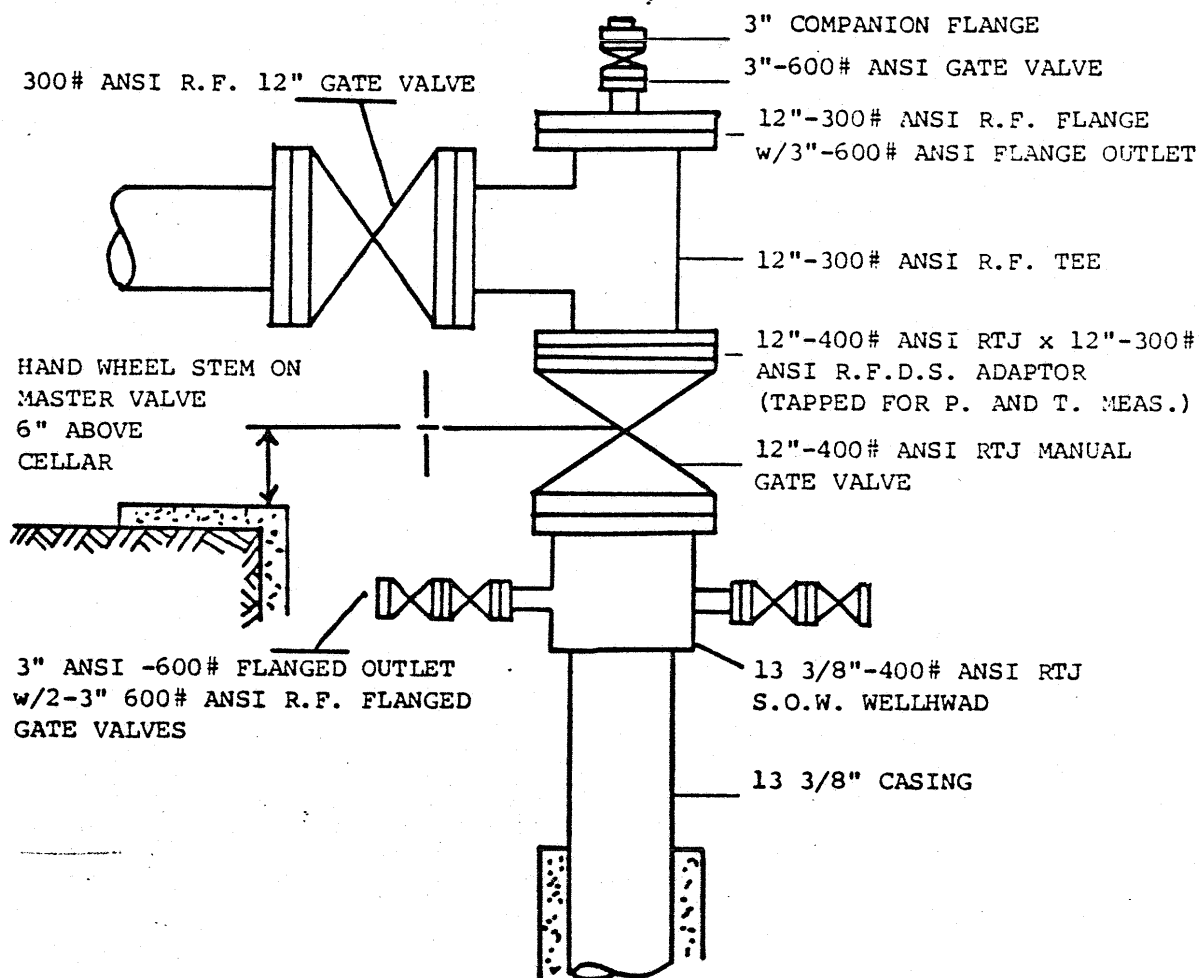
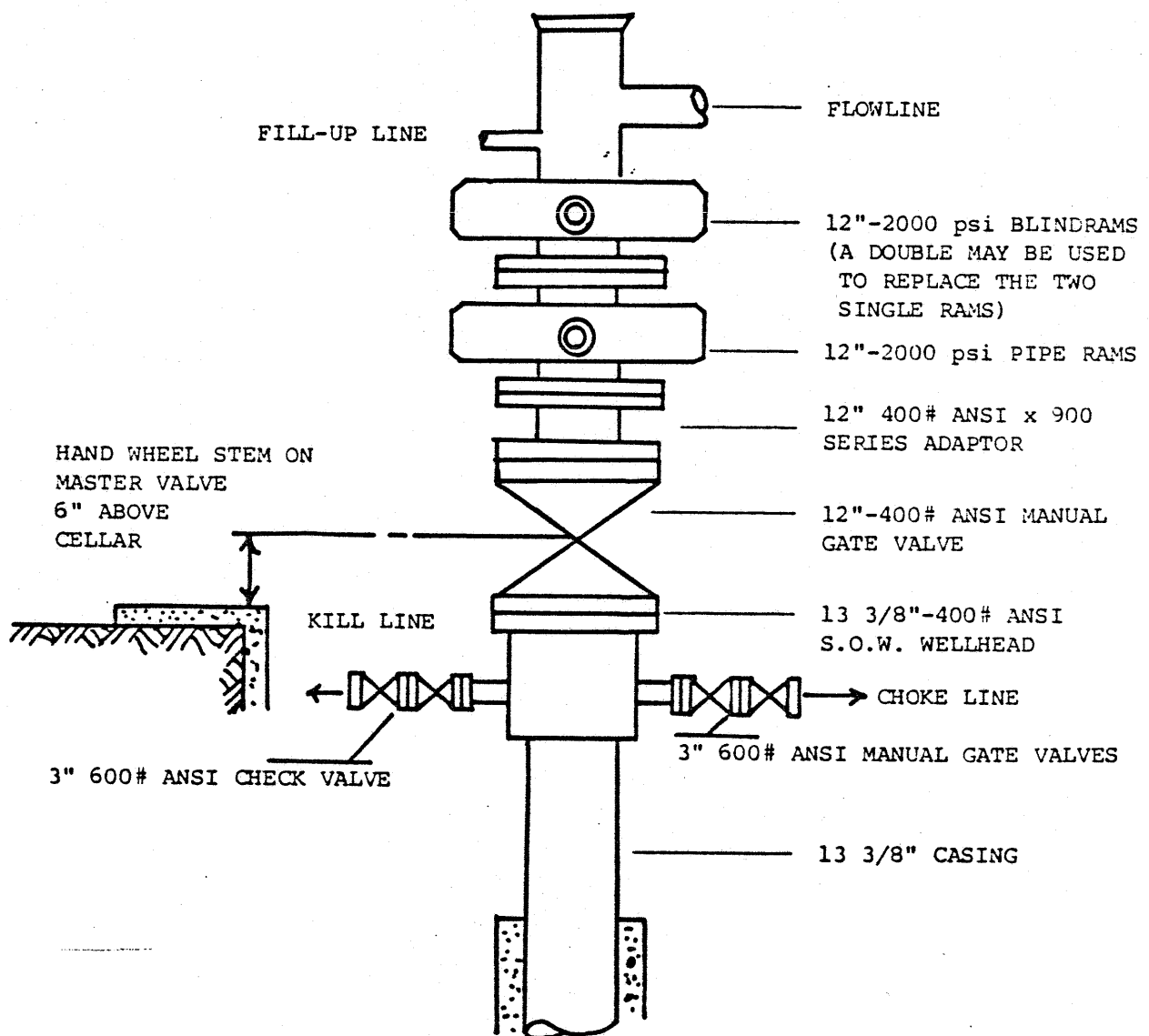


FIGURE 4B
BLOWOUT PREVENTER EQUIPMENT
FOR DRILLING BELOW 13 3/8" CASING



APPENDIX C

GENERAL INSTRUCTIONS AND
BLOWOUT CONTINGENCY PLAN

APPENDIX

BLOWOUT CONTINGENCY PLAN

FOR PERSONNEL INJURY CALL (TO BE SUPPLIED
BY OPERATOR)

1. The hole will be kept full of drilling or completion fluids at all times.
2. Before starting out of the hole with drill pipe or tubing, the mud will be circulated off bottom until properly conditioned.
3. Pipe rams and Hydril BOP's will be closed and opened once each day and logged on the tour sheet. BOP's will be pressure tested prior to drilling out of casing shoes, coincident with casing tests and results will be logged on the blowout preventor check list.
4. Blind rams will be closed when the drill pipe is out of the hole and this will be logged on the tour sheet.
5. The hole will be filled at ten (10) stand intervals or less while pulling drill pipe out of the hole. The designated operator's representative will count pump strokes or use the chart attached to the pit volume indicator to determine the volume required to fill the hole. Prior to installing the stripper rubber, the drilling foreman must be on the rig floor to observe if the hole swabs or takes mud while pulling the first five stands off bottom.
6. The pit flow or pit level indicator will be watched when running in the hole to insure that the volume of mud displaced by the drill pipe is not exceeded.
7. The pit volume indicator and alarms will be determined operable and in proper adjustment prior to making trips with the drill pipe.
8. The drill pipe will be run in the hole to the shoe of the casing with the inside BOP installed to perform any of the following operations:
 - a. Slide or cut the drilling line.
 - b. Repair equipment if possible.
 - c. Any foreseen delay.

9. The reduced circulating pressure will be recorded at 30 or other suitable kick control SPM daily and after each bit change.
10. An approved inside blowout preventor and full opening safety valve will be immediately available on the rig floor.
11. The operator's representative or drilling foreman will be responsible for keeping the attached well control data sheet up to date. It shall be reviewed daily, updated whenever necessary, and posted near the tour sheets in the rig floor dog house.
12. A blowout prevention drill will be conducted for each drilling crew to insure that each person is properly trained to carry out emergency procedures. Kick control duties will be assigned in advance: mud mixing - floormen, operate pumps - derrickmen, etc.
13. At first indication of gain in pit level (or other sign of possible blowout) the driller will immediately do what is necessary to control the well and inform the operator's representative or drilling foreman. In most cases this action should be:

While Drilling:

- a. Pull kelly up out of rotary, and stop pumps.
- b. Open valve(s) on choke line.
- c. Close the blowout preventor and gradually reclose valve on choke line.
- d. Record shut-in drill pipe and casing pressure. Maximum allowable casing pressure to be dependent on casing depth, mud weight and burst rating. Allowable pressure for each string to be posted and noted in driller's instructions and on well control data sheet.
- e. Inform drilling manager and/or proceed with appropriate kick control measures as follows in Step 14.

While Tripping:

- a. Install full opening safety valve.
- b. Open valve on choke line.
- c. Close safety valve.
- d. Close blowout preventor and gradually reclose valve on choke line.
- e. Record shut-in drill pipe and casing pressure. Maximum allowable casing pressure to be dependent on casing depth, mud weight and burst rating. Allowable pressure for each string to be posted and noted in driller's instructions and on well control data sheet.

f. Inform drilling manager. Run drill string in hole as far as practical after first installing inside BOP and reopening safety valve and/or proceed with appropriate kick control measures as follows in Step 14. Record new shut-in drill pipe and casing pressures, if applicable.

14. Open choke line, start pump and run at 30 or other previously set up SPM while adjusting choke line valve to set drill pipe circulation pressure equal to normal circulation pressure at 30 SPM plus shut-in drill pipe pressure.

15. Calculate and mix up mud of weight necessary to keep the well under control using the well control worksheet and attached nomograph.

Mud weight increase in lbs/ft³=

$$\frac{\text{Pdp} \times 144}{\text{Drlg String Depth in Feet}} + 3 \text{ lbs/ft}^3$$

Where Pdp = Shut-in Drill Pipe Pressure in PSI.

16. When a sufficient volume of properly weighted mud has been prepared, start pumping the increased weight mud down the drill pipe, reducing the circulating pressure downward gradually from Pi as calculated on the well control worksheet to Pf when drill pipe is filled with weighted mud. Thereafter hold drill pipe pressure constant at Pf until the heavier mud returns to surface.
17. When the heavier mud returns to surface, stop pump, release any remaining pressure on casing, and check for additional kick before returning to normal operations. Should the well continue to flow, return to Step 13 and circulate out the secondary kick as prescribed in Steps 13 through 17.
18. When a kick has been successfully circulated out even though a blowout or spill has not resulted, the operations manager should always be informed. Depending upon the severity of the situation, other notifications may be required as follows:
- a. If a kick or emergency has occurred, field supervisory personnel will immediately contact:

- b. In the event that the drilling engineering manager is not available, or a blowout or other dangerous situation has developed, field supervisory personnel will immediately advise and consult the following additional personnel:

Name:

Address:

Phone Number:

(To be supplied by operator)

- c. If the blowout has resulted in a potential threat to local residents, the marshal will be notified as soon as possible:

Name:

Address:

Phone Number:

- d. Every effort will be made to minimize possible deleterious environmental effects of the blowout and operations performed to control the blowout. Pump trucks and earth moving equipment may be obtained from local contractors.

- e. The manager, operations, upon notification of a blowout, will:

1. Brief his immediate supervisor on the situation and the corrective course of action underway.
2. Contact the following agencies or regulatory bodies as soon as practical and in the following order:

(List Agencies)

WELL CONTROL DATA SHEET

WELL NAME _____ RIG _____ T.D. _____ DATE: _____

I. Pump Output

	<u>Liner-In.</u>	<u>Stroke-In.</u>	<u>Displacement-bbl/stk</u>
Pump No.1	_____	_____	0.9 X = _____
Pump No.2	_____	_____	0.9 X = _____

II. Capacity & Displacement of Drill String

	<u>Cap-bbl/1000'</u>	<u>Displ-bbl/1000</u>	<u>Cap-bbls</u>
Drill Pipe _____	_____	_____	_____
Drill Pipe _____	_____	_____	_____
Drill Collars _____	_____	_____	_____
Total Depth _____	Total _____	_____	_____

III. Pump Strokes To Fill = $\frac{\text{DP DISPL-bbl/1000'}}{10 \times \text{Pump DISPL-bbl/stk}} = \frac{\text{DP DISPL-bbl/1000'}}{10 \times \text{Pump DISPL-bbl/stk}} = \text{_____ stk/sta}$
 The Hole During A Trip

IV. <u>Ann. Cap.</u>	<u>Size-in</u>	<u>Length-ft.</u>	<u>Ann.Cap.bbl-1000'</u>	<u>Ann.Cap.-bbls</u>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
Total Depth= _____		Total Ann.Capacity= _____		

V. Pit Volume -

Pit Cap, bbl/in.: Pit No. 1 _____
 Pit No. 2 _____
 Pit No. 3 _____

VI. Well Killing Volumes = $\frac{\text{TTL Drl String Cap-bbl}}{\text{Pump DISPL-bbl/stk}} = \text{_____} = \text{_____ stk}$
Circ to Bit (DP Dead)

Circ Annulus = $\frac{\text{TTL Ann Cap-bbl}}{\text{Pump DISPL-bbl/stk}} = \text{_____} = \text{_____ stk}$
(Old Mud To Surf)

Circ All Around (Annulus Dead)=Cap Drl String+Cap Annulus=_____stk

VII. Plow=Circ pressure at reduced pump SPM=_____psi at _____SPM;
 Pump No. _____

VIII. Burst rating of _____CSG.

IX. Maximum allowable casing pressure = _____psi w/ _____pcf mud

WELL CONTROL WORKSHEET

I. MEASURE:

Shut in Drill Pipe Pressure, Pdp _____ psi

Shut in Casing Pressure, Pcsq _____ psi

Volume Gained, Vol _____ bbl

Mud Weight In Drill String, MW₁ _____ Pcf

II. DETERMINE:

Mud Weight To Balance Drill Pipe Pressure =
(see nomograph)

$$\frac{Pdp \times 144}{\text{Depth}} = \frac{\text{ } \times 144}{\text{ } } = \text{ } \text{ Pcf}$$

Add 3 Pcf (gauge error) + overbalance = _____ Pcf

New Mud Wt., MW_n = MW₁ + $\frac{Pdp \times 144 + 3Pcf}{\text{Depth}}$ = _____ Pcf

Initial Circulating Pressure, _____ psi
Pi = Pdp + Plow

Final Circulating Pressure, _____ psi
Pf = Plow x $\frac{MW_n}{MW_2}$

APPENDIX D

COST ESTIMATE FOR THE MCGA

EXPLORATORY PRODUCTION WELL

WELL COST ESTIMATE

WELL Production - MCGA-1 TVD 7,500'

DATE February, 1981

WE RECOMMEND Drill a vertical exploratory well to 7,500' with 13-3/8"
casing to 1000'

I. INTANGIBLES

1) LOCATION	1) 125,000 *
2) RIG MOVE (MOBILIZATION and DEMOBILIZATION)	2) 300,000
3) CONTRACTOR: <u>49</u> DAYS AT \$ <u>8,000</u> /DAY PLUS CAMP	3) 452,000
4) FUEL AND WATER	4) 110,000
5) DRILLING FLUIDS	5) 25,000
6) DRILLSTRING RENTALS AND BITS	6) 166,000
7) MISCELLANEOUS RENTALS AND SERVICES	7) 110,000
8) WELL SUPPLIES	8) 13,000
9) CEMENT AND SERVICES	9) 93,000
10) DIRECTIONAL TOOLS AND SERVICES	10) 10,000
11) ELECTRIC LOGGING	11) 45,000
12) MUD LOGGING	12) 17,000
13) CORING	13) -0-
14) COMPLETION & TESTING SERVICES (PIT TEST ONLY)	14) 25,000
15) FISHING	15) -0-
16) SUPERVISION	16) 27,500
17) ENGINEERING & GEOLOGIC SERVICES	17) 55,000
SUB TOTAL ON INTANGIBLES: <u>1,573,500</u>	
18) G & A	18) -?-

II. TANGIBLES

19) WELL PIPE:	19) 169,000
20) WELLHEAD	20) 53,000
21) DOWNHOLE PUMPING & OTHER COMPLETION EQUIPMENT	21) -0-
22) TAX ON TANGIBLES	22) -?-
SUB TOTAL ON TANGIBLES: <u>222,000</u>	
23) CONTINGENCY	23) -0-
TOTAL WELL COST	<u><u>1,795,500</u></u>

* Estimate Only

1. Location - Costs are not known and is estimated at \$125,000.
2. Rig Move - Per discussions w/contractors in Calgary \$200,000 is estimated to move in and \$100,000 is estimated to demobilize.
3. Contractor Day rate (see Table 1)

49 Days x \$8,000/Day = \$392,000

(Rates obtained from contractors in Calgary. The rate will vary depending on equipment, rig availability and negotiations.)

Camp costs \$1000/Day for 20 man Camp x 60 days (includes rig up and down) = \$60,000

4. Fuel, water

Fuel (49 days - 70,000 gals x \$1.4/gal) = \$98,000
 Temporary water line and pump = 12,000
\$110,000

5. Drilling Fluid

(Does not include air compressors) \$15,000
 Extra Barite 1000 sacks @ \$9.82/sack 9,820

6. Drill String Rental and Bits

Stablizers: (All integral blade w/carbide inserts)

4 17-1/2" w/9" body \$1400 each	\$5,600
6 12-1/4" w/8" body \$908 each	5,448
3 8-1/2" w/6" body \$645 each	1,935

Bits:

3 17-1/2" 4JS \$12,953 each	\$38,859
10 12-1/4" 4JS or 5JS \$6215 each	62,150
10 8-1/2" F47 \$3833 each	38,330

Drill String

18 Jts Heavy Weight (30 days)	4,320
80 Jts 3-1/2" (E) (15 days)	1,800
9 4-1/2" D.C. (15 day)	1,350
Handling Tools (est.)	2,500
3 10" D.C. (40.00/day) (5 days)	600
Miscellaneous Subs	<u>3,000</u>

Total \$165,892

*Selected
4-1/2" F47
10-1/2" F47
10-1/2" F47*

7. Miscellaneous Rental and Services

Estimate for transportation, cooling tower,
forklift, casing inspections \$110,000

8. Well Supplies

Usually estimated at \$200/day x 49 days plus:

13-3/8" Float Shoe \$1500
9-5/8" Float Collar \$535
9-5/8" Float Shoe \$490 \$12,325

9. Cement and Services

Unit rental (Halliburton prices from Fort St. John)	22,000
Transportation	10,000
Services	15,000
Cementing (13-3/8")	8,000
Cementing (9-5/8")	10,000
Storage bins and blender	7,500
Total	\$72,500

Cement:

Perlite \$2.25/CF	
Gel \$6.50/100 lbs.	
Silica Flour \$9.50/100 lbs.	
Neat Class G bulk \$6.50/sack	
CFR-2 \$3.40	
Liquid Retarder	
HRCL 5 gal \$35.50/5 gal	
HR13L 82.00/5 gal	
Total Cement Price as Per Program	14,000
Plus 1000 sacks Class G Neat	6,500
Total	93,000

10. Directional Tools and Services

Directional work is not anticipated however,
a gyro or multi-shot may be needed \$10,000

11. Electric Logging

A similar program recently cost \$35,000.
Thus, this estimate will be \$45,000 due to
the remote area and higher temperatures \$45,000

12. Mud Logging

Mud logging is recommended if the experienced services can be located at a reasonable cost
30 days at \$500/day + \$2000 R/U and travel \$17,000

13. Coring

It is recommended that coring not be planned in the first well.

14. Completion and Testing

Extra costs for samples plus gas lifting the well. (Rig time is already included.) \$25,000

15. Fishing

(No anticipated cost)

16. Supervision

Site supervisor \$500/day x 55 days \$27,500

17. Engineering and Geologic Services

\$1000/day x 55 days \$55,000

18. Well Pipe

13-3/8" 54.5 ppf K-55B 1000'	\$25,738
9-5/8" 40 ppf K-55B 5200'	94,917
7" 26 ppf K-55B 2500'	29,607
9-5/8" x 7" Liner Hanger w/lead seal	3,000
Slotting	10,050
Miscellaneous + 20" Conductor	5,000
Total	\$168,312

19. Wellhead

(As per drawing Figure 3A) 53,000

20. Downhole pumping equipment

-0-

TOTAL WELL \$1,795,500

TABLE 1 D

Rig-time Estimate for Drilling
the MCGA Exploratory Production Well

<u>Operation</u>	<u>Days</u>
1. Rig-up (fixed cost - 7 days)	
2. Set Conductor (if required)	1½
3. Drill 17-1/2" hole to 1000'	3½
4. Log, run casing, cement	2
5. Nipple up, drill-out test shoe	1
6. Drill 1000' to 5200'	18
7. Log, run casing, cement	2½
8. Nipple up, drill-out, test shoe	1½
9. Drill 5200' to 7500'	12
10. Log, nipple up to test, test	4
11. Nipple down test, complete well and lay down drill pipe	<u>3</u>
Total operating rig days	49

TABLE 2D
DESCRIPTION OF COST CATEGORIES
FOR MAKING WELL COST ESTIMATES

INTANGIBLES

1) MOBILIZATION/DEMOBILIZATION

Costs to contractor for moving, drilling or workover equipment to and from the well site.

2) CONTRACTOR

TURNKEY - Fixed cost bid by contractor to perform the specified operations.

DAYRATE - The daily cost bid by the contractor to perform the specified operations.

3) FUEL, POWER AND WATER

All costs not covered in the dayrate or turnkey cost for fuel, power and water to support the operation. Such items may include: diesel, diesel storage, and trucking, electric lines, generators, water lines, water pumps, water well, trucking of water, gas lines and meters.

4) DRILLING FLUIDS

Cost of the products used in the drilling, or workover, fluid to include diesel, or spotting fluids.

5) DRILL STRING RENTALS AND BITS

Cost of bits, stabilizers, reamers, hole openers, under-reamers, drill collars, (except for nonmagnetic), drill pipe, subs, cross-overs, drill pipe floats, Heavi-Wate drill pipe, drill string handling tools (slips, elevators, tongs).

6) MISCELLANEOUS RENTALS AND SERVICES

Costs for all service personnel and services not covered in other categories. This may include: mud rental equipment, BOP equipment, forklift, cranes, Kelly spinner, automatic chokes, liner hanger services, casing services (tool rental and personnel), special inspection services, trucking costs, tools and toolmen for packers, etc.

7) WELL SUPPLIES

All supplies purchased by the operator for use at the well site such as office supplies, special surface equipment and downhole supplies such as casing float shoes, float collars, centralizers, cement retainers, bridge plugs.

8) CEMENT AND SERVICES

All cement purchases and related mixing and pumping charges for casing jobs, squeezes, plug backs, plug and abandonment and grouting.

TABLE 2D cont.

DESCRIPTION OF COST CATEGORIES
FOR MAKING WELL COST ESTIMATES

Page Two

9) DIRECTIONAL TOOLS AND SERVICES

Costs associated with directional control, services and personnel. Such items to include Dyna-drills, turbines, kick subs, special bits if rented, nonmagnetic drill collars, whipstocks and whipstock bits, survey tools, multishots, gyros (single and multishot).

10) EVALUATION

All costs associated with electric logging evaluation. Such items to include mud loggers, wireline logging (open and cased hole) unless associated with completions, special prints, tapes and evaluations of wireline logs. Special sidewall samples and core analysis, temperature surveys.

11) MUD LOGGING

All costs for mud logger.

12) CORING

All costs related to downhole drill string coring to include core equipment, bits, and service personnel, special handling and packing.

13) COMPLETION AND TESTING

All costs associated with completion and testing to include perforating, slotting pipe, acidizing (acid and pumping), fracturing, packers packer setting charges, downhole test tools (packers, pressure and temperature bombs, test tool, samples, reversing subs, etc.), surface test tools (manifolds, chokes, separators, tanks, lines, etc.), water analyses, special wireline logs.

14) FISHING

All costs related to any downhole fishing operations such as overshots, wash pipe, etc., and service personnel.

15) SUPERVISION

Costs related to personnel working on drilling, testing or completion of well. Personnel time and travel expenses included.

16) ENGINEERING AND GEOLOGIC SERVICES

Not directly concerned with drilling.

17) G & A

Indirect general and administrative costs.

18) WELL PIPE

Direct cost for all well pipe including casing and tubing.

TABLE 2D, cont.
DESCRIPTION OF COST CATEGORIES
FOR MAKING WELL COST ESTIMATES

Page Three

- 19) WELLHEAD EQUIPMENT
All spools, flanges and valves left as part of the permanent well-head installation.
- 20) DOWNHOLE PUMPING AND OTHER COMPLETION EQUIPMENT
All sub surface completion equipment such as pumps, sliding sleeves, seating nipples, SSCU, etc.
- 21) TAX ON TANGIBLES
Percentage of tax paid by client on tangibles - Accounting to supply.
- 22) INDIRECT ON TANGIBLES
Percentage of operation overhead allocated to well. Accounting to supply percentage.
- 23) CONTINGENCY
Reasonable estimate of possible over-expenditures. Judgment based on previous experiences in area.

RWN/hr
04/04/80

APPENDIX E
TYPICAL IADC CONTRACT WITH
SUGGESTED CONTRACTOR AND OPERATOR
SUPPLIED EQUIPMENT



International Association of Drilling Contractors
DRILLING BID PROPOSAL
AND
DAYWORK DRILLING CONTRACT — U.S.

Daywork Contract
Revised Dec. 1975
7M-78

TO: DEEP WELL CONTRACTOR
315c Hot Water Ave.
Therm City, Canada

Please submit bid on this drilling contract form for performing the work outlined below, upon the terms and for the consideration set forth, with the understanding that if the bid is accepted by B.C. Hydro

this instrument will constitute a contract between us. Your bid should be mailed or delivered not later than N/A P.M. on _____, 19____ to the following address:

2000 Brine Flow Path
Vapor State, Canada

THIS AGREEMENT, made and entered into on the date hereinafter set forth by and between the parties herein designated as "Operator" and "Contractor":

OPERATOR: B.C. Hydro
Address: 2000 Brine Flow Path
Vapor State, Canada

CONTRACTOR: Deep Well Contractor
Address: 315c Hot Water Ave.
Therm City, Canada

IN CONSIDERATION of the mutual promises, conditions and agreements herein contained and the specifications and special provisions set forth in Exhibit "A" and Exhibit "B" attached hereto and made a part hereof, Operator engages Contractor as an independent Contractor to furnish the equipment and labor to drill the hereinafter designated well or wells in search of oil or gas on a daywork basis.

Contractor agrees to furnish equipment meeting the specifications designated herein, and capable of drilling to the depth indicated herein, including equipment capable of drilling in the water depths herein indicated if this Contract involves a marine operation. Contractor further agrees, subject to all other applicable clauses of this Contract, to provide any and all services required according to the specifications stated herein. It is expressly understood and agreed to by Operator and Contractor that such services are performed at the appropriate daywork rate, and the performance of such services by Contractor in no way subjects him to liability for any risk not elsewhere assumed by him under the terms of this Contract. Contractor agrees to perform all work to be conducted by him under the terms of this Contract in accordance with the orders and directions of Operator, with due diligence and care and in a good and workmanlike manner, and agrees to provide competent supervision of the work performed hereunder.

1. LOCATION OF WELL:

Well Name and Number: Meager Creek Geothermal Area (to be specified)
Parish/County: _____ State: _____ Field Name: MCGA
Well location and land description: Upper Lillooet River

1.1 Additional Well Locations or Areas: _____

Locations described above are for well and contract identification only and Contractor assumes no liability whatsoever for a proper survey or location stake on Operator's lease.

2. COMMENCEMENT DATE:

Contractor agrees to use best efforts to commence operations for the drilling of well by the _____ day of _____, 19____, or such later date as may be requested by operator and agreed to by contractor

3. DEPTH:

3.1 Well Depth: The well(s) shall be drilled to depth of approximately 7500' feet, or to the N/A formation, whichever is deeper, but Contractor shall not be required hereunder to drill said well(s) below a maximum depth of 12,000 feet, unless Contractor and Operator mutually agree to drill to a greater depth.

4. DAYWORK RATES:

Contractor shall be paid at the following rates for the work performed hereunder.

4.1 Mobilization: Operator shall pay Contractor a mobilization fee of \$ (T.B.D.) or a mobilization day rate of \$ N/A per 24 hour day. This sum shall be due and payable in full at the time the rig is rigged up or positioned at the well site ready to spud. Mobilization shall include: negotiated prices or invoiced costs from third party contractors

4.2 Demobilization: Operator shall pay Contractor a demobilization fee of \$ (T.B.D.) or a demobilization day rate during tear down of \$ N/A per 24 hour day, provided however that no demobilization fee shall be payable if the contract is terminated due to the total loss or destruction of the rig. Demobilization shall include: (T.B.D.)

4.3 Moving Rate: During the time the rig is in transit to or from a drill site, or between drill sites, commencing on Rig Down, Operator shall pay Contractor a sum of \$ (T.B.D.) per twenty-four (24) hour day.

4.4 Operating Day Rate: For work performed per twenty-four (24) hour day with 5* man crew the operating day rate shall be: * Plus one rig superintendent.

Depth Intervals		Without Drill Pipe		With Drill Pipe	
From	To				
0	12,000'	\$	N/A	\$	(T.B.D.)
			per day		per day
			per day		per day
			per day		per day

Using Operator's drill pipe \$ _____ per day.

If under the above column "With Drill Pipe" no day rates are specified, the daywork rate per twenty-four hour day when drill pipe is in use shall be the applicable daywork rate specified in the column "Without Drill Pipe" plus compensation for any drill pipe actually used at the rates specified below, computed on the basis of the maximum drill pipe in use at any time during each twenty-four hour day.

(N/A)

DRILL PIPE RATES PER 24-HOUR DAY

Straight Hole			Directional or Uncontrollable Deviated Hole		
Size	Grade		Size	Grade	
\$ _____ per ft.	_____	\$ _____	Per ft.	_____	_____
\$ _____ per ft.	_____	\$ _____	per ft.	_____	_____
\$ _____ per ft.	_____	\$ _____	per ft.	_____	_____

Drill pipe shall be considered in use not only when in actual use but also while it is being picked up or laid down. When drill pipe is standing in the derrick, it shall not be considered in use, provided, however, that if Contractor furnishes special strings of drill pipe, drill collar, and handling tools as provided for in Exhibit "A", the same shall be considered in use at all times when on location or until released by Operator. In no event shall fractions of an hour be considered in computing the amount of time drill pipe is in use but such time shall be computed to the nearest hour, with thirty minutes or more being considered a full hour and less than thirty minutes not to be counted.

Operating rate will begin when the drilling unit is rigged up at the drilling location, or positioned over the location during marine work, and ready to commence operations; and will cease when the rig is ready to be moved off the location.

4.5 Repair Rate: In the event it is necessary to shut down Contractor's rig for repairs, excluding routine rig servicing, while Contractor is performing daywork hereunder, Contractor shall be allowed compensation at the applicable daywork rate for each period of shutdown time up to a maximum of 6 hours for any one repair job and a total of 24 hours for each thirty (30) day period. Thereafter, Contractor shall be compensated at a rate of \$ 0 per twenty-four (24) hour day. Normal rig servicing, replacing swivel packing, slipping or cutting drilling line and replacing pump expendables shall not be included in computing the number of hours of shutdown time.

4.6 Standby Time Rate with Crews: \$ (T.B.D.) per twenty-four (24) hour day. Standby time shall be defined to include time when the rig is shut down although in readiness to begin or resume operations but Contractor is waiting on orders of Operator or on materials, services or other items to be furnished by Operator.

4.7 Force Majeure Rate: \$ T.B.D. per twenty-four (24) hour day for any continuous period that normal operations are suspended or cannot be carried on due to conditions of force majeure as defined in Paragraph 16 hereof. It is, however, understood that Operator can release the rig in accordance with Operator's right to direct stoppage of the work, effective when conditions will permit the rig to be moved from the location.

4.8 Reimbursable Costs: Operator shall reimburse Contractor for the costs of material, equipment, work or services which are to be furnished by Operator as provided for herein but which for convenience are actually furnished by Contractor at Operator's request, plus 5 percent for such cost of handling.

4.9 Revision in Rates: The rates and/or payments herein set forth due to Contractor from Operator shall be revised to reflect the change in costs if the costs of any of the items hereinafter listed shall vary by more than as per attachment A percent from the costs thereof on the date of this Contract or by the same percent after the date of any revision pursuant to this paragraph:

- Labor costs, including all benefits, of Contractor's personnel;
- Contractor's cost of insurance premiums;
- Contractor's cost of fuel, the cost per gallon/MCF being \$ Operator;
- Contractor's cost of catering, when applicable;
- If Operator requires Contractor to increase or decrease the number of Contractor's personnel;
- Operator's cost of spare parts and supplies with the understanding that such spare parts and supplies constitute 38 percent of the Operating Rate and that the parties shall use the U. S. Bureau of Labor Statistics Oilfield Drilling Machinery and Equipment Wholesale Price Index (Code No. 1191-02) to determine to what extent a price variance has occurred in said spare parts and supplies.
- If there is any change in legislation or regulations in the area in which Contractor is working or other unforeseen, unusual event that alters Contractor's financial burden.

5. TIME OF PAYMENT:

Subject to Operator's right to require that Contractor furnish him with satisfactory evidence that Contractor has paid all labor and material claims chargeable to Contractor, payment becomes due by Operator to Contractor as follows:

5.1 Payment for mobilization, drilling and other work performed at applicable day rates, and all other applicable charges shall be due upon acceptance by Operator of the work performed in accordance with this Contract, upon presentation of invoice therefor upon completion of mobilization, completion of the well, or at the end of the month in which such work was performed or other charges are incurred, whichever shall first occur. All invoices may be mailed to Operator at address hereinabove shown, unless Operator does hereby designate that such invoices shall be mailed as follows:

5.2 Any sum or sums not paid within 30 days after the date of invoice shall bear interest at the rate of 1 1/2 percent per month _____ or the maximum legal rate, whichever is less, from such date until paid.

5.3 Attorney's Fees: If this Contract is placed in the hands of an attorney for collection of any sums due hereunder, or suit is brought on same, or sums due hereunder are collected through bankruptcy or probate proceedings, then Operator agrees that there shall be added to the amount due reasonable attorney's fees and costs.

6. TERM:

6.1 Duration of Contract: This Contract shall remain in full force and effect until drilling operations are completed on the well or wells specified in Paragraph 1 above, or for a term of 6 months, commencing on the date specified in Paragraph 2 above.

6.2 Extension of Term: Operator may extend the term of this Contract for 1 or more well(s) or for a period of N/A by giving notice to Contractor at least 10 days prior to completion of the well then being drilled or by Mutual Agreement.

6.3 Early Termination:

(a) **By Either Party:** Upon giving of written notice, either party may terminate this Contract when conditions of force majeure, total loss or destruction of the rig, or a major breakdown with indefinite repair time necessitate stopping operations hereunder.

(b) **By Operator:** Notwithstanding the provisions of Paragraph 3 with respect to the depth to be drilled, Operator shall have the right to direct the stoppage of the work to be performed by Contractor hereunder at any time prior to reaching the specified depth, and even though Contractor has made no default hereunder. In such event Operator shall reimburse Contractor as set forth in sub-paragraph 6.4 hereof.

(c) **By Contractor:** Notwithstanding the provision of Paragraph 3 with respect to the depth to be drilled, in the event Operator shall become insolvent, or be adjudicated a bankrupt, or file, by way of petition or answer, a debtor's petition or other pleading seeking adjustment of Operator's debts, under any bankruptcy or debtor's relief laws now or hereafter prevailing, or if any such be filed against Operator, or in case a receiver be appointed of Operator or Operator's property, or any part thereof, or Operator's affairs be placed in the hands of a Creditor's Committee, Contractor may, at his option, elect to terminate further performance of any work under this Contract and Contractor's right to compensation shall be as set forth in subparagraph 6.4 hereof. In addition to Contractor's right to terminate performance hereunder, Operator hereby expressly agrees to protect, indemnify and save Contractor harmless from any claims, demands and causes of action, including all costs of defense, in favor of Operator, Operator's joint venturers, or other parties arising out of any drilling commitments or obligations contained in any lease, farmout agreement or other agreement, which may be affected by such termination of performance hereunder.

6.4 (a) If such termination occurs prior to the spudding of the well, ^{first} Operator shall pay to Contractor the sum of the following: (1) all expenses reasonably and necessarily incurred and to be incurred by Contractor by reason of the Contract and by reason of the premature termination of the work, including the expense of drilling or other crew members and supervision directly assigned to the rig; (2) Ten percent (10%) of the amount of such reimbursable expenses; and (3) a sum calculated at the standby rate for all time from the date upon which Contractor commences any operations hereunder down to such date subsequent to the date of termination as will afford Contractor reasonable time to dismantle his rig and equipment provided however, if this Contract is for a term of more than one well or for a period of time, Operator shall pay Contractor, in addition to the above, the force majeure rate less any unnecessary labor from that date subsequent to termination upon which Contractor completes dismantling his rig and equipment ~~XXXXXX XXXX XXXX XXXX~~ ^{is demobilized} Under a mutually acceptable arrangement.

(b) If such termination occurs after the spudding of the well, Operator shall pay Contractor (1) the amount for all applicable daywork rates and all other charges and reimbursements due to Contractor, but in no event shall such sum, exclusive of reimbursements due, be less than would have been earned for _____ days at the applicable day rate "Without Drill Pipe" and the actual amount due for drill pipe used in accordance with the above rates, or at the election of Contractor and in lieu of the foregoing, Operator shall pay Contractor for all expenses reasonably and necessarily incurred and to be incurred by reason of this Contract and by reason of such premature termination plus a lump sum of \$ N/A provided, however, if this Contract is for a term of more than one well or for a period of time, Operator shall pay Contractor, in addition to the above, the force majeure rate less any unnecessary labor from the date of termination until the end of the term.

7. CASING PROGRAM:

Contractor shall drill a well sufficient in size to set, at the approximate depths indicated, the size casing specified in the casing program provisions of Exhibit "A". Operator shall have the right to designate the points at which casing will be set and the manner of setting, cementing and testing. Operator may modify the casing program, however, any such modification which materially increases Contractor's hazards or costs can only be made by mutual consent of Operator and Contractor and upon agreement as to the additional compensation to be paid Contractor as a result thereof.

8. DRILLING METHODS AND PRACTICES:

8.1 Contractor shall maintain well control equipment in good condition at all times and shall use all reasonable means to control and prevent fires and blow-outs and to protect the hole.

8.2 Subject to the terms hereof, and at Operator's cost, at all times during the drilling of the well, Operator shall have the right to control the mud program, and the drilling fluid must be of a type and have characteristics and be maintained by Contractor in accordance with the specifications shown in Exhibit "A".

8.3 Contractor will conduct operations to comply with all laws, rules, orders, and regulations, Federal, State, and Local, which are applicable to Contractor, Contractor's business, equipment, and personnel engaged in operations covered by this Contract, including but not limited to those set forth in Exhibit "B".

8.4 Contractor shall keep and furnish to Operator an accurate record of the work performed and formations drilled on the IADC-API Daily Drilling Report Form or other form acceptable to Operator. A legible copy of said form signed by Contractor's representative shall be furnished by Contractor to Operator.

8.5 If requested by Operator, Contractor shall furnish Operator with copy of delivery tickets covering any material or supplies provided by Operator and received by Contractor.

9. INGRESS, EGRESS, AND LOCATION:

Operator hereby assigns to Contractor all necessary rights of ingress and egress with respect to the tract on which the well is to be located for the performance by Contractor of all work contemplated by this Contract. Should Contractor be denied free access to the location for any reason not reasonably within Contractor's control, any time lost by Contractor as a result of such denial shall be paid for at the applicable rate.

10. SOUND LOCATION:

Operator shall prepare a sound location adequate in size and capable of properly supporting the drilling rig, and shall be responsible for a conductor pipe program adequate to prevent soil and sub-soil wash out. It is recognized that Operator has superior knowledge of the location and access routes to the location, and must advise Contractor of any sub-surface conditions, or obstructions which Contractor might encounter while en route to the location or during operations hereunder. In the event sub-surface conditions cause a cratering or shifting of the location surface, or if seabed conditions prove unsatisfactory to properly support the rig during marine operations hereunder, and loss or damage to the rig, its associated equipment or personnel results therefrom, Operator shall, without regard to other provisions of this Contract, including Paragraph 14.1 hereof, reimburse Contractor to the extent not covered by Contractor's insurance, for all such loss or damage including payment of force majeure rate during repair and/or demobilization if applicable.

11. EQUIPMENT CAPACITY:

If applicable hereunder, operations shall not be attempted where canal or water depths are in excess of (N/A) on shore _____ feet, or under any other conditions which exceed the capacity of the equipment specified to be used hereunder. Contractor shall make final decision as to when an operation or attempted operation would exceed the capacity of specified equipment.

12. TERMINATION OF LOCATION LIABILITY:

When Contractor has complied with all obligations of the Contract regarding restoration of Operator's location, Operator shall thereafter be liable for damage to property, personal injury or death of any person which occurs as result of condition of the location and Contractor shall be relieved of such liability; provided, however, if Contractor shall subsequently reenter upon the location for any reason, including removal of the rig, any term of the Contract relating to such reentry activity shall become applicable during such period.

13. INSURANCE:

During the life of this Contract, Contractor shall at Contractor's expense maintain, with an insurance company or companies authorized to do business in the state where the work is to be performed or through a self-insurance program, insurance coverages of the kind and in the amounts set forth in Exhibit "A". Contractor shall, if requested to do so by Operator, procure from the company or companies writing said insurance a certificate or certificates that said insurance is in full force and effect and that the same shall not be cancelled or materially changed without ten (10) days prior written notice to Operator.

14. RESPONSIBILITY FOR LOSS OR DAMAGE:

14.1 **Contractor's Surface Equipment:** Contractor shall assume liability at all times, for damage to or destruction of Contractor's surface equipment, including but not limited to all drilling tools, machinery, and appliances for use above the surface, regardless of when or how such damage or destruction occurs, and Operator shall be under no liability to reimburse Contractor for any such loss except loss or damage under the provisions of Paragraphs 10 or 14.3.

14.2 **Contractor's In-Hole Equipment:** Operator shall assume liability at all times for damage to or destruction of Contractor's in-hole equipment, including but not limited to, drill pipe, drill collars, and tool joints, and Operator shall reimburse Contractor for the value of any such loss or damage; the value to be determined by agreement between Contractor and Operator as current repair cost or 100 percent of current new replacement cost of such equipment delivered to the well site.

14.3 **Contractor's Equipment — Environmental Loss or Damage:** Notwithstanding the provisions of Paragraph 14.1 above, Operator shall assume liability at all times for damage to or destruction of Contractor's equipment caused by exposure to highly corrosive or otherwise destructive elements, including those introduced into the drilling fluid.

14.4 **Operator's Equipment:** Operator shall assume liability at all times for damage to or destruction of Operator's equipment, including but not limited to casing, tubing, well head equipment, and platform if applicable, and Contractor shall be under no liability to reimburse Operator for any such loss or damage.

14.5 **The Hole:** In the event the hole should be lost or damaged, Operator shall be solely responsible for such damage or loss to the hole, including the casing therein.

14.6 **Underground Damage:** Operator agrees to defend and indemnify Contractor for any and all claims against Contractor resulting from operations under this Contract on account of injury to, destruction of, or loss or impairment of any property right in or to oil, gas, or other mineral substance or water, if at the time of the act or omission causing such injury, destruction, loss, or impairment, said substance had not been reduced to physical possession above the surface of the earth, and for any loss or damage to any formation, strata, or reservoir beneath the surface of the earth.

Well Name and Number. MC GA 1

1. CASING PROGRAM (See Par. 7)

2. MUD CONTROL PROGRAM (See Par. 8.2)

Other mud specifications:

3.6 Other insurance:

4.1 Drilling Rig:

Complete drilling rig, designated by Contractor as his Rig No. T.B.D., the major items of equipment being:

Drawworks:

(Make and Model)

Engines: Make, Model, and H.P. A.C., D.C. electric or mechanical

No. on Rig _____ (~~need approx 2000 to 2500 HP~~)

Pumps: No. 1 Make, Size, and Power 2 - triplex 800 H.P. each.

No. 2 Make, Size, and Power

Mud Mixing Pump: Make, Size, and Power 2 - 5" x 6" or 6" x 8" centrifugal

Boilers: Number, Make, H.P. and W.P.

N/A

Derrick or Mast: Make, Size, and Capacity Triple Rack Cap. (135 feet)

with 600,000 lbs cap.

Structure: Size and Capacity 600,000 lb. - 400,000 R.T. + 200,000

Rotary Drive Type 27-1 1/2"

Drill Pipe: Size 4-1/2 or 5 in. 12.000

Drill Collars: Number and Size 3 - 9" - 9 - 8" and 12 - 6"

Drill Collars: Number and Size 3 - 9 ; 9 - 8 and 12 - 6
Blowout Preventers: _____

Blowout Preventers:

B. C. F. Accumulator.

(Daywork Contract — Exhibit "A" — Page 1)

- 4.2 ~~XXXXXXXXXX~~
 4.3 Normal strings of drill pipe and drill collars specified above
 4.4 Conventional drift indicator
 4.5 Circulating mud pits
 4.6 Necessary pipe racks and rigging up material
 4.7 Normal storage for mud and chemicals
 4.8 Shale Shaker
 4.9 Drill Pipe rubbers to protect 7500' of D.P.
 4.10 D.P. to be hard banded
 4.11 _____
 4.12 _____
 4.13 _____
 4.14 _____
 4.15 _____
 4.16 _____
 4.17 _____

5. EQUIPMENT, MATERIALS AND SERVICES TO BE FURNISHED BY OPERATOR:

The machinery, equipment, tools, materials, supplies, instruments, services and labor hereinafter listed, including any transportation required for such items, shall be provided at the location at the expense of Operator unless otherwise noted hereon.

- 5.1 Furnish and maintain adequate roadway and/or canal to location, right-of-way, including rights-of-way for fuel and water lines, river crossings, highway crossings, gates and cattle guards.
 5.2 Stake location, clear and grade location, and provide turnaround, including surfacing when necessary.
 5.3 Test tanks with pipe and fittings
 5.4 Mud storage tanks with pipe and fittings
 5.5 Separator with pipe and fittings
 5.6 Labor to connect and disconnect mud tank, test tank, and separator
 5.7 Labor to disconnect and clean test tanks and separator
 5.8 Drilling mud, chemicals, lost circulation materials and other additives
 5.9 Pipe and connections for oil circulating lines
 5.10 Labor to lay, bury and recover ~~of XXXXXXXXXX~~
 5.11 Drilling bits, reamers, reamer cutters, stabilizers and special tools
 5.12 Contract fishing tool services and tool rental
 5.13 Wire line core bits or heads and wire line core catchers if required
 5.14 Conventional core bits and core catchers
 5.15 Diamond core barrel with head
 5.16 Cement and cementing service
 5.17 Electrical and Gamma-Neutron and Micro logging services
 5.18 Directional, caliper, or other special services
 5.19 Gun or jet perforating services
 5.20 Explosives and shooting devices
 5.21 Formation testing, hydraulic fracturing, acidizing and other related services
 5.22 Equipment for drill stem testing
 5.23 Mud logging services
 5.24 Sidewall coring service
 5.25 Welding service for welding bottom joints of casing, guide shoe, float shoe, float collar and in connection with installing of well head equipment if required
 5.26 Casing, tubing, lines, screen, float collars, guide and float shoes and associated equipment
 5.27 Casing scratchers and centralizers
 5.28 Well head connections and all equipment to be installed in or on well or on the premises for use in connection with testing, completion and operation of well
 5.29 Special or added storage for mud and chemicals
 5.30 Casinghead, API series, to conform to that shown for the blowout preventers specified in Paragraph 4.1 above
 5.31 Blowout preventer testing packoff
 5.32 Casing Thread Protectors and Casing Lubricants
 5.33 Mud cooling tower
 5.34 Air drilling equipment, if required
 5.35 Mud waste disposal
 5.36 All permits and costs thereof
 5.37 1" tubing to cement 13-3/8" as required
 5.38 _____
 5.39 _____
 5.40 _____
 5.41 _____

6. EQUIPMENT, MATERIALS AND SERVICES TO BE FURNISHED BY DESIGNATED PARTY:

The machinery, equipment, tools, materials, supplies, instruments, services, and labor listed as the following numbered items including any transportation required for such items unless otherwise specified, shall be provided at the location and at the expense of the party hereto as designated by an X mark in the appropriate column

Item	To Be Provided By and At The Expense Of	
	Operator	Contractor
6.1 Cellar and runways	X	-
6.2 Fuel (located at <u>supplied by operator</u>)	X	-
6.3 Fuel Lines (length _____)	-	X
6.4 Water at source, including required permits	X	-
6.5 Water well, including required permits	X	-
6.6 Water lines, including required permits	X	-
6.7 Water storage tanks _____ capacity	-	X
6.8 Labor to operate water well or water pump	X	-
6.9 Maintenance of water well, if required	X	-
6.10 Mats for engines and boilers, or motors and mud pumps	-	X
6.11 Transportation of Contractor's property		
Move in	X	-
Move out	X	-
6.12 Materials for "boxing in" rig and derrick	-	X
6.13 Special strings of drill pipe and drill collars as follows Equipment other than normal contractor's inventory		

To Be Provided By And
At The Expense Of

Item (Continued)	Operator	Contractor
6.14 Kelly joints, subs, elevators and slips for use with special drill pipe	X	
6.15 Drill pipe protectors for Kelly joint and each joint of drill pipe running inside of Surface Casing as required, for use with normal strings of drill pipe	-	X
6.16 Drill pipe protectors for Kelly joint and drill pipe running inside of Protection Casing	-	X
6.17 Coring reel with wire line of sufficient length for coring at maximum depth specified in Contract	X	-
6.18 Wire line core barrel	X	-
6.19 Conventional core barrel	X	-
6.20 Rate of penetration recording device	X	-
6.21 Extra labor for running and cementing casing	X	-
6.22 Casing tools	-	X
6.23 Power casing longs	X	-
6.24 Tubing tools	-	-
6.25 Power tubing tong	-	-
6.26 Swabbing unit with swabbing line	-	-
6.27 Swab	-	-
6.28 Swab lubricator	-	-
6.29 Swab rubbers	-	-
6.30 Crew Boats, Number	-	-
6.31 Service Barge	-	-
6.32 Service Tug Boat	-	-
6.33 Helicopter service	-	X
6.34 Rat Hole	-	X
6.35 Mouse Hole	-	X
6.36 Reserve Pits	-	X
6.37 Erect and Dismantle Derrick	-	X
6.38 Upper Kelly Cock	-	X
6.39 Drilling hole for or driving for conductor pipe	T.B.D.	-
6.40 Charges, cost of bonds for public roads	X	-
6.41		
6.42		
6.43		

7. OTHER PROVISIONS:

Operator shall pay costs for crew subsistence from start of rig up through movement of contractor's equipment upon completion of contract.

Signed by the
Parties as correct:

For Contractor

For Operator

(Daywork Contract - Exhibit A Page 3)

1. EQUAL EMPLOYMENT OPPORTUNITY

A. Operator is an Equal Opportunity Employer. It is agreed as a condition of this Contract that unless any or all work performed hereunder is exempt under Executive Order 11246 (30 Fed. Reg. 12319) as amended, or under the rules and regulations issued thereunder, during the performance of this Contract, the Contractor agrees as follows:

1. The Contractor will not discriminate against any employee or applicant for employment because of race, religion, color, sex or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, color, sex or national origin. Such action shall include, but not be limited to the following: Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

2. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, religion, color, sex or national origin.

3. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided by the agency contracting officer, advising the labor union or workers' representative of the Contractor's commitments under Section 202 of Executive Order 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

5. The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

6. In the event of the Contractor's noncompliance with the nondiscrimination clauses of this Contract or with any of such rules, regulations, or orders, this Contract may be cancelled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

7. The Contractor will include the provisions of Paragraphs 1 through 7 in every subcontract or purchase order unless exempted by rules, regulations, or orders of Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the contracting agency may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, however, that in the event the Contractor becomes involved in, or is threatened with litigation with a subcontractor or vendor as a result of such direction by the contracting agency, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

B. Filing Standard Form 100 (EEO-1) and Development of Affirmative Action Program.

1. Contractor acknowledges that he may be required to file Standard Form 100 (EEO-1) promulgated jointly by the Office of Federal Contract Compliance, the Equal Employment Opportunity Commission and Plans for Progress within thirty (30) days of contract award, if such report has not been filed for the current year and otherwise comply with or file such other compliance reports as may be required under Executive Order 11246, as amended and Rules and Regulations adopted thereunder.

2. Contractor further acknowledges that he may be required to develop a written affirmative action compliance program as required by the Rules and Regulations approved by the Secretary of Labor under authority of Executive Order 11246 and supply Operator with a copy of such program if Operator so requests.

C. Nonsegregated Facilities.

Contractor certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. Contractor agrees that a breach of his certification is a violation of the Equal Opportunity Clause in this Contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex, age or national origin, because of habit, local custom or otherwise. Contractor's policies and practices must assure appropriate physical facilities to both sexes. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding \$10,000 which are not exempt from the provisions of Equal Opportunity Clause; that he will retain such certifications in his files, and that he will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods): **NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES.** A Certification of Nonsegregated Facilities as required by the May 21, 1968, order on Elimination of Segregated Facilities, by the Secretary of Labor (33 Fed. Reg. 7804, May 28, 1968), must be submitted prior to the award of a subcontract exceeding \$10,000 which is not exempt from the provisions of the Equal Opportunity Clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semiannually, or annually).

D. Penalties

Contractor further understands and agrees that a breach of the assurance contained in Paragraphs A through C above subjects it to the provisions of the Order at 41 CFR Chapter 60 of the Secretary of Labor dated May 21, 1968. In the event of Contractor's noncompliance with the nondiscrimination clauses of this Contract or with any of such rules, regulations, or orders, such noncompliance shall constitute sufficient grounds, and the parties hereto agree to immediate cancellation of this Contract on the basis of such noncompliance with no further obligation whatsoever on the part of the Operator.

2. LISTING OF EMPLOYMENT OPENINGS

The undersigned Contractor further agrees, if the value of any contract or purchase order is \$2,500 or more, that it will be bound by the following provisions contained in 41 CFR 50-250 promulgated pursuant to Executive Order No. 11701:

A. The Contractor, to provide special emphasis to the employment of qualified disabled veterans and veterans of the Vietnam era, agrees that all suitable employment openings of the Contractor which exist at the time of the execution of this Contract and those which occur during the performance of this Contract, including those not generated by this Contract and including those occurring at an establishment of the Contractor other than the one wherein the Contract is being performed but excluding those of independently operated corporate affiliates, shall be offered for listing at an appropriate local office of the State employment service system wherein the opening occurs and to provide such reports to such local office regarding employment openings and hires as may be required. Provided, That this provision shall not apply to openings which the Contractor fills from within the Contractor's organization or are filled pursuant to a customary and traditional employer-union hiring arrangement.

B. Listing of employment openings with the employment service system pursuant to this clause shall be made at least concurrently with the use of any other recruitment service or effort and shall involve the normal obligations which attach to the placing of a bona fide job order, including the acceptance of referrals of veterans and nonveterans. The listing of employment openings does not require the hiring of any particular job applicant or from any particular group of job applicants, and nothing herein is intended to relieve the Contractor from any requirements in any Executive Orders or regulations regarding nondiscrimination in employment.

14.7 Inspection of Materials Furnished by Operator: Contractor agrees to visually inspect all materials furnished by Operator before using same and to notify Operator of any apparent defects therein. Contractor shall not be liable for any loss or damage resulting from the use of materials furnished by Operator.

14.8 Contractor's Indemnification of Operator: Subject to the provisions of Article 12 hereof, Contractor agrees to protect, defend, indemnify and save Operator and its joint owners harmless from and against all claims, demands, and causes of action of every kind and character, without limit and without regard to the cause or causes thereof or the negligence of any party arising in connection herewith in favor of Contractor's employees. Contractor's subcontractors or their employees, on account of bodily injury, death or damage to property.

14.9 Operator's Indemnification of Contractor: Operator agrees to protect, defend, indemnify and save Contractor harmless from and against all claims, demands and causes of action of every kind and character, without limit and without regard to the cause or causes thereof or the negligence of any party, arising in connection herewith in favor of Operator's employees, Operator's contractors or their employees, other than those identified in 14.8 above, on account of bodily injury, death or damage to property.

14.10 Liability for Wild Well: Operator shall be liable for the cost of regaining control of any wild well, as well as for cost of removal of any debris, and shall indemnify Contractor in this regard.

14.11 Pollution and Contamination: Notwithstanding anything to the contrary contained herein, except the provisions of Paragraphs 10 and 12, it is understood and agreed by and between Contractor and Operator that the responsibility for pollution and contamination shall be as follows:

(a) Unless otherwise provided herein, Contractor shall assume all responsibility for, including control and removal of, and protect, defend and save harmless Operator from and against all claims, demands and causes of action of every kind and character arising from pollution or contamination, which originates above the surface of the land or water from spills of fuels, lubricants, motor oils, normal water base drilling fluid, pipe dope, paints, solvents, ballast, bilge and garbage, except unavoidable pollution from reserve pits, wholly in Contractor's possession and control and directly associated with Contractor's equipment and facilities.

(b) Operator shall assume all responsibility for, including control and removal of, protect, defend and save Contractor harmless from and against all claims, demands, and causes of action of every kind and character arising from all other pollution or contamination which may occur during the conduct of operations hereunder, including but not limited to, that which may result from fire, blowout, cratering, seepage or any other uncontrolled flow of oil, gas, water or other substance, as well as, the use or disposition of oil emulsion, oil base or chemically treated drilling fluids, contaminated cuttings or cavings, lost circulation and fish recovery materials and fluids.

(c) In the event a third party commits an act or omission which results in pollution or contamination for which either Contractor or Operator, for whom such party is performing work, is held to be legally liable, the responsibility therefor shall be considered, as between Contractor and Operator, to be the same as if the party, for whom the work was performed had performed the same and all of the obligations respecting defense, indemnity, holding harmless and limitation of responsibility and liability, as set forth in (a) and (b) above, shall be specifically applied.

14.12 Consequential Damages: Neither party shall be liable to the other for special indirect or consequential damages resulting from or arising out of this Contract, including, without limitation, loss of profit or business interruptions, however same may be caused.

15. NO WAIVER EXCEPT IN WRITING:

It is fully understood and agreed that none of the requirements of this Contract shall be considered as waived by either party unless the same is done in writing, and then only by the persons executing this Contract, or other duly authorized agent or representative of the party.

16. FORCE MAJEURE:

Neither Operator nor Contractor shall be liable to the other for any delays or damage or any failure to act due, occasioned or caused by reason of any laws, rules, regulations or orders promulgated by any Federal, State or Local governmental body or the rules, regulations, or orders of any public body or official purporting to exercise authority or control respecting the operations covered hereby, including the procurement or use of tools and equipment, or due, occasioned or caused by strikes, action of the elements, water conditions, inability to obtain fuel or other critical materials, or other causes beyond the control of the party affected thereby. In the event that either party hereto is rendered unable, wholly or in part, by any of these causes to carry out its obligation under this Contract, it is agreed that such party shall give notice and details of Force Majeure in writing to the other party as promptly as possible after its occurrence. In such cases, the obligations of the party giving the notice shall be suspended during the continuance of any inability so caused except that Operator shall be obligated to pay to Contractor the Force Majeure Rate provided for in Paragraph 4.7 above.

17. INFORMATION CONFIDENTIAL:

Upon written request by Operator, information obtained by Contractor in the conduct of drilling operations on this well including, but not limited to, depth, formations penetrated, the results of coring, testing, and surveying, shall be considered confidential and shall not be divulged by Contractor or his employees, to any person, firm, or corporation other than Operator's designated representatives.

18. SUBCONTRACTS BY OPERATOR:

Operator may employ other contractors to perform any of the operations or services to be provided or performed by it according to Exhibit "A".

19. ASSIGNMENT:

Neither party may assign this Contract without the prior written consent of the other, and prompt notice of any such intent to assign shall be given to the other party. In the event of such assignment, the assigning party shall remain liable to the other party as a guarantor of the performance by the assignee of the terms of this Contract. If any assignment is made that materially alters Contractor's financial burden, Contractor's compensation shall be adjusted to give effect to any increase or decrease in Contractor's operating costs.

20. NOTICES AND PLACE OF PAYMENT:

All notices to be given with respect to this Contract unless otherwise provided for shall be given to the Contractor and to the Operator respectively at the addresses hereinabove shown. All sums payable hereunder to Contractor shall be payable at his address hereinabove shown unless otherwise specified herein.

21. SPECIAL PROVISIONS:

That attachments "A", "B", and "C" be made a part of this contract.

22. ACCEPTANCE OF CONTRACT:

The foregoing Contract is agreed to and accepted by Operator this _____ day of _____, 19____

OPERATOR: B.C. Hydro

By _____

Title _____

The foregoing Contract is accepted by the undersigned as Contractor this _____ day of _____, 19____ which is effective date of this agreement, subject to rig availability, and subject to all of its terms and provisions, with the understanding that unless said Contract is thus executed by Operator within _____ days of the above date, Contractor shall be in no manner bound by its signature thereto.

CONTRACTOR: DEEP WELL CONTRACTOR

By _____

Title _____

APPENDIX F

WELL COST ESTIMATE FOR THE
MCGA INJECTION WELL

WELL COST ESTIMATE

WELL Injection TVD 3500' DATE February, 1981

WE RECOMMEND Vertically drill an injection well to 3500 feet with
13-3/8" surface casing and 9-5/8" slotted liner.

I. INTANGIBLES

1) LOCATION	1) <u>125,000</u>
2) RIG MOVE	2) <u>20,000</u>
3) CONTRACTOR: <u>29</u> DAYS AT \$ <u>8000</u> /DAY	3) <u>232,000</u>
4) POWER	4) <u>50,000</u>
5) DRILLING FLUIDS	5) <u>15,000</u>
6) DRILLSTRING RENTALS AND BITS	6) <u>80,000</u>
7) MISCELLANEOUS RENTALS AND SERVICES	7) <u>45,000</u>
8) WELL SUPPLIES	8) <u>8,000</u>
9) CEMENT AND SERVICES	9) <u>40,000</u>
10) DIRECTIONAL TOOLS AND SERVICES	10) <u>-0-</u>
11) ELECTRIC LOGGING	11) <u>25,000</u>
12) MUD LOGGING	12) <u>-0-</u>
13) CORING	13) <u>-0-</u>
14) COMPLETION & TESTING SERVICES	14) <u>10,000</u>
15) FISHING	15) <u>-0-</u>
16) SUPERVISION	16) <u>15,000</u>
17) ENGINEERING & GEOLOGIC SERVICES	17) <u>15,000</u>

SUB TOTAL ON INTANGIBLES: 680,000

18) G & A	18) <u>-?-</u>
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II. TANGIBLES

19) WELL PIPE	19) <u>85,000</u>
20) WELLHEAD	20) <u>22,000</u>
21) DOWNHOLE PUMPING & OTHER COMPLETION EQUIPMENT	21) <u>-0-</u>
22) TAX ON TANGIBLES	22) <u>-?-</u>

SUB TOTAL ON TANGIBLES: 107,000

23) CONTINGENCY	23) <u>-0-</u>
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TOTAL WELL COST 787,000

APPENDIX B

List of Drilling Contractors

Appendix B - List of Drilling Contractors

ADECO DRILLING & ENGINEERING LTD.
4th Floor - 505 - 2nd Street, S.W.
Calgary, Alberta

ARGUS DRILLING LIMITED
1580 - 540 - 5th Avenue, S.W.
Calgary, Alberta

ATCO DRILLING LTD.
800 - 800 - 6th Avenue, S.W.
Calgary, Alberta

BADGER DRILLING
2203 - 505 - 4th Avenue, S.W.
Calgary, Alberta

PETER BAWDEN DRILLING LTD.
501 - 500 - 4th Avenue, S.W.
Calgary, Alberta

BIRD OIL EQUIPMENT LIMITED
800 Lancaster Building
304 - 8th Avenue, S.W.
Calgary, Alberta

BLUEBIRD DRILLING CO. LTD.
Box 2274
Taber

BRADCO DRILLING AND EXPLORATION LTD.
8 - 2235 - 30th Avenue, N.E.
Calgary, Alberta

BRINKERHOFF DRILLING LTD.
8749 - 51st Avenue
Edmonton, Alberta

CAMARO DRILLING
104 - 5621 - 11th Street, N.E.
Calgary, Alberta

CANTEX DRILLING & EXPLORATION LTD.
1520 Royal Bank Building
335 - 8th Avenue, S.W.
Calgary, Alberta

ANSCHUTZ (CANADA) EXPLORATION LTD.
1100 - 333 - 5th Avenue, S.W.
Calgary, Alberta

ARROWHEAD DRILLING
340 - 999 - 8th Street, S.W.
Calgary, Alberta

BALTIC DRILLING (1979) LIMITED
901 Centre 70, 7015 MacLeod Trail, S.W.
Calgary, Alberta

BASTION DRILLING
1200 - 717 - 7th Avenue, S.W.
Calgary, Alberta

BEAVER DRILLING LTD.
1117 - 500 - 4th Avenue, S.W.
Calgary, Alberta

BLOCKER DRILLING CANADA LIMITED
9th Floor - 304 - 6th Avenue, S.W.
Calgary, Alberta

BODOR DRILLING LTD.
302 - 816 - 7th Avenue, S.W.
Calgary, Alberta

BRELCO DRILLING LTD.
1704 - 505 - 3rd Street, S.W.
Calgary, Alberta

CACTUS DRILLING CORP. LTD.
500 - 622 - 5th Avenue, S.W.
Calgary, Alberta

CANADIAN MARINE DRILLING LTD.
19th Floor - 333 - 7th Avenue, S.W.
Calgary, Alberta

CANWELL DRILLING
104 - 5621 - 11th Street, N.E.
Calgary, Alberta

. . .

CAPE DRILLING SERVICES
2102 - 506 - 6th Street, S.W.
Calgary, Alberta

CENTENNIAL DRILLING LTD.
711 - 614 - 5th Avenue, S.W.
Calgary, Alberta

COMANCHE DRILLING
2015 - 715 - 5th Avenue, S.W.
Calgary, Alberta

CROWN DRILLING
P.O. Box 1390
Virden, Manitoba

DAWN DRILLING
P.O. Box 38
Red Deer, Alberta

FRONTIER DRILLING SERVICES LTD.
402 - 605 - 7th Avenue, S.W.
Calgary, Alberta

GARNETT DRILLING LTD.
8th Floor - 603 - 7th Avenue, S.W.
Calgary, Alberta

GUTHRIE MCLAREN DRILLING LTD.
P.O. Box 3835, Postal Stn. "D"
Edmonton, Alberta

HEMSING DRILLING LTD.
P.O. Box 2050
Brooks, Alberta

MART HOVIS DRILLING LTD.
3219 - 97th Street
Edmonton, Alberta

JADE DRILLING
9816B - 44th Avenue
Edmonton, Alberta

KCA DRILLING (CANADA) LIMITED
314 - 603 - 7th Avenue, S.W.
Calgary, Alberta

CAPRI DRILLING LTD.
314 - 540 - 12th Avenue, S.W.
Calgary, Alberta

CHALLENGER DRILLING
220 - 444 - 7th Avenue S.W.
Calgary, Alberta

CORUNNA PETROLEUM LIMITED
264 Piget Street
Corunna, Ontario

CUSTOM DRILLING CO. LTD.
Box 670
Leduc, Alberta

FLINT ENGINEERING & CONSTRUCTION LTD.
200 Fina Building
Calgary, Alberta

GCO DRILLING COMPANY
P.O. Box 78
Nisku

GOODLANDS DRILLING LTD.
203 - 10335 - 172nd Street
Edmonton, Alberta

ENSIGN DRILLING
Box 1160
Lloydminster

HI-TOWER DRILLING
1600 -321 - 6th Avenue, S.W.
Calgary, Alberta

HUSSAR DRILLING
2735 Scotia Centre
Calgary, Alberta

JOMAX DRILLING
1700 - 505 - 3rd Street, S.W.
Calgary, Alberta

KENTING DRILLING CO. LTD.
370 - 700 - 6th Avenue, S.W.
Calgary, Alberta

KISSINGER PETROLEUMS LTD.
14th Floor
Aquitaine Tower
Calgary, Alberta

LAREDO DRILLING LTD.
702 - 500 - 4th Avenue, S.W.
Calgary, Alberta

LOFFLAND BROTHERS CO. OF CANADA
8716 - 48th Street, S.E.
Calgary, Alberta

MONTGOMERY DRILLING CANADA LTD.
410 Britannia Building
703 - 6th Avenue S.W.
Calgary, Alberta

NABORS DRILLING LIMITED
11th Floor - 324 - 8th Avenue, S.W.
Calgary, Alberta

NEW DISCOVERY DRILLING LTD.
20th Floor - 324 - 8th Avenue, S.W.
Calgary, Alberta

NORTH EASTERN DRILLING
402 - 1015 - 4th Street, S.W.
Calgary, Alberta

SASKATOBA DRILLING CO. LTD.
701 - 505 - 6th Street, S.W.
Calgary, Alberta

SEDCO DRILLING
1600 - 321 - 6th Avenue, S.W.
Calgary, Alberta

SHELBY DRILLING LTD.
400 - 1550 - 5th Street, S.W.
Calgary, Alberta

SIERRA DRILLING LTD.
P.O. Box 177
Medicine Hat, Alberta

LACOMBE DRILLING LTD.
1501 - 500 - 4th Avenue, S.W.
Calgary, Alberta

LEMKCO DRILLING CO.
6767 Golden West Avenue
Red Deer, Alberta

MAYAN DRILLING
4120 - 23rd Street, N.E.
Calgary, Alberta

SKL DRILLING LTD.
4140 - 76th Avenue
Edmonton, Alberta

S & T DRILLING (NORTHERN) LTD.
5825 - 1st Street, S.E.
Calgary, Alberta

SDS DRILLING DIV. OF SDS IND. LTD.
4636 - 1st Street, S.E.
Calgary, Alberta

NUGGET DRILLING
8755 - 51st Avenue
Edmonton, Alberta

OMNI DRILLING
304 - 425 - 4th Avenue, S.W.
Calgary, Alberta

PADRILCO DRILLING LTD.
Box 490
Kindersley, Saskatchewan

PERMIAN DRILLING LTD.
C-322, 706 - 7th Avenue, S.W.
Calgary, Alberta

PRECISION DRILLING LIMITED
1204 - 500 - 4th Avenue, S.W.
Calgary, Alberta

SIMMONS DRILLING
524 - 550 - 6th Avenue, S.W.
Calgary, Alberta

SUTHERLAND ENGINEERING & DRILLING CO. LTD.
412 - 703 - 6th Avenue, S.W.
Calgary, Alberta

THREE HUNDRED DRILLING LTD.
503 - 630 - 8th Avenue, S.W.
Calgary, Alberta

TRI-CITY (1968) LTD.
14305 - 120th Avenue
Edmonton, Alberta

TRIPLE T LEASING LIMITED
15 Valleyview Drive, S.W.
Medicine Hat, Alberta

BECHTEL NATIONAL INC.
50 Beale Street
P.O. Box 3965
San Francisco, CA 94119

GEOTERMEX, INC.
901 Mendocino Avenue
Berkeley, CA 94707

PHILLIPS PETROLEUM COMPANY
431 South 300 East/P.O. Box 239
Salt Lake City, UT 84110

CHEVRON RESOURCES CO.
595 Market Street
San Francisco, CA 94105

MCCULLOCH GEOTHERMAL CORPORATION
10880 Wilshire Blvd.
Los Angeles, CA 90024

GEOHERMAL SERVICES INC.
10072 Willow Creek Road
San Diego, CA 92131

CASCADIA EXPLORATION CORP.
3358 Apostol Road
Escondido, CA 92025

QUADRILL RESOURCES LTD.
250 - 11012 MacLeod Trail S.
Calgary, Alberta

RED ARROW DRILLING LTD.
520 - 304 - 8th Avenue, S.W.
Calgary, Alberta

REGENT DRILLING LIMITED
12912 - 125th Avenue
Edmonton, Alberta

RIM FIRE DRILLING LTD.
7833 Coronet Road
Edmonton, Alberta

THERMAL POWER COMPANY
601 California Street
San Francisco, CA 94108

OCCIDENTAL GEOTHERMAL, INC.
5000 Stockdale Highway
Bakersfield, CA 93309

GEOHERMAL KINETICS INC.
2300 County Center Drive, Suite 211A
Santa Rosa, CA 95401

GEOHERMAL RESOURCES INT'L
4676 Admiralty Way
Marina del Rey, CA 92091

B & B DRILLING CO, INC.
P.O. Box 2666
Grand Junction, CO 81502

GEOHERMAL KINETICS, INC.
50 California Street, Suite 1270
San Francisco, CA 94111

AQUITAINE OF CANADA
555 - 4th Avenue, S.W.
Calgary, Alberta

NEVIN SADLIER-BROWN GOODBRAND LTD.
401-134 Abbott Street
Vancouver, B.C.

KINGSTON, REYNOLDS, THOM & ALLARDICE
P.O. Box 5348, Wellesley Street
Auckland, New Zealand 795 700

PETER BAWDEN DRILLING INC.
12832 Valley View Street, #210
Garden Grove, CA 92645

KEPLINGER & ASSOC.
City Centre Office Towers
6400 Uptown Blvd. N.E. Ste. 437
Albuquerque, NM 87110

UNICOR DRILLING LTD.
8th Floor - 640 - 8th Avenue, S.W.
Calgary, Alberta

WESTBURNE HI-TOWER ARCTIC DRILLING
DIV. OF WESTBURN INTERNATIONAL IND.
200 - 535 - 7th Avenue, S.W.
Calgary, Alberta

WORLDWIDE DRILLING DIVISION
P.O. Box 1827
Bonnyville, Alberta

REPUBLIC GEOTHERMAL INC. .
11823 E. Slauson Avenue, Suite 1
Santa Fe Springs, CA 90670

ROGERS ENGINEERING CO. INC.
111 Pine Street
San Francisco, CA 94111

ROCKY MOUNTAIN DRILLING LIMITED
415 - 10333 Southport Road, S.W.
Calgary, Alberta

UNDERWATER GAS DEVELOPMENT LTD.
P.O. Box 90
Suite 4200 - 1 First Canadian Place
Toronto, Ontario

WESTBURNE DRILLING (CANADA) LIMITED
200 - 535 - 7th Avenue, S.W.
Calgary, Alberta

WHITCO DRILLING
1580 - 540 - 5th Avenue, S.W.
Calgary, Alberta

APPENDIX C

Contractors Specifications

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

CEMENTING PROGRAM

CONTRACT NO. Q1-1142

TENDER DOCUMENTS

Contents

Advertisement for Tenders; Instructions to Tenderers;
Form of Tender; General Conditions; Detail Specifications

April 1981

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

CEMENTING PROGRAM

CONTRACT NO. Q1-1142

CONTENTS

VOLUME 1

- PART 1 - ADVERTISEMENT FOR TENDERS
- PART 2 - INSTRUCTIONS TO TENDERERS
- PART 3 - FORM OF TENDER
- PART 4 - GENERAL CONDITIONS
- PART 5 - DETAIL SPECIFICATIONS

CONTRACT NO. Q1-1142

PART 1 - ADVERTISEMENT FOR TENDERS

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

CEMENTING PROGRAM

CONTRACT NO. Q1-1142

PART 1 - ADVERTISEMENT FOR TENDERS

Tenders are invited for the supply of labour, equipment and materials for cementing services required in the drilling of a deep geothermal exploration well in the Meager Creek geothermal area. Meager Creek is located approximately 160 km north of Vancouver, British Columbia.

The Tender Documents for Q1-1142 may be obtained free of charge in the amount of two copies per request, from the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3 (Telephone (604) 663-2577 or Telex 04-54395).

Tenders will be considered only from Tenderers whose financial resources, technical ability and experience are commensurate with the work to be performed. The lowest or any tender may not necessarily be accepted and the Authority will not be responsible for any costs incurred by any Tenderer in preparing his Tender.

Tenders will be received until 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 6 May 1981 at Room 1026, Office of the Purchasing Agent at the above address. The tenders will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day.

When requesting information or documents pertaining to this tender, please quote Contract No. Q1-1142.

CONTRACT NO. Q1-1142

PART 2 - INSTRUCTIONS TO TENDERERS

CONTRACT NO. Q1-1142

PART 2 - INSTRUCTIONS TO TENDERERS

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CONTRACT NO. Q1-1142

PART 2 - INSTRUCTIONS TO TENDERERS

2.01 SUBMISSION OF TENDERS

Tenders shall be submitted in triplicate on the separate copies of the Form of Tender provided with the Tender Documents and shall be enclosed in a sealed envelope addressed to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3, and marked:

"Q1-1123 - Tender for the supply of labour, equipment and materials for cementing services required for the Meager Creek geothermal area deep exploratory well"

and with the name of the Tenderer clearly shown. Tenders shall be delivered to Room 1026 at the above address not later than 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 6 May 1981 hereinafter called the "closing time", and will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day.

Tenders which are delivered after the closing time will not be considered.

2.02 ACCEPTANCE AND REJECTION OF TENDERS

The Authority reserves the right to reject any or all tenders and to accept any tender it considers advantageous.

Tenders may not be withdrawn for a period of 30 calendar days after the closing time.

Tenders which are incomplete, conditional or obscure, or which in any way fail to conform strictly to the requirements of these Tender Documents or which contain alterations, erasures or irregularities of any kind may be rejected as informal.

Notice to the Contractor of the acceptance of his tender shall constitute the award of the Contract.

2.03 TENDERER'S RESPONSIBILITY

It shall be the Tenderer's responsibility to inform himself of all aspects of the Work and no claim will be considered at any time for

reimbursement for any expenses incurred as a result of any misunderstanding in regard to the conditions of the work. Should any details necessary for a clear and comprehensive understanding be omitted or any error appear in the Tender Documents or should the Tenderer note facts or conditions which in any way conflict with the letter or spirit of the Tender Documents, it shall be the responsibility of the Tenderer to obtain clarifications. Queries shall be made in writing to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 and shall be submitted not later than 15 days before the closing time, and will be answered by a Question and Answer Series which will be issued to all parties registered as having received a copy of the Tender Documents. Immediately upon receiving any Question and Answer series each Tenderer shall acknowledge receipt thereof in writing, in duplicate, to the Purchasing Agent.

Neither the Authority nor the Authority's Representative shall be responsible for any instructions or information given to any Tenderer otherwise than by the Purchasing Agent, in accordance with this Clause.

2.04 ADDENDA

Any changes to the Tender Documents will be issued as written Addenda to all parties registered as having received a copy of the Tender Documents and shall become part of the Tender Documents. If such Addenda are issued each Tenderer shall acknowledge, that he has received them and that his tender has been prepared in accordance therewith.

Immediately upon receiving any Addenda each Tenderer shall acknowledge receipt thereof in writing, in duplicate to the Purchasing Agent.

2.05 PRICING REQUIREMENTS

All prices tendered shall be firm, except as provided in the General Conditions or Detail Specifications, shall be in Canadian dollars and shall include all freight, customs and excise duties and all applicable taxes and shall be all inclusive as provided in the Tender Documents.

The Tenderer shall make his own assessment of wage rates and working conditions to prevail during the period of the Work and prepare his Tender accordingly. No claim for adjustment will be entertained by the Authority.

Prices shall not be subject to adjustment for fluctuation in foreign exchange.

2.06 SIGNATURES AND SEALS

All tenders shall be executed under seal and if the Tenderer is a corporation, the affixing of its corporate seal shall be duly attested by the signature of its authorized signing officers.

2.07 DATA TO BE SUBMITTED WITH TENDER

The information and data hereinafter described shall be submitted with the Tender to demonstrate the Tenderer's ability to comply with the requirements of the Tender Documents. Such submissions shall be in the form of Appendices (in triplicate) clearly marked and referenced.

(a) Technical Data

Each Tenderer shall submit the following technical data with his Tender:

Details, which are not otherwise covered in the Tender Documents, of the equipment the Tender proposes to supply.

(b) Tenderer's Qualifications

Each Tenderer shall submit sufficient information, as Appendix A, with his Tender to show that he has the staff, ability, experience, capital and plant to perform the Work. This shall include a brief description of the equipment the Tenderer proposes to use for this Contract listing its size, rating, year of manufacture and whether it is owned or rented. Details of previous geothermal experience should be included in Appendix A.

Foreign Tenderers shall indicate whether or not they will be represented in British Columbia by competent technical personnel with a good command of the English language.

(c) Financial Information

One (1) only, audited copy of the latest balance sheet, to accompany the original of the Tender, noting any material change that may have occurred since its preparation or effective date. If a copy has been submitted in support of a recent tender, and there has been no material change in the balance sheet, a copy is not required but a note to this effect is required. Other financial information necessary to adequately establish the Tenderer's financial capability may be required, and shall be made available if asked for.

(d) Work Force

Tenderers are referred to the "Reservations Clause" agreed to in the 1980-82 B.C. Building Trades - C.L.R.A. settlement and to Section 40 of the Labour Code of B.C. Each tenderer shall list all union certifications and employer bargaining affiliations, if any, applicable to the Work, including those for each subcontractor.

2.08 BASIC TENDER AND ALTERNATIVES

(a) Basic Tender

Each Tenderer shall submit a basic tender which conforms strictly to the requirements of the Tender Documents.

(b) Alternatives

In addition to the basic tender, Tenderers are free to offer any alternatives to the basic tender which the Tenderer considers to be superior or substantially less costly. Each alternative shall be submitted in duplicate in an appendix to the basic tender. This appendix shall include a description of each alternative in detail equivalent to that required for the basic tender and shall clearly indicate all the advantages and the cost variation for each alternative. The Contract Price for each alternative shall be broken down in the same way as the basic tender.

2.09 PREFERENCE TO BRITISH COLUMBIA AND CANADIAN PRODUCTS

Tenderers are hereby advised that it is a policy of the Authority that where in the sole discretion of the Authority it believes circumstances so warrant, a preference up to 10 percent will be given to tenders which offer products of British Columbia manufacture, or where such manufacture is not possible, a preference of up to 5 percent will be given to products of Canadian manufacture. Tenderers are invited to disclose the British Columbia and Canadian content of their tenders in appendices to be marked B and C respectively to the Form of Tender.

2.10 PERIOD OF THE WORK

The period of the work shall be from the date of award of this contract up to 30 November 1981 or for such further period of time as may be agreed with the Authority.

2.11 ARRANGEMENTS FOR TENDERERS' VISITS TO THE SITE

At least 2 days prior to visiting the Site, each Tenderer shall inform the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 (Telephone (604) 663-2558), of the expected timing and duration of his visit and the number of persons in his party.

Upon arrival at the Site, each Tenderer shall report to the Authority's exploration camp office (see location maps in Part 5). Tenderers must provide their own accommodation and transportation when visiting the Site.

A prospective Tenderer by visiting the Site shall be deemed to have assumed all risk of loss, damage or injury (including death) to the persons and property of himself, his servants and agents, from any cause whatsoever during such visit and shall be deemed to have undertaken to indemnify the Authority, the Authority's Representative, their employees, agents and contractors, from and against all loss, costs, damages, suits, actions and demands whatsoever and any liability therefor to any person arising out of any such visit.

CONTRACT NO. Q1-1142

PART 3 - FORM OF TENDER

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

CEMENTING PROGRAM

CONTRACT NO. Q1-1142

PART 3 - FORM OF TENDER

3.01

(Name of Tenderer)

(Full Address of Tenderer)

hereinafter called the "Tenderer", hereby declares that the Tenderer is: (Strike out (a) or (b) below, whichever does not apply).

(a) A company duly incorporated under the laws of

(Insert Authorizing Jurisdiction)

(b) A Partnership, Sole Trader, or Joint Venture carrying on a business under the firm name and style above stated; the names, addresses and places of incorporation, if any, of all partners or members of the firm being the following:

(If a Joint Venture, state which is the sponsoring member and the percentage participation by each member.)

- 3.02 Having examined the Tender Documents, the Tenderer hereby offers to perform the whole of the Work provided for in the Tender Documents and to comply with all other requirements of the Tender Documents for the Contract Price of _____ (\$ _____) for Schedule 1 or such other sum as may be ascertained in accordance with the conditions and provisions set forth in the Contract Documents.

The attached Schedule(s) of Quantities and Prices forms part of this tender, and if there is any conflict between the Contract Price entered above and the correct summation of the lump sum prices; provisional sums, if any; and correct extensions of the unit prices and approximate quantities entered in the aforesaid Schedule(s), the said summation shall take precedence.

If the Tenderer does not enter a price for any payment item in his tender, that payment item shall be deemed to be covered by such prices as the Tenderer did enter in his tender.

The quantities in the Schedule(s) are estimates of what the actual quantities of work may be and will be used to compare tenders on a uniform basis. The quantities shown are not a representation or warranty by the Authority, expressly or by implication, of what will be the actual quantities required in the work. Accordingly, the Authority will not consider any claims for adjustments to unit prices resulting from a variance between the actual quantities and those listed in the Schedule(s) and shall not be liable if those listed are not even approximately correct.

- 3.03 The following Question and Answer Series and Addenda to the Tender Documents have been received by the Tenderer, and this tender has been prepared in accordance therewith:

<u>Question and Answer Series</u>	<u>Date Received</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Addendum to Tender Documents

Date Received

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

- 3.04 The Tenderer's Workers' Compensation Board Registration No. is _____.
- 3.05 This tender is irrevocable for 30 calendar days after the closing time, whether any other tender has previously been accepted or not and whether notice of acceptance of another tender has been given or not.
- 3.06 The Tenderer hereby represents that this tender is genuine and not a sham or collusion or made in the interest or on behalf of any person or corporation not herein named, or after comparison of any prices with any other tenderer for the Work, and further, that the Tenderer has not directly or indirectly induced or solicited any other tenderer to submit a sham tender, or any other person or corporation to refrain from tendering, and that the Tenderer has not in any manner sought by collusion to secure for himself or for any other person or corporation an advantage over any other tenderer.
- 3.07 If this tender is signed by or on behalf of more than one person, then all the agreements, promises, covenants and obligations of the Tenderer are and shall be deemed to be the joint and several agreements, promises, covenants and obligations of all and each of those persons. Each and every member of the Joint Venture making this tender has signed and sealed this tender or had this tender signed and sealed upon its behalf as a separate person.

3.08 The following appendices are attached hereto:

<u>Appendix No.</u>	<u>Reference Clause</u>

SCHEDULE I

MEAGER CREEK GEOTHERMAL WELL
SCHEDULE OF QUANTITIES AND PRICES - CEMENTING PROGRAM

<u>Item</u>	<u>Description</u>	<u>Approximate Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>
1	Mobilization and demobilization of on-site equipment		lump sum		
2	Mobilization and demobilization of personnel				
3	Supply of cementing crew				
4	Supply of cement:				
	- 1:1 API class G to Perlite + 3% Gel + 40% Silica flour + 0.5% CFR-2	1100	100 lb sacks		
	- Class G neat pre-mixed with 35% Silica flour and 0.5% CFR-2	200	100 lb sacks		
	- Portland neat	260	100 lb sacks		
5	Liquid retarder	20	gallons		
6	Supply of dry cement storage facility for above	1			
7	Supply of 1500 gallon water storage tanks	2			
8	Cement pumping unit on site for duration of job	1			
9	Backup cement pumping unit on site during casing, cementing jobs	1			
10	Plug dropping heads,				
	- drill pipe 13 3/8", casing job and drill pipe wiper plug	1			
	- 9 5/8" conventional cementing head with crossover to 9 5/8" Buttress	1			

<u>Item</u>	<u>Description</u>	<u>Approximate Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>
11	Top 9 5/8" wiper plugs	1			
	Bottom 9 5/8" wiper plugs	1			
	13 3/8" cementing shoe	1			
	9 5/8" float shoe	1			
	9 5/8" float collar	1			
12	Thread-Lok compound	3	kits		
13	Casing centralizers				
	(13 3/8")	5			
	Casing centralizers				
	(9 5/8")	30			
	Casing centralizers				
	(7")	5			
14	Breathing apparatus				

3.10 IN WITNESS whereof the Tenderer has caused its seal to be affixed
at the day of 19

The seal of the Tenderer was here-)
unto affixed in the presence of:)
)
)
)
_____)
)
)
_____)

CONTRACT NO. Q1-1142

PART 4 - GENERAL CONDITIONS

CONTRACT NO. Q1-1142

PART 4 - GENERAL CONDITIONS

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<u>Clause</u>	<u>Subject</u>	<u>Page</u>
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4.02	Assessment of Conditions	4 - 1
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PART 4 - GENERAL CONDITIONS

4.01 DEFINITIONS AND MEANINGS OF TERMS

The following words and terms wherever used in the Tender Documents shall have the meanings herein assigned to them and the following rules of construction shall apply:

1. "Authority" shall mean the British Columbia Hydro and Power Authority, a body corporate, with head office at 970 Burrard Street, Vancouver, British Columbia, its successors and assigns.
2. "Authority's Representative" shall mean the Manager, System Engineering Division or his delegate, who shall be authorized to supervise the technical direction of the Work.
3. "Contract Documents" shall mean the Tender Documents and the tender of the Contractor as accepted by the Authority, together with the purchase order issued by the Authority.
4. "Contractor" shall mean the Tenderer whose tender has been accepted.
5. "Day" shall mean a calendar day.
6. "Tenderer" shall mean any party or parties tendering for the Work, or the successful Tenderer who later becomes the Contractor for such Work.
7. "Site" shall mean the lands and other places on, under, in, or through which the Work is to be carried out.
8. "Tender Documents" shall mean the Advertisement for Tenders; Instructions to Tenderers; Form of Tender; General Conditions; Detail Specifications; Addenda; and Question and Answer Series, if any.
9. "Work" shall mean everything to be done by the Contractor under the Contract whether temporary or permanent, including equipment and material to be supplied by the Contractor.

4.02 ASSESSMENT OF CONDITIONS

The Contractor shall be deemed to have informed himself fully as to the risks and contingencies and all other data, matters and things, local

or otherwise, requisite to the fulfillment of the Contract. Failure to acquaint himself fully with all available information concerning conditions affecting or which may be encountered in performing the Work will not relieve the Contractor of the responsibility for estimating the difficulties and costs of satisfactorily performing the Work, or for actually performing the Work in conformity with the Contract.

4.03 COMPLIANCE WITH LAWS

The Contractor and his employees in carrying out the Contract shall comply with all laws, statutes, by-laws, ordinances and regulations of all Federal, Provincial, Municipal or other governmental authorities, any of which are applicable to the Contract or the performance of the Work, and the Contractor shall indemnify the Authority against any cost, loss, liability or obligation which may arise as a consequence of the failure of the Contractor and/or his employees to comply fully with the said laws and regulations.

Without restricting the foregoing, the Contractor shall conform to the provisions of the "Workers' Compensation Act" and all other statutes, by-laws, or regulations in force from time to time in respect of or affecting in any manner performance of the Contract, the Work or the Site, and shall give all notices required by the said statutes, by-laws or regulations and pay all fees, assessments and other sums payable thereunder or in respect thereof.

Except as otherwise specified in writing by the Authority or in the Tender Documents, the Contractor shall be responsible for obtaining at his own expense, all necessary authorizations, licenses and permits in connection with or required for the Work as are prescribed by such governmental authorities, notwithstanding that the Authority is an agency of the Crown.

4.04 INSURANCE

(a) Comprehensive General Liability Insurance

The Contractor shall, at his own expense, provide a Comprehensive General Liability Insurance Policy, to the satisfaction of the Authority's Insurance Manager, in an amount not less than \$1 000 000.00, all inclusive together with a standard Non-owned Automobile Liability and Statutory Conditions Endorsement. This insurance shall be maintained during the continuance of the Contract. It shall insure both the Contractor and the Authority, and the policy shall contain a "cross-liability" clause.

(b) Automobile Public Liability and Property Damage Insurance

The Contractor shall, at his own expense, obtain and maintain during the continuance of this Contract, Automobile Public Liability

and Property Damage insurance covering the ownership, use or operation or any motor vehicle or trailer licensed for use on public highways and that is owned, leased or controlled by the Contractor, in an amount not less than \$1 000 000.00 all inclusive.

(c) Insurance Manager

All policies of insurance shall be to the satisfaction of the Insurance Manager of the Authority and a certified copy of such policies shall be presented to the said Insurance Manager prior to the commencement of any work in connection with this Contract.

4.05 CLEAN-UP

The Contractor shall at all times during the carrying out of the Work keep the site neat and free from any of his waste materials including lunch bags, cans and rubbish. Should the Contractor fail to do so, the Authority's representative may arrange to have the site cleaned up by others and the costs thereof shall be recovered as monies due to the Authority.

4.06 ENVIRONMENTAL PRECAUTIONS

The Contractor shall conduct his operations so that pollution of the environment and the destruction of trees, crops and damage to the landscape is kept to a minimum.

Roads, ditches and watercourses, if disturbed by the Contractor's operations, shall be restored prior to leaving the Site.

Survey markings shall not be disturbed.

The Contractor shall have available at the Site sufficient fire fighting equipment adequate to handle an outbreak of fire brought about by his operations.

The cost of any repairs or damages resulting from non-compliance with the provisions of this Clause shall be paid by the Contractor.

4.07 EARLY TERMINATION

The Authority reserves the right to terminate the Work on the Site upon providing at any time reasonable advance notice to the Contractor. In the event of such termination, the Authority's sole obligation to the Contractor shall be limited to the payment for Contractor services performed to that time and payment for other items mutually agreed to in the Contract.

4.08 COMPLETION TIME

If, in the opinion of the Authority's representative the Contractor fails to advance the Work at a rate which will enable the Contractor to meet a completion time agreed to by the Contractor and the Authority prior to the start of work, the Authority's representative may instruct the Contractor to take such action as he considers necessary to sufficiently accelerate the Work; and in particular, with respect to the labour force or plant assigned by the Contractor to the Work, may instruct the Contractor to increase either or both. The Contractor shall forthwith comply with any such instruction.

4.09 SUBCONTRACTS

1. The Contractor shall notify the Authority in writing of the terms of all subcontracts, if any, and the names of subcontractors proposed for the principal parts of the Work and shall not employ any to whom the Authority may reasonably object.
2. The Contractor shall be as fully responsible for the acts and omissions of his subcontractors and their employees as if such subcontractors and their employees were persons directly employed by the Contractor.
3. Subcontractors may be required to provide proof, satisfactory to the Authority, as to their financial capability. The Contractor shall provide the necessary information upon request from the Authority.

4.10 CO-OPERATION

The Contractor shall have no right to the exclusive occupation of the Site of the Work. The Contractor shall co-operate harmoniously with Authority personnel and with other Contractors working at the site. All instructions given by the Authority's representative or his delegate shall be carefully and promptly executed.

4.11 WAGES AND WORKING CONDITIONS

The Public Construction Fair Wages Act applies to this Contract and to every subcontract and to any work done by any other person under this Contract.

4.12 ASSIGNING THE CONTRACT

Neither party to this Contract shall assign the Contract or any interest therein without the written consent of the other party.

4.13 AUDIT

The Contractor shall permit representatives of the Authority at all reasonable times, to inspect and audit all records, accounts, statements and other documents of the Contractor relating to the Work and shall keep such records, accounts, statements and documents for at least 1 year after completion of the Work or for such extended period as the Authority may have requested, in advance and in writing, of the Contractor. The liability of the Authority to make any payment other than the sums provided or calculated in accordance with the actual quantities of payment items and prices set out in the Form of Tender, shall be subject to the right of the Authority to inspection and audit as above provided.

4.14 PAYMENT GENERAL

(a) Terms of Payment

Invoices shall be rendered in the first 7 days of each month in respect of all amounts earned by the Contractor during the previous month, and except as provided below such invoices shall be payable in full within 30 days of the receipt of such invoices, provided that if the Authority is unable to verify such invoices within the said period any payment made shall be treated as an advance pending verification of the invoices.

Any necessary adjustments, which have not been made prior to the final invoice for work done shall be made at the time of final payment. If the Authority is shown to have overpaid the Contractor, the Contractor agrees that the Authority may deduct the amount from any other sums due to the Contractor from the Authority or that it will pay the amount to the Authority within 30 days of the amount being agreed or otherwise established.

(b) Submitting of Invoices

All invoices shall be directed to B.C. Hydro and Power Authority, 555 West Hastings Street, Vancouver, B.C., Canada, V6B 4T6, attention System Engineering Division, Meager Creek Geothermal Project. They shall be clearly identified by Purchase Order number and name of project.

CONTRACT NO. Q1-1142

PART 5 - DETAIL SPECIFICATIONS

CONTRACT NO. Q1-1142

PART 5 - DETAIL SPECIFICATIONS

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CONTRACT NO. Q1-1142

PART 5 - DETAIL SPECIFICATIONS

5.01 LOCATION AND ACCESS

The Meager Creek geothermal project area is located 160 km north-northwest of Vancouver and approximately 60 km northwest of Pemberton, B.C. (see Maps Nos. 1 and 2). Access to the project is via Highway 99 from Vancouver to Pemberton continuing on good gravel surface forestry development and private logging roads to the site.

5.02 SCOPE OF WORK

The Work shall include the supply of all labour, plant and materials and the performance of all things required in connection with the cementing, the setting of casings, plus setting other cement plugs as required, including the following principal items of work:

1. Cementing Program (see Fig. 1 for well cross section)

a. 20-inch conductor pipe

Cemented to surface with Portland cement

Volume: (100% excess)
26" x 20" - 100' = 150 CF

260 sacks Portland neat cement with 100% excess

b. 13 3/8-inch Surface Casing

Cemented through shoe with inner string cementing method

Volume: 17 1/2" x 13 3/8" - 1000' = 695 CF
(25% excess)

399 sacks of 1:1 API class G to Perlite + 3% gel + 40% Silica flour + 0.5% CFR-2 mixed with 1.42 CF of water per sack.

Tail end with 100 sacks of class G neat pre-mixed with 35% Silica flour and 0.5% CFR-2 with 0.87 CF of water per sack.

Note: Liquid retarder should be available in the event bottom hole temperatures from the logs indicate the need for retarder.

c. 9 5/8-inch Production Casing

Cemented conventionally from bottom to surface

Volume:	9 5/8" x 13 3/8" Casing - 1000'	-	363 CF
	9 5/8" x 12 1/4" Hole - 4200'	-	1315 CF
	2 Jts between shoe and float collar (80')	-	<u>34 CF</u>

Total Volume 1712 CF

(15% excess)

720 sacks of 1:1 API class G to Perlite + 3% gel + 40% Silica flour + 0.5% CFR-2 mixed with 1.42 CF of water per sack. Tail end with 100 sacks of class G neat pre-mixed with 35% Silica flour and 0.5% CFR-2 with 0.87 CF of water per sack.

Note: Liquid retarder should be available to use in the mixing water. The amount of retarder will be determined after the bottom hole temperatures are found from the logs.

2. Slurry Properties

	<u>Weight</u>	<u>Yield</u>	<u>Water</u>	<u>Strength</u>
Perlite	12.7 PPG	2.22 CF/SX	1.42 CF/SX	405 PSI (8 hr)
Tail Slurry	15.6 PPG	1.50 CF/SX	0.87 CF/SX	1300 PSI (8 hr)

3. Properties of Casing

	<u>Burst (PSI)</u>	<u>Tension (KIPS)</u>	<u>Collapse (PSI)</u>
13 3/8" - (54.5-K)	2730	1038	1130
9 5/8" - (40.5 PPF-K)	3950	843	2570
7" - (26 PPF-K)	7240	667	5410

All safety factors are better than: 1.68 Joint Tension, 1.25 Body Tension, 1.25 Burst, 1.15 Collapse.

4. Tubular Goods Required

Casing: 100' - 20" conductor
1000' - 13 3/8" - 54.4 lb/ft, K-55, Buttress
5200' - 9 5/8" - 40.5 lb/ft, K-55, Buttress
2500' - 7" - 26 lb/ft, K-55 Buttress (slotted 0.25" 16 row)

5. Casing Equipment Required

13 3/8": Float shoe (stab-in), wash down type
Five 13 3/8" centralizers

9 5/8": 9 5/8" differential fill-up float collar for 9 5/8"
40 lb/ft

9 5/8" guide shoe-wash down type with side ports

Thirty 9 5/8" centralizers

Two 9 5/8" Buttress collars

5.03 COMPLETION TIME

The Contractor shall perform all work as dictated by the drilling program and in a manner so as not to interfere with drilling progress.

5.04 FOOD, LODGING AND TRANSPORTATION

The Contractor shall be responsible for supplying daily transportation between the drill site and the Contractor's personnel place of lodging.

Food and lodging will be provided by the Contractor. It should be noted that the drilling contractor will have a camp at the drill site and it is possible that an arrangement could be made to house cementing contractor's personnel.

5.05 CEMENTING EQUIPMENT

Subject to the approval of the Authority the Contractor may use cementing equipment and materials of his own preference in the work, except for those items which are specifically required in these detailed specifications. Items of equipment or materials which, in the opinion of the Authority do not meet the specified requirements shall be replaced by the Contractor with equipment and materials meeting the specified requirements.

The Contractor shall supply one cementing unit on site at all times and shall supplement with an additional unit during casing cementing jobs.

5.06 EQUIPMENT DESCRIPTION

The type of pumping and mixing equipment and operating characteristics shall be described in an appendix to the Form of Tender.

5.07 BULK STORAGE

The Contractor shall supply sufficient bin storage including installation and removal - pneumatic or gravity to store the cement needed for the largest cementing job (3000 ft³).

5.08 SUPPORT EQUIPMENT

The Contractor shall supply all subsidiary equipment required to perform the casing cementing jobs presented in Section 2.0 above. This equipment shall include but is not limited to:

1. Top and bottom wiper plugs.
2. Plug dropping head.
3. Casing swage.
4. Any required crossover equipment from operator's equipment to contractor's equipment.
5. Sufficient number of air packs for Contractors on site personnel.

5.09 CEMENT RETARDER

Cement shall be pre-mixed as required except for retarder. Liquid retarders shall be pre-mixed in the mixing water prior to the cementing jobs. Sufficient retarder for these jobs shall be on-site ready for use at all times.

5.10 OPERATING PERSONNEL

Contractor shall supply operating personnel within 24 hours upon notification by the Authority.

5.11 WATER STORAGE

Contractor shall supply two 1500-gallon tanks for pre-mixing of mixing water for cement jobs.

5.12 TESTING

Contractor shall perform pumpability tests under downhole conditions and any other standard or specified by the Authority.

5.13 CEMENTING AND MATERIALS

1. Cement Materials shall be supplied to accomplish the cementing program presented in Section 5.02. In addition, 1000 sacks of class G neat cement shall be on site at all times for control of possible lost circulation problems.
2. The Contractor shall provide:

- a. 13 3/8-inch stab-in, washdown cementing shoe and stab-in sub along with pump-in head for operator's drill pipe, and drill pipe wiper plug (latch-in type).
 - b. 9 5/8-inch conventional float shoe and float collar.
 - c. Epoxy Thread-Lok compound sufficient to thread-lok two 13 3/8-inch Buttress collars and three 9 5/8-inch Buttress collars.
 - d. Centralizers as specified in Section 2.0.
3. Supplying water required for the cementing program will be the responsibility of the Authority. The Authority will also supply water analysis required by the Contractor for mix design.

5.14 RECORD KEEPING

Contractor shall provide test results as requested by the Authority. In addition, the Contractor shall provide the Authority with all calculation results (volumes, times, rates, etc.) and pressure charts for all cementing jobs.

5.15 GENERAL BASIS OF PAYMENT

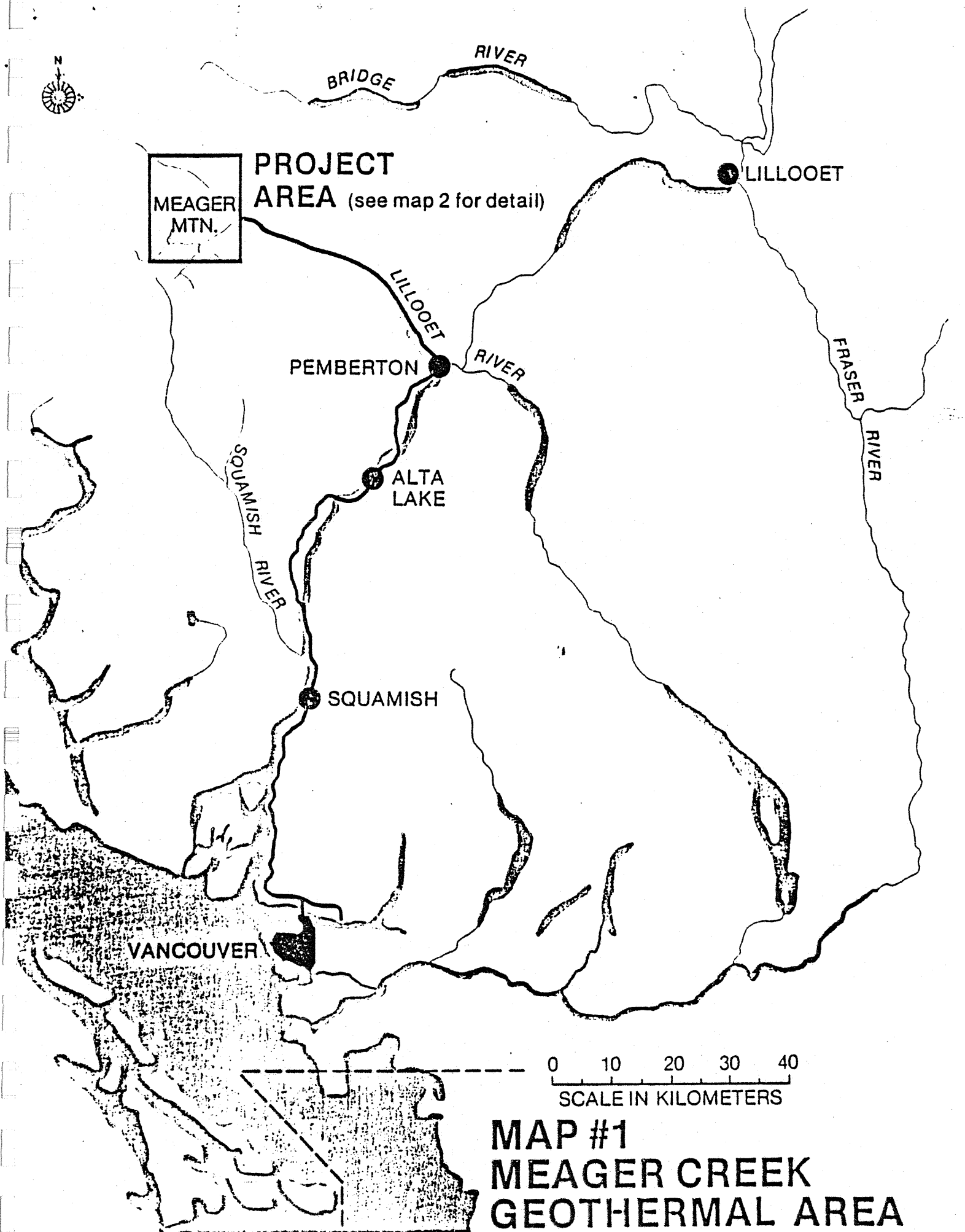
Except as otherwise specifically provided, the prices entered in the Schedule (see Part 3 - Form of Tender) for payment for the various items of work and materials, as described in these Detail Specifications, shall constitute full compensation for supplying and maintaining all equipment, material, accommodation, labour, supervision and all other work for performing all parts of the cementing program to be carried out by the Contractor in accordance with the provisions of the Contract. The unit prices entered in the Tender Form shall also apply to any additional work required by the Authority.

The Contractor shall submit daily to the Authority, on a form supplied by the Authority, a signed record of the work completed and the number of hours worked during each shift of the previous working day. When signed by the Authority, this record shall constitute the sole basis of compensation for work covered by these Detail Specifications.

Time associated with breakdown of Contractor's ^{equipment} or unreasonable delays will not be paid for.



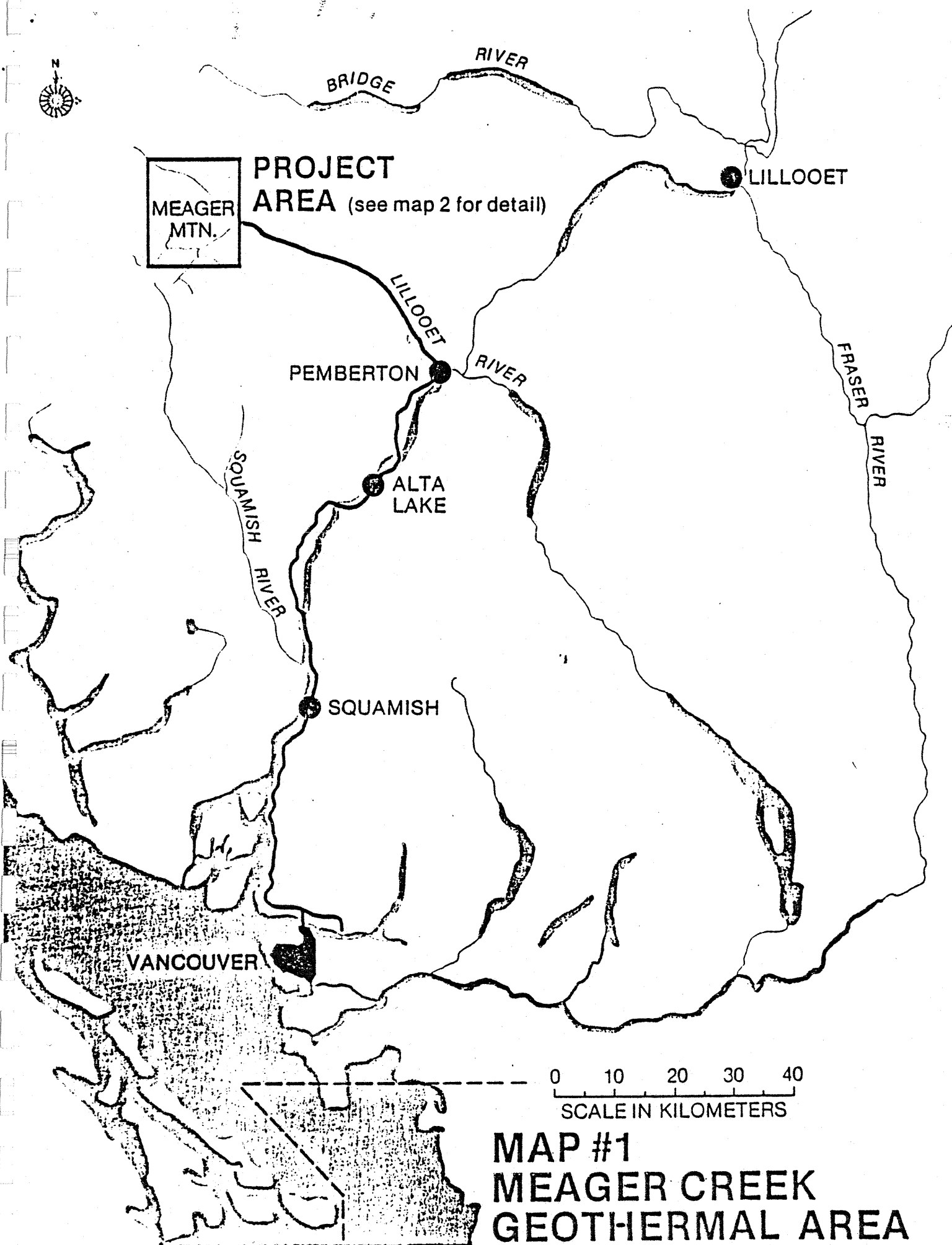
PROJECT AREA (see map 2 for detail)



MAP #1
MEAGER CREEK
GEO THERMAL AREA

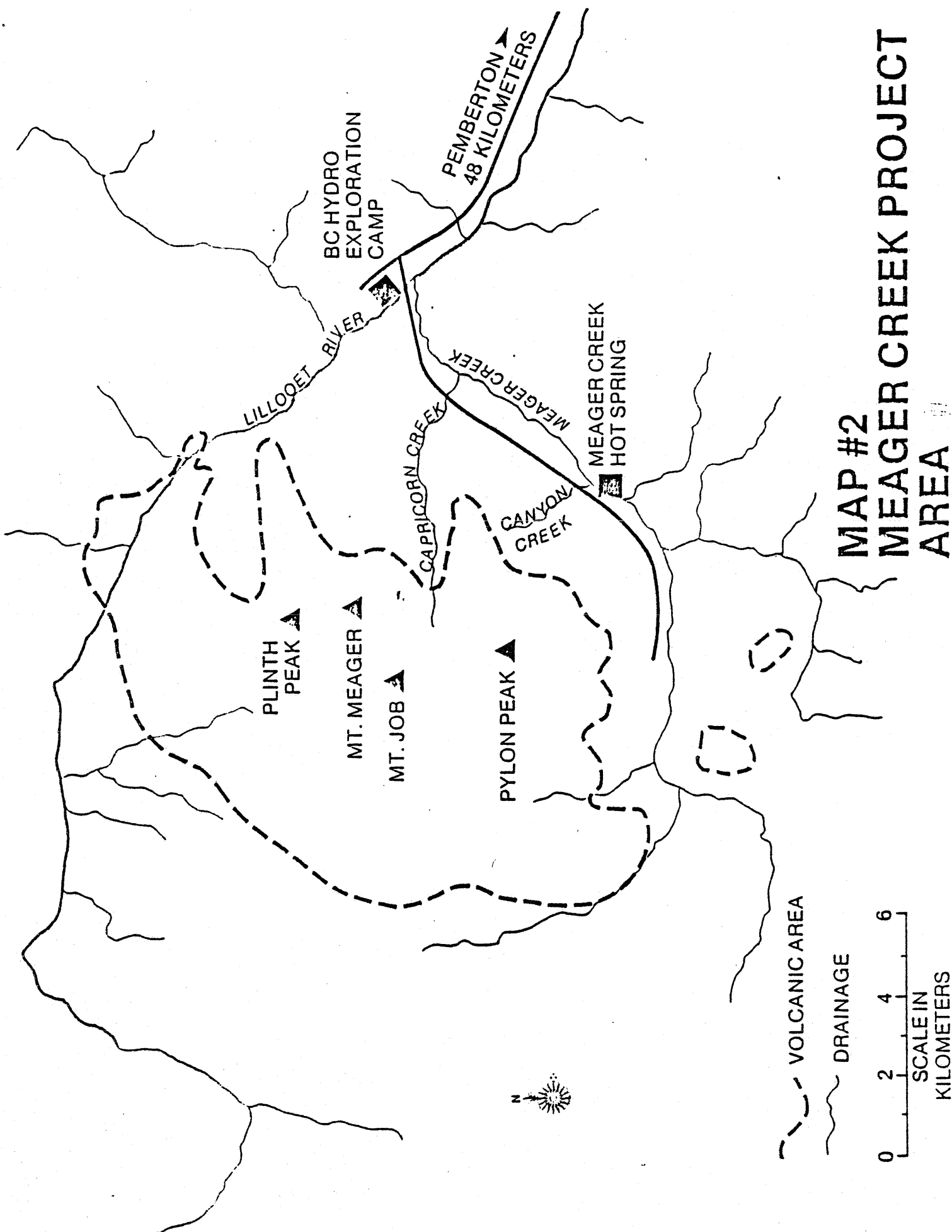


PROJECT AREA (see map 2 for detail)



0 10 20 30 40
SCALE IN KILOMETERS

**MAP #1
MEAGER CREEK
GEOTHERMAL AREA**



MAP #2 MEAGER CREEK PROJECT AREA

FIGURE 1

SCHEMATIC CROSS SECTION
OF CASING/HOLE SIZE PROGRAM FOR
MCGA PRODUCTION WELL

NOTE: CASINGS FULLY
CEMENTED FROM SHOE
TO SURFACE

NOTE: FINAL SETTING
DEPTHS TO BE
DETERMINED DURING
DRILLING

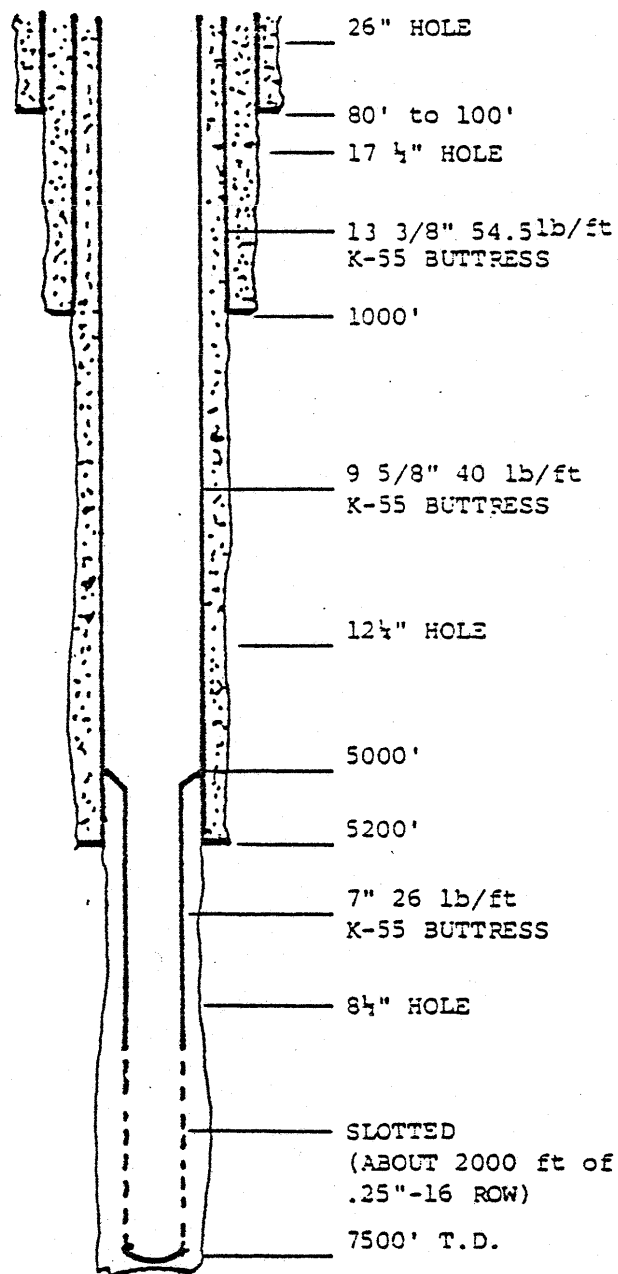
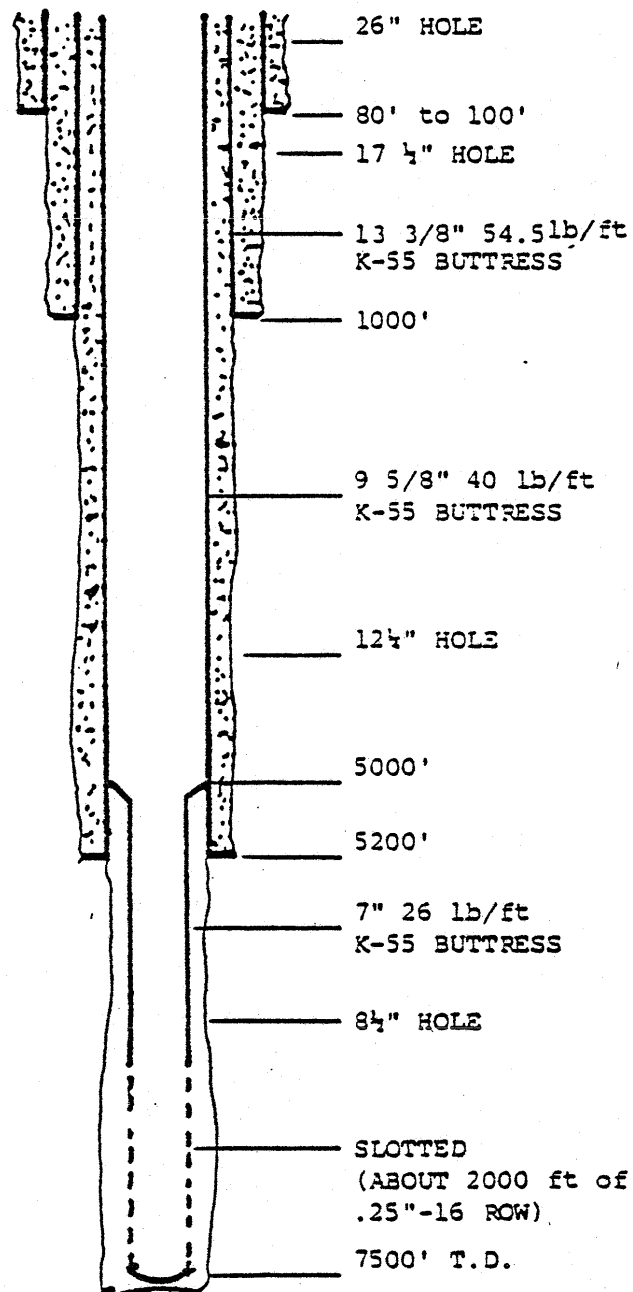


FIGURE 1

SCHEMATIC CROSS SECTION
OF CASING/HOLE SIZE PROGRAM FOR
MCGA PRODUCTION WELL

NOTE: CASINGS FULLY
CEMENTED FROM SHOE
TO SURFACE

NOTE: FINAL SETTING
DEPTHS TO BE
DETERMINED DURING
DRILLING



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELLS

CEMENTING PROGRAM

CONTRACT NO. Q1-1142

ADDENDUM NO. 1

29 April 1981

The Tender Documents for the above work, the original issue of which is dated April 1981, are hereby amended as follows:

AMENDMENT TO PART 1

Delete page 1-1 and substitute the attached page marked Addendum No. 1.

AMENDMENTS TO PART 2

Delete pages 2-1, 2-4 and substitute the attached pages marked Addendum No. 1.

AMENDMENTS TO PART 3

Delete pages 3-5 and 3-6 and substitute the attached pages marked Addendum No. 1.

AMENDMENT TO PART 4

Delete page 4-4 and substitute the attached page marked Addendum No. 1.

AMENDMENTS TO PART 5

Delete pages 5-i, 5-1, 5-2, 5-3, 5-4 and 5-5 and substitute attached pages marked Addendum No. 1.

Three additional copies of the revised Form of Tender are also enclosed.

NOTICE TO TENDERS

Please acknowledge receipt of this Addendum in accordance with Clause 2.04 of the Tender Documents.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

CEMENTING PROGRAM

CONTRACT NO. Q1-1142

PART 1 - ADVERTISEMENT FOR TENDERS

Tenders are invited for the supply of labour, equipment and materials for cementing services required in the drilling of two deep geothermal exploration well in the Meager Creek geothermal area. Meager Creek is located approximately 160 km north of Vancouver, British Columbia. *

The Tender Documents for Q1-1142 may be obtained free of charge in the amount of two copies per request, from the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3 (Telephone (604) 663-2577 or Telex 04-54395).

Tenders will be considered only from Tenderers whose financial resources, technical ability and experience are commensurate with the work to be performed. The lowest or any tender may not necessarily be accepted and the Authority will not be responsible for any costs incurred by any Tenderer in preparing his Tender.

Tenders will be received until 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 13 May 1981 at Room 1026, Office of the Purchasing Agent at the above address. The tenders will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day. *

When requesting information or documents pertaining to this tender, please quote Contract No. Q1-1142.

CONTRACT NO. Q1-1142

PART 2 - INSTRUCTIONS TO TENDERERS

2.01 SUBMISSION OF TENDERS

Tenders shall be submitted in triplicate on the separate copies of the Form of Tender provided with the Tender Documents and shall be enclosed in a sealed envelope addressed to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3, and marked:

"Q1-1123 - Tender for the supply of labour, equipment and materials for cementing services required for two deep exploratory wells in the Meager Creek geothermal area"

*

and with the name of the Tenderer clearly shown. Tenders shall be delivered to Room 1026 at the above address not later than 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 13 May 1981 hereinafter called the "closing time", and will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day.

*

Tenders which are delivered after the closing time will not be considered.

2.02 ACCEPTANCE AND REJECTION OF TENDERS

The Authority reserves the right to reject any or all tenders and to accept any tender it considers advantageous.

Tenders may not be withdrawn for a period of 30 calendar days after the closing time.

Tenders which are incomplete, conditional or obscure, or which in any way fail to conform strictly to the requirements of these Tender Documents or which contain alterations, erasures or irregularities of any kind may be rejected as informal.

Notice to the Contractor of the acceptance of his tender shall constitute the award of the Contract.

2.03 TENDERER'S RESPONSIBILITY

It shall be the Tenderer's responsibility to inform himself of all aspects of the Work and no claim will be considered at any time for

(b) Alternatives

In addition to the basic tender, Tenderers are free to offer any alternatives to the basic tender which the Tenderer considers to be superior or substantially less costly. Each alternative shall be submitted in duplicate in an appendix to the basic tender. This appendix shall include a description of each alternative in detail equivalent to that required for the basic tender and shall clearly indicate all the advantages and the cost variation for each alternative. The Contract Price for each alternative shall be broken down in the same way as the basic tender.

2.09 PREFERENCE TO BRITISH COLUMBIA AND CANADIAN PRODUCTS

Tenderers are hereby advised that it is a policy of the Authority that where in the sole discretion of the Authority it believes circumstances so warrant, a preference up to 10 percent will be given to tenders which offer products of British Columbia manufacture, or where such manufacture is not possible, a preference of up to 5 percent will be given to products of Canadian manufacture. Tenderers are invited to disclose the British Columbia and Canadian content of their tenders in appendices to be marked B and C respectively to the Form of Tender.

2.10 PERIOD OF THE WORK

The period of the work shall be from the date of award of this contract up to 30 April 1982 or for such further period of time as may be agreed with the Authority.

2.11 ARRANGEMENTS FOR TENDERERS' VISITS TO THE SITE

At least 2 days prior to visiting the Site, each Tenderer shall inform the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 (Telephone (604) 663-2558), of the expected timing and duration of his visit and the number of persons in his party.

Upon arrival at the Site, each Tenderer shall report to the Authority's exploration camp office (see location maps in Part 5). Tenderers must provide their own accommodation and transportation when visiting the Site.

A prospective Tenderer by visiting the Site shall be deemed to have assumed all risk of loss, damage or injury (including death) to the persons and property of himself, his servants and agents, from any cause whatsoever during such visit and shall be deemed to have undertaken to indemnify the Authority, the Authority's Representative, their employees, agents and contractors, from and against all loss, costs, damages, suits, actions and demands whatsoever and any liability therefor to any person arising out of any such visit.

MEAGER CREEK GEOTHERMAL WELLS
SCHEDULE OF QUANTITIES AND PRICES - CEMENTING PROGRAM (2 WELLS)

<u>Item</u>	<u>Description</u>	<u>Approximate Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>
1	Mobilization and demobilization of on-site equipment	-	lump sum		
2	Mobilization and demobilization of personnel per trip	6	round trips		
3	Supply of cementing crew at site	18	days		
4	Supply of cement:				
	- 1:1 API class G to Perlite + 3% Gel + 40% Silica flour + 0.5% CFR-2	100 000	kg		
	- Class G neat pre-mixed with 35% Silica flour and 0.5% CFR-2	18 000	kg		
	- Class G neat	70 000	kg		
5	Retarder	400	kg		
6	Cement/mud spacer and washer	3500	U.S. gallons		
7	Supply of dry cement storage facility for above	-	lump sum		
8	Supply of mixing water storage tank(s)	-	lump sum		
9	Cement pumping unit on site for duration of job				
	(a) monthly rental	6	months		
	(b) set up charges for six jobs	-	lump sum		
10	Backup cement pumping unit on site during casing, cementing jobs (required for 13 3/8" and 9 5/8" jobs, only)	-	lump sum (for 4 jobs)		

4.08 COMPLETION TIME

If, in the opinion of the Authority's representative the Contractor fails to advance the Work at a rate which will enable the Contractor to meet a completion time agreed to by the Contractor and the Authority prior to the start of work, the Authority's representative may instruct the Contractor to take such action as he considers necessary to sufficiently accelerate the Work; and in particular, with respect to the labour force or plant assigned by the Contractor to the Work, may instruct the Contractor to increase either or both. The Contractor shall forthwith comply with any such instruction.

4.09 SUBCONTRACTS

1. The Contractor shall notify the Authority in writing of the terms of all subcontracts, if any, and the names of subcontractors proposed for the principal parts of the Work and shall not employ any to whom the Authority may reasonably object.
2. The Contractor shall be as fully responsible for the acts and omissions of his subcontractors and their employees as if such subcontractors and their employees were persons directly employed by the Contractor.
3. Subcontractors may be required to provide proof, satisfactory to the Authority, as to their financial capability. The Contractor shall provide the necessary information upon request from the Authority.

4.10 CO-OPERATION

The Contractor shall have no right to the exclusive occupation of the Site of the Work. The Contractor shall co-operate harmoniously with Authority personnel and with other Contractors working at the site. All instructions given by the Authority's representative or his delegate shall be carefully and promptly executed.

4.11 WAGES AND WORKING CONDITIONS

The Wage (Public Construction) Act applies to this Contract and to every subcontract and to any work done by any other person under this Contract.

*

4.12 ASSIGNING THE CONTRACT

Neither party to this Contract shall assign the Contract or any interest therein without the written consent of the other party.

CONTRACT NO. Q1-1142

PART 5 - DETAIL SPECIFICATIONS

CONTENTS

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CONTRACT NO. Q1-1142

PART 5 - DETAIL SPECIFICATIONS

5.01 GENERAL

The Meager Creek geothermal project area is located 160 km north-northwest of Vancouver and approximately 60 km northwest of Pemberton, B.C. (see Maps Nos. 1 and 2). Access to the project is via Highway 99 from Vancouver to Pemberton continuing on good gravel surface forestry development and private logging roads to the site.

The drilling program would be for two geothermal production wells to be located on the southern side of the volcanic complex (see Map 2). A schematic cross section which would apply to both wells is shown in Fig. 1. It is expected that static temperatures of about 200°C would be encountered at a depth of 300 m (1000 feet), increasing to 300 to 350°C in the production zone. The production zone may be encountered at depths considerably less than 1585 m (5200 feet) to 2285 m (7500 feet) range shown, but cementing quantities are based on the anticipated maximum depth.

Drilling on the first well would likely start in mid June or early July. An approximate time of 3 1/2 months has been estimated for completion of each well.

5.02 SCOPE OF WORK

The Work would be for two wells and shall include the supply of all labour, plant and materials and the performance of all things required in connection with the cementing, the setting of casings, plus setting other cement plugs as required. The following principal items of work are included:

1. Cementing Program (Cement quantities shown are for one well.)

a. 20-inch conductor pipe

Cemented to surface with Portland cement

Volume: (100% excess)
26" x 20" - 100' = 150 CF

260 sacks Class G neat cement with 100% excess

b. 13 3/8-inch Surface Casing

Cemented through shoe with inner string cementing method

Volume: 17 1/2" x 13 3/8" - 1000' = 695 CF
(25% excess)

399 sacks of 1:1 API class G to Perlite + 3% gel + 40% Silica flour + 0.5% cement dispersent mixed with 1.42 CF of water per sack. *

Tail end with 100 sacks of class G neat pre-mixed with 35% Silica flour and 0.5% cement dispersent with 0.87 CF of water per sack. *

Note: Liquid retarder should be available in the event bottom hole temperatures from the logs indicate the need for retarder.

c. 9 5/8-inch Production Casing

Cemented conventionally from bottom to surface

Volume: 9 5/8" x 13 3/8" Casing - 1000' - 363 CF
9 5/8" x 12 1/4" Hole - 4200' - 1315 CF
2 Jts between shoe and float collar (80') - 34 CF

Total Volume 1712 CF

(15% excess)

720 sacks of 1:1 API class G to Perlite + 3% gel + 40% Silica flour + 0.5% cement dispersent mixed with 1.42 CF of water per sack. Tail end with 100 sacks of class G neat pre-mixed with 35% Silica flour and 0.5% cement dispersent with 0.87 CF of water per sack. *

Note: Liquid retarder should be available to use in the mixing water. The amount of retarder will be determined after the bottom hole temperatures are found from the logs.

2. Slurry Properties

	<u>Weight</u>	<u>Yield</u>	<u>Water</u>	<u>Strength</u>
Perlite	12.7 PPG	2.22 CF/SX	1.42 CF/SX	405 PSI (8 hr)
Tail Slurry	15.6 PPG	1.50 CF/SX	0.87 CF/SX	1300 PSI (8 hr)

3. Properties of Casing

	<u>Burst (PSI)</u>	<u>Tension (KIPS)</u>	<u>Collapse (PSI)</u>	
13 3/8" - (54.5-K)	2730	1038	1130	
9 5/8" - (40.0 PPF-K)	3950	843	2570	*
7" - (26 PPF-K)	7240	667	5410	

All safety factors are better than: 1.68 Joint Tension, 1.25 Body Tension, 1.25 Burst, 1.15 Collapse.

4. Tubular Goods Required (To be supplied by Drilling Contractor.) *

Casing: 100' - 20" conductor
1000' - 13 3/8" - 54.4 lb/ft, K-55, Buttress
5200' - 9 5/8" - 40.0 lb/ft, K-55, Buttress
2500' - 7" - 26 lb/ft, K-55 Buttress (slotted 0.25" 16 row) *

5. Casing Equipment Required

13 3/8": Float shoe (stab-in), wash down type
Five 13 3/8" centralizers

9 5/8": 9 5/8" differential fill-up float collar for 9 5/8"
40 lb/ft

9 5/8" guide shoe-wash down type with side ports

Thirty 9 5/8" centralizers *

5.03 COMPLETION TIME

The Contractor shall perform all work as dictated by the drilling program and in a manner so as not to interfere with drilling progress.

5.04 FOOD, LODGING AND TRANSPORTATION

The Contractor shall be responsible for supplying daily transportation between the drill site and the Contractor's personnel place of lodging.

Food and lodging will be provided by the Contractor. It should be noted that the drilling contractor will have a camp at the drill site and it is possible that an arrangement could be made to house cementing contractor's personnel.

5.05 CEMENTING EQUIPMENT

Subject to the approval of the Authority the Contractor may use cementing equipment and materials of his own preference in the work, except for

those items which are specifically required in these detailed specifications. Items of equipment or materials which, in the opinion of the Authority do not meet the specified requirements shall be replaced by the Contractor with equipment and materials meeting the specified requirements.

The Contractor shall supply one cementing unit on site at all times and shall supplement with an additional unit during casing cementing jobs.

Fuel for the operation of all the Contractor's on-site equipment will be supplied by the Authority.

*
*

5.06 EQUIPMENT DESCRIPTION

The type of pumping and mixing equipment and operating characteristics shall be described in an appendix to the Form of Tender.

5.07 BULK STORAGE

The Contractor shall supply sufficient bin storage including installation and removal - pneumatic or gravity to store the cement needed for the largest cementing job (3000 ft³).

5.08 SUPPORT EQUIPMENT

The Contractor shall supply all subsidiary equipment required to perform the casing cementing jobs presented in Section 5.02 above. This equipment shall include but is not limited to:

*

1. Top and bottom wiper plugs.
2. Plug dropping head.
3. Casing swage.
4. Any required crossover equipment from operator's equipment to contractor's equipment.

*

5.09 CEMENT RETARDER

Cement shall be pre-mixed as required except for retarder. Liquid retarders shall be pre-mixed in the mixing water prior to the cementing jobs. Sufficient retarder for these jobs shall be on-site ready for use at all times.

5.10 OPERATING PERSONNEL

Contractor shall supply operating personnel within 24 hours upon notification by the Authority.

5.11 WATER STORAGE

Contractor shall supply tanks for pre-mixing of mixing water for cement jobs. *

5.12 TESTING

Contractor shall perform pumpability tests under downhole conditions and any other standard or specified by the Authority.

5.13 CEMENTING AND MATERIALS

1. Cement Materials shall be supplied to accomplish the cementing program presented in Section 5.02. In addition, 45 000 kg of class G neat cement shall be on site at all times for control of possible lost circulation problems. *
2. The Contractor shall provide:
 - a. 13 3/8-inch stab-in, washdown cementing shoe and stab-in sub along with pump-in head for operator's drill pipe, and drill pipe wiper plug (latch-in type).
 - b. 9 5/8-inch conventional float shoe and float collar.
 - c. Epoxy Thread-Lok compound sufficient to thread-lok two 13 3/8-inch Buttress collars and three 9 5/8-inch Buttress collars.
 - d. Centralizers as specified in Section 5.02. *
3. Supplying water required for the cementing program will be the responsibility of the Authority. The Authority will also supply water analysis required by the Contractor for mix design.

5.14 RECORD KEEPING

Contractor shall provide test results as requested by the Authority. In addition, the Contractor shall provide the Authority with all calculation results (volumes, times, rates, etc.) and pressure charts for all cementing jobs.

5.15 EMERGENCY WORK

At the request of the Authority, the Contractor shall perform cementing operations required as a result of unforeseen conditions in the wells. Payment for such work will be made from the Provisional Sum entered as Item 15 on Schedule I on terms mutually agreed to between the Contractor and the Authority.

5.16 GENERAL BASIS OF PAYMENT

Except as otherwise specifically provided, the prices entered in the Schedule (see Part 3 - Form of Tender) for payment for the various items of work and materials, as described in these Detail Specifications, shall constitute full compensation for supplying and maintaining all equipment, material, accommodation, labour, supervision and all other work for performing all parts of the cementing program to be carried out by the Contractor in accordance with the provisions of the Contract. The unit prices entered in the Tender Form shall also apply to any additional work required by the Authority.

The Contractor shall submit daily to the Authority, on a form supplied by the Authority, a signed record of the work completed and the number of hours worked during each shift of the previous working day. When signed by the Authority, this record shall constitute the sole basis of compensation for work covered by these Detail Specifications.

Time associated with breakdown of Contractor's equipment, or unreasonable delays will not be paid for.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

DRILLING FLUID PROGRAM

CONTRACT NO. Q1-1143

TENDER DOCUMENTS

Contents

Advertisement for Tenders; Instructions to Tenderers;
Form of Tender; General Conditions; Detail Specifications

April 1981

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

DRILLING FLUID PROGRAM

CONTRACT NO. Q1-1143

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- PART 2 - INSTRUCTIONS TO TENDERERS
- PART 3 - FORM OF TENDER
- PART 4 - GENERAL CONDITIONS
- PART 5 - DETAIL SPECIFICATIONS

CONTRACT NO. Q1-1143

PART 1 - ADVERTISEMENT FOR TENDERS

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

DRILLING FLUID PROGRAM

CONTRACT NO. Q1-1143

PART 1 - ADVERTISEMENT FOR TENDERS

Tenders are invited for the supply of labour, equipment and materials for drilling fluid services required in the drilling of a deep geothermal exploration well in the Meager Creek geothermal area. Meager Creek is located approximately 160 km north of Vancouver, British Columbia.

The Tender Documents for Q1-1143 may be obtained free of charge in the amount of two copies per request, from the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3 (Telephone (604) 663-2577 or Telex 04-54395).

Tenders will be considered only from Tenderers whose financial resources, technical ability and experience are commensurate with the work to be performed. The lowest or any tender may not necessarily be accepted and the Authority will not be responsible for any costs incurred by any Tenderer in preparing his Tender.

Tenders will be received until 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 6 May 1981 at Room 1026, Office of the Purchasing Agent at the above address. The tenders will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day.

When requesting information or documents pertaining to this tender, please quote Contract No. Q1-1143.

CONTRACT NO. Q1-1143

PART 2 - INSTRUCTIONS TO TENDERERS

CONTRACT NO. Q1-1143

PART 2 - INSTRUCTIONS TO TENDERERS

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CONTRACT NO. Q1-1143

PART 2 - INSTRUCTIONS TO TENDERERS

2.01 SUBMISSION OF TENDERS

Tenders shall be submitted in triplicate on the separate copies of the Form of Tender provided with the Tender Documents and shall be enclosed in a sealed envelope addressed to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3, and marked:

"Q1-1143 - Tender for the supply of labour, equipment and materials for drilling fluid services required for the Meager Creek geothermal area deep exploratory well"

and with the name of the Tenderer clearly shown. Tenders shall be delivered to Room 1026 at the above address not later than 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 6 May 1981 hereinafter called the "closing time", and will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day.

Tenders which are delivered after the closing time will not be considered.

2.02 ACCEPTANCE AND REJECTION OF TENDERS

The Authority reserves the right to reject any or all tenders and to accept any tender it considers advantageous.

Tenders may not be withdrawn for a period of 30 calendar days after the closing time.

Tenders which are incomplete, conditional or obscure, or which in any way fail to conform strictly to the requirements of these Tender Documents or which contain alterations, erasures or irregularities of any kind may be rejected as informal.

Notice to the Contractor of the acceptance of his tender shall constitute the award of the Contract.

2.03 TENDERER'S RESPONSIBILITY

It shall be the Tenderer's responsibility to inform himself of all aspects of the Work and no claim will be considered at any time for

reimbursement for any expenses incurred as a result of any misunderstanding in regard to the conditions of the work. Should any details necessary for a clear and comprehensive understanding be omitted or any error appear in the Tender Documents or should the Tenderer note facts or conditions which in any way conflict with the letter or spirit of the Tender Documents, it shall be the responsibility of the Tenderer to obtain clarifications. Queries shall be made in writing to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 and shall be submitted not later than 15 days before the closing time, and will be answered by a Question and Answer Series which will be issued to all parties registered as having received a copy of the Tender Documents. Immediately upon receiving any Question and Answer series each Tenderer shall acknowledge receipt thereof in writing, in duplicate, to the Purchasing Agent.

Neither the Authority nor the Authority's Representative shall be responsible for any instructions or information given to any Tenderer otherwise than by the Purchasing Agent, in accordance with this Clause.

2.04 ADDENDA

Any changes to the Tender Documents will be issued as written Addenda to all parties registered as having received a copy of the Tender Documents and shall become part of the Tender Documents. If such Addenda are issued each Tenderer shall acknowledge, that he has received them and that his tender has been prepared in accordance therewith.

Immediately upon receiving any Addenda each Tenderer shall acknowledge receipt thereof in writing, in duplicate to the Purchasing Agent.

2.05 PRICING REQUIREMENTS

All prices tendered shall be firm, except as provided in the General Conditions or Detail Specifications, shall be in Canadian dollars and shall include all freight, customs and excise duties and all applicable taxes and shall be all inclusive as provided in the Tender Documents.

The Tenderer shall make his own assessment of wage rates and working conditions to prevail during the period of the Work and prepare his Tender accordingly. No claim for adjustment will be entertained by the Authority.

Prices shall not be subject to adjustment for fluctuation in foreign exchange.

2.06 SIGNATURES AND SEALS

All tenders shall be executed under seal and if the Tenderer is a corporation, the affixing of its corporate seal shall be duly attested by the signature of its authorized signing officers.

2.07 DATA TO BE SUBMITTED WITH TENDER

The information and data hereinafter described shall be submitted with the Tender to demonstrate the Tenderer's ability to comply with the requirements of the Tender Documents. Such submissions shall be in the form of Appendices (in triplicate) clearly marked and referenced.

(a) Technical Data

Each Tenderer shall submit the following technical data with his Tender:

Details, which are not otherwise covered in the Tender Documents, of the equipment the Tender proposes to supply.

(b) Tenderer's Qualifications

Each Tenderer shall submit sufficient information, as Appendix A, with his Tender to show that he has the staff, ability, experience, capital and plant to perform the Work. This shall include a brief description of the equipment the Tenderer proposes to use for this Contract listing its size, rating, year of manufacture and whether it is owned or rented. Details of previous geothermal experience should be included in Appendix A.

Foreign Tenderers shall indicate whether or not they will be represented in British Columbia by competent technical personnel with a good command of the English language.

(c) Financial Information

One (1) only, audited copy of the latest balance sheet, to accompany the original of the Tender, noting any material change that may have occurred since its preparation or effective date. If a copy has been submitted in support of a recent tender, and there has been no material change in the balance sheet, a copy is not required but a note to this effect is required. Other financial information necessary to adequately establish the Tenderer's financial capability may be required, and shall be made available if asked for.

(d) Work Force

Tenderers are referred to the "Reservations Clause" agreed to in the 1980-82 B.C. Building Trades - C.L.R.A. settlement and to Section 40 of the Labour Code of B.C. Each tenderer shall list all union certifications and employer bargaining affiliations, if any, applicable to the Work, including those for each subcontractor.

2.08 BASIC TENDER AND ALTERNATIVES

(a) Basic Tender

Each Tenderer shall submit a basic tender which conforms strictly to the requirements of the Tender Documents.

(b) Alternatives

In addition to the basic tender, Tenderers are free to offer any alternatives to the basic tender which the Tenderer considers to be superior or substantially less costly. Each alternative shall be submitted in duplicate in an appendix to the basic tender. This appendix shall include a description of each alternative in detail equivalent to that required for the basic tender and shall clearly indicate all the advantages and the cost variation for each alternative. The Contract Price for each alternative shall be broken down in the same way as the basic tender.

2.09 PREFERENCE TO BRITISH COLUMBIA AND CANADIAN PRODUCTS

Tenderers are hereby advised that it is a policy of the Authority that where in the sole discretion of the Authority it believes circumstances so warrant, a preference up to 10 percent will be given to tenders which offer products of British Columbia manufacture, or where such manufacture is not possible, a preference of up to 5 percent will be given to products of Canadian manufacture. Tenderers are invited to disclose the British Columbia and Canadian content of their tenders in appendices to be marked B and C respectively to the Form of Tender.

2.10 PERIOD OF THE WORK

The period of the work shall be from the date of award of this contract up to 30 November 1981 or for such further period of time as may be agreed with the Authority.

2.11 ARRANGEMENTS FOR TENDERERS' VISITS TO THE SITE

At least 2 days prior to visiting the Site, each Tenderer shall inform the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 (Telephone (604) 663-2558), of the expected timing and duration of his visit and the number of persons in his party.

Upon arrival at the Site, each Tenderer shall report to the Authority's exploration camp office (see location maps in Part 5). Tenderers must provide their own accommodation and transportation when visiting the Site.

A prospective Tenderer by visiting the Site shall be deemed to have assumed all risk of loss, damage or injury (including death) to the persons and property of himself, his servants and agents, from any cause whatsoever during such visit and shall be deemed to have undertaken to indemnify the Authority, the Authority's Representative, their employees, agents and contractors, from and against all loss, costs, damages, suits, actions and demands whatsoever and any liability therefor to any person arising out of any such visit.

CONTRACT NO. Q1-1143

PART 3 - FORM OF TENDER

- 3.02 Having examined the Tender Documents, the Tenderer hereby offers to perform the whole of the Work provided for in the Tender Documents and to comply with all other requirements of the Tender Documents for the Contract Price of _____ (\$ _____) for Schedule 1 or such other sum as may be ascertained in accordance with the conditions and provisions set forth in the Contract Documents.

The attached Schedule(s) of Quantities and Prices forms part of this tender, and if there is any conflict between the Contract Price entered above and the correct summation of the lump sum prices; provisional sums, if any; and correct extensions of the unit prices and approximate quantities entered in the aforesaid Schedule(s), the said summation shall take precedence.

If the Tenderer does not enter a price for any payment item in his tender, that payment item shall be deemed to be covered by such prices as the Tenderer did enter in his tender.

The quantities in the Schedule(s) are estimates of what the actual quantities of work may be and will be used to compare tenders on a uniform basis. The quantities shown are not a representation or warranty by the Authority, expressly or by implication, of what will be the actual quantities required in the work. Accordingly, the Authority will not consider any claims for adjustments to unit prices resulting from a variance between the actual quantities and those listed in the Schedule(s) and shall not be liable if those listed are not even approximately correct.

- 3.03 The following Question and Answer Series and Addenda to the Tender Documents have been received by the Tenderer, and this tender has been prepared in accordance therewith:

<u>Question and Answer Series</u>	<u>Date Received</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

SCHEDULE I

MEAGER CREEK GEOTHERMAL WELL; DRILLING FLUID PROGRAM

SCHEDULE OF QUANTITIES AND PRICES

<u>Item</u>	<u>Description</u>	<u>Approximate Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>
1	Bentonite	1000	50 lb sack		
2	Sepiolite	500	50 lb sack		
3	Lignite	300	50 lb sack		
4	Polyacrylamide	200	50 lb sack		
5	Caustic Soda	700	1 lb		
6	Soda ash	10	50 lb sack		
7	Bicarbonate of soda	20	50 lb sack		
8	Lime	50	50 lb sack		
CONTINGENCY PRODUCTS					
1	Barite S.G. 4.23	2500	100 lb		
2	Sawdust	400	sacks		
3	Mica	200	50 lb		
4	Walnut fine	400	50 lb		
CORROSION PRODUCTS					
1	Oxygen scavenger	15	drums		
2	H ₂ S scavenger	250	50 lb sack		
3	High temp filming agent	150	gal		

All prices to include supervision, all required testing and testing equipment, transportation to Vancouver and site storage. The Authority will pay for transportation from Vancouver to site.

3.10 IN WITNESS whereof the Tenderer has caused its seal to be affixed
at the day of 19

The seal of the Tenderer was here-)
unto affixed in the presence of:)
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CONTRACT NO. Q1-1143

PART 4 - GENERAL CONDITIONS

CONTRACT NO. Q1-1143

PART 4 - GENERAL CONDITIONS

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CONTRACT NO. Q1-1143

PART 4 - GENERAL CONDITIONS

4.01 DEFINITIONS AND MEANINGS OF TERMS

The following words and terms wherever used in the Tender Documents shall have the meanings herein assigned to them and the following rules of construction shall apply:

1. "Authority" shall mean the British Columbia Hydro and Power Authority, a body corporate, with head office at 970 Burrard Street, Vancouver, British Columbia, its successors and assigns.
2. "Authority's Representative" shall mean the Project Manager, Meager Creek Project or his delegate, who shall be authorized to supervise the technical direction of the Work.
3. "Contract Documents" shall mean the Tender Documents and the tender of the Contractor as accepted by the Authority, together with the purchase order issued by the Authority.
4. "Contractor" shall mean the Tenderer whose tender has been accepted.
5. "Day" shall mean a calendar day.
6. "Tenderer" shall mean any party or parties tendering for the Work, or the successful Tenderer who later becomes the Contractor for such Work.
7. "Site" shall mean the lands and other places on, under, in, or through which the Work is to be carried out.
8. "Tender Documents" shall mean the Advertisement for Tenders; Instructions to Tenderers; Form of Tender; General Conditions; Detail Specifications; Addenda; and Question and Answer Series, if any.
9. "Work" shall mean everything to be done by the Contractor under the Contract whether temporary or permanent, including equipment and material to be supplied by the Contractor.

4.02 ASSESSMENT OF CONDITIONS

The Contractor shall be deemed to have informed himself fully as to the risks and contingencies and all other data, matters and things, local

or otherwise, requisite to the fulfillment of the Contract. Failure to acquaint himself fully with all available information concerning conditions affecting or which may be encountered in performing the Work will not relieve the Contractor of the responsibility for estimating the difficulties and costs of satisfactorily performing the Work, or for actually performing the Work in conformity with the Contract.

4.03 COMPLIANCE WITH LAWS

The Contractor and his employees in carrying out the Contract shall comply with all laws, statutes, by-laws, ordinances and regulations of all Federal, Provincial, Municipal or other governmental authorities, any of which are applicable to the Contract or the performance of the Work, and the Contractor shall indemnify the Authority against any cost, loss, liability or obligation which may arise as a consequence of the failure of the Contractor and/or his employees to comply fully with the said laws and regulations.

Without restricting the foregoing, the Contractor shall conform to the provisions of the "Workers' Compensation Act" and all other statutes, by-laws, or regulations in force from time to time in respect of or affecting in any manner performance of the Contract, the Work or the Site, and shall give all notices required by the said statutes, by-laws or regulations and pay all fees, assessments and other sums payable thereunder or in respect thereof.

Except as otherwise specified in writing by the Authority or in the Tender Documents, the Contractor shall be responsible for obtaining at his own expense, all necessary authorizations, licenses and permits in connection with or required for the Work as are prescribed by such governmental authorities, notwithstanding that the Authority is an agency of the Crown.

4.04 INSURANCE

(a) Comprehensive General Liability Insurance

The Contractor shall, at his own expense, provide a Comprehensive General Liability Insurance Policy, to the satisfaction of the Authority's Insurance Manager, in an amount not less than \$1 000 000.00, all inclusive together with a standard Non-owned Automobile Liability and Statutory Conditions Endorsement. This insurance shall be maintained during the continuance of the Contract. It shall insure both the Contractor and the Authority, and the policy shall contain a "cross-liability" clause.

(b) Automobile Public Liability and Property Damage Insurance

The Contractor shall, at his own expense, obtain and maintain during the continuance of this Contract, Automobile Public Liability

and Property Damage insurance covering the ownership, use or operation or any motor vehicle or trailer licensed for use on public highways and that is owned, leased or controlled by the Contractor, in an amount not less than \$1 000 000.00 all inclusive.

(c) Insurance Manager

All policies of insurance shall be to the satisfaction of the Insurance Manager of the Authority and a certified copy of such policies shall be presented to the said Insurance Manager prior to the commencement of any work in connection with this Contract.

4.05 CLEAN-UP

The Contractor shall at all times during the carrying out of the Work keep the site neat and free from any of his waste materials including lunch bags, cans and rubbish. Should the Contractor fail to do so, the Authority's representative may arrange to have the site cleaned up by others and the costs thereof shall be recovered as monies due to the Authority.

4.06 ENVIRONMENTAL PRECAUTIONS

The Contractor shall conduct his operations so that pollution of the environment and the destruction of trees, crops and damage to the landscape is kept to a minimum.

Roads, ditches and watercourses, if disturbed by the Contractor's operations, shall be restored prior to leaving the Site.

Survey markings shall not be disturbed.

The Contractor shall have available at the Site sufficient fire fighting equipment adequate to handle an outbreak of fire brought about by his operations.

The cost of any repairs or damages resulting from non-compliance with the provisions of this Clause shall be paid by the Contractor.

4.07 EARLY TERMINATION

The Authority reserves the right to terminate the Work on the Site upon providing at any time reasonable advance notice to the Contractor. In the event of such termination, the Authority's sole obligation to the Contractor shall be limited to the payment for Contractor services performed to that time and payment for other items mutually agreed to in the Contract.

4.08 COMPLETION TIME

If, in the opinion of the Authority's representative the Contractor fails to advance the Work at a rate which will enable the Contractor to meet a completion time agreed to by the Contractor and the Authority prior to the start of work, the Authority's representative may instruct the Contractor to take such action as he considers necessary to sufficiently accelerate the Work; and in particular, with respect to the labour force or plant assigned by the Contractor to the Work, may instruct the Contractor to increase either or both. The Contractor shall forthwith comply with any such instruction.

4.09 SUBCONTRACTS

1. The Contractor shall notify the Authority in writing of the terms of all subcontracts, if any, and the names of subcontractors proposed for the principal parts of the Work and shall not employ any to whom the Authority may reasonably object.
2. The Contractor shall be as fully responsible for the acts and omissions of his subcontractors and their employees as if such subcontractors and their employees were persons directly employed by the Contractor.
3. Subcontractors may be required to provide proof, satisfactory to the Authority, as to their financial capability. The Contractor shall provide the necessary information upon request from the Authority.

4.10 CO-OPERATION

The Contractor shall have no right to the exclusive occupation of the Site of the Work. The Contractor shall co-operate harmoniously with Authority personnel and with other Contractors working at the site. All instructions given by the Authority's representative or his delegate shall be carefully and promptly executed.

4.11 WAGES AND WORKING CONDITIONS

The Public Construction Fair Wages Act applies to this Contract and to every subcontract and to any work done by any other person under this Contract.

4.12 Assigning the Contract

Neither party to this Contract shall assign the Contract or any interest therein without the written consent of the other party.

4.13 AUDIT

The Contractor shall permit representatives of the Authority at all reasonable times, to inspect and audit all records, accounts, statements and other documents of the Contractor relating to the Work and shall keep such records, accounts, statements and documents for at least 1 year after completion of the Work or for such extended period as the Authority may have requested, in advance and in writing, of the Contractor. The liability of the Authority to make any payment other than the sums provided or calculated in accordance with the actual quantities of payment items and prices set out in the Form of Tender, shall be subject to the right of the Authority to inspection and audit as above provided.

4.14 PAYMENT GENERAL

(a) Terms of Payment

Invoices shall be rendered in the first 7 days of each month in respect of all amounts earned by the Contractor during the previous month, and except as provided below such invoices shall be payable in full within 30 days of the receipt of such invoices, provided that if the Authority is unable to verify such invoices within the said period any payment made shall be treated as an advance pending verification of the invoices.

Any necessary adjustments, which have not been made prior to the final invoice for work done shall be made at the time of final payment. If the Authority is shown to have overpaid the Contractor, the Contractor agrees that the Authority may deduct the amount from any other sums due to the Contractor from the Authority or that it will pay the amount to the Authority within 30 days of the amount being agreed or otherwise established.

(b) Submitting of Invoices

All invoices shall be directed to B.C. Hydro and Power Authority, 555 West Hastings Street, Vancouver, B.C., Canada, V6B 4T6, attention System Engineering Division, Meager Creek Geothermal Project. They shall be clearly identified by Purchase Order number and name of project.

CONTRACT NO. Q1-1143

PART 5 - DETAIL SPECIFICATIONS

CONTRACT NO. Q1-1143

PART 5 - DETAIL SPECIFICATIONS

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PART 5 - DETAILED SPECIFICATIONS

5.01 LOCATION AND ACCESS

The Meager Creek Project area is located 160 kilometres northwest of Vancouver and approximately 60 kilometres northwest of Pemberton, B.C. (see Maps 1 and 2). Access to the project is via Highway 99 from Vancouver to Pemberton continuing on good gravel surface forestry development and private logging roads to the Site.

5.02 SCOPE OF WORK

The Work shall include the supply of all labour, plant and materials and the performance of all things required in connection with the drilling fluid program as described below:

Drilling Fluid Program:

From surface to 1000 feet use lightweight, low solids fresh water clay base mud treated with lignite, caustic and bicarbonate of soda for cement contamination, and bit lube as required.

From 1000 feet to 7500 feet use lightweight, lignosulfonate thinned sepiolite mud with caustic soda.

Below 5200 feet one 1-liter sample of drilling fluid and one 1-liter sample of make-up water are to be taken every 12 hours while drilling or circulating.

Notes:

Fresh water may be used without gel. Slugs of gelled water should be used occasionally to clean the hole. This should be determined by the drilling conditions.

Zones of lost circulation and temperatures in excess of 200°C are anticipated.

A cooling tower will be installed by the Authority in the mud system and the mud pumped through the cooling tower when the mud return temperature exceeds 160°F (71°C).

Fluid density should be kept to a minimum unless drilling conditions require the density to be increased.

Because of the remoteness of the location, 2500 sacks of barite should be on site in the event abnormally high subsurface pressures are encountered.

5.03 COMPLETION TIME

The Contractor shall perform all work as dictated by the drilling program and in a manner so as not to interfere with drilling progress.

5.04 FOOD, LODGING AND TRANSPORTATION

The Contractor shall be responsible for transportation between the drill site and the Contractor's personnel's place of lodging.

Food and lodging will be provided by the Contractor. It should be noted that the drilling contractor will have a camp at the drill site and it is possible that an arrangement might be made to house drilling fluid contractor's personnel.

5.05 DRILLING FLUID EQUIPMENT

Subject to the approval of the Authority, the Contractor may use equipment and materials of his own preference in the work, except for those items which are specifically required in the Detailed Specifications. Items of equipment or materials which, in the opinion of the Authority do not meet specified requirements shall be replaced by the Contractor with equipment and materials meeting the specified requirements.

5.06 EQUIPMENT DESCRIPTION

Details on all equipment to be supplied by the Contractor will be included with the bid.

5.07 STORAGE

The Contractor shall supply sufficient dry storage for all materials included in the drilling fluid program.

5.08 SUPPORT EQUIPMENT

The Contractor shall supply all subsidiary equipment required to maintain properties of the mud as specified in this document. This equipment shall include but is not limited to:

1. A sufficient number of air packs for Contractor's onsite personnel.

2. Fluid testing equipment.

5.09 OPERATING PERSONNEL

The Contractor shall supply operating personnel for 24-hour supervision of the drilling fluid program when required by the Authority.

5.10 TESTING

The Contractor shall perform all drilling fluid tests either standard or specified by the Authority.

5.11 DRILLING FLUID MATERIALS

Drilling fluid materials shall be supplied to accomplish the drilling fluid program presented in Section 5.02. These materials and quantities are laid out in Schedule 1 of Part 3 of this document. The Contractor should supply with his bid details on materials to be used and certification that all materials meet API specifications.

5.12 RECORD KEEPING

The Contractor shall provide test results in a mud report twice daily or as requested by the Authority.

5.13 BASIS OF PAYMENT

(a) General

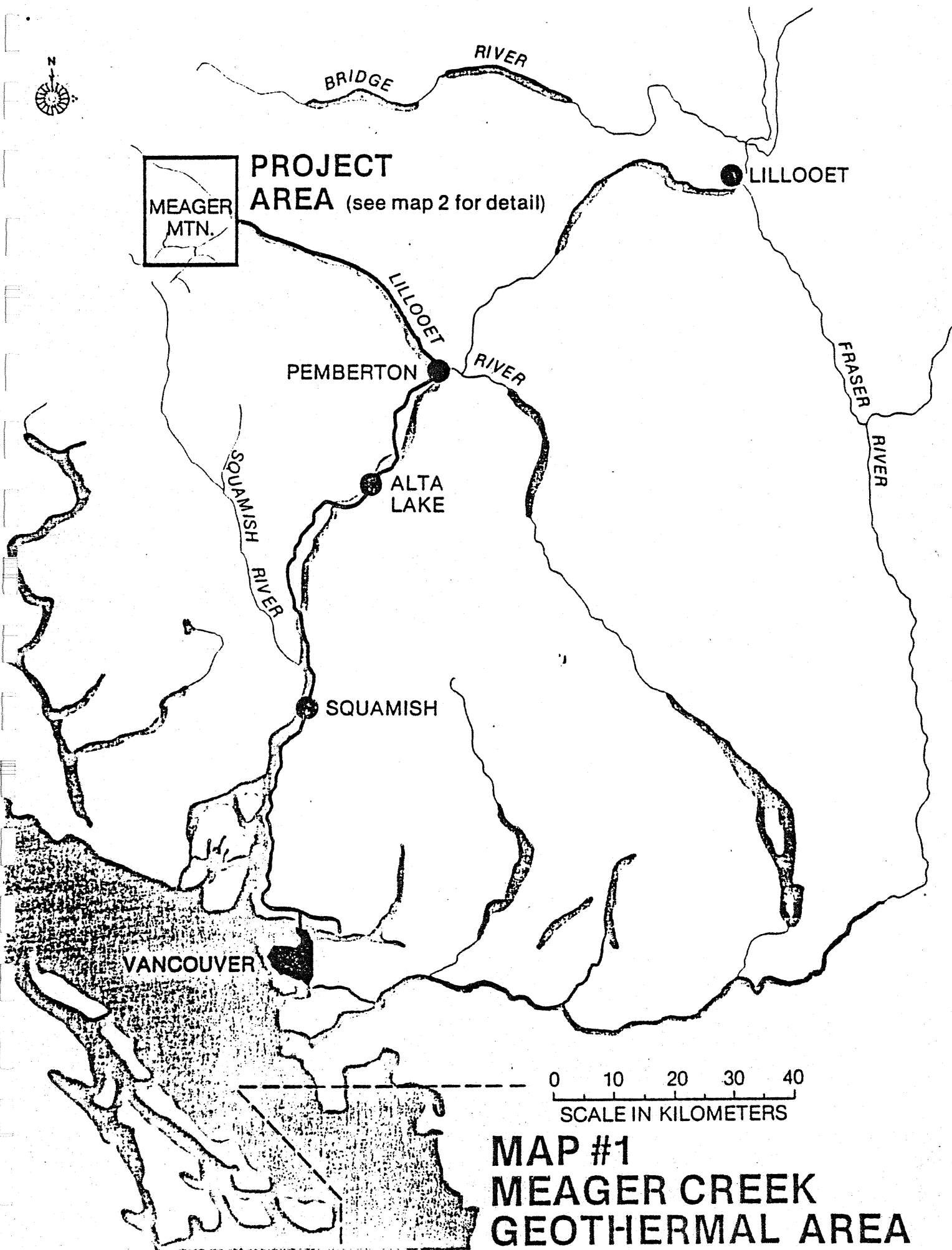
Except as otherwise specifically provided, the prices in the Schedule for payment for the various items of work and materials as described in these detailed specifications shall constitute full compensation for supplying and maintaining all equipment, material, accommodation, labour and supervision and all other work for performing all parts of the drilling fluid program to be carried out by the Contractor in accordance with the provisions of the Contract. The unit prices entered in the tender form shall also apply to any additional work required by the Authority.

(b) Transportation

Transportation of all materials and equipment to Vancouver shall be the responsibility of the Contractor. Transportation of materials and equipment from Vancouver to site shall be paid for by the Authority.

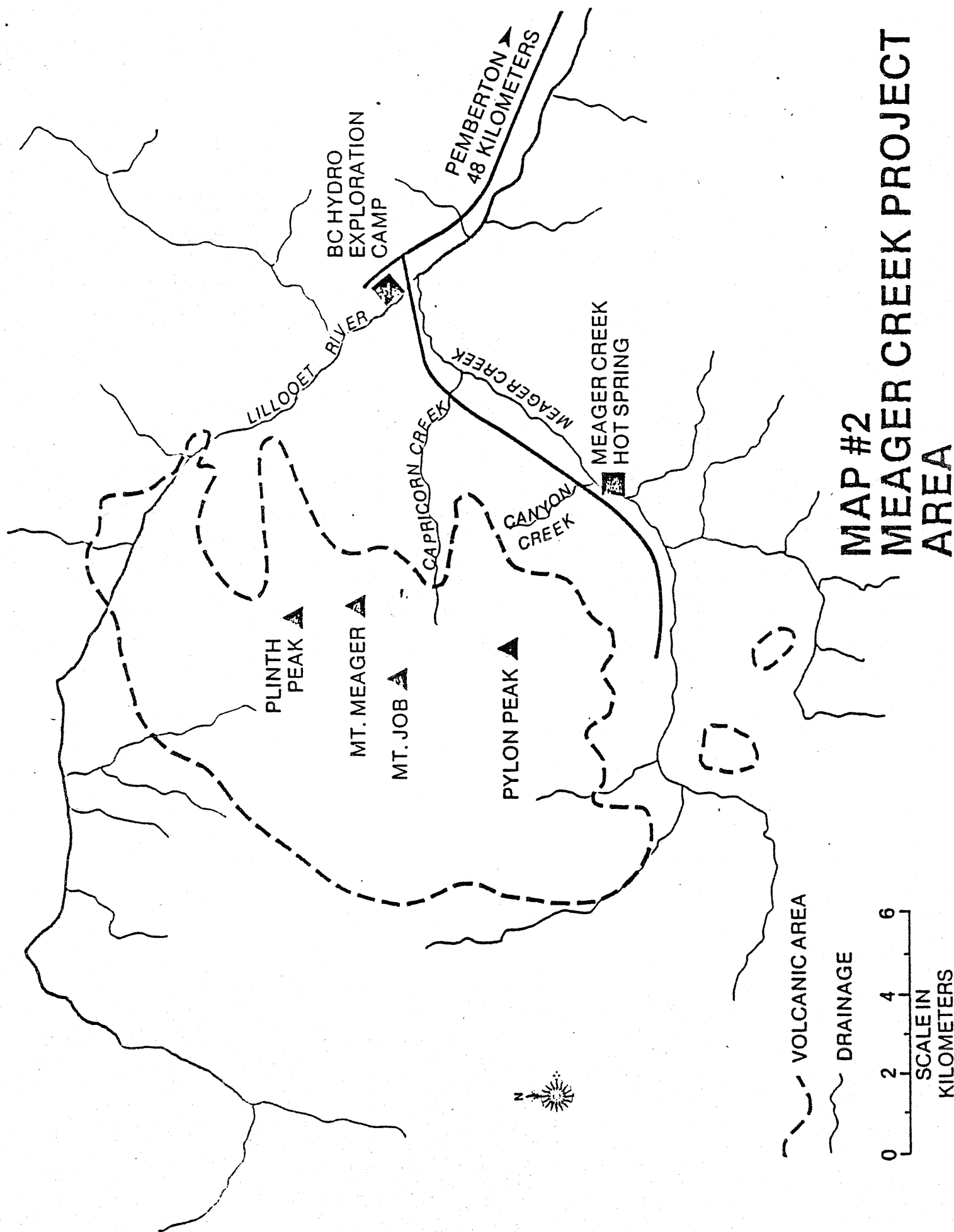


**PROJECT
AREA** (see map 2 for detail)



**MAP #1
MEAGER CREEK
GEOTHERMAL AREA**

MAP #2 MEAGER CREEK PROJECT AREA



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

DRILLING FLUID PROGRAM

CONTRACT NO. Q1-1143

ADDENDUM NO. 1

27 April 1981

The Tender Documents for the above work, the original issue of which is dated April 1981, are hereby amended as follows:

AMENDMENT TO PART 1

Delete page 1-1 and substitute the attached page marked Addendum No. 1.

AMENDMENTS TO PART 2

Delete pages 2-2 and 2-4 and substitute the attached pages marked Addendum No. 1.

AMENDMENTS TO PART 3

Delete pages 3-2, 3-5 and 3-6 and substitute the attached pages marked Addendum No. 1.

AMENDMENTS TO PART 5

Delete pages 5-i, 5-2 and 5-3 and substitute the attached pages marked Addendum No. 1.

Three additional copies of the revised Form of Tender are also enclosed.

NOTICE TO TENDERERS

Please acknowledge receipt of this Addendum in accordance with Clause 2.04 of the Tender Documents.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

DRILLING FLUID PROGRAM

CONTRACT NO. Q1-1143

PART 1 - ADVERTISEMENT FOR TENDERS

Tenders are invited for the supply of labour, equipment and materials for drilling fluid services required in the drilling of a deep geothermal exploration well in the Meager Creek geothermal area. Provision is made in the Tender Documents for the option of additional work on a second well. Meager Creek is located approximately 160 km north of Vancouver, British Columbia.

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The Tender Documents for Q1-1143 may be obtained free of charge in the amount of two copies per request, from the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3 (Telephone (604) 663-2577 or Telex 04-54395).

Tenders will be considered only from Tenderers whose financial resources, technical ability and experience are commensurate with the work to be performed. The lowest or any tender may not necessarily be accepted and the Authority will not be responsible for any costs incurred by any Tenderer in preparing his Tender.

Tenders will be received until 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 13 May 1981 at Room 1026, Office of the Purchasing Agent at the above address. The tenders will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day.

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When requesting information or documents pertaining to this tender, please quote Contract No. Q1-1143.

PART 2 - INSTRUCTIONS TO TENDERERS

2.01 SUBMISSION OF TENDERS

Tenders shall be submitted in triplicate on the separate copies of the Form of Tender provided with the Tender Documents and shall be enclosed in a sealed envelope addressed to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3, and marked:

"Q1-1143 - Tender for the supply of labour, equipment and materials for drilling fluid services required for the Meager Creek geothermal area deep exploratory well"

and with the name of the Tenderer clearly shown. Tenders shall be delivered to Room 1026 at the above address not later than 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 13 May 1981 hereinafter called the "closing time", and will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day.

Tenders which are delivered after the closing time will not be considered.

2.02 ACCEPTANCE AND REJECTION OF TENDERS

The Authority reserves the right to reject any or all tenders and to accept any tender it considers advantageous.

The Authority also reserves the right to exercise its option for Schedule II (option for second well) at any time prior to 30 November 1981. *

Tenders may not be withdrawn for a period of 30 calendar days after the closing time.

Tenders which are incomplete, conditional or obscure, or which in any way fail to conform strictly to the requirements of these Tender Documents or which contain alterations, erasures or irregularities of any kind may be rejected as informal.

Notice to the Contractor of the acceptance of his tender shall constitute the award of the Contract.

2.03 TENDERER'S RESPONSIBILITY

It shall be the Tenderer's responsibility to inform himself of all aspects of the Work and no claim will be considered at any time for

(b) Alternatives

In addition to the basic tender, Tenderers are free to offer any alternatives to the basic tender which the Tenderer considers to be superior or substantially less costly. Each alternative shall be submitted in duplicate in an appendix to the basic tender. This appendix shall include a description of each alternative in detail equivalent to that required for the basic tender and shall clearly indicate all the advantages and the cost variation for each alternative. The Contract Price for each alternative shall be broken down in the same way as the basic tender.

2.09 PREFERENCE TO BRITISH COLUMBIA AND CANADIAN PRODUCTS

Tenderers are hereby advised that it is a policy of the Authority that where in the sole discretion of the Authority it believes circumstances so warrant, a preference up to 10 percent will be given to tenders which offer products of British Columbia manufacture, or where such manufacture is not possible, a preference of up to 5 percent will be given to products of Canadian manufacture. Tenderers are invited to disclose the British Columbia and Canadian content of their tenders in appendices to be marked B and C respectively to the Form of Tender.

2.10 PERIOD OF THE WORK

The period of the work for Schedule I shall be from the date of award of this contract up to 30 November 1981 or for such further period of time as may be agreed with the Authority. If the option for Schedule II is exercised by the Authority, then the period of work would be extended up to 30 April 1982.

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2.11 ARRANGEMENTS FOR TENDERERS' VISITS TO THE SITE

At least 2 days prior to visiting the Site, each Tenderer shall inform the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 (Telephone (604) 663-2558), of the expected timing and duration of his visit and the number of persons in his party.

Upon arrival at the Site, each Tenderer shall report to the Authority's exploration camp office (see location maps in Part 5). Tenderers must provide their own accommodation and transportation when visiting the Site.

A prospective Tenderer by visiting the Site shall be deemed to have assumed all risk of loss, damage or injury (including death) to the persons and property of himself, his servants and agents, from any cause whatsoever during such visit and shall be deemed to have undertaken to indemnify the Authority, the Authority's Representative, their employees, agents and contractors, from and against all loss, costs, damages, suits, actions and demands whatsoever and any liability therefor to any person arising out of any such visit.

3.02 Having examined the Tender Documents, the Tenderer hereby offers to perform the whole of the Work provided for in the Tender Documents and to comply with all other requirements of the Tender Documents for the Contract Price of _____ (\$ _____) for Schedule I and _____ (\$ _____) for Schedule II or such other sum as may be ascertained in accordance with the conditions and provisions set forth in the Contract Documents.

*
*

The attached Schedule(s) of Quantities and Prices forms part of this tender, and if there is any conflict between the Contract Price entered above and the correct summation of the lump sum prices; provisional sums, if any; and correct extensions of the unit prices and approximate quantities entered in the aforesaid Schedule(s), the said summation shall take precedence.

If the Tenderer does not enter a price for any payment item in his tender, that payment item shall be deemed to be covered by such prices as the Tenderer did enter in his tender.

The quantities in the Schedule(s) are estimates of what the actual quantities of work may be and will be used to compare tenders on a uniform basis. The quantities shown are not a representation or warranty by the Authority, expressly or by implication, of what will be the actual quantities required in the work. Accordingly, the Authority will not consider any claims for adjustments to unit prices resulting from a variance between the actual quantities and those listed in the Schedule(s) and shall not be liable if those listed are not even approximately correct.

3.03 The following Question and Answer Series and Addenda to the Tender Documents have been received by the Tenderer, and this tender has been prepared in accordance therewith:

<u>Question and Answer Series</u>	<u>Date Received</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

SCHEDULE I

MEAGER CREEK GEOTHERMAL WELL; DRILLING FLUID PROGRAM

SCHEDULE OF QUANTITIES AND PRICES

<u>Item</u>	<u>Description</u>	<u>Approximate Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>
1	Bentonite	22 700	kg		
2	Sepiolite	11 300	kg		
3	Lignite	6 800	kg		
4	Polyacrylamide	4 500	kg		
5	Caustic Soda	320	kg		
6	Soda ash	230	kg		
7	Bicarbonate of soda	450	kg		
8	Lime	1 130	kg		
	CONTINGENCY PRODUCTS				
1	Barite S.G. 4.23	114 000	kg		
2	Sawdust	400	sacks		
3	Mica	4 500	kg		
4	Walnut fine	9 100	kg		
	CORROSION PRODUCTS				
1	Oxygen scavenger	675	l gal		
2	H ₂ S scavenger	5 700	kg		
3	High temp filming agent	150	l gal		
	TOTAL				\$

All prices to include supervision, all required testing and testing equipment, transportation to Vancouver and site storage. The Authority will pay for transportation from Vancouver to site.

SCHEDULE II

OPTION FOR SECOND WELL

MEAGER CREEK GEOTHERMAL WELL

SCHEDULE OF QUANTITIES AND PRICES

<u>Item</u>	<u>Description</u>	<u>Approximate Quantity</u>	<u>Unit</u>	<u>Unit Price</u>	<u>Amount</u>
1	Bentonite	22 700	kg		
2	Sepiolite	11 300	kg		
3	Lignite	6 800	kg		
4	Polyacrylamide	4 500	kg		
5	Caustic Soda	320	kg		
6	Soda ash	230	kg		
7	Bicarbonate of soda	450	kg		
8	Lime	1 130	kg		
	CONTINGENCY PRODUCTS				
1	Barite S.G. 4.23	114 000	kg		
2	Sawdust	400	sacks		
3	Mica	4 500	kg		
4	Walnut fine	9 100	kg		
	CORROSION PRODUCTS				
1	Oxygen scavenger	675	Igal		
2	H ₂ S scavenger	5 700	kg		
3	High temp filming agent	150	Igal		
	TOTAL				\$

All prices to include supervision, all required testing and testing equipment, transportation to Vancouver and site storage. The Authority will pay for transportation from Vancouver to site.

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CONTRACT NO. Q1-1143

PART 5 - DETAIL SPECIFICATIONS

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5.13	Option for Second Well	5 - 3	*
5.14	Basis of Payment	5 - 3	

Because of the remoteness of the location, 114 000 kg of barite should be on site in the event abnormally high subsurface pressures are encountered. *

5.03 COMPLETION TIME

The Contractor shall perform all work as dictated by the drilling program and in a manner so as not to interfere with drilling progress.

5.04 FOOD, LODGING AND TRANSPORTATION

The Contractor shall be responsible for transportation between the drill site and the Contractor's personnel's place of lodging.

Food and lodging will be provided by the Contractor. It should be noted that the drilling contractor will have a camp at the drill site and it is possible that an arrangement might be made to house drilling fluid contractor's personnel.

5.05 DRILLING FLUID EQUIPMENT

Subject to the approval of the Authority, the Contractor may use equipment and materials of his own preference in the work, except for those items which are specifically required in the Detailed Specifications. Items of equipment or materials which, in the opinion of the Authority do not meet specified requirements shall be replaced by the Contractor with equipment and materials meeting the specified requirements.

5.06 EQUIPMENT DESCRIPTION

Details on all equipment to be supplied by the Contractor will be included with the bid.

5.07 STORAGE

The Contractor shall supply sufficient dry storage for all materials included in the drilling fluid program.

5.08 SUPPORT EQUIPMENT

The Contractor shall supply all subsidiary equipment required to maintain properties of the mud as specified in this document. This equipment shall include but is not limited to:

1. A sufficient number of air packs for Contractor's onsite personnel.

2. Fluid testing equipment.

5.09 OPERATING PERSONNEL

The Contractor shall supply operating personnel for 24 hour supervision of the drilling fluid program when required by the Authority.

5.10 TESTING

The Contractor shall perform all drilling fluid tests either standard or specified by the Authority.

5.11 DRILLING FLUID MATERIALS

Drilling fluid materials shall be supplied to accomplish the drilling fluid program presented in Section 5.02. These materials and quantities are laid out in Schedule 1 of Part 3 of this document. The Contractor should supply with his bid details on materials to be used and certification that all materials meet API specifications.

5.12 RECORD KEEPING

The Contractor shall provide test results in a mud report twice daily or as requested by the Authority.

5.13 OPTION FOR SECOND WELL

At the Authority's option, a second well could follow completion of the first. The detail specifications in Clauses 5.02 to 5.12 above would also apply to the second well.

Tenderer's should complete Schedule II in Part 3 which covers the quantities and prices for the second well.

5.14 BASIS OF PAYMENT

(a) General

Except as otherwise specifically provided, the prices in the Schedule for payment for the various items of work and materials as described in these detailed specifications shall constitute full compensation for supplying and maintaining all equipment, material, accommodation, labour and supervision and all other work for performing all parts of the drilling fluid program to be carried out by the Contractor in accordance with the provisions of the Contract. The unit prices entered in the tender form shall also apply to any additional work required by the Authority.

(b) Transportation

Transportation of all materials and equipment to Vancouver shall be the responsibility of the Contractor. Transportation of materials and equipment from Vancouver to site shall be paid for by the Authority.

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

MUD LOGGING SERVICES

CONTRACT NO. Q1-1154

TENDER DOCUMENTS

Contents

Advertisement for Tenders; Instructions to Tenderers;
Form of Tender; General Conditions; Detail Specifications

April 1981

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

MUD LOGGING SERVICES

CONTRACT NO. Q1-1154

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CONTRACT NO. Q1-1154

PART 1 - ADVERTISEMENT FOR TENDERS

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

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CONTRACT NO. Q1-1154

PART 1 - ADVERTISEMENT FOR TENDERS

Tenders are invited for the supply of labour, equipment and materials for mud logging services required for the deep geothermal exploration well to be drilled in the Meager Creek geothermal area. Meager Creek is located approximately 160 km north of Vancouver, British Columbia.

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Tenders will be considered only from Tenderers whose financial resources, technical ability and experience are commensurate with the work to be performed. The lowest or any tender may not necessarily be accepted and the Authority will not be responsible for any costs incurred by any Tenderer in preparing his Tender.

Tenders will be received until 11:00 a.m. local time (19:00 hours Greenwich Mean Time) on Wednesday 27 May 1981 at Room 1026, Office of the Purchasing Agent at the above address. The tenders will be publicly opened and the prices will be made known at 2:00 p.m. local time (22:00 hours Greenwich Mean Time) on that day.

When requesting information or documents pertaining to this tender, please quote Contract No. Q1-1154.

CONTRACT NO. Q1-1154

PART 2 - INSTRUCTIONS TO TENDERERS

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PART 2 - INSTRUCTIONS TO TENDERERS

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CONTRACT NO. Q1-1154

PART 2 - INSTRUCTIONS TO TENDERERS

2.01 SUBMISSION OF TENDERS

Tenders shall be submitted in quadruplicate on the separate copies of the Form of Tender provided with the Tender Documents and shall be enclosed in a sealed envelope addressed to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, Canada, V6Z 1Y3, and marked:

"Q1-1154 - Tender for the supply of labour, equipment and materials for mud logging services required for the deep exploratory well to be drilled in the Meager Creek geothermal area"

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Notice to the Contractor of the acceptance of his tender shall constitute the award of the Contract.

2.03 TENDERER'S RESPONSIBILITY

It shall be the Tenderer's responsibility to inform himself of all aspects of the Work and no claim will be considered at any time for reimbursement for any expenses incurred as a result of any misunderstanding in regard to the conditions of the work. Should any details

necessary for a clear and comprehensive understanding be omitted or any error appear in the Tender Documents or should the Tenderer note facts or conditions which in any way conflict with the letter or spirit of the Tender Documents, it shall be the responsibility of the Tenderer to obtain clarifications. Queries shall be made in writing to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 and shall be submitted not later than 10 days before the closing time, and will be answered by a Question and Answer Series which will be issued to all parties registered as having received a copy of the Tender Documents. Immediately upon receiving any Question and Answer series each Tenderer shall acknowledge receipt thereof in writing, in duplicate, to the Purchasing Agent.

Neither the Authority nor the Authority's Representative shall be responsible for any instructions or information given to any Tenderer otherwise than by the Purchasing Agent, in accordance with this Clause.

2.04 ADDENDA

Any changes to the Tender Documents will be issued as written Addenda to all parties registered as having received a copy of the Tender Documents and shall become part of the Tender Documents. If such Addenda are issued each Tenderer shall acknowledge, that he has received them and that his tender has been prepared in accordance therewith.

Immediately upon receiving any Addenda each Tenderer shall acknowledge receipt thereof in writing, in duplicate to the Purchasing Agent.

2.05 PRICING REQUIREMENTS

All prices tendered shall be firm, except as provided in the General Conditions or Detail Specifications, shall be in Canadian dollars and shall include all freight, customs and excise duties and all applicable taxes and shall be all inclusive as provided in the Tender Documents.

The Tenderer shall make his own assessment of wage rates and working conditions to prevail during the period of the Work and prepare his Tender accordingly. No claim for adjustment will be entertained by the Authority.

Prices shall not be subject to adjustment for fluctuation in foreign exchange.

2.06 SIGNATURES AND SEALS

All tenders shall be executed under seal and if the Tenderer is a corporation, the affixing of its corporate seal shall be duly attested by the signature of its authorized signing officers.

2.07 DATA TO BE SUBMITTED WITH TENDER

The information and data hereinafter described shall be submitted with the Tender to demonstrate the Tenderer's ability to comply with the requirements of the Tender Documents. Such submissions shall be in the form of Appendices (in triplicate) clearly marked and referenced.

(a) Technical Data

Each Tenderer shall submit the following technical data with his Tender:

Details, which are not otherwise covered in the Tender Documents, of the equipment the Tender proposes to supply.

(b) Tenderer's Qualifications

Each Tenderer shall submit sufficient information, as Appendix A, with his Tender to show that he has the staff, ability, experience, capital and plant to perform the Work. Details of previous geo-thermal drilling experience should be included in Appendix A. This shall include a brief description of the equipment the Tenderer proposes to use for this Contract listing its size, rating, year of manufacture and whether it is owned or rented.

Foreign Tenderers shall indicate whether or not they will be represented in British Columbia by competent technical personnel with a good command of the English language.

(c) Financial Information

One (1) only, audited copy of the latest balance sheet, to accompany the original of the Tender, noting any material change that may have occurred since its preparation or effective date. If a copy has been submitted in support of a recent tender, and there has been no material change in the balance sheet, a copy is not required but a note to this effect is required. Other financial information necessary to adequately establish the Tenderer's financial capability may be required, and shall be made available if asked for.

(d) Work Force

Tenderers are referred to the "Reservations Clause" agreed to in the 1980-82 B.C. Building Trades - C.L.R.A. settlement and to Section 40 of the Labour Code of B.C. Each tenderer shall list all union certifications and employer bargaining affiliations, if any, applicable to the Work, including those for each subcontractor.

2.08 BASIC TENDER AND ALTERNATIVES

(a) Basic Tender

Each Tenderer shall submit a basic tender which conforms strictly to the requirements of the Tender Documents.

(b) Alternatives

In addition to the basic tender, Tenderers are free to offer any alternatives to the basic tender which the Tenderer considers to be superior or substantially less costly. Each alternative shall be submitted in duplicate in an appendix to the basic tender. This appendix shall include a description of each alternative in detail equivalent to that required for the basic tender and shall clearly indicate all the advantages and the cost variation for each alternative. The Contract Price for each alternative shall be broken down in the same way as the basic tender.

2.09 PREFERENCE TO BRITISH COLUMBIA AND CANADIAN PRODUCTS

Tenderers are hereby advised that it is a policy of the Authority that where in the sole discretion of the Authority it believes circumstances so warrant, a preference up to 10 percent will be given to tenders which offer products of British Columbia manufacture, or where such manufacture is not possible, a preference of up to 5 percent will be given to products of Canadian manufacture. Tenderers are invited to disclose the British Columbia and Canadian content of their tenders in appendices to be marked B and C respectively to the Form of Tender.

2.10 PERIOD OF THE WORK

The period of the work shall be from the date of award of this contract up to 30 November 1981 or for such further period of time as may be agreed with the Authority.

2.11 ARRANGEMENTS FOR TENDERERS' VISITS TO THE SITE

At least 2 days prior to visiting the Site, each Tenderer shall inform the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 (Telephone (604) 663-2558), of the expected timing and duration of his visit and the number of persons in his party.

Upon arrival at the Site, each Tenderer shall report to the Authority's exploration camp office (see location maps in Part 5). Tenderers must provide their own accommodation and transportation when visiting the Site.

A prospective Tenderer by visiting the Site shall be deemed to have assumed all risk of loss, damage or injury (including death) to the persons and property of himself, his servants and agents, from any cause whatsoever during such visit and shall be deemed to have undertaken to indemnify the Authority, the Authority's Representative, their employees, agents and contractors, from and against all loss, costs, damages, suits, actions and demands whatsoever and any liability therefor to any person arising out of any such visit.

CONTRACT NO. Q1-1154

PART 4 - GENERAL CONDITIONS

CONTRACT NO. Q1-1154

PART 4 - GENERAL CONDITIONS

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CONTRACT NO. Q1-1154

PART 4 - GENERAL CONDITIONS

4.01 DEFINITIONS AND MEANINGS OF TERMS

The following words and terms wherever used in the Tender Documents shall have the meanings herein assigned to them and the following rules of construction shall apply:

1. "Authority" shall mean the British Columbia Hydro and Power Authority, a body corporate, with head office at 970 Burrard Street, Vancouver, British Columbia, its successors and assigns.
2. "Authority's Representative" shall mean the Manager, Meager Creek Geothermal Project or his delegate, who shall be authorized to supervise the technical direction of the Work.
3. "Contract Documents" shall mean the Tender Documents and the tender of the Contractor as accepted by the Authority, together with the purchase order issued by the Authority.
4. "Contractor" shall mean the Tenderer whose tender has been accepted.
5. "Day" shall mean a calendar day.
6. "Tenderer" shall mean any party or parties tendering for the Work, or the successful Tenderer who later becomes the Contractor for such Work.
7. "Site" shall mean the lands and other places on, under, in or through which the Work is to be carried out.
8. "Tender Documents" shall mean the Advertisement for Tenders; Instructions to Tenderers; Form of Tender; General Conditions; Detail Specifications; Addenda; and Question and Answer Series, if any.
9. "Work" shall mean everything to be done by the Contractor under the Contract whether temporary or permanent, including equipment and material to be supplied by the Contractor.

4.02 ASSESSMENT OF CONDITIONS

The Contractor shall be deemed to have informed himself fully as to the risks and contingencies and all other data, matters and things, local or otherwise, requisite to the fulfillment of the Contract. Failure to

acquaint himself fully with all available information concerning conditions affecting or which may be encountered in performing the Work will not relieve the Contractor of the responsibility for estimating the difficulties and costs of satisfactorily performing the Work, or for actually performing the Work in conformity with the Contract.

4.03 COMPLIANCE WITH LAWS

The Contractor and his employees in carrying out the Contract shall comply with all laws, statutes, by-laws, ordinances and regulations of all Federal, Provincial, Municipal or other governmental authorities, any of which are applicable to the Contract or the performance of the Work, and the Contractor shall indemnify the Authority against any cost, loss, liability or obligation which may arise as a consequence of the failure of the Contractor and/or his employees to comply fully with the said laws and regulations.

Without restricting the foregoing, the Contractor shall conform to the provisions of the "Workers' Compensation Act" and all other statutes, by-laws, or regulations in force from time to time in respect of or affecting in any manner performance of the Contract, the Work or the Site, and shall give all notices required by the said statutes, by-laws or regulations and pay all fees, assessments and other sums payable thereunder or in respect thereof.

Except as otherwise specified in writing by the Authority or in the Tender Documents, the Contractor shall be responsible for obtaining at his own expense, all necessary authorizations, licenses and permits in connection with or required for the Work as are prescribed by such governmental authorities, notwithstanding that the Authority is an agency of the Crown.

4.04 INSURANCE

(a) Comprehensive General Liability Insurance

The Contractor shall, at his own expense, provide a Comprehensive General Liability Insurance Policy, to the satisfaction of the Authority's Insurance Manager, in an amount not less than \$1 000 000.00, all inclusive together with a standard Non-owned Automobile Liability and Statutory Conditions Endorsement. This insurance shall be maintained during the continuance of the Contract. It shall insure both the Contractor and the Authority, and the policy shall contain a "cross-liability" clause.

(b) Automobile Public Liability and Property Damage Insurance

The Contractor shall, at his own expense, obtain and maintain during the continuance of this Contract, Automobile Public Liability and Property Damage insurance covering the ownership, use or

operation or any motor vehicle or trailer licensed for use on public highways and that is owned, leased or controlled by the Contractor, in an amount not less than \$1 000 000.00 all inclusive.

(c) Insurance Manager

All policies of insurance shall be to the satisfaction of the Insurance Manager of the Authority and a certified copy of such policies shall be presented to the said Insurance Manager prior to the commencement of any work in connection with this Contract.

4.05 CLEAN-UP

The Contractor shall at all times during the carrying out of the Work keep the site neat and free from any of his waste materials including lunch bags, cans and rubbish. Should the Contractor fail to do so, the Authority's representative may arrange to have the site cleaned up by others and the costs thereof shall be recovered as monies due to the Authority.

4.06 ENVIRONMENTAL PRECAUTIONS

The Contractor shall conduct his operations so that pollution of the environment and the destruction of trees, crops and damage to the landscape is kept to a minimum.

Roads, ditches and watercourses, if disturbed by the Contractor's operations, shall be restored prior to leaving the Site.

Survey markings shall not be disturbed.

The Contractor shall have available at the Site sufficient fire fighting equipment adequate to handle an outbreak of fire brought about by his operations.

The cost of any repairs or damages resulting from non-compliance with the provisions of this Clause shall be paid by the Contractor.

4.07 EARLY TERMINATION

The Authority reserves the right to terminate the Work on the Site upon providing at any time reasonable advance notice to the Contractor. In the event of such termination, the Authority's sole obligation to the Contractor shall be limited to the payment for Contractor services performed to that time and payment for other items mutually agreed to in the Contract.

4.08 COMPLETION TIME

If, in the opinion of the Authority's representative the Contractor fails to advance the Work at a rate which will enable the Contractor to meet a completion time agreed to by the Contractor and the Authority prior to the start of work, the Authority's representative may instruct the Contractor to take such action as he considers necessary to sufficiently accelerate the Work; and in particular, with respect to the labour force or plant assigned by the Contractor to the Work, may instruct the Contractor to increase either or both. The Contractor shall forthwith comply with any such instruction.

4.09 SUBCONTRACTS

1. The Contractor shall notify the Authority in writing of the terms of all subcontracts, if any, and the names of subcontractors proposed for the principal parts of the Work and shall not employ any to whom the Authority may reasonably object.
2. The Contractor shall be as fully responsible for the acts and omissions of his subcontractors and their employees as if such subcontractors and their employees were persons directly employed by the Contractor.
3. Subcontractors may be required to provide proof, satisfactory to the Authority, as to their financial capability. The Contractor shall provide the necessary information upon request from the Authority.

4.10 CO-OPERATION

The Contractor shall have no right to the exclusive occupation of the Site of the Work. The Contractor shall co-operate harmoniously with Authority personnel and with other Contractors working at the site. All instructions given by the Authority's representative or his delegate shall be carefully and promptly executed.

4.11 WAGES AND WORKING CONDITIONS

The Public Construction Fair Wages Act applies to this Contract and to every subcontract and to any work done by any other person under this Contract.

4.12 ASSIGNING THE CONTRACT

Neither party to this Contract shall assign the Contract or any interest therein without the written consent of the other party.

4.13 AUDIT

The Contractor shall permit representatives of the Authority at all reasonable times, to inspect and audit all records, accounts, statements and other documents of the Contractor relating to the Work and shall keep such records, accounts, statements and documents for at least 1 year after completion of the Work or for such extended period as the Authority may have requested, in advance and in writing, of the Contractor. The liability of the Authority to make any payment other than the sums provided or calculated in accordance with the actual quantities of payment items and prices set out in the Form of Tender, shall be subject to the right of the Authority to inspection and audit as above provided.

4.14 PAYMENT GENERAL

(a) Terms of Payment

Invoices shall be rendered in the first 7 days of each month in respect of all amounts earned by the Contractor during the previous month, and except as provided below such invoices shall be payable in full within 30 days of the receipt of such invoices, provided that if the Authority is unable to verify such invoices within the said period any payment made shall be treated as an advance pending verification of the invoices.

Any necessary adjustments, which have not been made prior to the final invoice for work done shall be made at the time of final payment. If the Authority is shown to have overpaid the Contractor, the Contractor agrees that the Authority may deduct the amount from any other sums due to the Contractor from the Authority or that it will pay the amount to the Authority within 30 days of the amount being agreed or otherwise established.

(b) Submitting of Invoices

All invoices shall be directed to B.C. Hydro and Power Authority, 555 West Hastings Street, Vancouver, B.C., Canada, V6B 4T6, attention System Engineering Division, Meager Creek Geothermal Project. They shall be clearly identified by Purchase Order number and name of project.

CONTRACT NO. Q1-1154

PART 5 - DETAIL SPECIFICATIONS

CONTRACT NO. Q1-1154

PART 5 - DETAIL SPECIFICATIONS

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MUD LOGGING CONTRACT

PART 5 - DETAIL SPECIFICATIONS

5.01 LOCATION AND ACCESS

The Meager Creek project area is located 160 kilometres north-northwest of Vancouver and approximately 60 kilometres northwest of Pemberton, B.C. (see Maps 1 and 2). Access to the project is via Highway 99 from Vancouver to Pemberton continuing on good gravel surface forestry development and private logging roads to the site.

5.02 SCOPE OF WORK

The Work shall include but is not limited to the supply of all labour, plant and materials and the performance of all things required in connection with the mud logging program including the following surveys:

1. Mud temperature in/out
2. Continuous CO₂
3. Continuous H₂S
4. Hydrocarbon gas analysis
5. Rock bulk density
6. Drill Rate
7. Resistivity in/out
8. Mud flow
9. Mud pit level gain/loss
10. H₂S detector; dual channel remote with audio-visual alarms
11. Supply of self-contained breathing apparatus sufficient for Contractor's personnel and ten other personnel.

5.03 COMPLETION TIME

The Contractor shall perform all work as dictated by the drilling program and in a manner so as not to interfere with drilling progress.

5.04 FOOD, LODGING AND TRANSPORTATION

The Contractor shall be responsible for daily transportation between the drill site and the Contractor's personnel's place of lodging.

Food and lodging will be provided by the Contractor. It should be noted that the drilling contractor will have a camp at the drill site and it is possible that an arrangement could be made to house mud logging contractor's personnel.

5.05 MUD LOGGING EQUIPMENT

Subject to the approval of the authority the Contractor may use mud logging equipment and materials of his own preference in the work, except for those items which are specifically required in these detailed specifications. Items of equipment or materials which, in the opinion of the Authority do not meet the specified requirements shall be replaced by the Contractor with equipment and materials meeting the specified requirements.

5.06 EQUIPMENT DESCRIPTION

Details on all equipment to be supplied in connection with the mud logging program shall be supplied as an appendix to the Form of Tender.

5.07 OPERATING PERSONNEL

Contractor will provide personnel and equipment on 7 days notice prior to rig up. Contractor shall supply operating personnel upon 24 hours notice of resumption of drilling following standby periods.

5.08 RECORD KEEPING

Contractor shall maintain records of all data obtained and provide survey results as requested by the operators. In addition, the Contractor shall provide the Authority with any and all calculation results derived from the surveys.

5.09 BASIS OF PAYMENT

(a) General

Except as otherwise specifically provided the prices in the Schedule for payment for the various items of work and materials as described in these detailed specifications shall constitute full compensation for supplying and maintaining all equipment, material, accommodation, labour and supervision and all other work for performing all parts

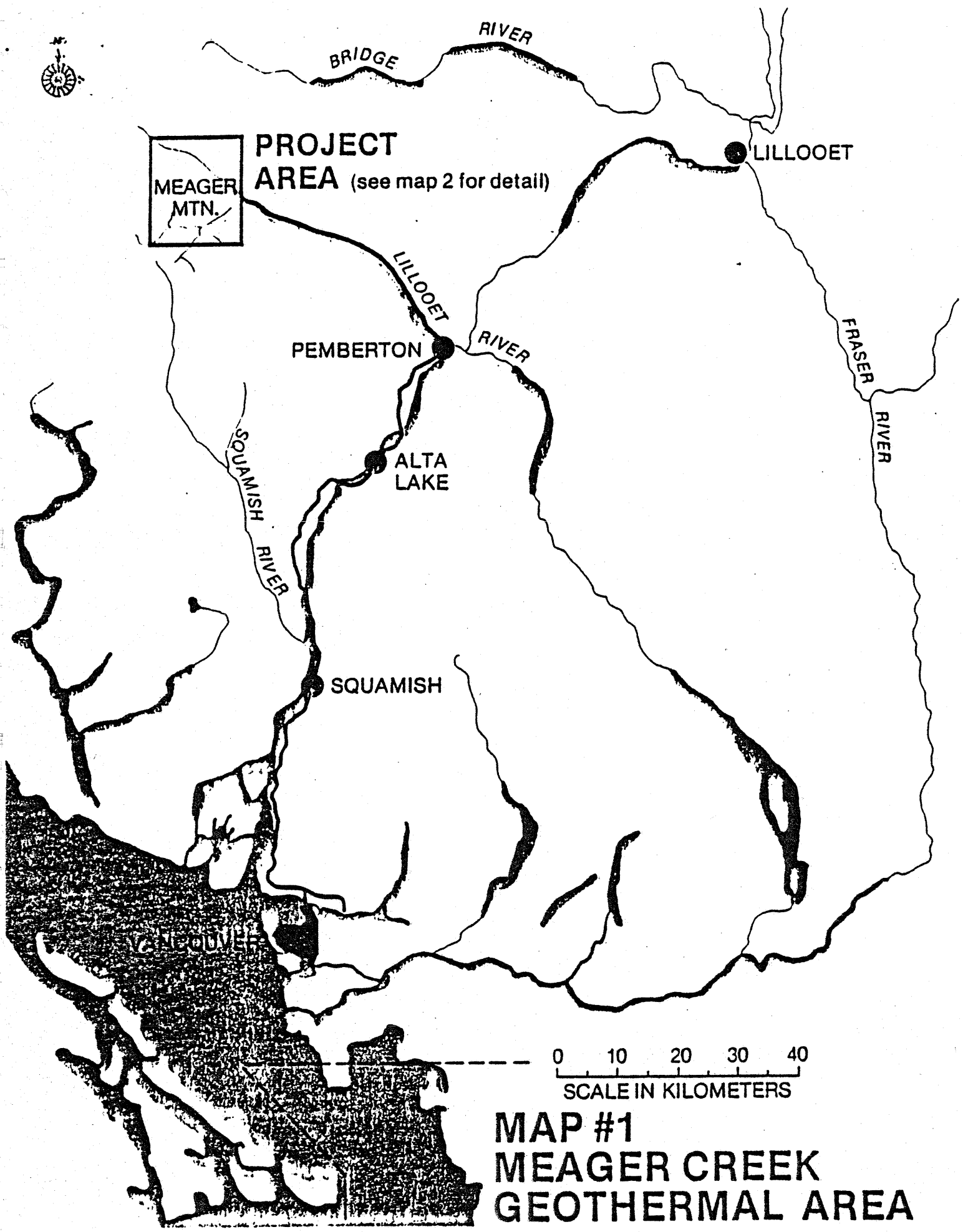
of the mud logging program to be carried out by the Contractor in accordance with the provisions of the Contract. The prices entered in the Form of Tender shall also apply to any additional work required by the Authority.

(b) Transportation

Transportation of all materials, equipment and personnel to the site shall be the responsibility of the Contractor and the cost thereof should be included in the bid.

5.10 LOCATION MAPS

Maps 1 and 2 are attached.



MEAGER
MTN.

**PROJECT
AREA** (see map 2 for detail)

LILLOOET

PEMBERTON

ALTA
LAKE

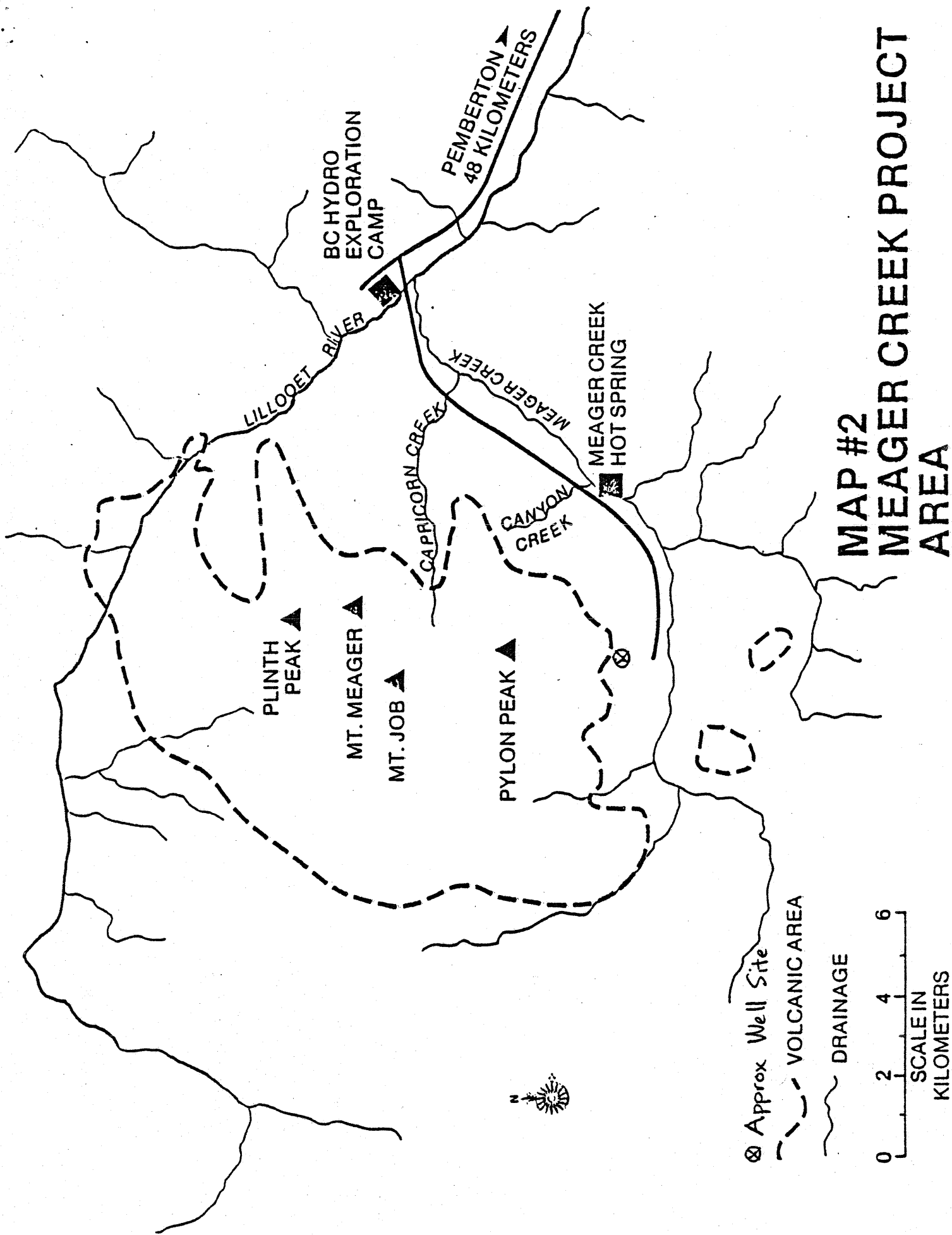
SQUAMISH

VANCOUVER

0 10 20 30 40
SCALE IN KILOMETERS

**MAP #1
MEAGER CREEK
GEOTHERMAL AREA**

MAP #2 MEAGER CREEK PROJECT AREA



BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

WELL LOGGING SERVICES

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April 1981

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

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CONTRACT NO. Q1-1153

PART 1 - ADVERTISEMENT FOR TENDERS

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

WELL LOGGING SERVICES

CONTRACT NO. Q1-1153

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CONTRACT NO. Q1-1153

PART 2 - INSTRUCTIONS TO TENDERERS

CONTRACT NO. Q1-1153

PART 2 - INSTRUCTIONS TO TENDERERS

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CONTRACT NO. Q1-1153

PART 2 - INSTRUCTIONS TO TENDERERS

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"Q1-1153 - Tender for the supply of labour, equipment and materials for well logging services required for the deep exploratory well to be drilled in the Meager Creek geothermal area"

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2.03 TENDERER'S RESPONSIBILITY

It shall be the Tenderer's responsibility to inform himself of all aspects of the Work and no claim will be considered at any time for

reimbursement for any expenses incurred as a result of any misunderstanding in regard to the conditions of the work. Should any details necessary for a clear and comprehensive understanding be omitted or any error appear in the Tender Documents or should the Tenderer note facts or conditions which in any way conflict with the letter or spirit of the Tender Documents, it shall be the responsibility of the Tenderer to obtain clarifications. Queries shall be made in writing to the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 and shall be submitted not later than 15 days before the closing time, and will be answered by a Question and Answer Series which will be issued to all parties registered as having received a copy of the Tender Documents. Immediately upon receiving any Question and Answer series each Tenderer shall acknowledge receipt thereof in writing, in duplicate, to the Purchasing Agent.

Neither the Authority nor the Authority's Representative shall be responsible for any instructions or information given to any Tenderer otherwise than by the Purchasing Agent, in accordance with this Clause.

2.04 ADDENDA

Any changes to the Tender Documents will be issued as written Addenda to all parties registered as having received a copy of the Tender Documents and shall become part of the Tender Documents. If such Addenda are issued each Tenderer shall acknowledge, that he has received them and that his tender has been prepared in accordance therewith.

Immediately upon receiving any Addenda each Tenderer shall acknowledge receipt thereof in writing, in duplicate to the Purchasing Agent.

2.05 PRICING REQUIREMENTS

All prices tendered shall be firm, except as provided in the General Conditions or Detail Specifications, shall be in Canadian dollars and shall include all freight, customs and excise duties and all applicable taxes and shall be all inclusive as provided in the Tender Documents.

The Tenderer shall make his own assessment of wage rates and working conditions to prevail during the period of the Work and prepare his Tender accordingly. No claim for adjustment will be entertained by the Authority.

Prices shall not be subject to adjustment for fluctuation in foreign exchange.

2.06 SIGNATURES AND SEALS

All tenders shall be executed under seal and if the Tenderer is a corporation, the affixing of its corporate seal shall be duly attested by the signature of its authorized signing officers.

2.07 DATA TO BE SUBMITTED WITH TENDER

The information and data hereinafter described shall be submitted with the Tender to demonstrate the Tenderer's ability to comply with the requirements of the Tender Documents. Such submissions shall be in the form of Appendices (in triplicate) clearly marked and referenced.

(a) Technical Data

Each Tenderer shall submit the following technical data with his Tender:

Details, which are not otherwise covered in the Tender Documents, of the equipment the Tender proposes to supply.

(b) Tenderer's Qualifications

Each Tenderer shall submit sufficient information, as Appendix A, with his Tender to show that he has the staff, ability, experience, capital and plant to perform the Work. This shall include a brief description of the equipment the Tenderer proposes to use for this Contract listing its size, rating, year of manufacture and whether it is owned or rented. Details of previous geothermal drilling experience should be included in Appendix A.

Foreign Tenderers shall indicate whether or not they will be represented in British Columbia by competent technical personnel with a good command of the English language.

(c) Financial Information

One (1) only, audited copy of the latest balance sheet, to accompany the original of the Tender, noting any material change that may have occurred since its preparation or effective date. If a copy has been submitted in support of a recent tender, and there has been no material change in the balance sheet, a copy is not required but a note to this effect is required. Other financial information necessary to adequately establish the Tenderer's financial capability may be required, and shall be made available if asked for.

(d) Work Force

Tenderers are referred to the "Reservations Clause" agreed to in the 1980-82 B.C. Building Trades - C.L.R.A. settlement and to Section 40 of the Labour Code of B.C. Each tenderer shall list all union certifications and employer bargaining affiliations, if any, applicable to the Work, including those for each subcontractor.

2.08 BASIC TENDER AND ALTERNATIVES

(a) Basic Tender

Each Tenderer shall submit a basic tender which conforms strictly to the requirements of the Tender Documents.

(b) Alternatives

In addition to the basic tender, Tenderers are free to offer any alternatives to the basic tender which the Tenderer considers to be superior or substantially less costly. Each alternative shall be submitted in duplicate in an appendix to the basic tender. This appendix shall include a description of each alternative in detail equivalent to that required for the basic tender and shall clearly indicate all the advantages and the cost variation for each alternative. The Contract Price for each alternative shall be broken down in the same way as the basic tender.

2.09 PREFERENCE TO BRITISH COLUMBIA AND CANADIAN PRODUCTS

Tenderers are hereby advised that it is a policy of the Authority that where in the sole discretion of the Authority it believes circumstances so warrant, a preference up to 10 percent will be given to tenders which offer products of British Columbia manufacture, or where such manufacture is not possible, a preference of up to 5 percent will be given to products of Canadian manufacture. Tenderers are invited to disclose the British Columbia and Canadian content of their tenders in appendices to be marked B and C respectively to the Form of Tender.

2.10 PERIOD OF THE WORK

The period of the work shall be from the date of award of this contract up to 30 November 1981 or for such further period of time as may be agreed with the Authority.

2.11 ARRANGEMENTS FOR TENDERERS' VISITS TO THE SITE

At least 2 days prior to visiting the Site, each Tenderer shall inform the Office of the Purchasing Agent, British Columbia Hydro and Power Authority, 970 Burrard Street, Vancouver, British Columbia, V6Z 1Y3 (Telephone (604) 663-2558), of the expected timing and duration of his visit and the number of persons in his party.

Upon arrival at the Site, each Tenderer shall report to the Authority's exploration camp office (see location maps in Part 5). Tenderers must provide their own accommodation and transportation when visiting the Site.

A prospective Tenderer by visiting the Site shall be deemed to have assumed all risk of loss, damage or injury (including death) to the persons and property of himself, his servants and agents, from any cause whatsoever during such visit and shall be deemed to have undertaken to indemnify the Authority, the Authority's Representative, their employees, agents and contractors, from and against all loss, costs, damages, suits, actions and demands whatsoever and any liability therefore to any person arising out of any such visit.

CONTRACT NO. Q1-1153

PART 3 - FORM OF TENDER

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY

MEAGER CREEK GEOTHERMAL AREA

DEEP EXPLORATORY WELL

WELL LOGGING SERVICES

CONTRACT NO. Q1-1153

PART 3 - FORM OF TENDER

3.01

(Name of Tenderer)

(Full Address of Tenderer)

hereinafter called the "Tenderer", hereby declares that the Tenderer is: (Strike out (a) or (b) below, whichever does not apply).

(a) A company duly incorporated under the laws of

(Insert Authorizing Jurisdiction)

(b) A Partnership, Sole Trader, or Joint Venture carrying on a business under the firm name and style above stated; the names, addresses and places of incorporation, if any, of all partners or members of the firm being the following:

(If a Joint Venture, state which is the sponsoring member and the percentage participation by each member.)

3.02 Having examined the Tender Documents, the Tenderer hereby offers to perform the whole of the Work provided for in the Tender Documents and to comply with all other requirements of the Tender Documents for the Contract Price of _____ (\$ _____) for Schedule 1 or such other sum as may be ascertained in accordance with the conditions and provisions set forth in the Contract Documents.

The attached Schedule(s) of Quantities and Prices forms part of this tender, and if there is any conflict between the Contract Price entered above and the correct summation of the lump sum prices; provisional sums, if any; and correct extensions of the unit prices and approximate quantities entered in the aforesaid Schedule(s), the said summation shall take precedence.

If the Tenderer does not enter a price for any payment item in his tender, that payment item shall be deemed to be covered by such prices as the Tenderer did enter in his tender.

The quantities in the Schedule(s) are estimates of what the actual quantities of work may be and will be used to compare tenders on a uniform basis. The quantities shown are not a representation or warranty by the Authority, expressly or by implication, of what will be the actual quantities required in the work. Accordingly, the Authority will not consider any claims for adjustments to unit prices resulting from a variance between the actual quantities and those listed in the Schedule(s) and shall not be liable if those listed are not even approximately correct.

3.03 The following Question and Answer Series and Addenda to the Tender Documents have been received by the Tenderer, and this tender has been prepared in accordance therewith:

<u>Question and Answer Series</u>	<u>Date Received</u>
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Addendum to Tender Documents

Date Received

- 3.04 The Tenderer's Workers' Compensation Board Registration No. is _____.
- 3.05 This tender is irrevocable for 30 calendar days after the closing time, whether any other tender has previously been accepted or not and whether notice of acceptance of another tender has been given or not.
- 3.06 The Tenderer hereby represents that this tender is genuine and not a sham or collusion or made in the interest or on behalf of any person or corporation not herein named, or after comparison of any prices with any other tenderer for the Work, and further, that the Tenderer has not directly or indirectly induced or solicited any other tenderer to submit a sham tender, or any other person or corporation to refrain from tendering, and that the Tenderer has not in any manner sought by collusion to secure for himself or for any other person or corporation an advantage over any other tenderer.
- 3.07 If this tender is signed by or on behalf of more than one person, then all the agreements, promises, covenants and obligations of the Tenderer are and shall be deemed to be the joint and several agreements, promises, covenants and obligations of all and each of those persons. Each and every member of the Joint Venture making this tender has signed and sealed this tender or had this tender signed and sealed upon its behalf as a separate person.

3.08 The following appendices are attached hereto:

<u>Appendix No.</u>	<u>Reference Clause</u>

3.09

SCHEDULE 1

MEAGER CREEK GEOTHERMAL WELL
SCHEDULE OF QUANTITIES AND PRICES: WELL LOGGING SERVICES

<u>Item</u>	<u>Description</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Amount (\$)</u>
1	Mobilization and demobilization of on site equipment	Lump Sum		
2	Mobilization and demobilization of personnel	Lump Sum		
3	Logging runs; high temperature tools and cable to 1000 feet - IES - DIL - FDC/CNL - Sonic - Caliper - Temperature - TDT	3 runs		
4	Logging runs; high temperature tools 1000 to 5200 feet - FDC/CNL - GR - Sonic - Caliper - CBL (in 13-3/8" casing) - Temperature - TDT	3 runs		
5	Logging runs; high temperature tools-production interval 5200 to 7500 feet - FDC/CNL - Sonic - GR - Temperature - CBL (9-5/8" casing) - TDT	3 runs		
6	Standby Time Rate	10 days		
TOTAL				

3.10 IN WITNESS whereof the Tenderer has caused its seal to be affixed
at the day of 19

The seal of the Tenderer was here-)
unto affixed in the presence of:)

_____)
_____)
_____)

CONTRACT NO. Q1-1153

PART 4 - GENERAL CONDITIONS

CONTRACT NO. Q1-1153

PART 4 - GENERAL CONDITIONS

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CONTRACT NO. Q1-1153

PART 4 - GENERAL CONDITIONS

4.01 DEFINITIONS AND MEANINGS OF TERMS

The following words and terms wherever used in the Tender Documents shall have the meanings herein assigned to them and the following rules of construction shall apply:

1. "Authority" shall mean the British Columbia Hydro and Power Authority, a body corporate, with head office at 970 Burrard Street, Vancouver, British Columbia, its successors and assigns.
2. "Authority's Representative" shall mean the Manager, Meager Creek Geothermal Project or his delegate, who shall be authorized to supervise the technical direction of the Work.
3. "Contract Documents" shall mean the Tender Documents and the tender of the Contractor as accepted by the Authority, together with the purchase order issued by the Authority.
4. "Contractor" shall mean the Tenderer whose tender has been accepted.
5. "Day" shall mean a calendar day.
6. "Tenderer" shall mean any party or parties tendering for the Work, or the successful Tenderer who later becomes the Contractor for such Work.
7. "Site" shall mean the lands and other places on, under, in, or through which the Work is to be carried out.
8. "Tender Documents" shall mean the Advertisement for Tenders; Instructions to Tenderers; Form of Tender, General Conditions; Detail Specifications; Addenda; and Question and Answer Series, if any.
9. "Work" shall mean everything to be done by the Contractor under the Contract whether temporary or permanent, including equipment and material to be supplied by the Contractor.

4.02 ASSESSMENT OF CONDITIONS

The Contractor shall be deemed to have informed himself fully as to the risks and contingencies and all other data, matters and things, local

or otherwise, requisite to the fulfillment of the Contract. Failure to acquaint himself fully with all available information concerning conditions affecting or which may be encountered in performing the Work will not relieve the Contractor of the responsibility for estimating the difficulties and costs of satisfactorily performing the Work, or for actually performing the Work in conformity with the Contract.

4.03 COMPLIANCE WITH LAWS

The Contractor and his employees in carrying out the Contract shall comply with all laws, statutes, by-laws, ordinances and regulations of all Federal, Provincial, Municipal or other governmental authorities, any of which are applicable to the Contract or the performance of the Work, and the Contractor shall indemnify the Authority against any cost, loss, liability or obligation which may arise as a consequence of the failure of the Contractor and/or his employees to comply fully with the said laws and regulations.

Without restricting the foregoing, the Contractor shall conform to the provisions of the "Workers' Compensation Act" and all other statutes, by-laws, or regulations in force from time to time in respect of or affecting in any manner performance of the Contract, the Work or the Site, and shall give all notices required by the said statutes, by-laws or regulations and pay all fees, assessments and other sums payable thereunder or in respect thereof.

Except as otherwise specified in writing by the Authority or in the Tender Documents, the Contractor shall be responsible for obtaining at his own expense, all necessary authorizations, licenses and permits in connection with or required for the Work as are prescribed by such governmental authorities, notwithstanding that the Authority is an agency of the Crown.

4.04 INSURANCE

(a) Comprehensive General Liability Insurance

The Contractor shall, at his own expense, provide a Comprehensive General Liability Insurance Policy, to the satisfaction of the Authority's Insurance Manager, in an amount not less than \$1 000 000.00, all inclusive together with a standard Non-owned Automobile Liability and Statutory Conditions Endorsement. This insurance shall be maintained during the continuance of the Contract. It shall insure both the Contractor and the Authority, and the policy shall contain a "cross-liability" clause.

(b) Automobile Public Liability and Property Damage Insurance

The Contractor shall, at his own expense, obtain and maintain during the continuance of this Contract, Automobile Public Liability

and Property Damage insurance covering the ownership, use or operation or any motor vehicle or trailer licensed for use on public highways and that is owned, leased or controlled by the Contractor, in an amount not less than \$1 000 000.00 all inclusive.

(c) Insurance Manager

All policies of insurance shall be to the satisfaction of the Insurance Manager of the Authority and a certified copy of such policies shall be presented to the said Insurance Manager prior to the commencement of any work in connection with this Contract.

4.05 CLEAN-UP

The Contractor shall at all times during the carrying out of the Work keep the site neat and free from any of his waste materials including lunch bags, cans and rubbish. Should the Contractor fail to do so, the Authority's representative may arrange to have the site cleaned up by others and the costs thereof shall be recovered as monies due to the Authority.

4.06 ENVIRONMENTAL PRECAUTIONS

The Contractor shall conduct his operations so that pollution of the environment and the destruction of trees, crops and damage to the landscape is kept to a minimum.

Roads, ditches and watercourses, if disturbed by the Contractor's operations, shall be restored prior to leaving the Site.

Survey markings shall not be disturbed.

The Contractor shall have available at the Site sufficient fire fighting equipment adequate to handle an outbreak of fire brought about by his operations.

The cost of any repairs or damages resulting from non-compliance with the provisions of this Clause shall be paid by the Contractor.

4.07 EARLY TERMINATION

The Authority reserves the right to terminate the Work on the Site upon providing at any time reasonable advance notice to the Contractor. In the event of such termination, the Authority's sole obligation to the Contractor shall be limited to the payment for Contractor services performed to that time and payment for other items mutually agreed to in the Contract.

4.08 COMPLETION TIME

If, in the opinion of the Authority's representative the Contractor fails to advance the Work at a rate which will enable the Contractor to meet a completion time agreed to by the Contractor and the Authority prior to the start of work, the Authority's representative may instruct the Contractor to take such action as he considers necessary to sufficiently accelerate the Work; and in particular, with respect to the labour force or plant assigned by the Contractor to the Work, may instruct the Contractor to increase either or both. The Contractor shall forthwith comply with any such instruction.

4.09 SUBCONTRACTS

1. The Contractor shall notify the Authority in writing of the terms of all subcontracts, if any, and the names of subcontractors proposed for the principal parts of the Work and shall not employ any to whom the Authority may reasonably object.
2. The Contractor shall be as fully responsible for the acts and omissions of his subcontractors and their employees as if such subcontractors and their employees were persons directly employed by the Contractor.
3. Subcontractors may be required to provide proof, satisfactory to the Authority, as to their financial capability. The Contractor shall provide the necessary information upon request from the Authority.

4.10 CO-OPERATION

The Contractor shall have no right to the exclusive occupation of the Site of the Work. The Contractor shall co-operate harmoniously with Authority personnel and with other Contractors working at the site. All instructions given by the Authority's representative or his delegate shall be carefully and promptly executed.

4.11 WAGES AND WORKING CONDITIONS

The Public Construction Fair Wages Act applies to this Contract and to every subcontract and to any work done by any other person under this Contract.

4.12 Assigning the Contract

Neither party to this Contract shall assign the Contract or any interest therein without the written consent of the other party.

4.13 AUDIT

The Contractor shall permit representatives of the Authority at all reasonable times, to inspect and audit all records, accounts, statements and other documents of the Contractor relating to the Work and shall keep such records, accounts, statements and documents for at least 1 year after completion of the Work or for such extended period as the Authority may have requested, in advance and in writing, of the Contractor. The liability of the Authority to make any payment other than the sums provided or calculated in accordance with the actual quantities of payment items and prices set out in the Form of Tender, shall be subject to the right of the Authority to inspection and audit as above provided.

4.14 PAYMENT GENERAL

(a) Terms of Payment

Invoices shall be rendered in the first 7 days of each month in respect of all amounts earned by the Contractor during the previous month, and except as provided below such invoices shall be payable in full within 30 days of the receipt of such invoices, provided that if the Authority is unable to verify such invoices within the said period any payment made shall be treated as an advance pending verification of the invoices.

Any necessary adjustments, which have not been made prior to the final invoice for work done shall be made at the time of final payment. If the Authority is shown to have overpaid the Contractor, the Contractor agrees that the Authority may deduct the amount from any other sums due to the Contractor from the Authority or that it will pay the amount to the Authority within 30 days of the amount being agreed or otherwise established.

(b) Submitting of Invoices

All invoices shall be directed to B.C. Hydro and Power Authority, 555 West Hastings Street, Vancouver, B.C., Canada, V6B 4T6, attention System Engineering Division, Meager Creek Geothermal Project. They shall be clearly identified by Purchase Order number and name of project.

CONTRACT NO. Q1-1153

PART 5 - DETAIL SPECIFICATIONS

CONTRACT NO. Q1-1153

PART 5 - DETAIL SPECIFICATIONS

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CONTRACT NO. Q1-1153

PART 5 - DETAIL SPECIFICATIONS

5.01 LOCATION AND ACCESS

The Meager Creek project area is located 160 km north-northwest of Vancouver and approximately 60 km northwest of Pemberton, B.C. (see Maps 1 and 2). Access to the project is via Highway 99 from Vancouver to Pemberton continuing on good gravel surface forestry development and private logging roads to the site.

5.02 SCOPE OF WORK

The Work shall include but is not limited to the supply of all labour, plant and materials and the performance, in accordance with good oilfield and geothermal practice of all things required in connection with the well logging program which includes the following services:

To 1000 feet (300 m)

1. Induction Electric Log. (IES).
2. Dual Induction Laterolog (DIL).
3. Formation Density and Compensated Neutron Logs (FDC/CNL)
4. Sonic Log.
5. Caliper Log.
6. Temperature Log.
7. Thermal Decay Time Log (TDT).

From 1000 (300 m) to 5200 feet (1500 m)

1. Formation Density and Compensated Neutron Log (FDC/CNL).
2. Gamma Ray Log (GR).
3. Sonic Log.
4. Caliper Log.
5. Cement Bond Log in 13 3/8-inch casing (CBL).

6. Temperature Log.
7. Thermal Decay Time Log (TDT).

From 5200 (1500 m) to 7500 feet (2300 m) (Production Interval)

1. Formation Density and Compensated Neutron Log (FDC/CNL).
2. Gamma Ray Log (GR).
3. Sonic Log.
4. Temperature Log.
5. Cement Bond Log in 9 5/8-inch Casing (CBL).
6. Thermal Decay Time Log (TDT).

5.03 COMPLETION TIME

The Contractor shall perform all work as dictated by the drilling program and in a manner so as to keep drill standby time to a minimum.

5.04 FOOD, LODGING AND TRANSPORTATION

The Contractor shall be responsible for daily transportation between the drill site and the Contractor's personnel's place of lodging.

Food and lodging will be provided by the Contractor. It should be noted that the drilling contractor will have a camp at the drill site and it is possible that an arrangement could be made to house well logging contractor's personnel.

5.05 WELL LOGGING EQUIPMENT

Subject to the approval of the Authority, the Contractor may use well logging equipment of his own preference in providing the above listed services. All services are to be performed with high temperature tools and cable (maximum temperature rating 260°C (500°F) or better). Temperatures in excess of 100°C (212°F) can be expected within 500 feet (150 m) of surface and maximum hole temperatures could approach 300°C (575°F) although logging may be difficult in this zone. Items of equipment or materials which in the opinion of the Authority do not meet the specified requirements shall be replaced by the Contractor with equipment and materials meeting the specified requirements.

5.06 EQUIPMENT DESCRIPTION

Details on all equipment to be supplied in connection with the well logging program shall be supplied in an appendix to the Form of Tender.

5.07 OPERATING PERSONNEL

The Contractor will supply all necessary equipment and personnel on site within 24 hours of receiving notice.

5.08 RECORD KEEPING

The Contractor shall maintain strip chart records of all data obtained and provide survey results as requested by the Authority, including six paper copies of all data upon completion of the surveys. In addition, the Contractor shall provide the Authority with any and all calculation results derived from the surveys.

5.09 BASIS OF PAYMENT

(a) General

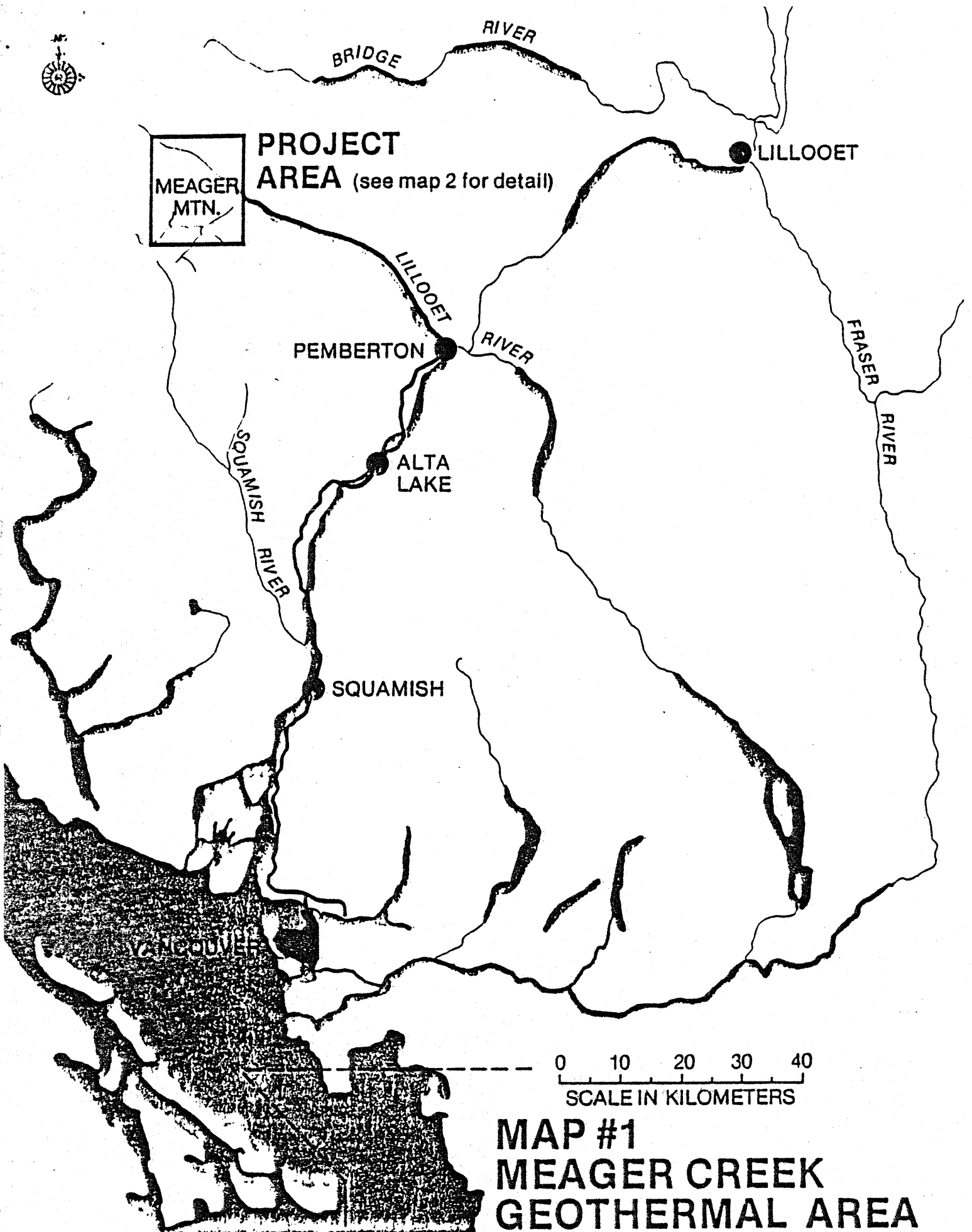
Except as otherwise specifically provided, the prices in the Schedule for payment for the various items of work and materials as described in the Detailed Specifications shall constitute full compensation for supplying and maintaining all equipment, materials, accommodation, labour and supervision and all other work for performing all parts of the well logging program to be carried out by the Contractor in accordance with the provisions of the Contract. The prices entered in the Form of Tender shall also apply to any additional work required by the authority.

(b) Transportation

Transportation of all materials, equipment and personnel to the site shall be the responsibility of the Contractor and the cost thereof should be included in the bid.

5.10 LOCATION MAPS

Maps 1 and 2 are attached.



MEAGER
MTN.

**PROJECT
AREA** (see map 2 for detail)

LILLOOET

PEMBERTON

ALTA
LAKE

SQUAMISH

VANCOUVER

0 10 20 30 40
SCALE IN KILOMETERS

**MAP #1
MEAGER CREEK
GEOTHERMAL AREA**

