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HAT CREEK PROJECT

ASSESSMENT OF THE IMPACT OF CONSTRUCTION WATER SUPPLY: LONG-TERM PUMP TEST PROGRAM ON GROUND AND SURFACE WATER RESOURCES

PREPARED FOR:

BRITISH COLUMBIA HYDRO & POWER AUTHORITY
VANCOUVER, B.C.

SUBMITTED BY:

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REPORT SECTIONS

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SECTION A - REPORT SUMMARY

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1.0 INTRODUCTION

This report is to provide fulfilment of work presented in BEAK's 22 January 1981 proposal to B.C. Hydro and the 22 May 1981 revision.

The scope of this project was to examine the surface water and ground water effects of long-term pumping of ground water at the site of B.C. Hydro's future thermal electrical generating station at Hat Creek. Ground water is going to be required during the construction of the generating station.

BEAK investigated the surface water effects and retained Golder Associates to provide interpretation of the ground water regime.

This report has been divided into three sections. This section (Section A) provides a summary of the overall findings of the whole project. Section B provides a description of the surface water monitoring and Section C contains a report to BEAK by Golder Associates on the ground water aspects of the study.

2.0 DISCUSSION

Two wells capable of pumping ground water from two different aquifers have been drilled at the Hat Creek site.

Well PW1 produces water from an interval of 100 to 113 metres below ground level. Since PW1 produces from a deep aquifer and the aquifer lies below 67 metres of impervious silty clay, Golder Associates determined that pumping from here would not affect Hat Creek. Hence, this well was neither pumped nor assessed for impact during this investigation. A further investigation is planned to identify the extent and characteristics of this aquifer at the northern pit rim.

Pumping well PW2 was the only well pumped during this study. It produces ground water from the Marble Canyon aquifer which is located downstream and north of the Hat Creek aquifer of PW1. The producing interval of PW2 is located from 26 to 29 metres below ground level and hence was believed that pumping from here might affect the flows in Hat Creek. Hence, PW2 was pumped for 30 days from 6 October until 5 November, 1981 in order to investigate possible effects on the creek from long term pumping.

Pumping well PW2 was pumped at a near constant rate of 9.4 l/s (148 U.S. gpm) for 30 days. This resulted in a drawdown of approximately 14 m in the well after 30 days. Three metres of available drawdown remained at the end of the test. Approximately 95 per cent recovery of the well occurred within one hour after pumping ceased. The pumping test was carried out at the end of the dry season (which usually occurs from September to October) to permit the maximum impact on the creek flows to be assessed.

BEAK established stream gauging stations approximately 400 metres apart on Hat Creek, upstream and downstream of the pumping well. For the first 24 days of pumping, the upstream flow measured 10 to 14% greater than downstream flows. Immediately before pumping commenced on 6 October, the upstream flow was 14% greater than the downstream measurement. This 10 - 14% upstream/

downstream difference was 4 to 6 times greater than the removal rate of ground water. On the last 6 days of pumping, the upstream/downstream flow difference was virtually zero.

Since the difference in upstream and downstream creek flows did not increase over the pumping period (in fact it decreased), it is concluded that long-term ground water removal will not affect the volume of Hat Creek. This bears out the conclusion from the ground water monitoring program. While the pumping well was drawn down by 14 metres, the water level in the observation wells dropped by only 2 and 0.13 metres at distances of 47 and 90 metres respectively. Golder Associates accounts for the early difference in upstream and downstream creek flows by the loss of creek water in this interval to surficial gravel deposits because of the depression of the water table during the dry season.

Twenty-five water quality parameters were examined on water sampled from the well and in the creek at the upstream and downstream gauging stations. The water analyses indicated that the water quality in the creek did not suffer during the pumping. In addition, both the ground water and creek water had water acceptable for aquatic life and drinking health standards. Only manganese in the well water was high which is aesthetically undesirable for drinking water.

3.0 CONCLUSIONS

The following conclusions are drawn from the overall study:

1. Long-term pumping of ground water will not affect the flow volumes in Hat Creek.
2. Long-term pumping of ground water will not affect the water quality of Hat Creek if the ground water is used as a source of supply.
3. The creek's water and the ground water should be acceptable for the health of aquatic life and drinking water standards. However, slightly high manganese concentrations make the ground water aesthetically undesirable for drinking water use.
4. The pumping well in this test appears to be capable of pumping continuously a maximum of 800 cubic metres per day (at least 9.4 litres per second or 148 U.S. gallons per minute).
5. The cone of drawdown of the pumping well in this test appears to be limited in extent.

4.0 RECOMMENDATION

Because of the difference in flow rates measured at the upstream and downstream gauging stations in this study, it would be advisable to re-monitor the flows at these same points at a similar time of the year in 1982. Another set of similar data would solidify the findings of the unexpected upstream/ downstream flow differences encountered in this study and would provide more of a data base for the future comparison.

SECTION B - SURFACE WATER STUDY

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1.0 INTRODUCTION

During the 30 day test (October 6 - November 5, 1981) of continuous pumping of ground water from the Hat Creek aquifer, Beak Consultants Limited examined the possibility for changes that could have occured in the surface water of Hat Creek.

Two stream gauging stations were established to determine creek flows upstream and downstream of the pumping well. In addition, water samples were taken for chemical analysis from the two gauging stations and the pump discharge. The following is a report on these aspects of the ground water pumping test.

2.0 DESCRIPTION OF FIELD WORK

Two sites were selected on Hat Creek to serve as stations for water quality sampling and discharge measurements. It was desired to locate both stations outside of the drawdown cone of pumping well PW2 (see Figure 1). One gauging station was located upstream and the other downstream from the potentially affected portion of Hat Creek. It was decided that the Downstream Gauging Station would be situated upstream of where the pump water was discharged into Hat Creek in order to best simulate the situation which would result if the construction camp were consuming the pumped ground water. To ease the analysis of results, it was ensured that Hat Creek received no tributaries between the two gauging stations so that the pump test was the sole influence on this portion of the creek. In addition, to ensure optimium results for stream discharge, the gauging stations were located in a section of the creek where the flow regime was uniform and unimpeded and where the velocity of flow was within the ideal range of the velocity meter.

Based on the proceding considerations, the Upstream Gauging Station was located about 300 metres upstream from the B.C. Hydro Information Centre and the Downstream Gauging Station was situated about 100 metres downstream from the Information Centre. Water samples were taken at these two gauging stations and from the pumping well's (PW2) discharge. The locations of the two gauging stations, pumping well and observation wells are shown in Figure 1.

3.0 SURFACE WATER FLOW RESULTS

Before the results of the creek's flow measurements are presented and discussed, a brief description of the means by which these measurements were determined will be made.

The objective of stream discharge measurement procedure is to determine the volume of water passing through a selected cross section of the stream in a given period of time. First, a channel profile is constructed by measuring the water depth at regular intervals across the width of the stream. Next, the velocity of flow is measured at the same positions across the stream width. The velocity measurements are made at 60% depth (where the average velocity in vertical section is found) using a velocity meter. For this project, a velocity meter manufactured by A.Ott (Kempton, West Germany) was employed. The Ott meter consists of a propeller mounted on a rod and an electrical digital counter which counts rotations of the propeller. Hence, this instrument has been calibrated by the manufacturer to allow calculation of stream velocity from the rate of revolution of the propeller.

When measurements have been completed, usually at ten or more points across the stream width, the velocities are calculated and the corresponding depths are recorded. A plot of velocity X depth versus the stream width is then made after which the stream discharge is determined by measuring the area under the resulting curve.

Since it was expected that any changes in the surface water flow regime in Hat Creek during the pump test would be relatively small, it was thought worthwhile to determine the Ott meter's sensitivity with which discharge could be measured. To carry out this determination, two measurements were made in a very short time space during which there was no rain. These two measurements were made on October 5, 1981, the day before the 30 day pump test began. Measurements were made at the Upstream Gauging Station and at a site 3 metres upstream of the Upstream Gauging Station. Based on the flows calculated at these two sites,

the accuracy for the Ott meter in this project appears to have been within ± 0.003 cubic metres per second:

SITE	TIME	FLOW (m^3/s)
3 m upstream of the Upstream Gauging Station	17:00	0.363
Upstream Gauging Station	17:45	0.360

Creek discharge (flow) measurements were made at the Upstream and Downstream Gauging Stations on five days of the 30 day pumping period. In addition, on October 6, 1981 just before the pumping commenced, flows were measured at the two stations. This data along with the pumping well's discharge rate is presented in Table 1.

From Table 1, after the pumping began, it is seen that the first three upstream flow measurements were 10 - 14% higher than the corresponding downstream flows. These first three measurements span the first 24 days of the 30 day pumping period. Before the pumping began, the upstream flow was 14% higher than the downstream flow. The last two flow determinations show the upstream and downstream flows which are close to being equal when considering the accuracy of the Ott meter previously discussed.

The first upstream/downstream flow measurements in Table 1, which were taken just before the pumping began, indicates that the upstream - downstream difference in the first 24 days was not caused by the pumping. In addition, the differences of the first three upstream/downstream measurements after pumping began were 4 - 5 times greater than the pumping rate.

4.0 WATER QUALITY

Samples analyzed for 25 water quality parameters, were collected on four occasions from each stream gauging station on October 6, 13, 26 and November 3, 1981. The October 6 sample was taken just before the pumping commenced. The pump discharge water was sampled for the same 25 analyses on October 13, 26 and November 3. The water quality analyses varied little to not at all for each sampling source. The water quality parameters (after pumping began) were averaged and are presented in Table II. Table III compares the analyses before and during the pump test.

All of the 25 parameters analyzed fall within the recommended health limits for acceptable water for aquatic life and drinking water standards. However, the manganese level in the well water is higher than the recommended (0.05 mg/L) and objective (0.01 mg/L) levels for drinking water. Manganese concentrations over 0.05 mg/L are not aesthetically ideal for drinking water. The pumping does not appear to have affected the water quality at the Upstream and Downstream Gauging Stations. Further, the discharging of all of the pumped ground water into Hat Creek during the test does not appear to have changed the water quality in the creek as seen in the last column of Table II.

The total dissolved solids (nonfiltrable residue) of the well water averaged about 350 mg/L which is typical of ground water from surficial materials as sampled by B.C. Hydro*. The Hat Creek surface water total dissolved solids of approximately 290 mg/L is also within the range of previously measured samples although this parameter has been shown to vary widely during the year*.

This sampling program should now provide a baseline water quality against which any progressive changes in the creek or ground water can be assessed.

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* British Columbia Hydro & Power Authority, Thermal Generation Projects Division: "Hat Creek Project 1979 Environmental Field Programmes" (April, 1981).

5.0 CONCLUSIONS

1. The pumping of ground water from well PW2 does not appear to have influenced the creek's flow because:

   (a) The upstream flow was greater than the downstream flow before pumping started and continued to be greater by about the same magnitude during the first 24 days of the test. Before pumping, the upstream/downstream flow difference was 6 times greater than the ground water pumping rate and 4 - 5 times greater than the pumping rate during the first 24 days of the test.

   (b) The upstream/downstream flow difference on the last 6 days of the test was virtually zero. If the pumping had affected the creek's flow, the upstream/downstream flow difference should have increased.

2. The water quality of Hat Creek was not affected by the pumping of ground water from pumping well PW2.

3. The water quality of Hat Creek was not materially affected by the discharge of ground water into the creek (see Column 4 of Table II).

4. The water quality of the creek appears to be suitable for aquatic life.

5. The ground water appears to be generally suitable for drinking water and only its manganese concentration is slightly high from an aesthetic standpoint.

6.0 RECOMMENDATION

The creek flow at the two gauging stations should be remonitored during the dry season in 1982 to determine if the upstream/downstream flow difference is a normal phenomenon during this time of year.

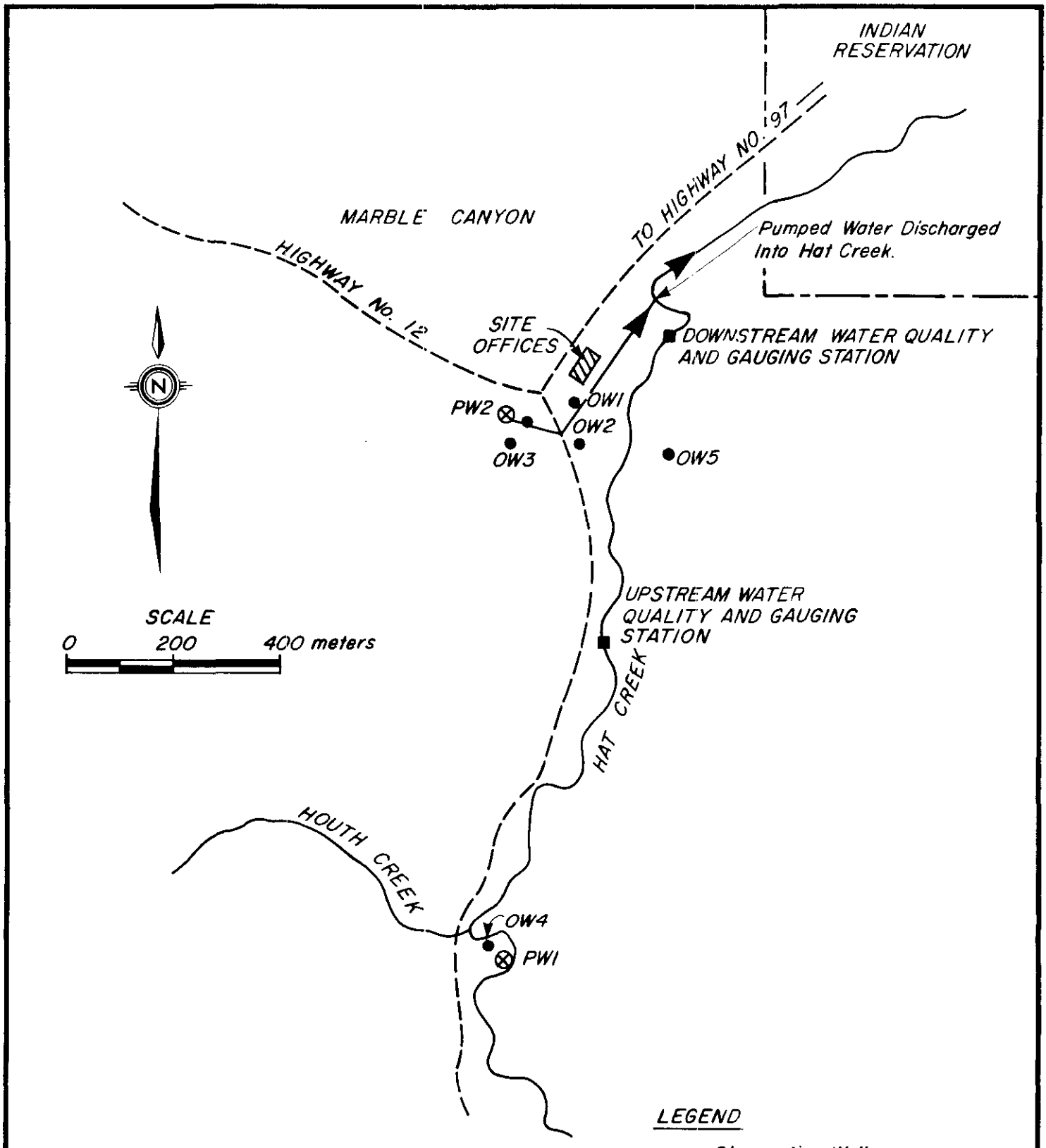

FIGURE 1 : *HAT CREEK*

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TABLE I

FLOW DATA (m^3/s)

Date (1981)	(1) Upstream Gauging Station	(2) Downstream Gauging Station	(3) Difference of (1) - (2)	(4) Well Discharge	(5) Sum of (2) + (4)
October 6 Pumping Commenced	0.442	0.387	0.055	0.0094	0.3964
October 27	0.358	0.317	0.041	0.0094	0.3264
October 28	0.387	0.340	0.047	0.0094	0.3494
October 30	0.355	0.322	0.033	0.0094	0.3314
November 1	0.338	0.332	0.006	0.0094	0.3414
November 3	0.332	0.330	0.002	0.0094	0.3394
Average During Pumping	0.354	0.328	0.026	0.0094	0.3374

TABLE II

WATER QUALITY ANALYSES DURING THE PUMP TEST OF HAT CREEK WELL WATER AND THEORETICAL CALCULATION DOWNSTREAM OF THE WELL WATER DISCHARGE INTO HAT CREEK

ANALYSIS	UPSTREAM GAUGING STATION	DOWNSTREAM GAUGING STATION	WELL WATER	*THEORETICAL CALCULATION DOWNSTREAM OF WELL WATER DISCHARGE
Total Cyanide	<0.005	<0.005	<0.005	<0.005
Dissolved Fluoride	0.09	0.08	0.12	0.08
Nitrate Nitrogen	0.021	0.011	0.011	0.011
pH	8.3	8.3	7.9	8.3
Filtrable Residue	291	285	346	287
Nonfiltrable Residue	2	1	<1	<1
Dissolved Aluminum	0.006	0.012	0.007	0.012
Dissolved Antimony	<0.001	<0.001	<0.001	<0.001
Dissolved Arsenic	0.009	0.007	<0.005	<0.007
Dissolved Cadmium	<0.005	<0.005	<0.005	<0.005
Dissolved Chromium	<0.01	<0.01	<0.01	<0.01
Dissolved Cobalt	<0.01	<0.01	<0.01	<0.01
Dissolved Copper	<0.005	<0.005	<0.005	<0.005
Dissolved Iron	0.03	0.03	0.02	0.03
Dissolved Lead	0.02	0.02	0.02	0.02
Dissolved Manganese	0.01	0.01	0.12	0.01
Dissolved Molybdenum	<0.03	<0.03	<0.03	<0.03
Dissolved Nickel	<0.01	<0.01	<0.01	<0.01
Dissolved Selenium	<0.001	<0.001	<0.001	<0.001
Dissolved Silver	<0.01	<0.01	<0.01	<0.01
Dissolved Uranium	0.0044	0.0043	0.0047	0.0043
Dissolved Zinc	0.008	0.007	0.022	0.007
Total Arsenic	0.009	0.007	<0.005	<0.007
Total Mercury	<0.00025	<0.00025	<0.00025	<0.00025
Radium 226 Radioactivity (Bq/L)**	0.02	0.02	0.02	0.02

1. All units are in mg/L except pH and Radium 226.
2. Upstream and downstream numbers tabulated are averages of 3 samples taken on separate days.

* The theoretical concentrations are calculated from:

$$\frac{(\text{Average Downstream Flow} \times \text{Concentration}) + (\text{Well Discharge Rate} \times \text{Concentration})}{\text{Average Downstream Flow} + \text{Well Discharge Rate}}$$

** 1 Bq/L = 27 pCi/L

TABLE III

BEFORE AND DURING PUMP TEST

ANALYSIS	UPSTREAM GAUGING STATION BEFORE TEST	UPSTREAM GAUGING STATION DURING TEST	DOWNSTREAM GAUGING STATION BEFORE TEST	DOWNSTREAM GAUGING STATION DURING TEST
Total Cyanide	<0.005	<0.005	<0.005	<0.005
Dissolved Fluoride	0.09	0.09	0.09	0.08
Nitrate Nitrogen	0.025	0.021	0.019	0.011
pH	8.3	8.3	8.2	8.3
Filtrable Residue	298	291	289	285
Nonfiltrable Residue	3	2	2	1
Dissolved Aluminum	0.032	0.06	0.014	0.012
Dissolved Antimony	<0.001	<0.001	<0.001	<0.001
Dissolved Arsenic	0.009	0.009	0.008	0.007
Dissolved Cadmium	<0.005	<0.005	<0.005	<0.005
Dissolved Chromium	<0.01	<0.01	<0.01	<0.01
Dissolved Cobalt	<0.01	<0.01	<0.01	<0.01
Dissolved Copper	<0.005	<0.005	<0.005	<0.005
Dissolved Iron	0.03	0.03	0.04	0.03
Dissolved Lead	0.02	0.02	0.02	0.02
Dissolved Manganese	0.01	0.01	0.01	0.01
Dissolved Molybdenum	<0.03	<0.03	<0.03	<0.03
Dissolved Nickel	<0.01	<0.01	<0.01	<0.01
Dissolved Selenium	<0.001	<0.001	<0.001	<0.001
Dissolved Silver	<0.01	<0.01	<0.01	<0.01
Dissolved Uranium	0.0032	0.0044	<0.00002	0.0043
Dissolved Zinc	0.005	0.008	<0.005	0.007
Total Arsenic	0.009	0.009	0.014	0.007
Total Mercury	<0.00025	<0.00025	<0.00025	<0.00025
Radium 226 Radioactivity (Bq/L)	0.03	0.02	0.02	0.02

1. All units are in mg/L except pH and Radium 226.

Results during pumping are averages of 3 samples.
Results before pumping are from one sample.

APPENDIX I

WATER QUALITY DATA OCTOBER 6, 1981

BEFORE PUMP TEST COMMENCED

ANALYSIS	UPSTREAM GAUGING STATION	DOWNSTREAM GAUGING STATION
Total Cyanide	<0.005	<0.005
Dissolved Flouride	0.09	0.09
Nitrate Nitrogen	0.025	0.019
pH	8.3	8.2
Filtrable Residue	298	289
Nonfiltrable Residue	3	2
Dissolved Aluminum	0.032	0.014
Dissolved Antimony	<0.001	<0.001
Dissolved Arsenic	0.009	0.008
Dissolved Cadmium	<0.005	<0.005
Dissolved Chromium	<0.01	<0.01
Dissolved Cobalt	<0.01	<0.01
Dissolved Copper	<0.005	<0.005
Dissolved Iron	0.03	0.04
Dissolved Lead	0.02	0.02
Dissolved Manganese	0.01	0.01
Dissolved Molybdenum	<0.03	<0.03
Dissolved Nickel	<0.01	<0.01
Dissolved Selenium	<0.001	<0.001
Dissolved Silver	<0.01	<0.01
Dissolved Uranium	0.0032	<0.00002
Dissolved Zinc	<0.005	<0.005
Total Arsenic	0.009	0.014
Total Mercury	<0.00025	<0.00025
Radium 226 Radioactivity (Bq/L)	0.03	0.02

Results are in mg/L except pH and Radium 226.

APPENDIX II

WATER QUALITY DATA OCTOBER 13, 1981

ANALYSIS	UPSTREAM GAUGING STATION	DOWNSTREAM GAUGING STATION	PUMP WATER
Total Cyanide	<0.005	<0.005	<0.005
Dissolved Flouride	0.09	0.08	0.12
Nitrate Nitrogen	0.022	0.009	0.010
pH	8.3	8.3	7.8
Filtrable Residue	292	276	340
Nonfiltrable Residue	1	1	<1
Dissolved Aluminum	0.005	0.013	0.005
Dissolved Antimony	<0.001	<0.001	<0.001
Dissolved Arsenic	0.009	0.006	0.005
Dissolved Cadmium	<0.005	<0.005	<0.005
Dissolved Chromium	<0.01	<0.01	<0.01
Dissolved Cobalt	<0.01	<0.01	<0.01
Dissolved Copper	<0.005	<0.005	<0.005
Dissolved Iron	0.04	0.03	0.02
Dissolved Lead	0.03	0.03	0.03
Dissolve Manganese	0.01	0.01	0.11
Dissolved Molybdenum	<0.03	<0.03	<0.03
Dissolved Nickel	<0.01	<0.01	<0.01
Dissolved Selenium	<0.001	<0.001	<0.001
Dissolved Silver	<0.01	<0.01	<0.01
Dissolved Uranium	0.0042	0.0042	0.0038
Dissolved Zinc	0.007	0.007	0.023
Total Arsenic	0.008	0.006	<0.005
Total Mercury	<0.00025	<0.00025	<0.00025
Radium 226 Radioactivity (Bq/L)	0.03	0.03	0.02

Results are in mg/L except pH and Radium 226.

APPENDIX III

WATER QUALITY DATA OCTOBER 26, 1981

ANALYSIS	UPSTREAM GAUGING STATION	DOWNSTREAM GAUGING STATION	PUMP WATER
Total Cyanide	<0.005	<0.005	<0.005
Dissolved Flouride	0.09	0.08	0.12
Nitrate Nitrogen	0.015	0.007	0.012
pH	8.3	8.3	7.9
Filtrable Residue	294	292	351
Nonfiltrable Residue	2	1	<1
Dissolved Aluminum	0.005	0.014	0.005
Dissolved Antimony	<0.001	<0.001	<0.001
Dissolved Arsenic	0.009	0.007	<0.005
Dissolved Cadmium	<0.005	<0.005	<0.005
Dissolved Chromium	<0.01	<0.01	<0.01
Dissolved Cobalt	<0.01	<0.01	<0.01
Dissolved Copper	<0.005	<0.005	<0.005
Dissolved Iron	0.03	0.03	0.02
Dissolved Lead	0.02	0.02	0.02
Dissolve Manganese	0.02	0.01	0.12
Dissolved Molybdenum	<0.03	<0.03	<0.03
Dissolved Nickel	<0.01	<0.01	<0.01
Dissolved Selenium	<0.001	<0.001	<0.001
Dissolved Silver	<0.01	<0.01	<0.01
Dissolved Uranium	0.0046	0.0040	0.0046
Dissolved Zinc	0.008	0.005	0.023
Total Arsenic	0.009	0.007	<0.005
Total Mercury	<0.00025	<0.00025	<0.00025
Radium 226 Radioactivity (Bq/L)	0.01	0.01	0.02

Results are in mg/L except pH and Radium 226.

APPENDIX IV

WATER QUALITY DATA NOVEMBER 3, 1981

ANALYSIS	UPSTREAM GAUGING STATION	DOWNSTREAM GAUGING STATION	PUMP WATER
Total Cyanide	< 0.005	<0.005	<0.005
Dissolved Flouride	0.08	0.08	0.11
Nitrate Nitrogen	0.027	0.018	0.012
pH	8.4	8.4	8.1
Filtrable Residue	286	288	346
Nonfiltrable Residue	2	2	<1
Dissolved Aluminum	0.009	0.010	0.010
Dissolved Antimony	<0.001	<0.001	<0.001
Dissolved Arsenic	0.010	0.007	<0.005
Dissolved Cadmium	<0.005	<0.005	<0.005
Dissolved Chromium	<0.01	<0.01	<0.01
Dissolved Cobalt	<0.01	<0.01	<0.01
Dissolved Copper	<0.005	<0.005	<0.005
Dissolved Iron	0.03	0.03	0.02
Dissolved Lead	0.02	0.02	0.02
Dissolve Manganese	0.01	0.01	0.12
Dissolved Molybdenum	<0.03	<0.03	<0.03
Dissolved Nickel	<0.01	<0.01	<0.01
Dissolved Selenium	<0.001	<0.001	<0.001
Dissolved Silver	<0.01	<0.01	<0.01
Dissolved Uranium	0.0044	0.0048	0.0056
Dissolved Zinc	<0.005	0.007	0.021
Total Arsenic	0.010	0.008	<0.005
Total Mercury	<0.00025	<0.00025	<0.00025
Radium 226 Radioactivity (Bq/L)	0.02	0.02	0.03

Results are in mg/L except pH and Radium 226.

SECTION C - GROUND WATER STUDY

REPORT TO BEAK CONSULTANTS ON THE EXTENSION TO THE HAT CREEK ENVIRONMENTAL GROUND WATER ASSESSMENT

BRITISH COLUMBIA

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Vancouver, British Columbia

January 1982

812-1512

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1.0 INTRODUCTION

The terms of reference for the work covered by this report are contained in Golder Associates proposal 812-1512 dated January 1981. The work involved the assessment of the impact on the ground and surface water resources at Hat Creek, caused by the long-term pump testing of wells drilled for the purpose of providing a water supply for construction purposes. The details of the exploration, design and construction of the wells has been reported on in Golder Associates report 812-1507 submitted to British Columbia Hydro and Power Authority (BCH) in January 1982.

Golder Associates hydrogeological staff carried out the ground water field work during October and November 1981. Field work for the surface water program involving water quality sampling and stream gauging was separately undertaken by Beak Consultants. Routine ground water measurements were made by the BCH site staff.

2.0 PROJECT OBJECTIVE

Production wells have been installed in two separate aquifers; one the Hat Creek Valley aquifer lies just north of the proposed pit and the other the Marble Canyon aquifer is at the Hat Creek road junction close to the BCH temporary office (see Figure 1). Because of the proximity of these aquifers to Hat Creek itself, it was considered necessary to assess the impact that pumping from them would have on the flows in the creek. This has particular significance due to the fact that the water is abstracted from the creek by the Boneparte Indian Band downstream of the well sites. It was decided that the optimum time for carrying out this assessment would be at the end of the dry season in say September/October time when flows would be minimal.

Of the two wells installed, only that in the Marble Canyon aquifer (PW2) is considered to be able to impact the creek flows. Well PW1 installed in the Hat Creek aquifer was screened between 100 and 113 m below ground; some 67 m of silty clay overlies the sandy gravel aquifer in this well.

The methods used to assess the impact of pumping on the creek were as follows:

- establishment of gauging stations on Hat Creek both upstream and downstream of the area likely to be impacted by pumping (see Figure 1).
- monitoring of creek flows both before, during and after pumping.
- execution of a 30-day pumping test on well PW2 with monitoring in the surrounding observation wells.
- measurement of flows from the well (returned to the creek downstream of the test)
- sampling and chemical analysis of creek and well water at periodic intervals during testing.
- analysis of data and assessment of potential impacts.

3.0 TEST PROCEDURE

During June and July 1981, two production wells 203 mm (8") in diameter (PW1, PW2), three observation wells 152 mm (6") in diameter (OW2, OW3, OW4) and two standpipe piezometers (OW1, OW5) were completed in the Hat Creek area north of the proposed pit for the purpose of providing a water supply for construction purposes. The locations of these installations are shown on Figure 1 and presented in schematic hydrogeological section in Figure 2; the wells are described in GA report 812-1507 dated January, 1982. Following the completion of the wells, and prior to the long-term pump testing, a program of ground water monitoring was carried out by B.C. Hydro staff during August and September. Over this period water levels in all completed installations was recorded daily.

A five horsepower submersible pump was installed in production well PW2 by A and H Construction of Abbotsford, B.C. under the supervision of Golder Associates. The pumped water was discharged through a 100 mm diameter hose into Hat Creek at the location shown on Figure 1. This site was selected to be downstream of the stream gauging locations so as not to interfere with the pumping test results. A digital flow meter was attached to the discharge pipe approximately 2 m from the well.

Pumping of this well commenced on the 6th of October 1981 and was continued for 30 days. A near constant pumping rate of 9.4 l/s was maintained throughout the length of the test. It was found that as the drawdown in the well increased, the pump rate decreased, since the water had to be pumped against an increasing hydraulic head. It was thus necessary to occasionally adjust the pump rate.

It was intended to produce as much drawdown in the well as was available, and hence create as large an impact as possible on the surrounding ground water regime. This aim was achieved, since at the end of the test period only 3 m of available drawdown in the pump well remained.

The response of the ground water regime to pumping was monitored in the nearby wells and piezometers. For the first two days of the test, water levels were monitored by Golder Associates field staff. Thereafter BCH staff took daily readings of water levels and pumping rates and reported to Golder Associates.

Pumping ceased on the 5th of November. The first day of the recovery was monitored by Golder Associates with BCH field staff continuing the monitoring program until sufficient stabilisation had been achieved.

4.0 TEST RESULTS AND ANALYSIS

The pump test data was reduced using Golder Associates' pump test program. The reduced data was then used to plot hydrographs to permit analysis by conventional methods.

The pump test hydrograph shown in Figure 3 illustrates the response of the wells in Marble Canyon to pumping. Three conventional methods of analysis were used for this test. The Theis and Jacob methods were used to analyze drawdown data and the Theis recovery method was used to analyze the recovery data. Although many of the assumptions inherent in all these methods could not be completely satisfied, due mainly to the geological nature of the material being tested, it is felt that the results of analysis are adequate for the purposes of this study. In the absence of analytical techniques for complex situations, it is acceptable to utilize conventional techniques as long as the limitations and inaccuracies are kept in mind.

For the interpretation a pumping rate of 9.4 1/s (148 U.S. gpm) was used although at times during the pumping a slight fluctuation was recorded. Analysis of the recovery data should be considered more reliable since the curves are smooth and not influenced by a fluctuating pump rate. It was only considered possible to analyse the responses in OW3 and PW2 to pumping. OW2 is screened in a lower aquifer, while the piezometers in OW5 and OW1 showed only slight response to pumping PW2 even though they were screened within the same aquifer. It is considered that the decline in water level of 70 mm in OW5 is due to the natural ground water recession associated with a period of no recharge. Water levels in OW4 and PW1, completed in the deep Hat Creek Aquifer, continued to rise during the pump test in PW2. The recovery of water levels in these wells was associated with the pump test carried out in PW1 during July, 1981 and reported in Golder Associates' report 812-1507 submitted to B.C. Hydro and Power Authority, January 1982.

The results of the analysis are contained in Table 1.

It can be seen that the results from the various methods are in good agreement with a median hyraulic conductivity for the sandy gravel of 5×10^{-5} m/s. The value of storage calculated is in the order of 1×10^{-4}.

The time drawdown graphs for both PW2 and OW3 can be matched to the Theis type curve for early times (less than 10 minutes). Thereafter the response can be matched to "leaky" type curves indicating a probable semi-confined recharging aquifer system. At times greater than 1000 minutes, a deviation from the leakage curves is observed and this is assumed to be due to a boundary effect limiting the extent of the expanding cone of depression.

A schematic geological section of Marble Canyon is presented in Figure 2. This area is a zone of ground water discharge to Hat Creek and is characterized by increasing hydraulic heads with depth (i.e. near vertical upward ground water flow). It is suspected that the recharging response seen in the time drawdown curves is due to leakage from the underlying gravelly sand aquifer screened in OW2. A value of hydaulic conductivity for the intervening aquitard is calculated as 7.8×10^{-7} m/s.

The results of streamflow gauging of Hat Creek during the pumping test is shown in Table 2. The results indicate a greater decline in upstream flows over downstream flows over the duration of the test. This is contrary to what would be expected if test pumping was affecting streamflow. It is considered that this decline in streamflow upstream is possibly due to increased abstraction for irrigation purposes or due to the loss of stream water flow into the surficial gravels as ground water levels declined seasonally. Pumping PW2 does not appear to have had any effects on the aquifer in the vicinity of Hat Creek.

5.0 SUMMARY AND CONCLUSIONS

Drawdown in PW2 was approaching stabilization after only 100 minutes of pumping at 9.4 l/s. Fluctuations after this time are considered more a function of fluctuating pumping rate rather that aquifer characteristics.

The cone of drawdown appears to be very steep and limited in extent. A drawdown of approximately 14 metres at the pump well-produced only 2.0 metres of drawdown at a distance of 47 metres (OW3) and only about .13 metres of drawdown at a distance of 90 metres (OW1). Approximately 95 per cent recovery of the pumping well, after 30 days of pumping occurred within 1 hour.

There are no indications that the pumping of well (PW2) at the rates being considered will have any impact on flow rates in Hat Creek.

We trust that this report provides the information you require at this time. If you should have any questions or comments, please do not hesitate to contact us.

Yours very truly,
GOLDER ASSOCIATES

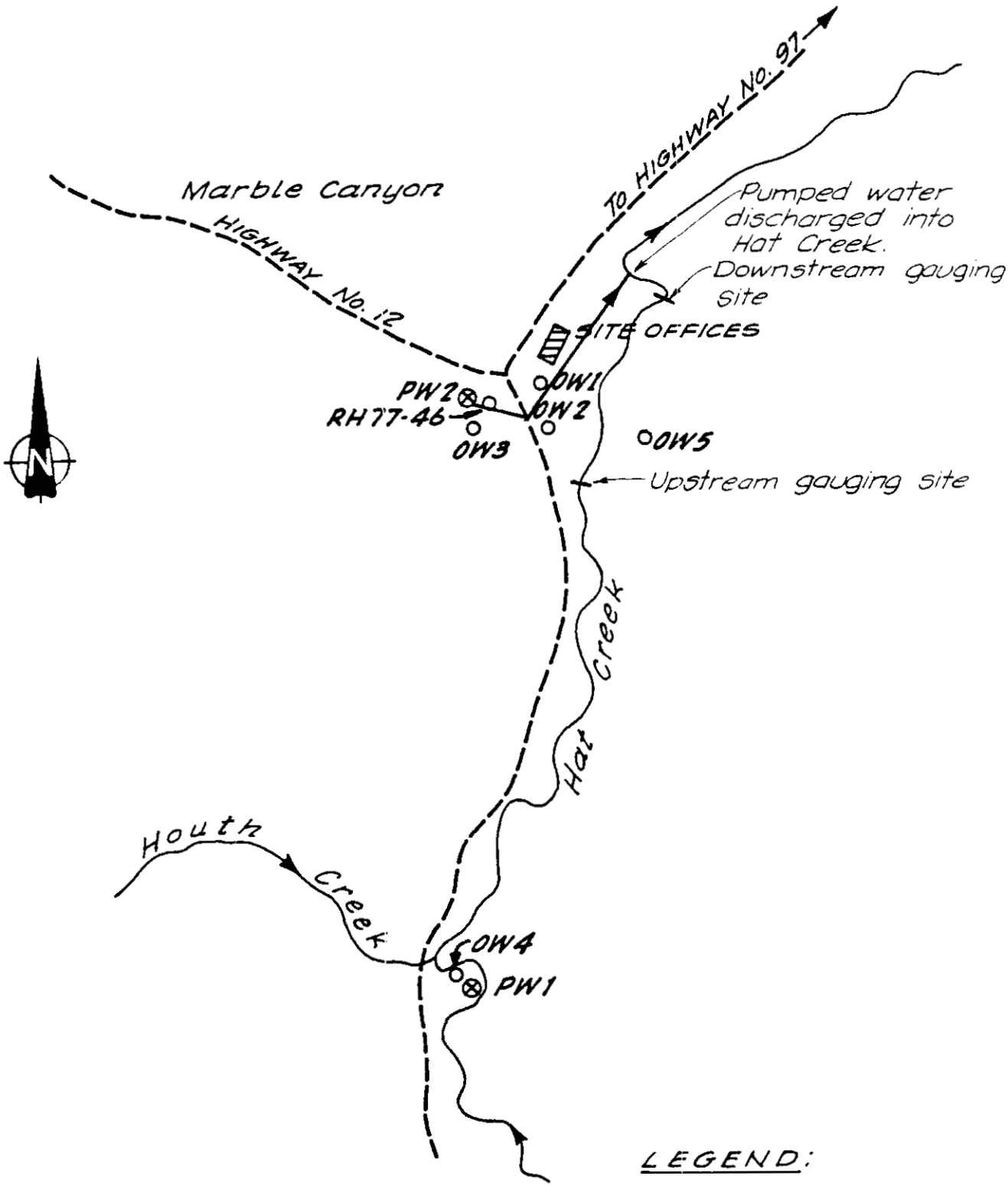
G.E. Rawlings, P. Eng.

R.S. Guiton

GER/RSG/km
812-1512

WELL LOCATION PLAN
HAT CREEK

Figure 1

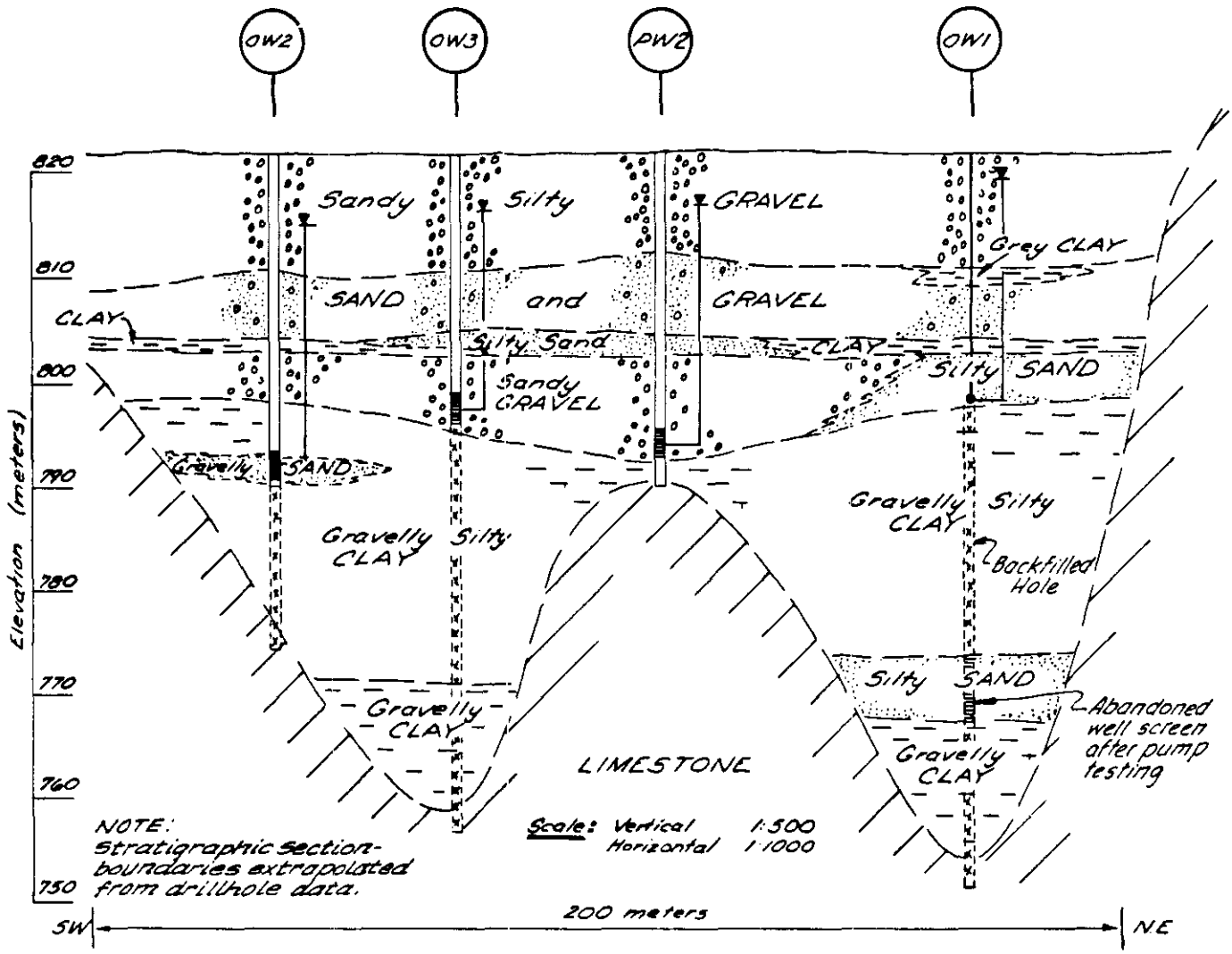


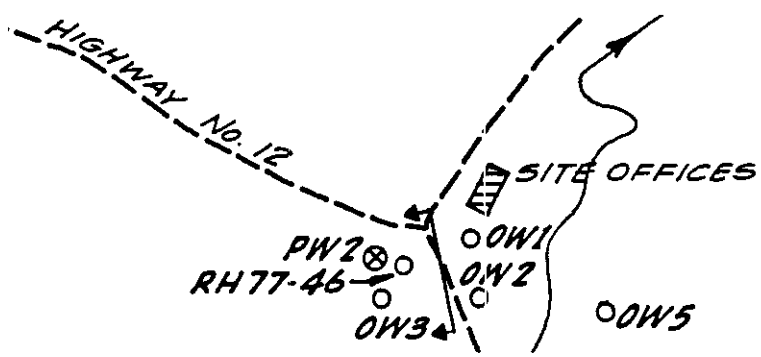
PROJECT NO. 812/1512 DRAWN HB REVIEWED DATE Nov. '81

Golder Associates

SCHEMATIC SECTION - MARBLE CANYON AQUIFER SYSTEM

Figure 2





Location of Section

LEGEND

Water level

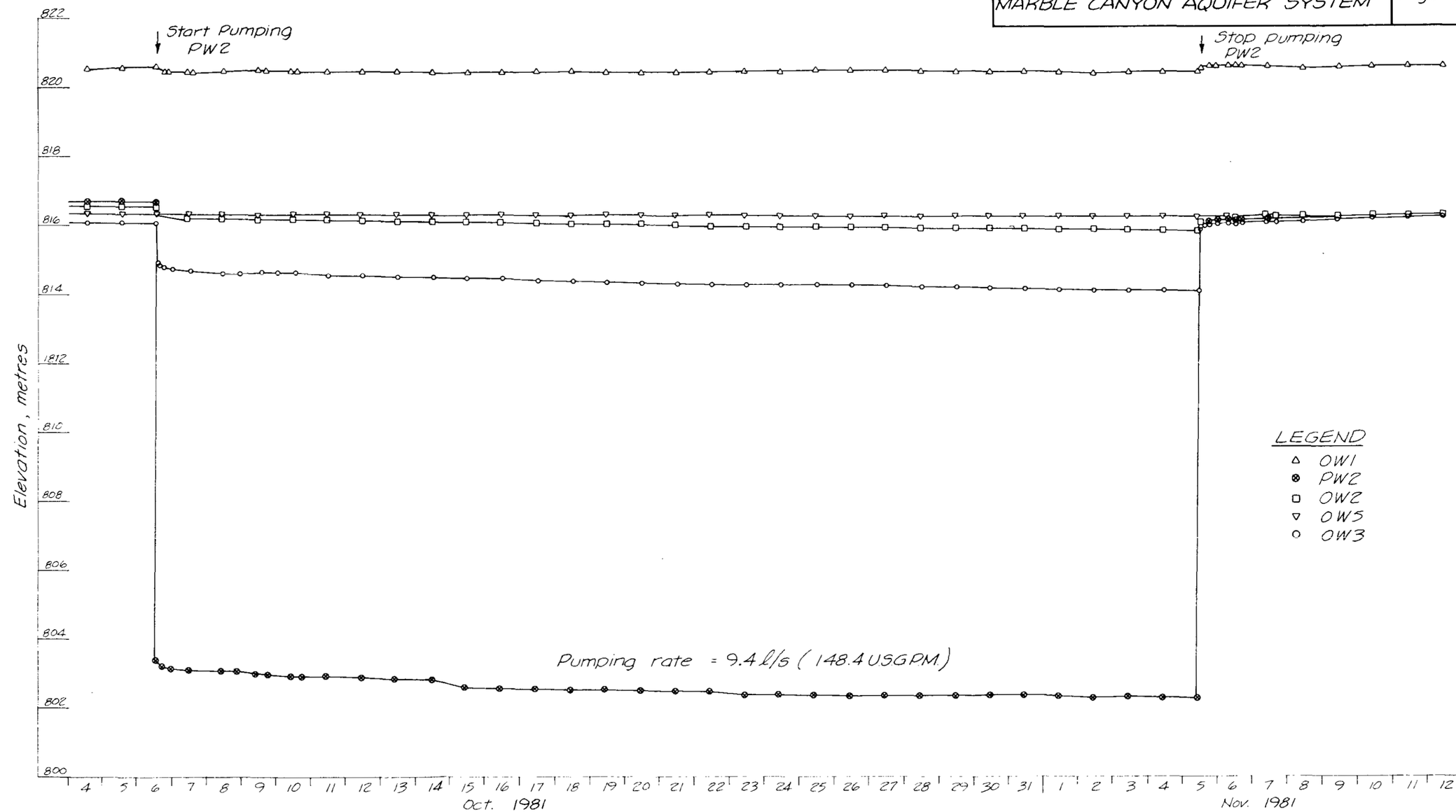
Well screen

Piezometer

PROJECT NO. 812-1507 DRAWN R.Q REVIEWED DATE July '81

LONG TERM PUMPTEST HYDROGRAPH
MARBLE CANYON AQUIFER SYSTEM

Figure 3



Golder Associates

Drawn R.D.
Reviewed
Date: Nov. '81

812-1512

TABLE 1 Summary of Pump Test Results

Well Number	Method of Analysis	Transmissivity m^2/s	Storage Coefficient	Hydraulic Conductivity m/s	Estimated Acquifer Thickness m
PW2	Theis Drawdown	1.52×10^{-4}	-------	1.52×10^{-5}	10.0
"	Theis Recovery	2.25×10^{-4}	-------	2.25×10^{-5}	10.0
"	Jacob Drawdown	4.3×10^{-4}	-------	4.3×10^{-5}	10.0
OW3	Jacob Drawdown	1.92×10^{-3}	1.31×10^{-4}	3.0×10^{-4}	6.4
"	Theis Drawdown	9.6×10^{-4}	1.67×10^{-4}	1.5×10^{-4}	6.4
"	Theis Recovery	2.04×10^{-3}	-------	3.2×10^{-4}	6.4

TABLE 2 Streamflow Measurements in Hat Creek
(Beak Consultant)

Date(1981)	Upstream Station l/s	Downstream Station l/s	Qu/Qd
6th October	442	387	1.14
27th October	358	317	1.13
28th October	387	340	1.14
30th October	355	322	1.10
1st November	338	332	1.02
3rd November	332	330	1.01

APPENDIX A

A-1 Data
A-2 Theis Analysis
A-3 Jacob Analysis

GOLDER ASSOCIATES

PUMP TEST SUMMARY FOR WELL/PIEZOMETER NUMBER = Pw2,

20/11/81-12.07.50

PUMPED WELL NUMBER = Pw2,
CLIENT = B.C. HYDRO,
PROJECT NAME = HAT CREEK ENVIRONMENTAL STUDY,
PROJECT NUMBER = 8121512,
LOCATION OF TEST = HAT CREEK B.C.,
TYPE OF TEST = CONSTANT RATE
DATE PUMP STARTED = 6/10/81-20.0/13
(DAY/MO/YR-MIN/HRS)
DATE PUMP STOPPED = 5/11/81- 0.0/11

DATA ON OBSERVATION WELL

GROUND ELEVATION =	822.26	METRES
DATUM POINT =		TOP OF WELL CASING,
HEIGHT OF DATUM ABOVE GROUND LEVEL =	.41	METRES
DEPTH TO STATIC WATER LEVEL =	5.98	METRES
ELEVATION OF STATIC WATER LEVEL =	816.69	METRES
TYPE OF OBSERVATION WELL =		SCREENED WELL
DEPTH OF SCREENED INTERVAL =	25.93 TO	29.18 METRES
DISTANCE FROM PUMPING WELL =	0.00	METRES

DATA ON PUMPED WELL

WELL DIAMETER =	.203	m
PUMP TYPE =		SUBMERSIBLE

FLOW MEASUREMENT

FLOWMETER, TYPE =		DIGITAL,
PUMPING RATE =	9.399E+00	LITRES/S

AQUIFER DATA

AQUIFER CONDITIONS =		UNCONFINED
AQUIFER DESCRIPTION =		SANDY GRAVEL,
AQUIFER THICKNESS =	100	METRES

TEST DETAILS
WEATHER CONDITIONS = VARIABLE,
TESTED BY = GOLDER ASSOCIATES,
COMMENTS = NONE,

DATE YR	MON	DAY	TIME HR	MIN	ELAPSED TIME MINUTES	PRESSURE READING PSI	DEPTH TO WATER METRES	DRAWDOWN METRES	WATER ELEVATION METRES	DISCHARGE RATE LITRES/S	COMMENTS
0	0	0	0	0.0			0.00		822.67		
0	0	0	0	0.0			0.00		822.67		
81	10	6	9	55.0			5.98		816.69		
81	10	6	13	28.3	0.3		10.82	4.84	811.85	9.46	START PUMP 1328 METER READING 212090
81	10	6	13	28.6	0.6		13.66	7.68	809.01		
81	10	6	13	29.2	1.2		14.48	8.86	807.83		
81	10	6	13	29.5	1.5		15.74	9.76	806.93		
81	10	6	13	30.0	2.0		16.29	10.31	806.38		
81	10	6	13	30.5	2.5		16.71	10.73	805.96		
81	10	6	13	31.0	3.0		17.07	11.09	805.60		
81	10	6	13	31.5	3.5		17.38	11.36	805.33		
81	10	6	13	32.0	4.0		17.50	11.52	805.17		
81	10	6	13	32.5	4.5		17.71	11.73	804.96		
81	10	6	13	33.0	5.0		17.80	11.82	804.87		
81	10	6	13	34.0	6.0		18.01	12.03	804.66		
81	10	6	13	36.5	8.5		18.22	12.24	804.45		
81	10	6	13	37.0	9.0		18.35	12.37	804.32		
81	10	6	13	38.0	10.0		18.47	12.49	804.20		
81	10	6	13	43.0	15.0		18.73	12.75	803.94		
81	10	6	13	48.2	20.2		18.96	12.98	803.71		
81	10	6	13	50.2	22.2		19.00	13.02	803.67		
81	10	6	13	53.0	25.0		19.04	13.06	803.63		
81	10	6	13	58.0	30.0		19.09	13.11	803.58		
81	10	6	14	8.0	40.0		19.16	13.18	803.51		
81	10	6	14	19.0	51.0		19.20	13.22	803.47		
81	10	6	14	29.0	61.0		19.25	13.27	803.42	9.64	METER READING 221255 AT 1428
81	10	6	14	51.0	83.0		19.30	13.32	803.37		
81	10	6	15	10.0	102.0		19.33	13.35	803.34		
81	10	6	16	0.0	152.0		19.40	13.42	803.27		
81	10	6	16	48.0	200.0		19.38	13.40	803.29		
81	10	6	17	38.0	250.0		19.40	13.42	803.27		
81	10	6	18	28.0	300.0		19.46	13.48	803.21		METER READING 257430 AT 6129
81	10	6	20	8.0	400.0		19.44	13.46	803.23		
81	10	6	21	48.0	500.0		19.46	13.48	803.21		METER READING 287330 AT 2114R
81	10	6	23	28.0	600.0		19.51	13.53	803.16		METER READING 302320 AT 2312R
81	10	7	2	48.0	800.0		19.52	13.54	803.15		
81	10	7	6	8.0	1000.0		19.53	13.55	803.14	9.45	
81	10	7	14	28.0	1500.0		19.59	13.61	803.08		METER READING 436R10
81	10	7	16	51.0	1643.0		19.67	13.69	803.00		
81	10	8	8	0.0	2552.0		19.62	13.64	803.05		
81	10	8	16	0.0	3032.0		19.60	13.62	803.07	9.28	METER READING 665770
81	10	9	8	0.0	3992.0		19.67	13.69	803.00	9.34	
81	10	9	16	0.0	4472.0		19.71	13.73	802.96	9.37	
81	10	10	8	0.0	5432.0		19.69	13.71	802.98	9.28	METER READING 1023300
81	10	10	16	0.0	5912.0		19.70	13.72	802.97	9.39	

DATE			TIME		ELAPSED TIME	PRESSURE READING	DEPTH TO WATER	DRAWDOWN	WATER ELEVATION	DISCHARGE RATE	COMMENTS
YR	MON	DAY	HR	MIN	MINUTES	PSI	METRES	METRES	METRES	LITRES/S	
81	10	11	8	0.0	6872.0		19.71	13.75	802.96	9.37	
81	10	12	8	0.0	8312.0		19.75	13.75	802.94	9.36	
81	10	13	8	0.0	9752.0		19.78	13.80	802.89	9.36	METER READING 1664150
81	10	14	8	0.0	11192.0		19.81	13.83	802.86	9.56	INCREASE PUMP RATE
81	10	15	8	0.0	12632.0		20.10	14.12	802.57	9.44	
81	10	16	8	0.0	14072.0		20.13	14.15	802.54	9.45	METER READING 2525100
81	10	17	8	0.0	15512.0		20.13	14.15	802.54	9.46	
81	10	18	8	0.0	16952.0		20.16	14.18	802.51	9.46	
81	10	19	8	0.0	18392.0		20.17	14.19	802.50	9.42	
81	10	20	8	0.0	19832.0		20.19	14.21	802.48	9.42	
81	10	21	8	0.0	21272.0		20.20	14.22	802.47	9.42	
81	10	22	8	0.0	22712.0		20.17	14.19	802.50	9.43	
81	10	23	8	0.0	24152.0		20.25	14.27	802.42	9.39	
81	10	24	8	0.0	25592.0		20.25	14.27	802.42	9.43	
81	10	25	8	0.0	27032.0		20.27	14.29	802.40	9.39	*CHANGE TO PST-EXTRA HOUR*
81	10	26	8	0.0	28472.0		20.32	14.34	802.35	9.44	
81	10	27	8	0.0	29912.0		20.29	14.31	802.38	9.41	
81	10	28	8	0.0	31352.0		20.33	14.35	802.34	9.40	
81	10	29	8	0.0	32792.0		20.32	14.34	802.35	9.39	
81	10	30	8	0.0	34232.0		20.30	14.32	802.37	9.39	
81	10	31	8	0.0	35680.0		20.29	14.31	802.38	9.49	
81	11	1	7	57.0	37109.0		20.34	14.36	802.33	9.27	
81	11	2	8	0.0	38552.0		20.41	14.43	802.26	9.37	
81	11	3	8	0.0	39992.0		20.35	14.37	802.32	9.37	
81	11	4	8	0.0	41432.0		20.40	14.42	802.27	9.39	METER READING 6398390
81	11	5	11	0.0	43052.0		20.42	14.44	802.25		RECOVERY,METER READING
81	11	5	11	.2	43052.2		16.20	10.22	806.47		6640000 11:00
81	11	5	11	.5	43052.5		12.27	6.29	810.40		
81	11	5	11	.8	43052.8		10.59	4.61	812.08		
81	11	5	11	1.0	43053.0		9.67	3.69	813.00		
81	11	5	11	1.3	43053.3		8.87	2.89	813.80		
81	11	5	11	1.5	43053.5		8.44	2.46	814.23		
81	11	5	11	2.0	43054.0		8.10	2.12	814.57		
81	11	5	11	2.5	43054.5		7.98	2.00	814.69		
81	11	5	11	3.0	43055.0		7.73	1.75	814.94		
81	11	5	11	3.5	43055.5		7.64	1.66	815.03		
81	11	5	11	4.0	43056.0		7.55	1.57	815.12		
81	11	5	11	5.0	43057.0		7.44	1.46	815.23		
81	11	5	11	6.0	43058.0		7.34	1.36	815.33		
81	11	5	11	8.0	43060.0		7.23	1.25	815.44		
81	11	5	11	10.0	43062.0		7.14	1.16	815.53		
81	11	5	11	15.0	43067.0		7.10	1.12	815.57		
81	11	5	11	20.0	43072.0		6.94	0.96	815.73		
81	11	5	11	25.0	43077.0		6.89	0.91	815.78		
81	11	5	11	30.0	43082.0		6.85	0.87	815.82		

DATE			TIME		ELAPSED TIME	PRESSURE READING	DEPTH TO WATER	DRAWDOWN	WATER ELEVATION	DISCHARGE RATE	COMMENTS
YR	MON	DAY	HR	MIN	MINUTES	PSI	METRES	METRES	METRES	LITRES/S	
81	11	5	11	40.0	43092.0		6.44	0.46	815.83		
81	11	5	11	50.0	43102.0		6.42	0.44	815.85		
81	11	5	12	0.0	43112.0		6.79	0.81	815.88		
81	11	5	12	40.0	43152.0		6.72	0.74	815.95		
81	11	5	13	30.0	43202.0		6.68	0.70	815.99		
81	11	5	14	30.0	43262.0		6.64	0.66	816.03		
81	11	5	15	30.0	43322.0		6.62	0.64	816.05		
81	11	5	16	15.0	43367.0		6.62	0.64	816.05		
81	11	5	17	40.0	43452.0		6.60	0.62	816.07		
81	11	5	19	20.0	43552.0		6.58	0.60	816.09		
81	11	5	21	20.0	43672.0		6.57	0.59	816.10		
81	11	5	23	10.0	43782.0		6.56	0.58	816.11		
81	11	6	7	10.0	44262.0		6.53	0.55	816.14		
81	11	6	12	0.0	44552.0		6.52	0.54	816.15		
81	11	6	16	0.0	44792.0		6.51	0.53	816.16		
81	11	7	8	0.0	45752.0		6.48	0.50	816.19		
81	11	7	16	0.0	46232.0		6.47	0.49	816.20		
81	11	8	8	0.0	47192.0		6.44	0.46	816.23		
81	11	9	8	0.0	48632.0		6.43	0.45	816.24		
81	11	10	8	0.0	50072.0		6.43	0.45	816.24		
81	11	11	8	0.0	51512.0		6.41	0.43	816.26		
81	11	12	8	0.0	52952.0		6.38	0.40	816.29		

RESIDUAL DRAWDOWN

ERVATION WELL - PW2,

ELAPSED TIME (T)	TIME SINCE PUMP STOPPED (T1)	RATIO (T/T1)	DRAWDOWN (S)
43052.2	.2	253248.06	10.22
43052.5	.5	86105.00	6.29
43052.8	.8	57403.67	4.61
43054.0	1.0	43054.00	3.69
43053.3	1.3	33117.69	2.89
43053.5	1.5	28702.33	2.46
43054.0	2.0	21527.00	2.12
43054.5	2.5	17221.80	2.00
43055.0	3.0	14351.67	1.75
43055.5	3.5	12301.57	1.66
43056.0	4.0	10764.00	1.57
43057.0	5.0	8611.40	1.46
43058.0	6.0	7176.33	1.36
43060.0	8.0	5382.50	1.25
43062.0	10.0	4306.20	1.16
43067.0	15.0	2871.13	1.12
43072.0	20.0	2153.60	.96
43077.0	25.0	1723.08	.91
43082.0	30.0	1436.07	.87
43092.0	40.0	1077.30	.86
43102.0	50.0	862.04	.84
43112.0	60.0	718.53	.81
43152.0	100.0	431.52	.74
43202.0	150.0	288.01	.70
43262.0	210.0	206.01	.66
43322.0	270.0	160.45	.64
43367.0	315.0	137.67	.64
43452.0	400.0	108.63	.62
43552.0	500.0	87.10	.60
43672.0	620.0	70.44	.59
43782.0	730.0	59.98	.58
44262.0	1210.0	36.58	.55
44552.0	1500.0	29.70	.54
44792.0	1740.0	25.74	.53
45752.0	2700.0	16.95	.50
46232.0	3180.0	14.54	.49
47192.0	4140.0	11.40	.46
48632.0	5580.0	8.72	.45
50072.0	7020.0	7.13	.45
51512.0	8460.0	6.09	.43
52952.0	9900.0	5.35	.40

GOLDER ASSOCIATES

PUMP TEST SUMMARY FOR WELL/PIEZOMETER NUMBER = UNI,

20/11/81-12.08.00

PUMPED WELL NUMBER = PW2,
CLIENT = B.C. HYDRO,
PROJECT NAME = HAT CREEK ENVIRONMENTAL STUDY,
PROJECT NUMBER = 812512,
LOCATION OF TEST = HAT CREEK B.C.,
TYPE OF TEST = CONSTANT RATE
DATE PUMP STARTED = 5/10/81-20.0/13
(DAY/MO/YR-MIN/HRS)
DATE PUMP STOPPED = 5/11/81- 0.0/11

DATA ON OBSERVATION WELL

GROUND ELEVATION =	822.40	METRES
DATUM POINT =		TOP OF 19MM PVC PIPE,
HEIGHT OF DATUM ABOVE GROUND LEVEL =	.61	METRES
DEPTH TO STATIC WATER LEVEL =	2.43	METRES
ELEVATION OF STATIC WATER LEVEL =	820.58	METRES
TYPE OF OBSERVATION WELL =		STANDPIPE PIEZOMETER
DEPTH OF GRAVEL PACK INTERVAL =	23.06	TO 26.41 METRES
DISTANCE FROM PUMPING WELL =	90.00	METRES

DATA ON PUMPED WELL

WELL DIAMETER =	.203 m	
PUMP TYPE =		SUBMERSIBLE

FLOW MEASUREMENT

FLOWMETER, TYPE =		DIGITAL,
PUMPING RATE =	9.399E+00	LITRES/S

AQUIFER DATA

AQUIFER CONDITIONS =		UNCONFINED
AQUIFER DESCRIPTION =		SANDY GRAVEL,
AQUIFER THICKNESS =	4.90	METRES

TEST DETAILS
WEATHER CONDITIONS = VARIABLE,
TESTED BY = GOLDER ASSOCIATES,
COMMENTS = NONE,

DATE			TIME		ELAPSED TIME	PRESSURE READING	DEPTH TO WATER	DRAWDOWN	WATER ELEVATION	DISCHARGE RATE	COMMENTS
YR	MON	DAY	HR	MIN	MINUTES	PSI	METRES	METRES	METRES	LITRES/S	
0	0	0	0	0.0			0.00		823.01		
0	0	0	0	0.0			0.00		823.01		
81	10	6	9	32.0			2.43		820.58		PUMPING PW2 13128
81	10	6	14	0.0	32.0		2.51	0.08	820.50		
81	10	6	14	22.0	54.0		2.53	0.10	820.48		
81	10	6	14	41.0	73.0		2.52	0.09	820.49		
81	10	6	14	53.0	85.0		2.51	0.08	820.50		
81	10	6	16	4.0	156.0		2.54	0.11	820.47		
81	10	6	16	45.0	197.0		2.54	0.11	820.47		
81	10	6	17	35.0	247.0		2.54	0.11	820.47		
81	10	6	18	25.0	297.0		2.54	0.11	820.47		
81	10	6	20	5.0	397.0		2.53	0.10	820.48		
81	10	6	21	45.0	497.0		2.53	0.10	820.48		
81	10	7	10	40.0	1272.0		2.57	0.14	820.44		
81	10	7	14	28.0	1500.0		2.57	0.14	820.44		
81	10	7	16	47.0	1639.0		2.56	0.13	820.45		
81	10	8	8	0.0	2552.0		2.58	0.15	820.43		
81	10	8	10	0.0	2672.0		2.61	0.18	820.40		
81	10	9	8	0.0	3992.0		2.52	0.09	820.49		
81	10	9	16	0.0	4472.0		2.52	0.09	820.49		
81	10	10	8	0.0	5432.0		2.56	0.13	820.45		
81	10	10	16	0.0	5912.0		2.55	0.12	820.46		
81	10	11	8	0.0	6872.0		2.57	0.14	820.44		
81	10	12	8	0.0	8312.0		2.56	0.13	820.45		
81	10	13	8	0.0	9752.0		2.56	0.13	820.45		
81	10	14	8	0.0	11192.0		2.58	0.15	820.43		
81	10	15	8	0.0	12632.0		2.59	0.16	820.42		
81	10	16	8	0.0	14072.0		2.57	0.14	820.44		
81	10	17	7	55.0	15507.0		2.54	0.11	820.47		
81	10	18	7	55.0	16947.0		2.54	0.11	820.47		
81	10	19	7	55.0	18387.0		2.58	0.15	820.43		
81	10	20	8	9.0	19841.0		2.54	0.11	820.47		
81	10	21	8	8.0	21280.0		2.54	0.11	820.47		
81	10	22	7	57.0	22709.0		2.53	0.10	820.48		
81	10	23	7	55.0	24147.0		2.53	0.10	820.48		
81	10	24	7	57.0	25589.0		2.52	0.09	820.49		
81	10	25	8	8.0	27040.0		2.48	0.05	820.53		
81	10	26	7	57.0	28469.0		2.54	0.11	820.47		
81	10	27	7	55.0	29907.0		2.55	0.12	820.46		
81	10	28	7	55.0	31347.0		2.55	0.12	820.46		
81	10	29	7	55.0	32787.0		2.57	0.14	820.44		
81	10	30	7	55.0	34227.0		2.56	0.13	820.45		
81	10	31	8	5.0	35677.0		2.57	0.14	820.44		
81	11	1	7	55.0	37107.0		2.57	0.14	820.44		
81	11	2	7	55.0	38547.0		2.61	0.18	820.40		

DATE			TIME		ELAPSED TIME	PRESSURE READING	DEPTH TO WATER	DRAWDOWN	WATER ELEVATION	DISCHARGE RATE	COMMENTS
YR	MON	DAY	HR	MIN	MINUTES	PSI	METRES	METRES	METRES	LITRES/S	
81	11	3	7	55.0	39987.0		2.56	0.15	820.45		
81	11	4	7	55.0	41427.0		2.56	0.15	820.45		
81	11	5	7	55.0	42867.0		2.53	0.10	820.48		
81	11	5	11	30.0	43082.0		2.45	0.02	820.56		RECOVERY IN PW2 11:00
81	11	5	12	45.0	43157.0		2.43	0.00	820.58		
81	11	5	15	45.0	43337.0		2.40	-0.03	820.61		
81	11	5	17	40.0	43452.0		2.40	-0.03	820.61		
81	11	5	19	25.0	43557.0		2.40	-0.03	820.61		
81	11	5	23	5.0	43777.0		2.40	-0.03	820.61		
81	11	6	7	15.0	44267.0		2.40	-0.03	820.61		
81	11	6	12	0.0	44552.0		2.38	-0.05	820.63		
81	11	6	16	0.0	44792.0		2.40	-0.03	820.61		
81	11	7	8	0.0	45752.0		2.43	0.00	820.58		
81	11	7	16	0.0	46232.0		2.47	0.04	820.54		
81	11	8	8	0.0	47192.0		2.48	0.05	820.53		
81	11	9	8	0.0	48632.0		2.46	0.03	820.55		
81	11	10	8	0.0	50072.0		2.42	-0.01	820.59		
81	11	11	8	0.0	51512.0		2.40	-0.03	820.61		
81	11	12	8	0.0	52952.0		2.37	-0.06	820.64		

RESIDUAL DRAWDOWN

OBSERVATION WELL = OW1,

ELAPSED TIME (T)	TIME SINCE PUMP STOPPED (T1)	RATIO (T/T1)	DRAWDOWN (S)
43082.0	30.0	1436.07	.02
43157.0	105.0	411.02	.00
43337.0	285.0	152.06	-.03
43452.0	400.0	108.63	-.03
43557.0	505.0	86.25	-.03
43777.0	725.0	60.38	-.03
44267.0	1215.0	36.45	-.03
44552.0	1500.0	29.70	-.05
44792.0	1740.0	25.74	-.03
45752.0	2700.0	16.95	.00
46232.0	3180.0	14.54	.04
47192.0	4140.0	11.40	.05
48632.0	5580.0	8.72	.03
50072.0	7020.0	7.13	-.01
51512.0	8460.0	6.09	-.03
52952.0	9900.0	5.35	-.06

GOLDER ASSOCIATES

PUMP TEST SUMMARY FOR WELL/PIEZOMETER NUMBER = OW2,

20/11/81-12,08,00

PUMPED WELL NUMBER = PW2,
CLIENT = B.C. HYDRO,
PROJECT NAME = HAT CREEK ENVIRONMENTAL STUDY,
PROJECT NUMBER = 812512,
LOCATION OF TEST = HAT CREEK B.C.,
TYPE OF TEST = CONSTANT RATE
DATE PUMP STARTED = 6/10/81-28,0/13
(DAY/MO/YR-MIN/HRS)
DATE PUMP STOPPED = 5/11/81- 0,0/11

DATA ON OBSERVATION WELL

GROUND ELEVATION =	823.60	METRES
DATUM POINT =		TOP OF WELL SEAL,
HEIGHT OF DATUM ABOVE GROUND LEVEL =	.25	METRES
DEPTH TO STATIC WATER LEVEL =	7.28	METRES
ELEVATION OF STATIC WATER LEVEL =	816.57	METRES
TYPE OF OBSERVATION WELL =		SCREENED WELL
DEPTH OF SCREENED INTERVAL =	30.00 TO	32.90 METRES
DISTANCE FROM PUMPING WELL =	122.00	METRES

DATA ON PUMPED WELL

WELL DIAMETER =	.203	m
PUMP TYPE =		SUBMERSIBLE

FLOW MEASUREMENT

FLOWMETER, TYPE =		DIGITAL,
PUMPING RATE =	9.399E+00	LITRES/S

AQUIFER DATA

AQUIFER CONDITIONS =		UNCONFINED
AQUIFER DESCRIPTION =		SANDY GRAVEL,
AQUIFER THICKNESS =	2.40	METRES

TEST DETAILS
WEATHER CONDITIONS = VARIABLE,
TESTED BY = GOLDER ASSOCIATES,
COMMENTS = NONE,

DATE YR	MON	DAY	TIME HR	MIN	ELAPSED TIME MINUTES	PRESSURE READING PSI	DEPTH TO WATER METRES	DRAWDOWN METRES	WATER ELEVATION METRES	DISCHARGE RATE LITRES/S	COMMENTS
0	0	0	0	0.0			0.00		H23.H5		
0	0	0	0	0.0			0.00		H23.H5		
H1	10	6	9	45.0			7.28		H16.57		PUMPING PW2 13:2H
H1	10	6	14	5.0	37.0		7.50	0.22	H16.35		INSTALL PUMP AND FILL
H1	10	6	14	24.0	56.0		7.52	0.24	H16.33		PRESSURE TANK
H1	10	7	10	45.0	1277.0		7.64	0.36	H16.21		
H1	10	H	H	25.0	2577.0		7.64	0.36	H16.21		
H1	10	9	H	10.0	4002.0		7.67	0.39	H16.18		
H1	10	10	H	15.0	5407.0		7.69	0.41	H16.16		
H1	10	11	H	10.0	6HH2.0		7.71	0.43	H16.14		
H1	10	12	H	10.0	H322.0		7.72	0.44	H16.13		
H1	10	13	H	10.0	9762.0		7.74	0.46	H16.11		
H1	10	14	H	15.0	11207.0		7.75	0.47	H16.10		
H1	10	15	H	10.0	12642.0		7.77	0.49	H16.08		
H1	10	16	H	10.0	14082.0		7.79	0.51	H16.06		
H1	10	17	H	5.0	15517.0		7.80	0.52	H16.05		
H1	10	18	H	10.0	16962.0		7.82	0.54	H16.03		
H1	10	19	H	5.0	18397.0		7.83	0.55	H16.02		
H1	10	20	H	12.0	19H88.0		7.84	0.56	H16.01		
H1	10	21	H	18.0	21290.0		7.85	0.57	H16.00		
H1	10	22	H	10.0	22722.0		7.87	0.59	H15.98		
H1	10	23	H	5.0	24157.0		7.87	0.59	H15.98		
H1	10	24	H	10.0	25602.0		7.88	0.60	H15.97		
H1	10	25	H	15.0	27047.0		7.89	0.61	H15.96		
H1	10	26	H	10.0	28482.0		7.90	0.62	H15.95		
H1	10	27	H	5.0	29917.0		7.92	0.64	H15.93		
H1	10	28	H	6.0	31358.0		7.93	0.65	H15.92		
H1	10	29	H	10.0	32802.0		7.94	0.66	H15.91		
H1	10	30	H	6.0	34238.0		7.95	0.67	H15.90		
H1	10	31	H	20.0	35692.0		7.96	0.68	H15.89		
H1	11	1	7	50.0	37102.0		7.97	0.69	H15.88		
H1	11	2	H	6.0	38558.0		7.97	0.69	H15.88		
H1	11	3	H	5.0	39997.0		7.99	0.71	H15.86		
H1	11	4	H	6.0	H1438.0		H.00	0.72	H15.85		
H1	11	5	H	6.0	H2878.0		H.02	0.74	H15.83		
H1	11	5	12	50.0	H3162.0		7.76	0.48	H16.09		RECOVERY IN PW2 11:00
H1	11	5	13	20.0	H5192.0		7.75	0.47	H16.10		
H1	11	5	15	50.0	H3342.0		7.73	0.45	H16.12		
H1	11	6	7	20.0	H0272.0		7.66	0.38	H16.19		
H1	11	6	12	0.0	H0552.0		7.65	0.37	H16.20		
H1	11	6	16	0.0	H0792.0		7.53	0.25	H16.32		
H1	11	7	H	0.0	45752.0		7.58	0.30	H16.27		
H1	11	7	16	0.0	H6232.0		7.60	0.32	H16.25		
H1	11	H	H	0.0	H7192.0		7.60	0.32	H16.25		
H1	11	9	H	0.0	H8632.0		7.59	0.31	H16.26		

DATE			TIME		ELAPSED TIME	PRESSURE READING	DEPTH TO WATER	DRAWDOWN	WATER ELEVATION	DISCHARGE RATE	COMMENTS
YR	MON	DAY	HR	MIN	MINUTES	PSI	METRES	METRES	METRES	LITRES/S	
81	11	10	8	0.0	50072.0		7.58	0.30	816.27		
81	11	11	8	0.0	51512.0		7.57	0.29	816.28		
81	11	12	8	0.0	52952.0		7.57	0.29	816.28		

RESIDUAL DRAWDOWN

OBSERVATION WELL = OW2.

ELAPSED TIME (T)	TIME SINCE PUMP STOPPED (T1)	RATIO (T/T1)	DRAWDOWN (S)
43162.0	110.0	392.38	.48
43192.0	140.0	308.51	.47
43342.0	290.0	149.46	.45
44272.0	1220.0	36.29	.38
44552.0	1500.0	29.70	.37
44792.0	1740.0	25.74	.25
45752.0	2700.0	16.95	.30
46232.0	3180.0	14.54	.32
47192.0	4140.0	11.40	.32
48632.0	5580.0	8.72	.31
50072.0	7020.0	7.13	.30
51512.0	8460.0	6.09	.29
52952.0	9900.0	5.35	.29

GOLDER ASSOCIATES

PUMP TEST SUMMARY FOR WELL/PIEZOMETER NUMBER = OW3,

20/11/81-12,08,05

PUMPED WELL NUMBER = PW2,
CLIENT = H,C, HYDRO,
PROJECT NAME = HAT CREEK ENVIRONMENTAL STUDY,
PROJECT NUMBER = 81215I2,
LOCATION OF TEST = HAT CREEK B,C,,
TYPE OF TEST = CONSTANT RATE
DATE PUMP STARTED = 6/10/81-28,0/13
(DAY/MO/YR-MIN/HRS)
DATE PUMP STOPPED = 5/11/81- 0,0/11

DATA ON OBSERVATION WELL

GROUND ELEVATION =	822,20	METRES
DATUM POINT =		TOP OF CASING,
HEIGHT OF DATUM ABOVE GROUND LEVEL =	,61	METRES
DEPTH TO STATIC WATER LEVEL =	6,11	METRES
ELEVATION OF STATIC WATER LEVEL =	816,70	METRES
TYPE OF OBSERVATION WELL =		SCREENED WELL
DEPTH OF SCREENED INTERVAL =	23,80 TO	26,20 METRES
DISTANCE FROM PUMPING WELL =	47,00	METRES

DATA ON PUMPED WELL

WELL DIAMETER =	.203 m	
PUMP TYPE =		SUBMERSIBLE

FLOW MEASUREMENT

FLOWMETER, TYPE =		DIGITAL,
PUMPING RATE =	9,3991+00	LITRES/S

AQUIFER DATA

AQUIFER CONDITIONS =		UNCONFINED
AQUIFER DESCRIPTION =		SANDY GRAVEL,
AQUIFER THICKNESS =	6.4	METRES

TEST DETAILS
WEATHER CONDITIONS = VARIABLE,
TESTED BY = GOLDER ASSOCIATES,
COMMENTS = NONE,

DATE YR	MON	DAY	TIME HR	MIN	ELAPSED TIME MINUTES	PRESSURE READING PSI	DEPTH TO WATER METRES	DRAWDOWN METRES	WATER ELEVATION METRES	DISCHARGE RATE LITRES/S	COMMENTS
0	0	0	0	0.0			0.00		A22.A1		
0	0	0	0	0.0			0.00		A22.A1		
A1	10	6	9	50.0			6.11		A16.70		
A1	10	6	13	25.0			6.11		A16.70		
A1	10	6	13	28.5	0.5		6.13	0.02	A16.68		PUMPING PW2 1312H
A1	10	6	13	29.0	1.0		6.19	0.08	A16.62		
A1	10	6	13	29.5	1.5		6.26	0.15	A16.55		
A1	10	6	13	30.0	2.0		6.34	0.23	A16.47		
A1	10	6	13	30.5	2.5		6.41	0.30	A16.40		
A1	10	6	13	31.0	3.0		6.48	0.37	A16.33		
A1	10	6	13	32.0	4.0		6.60	0.49	A16.21		
A1	10	6	13	33.0	5.0		6.70	0.59	A16.11		
A1	10	6	13	34.0	6.0		6.77	0.66	A16.04		
A1	10	6	13	36.0	8.0		6.90	0.79	A15.91		
A1	10	6	13	38.0	10.0		6.98	0.87	A15.83		
A1	10	6	13	43.0	15.0		7.11	1.00	A15.70		
A1	10	6	13	48.0	20.0		7.18	1.07	A15.65		
A1	10	6	13	53.0	25.0		7.22	1.11	A15.59		
A1	10	6	13	58.0	30.0		7.25	1.14	A15.56		
A1	10	6	14	8.0	40.0		7.27	1.16	A15.54		
A1	10	6	14	18.0	50.0		7.28	1.17	A15.53		
A1	10	6	14	28.0	60.0		7.30	1.19	A15.51		
A1	10	6	14	49.0	81.0		7.31	1.20	A15.50		
A1	10	6	15	8.0	100.0		7.33	1.22	A15.48		
A1	10	6	15	58.0	150.0		7.35	1.24	A15.46		
A1	10	6	16	48.0	200.0		7.36	1.25	A15.45		
A1	10	6	17	38.0	250.0		7.37	1.26	A15.44		
A1	10	6	18	28.0	300.0		7.39	1.28	A15.42		
A1	10	6	20	8.0	400.0		7.37	1.26	A15.44		
A1	10	6	21	48.0	500.0		7.38	1.27	A15.43		
A1	10	6	23	28.0	600.0		7.40	1.29	A15.41		
A1	10	7	2	48.0	800.0		7.41	1.30	A15.40		
A1	10	7	6	8.0	1000.0		7.42	1.31	A15.39		
A1	10	7	14	28.0	1500.0		7.45	1.34	A15.36		
A1	10	7	16	55.0	1647.0		7.45	1.34	A15.36		
A1	10	8	8	0.0	2552.0		7.49	1.38	A15.32		
A1	10	8	16	0.0	3032.0		7.50	1.39	A15.31		
A1	10	9	8	0.0	3992.0		7.54	1.43	A15.27		
A1	10	9	16	0.0	4472.0		7.55	1.44	A15.26		
A1	10	10	8	0.0	5432.0		7.57	1.46	A15.24		
A1	10	10	16	0.0	5912.0		7.59	1.48	A15.22		
A1	10	11	8	0.0	6872.0		7.61	1.50	A15.20		
A1	10	12	8	0.0	8312.0		7.64	1.53	A15.17		
A1	10	13	8	0.0	9752.0		7.68	1.57	A15.13		
A1	10	14	8	30.0	11222.0		7.71	1.60	A15.10		

DATE			TIME		ELAPSED TIME	PRESSURE READING	DEPTH TO WATER	DRAWDOWN	WATER ELEVATION	DISCHARGE RATE	COMMENTS
YR	MON	DAY	HR	MIN	MINUTES	PSI	METRES	METRES	METRES	LITRES/S	
81	10	15	8	0.0	12632.0		7.76	1.65	815.05		
81	10	16	8	0.0	14072.0		7.78	1.67	815.03		
81	10	17	8	0.0	15512.0		7.80	1.69	815.01		
81	10	18	8	0.0	16952.0		7.82	1.71	814.99		
81	10	19	8	0.0	18392.0		7.84	1.73	814.97		
81	10	20	8	0.0	19832.0		7.86	1.75	814.95		
81	10	21	8	3.0	21275.0		7.88	1.77	814.93		
81	10	22	8	5.0	22717.0		7.90	1.79	814.91		
81	10	23	8	3.0	24155.0		7.92	1.81	814.89		
81	10	24	8	4.0	25596.0		7.93	1.82	814.88		
81	10	25	8	4.0	27036.0		7.94	1.83	814.87		
81	10	26	8	4.0	28476.0		7.97	1.86	814.84		
81	10	27	8	3.0	29915.0		7.98	1.87	814.83		
81	10	28	8	3.0	31355.0		8.00	1.89	814.81		
81	10	29	8	3.0	32795.0		8.02	1.91	814.79		
81	10	30	8	2.0	34234.0		8.03	1.92	814.78		
81	10	31	8	12.0	35680.0		8.03	1.92	814.78		
81	11	1	8	0.0	37112.0		8.06	1.95	814.75		
81	11	2	8	2.0	38554.0		8.07	1.96	814.74		
81	11	3	8	2.0	39994.0		8.08	1.97	814.73		
81	11	4	8	3.0	41435.0		8.10	1.99	814.71		
81	11	5	8	3.0	42875.0		8.11	2.00	814.70		
81	11	5	11	0.0	43052.0		8.11	2.00	814.70		RECOVERY PW2 11100
81	11	5	11	.3	43052.3		8.10	1.99	814.71		
81	11	5	11	.8	43052.8		8.06	1.95	814.75		
81	11	5	11	1.3	43053.3		8.00	1.89	814.81		
81	11	5	11	1.8	43053.8		7.91	1.80	814.90		
81	11	5	11	2.3	43054.3		7.83	1.72	814.98		
81	11	5	11	2.8	43054.8		7.75	1.64	815.06		
81	11	5	11	3.8	43055.8		7.62	1.51	815.19		
81	11	5	11	4.8	43056.8		7.52	1.41	815.29		
81	11	5	11	5.8	43057.8		7.45	1.34	815.36		
81	11	5	11	8.0	43060.0		7.34	1.23	815.47		
81	11	5	11	10.0	43062.0		7.26	1.15	815.55		
81	11	5	11	15.0	43067.0		7.16	1.05	815.65		
81	11	5	11	20.0	43072.0		7.09	0.98	815.72		
81	11	5	11	25.0	43077.0		7.05	0.94	815.76		
81	11	5	11	30.0	43082.0		7.02	0.91	815.79		
81	11	5	11	40.0	43092.0		6.98	0.87	815.83		
81	11	5	11	50.0	43102.0		6.96	0.85	815.85		
81	11	5	12	0.0	43112.0		6.95	0.84	815.86		
81	11	5	12	40.0	43152.0		6.89	0.78	815.92		
81	11	5	13	30.0	43202.0		6.87	0.76	815.94		
81	11	5	14	30.0	43262.0		6.84	0.73	815.97		
81	11	5	15	30.0	43322.0		6.82	0.71	815.99		

DATE			TIME		ELAPSED TIME	PRESSURE READING	DEPTH TO WATER	DRAWDOWN		WATER ELEVATION	DISCHARGE RATE	COMMENTS
YR	MON	DAY	HR	MIN	MINUTES	PSI	METRES	METRES		METRES	LITRES/S	
81	11	5	16	15.0	43367.0		6.81	0.70		816.00		
81	11	5	17	40.0	43452.0		6.80	0.69		816.01		
81	11	5	19	20.0	43552.0		6.78	0.67		816.03		
81	11	5	21	20.0	43672.0		6.77	0.66		816.04		
81	11	5	23	10.0	43782.0		6.76	0.65		816.05		
81	11	6	7	10.0	44262.0		6.72	0.61		816.09		
81	11	6	12	0.0	44552.0		6.58	0.47	-64	816.23	816.06	INSTALL PUMP S/D 8.44M
81	11	6	16	0.0	44792.0		6.55	0.44	-61	816.26	816.09	ADD .17M TO DRAWDOWN
81	11	7	8	0.0	45752.0		6.53	0.42	-59	816.28	816.11	
81	11	7	16	0.0	46232.0		6.50	0.39	-56	816.31	816.14	
81	11	8	8	0.0	47192.0		6.48	0.37	-54	816.33	816.16	
81	11	9	8	0.0	48632.0		6.45	0.34	-51	816.36	816.19	
81	11	10	8	0.0	50072.0		6.39	0.28	-45	816.42	816.25	
81	11	11	8	0.0	51512.0		6.39	0.28	-45	816.42	816.25	
81	11	12	8	0.0	52952.0		6.38	0.27	-44	816.43	816.26	

RESIDUAL DRAWDOWN

OBSERVATION WELL = OBS.

ELAPSED TIME (T)	TIME SINCE PUMP STOPPED (T1)	RATIO (T/T1)	DRAWDOWN (S)
43052.3	.3	143507.67	1.99
43052.8	.8	53816.00	1.95
43053.3	1.3	33117.92	1.89
43053.8	1.8	23918.78	1.80
43054.3	2.3	18719.26	1.72
43054.8	2.8	15376.71	1.64
43055.8	3.8	11330.47	1.51
43056.8	4.8	8970.17	1.41
43057.8	5.8	7423.76	1.34
43060.0	8.0	5382.50	1.23
43062.0	10.0	4306.20	1.15
43067.0	15.0	2871.13	1.05
43072.0	20.0	2153.60	.98
43077.0	25.0	1723.08	.94
43082.0	30.0	1436.07	.91
43092.0	40.0	1077.30	.87
43102.0	50.0	862.04	.85
43112.0	60.0	718.53	.82
43152.0	100.0	431.52	.78
43202.0	150.0	288.01	.76
43262.0	210.0	206.01	.73
43322.0	270.0	160.45	.71
43367.0	315.0	137.67	.70
43452.0	400.0	108.63	.69
43552.0	500.0	87.10	.67
43672.0	620.0	70.44	.66
43782.0	730.0	59.98	.65
44262.0	1210.0	36.58	.61
44552.0	1500.0	29.70	.57
44792.0	1740.0	25.74	.54
45752.0	2700.0	16.95	.42
46232.0	3180.0	14.54	.39
47192.0	4140.0	11.40	.37
48632.0	5580.0	8.72	.34
50072.0	7020.0	7.13	.28
51512.0	8460.0	6.09	.28
52952.0	9900.0	5.35	.27

GOLDER ASSOCIATES

PUMP TEST SUMMARY FOR WELL/PIEZOMETER NUMBER = DH4,

20/11/81-12.08.19

PUMPED WELL NUMBER = PW2,
CLIENT = B.C. HYDRO,
PROJECT NAME = HAT CREEK ENVIRONMENTAL STUDY,
PROJECT NUMBER = 8121512,
LOCATION OF TEST = HAT CREEK B.C.,
TYPE OF TEST = CONSTANT RATE
DATE PUMP STARTED = 6/10/81-20.0/13
(DAY/MO/YR-MIN/HRS)
DATE PUMP STOPPED = 5/11/81- 0.0/11

DATA ON OBSERVATION WELL

GROUND ELEVATION =	838.06	METRES
DATUM POINT =		TOP OF PVC CASING,
HEIGHT OF DATUM ABOVE GROUND LEVEL =	3.07	METRES
DEPTH TO STATIC WATER LEVEL =	.04	METRES
ELEVATION OF STATIC WATER LEVEL =	841.09	METRES
TYPE OF OBSERVATION WELL =		SCREENED WELL
DEPTH OF SCREENED INTERVAL =	104.10 TO	106.70 METRES
DISTANCE FROM PUMPING WELL =	2000.00	METRES

DATA ON PUMPED WELL

WELL DIAMETER =	.203 m	
PUMP TYPE =		SUBMERSIBLE

FLOW MEASUREMENT

FLOWMETER, TYPE =		DIGITAL,
PUMPING RATE =	9.399E+00	LITRES/S

AQUIFER DATA

AQUIFER CONDITIONS =	UNCONFINED
AQUIFER DESCRIPTION =	SANDY GRAVEL,
AQUIFER THICKNESS =	UNKNOWN

TEST DETAILS
WEATHER CONDITIONS = VARIABLE,
TESTED BY = GOLDER ASSOCIATES,
COMMENTS = THE WATER LEVEL IN THIS WELL CONTINUED
= TO RECOVER TO STATIC LEVEL DURING OCT.,

DATE YR	MON	DAY	TIME HR	MIN	ELAPSED TIME MINUTES	PRESSURE READING PSI	DEPTH TO WATER METRES	DRAWDOWN METRES	WATER ELEVATION METRES	DISCHARGE RATE LITRES/S	COMMENTS
0	0	0	0	0.0			0.00		841.13		
0	0	0	0	0.0			0.00		841.13		
81	10	6	10	10.0			.26		840.87		PUMPING PW2 13:28
81	10	7	13	40.0	1452.0		.24	0.20	840.89		
81	10	8	8	45.0	2597.0		.23	0.19	840.90		
81	10	9	8	25.0	4017.0		.22	0.18	840.91		
81	10	10	8	15.0	5097.0		.22	0.18	840.91		
81	10	11	8	15.0	6897.0		.22	0.18	840.91		
81	10	12	8	15.0	8327.0		.21	0.17	840.92		
81	10	13	8	35.0	9787.0		.23	0.19	840.90		
81	10	14	8	20.0	11212.0		.23	0.19	840.90		
81	10	15	8	20.0	12652.0		.22	0.18	840.91		
81	10	16	8	20.0	14092.0		.21	0.17	840.92		
81	10	17	8	20.0	15532.0		.22	0.18	840.91		
81	10	18	8	25.0	16977.0		.20	0.16	840.93		
81	10	19	8	25.0	18417.0		.18	0.14	840.95		
81	10	20	8	25.0	19857.0		.18	0.14	840.95		
81	10	24	8	25.0	25617.0		.12	0.08	841.01		
81	10	25	8	25.0	27057.0		.12	0.08	841.01		
81	10	26	8	25.0	28497.0		.08	0.04	841.05		
81	10	27	8	25.0	29937.0		.06	0.02	841.07		
81	10	28	7	50.0	31342.0		.04	0.	841.09		
81	10	29	8	20.0	32812.0		.05	0.01	841.08		
81	10	30	8	20.0	34252.0		.09	0.05	841.04		
81	10	31	8	40.0	35712.0		.08	0.04	841.05		
81	11	1	7	45.0	37097.0		.11	0.07	841.02		
81	11	2	8	30.0	38582.0		.09	0.05	841.04		
81	11	3	8	15.0	40007.0		.05	0.01	841.08		
81	11	4	8	15.0	41447.0		.11	0.07	841.02		
81	11	5	8	20.0	42892.0		.09	0.05	841.04		INSTALL PUMP =
81	11	7	8	0.0	45752.0		0.00	-0.04	841.13	2.50	NATURAL OVERFLOW RECORDED
81	11	8	8	0.0	47192.0		0.00	-0.04	841.13	2.27	
81	11	9	8	0.0	48632.0		0.00	-0.04	841.13	2.27	
81	11	10	8	0.0	50072.0		0.00	-0.04	841.13	2.27	
81	11	11	8	0.0	51512.0		0.00	-0.04	841.13	2.27	
81	11	12	8	0.0	52952.0		0.00	-0.04	841.13	2.27	

GOLDER ASSOCIATES

PUMP TEST SUMMARY FOR WELL/PIEZOMETER NUMBER = DH5,

20/11/81-12.08.22

PUMPED WELL NUMBER = PW2,
CLIENT = B.C. HYDRO,
PROJECT NAME = MAT CREEK ENVIRONMENTAL STUDY,
PROJECT NUMBER = #121512,
LOCATION OF TEST = MAT CREEK B.C.,
TYPE OF TEST = CONSTANT RATE
DATE PUMP STARTED = 6/10/81-20.0/13
(DAY/MO/YR-MIN/HRS)
DATE PUMP STOPPED = 5/11/81- 0.0/11

DATA ON OBSERVATION WELL

GROUND ELEVATION =	820.94	METRES
DATUM POINT =		TOP OF 19MM PVC PIPE,
HEIGHT OF DATUM ABOVE GROUND LEVEL =	.61	METRES
DEPTH TO STATIC WATER LEVEL =	5.24	METRES
ELEVATION OF STATIC WATER LEVEL =	816.31	METRES
TYPE OF OBSERVATION WELL =		STANDPIPE PIEZOMETER
DEPTH OF GRAVEL PACK INTERVAL =	13.94	TO 19.22 METRES
DISTANCE FROM PUMPING WELL =	326.00	METRES

DATA ON PUMPED WELL

WELL DIAMETER =	.203	M
PUMP TYPE =		SUBMERSIBLE

FLOW MEASUREMENT

FLOWMETER, TYPE =		DIGITAL,
PUMPING RATE =	9.3998+00	LITRES/S

AQUIFER DATA

AQUIFER CONDITIONS =		UNCONFINED
AQUIFER DESCRIPTION =		SANDY GRAVEL,
AQUIFER THICKNESS =	12.5	METRES

TEST DETAILS
WEATHER CONDITIONS = VARIABLE,
TESTED BY = GOLDER ASSOCIATES,
COMMENTS = NONE,

DATE			TIME		ELAPSED TIME	PRESSURE READING	DEPTH TO WATER	DRAWDOWN	WATER ELEVATION	DISCHARGE RATE	COMMENTS
YR	MON	DAY	HR	MIN	MINUTES	PSI	METRES	METRES	METRES	LITRES/S	
0	0	0	0	0.0			0.00		M21.55		
0	0	0	0	0.0			0.00		M21.55		
81	10	6	9	42.0			5.24		M16.31		PUMPING PW2 13:28
81	10	6	14	52.0	84.0		5.25	0.00	M16.31		
81	10	6	16	15.0	167.0		5.25	0.01	M16.30		
81	10	6	17	40.0	252.0		5.26	0.01	M16.30		
81	10	7	10	45.0	1277.0		5.25	0.01	M16.30		
81	10	8	8	10.0	2562.0		5.25	0.01	M16.30		
81	10	9	8	0.0	3992.0		5.25	0.01	M16.30		
81	10	10	8	0.0	5432.0		5.24	0.	M16.31		
81	10	11	8	0.0	6872.0		5.24	0.	M16.31		
81	10	12	8	0.0	8312.0		5.24	0.	M16.31		
81	10	13	8	0.0	9752.0		5.24	0.	M16.31		
81	10	14	8	0.0	11192.0		5.24	0.	M16.31		
81	10	15	8	15.0	12647.0		5.24	0.	M16.31		
81	10	16	8	15.0	14087.0		5.24	0.	M16.31		
81	10	17	8	10.0	15522.0		5.24	0.	M16.31		
81	10	18	8	15.0	16967.0		5.24	0.	M16.31		
81	10	19	8	10.0	18402.0		5.25	0.01	M16.30		
81	10	20	8	10.0	19842.0		5.25	0.01	M16.30		
81	10	21	8	12.0	21284.0		5.24	0.	M16.31		
81	10	22	8	15.0	22727.0		5.25	0.01	M16.30		
81	10	23	8	10.0	24162.0		5.26	0.02	M16.29		
81	10	24	8	15.0	25607.0		5.26	0.02	M16.29		
81	10	25	8	11.0	27043.0		5.27	0.03	M16.28		
81	10	26	8	15.0	28487.0		5.26	0.02	M16.29		
81	10	27	8	10.0	29922.0		5.27	0.03	M16.28		
81	10	28	8	10.0	31362.0		5.27	0.03	M16.28		
81	10	29	8	10.0	32802.0		5.28	0.04	M16.27		
81	10	30	8	10.0	34242.0		5.28	0.04	M16.27		
81	10	31	8	25.0	35697.0		5.28	0.04	M16.27		
81	11	1	8	5.0	37117.0		5.29	0.05	M16.26		
81	11	2	8	10.0	38562.0		5.29	0.05	M16.26		
81	11	3	8	10.0	40002.0		5.30	0.06	M16.25		
81	11	4	8	10.0	41442.0		5.30	0.06	M16.25		
81	11	5	8	10.0	42882.0		5.31	0.07	M16.24		PW2 RECOVERY 11:00
81	11	5	12	55.0	43167.0		5.30	0.06	M16.25		
81	11	6	7	20.0	44272.0		5.30	0.06	M16.25		
81	11	6	16	0.0	44792.0		5.30	0.06	M16.25		
81	11	7	8	0.0	45752.0		5.30	0.06	M16.25		
81	11	8	8	0.0	47192.0		5.30	0.06	M16.25		
81	11	9	8	0.0	48632.0		5.29	0.05	M16.26		
81	11	10	8	0.0	50072.0		5.30	0.06	M16.25		
81	11	11	8	0.0	51512.0		5.30	0.06	M16.25		
81	11	12	8	0.0	52952.0		5.30	0.06	M16.25		

RESIDUAL DRAWDOWN

OBSERVATION WELL = OW5,

ELAPSED TIME (T)	TIME SINCE PUMP STOPPED (T1)	RATIO (T/T1)	DRAWDOWN (S)
43167.0	115.0	375.37	.06
44272.0	1220.0	36.29	.06
44792.0	1740.0	25.74	.06
45752.0	2700.0	16.95	.06
47192.0	4140.0	11.40	.06
48632.0	5580.0	8.72	.05
50072.0	7020.0	7.13	.06
51512.0	8460.0	6.09	.06
52952.0	9900.0	5.35	.06

GOLDER ASSOCIATES

PUMP TEST SUMMARY FOR WELL/PIEZOMETER NUMBER - PW1,

20/11/81-12.08.24

PUMPED WELL NUMBER - PW2,
CLIENT - B.C. HYDRO,
PROJECT NAME - HAT CREEK ENVIRONMENTAL STUDY,
PROJECT NUMBER - 8121512,
LOCATION OF TEST - HAT CREEK B.C.,
TYPE OF TEST - CONSTANT RATE
DATE PUMP STARTED - 6/10/81-20.0/13
(DAY/MO/YR-MIN/HRS)
DATE PUMP STOPPED - 5/11/81- 0.0/11

DATA ON OBSERVATION WELL

GROUND ELEVATION -	838.34	METRES
DATUM POINT -		TOP OF 19MM PVC CASING,
HEIGHT OF DATUM ABOVE GROUND LEVEL -	2.80	METRES
DEPTH TO STATIC WATER LEVEL -	.45	METRES
ELEVATION OF STATIC WATER LEVEL -	840.69	METRES
TYPE OF OBSERVATION WELL -		SCREENED WELL
DEPTH OF SCREENED INTERVAL -	100.28 TO	109.91 METRES
DISTANCE FROM PUMPING WELL -	2000.00	METRES

DATA ON PUMPED WELL

WELL DIAMETER -	.203	m
PUMP TYPE -		SUBMERSIBLE

FLOW MEASUREMENT

FLOWMETER, TYPE -		DIGITAL,
PUMPING RATE -	9.399E+00	LITRES/S

AQUIFER DATA

AQUIFER CONDITIONS -	UNCONFINED
AQUIFER DESCRIPTION -	SANDY GRAVEL,
AQUIFER THICKNESS -	UNKNOWN

TEST DETAILS
WEATHER CONDITIONS - VARIABLE,
TESTED BY - GOLDER ASSOCIATES,
COMMENTS - THE WATER LEVEL IN THIS WELL CONTINUED
- TO RECOVER UNAFFECTED BY PUMPING PW2,

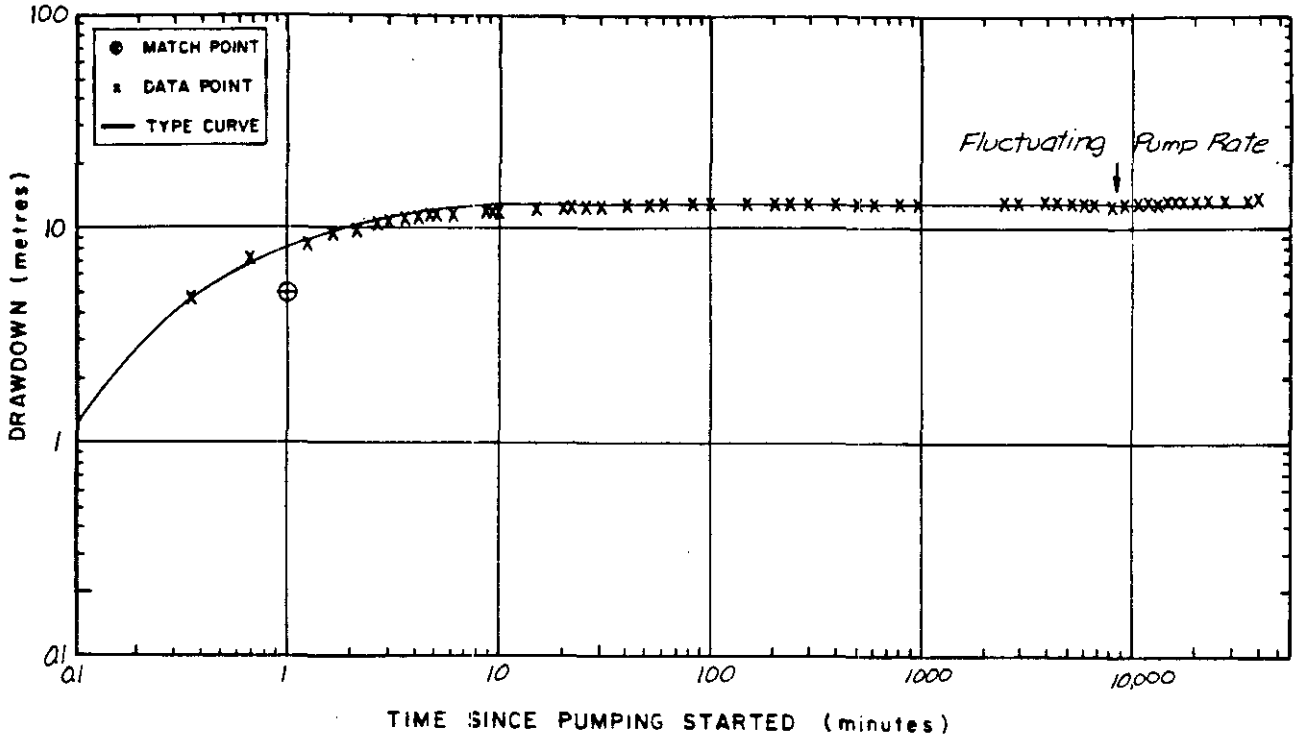
DATE YR	MON	DAY	TIME HR	MIN	ELAPSED TIME MINUTES	PRESSURE READING PSI	DEPTH TO WATER METRES	DRAWDOWN METRES	WATER ELEVATION METRES	DISCHARGE RATE LITRES/S	COMMENTS
0	0	0	0	0.0			0.00		841.14		
0	0	0	0	0.0			0.00		841.14		
81	10	6	10	12.0			.66		840.48		
81	10	7	15	40.0	1452.0		.63	0.18	840.51		
81	10	8	8	45.0	2597.0		.62	0.17	840.52		
81	10	9	8	23.0	4015.0		.62	0.17	840.52		
81	10	13	8	35.0	9787.0		.63	0.18	840.51		
81	10	14	8	20.0	11212.0		.64	0.19	840.50		
81	10	15	8	20.0	12652.0		.62	0.17	840.52		
81	10	16	8	20.0	14092.0		.61	0.16	840.53		
81	10	17	8	20.0	15532.0		.62	0.17	840.52		
81	10	19	8	25.0	18417.0		.59	0.14	840.55		
81	10	20	8	20.0	19852.0		.59	0.14	840.55		
81	10	24	8	25.0	25617.0		.52	0.07	840.62		
81	10	26	8	25.0	28497.0		.48	0.03	840.66		
81	10	27	8	25.0	29937.0		.45	-0.00	840.69		
81	10	28	7	50.0	31342.0		.45	-0.00	840.69		
81	10	31	8	35.0	35707.0		.50	0.05	840.64		
81	11	1	7	45.0	37097.0		.52	0.07	840.62		
81	11	2	8	30.0	38582.0		.50	0.05	840.64		
81	11	6	16	0.0	44792.0		2.20	1.75	838.94		PUMP INSTALLED IN OW4=
81	11	7	8	0.0	45752.0		2.10	1.65	839.04		OVERFLOW CASES DRAWDOWN
81	11	8	8	0.0	47192.0		1.98	1.53	839.16		
81	11	9	8	0.0	48632.0		1.96	1.51	839.18		
81	11	10	8	0.0	50072.0		1.83	1.38	839.31		
81	11	11	8	0.0	51512.0		1.80	1.35	839.34		
81	11	12	8	0.0	52952.0		1.79	1.34	839.35		

HY-7

TIME - DRAWDOWN GRAPH FOR PUMP TEST No. 1

Well No. PW2 Data observed in PW2 **Figure** A.2.1

LEAKY AQUIFER ANALYSIS (Hantush Method)



CALCULATIONS:

$$T = \frac{Q\,10^{-3}\,W(u,r/B)}{4\pi s} = \frac{(9.4)\,10^{-3}\,(1)}{12.57\,(4.9)} = 1.5\times10^{-4} \text{ metres}^2/\text{sec.}$$

$$S = \frac{240\,Ttu}{r^2} = \frac{240\,(\quad)(\quad)(\quad)}{(\quad)^2} = -$$

$$P = \frac{Tm'\,(r/B)^2}{r^2} = \frac{(\quad)(\quad)(\quad)^2}{(\quad)^2} = - \text{ metres/sec.}$$

WHERE:

r = Radius from pumped well – (metres)

Q = Pumping rate, 9.4 (litres/sec.)

m' = Average thickness of aquitard (metres)

T = Transmissivity (metres²/sec.)

S = Storage coefficient (fraction)

P = Hydraulic conductivity of aquitard (metres/sec.)

s = Drawdown 4.9 (metres)

t = Time since pumping started – (minutes)

W(u, r/B) 1
u 1
r/B 3
} Match point parameters from Hantush leaky aquifer type curve

Project No. 812-1512 Drawn R.D. Revised Date Jan. 82

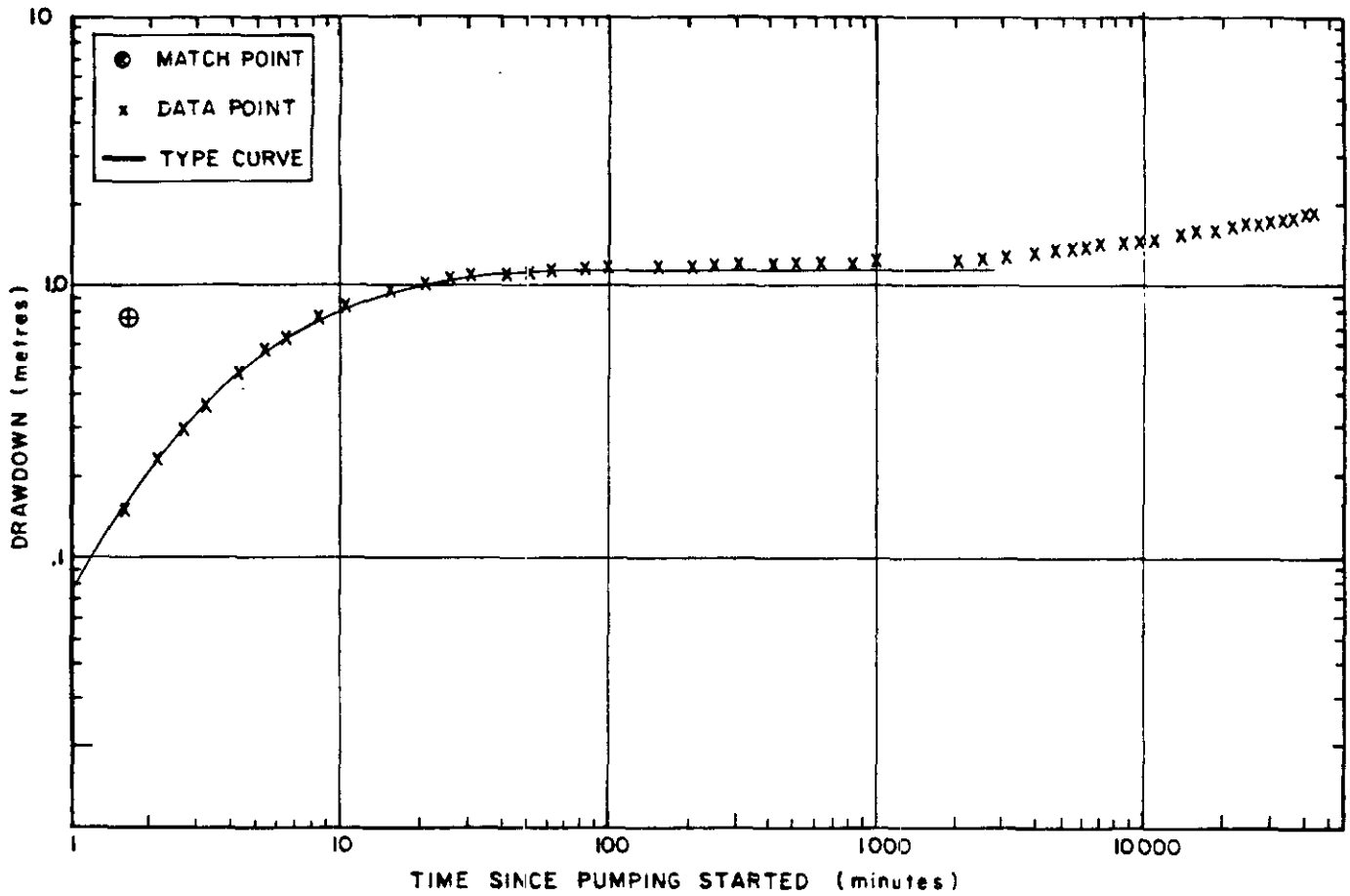
HG-7

TIME - DRAWDOWN GRAPH FOR PUMP TEST No. 1

Well No. PW2 Data observed in OW3

Figure A.2.2

LEAKY AQUIFER ANALYSIS (Hantush Method)



CALCULATIONS:

$$T = \frac{Q\,10^{-3}\,W(u,r/B)}{4\pi s} = \frac{(9.4)\,10^{-3}\,(1)}{12.57\,(.78)} = 9.6\times10^{-4} \text{ metres}^2/\text{sec.}$$

$$S = \frac{240\,Ttu}{r^2} = \frac{240\,(9.6\times10^{-4})\,(1.6)\,(.1)}{(47)^2} = 1.7\times10^{-4}$$

$$P = \frac{Tm'\,(r/B)^2}{r^2} = \frac{(9.6\times10^{-4})\,(5)\,(.6)^2}{(47)^2} = 7.8\times10^{-7} \text{ metres/sec.}$$

WHERE:

r = Radius from pumped well 47 (metres)

Q = Pumping rate, 9.4 (litres/sec.)

m' = Average thickness of aquitard 5 (metres)

T = Transmissivity (metres²/sec.)

S = Storage coefficient (fraction)

P = Hydraulic conductivity of aquitard (metres/sec.)

s = Drawdown .78 (metres)

t = Time since pumping started 1.6 (minutes)

W(u,r/B) 1
u .1
r/B .6
} Match point parameters from Hantush leaky aquifer type curve

Project No. 812-1512 Drawn R.O. Reviewed [illegible] Date Jan. 82

TIME - DRAWDOWN GRAPH FOR PUMP TEST No. 1

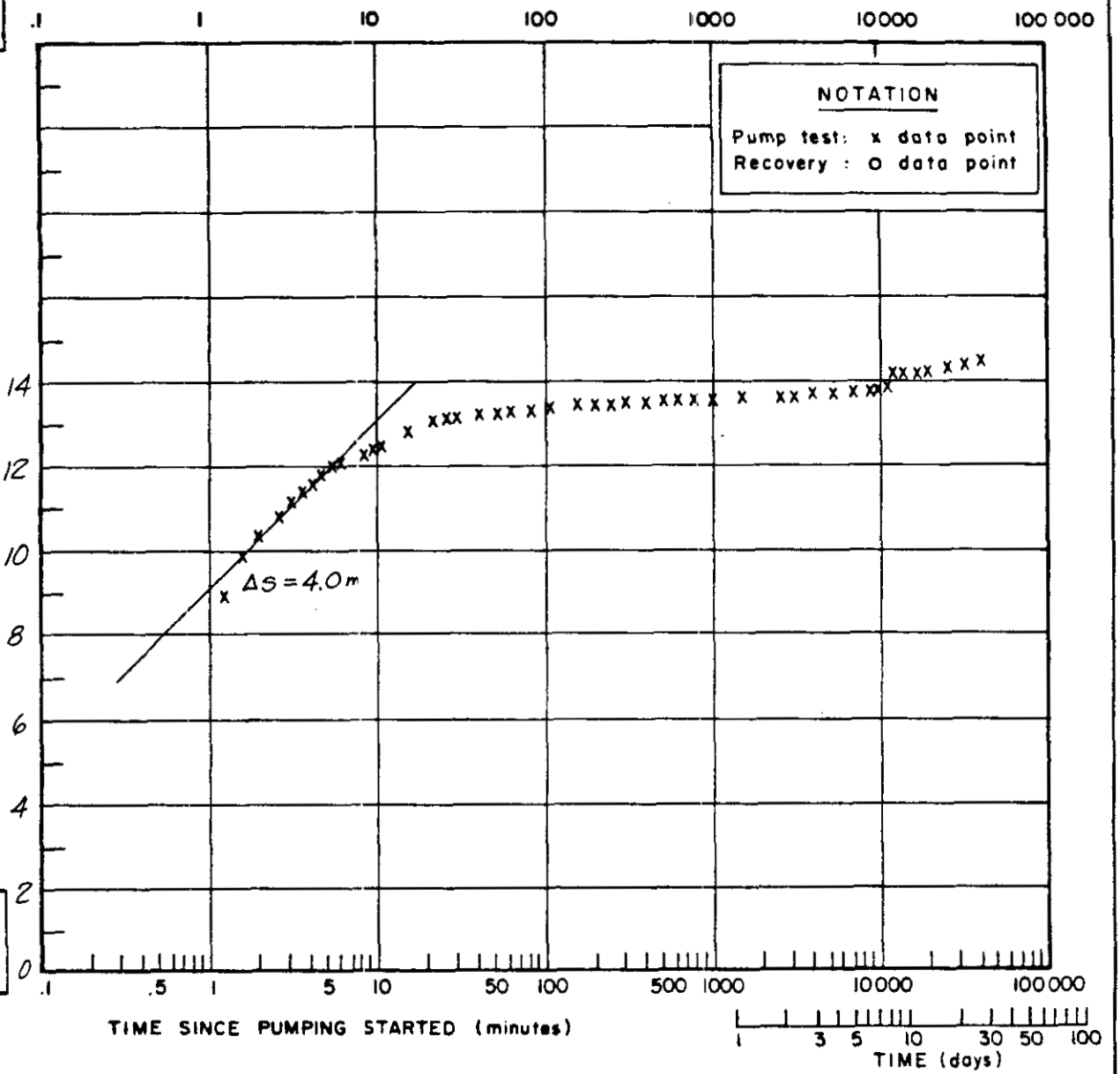
Well No. PW2 Data observed in PW2

Figure A. 3. 1

HY-1

Depth to static water level 5.98 m

t/t' = Ratio of time since pumping started to time since pumping ceased



Available drawdown to piezo tip ..... m

CALCULATIONS

Leg no. ..... $T = \frac{1.83\,Q}{\Delta s \times 10^4}$

Leg no. ..... $T = \frac{1.83\,Q}{\Delta s \times 10^4}$

Pumping	Recovery
$\frac{1.83 \times 9.4}{10^{+4} \times 4.0} = 4.3 \times 10^{-4}\ m^2/s$	$\frac{1.83 \times \ldots}{10^{+4} \times \ldots} =$ —
$\frac{1.83 \times \ldots}{10^{+4} \times \ldots} =$ —	$\frac{1.83 \times \ldots}{10^{+4} \times \ldots} =$ —

$$S = \frac{135\,T.t_o}{r^2} = \frac{135(\quad)(\quad)}{(\quad)^2} = \ldots\ldots \times 10^{-}$$

$$t_{min} = \frac{.42\,r^2 S}{T} = \frac{.42(\quad)^2(\quad)}{(\quad)} = \ldots\ldots \text{ minutes}$$

WHERE r = Radius from pumped well — (metres)
Q = Pumping rate 9.4 (litres/sec.)
t_o = Time intercept for zero drawdown ..... (min.)
t_{min} = Approx. minimum value for which $u \leq 0.01$

Δs = Drawdown (metres per log cycle)
T = Transmissivity (metres²/sec.)
S = Storage coefficient (fraction)

Project No. 812-1512 Drawn R.D. Reviewed G.C. Date Jan. '82

Golder Associates

TIME - DRAWDOWN GRAPH FOR PUMP TEST No. 1

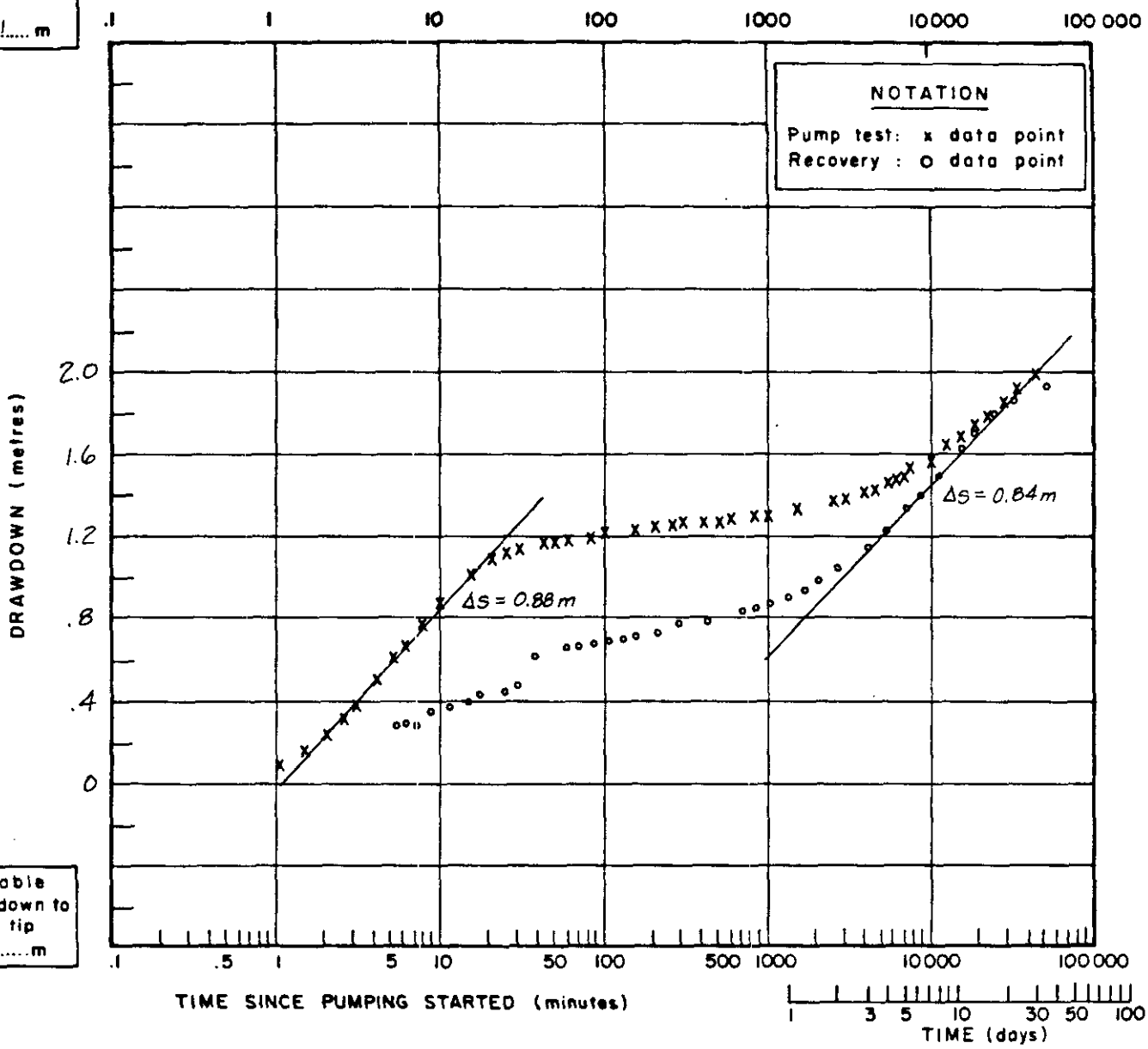
Well No. PW2 Data observed in OW3

Figure A.3.2

HY-1

Depth to static water level 6.11 m

t/t' = Ratio of time since pumping started to time since pumping ceased



Available drawdown to piezo tip ..... m

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CALCULATIONS

Leg no. 1 $T = \frac{1.83\,Q}{\Delta s \times 10^4}$

Pumping	Recovery
$\frac{1.83 \times 9.4}{10^{+4} \times .88} = 1.9 \times 10^{-3}\ m^2/s$	$\frac{1.83 \times 9.4}{10^{+4} \times .84} = 2 \times 10^{-3}\ m^2/s$
$\frac{1.83 \times \ldots}{10^{+4} \times \ldots} = -$	$\frac{1.83 \times \ldots}{10^{+4} \times \ldots} = -$

Leg no. – $T = \frac{1.83\,Q}{\Delta s \times 10^4}$

$$S = \frac{135\,T.t_o}{r^2} = \frac{135\,(1.9\times10^{-3})(1.1)}{(47)^2} = 1.3 \times 10^{-4}$$

$$t_{min} = \frac{.42\,r^2 S}{T} = \frac{.42\,(47)^2(1.3\times10^{-4})}{(1.9\times10^{-3})} = 63 \text{ minutes}$$

WHERE r = Radius from pumped well 47 (metres)
Q = Pumping rate 9.4 (litres/sec.)
t_o = Time intercept for zero drawdown 1.1 (min.)
t_{min} = Approx. minimum value for which $u < 0.01$
Δs = Drawdown (metres per log cycle)
T = Transmissivity (metres²/sec.)
S = Storage coefficient (fraction)

Golder Associates

TIME - DRAWDOWN GRAPH FOR PUMP TEST No. 1

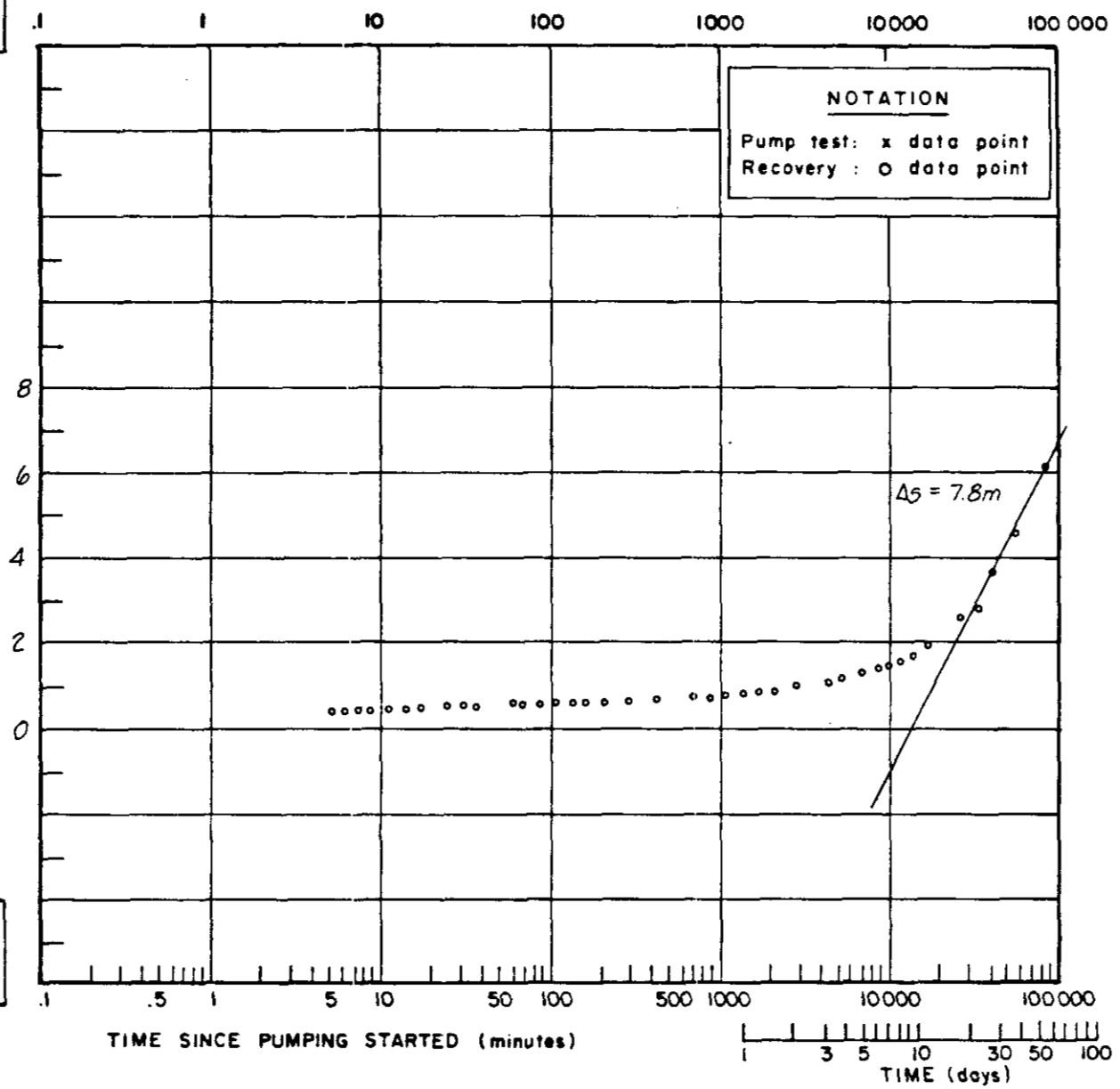
Well No. PW2 Data observed in PW2

Figure A.3.3

HY-1

Depth to static water level 5.98 m

t/t' = Ratio of time since pumping started to time since pumping ceased.



Available drawdown to piezo tip ..... m

CALCULATIONS

Leg no. 1 $T = \frac{1.83\,Q}{\Delta s \times 10^4}$

Pumping	Recovery
$\frac{1.83 \times \ldots\ldots}{10^{+4} \times \ldots\ldots} = -$	$\frac{1.83 \times 9.4}{10^{+4} \times 7.8} = 2.25 \times 10^{-4}\ m^2/s$
$\frac{1.83 \times \ldots\ldots}{10^{+4} \times \ldots\ldots} = -$	$\frac{1.83 \times \ldots\ldots}{10^{+4} \times \ldots\ldots} = -$

Leg no. ..... $T = \frac{1.83\,Q}{\Delta s \times 10^4}$

$S = \frac{135\,T.t_o}{r^2} = \frac{135(\quad)(\quad)}{(\quad)^2} = \ldots\ldots \times 10^{-}$

$t_{min} = \frac{.42\,r^2 S}{T} = \frac{.42(\quad)^2(\quad)}{(\quad)} = \ldots\ldots$ minutes

WHERE r = Radius from pumped well — (metres)
Q = Pumping rate 9.4 (litres/sec.)
t_o = Time intercept for zero drawdown — (min.)
t_{min} = Approx. minimum value for which $u < 0.01$
Δs = Drawdown (metres per log cycle)
T = Transmissivity (metres²/sec.)
S = Storage coefficient (fraction)

Project No. 812-1512 Drawn RA Reviewed Date Jan. '82

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