



BROWN, ERDMAN & ASSOCIATES LTD.

1409 BEWICKE AVENUE, NORTH VANCOUVER, BRITISH COLUMBIA V7M 3C7
TELEPHONE 986-1557

ALPEX DEVELOPMENT CORPORATION

GROUNDWATER TESTING

WELLS NO. 3 AND NO. 5
DISTRICT LOTS 46 AND 60
MALAHAT DISTRICT

R. B. ERDMAN

NOVEMBER 1981

79-135

1.0 INTRODUCTION

Brown, Erdman & Associates Ltd. supervised the pump testing of the Alpex-Mill Bay bedrock well (Well No. 3) and a well completed in gravel overburden (Well No. 5). The bedrock well was pumped for a total of 12,400 minutes (September 28 to October 7, 1981) during which time a second bedrock well, Well No. 2, was used as an observation well. The overburden well, Well No. 5, was pumped for 10,200 minutes from September 28 to October 5, 1981. During this period, drawdown water level measurements were recorded in the pumping well, Well No. 5, and in Well No. 4 which is also completed in the overburden. Recovery water level measurements were taken and recorded in the wells for 2,450 minutes (1.7 days) after pump shutdown.

2.0 WELL CONSTRUCTION

2.1 Well No. 3 (Bedrock)

This well was drilled in December, 1980 to a depth of 122 meters with an air rotary rig. The well was cased to 12.2 meters with 20.3 cm diameter casing which is sealed into the bedrock. A 15.2 cm diameter open hole was then drilled to the total depth of 122 meters. The driller's log shows the following:

<u>Depth (Meters)</u>	<u>Lithology</u>
0 to .0	Clay
.9 to 2.4	Silty gravel
2.4 to 7.0	Gravel
7.0 to 7.9	Silty gravel
7.9 to 12.2	Till
12.2 to 122.0 (105)	Granite

Water-bearing fractures with flows in the granitic rocks were logged at:

<u>Depth (Meters)</u>	<u>Flow (L/s)</u>
45.7 to 48.8	.19
53.3 to 54.2	2.50
76.2 250	3.15 to 3.78

In September, 1981, this well was reamed to a diameter of 20.3 cm to a depth of 91 meters. A 20 hp submersible test pump was set with the suction at 80 meters. The

2.1 Well No. 3 (Bedrock) continued ...

well had not fully recovered from the reaming operations when the pump testing started.

2.2 Well No. 5 (Overburden)

This well was drilled to a total depth of 21.3 meters with the drillers reporting the following:

<u>Depth (Meters)</u>	<u>Lithology</u>
0 to 3.96	Silty sand and gravel
3.96 to 7.00	Sand
7.00 to 17.98	Silty sand and gravel
17.98 to 19.20	Silty gravel
19.20 to 20.72	Gravel, <u>water-bearing</u>
20.72 to 21.34 70	Clay

A 30/1000 slot stainless steel well screen was set between depths of 18.89 and 20.72 meters. The well was developed by blowing and surging with an air rotary machine.

3.0 WELL HYDROGEOLOGY

3.1 Well No. 3

This well was pumped for a total of 12,400 minutes (8.6 days) at rates that varied between 9.38 L/sec. at the start of the test to 4.3 L/sec at the end of the test. The last reading shows a pumping level of 70.200 meters or 6 meters above the main fracture. A plot of the drawdown data shows that after 10,000 minutes, the curve had started to round out.

The plot of the recovery data shows the steeper leg to have a transmissivity of $3.40 \text{ m}^2/\text{day}$. There is, at present, 69 meters of available drawdown above the major fracture. This should be a minimum amount because of the late summer measurements.

To obtain the productive capacity of the aquifer over a 20-year period with no recharge, the formula used is:

$$Q_{20} = \frac{TSa}{126.5} \quad \text{where}$$

Q = Yield after 20 years in L/sec.

T = Transmissivity in m^2/day

Sa = Available drawdown

3.1 Well No. 3 continued ...

The transmissivity (T) has been calculated to be $3.40 \text{ m}^2/\text{day}$ from the steeper log of the recovery curve. The available drawdown (S_a) is 69 meters; therefore Q_{20} is calculated as:

$$Q_{20} = \frac{3.40 \times 69}{126.5} = 1.85 \text{ L/sec.} = 35,167 \text{ Imp. gpd}$$

Because the above formula does not take into consideration recharge to the aquifer, the calculated productive capacity of 1.85 L/sec. is considered to be conservative.

A second calculation for the well yield is made using the specific capacity obtained from the test and the available drawdown. The specific capacity of the well after 12,400 minutes of pumping was 0.068 L/sec. per meter of drawdown. The available drawdown, as pointed out before, is 69 meters. Using a safety factor of 50 per cent (50 per cent of available drawdown), the usable drawdown will be 34.5 meters. The capacity of the well using this calculation would therefore be 2.35 L/sec. (44,672 Imp. gpd). This calculation compares with the 1.85 L/sec. obtained from the Q_{20} calculation. We would, therefore, rate the well at 2.35 L/sec. or 44,672 Imp. gpd.

3.2 Well No. 5

This well was pumped for 10,200 minutes (7.08 days) at rates of between 3.12 and 2.54 L/sec. The rate of 2.54 L/sec. was maintained for the last 10,165 minutes of the test. The lowest water level measured during the test was 18.046 meters below the measuring point.

It will be noted on the drawdown curve that, while the pump discharge rate remained the same, the water level fluctuated after 350 minutes of the test. While this fluctuation would normally be associated with interference from a second well in the aquifer, the time that the fluctuations happened (midnight to 02:00) do not agree with normal water usage. The same fluctuations were noted in Well No. 4 which was used as an observation well during the pumping test.

The plot of the recovery data has been used to calculate a Q_{20} yield from this aquifer. The best fit curve for the recovery gives a transmissivity of 47.27 m²/day. The available drawdown is 5.95 meters, therefore:

$$Q_{20} = \frac{TSa}{126.5} = \frac{47.27 \times 5.95}{126.5} = 2.22 \text{ L/sec.} = 42,192 \text{ Imp gpd}$$

3.2 Well No. 5 continued ...

Using 75 per cent of the available drawdown, the calculated yield of the well is 2.33 L/sec. The lowest pumping level measured during the test was 18.046 meters below the measuring point. The static water level at the time of the test was 13.195 meters, giving a total drawdown of 4.851 meters at a pumping rate of 2.54 L/sec. The specific yield of the well is therefore .524 L/sec. per meter. The total available drawdown as calculated between the static water level and the top of the well screen (corrected for difference between the measuring point and ground level) is 5.953 meters. Seventy-five per cent of this figure is 4.46 meters, therefore, by this calculation, the safe yield of the well will be:

$$Q = .524 \text{ L/sec./m} \times 4.46 \text{ m} = 2.34 \text{ L/sec.} = 44,473 \text{ Imp. gpd}$$

The figures of 2.34 L/sec. and 2.22 L/sec. are in close agreement, therefore the well is rated at 42,200 Imp. gpd or 2.22 L/sec.

4.0 WATER QUALITY

The attached chemical analyses conducted by Can Test Ltd. shows that the waters from both wells meet the Canadian Drinking Water Standards for the parameters tested.

5.0 CONCLUSIONS

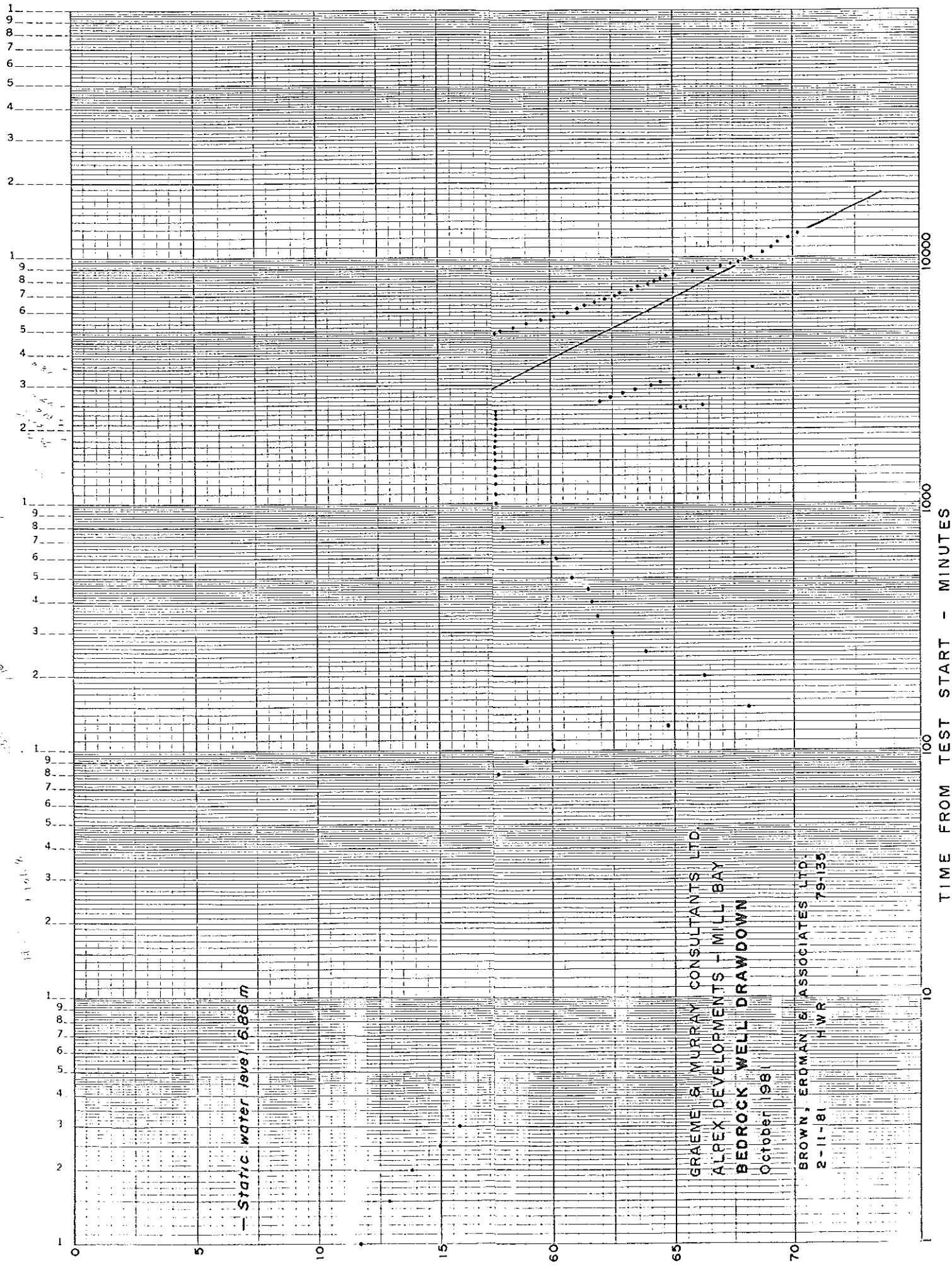
Well No. 3 is completed in bedrock and Well No. 5 is completed in overburden. The distances between the two wells is 900 feet and both wells were pumped at the same time. Any interference (none could be noted) has been taken into consideration in the test data. The combined yield of both wells is 86,872 Imp. gpd or 4.57 L/sec.

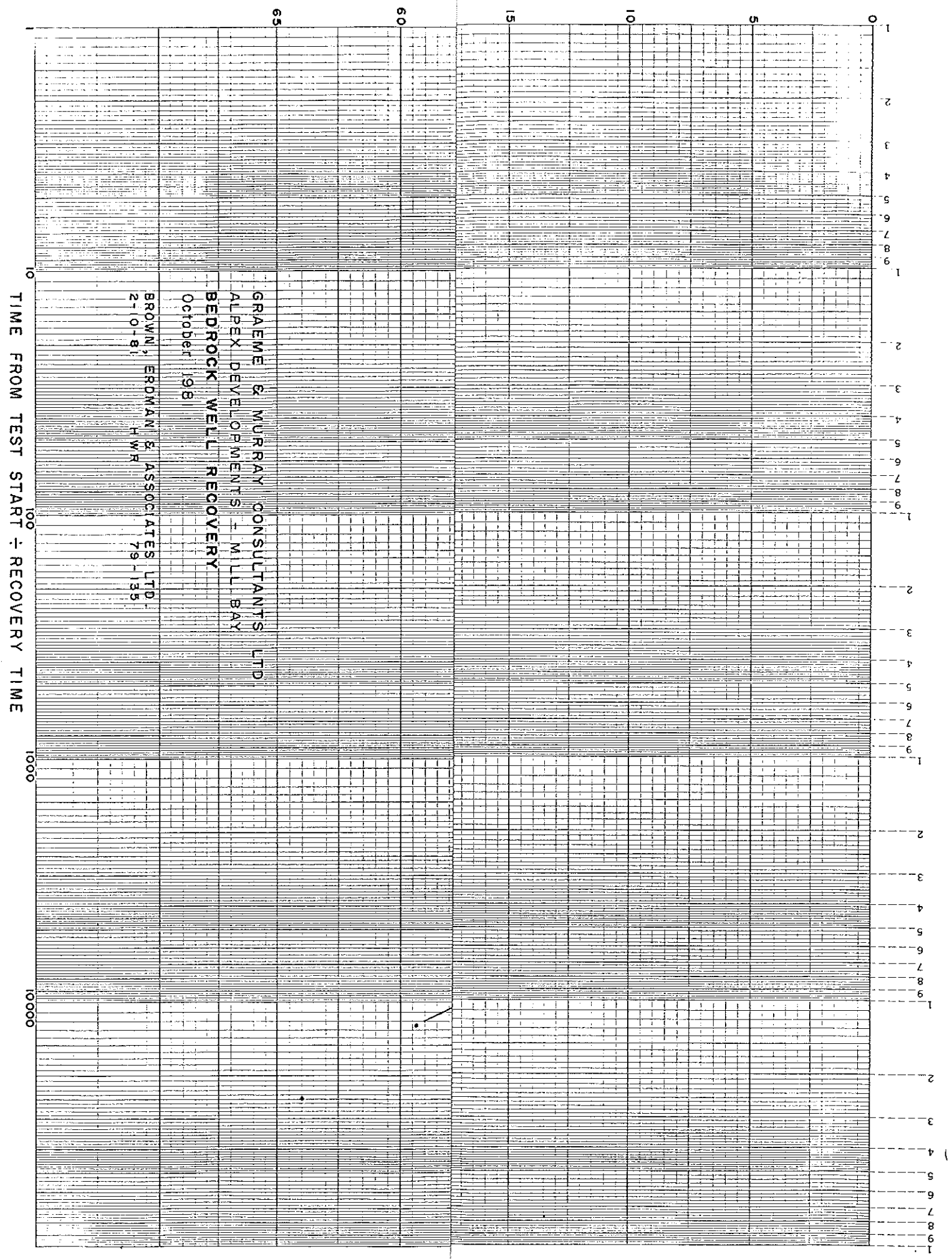
During the pumping of Well No. 5, Well No. 4 was used for observation. Both wells are completed in the overburden. The distance between Wells 4 and 5 is 198 meters. The plot of the distance drawdown curve shows that, at a distance of 250 meters, there will be no drawdown.

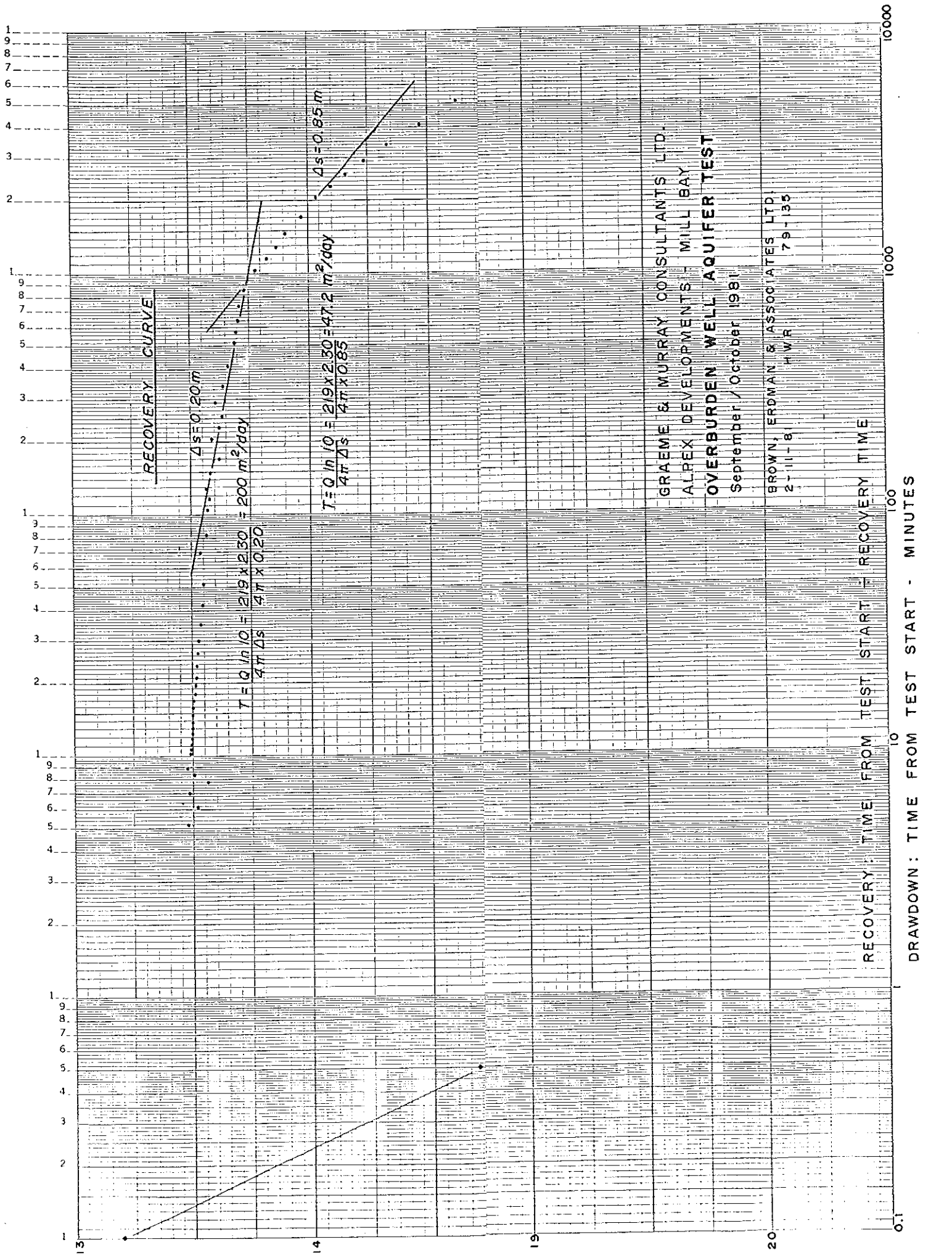
It was not practical to measure the present Mill Bay Water Works System Well because of its use, but since the wells are of sufficient distance apart, there will be no effect on the Mill Bay Well by pumping the wells on the subject property.

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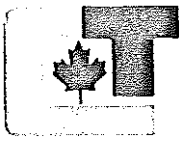


GRAEME & MURRAY CONSULTANTS LTD.
 ALPHEX DEVELOPMENTS - MILL BAY
OVERBURDEN WELL AQUIFER TEST
 September / October 1981

BROWN, ERDMAN & ASSOCIATES LTD.
 2111-8 HWY 79-135

RECOVERY TIME FROM TEST START - RECOVERY TIME

DRAWDOWN: TIME FROM TEST START - MINUTES



ERM test ltd.

1650 PANDORA STREET, VANCOUVER, B.C. V5L 1L6 • TELEPHONE 254-7278 • TELEX 04-54210

Report On Water analysis File No. 3808E

Reported To Brown, Erdman & Assoc. Report No. _____

1409 Bewicke Avenue P.O. # _____

North Vancouver, B.C. Date Nov. 5, 1981

Attention: Mr. Bill Brown

We have tested the samples of water submitted by you on October 9, 1981 and report as follows:

SAMPLE IDENTIFICATION:

The samples were submitted in plastic bottles labelled:

PROJECT: ALPEX DEVELOPMENTS

<u>CTL#</u>	<u>IDENTIFICATION</u>
1	Overburden Well Deloume Rd 16:40 Hr Oct. 5/81
2	Rock Well Deloume Rd 8:20 Hr Oct. 7/81

METHOD OF TESTING:

The analyses were carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater (14th Edition)" published by the American Public Health Association, 1975, and "Laboratory Manual for the Chemical Analysis of Water, Wastewater, Sediments and Biological Materials (2nd Edition)" published by the Government of B.C., Ministry of the Environment, Water Resources Services, 1976.

RESULTS OF TESTING:

(on the following page)

...../2

RESULTS OF TESTING:

SAMPLE #		1	2
CLIENT SAMPLE I.D.		OVERBURDEN WELL	ROCK WELL
PHYSICAL TESTS			
pH		7.25	7.85
Conductivity (micromhos/cm)		120.	178.
Colour [Pt-Co scale] (CU)		10.	10.
Turbidity (JTU)		1.7	3.3
Hardness (mg/L)	CaCO3	48.5	68.0
SOLIDS (mg/L)			
Total Suspended		< 0.5	1.5
Total Dissolved		108.	162.
DISSOLVED ANIONS (mg/L)			
Alkalinity: Bicarbonate	HCO3	67.2	104.
Alkalinity: Carbonate	CO3	Nil	Nil
Alkalinity: Hydroxide	OH	Nil	Nil
Chlorides	Cl	3.13	2.60
Sulfates	SO4	< 5.0	< 5.0
Nitrates and Nitrites	N	0.057	< 0.001
Ortho Phosphates	o-PO4	< 0.030	0.76
Fluorides	F	0.11	0.21
DISSOLVED METALS (mg/L)			
Cadmium	Cd	< 0.001	< 0.001
Calcium	Ca	10.0	20.0
Copper	Cu	0.005	0.036
Iron	Fe	0.077	< 0.030
Lead	Pb	< 0.001	< 0.001
Magnesium	Mg	5.71	4.43
Manganese	Mn	0.015	0.12
Potassium	K	0.41	0.40
Silicon	SiO2	18.0	18.3
Sodium	Na	3.91	11.6
Zinc	Zn	0.017	< 0.010
TOTAL METALS (mg/L)			
Iron	Fe	0.28	0.060
Manganese	Mn	0.015	0.14

mg/L = milligrams per liter

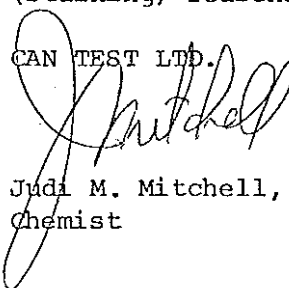
REMARKS:

The waters represented by the samples submitted can be characterized as moderate with respect to hardness and dissolved mineralization.

For the parameters tested, the samples met the limits set by "Guidelines for Canadian Drinking Water Quality, 1978", published by authority of Health and Welfare, Canada with the exception of dissolved manganese (limit = 0.05 mg/L).

Manganese is limited for aesthetic (staining) reasons.

CAN TEST LTD.



Judi M. Mitchell, B.Sc.,
Chemist

/cs