Wells No S27/0846
WAI I/D 6E/88/18/I

PROFESSIONAL GROUND WATER AND ENVIRONMENTAL SERVICES

. RESOURCE CONSENTS
. ASSESSMENT OF EFFECTS
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. HYDROGEOLOGIC STUDIES

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WATER PERMIT APPLICATION

J. PETRIE, TE KOPURA, FEATHERSTON

ASSESSMENT OF EFFECTS

February 2007

1. Purpose of Report

The purpose of this report is to present an assessment of actual or potential effects on the environment of granting a Water Permit application to take ground water from a new bore at Te Kopura, Featherston. This assessment is carried out in accordance with Section 88 and the Fourth Schedule of the Resource Management Act 1991.

2. Water Permit Details

This Water Permit application is for the taking of up to 20 litres per second (l/s) of ground water, 24 hours per day and up to 150 days per year. The water is to be used for the irrigation of up to 40 hectares of pasture and/or crops.

Maximum water application rate is 302 m^3/hectare/week.

3. Site and Bore Location

The applicant's bore is located at Te Kopura, Featherston (grid reference S27: 07791 95276). Bore location is shown in Figure 1. The bore is located within the Tawaha Ground Water Zone, but close to the boundary with the Pukio Ground Water Zone. Ground water zones are as defined in the Wellington Regional Council's Regional Freshwater Plan.

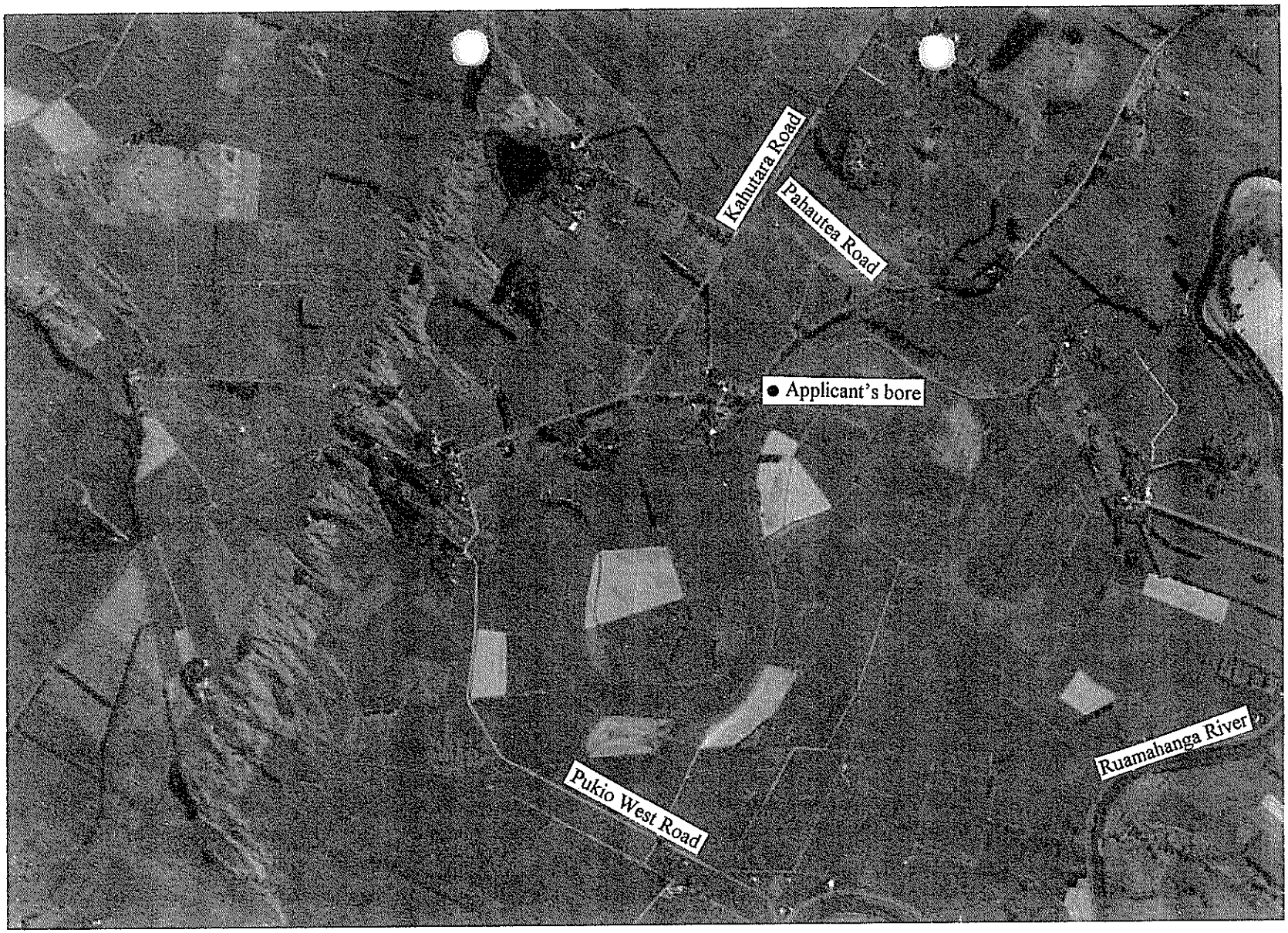

Figure 1 Location

Scale 1:26300

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4. Bore Construction Details

Bore depth:	18.14 metres
Bore diameter:	250 mm
Screen setting:	7 - 16 metres, 1.2 metre long riser on top of screen, 2.14 metre long sump on bottom of screen
Screen type:	stainless steel wedgewire

5. Borelog and Hydrogeology

Borelog details for the applicant's bore are illustrated in Figure 2.

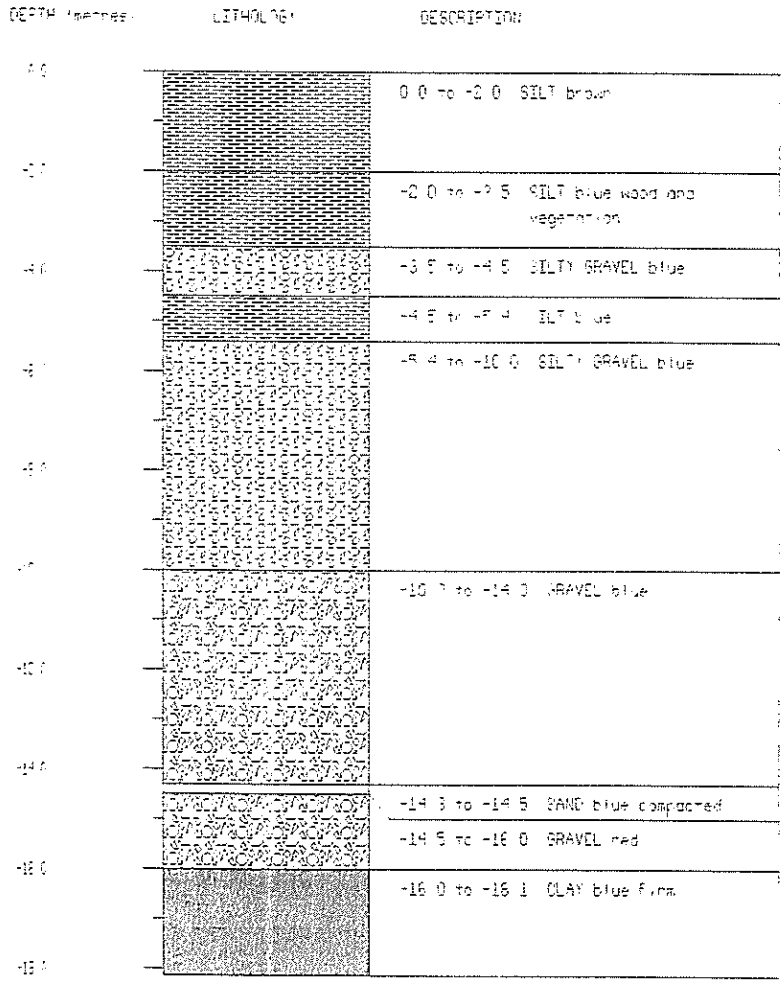

Figure 2 Borelog details

The applicant's bore is screened in a shallow aquifer (ground water bearing horizon) located between depths of 3.5 to 16.0 metres. The aquifer is overlain by a 3.5 metre thick silt layer and underlain by firm blue clay.

Borelog details for the applicant's bore have been included in two hydrogeological sections in this area (Figures 4 and 5). Bore and section locations are shown in Figure 3. Based on currently available borelog information it is considered that the

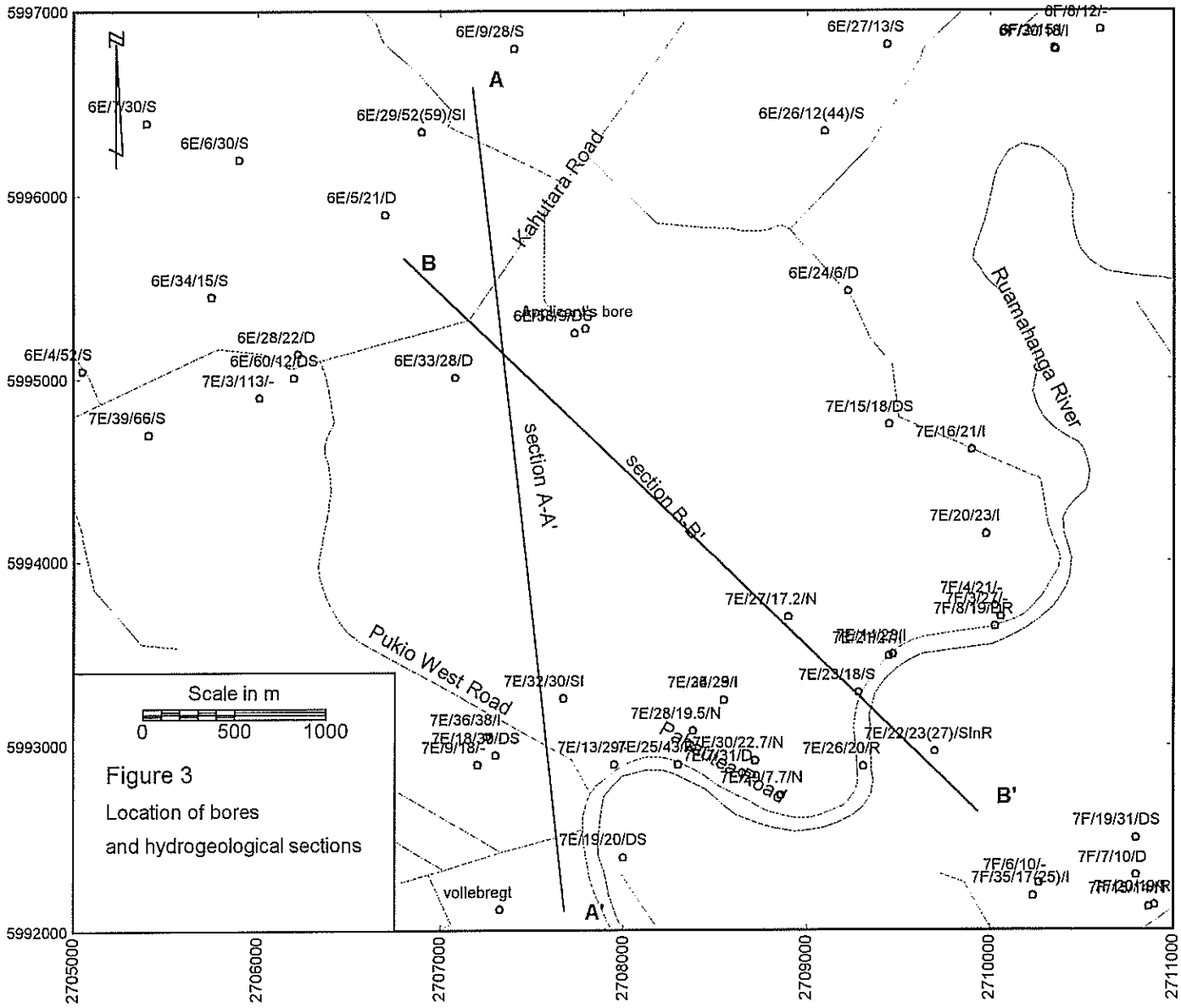

Figure 3

Location of bores and hydrogeological sections

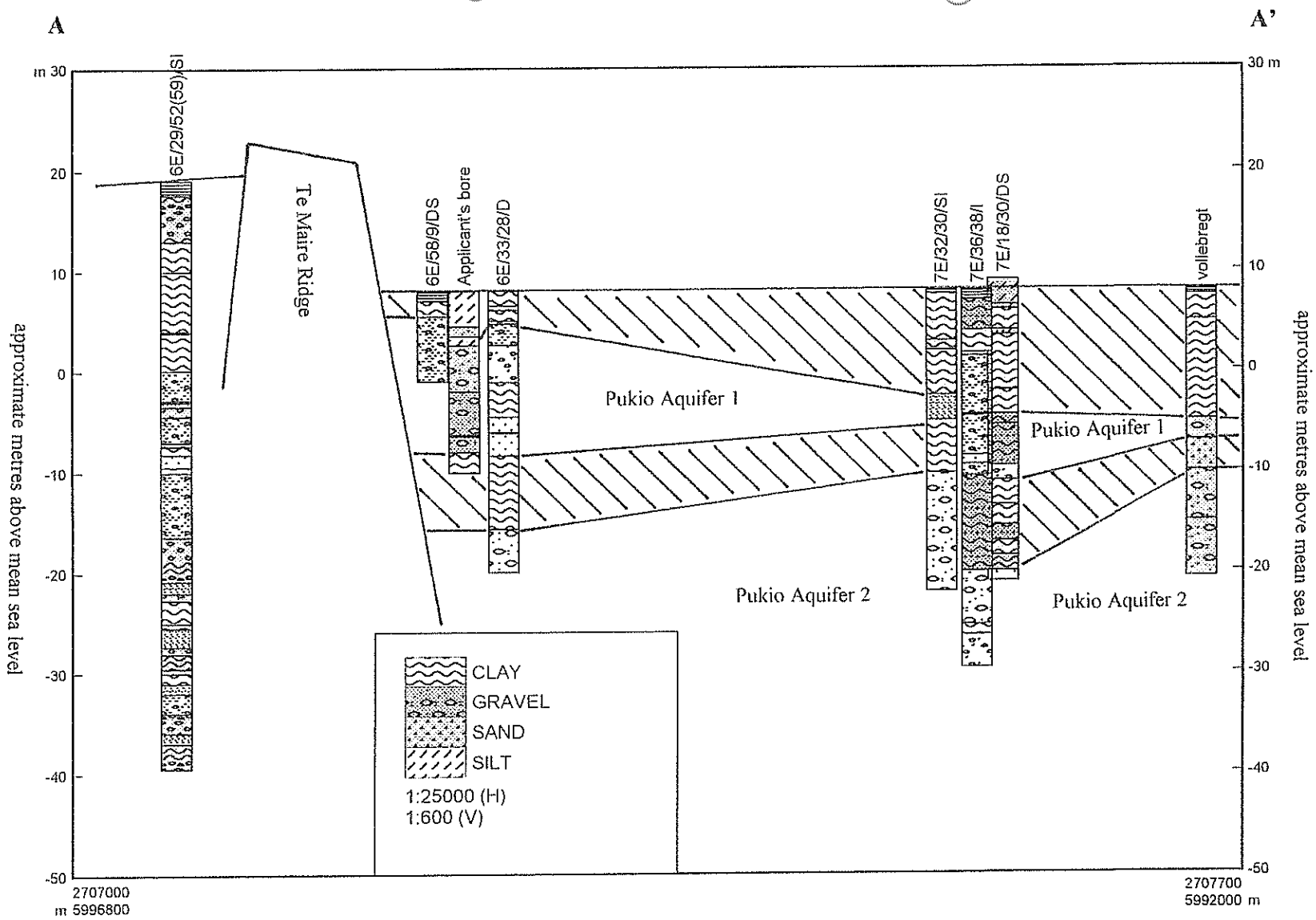
A
A'
m 30
30 m
6E/29/52(59)/SI
Te Maire Ridge
6E/58/9/DS
Applicant's bore
6E/33/28/D
7E/32/30/SI
7E/36/38/I
7E/18/30/DS
vollebregt
Pukio Aquifer 1
Pukio Aquifer 1
Pukio Aquifer 2
Pukio Aquifer 2
approximate metres above mean sea level
approximate metres above mean sea level
CLAY
GRAVEL
SAND
SILT
1:25000 (H)
1:600 (V)
2707000
m 5996800
2707700
5992000 m

Figure 4

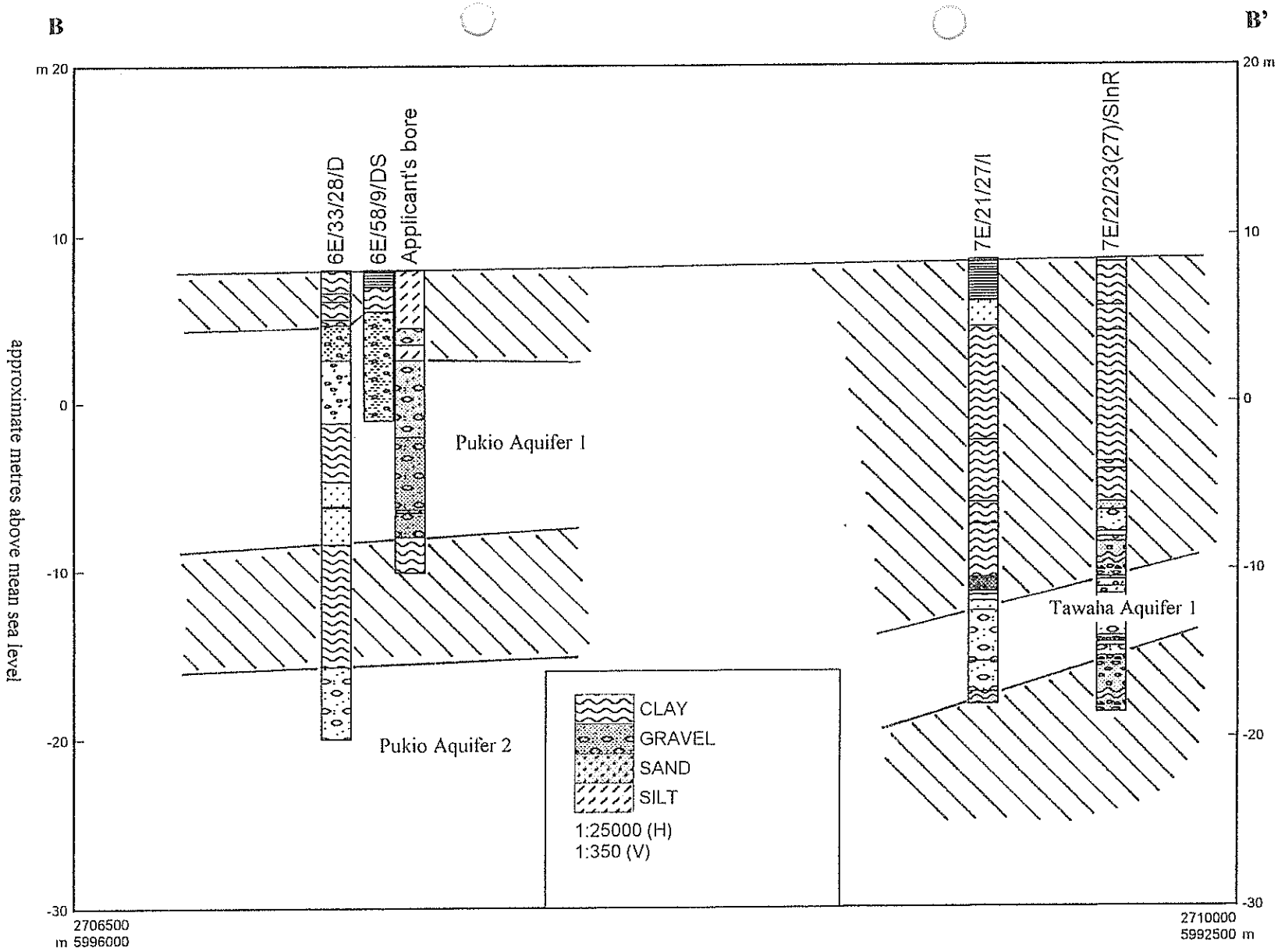
B
B'
m 20
20 m
10
0
-10
-20
-30
approximate metres above mean sea level
6E/33/28/D
6E/58/9/DS
Applicant's bore
7E/21/27/I
7E/22/23(27)/SInR
Pukio Aquifer 1
Pukio Aquifer 2
Tawaha Aquifer 1
CLAY
GRAVEL
SAND
SILT
1:25000 (H)
1:350 (V)
2706500
m 5996000
2710000
5992500 m

Figure 5

applicant's bore is screened in Pukio Aquifer 1.

To assist with aquifer definition an automatic water level recorder was installed in the applicant's existing stock water bore for a period of 41 days prior to the drilling of the irrigation bore. The stock water bore (6E/58/9/S) is located 50 metres from the irrigation bore. The aim of this monitoring was to compare water level trends in the stock water bore with water level trends in the Tawaha and Pukio Aquifers. The hydrograph for the applicant's stock water bore is shown in Figure 6. Over plotted in Figure 6 is the hydrograph from the Wellington Regional Council's Tawaha Aquifer monitoring site at 'Dry River Beef' (bore 7E/22/23(27)/SInR). The hydrograph for the applicant's stock water bore appears to be more representative of water level trends associated with the Pukio Aquifer. For example, the Tawaha Aquifer is known to be partially recharged from seepage losses from the Ruamahanga River (these effects are highlighted in Figure 6). This effect is not observed in the applicant's stock water bore.

6. Assessment of Actual or Potential Effects on the Environment

In order to assess actual or potential effects on the environment of pumping the applicant's bore, a 3 day constant rate pump test was completed on the bore by Baylis Brothers Well Drillers in association with Professional Ground Water and Environmental Services. Methods and results of the pump test are described in Appendix 1.

Results of the pump test indicate the aquifer has a good ability to transmit ground water.

Interference drawdowns due to the long term pumping of the bore at the design rate of 20 l/s should not have any adverse effects on nearby properly constructed bores with appropriate pumping systems. For example, the long term (100 day) interference drawdown at a distance of 500 metres in Pukio Aquifer 1 is estimated at approximately 0.6 metres.

Estimates of interference drawdown are based on the following parameters:

Aquifer transmissivity = 2000 (conservative figure based on pump test results)
Aquifer storage coefficient = 3.1×10^{-4}

Given the depth and available drawdown Pukio Aquifer 1 interference drawdowns of the above magnitude should not be significant. The only known bore screened in Pukio Aquifer 1 that is currently being used is bore S27/0832. The expected effect on this bore is listed in Table 1.

Bore	Available drawdown (metres)*	Drawdown with own pump operating (metres)	Interference drawdown from applicant's bore (metres)	Additional available drawdown (metres)
S27/0832	2	0.05	0.6	1.35

* allows for low seasonal water level, existing interference effects and safety factor

Table 1 Effect of bore S27/0832

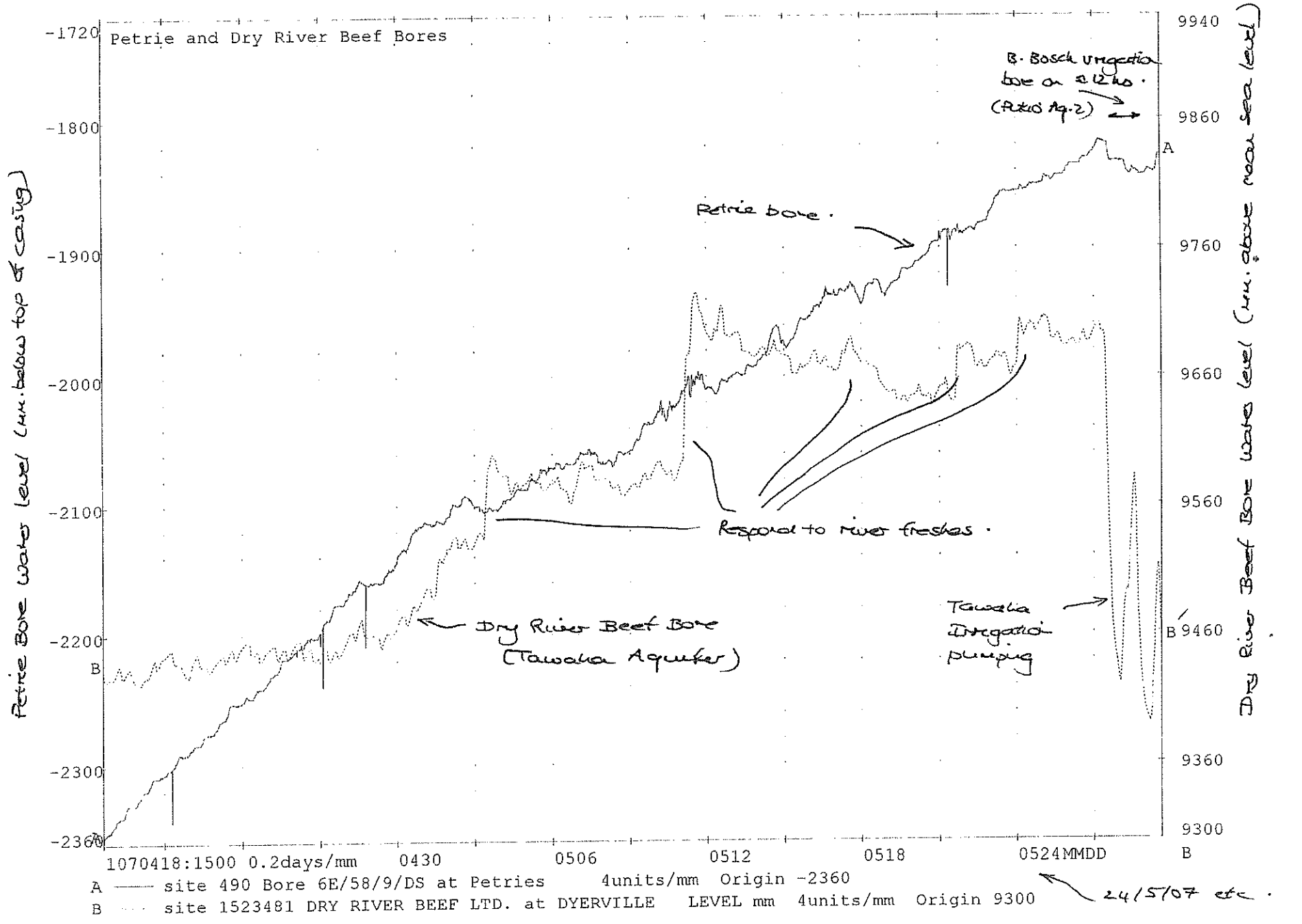
Petrie and Dry River Beef Bores
B. Bosch irrigation bore on ≈12ha.
(Rakaia Aq.2)
Petrie bore.
Response to river freshes.
Dry River Beef Bore (Tawaha Aquifer)
Tawaha Irrigation pumping
Petrie Bore Water Level (mm. below top of casing)
Dry River Beef Bore Water Level (mm. above mean sea level)
-1720
-1800
-1900
-2000
-2100
-2200
-2300
-2360
9940
9860
9760
9660
9560
9460
9360
9300
A
B
1070418:1500 0.2days/mm
0430
0506
0512
0518
0524MMDD
A —— site 490 Bore 6E/58/9/DS at Petries 4units/mm Origin -2360
B ···· site 1523481 DRY RIVER BEEF LTD. at DYERVILLE LEVEL mm 4units/mm Origin 9300
24/5/07 etc.

Figure 6

Interference drawdown effects in Pukio Aquifer 2 are expected to be minor i.e. less than 0.1 metres at 500 metres.

No safe yield or allocation limit has been defined for Pukio Aquifer 1. Due to the likely hydraulic connection between Pukio Aquifer 1 and 2 it would appear appropriate in this instance to include the allocation with that of Pukio Aquifer 2 in the Lower Valley ground water zone.

The safe yield of the Lower Valley Aquifer 2 has been estimated at 13.5 million m^3/year (Regional Freshwater Plan). Currently 11.7 million m^3/year is allocated from this aquifer or 87% of safe yield. Granting this consent application will increase the total allocation to 11.96 million m^3/year or 89 % of safe yield.

Figure 7 shows a hydrograph from a Wellington Regional Council monitoring bore (7E/26/20/R) screened in Pukio Aquifer 1. Maximum annual ground water levels in this bore may have declined by approximately 0.5 metres since about 1995. This trend is possibly related to rainfall variation, as shown in Figure 7 by a plot of running mean annual rainfall as recorded at 'Alloa'. Irrigation pumping of Pukio Aquifer 2 appears to effect ground water levels in Aquifer 1 at this site by between about 1 - 2 metres.

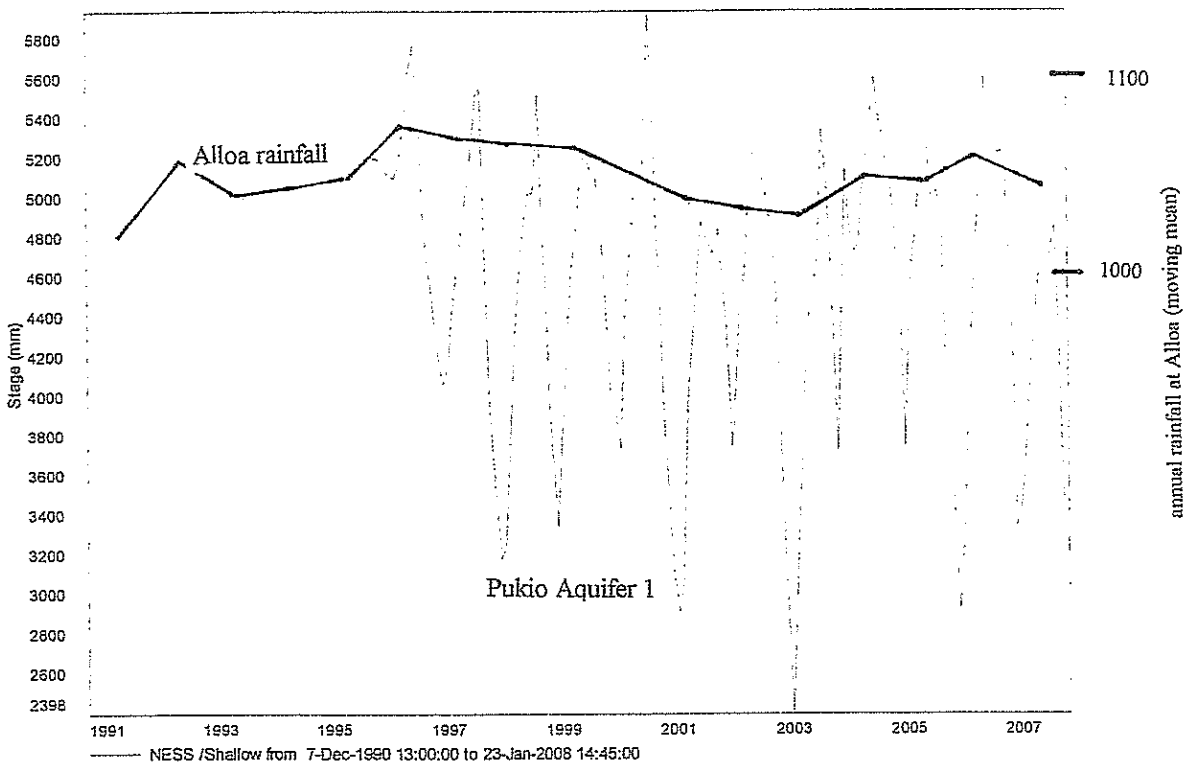

Figure 7 Pukio Aquifer 1 Hydrograph

Despite the relative shallowness of Pukio Aquifer 1 the low aquifer storage

coefficient (3 x 10^{-4}) indicates a high degree of aquifer confinement. Impact on surface water sources should therefore not be significant.

Based on the above findings no adverse environmental effects are anticipated from the granting of this Water Permit application.

Disclaimer
Due to the uncertainty involved in this type of analysis no liability can be accepted

APPENDIX 1

PUMP TEST ANALYSIS

Pump Test Method

The applicant's bore was pumped at a constant rate of 25 l/s for 3 days. The discharge rate was measured using an orifice weir. Pumped water was discharged to a nearby drain. Ground water levels were monitored throughout the pumping and recovery phases of the test in the pumped bore and 4 observation bores. Observation bore locations are shown in Figure A1. Some observation bore details are listed in Table A1.

Bore no.	Name	Distance from pumped bore (metres)	Aquifer
6E/58/9/DS	Petrie stock bore	50	Pukio 1
S27/0832	Collins	190	Pukio 1
7E/32/30/SI	B.Bosch	2300	Pukio 2
7E/20/23/I	Vollebregt (ex.Edwards)	2230	Tawaha 1

Table A1 Observation bore details

Complete listings of all pump test data are given in Appendix 2.

Automatic water level recorders were installed on the pumped bore and all observation bores four days prior to the commencement of the pump test. The recorders were removed six days after the completion of the test.

Pump Test Results

After 3 days pumping at a constant rate of 25 l/s the water level in the pumped bore had drawn down from the initial static water level of 0.66 metres below the top of the bore casing (m.b.t.c) to 5.01 m.b.t.c. i.e. a drawdown of 4.35 metres (Figure A2).

The rate of water level drawdown indicates that the aquifer has a good ability to transmit ground water. Aquifer transmissivity calculated from the pumped bore drawdown data varies between 434 and 988 m^2/day or an average of 711 m^2/day. Transmissivity is defined as the rate of ground water flow through a unit strip of aquifer under a unit hydraulic gradient.

After 60 minutes recovery the water level in the pumped bore had recovered back to 0.98 m.b.t.c. i.e. 0.32 metres from full recovery (Figure A3). Aquifer transmissivity calculated from the recovery data varies between 1224 and 3241 m^2/day.

Hydrographs for all monitoring bores are presented in Appendix 3.

Interference drawdowns measured in the monitored observation bores at the end of the pump test are listed in Table A2.

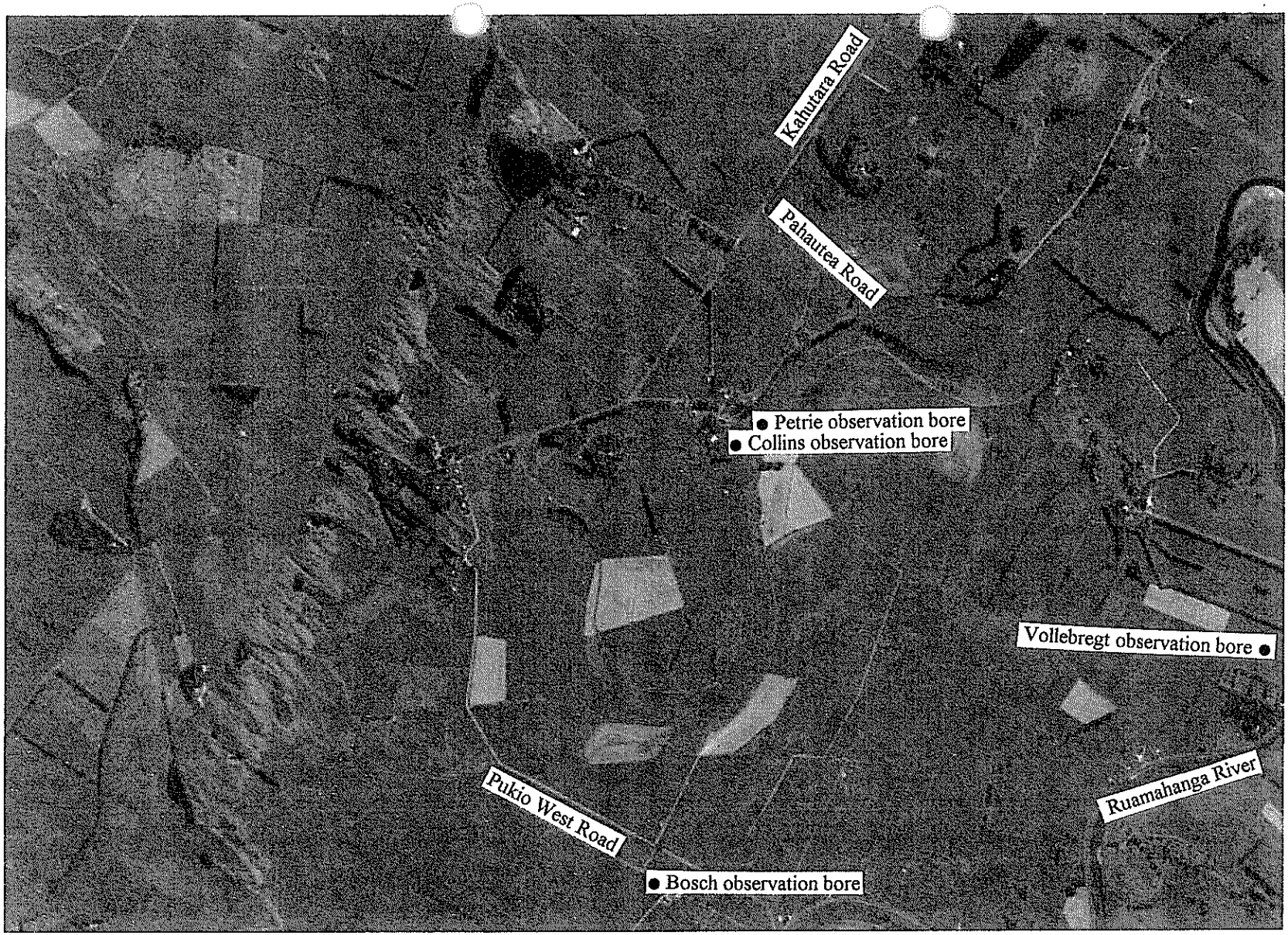

Figure A1 Location of monitoring bores

Scale 1:26300

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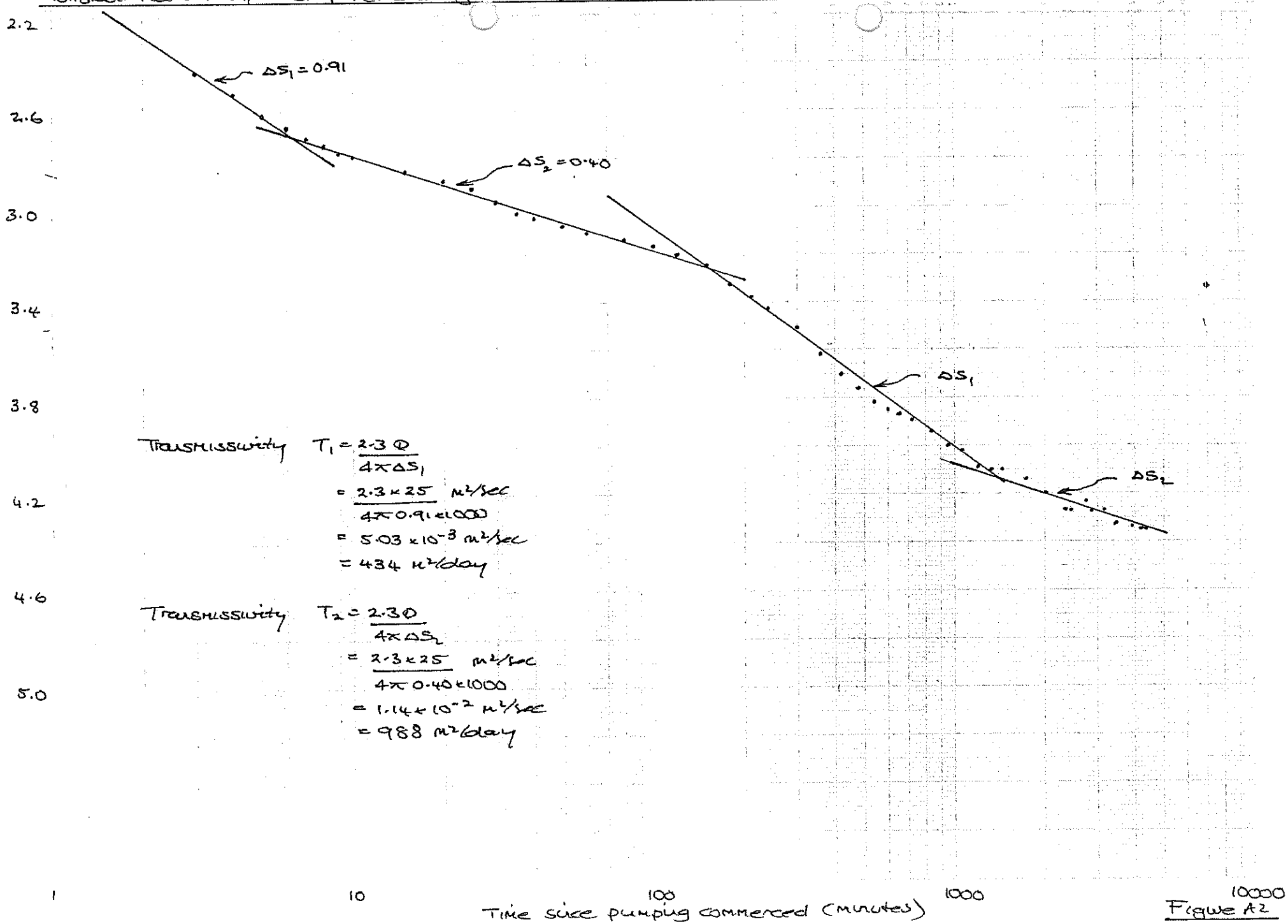
Constant Rate Pump Test of Petrie Irrigation Bore, Kahutara 5-8/11/07



Transmissivity $T_1 = \frac{2.30 Q}{4\pi \Delta S_1}$

$= \frac{2.3 \times 25}{4\pi \times 0.91 \times 1000}$ m²/sec

$= 5.03 \times 10^{-3}$ m²/sec

$= 434$ m²/day

Transmissivity $T_2 = \frac{2.30 Q}{4\pi \Delta S_2}$

$= \frac{2.3 \times 25}{4\pi \times 0.40 \times 1000}$ m²/sec

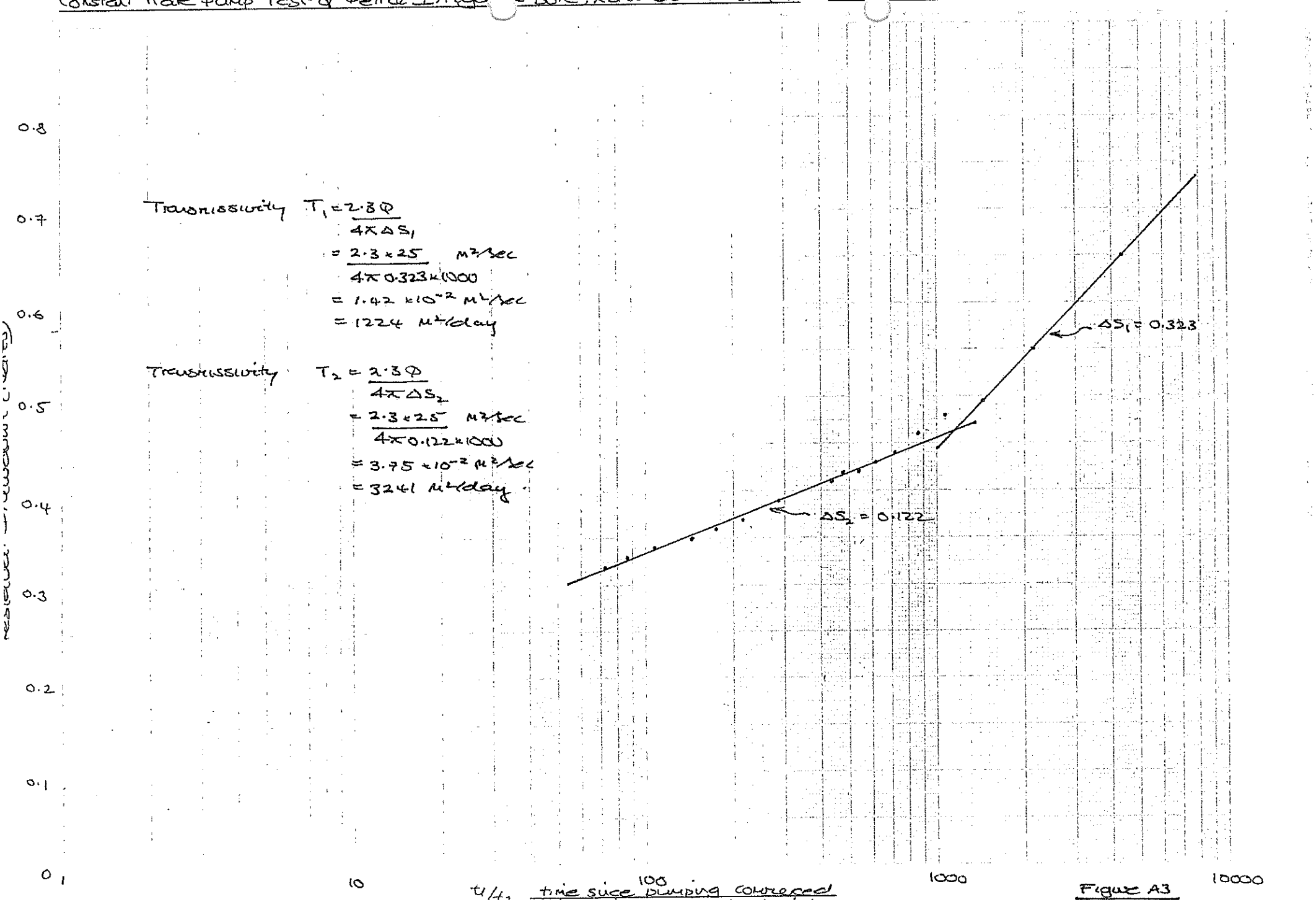
$= 1.14 \times 10^{-2}$ m²/sec

$= 988$ m²/day

Figure A2

Constant Rate Pump Test of Petrie Irrigation Bore, Kalutara 5-8/11/67

Pumped Bore Residual Drawdown (Recovery)



Transmissivity $T_1 = \frac{2.3Q}{4\pi\Delta S_1}$

$= \frac{2.3 \times 25}{4\pi \times 0.323 \times 1000}$ m^2/sec

$= 1.42 \times 10^{-2}\ m^2/sec$

$= 1224\ m^2/day$

Transmissivity $T_2 = \frac{2.3Q}{4\pi\Delta S_2}$

$= \frac{2.3 \times 25}{4\pi \times 0.122 \times 1000}$ m^2/sec

$= 3.75 \times 10^{-2}\ m^2/sec$

$= 3241\ m^2/day$

Figure A3

Bore no.	Name	Aquifer	Distance from pumped bore (metres)	Drawdown (metres)
6E/58/9/DS	Petrie stock bore	Pukio 1	50	0.737
S27/0832	Collins	Pukio 1	190	0.501
7E/32/30/SI	B.Bosch	Pukio 2	2300	0
7E/20/23/I	Vollebregt (ex.Edwards)	Tawahi 1	2230	0

Table A2 Observation bore drawdowns

Drawdown and recovery plots for the two effected observation bores are shown in Appendix 4.

Aquifer parameters estimated from observation bore data are listed in Table A3.

Bore	Transmissivity (m2/day, derived from drawdown data))	Transmissivity (m2/day, derived from recovery data)	Storage coefficient
Petrie stock bore	1459 - 4119	1757 - 3953	0.00037
Collins	2059 - 5342	5004	0.00024
Average	3340		0.00031

Table A3 Observation bore aquifer parameter data

Average transmissivity and storage coefficient calculated from the observation bore data are 3340 m^2/day and 3.1 x 10^{-4} respectively.

Bore Yield

An approximate yield curve for the applicant's bore is shown in Figure A4. Note that Figure A4 is only approximate. A more accurate yield curve would require completion of a 'step drawdown' type pump test.

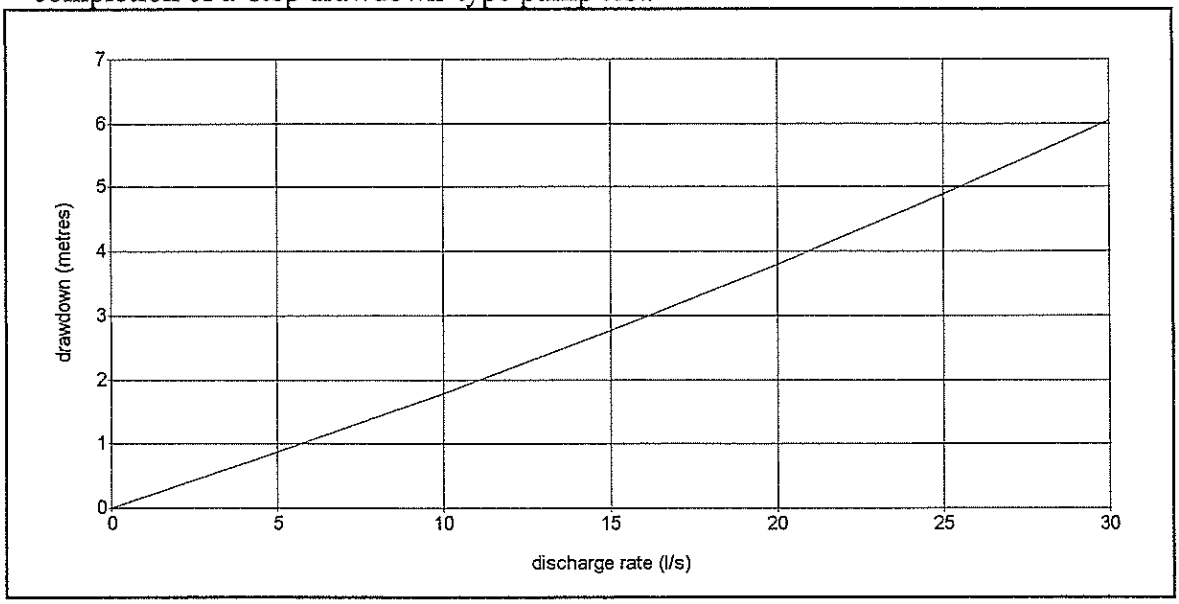


Figure A4 Approximate bore yield curve

Maximum available drawdown in the applicant's bore is approximately 3.0 metres, as below:

depth to top of screen:	7.0 metres
less low seasonal water level, estimated:	2.0 metres
less interference effects, estimated:	1.0 metres
less safety factor, say:	1.0 metres
	3.0 metres

From Figure A4 maximum long term sustainable bore yield is assessed at approximately 15 l/s. Higher yields of up to approximately 20 l/s are likely to be achievable at the commencement of an irrigation season but may not be sustainable as the season progresses. The above assessment does assume:

- no additional dewatering boundaries are encountered with long term pumping. If additional dewatering boundaries are encountered the long term sustainable bore yield may be less than stated above.
- bore efficiency remains the same as observed during the pump test. If bore efficiency decreases bore yield will also decline.
- interference drawdown effects are based on existing levels of ground water use from this aquifer. If major increases in ground water use occur, then bore yield could be reduced.
- if seasonal ground water levels are lower than anticipated then maximum bore yield may be reduced.
- a submersible pump is placed in the sump below the bore screen.

Appendix 2

Pump Test Data Listings

DATE	TIME	LAPSED TIME (mins)	WATER LEVEL (m.b.m.p)	DRAWDOWN (metres)
Pumped bore drawdown				
5/11/2007	1200	0	0.66	
5/11/2007	1203	3	3.1	2.44
5/11/2007	1204	4	3.19	2.53
5/11/2007	1205	5	3.28	2.62
5/11/2007	1206	6	3.33	2.67
5/11/2007	1207	7	3.37	2.71
5/11/2007	1208	8	3.4	2.74
5/11/2007	1209	9	3.43	2.77
5/11/2007	1210	10	3.45	2.79
5/11/2007	1215	15	3.51	2.85
5/11/2007	1220	20	3.55	2.89
5/11/2007	1225	25	3.58	2.92
5/11/2007	1230	30	3.64	2.98
5/11/2007	1235	35	3.69	3.03
5/11/2007	1240	40	3.71	3.05
5/11/2007	1250	50	3.74	3.08
5/11/2007	1300	60	3.77	3.11
5/11/2007	1320	80	3.8	3.14
5/11/2007	1340	100	3.83	3.17
5/11/2007	1400	120	3.86	3.2
5/11/2007	1430	150	3.91	3.25
5/11/2007	1500	180	3.99	3.33
5/11/2007	1530	210	4.04	3.38
5/11/2007	1600	240	4.09	3.43
5/11/2007	1700	300	4.17	3.51
5/11/2007	1800	360	4.28	3.62
5/11/2007	1900	420	4.36	3.7
5/11/2007	2000	480	4.42	3.76
5/11/2007	2100	540	4.48	3.82
5/11/2007	2200	600	4.51	3.85
5/11/2007	2300	660	4.53	3.87
5/11/2007	2400	720	4.55	3.89
6/11/2007	200	840	4.6	3.94
6/11/2007	400	960	4.66	4
6/11/2007	600	1080	4.68	4.02
6/11/2007	800	1200	4.75	4.09
6/11/2007	1000	1320	4.76	4.1
6/11/2007	1200	1440	4.76	4.1
6/11/2007	1700	1740	4.8	4.14
6/11/2007	2200	2040	4.86	4.2
7/11/2007	500	2460	4.93	4.27
7/11/2007	1000	2760	4.89	4.23
7/11/2007	1200	2880	4.915	4.255
7/11/2007	1700	3180	4.93	4.27
7/11/2007	2200	3480	4.99	4.33
8/11/2007	500	3900	5	4.34
8/11/2007	1000	4200	5.01	4.35
8/11/2007	1200	4320	5.01	4.35

DATE	TIME	LAPSED TIME (mins)	WATER LEVEL (m.b.m.p)	DRAWDOWN (metres)
Pumped bore recovery				
8/11/2007	1201	1	1.31	0.65
8/11/2007	1202	2	1.21	0.55
8/11/2007	1203	3	1.15	0.49
8/11/2007	1204	4	1.14	0.48
8/11/2007	1205	5	1.12	0.46
8/11/2007	1206	6	1.1	0.44
8/11/2007	1207	7	1.09	0.43
8/11/2007	1208	8	1.08	0.42
8/11/2007	1209	9	1.08	0.42
8/11/2007	1210	10	1.07	0.41
8/11/2007	1215	15	1.05	0.39
8/11/2007	1220	20	1.03	0.37
8/11/2007	1225	25	1.02	0.36
8/11/2007	1230	30	1.01	0.35
8/11/2007	1240	40	1	0.34
8/11/2007	1250	50	0.99	0.33
8/11/2007	1300	60	0.98	0.32

Petrie Observation Bore

Drawdown data

DATE	TIME	LAPSED TIME (mins)	WATER LEVEL (m.b.m.p)	DRAWDOWN (metres)
5/11/2007	1200	0	1.173	
5/11/2007	1201	1	1.278	0.105
5/11/2007	1202	2	1.357	0.184
5/11/2007	1203	3	1.413	0.24
5/11/2007	1204	4	1.442	0.269
5/11/2007	1205	5	1.463	0.29
5/11/2007	1206	6	1.474	0.301
5/11/2007	1207	7	1.487	0.314
5/11/2007	1208	8	1.496	0.323
5/11/2007	1209	9	1.502	0.329
5/11/2007	1210	10	1.508	0.335
5/11/2007	1215	15	1.528	0.355
5/11/2007	1220	20	1.54	0.367
5/11/2007	1225	25	1.549	0.376
5/11/2007	1230	30	1.557	0.384
5/11/2007	1235	35	1.563	0.39
5/11/2007	1240	40	1.571	0.398
5/11/2007	1250	50	1.576	0.403
5/11/2007	1300	60	1.59	0.417
5/11/2007	1320	80	1.6	0.427
5/11/2007	1340	100	1.61	0.437
5/11/2007	1400	120	1.61	0.437
5/11/2007	1430	150	1.62	0.447
5/11/2007	1500	180	1.63	0.457
5/11/2007	1530	210	1.64	0.467
5/11/2007	1600	240	1.65	0.477
5/11/2007	1700	300	1.65	0.477
5/11/2007	1800	360	1.67	0.497
5/11/2007	1900	420	1.68	0.507
5/11/2007	2000	480	1.69	0.517
5/11/2007	2100	540	1.7	0.527
5/11/2007	2200	600	1.71	0.537
5/11/2007	2300	660	1.72	0.547
5/11/2007	2400	720	1.72	0.547
6/11/2007	200	840	1.73	0.557
6/11/2007	400	960	1.75	0.577
6/11/2007	600	1080	1.76	0.587
6/11/2007	800	1200	1.77	0.597
6/11/2007	1000	1320	1.775	0.602
6/11/2007	1200	1440	1.78	0.607
6/11/2007	1700	1740	1.79	0.617
6/11/2007	2200	2040	1.815	0.642
7/11/2007	500	2460	1.83	0.657
7/11/2007	1000	2760	1.84	0.667
7/11/2007	1200	2880	1.845	0.672
7/11/2007	1700	3180	1.86	0.687
7/11/2007	2200	3480	1.89	0.717
8/11/2007	500	3900	1.9	0.727
8/11/2007	1000	4200	1.91	0.737
8/11/2007	1200	4320	1.91	0.737

Recovery data

DATE	TIME	LAPSED TIME (mins)	WATER LEVEL (m.b.m.p)	DRAWDOWN (metres)
8/11/2007	1202	2	1.71	0.537
8/11/2007	1203	3	1.67	0.497
8/11/2007	1204	4	1.64	0.467
8/11/2007	1205	5	1.62	0.447
8/11/2007	1206	6	1.605	0.432
8/11/2007	1207	7	1.595	0.422
8/11/2007	1208	8	1.59	0.417
8/11/2007	1209	9	1.58	0.407
8/11/2007	1210	10	1.57	0.397
8/11/2007	1215	15	1.55	0.377
8/11/2007	1220	20	1.53	0.357
8/11/2007	1225	25	1.52	0.347
8/11/2007	1230	30	1.51	0.337
8/11/2007	1240	40	1.5	0.327
8/11/2007	1250	50	1.49	0.317
8/11/2007	1300	60	1.485	0.312

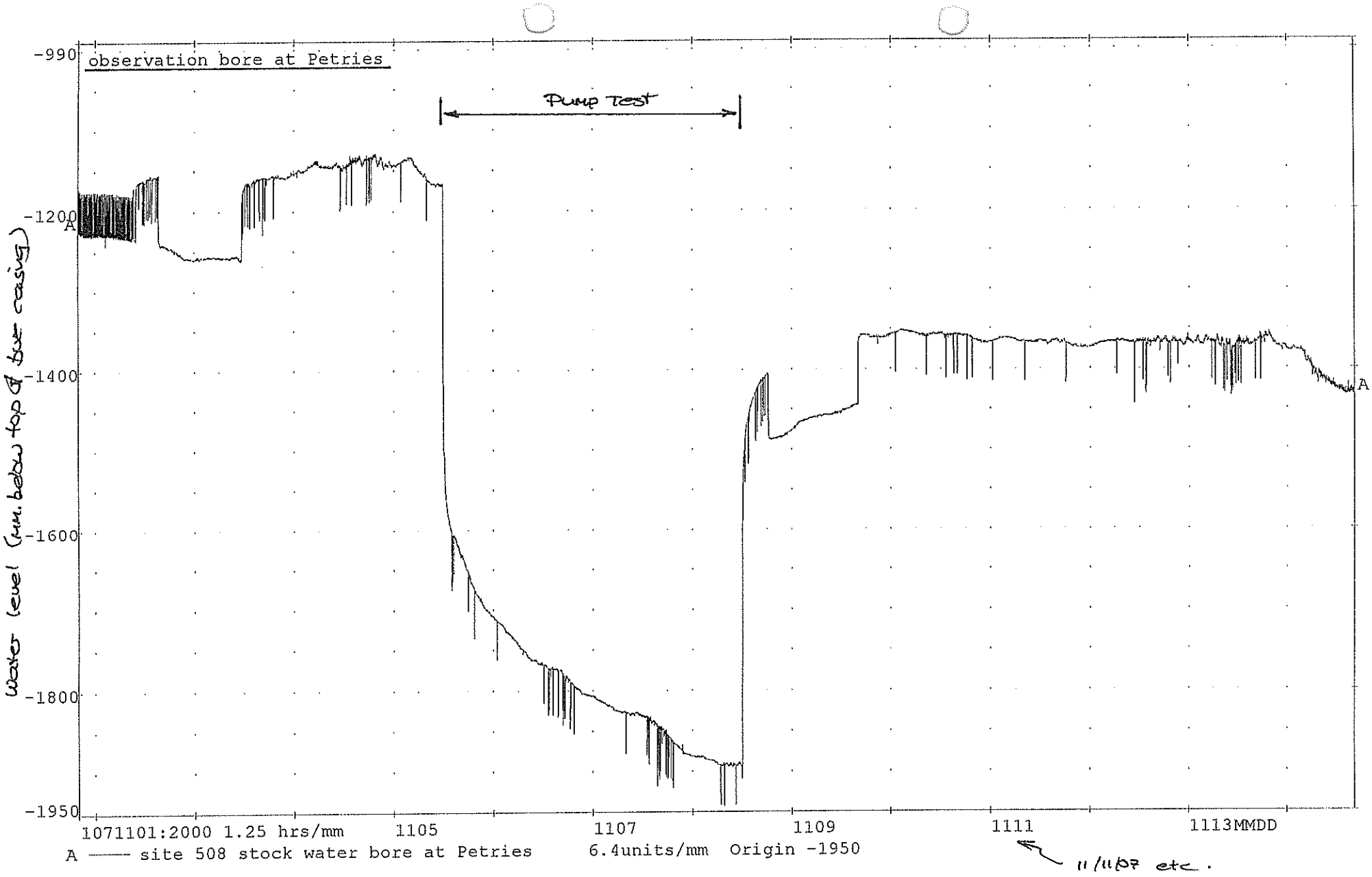
Collins observation bore

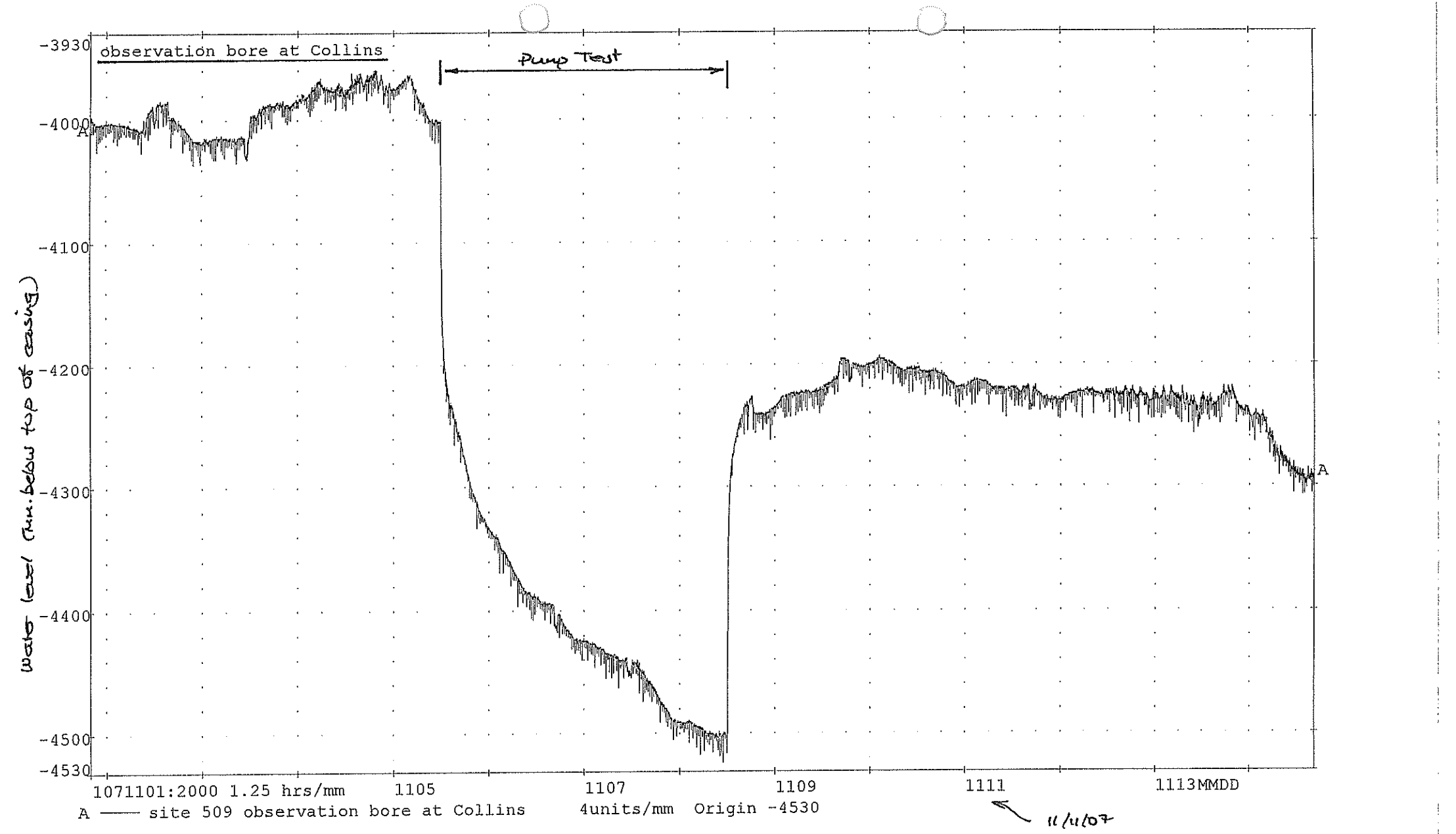
DATE	TIME	LAPSED TIME (mins)	WATER LEVEL (m.b.m.p)	DRAWDOWN (metres)
5/11/2007	1200	0	4.002	
5/11/2007	1201	1	4.002	0
5/11/2007	1202	2	4.008	0.006
5/11/2007	1203	3	4.019	0.017
5/11/2007	1204	4	4.036	0.034
5/11/2007	1205	5	4.053	0.051
5/11/2007	1206	6	4.07	0.068
5/11/2007	1207	7	4.083	0.081
5/11/2007	1208	8	4.094	0.092
5/11/2007	1209	9	4.106	0.104
5/11/2007	1210	10	4.113	0.111
5/11/2007	1211	11	4.121	0.119
5/11/2007	1212	12	4.127	0.125
5/11/2007	1213	13	4.133	0.131
5/11/2007	1214	14	4.137	0.135
5/11/2007	1215	15	4.142	0.14
5/11/2007	1220	20	4.159	0.157
5/11/2007	1225	25	4.169	0.167
5/11/2007	1230	30	4.177	0.175
5/11/2007	1235	35	4.183	0.181
5/11/2007	1240	40	4.188	0.186
5/11/2007	1245	45	4.193	0.191
5/11/2007	1250	50	4.196	0.194
5/11/2007	1255	55	4.2	0.198
5/11/2007	1300	60	4.203	0.201
5/11/2007	1330	90	4.215	0.213
5/11/2007	1400	120	4.226	0.224
5/11/2007	1430	150	4.234	0.232
5/11/2007	1500	180	4.238	0.236
5/11/2007	1530	210	4.247	0.245
5/11/2007	1600	240	4.255	0.253
5/11/2007	1630	270	4.257	0.255
5/11/2007	1700	300	4.267	0.265
5/11/2007	1730	330	4.275	0.273
5/11/2007	1800	360	4.279	0.277
5/11/2007	1900	420	4.293	0.291
5/11/2007	2000	480	4.304	0.302
5/11/2007	2100	540	4.314	0.312
5/11/2007	2200	600	4.323	0.321
5/11/2007	2300	660	4.327	0.325
5/11/2007	2400	720	4.334	0.332
6/11/2007	200	840	4.34	0.338
6/11/2007	400	960	4.353	0.351
6/11/2007	600	1080	4.367	0.365
6/11/2007	800	1200	4.377	0.375
6/11/2007	1000	1320	4.386	0.384
6/11/2007	1200	1440	4.389	0.387
6/11/2007	1500	1620	4.394	0.392
6/11/2007	1800	1800	4.406	0.404
6/11/2007	2100	1980	4.42	0.418

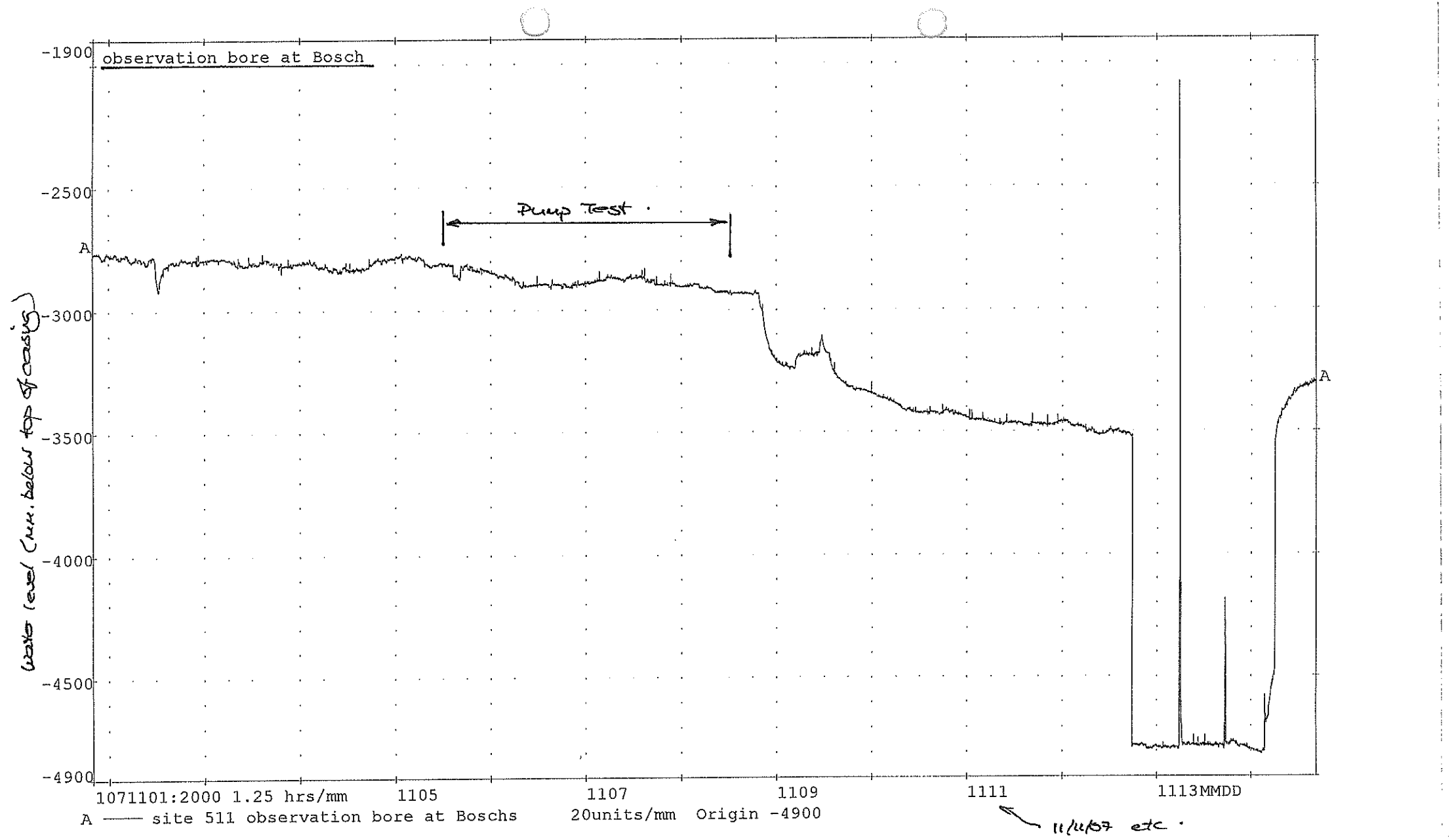
DATE	TIME	LAPSED TIME (mins)	WATER LEVEL (m.b.m.p)	DRAWDOWN (metres)
6/11/2007	2400	2160	4.424	0.422
7/11/2007	300	2340	4.429	0.427
7/11/2007	600	2520	4.435	0.433
7/11/2007	900	2700	4.442	0.44
7/11/2007	1200	2880	4.444	0.442
7/11/2007	1500	3060	4.452	0.45
7/11/2007	1800	3240	4.465	0.463
7/11/2007	2100	3420	4.482	0.48
7/11/2007	2400	3600	4.49	0.488
8/11/2007	300	3780	4.492	0.49
8/11/2007	600	3960	4.496	0.494
8/11/2007	900	4140	4.501	0.499
8/11/2007	1200	4320	4.503	0.501
Recovery				
8/11/2007	1230	30	4.317	0.315
8/11/2007	1300	60	4.285	0.283
8/11/2007	1330	90	4.273	0.271
8/11/2007	1400	120	4.263	0.261
8/11/2007	1430	150	4.255	0.253
8/11/2007	1500	180	4.247	0.245
8/11/2007	1530	210	4.245	0.243
8/11/2007	1600	240	4.241	0.239
8/11/2007	1630	270	4.234	0.232
8/11/2007	1700	300	4.231	0.229
8/11/2007	1730	330	4.23	0.228
8/11/2007	1800	360	4.227	0.225

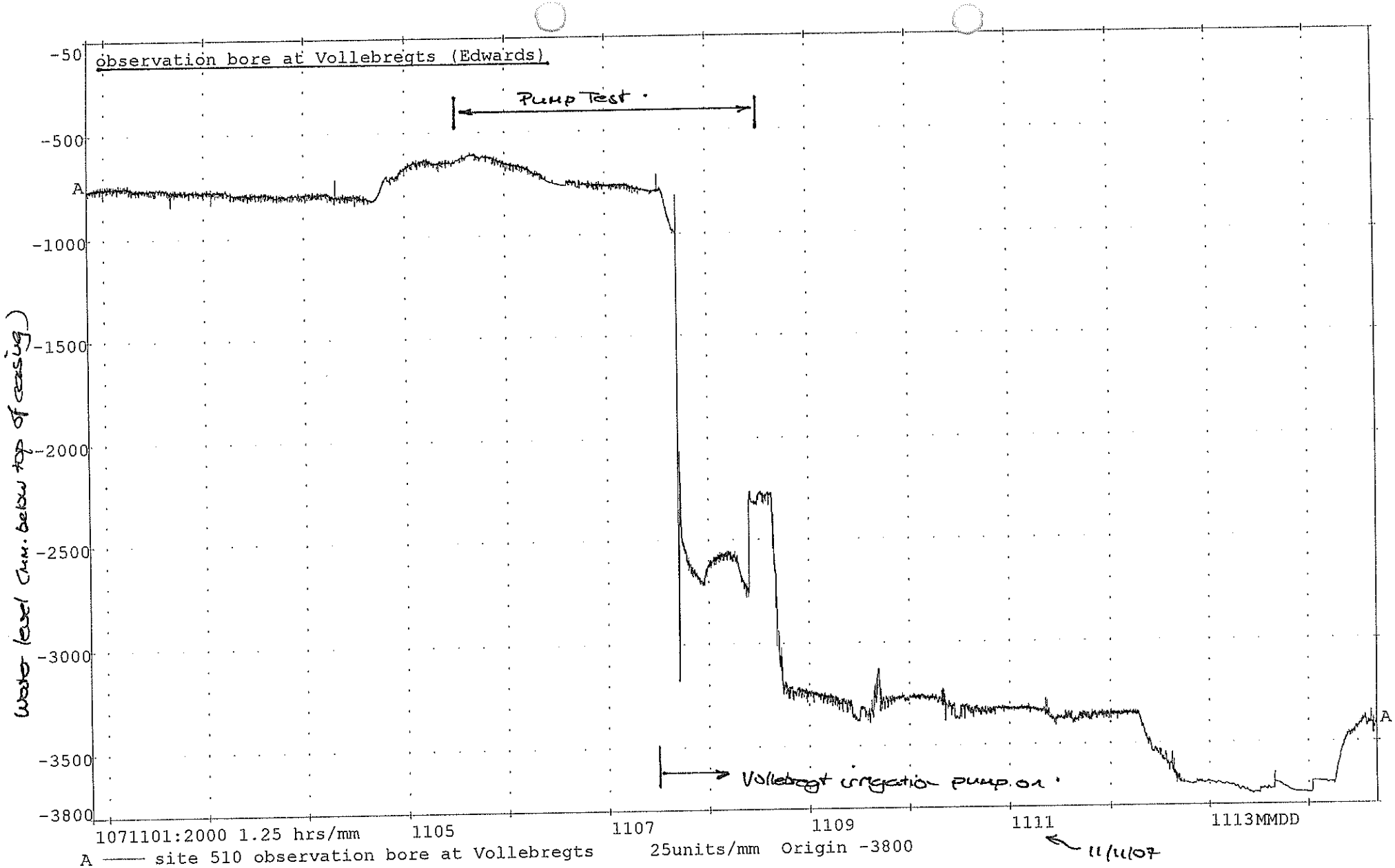
Appendix 3

Observation bore hydrographs


observation bore at Petries
Pump test
-990
-1200
-1400
-1600
-1800
-1950
A
A
Water level (mm. below top of bore casing)
1071101:2000 1.25 hrs/mm
1105
1107
1109
1111
1113MMDD
A —— site 508 stock water bore at Petries
6.4units/mm Origin -1950
11/11/07 etc.


observation bore at Collins
Pump Test
-3930
-4000
-4100
-4200
-4300
-4400
-4500
-4530
A
A
water level (m. below top of casing)
1071101:2000 1.25 hrs/mm
1105
1107
1109
1111
1113MMDD
A —— site 509 observation bore at Collins
4units/mm Origin -4530
11/11/07


observation bore at Bosch
-1900
-2500
-3000
-3500
-4000
-4500
-4900
Pump Test
A
A
water level (mm. below top of casing)
1071101:2000 1.25 hrs/mm
1105
1107
1109
1111
1113MMDD
A —— site 511 observation bore at Boschs
20units/mm Origin -4900
11/11/07 etc.

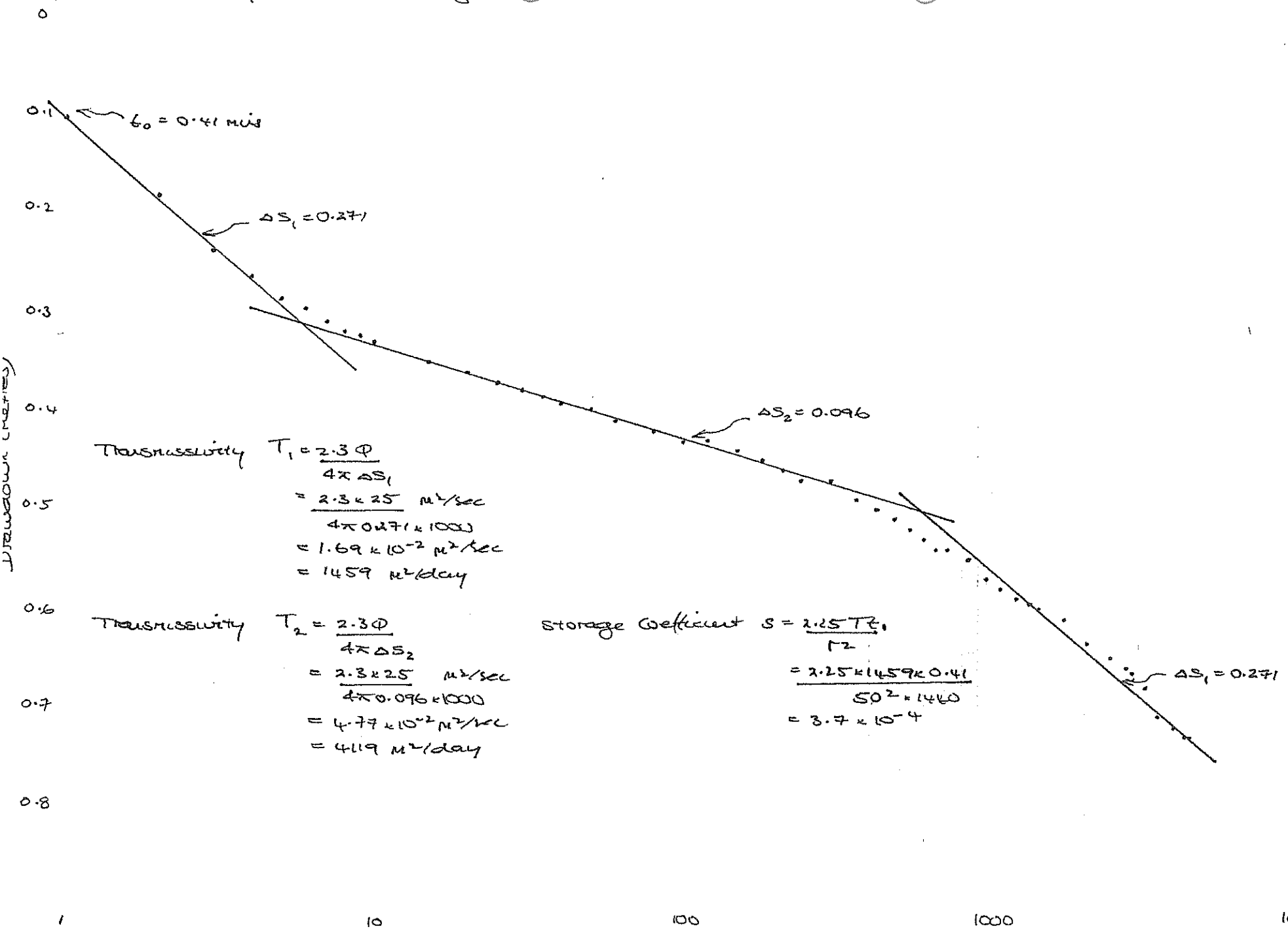

observation bore at Vollebregts (Edwards)
Pump Test.
-50
-500
-1000
-1500
-2000
-2500
-3000
-3500
-3800
A
Water level (m. below top of casing)
Vollebregt irrigation pump on.
1071101:2000 1.25 hrs/mm
1105
1107
1109
1111
1113MMDD
11/11/07
A —— site 510 observation bore at Vollebregts
25units/mm Origin -3800

Appendix 4

Observation Bore Drawdown Plots

Constant Rate Pump Test of Petrie Irrigation Bore, Kaluatora 5-8/11/07

Petrie Observation Bore Drawdown.



Transmissivity $T_1 = \frac{2.3Q}{4\pi\Delta S_1}$

$= \frac{2.3 \times 25}{4\pi 0.271 \times 1000}$ m²/sec

$= 1.69 \times 10^{-2}$ m²/sec

$= 1459$ m²/day

Transmissivity $T_2 = \frac{2.3Q}{4\pi\Delta S_2}$

$= \frac{2.3 \times 25}{4\pi 0.096 \times 1000}$ m²/sec

$= 4.77 \times 10^{-2}$ m²/sec

$= 4119$ m²/day

Storage Coefficient $S = \frac{2.25 T t_0}{r^2}$

$= \frac{2.25 \times 1459 \times 0.41}{50^2 \times 1440}$

$= 3.7 \times 10^{-4}$

Constant Rate Pump Test of Petrie Irrigation Bore, Kaiaua 5 - 8/11/07 Petrie Observation Bore Recovery (Residual Drawdown)

Transmissivity $T_1 = \frac{2.3\,Q}{4\pi\,\Delta S_1}$

$= \frac{2.3 \times 25}{4\pi\,0.225 \times 1000}\ m^2/sec$

$= 2.03 \times 10^{-2}\ m^2/sec$

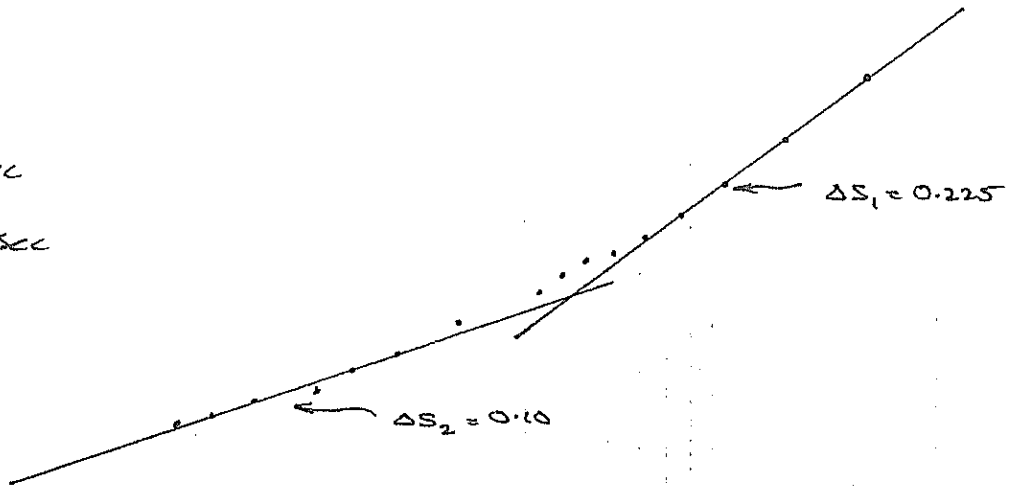
$= 1757\ m^2/day$

Transmissivity $T_2 = \frac{2.3\,Q}{4\pi\,\Delta S_2}$

$= \frac{2.3 \times 25}{4\pi\,0.10 \times 1000}\ m^2/sec$

$= 4.58 \times 10^{-2}\ m^2/sec$

$= 3953\ m^2/day$

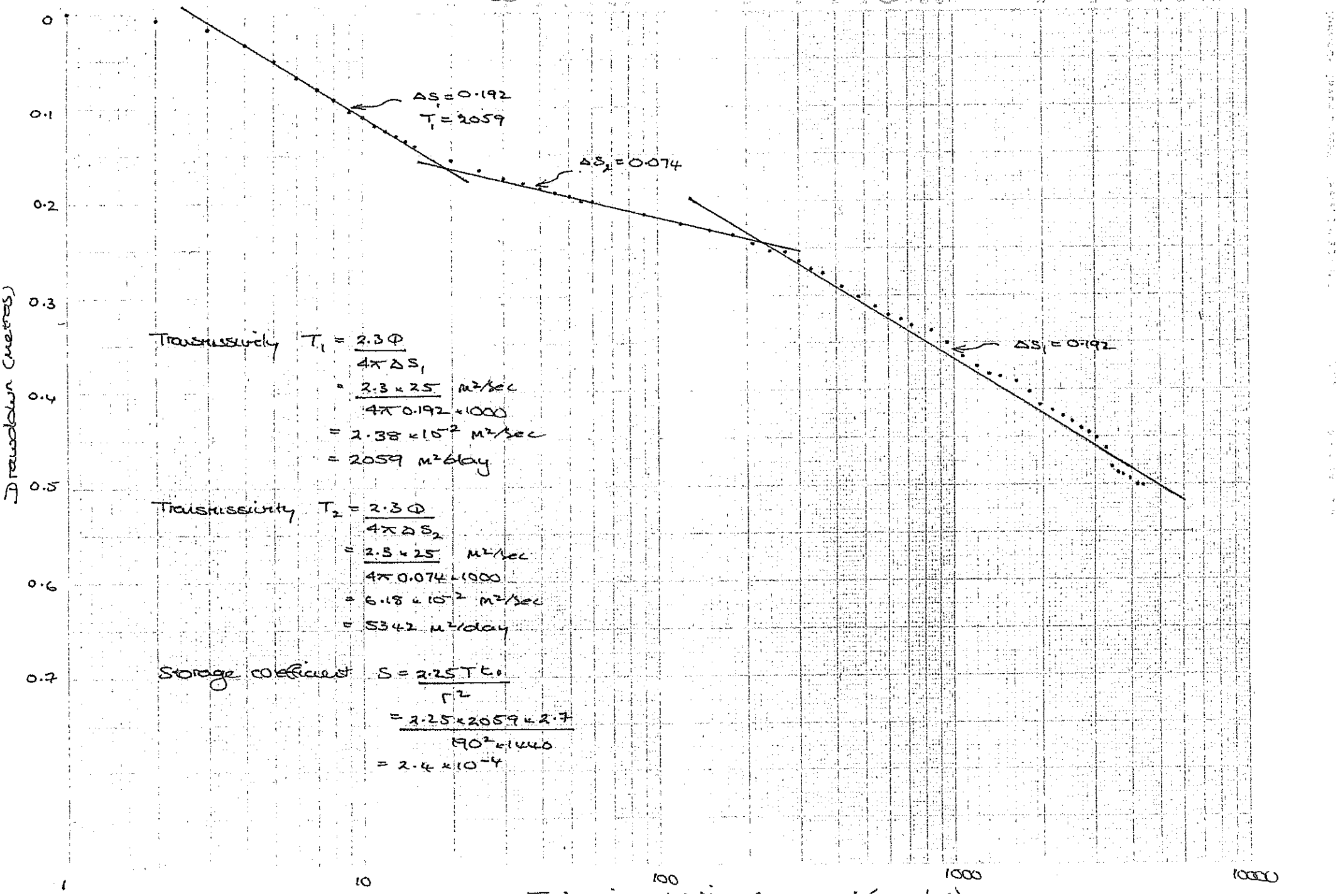


0.7 0.6 0.5 0.4 0.3 0.2 0.1 0

1 10 100 1000 10000

t/t' time since pumping commenced.

Constant Rate Pump Test of Petrie Irrig. Bore, Kakutoa 5-8/11107 — Collins Observation Bore Drawdown



Transmissivity $T_1 = \frac{2.3Q}{4\pi\Delta S_1}$

$= \frac{2.3 \times 25}{4\pi\ 0.192 \times 1000}$ m^2/sec

$= 2.38 \times 10^{-2}\ m^2/sec$

$= 2059\ m^2/day$

Transmissivity $T_2 = \frac{2.3Q}{4\pi\Delta S_2}$

$= \frac{2.3 \times 25}{4\pi\ 0.074 \times 1000}$ m^2/sec

$= 6.18 \times 10^{-2}\ m^2/sec$

$= 5342\ m^2/day$

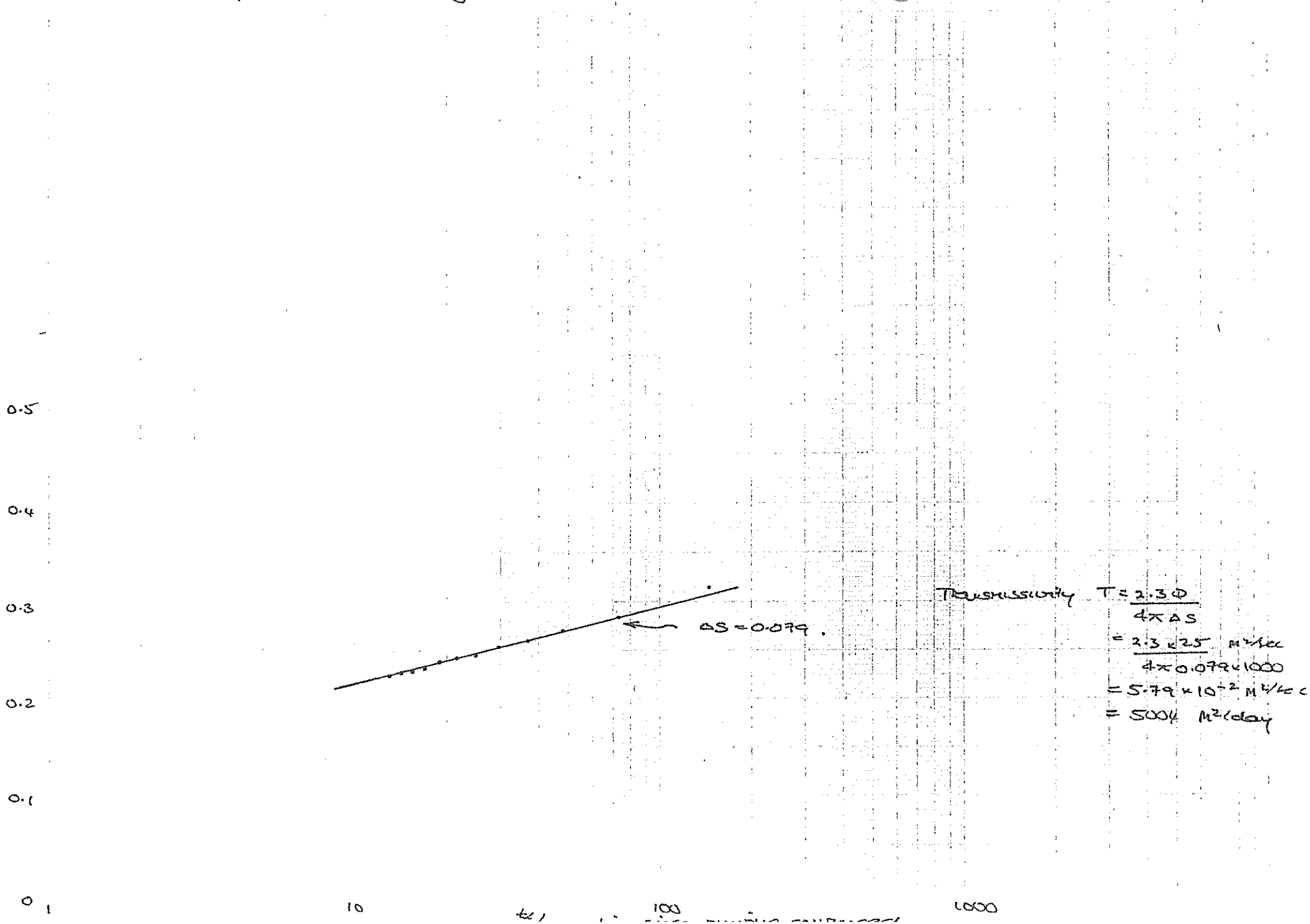
Storage coefficient $S = \frac{2.25 T t_0}{r^2}$

$= \frac{2.25 \times 2059 \times 2.7}{190^2 \times 1440}$

$= 2.4 \times 10^{-4}$

Constant Rate Pump Test of Petrie Irrigation Bore, Kahutoa 5-8/11/08

Collie Observation Bore Residual Drawdown



Transmissivity $T = \frac{2.3Q}{4\pi\Delta S}$

$= \frac{2.3 \times 25}{4 \times 0.079 \times 1000}$ M^2/sec

$= 5.79 \times 10^{-2}$ M^2/sec

$= 5004$ M^2/day