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Report on Pumping Test Analysis for JT & AM Best Well: Wairau Valley

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Report on Pumping Test Analysis for JT & AM Best Well: Wairau Valley

Prepared for
PALMS

February 2004

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Quality Control Sheet

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Directed, reviewed and approved by

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Limitations:

The report has been prepared for PALMS, according to their instructions, for the particular objectives described in the report. The information contained in the report should not be used by anyone else or for any other purposes.

Table of Contents

List of Tables

Appendix A: Figures

APPENDIX B: Water quality analysis

APPENDIX C: Pumping test data

Executive Summary

This report describes the results of a pumping test carried out on the Best well in The Narrows area. The well is situated about 250 m from the Wairau River, and 21 m from the Centre Valley well used for local supply. The report also describes the geological and hydrogeological environment.

The Best well draws water through a screen set at 4.9 m to 8.16 m, from a shallow unconfined gravel aquifer that is hydraulically connected to the Wairau River.

A drawdown of approximately 0.4 m would be expected in the Centre Valley well when the Best well is pumping continuously for 100 days.

A drawdown of less than 0.2 m would be expected at a distance of 100 m from the Best well if it was pumping continuously for 100 days.

These small drawdown effects are largely due to the recharge effect from the Wairau River induced by pumping from the well.

The water quality from the well is good and meets criteria for an irrigation supply.

1.0 Introduction

PALMS Limited are managing the resource consent application for irrigation abstraction from the JT & AM Best well in Wairau Valley. As part of the assessment of environmental effects resulting from this abstraction, a pumping test was supervised by Butt Drilling Ltd. At the request of PALMS, Pattle Delamore Partners Limited have been engaged to analyse the pumping test and comment on the likely effects resulting from the proposed irrigation abstraction. This report describes the analyses that have been carried out, and the results of the aquifer test on the Best well.

A regional map showing the area in which the pumping test was carried out is presented in Figure 1 (Appendix A).

2.0 Hydrogeological Setting

The Best well (pumping well) is located on a property at the east end of the Wairau Valley, known as "The Narrows", as shown in Figure 1.

The geology of the area is shown in Figure 2 (IGNS QMAP 9: Nelson area). The property is located on alluvial gravels associated with the flood plain of the Wairau River. To the south is a complex area of older, clay-bound, fluvio-glacial gravels, intersected by two strands of the Wairau Fault.

The hydrogeologic setting of the area has been interpreted from the geological map and from unpublished work in the area. A geological cross-section is presented in Figure 3. On Figure 2, the line X-X' denotes the location of the schematic geological cross section, Figure 3. The cross-section shows a shallow unconfined alluvial gravel aquifer. This is bordered and underlain by a lower permeability layer of gravel, sand, silt and clay, corresponding to older fluvio-glacial deposits of Pleistocene age. The precise relationship between these two units is locally unclear but it is not thought to have a bearing on the interpretation of this pumping test.

The Best well (Figure 1) is 8.16 m deep. At the time of drilling in September 1985, the standing water level was at 1.27 m below ground level.

The unconfined aquifer penetrated by the pumped well receives recharge via a combination of seepage losses from the Wairau River further upstream and rainfall infiltration and groundwater flow from the terraces to the south. During pumping, the largest contribution to groundwater flow in the aquifer is probably that associated with seepage from the river.

There is no long-term monitoring of water levels in this aquifer, however, they are expected to remain relatively constant because of their hydraulic connection with the Wairau River.

3.0 Details of Best Well

The Best well (O28w/5) was drilled in 1985 and has a 250 mm diameter casing, and is screened from 4.9 m to 8.16 metres below ground level (mbgl). There is a well log available for this well (Appendix B). The original drilling test showed that there was a drawdown of 2.08 m after pumping for 2.5 hours at a rate equivalent to 36.4 L/s.

The well is located about 250 metres from the Wairau River.

4.0 Pumping Test

To determine the effects of this proposed abstraction a 24 hour constant discharge aquifer test aquifer test was carried out on the Best well. The Best well (the pumping well) was pumped at a rate of 26.4 L/s commencing on the 22 January 2004, and stopping 23 January 2004, followed by a monitored 1 day recovery period. During this period, groundwater levels were measured in the Best well, and in one neighbouring well, referred to as the 2nd Centre Valley well. The recovery of the water levels in both the Best and 2nd Centre Valley wells were measured for a period of 23 hours after the cessation of pumping. All water level measurements ceased on 25th January 2004. The locations of the pumping well (Best well) and observation well (2nd Centre Valley well) are shown in Figure 1.

Details of the aquifer test wells are summarised in Table 1 and shown in Figure 4.

Table 1: Summary of Aquifer Test Wells.

Well ID	Well Status	Aquifer Type	Easting	Northing	Screen Depth (m)	Distance from Pumped Well (m)	Direction from Pumped Well
Best	Pumping	Unconfined	2563195	5963775	4.9 to 8.16	0	
2nd Centre Valley*	Observation	Unconfined	2563219	5963765	5.5 to 8.64	26	east

** Note: No screen details of the 2nd Centre Valley well are held by MDC. Details of screen depth are assumed to be similar to those recorded for the 1st Centre Valley well.*

During the pumping test, a neighbouring well (1st Centre Valley well) became active at a flow rate of about 4.5 L/s after the first 40 minutes and remained so until the end of the test.

5.0 Aquifer Test Data and Analysis

The aquifer test data is analysed to determine the pattern of groundwater flow to the pumping well and to assess values for the parameters that define this flow pattern. The determination of these aquifer parameters enables the prediction of the long-term effect of a groundwater abstraction on surrounding groundwater users.

Figure 5 shows the water levels measured in both the monitoring well and pumping well throughout the duration of the aquifer test and subsequent recovery period.

Late-time drawdown data for the pumped well was analysed using the Jacob straight line method (Figure 6). During this late-time period the drawdown effect caused by pumping is the dominant effect on water levels. Figure 6 shows a semi-log plot of the measured depth to water in the pumped well and monitoring well. An approximate analysis of the time – drawdown data, ignoring stream depletion produces a transmissivity in the order of 7000 m^2/day, a very high figure. A more rigorous analysis (Figure 7), involving stream depletion effects modelled using the Hunt method, indicates that the transmissivity for the aquifer is approximately 3050 m^2/day. A storativity value can be estimated from the modelling. The value obtained by matching modelled and actual results is in the region of 0.04.

6.0 Discussion of Results

The transmissivity value of approximately 3050 m^2/day, calculated from the pumping test data is comparable with values listed in the MDC 1988 report "Water and Soil Resources of the Wairau". Values of transmissivity range from 2000 to 3000 m^2/day in the unconfined aquifers on the Wairau Plains, but no values are cited for the Wairau Valley area between Wye Valley and The Narrows.

Based on this assessment, the pumping test data can be used to predict the drawdown effects that could result in neighbouring wells caused by longer term use of this well over an irrigation season. Using the estimated aquifer parameters described in Section 5, the abstraction from this well at a rate of 26.3 L/s for 100 days (Figure 7) will create a drawdown of approximately 0.2 m at a distance of 100 m from the well. This is a very small effect that should not affect any neighbouring users. It will, however, induce depletion of the Wairau River at a rate of approximately 90% of the abstraction rate after 30 days and about 94% after 100 days.

Using the Hunt analysis technique, it is estimated that a drawdown of 0.4 m would be expected in the 1st (pumped) Centre Valley well after continuous pumping of the Best well for 100 days at the proposed consented rate of 26.3 L/s.

7.0 Groundwater Quality

A water sample was collected from the Best well on 23rd January 2004 and analysed by Cawthron Laboratories. The analytical results of the sample are presented in Table 2, and a copy of the laboratory test report is included in Appendix C. All parameters analysed for, other than pH, are in compliance with the *Drinking Water Standards for New Zealand 2000 (DWSNZ)* guidelines for both the maximum acceptable value for health and aesthetics. The determinand, pH, lies outside the aesthetic guideline values; this is a common, naturally-occurring phenomenon in this area. Furthermore, all parameters analysed in the groundwater sample were below the Australian and New Zealand Environmental Conservation Commission (ANZECC) 2000 guidelines for irrigation supply.

Table 2: Analysis of water taken from Best well (O28w/5)

Determinand	Units	Value	NZDWS		ANZECC Irrigation guidelines
			Health based MAV	Aesthetic guideline	
pH		**6.5**		7.0 – 8.5	-
Conductivity	mS/m	16			-
Free Carbon Dioxide	g/m^3	19			
Acidity	g/m^3 as $CaCO_3$	22			-
Alkalinity	g/m^3 as $CaCO_3$	27			-
Chloride	g/m^3	29		250	175
Fluoride	g/m^3	0.11	1.5		2
Nitrate-N	g/m^3	0.41	11.3		25 – 125
Sulphate	g/m^3	4.2		250	-
Sodium	g/m^3	19		200	115
Potassium	g/m^3	1.1	-		-
Calcium	g/m^3	6.5			
Magnesium	g/m^3	2.2	-		-
Hardness	g/m^3 as $CaCO_3$	25			
Copper	g/m^3	0.002	2	1	5
Arsenic	g/m^3	<0.001	0.01		2
Iron	g/m^3	0.028		0.2	10
Manganese	g/m^3	<0.001	0.5	0.05	10

Based on the analytical results, the quality of the well water is good and should perform satisfactorily for its intended use.

8.0 Conclusion

The Best abstraction well draws water from an unconfined gravel aquifer. Pumping test results indicate it will achieve the desired pumping rate of 24.3 L/s and the drawdown effects are expected to be less than minor in nearby wells that abstract from the same gravel strata. The water quality is appropriate for its intended irrigation use.

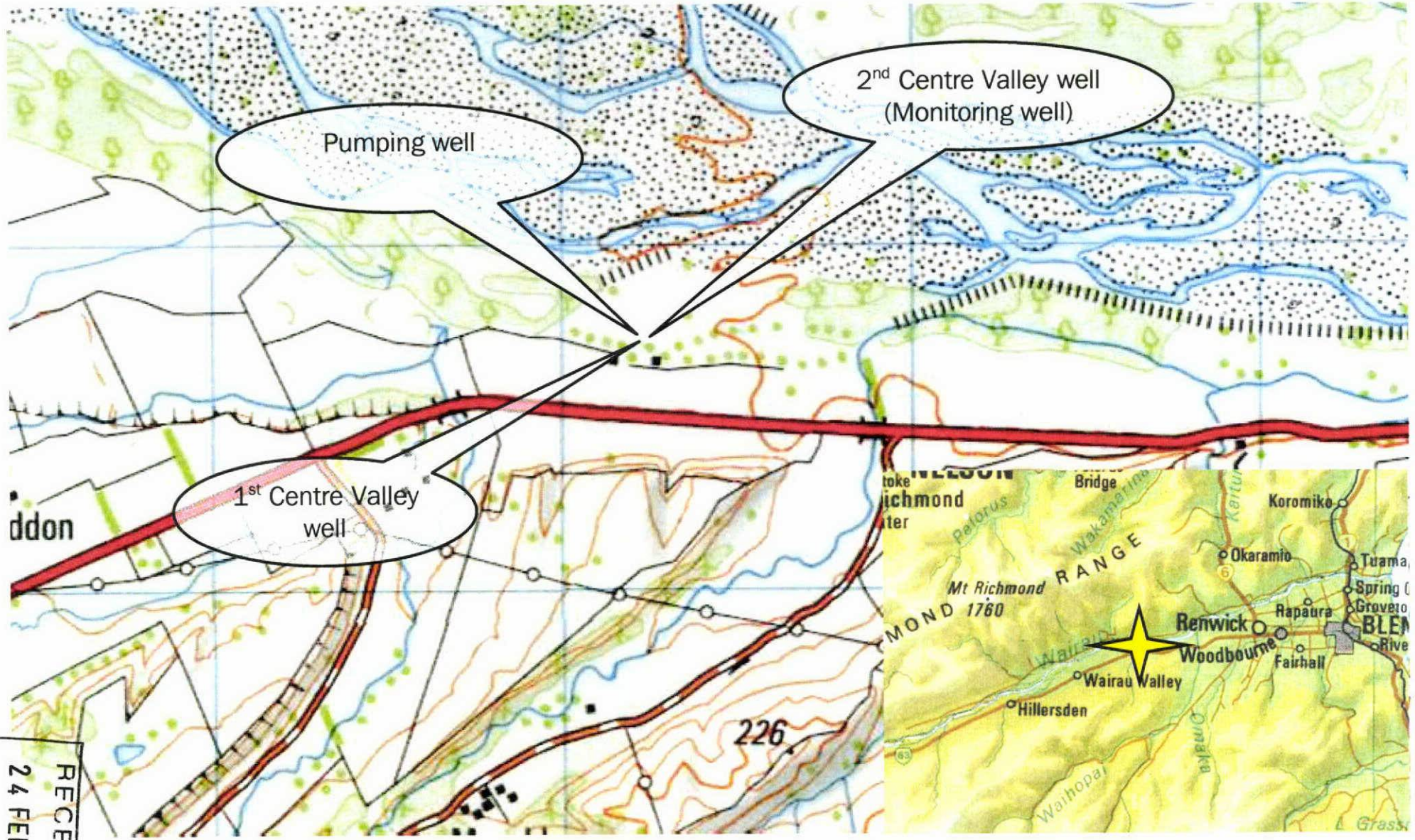

Figure 1: Location map. Inset shows location within Marlborough region. Locations of the pumping, monitoring, and Centre Valley well are shown.

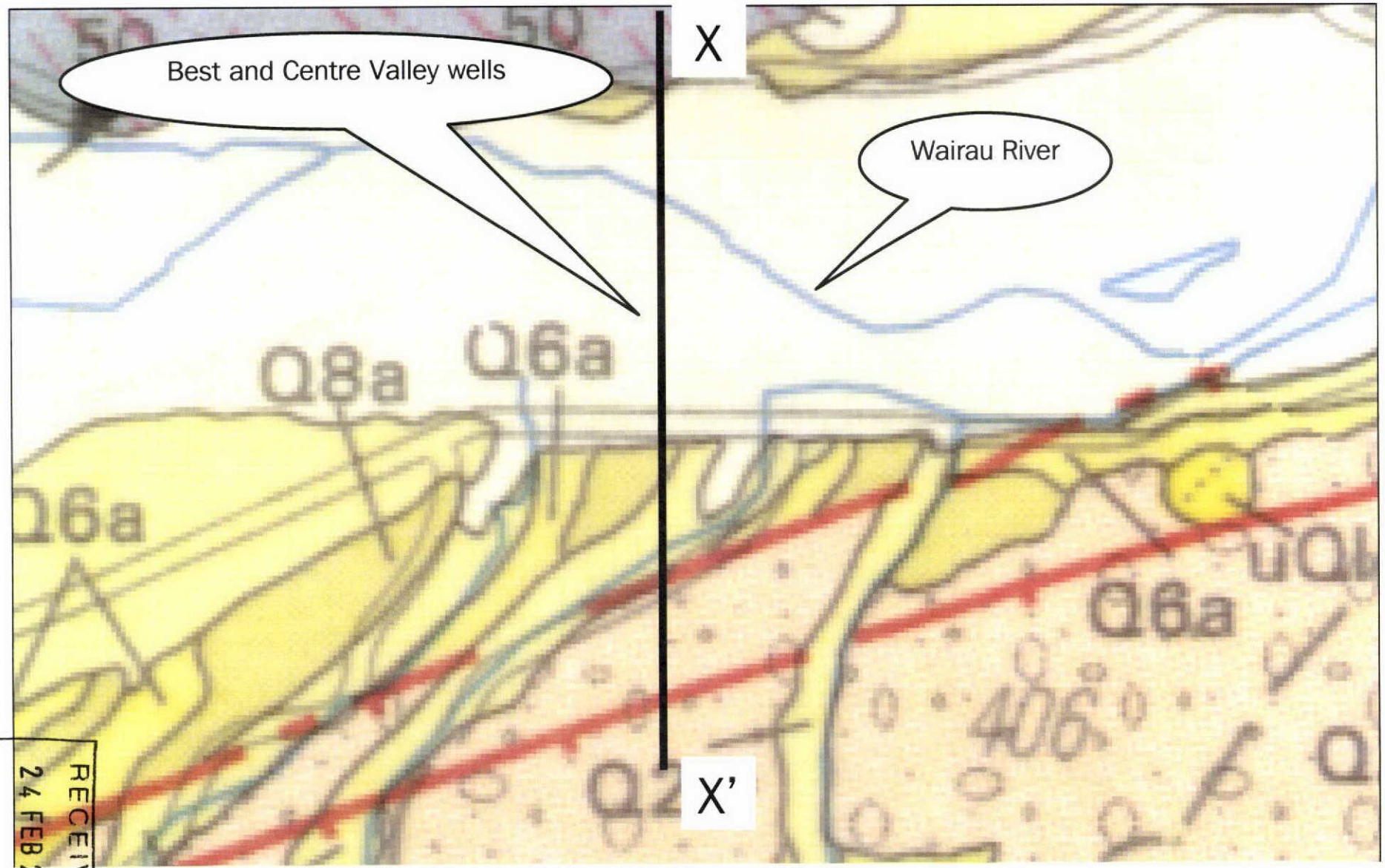

Figure 2: Geological map of the Wairau Valley area at "The Narrows" (from IGNS QMap 9). Location of area containing wells described in this report is marked. For legend, see Figure 3. Location of cross-section in Figure 3 is denoted X – X'.

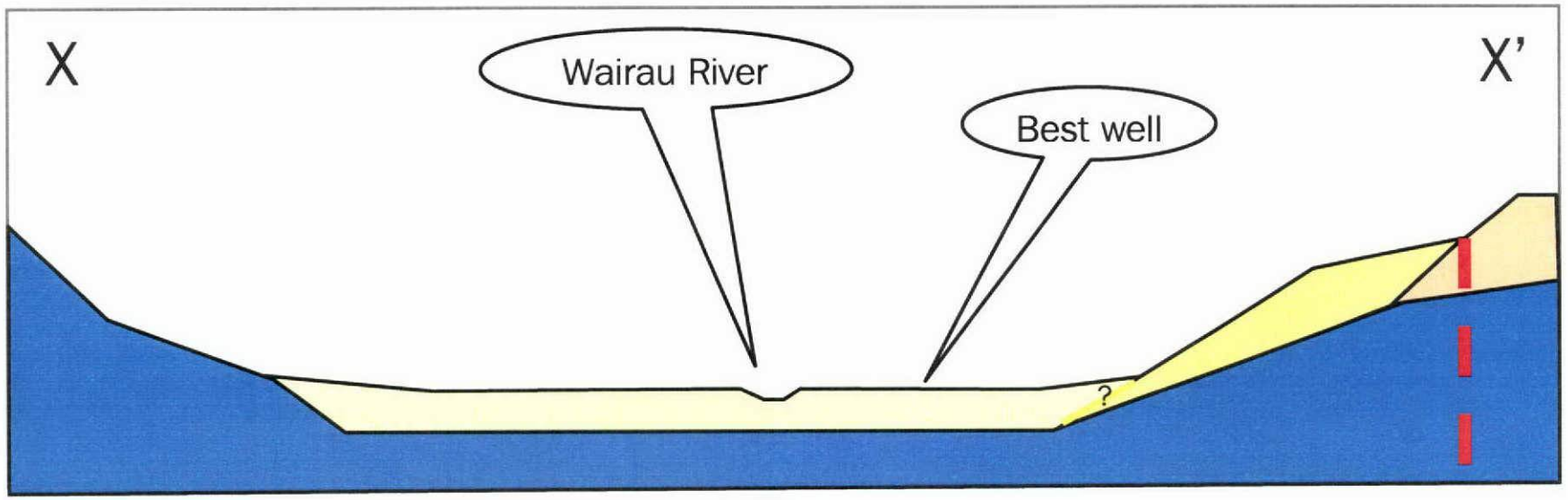

Figure 3: Sketch geological cross section. For location of cross section see Figure 2.

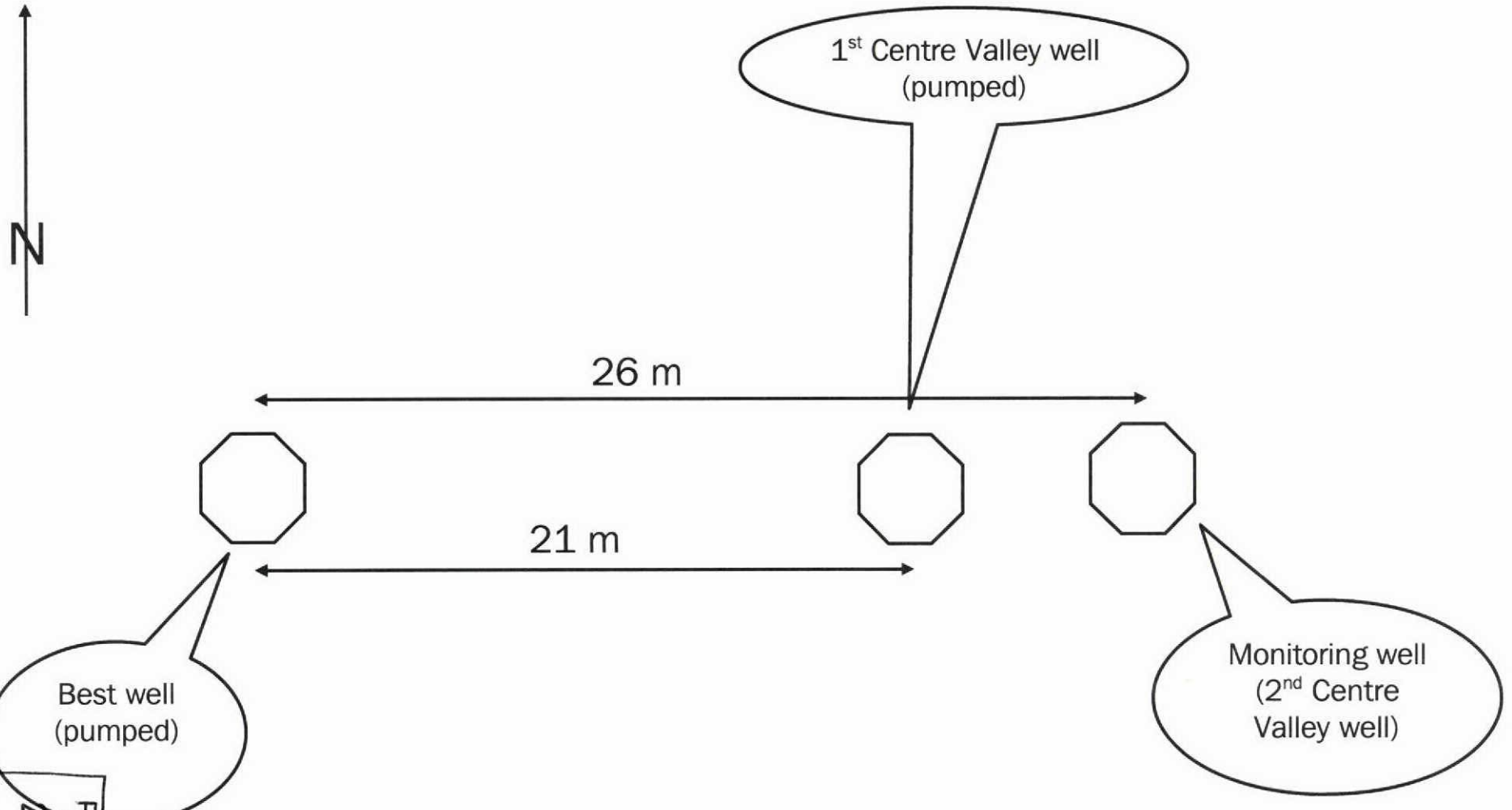

Figure 4: Schematic map of well locations

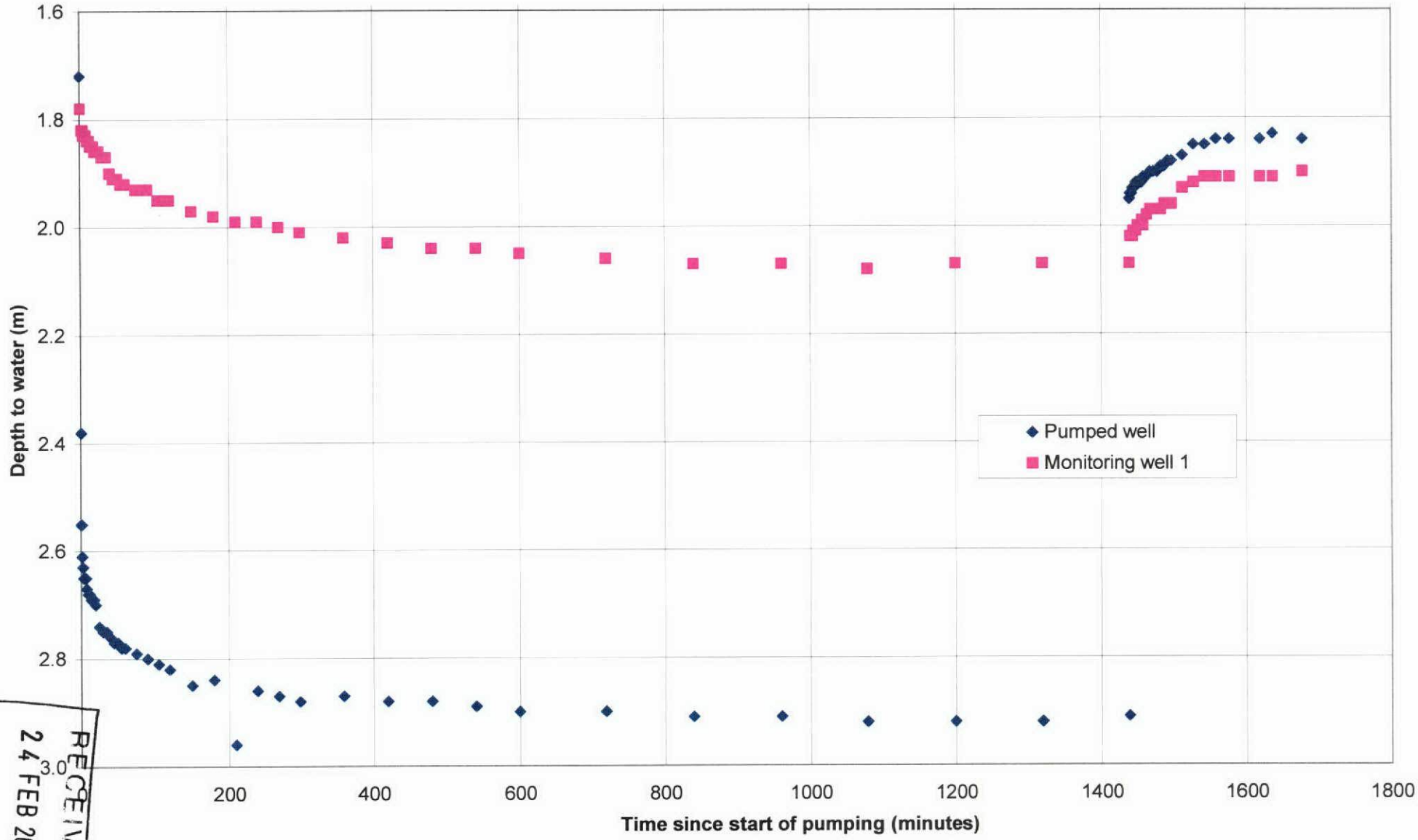

Figure 5: Time series plot of drawdown during the pumping test and recovery period for the pumping well and monitoring well

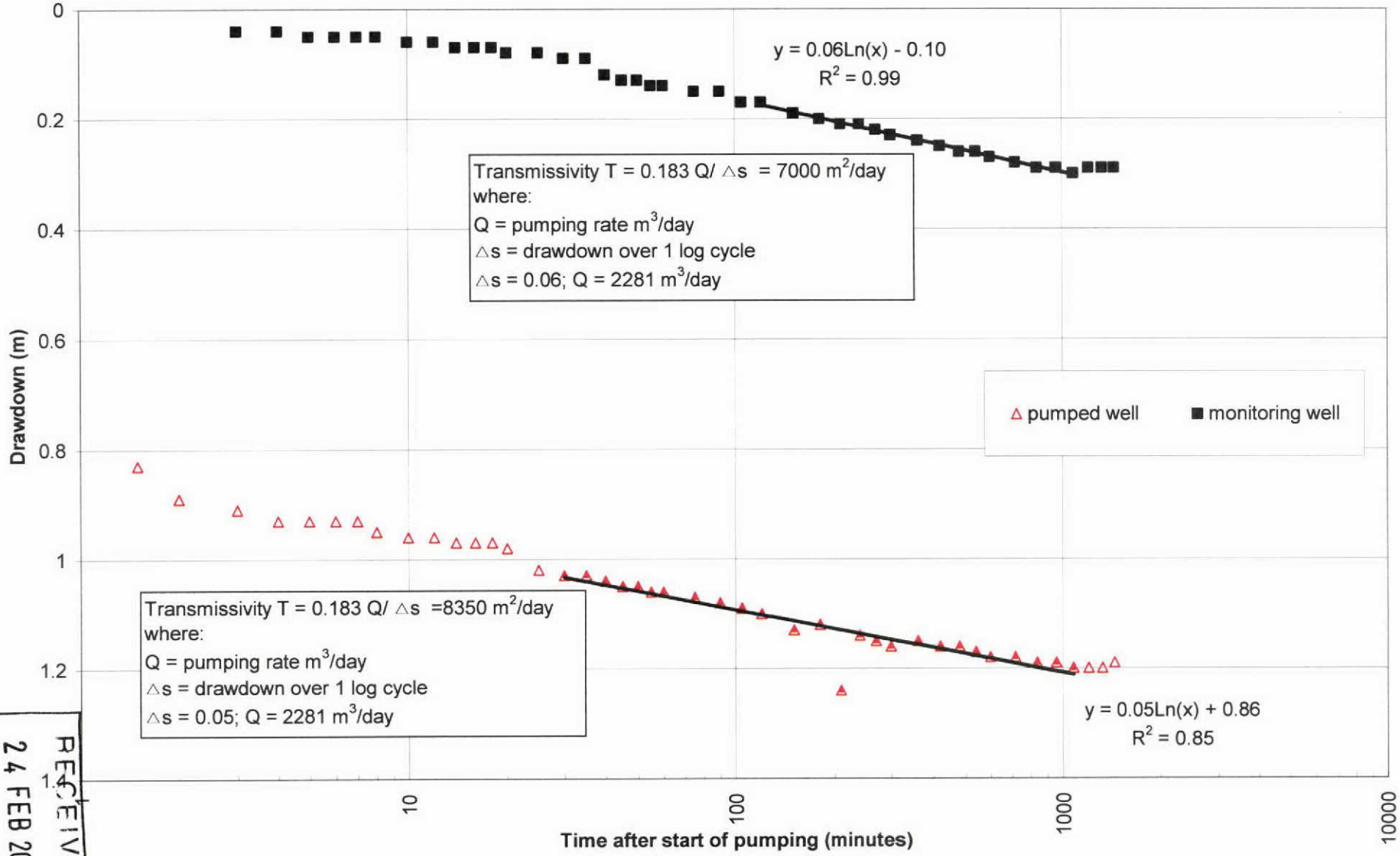

Figure 6: Semi-log plot of time versus drawdown for the pumped and monitoring wells.

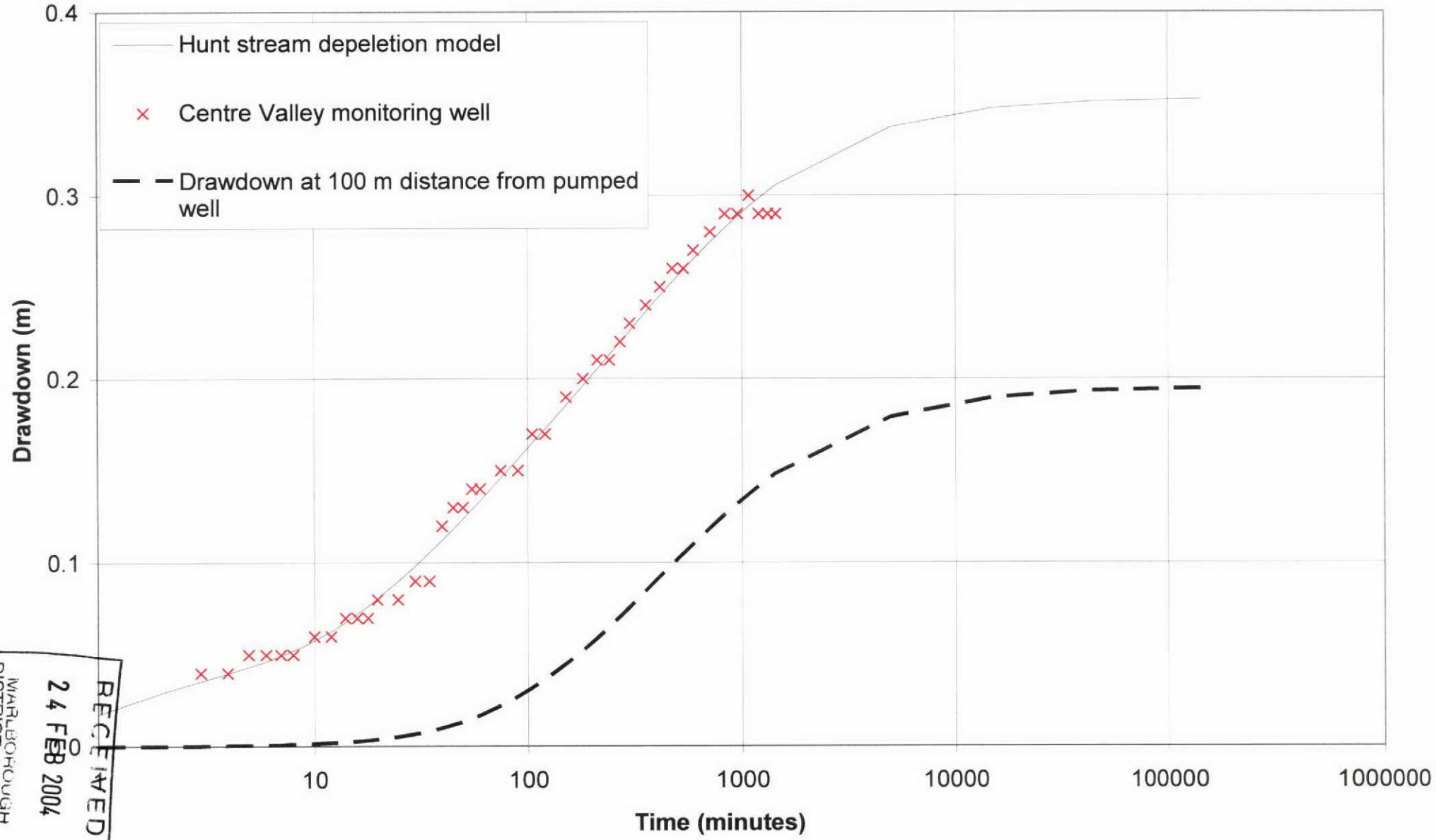

Figure 7: Hunt analysis of pumping test time drawdown data

Cawthron Laboratory Services Report

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CAWTHRON

Certificate of Test Analysis Report Type: Final

Project Number: P24358 **Cawthron Contract Number:** 10183

Butt Drilling
4 Springswood Grove
BLENHEIM
Attention: Mr John Butt

Customer order no: 3080

Sample Details
Laboratory ID: P24358-1 **Sample Type:** Water **Date Received:** 23/01/2004 03:23pm
Description: Best **Date Sampled:** 23/01/2004 08:00am

Analysis	Result	Units	Method
pH	6.5	–	APHA 20th Edn 4500H.B
Free Carbon Dioxide	19	g/m^3	APHA 20thEdn 4500-CO2C
Acidity	22	g/m3 as $CaCO_3$	APHA 20th Edn 2310B
Alkalinity	27	g/m3 as $CaCO_3$	APHA 20th Edn 2320B
Chloride	29	g/m^3	APHA 20th Edn 4110B
Fluoride	0.11	g/m^3	APHA 20th Edn 4110B
Nitrate-N	0.41	g/m^3	APHA 20th Edn 4110B
Sulphate	4.2	g/m^3	APHA 20th Edn 4110B
Conductivity	16	mSm^{-1}	APHA 20th Edn 2510B
Calcium	6.5	g/m^3	APHA 20th Edn 3120B Acid Preserved. ICP-OES
Copper	0.002	g/m^3	APHA 20th Edn 3120B Acid Preserved. ICP-OES
Iron	0.028	g/m^3	APHA 20th Edn 3120B Acid Preserved. ICP-OES
Magnesium	2.2	g/m^3	APHA 20th Edn 3120B Acid Preserved. ICP-OES
Manganese	<0.001	g/m^3	APHA 20th Edn 3120B Acid Preserved. ICP-OES
Potassium	1.1	g/m^3	APHA 20th Edn 3120B Acid Preserved. ICP-OES
Sodium	19	g/m^3	APHA 20th Edn 3114 B & C
Arsenic	<0.001	g/m^3	APHA 20th Edn 3120B Acid Preserved. ICP-OES
Hardness	25	g/m3 as $CaCO_3$	APHA 20th Edn 2340B Calculation.

Our routine detection limits for chemical testing relate to samples with a clean matrix.
Reported detection limits may be higher for individual samples if there is insufficient sample or the matrix is complex.

< means less than, > means greater than

Results apply to samples as received
Report Number: 50823
Date Generated: 9/2/04
Authorised By: Nico van Loon
Position: Laboratory Services Manager
Signature:

End Of Report

RECEIVED
24 FEB 2004
MARLBOROUGH DISTRICT COUNCIL

This laboratory is accredited by IANZ. Unless specified all tests reported herein have been performed in accordance with the laboratory's scope of registration.

* Indicates an analysis that is not IANZ accredited

BUTT DRILLING
4 Springswood Grove
BLENHEIM
Telephone 021-343 089
After hours 0-3-578 8270
Facsimile 0-3-578 8166

MEMBER OF: NZDF

WATER WELL ENGINEERS TO MARLBOROUGH

Constant rate flow test
J Best- The Narrows
22.01.04

Pre Test Measurements

Time (Clock)	Time Relitive to start Minutes	Depth to water Meters pumped well	Pumping Rate L/S	Depth to water Mointor well 1
8.00	-60	1.71	0.00	1.78
8.15	-45	1.72	0.00	1.78
8.30	-30	1.71	0.00	1.78
8.45	-15	1.72	0.00	1.78
9.00	0	1.72	0.00	1.78

Commencement of test

	0.5	2.55		
9.01	1	2.38		
	1.5	2.55		
	2	2.61		
	3	2.63	26.40	1.82
	4	2.65	26.40	1.82
	5	2.65	26.40	1.83
	6	2.65	26.40	1.83
	7	2.65	26.40	1.83
	8	2.67	26.40	1.83
	10	2.68	26.40	1.84
	12	2.68	26.40	1.84
	14	2.69	26.40	1.85
	16	2.69	26.40	1.85
	18	2.69	26.40	1.85
	20	2.70	26.40	1.86
	25	2.74	26.40	1.86
	30	2.75	26.40	1.87
	35	2.75	26.40	1.87
	40	2.76	26.40	1.90
	45	2.77	26.40	1.91
	50	2.77	26.40	1.91
	55	2.78	26.40	1.92
10.00	60	2.78	26.40	1.92
	1hr15min	2.79	26.40	1.93
	1hr30min	2.80	26.40	1.93
	1hr45min	2.81	26.40	1.95
11.00	2	2.82	26.40	1.95

Time (Clock)	Time Relitive to start Minutes	Depth to water Meters pumped well	Pumping Rate L/S	Depth to water Mointor well 1
	2.30	2.85	26.40	1.97
12.00	3	2.84	26.40	1.98
	3.30	2.86	26.40	1.99
1.00pm	4	2.86	26.40	1.99
	4.30	2.87	26.40	2.00
2.00	5	2.88	26.40	2.01
3.00	6	2.87	26.40	2.02
4.00	7	2.88	26.40	2.03
5.00	8	2.88	26.40	2.04
6.00	9	2.89	26.40	2.04
7.00	10	2.90	26.40	2.05
9.00	12	2.90	26.40	2.06
11.00	14	2.91	26.40	2.07
1.00am	16	2.91	26.40	2.07
3.00	18	2.92	26.40	2.08
5.00	20	2.92	26.40	2.07
7.00	22	2.92	26.40	2.07
9.00	24	2.91	26.40	2.07

Grid references

Pumped	e2563195	n5963775
Monitor	e2563219	n5963765

Distance from 1st Center Valley well	21Mtrs	(pumped Center Valley well)
Distance from 2nd Center Valley well	26Mtrs	(monitor 1)

From 40minutes into test till last readings Center Valley pump ran
Flow from this pump is approxamatly 4.5 L/s

Recovery

Time (Clock)	Time Relitive to start Minutes	Depth to water Meters pumped well	Pumping Rate L/S	Depth to water Mointor well 1
	0.5	1.95	0.00	
9.01	1	1.95	0.00	
	1.5	1.94	0.00	2.02
	2	1.94	0.00	2.02
	3	1.94	0.00	2.02
	4	1.94	0.00	2.02
	5	1.93	0.00	2.02
	6	1.93	0.00	2.01
	7	1.93	0.00	2.01
	8	1.93	0.00	2.01
	10	1.92	0.00	2.01
	12	1.92	0.00	2.00
	14	1.92	0.00	2.00
	16	1.92	0.00	2.00
	18	1.92	0.00	1.99
	20	1.91	0.00	2.00
	25	1.91	0.00	1.98
	30	1.90	0.00	1.97
	35	1.90	0.00	1.97
	40	1.90	0.00	1.97
	45	1.89	0.00	1.97
	50	1.89	0.00	1.96
	55	1.88	0.00	1.96
10.00	60	1.88	0.00	1.96
	1hr15min	1.87	0.00	1.93
	1hr30min	1.85	0.00	1.92
	1hr45min	1.85	0.00	1.91
11.00	2	1.84	0.00	1.91
	2.3	1.84	0.00	1.91
12.00	3	1.84	0.00	1.91
	3.3	1.83	0.00	1.91
1.00pm	4	1.84	0.00	1.90
23. Sat				
8.00am	23	1.79	0.00	1.86