Chapter 4 - Groundwater Resource Investigations

Introduction

Most people appreciate the need to gather information about groundwater systems. It is a vital resource, and arguably the region's most important one. We need to look after it because so many people and natural systems depend directly or indirectly upon it for their survival or prosperity. Whats more, this demand will be ongoing. A sound understanding and good working knowledge of the aquifers is a pre-requisite to managing them.

By its very nature groundwater is a hidden resource and as such it is difficult to determine the actual physical size of an aquifer, let alone measure the amount of water within it (Fig. 4.1). Despite the fact that groundwater serviced the earliest civilisations, it was not until the 1930s that a worldwide scientific approach was first adopted to quantify groundwater systems.

Locally the advent of coordinated investigations aimed at quantifying Marlborough's groundwater resources is a relatively recent phenomenon in the context of its use since the 1860s. Although there had been sporadic attempts by various interested parties to search for groundwater here since the late 19th century, systematic investigations really only began in the 1960s. The exceptions were government investigations associated with the establishment of military bases throughout the western Wairau Plain during the Second World War.

It is important to realise that the process of documenting or describing groundwater systems isn't as straight forward as other branches of natural resource sciences or engineering. Nature ensures that there is no shortage of anomalies or unexpected results.

Today in the 21st century, aquifer research is as important to Marlborough as ever. Recently the emphasis has shifted from exploring for groundwater, to its seasonal management as demand approaches full allocation in most areas.

Figure 4.1: Mr C.G. Simpson working on the Blenheim Library lift well (The Marlborough Express)

Ideally the safe yield or what can be sustainably pumped from a particular aquifer would be known before resource consents are issued to use groundwater, but generally this is not practical. In practice advances in aquifer knowledge normally occur concurrently with development and monitoring the response of the groundwater to its increasing use is a key contributor to that knowledge.

Widespread land conversion to viticulture since the 1980s and an accompanying increase in groundwater demand to irrigate these crops in often marginal or new areas, has meant investigation resources have been stretched in recent times.

History of local exploration

There is a hierarchy of knowledge needed in relation to groundwater resources depending on who you are. A key role of the MDC as a regulatory authority is to grant resource consents to use groundwater. This requires an understanding of how aquifers work, and their safe yield at a regional scale. For example, how much groundwater is stored in the sedimentary basin beneath the 30,000 hectare area of the Wairau Plain.

At the other end of the spectrum, a prospective well owner will be more interested in how deep they will need to drill to replace a domestic well in Old Renwick Road for instance.

The earliest documented European groundwater investigations in Marlborough took the form of well drilling to locate water for drinking. Adam Gibson and Son provided the earliest recorded information on Wairau Plain groundwater, with records dating from 1878.

In 1892 the BBC drilled an exploratory bore to a depth of 96 metres and the driller was on the job for nine and a half weeks. These days a modern drill rig is likely to complete the same task in a week.

In the 1930s the Public Works Department, a forerunner to the Ministry of Works and Development (MWD); carried out extensive investigations into the feasibility of irrigation in the Wairau Valley. One feature of that investigation programme was the regular monitoring of some fourteen wells in the lower Rapaura/Grovetown area.

Water levels in these fourteen wells were monitored monthly from 1936 until 1942. It is presumed that this information had more to do with drainage characteristics though than an assessment of the groundwater system.

The need for groundwater investigations was also recognised during the 1930s when it was felt that the Wairau Plain was not being used to its fullest potential. Land use was mostly dryland farming, although the area was also known for its high yields of barley and other grains.

Soil surveys were carried out by the Department of Scientific and Industrial Research (DSIR) in the late 1930s to assess the potential for vineyard and orchard production (Harris and Birrell 1939). This work was undertaken under the direction of the Public Works Department which was investigating the potential for irrigation on the Wairau Plain.

When Mr E.J. Speight arrived at RNZAF Base Woodbourne in 1940 just after the start of the Second World War, he commenced daily water level readings on the old north well 0662, which provided the base with its water supply. The recording of water levels at this well has continued with some breaks to the present day and represents a very long period of record.

In the 1940s the borough engineer, P. Bourgoyne, requested M. Ongley of the DSIR, to make a preliminary investigation of groundwater resources in the Wairau Valley (Fig. 4.2). Ongley's findings were published in 1944. Ongley's observations included the following:

"*This (groundwater) is so widespread that drillers safely undertake to drill wells on the terms of no water, no pay; and as, from their local knowledge of neighbouring wells, they know at what depth they will strike water, they easily estimate what the work will cost and so can quote a paying price. And: as, up to the present, water has been found wherever looked for in the valley, systematic work has not*

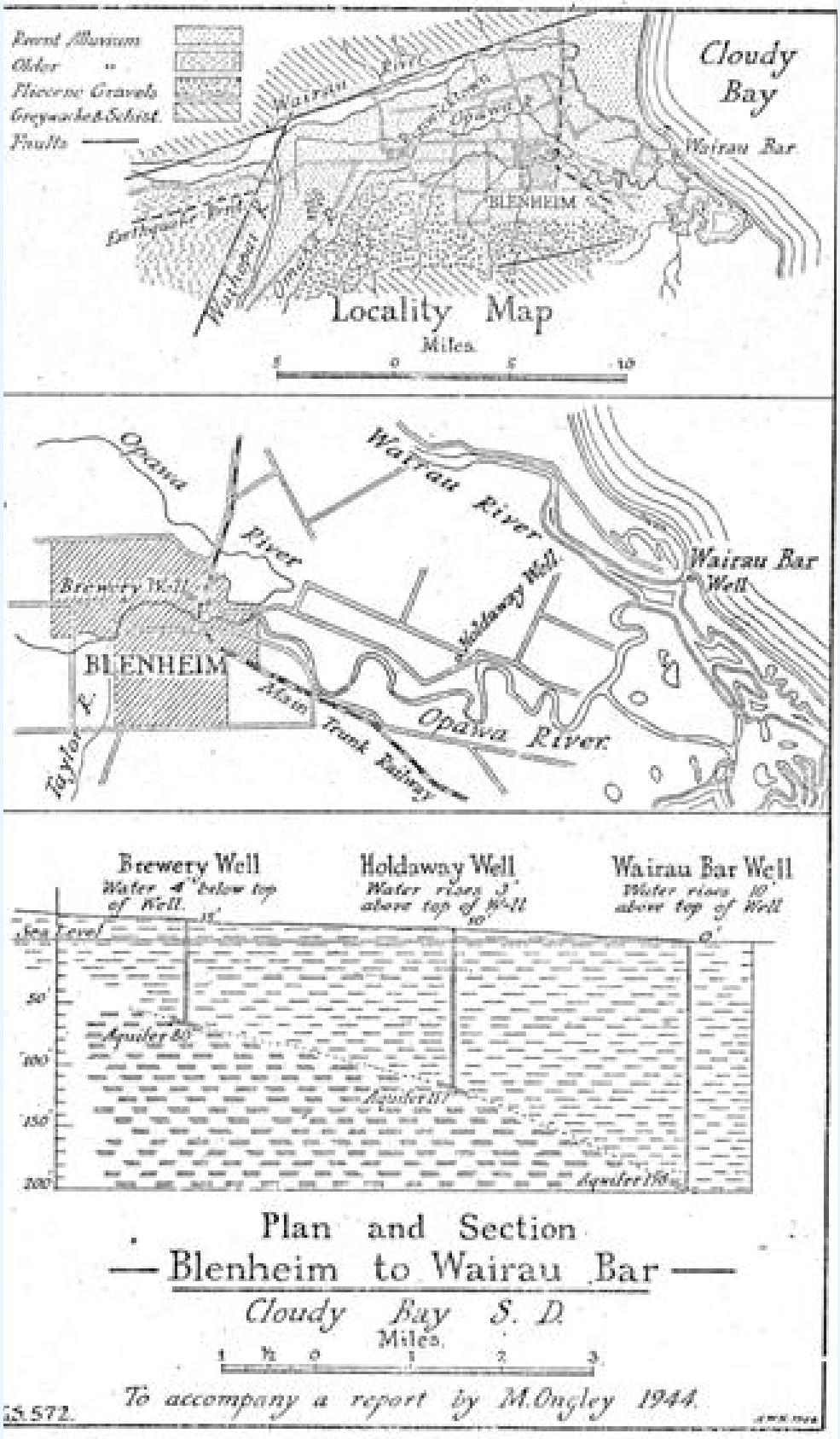

Figure 4.2: Early Wairau Aquifer section drawn by M. Ongley through the Wairau Aquifer from Blenheim through to the Lower Wairau area. It captures the general sequence of a confined aquifer structure which remains valid to this day.

been needed and has not been undertaken. For instance the Wairau River has not been gauged, the rainfall is measured very inadequately, and to say how much water there is will require systematic observation and record."

Until June 1964 groundwater investigations tended to continue as they had started. One off affairs of a generally exploratory nature were carried out by various individuals or agencies in which the BBC figured prominently. Much of these early investigations were linked to a groundwater supply for Blenheim to replace the Taylor River source.

In the rural areas there was also increased attention on groundwater hydrology. One of the first projects undertaken by the newly formed Marlborough Catchment and Regional Water Board (MCRWB) which was established in 1956, was the rewatering of Gibsons Creek. In December 1960 water was diverted from the Waihopai River into a newly formed diversion channel which subsequently fed the old water course known as Gibsons Creek.

This creek flowed eastwards through the Conders Bend area and Renwick to discharge into the Omaka-Opawa River system. As part of the project, some nine wells were measured regularly from 1959 through to 1970, to gauge the effect that this rewatering had on general groundwater levels in the aquifer.

In addition to those nine wells in the Rapaura and Upper Conders area, MCRWB staff also monitored wells in the Marshlands area, principally to determine whether or not the proposed Wairau Diversion channel would have any adverse effect on drainage of the beach gravels in that particular area.

Figure 4.3: Len Brown of the NZ Geological Survey logging the drill cuttings as they arrive at the surface during the drilling of a Kaikoura well in the 1980s. He is holding a sieve to collect the material for inspection and recording.

Moves were also afoot nationally on the groundwater front. In June 1964 the regional planning officer recommended to the Marlborough Regional Planning Authority that the Technical Advisory Committee be authorised to undertake a comprehensive survey of underground water supplies in Marlborough. "*Such a survey would establish findings of the utmost importance*".

Shortly afterwards Mr L.J. Brown from the NZGS, visited Marlborough. In February 1965 they submitted a report which set out the existing information available and listed proposals for future investigations (Fig. 4.3).

Len as he was known, pioneered many of the early investigations of local groundwater systems and was responsible for assembling an inventory of well locations which the current MDC continues to add to.

The MCRWB came into being in 1967, but didn't seriously evaluate the extent of groundwater resources until the early 1970s. Mapping the most likely sites for wells is also a very recent addition to the exploration tools available in this area. The first use of electrical resistivity methods occurred in Marlborough as recently as 1983 for example.

Later the Marlborough Regional Planning Authority requested the MCRWB to initiate further studies into the subject of groundwater and to communicate the results to the planning authority.

This was a significant development as it marked the commencement of coordinated investigations in Marlborough and on the Wairau Plain in particular. This association made significant progress and preceded by some seven years, a formal arrangement between the MWD and the DSIR, to collaborate on groundwater investigations.

This survey programme was setup with the assistance of the DSIR, and in the winter and spring of 1966 some 500 wells on the Wairau Plain were inspected. Details such as casing dimensions and water level were recorded. These records were in the form of distinctive yellow cards which were the precursor of the modern computer based database (Brown - 1972 & 1976).

A circular was sent to regional water boards in May 1973 detailing this association between the DSIR and MWD in the field of groundwater investigations. This represented the first indication that the Water Resources

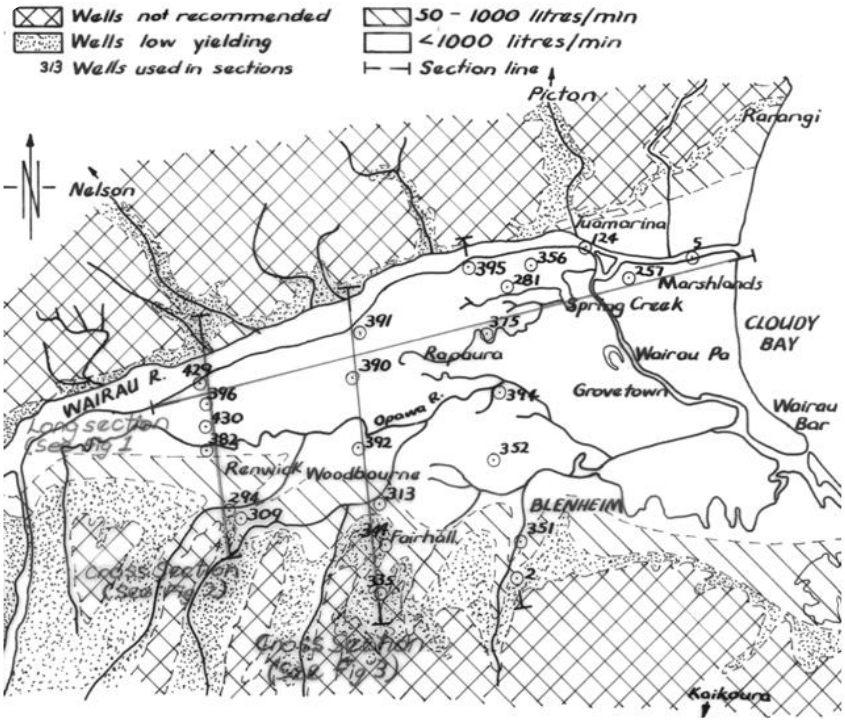

Figure 4.4: Original map of exploratory drilling site locations. Labels refer to the imperial map sheet well numbers

Council of the National Water and Soil Conservation Authority had become aware of the national need to accumulate groundwater information. This work was under the auspices of the Water and Soil Conservation Act.

Defining the Wairau Plain aquifers

Early investigations

Although a coordinated investigation into the groundwater resources beneath the Wairau Plain was underway prior to 1967, it was the advent of the Water and Soil Conservation Act of that year that provided the statutory backing for groundwater investigations to be carried out. This act recognised the need for them, created regional water boards to carry them out, and provided a mechanism for their funding.

The investigation programme into groundwater resources in the Wairau Catchment was originally funded under the Ministry of Works and Developments operational surveys scheme. The most active period was during the mid 1970s when an exploratory well drilling programme was carried out.

This was the first large-scale and systematic investigation of deep groundwater resources beneath the Wairau Plain and involved the drilling of ten exploration bores between 1973 and 1976. The objective was to assess the subsurface formations of the Wairau Plain and see if a layered aquifer system existed similar to that found on the Canterbury Plain.

The ten bores were drilled along three north-south lines at: Renwick-State Highway 6 (SH6) Bridge, Woodbourne-Giffords Road, and Wairau Hospital-Selmes Road. They filled gaps left by the earlier deep drilling to form a representative array across the Wairau Plain (Fig. 4.4). This pattern allowed a regional assessment of the groundwater resource to be made.

The exploration programme was carried out by the Marlborough Catchment and Regional Water Board in association with the MWD and the DSIR's Geological Survey. Careful logging and examination of samples from bores drilled in this programme provided the basis for todays geological maps of the Wairau Plain (Brown - 1981).

The new bores were used in conjunction with existing bore logs to draw four geological cross sections across the Wairau Plain (Table 4.1). This classification and description of the geological formations hosting the aquifer systems beneath the Wairau Plain largely stand unmodified to this day.

Cross sections of Wairau Plain hydrogeology were later redrawn by Len Brown in much greater detail (Brown - 1981a) (Fig. 4.5). It was this exploratory drilling program which allowed the hydrogeology of the Wairau Plain to be conceptualised for the first time.

Mr P.A. (Peter) Thompson was the Chief Engineer for the MCRWB at the time, and was also the main instigator of the project. Resources for the drilling program came from central government, which was the catalyst for any provincial development in those days.

Mr Tommy Shand, a Marlborough MP, played a key political role in obtaining funding for the project. Mr Shand was a minister of the Crown in charge of the MWD and the DSIR during the late 1960s.
The bores were drilled by Waimea Drilling using a cable tool type drill rig. The depth of drilling was largely limited by the capacity of the drilling rig. It was found that drilling was very difficult within the deeper sediments.

These deeper sediments consisted of glacial outwash gravels, large boulders within a glacial flour matrix. Some rotary drilling was carried out in these sediments as it was found that drilling was too hard for cable tool equipment.

The drilling program was supervised and logged by Len Brown. The advantage of one geologist assessing drill

Well Number	"S" Imperial Map Number	Easting	Northing	Original Owner	Depth (m)	Drilling Company	Drill Date	Test Bore?
0028	S22/257	2590654	5974776	Wooley	26.5	Bisley	Dec-74	
0060	S22/124	2590700	5973600	NZ Rail	32.6	Bisley	Sep-66	
0065	S22/005	2593900	5973400	MCRWB	33.2	Bisley	Jul-61	
0072	S21/356	2588960	5973340	Brown	15.9	Bisley	Mar-73	
0084	S21/281	2588870	5973021	Brown	14.6	Bisley	Feb-73	
0208	S28/375	2587283	5970865	MCRWB	51.2	Waimea	Dec-73	
0215	S21/391	2583000	5970700	MCRWB	9.1	Waimea	?	
0292	S21/429	2577800	5969200	MCRWB	32.6	Waimea	Feb-76	
0334	S21/390	2582600	5968900	MCRWB	39.6	Waimea	Nov-75	Y
0347	S21/394	2587810	5968859	MCRWB	103.6	Waimea	Oct-74	Y
0426	S21/430	2578113	5967543	Brooke-Taylor	39.6	Waimea	?	Y
0525	S21/392	2582190	5966470	MCRWB	32.9	Waimea	Oct-75	
0548	S28/382	2578130	5966410	MCRWB	29	Waimea	Feb-76	
0727	S28/313	2583600	5964600	Walsh	18	Bisley	May-73	
0746	S28/309	2578700	5964300	Partridge	13.1	Waimea	Aug-73	
0747	S28/294	2578200	5964300	MCC	24.7	Bisley	May-69	Y
0834	S28/344	2583435	5963255	Fairhall Golf Club	44.2	Waimea	Dec-74	Y
0838	S28/002	2588832	5962911	Wairau Hospital	153	?	1916	Y
0864	S28/335	2583750	5961810	Turnbull	30.5	Waimea	Oct-74	Y
0949	S28/351	2588500	5964700	MCRWB	68.6	?	?	Y
0950	S28/352	2588210	5966390	MCRWB	58.2	Waimea	1973/1974	
0951	S21/395	2586624	5972699	Pigou	42.6	Waimea	Nov-74	Y
0373	S21/396	2578160	5968400	MCRWB	27	Waimea	Mar-74	Y

Table 4.1: Exploratory bore details

cuttings from all the wells was a consistent description of the lithological sequence. Much of the information derived from these years of investigation was written up by Len Brown in his various publications.

Test drilling

It is useful to describe some of the details of these test wells and the following descriptions are from the earlier 1988 Water and Soil Resources of the Wairau publication. In October 1974 the deepest exploratory bore drilled in the central Wairau Plan for which a documented log exists was drilled for the MCRWB at the Thompsons Ford site. This well, 0347 was completed to a depth of 103.6 metres below ground level. Distinct lithologic changes were observed at depths of 28.4 and 54.9 metres.

The first 28.4 metres of the drill hole penetrated mainly good water-bearing gravels. At 28.4 metres less permeable and more tightly claybound gravels were encountered representing the Speargrass Formation. The Speargrass Formation is the youngest of a series of claybound gravels which underlie the clean gravels forming the Wairau Aquifer. At 54.9 metres where the water bearing claybound gravels terminated, drilling became considerably slower with very tight claybound gravel indicating the bottom of the Speargrass Formation.

Perhaps the most interesting feature of the drill hole were greywacke boulders encountered at 103.6 metres. These boulders of up to 900 millimetres in diameter were found within a matrix of yellow clay. They could represent deposition directly from a glacier, although it is unlikely a moraine deposit existed 65 kilometres down valley from Chrome Stream.

Two historical and unfortunately un-logged deep bores were drilled during earlier exploration for groundwater on the plain. One of these wells in the northern coastal part of the Wairau Plain near Rarangi is reported to have been drilled to a depth of 89 metres without encountering any appreciable groundwater below a depth of 34 metres.

The other well was the Parkinson Well located in the northern part of Blenheim adjacent to SH1 and drilled to a depth of 148 metres. It was reported that once out of the water-bearing gravels at around 55 metres there was a phenomenal layer of hard gravel bound by yellow clay probably from the Taylor River Hills. Once into this material there was absolutely no water bearing material in existence. At a depth of 137 metres a layer of "hard papa" was encountered.

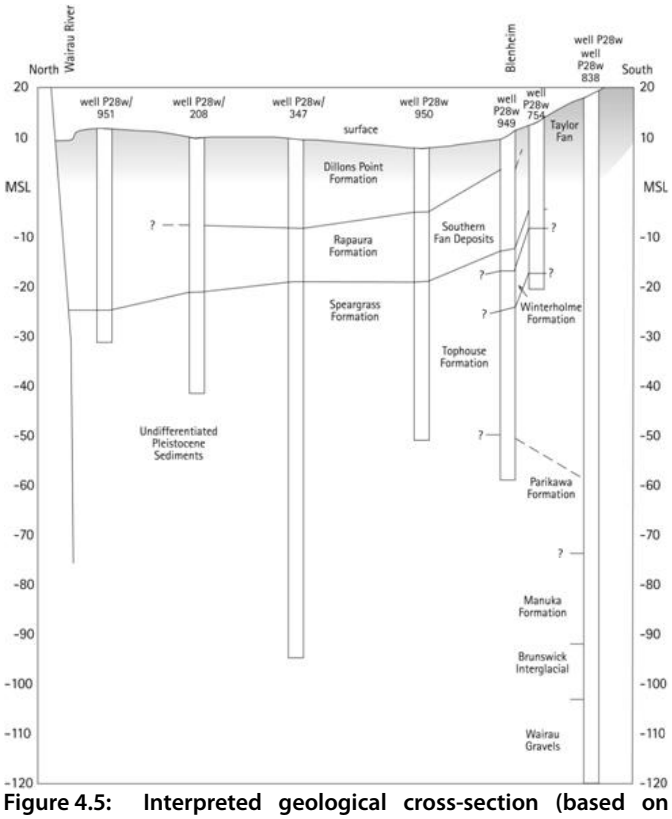

Figure 4.5: Interpreted geological cross-section (based on Brown 1981)

Unfortunately many wells have been drilled over the years for which formal records are no longer available. This is a shame because they include some relatively deep wells which may be significant in terms of defining the regional geology and water availability.

This highlights the need to keep good records on behalf of the community so that in the future this information can be reviewed in light of more recent results. We remain indebted to the major contributions of Len Brown.

Modern era

Since 1980 there has been a trend away from mixed farming on the Wairau Plain and Lower Awatere River Valley into more intensive horticulture and latterly viticulture, a pattern that continues to this day. Interestingly, many of the vineyards established in the early 1970s in Marlborough occurred on hitherto poorer, stony soils, representing less valuable land at the time.

Many of these were located on desirable land for grape plants, but were in areas where water was known to be a limiting factor. Irrigation water was recognised as an important ingredient in landuse intensification and this led to an investigation programme to quantify the size of the groundwater resource.

In the late 1980s the Marlborough Catchment and Regional Water Board received government funding for the largest systematic assessment of groundwater resources beneath the Wairau Plain ever undertaken. A budget in excess of $1 million spread over a 5 year period was a significant sum in those days.

Key projects included; understanding the Wairau River recharge mechanism, mapping the direction of groundwater flow away from the Wairau River, measuring aquifer hydraulic properties and understanding the Wairau Aquifer interface with the Pacific Ocean.

This work led to the development of a regional scale water balance for the Wairau Aquifer. These numbers were used to set interim allocation limits for groundwater abstraction from beneath the Wairau Plain. It also led to the description of the different aquifer systems underlying the Wairau Plain (Fig. 4.6).

This work represented the start of larger scale studies aimed at addressing regional scale, cumulative groundwater management issues. In the past the focus had been on locating groundwater or addressing localised interference effects between neighbouring wells, whereas today the emphasis is on the combined effects generated by multiple users.

The early 1980s also saw the arrival of private groundwater specialists advising local well owners, irrigators or water users. Groundwater Consultants New Zealand Ltd (GCNZ) were first on the scene and worked primarily in the Southern Valleys and Woodbourne areas; starting a trend which has seen increased private participation and contribution to groundwater science ever since.

The need for water users to hire external specialists heralded the era of competing demand for limited water resources. It also recognised the necessity to separate the regulatory role of the MCRWB as it increasingly became involved in first Planning Tribunal hearings and latterly Council hearings or Environment Court appeals. The cradle for the first of many hearings over the past 30 years has been the Woodbourne area.

The workload of external groundwater professionals has increased ten fold, reflecting the need for more detailed information as natural allocation limits are approached. The results of this work have complemented the efforts of MDC staff, enhancing the wider community understanding and appreciation of groundwater systems.

The last attempt to map the lithologic sequence occurred in August and September of 1995 when the MDC drilled a deep well. An exploratory bore (2917) was sunk to determine the existence or otherwise of deep aquifers beneath the Southern Valleys Catchments. Unfortunately the bore failed to discover

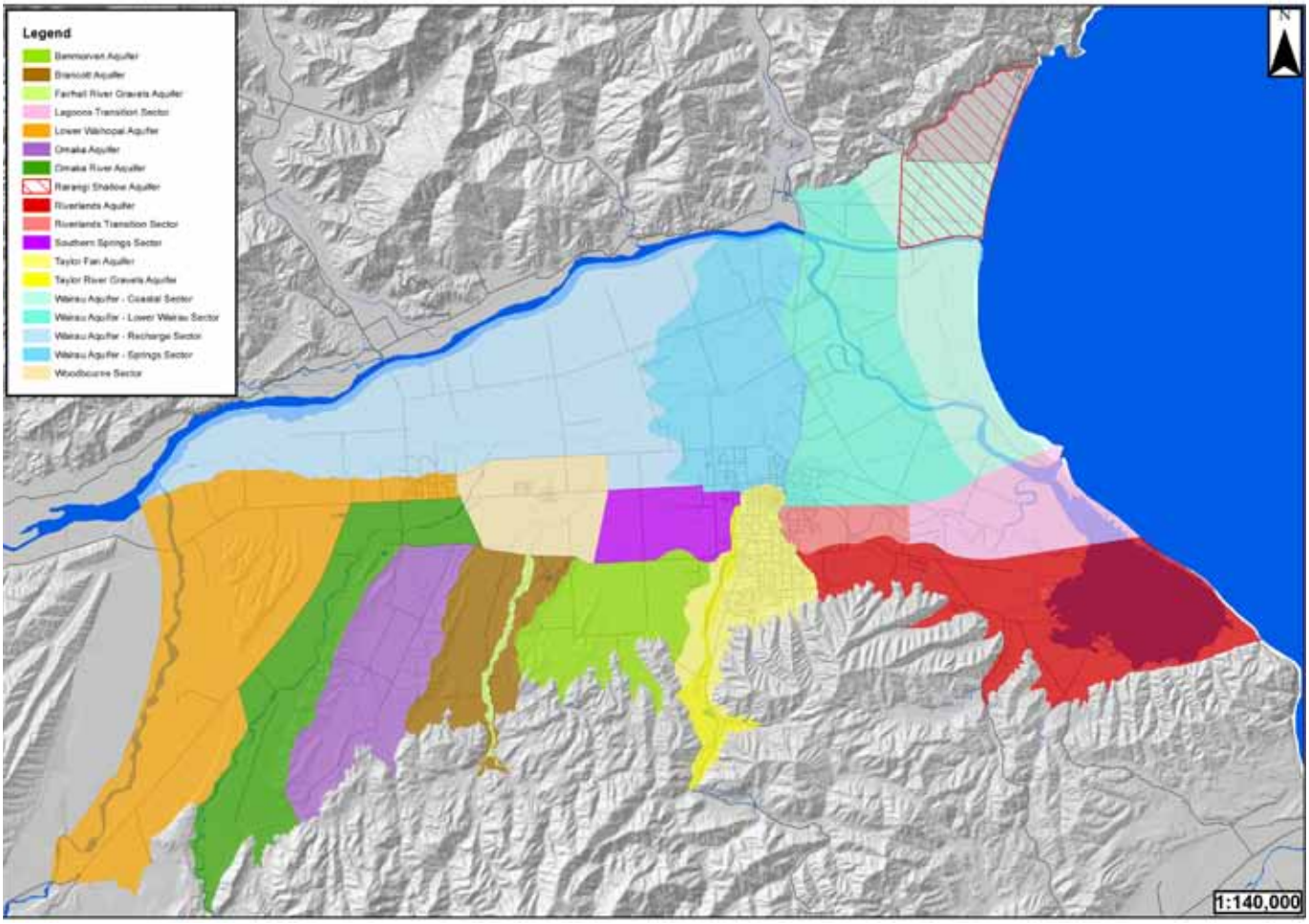

Figure 4.6: Wairau Plain aquifers

any new aquifer layers. Well 2917 currently represents the deepest well drilled in the province at just over 400 metres below the surface.

Developments such as the Southern Valleys Irrigation Scheme (SVIS) have reduced pressure on the Southern Valleys aquifers. However, there will be seasons when this supplementary scheme will be unavailable and active management of these resources will be necessary. When we inevitably revert to this situation in the future, knowledge of sustainable limits gained over 40 years of studying patterns between cause and effect will be crucial.

To keep pace with emerging issues, new tools or methods have been developed along the way by Crown Research Institutes (CRI), universities and regional councils. Many of these represent computer based models or calculators for predicting aquifer behaviour. A significant amount of time and effort has also been devoted over the years by MDC staff developing good record systems of wells, and aquifer knowledge such as hydraulic properties. Marlborough can be justifiably proud of its accurate wells database.

The region has also benefited from being involved with several recent national programmes such as the IGNS administered National Groundwater Monitoring Programme (NGMP). This has led to the standardisation of field collection techniques to ensure the best quality information is acquired which can be used for comparison at a national level (GNS - 2004).

From 2000 onwards there has been a geographical shift in investigations away from the traditionally farmed areas, to those with more marginal water supplies such as the Flaxbourne River Catchment, Wairau Valley, Linkwater and Kaituna Valley. These riparian aquifer systems are by their very nature smaller, and new assessment techniques have evolved to account for limited groundwater storage and the potential for stream depletion. This issue was hardly on the radar several decades ago but has become potentially significant as the level of consented demand rises.

As the limits of full allocation of groundwater resources are being approached throughout Marlborough, hydrological science is shifting away from the traditional investigation phase, towards seasonal allocation and management of groundwater resources. However, the importance and value of good science translated into meaningful information has never been more relevant.

Just when we think that no new issues can possibly arise, something unexpected occurs which requires science to explain its cause, risks and management

options. For example, levels of naturally occurring arsenic toxic to humans were first measured in Marlborough groundwater as recently as 2001. An allied issue related to the security of groundwater quality for human drinking purposes is the potential risk from leaching of preservatives from vineyard support posts (HortResearch - 2005).

In addition to information derived from crown research institutes or MDC initiated investigation programmes, much vital information has been acquired over a number of years from private well owners, consultants and drilling contractors too numerous to mention, and their assistance is gratefully acknowledged.

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