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Dear Stephen

**RE: UPDATE OF NATIONAL GROUNDWATER VOLUME STOCK
ACCOUNT (PROPOSAL 11GW828)**

This report describes the calculation of groundwater volumes in New Zealand for the period 2006 to 2010, following the same methodology as White and Reeves (2002), and White (2007). The first three sections of this letter report provide the description of methodology, parameter estimation and data limitations. The estimated volumes for the period 2006 to 2010 are then presented by region and by aquifer type (confined or unconfined). Comparison of the latest results to those of White and Reeves (2002) and White (2007) for the period 1994 to 2005 is also provided. The final part of this letter report is a list of recommendations to improve estimates of groundwater volume that could be incorporated in future reporting for minimal additional expense.

1.0 METHODOLOGY

Groundwater in the saturated zone occurs within pores and fractures of rock formations (Fetter, 1994). The saturated rock formation through which groundwater moves is called an aquifer. Aquifers are classified as either unconfined or confined for the purpose of groundwater volume calculations, because the confinement influences the storage of water (formation porosity for unconfined aquifers and elastic storage for confined aquifers; Fetter, 1994). In practice, it is not rare for an aquifer to be unconfined near ground surface and confined at depth. Aquifers may also behave as semi-confined. Such semi-confined aquifers are assumed to have confined aquifer storage characteristics for the purpose of groundwater volume calculations.

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White (2001) identified two hundred aquifers of national significance. These aquifers are shown in Figures 1 and 2 and listed by name and region in Tables 1 and 2. The aquifers identified by White (2001) have been used to estimate the national groundwater volume stock.

To calculate the volume of groundwater in an aquifer, the volume of saturated rock (areal extent multiplied by saturated thickness) is multiplied by the water storage parameter. The storage parameter is referred to as the porosity coefficient for unconfined aquifers, and as the storage coefficient for confined aquifers.

The change in the groundwater volume in an aquifer over time is estimated using water level measurements from an indicator well to calculate variation in saturated thickness compared to the reference year (1994), as illustrated by the summary equation below:

Change in groundwater volume (m³) = Groundwater volume in 1994 (m³) x Change in indicator well water level (m).

The estimates of groundwater volumes are reported in m³ at the request of Statistics New Zealand so they can easily be compared with estimates of water storage in surface water features. However, values are only reported to 10⁶ m³ accuracy due to the considerable assumptions and approximations used in the calculations. It is expected that estimates of New Zealand groundwater volume can be improved over time.

1.1 Parameter Estimation

1.1.1 Aquifer area

Aquifer area was estimated using the polygon boundaries shown on Figures 1 and 2. Where the mapped area contained more than one aquifer, the areal extent for each aquifer was based on geological information and experience (White and Reeves, 2002). Estimated aquifer areal extents range from 1.8 to 5,333 km².

1.1.2 Saturated aquifer thickness

Saturated aquifer thickness was based on a winter (June) groundwater level measurement from the indicator well and information obtained from existing reports, geophysical survey data and geological maps (White and Reeves, 2002). Assigned saturated aquifer thicknesses range from less than 1 m to 800 m.

1.1.3 Storage (porosity and storage coefficient)

The aquifer volumes and type (unconfined or confined) used in this report, for the two hundred aquifers, are the same as those used by White and Reeves (2002). Most aquifers in New Zealand do not have measured values of porosity or storage coefficient (White and Reeves, 2002). Where available, the value for storage used in the calculations was the mid-point of the range of measured or reported values. The reduction of aquifer storage with depth was also considered. Porosity coefficients range from 0.05 to 0.3 and storage coefficients range from 0.00005 to 0.04 (measured or reported values). Where no measured or reported values were

available, a porosity of 0.2 was attributed to unconfined aquifers and a storage coefficient of 0.008 was attributed to confined aquifers.

1.1.4 Changes in groundwater volume

Groundwater level measurements from fifteen indicator wells (Table 3) were used to estimate nationwide groundwater level variations, following the methodology used by White and Reeves (2002). These wells were the same as those used by White and Reeves (2002), except for two. The indicator well 2970710 (Takaka Marble aquifer, Tasman region) is no longer in use, and was replaced by well WWD6713, located in the same aquifer about 500 m north of the original well. Secondly, a new indicator well was added for the Bay of Plenty region (well 951, Mamaku Ignimbrite aquifer), where previously the Waikato indicator well was used (White and Reeves, 2002). In the absence of indicator wells for the Gisborne and West Coast regions, the indicator wells for Hawke's Bay and Southland, respectively, have been used as surrogate indicator wells (White and Reeves, 2002). Groundwater levels for the 2006 to 2010 period are compared to the 1994 levels (Table 4), for the purpose of calculating and reporting changes in groundwater volume, which is consistent with the approach used by White and Reeves (2002) and White (2007).

2.0 DATA LIMITATIONS

Data limitations are the same as reported by White and Reeves (2002) and are summarized below:

- The groundwater volume calculation is based on the 200 aquifers identified by White (2001). Small aquifers may have since been delineated and documented.
- Aquifer areas were obtained from 1:50 000 scale maps and/or report figures where aquifer boundaries had not been previously defined. There may be large errors in these estimates.
- Aquifer volumes have been calculated assuming the aquifer is a constant thickness, i.e. volume is average thickness x area. In reality, aquifer thickness is generally highly variable and a 'true' average thickness is rarely known.
- Similarly, storage coefficient and porosity generally vary laterally and vertically, and measured values are often sparse. The calculations assume uniform values for these parameters.
- The volume estimates obtained do not necessarily reflect the amount of water that can be abstracted from an aquifer. Due to physical, chemical, and/or economic constraints, the amount of groundwater available for abstraction may be significantly less than the total volume of groundwater in an aquifer.
- It is assumed the indicator well assigned to a region is representative of all groundwater changes in all aquifers in that region. Generally, there are different responses (in amplitude and response times) in different aquifers depending on characteristics such as aquifer confinement, depth, porosity, and location of the recharge zone.

- The groundwater volumes and changes in volumes obtained from calculations should only be considered accurate to the nearest 10^6 m^3 because of data limitations and assumptions.
- Uncertainties are additive values, therefore there is a potential for the uncertainty in a calculation to be greater than the result itself.
- The uncertainties in saturated thickness, aquifer area, and porosity/storage coefficient are not quantifiable for New Zealand aquifers because the information is generally sparse. Associated uncertainty analysis on the properties of the 200 aquifers was not undertaken. However, trends in groundwater volumes can be considered, because aquifer area, aquifer thickness, and porosity/storage coefficient are constant.

3.0 GROUNDWATER VOLUMES

The estimated groundwater volume in New Zealand aquifers is between $611 \times 10^9 \text{ m}^3$ and $618 \times 10^9 \text{ m}^3$ for the 2006 to 2010 period, of which less than 4% (c. $22 \times 10^9 \text{ m}^3$) is stored in confined aquifers. Canterbury is the region with the largest groundwater storage. The average groundwater volume for the Canterbury region during the period 2006 to 2010 is estimated to be $430 \times 10^9 \text{ m}^3$ (Table 5), or approximately 70% of New Zealand's groundwater. Waikato, with approximately $35 \times 10^9 \text{ m}^3$ of groundwater, has the second-largest groundwater volume, closely followed by Bay of Plenty with $32 \times 10^9 \text{ m}^3$. All other New Zealand regions are estimated to have over $1 \times 10^9 \text{ m}^3$ of groundwater (Figure 3), with the exception of Marlborough ($0.8 \times 10^9 \text{ m}^3$) and Gisborne ($0.6 \times 10^9 \text{ m}^3$). These numbers are very similar to previous groundwater volumes estimates for the 1994-2001 (White and Reeves, 2002) and 2002-2005 (White, 2007) periods. The changes in groundwater volume for all regions during the period 2006 to 2010 are less than 1% (Figure 4). The mean annual groundwater storage volume for all of New Zealand (c. $614 \times 10^9 \text{ m}^3$ of water) for the period 2006 to 2010 is significantly greater than the total groundwater consented allocation ($8.0 \times 10^9 \text{ m}^3$ per year, Aqualinc Research, 2010).

In estimating annual changes in groundwater volume in New Zealand aquifers for the period 2006 to 2010, a reference date of June 1994 was used for consistency with White and Reeves (2002) and White (2007). Annual changes in groundwater volume are reported per region in Table 6. The largest percentage changes in groundwater volume on a yearly basis occurred in Tasman, with -10% ($-0.89 \times 10^9 \text{ m}^3$) in 2007 and +11% ($+1.04 \times 10^9 \text{ m}^3$) in 2009. The second largest variation was observed in Otago, with -10% ($-0.95 \times 10^9 \text{ m}^3$) in 2006. The Waikato region had the largest annual change in groundwater volume between June 2007 and June 2008 ($1.24 \times 10^9 \text{ m}^3$). The Gisborne region showed no annual change in groundwater volume between June 2007 and June 2009. The variability in groundwater volume on a national basis was found to be only broadly related to national rainfall variability (White and Reeves 2002). A comparison of regional rainfall and regional groundwater volumes would be a more meaningful approach to examine relationships between rainfall and groundwater volume. However this analysis was beyond the scope of this report.

4.0 RECOMMENDATIONS

To improve the reliability of estimates of groundwater volume in New Zealand the following should be considered:

- Two hundred aquifers have been used in this study to estimate volume of groundwater in New Zealand, based on aquifer information reported in White (2001). New aquifers and refined estimates of areal extent and aquifer thickness may have subsequently been identified by regional authorities and could be included in future reporting.
- Calculations should incorporate porosity and storage coefficients measured since 2002. These data are typically submitted to regional authorities as part of the resource consent application process.
- Fifteen indicator wells have been used to estimate change in groundwater volume on a national basis. Indicator wells for the Gisborne and West Coast regions should be identified and incorporated into future calculations. Incorporation of more than one indicator well for each region should also be considered, for example one well in an unconfined and another well in a confined aquifer for each region.
- Simple correlation between regional groundwater volumes and regional rainfall could be undertaken to establish possible cause of variation in groundwater volumes. For this purpose rainfall stations located close to the indicator well should be used.
- Comparison of changes in regional groundwater volumes and allocated abstraction volumes would also be beneficial for putting estimated groundwater storage volumes into the context of groundwater usage. Allocated volumes for significant aquifers are typically available from regional authorities and have recently been compiled by Aqualinc Research (2010).

5.0 ACKNOWLEDGEMENTS

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Yours sincerely



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FIGURES

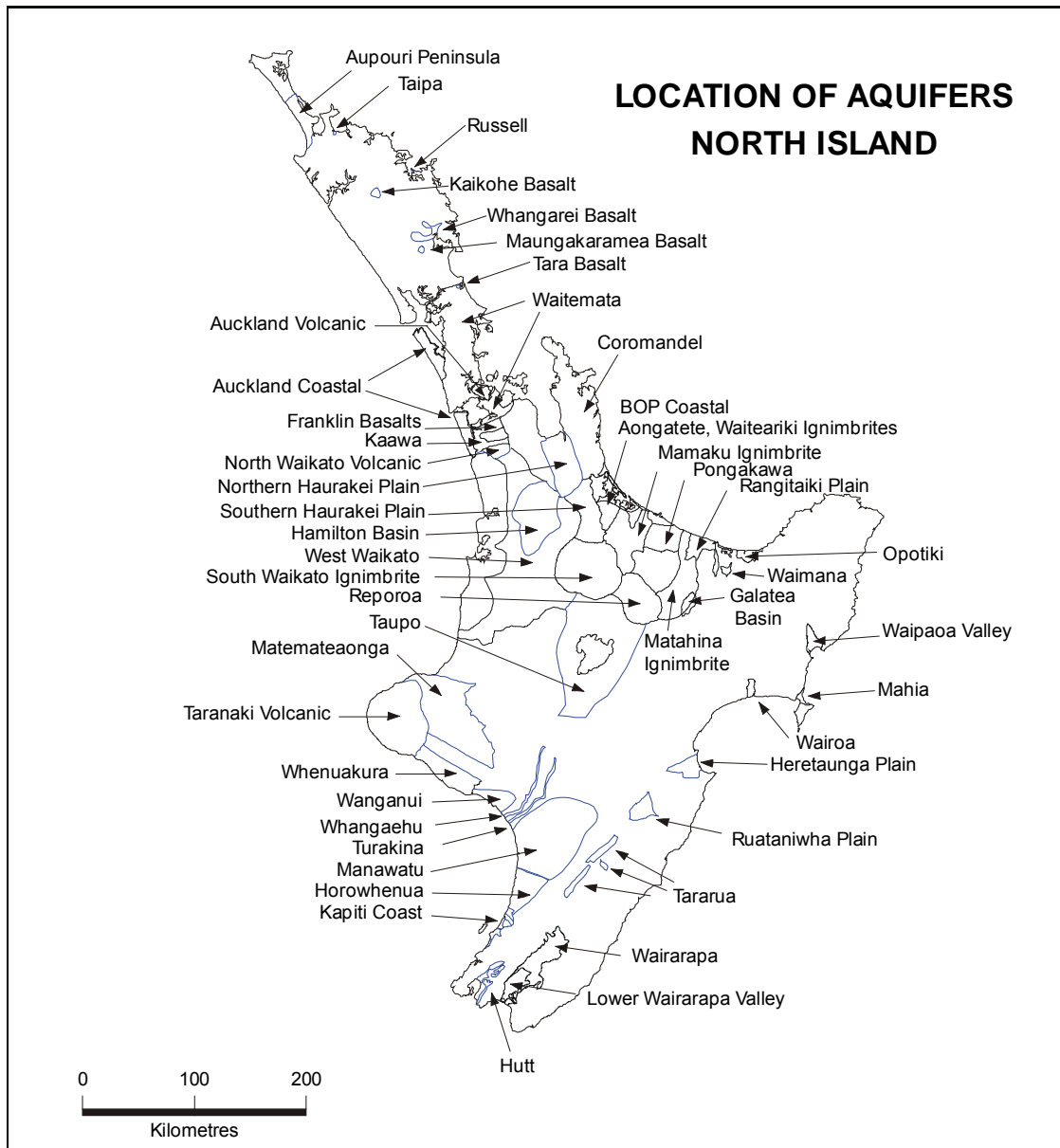


Figure 1: Location of North Island aquifers (White, 2001).

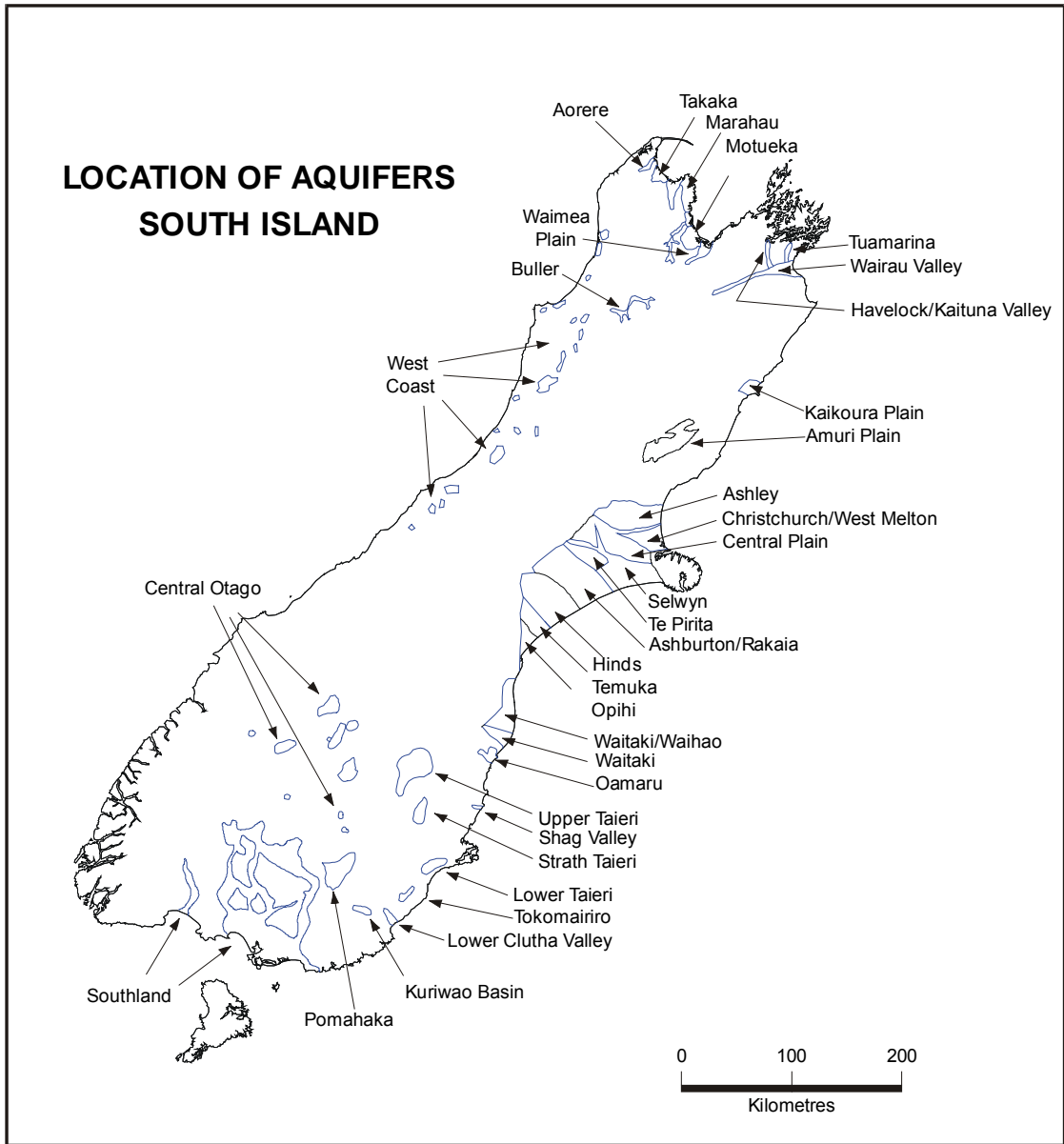


Figure 2: Location of South Island aquifers (White, 2001).

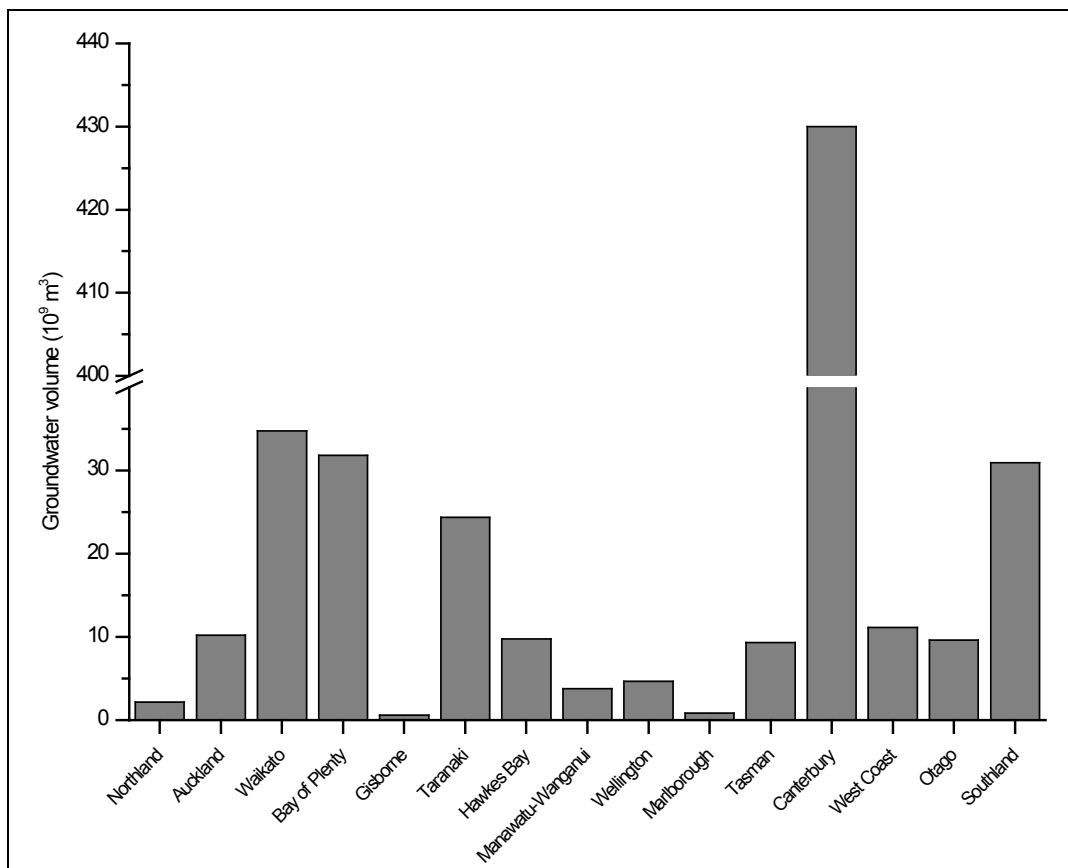


Figure 3: Average groundwater volumes for the period 2006-2010 by region. Note the split in the vertical axis from 40 to 400 x 10⁹ m³.

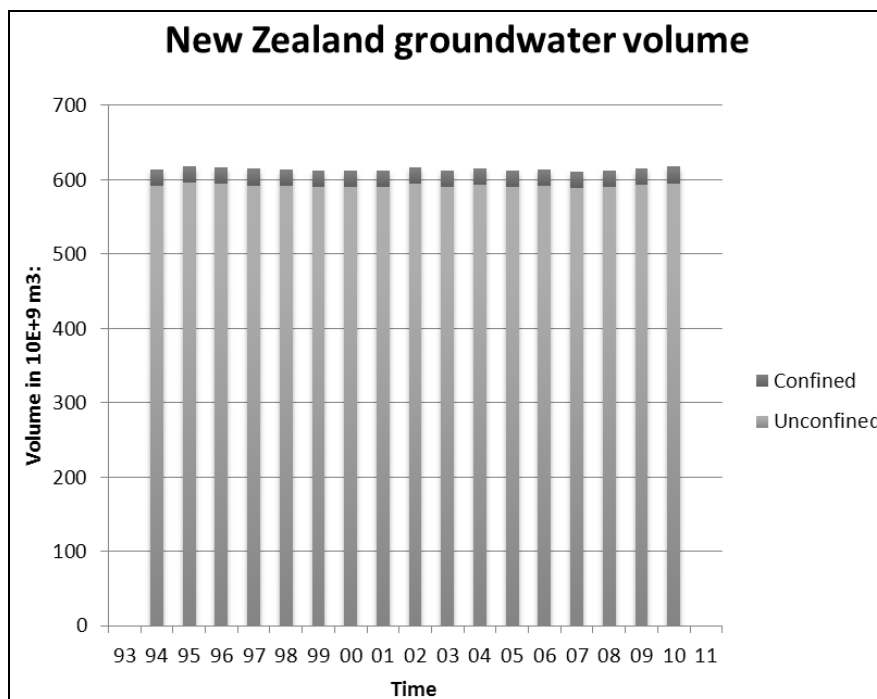


Figure 4: Variation of groundwater volume over the 1994-2010 period based on White and Reeves (2002), White (2007) and estimates from this study. Changes in total volume are less than 1%.

TABLES

Table 1: Regions and names of North Island aquifers (White, 2001).

Region		Aquifer Name
Northland		Aupouri
		Kerikeri
		Okaihau
		Waimate North
		Pakaraka
		Ngawha
		Kaikohe
		Matarau
		Glenbervie
		Three Mile Bush
		Maunu
		Whatitiri
		Maungatapere
		Maungakaramea
		Ruawai
		Tara
		Mangawhai
	Waikato	
		Auckland volcanics
		South Auckland volcanics
		Tauranga Group sediments
		Kaawa Formation
		Greywacke
		Auckland coastal aquifers
		South Auckland volcanics
		Tauranga Group sediments
		Kaawa Formation
		Hinuera Formation
		Coromandel volcanic
		Coromandel sand
		Waiotapu Ignimbrite
		Whakamaru ignimbrites
Bay of Plenty		Taupo ignimbrites
		Taupo sand
		Otorohanga and Orahiri limestone
		Aongatete Ignimbrite
		Waiteariki Ignimbrite
		Western Bay Rhyolite
		Mamaku Plateau
		Matahina Ignimbrite
		Pongakawa Breccia

Region		Aquifer Name
	Coastal Aquifers	Waihi Beach Rhyolite
		Katikati Gravel
		Mt Maunganui sand
		Matakana Island sand
		Maketu warm water
		Maketu Pumice
Gisborne	Waipaoa Valley	Waiapu and Tolaga Bay flats
		Te Hapara sand
		Shallow fluvial
		Waipaoa Gravel
		Makauri Gravel
		Matokitoki Gravel
Taranaki		Matemateaonga Formation
		Taranaki Volcanic
		Marine Terrace
		Whenuakura Formation
Hawke's Bay		Esk Valley
		Heretaunga Plains
		Poukawa Basin
		Papanui Stream Valley
		Ruataniwha Plains
	Northern Coastal	Wairoa Valley
		Nuhaka coastal
		Nuhaka limestone
		Mahia sand
		Mahia alluvium
Manawatu-Wanganui		Mahia
		Wanganui
		Wangaehui-Turakina
		Rangitikei
		Manawatu
		Horowhenua
		Tararua
Coastal		

Table 2: Regions and names of South Island aquifers (White, 2001).

Region		Aquifer Name	
Marlborough		Wairau	
		Rarangi Shallow	
		Tuamarino Valley	
		Rai Valley	
		Pelorus Valley	
		Kaituna Valley	
		Upper Wairau Valley	
		Lower Awatere Valley	
	Southern Valleys	Benmorven	
		Brancott	
		Fairhall River Gravels	
		Taylor - Burleigh	
		Omaka - Hawkesbury	
		Omaka River Valley	
		Deep Wairau	
Tasman		Motueka/Riwaka Plains	
		Motueka River Terraces	
		Aorere Gravel	
		Buller River Terraces	
		Marahau River	
	Waimea Plains	Appleby Gravel Unconfined	
		Hope Minor Confined and Unconfined	
		Upper Confined	
		Lower Confined	
	Moutere Valley	Shallow Moutere	
		Middle Moutere	
		Deep Moutere	
	Takaka Valley	Arthur Marble	
		Takaka Limestone	
		Takaka Valley Gravel	
	Canterbury	North Canterbury	Kaikoura Plain
			Hanmer Basin
Parnassus Basin			
Culverden Basin			
Waipara Basin			
Banks Peninsula			
Canterbury Plains		Ashley Downs	
		Waimakariri-Ashley plains	
		Christchurch-West Melton	
		Central Plains	
		Rakaia-Ashburton plains	
		Ashburton-Rangitata plains	
		Rangitata-Levels plains	

Region		Aquifer Name
	South Canterbury	Fairlie Basin
		Hakataramea Basin
		MacKenzie Basin
West Coast		West Coast alluvial
Otago		Lower Waitaki Alluvium
		Papakaio
		Waiareka and Deborah volcanic
		Kakanui-Kauru Alluvium
		Shag Alluvium
		Lower Taieri Plain - East and West
		Tokomairiro Basin
		Lower Clutha Plain
		Kuriwao Basin
		Pomahaka Basin
	Central Otago aquifers	Maniototo Basin
		Strath Taieri Basin
		Ettrick Basin
		Roxburgh East
	Alexandra Basin	Dunstan Flats
		Earnsclough Terrace
		Manuherikia Alluvium
		Springvale Terrace
		Kingston
		Pisa Terrace
	Upper Clutha Valley	Lindis Valley
Lowburn Valley		
Wanaka Basin		
Hawea Basin		
Glenorchy		
Wakatipu Basin		
Southland		Southland colluvial
		Southland alluvial
		Coastal aquifers
		Tertiary lignite measures
		Tertiary limestone
		Chatton Formation
		Caples and Murihiku Terrain

Table 3: Indicator wells used to estimate changes in groundwater volume.

Region	Indicator well name	Aquifer	Location	NZGM Easting	NZGM Northing	Screen depth (m)	Aquifer condition	Record length
Auckland	6498003	Auckland Volcanics	Angle St, Onehunga	2673100	6473400	N/A	Unconfined	1994 - 2011
Bay of Plenty	Well951	Mamaku Ignimbrite	Paengaroa	2810900	6371210	86.3-114.3	Confined	1990-2011
Canterbury	M35/0931	Ch-West Melton	West Melton	2459890	5746883	29	Confined	1994 - 2011
Gisborne	857009 -7D	N/A	Heretaunga Plains	2834452	6168216	29.2	Confined	1994 - 2011
Hawkes Bay	857009 -7D	Heretaunga Plains	Heretaunga Plains	2834452	6168216	29.2	Confined	1994 - 2011
Horizons	Te Matai #1, 336991	Manawatu Plains	Man. R. Plain E of PN	2736800	6092600	12-13	Unconfined	1997 - 2011
Marlborough	Condor's Forest 6280398	Wairau	Nth of Renwick, Wairau Plain	2577700	5968000	6	Unconfined	1994 - 2011
Northland	5347011	Kaikohe	Roadside at Kaikohe	2582800	6641000	6.0-8.8	Semi-Confined	1994 - 2011
Otago -coastal	Momona well, I44/0848	Lower Taieri Plain	Lower Taieri, west	2292700	5472500		Confined	1995 - 2011
Otago -unconfined	Websters well, J41/0178	Deborah Volcanics	Oamaru	2344800	5560500		Unconfined	1994 - 2011
Southland	Howdens, F46/0192	Edendale	South of Edendale	2183905	5416655	15 (est)	Unconfined	1996 - 2011
Taranaki	GND0508	Taranaki Volcanics	Carrington Rd	2604103	6231609	2.2-8.6	Unconfined	1994 - 2011
Tasman*	WWD6713	Takaka Marble	Hamama	2718600	6573700	29.5-49.5	Confined	2002-2011
Waikato	Fergusson	Hamilton Basin	Near Hamilton	2715600	6379500	3.26	Unconfined	1994 - 2011
Wellington –Wairarapa	1505551 Baring	Parkvale Zone, aquifer 2	Bristol Rd, Carterton	2725045	6013506	31-33	Confined	1994 - 2011
Wellington -Wellington	380027	Waikanae Groundwater Zone	McCardle, Waikanae	2685300	6050070	unknown	Unconfined	1994, 1996-2011
West Coast	Howdens, F46/0192	N/A	South of Edendale	2183905	5416655	15 (est)	Unconfined	1996 - 2011

* The monitoring bore used in White and Reeves (2002) is no longer in use and was replaced by another bore sunk in the Takaka aquifer, located ca. 500 m N of WWD6710)

Table 4: Groundwater levels (m above mean sea level) in indicator wells June 30th 1994, June 30th 2006 to June 30th 2010.

Region	Indicator well number	Jun 30 1994	Jun 30 2006	Jun 30 2007	Jun 30 2008	Jun 30 2009	Jun 30 2010
Auckland	2	2.44	2.56	2.68	2.88	2.84	2.78
Bay of Plenty	4	5.38	8.00	7.50	7.04	7.53	7.69
Canterbury	12	82.84	82.77	82.77	82.84	83.28	83.63
Hawkes Bay	6	15.02	15.29	14.94	15.11	14.94	15.37
Manawatu-Wanganui	7	32.37	32.65	32.00	31.94	32.45	32.29
Marlborough	11	35.63	35.61	34.73	34.69	35.39	36.15
Northland	1	165.89	167.77	166.23	167.74	168.51	167.40
Otago-confined	13	4.161*	3.90	3.24	3.43	4.23	4.31
Otago-unconfined	14	10.88*	8.23	8.43	8.71	9.48	10.95
Southland	15	18.51	18.22	17.98	17.47	18.27	18.29
Taranaki	5	115.20	113.55	114.16	114.54	113.50	115.11
Tasman	10	34.15	35.60	30.60	28.90	34.80	38.23
Waikato	3	39.51	39.97	39.60	40.21	39.79	39.93
Wellington-wairarapa	9	64.16	62.95	62.58	62.17	62.85	63.28
Wellington-wellington	8	9.13	8.95	8.77	8.95	9.00	9.08

Water levels reported in italics are values interpolated from non-continuous recording weekly, monthly or in the BOPRC case quarterly.

Water levels reported in bold are estimated from correlation from White and Reeves, 2002.

* These water levels are taken from White and Reeves (2002), however, due to water level datum uncertainties at the time, these values were shifted to reflect the most recent datum.

Table 5: Summary of groundwater volumes in 10⁹ m³ of water for each region.

Region	Aquifer Condition	30/06/94	30/06/06	30/06/07	30/06/08	30/06/09	30/06/10
Northland	Unconfined	1.1	1.2	1.12	1.2	1.24	1.18
	Confined	0.93	0.97	0.94	0.97	0.98	0.96
	Total Volume	2.03	2.17	2.06	2.17	2.22	2.14
Auckland	Unconfined	6.77	6.81	6.84	6.9	6.89	6.87
	Confined	3.31	3.31	3.32	3.32	3.32	3.32
	Total Volume	10.09	10.12	10.16	10.22	10.21	10.19
Waikato	Unconfined	27.13	28.02	27.31	28.49	27.67	27.93
	Confined	6.84	6.89	6.85	6.91	6.87	6.88
	Total Volume	33.97	34.91	34.16	35.4	34.54	34.82
Bay of Plenty	Unconfined	28.46	28.89	28.8	28.73	28.81	28.84
	Confined	2.94	3.02	3	2.99	3.01	3.01
	Total Volume	31.4	31.9	31.81	31.72	31.81	31.84
Gisborne	Unconfined	0.54	0.55	0.54	0.54	0.54	0.55
	Confined	0.02	0.02	0.02	0.02	0.02	0.02
	Total Volume	0.56	0.57	0.56	0.57	0.56	0.57
Taranaki	Unconfined	24.41	23.83	24.05	24.18	23.81	24.38
	Confined	0.33	0.32	0.32	0.33	0.32	0.33
	Total Volume	24.74	24.16	24.37	24.51	24.14	24.71
Hawkes Bay	Unconfined	9.67	9.71	9.66	9.69	9.66	9.72
	Confined	0.09	0.09	0.09	0.09	0.09	0.09
	Total Volume	9.76	9.8	9.75	9.77	9.75	9.81
Manawatu-Wanganui	Unconfined	3.41	3.45	3.36	3.36	3.42	3.4
	Confined	0.38	0.38	0.38	0.38	0.38	0.38
	Total Volume	3.79	3.83	3.74	3.73	3.8	3.78
Wellington	Unconfined	4.62	4.43	4.36	4.3	4.41	4.48
	Confined	0.24	0.23	0.23	0.23	0.23	0.24
	Total Volume	4.86	4.66	4.6	4.54	4.65	4.72

Region	Aquifer Condition	30/06/94	30/06/06	30/06/07	30/06/08	30/06/09	30/06/10
Marlborough	Unconfined	0.43	0.43	0.4	0.4	0.42	0.45
	Confined	0.41	0.41	0.41	0.41	0.41	0.41
	Total Volume	0.84	0.84	0.81	0.8	0.83	0.86
Tasman	Unconfined	9.06	9.32	8.44	8.13	9.18	9.79
	Confined	0.34	0.34	0.33	0.33	0.34	0.35
	Total Volume	9.4	9.66	8.77	8.46	9.52	10.13
Canterbury	Unconfined	427.03	426.87	426.86	427.02	428.01	428.78
	Confined	2.5	2.5	2.5	2.5	2.51	2.52
	Total Volume	429.53	429.37	429.35	429.52	430.51	431.3
West Coast	Unconfined	11.24	11.17	11.12	11.01	11.19	11.19
	Confined	0	0	0	0	0	0
	Total Volume	11.24	11.17	11.12	11.01	11.19	11.19
Otago	Unconfined	10.19	9.24	9.31	9.41	9.69	10.22
	Confined	0.01	0.01	0.01	0.01	0.01	0.01
	Total Volume	10.21	9.26	9.33	9.43	9.7	10.24
Southland	Unconfined	28	27.59	27.25	26.55	27.66	27.69
	Confined	3.63	3.61	3.6	3.57	3.62	3.62
	Total Volume	31.63	31.2	30.85	30.12	31.28	31.31
NZ total	Unconfined	592.08	591.51	589.42	589.9	592.61	595.48
	Confined	21.98	22.11	22	22.05	22.11	22.13
	Total Volume	614.06	613.63	611.43	611.95	614.72	617.61

Table 6: Summary of groundwater volume changes in 10^9 m^3 of water for each region.

Region	Aquifer Condition	Jun-94	Jun-06	Jun-07	Jun-08	Jun-09	Jun-10
Northland	Unconfined	0	0.1	-0.08	0.08	0.04	-0.06
	Confined	0	0.04	-0.03	0.03	0.01	-0.02
	Total Volume	0	0.14	-0.11	0.11	0.06	-0.08
Auckland	Unconfined	0	0.03	0.03	0.06	-0.01	-0.02
	Confined	0	0	0	0	0	0
	Total Volume	0	0.04	0.03	0.06	-0.01	-0.02
Waikato	Unconfined	0	0.89	-0.72	1.18	-0.82	0.26
	Confined	0	0.04	-0.03	0.06	-0.04	0.01
	Total Volume	0	0.94	-0.75	1.24	-0.86	0.27
Bay of Plenty	Unconfined	0	0.43	-0.08	-0.08	0.08	0.03
	Confined	0	0.07	-0.01	-0.01	0.01	0
	Total Volume	0	0.5	-0.1	-0.09	0.1	0.03
Gisborne	Unconfined	0	0.01	-0.01	0	0	0.01
	Confined	0	0	0	0	0	0
	Total Volume	0	0.01	-0.01	0	0	0.01
Taranaki	Unconfined	0	-0.58	0.21	0.14	-0.37	0.57
	Confined	0	0	0	0	0	0
	Total Volume	0	-0.58	0.21	0.14	-0.37	0.57
Hawkes Bay	Unconfined	0	0.04	-0.05	0.02	-0.02	0.06
	Confined	0	0	0	0	0	0
	Total Volume	0	0.04	-0.05	0.02	-0.02	0.06
Manawatu-Wanganui	Unconfined	0	0.04	-0.08	-0.01	0.07	-0.02
	Confined	0	0	0	0	0	0
	Total Volume	0	0.04	-0.09	-0.01	0.07	-0.02
Wellington	Unconfined	0	-0.2	-0.06	-0.06	0.11	0.07
	Confined	0	-0.01	0	0	0	0
	Total Volume	0	-0.2	-0.07	-0.06	0.11	0.07

Region	Aquifer Condition	Jun-94	Jun-06	Jun-07	Jun-08	Jun-09	Jun-10
Marlborough	Unconfined	0	0	-0.03	0	0.03	0.03
	Confined	0	0	0	0	0	0
	Total Volume	0	0	-0.04	0	0.03	0.03
Tasman	Unconfined	0	0.26	-0.89	-0.3	1.04	0.61
	Confined	0	0	-0.01	0	0.01	0.01
	Total Volume	0	0.26	-0.9	-0.31	1.06	0.62
Canterbury	Unconfined	0	-0.16	-0.01	0.16	0.99	0.78
	Confined	0	0	0	0	0.01	0.01
	Total Volume	0	-0.16	-0.01	0.16	1	0.78
West Coast	Unconfined	0	-0.07	-0.05	-0.11	0.18	0
	Confined	0	0	0	0	0	0
	Total Volume	0	-0.07	-0.05	-0.11	0.18	0
Otago	Unconfined	0	-0.95	0.07	0.1	0.28	0.53
	Confined	0	0	0	0	0	0
	Total Volume	0	-0.95	0.07	0.1	0.28	0.53
Southland	Unconfined	0	-0.41	-0.33	-0.71	1.11	0.03
	Confined	0	-0.02	-0.01	-0.03	0.05	0
	Total Volume	0	-0.43	-0.35	-0.74	1.16	0.03
NZ total	Unconfined	0	-0.57	-2.09	0.48	2.7	2.87
	Confined	0	0.14	-0.11	0.04	0.06	0.02
	Total Volume	0	-0.44	-2.2	0.52	2.77	2.89