Report

Modelling Permitted Groundwater Use in the Ruamāhanga Whaitua

Phase 3 report: Summary of model and outputs

Prepared for Greater Wellington Regional Council

Prepared by Beca Ltd (Beca)

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Revision History

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A	**Andy Haigh**	Issued to client	28 August 2015

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Action	Name	Signed	Date
Prepared by	**Andy Haigh**		28 August 2015
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on behalf of	Beca Ltd		

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Abbreviations used in this document

GIS   Geographic Information System

GDB Esri File Geodatabase

GW   Groundwater

GWRC   Greater Wellington Regional Council

Document References

The following documents are related to the modelling described in this report:

Beca Report (August 2015) *Modelling Permitted Groundwater Use in the Ruamāhanga Whaitua – Phase 2 report: Model development*. Beca red: NZ1-11118981-7.[1]

Greater Wellington Regional Council Report (May 2011) *Wairarapa Valley groundwater resource investigation: Proposed framework for conjunctive water management.*[2]

Beca Draft Report (March 2011) *Modelling the Magnitude of Unconsented Surface Water Use in the Wellington Region*. Beca ref: NZ1-4186268-10.[3]

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[1] As supplied to Greater Wellington Regional Council 5 August 2015

[2] http://www.gw.govt.nz/assets/council-publications/Wairarapa%20Valley%20Groundwater%20Resource%20Investigation%20Proposed%20Framework%20for%20Conjunctive%20Water%20Management%20Report%20updated.pdf

[3] As supplied to Greater Wellington Regional Council 18 March 2011

1 Introduction

The following report summarises the results and observations from the modelling of potential groundwater use in the Ruamāhanga Whaitua (Catchment).

The report includes content from the Phase 2 report (Model development) which outlines the inputs, structure and outputs of the Geographic Information Systems (GIS) model developed to estimate the levels of permitted groundwater use in the catchment.

2 Model extent

The potential permitted water use model covers the extent of the management zones in the Ruamāhanga Whaitua as illustrated below:

Figure 1 – Modelled Ruamāhanga Whaitua Management Zone
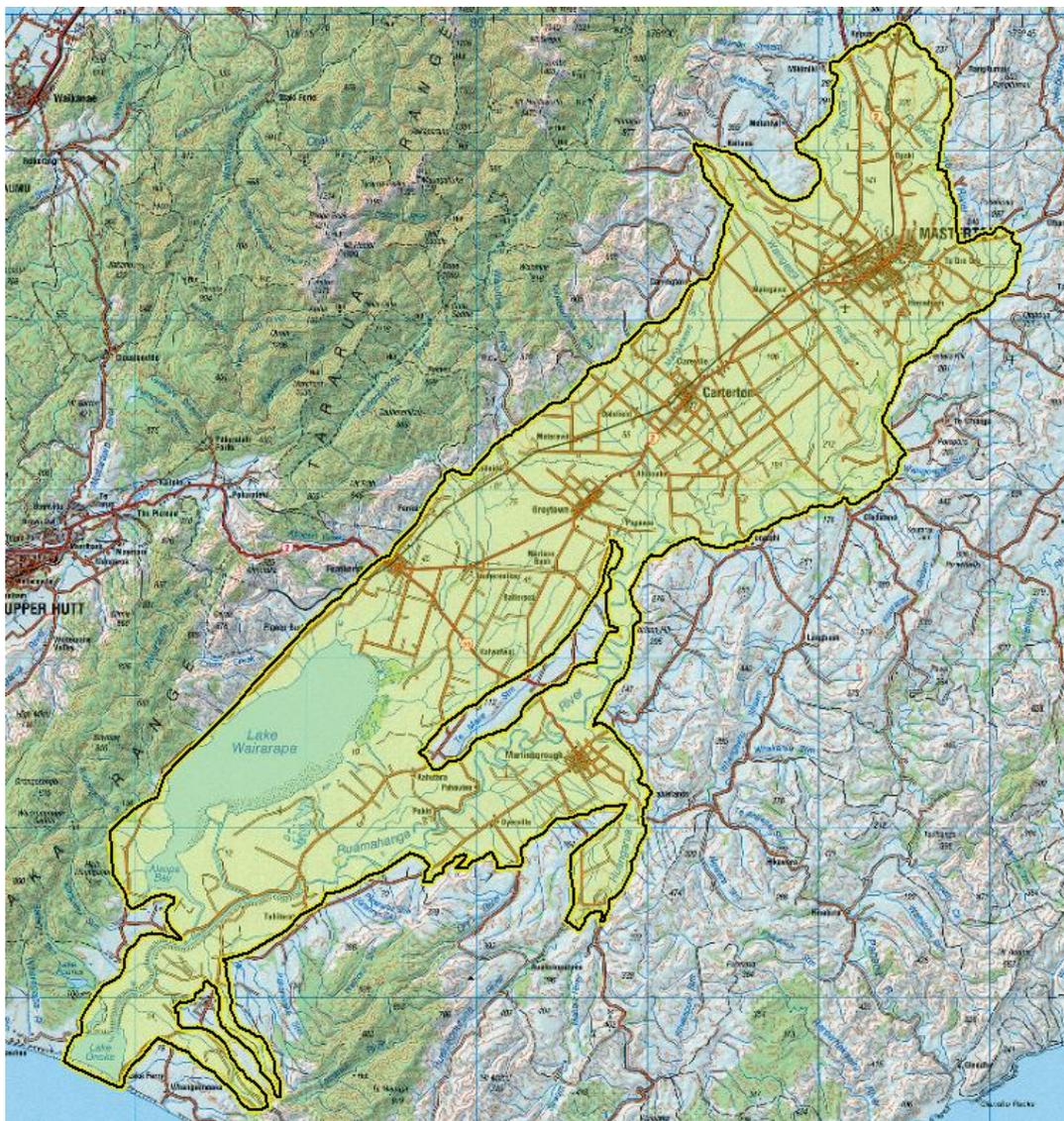
3 Overview of potential permitted groundwater model

The potential permitted groundwater model (the model) has been developed for the Ruamāhanga Whaitua to assist better understanding of the volume ground water abstraction from existing boreholes under the permitted activities rule under the GWRC Regional Freshwater Plan (1999) and Section 14(3)(b) of the Resource Management Act. The model uses the location and depth of selected boreholes (those with specific purposes) in conjunction with estimated stock numbers (beef, dairy, sheep and deer) and human population numbers to estimate potential permitted groundwater use using established water use volumes (litres / stock/human numbers / day). The model accounts for alternative water supply sources such as Urban Water Supply Schemes, Rural Water Supply Schemes and Water Races.

The model has been developed using GIS datasets and spatial analytics software. This allows the aggregation and analysis of a number of spatial datasets in the assessment of potential permitted groundwater use.

The results of the potential permitted groundwater model are presented in Microsoft Excel format (see Section 5.1), with results records for each property with an existing applicable borehole in the Ruamāhanga Whaitua. This allows both the matching of the results back to GIS property database for further analysis with additional datasets, as well as the ability to aggregate the Excel results by Management Zones and Abstraction Zones.

4 Model development

4.1 Data sources

The following table outlines the sources of data used in the model:

Table 1 – Data sources

Dataset	Source	Date supplied/sourced	Description
Properties	GWRC	Dec 2014	The base of the model. Properties across the Ruamāhanga catchment.
Agribase	AssureQuality[4]	Jul 2010	Farm extents and reported stock counts across the Ruamāhanga catchment. Not all farms are recorded in the Agribase dataset.
Land Cover Database 2 (LCDB2)	Ministry for the Environment[5]	As per MfE issue (July 2004)	Recorded landcover. Used to identify areas of pasture on properties as an indicator of farmed area (proportion) of a property.
Parcels Land Use	GWRC	Nov 2014	Dataset identifying Land Use on properties.
WELS Database	GWRC	Apr 2014	Location, depth and use of boreholes.
Urban Water Zones	GWRC	Jan 2011	Extents of Urban Water Supply.
Water Races	GWRC	Jul 2010	Extents of Water Races.
Rural Water	GWRC	Jul 2010	Extents of Rural Water Supply.

[4] As supplied by GWRC

[5] http://mfe.govt.nz/issues/land/land-cover-dbase/

Dataset	Source	Date supplied/sourced	Description
Supply Zones			
Groundwater Abstraction Zones	GWRC	Oct 2014	Groundwater abstraction categories and management zones.

4.2 Model structure

The following summarises the model structure.

Task numbers match the raw data tables supplied (see Section 5).

Table 2 – Model structure

Task	Results Table Column	Description
1	USER_CODE1 USER_CODE2 USER_CODE3	A Borehole is required for GW abstraction. Only Boreholes with the USER_CODE1, 2 or 3 is recorded as "Domestic Supply", "Stock Supply", "Irrigation" or "Dairy Use" are used for the model. [All other uses assumed to require a Consent i.e. not contributors to the Estimated Permitted Water Model]
2	Name	The groundwater management zone name for each borehole is recorded
3	Name1	The abstraction zone for boreholes is recorded (as A, B or C dependent on location and depth of borehole) using the Groundwater Zones 0_20m, 20_30m and 30m layers
4	Parcel_id1 NumberCombined Area	Properties (Parcels) where a borehole (identified above) are selected. Where there are multiple boreholes on a single property, only one property record is retained. (property results are combined where the parcel_id is the same)
5	Pasture_Area Pasture_Perc_Decimal	The % pasture (identified as "Low Producing Exotic Grassland" or "High Producing Exotic Grassland" in the LCDB2) per property is calculated
6	UWSS	Location of the property (any part) within a Urban Water Supply Scheme (UWSS) is recorded (Y/N)
7	RWSS	Location of the property (any part) within a Rural Water Supply Scheme (RWSS) is recorded (Y/N)
8	WR	Location of the property (any part) within a Water Race (WR) is recorded (Y/N)

9	AgribaseData
	LAND_USE
	LAND_USE_G
	DAI_NOS_EST
	DEE_NOS_EST
	BEF_NOS_EST
	SHP_NOS_EST
		Estimated stock density (Dairy, Beef, Deer and Sheep) is recorded for each property using either
		■ Agribase data,
		  – Recorded stock numbers and farm size used to calculate density across the Agribase property
		  – These densities applied to the property with the borehole, using the % pasture value to estimate stock numbers
		■ Estimated Stock where Agribase data is not available:
		  – Properties without Agribase data and not in an urban area, and having a Land Use Group of "Primary Industry" and Land Use of "Dairying", "Stock Fattening" or "Store Sheep" (from the Parcels Land Use database) (no Land Use specific to Deer farming is included in source data) have an average stock count applied, based upon the average density for Beef, Dairy and Sheep are calculated for all Agribase polygons
		  – This is only done for Agribase polygons where the Description field is identified as "Beef cattle farming" and "Sheep Farming", not "Mixed Beef and Sheep" (to avoid double accounting of farm areas)
		  – Values calculated and used:
		    ■ Beef = 0.62 animal /ha

Task	Results Table Column	Description
		■ Dairy = 2.42 animal /ha
10	PPL_NOS_EST	An average population for People of 0.95 is added for each property (excluding those within an urban area)

11	DAI_EST_WU
	DAI_EST_WU_DS
	BEF_EST_WU
	DEE_EST_WU
	SHP_EST_WU
	PPL_EST_WU
		Estimated water use for each property is calculated using the following water use rates and the following rules
		■ Rates:
		    – People = 300 litres /person /day
		    – Dairy = 70 litres /animal /day drinking and 70 litres /animal /day dairy shed wash down
		    – Beef = 45 litres /animal /day
		    – Sheep = 7 litres /animal /day
		    – Deer = 7 litres /animal /day

12	DAI_EST_GWU DAI_EST_GWU_DS BEF_EST_GWU DEE_EST_GWU SHP_EST_GWU PPL_EST_GWU TOTAL_EST_GWU	Potential Ground Water use for each property is then calculated for both properties abstracting from abstraction zones A, B and C, based on the following (excluding all urban water areas): ■ If property is in a Rural Water Scheme and a Water Race Scheme, no water is assumed to be abstracted from groundwater ■ If a property is in a Rural Water Scheme, but not a Water Race, water is assumed to be abstracted for stock, and estimated stock water use is summed ■ If a property is in a Water Race, but not a Rural Water Scheme, water is assumed to be abstracted for domestic use only ■ If in neither, then both stock and water assumed to be abstracted ■ Those in Urban Water Supply discounted

5   Model results

5.1   Raw results

The raw results are supplied as a separate Microsoft Excel (2010) file (Est_GWWaterUseCalcPhase3Deliverable.xlsx).

The raw results contain the records and values for all of the steps described in Section 4.2 above. Results are provided for all properties that have boreholes that meet the criteria in Task 1 (in Section 4.2 table). The unique attribute identifier for each property (*parcelid1*) is retained so that results can be matched to individual properties from the Parcels GIS dataset.

5.2   Aggregated results

The raw results can be aggregated in a number of ways to summarise potential permitted groundwater use by Management Zone and Abstraction Category, or as a breakdown of by stock and people potential water use.

The tables below provide an illustration of these results. The full results are provided in Appendix A.

Table 3 – Aggregated results - Potential permitted groundwater abstraction (l/d) by Management Zone and Category

Management Zone	Category A (l/d)	Category B (l/d)	Category C (l/d)
Dry River	N/A	117184	N/A
Fernhill-Tiffen	N/A	N/A	7125
Huangarua	20581	16846	N/A
Lake	N/A	311548	803918
Lower Ruamahanga	431593	N/A	N/A
Mangatarere	158001	296481	83168
Martinborough	N/A	N/A	46363
Middle Ruamahanga	477000	N/A	N/A
Moiki	159044	N/A	N/A
Onoke	145297	N/A	227597
Parkvale	N/A	60575	23313
Taratahi	N/A	10545	1425
Tauherenikau	209237	331291	N/A
Te Ore Ore	35935	31250	N/A
Upper Ruamahanga	141586	91057	23155
Waingawa	30750	79978	67722
Waiohine	126769	N/A	N/A
Waipoua	61902	N/A	N/A

These results can also be represented as bar chart as illustrated below (l/d (y-axis) by Management Zone and Abstraction Category (x-axis)).

Figure 2 – Graphed Aggregated results - Potential permitted groundwater abstraction (l/d) by Management Zone and Category
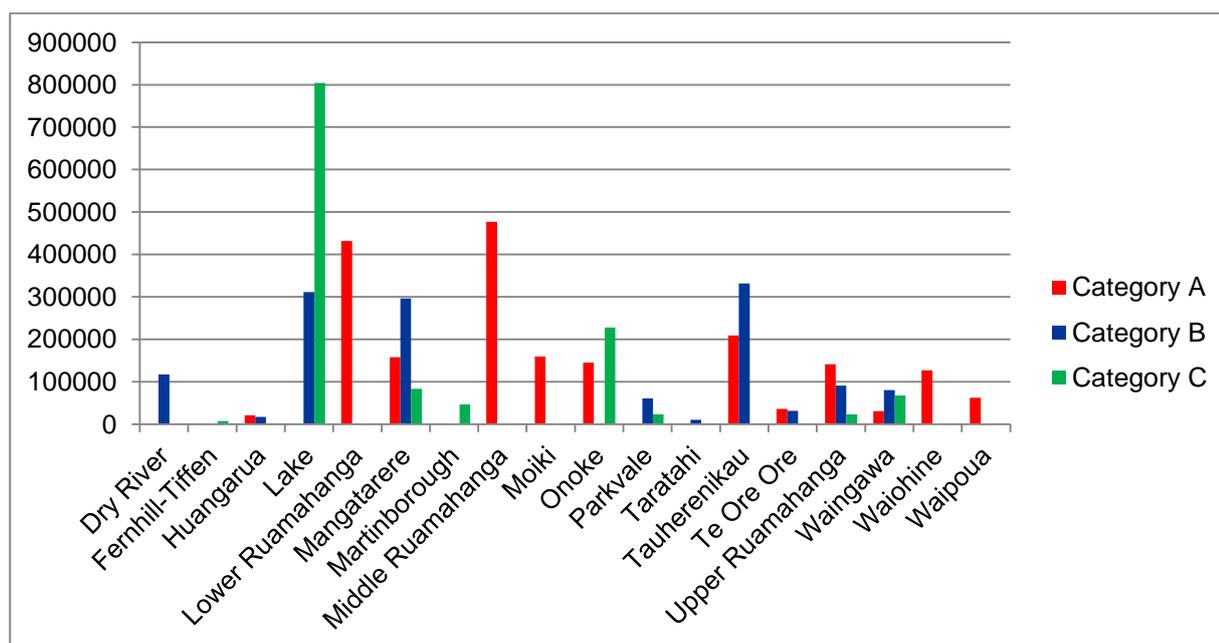
The results can also be broken down by abstraction zone, as illustrated in the table below for abstraction zone Category A.

Table 4 – Aggregated results – Potential permitted groundwater abstraction (l/d) by Management Zone and Water User for abstraction zone Category A

Management Zone	Category A (l/d)					
	DAI_EST_GWU	DAI_EST_GWU_DS	BEF_EST_GWU	DEE_EST_GWU	SHP_EST_GWU	PPL_EST_GWU
Dry River	N/A	N/A	N/A	N/A	N/A	N/A
Fernhill-Tiffen	N/A	N/A	N/A	N/A	N/A	N/A
Huangarua	N/A	N/A	7965	N/A	10906	1710
Lake	N/A	N/A	N/A	N/A	N/A	N/A
Lower Ruamahanga	189140	189140	11430	N/A	30198	11685
Mangatarere	69440	69440	6075	N/A	791	12255
Martinborough	N/A	N/A	N/A	N/A	N/A	N/A
Middle Ruamahanga	219800	219800	7065	N/A	8960	21375
Moiki	57400	57400	9675	N/A	30009	4560
Onoke	42490	42490	17640	259	40138	2280
Parkvale	N/A	N/A	N/A	N/A	N/A	N/A
Taratahi	N/A	N/A	N/A	N/A	N/A	N/A
Tauherenikau	86940	86940	24525	N/A	287	10545
Te Ore Ore	7070	7070	2745	N/A	4515	14535
Upper Ruamahanga	63490	63490	4500	490	5341	4275
Waingawa	280	280	7605	N/A	4060	18525
Waiohine	34300	34300	10125	N/A	11564	36480
Waipoua	17710	17710	9810	N/A	10402	6270

Figure 3 below illustrates the total potential permitted groundwater abstraction by Management Zone and abstraction category.

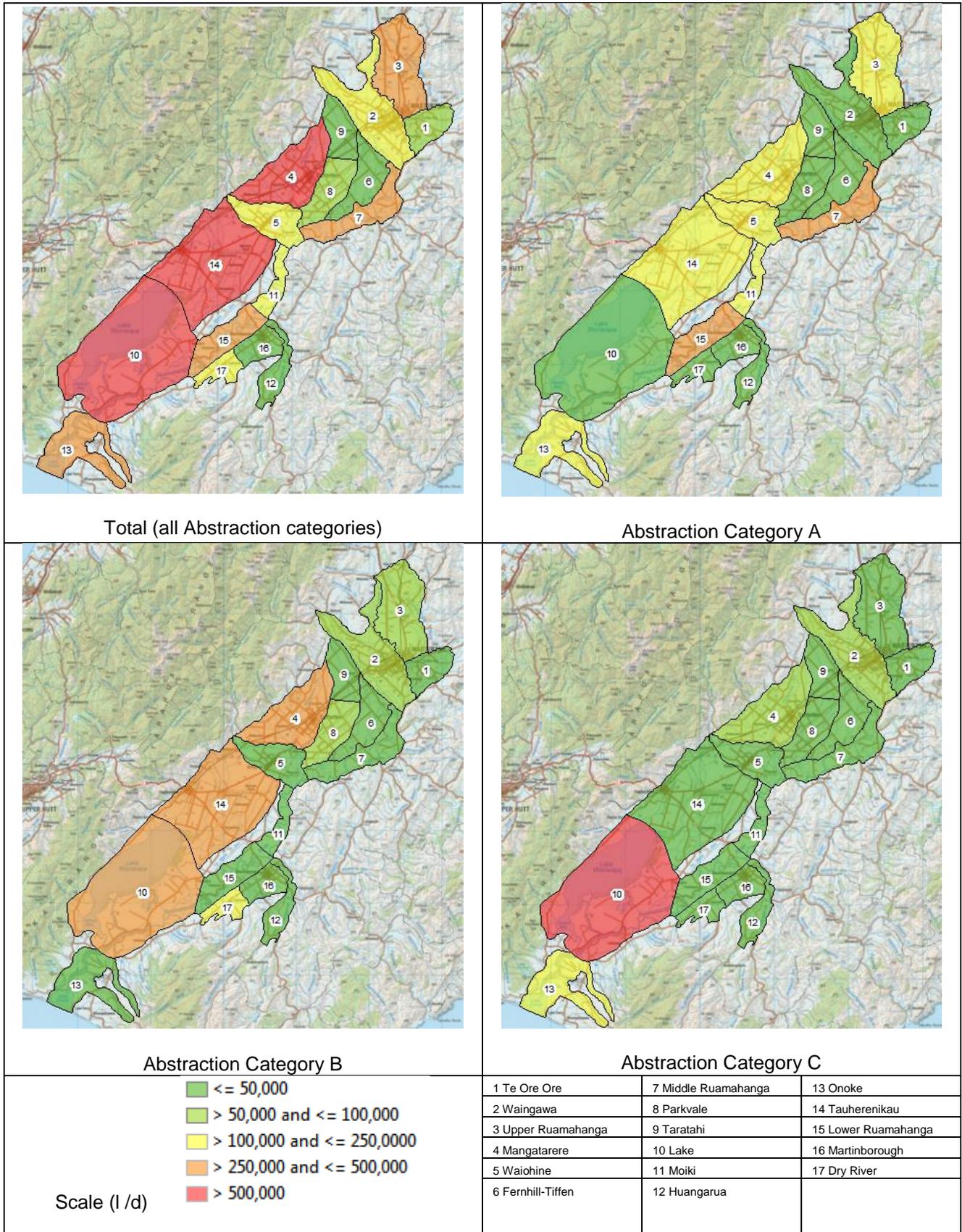Figure 3 – Mapped Aggregated results – Potential permitted groundwater abstraction (l/d) by Management Zone and Category

Total (all Abstraction categories)

Abstraction Category A

Abstraction Category B

Abstraction Category C

Scale (l /d)		
<= 50,000		
> 50,000 and <= 100,000		
> 100,000 and <= 250,0000		
> 250,000 and <= 500,000		
> 500,000		

1 Te Ore Ore	7 Middle Ruamahanga	13 Onoke
2 Waingawa	8 Parkvale	14 Tauherenikau
3 Upper Ruamahanga	9 Taratahi	15 Lower Ruamahanga
4 Mangatarere	10 Lake	16 Martinborough
5 Waiohine	11 Moiki	17 Dry River
6 Fernhill-Tiffen	12 Huangarua	

6   Opportunities for further model development

Whilst there are no immediate plans to update the model, the following are opportunities for potential further development:

Updated datasets

The input datasets used for the model could be updated to reflect any changes that have occurred since the dates of the datasets used in this iteration of the model. Specifically, opportunities exist with:

- The Agribase dataset
    - The Agribase dataset used for the model is dated 2010, taken from the previous potential permitted surface water use model undertaken by GWRC in 2010. The model could be re-run with an updated extract from the Agribase dataset which would allow for any changes in stock numbers (density) and stock types across the abstraction and management zones. An update to the Agribase dataset could also provide the opportunity to compare modelled results across the different time periods as a method of analysing the change in demand for permitted water use.
- The Land Cover dataset
    - The model uses the LandCover Database version 2 dataset as per the previous potential permitted surface water use model undertaken by GWRC in 2010. The LandCover Database has been updated (now version 4) with potential new data collected in the summer 2012/13. An update of the model with this updated LandCover database version may provide updated detail around pasture cover on farm properties with boreholes used for stock watering, thus providing updated potential stock densities and numbers. As with an update to the Agribase dataset, an update to the LandCover Database could provide the opportunity also to analyse potential permitted water use change over time by comparing the two different modelled results.
- WELS database
    - Inclusion of an updated WELS database would enable the model to be re-run and take into account any new relevant boreholes that have been added subsequent to this model run.
- Water Supply Zones
    - Any new or extended boundaries to Urban Water Schemes, Rural Water Supply Schemes and Water Races should be included in an updated model as the extents of these boundaries influence the potential permitted ground water use calculations.

Interactive tool to allow for new boreholes to be included in the model

The model could be developed as an interactive GIS application for use as a management tool when considering the application for boreholes. Such a model could allow the GWRC to assess such applications potential impact on the overall permitted water take for abstraction and management zones.

Considering potential permitted groundwater use against resource availability

The model assesses potential permitted ground water use by abstraction zone, but does not compare that against the ground water resource availability for that zone. The inclusion of potential resource availability figures could assist in the understanding of the use and availability of the resource. Those figures could be then included an interactive management tool (as above) in the consideration of new borehole applications.

Including a temporal attribute to the model

The model does not have a temporal element to the potential permitted ground water use calculation. Such an element could be introduced to determine temporal loading of ground water use, such as the consideration seasonal use of water for stock watering and irrigation against dairy shed washdown activities.

Combining with potential permitted surface water modelling

Finally, the results of the potential permitted water model could be combined with the similar modelling undertaken to estimated potential permitted surface water use in the Ruamāhanga Whaitua. In particular this could be useful in the consideration of potential permitted groundwater use in the Category A abstraction zones where surface water and groundwater environments are closely related.

Appendix A

The following results have been calculated and aggregated to groundwater management zone:

Estimated groundwater abstraction (l/d) by Management Zone and Category

	Category A	Category B	Category C
Dry River	N/A	117184	N/A
Fernhill-Tiffen	N/A	N/A	7125
Huangarua	20581	16846	N/A
Lake	N/A	311548	803918
Lower Ruamahanga	431593	N/A	N/A
Mangatarere	158001	296481	83168
Martinborough	N/A	N/A	46363
Middle Ruamahanga	477000	N/A	N/A
Moiki	159044	N/A	N/A
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Te Ore Ore	35935	31250	N/A
Upper Ruamahanga	141586	91057	23155
Waingawa	30750	79978	67722
Waiohine	126769	N/A	N/A
Waipoua	61902	N/A	N/A

Estimated groundwater abstraction (l/d) by Management Zone and Category and Use

	Category A						Category B						Category C					
	DAI_EST_GWU	DAI_EST_GWU_DS	BEF_EST_GWU	DEE_EST_GWU	SHP_EST_GWU	PPL_EST_GWU	DAI_EST_GWU	DAI_EST_GWU_DS	BEF_EST_GWU	DEE_EST_GWU	SHP_EST_GWU	PPL_EST_GWU	DAI_EST_GWU	DAI_EST_GWU_DS	BEF_EST_GWU	DEE_EST_GWU	SHP_EST_GWU	PPL_EST_GWU
Dry River	N/A	N/A	N/A	N/A	N/A	N/A	27370	27370	24030	N/A	30149	8265	N/A	N/A	N/A	N/A	N/A	N/A
Fernhill-Tiffen	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7125
Huangarua	N/A	N/A	7965	N/A	10906	1710	N/A	N/A	4230	N/A	10906	1710	N/A	N/A	N/A	N/A	N/A	N/A
Lake	N/A	N/A	N/A	N/A	N/A	N/A	118930	118930	35235	315	34433	3705	344330	344330	34605	N/A	67543	13110
Lower Ruamahanga	189140	189140	11430	N/A	30198	11685	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mangatarere	69440	69440	6075	N/A	791	12255	124530	124530	16110	77	1309	29925	38710	38710	1305	N/A	168	4275
Martinborough	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	140	140	7515	N/A	20328	18240
Middle Ruamahanga	219800	219800	7065	N/A	8960	21375	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Moiki	57400	57400	9675	N/A	30009	4560	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Onoke	42490	42490	17640	259	40138	2280	N/A	N/A	N/A	N/A	N/A	N/A	83510	83510	15660	N/A	38647	6270
Parkvale	N/A	N/A	N/A	N/A	N/A	N/A	19670	19670	4050	98	3122	13965	10150	10150	135	N/A	28	2850
Taratahi	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10545	N/A	N/A	N/A	N/A	N/A	1425
Tauherenikau	86940	86940	24525	N/A	287	10545	111020	111020	47205	N/A	9891	52155	N/A	N/A	N/A	N/A	N/A	N/A
Te Ore Ore	7070	7070	2745	N/A	4515	14535	2310	2310	10710	N/A	6230	9690	N/A	N/A	N/A	N/A	N/A	N/A
Upper Ruamahanga	63490	63490	4500	490	5341	4275	41650	41650	2025	7	2590	3135	3360	3360	3420	N/A	11305	1710
Waingawa	280	280	7605	N/A	4060	18525	15750	15750	14670	231	9352	24225	6930	6930	12420	2002	19775	19665
Waiohine	34300	34300	10125	N/A	11564	36480	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Waipoua	17710	17710	9810	N/A	10402	6270	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DAI_EST_GWU	Dairy cow estimated groundwater use (drinking) (l/d)
DAI_EST_GWU_DS	Dairy cow estimated groundwater use (shed washdown) (l/d)
BEF_EST_GWU	Beef cow estimated groundwater use (drinking) (l/d)
DEE_EST_GWU	Deer estimated groundwater use (drinking) (l/d)
SHP_EST_GWU	Sheep estimated groundwater use (drinking) (l/d)
PPL_EST_GWU	People estimated groundwater use (drinking) (l/d)