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Revised Applications for Take, Use and Discharge of Tranche 2 Groundwater Ruataniwha Basin

August 2021

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Ruataniwha Basin

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Contents

EXECUTIVE SUMMARY

Plan Change 6 (PC6) to the Hawke's Bay Regional Resource Management Plan (RRMP) became operative on 1 October 2015. PC6 set groundwater allocation limits for the Ruataniwha Basin which is located within the upper Tukituki River catchment. Included within those limits was an allocation of deep groundwater that PC6 labelled "Tranche 2".

In response to the establishment of the Tranche 2 allocation, during the period 19 November 2014 to 1 May 2017 the following seven parties lodged resource consent applications to abstract Tranche 2 deep groundwater[1]:

- Te Awahohonu Forest Trust (TAFT)
- Springhill Dairies (formerly Ingleton Farms)
- Tuki Tuki Awa
- Plantation Road Dairies
- I & P Farming (formerly Abernethy Partnership)
- Papawai Partnership
- Buchanan Trust No. 2

Plantation Road Dairies also amended their original application in January-April 2020, to reduce the volume of water they had applied for from 6,081,499 m^3/year to 3,751,225 m^3/year. Consequently, additional water was made available to Papawai Partnership to increase the volume they originally applied for by 1,052,455 m^3/year, and to I & P Farming to increase their original volume by 722,888 m^3/year. Purunui Trust applied in April 2020 for the remaining water (544,931 m^3/year).

A fundamental element of Tranche 2 groundwater abstraction is the RRMP requirement to augment river flows to mitigate the impact of the Tranche 2 deep groundwater abstractions on surface water bodies. The augmentation water is also abstracted from deep groundwater, and it forms part of the Tranche 2 allocation. This means that each Tranche 2 applicant must specify the maximum volume of deep groundwater they propose to abstract for irrigation and the maximum they propose to abstract for augmentation purposes.

The augmentation concept included in PC6 was novel, not only for Hawke's Bay, but for New Zealand generally. It was not instigated by the Hawke's Bay Regional Council (HBRC) but was introduced by the Board of Inquiry into the Tukituki Catchment Proposal in their June 2014 decision. Not surprisingly, the augmentation concept was not approached consistently by all of the applicants.

Each Tranche 2 groundwater abstraction will have an effect on groundwater levels and river flows across a wide area. The effects of all eight applicants then combine to produce Ruataniwha Basin-wide effects. Consequently, at a meeting with HBRC officials in March 2018, it was agreed that the applicants would work together in a collaborative manner to assess (or reassess) the cumulative effects of their proposed Tranche 2 abstractions.

This report is based on the outcomes of the collaborative modelling and effects assessments. It supersedes and replaces the individual assessments of environmental effects (AEEs) that were originally lodged by each of the eight applicants. However, while this AEE replaces the original AEEs, the original applications for resource consent remain in place.

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[1] Two other parties also lodged applications. The first was HBRIC, the investment arm of the Hawke's Bay Regional Council. The second was J M Bostock Ltd. Both of those applications have been withdrawn.

Importantly, when the original Tranche 2 applications were lodged, it was unclear how the PC6 augmentation provisions should be interpreted and implemented. For example, it was unclear whether, or not, the effects of the deep groundwater augmentation abstractions on surface flows would themselves need to be mitigated by further augmentation, and so on. Some applicants (including TAFT, Springhill Dairies, Plantation Road Dairies and Buchanan No. 2 Trust) assumed that would be the case, while others did not.

Consequently, this report focuses on the total amount of water originally sought by each applicant, as it is understood that this cannot be increased in the absence of fresh consent applications.

Irrigation demand for each applicant has been calculated for the irrigable areas applied for using the Aqualinc in-house soil-water balance model, IrriCalc. From these calculations, the 90-percentile (or 9 in 10 years) irrigation demand (in mm/year) has been calculated, assuming that all existing and future irrigated land use is pasture, which typically has a larger seasonal water demand than other land uses. This demand is then multiplied by the irrigated area to calculate a maximum irrigation volume.

To provide greater flexibility for applicants to use Tranche 2 groundwater for the duration of the consents, the Applicants are seeking conditions that enable the volume of Tranche 2 groundwater to be used to irrigate crops and/or horticulture, or a mixture of pasture, crops and horticulture. While the volume of water used will be the same or less for any applicant irrigating solely pasture, the amount of land over which this water is applied may be greater than the area modelled in the Aqualinc report (in Appendix B to this report).

The proposed revised areas of the Applicants' properties to be irrigated are set out in the Revised Overall Tranche 2 Proposal in Table 1, in Section 6.2 of this report, and are set out in the proposed set of draft consent conditions in Appendix F to this report.

The applicants therefore seek final conditions that allow for flexibility of use of any Tranche 2 water taken. This will enable crop rotations (temporary) and permanent transitions to other land uses. It is not possible at this stage to specify exactly when, and where that landuse change will occur within the consented land areas. Any change in land use, to a less water demanding crop, will also allow a greater area of land to benefit from irrigation. This will increase the positive effects arising from the water take, while any effects will be addressed in the land use consent. The precise wording of these conditions will need to be further discussed with Council.

As an outcome of the modelling undertaken by Aqualinc, some adjustments to the rates of take of Tranche 2 groundwater for irrigation are also required to optimise the balance between irrigation and augmentation water use and mitigate effects on rivers during low-flow periods. For all but one applicant, the rates are proposed to be less than the rate originally applied for. For Tuki Tuki Awa, it is proposed that their original rate of take be increased (from 78 L/s daily average to 94 L/s daily average). This small increased take on one site is predicted to have negligible effects, as demonstrated in this AEE.

A consent duration of 20 years is sought for all of the applications. For consistency, and given the collaborative approach being applied, it is requested that a 20-year consent duration be applied to <u>each</u> of the eight applications.

This AEE is prepared in accordance with the requirements of Section 88 and the Fourth Schedule of the Resource Management Act 1991 (RMA), and it is intended to provide the information necessary to fully understand the proposal and any actual or potential effects that the proposed activity may have on the environment.

This AEE concludes that with the imposition of appropriate consent conditions, any actual and potential adverse environmental effects of the proposed groundwater takes will be negligible or no more than minor, with the exception of the security of supply of groundwater to 4 existing bores within the Ruataniwha Basin which may be adversely affected to a minor extent. To the extent that some form of notification of this application is considered appropriate, then any such notification should be limited to those affected bore owners/users.

The proposed activity is consistent with the purpose and principles of the RMA.

In terms of section 104(1)(b), on the basis of the above assessment, the proposal is generally consistent with, and is not contrary to, the relevant objectives and policies of the National Policy Statement for Freshwater 2020, and the Hawke's Bay Regional Resource Management Plan (including the Regional Policy Statement).

Rule TT4 of the RRMP, as notified (as part of PC6), did not include provision for Tranche 2 groundwater takes and Rule TT4 became operative on 1 October 2015. Three of the applications were lodged prior to 1 October 2015. Regardless of this, based on legal advice received as to the effect of s 88A, Resource Management Act 1991 in circumstances where a previous rule becomes inoperative after lodgment, we consider that all eight applications should be assessed as Discretionary Activities. However, in the event that Non-Complying Activity status is required for the three applications lodged earlier, we consider that there is no difficulty in those applications passing both of the 'gateway' tests under s104D(1)(a) and (b) of the RMA.

Given the above, consent can be granted to all of the applications pursuant to sections 104, 104B, and 107, and, if necessary, s 104D, of the RMA, subject to the imposition of conditions under section 108 of the RMA (as proposed in Appendix F of this report).

1 Introduction

1.1 Tranche 2 Deep Groundwater Allocation >

Plan Change 6 (PC6) to the Hawke's Bay Regional Resource Management Plan (RRMP) became operative on 1 October 2015. PC6 set groundwater allocation limits for the Ruataniwha Basin which is located within the upper Tukituki River catchment. Included within those limits was an allocation of groundwater that PC6 labelled "Tranche 2".

Policy POL TT8(ca) of the RRMP now states:

"To manage the taking of surface water and groundwater in the Tukituki River catchment by:

[...]

(ca) Enabling additional groundwater to be abstracted as a discretionary activity (Table 5.9.5 Tranche 2) provided that river flows are augmented to maintain the relevant minimum flows specified in Table 5.9.3 commensurate to the scale of effect of the Tranche 2 groundwater take."

Table 5.9.5 sets a Tranche 2 deep groundwater allocation of 15,000,000 m^3/year collectively for Zone 2 (Ruataniwha Basin north of the Waipawa River) and Zone 3 (Ruataniwha Basin south of the Waipawa River) of the Ruataniwha Plains.

Rule TT4(b) applies to the take and use of new groundwater takes (applied for after 4 May 2013) that are located within the Ruataniwha Basin Groundwater Allocation Zones 1 to 3. Such takes and uses are Discretionary Activities, subject to compliance with conditions, including a requirement that no new groundwater takes from Groundwater Allocation Zones 2 and 3 utilising Tranche 2 groundwater may be exercised under the rule unless, and until, augmentation flows are discharged that are commensurate to the scale of effect of the proposed takes.

1.2 The Tranche 2 Applicants

In response to the establishment of the Tranche 2 allocation, during the period 19 November 2014 to 1 May 2017 seven parties lodged resource consent applications to abstract Tranche 2 deep groundwater. Those parties are:

- Te Awahohonu Forest Trust (TAFT)
- Springhill Dairies (formerly Ingleton Farms)
- Tuki Tuki Awa
- Plantation Road Dairies
- I & P Farming (formerly Abernethy Partnership)
- Papawai Partnership
- Buchanan Trust No. 2

Plantation Road Dairies also amended their original application in January-April 2020, to reduce the volume of water they had applied for from 6,081,499 m^3/year to 3,751,225 m^3/year. Consequently, additional water was made available to Papawai Partnership to increase the volume they originally applied for by 1,052,455 m^3/year, and to I & P Farming to increase their original volume by 722,888 m^3/year. Purunui Trust applied in April 2020 for the remaining water (544,931 m^3/year).

Details of each applicant's proposal, in terms of their irrigable area, intended crop type and the amount of Tranche 2 water applied for, are provided in Section 3 below.

1.3 Collaborative Approach

A fundamental element of Tranche 2 groundwater abstraction is the RRMP requirement to augment river flows to mitigate the impact of the Tranche 2 deep groundwater abstractions on surface water bodies. The augmentation water is also abstracted from deep groundwater, and it forms part of the Tranche 2 allocation. This means that each Tranche 2 applicant must specify the maximum volume of deep groundwater they propose to abstract for irrigation and the maximum volume they propose to abstract for augmentation purposes.

The augmentation concept included in PC6 was novel, not only for Hawke's Bay, but for New Zealand generally. It was not instigated by the Hawke's Bay Regional Council (HBRC) but was introduced by the Board of Inquiry into the Tukituki Catchment Proposal in their June 2014 decision. Not surprisingly, the augmentation concept was not approached consistently by all of the applicants.

Each Tranche 2 groundwater abstraction will have an effect on groundwater levels and river flows across a wide area. The effects of all eight applicants then combine to produce Ruataniwha Basin-wide effects. Consequently, at a meeting with HBRC officials in March 2018, it was agreed that the applicants would work together in a collaborative manner to assess (or reassess) the cumulative effects of their proposed Tranche 2 abstractions.

Aqualinc Research Ltd was engaged by the collaborative group to model the effects of the Tranche 2 deep groundwater abstractions and develop an augmentation regime that achieved the outcome specified by RRMP Policy POL TT8. Bay Geological Ltd (BGSL) was engaged to assess the effects of the Tranche 2 abstractions on existing shallow bores, and on wetlands and surface water bodies; and Lattey Group completed an assessment on the potential for well interference. The Aqualinc report forms Appendix B to this Report, the BGSL reports form Appendix C and Appendix E to this report, and the Lattey Group report forms Appendix D.

This AEE is based on the outcomes of the collaborative modelling and effects assessments. It supersedes and replaces the individual assessments of environmental effects (AEEs) that were originally lodged by each of the eight applicants.

Importantly, when the original Tranche 2 applications were lodged, it was unclear how the PC6 augmentation provisions should be interpreted and implemented. For example, it was unclear whether, or not, the effects of the deep groundwater augmentation abstractions on surface flows would themselves need to be mitigated by further augmentation, and so on. Some applicants (including TAFT, Springhill Dairies, Plantation Road Dairies and Buchanan No. 2 Trust) assumed that would be the case, while others did not.

Consequently, this report focuses on the total amount of water originally sought by each applicant, as it is understood that this cannot be increased in the absence of fresh consent applications. As noted earlier, while this AEE replaces the original AEEs lodged, the original applications remain in place and those applications define the scope of the applications, with the exception of some proposed amendments, as outlined in this report.

Irrigation demand (assuming pasture) has been calculated for the irrigable areas originally applied for using Aqualinc's in-house soil-water balance model, IrriCalc. From these calculations, the 90 percentile (or 9 in 10 years) irrigation demand was calculated. Once the irrigation demand was calculated, the irrigation volume was deducted from each applicant's total volume applied for to yield a volume of water available for augmentation. Various scenarios were then modelled to assess the effects of each applicant's take (singularly and cumulatively with all other applicants) and the optimum scale and timing for the commencement and duration of the augmentation takes and discharges. As discussed below, the purpose of this analysis was to ensure that, as required by Policy TT8(ca) and Rule TT4(b), any augmentation regime proposed will be commensurate with the nature of the effects generated.

The assessment undertaken by Aqualinc assumes that all Tranche 2 water is used for irrigation, except for Tuki Tuki Awa. If only some of Tuki Tuki Awa's Tranche 2 water is used to fill in gaps when their Tranche 1 water is unavailable, then the overall effects will be less than assessed: less Tranche 2 water will be taken for irrigation and augmentation will remain the same.

1.4 Maintaining the PC6 Minimum Flows

PC6 was briefly discussed in Section 1.1 above. In addition to POL TT8(ca), PC6 also introduced Rule TT4(b) to the RRMP. That rule applies to groundwater takes located within Ruataniwha Basin Groundwater Allocation Zones 1 to 3 and contains three conditions, standards and terms:

a. *The take, in addition to all existing consented takes but excluding takes consented in association with in-stream dams, does not result in any exceedance of the allocation limits in Table 5.9.4, 5.9.5 or 5.9.6 (whichever is applicable); and*

b. *The take complies with the relevant minimum flow regime.*

c. *No new groundwater takes from Groundwater Allocation Zones 2 and 3 utilising Tranche 2 groundwater may be exercised under this rule unless and until augmentation flows are discharged that are commensurate to the scale of effect of the proposed take, during the same irrigation season as the Tranche 2 groundwater takes are exercised, to each of the Waipawa River and the Upper Tukituki River or one or more of their respective tributaries at a rate of up to 715 l/s to each river catchment at the highest practicable elevation as required to maintain the relevant downstream minimum flows specified in Table 5.9.3*

As mentioned above, the implication of clause (a) of Rule TT4 is that one of the Tranche 2 applicants, Purunui Trust, cannot be granted all of the water they applied for because doing so would breach the Table 5.9.5 Tranche 2 groundwater allocation of 15,000,000 m^3/year.

Along with POL TT8(ca), the requirements of clauses (b) and (c) of Rule TT4 have underpinned the modelling undertaken by Aqualinc and their optimisation of the augmentation regime. That is discussed in detail in Section 5 of this report. However, by way of overview, it is proposed that the Tranche 2 applicants commence augmentation discharges to their respective adjoining surface waterbodies before the river flows at the flow management sites listed in RRMP Table 5.9.3 reach their respective Minimum Flows – essentially setting higher surface water trigger flows for the commencement of Tranche 2 augmentation. The augmentation discharges will occur whenever those higher trigger flows are reached, and regardless of whether or not irrigation is operating (except for Tuki Tuki Awa who propose to take Tranche 2 groundwater only when their existing surface water take is restricted).

Importantly, the augmentation discharges over-compensate for the effects of the Tranche 2 deep groundwater abstractions on surface water on a catchment-wide basis. In other words, notwithstanding the effects of the Tranche 2 deep groundwater abstractions, the associated Tranche 2 augmentation discharges result in higher river flows (during low flow periods) at the Waipawa River at SH2 and Tukituki River at Tapairu Road Minimum Flow sites located on the eastern (lower) side of the Ruataniwha Basin than would be the case in the absence of the Tranche 2 deep groundwater abstractions. Further detail is set out in Section 5 below. The requirements of Policy TT8(ca) and Rule TT4(b) will therefore be met by the proposed take augmentation regime.

2 Plan Change 6

The following provides a background to PC6 and the decision of the Board of Inquiry (BOI) to establish the "Tranche 2" groundwater allocation, in addition to the "Tranche 1" fully allocation groundwater volume of approximately 28.5million m^3/year.[2]

In the decision of the BOI on PC6 (dated 18 June 2014) the BOI considered the sustainable volume of groundwater that could be abstracted from the Ruataniwha aquifer.

They referred to the evidence of groundwater modellers (Dr Baalousha and Mr Weir) and noted that neither of them suggested there was any physical difficulty with extracting more than 30 million m^3 from the aquifer (at a catchment-size scale). Rather, the limitation on abstraction arose from the surface flow effects of lowering groundwater levels (particularly the reduced flow of some spring flows and the effects of reduced stream flows on habitat). The BOI therefore considered it necessary to have regard to two particular effects: firstly, the effect of abstracting groundwater on surface water flows, and secondly, the effect of lowering groundwater levels.

Adopting a conservative approach, the BOI considered that extraction of 45million m^3/year from the Ruataniwha aquifer would reduce flows in the Waipawa and Upper Tukituki Rivers (combined) by 1430 L/s. Of that 780 L/s would be attributed to existing takes. The evidence presented at the hearing for PC6 suggested that such a deduction could have an adverse effect on in-stream habitat. The BOI therefore considered that unless there was some way of mitigating the effect on surface flows it would be very difficult to justify any increase in groundwater takes above the limit of 28.5million m^3/year, being the volume proposed by HBRC.

The BOI referred to the evidence of Mr McIndoe, who was confident that the groundwater system could easily sustain a 45million m^3/year take. Mr Weir reached a similar conclusion, that there would be a relatively small change in the groundwater level, with the greatest changes occurring near pumping wells and the changes would vary with depth. The BOI accepted that a small reduction in groundwater levels did not present a problem. However, they considered that any reduction in minimum flows resulting from the extraction of groundwater presented an adverse effect that would need to be overcome.

On the basis of the evidence presented to it, the BOI came to the following conclusions:

- If possible, it was desirable for the limit on extraction from the aquifer to be lifted to 43.5million m^3/year (plus 1.5million m^3/year for "permitted" uses), as this was a sustainable yield and it would support the economic wellbeing of the rural community;
- But that could only be achieved if adverse effects on surface flows were adequately avoided, remedied or mitigated;
- Any reduction in the minimum flows that were set by PC6 would need to be mitigated to the extent and for the period that the minimum flow regime would be compromised; and
- Deep groundwater within the Ruataniwha aquifer represented the only source from which the necessary mitigation could be achieved.

The BOI concluded that augmentation of low river flows from deep groundwater (or from any storage source that might become available) was a realistic possibility. If extraction were lifted to 43.5million m^3/year the

[2] "*Final Report and Decisions of the Board of Inquiry into the Tukituki Catchment Proposal*", Volume 1 of 3: Report and Decisions, dated 18 June 2014, paragraphs 559-585, pages 173-179.

expert evidence indicated that around 12-13,000ha could be irrigated which would represent an increase of 6-7,000ha beyond the current situation.

The BOI recognised that some groundwater users might be remote from access to rivers or streams requiring augmentation, but they did not believe that was an insurmountable hurdle. One way the BOI thought it might be overcome was by a group approach on the part of the irrigators. The BOI stated:

> *"[575] Obviously the issue of augmentation will require further consideration and it is possible that a further plan change will be required. We contemplate that this augmentation regime can be in place by 1 July 2018 when the new minimum flow/allocation regime will come into force (except for the earlier review of existing consents). At this stage it is only necessary for the Board to provide a framework within which the allocation limit for Zones 2 and 3 can be lifted to 43.5million m^3/year provided the necessary augmentation regime is in place. Details can be worked out later. The Board anticipates that allocation of this additional 15million m^3/year will be managed through the consent process."*

The BOI considered whether the augmentation regime should apply on a pro rata basis across all consents for the extraction of groundwater from the Ruataniwha aquifer, or whether it should only apply to consents for the additional 15million m^3/year. The BOI recognised that allocation of a further 15million m^3/year to new consent holders, or by way of increased abstraction for existing consent holders, would provide them with an additional and new allocation of the Ruataniwha resource for commercial purposes. As such, the BOI did not consider it unreasonable or unfair to require them to carry responsibility for mitigating the adverse effects on the environment arising directly and indirectly from this additional abstraction. The BOI therefore considered that they should be responsible for the 'whole' of the augmentation requirement.

Given the above, the BOI identified that it would be necessary for the allocation regime proposed under PC6 to be modified so that between 28.5million m^3/year and 43.5million m^3/year (Tranche 2) allocation would be possible if an augmentation regime was provided for. The allocation would be a Discretionary Activity (provided the augmentation requirement was in place).

This is as much direction as the BOI provided in its decision, so it is not very clear how the Tranche 2 allocation is intended to work in practice.

Given this uncertainty, a meeting was held with HBRC staff and the Applicant's Planners (Rob van Voorthuysen (van Voorthuysen Environmental Ltd) and Janeen Kydd-Smith (Sage Planning HB Limited)) and technical expert, Susan Rabbitte (Lattey Group), on 10 April 2018 at the HBRC offices in Napier. The purpose of the meeting was to reach agreement between those present on answers to questions relating to the implementation of the Regional Plan policies for taking Tranche 2 groundwater. This was intended to assist preparation of this AEE and consideration of the subject applications. Notes of that meeting are contained in Appendix A of this report. This AEE has been prepared on the basis of the approach agreed at this meeting.

3 Tranche 2 Applicants

The following sub-sections introduce the eight Applicants and detail each property, irrigation demands, and the proposed groundwater volumes applied for.

3.1 Te Awahohonu Forest Trust (TAFT)

Application Site: Gwavas Station - 5740 State Highway 50 and 97 Matheson Road, Tikokino (Figure 1).

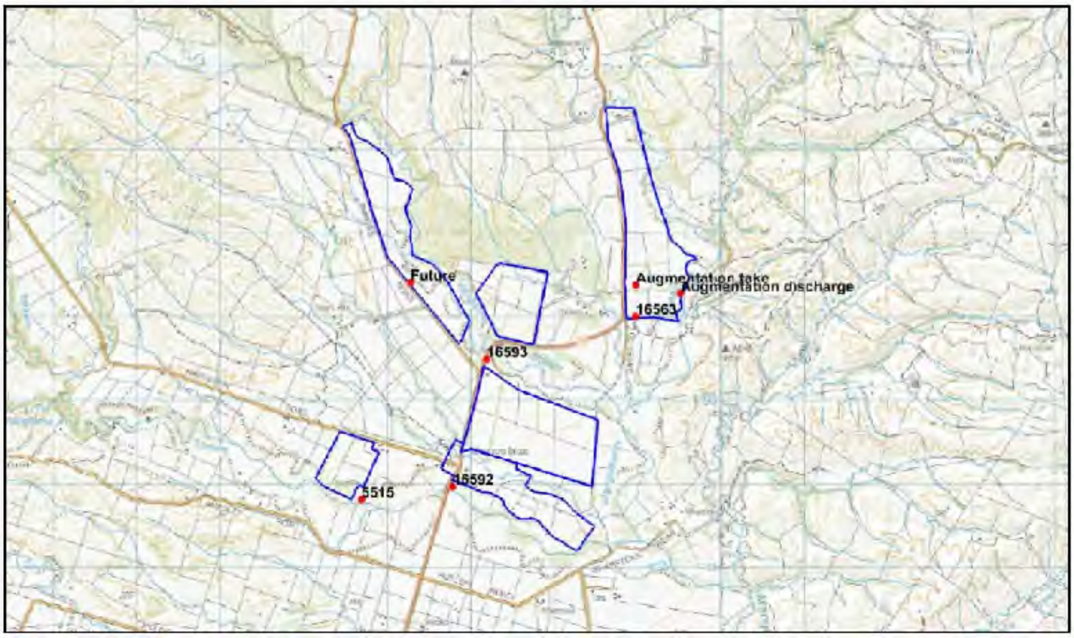

Figure 1: Locations of TAFT Groundwater Takes and Augmentation Discharge

TAFT applied in November 2014 for 4,914,920 m^3/year of Tranche 2 groundwater to irrigate 540 ha of pasture on the property located within the Mangaonuku Sub Catchment (T2[3]). It was proposed that 2,890,000 m^3/year of the Tranche 2 groundwater take be used for irrigation and the remaining 2,024,920m^3/year be used for augmentation.

TAFT does not hold any current groundwater resource consent for the property.

Groundwater for irrigation is proposed to be taken from five bores, comprising four existing bores (Well Nos. 16563, 16592, 16593 and 5515) and one future new deep bore. The bores are generally in the vicinity of the Mangamauku and Mangamate Streams. The combined rate of take of the Tranche 2 groundwater is proposed to not exceed 420 l/s and no one point of take is proposed to exceed a rate of 100 l/s.

Existing Well No. 16563 has a depth of 162.2 m below ground level (bgl) and is screened below 145 m depth, across blue gravel /blue clay layer. Well No. 16592 is an exploratory bore with a depth of 220.8 m bgl and is screened below 193.16 m across a coarse pink-grey ash and gravel layer. Well No. 16593 is also an exploratory bore with a depth of 222.3 m bgl and is screened below 138.30 m across a grey ash/pumice layer. Well No. 5515 has a depth of 66.0 m bgl and is screened below 54 m across a gravel layer.

The 90-percentile water demand for pasture is calculated to be approximately 580 mm/year (using 'IrriCalc'), which over an irrigated area of 490 ha equates to an annual volume of 2,841,220 m^3/year m^3/year.

[3] As identified on the map in Schedule XIVc Tukituki River Sub Catchments to the RRMP.

However, a larger area of 850 ha of less water-intensive crops and/or horticulture, or a mixture of pasture, crops and horticulture could be irrigated with 2,841,220 m^3/year m^3/year of Tranche 2 groundwater.

The augmentation volume will be abstracted from one or more new future deep bores and discharged directly to the Mangaonuku Stream at a rate of 189 l/s (daily average) (Figure 1).

A consent duration of 20 years was sought by TAFT.

3.2 Papawai Partnership

Application Site: 1041 State Highway 50, Ongaonga (Figure 2).

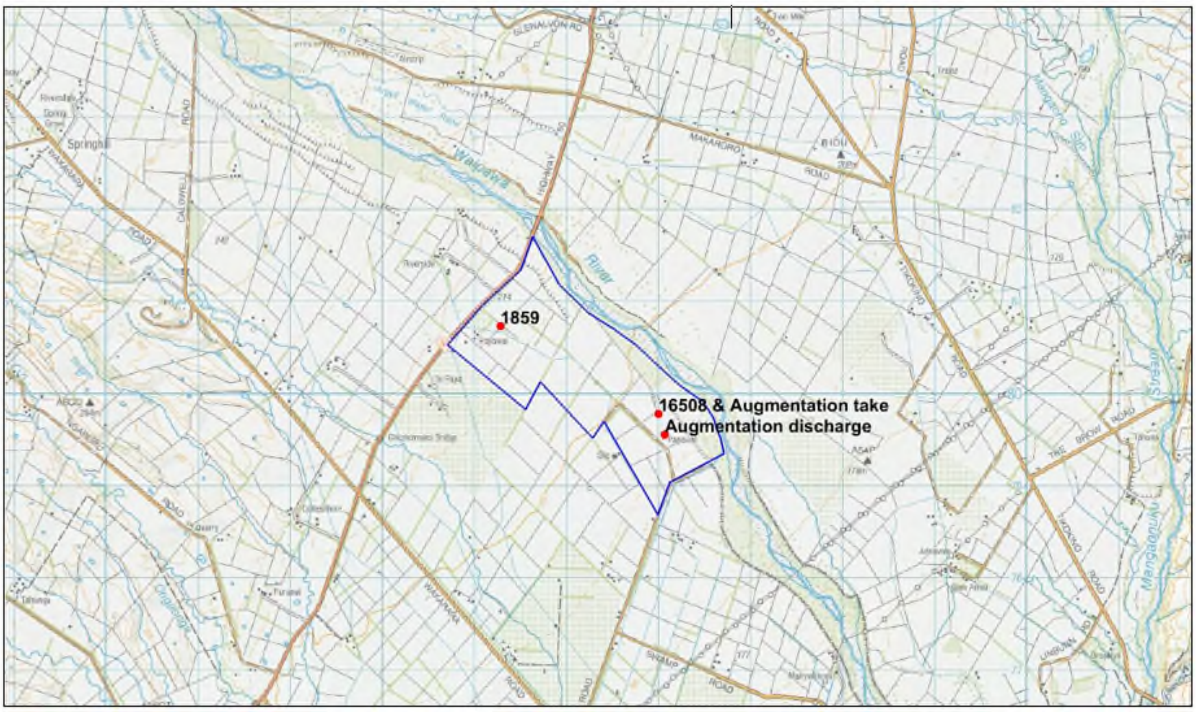

Figure 2: Locations of Papawai Partnership Groundwater Takes and Augmentation Discharge

Papawai holds current groundwater resource consent (WP 140555T) from Well Nos. 1859 and 16508 at a combined rate of 130 l/s. The consent grants a maximum volume of 608,212 m^3/year (1 July to 30 June in consecutive calendar years) and 120,960 m^3 in any 28-day period. The consented annual volume is not adequate to provide sufficient irrigation application rates.

Papawai Partnership have therefore made two applications for Tranche 2 groundwater. The original was submitted in March 2017, to take up to 423,062 m^3/year of groundwater, and a new application was submitted in August 2019 to take up to 1,052,455 m3/year of Tranche 2 groundwater. These combine to a total of 1,475,517 m^3/year and comprises 1,010,817 m^3/year for irrigation and 464,700 m^3/year for augmentation. The applicant seeks to increase production and more efficiently farm non-irrigated areas of the property located within the Waipawa Sub Catchment (T1[4]). The irrigation component of the proposed Tranche 2 take will supplement the existing consented take of 608,212 m^3/year to provide adequate irrigation of 181 ha of pasture, or a larger area of 320 ha of less water-intensive crops and/or horticulture, or a mixture of pasture, crops and horticulture.

[4] As identified on the map in Schedule XIVc Tukituki River Sub Catchments to the RRMP.

The requested Tranche 2 groundwater irrigation volume will be abstracted from Well Nos. 1859 and 16508 which are currently consented for 130 l/s; therefore, a portion of the effects of the Tranche 2 take will be regarded as part of the 'existing environment'.

The augmentation volume of 464,700 m^3/year will be abstracted from existing Well No. 16508 (or from other bore(s) on the property) and discharged into a shallow, disused well located approximately 300 m to the south (Figure 2). The discharge well is thought to be directly connected to the nearby Waipawa River; however, it will be tested prior to augmentation.

A consent duration of 20 years was sought by Papawai.

3.3 Tuki Tuki Awa

Application Site: 406 Tukituki Road, Takapau (Figure 3)

Tuki Tuki Awa has applied for Tranche 2 groundwater to provide security of water supply to more efficiently farm irrigated areas of the property within the Upper Tukituki Sub Catchment (T4) and the Tukipo Sub Catchment (T5)[5].

The Applicant owns and operates a dairy farm on Tukituki Road near Takapau, comprising approximately 136 ha of crops and pasture. The farm is currently irrigated using Surface Water Consent No. WP120320T which grants a volume of 174,180 m^3 in any 28-day period at a rate no greater than 78 l/s; and 560 m^3 in any 28-day period for dairy shed use. However, the consent is subject to low flow restrictions when the Tukituki River is at or below the relevant low flow level at specific monitoring sites.

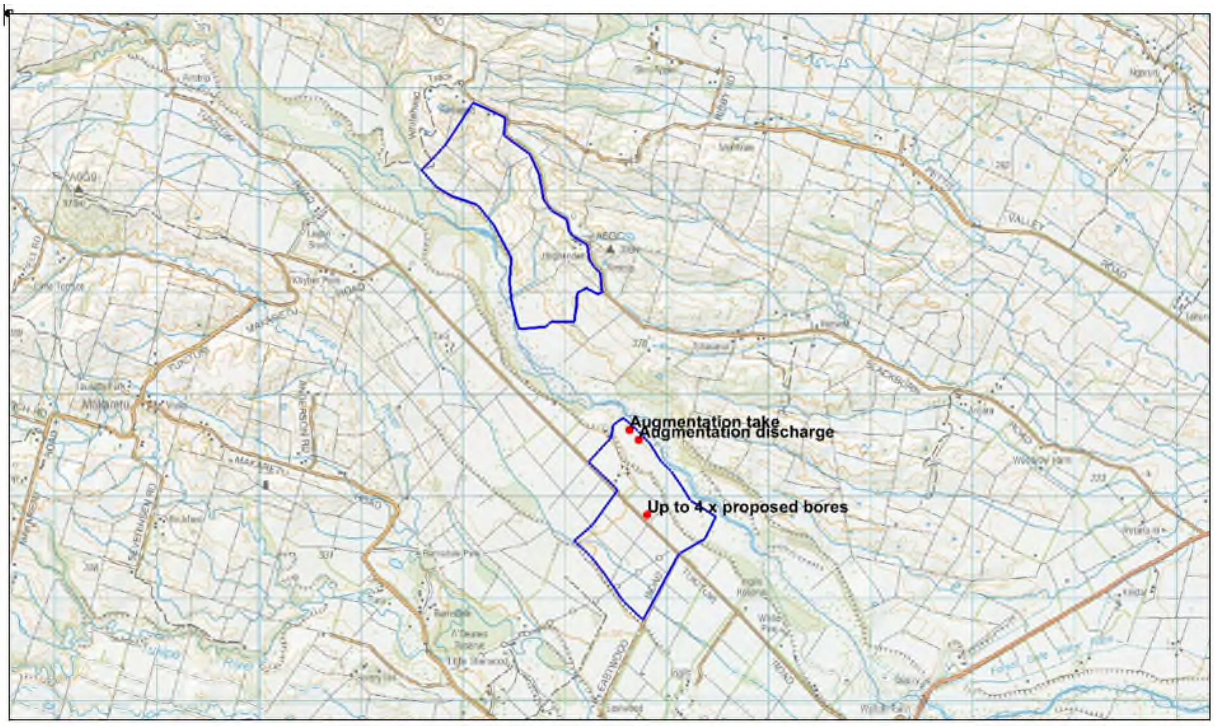

Figure 3: Locations of Tuki Tuki Awa Groundwater Takes and Augmentation Discharge

The Application for Tranche 2 water will not increase the volume of water applied to the property but will utilise the groundwater as a top-up during periods when the Tukituki River is on low-flow restrictions.

[5] As identified on the map in Schedule XIVc Tukituki River Sub Catchments to the RRMP.

The Applicant proposes the following:

i) To take groundwater from four proposed 300 mm diam. bores screened greater than 50 m below depth;
ii) To abstract up to 103 l/s of groundwater for irrigation of crops and pasture along with the required stream augmentation;
iii) The annual volume of groundwater taken between 1st July and the following 30th June shall not exceed 952,400 m^3; and
iv) A consent duration of 20 years is sought.

In February 2015, the Applicant lodged an application for groundwater made available through PC6 of 952,400 m^3/year comprising 882,800 m^3/year irrigation and 129,600 m^3/year augmentation.

To determine required irrigation across the property, IrriCalc was used to model water use on the Applicant's property for the period 1972 to 2014 and derived from the daily irrigation water use data the 90-percentile (1 in 10-year drought) annual volume. The irrigation seasonal depth was calculated as approximately 450 m^3/ha for the property which equates to an annual volume (assuming pasture) of 678,100 m^3/year. This is less than the volume of water sought by Tuki Tuki Awa for irrigation purposes (which was 822,800 m^3/year) but would be adequate to irrigate approximately 136 ha of pasture, or crops and/or horticulture, or a mixture of pasture, crops and horticulture.

The 90-percentile augmentation volume of 129,600 m^3/year is to be abstracted from one or more of the proposed four wells to be drilled on the property adjacent to the Tukituki River, into which the replenishment discharge would be pumped (Figure 3). During wet years, the farm is not likely to irrigate over the whole 150-day season, and therefore the full Tranche 2 allocation may not be utilised.

A review undertaken for the application revealed that there are no bores within 2 km of the Applicant’s property; and due to the proposed wells being screened greater than 50 m depth, the take will not be considered directly stream depleting.

The resource consent application sought a consent duration of 20 years.

3.4 Plantation Road Dairies (PRD)

Application Site: 1404 Ongaonga Road, and Wakarara Road, Ongaonga (Figure 4).

PRD originally applied to take 6,000,000 m^3/year of Tranche 2 groundwater. After their application was lodged, they changed their proposal and reduced the volume of groundwater sought to 3,751,225 m^3/year from deep bores on the property (Figure 4), located in the lower basin between the Waipawa and Tukituki Rivers within the Kahahakuri Sub Catchment (T3[6]).

The 90-percentile water demand for pasture is calculated to be approximately 600 mm/year (using ‘IrriCalc’), which over an irrigated area of 403 ha equates to a volume of approximately 2,418,225 m^3/year. This is less than the total volume of irrigation water initially sought by PRD for irrigation purposes (2,775,914 m^3/year). A larger area of up to 459 ha of less water-intensive crops and/or horticulture, or a mixture of pasture, crops and horticulture, may be irrigated from 2,418,225 m^3/year. The balance of the Tranche 2 groundwater taken will be used for augmentation (i.e., 1,333,000 m^3/year).

[6] As identified on the map in Schedule XIVc Tukituki River Sub Catchments to the RRMP.

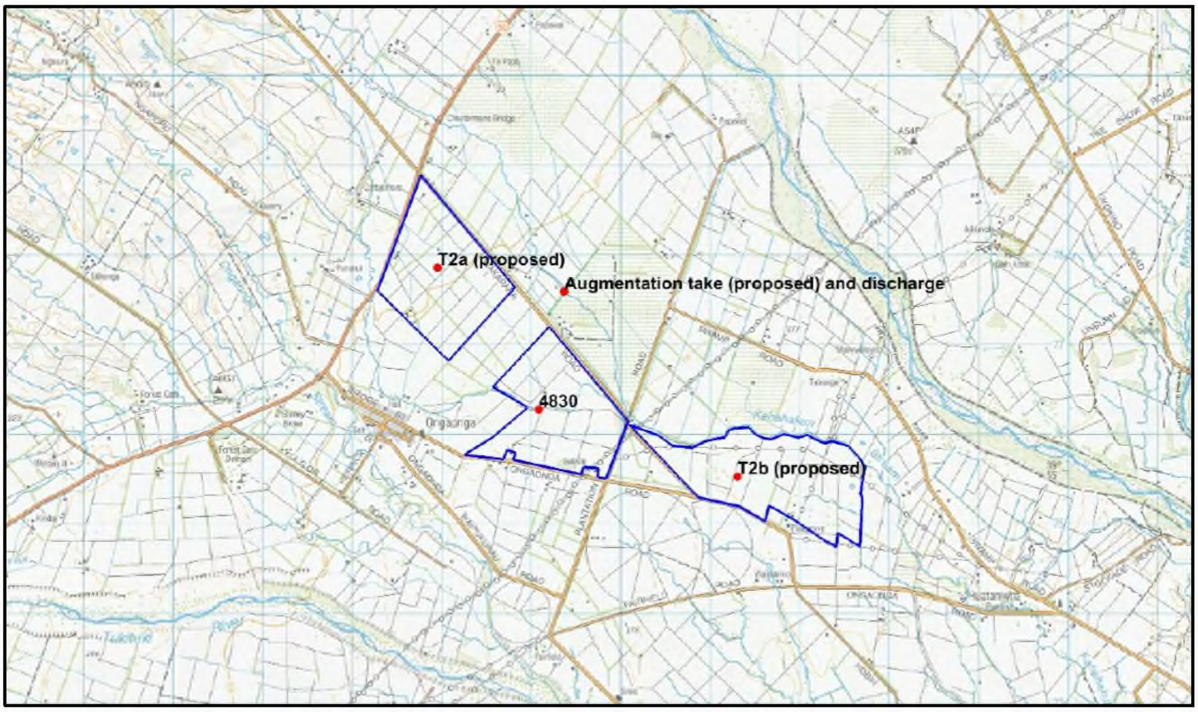

Figure 4: Locations of Plantation Road Dairies Groundwater Takes and Augmentation Discharge

It is proposed to take Tranche 2 groundwater for irrigation from an existing bore (Well No. 4830) which has a depth of 137 m bgl, and from two future deep bores (shown as T2a and T2b in Figure 4). Additional augmentation water will be taken from one or more new bores located on adjacent land also owned by PRD and will be discharged directly into the Kahahakuri Stream, immediately beside this location, at a rate of 103 l/s (daily average).

No specific consent duration was requested by the applicant in their resource consent application, but they seek a consent duration of 20 years to match the duration being sought by the other applicants.

3.5 Springhill Dairies (formerly Ingleton Farms)

Application Site: 665 State Highway 50 and 36 Butler Road, Tikokino (Figure 5).

Springhill Dairies applied in January 2014 to take up to 1,005,213 m^3/year of Tranche 2 groundwater from deep bores located around their property to supplement existing consented takes (with a combined volume of approximately 4,029,077 m^3/year) to provide adequate irrigation of 702 ha of pasture and crops located within the Mangaonuku Sub Catchment (T2) and partly within the Waipawa Sub Catchment (T1)[7].

The 90-percentile annual water demand for pasture (assumed) is calculated to be approximately 480 mm/year (using the web-based Aqualic/Irrigation New Zealand 'IrriCalc' water allocation calculator), which over an irrigated area of 702 ha equates to 3.4 million m^3/year. The irrigation demand can be met by utilising a combination of existing consented takes and a portion of the Tranche 2 volume applied for, while leaving a reasonable volume of Tranche 2 groundwater available for augmentation purposes. An irrigation volume of Tranche 2 groundwater of 588,313 m^3/year) would be adequate to irrigate approximately 123 ha of pasture, or a larger area of 188 ha of less water-intensive crops and/or horticulture, or a mixture of pasture, crops and horticulture. The balance of the Tranche 2 groundwater taken will be used for augmentation (i.e., 416,900 m^3/year).

[7] Ibid.

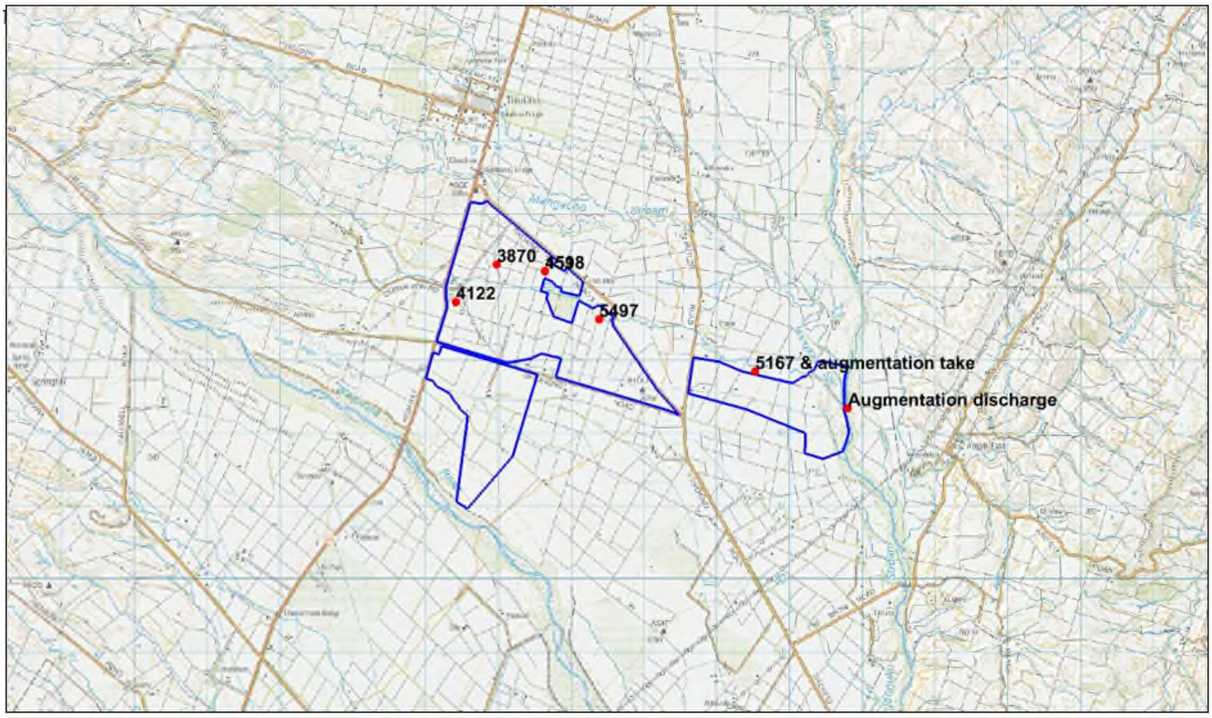

Figure 5: Locations of Springhill Dairies Groundwater Takes and Augmentation Discharge

It is proposed to take Tranche 2 groundwater for irrigation from up to five existing bores on the property (i.e. Well Nos. 5167, 4593, 1518, 3870 and 5497)[8]. Well No. 5167 will also be used for the augmentation groundwater take. The bores range in depth from 56.1 m bgl (Well No. 5497) to 124.6 m bgl (Well No. 5167). It is proposed to augment into the Mangaonuku Stream at a rate of 38 l/s (daily average). The location of the wells from which Tranche 2 groundwater will be taken, and the approximate locations of the augmentation take bore(s) and the discharge site, are shown in Figure 5.

The rates of Tranche 2 groundwater to be taken from the existing wells will not exceed (and will be less than) the Tranche 1 takes from the bores.

A consent duration of 20 years was sought by Springhill Dairies.

3.6 I & P Farming (formerly Abernethy Partnership)

Application Site: 337 Ongaonga-Waipukurau Road, Waipukurau (Figure 6).

I & P Farming Ltd (I&P) applied for Tranche 2 groundwater to increase production on their property located within the Kahahakuri Sub Catchment (T3)[9].

In March 2017, I & P lodged an initial application for Tranche 2 groundwater totalling 477,122 m^3/year. However, the volume applied for was not sufficient to irrigate the 166 ha of pasture and crops, and in August 2019 a second Application was lodged for 722,888 m^3/year with groundwater planned to be abstracted from a proposed new well (or wells). The volumes applied for total 1,200,010 m^3/year.

[8] Consented groundwater will also be taken from existing Well No 4122 and used in combination with the Tranche 2 groundwater for irrigation.
[9] As identified on the map in Schedule XIVc Tukituki River Sub Catchments to the RRMP.

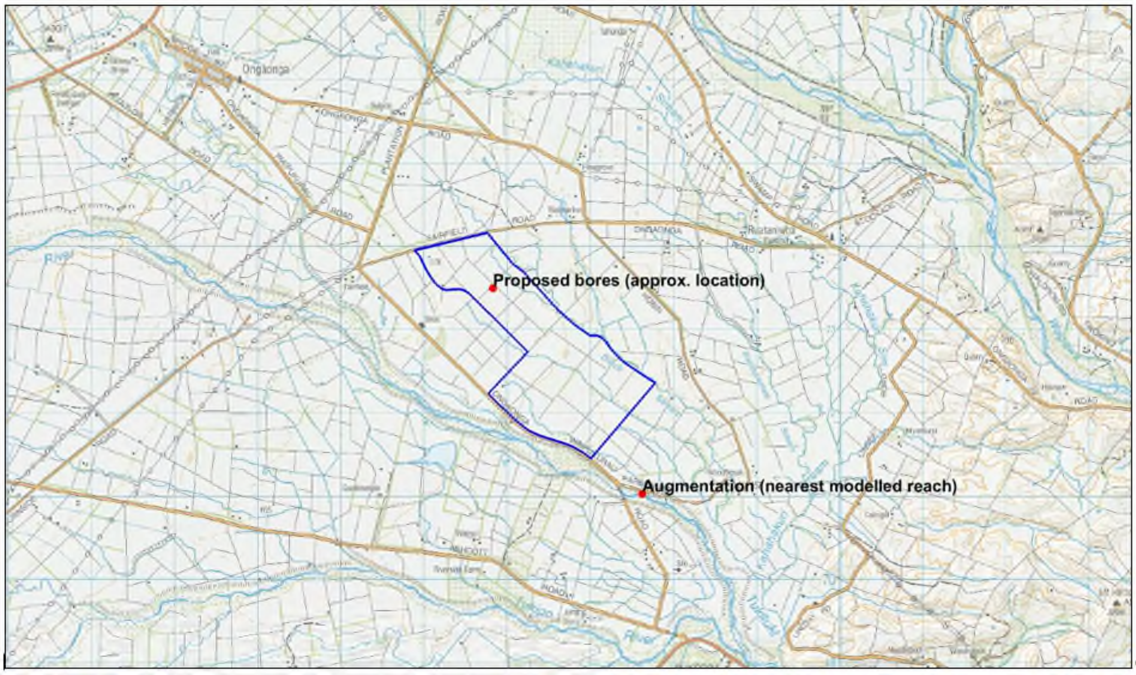

Figure 6: Locations of I & P Farming Groundwater Takes and Augmentation Discharge

There are currently no consented water takes on the property, and irrigation is required to increase crop production and pasture growth.

A proposed irrigation volume of 916,010 m^3/year (based on IrriCalc's 90% water use) equates to a flow rate of 83 l/s over a 150-day irrigation season and is based on irrigation of 166 ha of pasture (assumed). A larger area of up to 310 ha of less water-intensive crops and/or horticulture, or a mixture of pasture, crops and horticulture, may be irrigated from 916,010 m^3/year. The balance of the Tranche 2 groundwater taken will be used for augmentation (i.e., 284,000 m^3/year).

The rate of the augmentation portion of 284,000 m^3/year is 22 l/s (daily average) which will be discharged into an unnamed stream on their property that eventually flows into the lower reaches of the Tukituki River immediately south of the farm.

A consent duration of 20 years was requested by the applicant for the 2017 and 2019 resource consent applications.

3.7 Buchanan Trust No.2

Application Site: 19 Ngaruru Road, Ongaonga (Figure 7).

Buchanan Trust No.2 originally applied to take up to 1,631,018 m^3/year of Tranche 2 groundwater from an existing well (Well No. 16408, with a depth of 119.8 m bgl) and three proposed new deep bores (shown as proposed T2a, T2b and T2c in Figure 7) located around their property, within the Kahahakuri Sub Catchment, to irrigate 242.6 ha of pasture. At the time of their original application (April 2017), only 1,145,794 m^3/year was available from the total Tranche 2 allocatable volume, equating to approximately 70% of the water they had applied for. The Buchanan Trust subsequently advised Hawke's Bay Regional Council in November 2019, that the lesser volume available to them for both irrigation and augmentation was 1,145,794m^3/yr, which was less than they had applied for, but was now considered by them to be sufficient for their future needs[10].

[10] Email from Susan Rabbitte (Lattey Group Ltd) to Paul Barrett (HBRC Team Leader Consents), dated 5 November 2019.

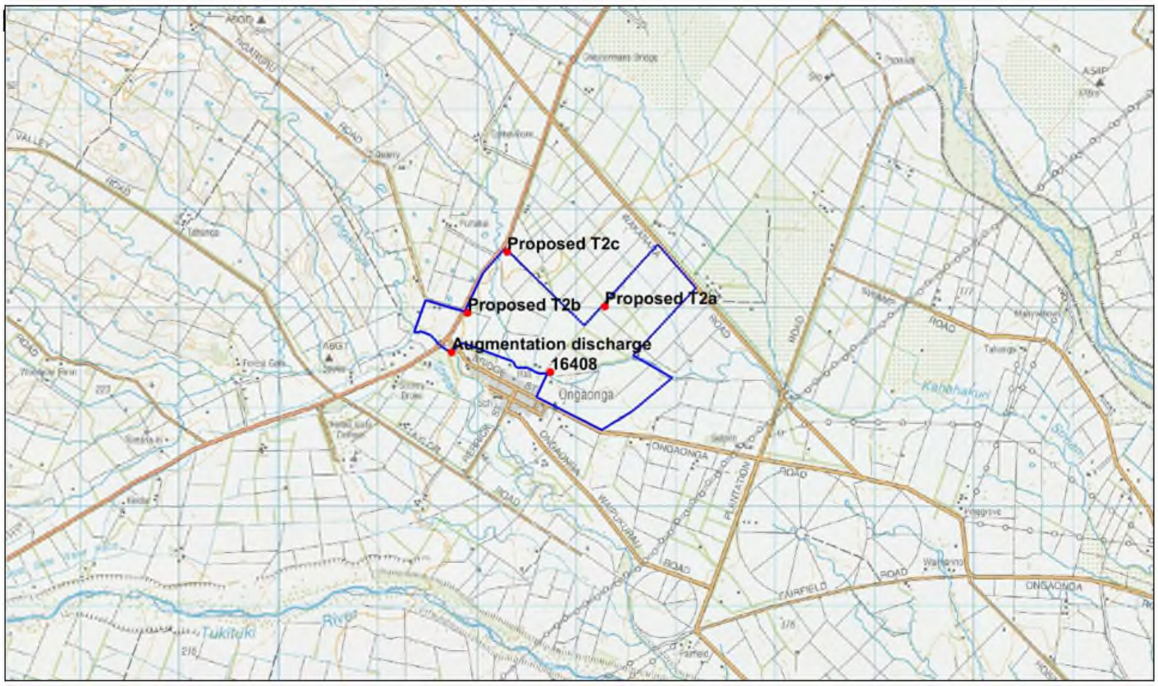

Figure 7: Locations of Buchanan Trust No.2 Groundwater Takes and Augmentation Discharge

It is proposed that 786,594 m^3/year of the Tranche 2 groundwater taken will be used for irrigation, and the balance (359,200 m^3/year) will be used for augmentation. Water for augmentation may be taken from one or more of the proposed bores on the site.

The 90-percentile annual water demand for pasture is calculated to be approximately 600 mm/year (using IrriCalc), which results in the 131 ha of pasture (assumed) being fully irrigable from the 786,594 m^3/year volume. However, a larger area of up to 230 ha of less water-intensive crops and/or horticulture, or a mixture of pasture, crops and horticulture could be irrigated from the 786,594 m^3/year volume. The balance of the Tranche 2 groundwater taken will be used for augmentation (i.e., 359,200 m^3/year).

The rate of the augmentation proposed is 51 l/s (daily average) which will be discharged into the nearby Ongaonga Stream, which converges with the Tukituki River approximately 4 km south of the property.

No specific consent duration was requested by Buchanan Trust in its resource consent application, but they seek a consent duration of 20 years to match the duration being sought by the other applicants.

3.8 Purunui Trust

Application Site: 385 and 375 Swamp Road, Ongaonga (Figure 8).

Purunui Trust applied to take up to 1,575,000 m^3/year of Tranche 2 groundwater in April 2020 to irrigate 175 ha of pasture/process crops on their property located within the Kahahakuri Sub Catchment (T3)[11].

[11] As identified on the map in Schedule XIVc Tukituki River Sub Catchments to the RRMP.

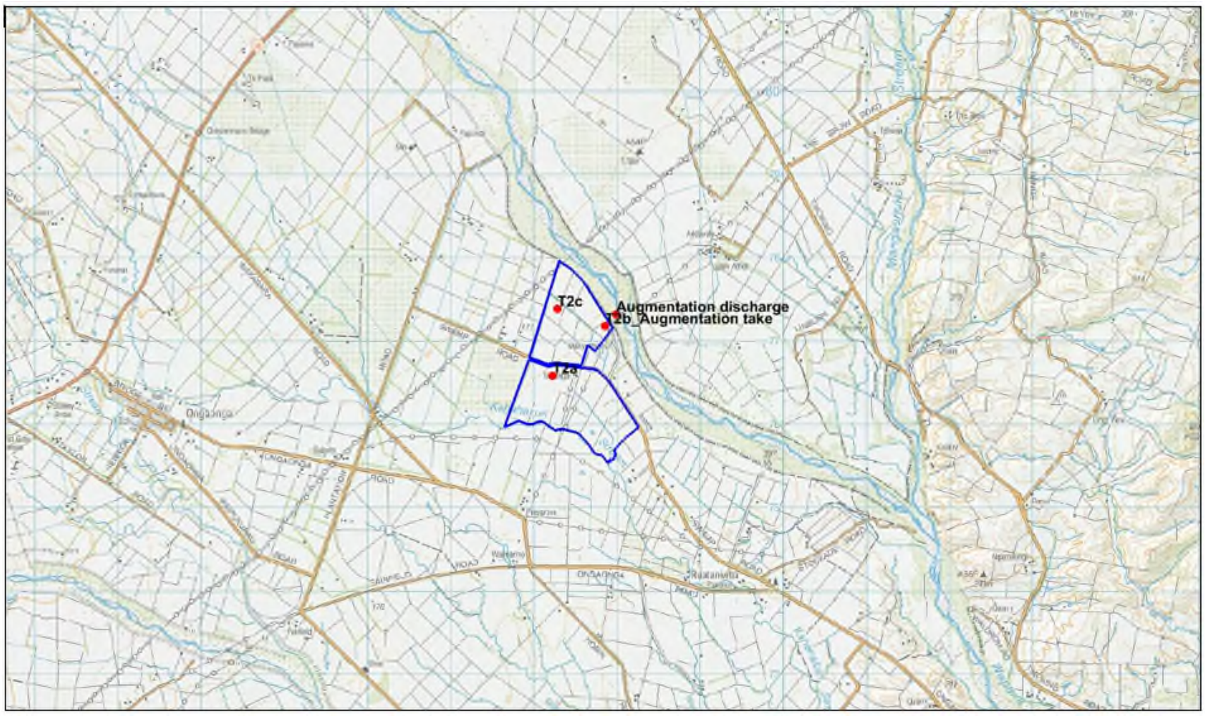

Figure 8: Locations of Purunui Groundwater Takes and Augmentation Discharge

It is proposed to take the Tranche 2 groundwater from three future new deep bores located around their property (shown as T2a, T2b and T2c in Figure 8) comprised of:

- 1,050,000 m^3/year (at a volume not exceeding 252,000 m^3 within any 28-day period) for irrigation, capped at meeting full water demand of up to a one-in-ten-year drought; and
- An additional 525,000 m^3/year (at a volume not exceeding 126,000 m^3 within any 28-day period) to provide river augmentation to mitigate the effects of the irrigation take during dry periods.

As Purunui Trust is last in the queue of Tranche 2 groundwater applications, the full volume applied for by the Trust is not available due to the 15 million m^3/year cap on the combined Tranche 2 takes (RRMP Table 5.9.5). Instead, a total volume of 554,921 m^3/year is available, which equates to approximately 35% of the water applied for. Assuming both the irrigation and augmentation volume is scaled equally, then the Tranche 2 volume remaining for Purunui Trust would be made up of 370,321 m^3/year for irrigation and a further 184,600 m^3/year for augmentation. This volume is adequate to irrigate approximately 62 ha of pasture (assumed), or a larger area of up to 93 ha of less water-intensive crops and/or horticulture, or a mixture of pasture, crops and horticulture.

The 90-percentile annual water demand for pasture is calculated to be approximately 600 mm/year (using IrriCalc), which over an area of 62 ha, equates to an annual volume of 370,321 m^3/year volume for irrigation. The balance of the Tranche 2 groundwater taken will be used for augmentation (i.e. 184,600 m^3/year).

The rate of the augmentation proposed is 14 l/s (daily average) which will be discharged into an existing, unused large diameter shallow well located near the Waipawa River. The discharge well is thought to be directly connected to the nearby Waipawa River; however, it will be tested prior to augmentation. The rates of Tranche 2 groundwater taken from the wells for irrigation will not exceed 14 l/s.

No specific consent duration was requested by Purunui Trust in its resource consent application.

4 Consent Categories

4.1 Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-F)

The NES-F came into force on 3 September 2020.

The NES-F includes standards for farming activities. This includes agricultural intensification, conversion of land on farms to dairy farm land, irrigation of dairy farm land, and arable and horticultural land uses. It also includes standards for vegetation clearance, earthworks or vegetation clearance and the taking, use, damming, diversion or discharge of water outside, but within, 100 m and 10 m (the distance applying depending on the relevant standards) of 'natural wetlands'[12].

Potential effects on wetlands and minor waterbodies associated with the subject Tranche 2 applications have been assessed by BGSL[13] (see report in Appendix C and Section 8.1.2 below). In undertaking this assessment, BGSL sought information from the Tranche 2 applicants about local wetlands, and guidance from the Hawke's Bay Regional Council, who provided information detailing wetland areas within southern and central Hawke's Bay (see the mapped wetlands in Figure 14 in Section 8.1.2 below) identified as part of the Council's State of the Environment (SOE) programme. The majority of the wetlands lie outside the study area and outside the influence of the proposed Tranche 2 groundwater takes and discharges. Only one of the SOE mapped wetlands (Mangatewai Wetland) is located within the study area, near the upper reaches of the Mangatewai River.

Two wetlands were inspected by BGSL off Swamp Road, Ongaonga, which are located centrally within the Ruataniwha Basin, south of the Waipawa River (Figures 9 and 10). A third wetland was inspected by BGSL near SH50, south of the Tukipo River (Figure 11).

Figure 9: Swamp Road wetlands, Ongaonga

[12] Defined in the National Policy Statement for Freshwater Management 2020 as: "*means a wetland (as defined in the Act) that is not (a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or (b) a geothermal wetland; or (c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling*."

[13] Letter from Bay Geological Services Ltd to Hawke's Bay Regional Council, dated 27 May 2021 (Reference BGS201-07)

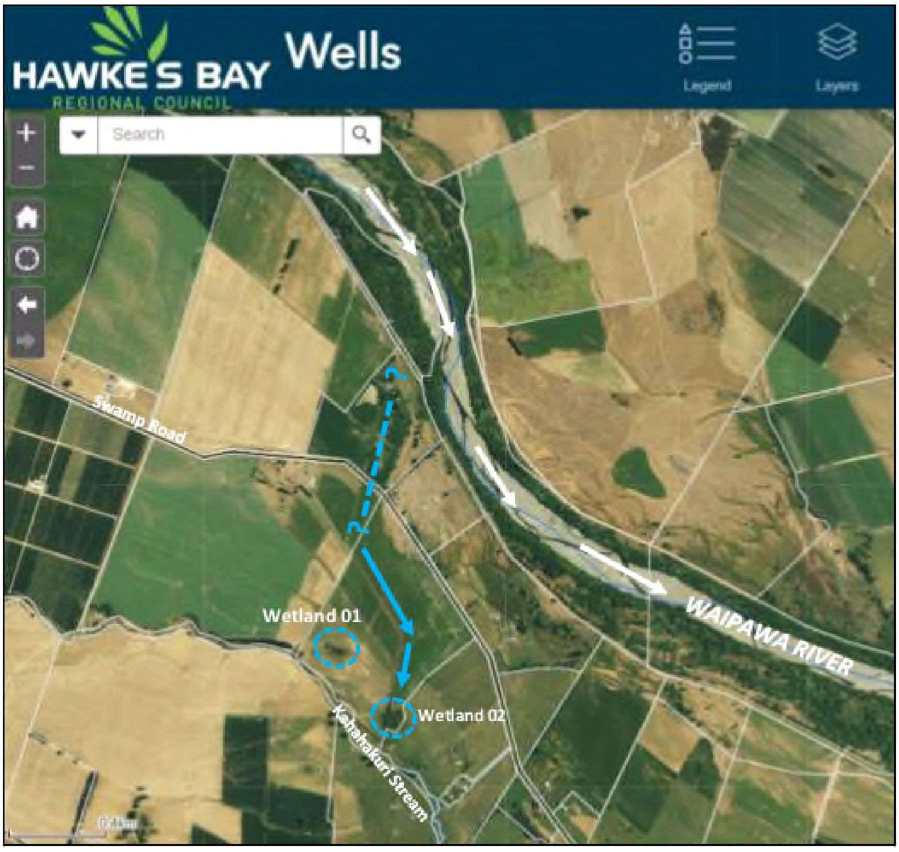

Figure 10: Swamp Road wetlands and surface water features

Figure 11: SH50 wetland (south of Tukipo River)

All wetlands were identified as 'natural' wetlands[14]. The BGSL assessment of effects on the wetlands (and minor streams) found that in the central and eastern areas, large wetlands were observed in the field which appeared to be fed by a possible subsurface divergent channel of the Waipawa River,

[14] Refer to Table 1 of the BGSL report (page 6).

upwelling in areas of lower elevation, where changes in lithology resulted in poor confinement. The assessment concluded that the estimated changes in surface water levels associated with the Tranche 2 proposals would have a 'negligible' effect on the three wetlands.

This AEE relates to an assessment of effects on the environment for the take of Tranche 2 groundwater and the discharge of a portion of that groundwater for augmentation. It does not include an assessment of effects relating to any applications for resource consents to Hawke's Bay Regional Council that may be needed by the subject applicants in the future (e.g. to drill wells, or install infrastructure for irrigation or augmentation, if within 100 m/10 m of a natural wetland).

Given the above, it is considered that no consents are currently required under the NES-F in relation to the subject applications.

4.2 Hawke's Bay Regional Resource Management Plan (RRMP)

4.2.1 Groundwater Takes

Policy POL TT8(ca) of the Hawke's Bay Regional Resource Management Plan (RRMP) is to enable additional groundwater to be abstracted as a Discretionary Activity (Table 5.9.5) provided that river flows are augmented to maintain the relevant minimum flows specified in Table 5.9.3 commensurate to the scale and effect of the Tranche 2 groundwater take.

Table 5.9.5 of the RRMP sets out the following groundwater allocation limits, including the Tranche 2 allocation limit of 15million m^3/year for Groundwater Allocation Zones 2 and 3 (Schedule XVII) collectively:

Table 5.9.5: Groundwater Allocation Limits

Groundwater Allocation Zones (Schedule XVII)	Allocation Limit (m^3/year)
Zone 1 – Otane Basin	4,134,000
Zone 2 – Ruataniwha Basin north of the Waipawa River	Tranche 1 7,224,000
Zone 3 – Ruataniwha Basin south of the Waipawa River	Tranche 1 21,277,000
Zones 2 and 3 collectively	Tranche 2 15,000,000
Rest of the catchment	No limit set[32]

The subject applications are located within Groundwater Allocation Zones 2 and 3, as identified in Figure 12 below.

Policy POL TT14(e) specifies that new takes within Table 5.9.5 complying with the minimum flow regime shall be a Discretionary Activity. Policy POL TT14(fa) specifies that, except as provided for in POL TT14(a) to (f), takes (including those that do not comply with the minimum flow regime) shall be Non-Complying Activities. POL TT14(fc) states that, for takes granted under POL TT14(e) to (fa) the consent duration shall be no more than 20 years.

Rule TT4 specifies that the take and use of groundwater comprising new groundwater takes located within Groundwater Allocations Zones 1 to 3 (applied for after 4 May 2013), excluding takes associated with a Community Irrigation Scheme involving an in-stream dam or any other in-stream dam, is a Discretionary Activity, subject to compliance with the following Conditions/Standards/Terms:

a. *The take, in addition to all existing consented takes but excluding takes consented in association with in-stream dams, does not result in any exceedance of the allocation limits in Table 5.9.4, 5.9.5 or 5.9.6 (whichever is applicable); and*

b. *The take complies with the relevant minimum flow regime.*

c. *No new groundwater takes from Groundwater Allocation Zones 2 and 3 utilising Tranche 2 groundwater may be exercised under this rule unless and until augmentation flows are discharged that are commensurate to the scale of effect of the proposed take, during the same irrigation season as the Tranche 2 groundwater takes are exercised, to each of the Waipawa River and the Upper Tukituki River or one or more of their respective tributaries at a rate of up to 715 l/s to each river catchment at the highest practicable elevation as required to maintain the relevant downstream minimum flows specified in Table 5.9.3*

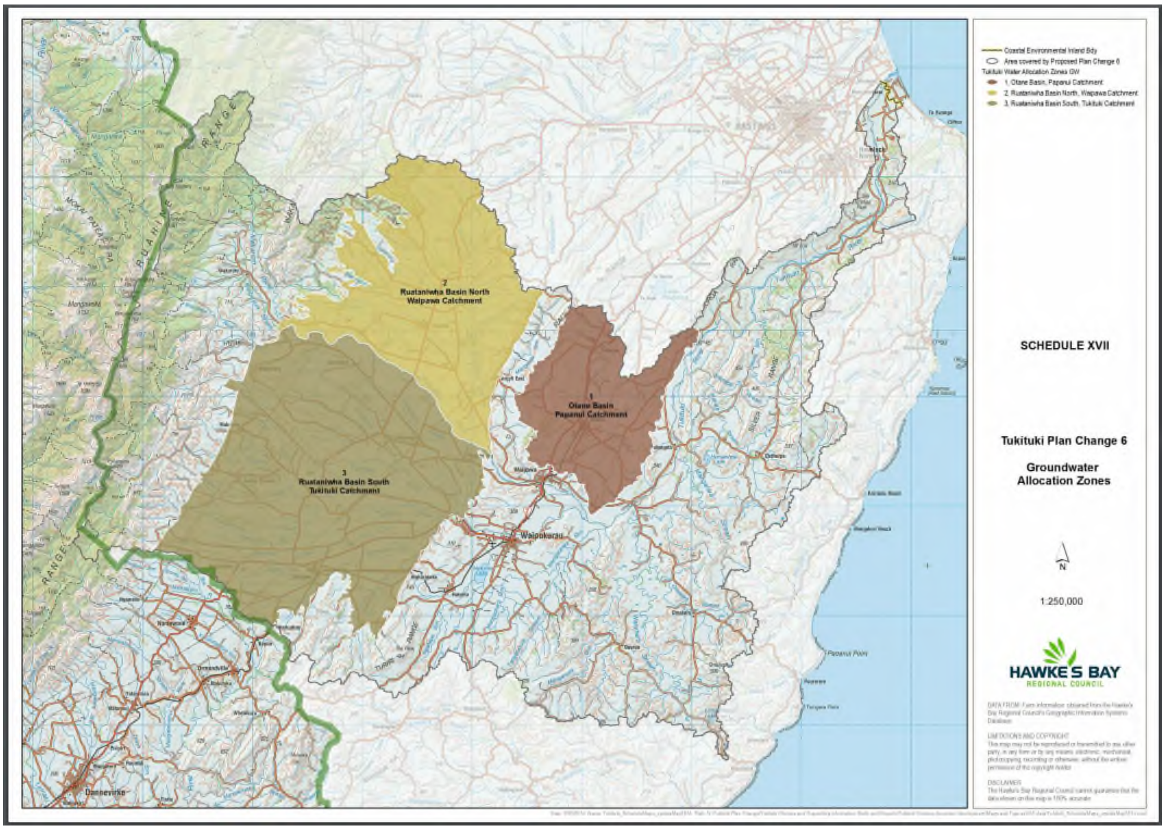

Figure 12: Tukituki Plan Change 6 Groundwater Allocation Zones

Rule TT4 as notified (as part of PC6) did not include provision for Tranche 2 groundwater takes. Rule TT4 (as referred to above) became operative on 1 October 2015. Three of the subject applications for Tranche 2 groundwater were lodged prior to 1 October 2015[15]. However, we consider it would be reasonable and appropriate to also assess them as Discretionary Activities, to be consistent with the status of the other five applications.

4.2.2 Augmentation Discharges

In accordance with Policy POL TT8(ca) of the RRMP, it is proposed to discharge a portion of the Tranche 2 groundwater taken for augmentation, as follows

- Te Awahohonu Forest Trust – discharge to the Mangaonuku Stream (as shown in Figure 7, page 15 of the Aqualinc modelling report);
- Papawai Partnership – discharge to an existing, disused, shallow groundwater bore located approximately 300 m south of Well No. 16508, and 600m west of Waipawa River (as shown in Figure 8, page 17 of the Aqualinc modelling report). It is thought the shallow bore is directly

[15] Te Awahohonu Forest Trust (lodged 19 November 2014), Springhill Dairies (lodged 26 January 2015, and Tuki Tuki Awa (lodged 17 February 2015).

connected to the nearby Waipawa River, and a detailed investigation of the bore will be undertaken prior to discharging augmentation water to verify the feasibility of this option.

- Tuki Tuki Awa – discharge to the Tukituki River (as shown in Figure 9, page 19 of the Aqualinc modelling report)
- Plantation Road Dairies – discharge to the Kahahakuri Stream (as shown in Figure 10, page 21 of the Aqualinc modelling report).
- Springhill Dairies – discharge to the Mangaonuku Stream (as shown in Figure 10, page 23 of the Aqualinc modelling report).
- I & P Farming – discharge to an unnamed tributary of the Tukituki River (as shown in Figure 12, page 25 of the Aqualinc modelling report).
- Buchanan Trust No. 2 – discharge to the Ongaonga Stream (as shown in Figure 13 of the Aqualinc modelling report, page 27).
- Purunui Trust – discharge to the Waipawa River (as shown in Figure 14, page 29 of the Aqualinc modelling report) via an existing unused large-diameter shallow bore located approximately 200-300 m from the river. Purunui Trust have advised that they believe this shallow bore is directly connected to the nearby Waipawa River, though this will be confirmed prior to commencing augmentation.

The locations of the proposed augmentation discharges are shown in Figure 13 below.

The discharge of water into water is a Permitted Activity under Rule 31 of the RRMP, subject to compliance with the following conditions/standards/terms:

a. *The discharge shall not cause or contribute to the flooding of any property, unless written approval is obtained from the affected property owner.*

b. *The discharge shall not cause any scouring or erosion of any land or any watercourse beyond the point of discharge.*

c. *The discharge shall not cause the natural temperature of any receiving water to be changed by more than 3^{O}C from normal seasonal water temperature fluctuations, after reasonable mixing.*

The proposed augmentation discharges will be at a rate and volume required to maintain minimum flows during drier periods (in accordance with Table 5.9.3 of the RRMP), therefore, they will not cause or contribute to the flooding of any property. Erosion protection (e.g. establishment of rip rap) will be provided at the point of discharge where necessary, to avoid scouring or erosion of any land or watercourse beyond the point of discharge. It is considered unlikely that the discharges would cause the natural temperature of the receiving water to change by more than 3^{o}C after reasonable mixing.

It is therefore considered that the augmentation discharges are a Permitted Activity under Rule 31 of the RRMP.

4.2.3 Discharge Structures

As set out above, most augmentation discharges will be to rivers, via pipes. A small structure (e.g. headwall and/or rip rap) may need to be constructed at the end of each pipe at the point of discharge, to fix the pipe to the land and ensure that the discharge from it is appropriately dispersed, to avoid erosion.

Rule 72 of the RRMP provides for the erection or placement of any structure in, on, under or over the bed of a river, not expressly regulated by other rules within the RRMP, and any associated disturbance of the river bed, any associated discharge of sediment and associated damming or diversion of water as a Permitted Activity, subject to compliance with conditions.

None of the structures will occupy an area of river bed greater than 10m^2, change the course of a river, be made of material toxic to aquatic ecosystems, prevent the passage of fish past the structure, cause or increase any risk of flooding or damage to properties during flood events (including trapping debris), require the diversion of water during construction for a period greater than 5 consecutive days (it is anticipated that no diversions will be required), cause any erosion or scouring, or interfere with fish spawning. It is therefore anticipated that all structures will comply with the conditions of Rule 72 and will therefore be a Permitted Activity.

The rivers associated with the augmentation discharges are located within the Hawke's Bay Regional Council's Upper Tukituki River Control and Drainage Scheme. This scheme protects the River plains from frequent flooding of the Upper Tukituki River and its tributaries, the Waipawa, Makaretu, Mangaonuku and Tukipo Rivers. Rule 71 of the RRMP specifies that the erection of any structure in, on or under the bed of a river, or within 6 metres of the bed, undertaken by persons other than the local authority or persons acting on behalf, within a land drainage or flood control scheme area, is a Discretionary Activity.

4.3 Summary

On the basis of the above assessment of the applications against the relevant regulations and rules, resource consents are required as follows:

- Discretionary Activity resource consents under Rule TT4 and Rule 71.

As noted above, three of the subject applications for Tranche 2 groundwater were lodged prior to 1 October 2015[16]. However, we consider it would be reasonable and appropriate to also assess them as Discretionary Activities, to be consistent with the status of the other five applications.

[16] Te Awahohonu Forest Trust (lodged 19 November 2014), Springhill Dairies (lodged 26 January 2015, and Tuki Tuki Awa (lodged 17 February 2015).

5 Approach Taken

The Tranche 2 groundwater applicants propose to abstract groundwater and mitigate the consequential stream depletion effects via further abstraction to directly augment river flows during drier periods (when takes from the rivers are restricted). The concept of augmentation is based on using groundwater stored in the aquifer system during wetter periods to mitigate stream depletion effects during drier periods. The augmentation takes will also result in additional stream depletion effects, but this too will be delayed and spread over space and time through the storage response of the aquifer system. While there is on average more water abstracted from the basin's aquifer system (compared to current), the rationale is founded on the principle of using the groundwater system to smooth, buffer and delay stream depletion effects using groundwater storage that is later replenished naturally.

5.1 Irrigable Area and Crop Water Demand

Irrigation demand for each applicant has been calculated for the irrigable areas applied for using Aqualinc's in-house soil-water balance model, IrriCalc. Importantly, we understand that IrriCalc is endorsed by HBRC (it is specified in Policy 47 of the recently notified TANK Plan Change to the RRMP). From these calculations, the 90-percentile (or 9 in 10 years) irrigation demand (in mm/year) has been calculated, assuming that all existing and future irrigated land use is pasture, which typically has a larger seasonal water demand than other land uses. This demand is then multiplied by the irrigated area to calculate a maximum irrigation volume.

Policy 32 of the RRMP is to allocate groundwater for irrigation purposes on the basis of actual crop water requirements up to a maximum equal to that required during a one in ten-year drought. The maximum volumes of Tranche 2 groundwater proposed to be taken and used for irrigation have been calculated for each Applicant by Aqualinc on the basis of the water being used to irrigate pasture. If land uses other than pasture are irrigated (e.g. cropping and/horticulture, or a mixture of pasture, horticulture and cropping), then the seasonal water use and associated recharge will be less for the same irrigated area, or a larger area could be irrigated for the same seasonal volume. In these cases, the Aqualinc report has assessed that the modelled effects on river flows will be either less or similar (respectively) than the assessment of the modelled effects for pasture only[17].

During wet periods, the properties will not irrigate throughout the whole season, and therefore the full Tranche 2 allocation may not be utilised.

To provide greater flexibility for applicants to use Tranche 2 groundwater for the duration of the consents, it is requested that the Applicants be able to utilise the maximum volume of Tranche 2 groundwater calculated to irrigate a larger area of their properties for crops and/or horticulture, or for a mixture of pasture, crops and horticulture, than the area modelled to irrigate pasture in the Aqualinc report.

The proposed revised areas of the Applicants' properties to be irrigated are set out in the Revised Overall Tranche 2 Proposal in Table 1, in Section 6.2 of this report.

5.2 Augmentation Take and Discharge Locations

Each applicant's augmentation discharge location is shown on Figure 13 below. Additional detail is provided in Sections 3.3 to 3.10 of the Aqualinc report.

[17] Refer to Section 3.2, page 13, of the Aqualinc report.

It is possible that some applicants may take water for augmentation from one or more bores on their property. If the same volume of water was abstracted for a different number of bores than assumed in the Aqualinc report, it would make very little difference to the catchment-scale effects of the takes assessed by the modelling.

It is also recognised that some applicants may in the future seek additional consents from the Council, as may be necessary, to utilise alternative sources of water for augmentation, such as from the construction of water storage dams on their properties. Objective OBJ TT5 of the RRMP is (subject to Objectives TT1, TT2 and TT4) to enable the development of on-farm storage and Community Irrigation Schemes that improve and maximise the efficient allocation and efficient use of water. Therefore, there is support within the RRMP for such alternatives.

5.3 Consent Durations

As set out in Sections 3.1-3.8 of this report, all but three applications requested a consent duration of 20 years. No consent duration was specified in the applications from Plantation Road Dairies, Buchanan Trust and Purunui Trust.

Policy TT14(fc) specifies that, for takes granted under Policy TT14(e) to (fa), including new takes within the Table 5.9.5 Allocation Limits complying with the minimum flow regime, the consent duration shall be no more than 20 years.

For consistency, and given the collaborative approach being applied, it is requested that a 20-year consent duration be applied to each of the eight applications.

5.4 Protocols for the Takes and Augmentation

To aid practical management, operation and compliance of the Tranche 2 takes, several protocols for the takes and augmentation are proposed which relate to:

- Staged development and transitional implementation
- Automated monitoring of river flows
- Defining a 'Water Year' and associated start date of irrigation and augmentation.

5.4.1 Staged Development and Transitional Implementation

Some of the applicants have existing bores from which they will be able to irrigate as soon as consents are granted. Other applicants have partial development of bores, and the remainder currently have no infrastructure and will wait for consents to be granted prior to commencing any significant investment in infrastructure for Tranche 2 water. Therefore, the full uptake of Tranche 2 water will not be instantaneous upon granting of consents, but will be transitional, progressively developing ('ramping up') over several years.

To practically manage the effects of takes throughout this transition period, each consent holder will nominate (to HBRC) a maximum seasonal volume of Tranche 2 water they expect to need that season, proportional to the scale of their property development. This volume will become the maximum allocation volume for that season only and the augmentation discharge rate will be pro-rated on this same basis. This volume will then be reassessed in subsequent years. For example, a property with a 1-in-10-year maximum seasonal volume of 1 million m^3/year proposes to augment the adjacent river at 20 L/s when low-flow triggers are reached. If by the first irrigation season the property is 40% developed, then the maximum irrigation volume for that year would be 400,000 m^3 (i.e., 40% of 1M m^3) and the augmentation rate would be 8 L/s (i.e., 40% of 20L/s). If by the following year development expanded to 60%, then the maximum irrigation volume for that year would be 600,000 m^3 and the augmentation rate would be 12 L/s. The nomination of the maximum seasonal volume of Tranche 2 water would continue on this basis, up to 100% development.

This transitional implementation proposed is based on the principle that, while the effects of pumping propagate over a relatively large distance, the effects are largely seen in the vicinity of the abstraction location. Consequently, effects and subsequent augmentation to mitigate these effects (during low flows) are proportional to the scale of the take.

If a Tranche 2 consent holder is unsure of the level of development expected for an upcoming season, they will not want to under predict their water needs. Hence, they would be more likely to nominate a higher percentage than a lower one. The nominated percentage of development then dictates (and locks in) the rate of augmentation for that year, regardless of whether the irrigation volume is used or not. It is therefore more likely that the augmentation rate will be over-compensated in these transitional years, which will provide benefits to the rivers greater than modelled.

5.4.2 Automated Monitoring of River Flows

It is proposed that the Applicants' Tranche 2 augmentation discharges will be controlled daily based only on the existing three monitoring sites currently automatically monitored by HBRC (i.e., Waipawa at SH2, Tukituki at Tapairu Road, and Tukipo at SH50). If automatic flow recorders are installed in the future at the other two low-flow trigger sites modelled (i.e., Tukipo at Ashcott Road, and Mangaonuku u/s Waipawa), then these can be added to the daily control regime.

The Aqualinc modelling report[18] notes that this triggering regime (ie only 3 flow recorders) is expected to make little difference in the very dry years when augmentation is needed the most (all rivers experience low flows). There may be some 'unders and overs' in the wetter years where the three continuously monitored sites do not fully represent the other two sites. In these cases, the augmentation may not be triggered when these smaller streams are below the low flow trigger. However, it is expected that the targeted over-compensation at other times will provide a buffer that will partially mitigate effects on these streams at these times.

5.4.3 'Water Year' Definition and Associated Start Dates of Irrigation and Augmentation

The Tranche 2 applicants will have two volumetric limits: an irrigation volume; and an augmentation volume, both defined by a 9-in10 year season. If the water year was to commence on 1 July (as is currently defined by HBRC), it is possible that augmentation to rivers may be needed through winter at the start of the water year, when there is no irrigation pumping. While it is acknowledged that the effects of irrigation continue after pumping stops (as it takes time for the aquifer system to recover), there is a small possibility that augmentation water will be used in the cooler, wetter winter months (if minimum flows are triggered) resulting in insufficient water later in the warmer, drier parts of the season when augmentation is needed most (i.e., late summer/autumn).

For the purposes of the subject applications, it is therefore proposed that the water year be defined as commencing at the start of the irrigation season, nominally 1 October. Then, given that effects from the deep pumping take time to propagate to the surface, it is proposed that the augmentation year starts 1 month after this (i.e., 1 November). The Aqualinc modelling report notes that this is expected to have the following consequences[19]:

[18] Section 3.12.2, page 47.
[19] Section 3.12.3, pages 47-58.

- Augmentation water is 'saved' for the driest times of the year when it is needed most, usually well beyond the start of the irrigation season.
- Delaying the start of augmentation will mean that, in most years, the augmentation volume will not be fully used before winter. This unused water can then be discharged throughout winter when low flows are triggered.
- Continuing to augment during winter results in the equivalent of full-year augmentation for most years (9 in 10) but provides the added assurance that there will be augmentation water available in the driest parts of the driest seasons when it is needed most (rather than potentially running out just before it is needed).
- There may be the occasional time when low flows are reached during winter, but the augmentation volume is fully used, and augmentation cannot continue. Based on historical records, this would occur infrequently (1 year in 10).

6 Groundwater Modelling

In 2013, Aqualinc developed a three-dimensional numerical flow model of the Ruataniwha basin as part of the PC6 hearing. The model was updated and has been used to test the hydraulic response of the groundwater and surface water system in the basin from the subject proposed Tranche 2 groundwater take applications. This work has been completed in a collaborative manner with HBRC and the eight applicants.

Since the original model documented in Weir (2013[20]), the model has been updated and recalibrated, with a particular focus on matching low (dry-period) river flows to align with HBRC's water management strategies. Good matches were achieved between measured and modelled outputs. The model simulates the period 1972-2012, which incorporates a wide range of climatic variability from very wet to very dry years. Details of the model updates and the scenarios are provided in the Aqualinc report to Hawke's Bay Regional Council in Appendix B.

The updated numerical model has been used to quantify the stream depletion effects of the proposed Tranche 2 takes and the subsequent surface water augmentation requirements. This is not an exact science as there are several variables that need to be assumed or approximated. However, the modelling work has provided a realistic quantification of the magnitude, location and timing of effect.

To reduce the influence of measurement and model uncertainty, the most appropriate application of model results is to consider changes in key outputs (river flows and groundwater levels) rather than absolute values. In this regard, the model tests the effectiveness of the proposed augmentation to mitigate the changes in river low-flows that would be induced by the Tranche 2 takes.

The numerical model domain encompasses the Ruataniwha basin and does not extend to HBRC's flow monitoring site on the Tukituki River at Red Bridge, down catchment. Therefore, the flow monitoring sites on the Waipawa at SH2 and Tukituki at Tapairu Road have been considered to represent this site. So long as the combined 7-day MALF at the SH2 and Tapairu sites are maintained (or improved), then there will be no adverse downstream effects on low flows at Red Bridge as a result of the proposed Tranche 2 takes.

[20] *Statement of Evidence of Julian James Weir for Ruataniwha Water Users Group (Groundwater Modelling)*. Expert evidence presented before the Board of Inquiry for the proposed Tukituki Catchment Plan Change 6. 7 October 2013.

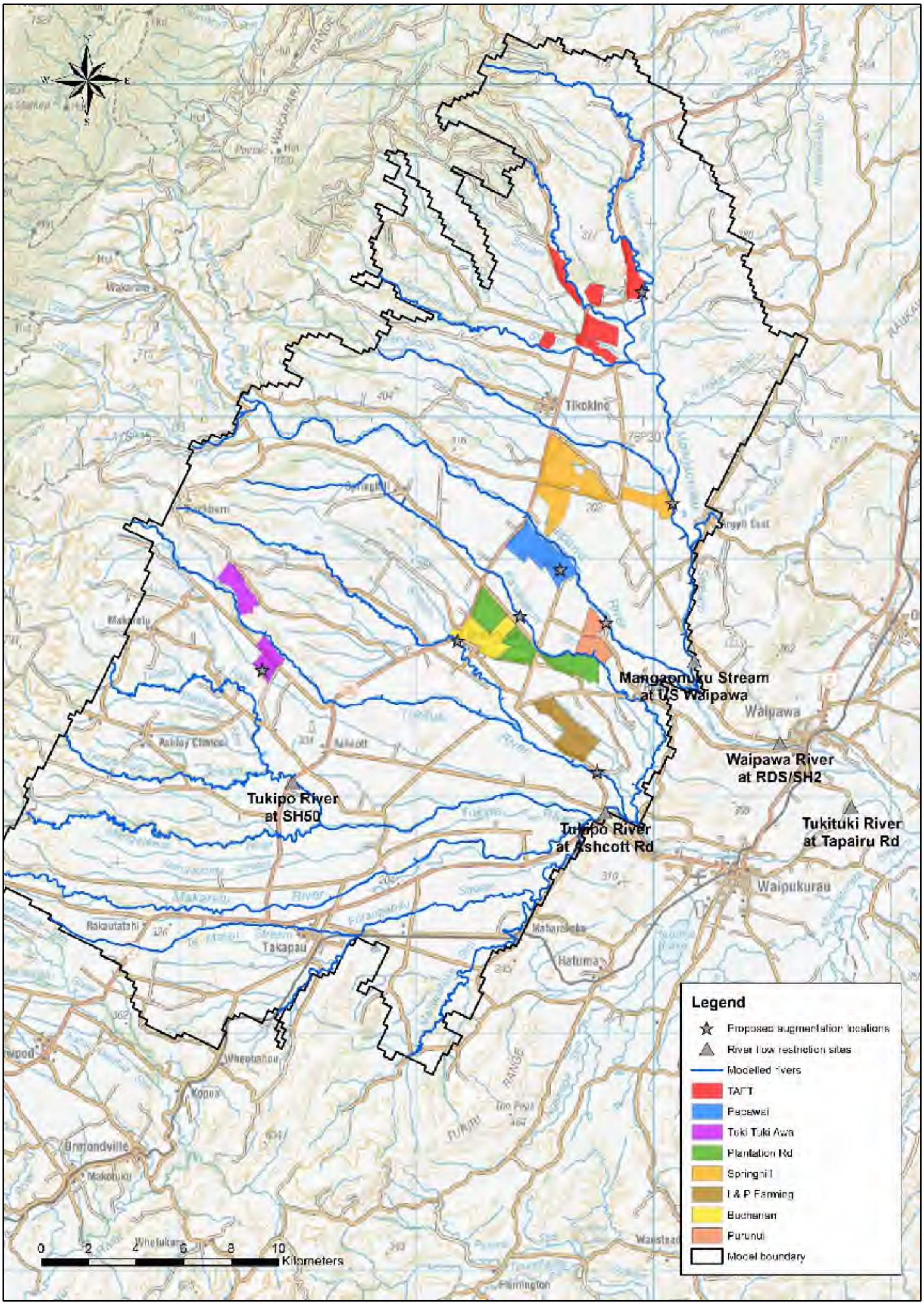

Figure 13: Location of Applicants' Properties and Augmentation Discharge Sites

6.1 Scenarios Modelled

Several scenarios of abstraction and augmentation were modelled by Aqualinc, as follows:

- Baseline Scenario (Status Quo): This includes all existing takes, but no proposed Tranche 2 takes, and represents the current irrigated area of approx. 6,000 ha within the Ruataniwha Basin (comprising 4,025 ha from groundwater and 1,975 ha from surface water), assuming the irrigated land use is pasture.
- Scenarios 1-8: One model run for each of the eight proposed Tranche 2 applicants. These model runs are all founded on the Baseline scenario, but with each applicant's proposed full irrigation needs at their proposed location. The results of these scenarios (compared to the Baseline) were then used to determine the timing of the augmentation requirements (for mitigating stream depletion effects of the irrigation take alone) that would feed into subsequent augmentation scenarios.
- Augmentation Scenarios: Initially, a combined model scenario including all applicants' takes and with each applicants' augmentation operating. Then additional scenarios that balance environmental flows and irrigated areas, as follows:
    - *Augmentation Scenario 1:* This scenario includes the combined applicants' proposed irrigation and augmentation takes and assumes that augmentation occurs only when RRMP Table 5.9.3 minimum flows are reached and when irrigation is occurring.
    - *Augmentation Scenario 2:* This scenario assumes that augmentation occurs whenever RRMP Table 5.9.3 minimum flows are reached throughout the year, regardless of whether irrigation is occurring or not. This scenario aims to better mitigate the temporal effects of the takes during low-flow periods through more frequent augmentation. This in turn results in a greater volume of Tranche 2 water taken for augmentation, and in some cases means individual applicants are forecasted to take more than their applied volume. Therefore, some irrigated areas (and therefore irrigation volumes) have been reduced to counter this.
    - *Augmentation Scenario 3:* Under this augmentation scenario, an alternative augmentation time series has been trialed whereby low flow restrictions (and therefore augmentation) are assumed to occur sooner (at higher flow rates) than those listed in RRMP Table 5.9.3 minimum flows. These raised low-flow trigger values have been applied to the augmentation takes regardless of whether or not irrigation is occurring on the day (as was the case for augmentation Scenario 2; augmentation is assumed to occur even if the applicant is not irrigating). This scenario aims to better maintain existing users' reliability by triggering augmentation at higher river flows. In turn, this (again) results in a greater volume of Tranche 2 water taken for augmentation, which pushes some applicants total take beyond their applied volumes. So, some irrigated areas (and therefore irrigation volumes) have been further reduced to counter this.
    - *Augmentation Scenario 4:* Based on the results of Augmentation Scenario 3, some river flow sites were not fully mitigated at low flows and other sites were over compensated. Therefore, this Scenario iteratively arrives at an 'optimised' solution balancing irrigation takes with augmentation discharges.

6.2 Revised Overall Tranche 2 Proposal

The balancing of irrigation demand, augmentation takes and augmentation locations to achieve the environmental flow targets (under optimised Augmentation Scenario 4) has resulted in the following seasonal allocations for each applicant (adapted from Table 28 of the Aqualinc modelling report).

Table 1: Seasonal Allocations -irrigation area and Tranche 2 groundwater volumes

Applicant	Modelled augmentation rate (l/s, daily average)	Area irrigated from Tranche 2 groundwater (ha)	Modelled 90 percentile annual volumes (m^3/year) (1972-2012)			Tranche 2 GW volume to be taken (m^3/year)
			For irrigation	For augmentation (% of total)	Total	
TAFT	189	850	2,841,220	2,073,700 (42%)	4,914,920	4,914,920
Papawai	24	320	1,010,817	464,700 (31%)	1,475,517	1,475,517
Tuki Tuki Awa	10	136	678,100	29,100 (4%)	707,700	952,400
Plantation Rd Dairies	103	459	2,418,225	1,333,000 (36%)	3,751,225	3,751,225
Springhill Dairies	38	188	588,313	416,900 (41%)	1,005,213	1,005,213
I & P Farming	22	310	916,010	284,000 (24%)	1,200,010	1,200,010
Buchanan	51	230	786,594	359,200 (31%)	1,145,794	1,145,794
Purunui	14	93	370,321	184,600 (33%)	554,921	554,921
		Total	**9,609,600**	**5,145,700 (35%)**	**14,785,300**	**15,000,000**

As evident in the above table, the modelled total abstraction does not equate to 15 million m^3/year. This is a result of the amended proposal by Tuki Tuki Awa to only use Tranche 2 groundwater when their surface water take is restricted. However, this does not mean that the balance (244,700 m^3/year) is available for allocation to other applicants, because in some extreme years the full allocation sought by Tuki Tuki Awa may be used.

The values in Table 1 have been derived from the following:

- Irrigated areas and augmentation discharge rates a little smaller than applied for by some applicants;
- Adopting higher river low-flow restrictions (than those set out in Table 5.9.6 of the RRMP) to provide improved environmental low flows and to protect existing users' reliability;
- Full augmentation whenever these higher river flow restrictions are triggered, regardless of whether or not Tranche 2 irrigation is occurring; and
- Full augmentation occurring from all Tranche 2 applicants when any one of the flow monitoring sites within the basin is triggered. This acknowledges that all Tranche 2 applicants are operating collaboratively and effects from any one take can propagate across several streams.

This results in the following (modelled) changes in flows at the various river low monitoring sites for the given proposed low-flow triggers (reproduced from the Executive Summary of the Aqualinc modelling report) in Table 2:

Table 2: Modelled Changes in 7-day MALF (over the period 1972-2012) at the various river low monitoring sites for the given proposed low-flow triggers

Site				
Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
RRMP Table 5.9.6 minimum flow (l/s)				
2,500	2,300	150	1,043	1,170
Assumed low-flow restriction applied (l/s) (1)				
2,725	2,360	155	1,085	1,295
Change in mean 7-day annual low flow (MALF) (l/s)				
+3	+135	-1	+1	+2
Change in mean 7-day MALF as a percentage of low-flow limit				
+0.1%	+5.7%	-0.6%	+0.1%	+0.2%
(1) These are higher than current RRMP Table 5.9.3 limits to provide greater environmental benefit during low flows and to protect reliability of existing users.				

The small residual negative change to 7-day MALF flow in the Tukipo River is smaller than both model uncertainty and measurement precision.

As set out in Section 5.4 of this report, several management, operational and compliance protocols are proposed to aid practical implementation of the Tranche 2 takes and augmentation.

The following key findings are noted from the modelled scenarios:

- The effects on river flows from the proposed additional Tranche 2 takes are spread over both space and time throughout the basin.
- If augmentation occurs when both existing minimum flows are reached and when irrigation would be operating, it is insufficient to mitigate depletion of 7-day MALF flows due to additional Tranche 2 takes.
- If augmentation is applied when minimum flows are reached, regardless of whether or not irrigation is operating, augmentation is more beneficial and results in an overall improvement in low flows exiting the basin in both the Tukituki and Waipawa rivers. The exception to this is Tuki Tuki Awa who propose to take Tranche 2 groundwater and augment to the Tukituki River only when their existing surface water take is restricted. This also does not adversely affect low river flows.
- For the Tranche 2 applicants, the adoption of higher minimum flow triggers (and therefore more frequent augmentation) provides greater benefit to 7-day MALF. It also better protects the reliability for existing abstraction consent holders.
- Targeted over-compensation (i.e., the positive changes in MALF) accommodates modelling prediction uncertainty (qualitatively), enhances environmental low-flows, and accommodates across-catchment effects.
- Under augmentation Scenario 4, adverse effects on surface water low flows as a result of Tranche 2 takes are either avoided (positive effects occur as evidenced by the increased flows at the Waipawa and Tukituki low flow sites), or are so minor that they fall within the margin of modelling and measurement uncertainty (i.e., for the Tukipo SH50 low flow site).

- Groundwater will not be mined. While groundwater levels will lower further with the additional Tranche 2 takes (made available under Plan Change 6), they will not continue to lower - they will simply reach a new (lower) dynamic equilibrium. Shallow groundwater levels are predicted to lower a maximum of 0.8 m in the vicinity of the Tranche 2 take locations, and less than 0.3 m further afield.
- The reported irrigation and augmentation volumes are based on a 90-percentile year. Therefore, it is possible that in extreme dry years (e.g., 1 year in 10), low flows could still be triggered after irrigation and augmentation volumes have been exhausted.

7 Statutory Matters

Section 104(1) of the Resource Management Act 1991 ("RMA") specifies the matters that the consent authorities (in this case HBRC and HDC) must have regard to when considering the applications for resource consents, as follows:

> *"104 Consideration of applications*
> *(1) When considering an application for a resource consent and any submissions received, the consent authority must, subject to Part 2, have regard to–*
> *(a) any actual and potential effects on the environment of allowing the activity; and*
> *(b) any relevant provisions of—*
> *(i) a national environmental standard:*
> *(ii) other regulations:*
> *(iii) a national policy statement:*
> *(iv) a New Zealand coastal policy statement:*
> *(v) a regional policy statement or proposed regional policy statement:*
> *(vi) a plan or proposed plan; and*
> *(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application."*

The matters that are to be considered by the consent authorities under section 104 of the RMA include, subject to Part 2, any actual and potential effects on the environment and any relevant objectives, policies, rules or other provisions of a Plan or Proposed Plan.

In determining applications for Discretionary and Non-Complying Activities, section 104B of the RMA states that:

> *"104B Determination of applications for discretionary or non-complying activities*
> *After considering an application for a resource consent for a discretionary activity or non-complying activity, a consent authority—*
> *(a) may grant or refuse the application; and*
> *(b) if it grants the application, may impose conditions under section 108."*

Under s104D(1) of the RMA, a consent authority may only make a decision to grant resource consent to a Non-Complying Activity if it is satisfied that either:

> *"(a) the adverse effects of the activity on the environment (other than any effect to which section 104(3)(a)(ii) applies) will be minor; or*
> *(b) the application is for an activity that will not be contrary to the objectives and policies of—*
> *(i) the relevant plan, if there is a plan but no proposed plan in respect of the activity; or*
> *(ii) the relevant proposed plan, if there is a proposed plan but no relevant plan in respect of the activity; or*
> *(iii) both the relevant plan and the relevant proposed plan, if there is both a plan and a proposed plan in respect of the activity."*

An assessment of the actual and potential effects of the proposed activities on the environment is provided in Section 8, and an assessment of the proposal against the relevant objectives and policies of the relevant statutory planning documents is provided in Section 9.

8 Assessment of Environmental Effects

8.1 Surface Water Flow Effects

8.1.1 Low Flow Monitoring Sites

The proposed Tranche 2 groundwater abstractions being applied for will be taken from selected locations on each of the eight properties across the Ruataniwha Basin as displayed in Figure 13. However, groundwater modelling has determined that regardless of the point of take, effects of the proposed abstractions will impact surface water to varying degrees across the whole basin.

The Aqualinc 2021 modelling shows that proposed augmentation of rivers and streams when low-flow restrictions are imposed benefits the Tukituki and Waipawa Rivers exiting the basin, regardless of whether irrigation is occurring or not. The proposed Tuki Tuki Awa Tranche 2 take and augmentation, however, will only be activated when the farm's existing surface water take is restricted due to low flow bans in the Tukituki River. Modelling has shown that this does not adversely affect low flows.

However, if augmentation is only activated upon commencement of irrigation, the effects are such that the proposed groundwater contribution to waterways is not sufficient to offset depletion of the 7-day MALF.

In order to provide additional benefit to the waterways and mitigate prediction uncertainty and across-catchment effects, a proposed higher low-flow restriction scenario is included in the Tranche 2 Application modelling. This will result in more frequent augmentation and greater benefit to the 7-day MALF.

Table 2 outlines the existing low flow restrictions (l/s) as set out in the RRMP (Table 5.9.6) and the proposed low-flow scenario, along with the changes in mean 7-day MALF.

The Aqualinc modelling shows that proposing a higher minimum flow trigger results in positive effects at the Waipawa and Tukituki monitoring sites where increased flows are initiated. Although a small negative effect is predicted at the Tukipo (SH50) low flow site, it is so minor that it is below measurement precision and modelling uncertainty.

Generally, adverse effects on surface water as a result of the Tranche 2 groundwater abstractions are either avoided or considered minor based on a 90-percentile year; however, low flow restrictions could still be triggered during extreme dry years even after irrigation volumes have been fully utilised and augmentation discharged to surface water. As HBRC allocate water on a 9-in-10 year basis, mitigation of the very extreme years is beyond the control of the Applicants.

8.1.2 Small Streams and Wetlands

Potential effects on wetlands and minor waterbodies have been assessed by BGSL[21] (see report in Appendix C) using the Aqualinc 2021 assessment which predicted effects on shallow groundwater and applying the estimated changes to sites inspected in the field.

There are multiple small-scale streams and drains in the catchment. To determine which sites could be considered significant and warrant further assessment, the Tranche 2 Applicants provided information to BGSL regarding their local creeks, wetlands and streams. These included reaches that typically dry

[21] Letter from Bay Geological Services Ltd to Hawke's Bay Regional Council, titled "*Ruataniwha Basin Tranche 2 Application Response to PDP's Preliminary Review of the Aqualinc Model Items 9 and 10 Only*", dated 27 May 2021 (Reference BGS201-07)

up naturally in summer months, and therefore present little instream value, to those that flow or are wet year-round. Local knowledge of the Ruataniwha Plains was also used to inspect sites of interest, such as areas of recorded upwellings and spring flows.

Not every reach or wetland was inspected, as this was outside reasonable scope for the required outcome. However, sites were selected in strategic parts of the basin, these being representative of effects in other reaches across the study area.

Guidance was also sought from Hawke's Bay Regional Council (HBRC) who provided information detailing wetland areas within southern and central Hawke's Bay. HBRC provided shapefiles of the wetland State of the Environment (SOE) programme data, which was used by Aqualinc to generate a map to show the location of the wetlands.

The majority of the identified significant wetlands lie outside the study area and outside the influence of the proposed Tranche 2 groundwater takes. Only one significant wetland (near the upper reaches of the Mangatewai River) is identified within the study area (Figure 14).

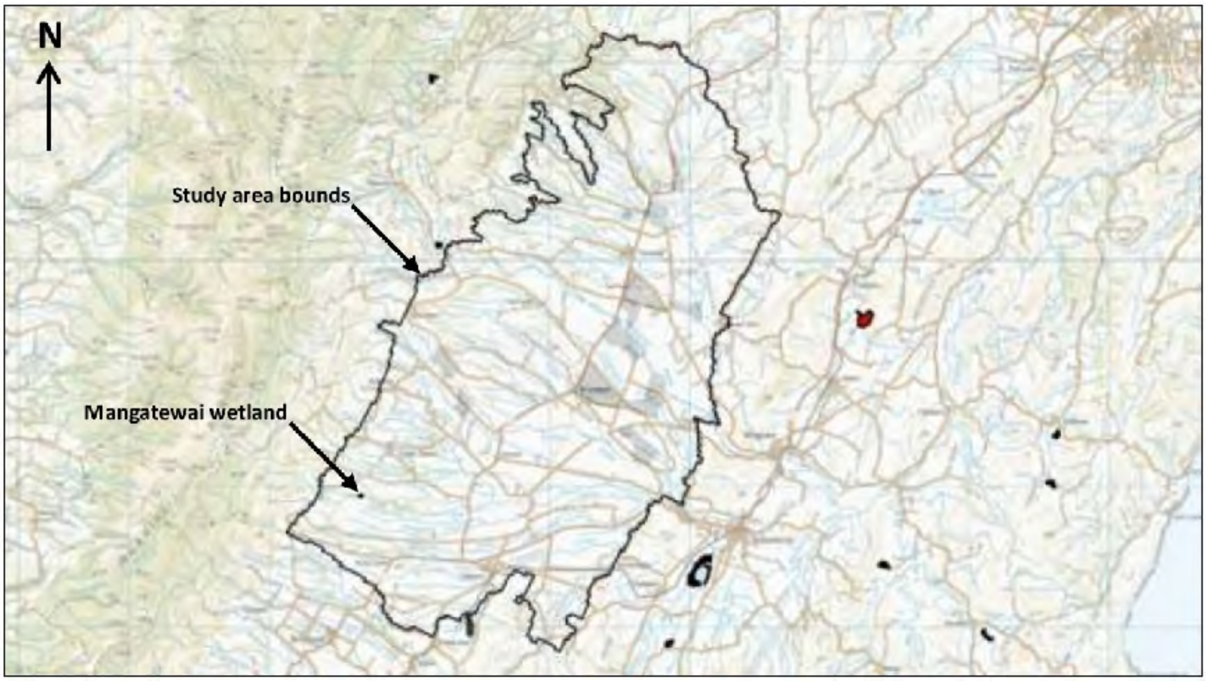

Figure 14: HBRC SOE wetland sites across central and southern Hawke's Bay.

The Ruataniwha Basin wetland and minor streams/waterways were visited by BGSL in March 2021 during a very dry period, to record the status of the surface water features during a very dry period. The sites visited are shown as green circles in Figure 15.

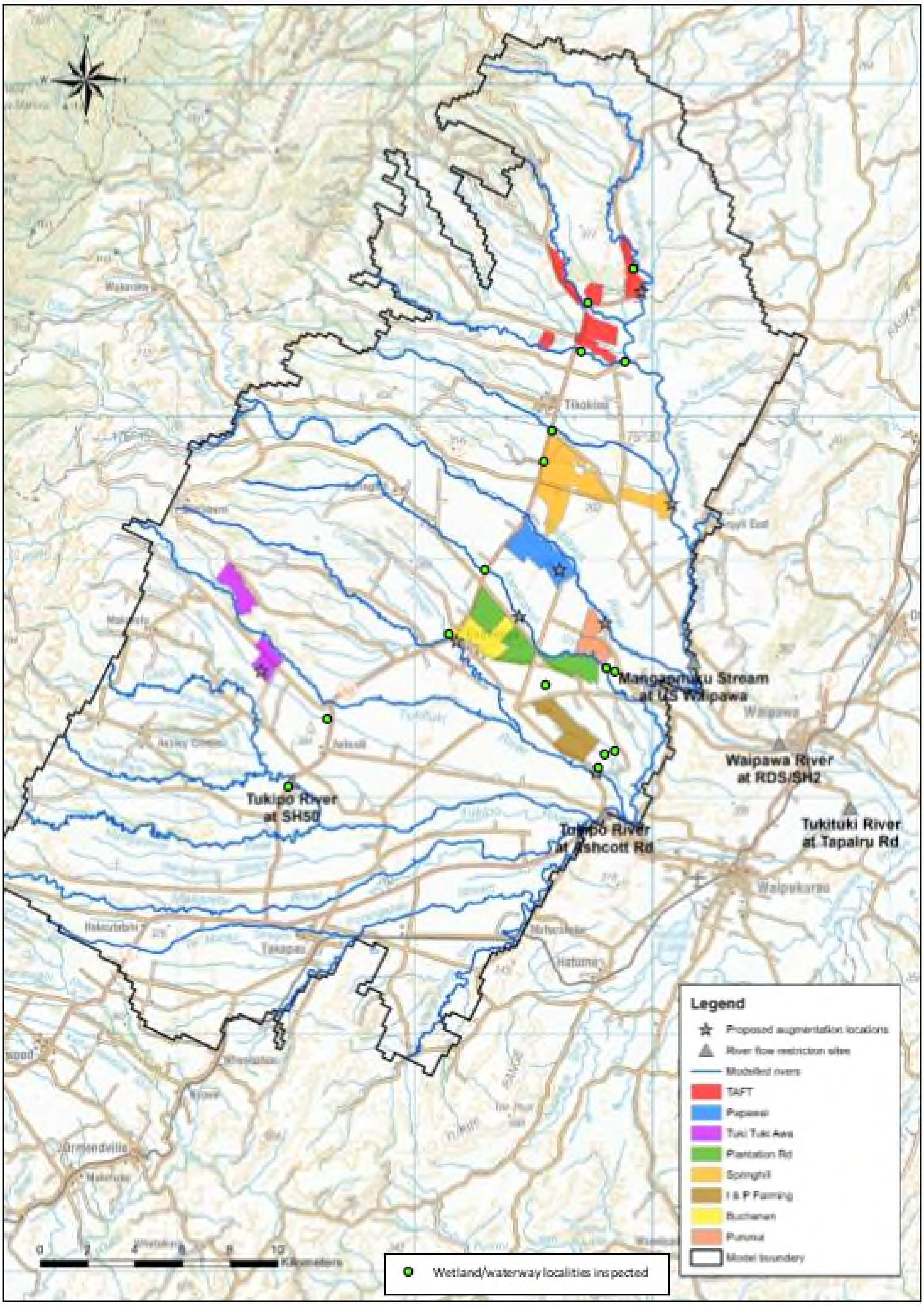

Figure 15: Surface water sites inspected by BGL (green circles).

The following surface water effects are predicted by BGSL, noting that the modelled effect is a prediction at a point in time during an extreme dry event, and not during a typical irrigation year:

- North of study area – the predicted effect on surface water features is estimated to be negligible and not likely to affect wetlands or minor streams.

- West of SH50 – the predicted effects on streams that typically dry out during the summer are thought to be negligible. However, it is possible that streams may experience dry conditions slightly earlier and/or resume flowing again a little later in the season (by a matter of a few days).
- Central and eastern areas – large wetlands and minor streams were observed in the field which appear to be fed by a possible subsurface divergent channel of the Waipawa River upwelling in areas of lower elevation, where changes in lithology result in poor confinement. Modelled effects on shallow groundwater as a result of the proposed Tranche 2 takes, are greatest in this area. However, anecdotal evidence and field inspections suggest that the majority of surface water levels are unlikely to result in significant effects on the majority of the natural occurring waterways, although, in places the effects will be measurable. The estimated effect across the lower reaches of the Black Stream may be such that the low flow rate observed in March 2021 could be reduced to a trickle.
- Southwest area – the predicted effects on streams that typically dry out during the summer are considered negligible. However, it is possible that streams may experience dry conditions slightly earlier and/or start flowing again a little later in the season (by a matter of a few days). Therefore, minor effects are anticipated on the wetland areas inspected.

On the basis of the above assessment, it is considered that, overall, potential effects on wetlands and minor surface waterbodies will be negligible or, at worst, no more than minor.

8.2 Groundwater Level and Well Interference Effects

Potential effects on groundwater levels and on existing groundwater wells within the Ruataniwha Basin have been assessed by the Lattey Group[22] (see report in Appendix D) and by BGSL[23] (see letter in Appendix E), using the Aqualinc 2021 assessment (Appendix B) which predicted effects on shallow groundwater levels and applying the estimated changes to bores inspected in the field.

A map of groundwater level difference between the status quo and augmentation Scenario 4 (being that proposed) is provided in the Aqualinc 2021 assessment[24] and presented in Figure 16. This demonstrates how shallow groundwater levels are predicted to change spatially during dry periods. Aqualinc 2021 predicts that shallow groundwater levels will lower up to a maximum of 0.8 m under augmentation scenario 4, focused near the applicants' properties. Elsewhere, shallow groundwater levels are predicted to change less than 0.3 m.

[22] "*Ruataniwha Basin Tranche 2 Irrigation Water Permit Consent Application – Assessment of Well Interference Effects, Central Hawke's Bay*", prepared by Lattey Group, dated December 2020.
[23] Letter from Bay Geological Services Ltd to Hawke's Bay Regional Council, titled "*Ruantaniwha Basin Tranche 2 Application Investigation of Shallow Groundwater Bores Identified in Assessment of Well Interference Effects*". dated 06 August 2021 (Reference BGS201-08).
[24] Page 45.

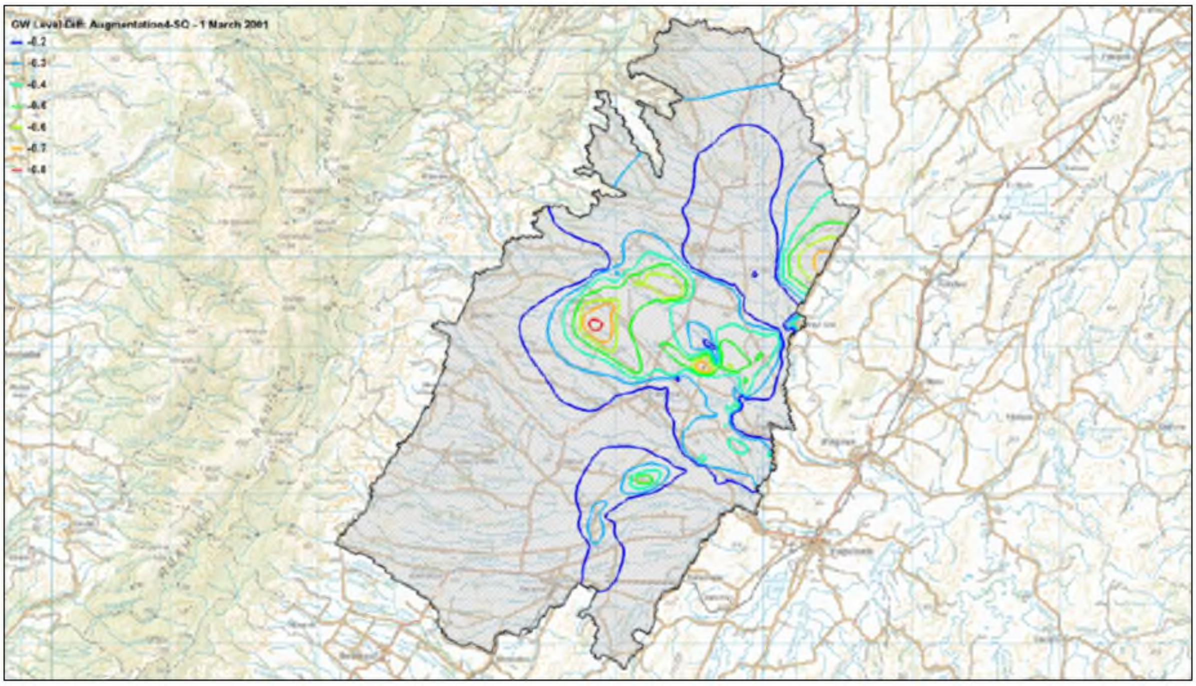

Figure 15: Difference in shallow (layer 1) groundwater levels at March 2001 between status quo and augmentation scenario 4

The Lattey report (2020) carried out a basin-wide well interference assessment associated with the proposed Tranche 2 groundwater takes. The assessment considered all recorded wells within the Ruataniwha Basin. There are many wells (703) and Lattey managed these by dividing them into groups based on their recorded total well depths. The initial focus was on wells within the 0 m to 50 m depth range and these were assessed against the Aqualinc 2021 model shallow (layer 1) impact predictions. To assess the potential impact on deeper wells, the modelled drawdown impact at a deeper level (layer 6) was reviewed separately against the deeper wells. It was not possible to fully consider wells of unknown depth, but, if it was assumed that they were sufficiently deep to enable "efficient" taking of water, Lattey considered they were unlikely to be adversely impacted.

Of a total of 657 wells (this value excluded 46 unknown depth wells) that were individually assessed, 94 were initially flagged in the well groups and 24 remained flagged following some further consideration. Of those flagged, 14 wells were in the depth range of <50 m and 10 were >50 m deep. Lattey 2020 considered that 96% of the wells assessed would not be adversely affected by the proposed Tranche 2 groundwater takes, but advised that further investigation was needed to assess whether the remaining 14 wells would be adversely affected or not.

BGSL were then engaged to assess the 14 remaining wells. They noted that, a rule of thumb suggested that if predicted well interference within a neighbouring bore was greater than 20% of the remaining water column in the bore, then there was a possibility that the neighbouring bore might be adversely affected by the additional drawdown. They noted that an adverse impact on the 14 wells identified could not be ruled out, as they had values greater than 20% and their use was not specified, or they were domestic or stockwater bores.

BGSL inspected the shallow wells in the field to gather additional information on well status, apart from one site at Well No. 5211 where no contact was able to be made with the landowner. Three of the 14 bores were found to be either abandoned, not in existence, or used as monitoring wells. Of the remaining 11 wells, the majority were shallow and provided domestic and stockwater, operated by surface pumps, apart from the deepest well (Well No. 10978) which was a submersible pump. The remaining 11 bores identified as having potential to be adversely affected are set out in Table 3.

Table 3: Remaining bores that have potential to be adversely affected

Details of Flagged Well within Ruataniwha Basin						
Well No. (diam.) Owner	Screen (m) bgl (aquifer)	SWL (m) datum	USE (1,2)	Pump	Predicted DD (m) (as % of Remaining Head)	Potential for adverse effect (Y/N)
1357 (100mm)	(well is 5.18 m deep) (limestone)	-2.00	domestic & stockwater supply	surface	0.72 (65%)	Yes, due to large potential drawdown
2773 (150mm)	12.00-18.00 (brown gravel)	-7.10	domestic water supply	surface	0.21 (84%)	Yes, due to large potential drawdown, and that well currently pumps gravels during summer months
2902 (100mm)	2.11-4.11 (bl/brn gravel)	-1.45	domestic water supply	surface	0.36 (42%)	Yes, due to large potential effect on remaining head
3590 (100mm)	(well is 7.30 m deep) (? limestone)	-5.50	domestic & stockwater supply	surface	0.13 (52%)	Yes, due to large potential drawdown and the bore can run dry in the summer months.
3664 (100mm)	14.03-25.60 (brown, white limestone brown gravel)	-8.02	domestic water supply	surface	0.11 (82%)	Yes, due to large potential effect on remaining head
3690 (100mm)	(well is 7.50 m deep) (? red gravel)	-4.30	domestic water supply	surface	0.47 (32%)	Yes, due to large potential drawdown, even though the bore taps a spring-fed stream that has never run dry.
3843 (300mm)	10.50-16.50 (brn gravel)	-4.17	pastoral farming irrigation	not used	0.08 (33%)	Yes, due to large potential effect on remaining head (noting that the well is not currently used).
5211 (300mm)	9.00-18.50 (brn gravel)	-3.90	cropping irrigation	likely surface	0.39 (27%)	Yes, due to large potential drawdown and the potential effect on remaining head
5532 (1200mm)	(well is 5 m deep) (grey gravel)	-1.92	misc. industry wastewater: washwater	surface	0.28 (25%)	Possibly No, due to the water take abstracted adjacent to and within the bed of the Waipawa River.
10978 (100mm)	21.88-22.82 (gravel)	-9.44	domestic & stockwater supply	submersible	0.57 (66%)	Yes, due to large potential drawdown and potential effect on remaining head which may drop water level below pump.
15866 (1000mm)	(well is 4 m deep) -	-1.92	domestic water supply	surface	0.08 (62%)	Yes, due to large potential drawdown and the potential effect on remaining head

BGSL advised that Well No. 5532 was described by the owner as a sump dug beside the Waipawa River bed, and it was inferred that the well would be directly recharged by the Waipawa River and not likely adversely affected should the modelled well interference of 280 mm occur.

BGSL applied bore and aquifer data, including screen elevation, static water level, seasonal variation, pump depth, and predicted well interference and concluded that 10 existing wells may experience well interference of 25% to 84% of the Remaining Head of Water, which may adversely affect security of supply to the landowners/occupiers. However, they found that six of the 10 bores were constructed relatively shallow, to depths less than 7.5 m, which resulted in a small available water column that was more sensitive to well interference. BGSL therefore considered that it was likely these wells struggled already during periods of low groundwater levels.

Policy 77(c) of the RRMP is "*To manage the groundwater resource in such a manner that existing efficient groundwater takes are not disadvantaged by new takes*". 'Efficient taking' is defined in the RMMP as follows:[25]:

> *For the purposes of this Plan **"efficient taking"** of groundwater means abstraction by a bore which penetrates the aquifer from which water is being drawn at a depth sufficient to enable water to be drawn*

[25] Note 21 under Policy 77, on page 107 of the RMMP.

> *all year (i.e. the bore depth is below the range of seasonal fluctuations in groundwater level), with the bore being adequately maintained, of sufficient diameter and screened to minimise drawdown, with a pump capable of drawing water from the base of the bore to the land surface*.

BGSL's assessment suggests that at least six of the ten existing bores are currently not providing efficient takes and are already disadvantaged during dry periods of low groundwater levels. Therefore, four of the existing bores may be adversely affected to a minor extent.

8.2.1 Summary

On the basis of the Aqualinc 2021, Lattey and BGSL modelling and assessments, it is concluded that:

- Groundwater will not be mined. While groundwater levels will lower further with additional Tranche 2 takes (made available under Plan Change 6), they will not continue to lower, they will simply reach a new (lower) dynamic equilibrium. Shallow groundwater levels are predicted to lower a maximum of 0.8 m in the vicinity of the Tranche 2 take locations, and less than 0.3m further afield;
- Of the 657 wells within the Ruataniwha Basin that were investigated, only 10 bores are expected to experience well interference of 25% to 84% of the Remaining Head of Water which may adversely affect security of supply to the landowners/occupiers. Of those 10 bores, it is very likely that six of them are currently not providing efficient takes and are already disadvantaged during periods of low groundwater levels. Therefore, four of the existing bores may be adversely affected to a minor extent.

8.3 Positive Effects

8.3.1 Te Awahohonu Forest Trust (TAFT)

TAFT has a long-term (100 year) vision to utilise the Tranche 2 water which will:

- Increase productivity from the land;
- Create a more resilient farming operation in Central Hawkes Bay;
- Give the Trust more flexibility in future land use opportunities;
- Create jobs for the Trust owners, Iwi, and other local residents;
- Improve the surrounding environment; and
- Help stimulate the local economy

The Trusts vision for their allocation of water is staged.

Initially water will be applied to the existing farm to allow for increased stock trading. In the first stage of irrigation the farm could trade at least an additional 3,000 - 5,000 lambs and 800 cattle each year, increasing farm output by over 25%. The farm will likely require an extra 1 or 2 full time labour units to manage the increased stock number movements and workload associated with monitoring and managing an efficient irrigation system.

Irrigation allows stock finishing to be spread more evenly over the year and involve a less intensive winter cropping regime, the result being a reduction in overall nutrient losses into the environment. The irrigation program is set to be accompanied by planting programs which will enhance the indigenous vegetation environment around waterways and across the farm.

The second stage of Irrigation for TAFT involves the utilisation of more land in the immediate area to enable new business opportunities and create employment opportunities. The possibilities include horticulture and cropping.

8.3.2 Papawai Partnership

With the aid of Tranche 2 water Papawai will have the ability to grow different crops for McCain's – sweetcorn and beans. Beans can yield 12 – 15 tonnes/ha with adequate irrigation, which is at the top end of the yield curve. Papawai will also be able to grow more supplement feed for its stock, to be used in times of droughts or extreme weather patterns, as we have seen in 2020. Tranche 2 water will also provide a 'safety net' to enable seed production with different companies that have approached us, growing seeds of carrots, broccoli, and onions.

Tranche 2 water will not necessarily increase yields on existing crops already grown with the use of Papawai's existing water consent, but it will assist with guaranteeing a good solid yield every time a crop is planted. A good crop maintains lower weed production and so less herbicide and insecticide will be used. If Papawai is able to maintain its business, it hopes to employ another full-time staff member, and an extra seasonal staff person when required.

The 2019/2020 year was very trying with a drought, that has given Papawai another set of problems. All of the existing consented water was used just trying to keep grass alive and growing, so that lambs could get to a weight acceptable for the meat works. Additional Tranche 2 water would enable Papawai to avoid that situation in the future.

8.3.3 Tukituki Awa

Tukituki Awa's main reason for seeking Tranche 2 water is to alleviate the reduced security of supply for its existing surface water irrigation take resulting from the increased minimum flows on the Tukituki River. In the event of low flow restrictions being imposed on surface water takes (as occurred this 2019/2020 season when low flow restrictions were imposed early in the season and not lifted until late in May) the Tranche 2 water will enable reliable irrigation and consequently on-farm production to be maintained.

In that context, the positive effects of having Tranche 2 water can be directly equated avoiding the losses that occurred this season. Those losses were a reduction of 30,000 kg milk solids (lost revenue of $146,000) and extra feed being required (PKE, corn waste and maize silage at a cost of $114,000) or $260,000 in total.

8.3.4 Plantation Road Dairies Ltd

Should Plantation Road Dairies' (PRD) Tranche 2 groundwater application be granted, then the intention is to transition from dairy support farming into horticulture. The PRD property is sizeable and so this transition would occur over a 5 to 10-year period. The investment required for that transition will be significant, including the purchase of goods and services and the employment of additional staff both during the transitional phase and the operational phase of the horticultural development. At this stage there are no definitive development plans (including the likely horticultural activities and mix of plantings) and that planning will commence once the Tranche 2 water is secured.

Should this transition to horticulture proceed, then there is a very real likelihood that the environmental footprint of the property would reduce, particularly in terms of nitrogen leaching to the underlying shallow groundwater.

8.3.5 Springhill Dairies (formerly Ingleton Farms)

Springhill Dairies intends to use the Tranche 2 water to irrigate land on its run-off. There will not be any increase in cow numbers, with the main benefit being that feed crops can be grown for young stock. Feed crops could also be grown, harvested and fed to cows. These initiatives will result in Springhill being less dependent on imported feed such as palm kernel. There will be additional employment for contractors involved in planting and harvesting these feed crops.

8.3.6 I & P Farming (formerly Abernethy Partnership)

I & P Farming operates a mixed cropping and livestock finishing farm. The land is currently unirrigated, flat and comprises a high proportion of quality soils well suited to crop production, including Hastings silt loam and Kaiapo silt sandy loam. Access to Tranche 2 groundwater will reduce volatility in cropping performance that is driven by periods of low soil moisture over the cropping season. This reduction in risk will provide I & P Farming with the confidence to optimise its cropping production and with positive effects including but not limited to:

- New investment. Initial estimates are that approximately $3 million of infrastructure investment may be required to establish an irrigation system as well as the related re-purposing of farm operations. As well as directly benefiting suppliers, surrounding farms and the community may also benefit from this investment such as through any required power supply upgrades;
- Optimised land use. Once access to Tranche 2 water is secured, I&P Farming intends to commission a review of farm soil types and environmental factors in order to optimise the long-term sustainability of production. It is anticipated that this will result in a re-weighting of production towards higher value process vegetable crops, as well as enhancing crop mixtures and rotation to maintain soil quality;
- Significant crop production increase. Although the review of land use is yet to be undertaken, it is estimated that average yields on cereal and pea crops will increase by 3 tonnes/ha under irrigation. This increase would result in at least an additional ~550 tonnes of total crop production per annum across the intended irrigation area of approximately 184 ha.
- Reduced soil erosion risk. Irrigation will reduce the turnaround time between crops, allowing better cover to be maintained and the use of soil enhancing cover during soil water deficits; and
- Increased employment. I & P Farming currently employs 1 full time farm manager as well as engaging regular part-time labour as required and outsourcing all other needs. Increased crop production of at least 550 tonnes per annum as well as maintaining a ~$3 million irrigation system, will lead to an increase in part-time labour as well as regular work opportunities for Hawkes Bay contracting firms and support of local agri-business suppliers. The reduced volatility in cropping performance under irrigation, should translate into greater stability of business from the farm for local suppliers.

8.3.7 Buchanan Trust No 2

The Trust currently rears bulls year-round on dry land. Tranche 2 groundwater would enable the Trust to transition to growing crops under irrigation during the summer months and trading lambs on grass during the winter. An anticipated typical year of irrigated crop yields would be 22 tonnes of maize, 23 tonnes of sweetcorn, 9 tonnes of peas, 9 tonnes of barley, 500 kg of carrot seed and 200 kg of radish seeds. The Trust may also lease some irrigated area to a squash grower.

Importantly, the Tranche 2 water will enable the Trust to establish grass for the winter. This will enable two trades of 18 lambs per hectare (or 4500 trades in total from 127 hectares) over the winter months.

The change in the Trust's farming operation will require the employment of one extra full time labour unit to manage the increased stock number movements and workload associated with monitoring and managing an efficient irrigation system.

8.3.8 Purunui Trust

The Purunui Trust currently runs a dairy farm support unit. The availability of Tranche 2 water and the ability to irrigate 60 ha of land is expected to provide the following benefits:

- ability to move into mixed cropping, lamb and some beef finishing.
- yields of crops will increase, along with better lamb finishing weights with the increase in dry matter production.
- increase the use of agricultural contractors, and people in the agri-business sector.
- growing squash, onions and carrot seed.
- reduced soil erosion on the 60 ha of light Takapau soils.
- opportunity to diversify into Pipfruit orcharding which could provide more jobs in the area. Demand for land in this sector continues to grow.
- increases in production will require an additional 1.0 FTE employees.

9 Assessment of Planning and Policy Documents

The following provides an assessment of the proposed activities against the relevant statutory planning and policy documents, as required under section 104(1)(b) and section 104D of the RMA.

Objectives and policies relevant to the proposal are contained in the following statutory planning documents:

- National Policy Statement for Freshwater Management 2020; and
- Operative Regional Policy Statement ("RPS").

The RPS is contained within the Hawke's Bay Regional Resource Management Plan (operative 28 August 2006).

The relevant objectives and policies of the statutory planning documents are set out and assessed below.

9.1 National Policy Statement for Freshwater Management (NPS-FM) 2020

The NPS-FM 2020 came into effect on 3 September 2020. It covers the management of freshwater, including groundwater, and the effects on receiving environments. On the same date the National Environmental Standards (NES) for Freshwater Regulations came into effect.

The NPS-FM directs Regional Councils to give effect to it, including Te Mana o Te Wai, as soon as practicable. The HBRC has not yet given effect to the NPS-FM 2020 in either its Regional Policy Statement or Regional Resource Management Plan.

The relevant provisions of the NPS-FM 2020 are outlined below.

The Objective of the NPS-FM is to ensure natural and physical resources are managed in a way that prioritises:

(a) first, the health and well-being of water bodies and freshwater ecosystems
(b) second, the health needs of people (such as drinking water)
(c) third, the ability of people and communities to provide for their social, economic and cultural well-being, now and in the future.

Six policies in the NPS-FM are also considered relevant to this application:

Policy 3 - that freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.

Policy 5 - freshwater management through a National Objectives Framework (NOF) to ensure the health and wellbeing of water bodies is maintained and (if communities choose) improved.

Policy 6 - that there is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.

Policy 7 - that the loss of river extent and values is avoided to the extent practicable.

Policy 9 - that the habitats of indigenous freshwater species are protected.

Policy 10 - the habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.

Policy 11 - to ensure the freshwater is allocated and used efficiently, all existing over allocation is phased out and future over allocation is avoided.

The assessment of environmental effects in Section 8 of this report has found that:

- proposing a higher minimum flow trigger results in positive effects at the Waipawa and Tukituki monitoring sites where increased flows are initiated. Although a low negative effect is predicted at the Tukipo (SH50) low flow site, it is so minor that it is below measurement precision and modelling uncertainty;
- generally, adverse effects on surface water as a result of the Tranche 2 groundwater abstractions will be either avoided or considered minor based on a 90-percentile year;
- overall, potential effects on wetlands and minor surface waterbodies will be negligible or no more than minor;
- groundwater will not be mined. While groundwater levels will lower further with additional Tranche 2 takes (made available under Plan Change 6), they will not continue to lower, they will simply reach a new (lower) dynamic equilibrium. Shallow groundwater levels are predicted to lower a maximum of 0.8 m in the vicinity of the Tranche 2 take locations, and less than 0.3 m further afield;
- of the 657 recorded wells within the Ruataniwha Basin (excluding 46 unknown depth wells) that were investigated, only 10 wells are expected to experience well interference of 25% to 84% of the remaining head of water within the bores that may adversely affect security of supply to the landowners/occupiers.; and
- there will be positive effects associated with the proposed take and use of the Tranche 2 groundwater (as set out in Section 8.3), including
    - increased productivity from the land;
    - more resilient farming operations;
    - more flexibility in future land use opportunities; and
    - creation of jobs and benefits for the local economy.

As the effects on the rivers, wetlands and minor surface waterbodies are expected to be negligible or no more than minor, it is expected that there will be negligible or less than minor effects on the habitats of indigenous freshwater species, trout and salmon.

The majority of wells within the Ruataniwha Basin will not be adversely affected by the proposed Tranche 2 groundwater takes. Only the security of supply to 10 wells may be adversely affected.

It is therefore considered that the proposed activities will be generally consistent with, and not contrary to, the relevant objective and policies of the NPS-FM.

9.2 Hawke's Bay Regional Policy Statement (RPS)

The Hawke's Bay Regional Policy Statement (RPS) is contained within the Operative Hawke's Bay Regional Resource Management Plan (made operative on 28 August 2006).

The following objectives and policies of the RPS are relevant to the proposal:

OBJ 1
To achieve the integrated sustainable management of the natural and physical resources of the Hawke's Bay region, while recognising the importance of resource use activity in Hawke's Bay, and its contribution to the development and prosperity of the region.

OBJ 23
The avoidance of any significant adverse effects of water takes on the long-term quantity of groundwater in aquifers and on surface water resources.

OBJ 24
The avoidance or remedy of any significant adverse effects of water takes on the operation of existing lawful efficient groundwater takes.

POL 28 DECISION-MAKING CRITERIA – EFFECTS ON EXISTING USERS
3.9.18 To require applicants to avoid, remedy or mitigate any significant interference of new takes of groundwater on existing lawfully established efficient groundwater takes, including existing efficient takes and uses of groundwater for an individual's reasonable domestic needs or the reasonable needs of an individual's animals for drinking water or takes for firefighting.

POL 32 TECHNICAL PROCEDURE – IRRIGATION TAKES
3.9.31 To allocate groundwater for irrigation purposes on the basis of actual crop water requirements up to a maximum equal to that required during a one in ten year drought. The allocation assessment will take into account information on crop type, rainfall, potential evapotranspiration rates, and best irrigation management practices. The allocation assessment may also have regard to soil type and soil moisture capacity.

OBJ 25
The quantity of water in wetlands, rivers and lakes is suitable for sustaining aquatic ecosystems, for achieving other freshwater objectives, and ensuring resource availability for a variety of purposes across the region, while recognising the impact caused by climatic fluctuations in Hawke's Bay.

OBJ 26
The avoidance of any significant adverse effects of water takes, uses, damming or diversion on lawfully established activities in surface water bodies.

POL 38 DECISION-MAKING CRITERIA – EFFECTS OF NEW TAKES
3.10.13 To avoid any significant adverse effects of new takes, uses, damming or diversion of water on lawfully established activities in surface water bodies, including any significant adverse effects on takes and uses of water for an individual's reasonable domestic needs or the reasonable needs of an individual's animals for drinking water or takes for firefighting.

Objectives Obj 23 and Obj 24 are to avoid any significant adverse effects of water takes on the long-term quantity of groundwater in aquifers and on surface water resources and to avoid or remedy any significant adverse effects of water takes on the operation of existing, lawful, efficient groundwater takes. Objective Obj 26 is the avoidance of any significant adverse effects of water takes and uses on lawfully established activities in surface water bodies. Policy 28 and Policy 38 are to avoid, remedy or mitigate any significant interference and adverse effects of new takes of groundwater on existing lawfully established efficient groundwater takes, and to avoid any significant adverse effects of new takes and uses on lawfully established activities in surface water bodies.

Policy 32 is to allocate groundwater for irrigation purposes on the basis of actual crop water requirements up to a maximum equal to that required during a one in ten-year drought. The maximum volumes of Tranche 2 groundwater proposed to be taken and used for irrigation have been calculated for each Applicant by Aqualinc assuming that the water will be used to irrigate pasture. If land uses other than pasture are applied (e.g. cropping and/or horticulture, or a mixture of pasture, cropping and horticulture), then the seasonal water use and associated recharge will be less for the same irrigated area, or a larger area could be irrigated for the same seasonal volume. In these cases, the Aqualinc report has assessed that the modelled effects on river flows will be either less or similar (respectively) than the assessment of the modelled effects for pasture only[26].

As outlined in Sections 6 and 8 of this report, the Aqualinc modelling and BGSL's assessments of effects on groundwater levels and surface water flows (including small streams and wetlands) have concluded

[26] Refer to Section 3.2, page 13, of the Aqualinc report.

that the effects on the rivers, wetlands and minor surface waterbodies are expected to be negligible or no more than minor, and adverse effects on the security of supply of all but 10 existing lawfully established efficient groundwater takes within the Ruataniwha Basin will be avoided. As the effects on the rivers, wetlands and minor surface waterbodies are expected to be negligible or no more than minor, it is expected that there will be negligible or less than minor effects on the habitats of indigenous freshwater species, trout and salmon.

It is therefore considered that the proposed activities are generally consistent with, and not contrary to, these objectives and policies.

9.3 Hawke's Bay Regional Resource Management Plan (RRMP)

The following objectives and policies of the RMMP are relevant to the proposal:

OBJ 44
The maintenance of a sustainable groundwater resource.

POL 77 ENVIRONMENTAL GUIDELINES - GROUNDWATER QUANTITY
(a) *To manage takes of groundwater to ensure abstraction does not exceed the rate of recharge.*
(b) *To manage the available groundwater resource to ensure supplies of good quality groundwater.*
(c) *To manage the groundwater resource in such a manner that existing efficient groundwater takes are not disadvantaged by new takes.*
(d) *To manage takes of groundwater to ensure abstraction does not have an adverse effect on rivers, lakes, springs, or wetlands.*

OBJ TT1
To sustainably manage the use and development of land, the discharge of contaminants including nutrients, and the taking, using, damming, or diverting of fresh water in the Tukituki River catchment so that:
(a) *Groundwater levels, river flows, lake and wetland levels and water quality maintain or enhance the habitat and health of aquatic ecosystems, macroinvertebrates, native fish and trout;*
(b) *Water quality enables safe contact recreation and food gathering;*
(ba) *Water quality and quantity enables safe and reliable human drinking water supplies;*
(c) *The frequency and duration of excessive periphyton growths that adversely affect recreational and cultural uses and amenity are reduced;*
(d) *The significant values of wetlands are protected;*
(e) *The mauri of surface water bodies and groundwater is recognised and adverse effects on aspects of water quality and quantity that contribute to healthy mauri are avoided, remedied or mitigated; and*
(f) *The taking and use of water for primary production and the processing of beverages, food and fibre is provided for.*

POL TT8 ALLOCATION LIMITS
1. To manage the taking of surface water and groundwater in the Tukituki River catchment by:
[…]
(b) *Recognising that there is a significant degree of interconnectedness between groundwater in the Ruataniwha Basin and surface water flows within the basin as a whole and consequently surface flows further downstream;*
[…]
(ca) *Enabling additional groundwater to be abstracted as a discretionary activity (Table 5.9.5 Tranche 2) provided that river flows are augmented to maintain the relevant minimum flows specified in Table 5.9.3 commensurate to the scale of effect of the Tranche 2 groundwater take.*

Objective Obj 44 is to maintain a sustainable groundwater resource and Policy 77 seeks to manage groundwater takes to ensure abstraction does not exceed the rate of recharge, there are supplies of good quality groundwater, existing efficient groundwater takes are not disadvantaged by new takes, and abstraction does not have an adverse effect on rivers, lakes, springs, or wetlands.

Objective TT1 is to sustainably manage the taking, using, damming, or diverting of fresh water in the Tukituki River catchment so that: groundwater levels, river flows, lake and wetland levels and water quality maintain or enhance the habitat and health of aquatic ecosystems, macroinvertebrates, native fish and trout; water quality and quantity enables safe contact recreation and food gathering and safe and reliable human drinking water supplies; frequency and duration of excessive periphyton growths that adversely affect recreational and cultural uses and amenity are reduced; the significant values of wetlands are protected; and adverse effects on aspects of water quality and quantity that contribute to healthy mauri are avoided, remedied or mitigated.

Policy TT8 recognises the significant degree of interconnectedness between groundwater in the Ruataniwha Basin and surface water flows in the Basin as a whole, and consequently surface flows further downstream. It is also to enable additional groundwater to be abstracted as a discretionary activity provided that flows are augmented to maintain the relevant minimum flows in Table 5.9.3 commensurate with the scale of effect of the Tranche 2 groundwater take.

As outlined in Sections 6 and 8 of this report, the Aqualinc modelling, Lattey and BGSL's assessments of effects on groundwater levels and surface water flows (including small streams and wetlands) have concluded that the effects on the rivers, wetlands and minor surface waterbodies are expected to be negligible or no more than minor, and adverse effects on the security of supply of all but 10 of the 657 existing, lawfully established groundwater takes within the Ruataniwha Basin will be avoided. Four of the 10 bores may be adversely affected to a minor extent.

As the effects on the rivers, wetlands and minor surface waterbodies are expected to be negligible or no more than minor, it is expected that there will be negligible or less than minor effects: on the habitat and health of aquatic ecosystems, macroinvertebrates, native fish and trout; on contact recreation, amenity and food gathering, on the safety and reliability of safe human drinking water supplies; and the water quality and quantity that contribute to healthy mauri.

It is therefore considered that the proposed activities are consistent with, and not contrary to, these objectives and policies.

10 Section 104D Assessment

This AEE has been prepared on the basis that all applications should be assessed as Discretionary Activities. This is on the basis of legal advice relating to the effect of s 88A, Resource Management Act 1991, and how that section applies to previously operative rules that become inoperative after lodgment of a resource consent application but prior to the consent being determined.

However, in the event that these applications are assessed as a Non-complying Activity, both of the threshold tests in s 104D are met. This is because:

a) The effects of the proposed takes are minor or less (s 104D(1)(a), RMA) (refer to the assessment of effects in Section 8 above).

b) The only identified effects that are *potentially* more than minor relate to effects on 4 existing groundwater bores. However, when the effects of the proposal overall are assessed, these effects can be considered minor.

The activity is entirely consistent with – and is certainly not contrary to – relevant objectives and policies (s 104D(1)(b), RMA) (refer assessment at Section 9.3 of this report). The opportunity to use the Tranche 2 water in the manner proposed is expressly provided for by the RRMP, subject to certain augmentation obligations which are incorporated into the current proposal.

11 Consent Conditions

A set of proposed consent conditions is provided in Appendix F of this report, which is intended to provide the starting point of a template for consent conditions for each applicant's consent (Note: it is proposed that separate resource consents be issued for each Applicant, and tailored to include their specific details (e.g., volume of groundwater for irrigation and augmentation, maximum rate of take, etc.)).

The proposed conditions accommodate the proposed protocols for the Tranche 2 groundwater takes and augmentation, as set out in Section 5.4 of this report. This includes enabling staged development and transitional implementation of the consents, inclusion of the proposed 'water year' and associated start dates for irrigation and augmentation, and the application of higher minimum flow rates for the relevant rivers to trigger the commencement of the discharge of augmentation water.

The applicants also seek final conditions that allow for flexibility of use of any Tranche 2 water taken. This will allow crop rotations (temporary) and permanent transitions to other land uses. It is not possible at this stage to specify exactly when, and on what parcels of land that landuse change will occur. Any change in land use, to a less water demanding crop, will also allow a greater area of land to benefit from irrigation. This will increase the positive effects arising from the water take, while any effects will be addressed in the land use consent. The precise wording of these conditions will need to be further discussed with Council.

12 Part 2 RMA

The matters to be considered under section 104 are subject to Part 2 of the RMA.

11.1 Section 5 - Purpose of the RMA

The cornerstone of Part 2 is the Purpose of the Act as set out in section 5(1), which is:

> *"To promote the sustainable management of natural and physical resources".*

Section 5(2) of the RMA defines 'sustainable management' as:

"Managing the use, development and protection of natural and physical resources in a way or at a rate which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while-

- *(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
- *(b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and*
- *(c) Avoiding, remedying or mitigating any adverse effects of activities on the environment."*

In the recent decision *RJ Davidson Family Trust v Marlborough District Council* [2018] NZCA 316 the Court of Appeal reconfirmed the relevance of Part 2 matters in the consideration of resource consents.

In this instance, Part 2 has been assessed. This is intended to assist the overall evaluation of the current proposal.

The take and use of the proposed Tranche 2 groundwater will enable the applicants to provide for their social, economic and cultural wellbeing and for their health and safety by providing a new source of water to support productive land uses. This will also have associated benefits for the wider local and regional community.

With respect to safeguarding the life-supporting capacity of air, water, soil and ecosystems and avoiding, remedying, or mitigating any adverse effects of the proposed activities on the environment, the AEE (in Section 8 of this report) has concluded that the proposed take and use of Tranche 2 groundwater will generally be negligible or no more than minor, subject to the imposition of appropriate consent conditions, with the exception of the security of supply of 10 existing wells within the Ruataniwha Basin which may be adversely affected. Therefore, overall, it is considered that the requirements of section 5(2)(b) and (c) will be achieved.

It is therefore considered that granting consent to the proposed water takes will achieve the purpose of the RMA.

11.2 Section 6 - Matters of National Importance

Section 6 of the RMA sets out the following 'Matters of National Importance' that must be recognised and provided for in managing the use, development and protection of natural and physical resources:

- *"(a) The preservation of the natural character of the coastal environment (including coastal marine area) wetlands and lakes and rivers and their margins and the protection of them from inappropriate subdivision, use and development:*
- *(b) The protection of outstanding natural features and landscapes from inappropriate subdivision, use and development:*
- *(c) The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*

(d) The maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers:
(e) The relationship of Māori and their culture and traditions with their ancestral lands, water, waahi tapu, and other taonga;
(f) The protection of historic heritage from inappropriate subdivision, use and development;
(g) The protection of recognised customary activities."

Sections 6(a), 6(e) and6(g) are relevant.

Section 6(a) requires the preservation of the natural character of wetlands, lakes and rivers and their margins and the protection of them from inappropriate use and development. The AEE in Section 8 of this report has assessed that the effects of the proposed takes and discharges of Tranche 2 groundwater on the rivers, wetlands and minor surface waterbodies are expected to be negligible or no more than minor with the imposition of appropriate consent conditions. Given this, it is expected that there will be negligible or no more than minor effects on the habitats of indigenous freshwater species, trout and salmon. It is therefore considered that the proposed takes and discharges are consistent with s6(a).

Section 6(e) requires the relationship of Māori and their culture and traditions with their ancestral lands, water, waahi tapu, and other taonga to be recognised and provided for. Section 6(g) requires the protection of recognised customary activities to be recognises and provided for.

It is considered that the proposed water takes and discharges will not have any adverse effects on this relationship. It is therefore considered that the proposed take and use of water is consistent with s6(e) and s6(g).

It is therefore considered that the proposal is consistent with the relevant Matters of National Importance in Section 6 of the RMA.

11.3 Section 7 - Other Matters

Section 7 of the RMA sets out the matters that particular regard must be had to in managing the use, development and protection of natural and physical resources:

"(a) Kaitiakitanga:
(aa) the ethic of stewardship:
(b) The efficient use and development of natural and physical resources:
(ba) the efficiency of the end use of energy:
(c) The maintenance and enhancement of amenity values:
(d) Intrinsic values of ecosystems:
(e) Repealed:
(f) Maintenance and enhancement of the quality of the environment:
(g) Any finite characteristics of natural and physical resources:
(h) The protection of the habitat of trout and salmon:
(i) The effects of climate change:
(j) The benefits to be derived from the use and development of renewable energy.

Sections 7(a), 7(aa), 7(b), 7(d), 7(f), 7(g), 7(h) and 7(i) are considered relevant.

The Assessment of Environmental Effects (in Section 8) has concluded that the proposed take and use of Tranche 2 groundwater will generally be negligible or no more than minor, subject to the imposition of appropriate consent conditions, with the exception of the security of supply of 10 existing wells within the Ruataniwha Basin which may be adversely affected. The water taken will be used to irrigate productive land uses and to provide greater resilience for the applicants during dry summer months, when takes from rivers are restricted. Restrictions on takes are expected to become more frequent and be of longer duration in the future as a result of climate change.

It is proposed that augmentation will be applied when minimum flows in the rivers are reached, regardless of whether or not irrigation is operating. As such, augmentation will be more beneficial and will result in an overall improvement in low flows exiting the basin in both the Tukituki and Waipawa Rivers. The exception to this is Tuki Tuki Awa, who propose to take Tranche 2 groundwater and augment to the Tukituki River only when their existing surface water take is restricted. This also will not adversely affect low river flows. For the Tranche 2 applicants, the adoption of higher minimum flow triggers (and therefore more frequent augmentation) will provide greater benefit to the 7-day MALF, and it will also better protect the reliability for existing abstraction consent holders. Targeted over-compensation will accommodate prediction uncertainty, enhancing environmental low-flows, and will accommodate across-catchment effects.

Groundwater in the Ruataniwha Basin is a finite resource. Groundwater will not be mined. While groundwater levels will lower further with the proposed Tranche 2 groundwater takes (in accordance with the 15 million m^3 allocation made available under PC 6), they will not continue to lower and will simply reach a new, lower, dynamic equilibrium. Shallow groundwater levels are predicted to lower a maximum of 0.8 m in the vicinity of Tranche 2 take locations, and less than 0.3 m further afield.

On the basis of the above, it is considered that the proposal is consistent with the relevant Other Matters in Section 7 of the RMA.

11.4 Section 8 - Treaty of Waitangi

Section 8 of the RMA states that, in relation to managing the use, development and protection of natural and physical resources, the principles of the Treaty of Waitangi (Te Tiriti o Waitangi) must be taken into account.

While there is no comprehensive or authoritative list of principles of the Treaty of Waitangi available for consideration, case law has indicated that these may include principles of active protection, good faith consultation and communication, and a spirit of partnership.

The proposal will not cause a change in the manner in which the principles of the Treaty of Waitangi apply.

11.5 Conclusions

Overall, the proposal is consistent with the purpose and principles of the RMA.

13 Summary and Conclusion

Plan Change 6 (PC6) to the Hawke's Bay Regional Resource Management Plan (RRMP) became operative on 1 October 2015. PC6 set groundwater allocation limits for the Ruataniwha Basin which is located within the upper Tukituki River catchment. Included within those limits was an allocation of deep groundwater that PC6 labelled "Tranche 2".

In response to the establishment of the Tranche 2 allocation, during the period 19 November 2014 to 1 May 2017 the following seven parties lodged resource consent applications to abstract Tranche 2 deep groundwater[27]:

- Te Awahohonu Forest Trust (TAFT)
- Springhill Dairies (formerly Ingleton Farms)
- Tuki Tuki Awa
- Plantation Road Dairies
- I & P Farming (formerly Abernethy Partnership)
- Papawai Partnership
- Buchanan Trust No. 2

Plantation Road Dairies also amended their original application in January-April 2020, to reduce the volume of water they had applied for from 6,081,499 m^3/year to 3,751,225 m^3/year. Consequently, additional water was made available to Papawai Partnership to increase the volume they originally applied for by 1,052,455 m^3/year, and to I & P Farming to increase their original volume by 722,888 m^3/year. Purunui Trust applied in April 2020 for the remaining water (544,931 m^3/year).

A fundamental element of Tranche 2 groundwater abstraction is the RRMP requirement to augment river flows to mitigate the impact of the Tranche 2 deep groundwater abstractions on surface water bodies. The augmentation water is also abstracted from deep groundwater, and it forms part of the Tranche 2 allocation. This means that each Tranche 2 applicant must specify how much deep groundwater they propose to abstract for irrigation and how much they propose to abstract for augmentation purposes.

The augmentation concept included in PC6 was novel, not only for Hawke's Bay, but for New Zealand generally. It was not instigated by the Hawke's Bay Regional Council (HBRC) but was introduced by the Board of Inquiry into the Tukituki Catchment Proposal in their June 2014 decision. Not surprisingly, the augmentation concept was not approached consistently by all of the applicants.

Each Tranche 2 groundwater abstraction will have an effect on groundwater levels and river flows across a wide area. The effects of all eight applicants then combine to produce Ruataniwha Basin-wide effects. Consequently, at a meeting with HBRC officials in March 2018, it was agreed that the applicants would work together in a collaborative manner to assess (or reassess) the cumulative effects of their proposed Tranche 2 abstractions.

This report is based on the outcomes of the collaborative modelling and effects assessments. It supersedes and replaces the individual assessments of environmental effects (AEEs) that were originally lodged by each of the eight applicants. However, while this AEE replaces the original AEEs, the original applications for resource consent remain in place.

[27] Two other parties also lodged applications. The first was HBRIC, the investment arm of the Hawke's Bay Regional Council. The second was J M Bostock Ltd. Both of those applications have been withdrawn.

Importantly, when the original Tranche 2 applications were lodged, it was unclear how the PC6 augmentation provisions should be interpreted and implemented. For example, it was unclear whether, or not, the effects of the deep groundwater augmentation abstractions on surface flows would themselves need to be mitigated by further augmentation, and so on. Some applicants (including TAFT, Springhill Dairies, Plantation Road Dairies and Buchanan No. 2 Trust) assumed that would be the case, while others did not.

Irrigation demand for each applicant has been calculated for the irrigable areas applied for using the Aqualinc in-house soil-water balance model, IrriCalc. From these calculations, the 90-percentile (or 9 in 10 years) irrigation demand (in mm/year) has been calculated, assuming that all existing and future irrigated land use is pasture, which typically has a larger seasonal water demand than other land uses. This demand is then multiplied by the irrigated area to calculate a maximum irrigation volume.

To provide greater flexibility for applicants to use Tranche 2 groundwater for the duration of the consents, the Applicants are seeking conditions that enable the volume of Tranche 2 groundwater to be used to irrigate crops and/or horticulture, or a mixture of pasture, crops and horticulture. While the volume of water used will be the same or less for any applicant irrigating solely pasture, the amount of land over which this water is applied may be greater than the area modelled in the Aqualinc report (in Appendix B to this report).

The proposed revised areas of the Applicants' properties to be irrigated are set out in the Revised Overall Tranche 2 Proposal in Table 1, in Section 6.2 of this report, and are set out in the proposed set of draft consent conditions in Appendix F to this report.

The applicants therefore seek final conditions that allow for flexibility of use of any Tranche 2 water taken. This will enable crop rotations (temporary) and permanent transitions to other land uses. It is not possible at this stage to specify exactly when, and where that landuse change will occur within the consented land areas. Any change in land use, to a less water demanding crop, will also allow a greater area of land to benefit from irrigation. This will increase the positive effects arising from the water take, while any effects will be addressed in the land use consent. The precise wording of these conditions will need to be further discussed with Council.

As an outcome of the modelling undertaken by Aqualinc, some adjustments to the rates of take of Tranche 2 groundwater for irrigation are also required to optimise the balance between irrigation and augmentation water use and mitigate effects on rivers during low-flow periods. For all but one applicant, the rates are proposed to be less than the rate originally applied for. For Tuki Tuki Awa, it is proposed that their original rate of take be increased (from 78 L/s daily average to 94 L/s daily average). This small increased take on one site is predicted to have negligible effects, as demonstrated in this AEE.

A consent duration of 20 years is sought for all of the applications. For consistency, and given the collaborative approach being applied, it is requested that a 20-year consent duration be applied to each of the eight applications.

This AEE is prepared in accordance with the requirements of Section 88 and the Fourth Schedule of the Resource Management Act 1991 (RMA), and it is intended to provide the information necessary to fully understand the proposal and any actual or potential effects that the proposed activity may have on the environment.

This AEE concludes that with the imposition of appropriate consent conditions, any actual and potential adverse environmental effects of the proposed groundwater takes will be negligible or no more than minor, with the exception of the security of supply of groundwater to 4 existing bores within the Ruataniwha Basin which may be adversely affected to a minor extent. To the extent that some form of notification of this application is considered appropriate, then any such notification should be limited to those affected bore owners/users.

The proposed activity is consistent with the purpose and principles of the RMA.

In terms of section 104(1)(b), on the basis of the above assessment, the proposal is generally consistent with, and is not contrary to, the relevant objectives and policies of the National Policy Statement for Freshwater 2020, and the Hawke's Bay Regional Resource Management Plan (including the Regional Policy Statement).

Rule TT4 of the RRMP, as notified (as part of PC6), did not include provision for Tranche 2 groundwater takes and Rule TT4 became operative on 1 October 2015. Three of the applications were lodged prior to 1 October 2015. Regardless of this, based on legal advice received as to the effect of s 88A, Resource Management Act 1991 in circumstances where a previous rule becomes inoperative after lodgment, we consider that all eight applications should be assessed as Discretionary Activities. However, in the event that Non-Complying Activity status is required for the three applications lodged earlier, we consider that there is no difficulty in those applications passing both of the 'gateway' tests under s104D(1)(a) and (b) of the RMA.

Given the above, consent can be granted to all of the applications pursuant to sections 104, 104B, and 107, and, if necessary, s 104D, of the RMA, subject to the imposition of conditions under section 108 of the RMA (as proposed in Appendix F of this report).

APPENDIX A – Agreed Interpretation of RRMP Policies

TRANCHE 2 TAKES - PLAN CHANGE 6 'POLICY QUESTIONS'

Notes of meeting held on 10 April 2018 at Hawke's Bay Regional Council Offices

Present: Malcolm Miller (Consents Manager, Hawke's Bay Regional Council
Paul Barrett (Senior Planner, Hawke's Bay Regional Council)
Rob van Voorthuysen (van Voorthuysen Environmental Ltd)
Susan Rabbitte (Lattey Group)
Janeen Kydd-Smith (Sage Planning HB Limited)

The purpose of the meeting was to reach agreement between those present to a number of questions (outlined below) relating to the implementation of the Regional Plan policies for taking Tranche 2 groundwater that would assist consideration of the applications going forward.

Relevant Regional Plan Policies

Policy TT8(1)(ca)

Enabling additional groundwater to be abstracted as a discretionary activity (Table 5.9.5 Tranche 2) provided that river flows are augmented to maintain the relevant minimum flows specified in Table 5.9.3 commensurate to the scale of effect of the Tranche 2 groundwater take.

Policy TT14(e), TT14(fa) and TT14(fc) and TT14(h)

(e) New takes within the table 5.9.4, 5.9.5 or 5.9.6 Allocation Limited and complying with the minimum flow regime shall be a Discretionary Activity.

(fa) Except as provided for in (a) to (f) above, takes (including those that do not comply with the minimum flow regime), shall be Non-complying Activities.

(fc) For takes granted under (e) to (fa) above the consent duration shall be no more than 20 years.

Rule TT4(c)

No new groundwater takes from Groundwater Allocation Zones 2 and 3 utilising Tranche 2 groundwater may be exercised under this rule unless and until augmentation flows are discharged that are commensurate to the scale of effect of the proposed take, during the same irrigation season as the Tranche 2 groundwater takes are exercised, to each of the Waipawa River and the Upper Tukituki River or one or more of their respective tributaries at a rate of up to 715 l/s to each river catchment at the highest practicable elevation as required to maintain the relevant downstream minimum flows specified in Table 5.9.3.

Questions:

Responses to the questions, as agreed by the parties present at the meeting, are shown in red below.

1) Are some of the applications non-complying activities because Rule TT4 as notified did not include provision for Tranche 2 takes. The RRMP (with Rule TT4(c)) became operative on 1 October 2015.

   Yes – some applications will be non-complying activities depending on the date they were lodged. To be granted these applications will need to meet the s104D 'gateway test'. HBRC will advise which of the applications are non-complying. Agreed.

2) Does "river flows" include both tributaries and mainstems of the Tukituki and Waipawa Rivers?

   Yes, tributaries included, and a distributed affect of the Tranche 2 takes on surface water flows is likely. Agreed.

3) Where should the augmentation discharges occur, for example?
   - As near as possible to the groundwater take?
     Not necessarily – a regime where augmentation occurs away from the site of take could be possible/preferable, but implementation also needs to be practicable.
   - In the nearest tributary that is permanently flowing?
     Yes, that is sensible and preferable as greater benefits to surface water flows would accrue from that as opposed to discharging augmentation flows above a drying reach.
   - Not upstream of a 'drying reach'?
     Preferable ., but may not be practicable.

   A geographic spread of augmentation may be preferable, as long as this does not cause excessive costs to individual applicants or cost inequities across applicants.

4) Are the augmentation discharges required to be of a rate that ensures that the relevant minimum flows specified in Table 5.9.3 are not breached, or

   No, given direction of POL TT8(ca)

5) Is each individual augmentation discharge required to be of a rate that offsets (equates to) the assessed depletion effect of each respective Tranche 2 take on the surface water flows in the Ruataniwha basin?

   Yes

6) Are the augmentation discharges required to commence when the Table 5.9.3 minimum flows are reached on the relevant river with respect to each Tranche 2 take ("relevant river" being the river most directly affected by the Tranche 2 take), or
7) Are the augmentation discharges required to commence <u>prior</u> to exercising the new groundwater takes? Refer to Rule TT4(c) which states: "*No new groundwater takes […] may be exercised under this rule unless and until augmentation flows are discharged […]*."
8) Should Red Bridge also be considered a relevant downstream minimum flow site?
9) Are the augmentation discharges required to commence before the Table 5.9.3 minimum flows are reached on a relevant river with respect to each Tranche 2 take?

10) If (9) applies, what factors should be taken into account to determine when the augmentation discharges should commence, for example?
   - Effects on existing surface water takes (reliability of supply)? High flow takes not specifically considered?
   - Effects on POL TT10 high flow takes (those that existed at the time the application for Tranche 2 was lodged)?
   - Temporal effects on when minimum flows may be breached?
   - Lag time (time it takes for the effects of a Tranche 2 take to manifest in surface water)

   Augmentation should commence in advance of the minimum flow occurring, and this should be a simple trigger level, that is the estimated rate of stream depletion above the relevant minimum flow. At Red Bridge, this will be the effect of the full Tranche 2 allocation above the red bridge minimum flow level (e.g. 650 L/s or similar). Will this be proportional based on the level of allocation if T2 is not fully allocated? The trigger level will need to be developed at each other minimum flow site based on the scale of effects/abstraction (or some other proportional approach e.g. catchment area) above these sites. The relevant recession curves (or similar) could be used to estimate the duration of augmentation requirement between the trigger and minimum flows to permit calculation of the appropriate augmentation volumes to be applied to each consent.

   This approach would mean that effects on existing surface water user are avoided. As the full effects of the Tranche 2 takes on surface flows will build up over time (years), the above approach to the use of trigger levels may benefit surface water flows in the short to medium term (namely the rate of augmentation will exceed the level of induced stream depletion), and therefore also existing surface water abstractions where these occur in streams or rivers that are augmented.

11) How long should each augmentation discharge occur for:
   - Only when the relevant Tranche 2 take is occurring? No
   - Before the Tranche 2 take commences? No
   - For the period of time when a relevant minimum flow (or some other trigger level – see 9 above) is breached? yes
   - For the whole 'irrigation season'? no
   - For the length of time that effects from a take will continue to occur, including possible inter-seasonal effects? no

   Augmentation should occur when the river flows are below the trigger levels described above, within the irrigation season (November to April inclusive), and until the augmentation volume provided for by the consent is fully expended.

   It is noted that once the augmentation volume is expended, the irrigation volume should also be fully utilised, and that irrigation could not continue to occur after the augmentation is fully expended.

   The length of the augmentation period (low flow period + stream depletion effect) determines how much augmentation volume is required (i.e. augmentation requirement x no. of days per season augmentation is required). This should be approached consistently so that an equitable allocation is achieved. Irrigation demand is determined on a 1 in 10 year basis (see RPS Policy 32). The augmentation volume could be determined on the same basis. [HBRC to look at doing this analysis].

12) Taking into account OBJ TT1 and POL TT11(1)(a) [which excludes takes deeper than 50m from direct stream depletion effects including those on wetlands] do any other effects need to be taken into account when determining the above matters (e.g. aquatic effects)?

    Maybe, if specific high value reaches could be identified, and the effect of these estimated and considered.

    This might be best considered on an individual basis, and could be a factor that helps determine the best augmentation location. Other mitigation could potentially be considered (e.g. riparian planting/shading).

13) Should each groundwater take for irrigation be assigned a maximum rate of take and a seasonal volume?

    Yes – as per Pol TT14. Augmentation rate and volumes should also be specified.

14) Having regard to POL TT14(e) and (fc) what consent duration is appropriate?

    20 years

15) Do the effects need to be modelled in relation to takes occurring over the appropriate consent duration?

    Yes

APPENDIX B – Aqualinc 2021 Groundwater Modelling Report

aqualinc

Groundwater REPORT

RUATANIWHA BASIN
Tranche 2 Groundwater Modelling

PREPARED FOR
Various Collaborative Participants

WL18045

19/08/2021

PREPARED BY
Julian Weir

aqualinc.com

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Quality Control

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EXECUTIVE SUMMARY

In 2013, Aqualinc Research Ltd (Aqualinc) developed a three-dimensional numerical flow model of the Ruataniwha basin as part of the Tukituki catchment Plan Change 6 (PC6) hearing. Recently, the model has been updated and used to test the hydraulic response of the groundwater and surface water system in the basin from multiple proposed Tranche 2 groundwater take applications. This work has been completed in a collaborative environment with Hawke's Bay Regional Council (HBRC) and eight Tranche 2 groundwater applicants.

The Tranche 2 groundwater applicants propose to abstract groundwater, and (as required under PC6) mitigate the consequential stream depletion effects via further abstraction to directly augment river flows during drier periods (when takes from the rivers are restricted). The concept of augmentation is based on using groundwater stored in the aquifer system during wetter periods to mitigate stream depletion effects during drier periods. The augmentation takes will also result in additional stream depletion effects, but this too will be delayed and spread over space and time through the storage response of the aquifer system. While there is on average more water abstracted from the basin's aquifer system (compared to current), the rationale is founded on the principle of using the groundwater system to smooth, buffer and delay stream depletion effects using groundwater storage that is later replenished naturally.

Since the original model documented in Weir (2013), the model has been updated with new aquifer test data received from HBRC. The model was then recalibrated to measured groundwater levels and river flows, with a particular focus on matching low (dry-period) river flows to align with HBRC's water management strategies. Good matches were achieved between measured and modelled outputs. The model simulates the period 1972-2012, which incorporates a wide range of climatic variability from very wet to very dry years.

The updated numerical model has been used to quantify the stream depletion effects of the proposed Tranche 2 groundwater takes and the subsequent surface water augmentation requirements. This is not an exact science as there are several variables that need to be assumed or approximated. However, the modelling work has provided a realistic quantification of the magnitude, location and timing of effect.

Several scenarios of abstraction and augmentation were modelled to arrive at an 'optimised' solution. This includes:

- Irrigated areas and augmentation rates a little smaller than applied for by some applicants;
- Adopting higher river low-flow restrictions (than those set out in Table 5.9.6 of HRBC's Regional Resource Management Plan) to provide improved environmental low flows and to protect existing users' reliability;
- Full augmentation whenever these higher river flow restrictions are triggered, regardless of whether or not Tranche 2 irrigation is occurring; and
- Full augmentation occurring from all Tranche 2 applicants when any one of the flow monitoring sites within the basin is triggered; this acknowledges that all Tranche 2 applicants are operating collaboratively, and effects from any one take can propagate across several streams. The exception to this is Tuki Tuki Awa who propose to take Tranche 2 groundwater and augment to the Tukituki River only when their existing surface water take is restricted.

The numerical model domain encompasses the Ruataniwha basin, and does not extend to HBRC's flow monitoring site on the Tukituki River at Red Bridge, down catchment. Therefore, the flow monitoring sites on the Waipawa at SH2 and Tukituki at Tapairu Road have been considered to represent this site. So long as the combined 7-day MALF at the SH2 and Tapairu Road sites are maintained (or improved), then there will be no adverse downstream effects on low flows at Red Bridge as a result of the proposed Tranche 2 takes.

Summary of Effects

Proposed low-flow triggers and net changes in 7-day MALF for key river low monitoring sites under the optimised scenario are summarised in the table below.

Site				
Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
RRMP Table 5.9.6 minimum flow (l/s)				
2,500	2,300	150	1,043	1,170
Assumed low-flow restriction applied (l/s) [(1)]				
2,725	2,360	155	1,085	1,295
Change in mean 7-day annual low flow (MALF) (l/s)				
+3	+135	-1	+1	+2
Change in 7-day MALF as a percentage of low-flow limit				
+0.1%	+5.7%	-0.6%	+0.1%	+0.2%
[(1)] These are higher than current RRMP Table 5.9.3 limits to provide greater environmental benefit during low flows and to protect reliability of existing users.				

The small residual negative change to 7-day MALF flow in the Tukipo River is smaller than both model uncertainty and measurement precision.

The following key findings have been derived from the modelled scenarios:

- The effects on river flows from the proposed additional Tranche 2 takes are spread over both space and time throughout the basin.
- If augmentation is applied when flow sites reach the higher flow restrictions (discussed above), regardless of whether or not Tranche 2 irrigation is operating, augmentation results in an overall improvement in low flows exiting the basin in both the Tukituki and Waipawa rivers. As noted above, the exception to this is Tuki Tuki Awa who propose to take Tranche 2 groundwater and augment to the Tukituki River only when their existing surface water take is restricted. This also does not adversely affect low river flows.
- Targeted over-compensation (i.e. the positive changes in MALF) accommodates modelling prediction uncertainty, enhances environmental low-flows, and accommodates across-catchment effects.
- Groundwater will not be mined. While groundwater levels will lower further with the additional Tranche 2 takes, they will not continue to lower; they will simply reach a new (lower) dynamic equilibrium. Shallow groundwater levels are predicted to lower a maximum of 0.8 m in the vicinity of the Tranche 2 take locations, and less than 0.3 m further afield.

Several management, operational and compliance protocols are recommended to aid practical implementations of the Tranche 2 takes and augmentation, including:

- Staged development and transitional implementation;
- Automated monitoring of river flows; and
- Defining a ‘Water Year’ and associated start date of irrigation and augmentation.

1 INTRODUCTION AND BACKGROUND

In 2013, Aqualinc Research Ltd (Aqualinc) developed a three-dimensional numerical flow model of the Ruataniwha basin as part of the Tukituki catchment Plan Change 6 (PC6) hearing. Recently, the model has been updated and used to test the hydraulic response of the groundwater and surface water system in the basin from multiple proposed Tranche 2 groundwater take applications.

The Tranche 2 groundwater applicants propose to abstract groundwater (primarily for irrigation use), and (as required under PC6) mitigate the consequential stream depletion effects via further abstraction to directly augment river flows during drier periods (when takes from the rivers are restricted). The concept of augmentation is based on using groundwater stored in the aquifer system during wetter periods to mitigate stream depletion effects during drier periods. The augmentation takes will also result in additional stream depletion effects, but this too will be delayed and spread over space and time through the storage response of the aquifer system. While there is on average more water abstracted from the basin's aquifer system (compared to current), the rationale is founded on the principle of using the groundwater system to smooth, buffer and delay stream depletion effects using groundwater storage that is later replenished naturally.

The numerical model has been used to quantify the stream depletion effects of the proposed Tranche 2 takes and the subsequent surface water augmentation requirements. This is not an exact science as there are several variables that need to be assumed or approximated. However, the modelling work has provided a realistic quantification of the magnitude, location and timing of effect.

To reduce the influence of measurement and model uncertainty, the most appropriate application of model results is to consider *changes* in key outputs (river flows and groundwater levels) rather than absolute values. In this regard, the model tests the effectiveness of the proposed augmentation to mitigate the changes in river flows that would be induced by the Tranche 2 takes. The modelled changes can be compared to measured values to derive absolute values, if required.

The original model development and calibration is documented in Weir (2013), much of which is not reproduced herein. The reader is referred to this publication for detail. More recently, the model has been updated with new field data, and used to run various scenarios to test the hydraulic response of the proposed Tranche 2 takes and the ability to mitigate adverse effects on surface water during low-flow periods through augmentation. Model updates, scenarios and results are documented below.

1.1 Collaborative Approach

This work has been completed in a collaborative environment with Hawke's Bay Regional Council (HBRC) and the following eight Tranche 2 groundwater applicants:

- Te Awahohonu Forest Trust (TAFT)
- Papawai Partnership
- Tukituki Awa
- Plantation Road Dairies
- Springhill Dairies (formerly Ingleton Farms)
- I & P Farming (formerly Abernethy Partnership)
- Buchanan Trust No 2
- Purunui Trust

TAFT have helpfully provided overall coordination and leadership from the perspective of the Tranche 2 Applicants, and further planning advice and support have been provided by Sage Planning, vVEnvironmental and other consultants working for some of the above applicants.

2 MODEL OVERVIEW AND UPDATES

The original Ruataniwha basin flow model was developed as a MODFLOW-NWT model (Niswonger *et al*, 2011) with a 200 x 200 m size grid. It includes the main rivers and streams in the basin, land surface recharge (both dryland and irrigated) and groundwater pumping. The study area is shown in Figure 2.

The model runs with daily stress periods from 1 July 1972 to 30 June 2012. It has been calibrated against transient groundwater levels and river flows within this time span, with a particular focus on matching low (dry-period) river flows to align with HBRC's water management strategies. The graphical user interface GMS (2019) has been used to generate the MODFLOW-NWT input files, and to post-process and visualise the outputs.

Since the original model documented in Weir (2013), a review of aquifer tests in the basin has been received from HBRC following a review by PDP (2018). Aquifer test results from this work have been incorporated into the model, specifically horizontal hydraulic conductivity, vertical hydraulic conductivity and aquifer storage parameters. After this new data was integrated into the model, it was recalibrated to measured groundwater levels and river flows (again, with a particular focus on matching low river flows).

Due to the length of time required to generate new model inputs, the model run period was not changed (i.e. not beyond 2012). However, the current model run period (1972-2012) incorporates a wide range of climatic variability from very wet to very dry years. This is demonstrated in Figure 1 which presents a histogram of annual rainfall totals (for each calendar year) for Ongaonga over the period 1970-2019. The range of annual rainfall totals over the simulation period (1972-2012) is also shown on this figure, and covers the full range on record, apart from the wettest year (this was 1971). Hence, extreme dry years (when the groundwater and surface water systems are most stressed) are captured in the simulation period, and therefore there was no need to re-run the model to include post-2012 climate data.

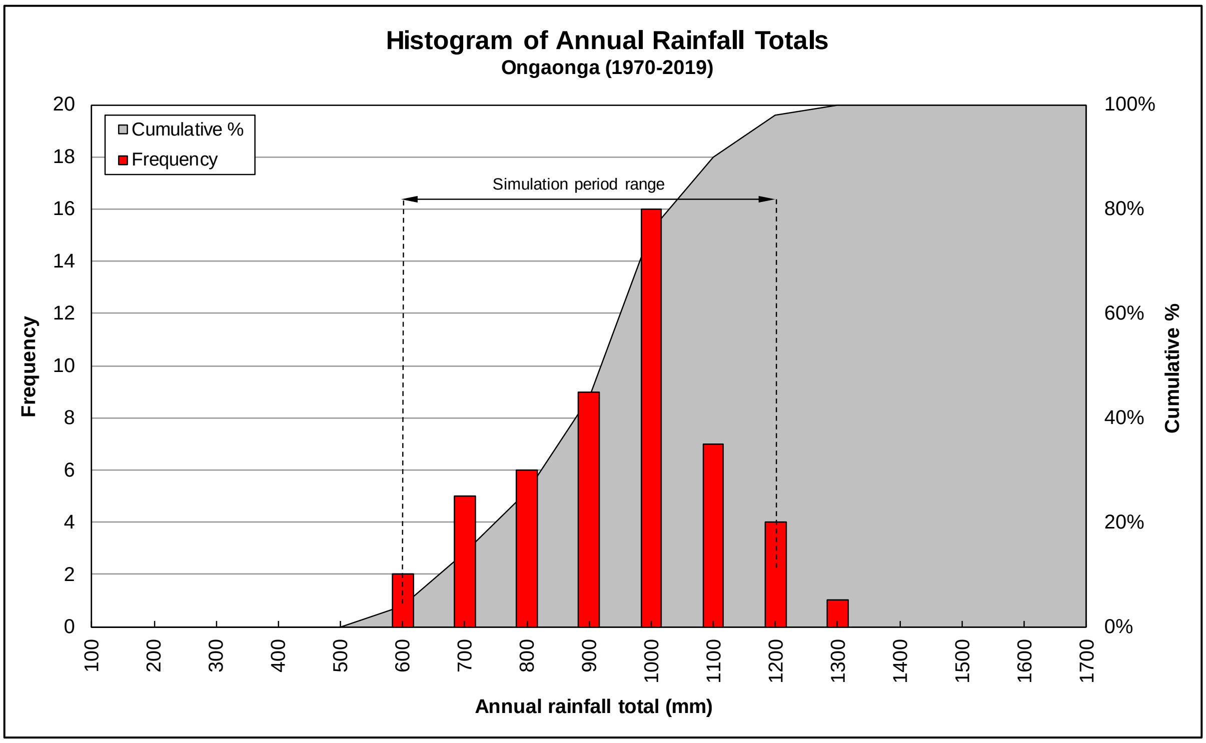


Figure 1: Histogram of annual rainfall totals for Ongaonga (data sourced from NIWA's CliFlow database)

2.1 Model Calibration

To ensure the model appropriately represents reality, the model was calibrated against measured data. This was achieved using a combination of manual trial-and-error methods and automated calibration using the software PEST (Doherty, 2010). Calibration focussed on two key datasets: groundwater levels and river flows. These are discussed in the following paragraphs. The calibration process is similar to that documented in Weir (2013).

2.1.1 Calibration to Groundwater Levels

During calibration, the modelled groundwater levels in a bore are compared to measured groundwater levels in the same bore, for all of the calibration bores. The difference between the modelled and measured groundwater level is called the ‘residual’. If the residuals are all generally positive or negative, then the system is said to be biased. One of the goals during model calibration is to minimise the residuals and bias.

Groundwater level calibration was based on groundwater level measurements (supplied by HBRC) from 30 monitoring bores within the basin (shown in Figure 3). Initially a steady-state version of the Ruataniwha Basin groundwater model was run using average model inputs and outputs, and this was calibrated against average measured groundwater levels in the calibration bores.

Once suitable steady state calibration had been achieved, a transient model was then run. The transient simulation period spans 1 July 1972 through to 30 June 2012 (40 years). The model was calibrated against any measurements available within this period.

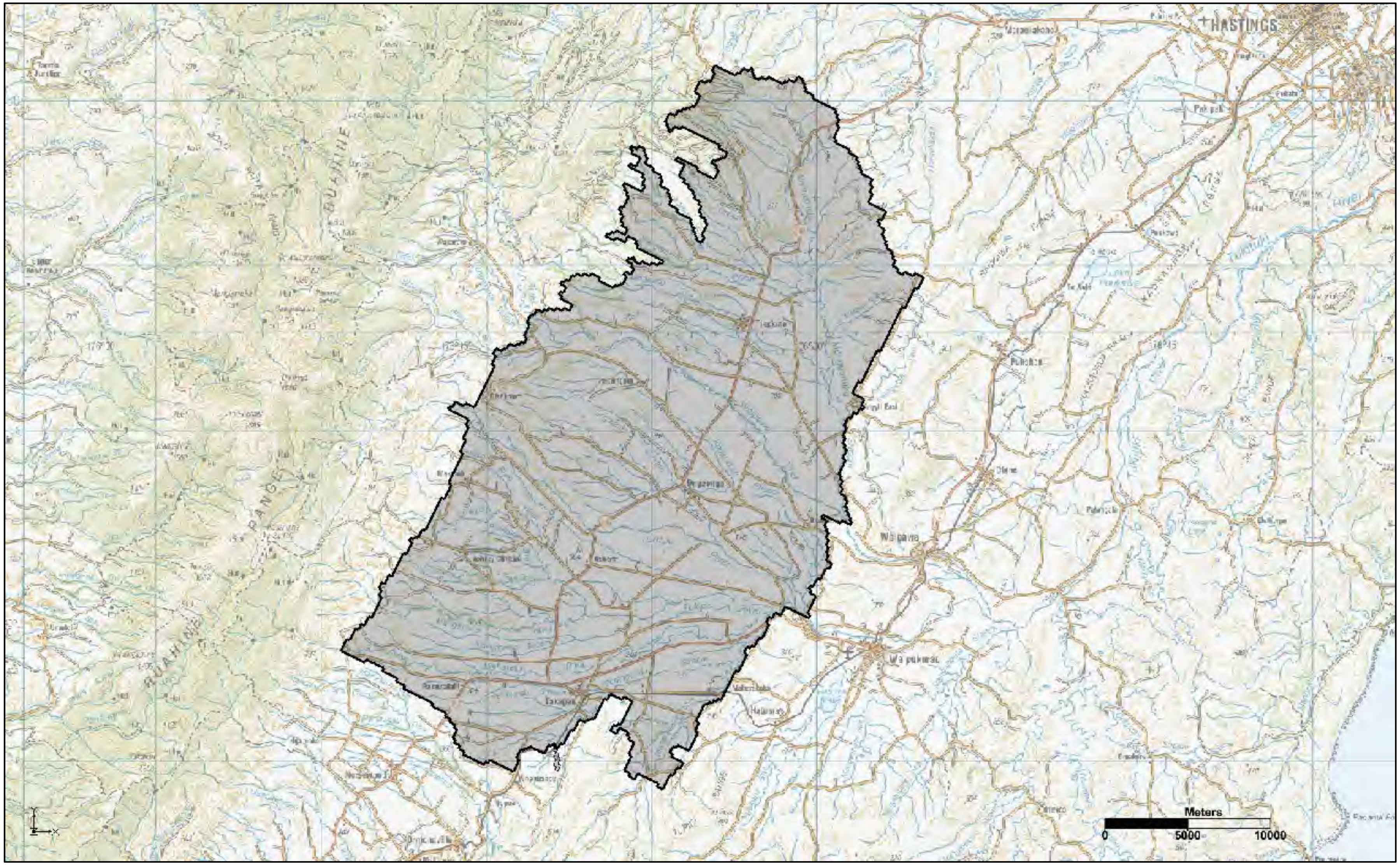


Figure 2: Study area with model extent shown by the shaded polygon (reproduced from Weir, 2013)

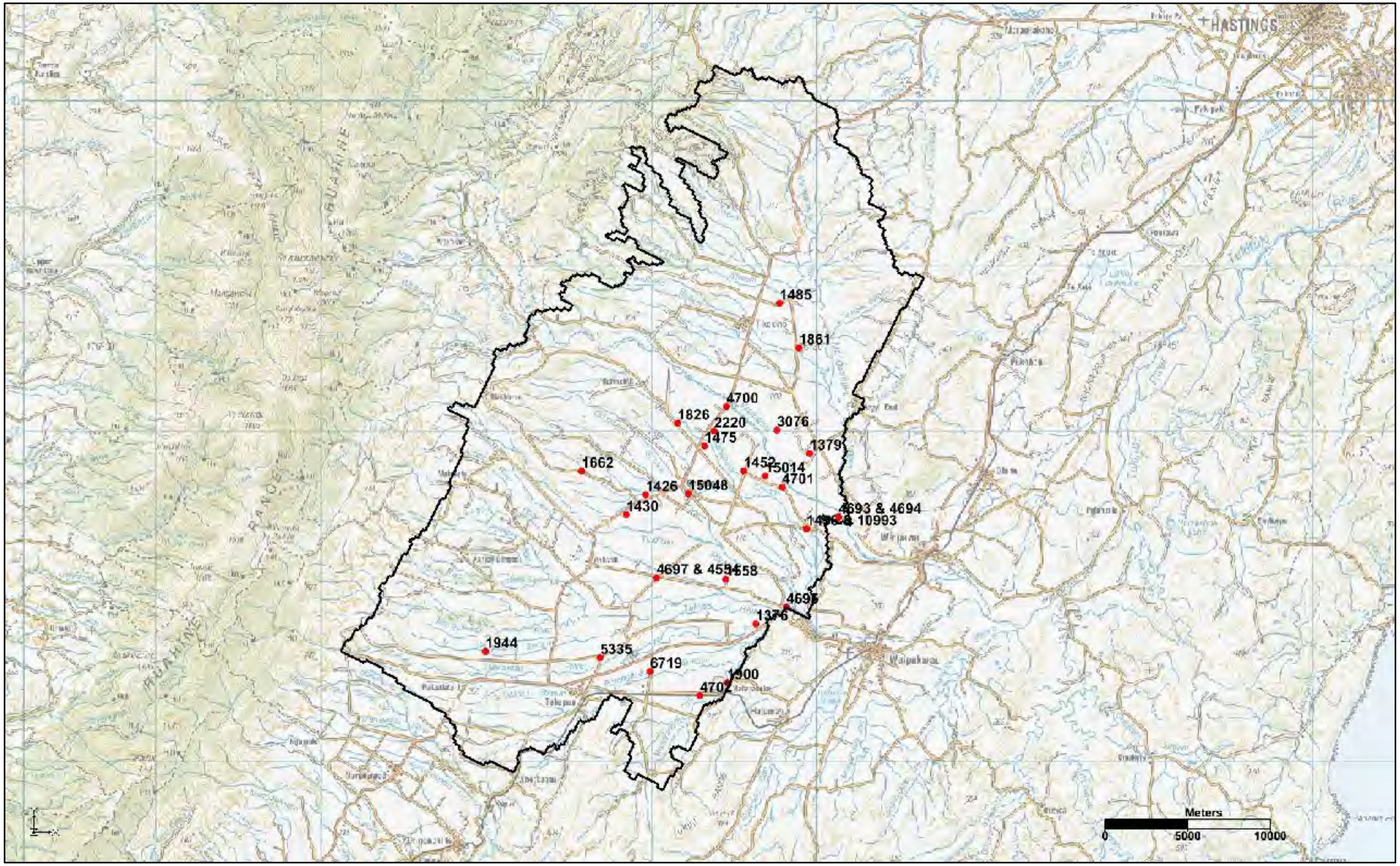


Figure 3: Location of bores used for groundwater level calibration

For groundwater level calibration, initially a 'No Irrigation' model scenario was used to simulate the groundwater level response under natural conditions. Therefore, calibration focussed on matching groundwater levels that were measured during periods that were unaffected by groundwater pumping (i.e. winter levels). The effects of groundwater abstraction were then verified against a model scenario that simulates the current level of groundwater abstraction (with no Tranche 2 takes occurring) with comparisons focussed on more recent groundwater level measurements that are affected by groundwater pumping.

The model calibrated very well. Plots of measured and modelled groundwater levels in the 30 monitoring bores are presented in Appendix A. The modelled groundwater level shown on these plots is for the full 40 year simulation period. Most bores have a plotted vertical axis range of 20 m so that a relative comparison between bores can be visualised.

Groundwater level measurements from bores 4697 and 5445 both show variations of over 30 m within each season. This appears to be a local phenomenon resulting from pumping in the bore or from another nearby bore. The model is a catchment-scale representation and has not been constructed to simulate these local effects. Hence, differences between measured and modelled groundwater levels are large for these bores. This does not jeopardise the model's ability to predict regional-scale effects.

Figure 4 presents a plot of measured versus modelled groundwater levels for the 'No Irrigation' scenario. For a model perfectly calibrated at every observation bore, all points would lie exactly along the dashed line running diagonally though the plot. The amount of scatter either side of this line provides an indication of the goodness of fit. Some scatter around this line is normal for any model that simplifies a complex real-world system. The scatter occurs as a result of measurement error and model structural uncertainty. The pumping effects in bores 4697 and 5445 (discussed in the above paragraph) are labelled on this plot.

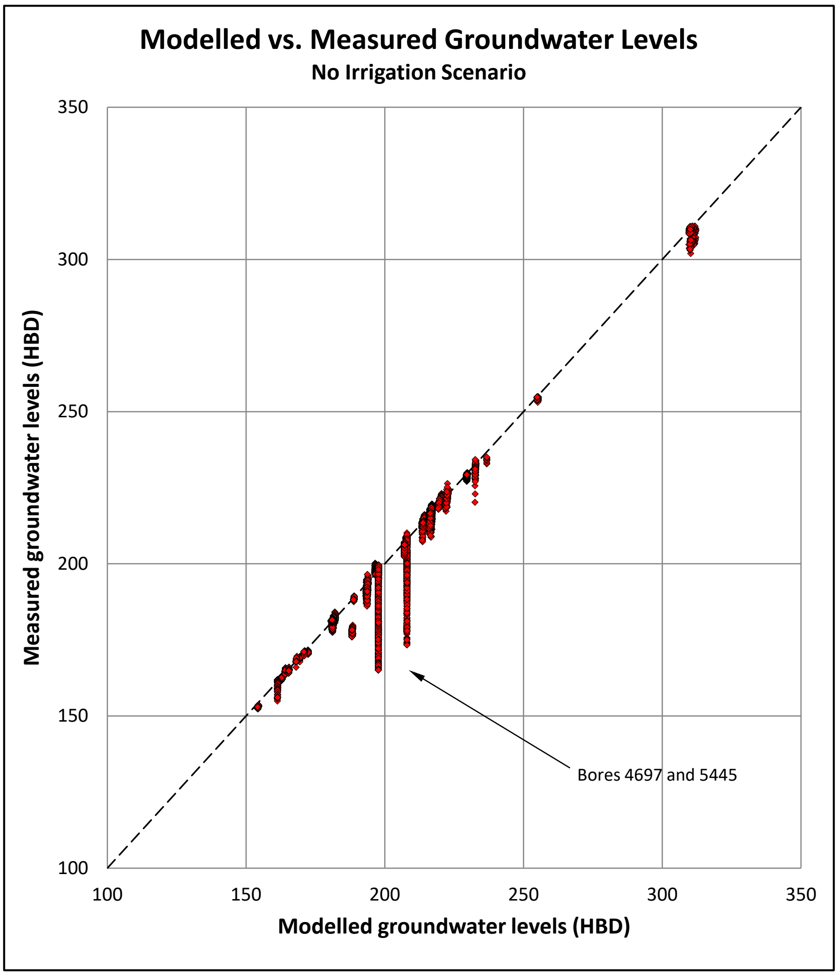


Figure 4: Modelled versus measured groundwater levels

An objective function is a mathematical formula that expresses numerically the goal that is to be achieved during calibration. For the purpose of this model, two objective functions have been considered, as follows:

a. The mean error (ME), which assists in showing the presence of bias (systematic error); and

b. The root mean square error (RMSE), which is a classical measure of model error. The RMSE is usually reported as a percentage of the range within which the measured values vary (this is also referred to as the 'normalised' RMSE).

One of the key goals of model calibration is to minimise the objective functions. Table 1 presents the groundwater level objective function values for the entire 40 year model simulation period. Also in Table 1 are additional statistics that have been generated and a brief description of these statistics.

Table 1: Groundwater level objective function values and other statistics for the calibrated model

Objective function or statistic	Full simulation period (1972-2012)	Definition
Mean error (ME) (m)	0.74	Average difference between modelled and measured groundwater level.
Maximum absolute residual (m)	34.6	Maximum difference between modelled and measured groundwater level.
Minimum absolute residual (m)	0	Minimum difference between modelled and measured groundwater level.
Root mean square error (RMSE) (m)	3.4	Classical measure of error.
Normalised RMSE	2.2%	RMSE normalised by the amount that the measured values vary during the simulation period.
R^2 (square of the correlation coefficient)	0.98	Correlation between measured and modelled values.

The United States Army Corps of Engineers use a rule of thumb for an acceptable normalised RMSE of 10% when considering groundwater flow calibration or verification (Donnell *et al.*, 2004). The 2001 Australian Groundwater Flow Modelling Guidelines indicate that the normalised RMSE should be less than 5% (MDBC, 2001) though the revised 2012 guidelines (Barnett *et al.*) suggest that alternative (larger) values may be acceptable depending on the model scope. The normalised RMSE is 2.2% for the calibrated model (Table 1). Based on these statistics, the transient model is suitably calibrated.

Model mass balance errors are less than 0.6% for all time steps and average approximately 0.01% over the full 40 year simulation. This implies that the model has sufficiently accurately accounted for all water movements.

2.2 Calibration to River Flows

River flow calibration primarily focussed on matching low flows, as abstraction potentially causes the greatest stresses to the rivers at these times. In addition, HBRC's management regimes are typically based on low flow statistics (such as the 7-day MALF).

River flow calibration focussed on the Tukituki and Waipawa rivers as these are the two rivers that drain the Ruataniwha Basin and have the greatest length of record within the model simulation period. River flow calibration data was supplied by HBRC for the Tukituki River at Tapairu Road and Waipawa River at RDS/SH2. The flow sites are located 5-11 km downstream of the outlets from the Ruataniwha Basin, as shown in Figure 5. However, for the purposes of model calibration, it has been assumed that river gains and losses between the basin outlets and these flow monitoring sites are negligible (i.e. these sites represent the flows exiting the basin).

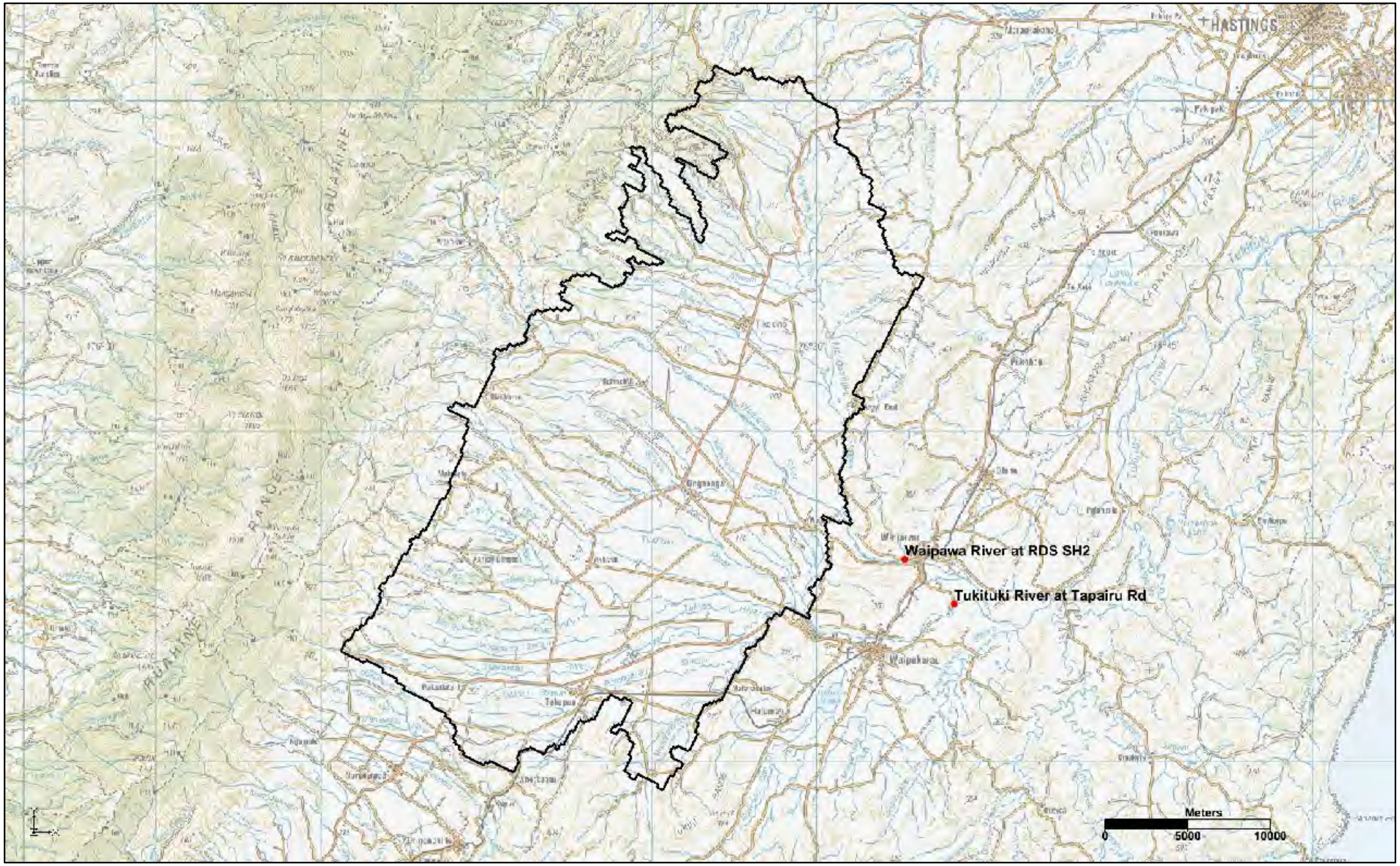


Figure 5: Location of river flow calibration sites

Appendix B presents hydrographs comparing measured and modelled flows for the calibration sites on the Tukituki and Waipawa rivers. Table 2 compares flow statistics for the different data sets.

Table 2: Measured and modelled river flow statistics

Data set	Time period	Tukituki at Tapairu Rd		Waipawa at RDS/SH2	
		Average (m^3/s)	MALF (m^3/s)	Average (m^3/s)	MALF (m^3/s)
Measured	April 1987-December 1990	17.03	2.65	16.89	3.09
Modelled		17.87	2.81	16.05	3.13
Modelled difference to measured		5%	6%	-5%	-1%
Modelled	1972-2012	16.95	2.68	15.41	2.98

Overall, modelled river flows are consistent with measured flows. Modelled flow statistics are within 6% of both the measured 7-day MALF and the measured average.

2.3 Calibrated Model Parameters

Aquifer horizontal conductivity, vertical conductivity and specific storage were assigned by interpolating between a series of points (called 'pilot points'). This resulted in spatially variable properties. Where available, aquifer test values were assigned individual fixed pilot points. Additional pilot points were then added between these values and varied throughout model calibration. River bed parameters were assigned as single values for each of 26 specific river reaches assigned throughout the model.

Specific storage (defined as the aquifer storage divided by the saturated thickness) for layer 1 was assigned separately to layers 2 and below to simulate the different hydraulic response of shallow unconfined/semi-confined aquifers compared to the deeper more confined layers.

Maps of horizontal hydraulic conductivity, vertical hydraulic conductivity and specific storages (for both layer 1 and also layers 2 and below) are shown in Appendix C.

River bed conductivities were varied for each calibration reach. Values varied between 0.0018 m/day and 5 m/day.

Subsurface flows under the two rivers at the outlets of the basin are relatively unknown but are expected to be small in comparison to river flows. The magnitude of these flows has been estimated by multiplying the groundwater gradient at these locations (based on nearby measured groundwater levels) with nearby aquifer transmissivities (reported by PDP, 2018), given the width of the groundwater opening. This yielded a total flow of approximately 0.06 m^3/s combined through the two subsurface outlets. This equates to less than 0.2% of the average measured river flow.

The conductances of the general head boundaries at these outlets were adjusted so that the modelled subsurface flows over these boundaries approximately equalled the estimated flows.

3 SCENARIOS

The calibrated flow model has been used to run multiple scenarios of future takes to quantify the net change in river flows. The following scenarios have been simulated:

- Baseline: Status quo. This includes all existing takes, but no proposed Tranche 2 takes.
- Scenarios 1-8: One model run for each of the eight proposed Tranche 2 applicants. These models are all founded on the Baseline scenario, but with each applicant's proposed full irrigation needs at their proposed location. The results of these scenarios (compared to the baseline) have then been used to determine the timing of the augmentation requirement (for mitigating stream depletion effects of the irrigation take alone) that would feed into subsequent augmentation scenarios.
- Augmentation Scenarios: Initially, a combined model scenario including all applicants' takes and with each applicant's augmentation operating. Then additional scenarios that balance environmental flows and irrigated areas.

Further details of these scenarios are provided below along with a brief discussion on each applicant's proposed activity and their water use. An overview of the applicants' farm locations, augmentation locations and key flow monitoring sites is provided in Figure 6.

3.1 Scenario Modelling and Augmentation Rationale

When the Tranche 2 applications were lodged, it was unclear how the Tukituki PC6 provisions should be interpreted and implemented. The reason being that the Tranche 2 regime was developed by the Tukituki Board of Inquiry and not by HBRC. For example, it was unclear whether or not the effects of the deep groundwater augmentation abstractions on surface flows would themselves need to be offset by further augmentation, and so on. Some applicants (including Te Awahohonu Forest Trust and Springhill Dairies) assumed that would be the case while others did not.

Consequently, the approach taken here is to focus on the total amount of Tranche 2 water sought by each applicant and the total irrigable area applied for.

Irrigation demand is then calculated for the irrigable areas applied for using Aqualinc's in-house soil-water balance model, IrriCalc. From these calculations, the 90 percentile (or 9 in 10 years) irrigation demand has been calculated. Once the irrigation demand is calculated, then the irrigation volume is deducted from the total volume applied for to yield a volume of water available for augmentation. Various scenarios are then modelled to assess the effects of each applicants' take (singularly and in combination with all other applicants) and the optimum timing for the commencement and duration of the augmentation takes. Consequently, the division between irrigation and augmentation use varies depending on the scenarios being modelled (discussed later), but the total volume of water taken will not exceed that originally applied for. However, in some cases the original irrigable area needed to be reduced to either enable sufficient water to be available for augmentation purposes (e.g. for Papawai Partnership) or to ensure that the total volume of Tranche 2 water available (15 million m^3) was not exceeded (e.g. for Purunui).

The assessments described herein assume that all Tranche 2 water is used for new irrigation, except for Tuki Tuki Awa. If only some Tranche 2 water is used to fill in gaps when Tranche 1 water is unavailable, then the overall effects will be less than assessed: less Tranche 2 water will be taken for irrigation and augmentation will remain the same.

3.2 Baseline Scenario

The Baseline (Status Quo) scenario represents the currently irrigated area of approximately 6,000 ha within the basin. This is comprised of 4,025 ha from groundwater and 1,975 ha from surface water. Surface water takes are restricted based on the relevant low flow abstraction cessation rules in HBRC's Regional Resource Management Plan (RRMP). This scenario has been used as a baseline against which other scenarios have been compared to quantify changes in river flows and groundwater levels.

For simplicity, it has been assumed that all existing and future irrigated land use is pasture, which typically has a larger seasonal water demand than other land uses. Irrigation return water is realised as an increase in land surface recharge.

If land uses other than pasture are applied (e.g. cropping, or mixed pasture and cropping), then the seasonal water use and associated recharge will be less for the same irrigated area, or a larger area could be irrigated for the same seasonal volume. In these cases, the modelled effects on river flows will be either less or similar (respectively) than the assessments presented below.

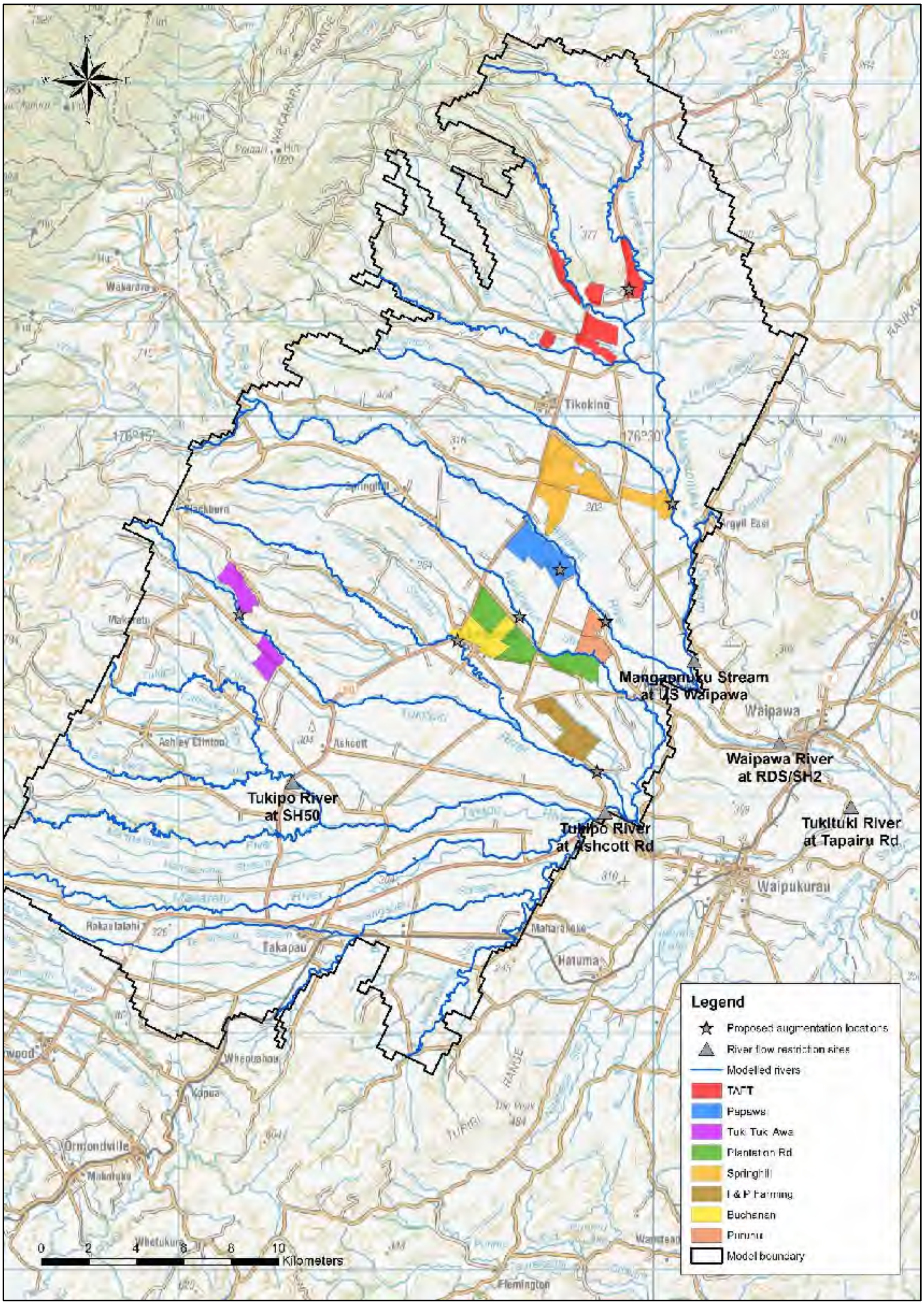


Figure 6: Tranche 2 applicants' farm locations for T2 water, proposed augmentation discharge locations, and key river flow monitoring sites

3.3 Te Awahohonu Forest Trust (TAFT)

Te Awahohonui Forest Trust (TAFT) have applied to take up to **4,914,920 m^3/year** of Tranche 2 groundwater from deep bores located around their Gwavas Station property, Tikokino. The proposed take is intended to irrigate 540 ha of pasture (assumed), or a larger area of less water-intensive crops or horticulture, and provide river augmentation to the Mangaonuku Stream.

The location of the bores (existing and proposed) from which TAFT have proposed to take groundwater, and the approximate locations of the augmentation take bore and the discharge site, are shown in Figure 7.

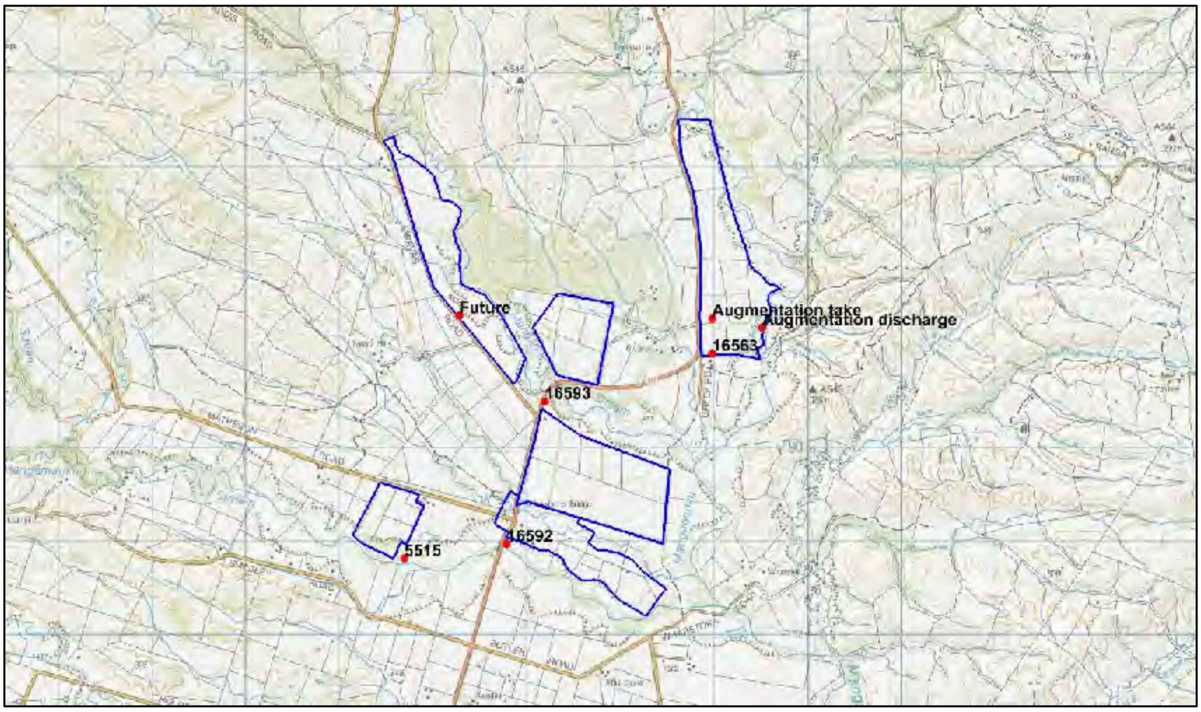


Figure 7: TAFT's proposed bore and augmentation locations (proposed irrigation areas are shown as blue outlines)

Key infrastructure for TAFT's proposed Tranche 2 take are summarised in Table 3.

Table 3: TAFT's proposed Tranche 2 infrastructure

Site	Use and/or status	Current status	Depth (m bgl)	Approx. irrigated area (ha)
Bore 16563	Irrigation	Existing	162.2	130
Bore 16592	Irrigation	Exploratory well	220.8	100
Bore 16593	Irrigation	Exploratory bore	222.3	110
Bore 5515	Irrigation	Existing	66.0	50
Future bore	Irrigation	Proposed	~ 200	150
Augmentation take	Augmentation take	Proposed	~160	-
Augmentation discharge	Discharge to Mangaonuku Stream	Proposed	-	-

3.3.1 Irrigation Demand

Irrigation demand has been modelled using Aqualinc's IrriCalc soil-water balance model. The 90 percentile water demand for pasture is calculated to be approximately 580 mm/year, which over an irrigated area of 540 ha equates to an annual volume of 3.1 million m^3/year.

The IrriCalc modelling provides a daily time series of crop water demand (assuming an unrestricted supply) and resulting daily time series of land surface recharge (LSR). The crop water demand has been modelled from the bores proposed to supply the property, as listed in Table 3, in proportion to the listed irrigated areas. Furthermore, new irrigation results in additional LSR compared to dryland. This has also been incorporated into the model by exchanging previously dryland LSR with irrigated LSR for the proposed irrigated areas shown in Figure 7.

3.3.2 Modelling Results for TAFT

The model has been run with daily outputs generated from 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites shown in Figure 6 have been processed to generate changes in flow statistics due to TAFT's irrigation take alone. Changes in these flow statistics compared to the baseline are summarised in Table 4. Although the results are presented to the nearest litre per second, the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect.

Table 4: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to TAFT's irrigation take alone (no augmentation)

Scenario	Site				
	Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)					
TAFT's irrigation take only	-64	-18	0	-8	-35
Change in mean 7-day annual low flow (MALF) (l/s)					
TAFT's irrigation take only	-48	-9	0	-6	-37

From Table 4, irrigation alone (with no augmentation) results in a reduction in river flows throughout much of the basin. The largest changes occur in the Waipawa catchment and tributaries, as this is the catchment within which Gwavas Station is located. However, small scale effects do propagate over to the lower Tukituki catchment and tributaries.

Changes in flows allowing for all Tranche 2 applicants' irrigation takes, augmentation takes and augmentation discharges are presented later.

3.4 Papawai Partnership

Papawai Partnership have submitted two applications to take Tranche 2 groundwater. An original application was submitted to take up to 423,062 m^3/year of groundwater, and a new application has recently been submitted to take up to 1,052,455 m^3/year of groundwater. These combine to a total of **1,475,517 m^3/year** and comprises 1,161,000 m^3/year for irrigation and 314,517 m^3/year for augmentation. The applications seek to take groundwater from an existing deep bore (16508) located on their property, adjacent to the Waipawa River, and provide river augmentation to this river. The irrigation component of the proposed Tranche 2 take will supplement an existing consented take of 608,212 m^3/year to provide adequate irrigation of 320 ha of pasture (assumed) or a larger area of less water-intensive crops or horticulture, from both bores 16508 and 1859 (combined).

Papawai Partnership have proposed to inject the augmentation water into an existing unused shallow bore located approximately 300 m from the Waipawa River. They have advised that they believe this shallow bore is directly connected to the nearby Waipawa River, though this will be confirmed prior to commencing augmentation. For the purpose of augmentation modelling, it will be assumed that the water will be discharge directly into the Waipawa River immediately adjacent to the shallow injection bore. Due to the fast hydraulic response between the Waipawa River and nearby shallow groundwater, this will make little difference to the modelled effects.

The location of existing bore 16508, from which Papawai Partnership have proposed to take the additional Tranche 2 groundwater, and the approximate location of the augmentation discharge site are shown in Figure 8. Also shown is the location of the other irrigation bore 1859.

Key infrastructure for Papawai Partnership's proposed Tranche 2 take are summarised in Table 5.

Table 5: Papawai Partnership's proposed Tranche 2 infrastructure

Site	Use and/or status	Current status	Depth (m bgl)	Approx. irrigated area (ha)
Bore 16508	Irrigation & augmentation take	Existing	119.6	160
Bore 1859	Irrigation	Existing	87.5	160
Augmentation discharge	Discharge to groundwater adjacent to Waipawa River	Existing	Unknown (shallow)	-

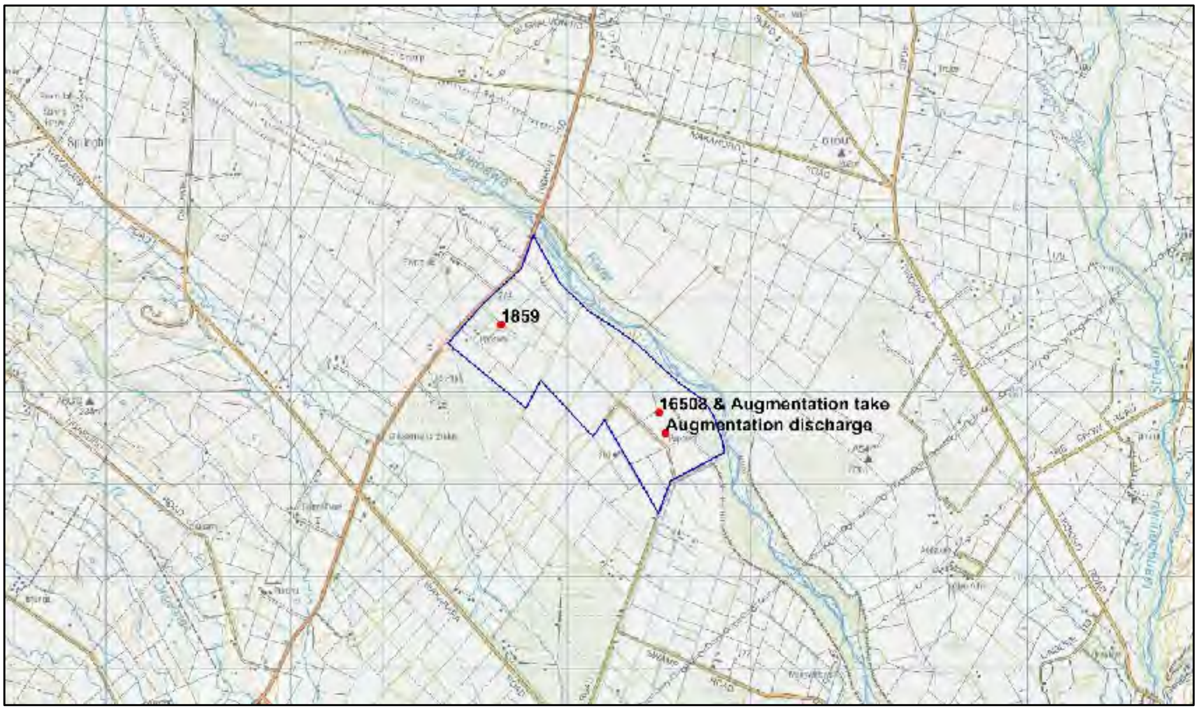


Figure 8: Papawai Partnership's existing bores and proposed and augmentation location (the total irrigated area is shown as a blue outline)

3.4.1 Irrigation Demand

Irrigation demand has been modelled using Aqualinc's IrriCalc soil-water balance model. The 90 percentile water demand for pasture is calculated to be approximately 560 mm/year, which over an irrigated area of 320 ha equates to an annual volume of 1.8 million m^3/year. In combination with their existing consented take, this is consistent with the total volume of water sought by Papawai

Partnership. The Tranche 2 groundwater applied for is adequate to irrigate approximately 207 ha of pasture.

The IrriCalc modelling provides a daily time series of crop water demand (assuming an unrestricted supply) and resulting daily time series of land surface recharge (LSR). The Tranche 2 crop water demand has been modelled from bores 1859 and 16508 (listed in Table 5), in proportion to the listed irrigated areas. Furthermore, new irrigation results in additional LSR compared to dryland. This has also been incorporated into the model by exchanging previously dryland LSR with irrigated LSR.

3.4.2 Modelling Results for Papawai Partnership

The model has been run with daily outputs generated from 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics due to Papawai Partnership's irrigation take alone. Changes in these flow statistics compared to the baseline are summarised in Table 6. Although the results are presented to the nearest litre per second, the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect.

Table 6: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to Papawai Partnership's irrigation take alone (no augmentation)

Scenario	Site				
	Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)					
Papawai's irrigation take only	-25	-8	0	-3	-9
Change in mean 7-day annual low flow (MALF) (l/s)					
Papawai's irrigation take only	-18	-3	0	-2	-10

From Table 6, irrigation alone (with no augmentation) results in a reduction in river flows throughout much of the basin. The largest changes occur in the mid-lower Waipawa catchment and tributaries, as this is the catchment within which Papawai Partnership is located. However, small scale effects do propagate over to the lower Tukituki catchment and tributaries.

Changes in flows allowing for all applicants' irrigation takes, augmentation takes and augmentation discharges are presented later.

3.5 Tuki Tuki Awa

Tuki Tuki Awa initially applied to take up to **952,400 m^3/year** of Tranche 2 groundwater from four proposed deep bores located on their southern irrigated property, adjacent to the Tukituki River. The irrigation component of the proposed Tranche 2 take is intended to replace existing surface supply for reliable and adequate irrigation of up to 136 ha of pasture (assumed) or a larger area of less water-intensive crops or horticulture.

Tuki Tuki Awa plan to maintain their surface water take and abstract only some of the proposed Tranche 2 groundwater to provide full reliability when their surface water take is on low-flow restrictions. However, the assessment described below has initially modelled a situation where all water is sourced from Tranche 2 groundwater with no change to the surface water take. This presents a worst-case scenario of effects. Any other combination of water supply from mixed sources (balancing surface and groundwater supplies) will result in smaller effects on river flows, and this is what is now proposed by Tuki Tui Awa. Therefore, a final scenario (Scenario 4, discussed later in this report) incorporates Tuki Tuki Awa's use of Tranche 2 water to only fill in the gaps in their existing surface water take when it is restricted.

Tuki Tuki Awa initially proposed to abstract Tranche 2 augmentation water from a series of new bores planned on their southern block, and discharge this directly into the Tukituki River adjacent to the block. The approximate location of the proposed new irrigation bores on the southern block, the proposed new augmentation abstraction bore, and the approximate location of the augmentation discharge site are shown in Figure 9. It is not proposed to irrigate the northern run-off block.

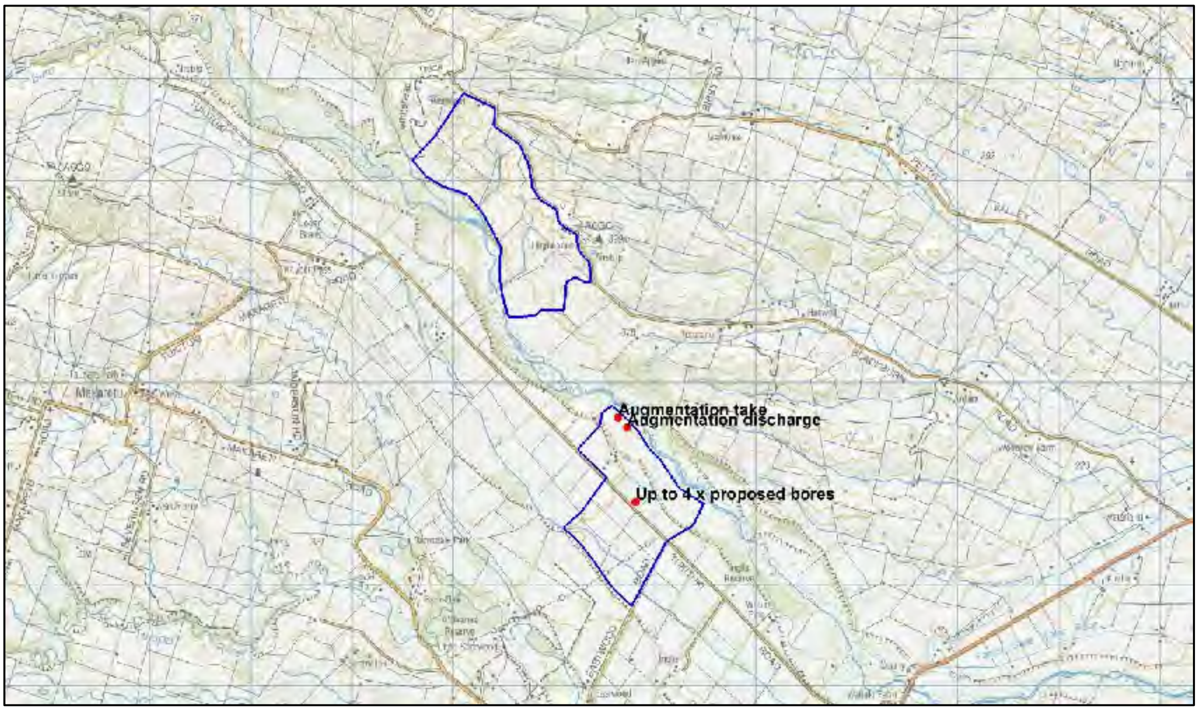


Figure 9: Tuki Tuki Awa's proposed bores and augmentation locations (the property boundaries are shown as blue outlines)

Key infrastructure for Tuki Tuki Awa's proposed Tranche 2 take are summarised in Table 7.

Table 7: Tuki Tuki Awa's proposed Tranche 2 infrastructure

Site	Use and/or status	Current status	Depth (m bgl)	Approx. irrigated area (ha)
Proposed bores x 4	Irrigation	Proposed	50 +	136
Augmentation take	Augmentation take	Proposed	50 +	-
Augmentation discharge	Discharge to Tukituki River	Proposed	-	-

3.5.1 Irrigation Demand

Irrigation demand has been modelled using Aqualinc's IrriCalc soil-water balance model. The 90 percentile water demand for pasture is calculated to be approximately 450 mm/year, which over an irrigated area of 136 ha equates to 612,000 m^3/year. This is less than the volume of water sought by Tuki Tuki Awa for irrigation purposes (which was 882,800 m^3/year) and suggests that not all of the water applied for would be used, except during extreme dry years. Alternatively, more Tranche 2 water could be used for augmentation than indicated in the application (if permitted).

The IrriCalc modelling provides a daily time series of crop water demand (assuming an unrestricted supply) and resulting daily time series of land surface recharge (LSR). The Tranche 2 crop water demand has been modelled from the location of the proposed bores (as listed in Table 7). Although irrigation results in additional LSR compared to dryland, the proposed Tranche 2 groundwater is sought to replace existing irrigation sourced from surface water. Hence, there will be no change to the irrigated area (and resulting LSR); the only change is from where the water is sourced.

3.5.2 Modelling Results for Tuki Tuki Awa

The model has been run with daily outputs generated from 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics due to Tuki Tuki Awa's irrigation take alone. Changes in these flow statistics compared to the baseline are summarised in Table 8. Although the results are presented to the nearest litre per second, the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect. As discussed above, these modelled flow changes do not allow for a reduction in Tuki Tuki Awa's surface water take due to Tranche 2 groundwater substitution.

Table 8: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to Tuki Tuki Awa's irrigation take alone (no augmentation)

Scenario	Site				
	Waipawa at SH2	Tukituki at Tapairu Rd	Tukipo at SH50	Tukipo at Ashcott Rd	Mangaonuku u/s Waipawa
Change in average flow (l/s)					
Tuki Tuki Awa's irrigation take only	-8	-11	-1	-7	-2
Change in mean 7-day annual low flow (MALF) (l/s)					
Tuki Tuki Awa's irrigation take only	-4	-5	-1	-5	-2

From Table 8, irrigation alone (with no augmentation) results in a reduction in river flows throughout much of the basin. The largest changes occur in the mid-lower Tukituki catchment and tributaries, as this is the catchment within which Tuki Tuki Awa is located. However, effects do propagate over to the lower Waipawa catchment and tributaries. The overall effects are relatively small compared to some other applicants because the total scale of the proposed Tranche 2 take is also relatively small.

Changes in flows allowing for all applicants' irrigation takes, augmentation takes and augmentation discharges are presented later.

3.6 Plantation Road Dairies

Plantation Road Dairies originally applied to take 6,000,000 m^3/year of Tranche 2 groundwater. After their application was lodged, they changed their proposal and reduced the volume of groundwater sought. The 'released' Tranche 2 groundwater was therefore available to fulfil the unmet volume applied by the last person in the Tranche 2 applicant queue at the time, and then for additional allocation under new applications. The volume of Tranche 2 groundwater that Plantation Road Dairies have now applied for is **3,751,225 m^3/year** from deep bores around their property, located in the lower basin between the Waipawa and Tukituki rivers. Approximately 26% of the volume has been assigned to augmentation, though this may change (discussed later under different scenarios). The remaining irrigation component of the proposed Tranche 2 take (2,775,914 m^3/year) will be used to irrigate up to 459 ha of pasture (assumed), or a larger area of less water-intensive crops or horticulture.

The location of the bores (existing and proposed), from which Plantation Road Dairies have proposed to take Tranche 2 groundwater, are shown in Figure 10. The proposed augmentation discharge site is also shown in this figure. It is proposed to take the additional augmentation water from a proposed new bore located in adjacent land also owned by Planation Road Dairies and discharge directly into the Kahahakuri Stream immediately beside this location.

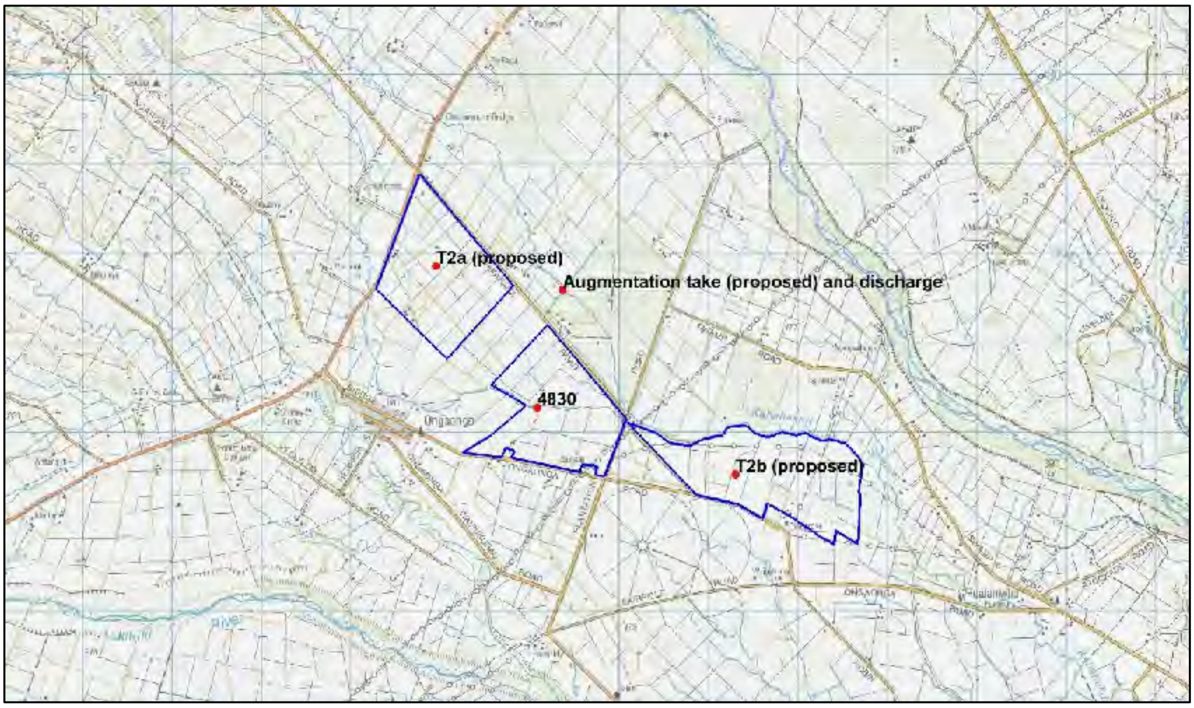


Figure 10: Plantation Road Dairies existing and proposed bores and augmentation locations (irrigation areas are shown as blue outlines)

Key infrastructure for Plantation Road Dairies proposed Tranche 2 take are summarised in Table 9.

Table 9: Plantation Road Dairies proposed Tranche 2 infrastructure

Site	Use and/or status	Current status	Depth (m bgl)	Approx. irrigated area (ha)
4830	Irrigation	Existing	137	144
T2a	Irrigation	Proposed	~ 100	155
T2b	Irrigation	Proposed	~ 100	160
Augmentation take	Augmentation take	Proposed	~ 100	-
Augmentation discharge	Discharge to Kahahakuri Stream	Proposed	-	-

3.6.1 Irrigation Demand

Irrigation demand has been modelled using Aqualinc's IrriCalc soil-water balance model. The 90 percentile water demand for pasture is calculated to be approximately 600 mm/year, which over an irrigated area of 459 ha equates to a volume of approximately 2.75 million m^3/year. This is similar to the total volume of irrigation water initially sought by Plantation Road Dairies for irrigation purposes (2,775,914 m^3/year).

The IrriCalc modelling provides a daily time series of crop water demand (assuming an unrestricted supply) and resulting daily time series of land surface recharge (LSR). The crop water demand has been modelled from the bores proposed to supply the property, as listed in Table 9, in proportion to the listed irrigated areas. Furthermore, new irrigation results in additional LSR compared to dryland. This has also been incorporated into the model by exchanging previously dryland LSR with irrigated LSR for the areas that were previously unirrigated.

3.6.2 Modelling Results for Plantation Road Dairies

The model has been run with daily outputs generated from 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics due to Plantation Road Dairies' irrigation take alone. Changes in these flow statistics compared to the baseline are summarised in Table 10. Although the results are presented to the nearest litre per second, the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect.

Table 10: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to Plantation Road Dairies' irrigation take alone (no augmentation)

Scenario	Site				
	Waipawa at SH2	Tukituki at Tapairu Rd	Tukipo at SH50	Tukipo at Ashcott Rd	Mangaonuku u/s Waipawa
Change in average flow (l/s)					
Plantation Road Dairies' irrigation take only	-43	-24	0	-8	-14
Change in mean 7-day annual low flow (MALF) (l/s)					
Plantation Road Dairies' irrigation take only	-38	-13	0	-6	-16

From Table 10, irrigation alone (with no augmentation) results in a reduction in river flows throughout much of the basin. The largest changes occur in the Waipawa catchment and tributaries, though effects do propagate over to the lower Tukituki catchment and tributaries.

Changes in flows allowing for all applicants' irrigation takes, augmentation takes and augmentation discharges are presented later.

3.7 Springhill Dairies

Springhill Dairies (formerly Ingleton Farms) have applied to take up to **1,005,213 m^3/year** of Tranche 2 groundwater from deep bores located around their property. The proposed Tranche 2 take will supplement existing consented takes with a combined volume of approximately 4,029,077 m^3/year to provide adequate irrigation of 702 ha of pasture (assumed), or a larger area of less water-intensive crops or horticulture, from bores 1518, 3870, 4122, 4593, 5497 and 5167 (combined). It is proposed to provide augmentation directly into the Mangaonuku Stream.

The location of the bores from which Springhill Dairies have proposed to take groundwater, and the approximate locations of the augmentation take bore and the discharge site, are shown in Figure 11.

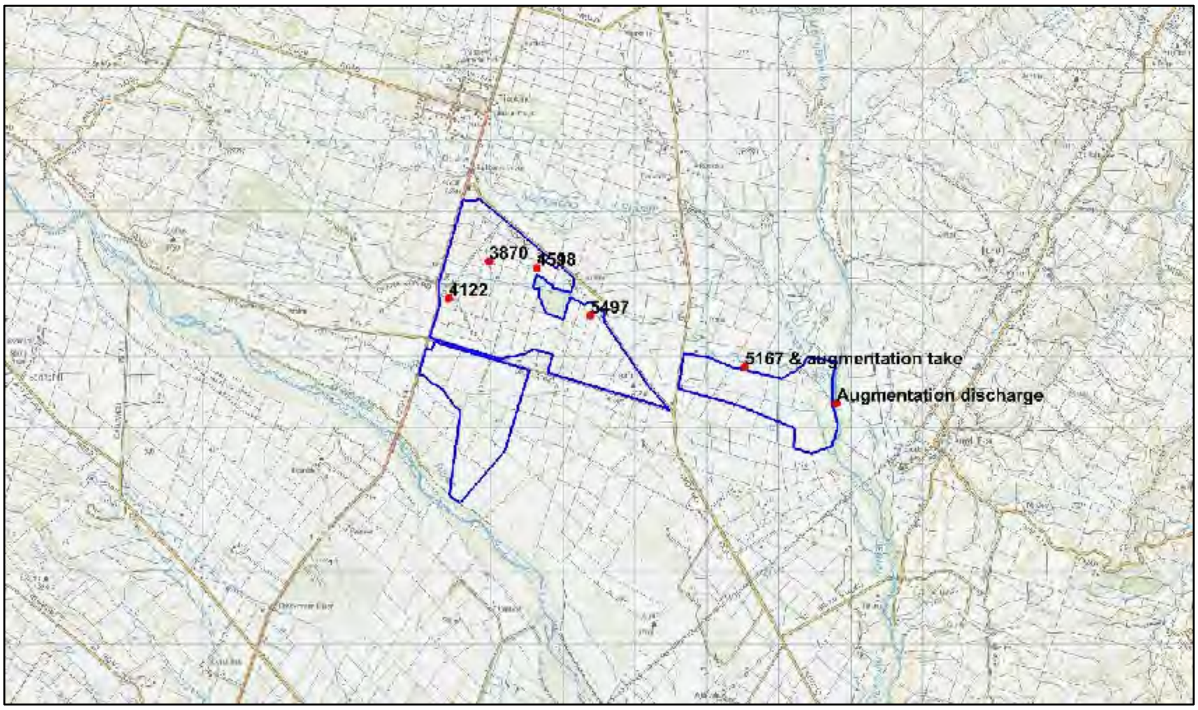


Figure 11: Springhill Dairies' bores and augmentation locations (irrigation areas are shown as blue outlines)

Key infrastructure for Springhill Dairies' proposed takes are summarised in Table 11.

Table 11: Springhill Dairies' proposed infrastructure

Site	Use and/or status	Current status	Depth (m bgl)
Bore 5167	Irrigation & augmentation take	Existing bore and irrigation take; proposed augmentation take	124.6
Bore 4593	Irrigation	Existing	84.7
Bore 1518	Irrigation	Existing	152.9
Bore 3870	Irrigation	Existing	144.7
Bore 4122	Irrigation	Existing	134.2
Bore 5497	Irrigation	Existing	56.1
Augmentation discharge	Discharge to Mangaonuku Stream	Proposed	-

For the purposes of this assessment, it has been assumed that the additional Tranche 2 water is extracted from bores 3870 and 5167.

3.7.1 Irrigation Demand

Irrigation demand has been modelled using Aqualinc's IrriCalc soil-water balance model. The 90 percentile annual water demand for pasture is calculated to be approximately 480 mm/year, which over an irrigated area of 702 ha equates to 3.4 million m^3/year. The irrigation demand is able to be met by utilising a combination of the exiting consented takes and a portion of the Tranche 2 volume applied for, whilst leaving a reasonable volume of Tranche 2 water available for augmentation purposes. The irrigation volume initially applied for (597,997 m^3/year) would be adequate to irrigate approximately 125 ha.

The IrriCalc modelling provides a daily time series of crop water demand (assuming an unrestricted supply) and resulting daily time series of land surface recharge (LSR). The crop water demand has been modelled from the bores proposed to supply the property, as listed in Table 11. Furthermore, new irrigation results in additional LSR compared to dryland. This has also been incorporated into the model by exchanging previously dryland LSR with irrigated LSR for the new irrigated areas.

3.7.2 Modelling Results for Springhill Dairies

The model has been run with daily outputs generated from 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics due to Springhill Dairies' irrigation take alone. Changes in these flow statistics compared to the baseline are summarised in Table 12. Although the results are presented to the nearest litre per second, the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect.

Table 12: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to Springhill Dairies' irrigation take alone (no augmentation)

Scenario	Site				
	Waipawa at SH2	Tukituki at Tapairu Rd	Tukipo at SH50	Tukipo at Ashcott Rd	Mangaonuku u/s Waipawa
Change in average flow (l/s)					
Springhill Dairies' irrigation take only	-13	-3	0	-1	-6
Change in mean 7-day annual low flow (MALF) (l/s)					
Springhill Dairies' irrigation take only	-11	-1	0	-1	-7

From Table 12, irrigation alone (with no augmentation) results in a reduction in river flows throughout much of the basin. The largest changes occur in the Waipawa catchment and tributaries, as this is the catchment within which Springhill Dairies is located. However, small scale effects do propagate over to the lower Tukituki catchment and tributaries. The overall effects are relatively small compared to some other applicants because the total scale of the proposed Tranche 2 take is also relatively small.

Changes in flows allowing for all applicants' irrigation takes, augmentation takes and augmentation discharges are presented later.

3.8 I&P Farming

I&P Farming have submitted two applications to take Tranche 2 groundwater. An original application was submitted to take up to 477,122 m^3/year of Tranche 2 groundwater, and a new application has recently been submitted to take up to 722,888 m^3/year of groundwater. These combine to a total of **1,200,010 m^3/year** and comprises 913,862 m^3/year for irrigation and 286,148 m^3/year for augmentation. The applications seek to take groundwater from new deep bores (likely two new bores) located on their property. The irrigation rate applied for is intended to fully irrigate approximately 184 ha of pasture (assumed), or a larger area of less water-intensive crops or horticulture.

The general location of the bores from which I&P Farming have proposed to take groundwater, and the approximate location of the augmentation discharge site, are shown in Figure 12. It is proposed to discharge water into an existing unnamed small stream that joins the Tukituki River less than 1 km below the downgradient boundary of the property. This unnamed stream is not included in the model, and therefore it has been assumed that the augmentation discharge occurs at the confluence of this stream with the Tukituki River, as indicated in Figure 12. This site is a little higher up-catchment than the site originally proposed by I&P Farming in their initial application.

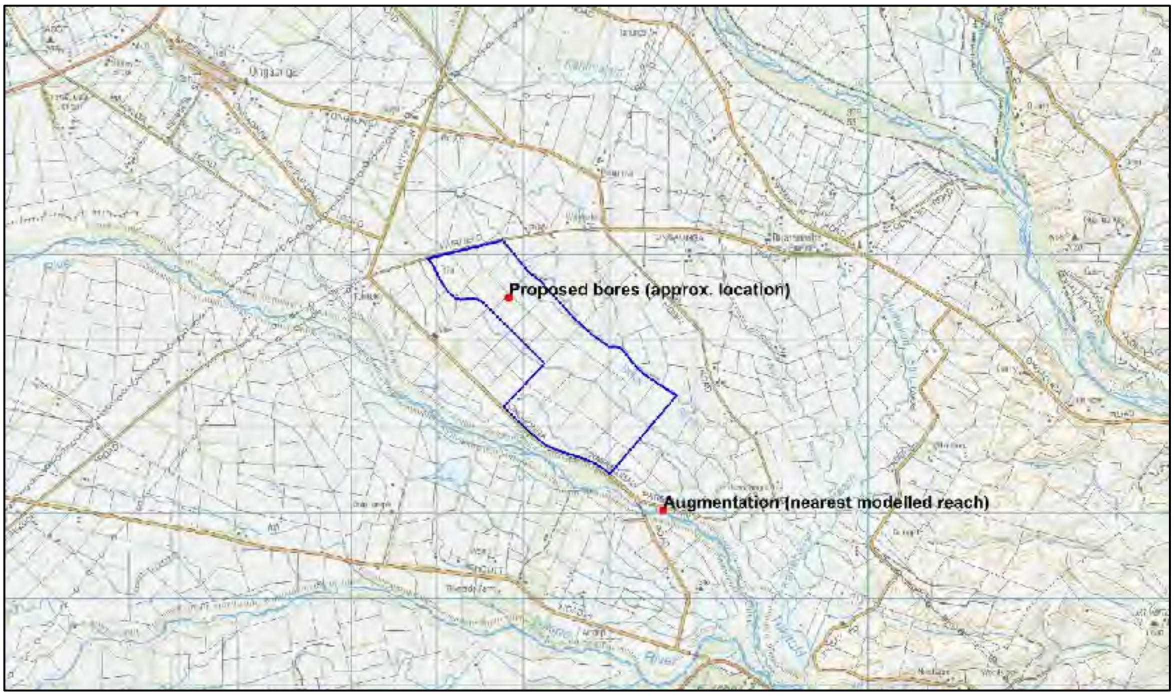


Figure 12: I&P Farming's bore and augmentation locations (irrigation areas are shown as blue outlines)

Key infrastructure for I&P Farming's proposed take are summarised in Table 13.

Table 13: I&P Farming's proposed infrastructure

Site	Use and/or status	Current status	Depth (m bgl)
Proposed bore	Irrigation & augmentation take	Proposed	60 m min (assumed)
Augmentation discharge	Discharge to unnamed stream, tributary of Tukituki River	Proposed	-

3.8.1 Irrigation Demand

Irrigation demand has been modelled using Aqualinc's IrriCalc soil-water balance model. The 90 percentile annual water demand for pasture is calculated to be approximately 550 mm/year. The irrigation volume applied is therefore adequate to irrigate approximately 166 ha of pasture, which is a little less than the 184 ha intended for mixed cropping. The smaller area of pasture will be assumed for modelling purposes.

The IrriCalc modelling provides a daily time series of crop water demand (assuming an unrestricted supply) and resulting daily time series of land surface recharge (LSR). The crop water demand has been modelled from the proposed bore to supply the property, as listed in Table 13. Furthermore, new irrigation results in additional LSR compared to dryland. This has also been incorporated into the model by exchanging previously dryland LSR with irrigated LSR for the new irrigated areas.

3.8.2 Modelling Results for I&P Farming

The model has been run with daily outputs generated from 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics due to I&P Farming's irrigation take alone. Changes in these flow statistics compared to the baseline are summarised in Table 14. Although the results are presented to the nearest litre per second, the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect.

Table 14: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to I&P Farming's irrigation take alone (no augmentation)

Scenario	Site				
	Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)					
I&P Farming's irrigation take only	-10	-13	0	-2	-2
Change in mean 7-day annual low flow (MALF) (l/s)					
I&P Farming's irrigation take only	-9	-5	0	-2	-2

From Table 14, irrigation alone (with no augmentation) results in a reduction in river flows throughout much of the basin.

Changes in flows allowing for all applicants' irrigation takes, augmentation takes and augmentation discharges are presented later.

3.9 Buchanan Trust No 2 (Buchanan)

Buchanan have applied to take up to 1,631,018 m^3/year of Tranche 2 groundwater from existing and proposed new deep bores located around their property. However, at the time of their original application, only **1,145,794 m^3/year** was available from the Tranche 2 volume available. This equates to approximately 70% of the water applied for.

Assuming augmentation volume is 20% of the total take (this may be adjusted in subsequent scenarios, discussed later), then the Tranche 2 volume remaining for Buchanan would be made up of 915,894 m^3/year for irrigation and a further 229,900 m^3/year for augmentation. This reduced volume has been applied to the modelling scenarios and is adequate to fully irrigate 153 ha of pasture (assumed) or a larger area of less water-intensive crops or horticulture.

The location of the bores from which Buchanan have proposed to take groundwater, and the approximate location of the augmentation discharge site, are shown in Figure 13. It is proposed to discharge water into the nearby reach of Ongaonga Stream, which converges with Tukituki River approximately 4 km below the property.

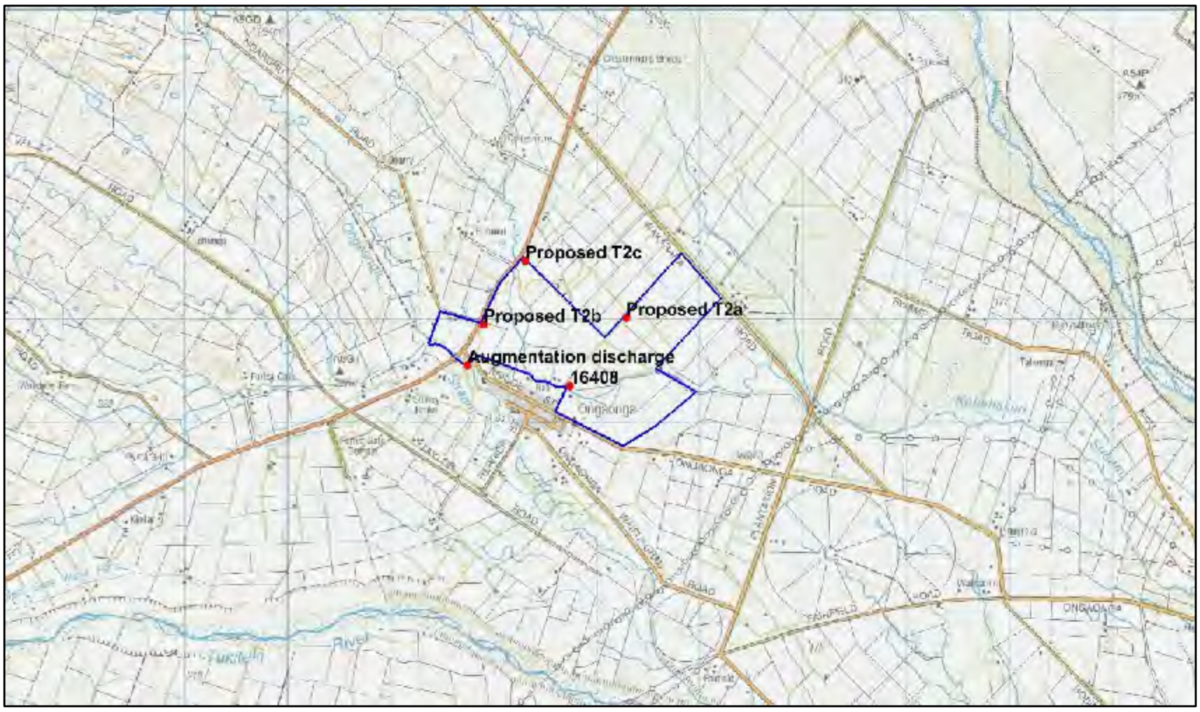


Figure 13: Buchanan's bores and augmentation locations (irrigation areas are shown as blue outlines)

Key infrastructure for Buchanan's proposed take are summarised in Table 15.

Table 15: Buchanan's proposed infrastructure

Site	Use and/or status	Current status	Depth (m bgl)
16408	Irrigation & augmentation take	Existing	119.8
Proposed T2a	Irrigation & augmentation take	Proposed	~ 110 m (assumed)
Proposed T2b	Irrigation & augmentation take	Proposed	
Proposed T2c	Irrigation & augmentation take	Proposed	
Augmentation discharge	Discharge to Ongaonga Stream	Proposed	-

3.9.1 Irrigation Demand

Irrigation demand has been modelled using Aqualinc's IrriCalc soil-water balance model. The 90 percentile annual water demand for pasture is calculated to be approximately 600 mm/year. This results in the 153 ha of pasture being fully irrigable from the 915,894 m^3/year volume.

The IrriCalc modelling provides a daily time series of crop water demand (assuming an unrestricted supply) and resulting daily time series of land surface recharge (LSR). The crop water demand has been modelled from the proposed bore to supply the property, as listed in Table 15. Furthermore, new irrigation results in additional LSR compared to dryland. This has also been incorporated into the model by exchanging previously dryland LSR with irrigated LSR for the new irrigated areas.

3.9.2 Modelling Results for Buchanan

The model has been run with daily outputs generated from 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics due to Buchanan's irrigation take alone. Changes in these flow statistics compared to the baseline are summarised in Table 16. Although the results are presented to the nearest litre per second, the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect.

Table 16: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to Buchanan's irrigation take alone (no augmentation)

Scenario	Site				
	Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)					
Buchanan's irrigation take only	-17	-9	0	-4	-5
Change in mean 7-day annual low flow (MALF) (l/s)					
Buchanan's irrigation take only	-13	-3	0	-2	-5

From Table 16, irrigation alone (with no augmentation) results in a reduction in river flows throughout much of the basin. The largest changes occur in the Waipawa catchment.

Changes in flows allowing for all applicants' irrigation takes, augmentation takes and augmentation discharges are presented later.

3.10 Purunui Trust

Purunui Trust have applied to take up to 1,575,000 m^3/year of Tranche 2 groundwater from three deep bores located around their property, near Ongaonga. The annual volume applied for is comprised of:

- 1,050,000 m^3/year (at a volume not exceeding 252,000 m^3 within any 28 day period) for irrigation of up to 175 ha (assumed all pasture), capped at meeting full water demand up to a one-in-ten year drought; and
- An additional 525,000 m^3/year (at volume not exceeding 126,000 m^3 within any 28 day period) to provide river augmentation to mitigate the effects of the irrigation take during dry periods.

Due to their position as last in the queue of Tranche 2 groundwater applications, the full volume applied for by Purunui Trust is not available due to the 15,000,000 m^3/year cap on the combined Tranche 2 takes (RRMP Table 5.9.5). Instead, a total volume of **554,921 m^3/year** is available, which equates to approximately 35% of the water applied for. Assuming both the irrigation and augmentation volume is scaled equally, then the Tranche 2 volume remaining for Purunui Trust would be made up of 369,944 m^3/year for irrigation and a further 184,977 m^3/day for augmentation. This reduced volume has been applied to the modelling scenarios and is adequate to fully irrigate approximately 62 ha of pasture (assumed), or a larger area of less water-intensive crops or horticulture.

The location of the bores (existing and proposed) from which Purunui Trust have proposed to take groundwater, and the approximate locations of the augmentation take bore and the discharge site, are shown in Figure 14. It is proposed to provide river augmentation into the Waipawa River via an existing unused large-diameter shallow bore located approximately 200-300 m from the river. Purunui Trust have advised that they believe this shallow bore is directly connected to the nearby Waipawa River, though this will be confirmed prior to commencing augmentation. For the purpose of augmentation modelling, it will be assumed that the water will be discharge directly into the Waipawa River immediately adjacent to the existing shallow bore. Due to the fast hydraulic response between the Waipawa River and nearby shallow groundwater, this will make little difference to the modelled effects.

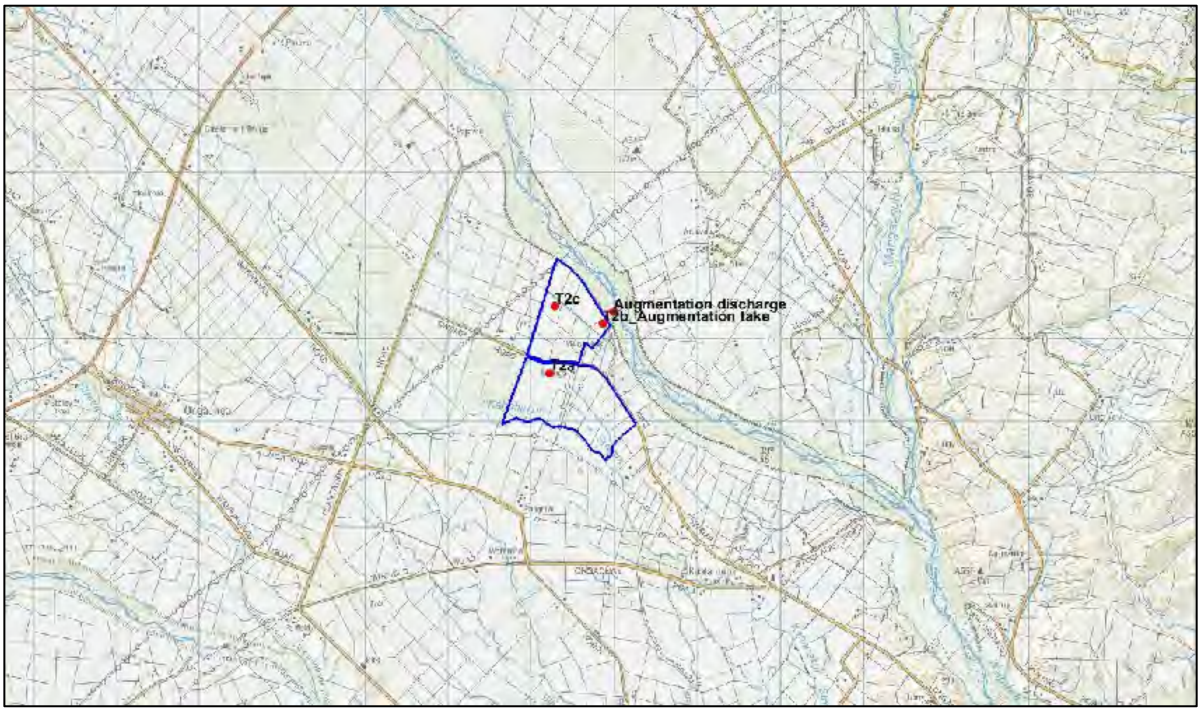


Figure 14: Purunui Trust's proposed bore and augmentation locations (proposed irrigation areas are shown as blue outlines)

Key infrastructure for Purunui Trust's proposed Tranche 2 take are summarised in Table 17.

Table 17: Purunui Trust's proposed Tranche 2 infrastructure

Site	Use and/or status	Current status	Depth (m bgl)	Approx. irrigated area (ha)
T2a	Irrigation	Proposed	50 m min (assumed)	31
T2b	Augmentation	Proposed		-
T2c	Irrigation	Proposed		31
Augmentation discharge	Discharge to Waipawa River	Proposed	-	-

3.10.1 Irrigation Demand

Irrigation demand has been modelled using Aqualinc's IrriCalc soil-water balance model. The 90 percentile water demand for pasture is calculated to be approximately 600 mm/year, which over an irrigated area of 62 ha equates to an annual volume of 372,000 million m^3/year.

The IrriCalc modelling provides a daily time series of crop water demand (assuming an unrestricted supply) and resulting daily time series of land surface recharge (LSR). The crop water demand has been modelled from the bores proposed to supply the property, as listed in Table 17, in proportion to the listed irrigated areas. Furthermore, new irrigation results in additional LSR compared to dryland. This has also been incorporated into the model by exchanging previously dryland LSR with irrigated LSR for the proposed irrigated areas shown in Figure 14.

3.10.2 Modelling Results for Purunui Trust

The model has been run with daily outputs generated from 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites shown in Figure 6 have been processed to generate changes in flow statistics due to Purunui Trust's irrigation take alone. Changes in these flow statistics compared to the baseline are summarised in Table 18. Although the results are presented to the nearest litre per second, the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect.

Table 18: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to Purunui Trust's irrigation take alone (no augmentation)

Scenario	**Site**				
	Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)					
Purunui Trust's irrigation take only	-6	-3	0	-1	-2
Change in mean 7-day annual low flow (MALF) (l/s)					
Purunui Trust's irrigation take only	-6	-1	0	-1	-2

From Table 18, irrigation alone (with no augmentation) results in a reduction in river flows throughout much of the basin. The largest changes occur in the Waipawa catchment and tributaries, as this is the catchment within which Purunui Trust's property is located. However, small scale effects do propagate over to the lower Tukituki catchment and tributaries.

Changes in flows allowing for all Tranche 2 applicants' irrigation takes, augmentation takes and augmentation discharges are presented later.

3.11 Augmentation Scenarios: All Takes Combined Plus Augmentation

The effects from individual applicants are summarised below. Following this, several scenarios have been developed that consider the combined effects of all applicants together with augmentation.

3.11.1 Summary of Individual Effects

Effects for individual applicants are summarised in Table 19.

Table 19: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due for all proposed Tranche 2 irrigation takes (no augmentation)

Applicant	Site				
	Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)					
TAFT	-64	-18	0	-8	-35
Papawai	-25	-8	0	-3	-9
Tuki Tuki Awa	-8	-11	-1	-7	-2
Plantation Rd Dairies	-43	-24	0	-8	-14
Springhill Dairies	-13	-3	0	-1	-6
I&P Farming	-10	-13	0	-2	-2
Buchanan	-17	-9	0	-4	-5
Purunui	-6	-3	0	-1	-2
Total	**-186**	**-89**	**-1**	**-34**	**-75**
Change in mean 7-day annual low flow (MALF) (l/s)					
TAFT	-48	-9	0	-6	-37
Papawai	-18	-3	0	-2	-10
Tuki Tuki Awa	-4	-5	-1	-5	-2
Plantation Rd Dairies	-38	-13	0	-6	-16
Springhill Dairies	-11	-1	0	-1	-7
I&P Farming	-9	-5	0	-2	-2
Buchanan	-13	-3	0	-2	-5
Purunui	-6	-1	0	-1	-2
Total	**-147**	**-40**	**-1**	**-25**	**-81**

From the above table, the changes in river flows statistics are concentrated in the Waipawa catchment where most of the new takes are located. However, effects do also occur in the lower Tukituki sites. No noticeable effect is predicted in the Tukipo River at SH50 as no properties are sited near or above this location.

3.11.2 Restrictions

To provide a reliable supply for irrigation, it is proposed that the Tranche 2 takes are operated unrestricted (supplying crop water demand as needed, day to day). To then mitigate stream depletion effects caused by the irrigation takes and to maintain reliability for existing users, surface water augmentation (sourced from groundwater) is proposed when rivers reach minimum flows. For the

Ruataniwha basin, the river flow restrictions were initially based on the following sites and flows, as specified in RRMP Table 5.9.3: Tukituki Catchment Minimum Flows framework:

- Waipawa at RDS/SH2: 2,500 l/s
- Tukituki River at Tapairu Road: 2,300 l/s
- Tukipo at SH50: 150 l/s
- Tukipo at Ashcott: 1,043 l/s
- Mangaonuku at u/s Waipawa confluence 1,170 l/s

The locations of these flow restriction sites are shown in Figure 6.

The daily river flow time series used to generate a time series of restrictions has been modified for the base case by a time series of changes in flows resulting from all applicants (combined) taking their irrigation takes alone. This was generated by the individual scenarios discussed in Section 3.3 through to Section 3.10.

A further flow restriction site exists on the Tukituki River at Red Bridge, down catchment from the Ruataniwha basin outlet. This is below the model's extent and therefore the flow monitoring sites on the Waipawa at SH2 and Tukituki at Tapairu Road have been considered to represent this site. So long as the combined 7-day MALF at the SH2 and Tapairu sites are maintained (or improved), then the downstream low flows at Red Bridge will not be adversely affected by the proposed Tranche 2 takes.

It has been assumed that the full augmentation rate is taken (sourced from Tranche 2 water) and discharged at the locations described above for each applicant whenever restrictions on any one of the above RMP Table 5.9.3 minimum flow sites occurs. Furthermore, as all Tranche 2 applicants are operating collaboratively, and effects from any one take potentially propagate across several streams, it has been assumed that augmentation will occur by all of the applicants if any one of the RRMP Table 5.9.3 minimum flow sites experiences a low-flow restriction. As will be discussed later, the exception to this is Tuki Tuki Awa in scenario 4.

3.11.3 Augmentation Scenario 1

Scenario 1 assumes that augmentation occurs only when irrigation from Tranche 2 groundwater is occurring on each applicant's property. However, as outlined above, if one of the RRMP Table 5.9.3 minimum flow sites is triggered then augmentation commences from all Tranche 2 applicants, but also only occurs when they are each irrigating. The model has been run with the combined applicants' proposed irrigation takes and augmentation, for the period 1 July 1972 through to 30 June 2012. Time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics (compared to the baseline), which are summarised in Table 20. Again, the results are presented to the nearest litre per second, but the model's accuracy is not that precise. Therefore, these results represent the approximate scale and direction of effect.

Table 20: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to all applicants' irrigation takes with augmentation scenario 1

Site				
Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)				
-179	-80	-2	-37	-67
Change in mean 7-day annual low flow (MALF) (l/s)				
-61	+74	-1	-28	-47

Calculated augmentation volumes for each applicant are summarised in Table 21. Also included in this table for comparison is a summary of the total Tranche 2 groundwater volumes applied for each applicant.

Table 21: Calculated seasonal augmentation volumes for augmentation scenario 1

Applicant	Approx. area irrigated from Tranche 2 groundwater (ha) [(1)]	Modelled 90 percentile annual volumes (m^3/year) (1972-2012)			Tranche 2 GW volume applied (m^3/year)
		For irrigation	For augmentation (% of total)	Total	
TAFT	540	3,100,000	868,700 (18%)	3,968,700	4,914,920
Papawai	207	1,161,000	122,800 (8%)	1,283,800	1,475,517
Tuki Tuki Awa	136	612,000	106,900 (11%)	718,900	952,400
Plantation Rd Dairies	459	2,754,000	577,300 (15%)	3,331,300	3,751,225
Springhill Dairies	125 [(2)]	597,997 [(2)]	177,300 (18%)	775,297	1,005,213
I&P Farming	166 [(3)]	913,862	70,300 (6%)	984,162	1,200,010
Buchanan	153 [(3)]	915,894	229,900 (20%)	1,145,794	1,145,794 [(3)]
Purunui	62 [(3)]	448,121	66,800 (12%)	514,921	554,921 [(3)]
	Total	**10,502,874**	**2,220,000 (15%)**	**12,722,874**	**15,000,000**

[(1)] These areas are based on the assumption that pasture is irrigated. However, larger areas of less intensive crops or horticulture can be irrigated within the same yearly volumes used by pasture, with little-to-no difference in the hydraulic effect.

[(2)] The Tranche 2 water will supplement existing takes to irrigate a larger area of land than can be irrigated from the Tranche 2 water alone. Therefore, it has been assumed above that all of the Tranche 2 irrigation water applied for is utilised.

[(3)] Less than applied for.

A map of groundwater level difference between the status quo and augmentation scenario 1 is presented in Figure 15 for the dry period of 1 March 2001. This is during a time of typically lowest groundwater levels (in most monitored wells), and is consistent with the equivalent datasets presented in Weir (2013). This demonstrates how groundwater levels are predicted to change spatially during dry periods. Temporal changes in groundwater are discussed later.

From Figure 15, the greatest changes in shallow groundwater levels occur west (upgradient) of the take locations. This is because shallow groundwater level changes in areas downgradient of the take locations are mitigated (or partially mitigated) by the river augmentation; areas upgradient (and also deeper layers, not shown) do not receive the full benefit of the augmentation.

The following key observations are derived from the above results:

- Augmentation benefits most the catchment below where it is directly discharged.
- From Table 19, the proposed irrigation takes combined (without augmentation) are predicted to result in a total reduction in the 7-day MALF out of the basin of approximately 187 l/s (-147 l/s from the Waipawa and -40 l/s from the Tukituki.
- From Table 20, with augmentation, the equivalent change in the combined 7-day MALF out of the basin is an increase of approximately 13 l/s (-61 l/s in the Waipawa and +74 l/s in the Tukituki). However, reductions in flows are predicted for the Mangaonuku River (upstream of the Waipawa confluence) and the lower Tukipo River site (at Ashcott Rd).
- Therefore, the augmentation trialled under this scenario is having a partial mitigating effect, but it is insufficient to fully mitigate the effects of the proposed new Tranche 2 takes, for the scenario tested.
- Shallow groundwater levels are predicted to lower up to a maximum of 0.8 m under augmentation scenario 1. This maximum change is focussed in the vicinity of greatest abstraction (the applicants' properties). Elsewhere, shallow groundwater levels are predicted to change less than 0.3 m.

The augmentation volumes in Table 21 were derived by summing (for each year) the proposed augmentation rate applied whenever it is triggered, and calculating the 90%ile annual volume. The total volume of Tranche 2 water abstracted (approximately 12.7 million m^3) is less than that available (15.0 million m^3). At face value, this might suggest that a greater volume of groundwater could be abstracted for irrigation. However, this is not the case as the effects on surface flows set out in Table 20 need to be further mitigated, and that can only occur by taking more deep groundwater for augmentation purposes and/or taking less water for irrigation. This leads into Scenario 2.

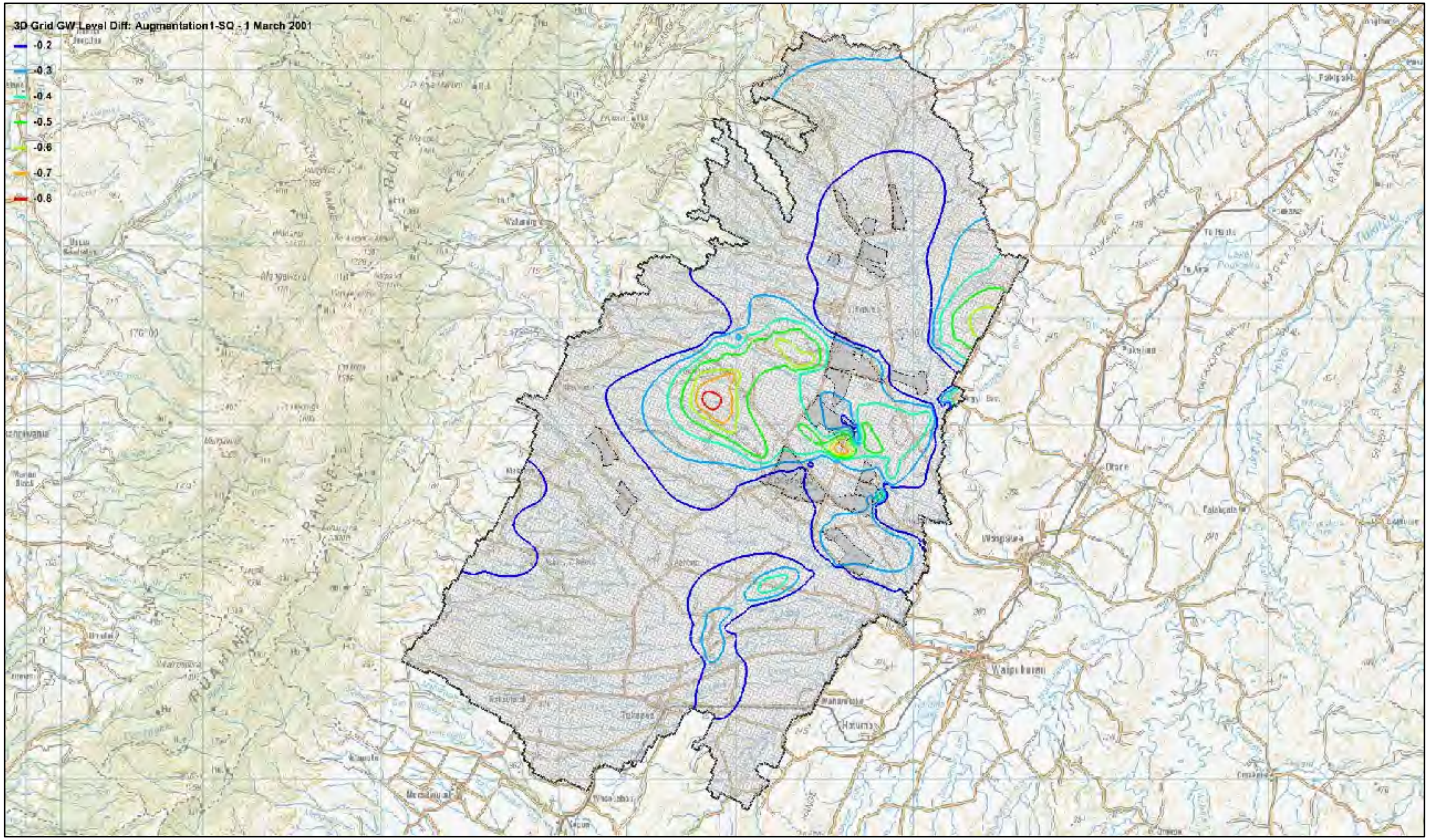


Figure 15: Difference in shallow (layer 1) groundwater levels at 1 March 2001 between status quo and augmentation scenario 1

3.11.4 Augmentation Scenario 2

From the above model results, augmentation is not predicted to fully mitigate the effects on low flows at some river sites. Therefore, an alternative augmentation regime has been trialled. Scenario 2 assumes augmentation occurs whenever RRMP Table 5.9.3 minimum flows are reached throughout the year, regardless of whether or not irrigation is occurring. This scenario aims to better mitigate the temporal effects of the takes during low-flow periods through more frequent augmentation. This in turn results in a greater volume of Tranche 2 water taken for augmentation, and in some cases means individual applicants are forecasted to take more than their applied volume. Therefore, some irrigated areas (and therefore irrigation volumes) have been reduced to counter this.

This scenario has been modelled, and time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics (compared to the baseline) which are summarised in Table 22.

Table 22: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to all applicants' irrigation takes with augmentation scenario 2

Site				
Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)				
-170	-65	-2	-40	-52
Change in mean 7-day annual low flow (MALF) (l/s)				
-1	+145	-1	-30	0

Calculated augmentation volumes for each applicant are summarised in Table 23 along with irrigation volumes and the necessary reduced irrigated areas, compared to the total Tranche 2 groundwater volumes and irrigated areas applied for.

Table 23: Calculated seasonal augmentation volumes for augmentation scenario 2

Applicant	**Approx. area irrigated from Tranche 2 groundwater (ha)** [(1)]		**Modelled 90 percentile annual volumes (m^3/year) (1972-2012)**			**Tranche 2 GW volume applied (m^3/year)**
	As applied	**Adjusted to annual volume**	**For irrigation**	**For augmentation (% of total)**	**Total**	
TAFT	540	453	2,627,120	2,287,800 (47%)	4,914,920	4,914,920
Papawai	207	207	1,161,000	290,500 (20%)	1,451,500	1,475,517
Tuki Tuki Awa	136	136	612,000	302,600 (32%)	914,600	952,400
Plantation Rd Dairies	459	380	2,280,525	1,470,700 (39%)	3,751,225	3,751,225
Springhill Dairies	125 [(2)]	114	545,213	460,000 (46%)	1,005,213	1,005,213
I&P Farming	166 [(3)]	166	913,862	266,300 (22%)	1,180,162	1,200,010
Buchanan	153 [(3)]	89	533,294	612,500 (53%)	1,145,794	1,145,794 [(3)]
Purunui	62 [(3)]	62	381,831	173,100 (31%)	554,931	554,921 [(3)]
		Total	**9,054,845**	**5,863,500 (39%)**	**14,918,345**	**15,000,000**

(1) These areas are based on the assumption that pasture is irrigated. However, larger areas of less intensive crops or horticulture can be irrigated within the same yearly volumes used by pasture, with little-to-no difference in the hydraulic effect.

(2) The Tranche 2 water will supplement existing takes to irrigate a larger area of land than can be irrigated from the Tranche 2 water alone. Therefore, it has been assumed above that all of the Tranche 2 irrigation water applied for is utilised.

(3) Less than applied for.

A map of groundwater level difference between the status quo and augmentation scenario 2 is presented in Figure 16 for 1 March 2011. This demonstrates how groundwater levels are predicted to change spatially during dry periods. Temporal changes in groundwater are discussed later.

The following key observations are derived from these results:

- Compared to augmentation scenario 1, the more frequent augmentation provides additional benefit to the low flows exiting the catchment.
- As previously noted in Table 19, the combined effects from the proposed irrigation takes alone are predicted to result in a total reduction in the 7-day MALF out of the basin of approximately 187 l/s (-147 l/s from the Waipawa and -40 l/s from the Tukituki). Under the alternative augmentation scenario 2 results in Table 22, the combined 7-day MALF out of the basin is expected to increase by 144 l/s, a result of a -1 l/s (decrease) in the Waipawa and +145 l/s (increase) in the Tukituki.
- Overall, alternative augmentation scenario 2 is having a much larger positive effect on the 7-day MALF exiting the basin, but does not fully mitigate the effects in the Tukipo River at Aschott Rd.
- Shallow groundwater levels are predicted to lower up to a maximum of 0.8 m under augmentation scenario 2. Again, this maximum change is focussed in the areas of greatest abstraction (near applicants' properties). Elsewhere, shallow groundwater levels are predicted to change less than 0.3 m.

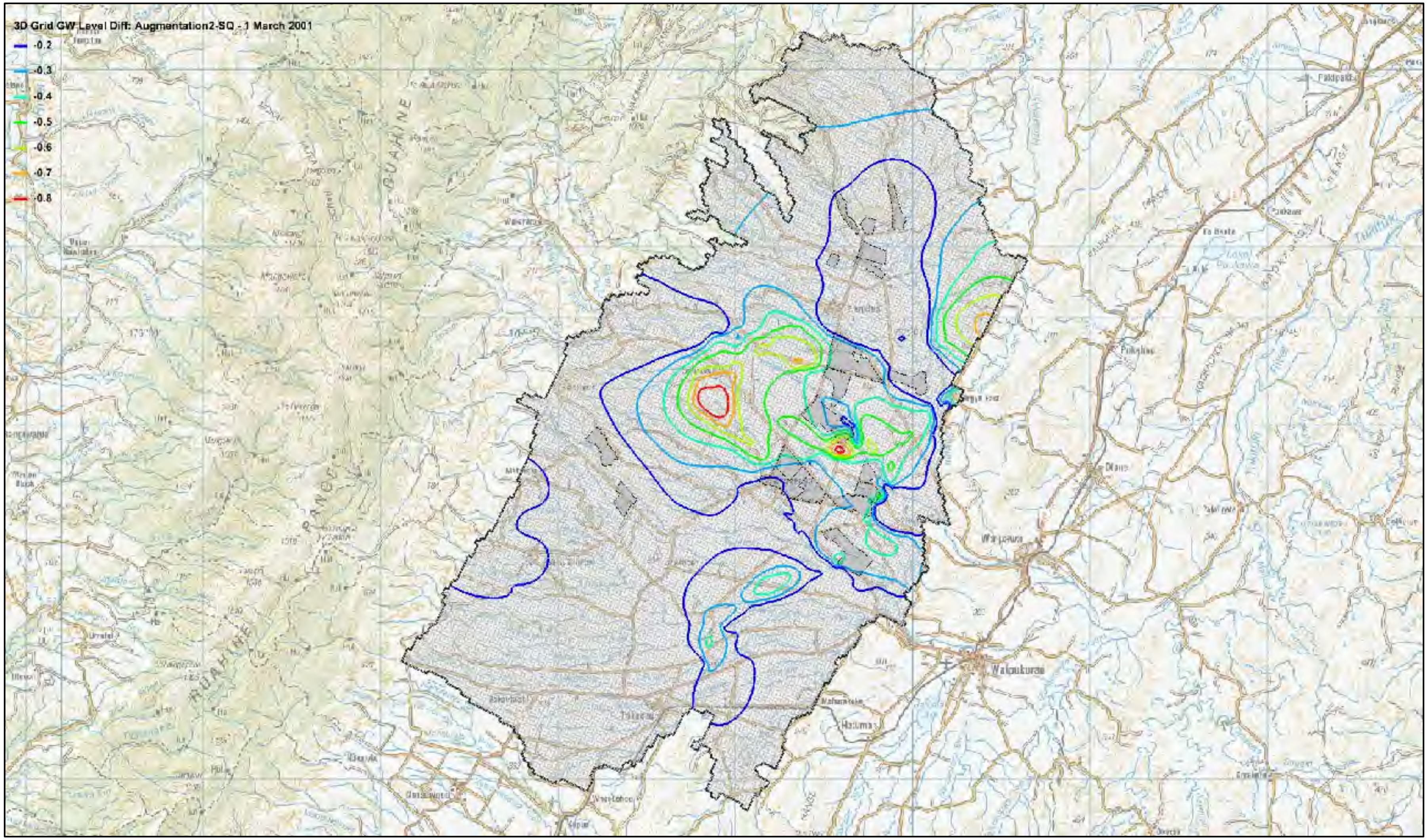


Figure 16: Difference in shallow (layer 1) groundwater levels at 1 March 2001 between status quo and augmentation scenario 2

3.11.5 Augmentation Scenario 3

An alternative augmentation time series has been trialled whereby low-flow restrictions (and therefore augmentation) are assumed to occur sooner (at higher flow rates) than those listed in Section 3.11.2. HBRC have previously indicated that they would consider this more favourable than operating on the low-flow restriction trigger values set out in RRMP Table 5.9.3. The following rationale has been applied to generate an alternative set of low flow trigger values when augmentation would commence:

- Waipawa at RDS/SH2: 2,500 l/s current flow trigger
  + 147 l/s low flow reduction due to takes (Table 19)
  + 50% additional reduction for augmentation take
  Round up to **2,725 l/s**
- Tukituki River at Tapairu Road: 2,300 l/s current flow trigger
  + 40 l/s low flow reduction due to takes (Table 19)
  + 50% additional reduction for augmentation take
  Round up to **2,360 l/s**
- Tukipo at SH50: 150 l/s current flow trigger
  + 1 l/s low flow reduction due to takes (Table 19)
  + 50% additional reduction for augmentation take
  Round up to **155 l/s**
- Tukipo at Ashcott: 1,043 l/s current flow trigger
  + 25 l/s low flow reduction due to takes (Table 19)
  + 50% additional reduction for augmentation take
  Round up to **1,085 l/s**
- Mangaonuku at u/s Waipawa confluence 1,170 l/s current flow trigger
  + 81 l/s low flow reduction due to takes (Table 19)
  + 50% additional reduction for augmentation take
  Round up to **1,295 l/s**

These raised low-flow trigger values have been applied to the augmentation takes regardless of whether or not irrigation is occurring on the day (as was the case for augmentation scenario 2; augmentation is assumed to occur even if the applicant is not irrigating). This scenario 3 aims to better maintain existing users' reliability by triggering augmentation at higher river flows. In turn, this (again) results in a greater volume of Tranche 2 water taken for augmentation, which pushes some applicants total take beyond their applied volumes. So some irrigated areas (and therefore irrigation volumes) have been further reduced to counter this.

This scenario 3 has been modelled, and time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics (compared to the baseline) which are summarised in Table 24.

Table 24: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to all applicants' irrigation takes with augmentation scenario 3

Site				
Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)				
-157	-56	-2	-40	-45
Change in mean 7-day annual low flow (MALF) (l/s)				
+17	+158	-1	-29	+11

Calculated augmentation volumes for each applicant are summarised in Table 25 along with irrigation volumes and the necessary reduced irrigated areas, compared to the total Tranche 2 groundwater volumes and irrigated areas applied for.

Table 25: Calculated seasonal augmentation volumes for augmentation scenario 3

Applicant	Approx. area irrigated from Tranche 2 groundwater (ha) [(1)]		Modelled 90 percentile annual volumes (m^3/year) (1972-2012)			Tranche 2 GW volume applied (m^3/year)
	As applied	Adjusted to annual volume	For irrigation	For augmentation (% of total)	Total	
TAFT	540	427	2,475,320	2,439,600 (50%)	4,914,920	4,914,920
Papawai	207	207	1,165,717	309,800 (21%)	1,475,517	1,475,517
Tuki Tuki Awa	136	136	629,700	322,700 (34%)	952,400	952,400
Plantation Rd Dairies	459	364	2,182,925	1,568,300 (42%)	3,751,225	3,751,225
Springhill Dairies	125 [(2)]	107	514,713	490,500 (49%)	1,005,213	1,005,213
I&P Farming	166 [(3)]	166	916,010	284,000 (24%)	1,200,010	1,200,010
Buchanan	153 [(3)]	82	492,594	653,200 (57%)	1,145,794	1,145,794 [(3)]
Purunui	62 [(3)]	62	370,321	184,600 (33%)	554,921	554,921 [(3)]
		Total	**8,474,300**	**6,252,700 (42%)**	**15,000,000**	**15,000,000**

[(1)] These areas are based on the assumption that pasture is irrigated. However, larger areas of less intensive crops or horticulture can be irrigated within the same yearly volumes used by pasture, with little-to-no difference in the hydraulic effect.

[(2)] The Tranche 2 water will supplement existing takes to irrigate a larger area of land than can be irrigated from the Tranche 2 water alone. Therefore, it has been assumed above that all of the Tranche 2 irrigation water applied for is utilised.

[(3)] Less than applied for.

A map of groundwater level difference between the status quo and augmentation scenario 3 is presented in Figure 17 for 1 March 2011. This demonstrates how groundwater levels are predicted to change spatially during dry periods. Temporal changes in groundwater are discussed later.

The following key observations are derived from these results:

- Compared to augmentation scenario 2, the more frequent and earlier-commenced augmentation provides additional benefit (again) to the 7-Day MALF of to the Waipawa and Tukituki rivers exiting the catchment.
- As previously noted in Table 19, the combined effects from the proposed irrigation takes alone are predicted to result in a total reduction in the 7-day MALF out of the basin of approximately 187 l/s (-147 l/s from the Waipawa and -40 l/s from the Tukituki). Under augmentation scenario 3 (Table 24), the combined 7-day MALF out of the basin is expected to increase by 175 l/s as a result of a +17 l/s (increase) in the Waipawa and +158 l/s (increase) in the Tukituki.
- Overall, the alternative augmentation scenario is having a larger positive effect on the 7-day MALF exiting the basin, but again does not fully mitigate the effects in the Tukipo River at Ashcott Rd.
- Similar to previous scenarios, shallow groundwater levels are predicted to lower up to a maximum of 0.8 m under augmentation scenario 3, focussed near the applicants' properties. Elsewhere, shallow groundwater levels are predicted to change less than 0.3 m.

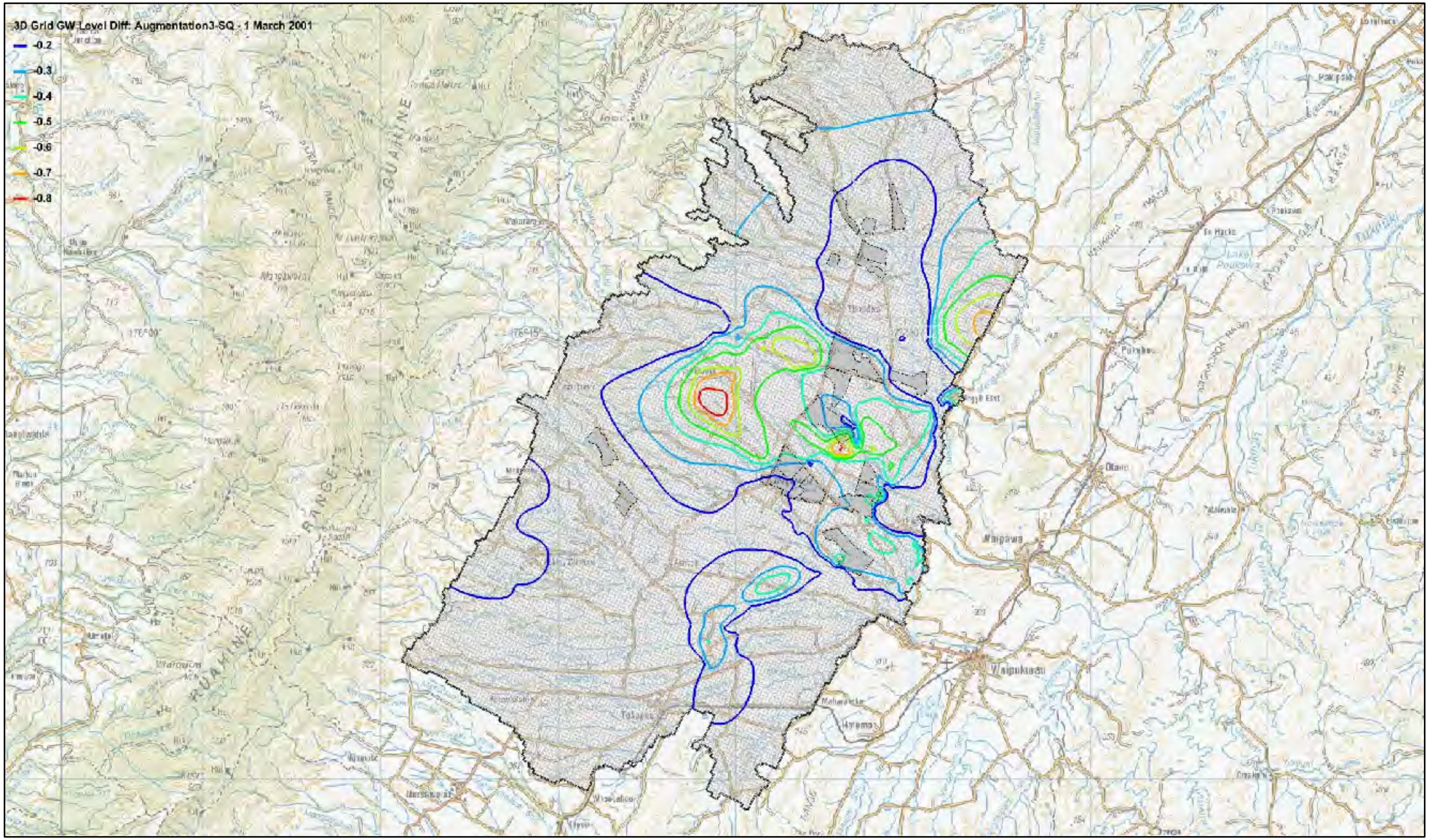


Figure 17: Difference in shallow (layer 1) groundwater levels at 1 March 2001 between status quo and augmentation scenario 3

Although there is a residual effect for the Tukipo River at Ashcott Rd of -29 l/s (Table 24), this equates to less than 3% of the minimum flow for this site (1,043 l/s). It could be argued that this is a minor adverse effect, as based on the modelled hydraulic response for this site, it is estimated that low-flow restrictions might commence hours (rather than days) earlier than might otherwise occur, as demonstrated in Figure 18. The green line shows how the flow in the Tukipo would recede under scenario 3 compared to the case if no Tranche 2 takes were occurring (the blue line).

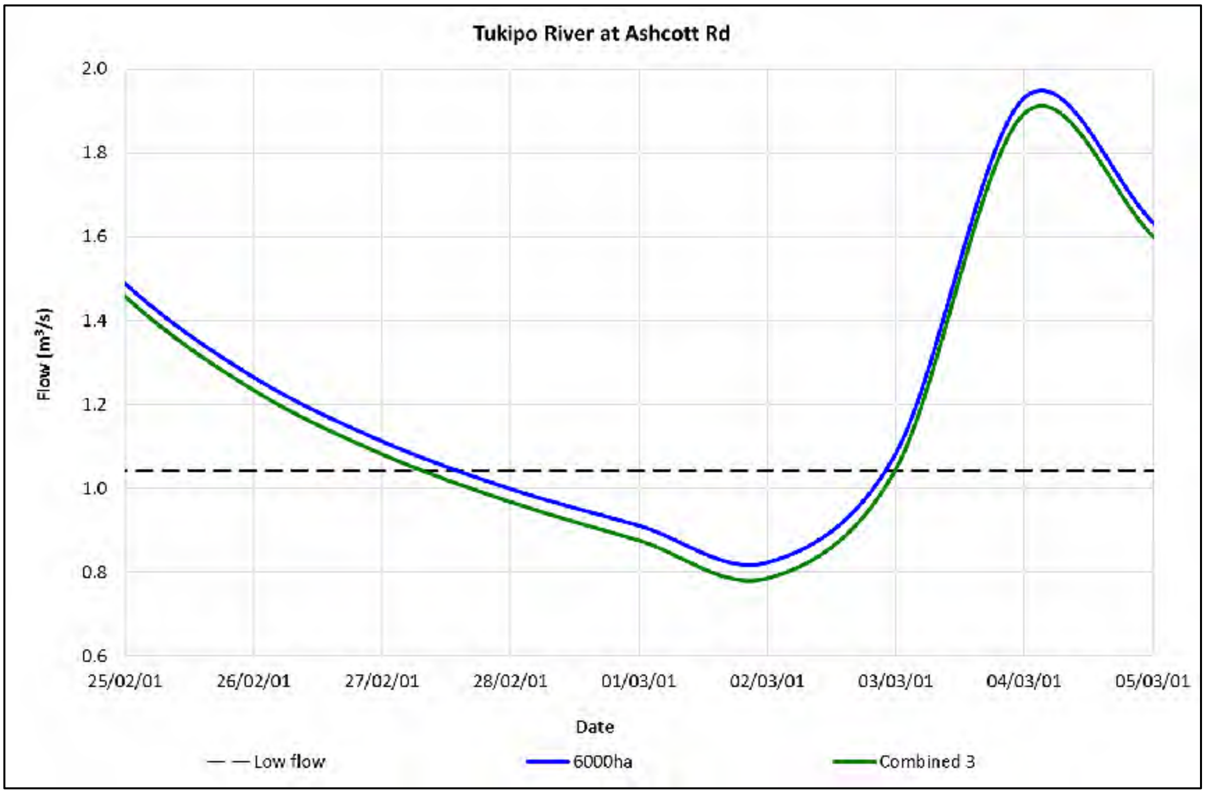


Figure 18: Example of hydraulic timing of modelled river flows in the Tukipo River at Ashcott Rd

Nevertheless, a further scenario has been explored with the aim being to avoid, or minimise to the extent practicable, the residual adverse effect on the Tukipo at Ashcott Rd. This, along with additional balancing of augmentation and irrigated area, is scenario 4 that is discussed next.

3.11.6 Augmentation Scenario 4

Based on the results of augmentation scenario 3, changes in flow in the Tukipo River at Aschott Rd are not fully mitigated. However, low flows exiting the basin are over compensated. Therefore, augmentation scenario 4 assumes a reduction of 15% to each applicant's augmentation discharge rate, with a corresponding increase in the irrigated areas such that the total volume of Tranche 2 groundwater proposed for each applicant is no more than the volume applied and the areas to be irrigated do not exceed the irrigable areas sought in the original Tranche 2 applications. However, the following exceptions apply:

- Buchanan's augmentation rate has been scaled back to 55% of the previously modelled rate due to the disproportionately high ratio of augmentation to irrigation take (compared to other applicants).
- I&P Farming and Purunui Trust's augmentation were not reduced due to the disproportionally low rate of augmentation to irrigation take (compared to other applicants).

- Papawai Partnership's augmentation was increased by 50% of the previously modelled rate due to the disproportionally low rate of augmentation to irrigation take (compared to other applicants) and the need to provide additional augmentation to the Waipawa River.
- Tuki Tuki Awa's augmentation reduced to 20% of the previously modelled rate since irrigation is only being used to gap fill and augment river flows when their river take is on low-flow restriction (discussed below).

Tuki Tuki Awa propose to use their Tranche 2 groundwater take only to gap-fill the surface water supply and augment rivers when the existing low-flow conditions on their take are triggered. This reduced take has been modelled under augmentation scenario 4.

Scenario 4 has been modelled, and time series of river flows at each of the flow restriction sites have been processed to generate changes in flow statistics (compared to the baseline) which are summarised in Table 26.

Table 26: Modelled changes in flow statistics (over the period 1972-2012) compared to status quo due to all applicants' irrigation takes with augmentation scenario 4

Site				
Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Change in average flow (l/s)				
-162	-36	-1	-7	-53
Change in mean 7-day annual low flow (MALF) (l/s)				
+3	+135	-1	+1	+2

Calculated augmentation volumes for each applicant are summarised in Table 27 along with irrigation volumes and the reduced irrigated areas, compared to the total Tranche 2 groundwater volumes and irrigated areas applied for.

Table 27: Calculated seasonal augmentation volumes for augmentation scenario 4

Applicant	Approx. area irrigated from Tranche 2 groundwater (ha) (1)		Modelled 90 percentile annual volumes (m^3/year) (1972-2012)			Tranche 2 GW volume applied (m^3/year)
	As applied	Adjusted to annual volume	For irrigation	For augmentation (% of total)	Total	
TAFT	540	490	2,841,220	2,073,700 (42%)	4,914,920	4,914,920
Papawai	207	181	1,010,817	464,700 (31%)	1,475,517	1,475,517
Tuki Tuki Awa	136	136	678,100 (2)	29,600 (4%)	707,700	952,400
Plantation Rd Dairies	459	403	2,418,225	1,333,000 (36%)	3,751,225	3,751,225
Springhill Dairies	125 (3)	123	588,313	416,900 (41%)	1,005,213	1,005,213
I&P Farming	166 (4)	166	916,010	284,000 (24%)	1,200,010	1,200,010
Buchanan	153 (4)	131	786,594	359,200 (31%)	1,145,794	1,145,794 (4)
Purunui	62 (4)	62	370,321	184,600 (33%)	554,921	554,921 (4)
		Total	**9,609,600**	**5,145,700 (35%)**	**14,755,300**	**15,000,000**

(1) These areas are based on the assumption that pasture is irrigated. However, larger areas of less intensive crops or horticulture can be irrigated within the same yearly volumes used by pasture, with little-to-no difference in the hydraulic effect.

(2) This is Tuki Tuki Awa's 90 percentile irrigation demand for 136 ha (as applied). However, because the Tranche 2 take is to be used only when their surface water take is restricted, the Tranche 2 irrigation use in most years will be less than this. Assuming past climatic patterns, the 90 percentile demand for irrigation only when their surface water take is restricted is approximately 258,400 m^3/year.

(3) The Tranche 2 water will supplement existing takes to irrigate a larger area of land than can be irrigated from the Tranche 2 water alone. Therefore, it has been assumed above that all of the Tranche 2 irrigation water applied for is utilised.

(4) Less than applied for.

A map of groundwater level difference between the status quo and augmentation scenario 4 is presented in Figure 19 for 1 March 2011. This demonstrates how groundwater levels are predicted to change spatially during dry periods. Temporal changes in groundwater are discussed later.

The following key observations are derived from these results:

- As previously noted in Table 19, the combined effects from the proposed irrigation takes alone are predicted to result in a total reduction in the 7-day MALF out of the basin of approximately 187 l/s (-147 l/s from the Waipawa and -40 l/s from the Tukituki). Under augmentation scenario 4 (Table 26), the combined 7-day MALF out of the basin is expected to increase by approximately 138 l/s as a result of +3 l/s (increase) in the Waipawa and +135 l/s (increase) in the Tukituki.
- Overall, augmentation scenario 4 is having a positive effect on the 7-day MALF exiting the basin, and also fully or nearly mitigates the effects on low flows in both the Mangaonuku and Tukipo rivers.
- Similar to previous scenarios, shallow groundwater levels are predicted to lower up to a maximum of 0.8 m under augmentation scenario 4, focussed near the applicants' properties. Elsewhere, shallow groundwater levels are predicted to change less than 0.3 m.

From the above, augmentation scenario 4 provides a reasonable balance between irrigation and augmentation while providing a positive benefit to low flows out of the catchment (low flows increase compared to the baseline scenario where no Tranche 2 water is taken). In other words, the baseline adverse effects of the Tranche 2 takes on surface water low flows exiting the basin are over-compensated under scenario 4. The small residual negative change to 7-day MALF in the Tukipo River at SH50 is smaller than both model uncertainty and measurement precision.

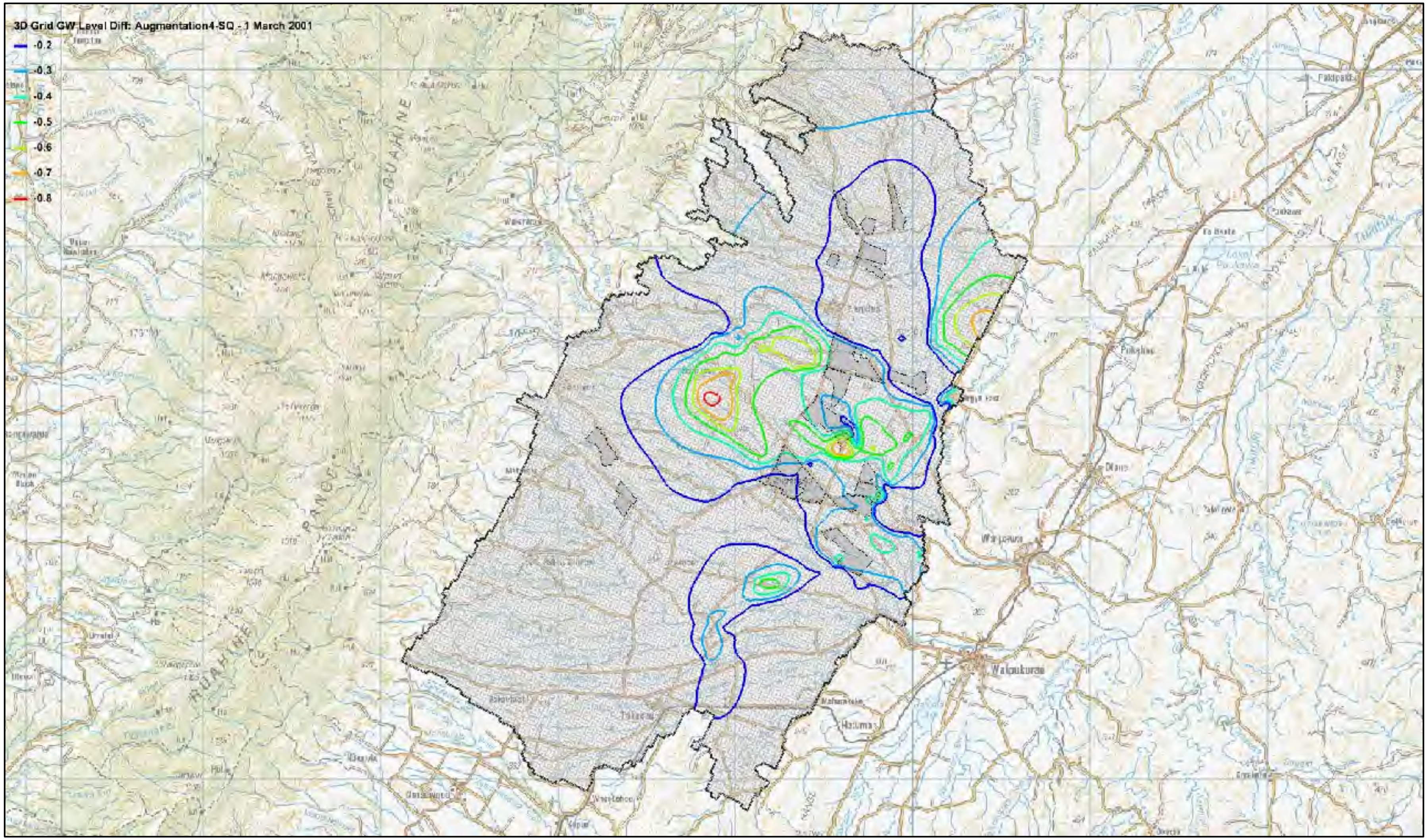


Figure 19: Difference in shallow (layer 1) groundwater levels at 1 March 2001 between status quo and augmentation scenario 4

3.11.7 Temporal Response in Calibration Wells

Appendix D provides groundwater level hydrographs comparing the baseline (status quo) with the four augmentation scenarios. Generally, the wells that respond less to climate and groundwater abstraction are shallower wells that are screened in the shallow unconfined aquifer that has higher storage coefficients compared to deeper wells. Groundwater levels in these shallower wells are also moderated by streams. Deeper wells experience greater seasonal variation and greater response to the additional Tranche 2 takes. However, there is no obvious temporal variation (over multiple years) to suggest that groundwater will be mined and continue to decline. Groundwater levels simply oscillate at a lower dynamic equilibrium.

For wells that are obviously influenced by pumping, the seasonal response (the saw-tooth effect) as a result of the additional Tranche 2 takes is much smaller than what is currently experienced from existing takes.

3.12 Practical Implications

To aid practical management, operation and compliance of the Tranche 2 takes, several protocols for the takes and augmentation are proposed. These proposals differ to the modelling assumptions. However, at a practical level, the differences are only marginal, and it is expected that the net effect on river flows and groundwater levels will be very similar to, or better than, those presented in the modelling above. The practical implications relate to:

- Staged development and transitional implementation;
- Automated monitoring of river flows; and
- Defining a 'Water Year' and associated start date of irrigation and augmentation.

These are each discussed below.

3.12.1 Staged Development and Transitional Implementation

The modelling scenarios presented above assume that every Tranche 2 take operates fully from day 1 (e.g. all bores are installed; irrigation systems are fully operational with mature pasture; augmentation is fully operational; etc.). This presents the extreme (or 'final') state that is eventually expected. However, this will not be the case initially. Some property owners have existing bores from which they can irrigate as soon as consents are granted; others have partial development; and others currently have no infrastructure and are awaiting for consents to be granted before commencing significant investment. This means that the full uptake of Tranche 2 water will not be instantaneous upon granting of the consents, but will progressively develop ('ramp up') over several years. Hence, implementation will be transitional.

The Tranche 2 applicants considered a range of options to practically manage the effects throughout the transition period. The most sensible solution arrived at proposes that each consent holder nominates (to HBRC) a maximum seasonal volume of water that they expect to need that season, proportional to the scale of property development. This then becomes the maximum allocation volume for that season (only) and the augmentation discharge rate is pro-rated on this same basis. This volume is then reassessed in subsequent years. For example, let's assume that a property has a 1-in-10 year maximum seasonal volume of 1,000,000 m^3/year and proposes to augment the adjacent river at 20 l/s when low-flow triggers are reached. If by the first irrigation season the property is 40% developed, then the maximum irrigation volume for that year will be 400,000 m^3 and the augmentation rate would be 8 l/s. If by the following year development has expanded to 60%, then the maximum irrigation volume for that year would be 600,000 m^3 and the augmentation rate would be 12 l/s. And so on up to 100% development.

This transitional implementation is founded on the principle that, while the effects of pumping propagate over a relatively large distance, the effects are largely seen in the vicinity of the abstraction location. Consequently, effects and subsequent augmentation to mitigate these effects (during low flows) are proportional to the scale of the take.

If a Tranche 2 consent holder is unsure of the level of development expected for an upcoming season, they will not want to under-predict their water needs. Hence, they would be more likely to nominate a higher percentage than a lower one. The nominated percentage of development then dictates (and locks in) the rate of augmentation for that year, regardless of whether or not the irrigation volume is used. Hence, it is more likely that the augmentation rate will be over compensated in these transitional years. This provides benefits to the rivers greater than modelled.

3.12.2 Automated Monitoring of River Flows

Of the five low-flow trigger sites modelled, HBRC currently monitor three of these automatically (Waipawa at SH2, Tukituki at Tapairu Rd, and Tukipo at SH50) with daily updates provided to consent holders. The other two sites are manually gauged, and updates are provided less frequently (such as weekly). Rivers and shallow groundwater downgradient of the augmentation discharge sites will respond rapidly to the discharge. Hence, daily controls are preferred to mitigate the low flows rapidly, but without significantly over compensating when river flows rise (e.g. if a fresh occurs between manual gaugings). Hence, the Tranche 2 applicants propose that their augmentation discharges are controlled daily based only on the existing three monitoring sites currently automatically monitored by HBRC. If automatic flow recorders are installed at the other two sites in the future, then these can then be added to the daily control regime.

This triggering regime is expected to make little difference in the very dry years when augmentation is needed the most (all rivers experience naturally low flows). There may be some ‘unders and overs’ in the wetter years where the three continuously monitored sites do not fully represent the other two sites. In these cases, the augmentation may not be triggered when these smaller streams are below the low flow trigger. However, it is expected that the targeted-overcompensation at other times provides a buffer that will partially mitigate effects on these streams at these times.

3.12.3 ‘Water Year’ Definition and Associated Start Dates of Irrigation and Augmentation

HBRC currently define the allocation water year from 1 July to 30 June. On 1 July, monitoring of the annual volume is reset to ‘zero’ for the upcoming season. The Tranche 2 applicants have two volumetric limits: an irrigation volume and an augmentation volume, both defined by a 9-in-10 year season. If the water year commences 1 July (as currently defined by HBRC), it is possible that augmentation to rivers may be needed through winter at the start of the water year when there is no irrigation pumping. While this does acknowledge the fact that the effects of irrigation continue on beyond when pumping stops (as it takes time for the aquifer system to recover), there is a small possibility that augmentation water will be used in the cooler, wetter months (if minimum flows are triggered) resulting in insufficient augmentation water later in the warmer, drier parts of the season when the augmentation is needed most.

Because of this, the Tranche 2 applicants propose to define the water year commencing at the start of the irrigation season, nominally 1 October. Then, given that effects from the deep pumping take time to propagate to the surface, it is proposed that the augmentation year starts 1 month after this (i.e. 1 November). This has multiple consequences:

- Augmentation water is ‘saved’ for the driest times of the year when it is needed most, usually well beyond the start of the irrigation season.
- Delaying the start of augmentation will mean that, in most years, the augmentation volume will not be fully used before winter; this unused water can then be discharged throughout winter when low flows are triggered.
- Continuing to augment during winter results in the equivalent of full-year augmentation for most years (9 in 10), but provides the added assurance that there will be augmentation water available

in the driest parts of driest seasons when it is needed most, rather than potentially running out just before it is needed.

- There may be the occasional time when low flows are reached during winter, but the augmentation volume is fully used and augmentation cannot continue. Based on historical records, this would occur infrequently (1 year in 10).

This proposal to define the water year as noted above will reduce the likelihood of augmentation water being used up before the irrigation water limit is reached.

3.13 Summary and Recommendations

The following key findings have been derived from the modelled scenarios:

- The effects on river flows from the proposed additional Tranche 2 takes are spread over both space and time throughout the basin.
- If augmentation occurs when both existing minimum flows are reached and when irrigation would be operating, it is insufficient to mitigate depletion of 7-day MALF flows due to additional Tranche 2 takes.
- If augmentation is applied when minimum flows are reached, regardless of whether or not irrigation is operating, augmentation is more beneficial and results in an overall improvement in low flows exiting the basin in both the Tukituki and Waipawa rivers. The exception to this is Tuki Tuki Awa who propose to take Tranche 2 groundwater and augment to the Tukituki River only when their existing surface water take is restricted. This also does not adversely affect low river flows.
- For the Tranche 2 applicants, the adoption of higher minimum flow triggers (and therefore more frequent augmentation) provides greater benefit to 7-day MALF. It also better protects the reliability for existing abstraction consent holders.
- Targeted over-compensation accommodates prediction uncertainty, enhances environmental low-flows, and accommodates across-catchment effects.
- Under augmentation scenario 4, adverse effects on surface water low flows as a result of the Tranche 2 takes are either avoided (positive effects occur as evidenced by the increased flows at the Waipawa and Tukituki low flow sites), or are so minor that they fall within the margin of modelling and measurement uncertainty (i.e. for the Tukipo SH50 low flow site).
- Groundwater will not be mined. While groundwater levels will lower further with the additional Tranche 2 takes (made available under PC6), they will not continue to lower; they will simply reach a new (lower) dynamic equilibrium. Shallow groundwater levels are predicted to lower a maximum of 0.8 m in the vicinity of the Tranche 2 take locations, and less than 0.3 m further afield.
- The reported irrigation and augmentation volumes are based on a 90-percentile year. Therefore, is it is possible that in extreme dry years (e.g. 1 year in 10), low flows could still be triggered after irrigation and augmentation volumes have been exhausted.

From the optimised scenario (augmentation scenario 4), the optimum area of irrigated pasture (and corresponding volumes) and augmentation volumes are summarised in Table 28.

Table 28: Optimised areas of irrigated pasture and Tranche 2 groundwater volumes (reproduced from Table 27)

Applicant	Modelled augmentation rate (l/s, daily average)	Approx. area irrigated from Tranche 2 GW (ha) [1]	Modelled 90 percentile annual volumes (m^3/year) (1972-2012)			Tranche 2 GW volume applied (m^3/year)
			For irrigation	For augmentation (% of total)	Total	
TAFT	189	490	2,841,220	2,073,700 (42%)	4,914,920	4,914,920
Papawai	24	181	1,010,817	464,700 (31%)	1,475,517	1,475,517
Tuki Tuki Awa	5	136	678,100	29,600 (4%)	707,700	952,400
Plantation Rd Dairies	103	403	2,418,225	1,333,000 (36%)	3,751,225	3,751,225
Springhill Dairies	38	123	588,313	416,900 (41%)	1,005,213	1,005,213
I&P Farming	22	166	916,010	284,000 (24%)	1,200,010	1,200,010
Buchanan	51	131	786,594	359,200 (31%)	1,145,794	1,145,794
Purunui	14	62	370,321	184,600 (33%)	554,921	554,921
		Total	**9,609,600**	**5,145,700 (35%)**	**14,755,300**	**15,000,000**

[1] These areas are based on the assumption that pasture is irrigated. However, larger areas of less intensive crops or horticulture can be irrigated within the same yearly volumes used by pasture, with little-to-no difference in the hydraulic effect.

From Table 28 it can be seen that the modelled total abstraction does not equate to 15,000,000 m^3/year. This is a result of the proposal by Tuki Tuki Awa to only use Tranche 2 groundwater when their surface wate take is restricted. However, this does not mean that the balance (244,700 m^3/year) is available for allocation to other applicants because in some extreme years the full allocation sought by Tuki Tuki Awa may be used.

Proposed minimum flow triggers and net changes in 7-day MALF for key river flow monitoring sites under the optimised scenario are summarised in Table 29.

Table 29: Modelled changes in 7-day MALF (over the period 1972-2012) compared to status quo due to all applicants' irrigation takes with optimised augmentation (scenario 4)

Site				
Waipawa at SH2	**Tukituki at Tapairu Rd**	**Tukipo at SH50**	**Tukipo at Ashcott Rd**	**Mangaonuku u/s Waipawa**
Assumed low-flow restriction applied (l/s) [1]				
2,725	2,360	155	1,085	1,295
Change in mean 7-day annual low flow (MALF) (l/s) [2]				
+3	+135	-1	+1	+2
Change in 7-day MALF as a percentage of low-flow limit				
+0.1%	+5.7%	-0.6%	+0.1%	+0.2%

[1] Discussed in Section 3.11.5. These are higher than current RRMP Table 5.9.3 limits to provide greater environmental benefit during low flows and to protect reliability of existing users.

[2] Reproduced from Table 26.

Several management, operational and compliance protocols are recommended to aid practical implementations of the Tranche 2 takes and augmentation.

REFERENCES

Barnet, B; Townley, LR; Post, V; Evans, RE; Hunt, RJ; Peeters, L; Richardson, S; Werner, AD; Knapton, A; Boronkay, A (2012): *Australian Groundwater Modelling Guidelines.* Waterlines Report. Published by the Australian National Water Commission, Canberra. June 2012.

Donnell, BP and the ERDC-CHL Groundwater Team (2004): *DDJC-Sharpe Defense Distribution Depot: FEMWATER 3D transport model of TCE plume migration with natural attenuation.* US Army Corps of Engineers report. March 2004.

Dougherty, J (2010): *PEST – Model-independent parameter estimation, User Manual: 5th Edition*. Watermark Numerical Computing.

GMS (2019): *Groundwater Modelling System*. Aquaveo LLC, USA. Latest build version 10.4.2 (64 bit) dated 1 February 2019.

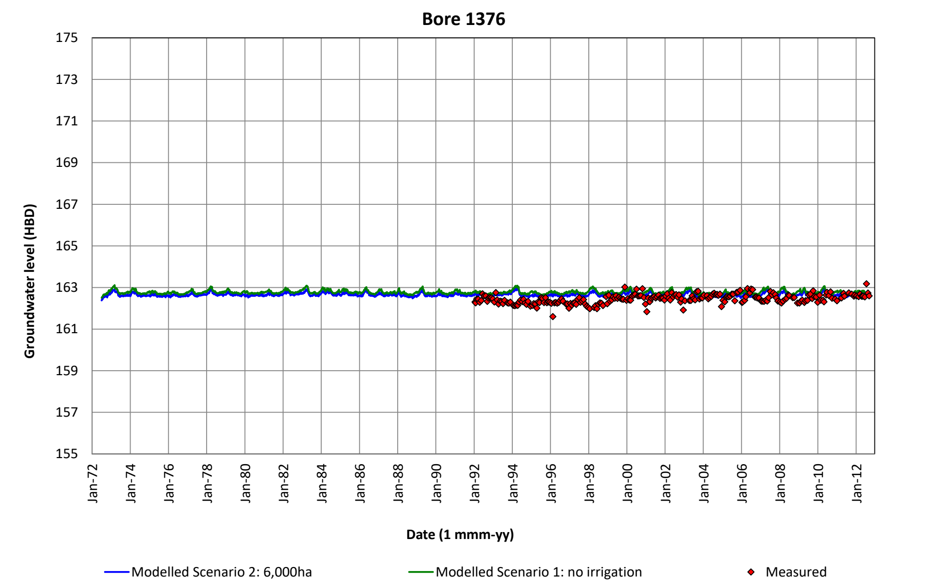
MDBC (2001): *Groundwater flow modelling guideline.* Murray-Darling Basin Commission. Aquaterra Consulting Pty Ltd. Project No. 125. Final Guideline – Issue I. 16 January 2001.

Niswonger, RG; Panday, S and Ibaraki, M. (2011): *MODFLOW-NWT, A Newton formulation for MODFLOW-2005.* US Geological Survey Techniques and Methods 6-A37.

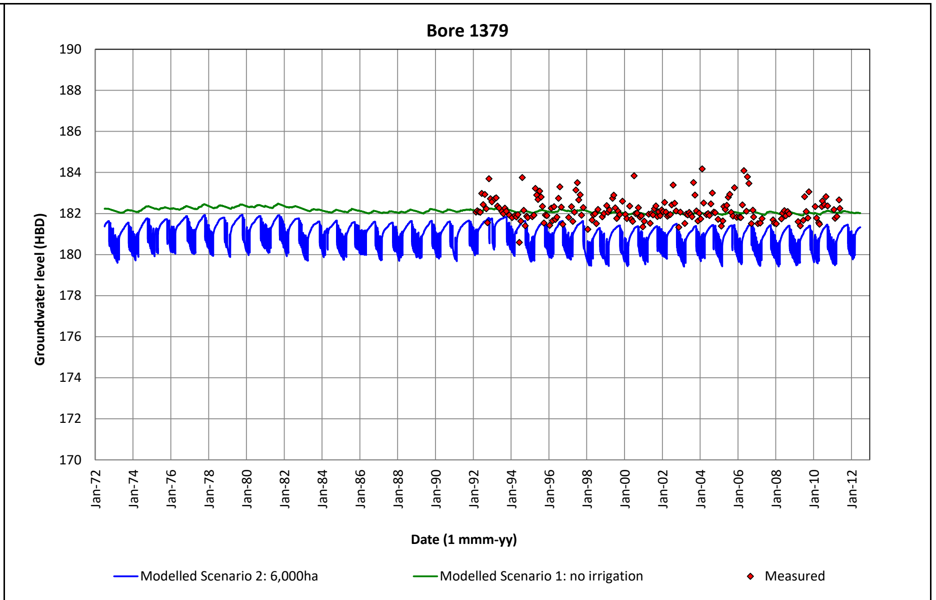
PDP (2018): *Ruataniwha Aquifer Properties Analysis and Mapping.* Parped for Hawke's Bay Regional Council. Job reference C02591543. Pattle Delamore Partners LTd. 14 December 2018.

Weir (2013): *Statement of Evidence of Julian James Weir for Ruataniwha Water Users Group (Groundwater Modelling).* Expert evidence presented before a Board of Inquiry for the proposed Tukituki Catchment plan change 6. 7 October 2013.

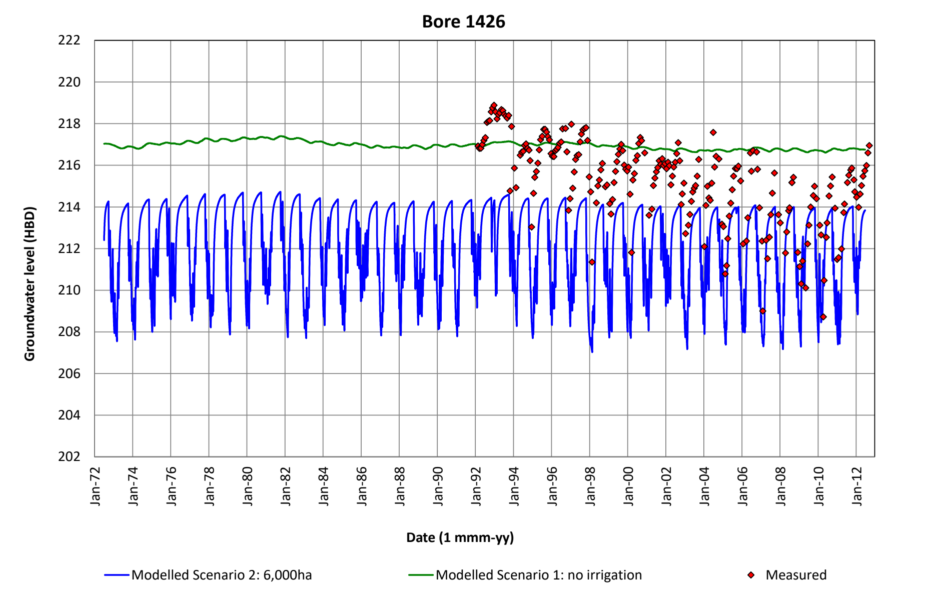
Appendix A: Groundwater level calibration plots



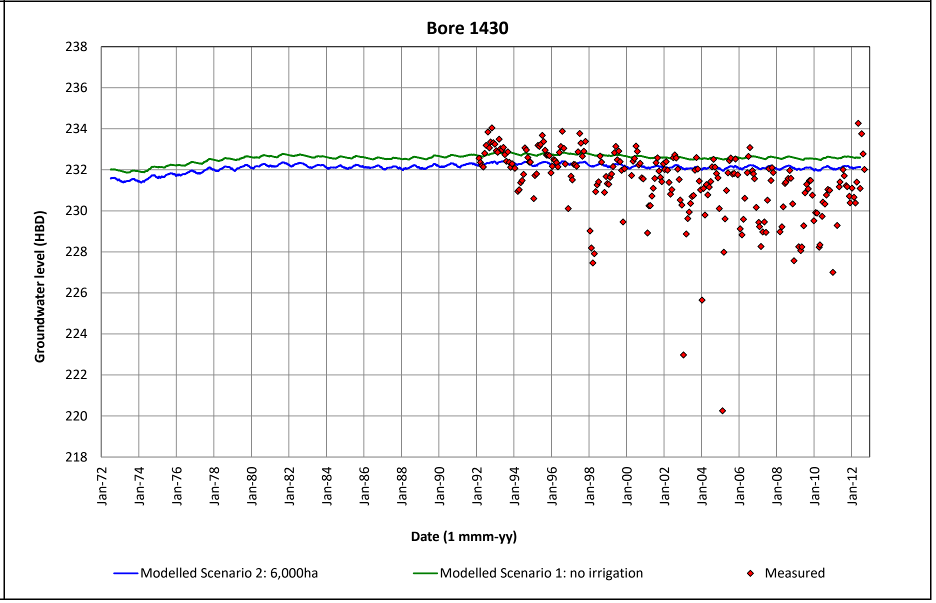
Bore 1376
Groundwater level (HBD)
175
173
171
169
167
165
163
161
159
157
155
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured



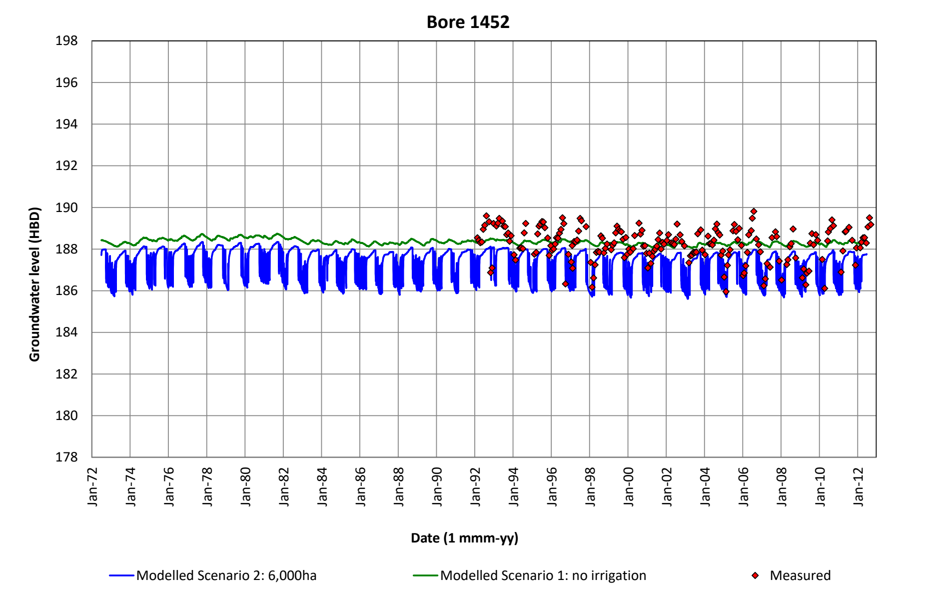
Bore 1379
Groundwater level (HBD)
190
188
186
184
182
180
178
176
174
172
170
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

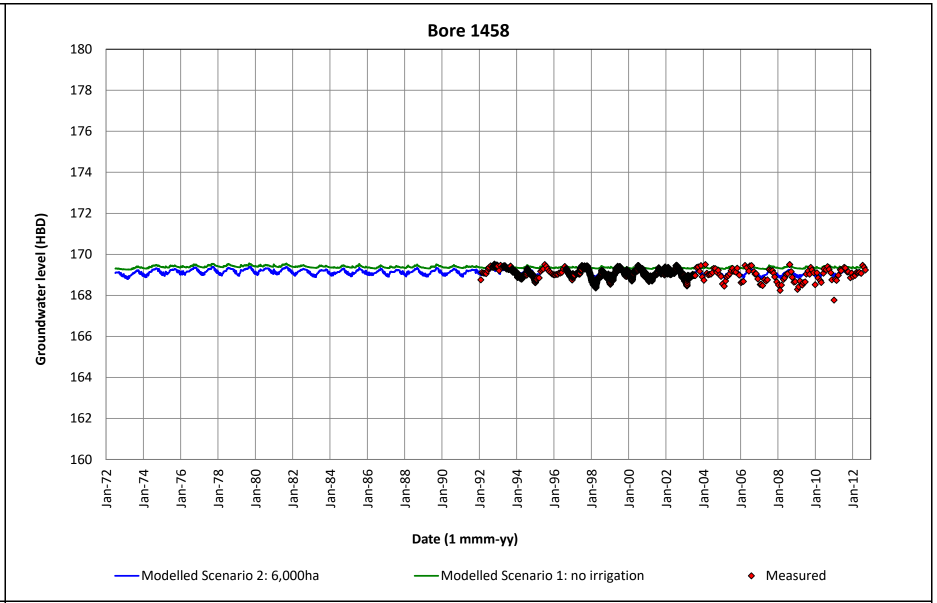


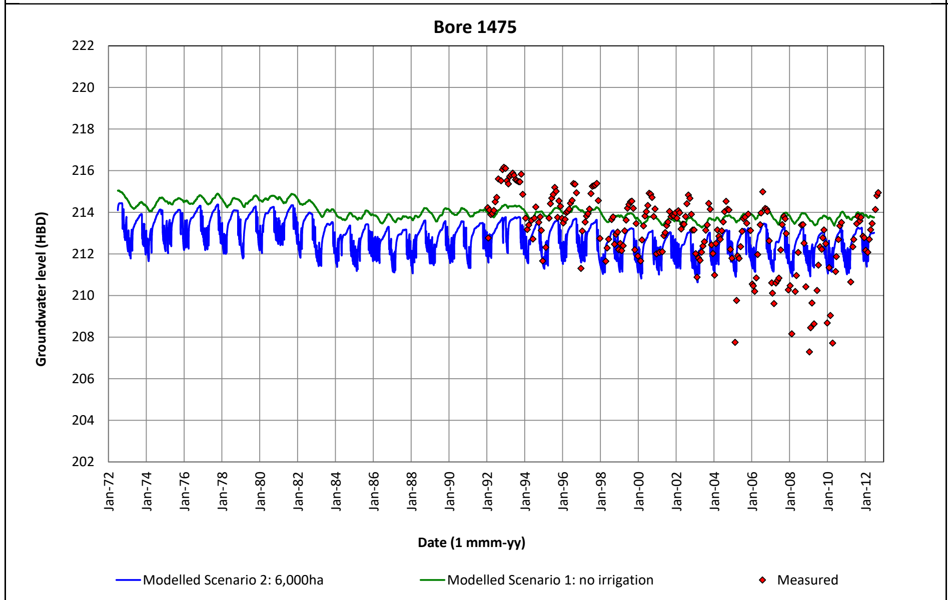
Bore 1426
Groundwater level (HBD)
222
220
218
216
214
212
210
208
206
204
202
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

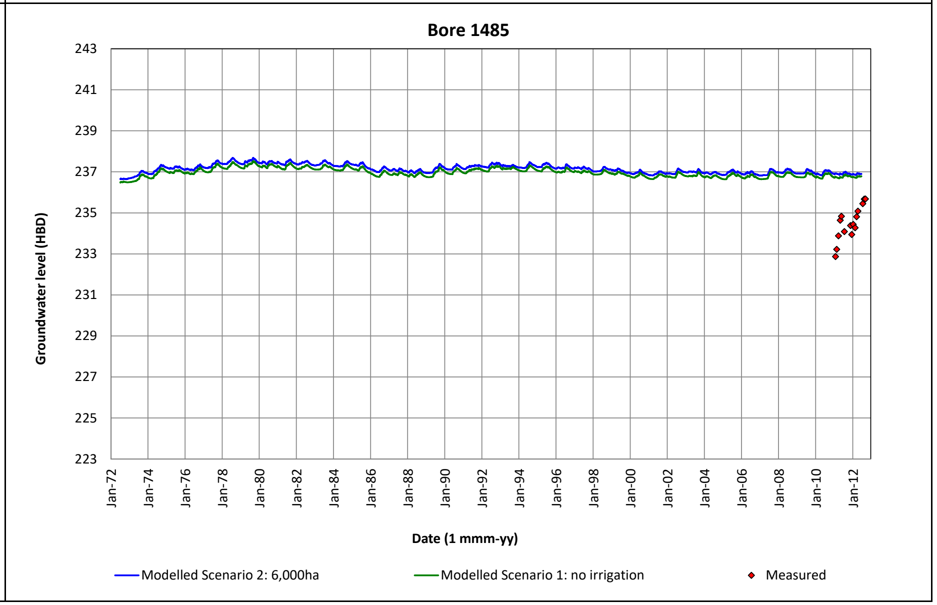


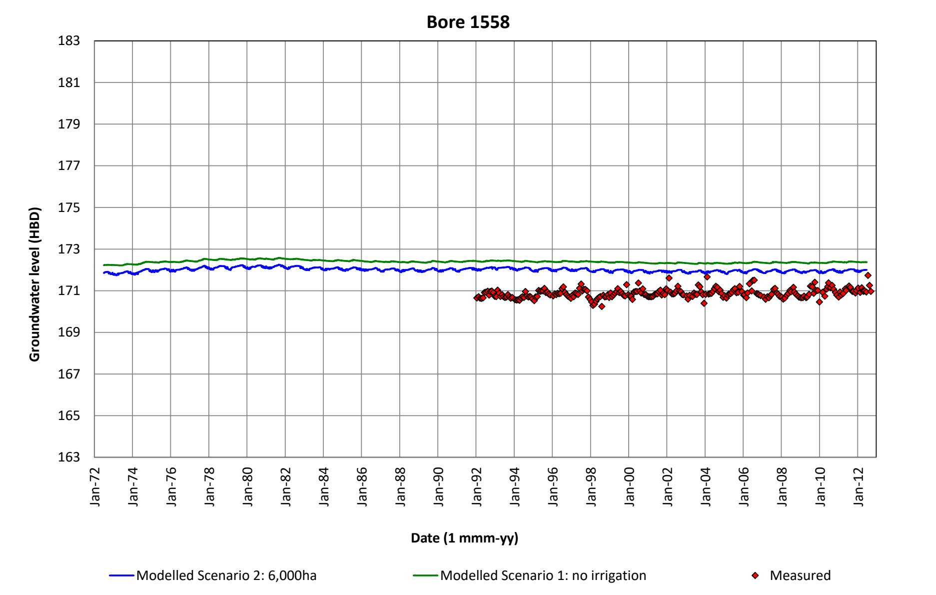
Bore 1430
Groundwater level (HBD)
238
236
234
232
230
228
226
224
222
220
218
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

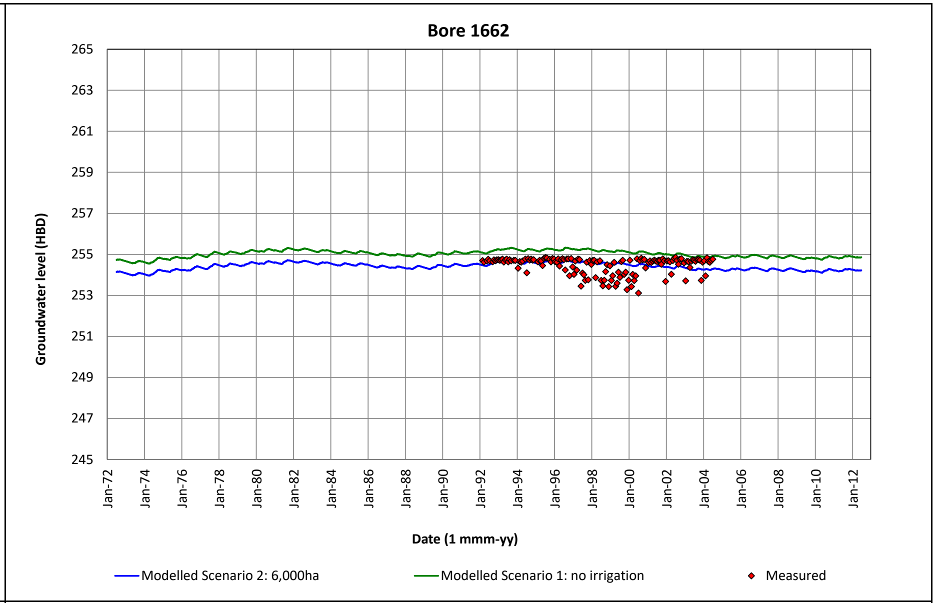

Bore 1452
Groundwater level (HBD)
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

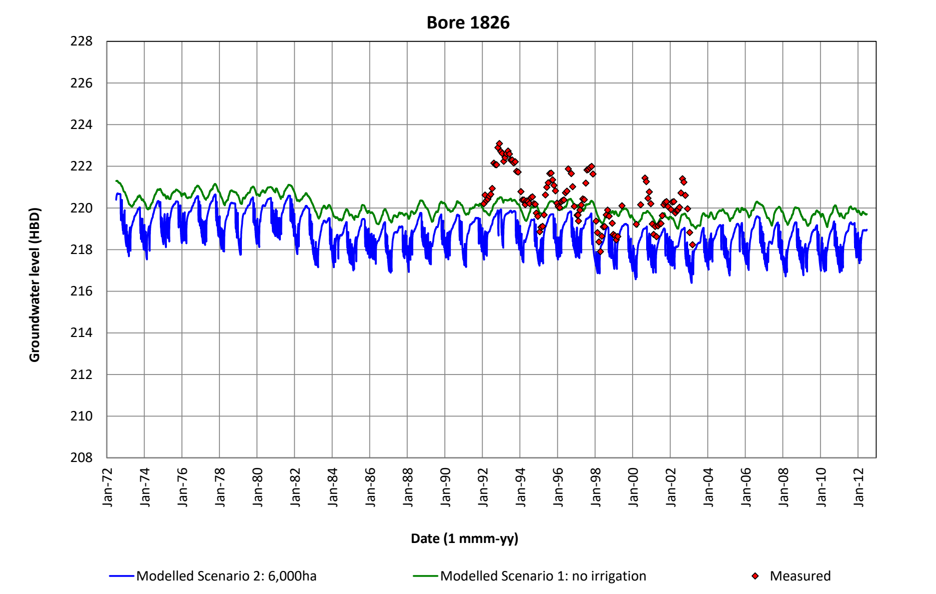

Bore 1458
Groundwater level (HBD)
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

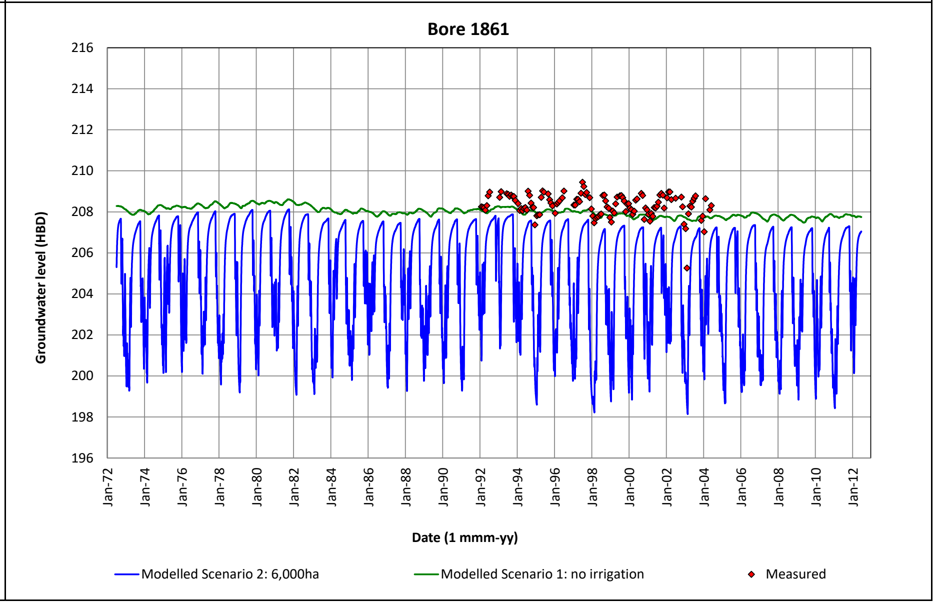

Bore 1475
Groundwater level (HBD)
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

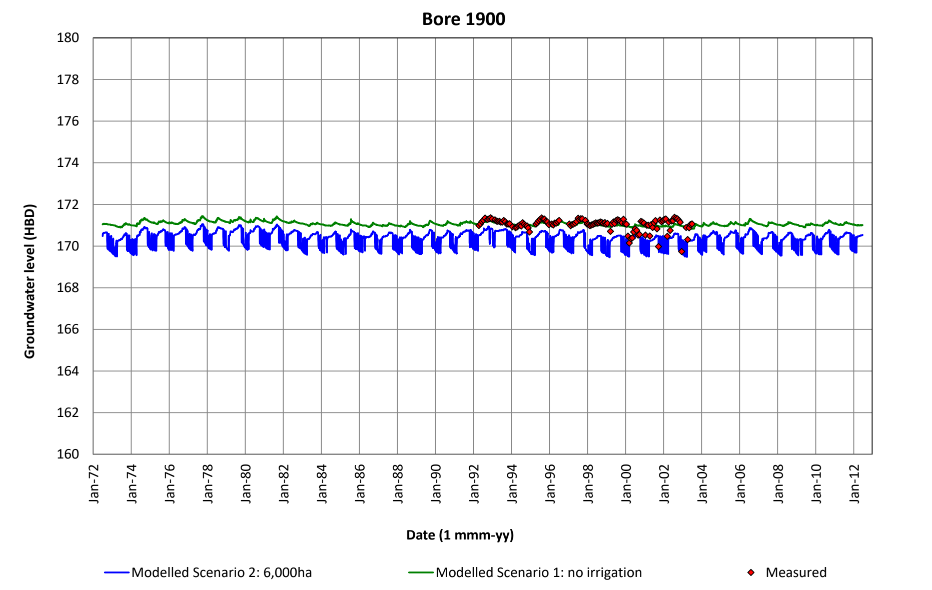

Bore 1485
Groundwater level (HBD)
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

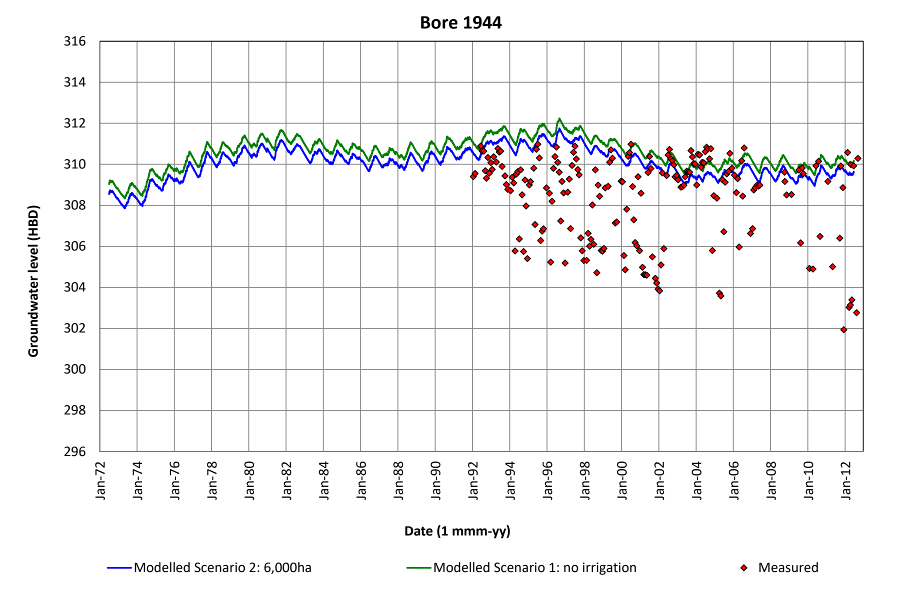

Bore 1558
Groundwater level (HBD)
183
181
179
177
175
173
171
169
167
165
163
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

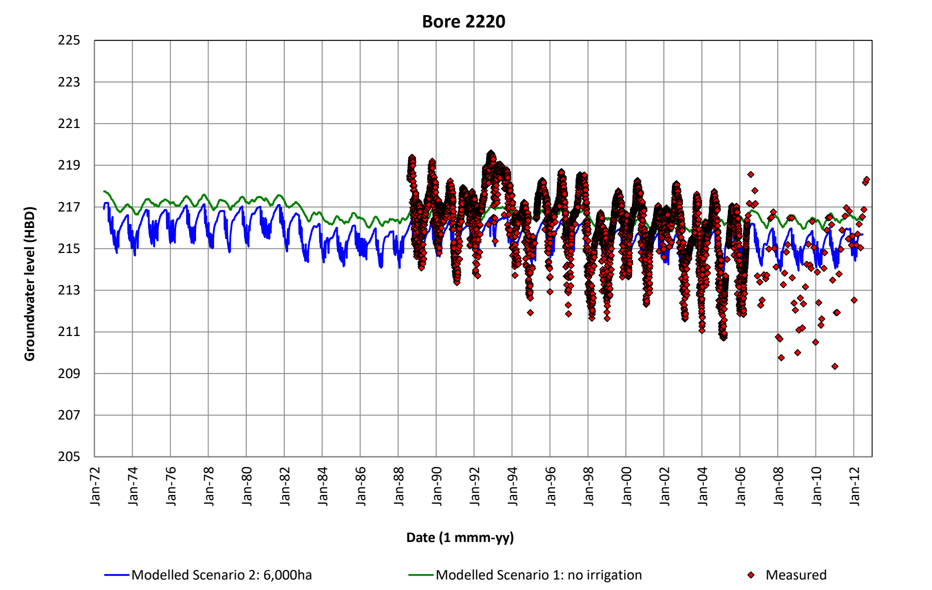

Bore 1662
Groundwater level (HBD)
265
263
261
259
257
255
253
251
249
247
245
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

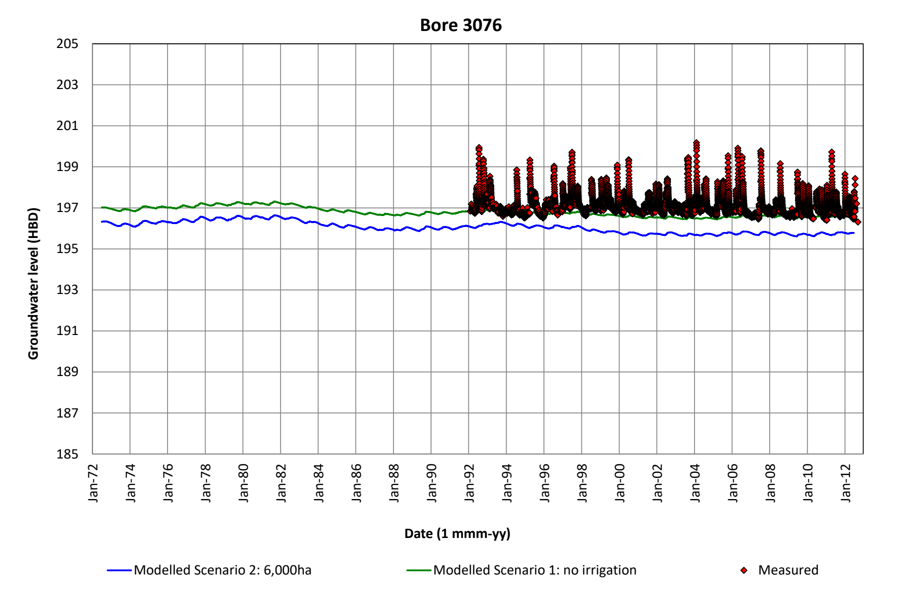

Bore 1826
Groundwater level (HBD)
228
226
224
222
220
218
216
214
212
210
208
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

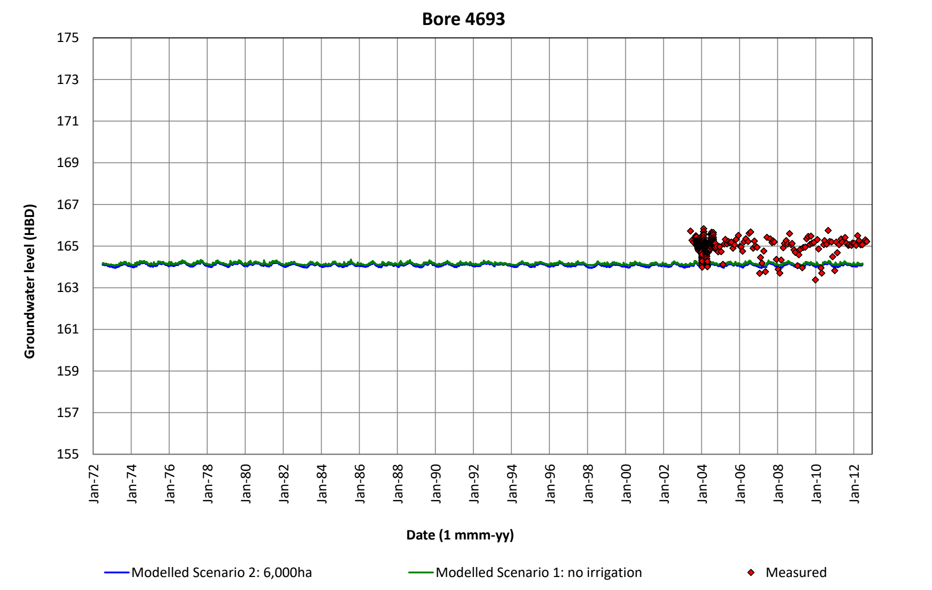

Bore 1861
Groundwater level (HBD)
216
214
212
210
208
206
204
202
200
198
196
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

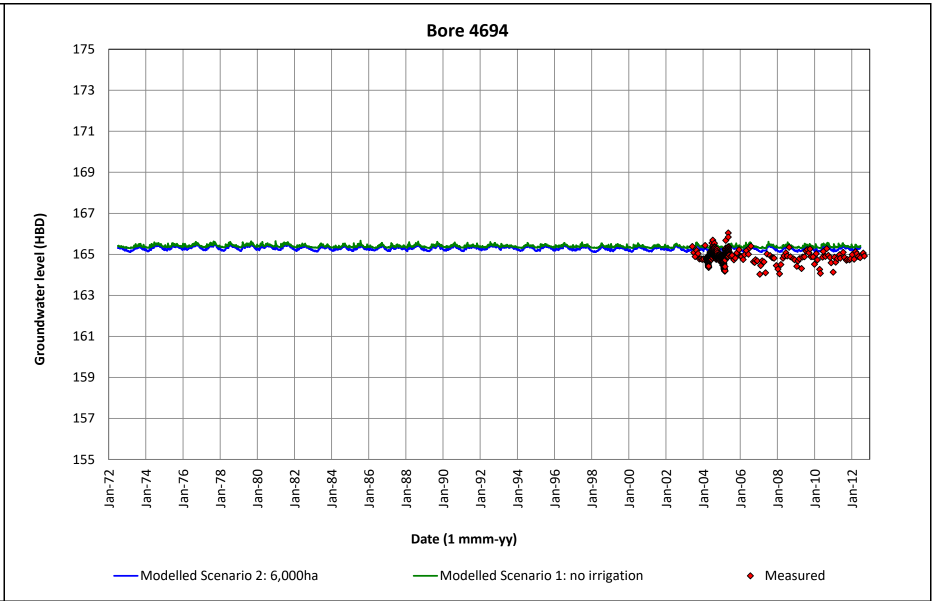

Bore 1900
Groundwater level (HBD)
180
178
176
174
172
170
168
166
164
162
160
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

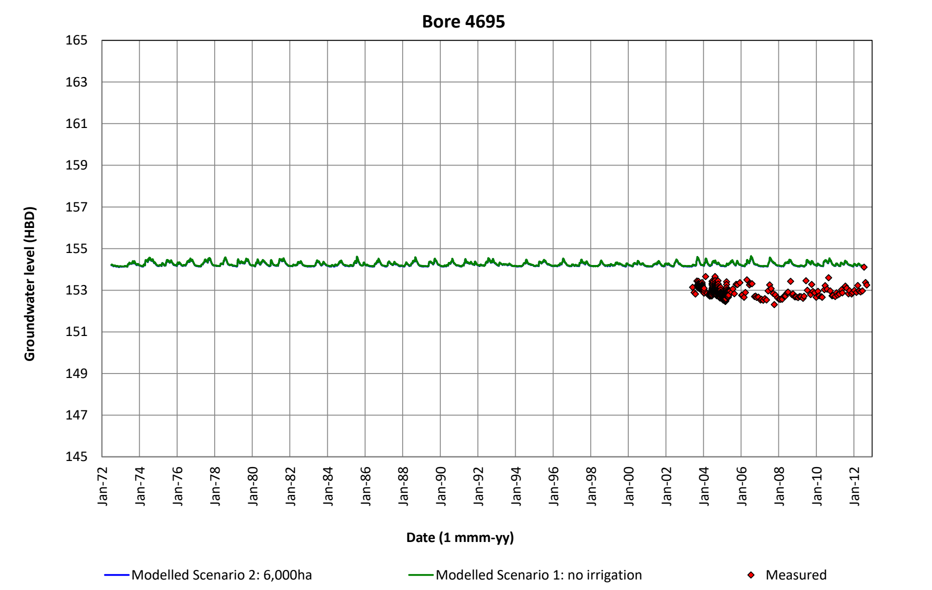

Bore 1944
Groundwater level (HBD)
316
314
312
310
308
306
304
302
300
298
296
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

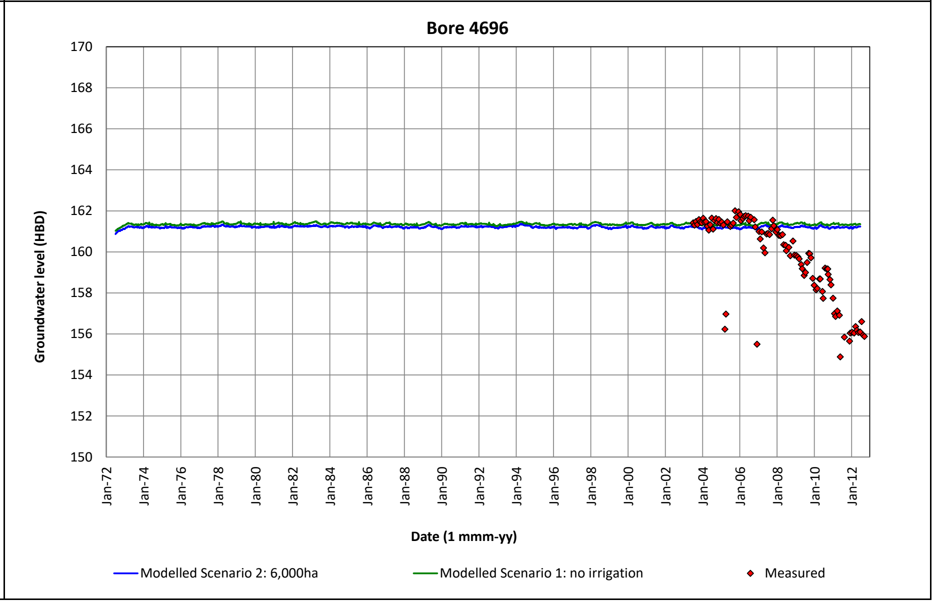

Bore 2220
Groundwater level (HBD)
225
223
221
219
217
215
213
211
209
207
205
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

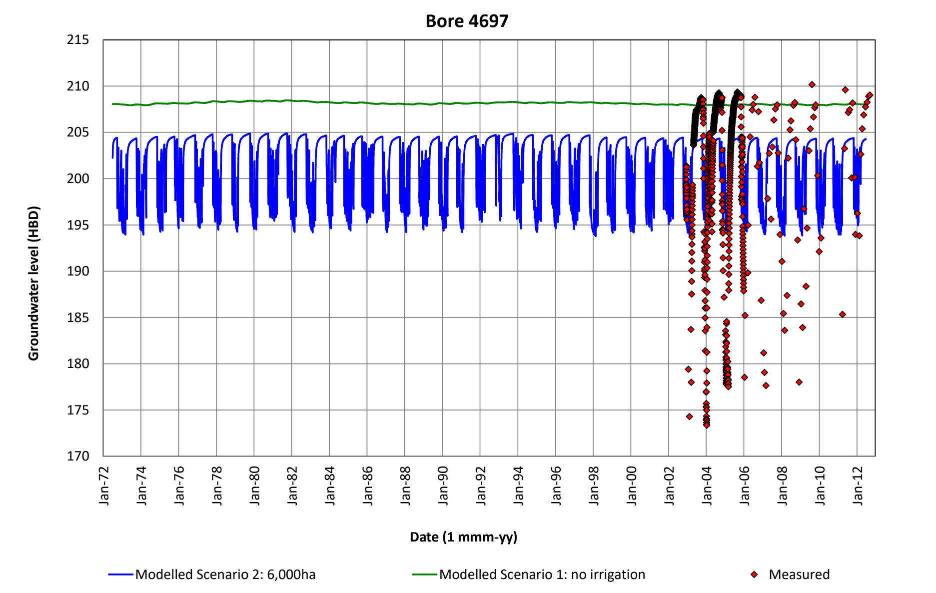

Bore 3076
Groundwater level (HBD)
205
203
201
199
197
195
193
191
189
187
185
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

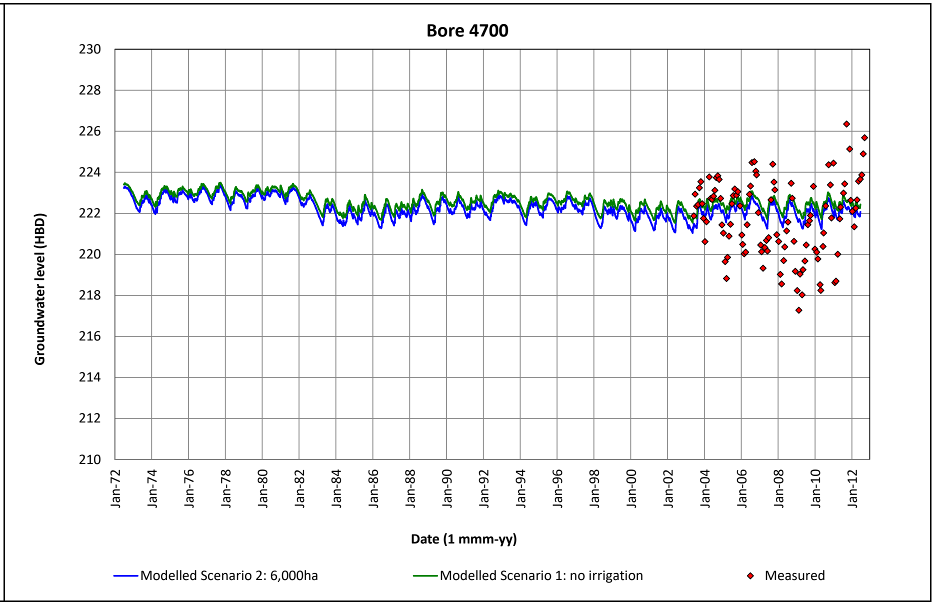

Bore 4693
Groundwater level (HBD)
175
173
171
169
167
165
163
161
159
157
155
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

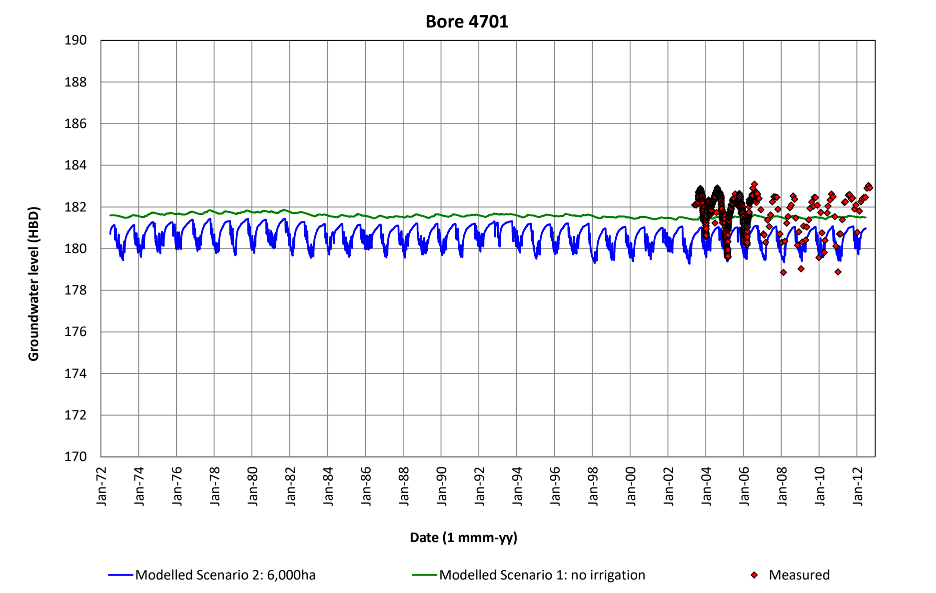

Bore 4694
Groundwater level (HBD)
175
173
171
169
167
165
163
161
159
157
155
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

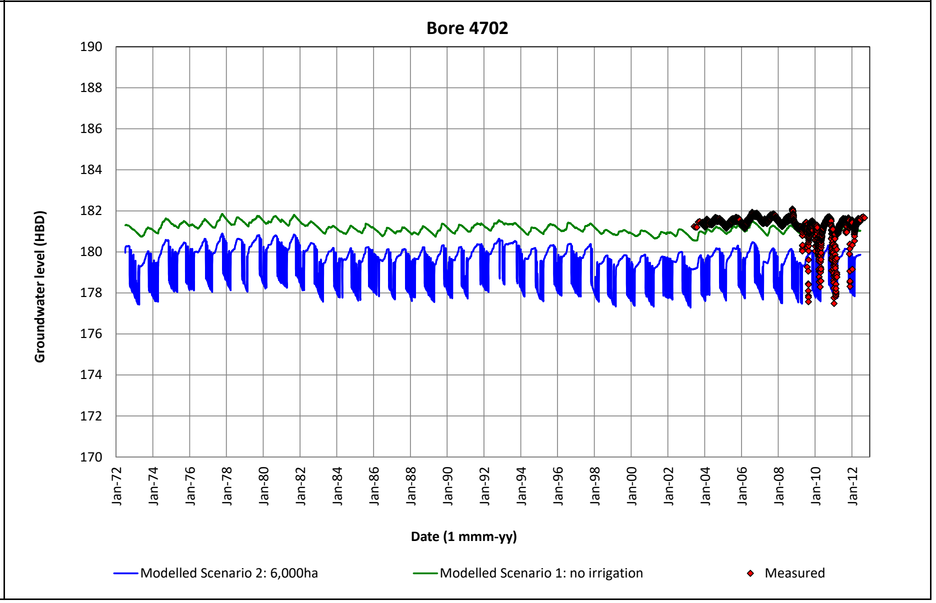

Bore 4695
Groundwater level (HBD)
165
163
161
159
157
155
153
151
149
147
145
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

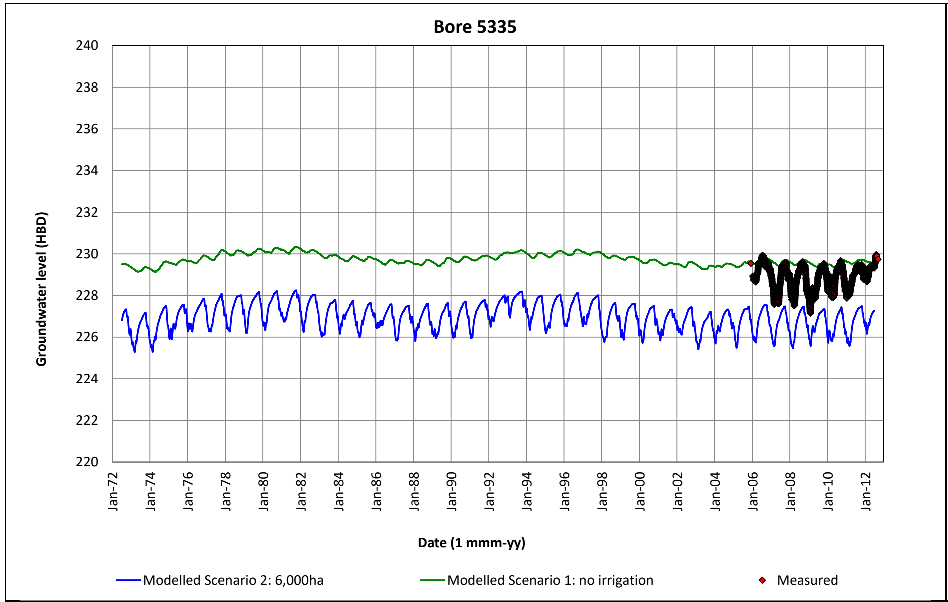

Bore 4696
Groundwater level (HBD)
170
168
166
164
162
160
158
156
154
152
150
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

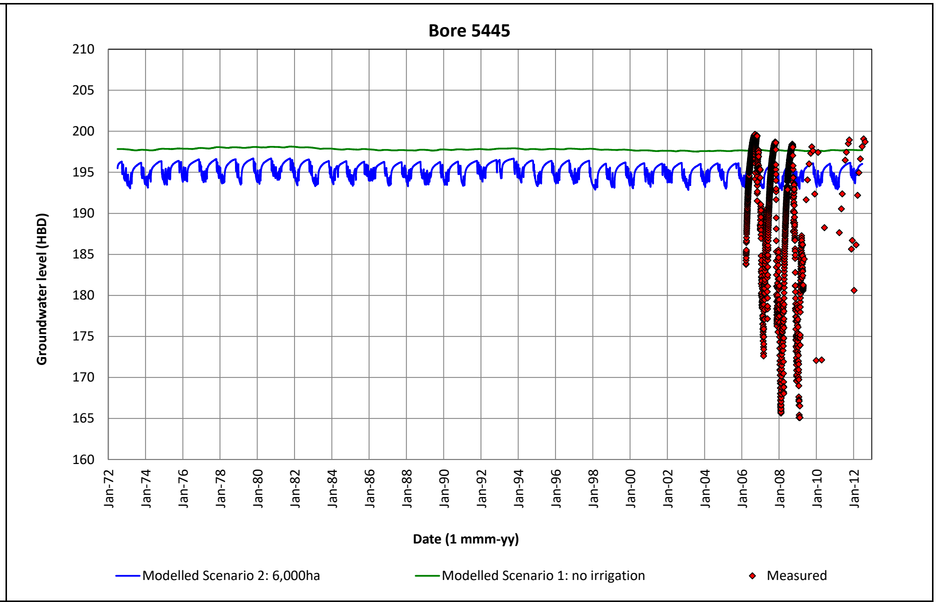

Bore 4697
Groundwater level (HBD)
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

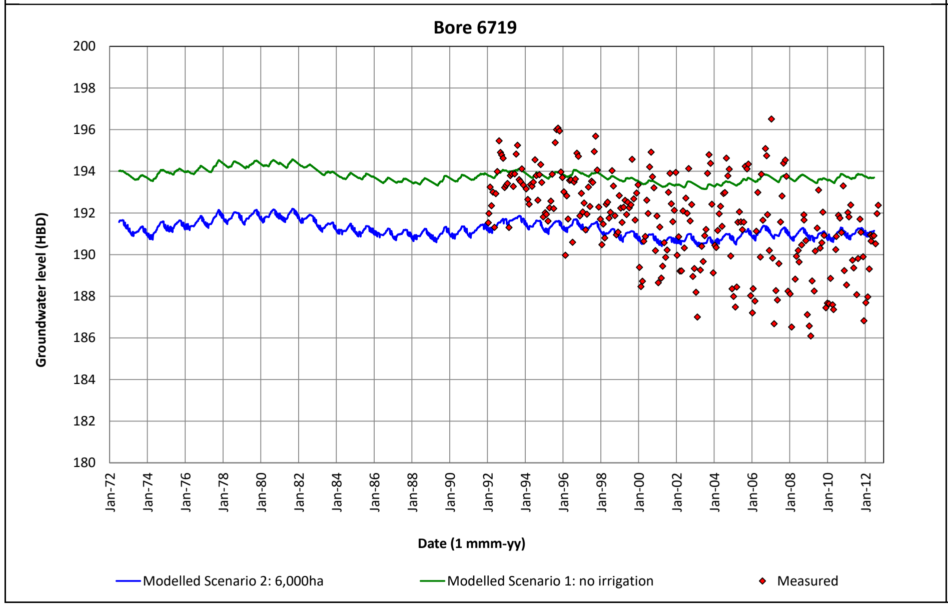

Bore 4700
Groundwater level (HBD)
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

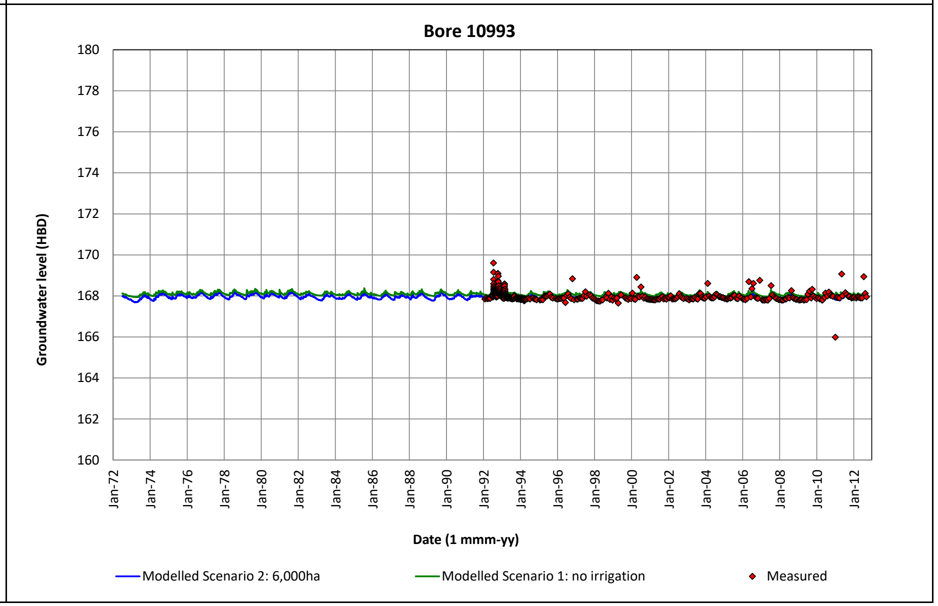

Bore 4701
Groundwater level (HBD)
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

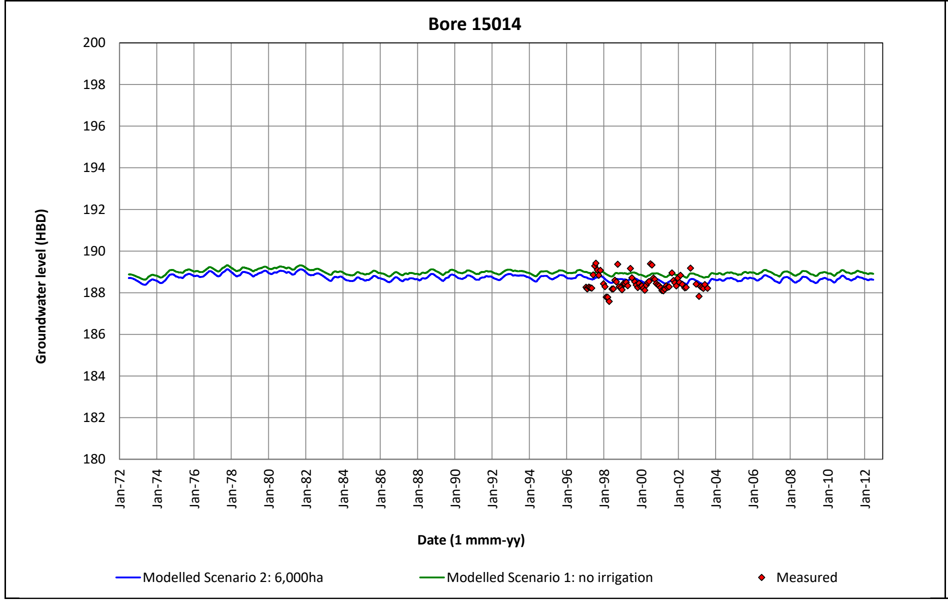

Bore 4702
Groundwater level (HBD)
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

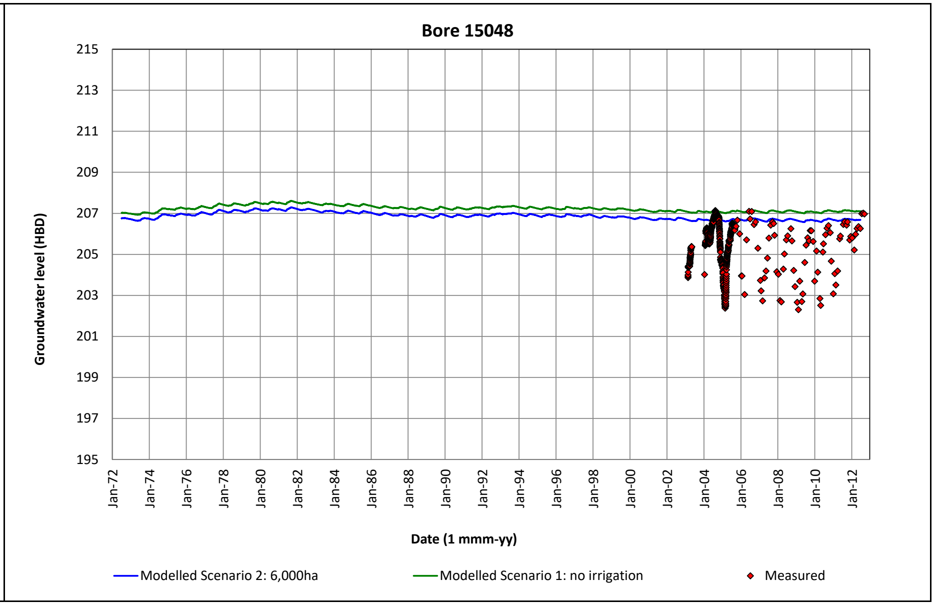

Bore 5335
Groundwater level (HBD)
240
238
236
234
232
230
228
226
224
222
220
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

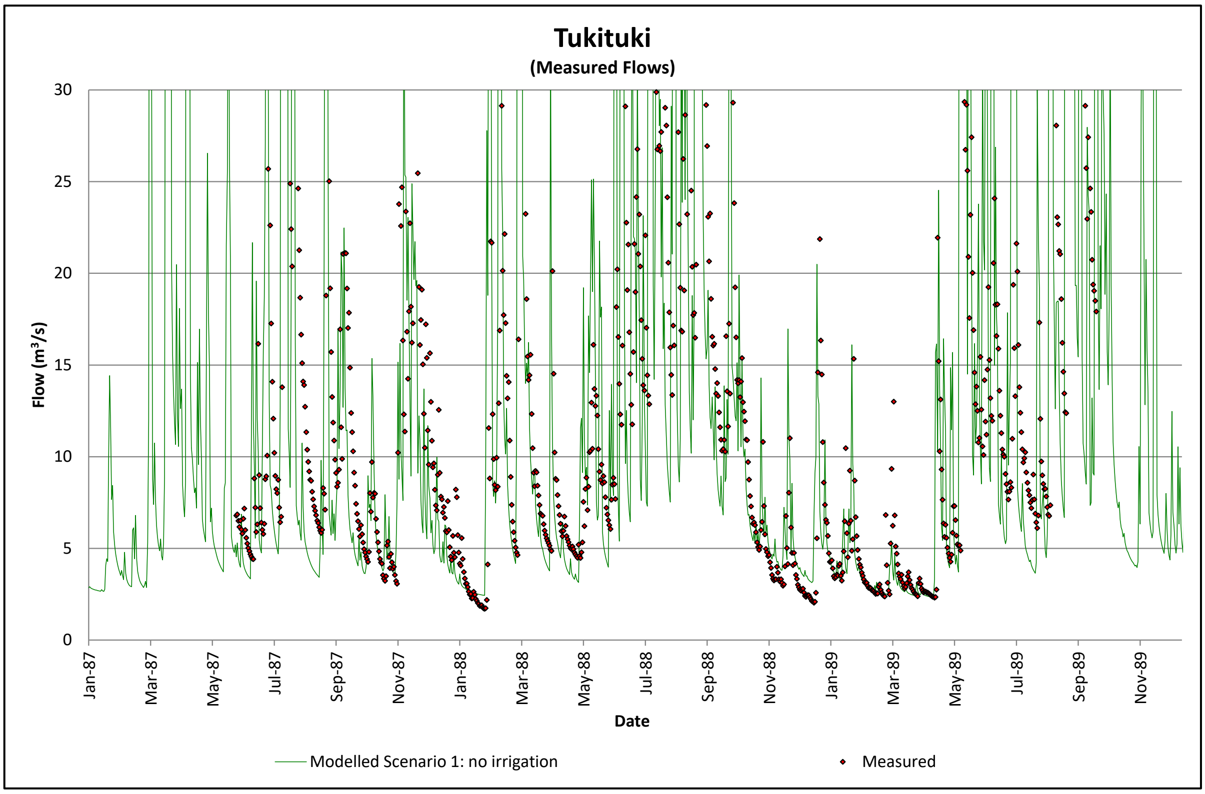

Bore 5445
Groundwater level (HBD)
210
205
200
195
190
185
180
175
170
165
160
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

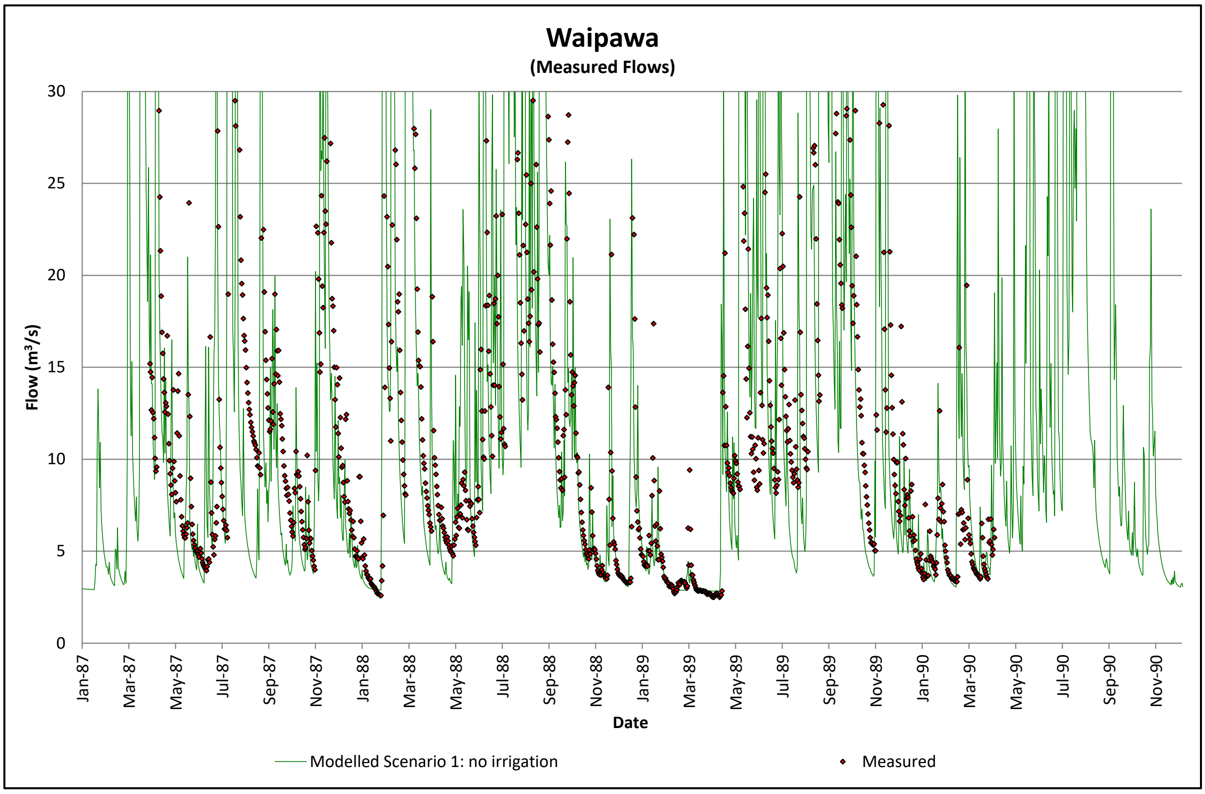

Bore 6719
Groundwater level (HBD)
200
198
196
194
192
190
188
186
184
182
180
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured


Bore 10993
Groundwater level (HBD)
180
178
176
174
172
170
168
166
164
162
160
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

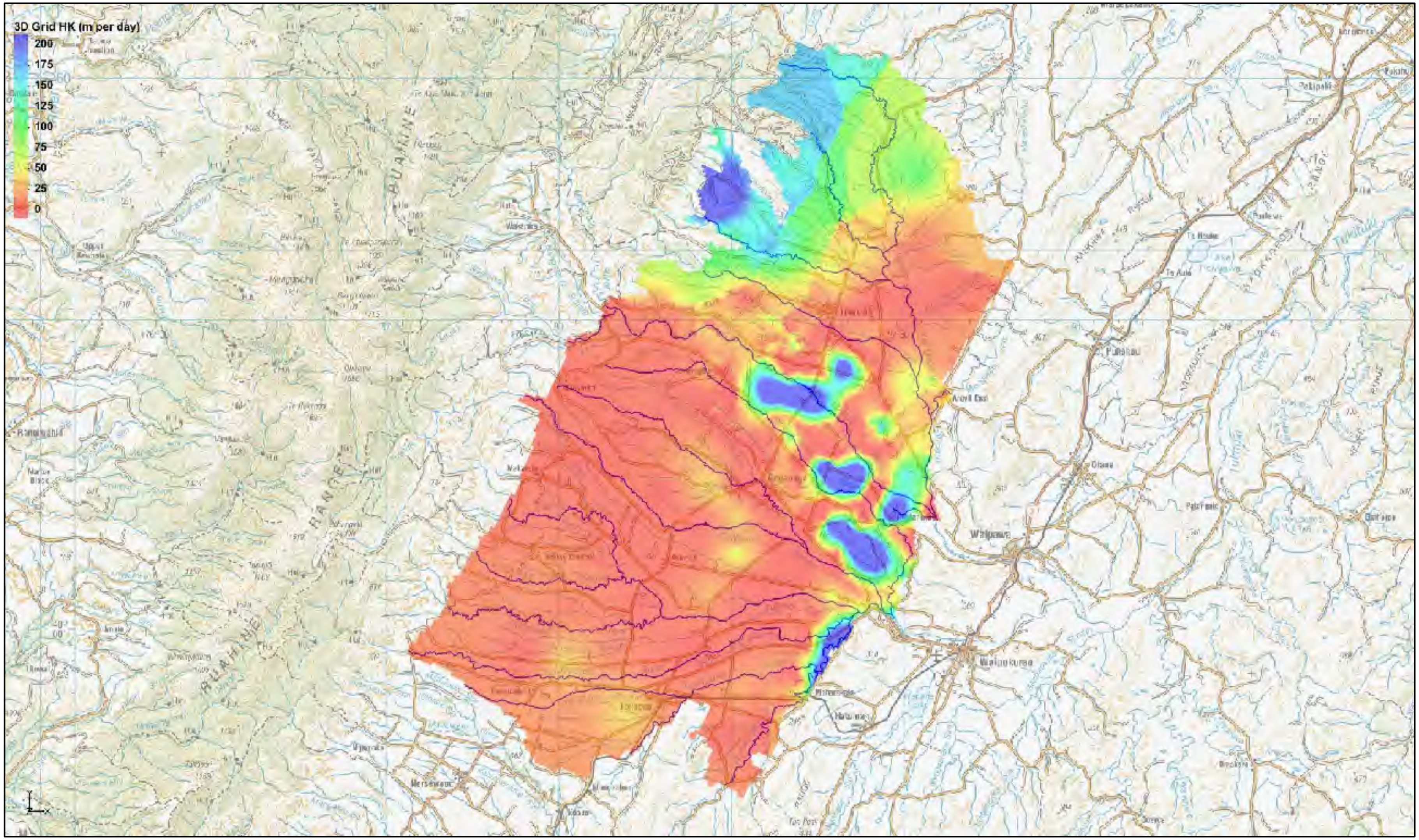

Bore 15014
Groundwater level (HBD)
200
198
196
194
192
190
188
186
184
182
180
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured


Bore 15048
Groundwater level (HBD)
215
213
211
209
207
205
203
201
199
197
195
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Modelled Scenario 2: 6,000ha
Modelled Scenario 1: no irrigation
Measured

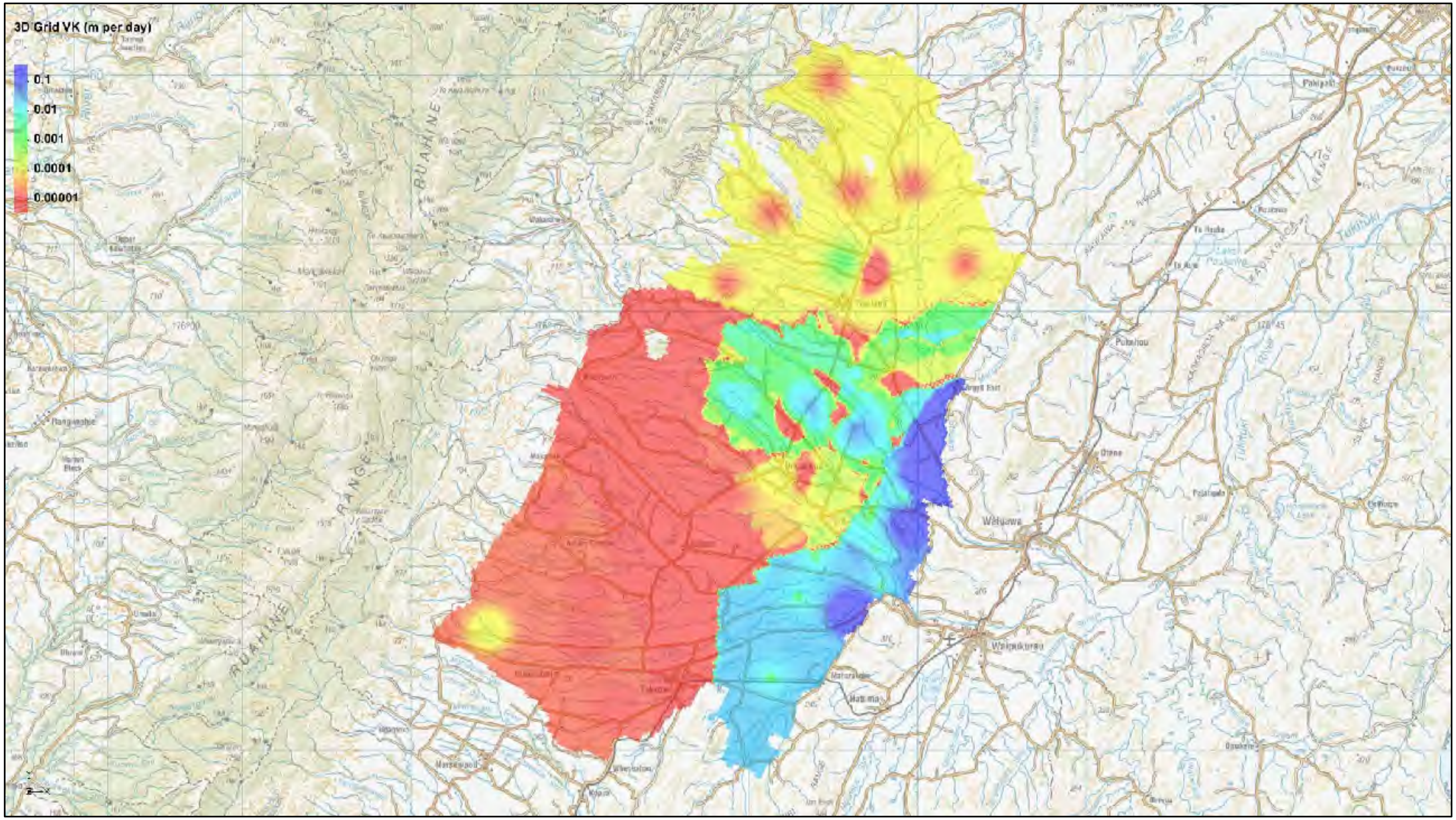

Tukituki
(Measured Flows)
Flow (m³/s)
30
25
20
15
10
5
0
Jan-87
Mar-87
May-87
Jul-87
Sep-87
Nov-87
Jan-88
Mar-88
May-88
Jul-88
Sep-88
Nov-88
Jan-89
Mar-89
May-89
Jul-89
Sep-89
Nov-89
Date
Modelled Scenario 1: no irrigation
Measured


Waipawa
(Measured Flows)
Flow (m³/s)
30
25
20
15
10
5
0
Jan-87
Mar-87
May-87
Jul-87
Sep-87
Nov-87
Jan-88
Mar-88
May-88
Jul-88
Sep-88
Nov-88
Jan-89
Mar-89
May-89
Jul-89
Sep-89
Nov-89
Jan-90
Mar-90
May-90
Jul-90
Sep-90
Nov-90
Date
Modelled Scenario 1: no irrigation
Measured

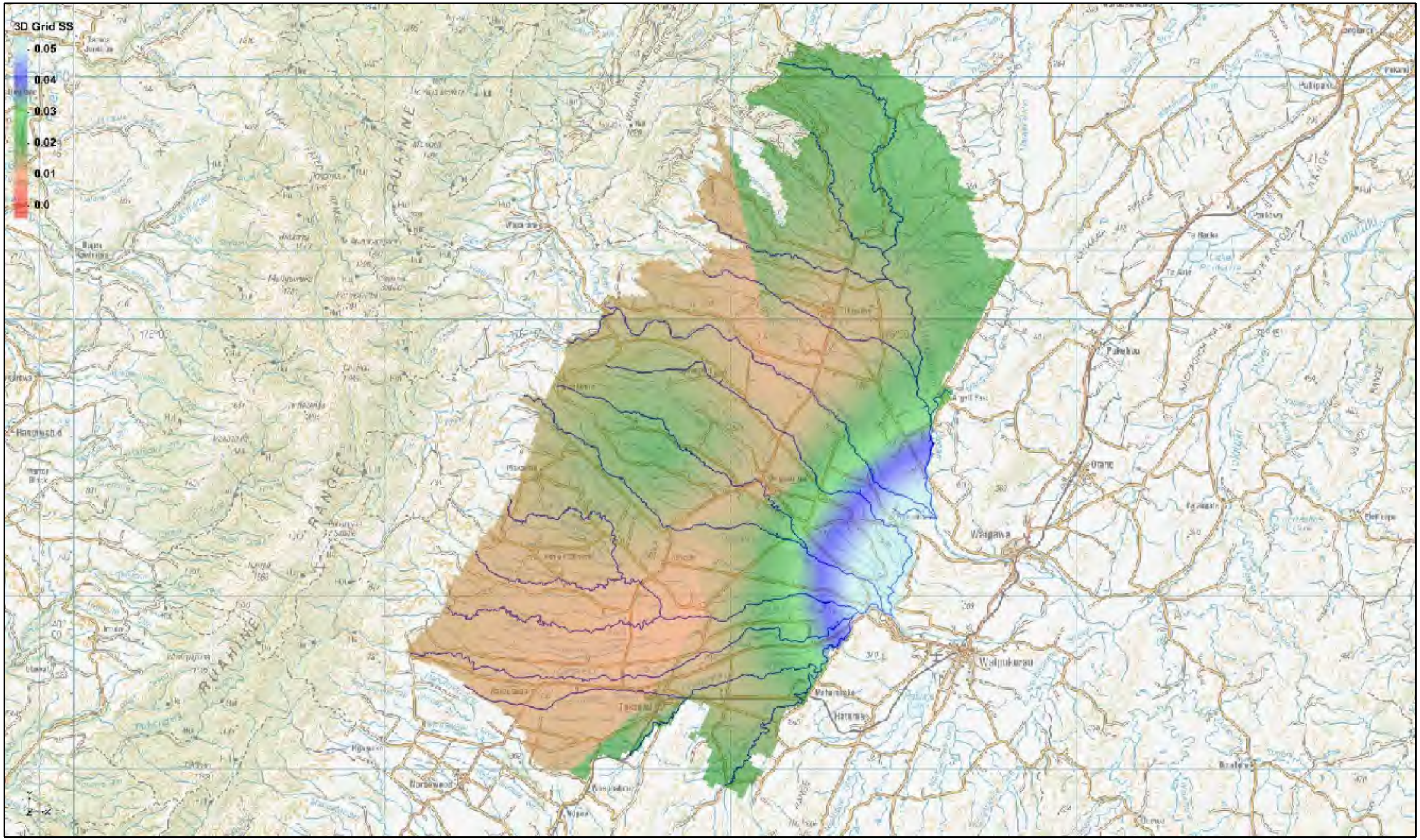
Appendix C: Calibrated Aquifer Parameters



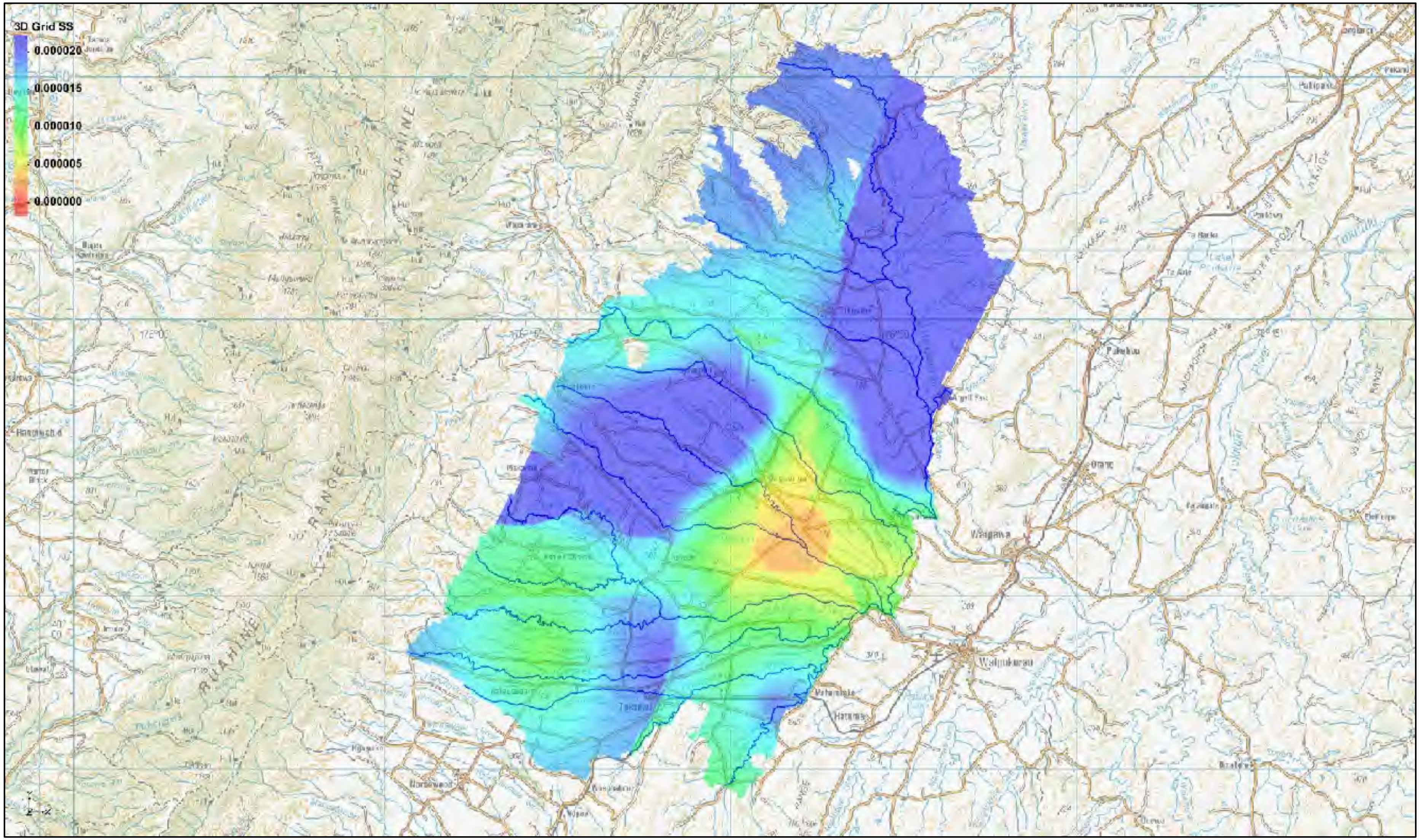
Horizontal hydraulic conductivities (for all layers)



Vertical hydraulic conductivities (for layers 2 and below)

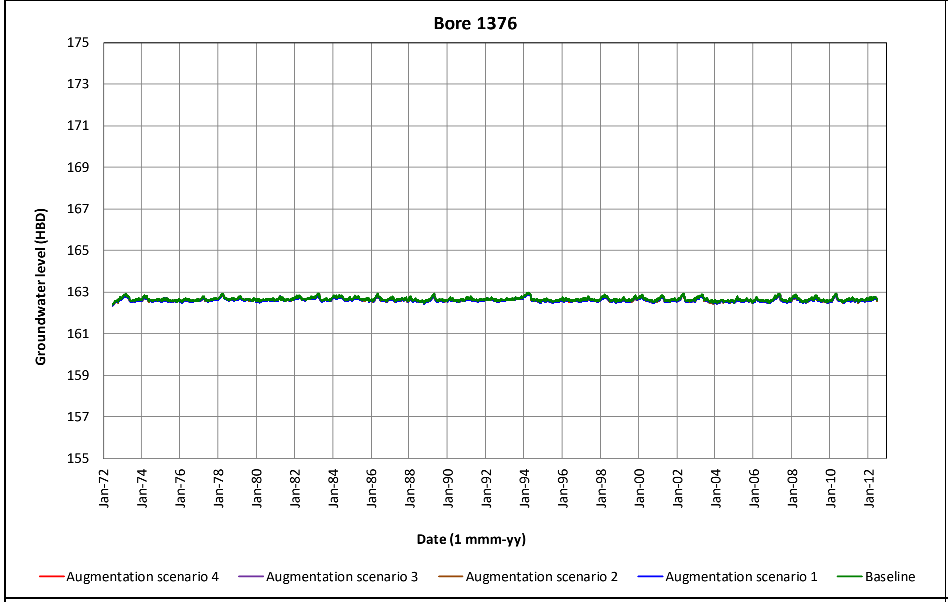


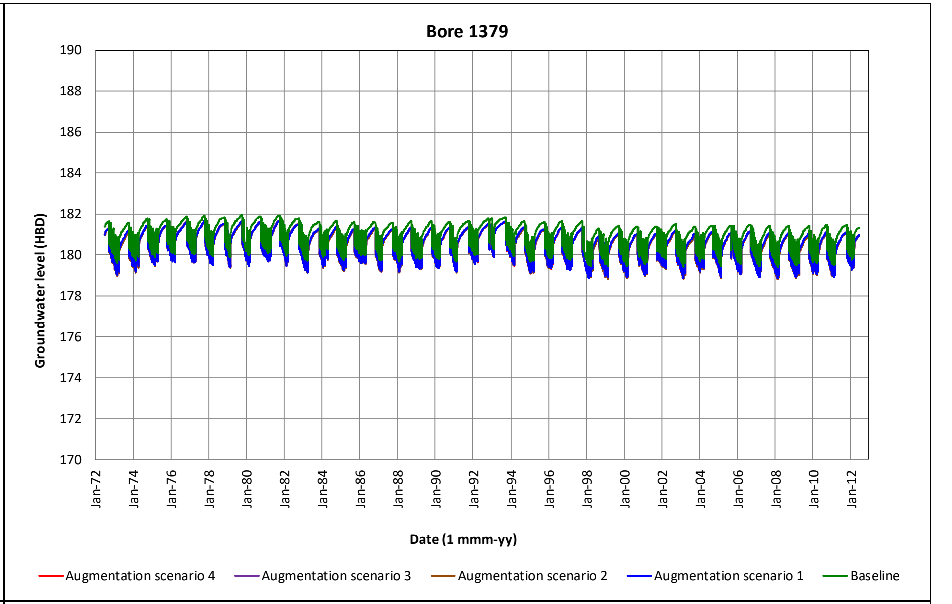
Specific storage for layer 1

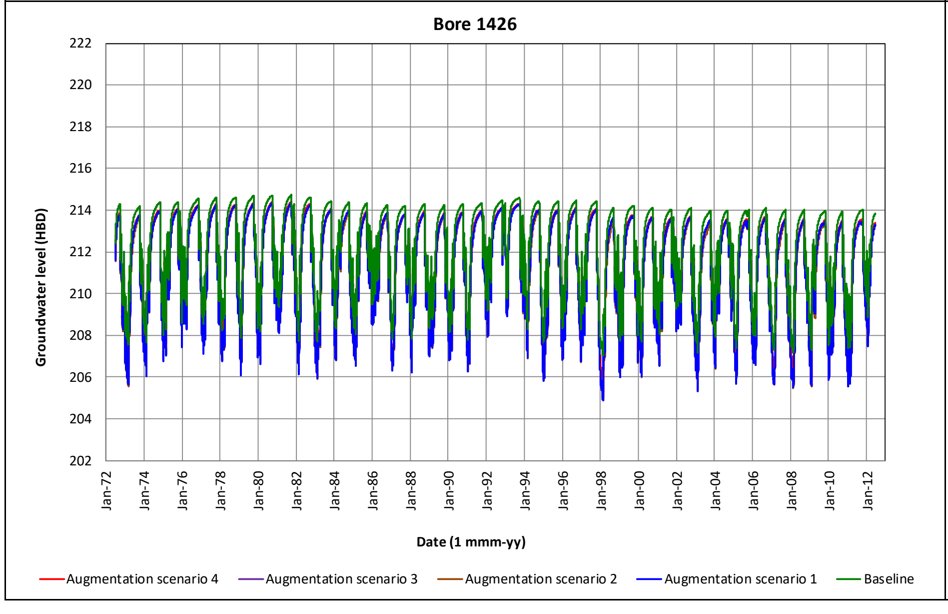


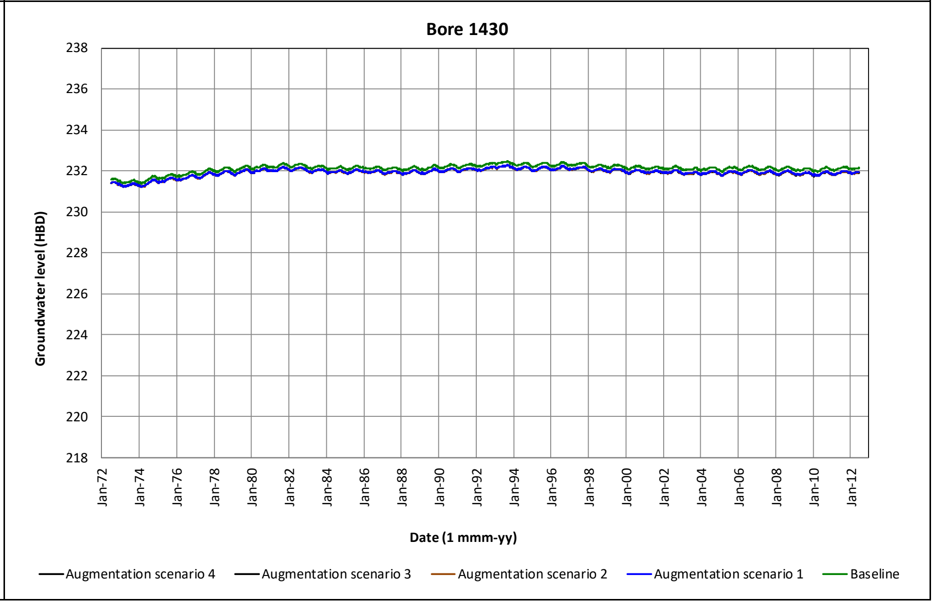
Specific storage for layers 2-10

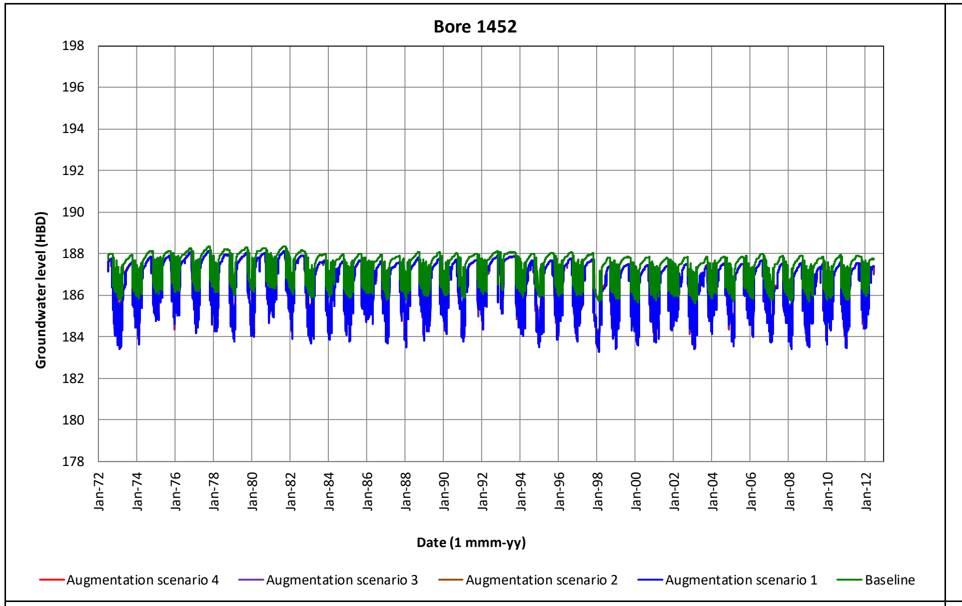
Appendix D: Groundwater level hydrographs for different scenarios

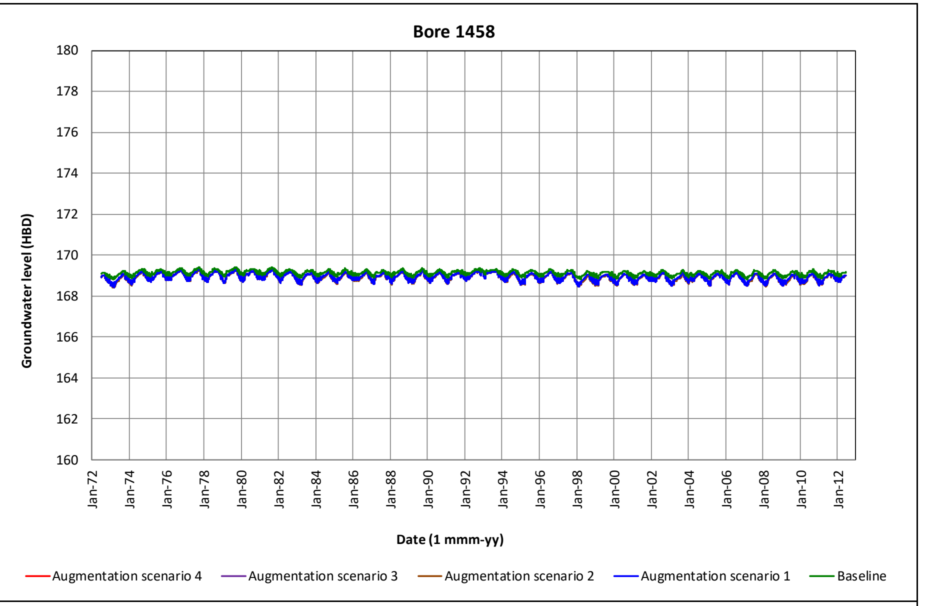

Bore 1376
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

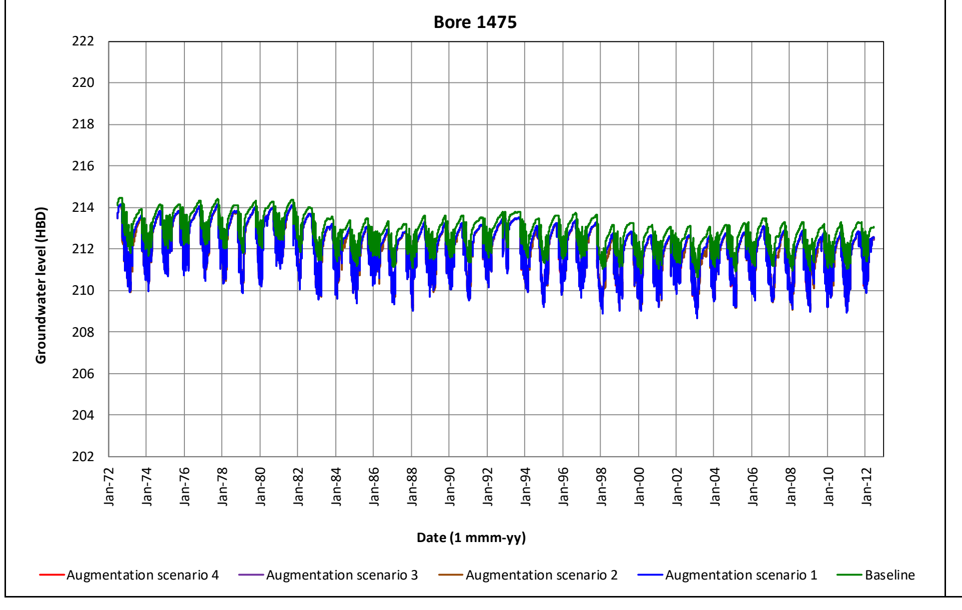

Bore 1379
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

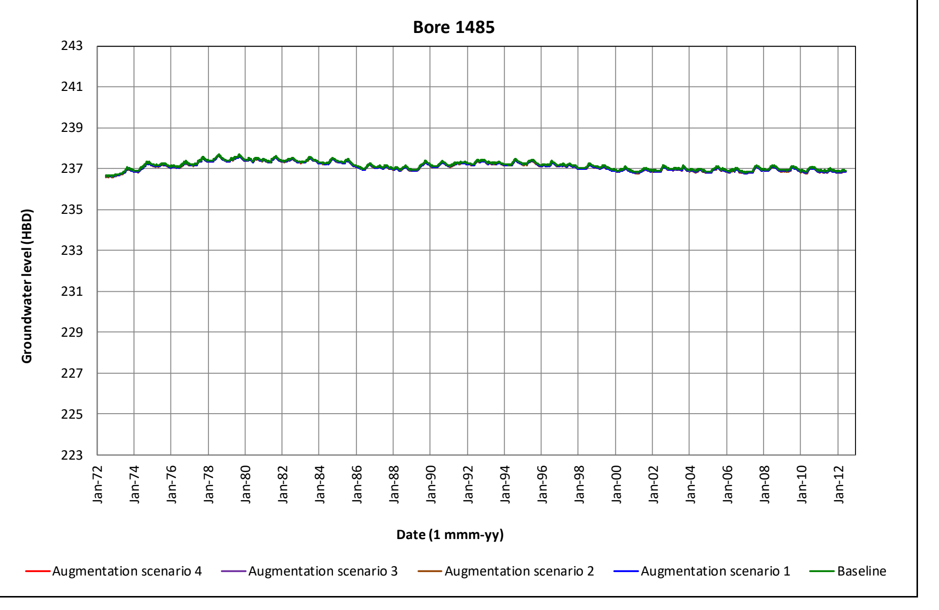

Bore 1426
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

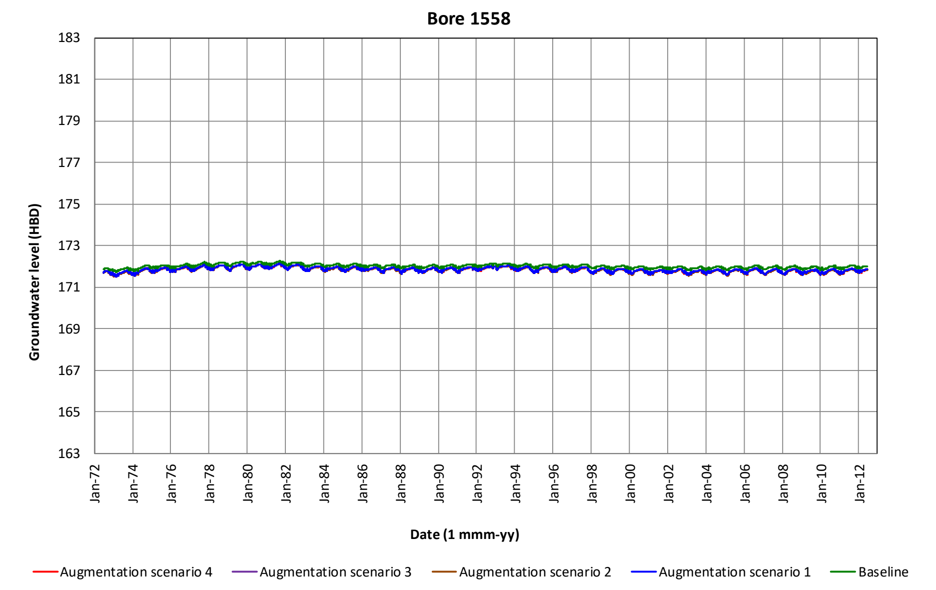

Bore 1430
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

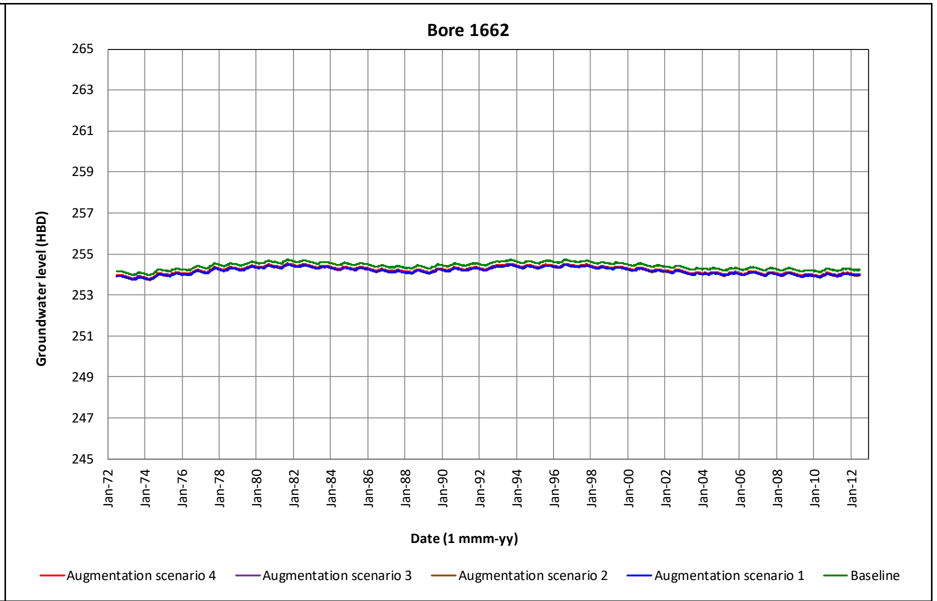

Bore 1452
Groundwater level (HBD)
198
196
194
192
190
188
186
184
182
180
178
Date (1 mmm-yy)
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

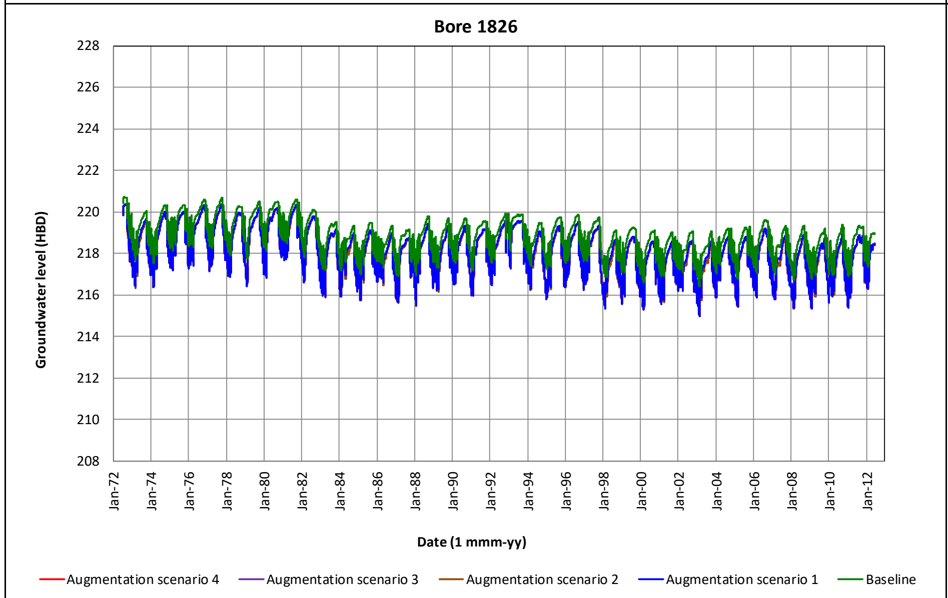

Bore 1458
Groundwater level (HBD)
180
178
176
174
172
170
168
166
164
162
160
Date (1 mmm-yy)
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

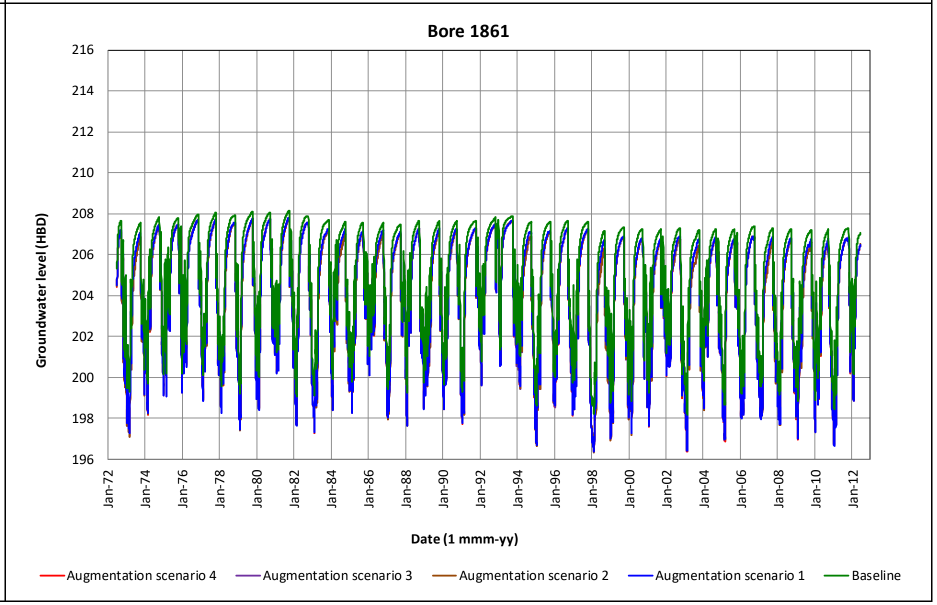

Bore 1475
Groundwater level (HBD)
222
220
218
216
214
212
210
208
206
204
202
Date (1 mmm-yy)
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

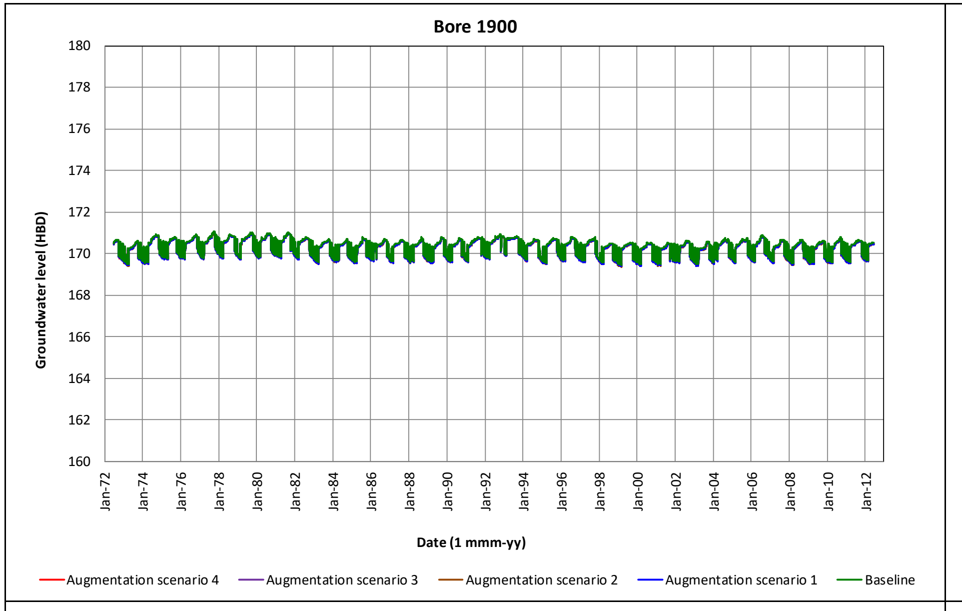

Bore 1485
Groundwater level (HBD)
243
241
239
237
235
233
231
229
227
225
223
Date (1 mmm-yy)
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

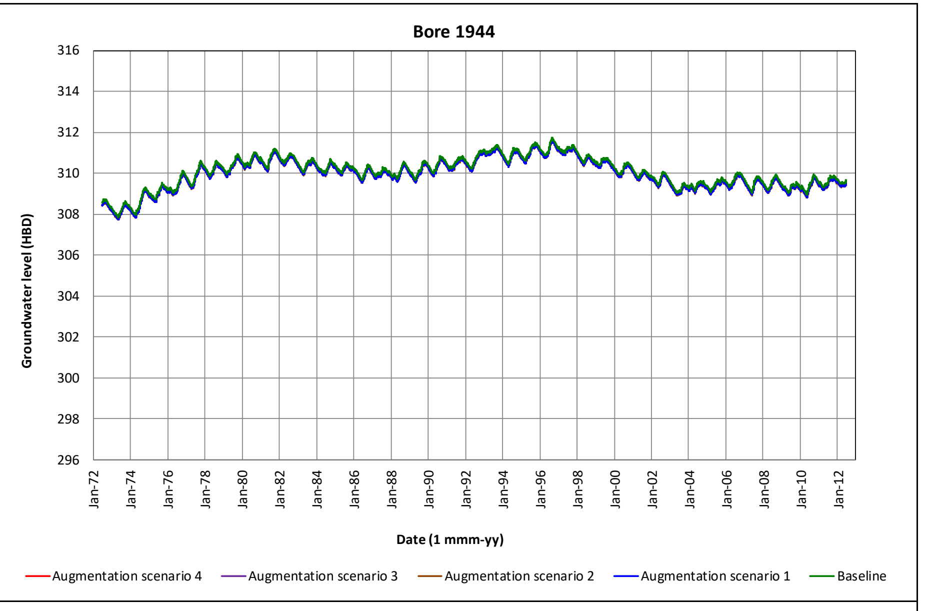

Bore 1558
Groundwater level (HBD)
183
181
179
177
175
173
171
169
167
165
163
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

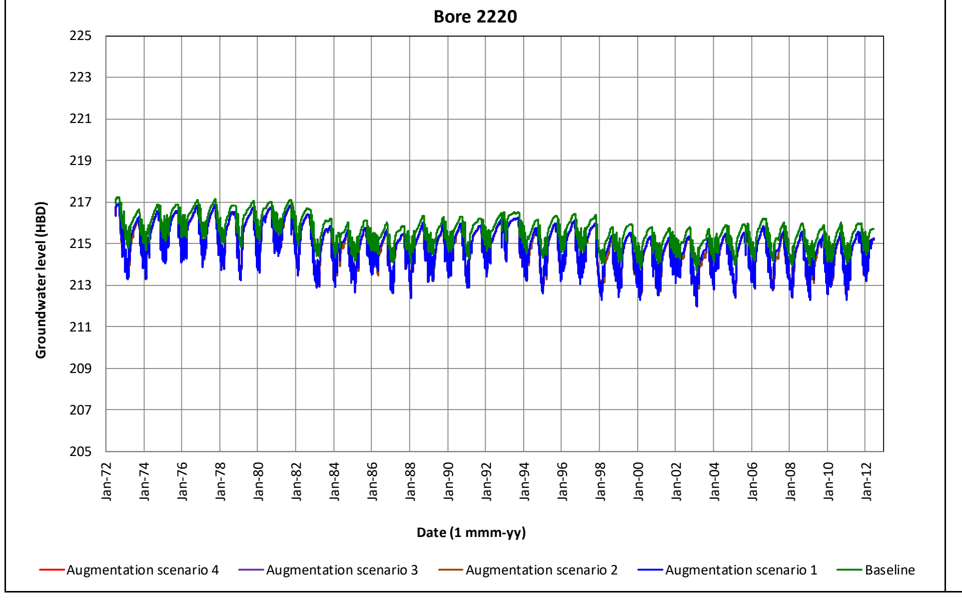

Bore 1662
Groundwater level (HBD)
265
263
261
259
257
255
253
251
249
247
245
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

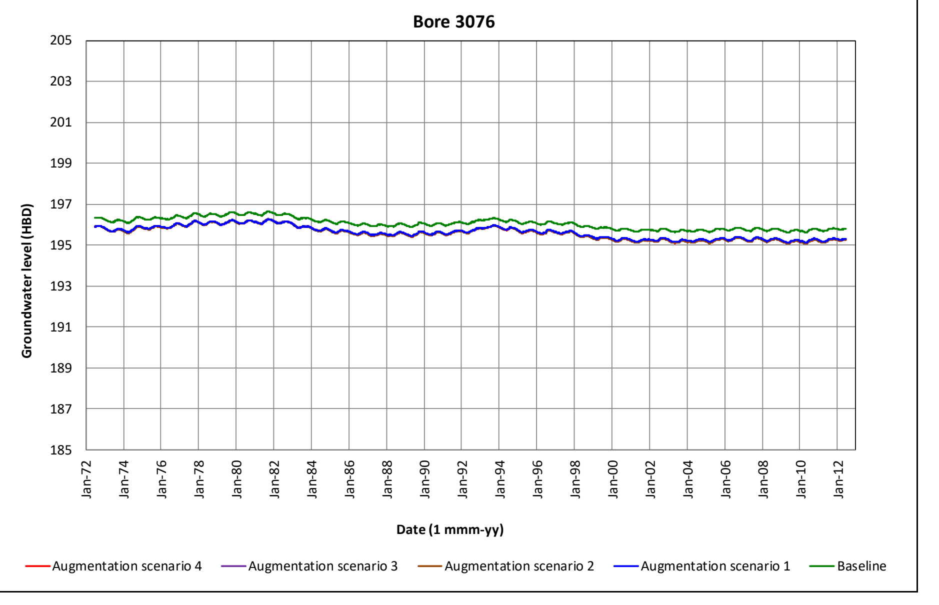

Bore 1826
Groundwater level (HBD)
228
226
224
222
220
218
216
214
212
210
208
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

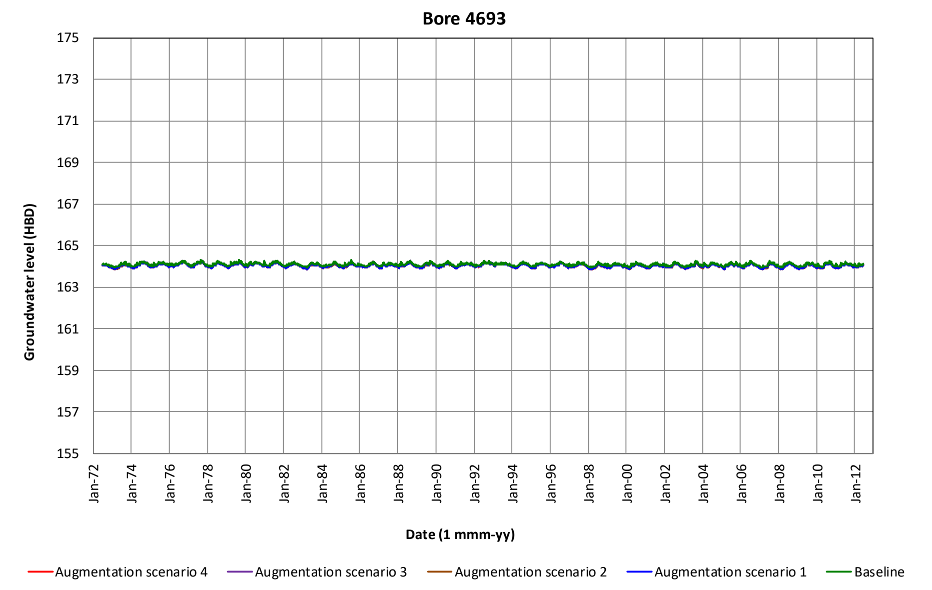

Bore 1861
Groundwater level (HBD)
216
214
212
210
208
206
204
202
200
198
196
Jan-72 Jan-74 Jan-76 Jan-78 Jan-80 Jan-82 Jan-84 Jan-86 Jan-88 Jan-90 Jan-92 Jan-94 Jan-96 Jan-98 Jan-00 Jan-02 Jan-04 Jan-06 Jan-08 Jan-10 Jan-12
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

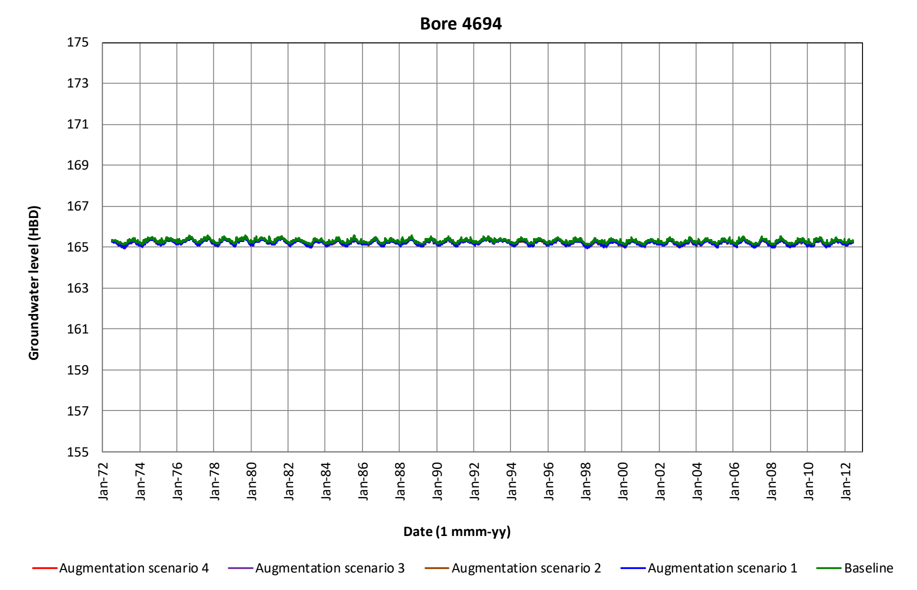

Bore 1900
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

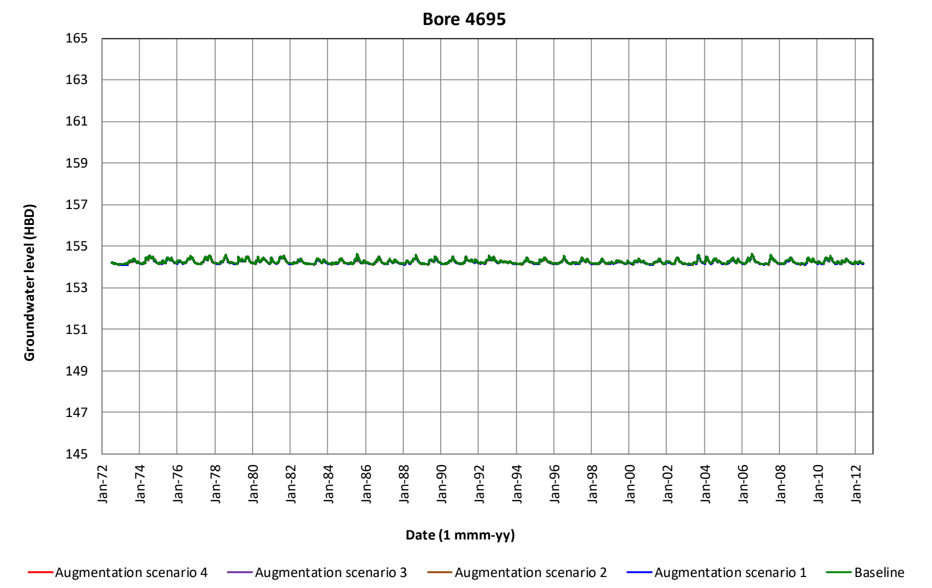

Bore 1944
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

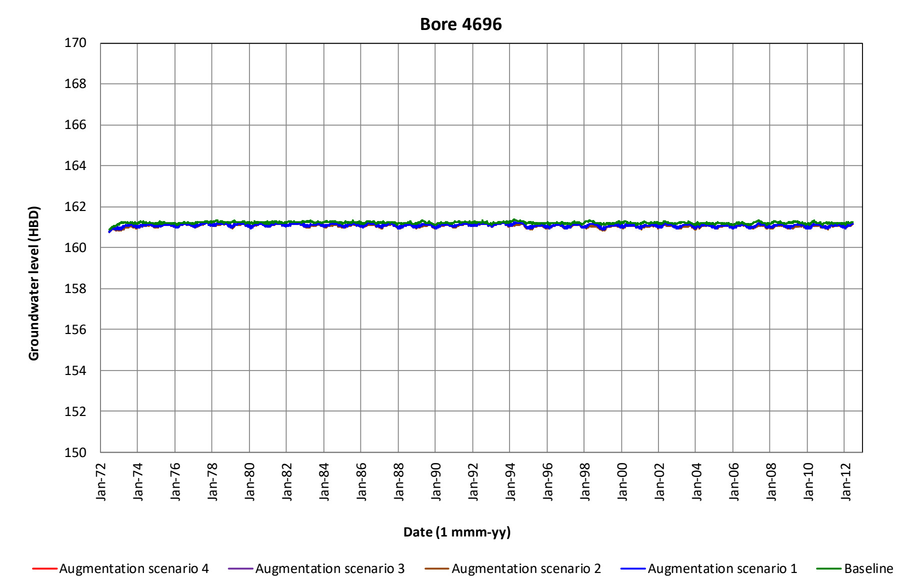

Bore 2220
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

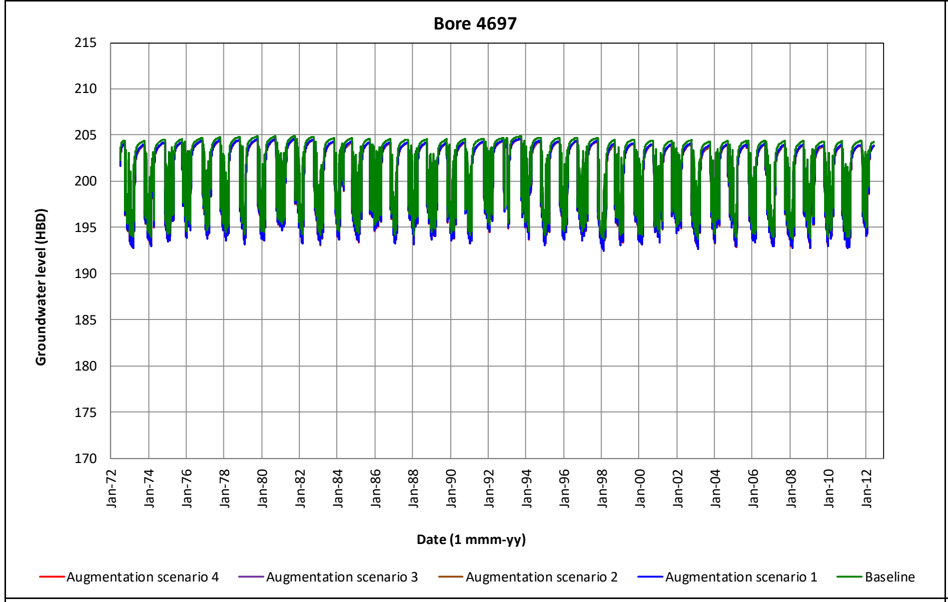

Bore 3076
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

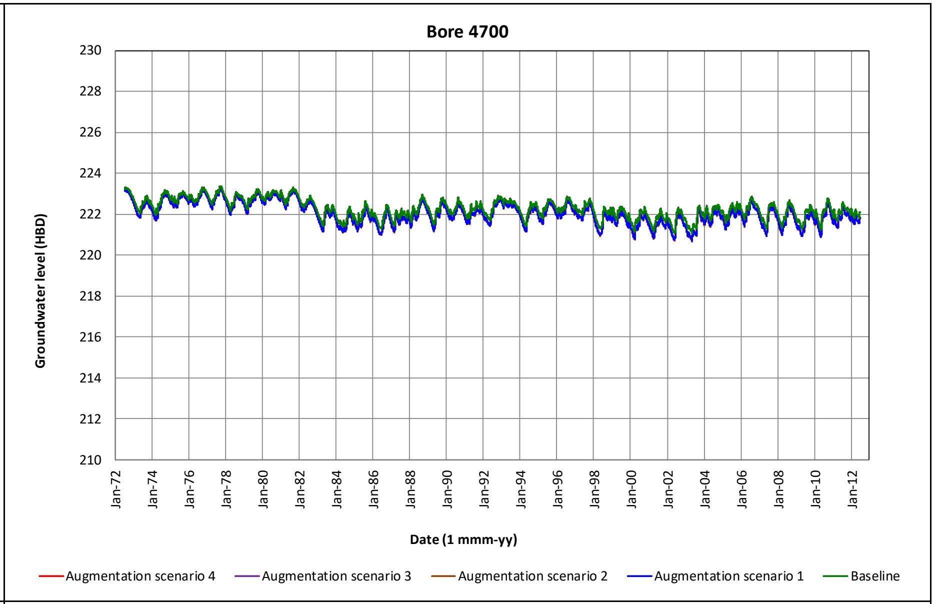

Bore 4693
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

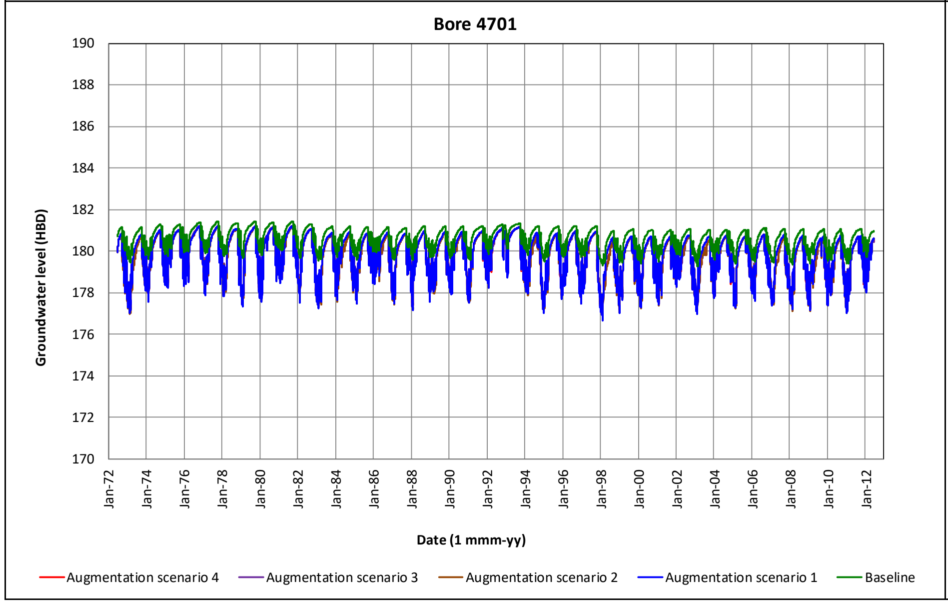

Bore 4694
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

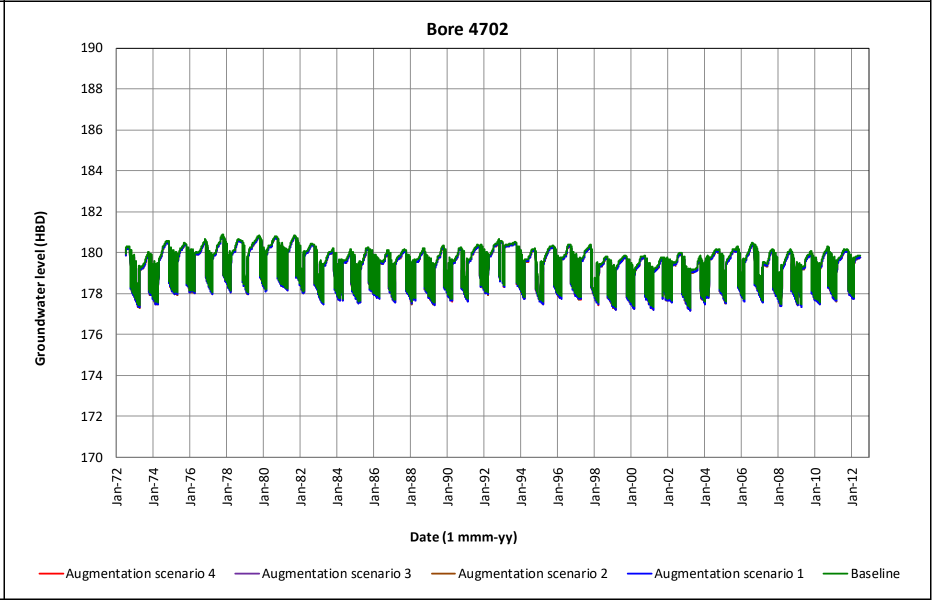

Bore 4695
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

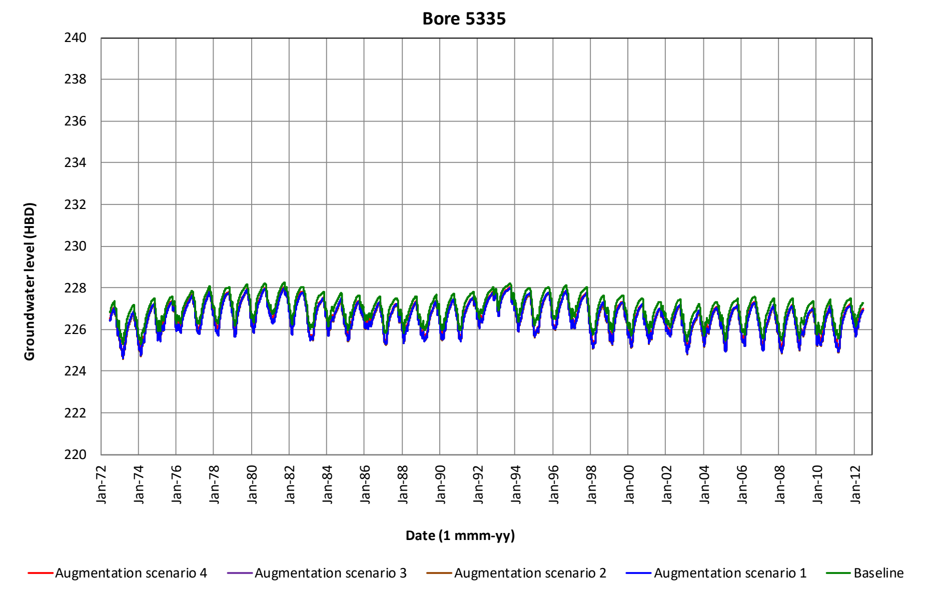

Bore 4696
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline


Bore 4697
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

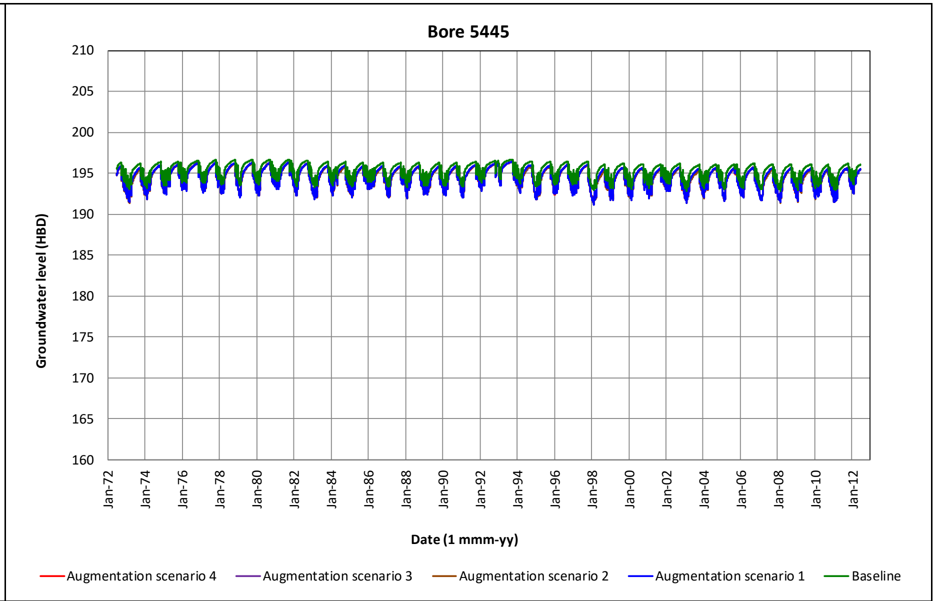

Bore 4700
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline


Bore 4701
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

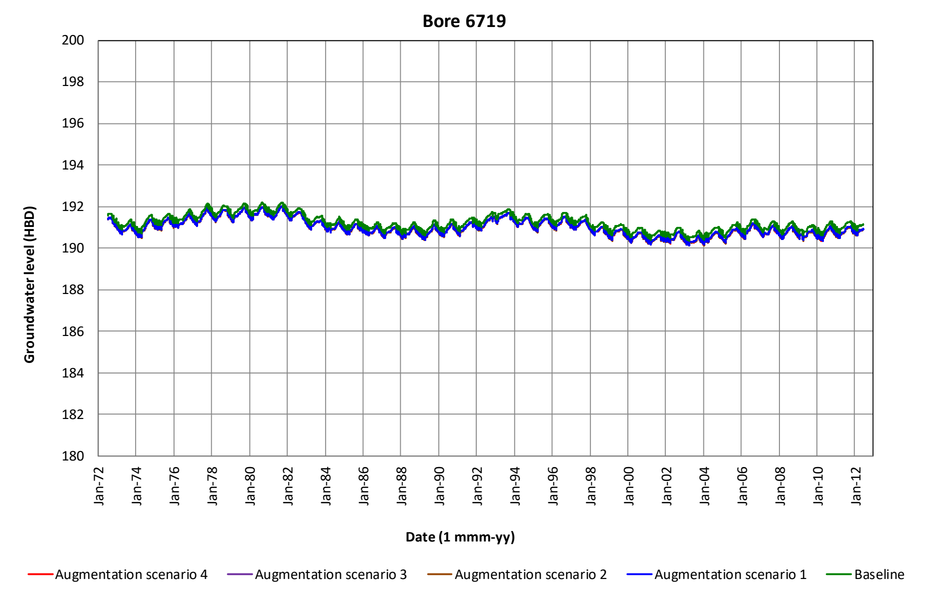

Bore 4702
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline



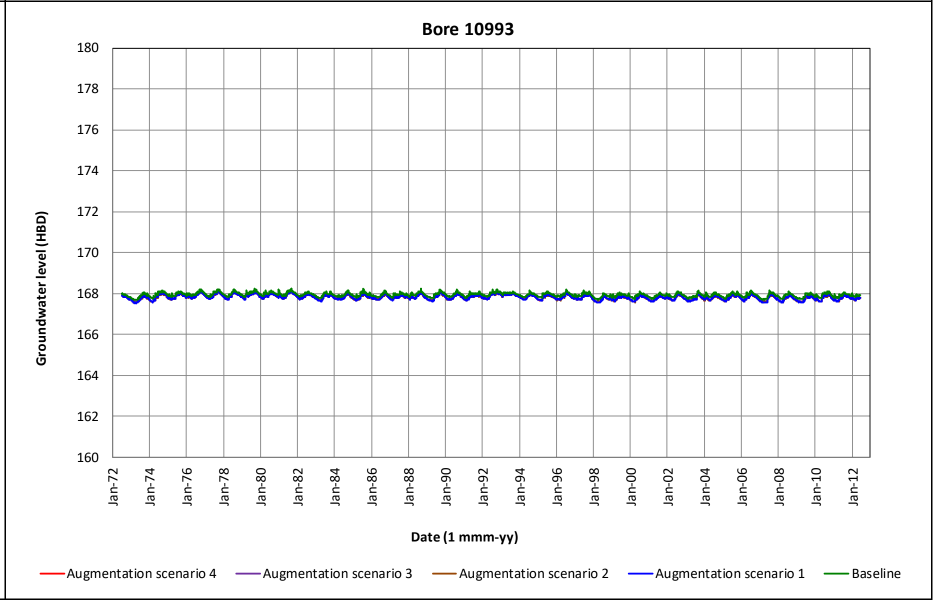
Bore 5335
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline



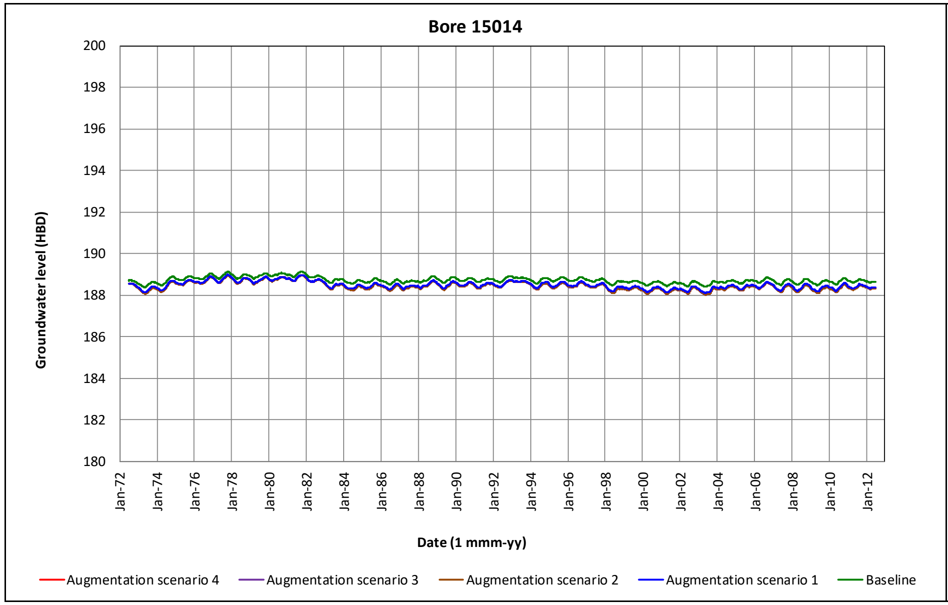
Bore 5445
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

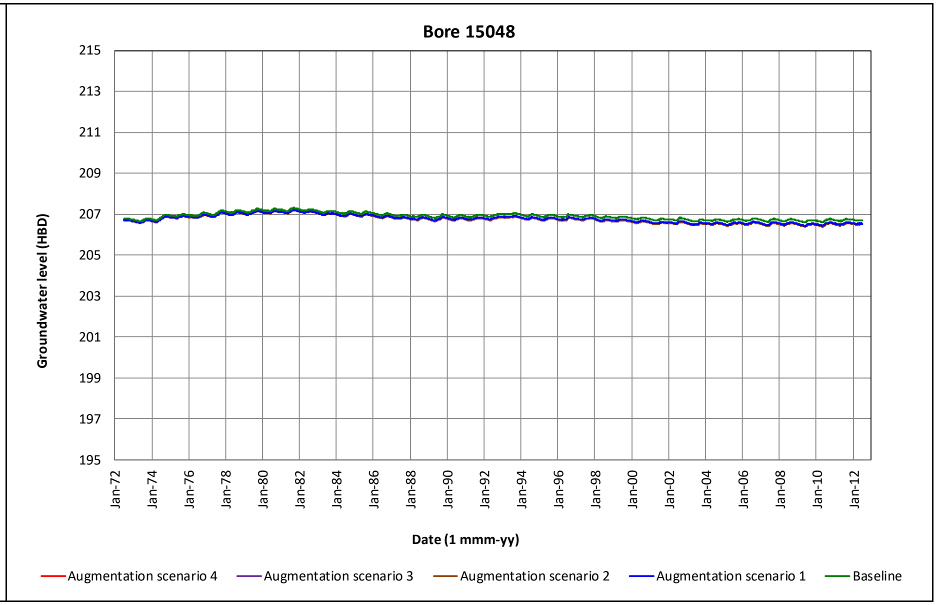


Bore 6719
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline



Bore 10993
Groundwater level (HBD)
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline


Bore 15014
Groundwater level (HBD)
200
198
196
194
192
190
188
186
184
182
180
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline


Bore 15048
Groundwater level (HBD)
215
213
211
209
207
205
203
201
199
197
195
Jan-72
Jan-74
Jan-76
Jan-78
Jan-80
Jan-82
Jan-84
Jan-86
Jan-88
Jan-90
Jan-92
Jan-94
Jan-96
Jan-98
Jan-00
Jan-02
Jan-04
Jan-06
Jan-08
Jan-10
Jan-12
Date (1 mmm-yy)
Augmentation scenario 4
Augmentation scenario 3
Augmentation scenario 2
Augmentation scenario 1
Baseline

APPENDIX C – Wetlands and Surface Water Effects Assessment

27 May, 2021 ref: BGS201_07

Consents Planner
Hawkes Bay Regional Council
Private Bag 6006
Napier 4110

Dear Sir/Madam,

RUATANIWHA BASIN TRANCHE 2 APPLICATION
RESPONSE TO PDP'S PRELIMINARY REVIEW OF THE AQUALINC GROUNDWATER MODEL
ITEMS 9 AND 10 ONLY

A review of the Aqualinc Ruataniwha Basin Tranche 2 groundwater modelling (Weir, 2020) by Pattle Delamore Partners Ltd (PDP) resulted in preliminary comments by PDP communicated by Julian Weir (Aqualinc) in a memorandum to the Tranche 2 Applicants dated 27 January, 2021. The following report provides additional information as a full response to Items 9 and 10 raised by PDP, which question potential effects on wetlands and minor waterbodies upstream of the augmentation sites as detailed below:

9. *Effects on other river sites:*
The model simulates river flows at many reaches within the basin, but only a few have measurements with which to calibrate. There are also several smaller streams and drains that are too small to model at the basin scale of the model. Furthermore, it is not feasible to augment into every stream, so there may be some reaches that are depleted and do not receive augmentation water until further downstream, below a confluence with another stream that does.
10. *Effects on streams upstream of augmented rivers:*
This is the same as Item 9.

To assess the potential effects on wetlands and minor waterbodies, local knowledge (from Hawkes Bay Regional Council, Applicants and their Consultants) was sought to select representative stream and wetland sites for initial consideration. This was followed by a high-level assessment of the instream value of the waterbody as discussed in the following sections.

1. INTRODUCTION

The Ruataniwha Basin groundwater model (Weir, 2020) was developed by Aqualinc to predict effects on surface water flows as a result of the proposed Tranche 2 groundwater takes. However, the smaller river reaches and wetland areas were not included in the model due to the small scale of the features compared to the catchment scale of the model. Therefore, predicted effects on these waterbodies as a result of the takes were not specifically assessed.

There are multiple small-scale streams and drains in the catchment. In order to determine which sites could be considered significant and warrant further assessment, the Tranche 2 Applicants provided information regarding their local creeks, wetlands and streams to Bay Geological Services Ltd. These included reaches that typically dry up naturally in summer months and therefore present little instream value; to those that flow or are wet year-round. Further to this, local knowledge of the Ruataniwha Plains was used to inspect sites of interest, such as areas of recorded upwellings and spring flows. Not every reach or wetland was inspected as this was outside reasonable scope for the required outcome; however sites were selected in strategic parts of the basin, these being representative of effects in other reaches across the study area.

2. MAPPED SIGNIFICANT WETLAND AREAS

Guidance was also sought from Hawkes Bay Regional Council (HBRC) who were very helpful in providing information detailing wetland areas within southern and central Hawkes Bay. The council advised of the wetland State of the Environment (SOE) programme and the establishment (several years ago) of permanent water level recording sites installed to monitor potential effects of water abstraction on wetlands. Initially ten sites in the Tukituki River Catchment were selected with water-level loggers installed at these sites, and later other criteria were also selected in order to make the sites more suitable for the SOE programme. HBRC provided shapefiles of the SOE wetland data , from which Aqualinc generated a map included in Appendix A to show significant (SOE) wetlands.

The HBRC SOE wetlands are included in the Aqualinc map presented as Figure 1. The majority of the designated significant wetlands lie outside the study area, and are therefore outside of the influence of the proposed Tranche 2 groundwater takes. Only one significant wetland (near the upper reaches of the Mangatewai River) is identified within the project area, as displayed.

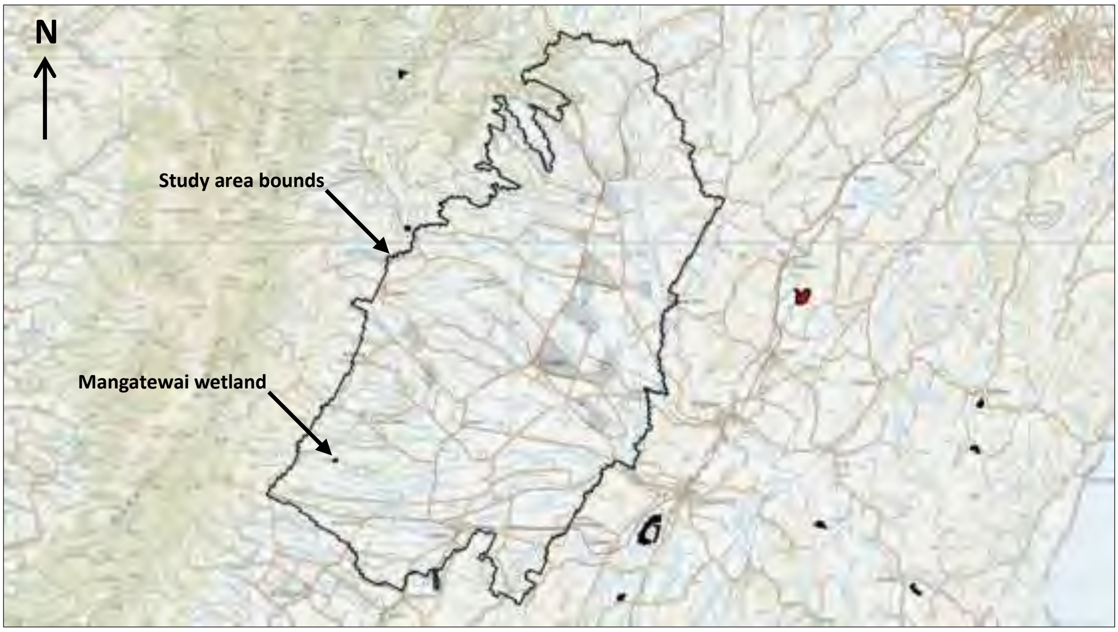


Figure 1. HBRC SOE wetland sites across central and southern Hawkes Bay (HBRC). Scale: 10 km grid.

3. REGIONAL GEOLOGY AND HYDROGEOLOGY

The NNE-SSW-oriented Ruataniwha Basin is fault-bound along the western Ranges, and lies adjacent to westward-dipping strata in the east which form the Raukawa Range. The development of the alluvial basin commenced with evacuation of the former inland sea as a result of tectonic uplift, followed by infilling of the basin with alluvial sediments. This resulted in a heterogeneous accumulation of sediments and multi-layered aquifer systems which comprise highly variable material ranging from gravels, sandstone, pumice and limestone (PDP 1999, Francis 2001).

Both groundwater-surface water interactions (as modelled by Baalousha, 2009a), and stream losses and gains (determined by Wood, 1998) as discussed in the 2012 Aqualinc report (Ballard, 2012) are presented in Figure 2. The boundary of the zero yield is observed to track alongside State Highway 50 (SH50) inferring that seepage from groundwater to rivers occurs east of the highway.

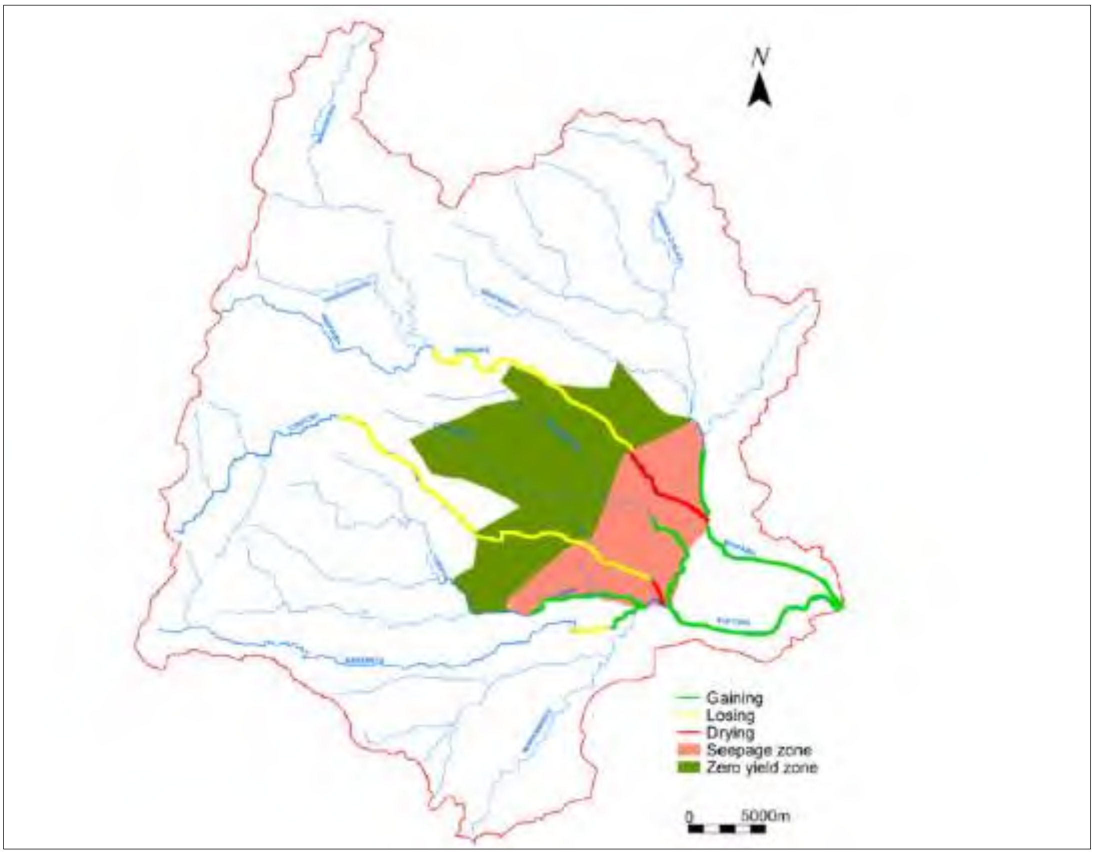


Figure 2. Aqualinc map displaying gain and loss patterns along with seepage zones in the Ruataniwha Basin (Ballard, 2012).

A review of published geological maps (Lee et al, 2011) reveals a series of active faults across the northeastern and southern periphery of the basin (refer Figure 3). The faults are typically orientated NNE with uplift to the west; however, they appear to terminate, or are not identified through the central part of the basin likely as a result of the extensive alluvial gravel cover sediments. If the faults were to track across the basin, it is likely that they would follow the regional NNE-SSW orientation. An overlay of the zero yield and seepage zones is added to the geological map as brown shading (zero yield) and blue shading (seepage) as presented in Figure 3.

The field sites are denoted as red dots on the geological map. The field inspection revealed several surface water sites which may be associated with deformation such as faulting or folding in response to tectonic stresses. These sites are denoted as blue circles on the geological map.

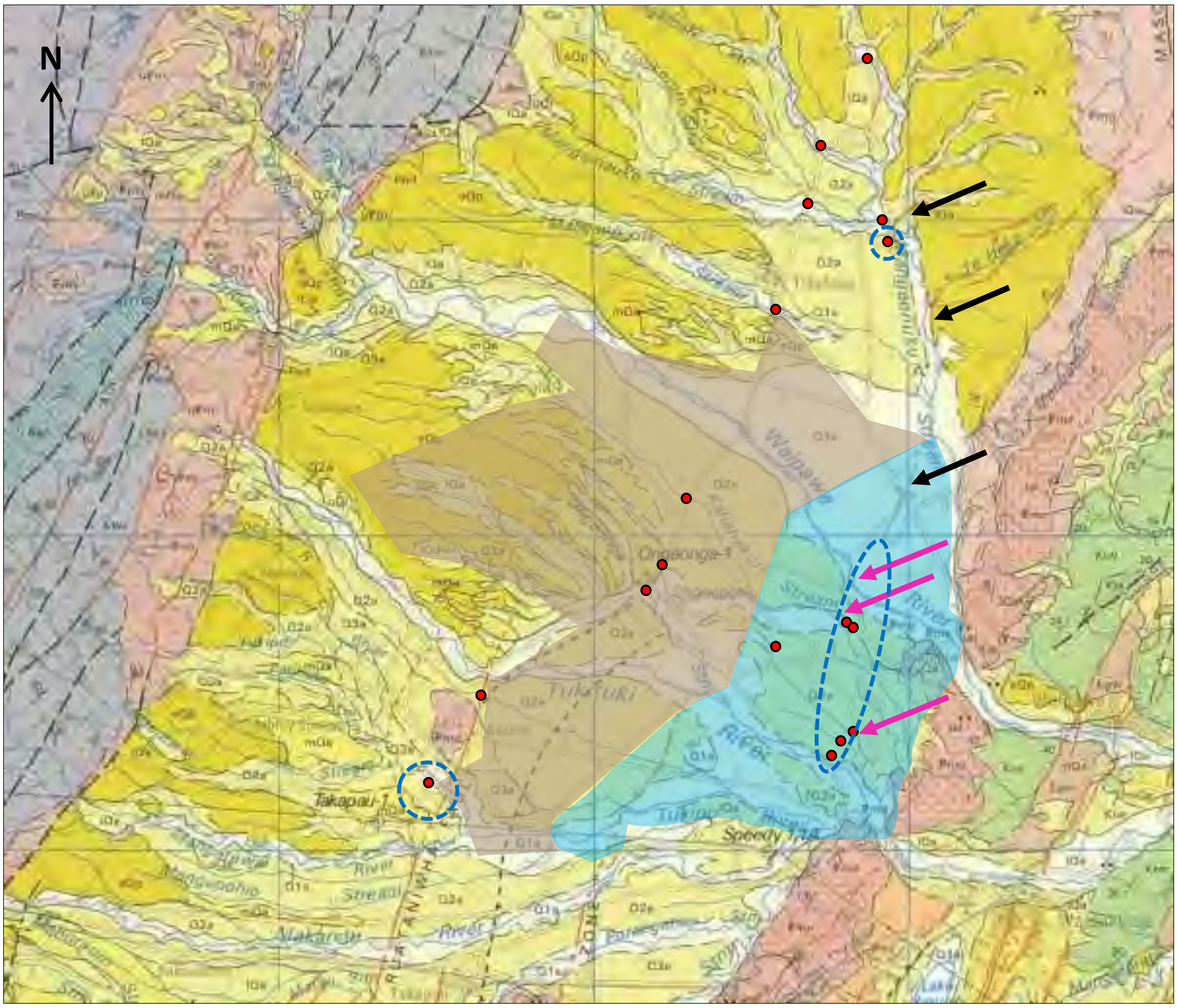


Figure 3. GNS 1:250,000 geological Qmap across Ruataniwha Plains (Lee et al, 2011). Scale 10 km grid. Red dots indicate field sites; black arrows indicate mapped faults/folds to the east. Pink arrows infer areas of possible deformation based on river/stream realignment; and blue circles denote wetland areas possibly associated with areas of tectonic deformation.

It could be inferred that the approximated NNE-SSW-oriented boundary between the zero yield and seepage zones follows the regional geologic trend. In addition, it is noted that a change in alignment of the Waipawa River and minor streams occurs in an area of inferred tectonic deformation (pink arrows).

4. FIELD INSPECTION OF WETLANDS & MINOR STREAMS

The Ruataniwha Basin wetland and minor streams/waterways were visited in March 2021 during a very dry period, in order to record the staus of the surface water features during a very dry period. These sites are shown as green circles, added to the Aqualinc (Weir, 2020) map as presented in Figure 4, which also displays the study area boundary and Applicants' property locations.

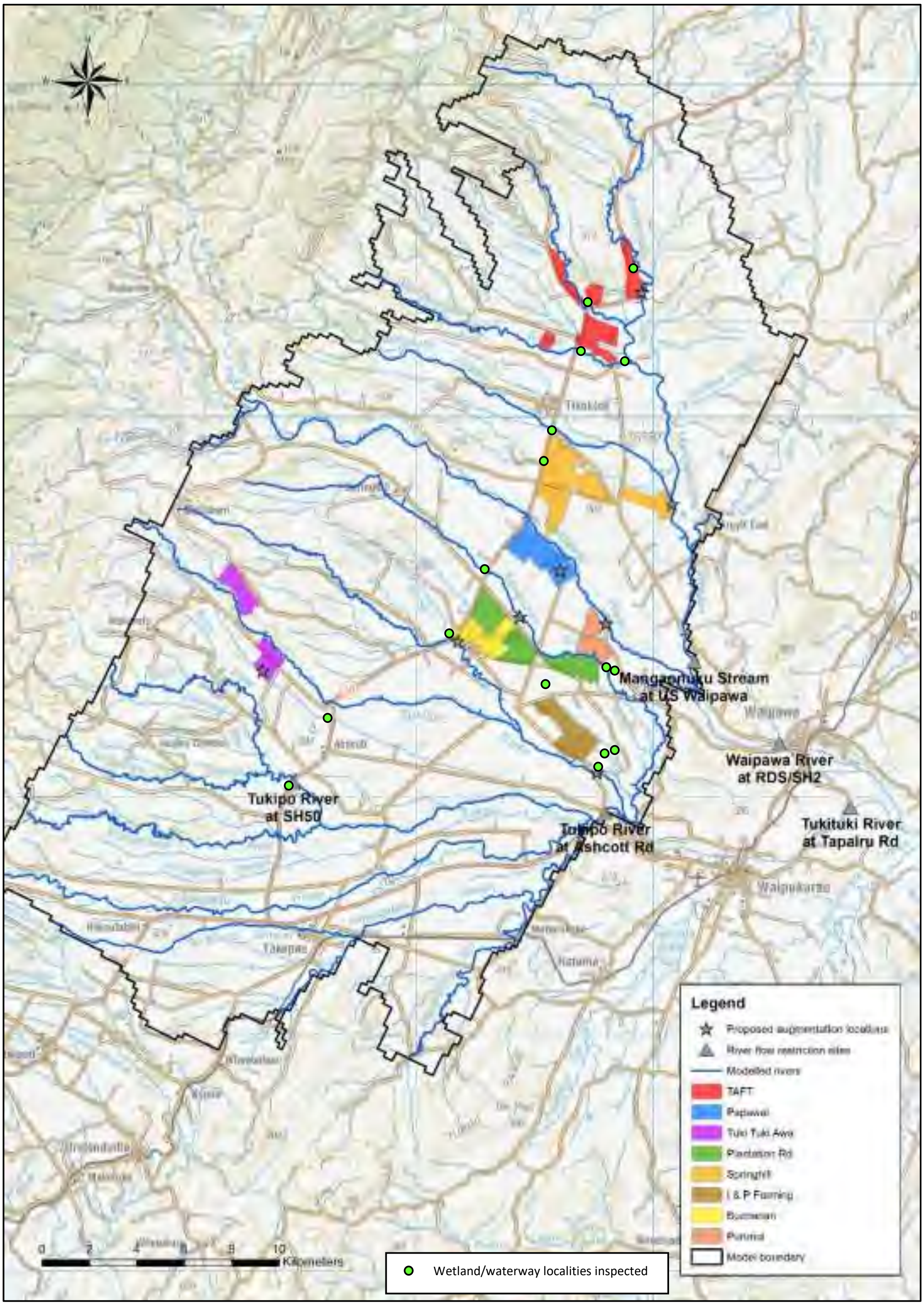


Figure 4. Surface water sites inspected (green circles) are displayed on the Aqualinc (Weir, 2020) map,

Details of surface water features inspected across the study area are listed in Table 1, which includes description and status of the waterbody as observed in the field by Bay Geological Services Ltd. The formation of the waterbody is also assessed, being either a natural feature or artificially formed such as a farm drain.

Table 1. Details of Ruataniwha Basin wetland and minor streams as inspected.

Ruataniwha Basin Wetlands and Waterways					
Site	**Grid ref (NZTM)**	**Description of Waterbody**	**Substrate/ Environment**	**Formation**	**Site Status (March 2021)**
Manga-o-nuku Stream (03)	1898590 5593590	major stream	fine to med gravels	natural	flowing (very low rate)
Mangamate Stream (SH50)	1897330 5590690	major stream	fine to med gravels	natural	flowing (very low rate)
Mangamauku Stream (SH50)	1896750 5588935	major stream	fine to coarse gravels	natural	dry (no water evident)
Mangamauku Stream (Creek Rd)	1898650 5588265	major stream	fine to med gravels	natural	no obvious flow (pools of water)
Mangaoho Stream (SH50)	1895753 5585550	major stream	fine to med gravels	natural	dry (no water evident)
Chesterman bridge (trib Kahahakuri Stm)	1892945 5579505	minor stream	fine gravels	natural	dry (no water evident)
Kahahakuri Stm (SH50)	1892200 5577550	minor stream	fine gravels	natural	dry (no water evident)
Ongaonga Stream SH50, Ongaonga	1891630 5576620	major stream	fine to coarse gravels	natural	dry (no water evident)
Swamp Rd Wetland 01	1897700 5575900	medium size pond	unknown	man-made	high level
Swamp Rd drain (ex Waipawa River, trib Kahahakuri Stream)	1897940 5575841	very minor stream/drain	fine to med gravels	man-made	moderate flow rate (flows year-round)
Swamp Rd Wetland 02	1897910 5575600	medium size pond	unknown	natural	high level
Swamp Rd drain (trib Kahahakuri Stream)	1897625 5575875	very minor stream/drain	fine to med gravels	man-made	low flow rate (flows year-round)
Kahahakuri Stream (Swamp Rd)	1897590 5575810	minor stream	fine to med gravels	natural	mod flow rate (flows year-round)
Black Stream Source (Fairfield Rd)	1895370 5574535	swale	grassed paddock	natural	damp underfoot (rare ponding)
top Black Stream (pond off Fairfield Rd)	1895470 5574465	small pond	unknown	man-made	low level (wet all year)
Woolshed pond, lower Black Stream	1898370 5571990	medium size pond	unknown	man-made	large pond
lower Black Stream (Hobin Road)	1898515 5571795	very minor stream	v fine to fine gravels/sand	natural	flows year-round (very low rate)
lower Black Stream Trib 01 (Hobin Road)	1897795 5571805	stream	v fine to fine gravels/sand	natural	flowing (moderate rate)
Swan pond, lower Black Stream Trib 01	1897710 5571690	medium size pond	silt and muds	man-made	high level
drain at lower Black Stream Trib (02)	1898030 5571370	very minor stream/drain	silt and muds minor pebbles	man-made	flowing (very low rate)
Ashcott Bridge (unnamed stream)	1886375 5572620	minor stream	fine gravels	natural	dry (no water evident)
SH50 wetland (adjacent Tukipo Rv)	1884665 5570615	small pond	grassed paddock	natural	moderate level

The sites are described in detail as follows:

4.1 Manga-o-nuku Stream (03), SH50, Tikokino

The minor stream is located near the northern bounds of the study area. The stream flow was assessed as very low in March, 2021 (refer Figure 5).

Figure 5. Manga-o-nuku Stream (03), SH50, Tikokino (view eastward). Very low flow observed.

4.2 Mangamate Stream, SH50, Tikokino

The minor stream is located near the northern bounds of the study area. The stream flow was assessed as very low in March, 2021 (refer Figure 6).

Figure 6. Mangamate Stream, SH50, Tikokino (view westward). Very low flow observed.

4.3 Mangamauku Stream, SH50, Tikokino

The minor stream is located near the northern bounds of the study area. No standing nor flowing surface water was observed along the stream bed in March, 2021 (refer Figure 7).

Figure 7. Mangamauku Stream, SH50, Tikokino (L = view west; R = view east). No surface water observed.

4.4 Swamp Road wetlands, Ongaonga

Two wetlands were inspected off Swamp Road, Ongaonga which are located centrally within the basin. Both wetlands appeared full, with Wetland 02 fed by moderately high flow rate, unnamed waterway (refer Figure 8).

Figure 8. Gunson Wetland 01 (L) and 02 (R), Swamp Road, Ongaonga.

An HBRC online wells map is presented as Figure 9, marked-up to illustrate waterways and the two wetlands south of the Waipawa River, and immediately north of the Kahahakuri Stream. The gaining reach of the Kahahakuri Stream lies to the south of the Waipawa River, from which river water is likely flowing subsurface and emanating across the property and draining into the stream.

The waterway draining into Wetland 02 is shown in Figure 10.

Figure 9. HBRC online map showing the Swamp Road wetlands and surface water features (HBRC).

Figure 10. Unnamed waterway flowing into Wetland 02, Swamp Road, Ongaonga.

4.5 Kahahakuri Stream, Swamp Road, Ongaonga

The Kahahakuri Steam flows east then southeast along the southern boundary of the Gunson property (refer Figures 11 and 12). The stream flows year-round across this reach, being fed in part by extensive drains and waterways that track across farm that lies to the south of the Waipawa River. The 2012 Aqualinc report (Ballard, 2012) indicates that the Kahahakuri Stream becomes a gaining reach at this point.

Figure 11. Kahahakuri Stream gaining reach, Swamp Road, Ongaonga.

Figure 12. Kahahakuri Stream, gaining reach, Swamp Road, Ongaonga.

4.6 Black Stream source, Fairfield Road, Ongaonga

The source of the Black Stream is located north off Fairfield Road, Ongaonga and is observed in the field as a grassed swale as displayed in Figure 13. The swale was damp underfoot, possibly due to the man-made dam located immediately to the south as shown in Figures 13 and 14 and discussed in Section 4.7.

Figure 13. HBRC Wells map (L) showing the Black Stream source off Fairfield Road; and photo of source (R), Fairfield Road, Ongaonga.

Figure 14. Black Stream pond near source, Fairfield Road, Ongaonga.

4.7 Black Stream, off Hobin Road, Ongaonga

A large pond exists on a property approximately 100 m west of Hobin Road which lies immediately adjacent to the Black Stream that flows year-round at this point.

4.8 Black Stream tributary 01, Hobin Road, Ongaonga

The tributary (01) of the Black Stream appears to originate south of Fairfield Road. The waterway is mapped as a drain at the head of a willow plantation on a property west off Hobin Road as shown in Figure 17, which was observed as a very slow to slow flow, to being damp underfoot within the willows.

Further west along an offshoot of the tributary, a moderately flow rate was observed, downstream of a large pond on the property. The flows are likely sourced from pond seepage.

Figure 17. Black Stream tributary, Hobin Road, Ongaonga.

4.9 Black Stream tributary 02, Ongaonga-Waipukurau Road, Ongaonga

The tributary (02) of the Black Stream appears to originate on land immediately east of Ongaonga-Waipukurau Road. The waterway was observed as a very slow flow with deep pools evident away from the culvert near the road.

4.10 State Highway 50 Wetland (south of the Tukipo River)

The wetland is located east of SH50 at the foot of a moderate embankment (refer Figure 18), observed as an abandoned meander, elevated several metres above the nearby Tukipo River. Groundwater seeps through the extensive gravel terraces and a minor waterway to the northwest.

Figure 18. SH50 wetland (south of the Tukipo River).

4.11 Streams originating west of SH50

It was noted during the field visit that the following streams originating west of SH50 and tracking eastward across the highway and into the Ruataniwha Plains were dry with no water ponding evident. Photos of the streams are presented in Figures 19 to 23.

- Mangaoho Stream (Tikokino)
- Tributary Kahahakuri Stream (Chestermans Bridge, Ongaonga);
- Kahahakuri Stream (Ongaonga);
- Ongaonga Stream (Ongaonga); and
- Unnamed Stream at Ashcott Bridge (Ashcott, Takapau).

Figure 19. Mangaoho Stream, Tikokino (view NW); **Figure 20. Chestermans Bridge. Ongaonga (view NW).**

Figure 21. Kahahakuri Stream, Ongaonga (view NW); **Figure 22. Ongaonga Stream, Ongaonga (view SE).**

Figure 23. Unnamed Stream at Ashcott bridge, Ashcott, Takapau (view SE).

4.12 Upper reaches of the Mangatewai River, Boyle Road, Ashley Clinton

The one significant wetland that occurs within the study area is identified near the upper reaches of the Mangatewai River, which is upstream and well outside of any area of influence of the proposed Tranche 2 takes (refer Appendix A, Map 3). It was noted at the time of field inspection, that the Mangatewai River at Boyle Road was almost dry (refer Figure 24); however, the wetland was not inspected due to limited access.

Figure 24. Upper reaches of the Mangatewai River, Boyle Road, Ashley Clinton.

5. PREDICTED EFFECTS ON WETLANDS AND MINIOR STREAMS

The Aqualinc model was developed to predict effects of the proposed Tranche 2 take on major river reaches only, and therefore the potential effects on wetlands and minor waterways were not directly predicted. However, in discussion with Aqualinc (J. Weir, 2021 *pers comm*), effects can be estimated by considering the change in shallow groundwater level predicted by the model at wetland locations and, with local knowledge, estimate a projected impact. This is relevant for wetlands, springs and surface water locations upstream of any reach receiving augmentation water. Surface water reaches downstream of augmentation sites will have the same or better flows during extreme dry periods (due to the added augmentation water), even if nearby groundwater levels are a little lower.

The modelled effect on shallow groundwater, as presented in the Aqualinc report (Weir, 2020), is presented in Figure 25. The locations inspected in the field were overlain onto the map, and the predicted changes in shallow groundwater levels were assigned. These predictions estimate a point in time during extreme dry conditions, being a very occasional event.

The predicted changes in shallow groundwater levels as modelled by Aqualinc (Weir, 2020) are included in Table 2, along with an estimate of how this may affect surface water bodies as inspected in the field. It is anticipated that this assessment reflects basin-wide changes.

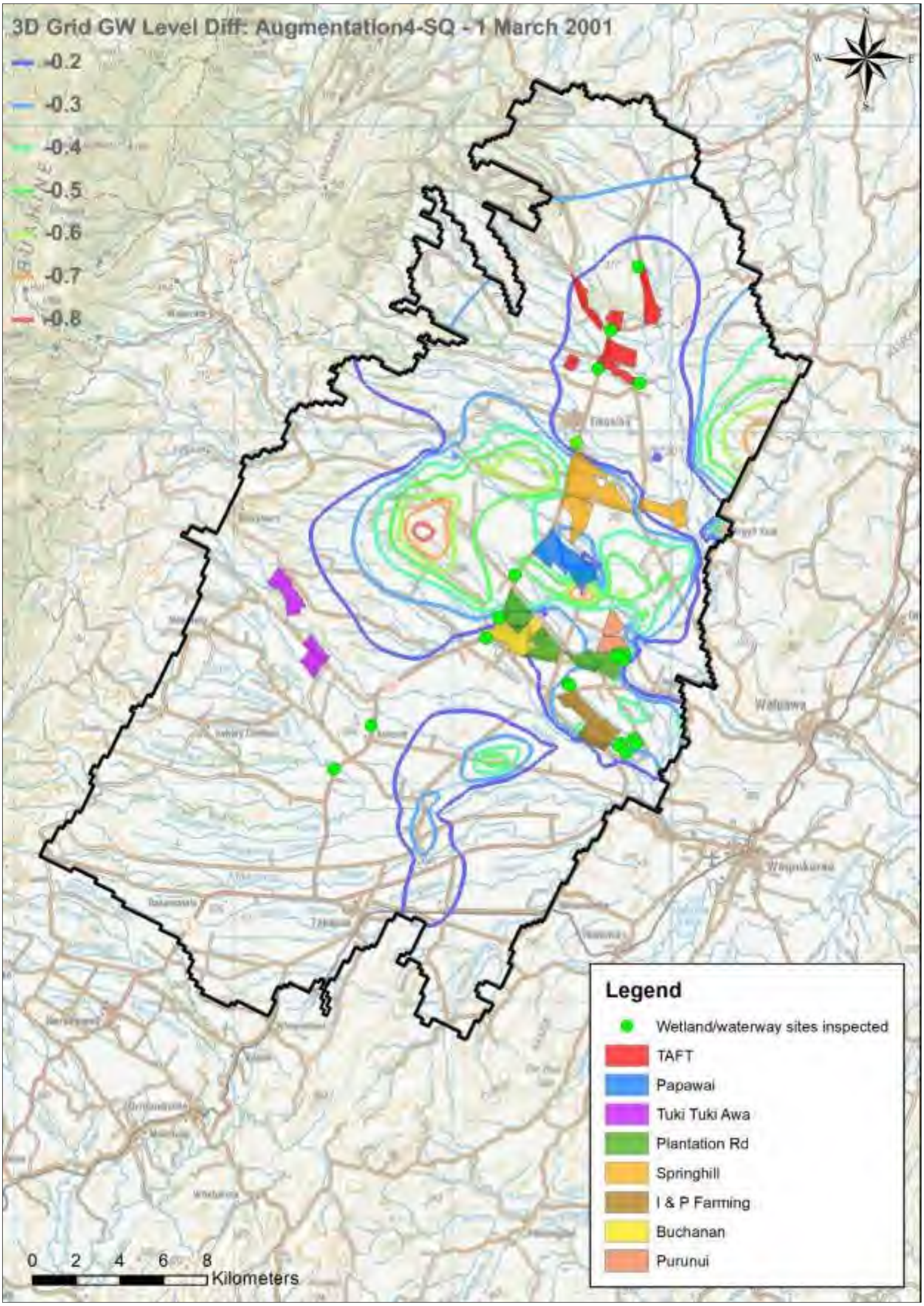


Figure 25. The Aqualinc map displaying modelled effect on shallow groundwater as an extreme event (Weir, 2020) showing Applicants' properties and wetland/waterway sites visited.

Table 2. Details of Ruataniwha Basin surface water features inspected and estimated effects on shallow groundwater applied to localised wetlands and minor streams.

Ruataniwha Basin Wetlands and Waterways Predicted Assessment of Effects						
Basin Location	**Site**	**Up/downstream of augmentation**	**Site Status (March 2021)**	**Formation**	**Predicted Effect on shallow GW**	**Predicted change to SW feature**
North	Manga-o-nuku Stream (03)	upstream	flowing (very low rate)	natural	-0.00	negligible
	Mangamate Stream (SH50)	upstream	flowing (very low rate)	natural	-0.00	negligible
	Mangamauku Stream (SH50)	upstream	dry (no water evident)	natural	-0.10	negligible
	Mangamauku Stream (Creek Rd)	downstream	no obvious flow (pools of water)	natural	-0.00	negligible
	Mangaoho Stream (SH50)	upstream	major stream	natural	-0.10	negligible
	Manga-o-nuku Stream (03)	upstream	flowing (very low rate)	natural	-0.00	negligible
West (SH50)	Chesterman bridge (trib Kahahakuri Stm)	upstream	dry (no water evident)	natural	-0.50	likely negligible (potential to dry earlier)
	Kahahakuri Stm (SH50)	upstream	dry (no water evident)	natural	-0.30	likely negligible (potential to dry earlier)
	Ongaonga Stream SH50, Ongaonga	upstream	dry (no water evident)	natural	-0.20	likely negligible (potential to dry earlier)
Central	Swamp Rd Wetland 01	downstream	high level	man-made	-0.40	negligible
	Swamp Rd drain (ex Waipawa River, trib Kahahakuri Stream)	downstream	moderate flow rate (flows all year)	man-made	-0.40	negligible
	Swamp Rd Wetland 02	downstream	high level	natural	-0.40	negligible
	Swamp Rd drain (trib Kahahakuri Stream)	downstream	low flow rate (flows year-round)	man-made	-0.40	likely measurable lowering of drain water level
	Kahahakuri Stream (Swamp Rd)	downstream	mod flow rate (flows all year)	natural	-0.30	possible minor lowering of water level
	Black Stream Source (Fairfield Rd)	upstream	damp underfoot (rare ponding)	natural	-0.30	potential to dry earlier
	top Black Stream (pond off Fairfield Rd)	upstream	low level (wet all year)	man-made	-0.40	likely measurable lowering of dam water level
East	Woolshed pond, lower Black Stream	upstream	large pond	man-made	-0.40	minor lowering of water level
	lower Black Stream (Hobin Road)	upstream	very low rate (flows all year)	natural	-0.30	potential to reduce flow
	lower Black Stream Trib 01 (Hobin Road)	upstream	flowing water (moderate rate)	natural	-0.30	minor lowering of water level
	Swan pond, lower Black Stream Trib 01	upstream	high level	man-made	-0.30	minor lowering of water level
	drain at lower Black Stream Trib (02)	downstream	flowing (very low rate)	man-made	-0.30	likely measurable lowering of water level

Southwest	Ashcott Bridge (unnamed stream)	upstream	dry (no water evident)	natural	-0.10	negligible
	SH50 wetland (adjacent Tukipo Rv)	upstream	moderate level	natural	-0.10	negligible

To assess what level of value the waterbody presents and whether the reach requires protecting, the formation of the water feature, whether artificially constructed or a naturally occurring stream/wetland is taken into consideration. Sites such as man-made drains provide little value other than collecting and redirecting rainfall runoff and shallow groundwater from across farmland, and therefore do not require protecting. Naturally occurring streams may have a greater value and the flows therefore may require protection.

In applying the estimated effects on sites inspected in the field, the following changes in water levels are predicted:

- North of study area: the predicted effect on surface water features is estimated to be negligible and not likely to affect minor streams and wetlands.
- West of SH50: the predicted effects on streams that typically dry out during the summer are thought to be negligible; however, it is possible that streams may experience dry conditions slightly earlier and/or resume flowing again a little later in the season (likely by a matter of a few days difference).
- Central and eastern areas: large wetlands and minor streams were observed in the field which appear to be fed by a possible subsurface divergent channel of the Waipawa River upwelling in areas of lower elevation, where changes in lithology result poor confinement. Modelled effects on shallow groundwater as a result of the proposed Tranche-2 takes are greatest in this area. However, anecdotal evidence and field inspections suggest that the majority of the surface water features flow year-round through formed drains.

  Therefore, the estimated changes in surface water levels are unlikely to result in significant effects on the majority of the naturally occurring waterways; although in places the effects will be measurable. The estimated effect across the lower reaches of the Black Stream may be such that the low flow rate observed in March 2021 could be reduced to a trickle.
- Southwest area: the predicted effects on streams that typically dry out during the summer are thought to be negligible; however, flows may be a little less during dry periods for sites upstream of any augmentation site. It is possible that streams may experience dry conditions slightly earlier and/or start flowing a little later in the season (likely by a matter of a few days difference) along with minor drying effects on the wetland areas inspected.

6. SUMMARY

The recent modelling completed by Aqualinc (Weir, 2020) predicted effects of surface water flows across the major river reaches that flow through the Ruataniwha Basin project area, as a result of abstracting the Tranche 2 allocation. However, wetlands and minor streams were not included in the modelling due to the catchment scale of the model. Therefore, this study sought to estimate the effect on wetlands and minor waterways as a result of predicted changes in shallow groundwater from the abstraction of Tranche-2 volumes as modelled by Aqualinc (Weir, 2020).

Following discussions with HBRC, shapefiles of wetlands were provided by Council from which Aqualinc generated a map which displays the significant wetlands monitored by HBRC as part of the SOE programme. In addition, Tranche-2 Applicants were asked to provide information on surface water features across their properties. To assess size, formation (natural/man-made) and state (dry/wet) of the recorded surface water features, field inspections were completed in March 2021 during a very dry period to record locations and the state of wetlands and minor streams across the basin. Not all localities were inspected due to the extensive area and project scope constraints; however, a robust representation of surface water example sites is provided. Assessing the formation of the water feature is critical in evaluating the level of protection required, where sites such as man-made drains provide little value; however, naturally occurring streams may require protection.

Using the Aqualinc 2020 assessment which predicted effect on shallow groundwater, and applying the estimated changes to sites inspected in the field, the following effects on surface water levels are predicted. It must be noted that the modelled effect is a prediction at a point in time during an extreme dry event, not a typical irrigation year:

- North of study area: the predicted effect on surface water features is estimated to be negligible and not likely to affect wetlands and minor streams.
- West of SH50: the predicted effects on streams that typically dry out during the summer are thought to be negligible; however, it is possible that streams may experience dry conditions slightly earlier and/or resume flowing again a little later in the season (by a matter of a few days).
- Central and eastern areas: large wetlands and minor streams were observed in the field which appear to be fed by a possible subsurface divergent channel of the Waipawa River upwelling in areas of lower elevation, where changes in lithology result poor confinement. Modelled effects on shallow groundwater as a result of the proposed Tranche-2 takes are greatest in this area. However, anecdotal evidence and field inspections suggest that the majority of the surface water features flow year-round through formed drains. Therefore, the estimated changes in surface water levels are unlikely to result in significant effects on the majority of the naturally occurring waterways; although in places the effects will be measurable. The estimated effect across the lower reaches of the Black Stream may be such that the low flow rate observed in March 2021 could be reduced to a trickle.
- Southwest area: the predicted effects on streams that typically dry out during the summer are thought to be negligible; however, it is possible that streams may experience dry conditions slightly earlier and/or start flowing again a little later in the season (by a matter of a few days). Therefore, minor effects are anticipated on the wetland areas inspected.

7. REFERENCES

Ballard, C., 2012: Ruataniwha Plains Water Resources – review of groundwater management investigations. Aqualinc Research Limited Client report prepared for Ruataniwha Water Users Group. Report No. C12064/1. Aqualinc, Christchurch, New Zealand.

Francis, D., 2001: Subsurface geology of the Ruataniwha Plains and relation to hydrology. Technical report. Geological Research Ltd., Lower Hutt, New Zealand.

Hawkes Bay Regional Council website (www.hbrc.govt.nz).

Lee, J.M., Bland, K.J., Townsend, D.B., Kamp, P.J.J. (compilers), 2011: Geology of the Hawkes Bay area. Institute of Geological & Nuclear Sciences 1:250,000 Geological Map 8. GNS Science, Lower Hutt, New Zealand.

Pattle Delamore Partners Ltd., 1999: Ruataniwha Plains conceptual hydrogeological model. HBRC Plan Number 2808, EMT 99/3. Environmental Technical Report ISSN 1174-3077, PDP, Wellington, New Zealand

Pattle Delamore Partners Ltd., 2020: Ruataniwha Basin Tranche 2 Groundwater Modelling – Preliminary Comments. Memorandum prepared for Hawke's Bay Regional Council. 15 December 2020.

Weir, J., 2020: Ruataniwha Basin: Tranche 2 Groundwater Modelling. Client Report Project No. WL18045 05/11/2020. Aqualinc Research Limited, Christchurch, New Zealand.

Report Limitations

This letter report is written based on conditions as they existed at the time of the study, and there is no interpretation made on potential changes that may occur across the sites. Subsurface conditions may exist across the project area that are not able to be detected or revealed by the investigation within the scope of the study, and are therefore not taken into account.

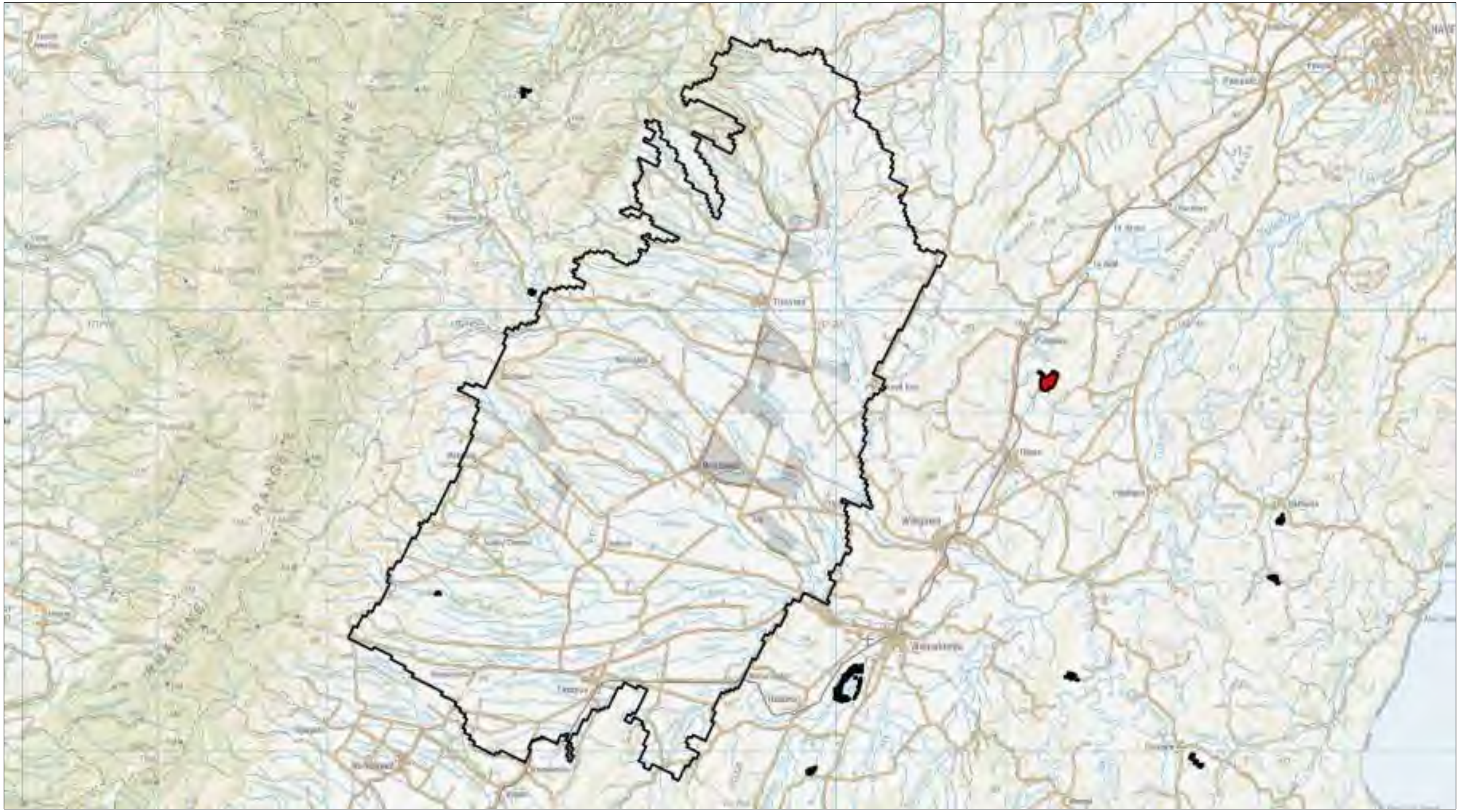
APPENDICES

APPENDIX A

Topo map illustrating SOE significant wetland areas

(***data sourced from HBRC and map generated by Aqualinc)***

A1.: Topo map illustrating SOE (significant) Wetland sites across the Central & Southern Hawkes Bay area (data sourced from HBRC)



APPENDIX D – Well Interference Assessment Report

RUATANIWHA BASIN TRANCHE 2 IRRIGATION WATER PERMIT CONSENT APPLICATION

-ASSESSMENT OF WELL INTERFERENCE EFFECTS

CENTRAL HAWKE'S BAY

PROJECT NO. J19220-REP-01 T2-WI

PREPARED FOR
COLLABORATIVE GROUP

PREPARED BY
SUSAN RABBITTE

DECEMBER 2020

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Report prepared by:

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Principal Geologist/Hydrogeologist

Report QA/QC review by:

Ivan Berra
Geologist

EXECUTIVE SUMMARY

Lattey Group (Lattey) was engaged by the Tranche 2 (T2) applicants' collaborative group to prepare a basin wide well interference assessment associated with the proposed T2 ground water abstraction.

For this assessment all the wells recorded within the Ruataniwha Basin are considered. There are many wells, and these wells were divided into groups based on their recorded total well depths. The initial focus is on the wells within the 0m to 50m depth range and these are assessed against the numerical groundwater model shallow (layer 1) impact predictions. To assess the potential for impact on deeper wells, the modelled drawdown impact at a deeper level (layer 6) was reviewed separately against the deeper wells. It was not possible to fully consider wells of unknown depth but, if it is assumed that they are sufficiently deep to enable "efficient" taking of water then they are unlikely to be adversely impacted.

Consideration of aquifer parameters from existing well aquifer pump testing supports the outputs from the numerical model and increases confidence in the drawdown predictions made for the well locations assessed in this report.

A methodology for the assessment is presented. In some cases, gaps within the data provided by the Hawkes Bay Regional Council (HBRC) database are filled. Where this has occurred, the assumed value is identified with red text, for example Static Water Levels (SWL) and top screen heights. The assumed SWL are a numerical average of all the SWL available for each depth group and the top screen heights where absent are assigned a value equivalent to the total well depth.

The two contour maps provided from the numerical modelling represent water level differences associated with the preferred scenario for the T2 water abstraction, for both shallow and deep layers within the aquifer. Values were interpolated from these contour maps and applied to specific basin well locations.

Seasonal variation was predicted based on analysis of the HBRC State of the Environment (SOE) monitoring wells network. A maximum value range was calculated based on the last 5 years of data. Where sufficient datapoints were available this data was contoured, and an interpolation of the seasonal variation value was applied to the individual well locations. Where the data was insufficient the available value or an average was applied.

Wells were initially flagged on the assessment spreadsheet for each depth group. They were then separated into those that were flagged because they are potentially of insufficient depth or otherwise classified as "inefficient" wells and those that might genuinely be adversely impacted by the proposed abstraction. Some could be further discounted from likely impact based on their recorded use or information from other recorded details.

Of a total of 657 wells (this value excludes the 46 unknown depth wells) that were individually assessed 94 were initially flagged in the well groups and 24 remain flagged following some further consideration. Of these flagged wells 14 are in the depth range <50m and 10 are >50m deep.

Further investigation is required to assess whether they will be adversely affected or not, and this may involve contacting the well owners or visiting the well locations. However, given that almost all of the wells assessed (i.e. 96%) are not considered as adversely affected, it is likely that this will also be the case for the remaining wells.

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1.0 INTRODUCTION

Lattey Group (Lattey) was engaged by the Tranche 2 Collaborative Group (T2 Group) to prepare an assessment of the impact of the proposed Tranche 2 (T2) water take on existing wells within the Ruataniwha Basin area. This is essentially a well interference assessment, that combines both the shallow (layer 1) and deeper (layer 6) groundwater level difference outputs from the numerical groundwater model, with data for the existing basin wells and seasonal water level variations. The numerical model outputs selected relate to a specific water use scenario developed for the collaborative group to optimally manage the impacts of the taking on river flows via augmentation.

This report is required to support the application for groundwater abstraction under the Ruataniwha Basin Tranche 2 allocation regime. It identifies wells within the basin area that may be impacted by the T2 abstraction and that may require further consideration or limited notification in relation to the consent application process. The scope of works and information provided by this report includes:

- Summary of the consent application;
- Description of the assessment methodology applied;
- Review of numerical modelling outputs;
- Identification of the basin wells;
- Influence of seasonal variation; and
- Assessment of results.

1.1 CONSENT APPLICATION DETAILS

Hawke's Bay Regional Council (HBRC) completed the process to finalise a change to their Regional Resource Management Plan (RRMP) within the Tukituki River Catchment. This plan change is known as Plan Change 6 (PC6). One of the outcomes of the plan change was the inclusion of a Tranche 2 groundwater allocation limit for Zones 2 and 3 of the Ruataniwha Basin of 15M m^3. The allocation is available primarily for irrigation use, however, to access it there is a requirement to augment river flows to off-set the impacts on them of the T2 taking. The abstraction must be sourced from wells screened at depths greater than 50m. The concept is to use aquifer storage as a buffer and to support river flows during times of low flow. However, this will still result in greater volumes of water being abstracted from the basin and over the longer term the water table will reach a new lower dynamic equilibrium.

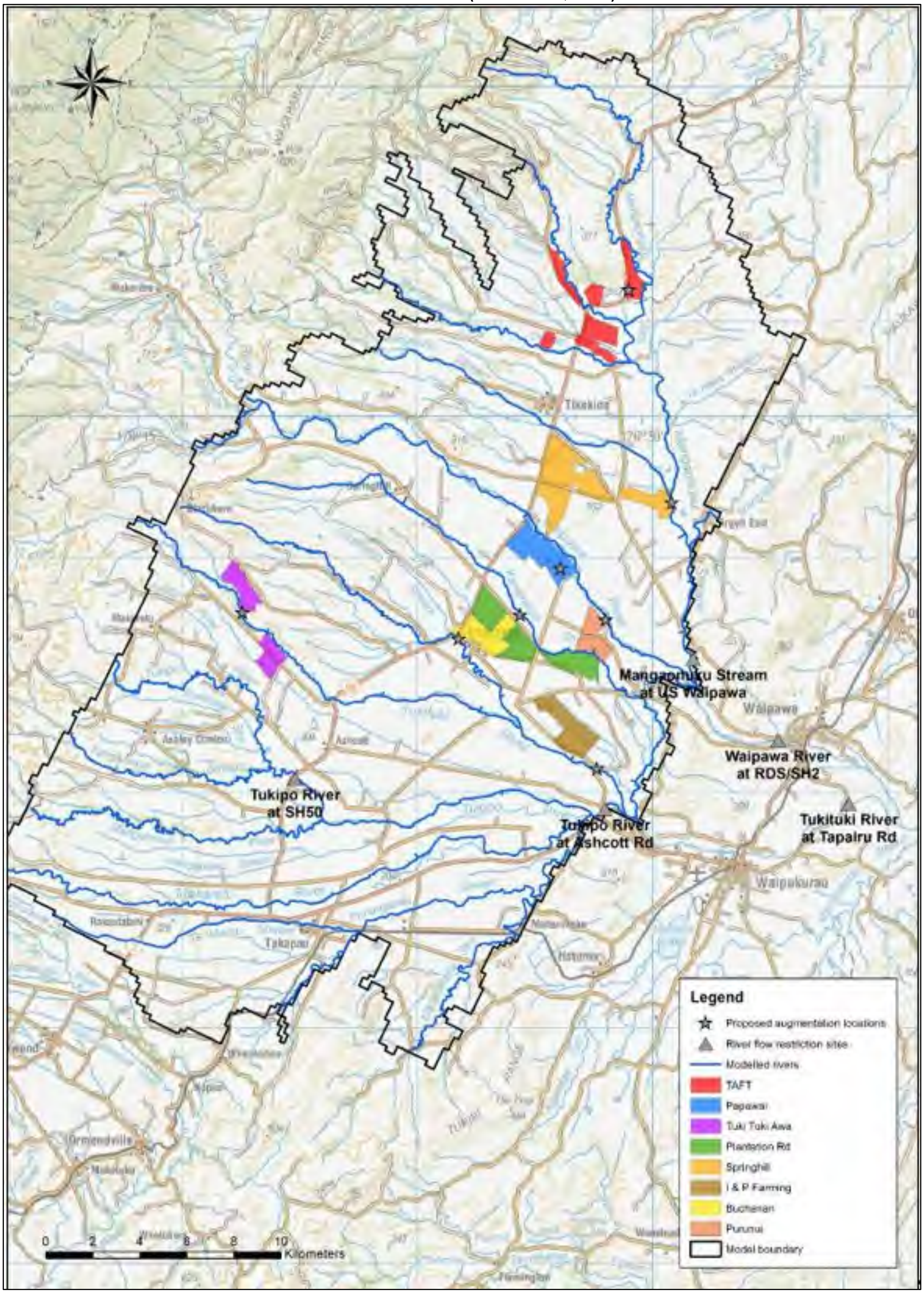
As part of the PC6 decision making process a 3D numerical groundwater model was developed (Weir, 2013). This model was recently updated and used to test the hydraulic response of the groundwater and surface water system in the basin from multiple proposed T2 groundwater take applications (Aqualinc, 2020). This revised model then informed the augmentation requirements and was used to identify an optimised scenario that provides for mitigation of the adverse impacts on river flows whilst maximising irrigation use.

The effects of the T2 taking are basin wide and mitigation requires a distributed approach to augmentation locations. There is a total of eight applicants and to ensure effective mitigation means a collaborative approach is required. The applicants are:

- Te Awahohonu Forest Trust (TAFT);
- Papawai Partnership;
- Tukituki Awa;
- Plantation Road Dairies;
- Springhill Dairies;
- I & P Farming;
- Buchanan Trust No. 2; and
- Purunui Trust.

Together these applicants have applied for the full 15M m^3 of groundwater allocation. The locations of the applicants' properties are shown on the map, Figure 1, along with the model boundary and augmentation locations.

FIGURE 1: TRANCHE 2 APPLICANTS' FARM LOCATIONS (AQUALINC, 2020)



1.2 RESULTS OF THE NUMERICAL MODELLING

The numerical groundwater modelling assessed the impact on river flows of each individual applicant in terms of change in average flows (L/s) and change in the mean 7-day annual low flow (MALF) (L/s). Following this, several scenarios were developed to consider the combined effects of all applicants together with augmentation. A total of four potential abstraction augmentation scenarios were developed and compared against a Status Quo.

For the purposes of this assessment Augmentation Scenario 4 is the preferred solution. This includes for Tuki Tuki Awa to abstract T2 water only to fill gaps in their surface water taking with subsequent discharge to the Tukituki River. This scenario represents the best optimisation of the volume of water taken for irrigation versus that taken for augmentation with a 15% reduction in augmentation discharge compared to Scenario 3, allowing a corresponding increase in the irrigated areas.

A map of the groundwater level difference between the Status Quo and Augmentation Scenario 4 was presented (Aqualinc, 2020), this map is shown here in Figure 2. The map shows how groundwater levels are predicted to change spatially during dry periods. The shallow groundwater levels are predicted to lower up to a maximum of 0.8m, and this is focussed in areas of greatest abstraction i.e. near the bulk of the applicant's properties and to the north-west of Ongaonga township. Elsewhere, shallow groundwater levels are predicted to change less than 0.3m (Aqualinc, 2020).

FIGURE 2: DIFFERENCE IN SHALLOW (LAYER 1) GROUNDWATER LEVEL - SCENARIO 4 (AQUALINC, 2020)

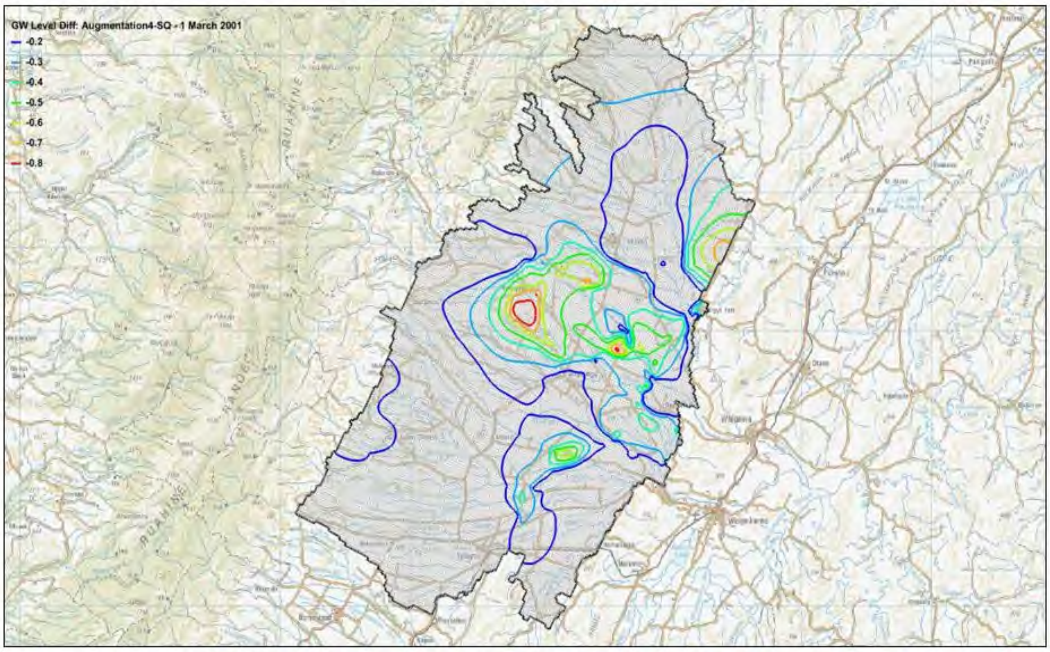


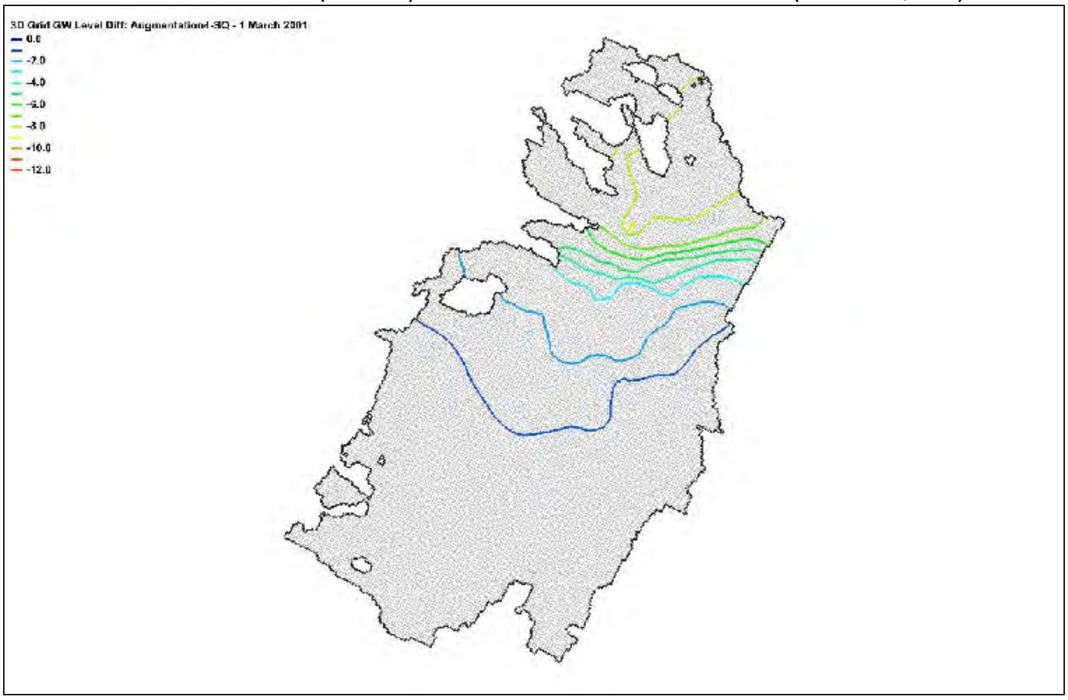
Figure 19: Difference in shallow (layer 1) groundwater levels at 1 March 2001 between status quo and augmentation scenario 4

This predicted drawdown contour map for shallow (layer 1) groundwater levels can be used to make well specific predictions for the shallow (<50m) deep well locations within the Ruataniwha Basin. These individual well locations can then be assessed to understand if the magnitude of well interference predicted is likely to have an adverse impact on them or not.

In addition to the shallow (layer 1) map, information was also provided from the numerical groundwater model regarding deep (layer 6) drawdown predicted effects, this map is shown in Figure 3. The information provided by this output is assessed against the deep (>50m) well locations, to assess the potential impacts on them.

The layer 6 model output shows zero, or almost zero, difference in groundwater level in the southern portion of the Ruataniwha Basin. The water level difference increases northward to around 8m or more in the north-eastern most area.

FIGURE 3: DIFFERENCE IN DEEP (LAYER 6) GROUNDWATER LEVEL - SCENARIO 4 (AQUALINC, 2020)



1.3 RUATANIWHA BASIN TRANSMISSIVITY VALUES

A review of the locally derived aquifer parameters i.e. those calculated from aquifer pump testing within the basin was made to aid understanding of the expected basin response to the proposed T2 abstraction. This review was carried out by Bay Geological Services Limited and a copy of their full report is provided as Appendix 2.

The report focuses on aquifer parameters calculated for wells >50m in depth as this represents the minimum top screen height for the existing and new T2 abstraction and augmentation points.

In summary, the Ruataniwha Basin comprises a series of spatially distributed and discontinuous alluvial aquifer deposits with variable properties. Meaning there are no discrete gravel aquifers present. High transmissivity (T) values >1,500m^2/d occur at depths of 40m to 60m below ground level (bgl). There are 4 deeper wells (>75m) with equally high T values, located between the Kahahakuri Stream and the Waipawa River, probably a result of well-developed, clean gravel paleo-channel deposits adjacent to the river.

Significantly lower T values are reported south of the Tukituki River. Likely because of a less active depositional setting. Resulting in a meandering river with a channel off-set by tectonic activity and subsequently less well-developed gravel rich paleo-channels.

Storativity (S) values reduce with increasing depth and confinement. Values of 0.001 to 0.002 are common in the basin centre at 40m to 75m bgl, lowering to 0.0001 to 0.00001 in the north and west. At depths of >75m the S value is generally between 0.0005 to 0.00001.

This information is consistent with what might be expected in this geological setting where tectonic basin development results in alluvial in-filling. The bulk of the historically successful wells are focused in the basin centre with the more marginal performances reported toward the boundaries.

The bulk of the T2 abstraction is also focused in these higher performing areas targeting the deep paleo-channels. Where the T and S values are higher the aquifers can better sustain abstraction with lower surrounding impacts. This is because the transmission of effect is more rapidly and widely distributed within the basin at this level, more is gained from the higher storage component and recharge is equally rapid. This is evident in Figure 3 where despite the greater proportion of T2 abstraction occurring in the central area of the basin the water level difference is minimal. However, as the effects propagate northwards, and combined with the abstractions at the northern end of the basin, the lower aquifer parameters are less able to distribute effects and maintain recharge, a greater decline occurs. South of the Tukituki River there is no T2 abstraction and this is reflected in the absence of water level difference effects at this deep level in this area. However, over time as the effects continue to spread and propagate to the surface the more basin wide impact is apparent and this is reflected in the water level difference contour map provided by the numerical model and shown in Figure 2.

1.4 WELL INTERFERENCE ASSESSMENT METHODOLOGY

When considering the potential for adverse impacts on an existing well it is necessary to understand the current availability of water within that well based on the water column. The amount of available water can then be compared with the magnitude of predicted effects associated with the new taking at that well location. In some cases, there will be water available and in others the existing situation may indicated that the well potentially already has issues with abstraction and is considered "inefficient".

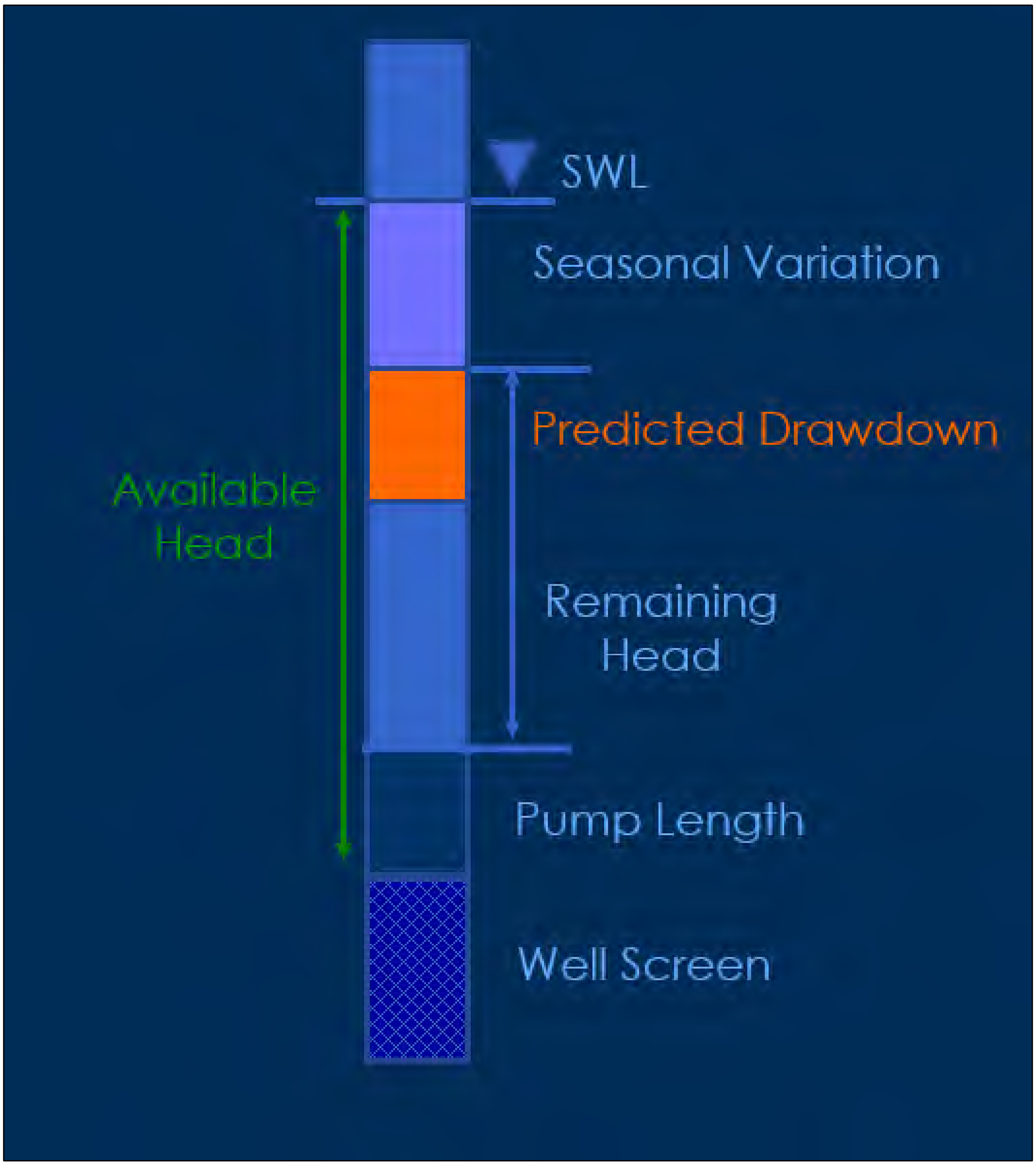
If the predicted effect of the take represents only a small proportion of the water that remains available at the location of interest, then it is unlikely that a significant adverse effect will occur. However, if the predicted impact makes up a large proportion of the remaining water column of existing wells, then they may be impacted such that access to the water supply by the user is reduced.

In terms of the HBRC Regional Resource Management Plan (RRMP) Policy 77 (POL77) identifies a requirement for "efficient taking" of groundwater, as it specifies that the groundwater be managed so "that existing efficient groundwater takes are not disadvantages by new takes". Efficient taking is further defined in the RRMP as abstraction by a bore which penetrates the aquifer from which water is being drawn at a depth sufficient to enable water to be drawn all year (i.e. the bore depth is below the range of seasonal fluctuations in groundwater level), with the bore being adequately maintained, of sufficient diameter and screened to minimise drawdown, with a pump capable of drawing water from the base of the bore to the land surface". Further information on POL77 and how it relates to this assessment is provided in Section 3.0 of this report.

How water availability is assessed in a well is illustrated on the diagram in Figure 4, here the total water column is calculated and then divided up for different uses. The total water column (Available Head) is the height from the top of the well screen to the SWL. However, this calculation is conservative as POL77 states that the pump should be capable of drawing from the base of the bore to land surface. In deeper wells a submersible pump will be used. This is usually placed above the top of the well screen and will have an intake point that must remain submerged, it is considered reasonable to allow a pump length of 1m. Shallow wells may use surface pumps to draw water, or small pumps if the rate and volume of abstraction is low i.e. a domestic take, so it is reasonable to have zero or <1m pump length allowance. For shallow wells <10m in total depth, it is reasonable to consider the total well depth rather than the top screen to determine available head because they may use surface pumps, foot valves and / or shrouds to draw from the base of the well. Where there is no information on the top screen height for a well even if it is deeper than 10m, it is also reasonable, in line with POL77, to use the total well depth value.

Seasonal water level fluctuations can affect water availability within a well. The groundwater levels are usually higher in the winter and lower in the summer, this change in level is termed seasonal variation. The amount of variation can be different from year to year depending on whether it is a particularly dry year or not. HBRC have a series of wells within the region that are monitored, including within the Ruataniwha Basin, to aid with understanding of the magnitude of this variation and winter recovery levels (i.e. is the gap widening significantly and is the winter rainfall topping up the aquifer each year, or is there a risk of long term water level decline that could adversely impact the overall aquifer sustainability). The magnitude of seasonal variation can vary dependant on the well depth and proximity to pumping wells. How this value is calculated for this assessment and applied to the basin wells is discussed in more detail in Section 2.2 of this report.

FIGURE 4: KEY FEATURES FOR ASSESSING WELL INTERFERENCE



Once the pump length and seasonal variation values are removed from the Available Head the water column that is left is known as the Remaining Head. This section of water column is the part that is used by the well owner when they pump their well. It may also be impacted by other nearby pumping wells, though some of this effect is included in the seasonal variation value. It is this section that is compared against the drawdown prediction. As a rule of thumb if the predicted drawdown value at the well is greater than 20% of the remaining head then there is a possibility that the well in question may be adversely impacted by this additional drawdown.

Often when making this sort of assessment there are many surrounding wells that must be considered. This method allows consideration of every well location to happen quickly and wells that are not likely to be impacted can rapidly be discounted and those where an effect is more likely can be flagged for further, more detailed, assessment. For example, a well that is identified as potentially being impacted may later be identified as of inadequate depth making it "inefficient", unused or of very low use. It may also have a real risk of potentially adverse effect that requires further consultation or mitigation.

2.0 RUATANIWHA BASIN WELLS

There are a large number of wells situated within the Ruataniwha Basin area. HBRC holds a database of all the recorded well locations and other details such as well depth, water level, lithology, date drilled etc. that are pertinent to that individual well. It is noted that there are likely other well locations that are not included in this database, or some in the database that have very little information, it is not possible to consider these at this point because of the absence of information.

2.1 ALL WELLS DATA

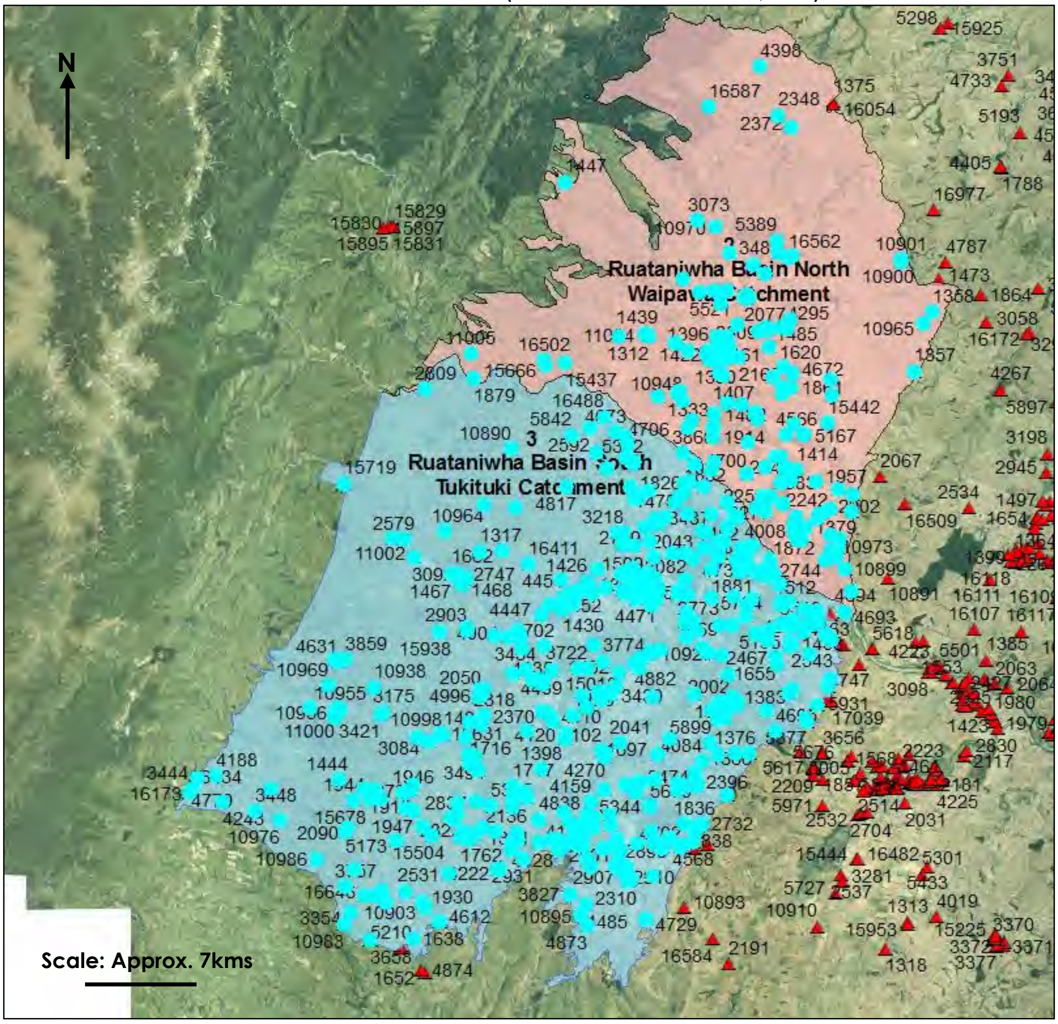
A request was made to HBRC to provide a spread sheet with their database information for all of the wells within the Ruataniwha Basin area. A total of 703 wells locations with associated data were identified. These wells represent a large range of different depths. It was noted that the numerical model drawdown predictions represent the change within the shallow (layer 1) and deeper (layer 6) groundwater levels. Within PC6 POL TT11 for managing groundwater takes hydraulically connected to surface water bodies there is an identified depth of 50m (top screen) where wells are excluded from assessment under this policy. Therefore, to assist with managing the large number of wells identified within the basin area they were divided into arbitrary groups based on their depths. The wells <50m in total depth are assessed against the shallow (layer 1) model output and the deeper wells >50m are assessed against the deep (layer 6) output. The well groups and number of wells associated with each group are shown in Table 1.

TABLE 1: WELL GROUPS ASSESSED

Group	Number Wells
0 -9.99m	109
10 – 19.99m	75
20 – 29.99m	75
30 – 39.99m	82
40 – 49.99m	79
+50m	236
Unknown	46
Total	703

The locations of wells within the basin area are illustrated on the map in Figure 5, with the pink area representing the Ruataniwha Basin North Waipawa Catchment and the blue area the Basin South Tukituki Catchment.

FIGURE 5: WELLS WITHIN THE RUATANIWHA BASIN (MAP PROVIDED BY HBRC, 2020)



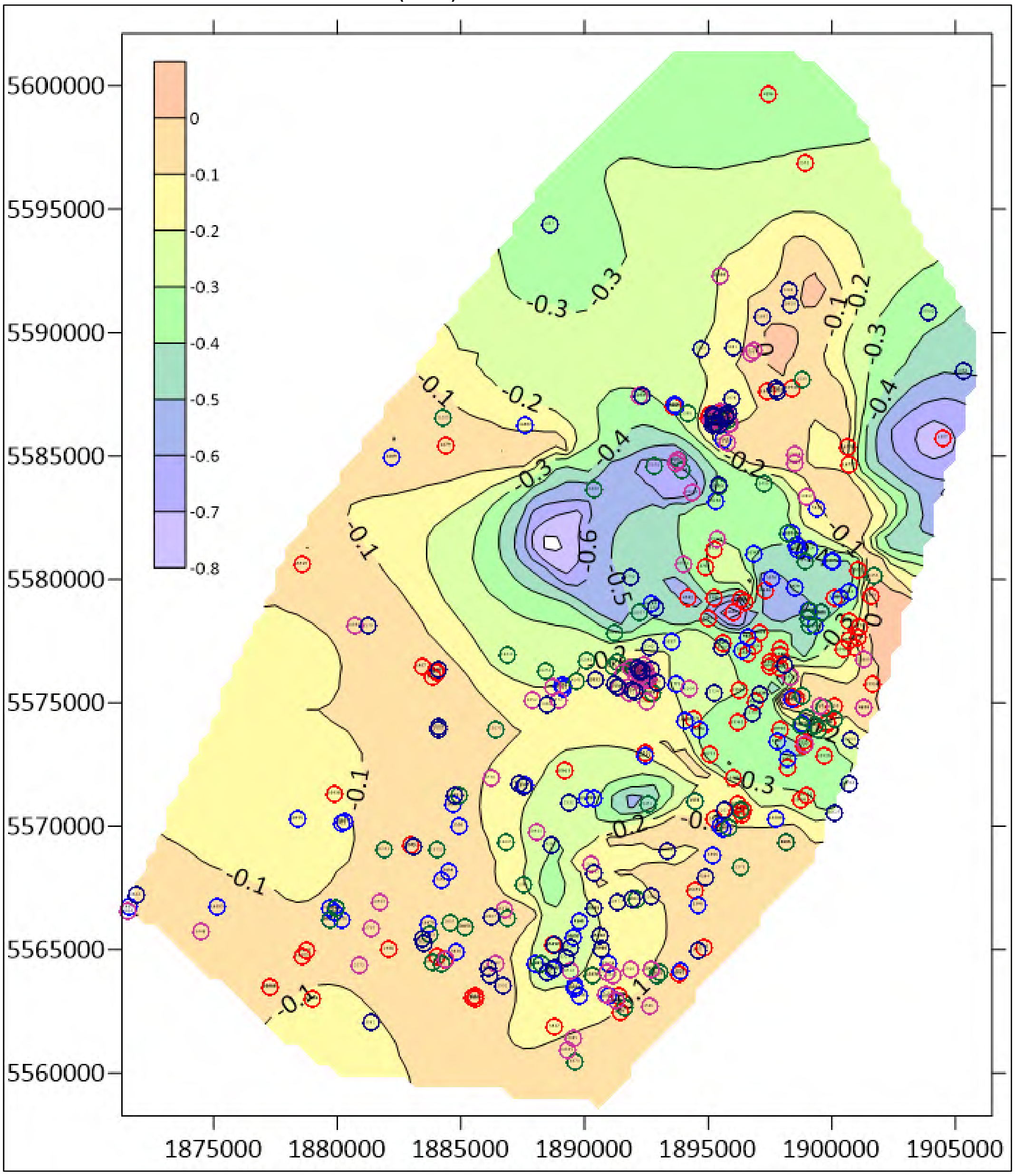
These well locations were divided into the groups identified in Table 1 and applied to contour maps created from data provided by Aqualinc of the shallow (layer 1) and deep (layer 6) groundwater level changes for Scenario 4, Figures 6 and 7. The well groups in Figure 6 are colour coded with the 0 – 9.99m layer as red circles, 10 – 19.99m layer blue, 20 – 29.99m dark green, 30 – 39.99m magenta, 40 – 49.99m dark blue.

In Figure 7, the points shown represent all the deep wells in the Ruataniwha Basin and some proposed deep wells that will be constructed for T2 irrigation or augmentation purposes. The T2 abstraction and augmentation points are shown as solid blue circles, the other deep wells (>50m) are represented by the purple/blue open circles.

There are 46 wells identified that have unknown depths, the locations of these are shown in Figure 6 as black circles. These well locations are spread across the basin area but seem to have a larger number to the south.

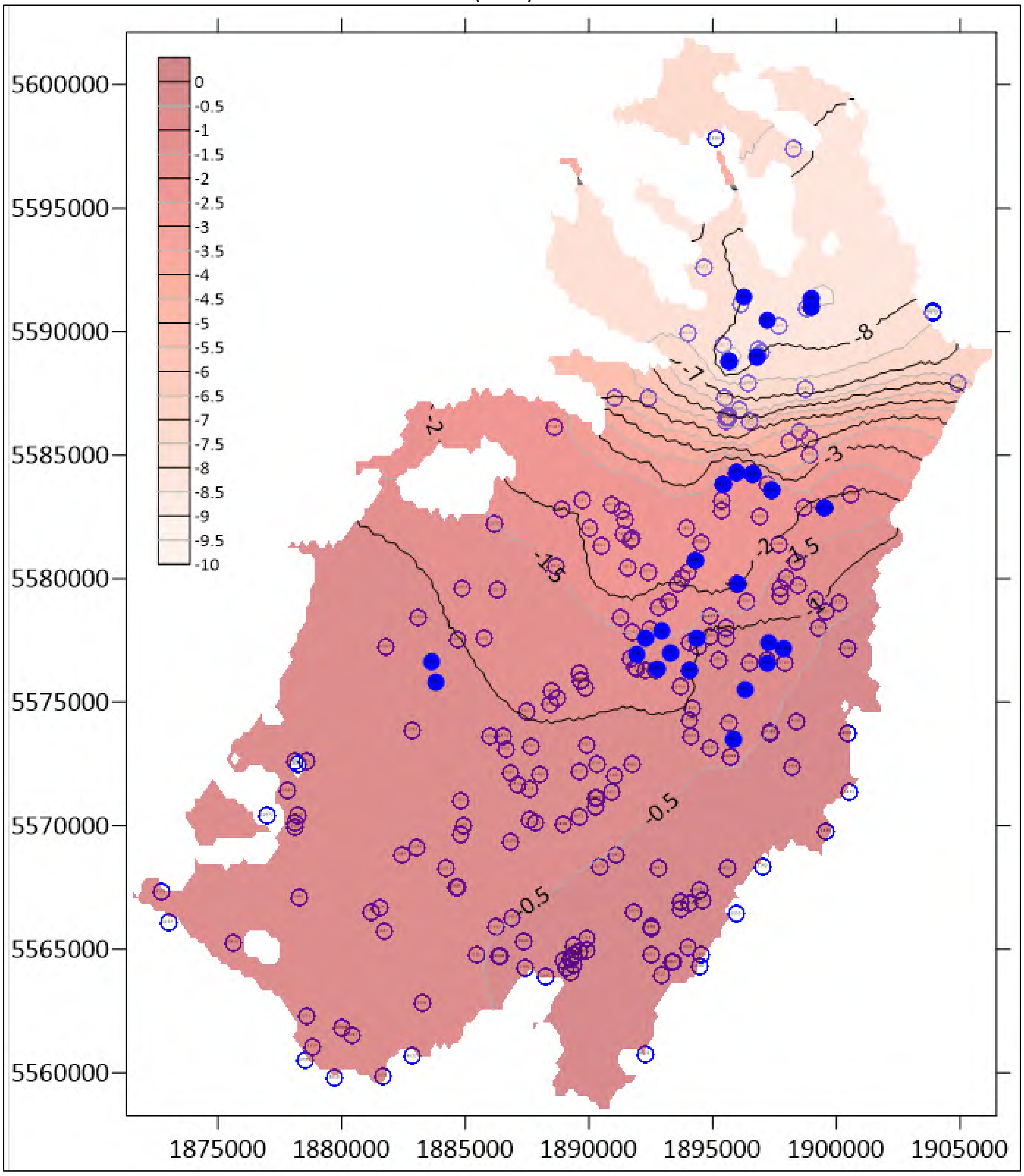
The separate well groups were then analysed using specialised software to generate point sample grid values for the individual well locations. These point sample values represent the numerical model predicted drawdown at the individual well locations. This information was applied to a spread sheet and converted to an absolute value to represent predicted drawdown at each well location. This information is shown on the spreadsheets in Appendix 3.

FIGURE 6: CONTOUR MAP WITH SHALLOW (<50M) WELL GROUPS



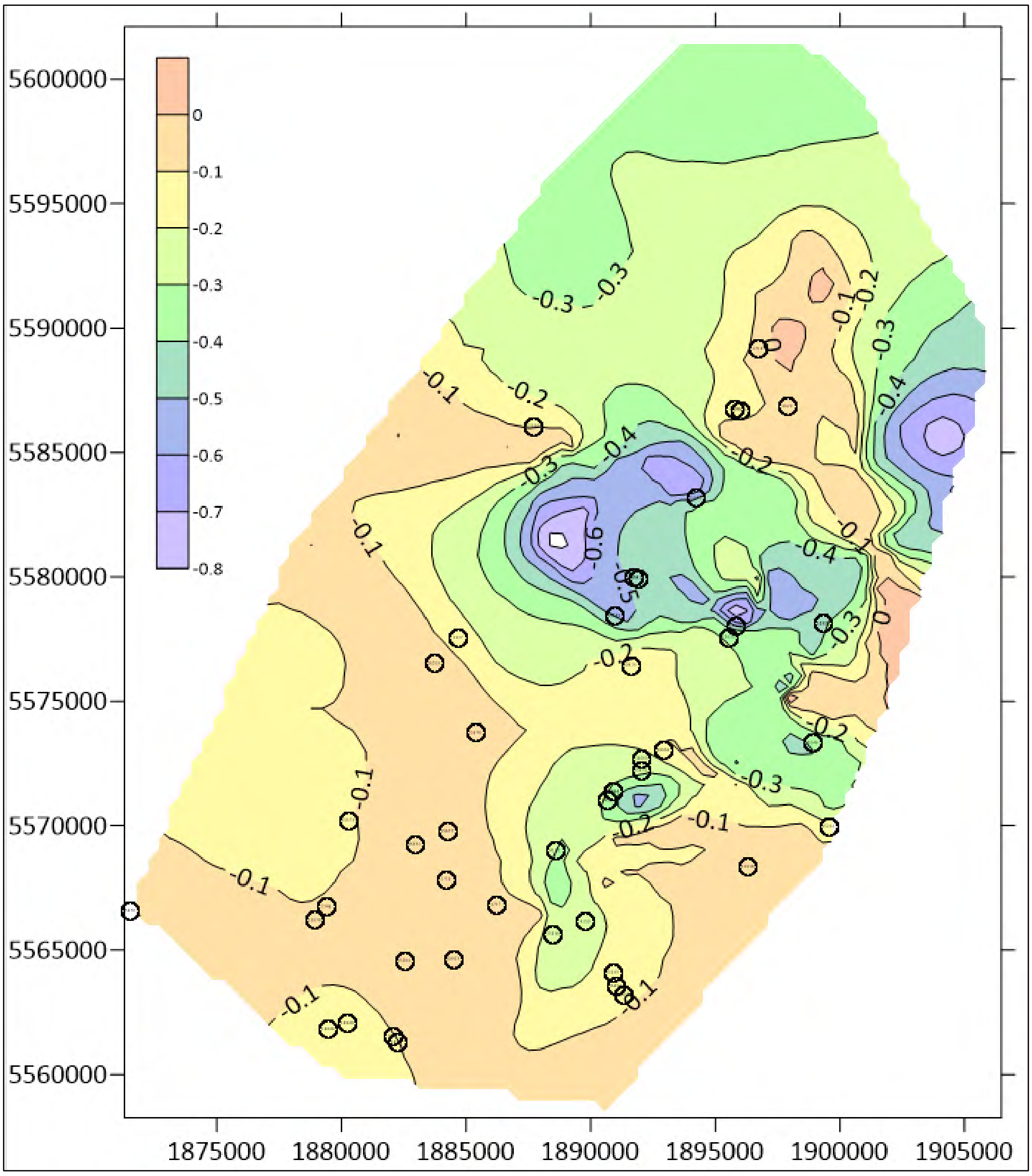
There is some data missing from the information provided in relation to the historic SWLs, top screen heights and in some cases also the total well depth. Where relevant data is missing values are assigned based on the information from the well in question or other nearby wells. For example, for the SWLs, an average of the existing data in each depth group was made and this average value was applied to wells missing this information. The assigned values are denoted in red text in the spreadsheets. Where the top screen height data is missing the total well depth value was assigned, again denoted in red text on the appended spreadsheets.

FIGURE 7: DEEP WELL ABSTRACTION LOCATIONS (>50M) AND TRANCHE 2 WELLS



The locations of the wells with no depth information are shown in Figure 8, but they are not included within the later well interference analysis spreadsheets. There is just not enough information to be able to consider them such that an estimate of the impact or otherwise can be reliably assessed using the methodology outlined here. It is likely that the majority are old or unused and that is why the information is so sparse. To consider them further, more well specific information for each location would need to be gathered.

FIGURE 8: UNKNOWN DEPTH WELL LOCATIONS



2.2 SEASONAL VARIATION VALUES

As noted in Section 1.3 of this report, seasonal water level fluctuations can affect water availability within a well. The groundwater levels are usually higher in the winter and lower in the summer and the magnitude of this change can also vary year on year.

HBRC have a series of wells within the region that are monitored, the locations of these State of the Environment (SOE) wells within the Ruataniwha Basin are shown in Figure 9. Some of these wells are monitored for only groundwater levels, others for water quality and some are for both. Within the basin area there are a total of 40 water level wells monitored.

The magnitude of seasonal variation can vary dependant on the well depth and proximity to pumping wells. The water level data for each SOE well location can be accessed via the HBRC website, with a 5-year water level record from which the maximum and minimum level can be obtained as shown in Figure 10. The wells within the basin were identified and a summary of the location, depth, maximum and minimum water levels was tabulated, Appendix 1.

FIGURE 9: LOCATIONS OF HBRC STATE OF THE ENVIRONMENT (SOE) MONITOR WELLS

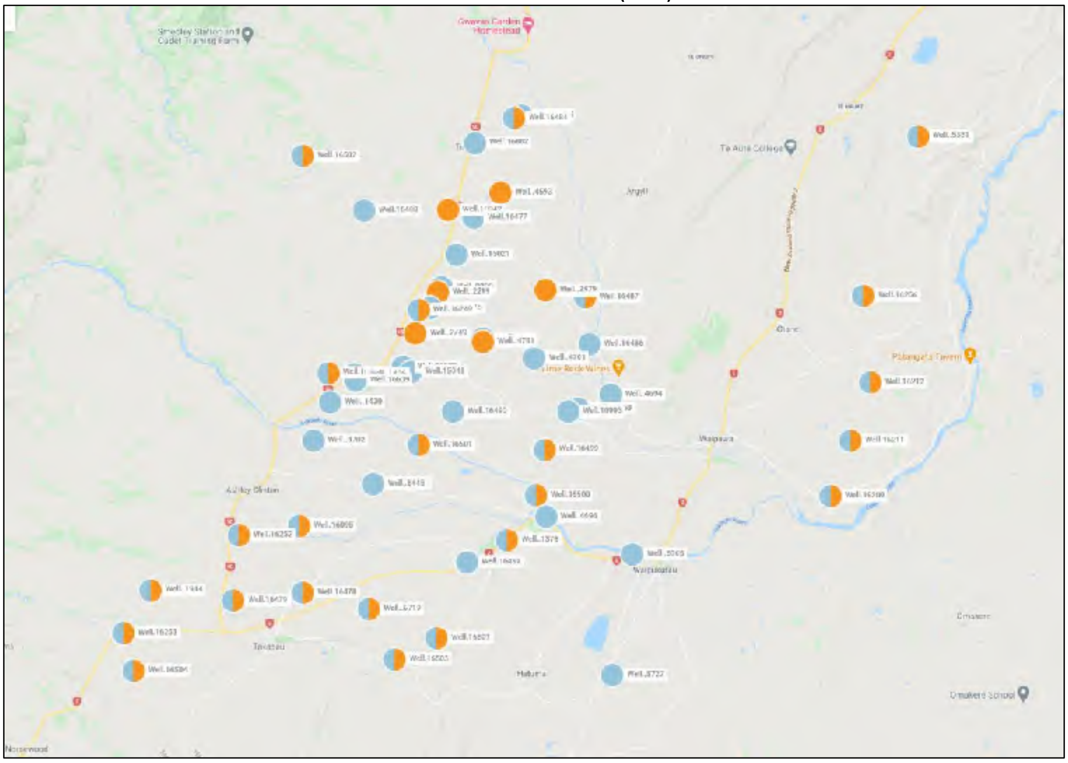


FIGURE 10: LAST 5 YEARS WATER LEVEL DATA IN SOE MONITOR WELL NO. 16252

This allowed calculation of the maximum seasonal variation at each well. The SOE wells were separated into the same groups based on depth as the basin wells. A summary of the number of wells in each depth group is provided as Table 2. There are shallow and deep well locations, but there is only one well between 30 – 39.99m depth and two that are 40 – 49.99m deep. Where there are enough SOE wells in a depth range to provide data points, it is possible to generate a contour map and then interpolate a value for the other specific well locations. Where there are not enough wells the value, or an average of the two values, is adopted and applied across all the wells at that level. For example, the 10 – 19.99m well group well locations and SOE well points, with the variations, are shown in red in Figure 11. A contour map of the seasonal variation values was generated, Figure 12, all of the wells in that depth range were plotted and point sample grid values were obtained for each well location. This same methodology was used for the wells in the >50m well group as there are 14 SOE wells at this level.

The contour map for the >50m depth range wells is shown in Figure 13, it is noticeable that Well No. 5445 has a much larger recorded variation than the other wells at 55.48m. The next deepest is Well No. 1475 with 21.49m. These large variations may be a direct result of the influence of nearby pumping and have resulted in the contour plot estimating negative values for wells located in the south west of the basin area. It is not realistic that these values would be negative so a conservative value of 2m for seasonal variation is used in the later well interference assessment for wells where the contour plot returned negative values. The locations of these wells, outside of the zero-contour line, are identified in Figure 13.

TABLE 2: SUMMARY OF SOE WELLS

Group	Number SOE Wells
0 -9.99m	6
10 – 19.99m	8
20 – 29.99m	9
30 – 39.99m	1
40 – 49.99m	2
+50m	14
Total	40

FIGURE 11: SOE WELL DATA AND WELL LOCATIONS FOR 10 - 19.99M WELL GROUP

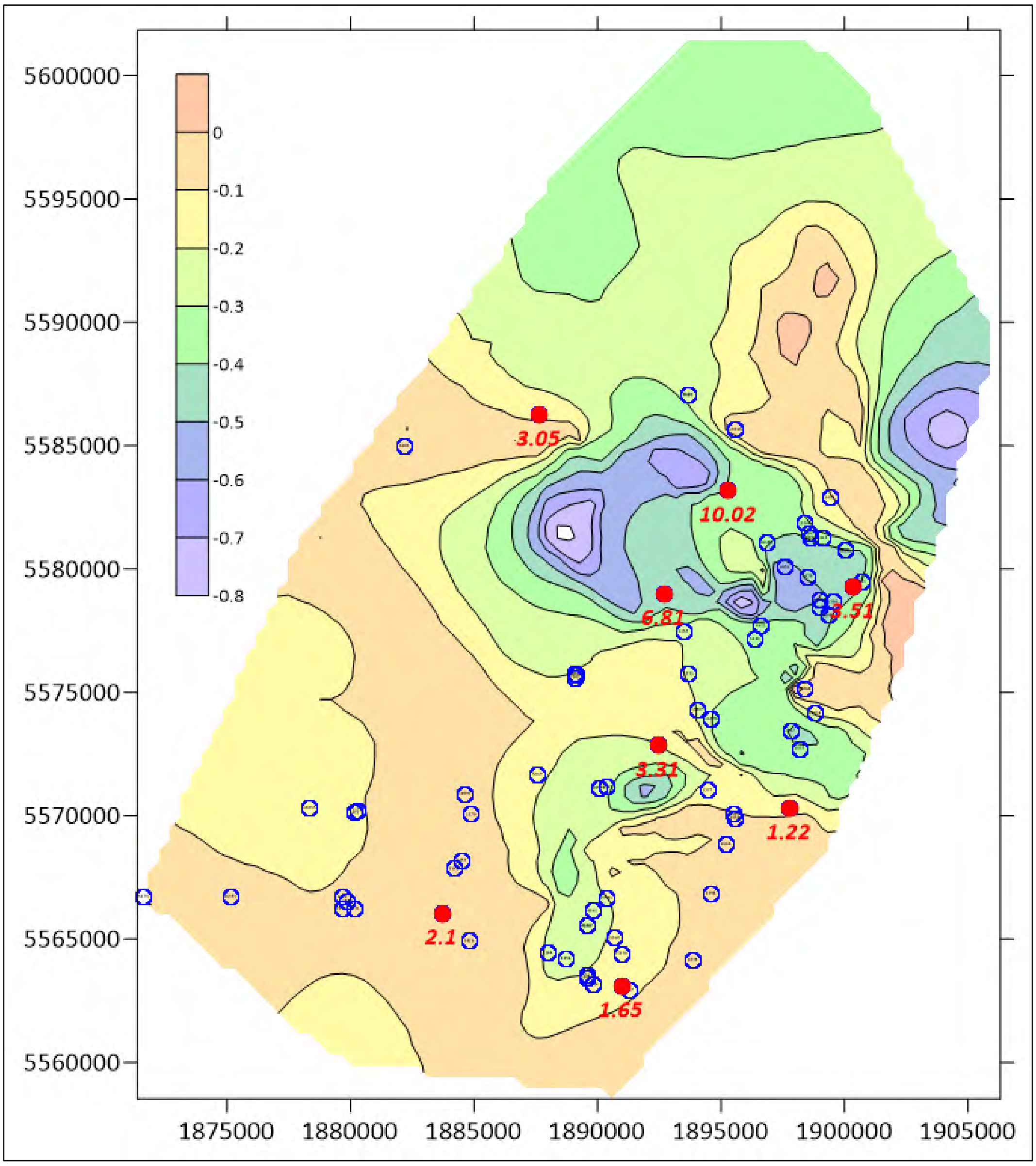


FIGURE 12: CONTOUR MAP - SOE WELL SEASONAL VARIATION DATA FOR 10 - 19.99M GROUP

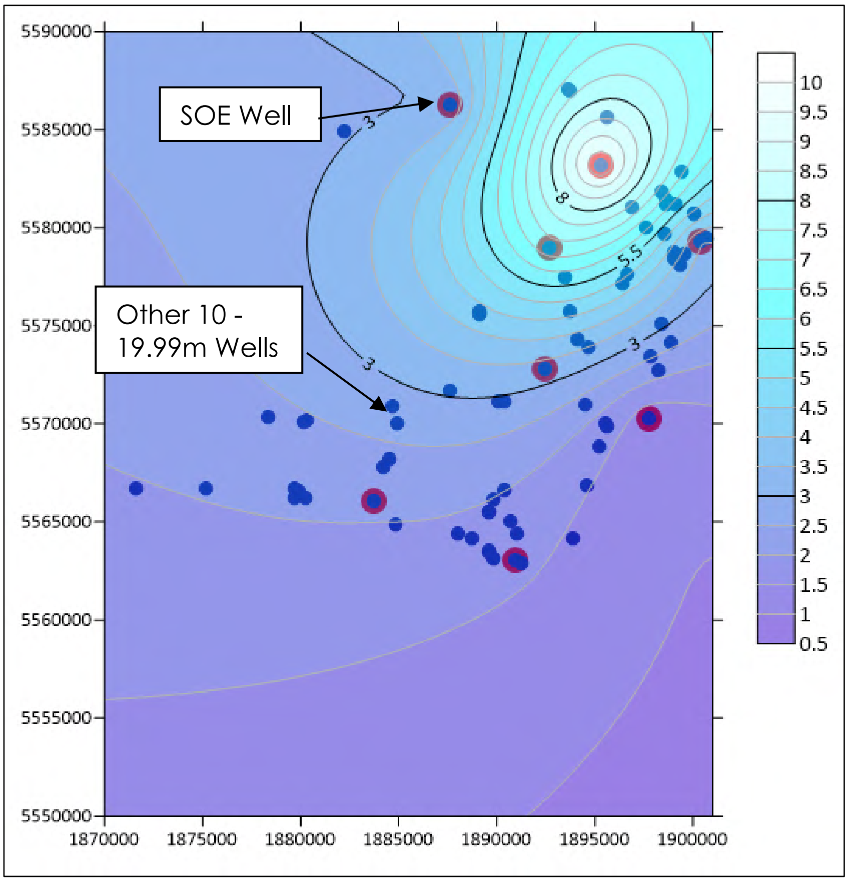
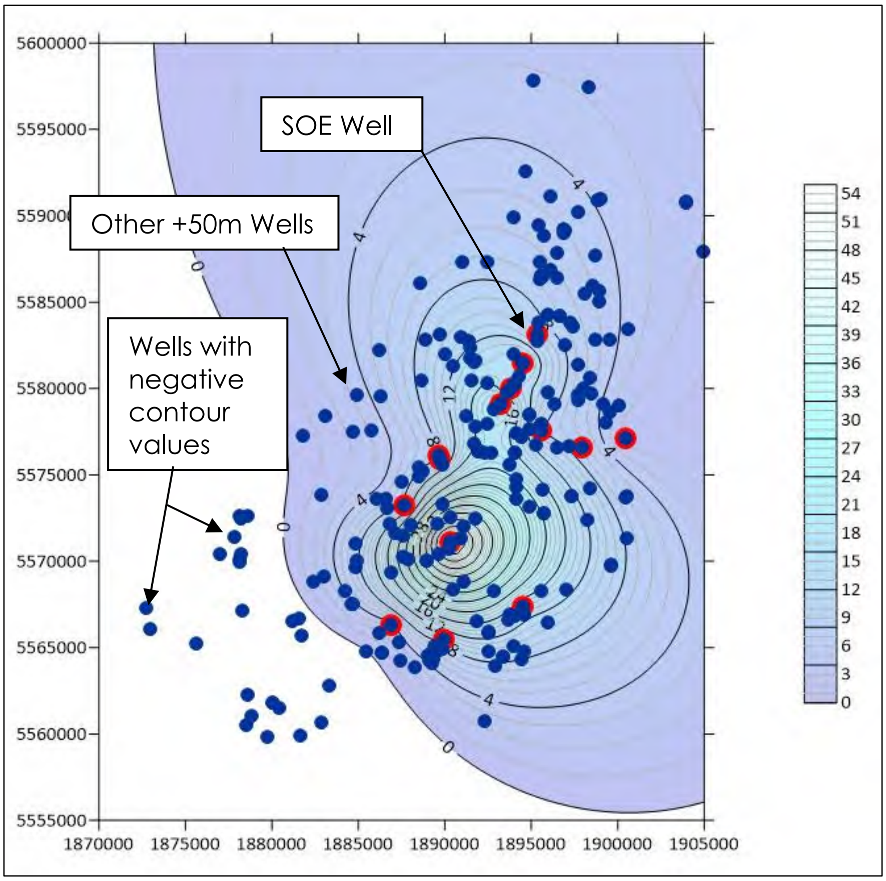


FIGURE 13: CONTOUR MAP - SOE WELL SEASONAL VARIATION DATA FOR +50M GROUP



3.0 RESULTS OF WELL INTERFERENCE ASSESSMENT

Spreadsheets were created for each well group and these show the locations where information was inferred from other nearby wells and calculates the available head, and the remaining head values for each well location. The predicted drawdown value is displayed, and this is calculated as a percentage of the remaining head value for each well. The values that are in excess of 20% or are a negative percentage value are highlighted. The highlighted wells are then assessed based on their potential for being categorised as "inefficient", their recorded use or other factors that may impact the outcome such as an unusually high value for SWL or very shallow top screen when compared with other similar depth wells.

The RRMP in Policy 77 provides guidance for assessing groundwater abstraction:

POL 77 ENVIRONMENTAL GUIDELINES - GROUNDWATER QUANTITY

(a) To manage takes of groundwater to ensure abstraction does not exceed the rate of recharge.

(b) To manage the available groundwater resource to ensure supplies of good quality groundwater.

(c) To manage the groundwater resource in such a manner that existing efficient groundwater takes[21] are not disadvantaged by new takes.

(d) To manage takes of groundwater to ensure abstraction does not have an adverse effect on rivers, lakes, springs, or wetlands.

Of particular interest to this assessment is POL77 (c) with regard to the management of groundwater such that existing efficient groundwater takes are not disadvantaged by new takes. There is a definition for "efficient taking" that is:

"[21]For the purposes of this Plan "efficient taking" of groundwater means abstraction by a bore which penetrates the aquifer from which water is being drawn at a depth sufficient to enable water to be drawn all year (i.e. the bore depth is below the range of seasonal fluctuations in groundwater level), with the bore being adequately maintained, of sufficient diameter and screened to minimise drawdown, with a pump capable of drawing water from the base of the bore to the land surface".

This definition allows the identification of wells through this process that could be considered as "inefficient" and that should therefore not prevent the abstraction proposed under this T2 take. A potentially inefficient well can be identified as one where the calculated value for remaining head on the well interference assessment spreadsheet returns a negative value. This negative value indicates that when the SWL and top screen (or total well depth in some cases) are considered along with the seasonal variation that the water column in the well may already be insufficient to provide for abstraction. This is before any other interference associated with additional drawdown predictions are considered. This tends to be most prevalent within shallow wells as they have minimal available head as a direct result of their depths. Copies of the spreadsheet assessments are provided in Appendix 3. It is also noted that the definition in POL77 refers to a pump capable of drawing water from the base of the bore to land surface. The 0m-9.99m group of wells is assessed based on the total well depth; the other well groups are more conservatively assessed based on top well screen values, or where this is absent the total well depth.

3.1 RESULTS - WELL GROUP 0 - 9.99M

There are 110 wells within the Ruataniwha Basin that are in the depth range 0m - 9.99m. The well interference assessment has initially flagged 28 wells for which the predicted drawdown as a percentage of remaining head is either a negative value or greater than 20%. Where the value is negative this represents a well that could be considered as "inefficient" and there are 14 negative values, 13 of which are wells that are 3.6m deep or less. The other negative value is from a well with a recorded SWL that is deeper than the recorded well depths, so could be an error in the database.

The other 14 wells identified have values greater than 20%. Of these 1 is less than 2m deep, 3 have recorded uses that are stated as unused or groundwater monitoring and 3 others are identified as groundwater sampling/monitoring. Wells that are used only for groundwater sampling/monitoring have a very low use requirement and will only have small amounts of water drawn at intermittent periods. It is unlikely that they will be adversely impacted, such that a sample cannot be obtained from them.

The result of this assessment is that a total of 7 wells remain flagged because they have a greater than 20% value and their use is not specified, or they are identified as providing domestic or stock water supplies. This means that from this assessment an adverse impact on them cannot be ruled out. Further consideration of these individual wells is therefore required, and this may take the form of an on-the-ground inspection to confirm if they are still operational and in use.

3.2 RESULTS – WELL GROUP 10 – 19.99M

There are 75 wells in this depth range and of these 17 were flagged initially as being less than 0% or greater than 20%.

Of these, 13 were negative values and therefore potentially "inefficient" wells. Closer inspection of the well details indicates that they are flagged because they have particularly shallow top screen heights or deep SWLs. Four of these wells are also identified as being groundwater sampling or monitoring wells.

The other four wells that are identified as being greater than 20% either do not have an identified use, or have exploratory, domestic and irrigation uses. Further consideration of these wells is recommended to confirm their uses and potential for impact.

3.3 RESULTS - WELL GROUP 20 - 29.99M

There are 75 wells in this depth range and of these 10 were flagged initially as being less than 0% or greater than 20%.

Of the 10 wells flagged 7 are negative values and therefore potentially inefficient, again these tend to be flagged because they have either deep SWLs or shallow top screens compared with other wells in this depth range.

There are 3 wells that have values of 20% or greater and these are retained as wells that need further consideration, their uses are identified as unknown, domestic supply and irrigation.

3.4 RESULTS - WELL GROUP 30 - 39.99M & 40 - 49.99M

The low numbers flagged by these groups means they are discussed together in this section. There is a total of 82 and 79 wells respectively in these depth groups. Both groups have 9 wells flagged initially. All but one of these was because of a negative percentage value suggesting potentially inefficient wells. It was noted that the flagged wells tended to have very shallow top screens or very deep SWLs compared to other wells in the depth groups. These could represent errors in the database or reflect SWL measurements that represent summer lows or are impacted by other nearby pumping wells. If the SWLs are already representing low stands then adding the seasonal variation to this makes for a very conservative assessment.

The one well in this group that was flagged as being greater than 20% was Well No. 2730 in the 40-49.99m depth range. This well records a SWL of 23.6m below ground level (bgl) which is considerably more than the average of the available SWL values of 9.01m bgl. With a total depth of 48.15m and a predicted interference value of 0.48m it is considered unlikely that this well will be adversely impacted.

3.5 RESULTS - WELL GROUP +50M

The greater than 50m deep wells comprises a large group of 236 wells. A different and deeper numerical model predicted drawdown layer, than for the shallower wells, was used to assess the potential impact at this level. Using the same methodology for assessment as for the shallow well interference of the 236 deep wells, a total of 21 were flagged initially. Of these 11 were removed as they have either very shallow top screen heights or very deep SWL recorded, this means that even without considering the impact of the proposed T2 abstraction these wells could be considered as "inefficient" in terms of the HBRC policy 77. The total number of wells that remain flagged at this depth range is 10.

3.6 SUMMARY - ALL WELLS GROUPS

The results of the previous well group discussions are summarised in Table 3. Of a total of 703 wells (including unknown depth wells) 94 were initially flagged in these well groups and 24 remain flagged following some further consideration.

There are 46 unknown depth wells. While it is not possible to specifically consider the impact on them, if it is assumed that they are still in use and that they, as noted in POL77, "penetrate the aquifer from which water is being drawn at a depth sufficient to enable water to be drawn all year (i.e. the bore depth is below the range of seasonal fluctuations in groundwater level)" and they are considered efficient wells, it is unlikely they will be adversely impacted. Of the 657 wells individually assessed only 24 are considered to require some further assessment.

TABLE 3: SUMMARY OF ALL FLAGGED WELLS

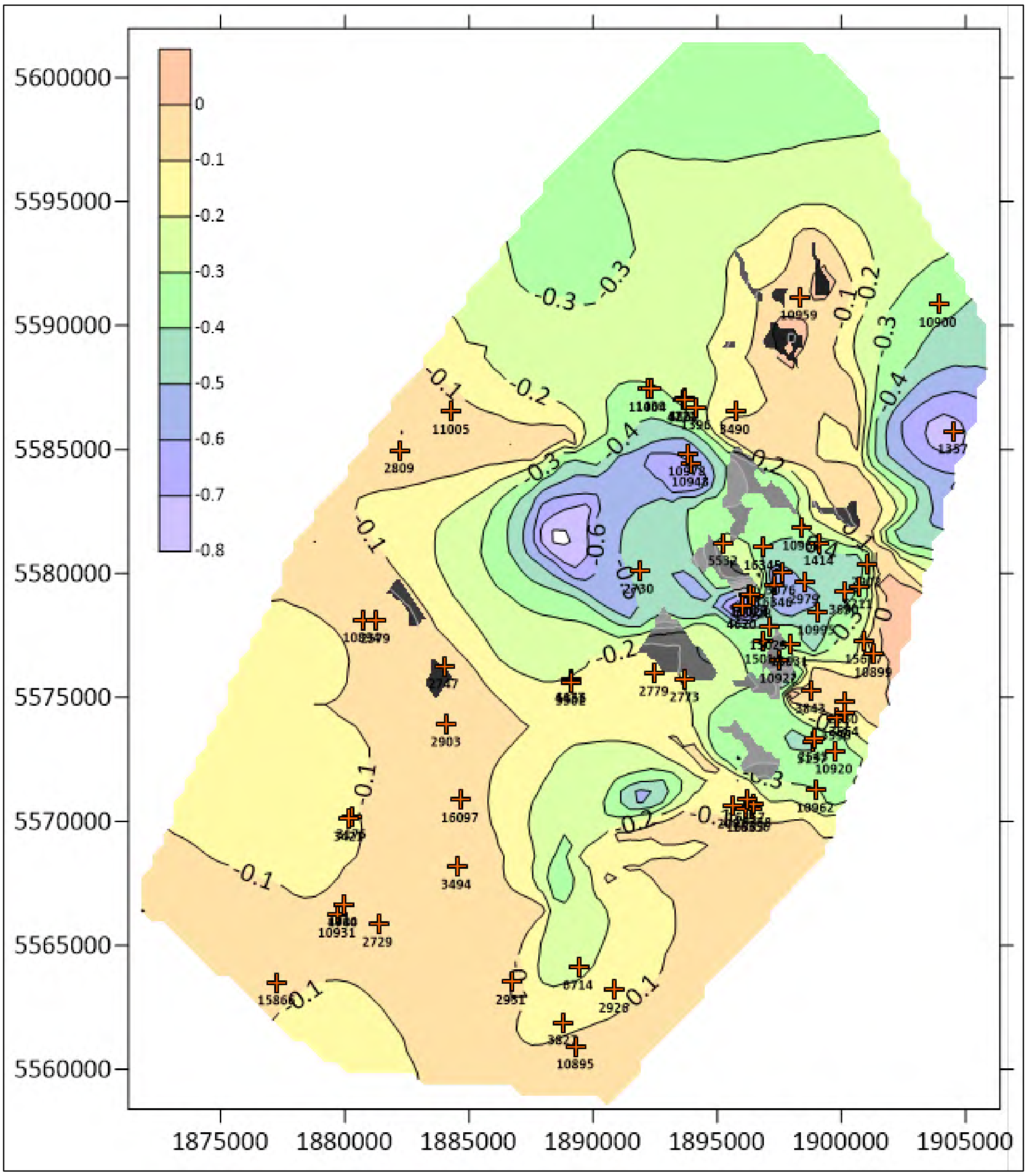
Well Group	Total No. Wells	Initially Flagged	Reduced	Comments
0-9.99m	110	28	7	"Inefficient" and monitor wells removed
10-19.99m	75	17	4	"Inefficient" and monitor wells removed
20-29.99m	75	10	3	"Inefficient" and monitor wells removed
30-39.99m	82	9	0	"inefficient" wells removed
40-49.99m	79	9	0	"inefficient" wells removed +1 deep SWL
+50m	236	21	10	"inefficient" wells removed, some with very deep SWL or shallow top screens
Unknown	46	--	--	--
Totals	703	94	24	

The locations of the shallow (<50m) initially flagged, and the reduced number of flagged wells are shown in Figures 14 and 15. The grey and black areas in these figures are the locations of the applicants' properties. In Figure 14 only a few of the flagged wells are on any of these properties. There is no specific pattern to the locations of these wells, they are distributed across the basin with some clustering towards the eastern margin. A summary of the well interference assessment for these wells is provided in Table 4.

TABLE 4: DETAILS OF REDUCED FLAGGED WELLS 0 - 50M DEPTH RANGE

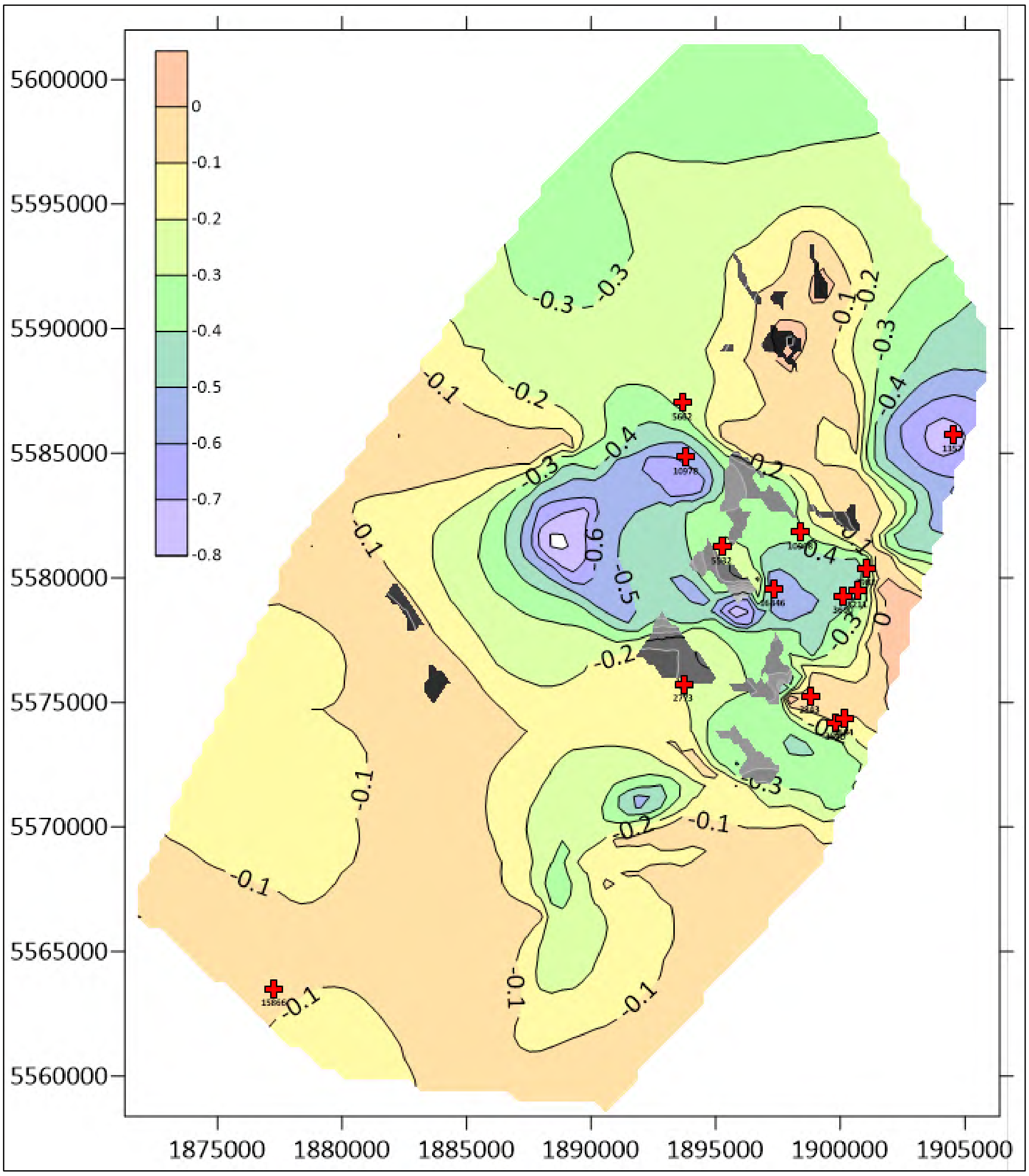
Well No.	Depth	H_SWL	Top Screen	Avail. head (m)	Seas. variation (m)	Pump length (m)	Remaining Head (m)	Predicted DD (m)	as % remaining head
15866	4	-1.92	4	2.08	1.95	0	0.13	0.08	66%
2902	4.11	-1.45	2.11	2.66	1.80	0	0.86	0.36	42%
5532	5	-1.92	5	3.08	1.96	0	1.12	0.28	25%
1357	5.18	-2.13	0.00	3.05	1.94	0	1.11	0.72	65%
16346	6	-1.92	6	4.08	1.83	0	2.25	0.51	23%
3590	7.3	-5.50	7.3	1.80	1.55	0	0.25	0.13	52%
3690	7.5	-4.30	7.5	3.20	1.75	0	1.45	0.47	32%
10968	13.1	-2.37	10.36	7.99	6.76	0	1.23	0.33	27%
5662	15.5	-3.9	11.5	7.60	7.30	0	0.30	0.28	91%
2773	18	-7.1	12	4.90	4.65	0	0.25	0.21	84%
5211	18.5	-3.9	9	5.10	3.63	0	1.47	0.39	27%
3664	25.6	-8.02	14.03	6.01	4.88	1	0.13	0.11	82%
3843	28	-4.17	10.50	6.33	5.09	1	0.24	0.08	35%
10978	28.35	-9.44	21.88	12.44	10.58	1	0.86	0.57	67%

FIGURE 14: LOCATIONS OF INITIALLY FLAGGED WELLS <50M DEPTH



The well locations identified in Figure 15 are predominantly within the central area of the basin, where the predicted impact of the T2 taking at this shallow level is expected to be greatest. The exception is Well No. 15866 located in the south western corner. It is the well locations identified in Figure 15 for which some further consideration is recommended.

FIGURE 15: LOCATIONS OF THE REDUCED NUMBER OF FLAGGED WELLS <50M DEPTH



A summary table of reduced flagged well interference assessment results for the deep wells (>50m) is provided as Table 5. Maps showing the locations of the identified flagged and reduced flagged wells at this deeper level are shown as Figures 16 and 17. The initially flagged wells at this deeper level are widespread across the basin area. However, it is notable that the reduced number of flagged wells shows a cluster at the northern end of the basin. This corresponds with the higher level of water level difference predicted in this northern area by the numerical model.

TABLE 5: DETAILS OF REDUCED FLAGGED WELLS >50M DEPTH RANGE

Well No.	Depth	H_SWL	Top Screen	Avail. head (m)	Seas. variation (m)	Pump length (m)	Remaining Head (m)	Predicted DD (m)	as % remaining head
3437	50	-10.5	46.0	35.5	6.23	1	28.27	6.45	22.81
10945	51.8	-17.86	24.6	6.7	2.30	1	3.41	0.99	29.09
3882	52.5	-8.3	44.5	36.2	4.97	1	30.23	8.04	26.59
5435	54	-12.17	23.6	11.5	9.37	1	1.08	0.27	25.00
16483	54.28	-12.17	52.3	40.2	4.97	1	34.19	7.99	23.36
16033	56.36	-12.17	53.5	41.3	5.53	1	34.76	7.56	21.75
10927	59.3	-12.17	59.3	47.1	5.40	1	40.73	8.20	20.14
16739	59.5	-12.17	57.6	45.4	5.04	1	39.39	8.01	20.33
1429	65.86	-3.65	42.0	38.4	34.50	1	2.89	0.74	25.60
5515	66	-12.17	54.0	41.8	5.56	1	35.27	8.97	25.42

FIGURE 16: LOCATIONS OF THE INITIALLY FLAGGED WELLS >50M DEPTH

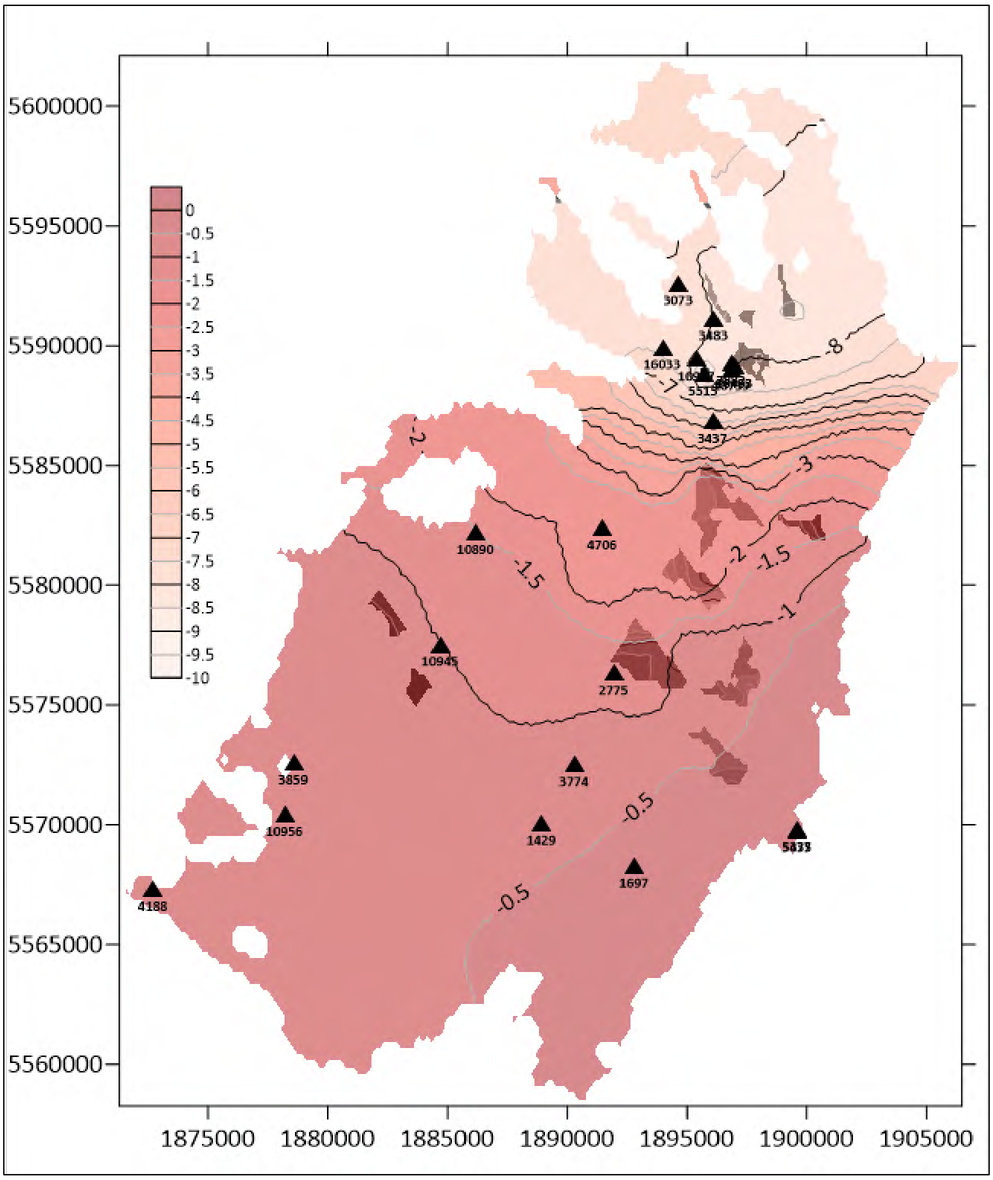
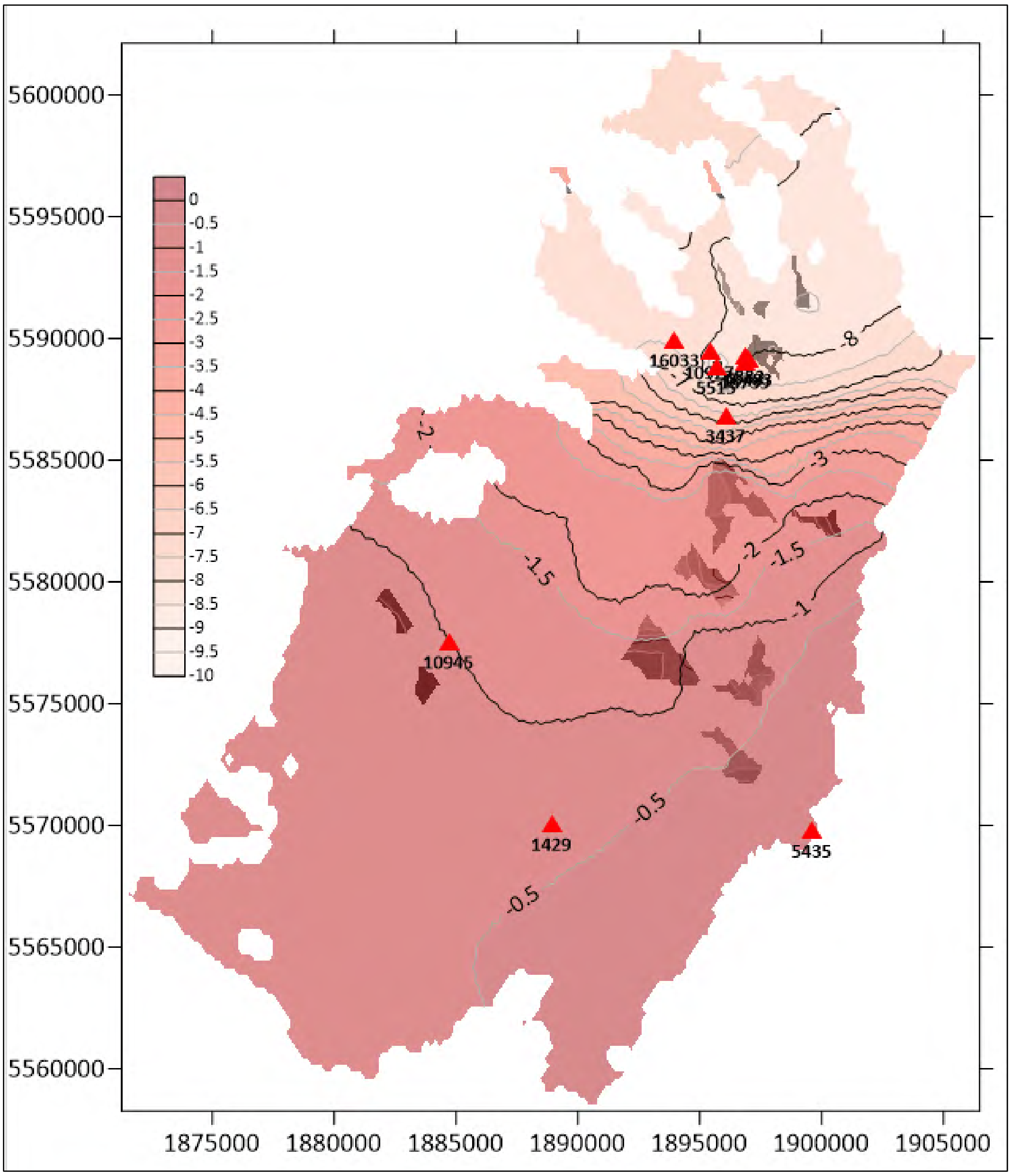


FIGURE 17: LOCATIONS OF THE REDUCED NUMBER OF FLAGGED WELLS >50M DEPTH



4.0 CONCLUSION

For this assessment all the wells recorded within the Ruataniwha Basin are considered. There are many wells, and these wells were divided into groups based on their recorded total well depths. The initial focus is on the wells within the 0m to 50m depth range and these are assessed against the numerical groundwater model shallow (layer 1) impact predictions. In order to assess the potential for impact on deeper wells, the modelled drawdown impact at a deeper level (layer 6) was reviewed separately against the deeper wells. It was not possible to fully consider wells of unknown depth but, if it is assumed that they are sufficiently deep to enable "efficient" taking of water then they are unlikely to be adversely impacted.

Consideration of aquifer parameters from existing well aquifer pump testing supports the outputs from the numerical model and increases confidence in the drawdown predictions made for the well locations assessed in this report.

A methodology for the assessment is presented. In some cases, gaps within the data provided by the Hawkes Bay Regional Council (HBRC) database are filled. Where this has occurred, the assumed value is identified with red text, for example Static Water Levels (SWL) and top screen heights. The assumed SWL are a numerical average of all the SWL available for each depth group and the top screen heights where absent are assigned a value equivalent to the total well depth.

The two contour maps provided from numerical modelling represent water level difference associated with the preferred scenario for the T2 water abstraction, for both shallow and deep layers within the aquifer. Values were interpolated from these contour maps and applied to specific basin well locations.

Seasonal variation was predicted based on analysis of the HBRC SOE monitoring wells network. A maximum value range was calculated based on the last 5 years of data. Where sufficient datapoints were available this data was contoured, and an interpolation of the seasonal variation value was applied to the individual well locations. Where the data was insufficient the available value or an average was applied.

Wells were initially flagged on the assessment spreadsheet for each depth group. They were then separated into those that were flagged because they are potentially of insufficient depth or otherwise classified as "inefficient" wells and those that might genuinely be adversely impacted by the proposed abstraction. Some could be further discounted from likely impact based on their recorded use or information from other recorded details.

Of a total of 657 wells (this value excludes the 46 unknown depth wells) that were individually assessed 94 were initially flagged in the well groups and 24 remain flagged following some further consideration. Of these flagged wells 14 are in the depth range <50m and 10 are >50m deep.

Further investigation is required to assess whether they will be adversely affected or not, and this may involve contacting the well owners or visiting the well locations. However, given that almost all of the wells assessed (i.e. 96%) are not considered as adversely affected, it is likely that this will also be the case for the remaining wells.

5.0 REFERENCES

Weir J. J. (2013): *Statement of Evidence of Julian James Weir for Ruataniwha Water Users Group (Groundwater Modelling)*. Expert evidence presented before a Board of Inquiry for the proposed Tukituki Catchment plan change 6. 7 October 2013.

Aqualinc Research Limited (2020) Ruataniwha Basin Tranche 2 Groundwater Modelling ref: WL18045 14/05/2020 Prepared by Julian Weir.

Board of Inquiry (2014) Final Report and Decisions Tukituki Catchment Proposal Volume 3 of 3 Plan Change and Conditions

APPENDIX 1

SEASONAL VARIATION VALUES

Easting	Northing	Well No.	Total depth	Actual Max WL (m)	Actual Min WL (m)	Variation (m)
1899373	5574074	10993	5	-0.6	-1.99	1.39
1879008	5562996	16504	5	-0.58	-1.93	1.35
1878608	5564741	16253	6	-0.67	-3.23	2.56
1897409	5587588	16484	7	-0.88	-3	2.12
1898231	5572395	16499	8	-1.58	-3.4	1.82
1899808	5574191	16250	9	-2.82	-4.41	1.59
1887629	5586252	16502	11	-1.94	-4.99	3.05
1900352	5579269	16487	11	-2.54	-6.05	3.51
1897758	5570302	16500	11	-0.77	-1.99	1.22
1883705	5566043	16479	11	-2.89	-4.99	2.1
1890974	5563088	16503	11	-0.85	-2.5	1.65
1892688	5578991	16249	14	-2.6	-9.41	6.81
1892460	5572835	16501	16	-2.25	-5.56	3.31
1895306	5583180	16248	19	-8.28	-18.3	10.02
1879938	5566652	1944	20	-2.65	-14.23	11.58
1888442	5576277	16251	21	-7.7	-11.45	3.75
1884059	5569027	16252	23	-10.04	-11.02	0.98
1896318	5568312	1376	24	-0.12	-1.76	1.64
1898169	5569335	4696	25	1.47	-1.79	3.26
1890368	5583649	16488	26	-12.37	-24.06	11.69
1891886	5576425	16880	26	-2.46	-7.4	4.94
1886853	5569343	16095	26	-2.06	-7.68	5.62
1892933	5563971	16507	28	-8.51	-12.6	4.09
1892218	5576195	15048	33	-1.86	-9.28	7.42
1897746	5587727	1485	45	-8.68	-13.92	5.24
1888469	5574925	1430	46	-6.03	-34.11	28.08
1893206	5579093	1475	52	-12.76	-34.25	21.49
1895573	5577578	1452	55	-19.84	-27.59	7.75
1886887	5566285	16478	58	-5.36	-8.33	2.97
1894468	5567403	16492	73	-1.41	-15.34	13.93
1889640	5576143	1426	75	-8.19	-15.93	7.74
1889691	5575889	4685	77	-12.04	-20.07	8.03
1900477	5577147	16486	79	0.36	-1.02	1.38
1895377	5583147	16477	82	-2.87	-11.74	8.87
1889909	5565432	6719	88	-5.98	-14.64	8.66
1893783	5579993	2220	110	-10.14	-22.73	12.59
1897911	5576587	4701	111	-1.28	-7.89	6.61
1887644	5573215	3702	123	-30.53	-38.46	7.93
1890301	5571106	5445	130	-6.01	-61.49	55.48
1894517	5581470	15021	148	0.65	-15.35	16

APPENDIX 2

REVIEW OF TRANSMISSIVITY VALUES

Bay Geological Services Ltd

Bay Geological Services Ltd
RD6
Napier 4186

mobile: +64 275 014 984
email: baygeological@xtra.co.nz

3 December, 2020

ref: BGS201_05

Consents Planner
Hawkes Bay Regional Council
Private Bag 6006
Napier 4110

Dear Sir/Madam,

DISCUSSION ON AQUIFER PARAMETERS ACROSS THE RUATANIWHA BASIN
TRANCHE 2 RESOURCE CONSENT APPLICATION

1. BACKGROUND

The collective Application for Tranche 2 groundwater allocation provides detailed investigations into groundwater resources across the Ruataniwha Basin, including comprehensive numerical modelling of existing parameters to ascertain augmentation volumes along with calculations to determine potential adverse effects as a result of the proposed activity (Weir, 2020).

A long-term well interference assessment has been completed on the shallow (<50 m depth) aquifer wells, along with an assessment on potential effects on deep (>50 m depth) wells as part of the Tranche 2 Application.

This letter report was prepared to better understand aquifer parameters across the basin, particularly within the vicinity of the proposed Tranche 2 water takes which lie predominantly in the west of the Ruataniwha Plains.

2. SITE INFORMATION

The majority of the proposed Tranche 2 water takes are generally concentrated centrally and across the west of the gently sloping Ruataniwha Plains, immediately east of State Highway 50. Two Applicants are located on the western periphery, bound by rolling hills, and a third Applicant is located near the eastern edge of the basin. The extent of the study area across the Ruataniwha Basin is illustrated in Figure 1.

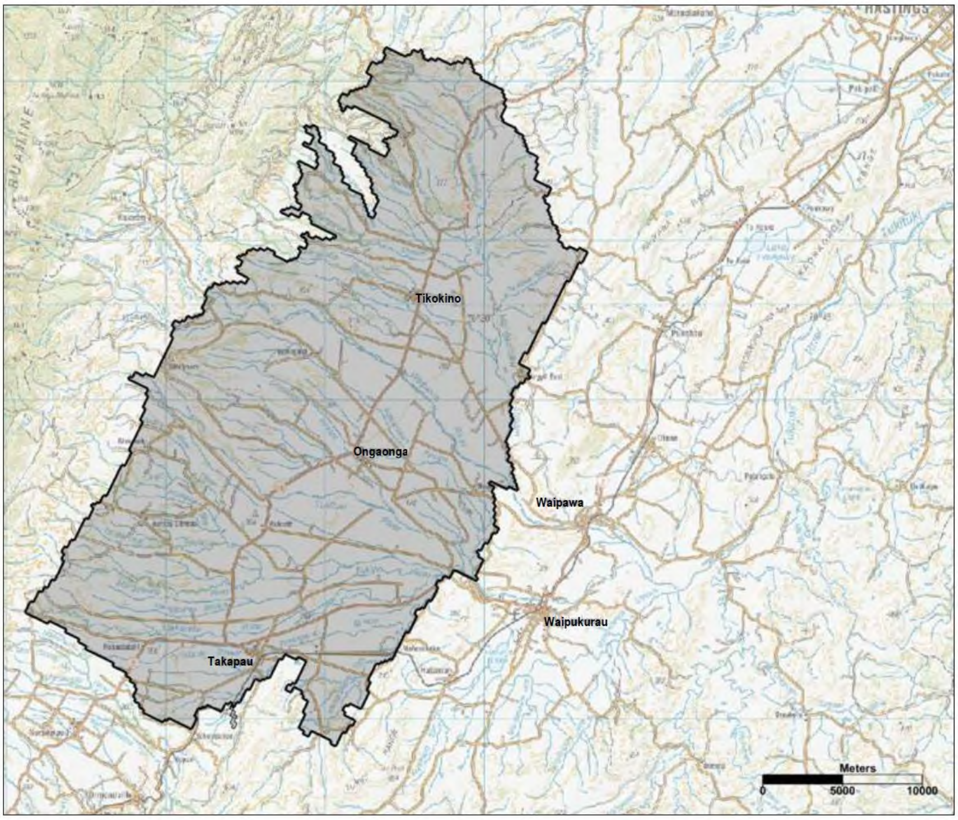


Figure 1. Topographic map showing extent of Ruataniwha Basin study area (Aqualinc, 2020)

3. HYDROGEOLOGY

The Ruataniwha Plains alluvial basin has been comprehensively studied in the past, resulting in interpretations of the geology and hydrology by PDP (1999, 2018), Francis (2001), and Morgenstern et al (2012). These reports describe the NNE-SSW-oriented sedimentary basin as being fault-bound at the western Ranges, and the eastern edge defined by westward-dipping strata which forms the Raukawa Range. The development of the basin commenced approximately 2 Ma years ago, with gradual evacuation of the former inland sea as a result of continual tectonic uplift, followed by infilling with alluvial sediments. This resulted in accumulations of material ranging from gravels, sandstone, silts and clays along with pumice and peat forming multi-layered aquifer systems with highly variable parameters (PDP 1999, Francis 2001). The alluvial sediments associated with the basin and relevant to hydrology are divided into two main units, oldest to youngest as follows (Francis, 2001):

- Salisbury Gravel (Upukororo) Formation: A unit comprising lower Quaternary, slightly to unconsolidated, typically blue-grey gravels, ignimbrite, clays and minor peat. The formation is observed in outcrop along hills to the north and northeast/west of the Plains, particularly east of the Mangaonuku Stream. Overlies marine sandstone and pumiceous siltstone; and,
- "Young Gravels" unit (including the Recent Terrace Aquifer Group and Old Terrace Aquifer Group). An upper Quaternary unit, observed as typically red, free and clay-bound gravels, silts and clays generally deposited basin-wide in a dominantly alluvial environment with minor lacustrine and swamp deposits.

The majority of the wells drilled across the Ruataniwha Plains intercept red-brown, poorly sorted Young Gravels that extend to approximately 40 m depth. The Young Gravels typically overlie significant thicknesses (250 m observed in outcrop) of blue grey, well sorted gravels and associated sediments attributed to the Salisbury Gravel Formation (Francis, 2001). The gravels overlie bedrock that forms the base of the alluvial basin including top Pliocene-aged siltstone, sandstone and mudstone.

4. AQUIFER PARAMETERS ACROSS THE RUATANIWHA BASIN

Information provided by HBRC staff and via the HBRC website associated with bore logs and aquifer test reports were reviewed in order to analyse aquifer parameters across the Ruataniwha Basin. Furthermore, a report was completed for HBRC by PDP (2018) which investigated basin aquifer properties. The Tranche 2 Well Interference report discussed the potential for long-term well interference across the shallow (<50m depth) wells as a result of the proposed activity. However, in line with the HBRC Plan Change 6 (PC6), the Applicants' wells will be drilled and screened to depths greater than 50m below ground level (bgl) in order to avoid stream depletion effects. Therefore, the aquifer parameters discussed in this report are from pump tested wells screened > 50 m depth.

4.1 Transmissivity values

The transmissivity (T) values determined from wells as included in the PDP (2018) study are included in Appendix A. The report findings indicate that high transmissivity values greater than T = 1500 m^2/day are noted at well screen depths between about 40 and 60 m bgl (PDP, 2018); however, there are exceptions to this observation. Zones of transmissivity values from all wells were plotted by PDP (2018) as presented in Figure 2, recognising that the wide distribution of T values make a detailed analysis impractical. It is also noted that there are no discrete gravel aquifers within the basin, rather a series of discontinuous alluvial deposits with varying properties dependent upon depth and location (PDP 1999, PDP 2018). This results in a wide range of T values distributed spatially across the basin at varying depths.

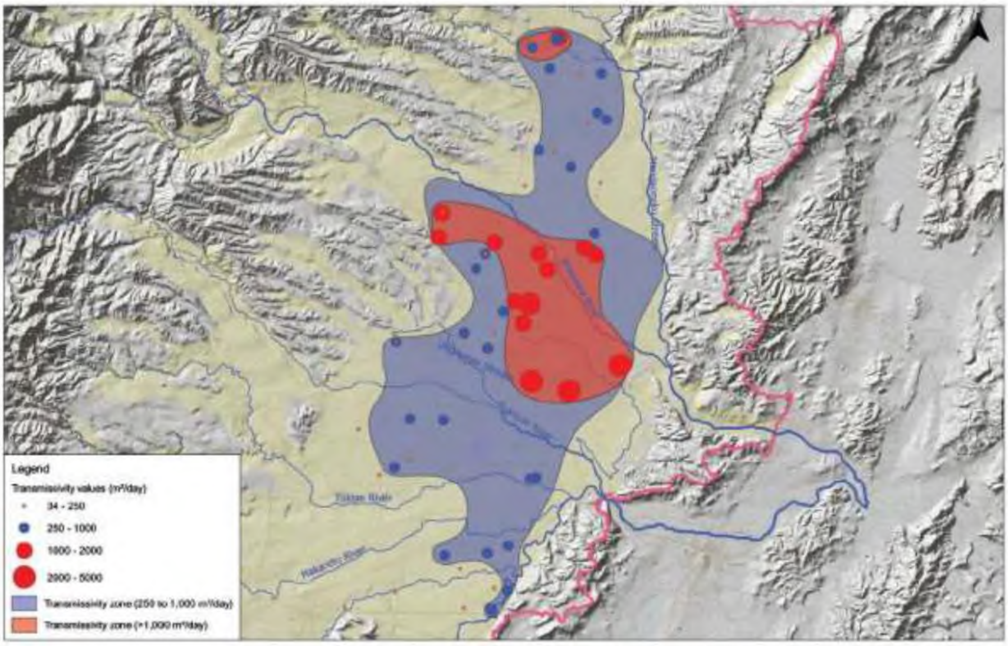


Figure 2. Map illustrating range of transmissivity values across the Ruataniwha Basin from all bores analysed (PDP, 2018).

The locations of the eight Applicants' properties are displayed on the Aqualinc map (Weir, 2020) as presented in Figure 3, along with annotations of aquifer transmissivities. The T values are denoted as being from Intermediate (I) depth wells (50 to 75 m bgl screen) or Deep (D) wells (screen > 75 m bgl).

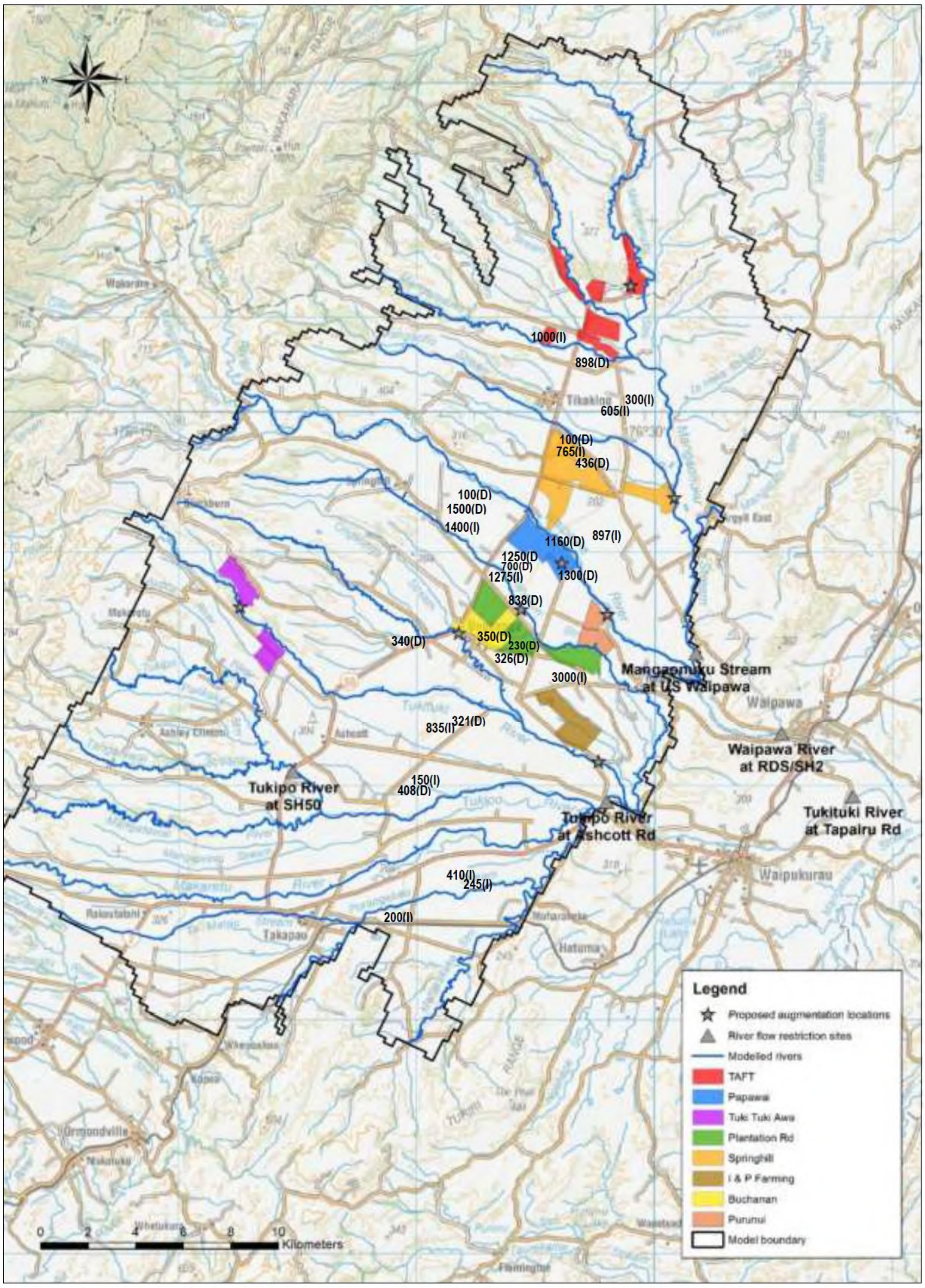


Figure 3. Aqualinc (Weir, 2020) map illustrating Applicant farm locations, with transmissivity values annotated defining the Intermediate (I) gravel (50 to 75 m bgl) and Deep (D) gravel (>75 m bgl) aquifers.

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Figure 4 shows that the highest T values (>1000 m^2/day) for the deep wells (>75 m bgl) are clustered north of the Kahahakuri Stream and generally south of the Waipawa River, likely inferring development of a wide, gravel-rich paleo-channel subparallel to the existing waterways. One intermediate depth well within the same area also displays a high T value of 1275 m^2/day.

To the south of the Kahahakuri Stream, T values determined from deep wells reduce significantly to around 200 to 400 m^2/day as far south as the Tukipo River, although it is noted that the number of pump-tested wells also decreases. Intermediate depth wells across this area provide a wide range of transmissivities from 150 to 850 m^2/day, with test data available as far south as the Porangahau Stream.

To the north of the Waipawa River, limited aquifer parameter data is available for deep wells, with recorded transmissivities also lower, ranging from about 100 to 900 m^2/day. Intermediate depth wells report T values from 300 to almost 900 m^2/day, with a value of 1000 m^2/day from a well immediately adjacent to the Mangamauku Stream near the northern bounds of the basin.

The details of T values within wells screened from 40 to 75 m bgl are shown in Figure 4, and clearly display the clustering of aquifer pump tested wells with significant gaps in the record. It is noted that zones of higher transmissivities (1000 to 2000 m^2/day) are concentrated across the central part of the basin, with an outlier value (1400 m^2/day) further to the west.

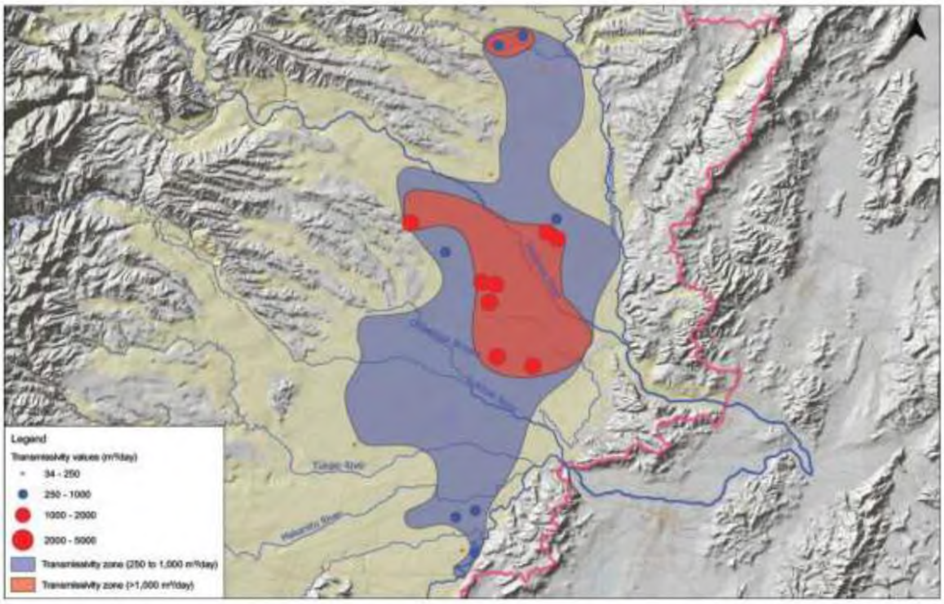

Figure 4. Plotted transmissivity values for screen depths from 40 to 75 m bgl (PDP, 2018).

The transmissivity values for wells screened >75 m depth were also plotted (PDP, 2018) and are displayed in Figure 5 which indicate that four wells recorded high T values (1000 to 2000 m^2/day) in the central-western part of the basin, clustered between the Kahahakuri Stream to the south and the Waipawa River to the north. Lower transmissivities (250 to 1000 m^2/day) are mapped to the north and south of this zone.

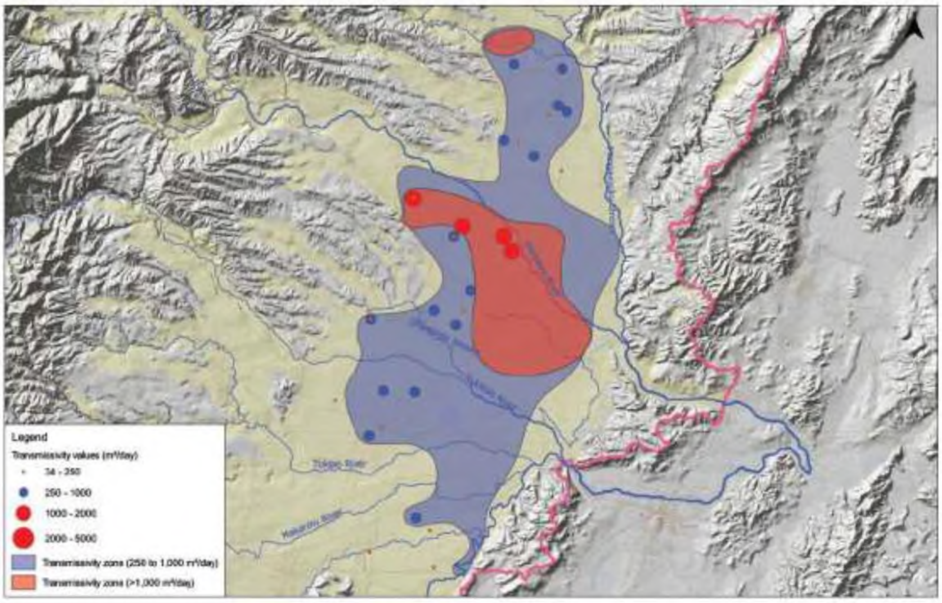

Figure 5. Plotted transmissivity values for screen depths >75 m bgl (PDP, 2018).

The available aquifer pump test data indicate that transmissivity values are generally highest north of the Kahahakuri Stream and south of the Waipawa River, although there are exceptions to this. The higher values lie adjacent to the meandering Waipawa River, which suggest that the river hydraulics provided consistent supply of clean, coarse material. The river is more linear than the Tukituki River, as illustrated on the GNS 1:250,000 geological map (Lee et al) presented as Figure 6.

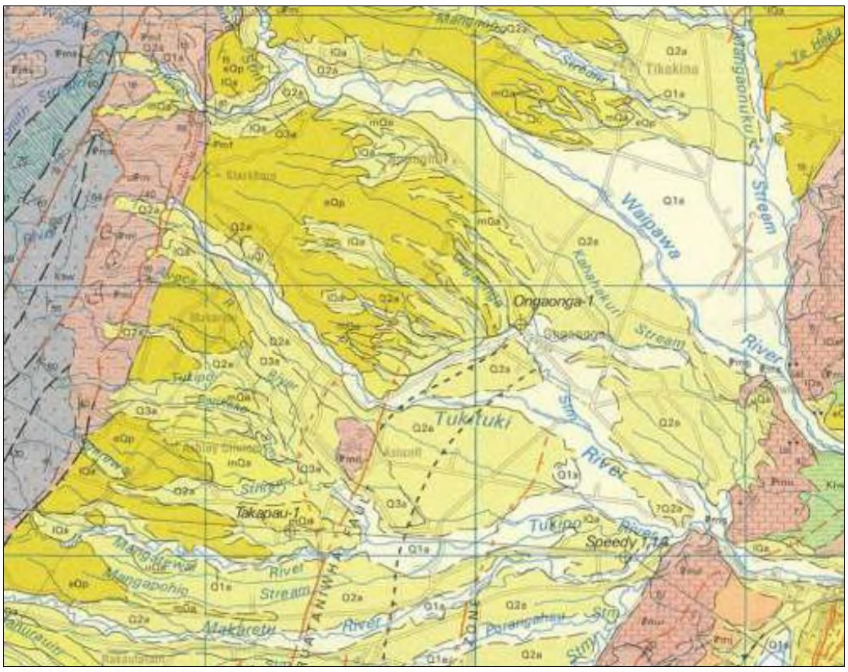

Figure 6. GNS 1:250,000 geological map across the Ruataniwha Plains (Lee et al, 2011).

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The recorded transmissivities across the vicinity of the Tukituki River are variable and significantly lower than those further north. This reflects an increase in fine grained material within the gravel aquifer with possibly less well-developed paleo-channels. It is considered that velocities within the Tukituki River were lower compared to that in the Waipawa River.

In addition, tectonic activity along the active Ruataniwha Fault offset the main stem of the Tukituki River at the point where it crosses the river, likely affecting flow direction and velocity. This may have resulted in a lower velocity system meandering across the near level topography, re-working over-bank deposits with gravel deposits. The Waipawa River does not appear to be significantly offset by tectonic activity due to the fault pinching out north of the Tukituki River (Lee et al, 2011).

4.2 Storativity values

A review of pump test data and bore logs revealed a reduction in availability of storativity values in comparison to transmissivity, particularly across the older wells, which is likely due to more comprehensive pump testing being required. The storativity values determined from wells as included in the PDP (2018) study are included in Appendix A. Generally, storativity values decrease with greater depth, as a higher level of confinement is typically provided by layers of low permeability strata. The storativity data collected from wells screened from 40 to 75 m bgl (PDP, 2018) are presented in Figure 7.

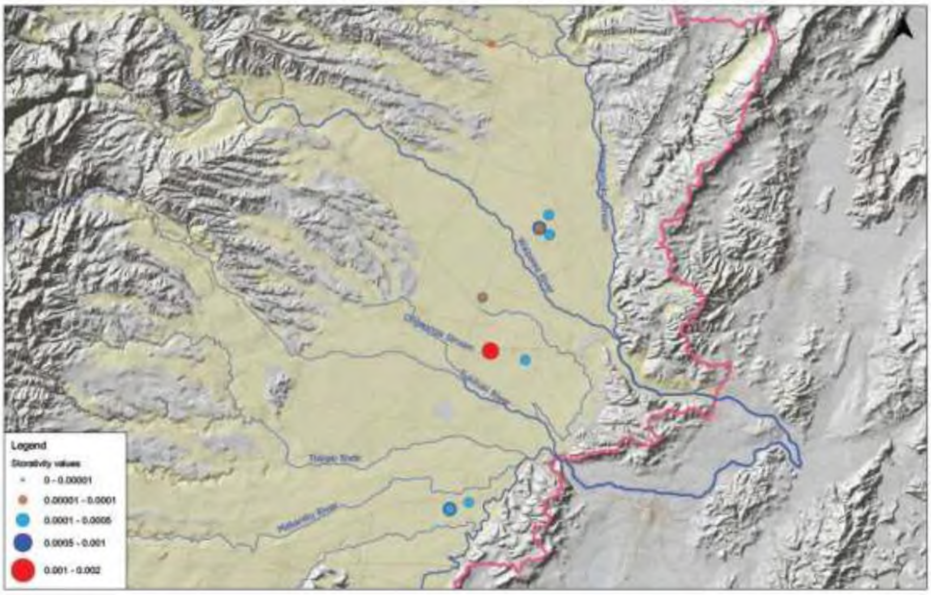

Figure 7 Storativity values for well screen depths 40 to 75 m bgl (PDP, 2018).

The available data is relatively variable, with storativity values of 0.001 to 0.002 mapped across the central part of the basin, and a greater level of confinement (storativity of 0.00001 to 0.0001) recorded in wells to the north and to the west of the basin.

The image presented as Figure 8 maps storativity values gathered from wells screened greater than 75 m depth (PDP, 2018). As expected for deeper wells, the values determined range below 0.001, where a higher level of confinement is afforded by the greater depth and likely inclusion of additional low permeability layers.

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Although there are more points in the dataset, the storativity values for wells screened > 75 m bgl are lower, with the majority ranging from 0.0005 to 0.00001.

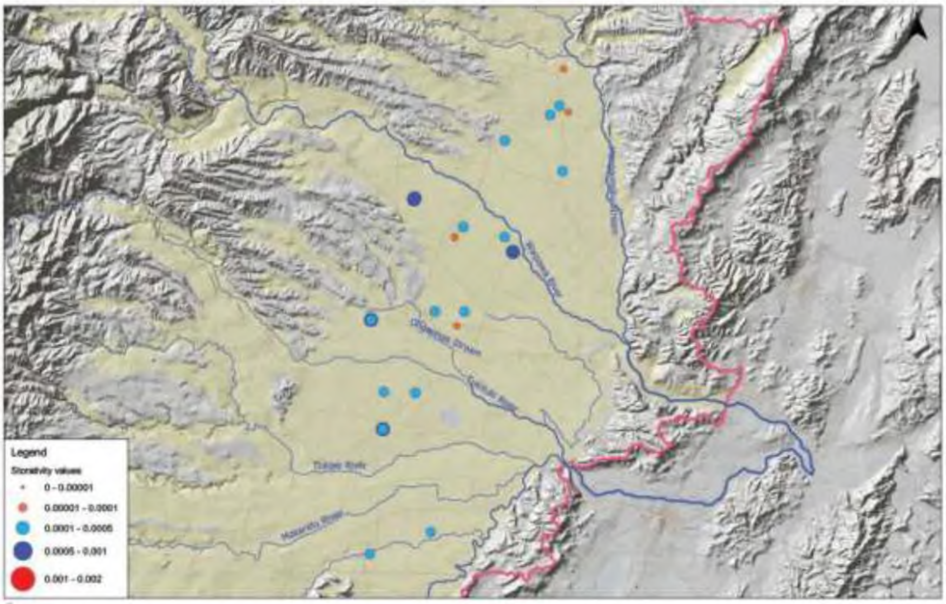

Figure 8 Storativity values for well screen depths >75 m bgl (PDP, 2018).

5 SUMMARY

The following points are made following a review of the available aquifer parameters in Intermediate depth (screened 50 to 75 m bgl) and Deep (screened >75 m bgl) wells across the Ruataniwha Basin:

- The aquifer pump test data indicate that no discrete gravel aquifers are present within the basin, rather a series of discontinuous alluvial deposits with varying properties dependent upon depth and location, which results in a wide range of T values distributed spatially across the basin at varying depths;
- High transmissivity values greater than T = 1500 m^2/day are generally noted at well screen depths between about 40 and 60 m bgl;
- The transmissivity values for wells screened >75 m depth indicate that four wells recorded high T values (1000 to 2000 m^2/day) in the central-western part of the basin, clustered between the Kahahakuri Stream to the south and the Waipawa River to the north likely where well-developed, clean gravel paleo-channels lie adjacent to the river;
- Lower transmissivities (250 to 1000 m^2/day) are mapped south of the Tukituki River;
- The ancient Tukituki River likely meandered across the plains moreso than the Waipawa River, partially as a result of tectonic activity offsetting river channels, resulting in less well-developed gravel paleo-channels, infilled with re-worked fine grained material from over-bank deposits;
- Storativity values across the basin are lower with increasing depth likely due to the presence of additional layers of low permeability clays and silts.
- In the majority of wells screened from 40 to 75 m bgl, storativity values of 0.001 to 0.002 are mapped across the central part of the basin, with a greater level of confinement (storativity of 0.00001 to 0.0001) recorded in wells to the north and to the west of the basin;
- The storativity for wells screened > 75 m bgl generally ranges from 0.0005 to 0.00001 for the majority of the bores.

6 REFERENCES

Francis, D., 2001: Subsurface geology of the Ruataniwha Plains and relation to hydrology. Technical report. Geological Research Ltd., Lower Hutt, New Zealand.

Hawkes Bay Regional Council website (www.hbrc.govt.nz).

Lee, J.M., Bland, K.J., Townsend, D.B., Kamp, P.J.J. (compilers), 2011: Geology of the Hawkes Bay area. Institute of Geological & Nuclear Sciences 1:250,000 Geological Map 8. GNS Science, Lower Hutt, New Zealand.

Morgenstern, U., van der Raaij, R., Baalousha, H., 2010: Groundwater flow pattern in the Ruataniwha Plains as derived from the isotope and chemistry signature on the water. GNS Science Report 2012/23. Wellington, New Zealand.

Pattle Delamore Partners Ltd., 1999: Ruataniwha Plains conceptual hydrogeological model. HBRC Plan Number 2808, EMT 99/3. Environmental Technical Report ISSN 1174-3077, PDP, Wellington, New Zealand

Pattle Delamore Partners Ltd, 2018: Ruataniwha Aquifer Properties Analysis and Mapping. Client Report No. C02591543 for Hawkes Bay Regional Council, prepared by Cameron Jasper, Pattle Delamore Partners Ltd., Christchurch, New Zealand.

Weir, J., 2020: Ruataniwha Basin: Tranche 2 Groundwater Modelling. Client Report Project No. WL18045. Aqualinc Research Limited, Christchurch, New Zealand.

Report Limitations

This letter report is written based on conditions as they existed at the time of the study, and there is no interpretation made on potential changes that may occur across the site. Subsurface conditions may exist across the site that are not able to be detected or revealed by the investigation within the scope of the desktop project, and are therefore not taken into account.

APPENDICES

10

APPENDIX A

AQUIFER PROPERTY DATA FOR

RUATANIWHA BASIN BORES

PDP (2018)

Bore number	Easting	Northing	Final T (m^2/day)	Final S	Final K'/B' (Max) (day^{-1})	Final K'/B' (Matched) (day^{-1})	Top Screen (m bgl)	Bottom Screen (m bgl)	Total Depth (m)	Final B' conf (m)	Final K_v (Max) (m/d)	Final K_v (Matched) (m/d)	Screen length (m)	Final K_h (m/d)
16508	1895969	5579781	1160	1.50E-04	2.00E-05		85.62	119.6	119.6	81	1.62E-03		33.9	29
16408	1892693	5576292	350	1.20E-04	1.00E-05		114.53	119.8	119.8	109	1.09E-03		5.3	31
15755	1897306	5573747	2500	1.80E-04		7.00E-05	40	60.0	60.0	23		1.61E-03	20.0	96
15431	1896453	5587889	898				134	150.0	150.0	116			16.0	41
6721	1889635	5564890	200	2.80E-04	1.00E-05		61.56	67.7	77.1	26	2.60E-04		6.1	16
5723	1898543	5585936	605	1.55E-04			61.45	81.0	81.0	61.45			19.6	24
5707	1898101	5585510	210	1.40E-04	1.00E-06		111	117.0	117.0	107	1.07E-04		6.0	18
5591	1891706	5581548	1500	5.00E-04			133	135.0	162.5	118			2.0	188
5515	1895692	5588811	1000	5.90E-05		3.00E-05	54	66.0	66.0	39		1.17E-03	12.0	56
5498	1893721	5575604	326				132.7	139.7	139.7	85.5			7.0	25
5498	1893721	5575604	300	4.00E-05			132.7	139.7	139.7	85.5			7.0	23
5497	1897384	5583557	436				151	157.1	157.1	142.5			6.1	36
5419	1895646	5574173	3000	2.00E-03	1.00E-04		52	60.0	60.0	46	4.60E-03		8.0	214
5392	1891736	5581595	250	5.00E-04										
5344	1892498	5565918	245	1.05E-04	3.00E-05		69	74.0	77.0	68	2.04E-03		5.0	22
4882	1891769	5572459	300	1.15E-04	3.00E-06		109.5	123.8	123.8	74	2.22E-04		14.3	15
4882	1891769	5572459	480	2.70E-04	3.00E-05		109.5	123.8	123.8	74	2.22E-03		14.3	24
4830	1894084	5576273	230	3.14E-04		7.00E-06	125	135.0	137.0	94		6.58E-04	10.0	14
4764	1896353	5579075	1300	5.00E-04		7.00E-04	96	120.0	123.0	98		6.86E-02	24.0	43
4685	1889691	5575889	340	6.50E-04	1.00E-04		76	77.0	77.0				1.0	49
4685	1889691	5575889	240	1.70E-04	5.00E-05		76	77.0	77.0				1.0	34
4672	1898948	5585643	300	8.00E-05	3.00E-06		68.7	88.8	90.9	63	1.89E-04		20.1	11
4656	1893704	5566631	270	5.00E-04	1.00E-04		49.8	74.8	74.8	37	3.70E-03		25.0	9
4656	1893704	5566631	260	1.70E-04	5.00E-05		49.8	74.8	74.8	37	1.85E-03		25.0	8
4654	1894618	5566947	320	3.40E-04	1.00E-05		49	58.0	58.0	36	3.60E-04		9.0	21
4593	1896642	5584217	100				111.6	129.0	134.0	92.5			17.4	4
4566	1898683	5582866	52	1.27E-04	7.00E-05		48	77.0	111.0	30	2.10E-03		29.0	1
4489	1888029	5572055	50				48.4	72.0	342.0	33			23.6	2
4295	1898731	5587673	607	9.60E-05									0.0	
4271	1896856	5589256	1109	1.02E-04			22.4	39.4	39.4				17.0	48
4110	1890247	5570750	150	6.20E-04	2.00E-04		70.67	80.4	81.2	69	1.38E-02		9.7	10
4110	1890247	5570750	123	4.00E-04	5.50E-04		70.67	80.4	81.2	69	3.80E-02		9.7	8
4049	1899529	5574873	3500	4.40E-04		2.00E-03	30	36.0	36.0	10		2.00E-02	6.0	292
3882	1896858	5589264	576				44.5	51.5	52.5	44.2			7.0	44
3870	1895977	5584310	765	2.00E-04		7.00E-05	57.39	77.4	77.4	53.8		1.40E-06	20.0	29
3854	1891828	5566526	410				60.5	100.0	121.0	58.4			39.5	9
3852	1889611	5570382	408				115	121.0	123.0	112.51			6.0	34
3774	1890300	5572513	835	3.00E-04			68.4	75.5	97.5	28.8			7.1	64
2933	1894023	5580255	860	3.60E-04		9.00E-04	75.3	89.3	90.0	74		6.66E-02	14.0	43
2933	1894023	5580255	1250	1.70E-04		2.00E-04	75.3	89.3	90.0	74		1.48E-02	14.0	62
2911	1892678	5564205	207				28.8	31.7	31.7	0			2.9	23
2278	1898466	5579717	365	1.60E-04	8.00E-04		49.6	52.6	69.5	35	2.80E-02		3.0	41
2278	1898466	5579717	1595	1.82E-04	1.00E-03		49.6	52.6	69.5	35	3.50E-02		3.0	177
2277	1897978	5580036	812	4.06E-05		1.00E-04	57	66.0	66.0	53		5.30E-03	9.0	54
2277	1897978	5580036	533	7.20E-04		2.00E-03	57	66.0	66.0	53		1.06E-01	9.0	36
2277	1897978	5580036	897	2.23E-04		5.00E-04	57	66.0	66.0	53		2.65E-02	9.0	60
2277	1897978	5580036	1412	8.28E-05		2.00E-04	57	66.0	66.0	53		1.06E-02	9.0	94
2246	1898424	5580655	520	4.00E-04	1.00E-03		50	60.0	61.7	50	5.00E-02		10.0	33
2246	1898424	5580655	900	1.40E-04	8.00E-04		50	60.0	61.7	50	4.00E-02		10.0	56
2219	1893617	5579768	700	3.50E-05		9.00E-05	88.5	94.5	98.0	89		8.01E-03	6.0	58
2219	1893617	5579768	170	6.70E-05		4.10E-04	88.5	94.5	98.0	89		3.65E-02	6.0	14

Bore number	Easting	Northing	Final T (m^2/day)	Final S	Final K'/B' (Max) (day^{-1})	Final K'/B' (Matched) (day^{-1})	Top Screen (m bgl)	Bottom Screen (m bgl)	Total Depth (m)	Final B' conf (m)	Final K_v (Max) (m/d)	Final K_v (Matched) (m/d)	Screen length (m)	Final K_h (m/d)
2077	1896736	5589134	458				24.1	35.7	38.4				11.6	26
2044	1895868	5569942	495				13.7	15.5	29.9				1.8	63
2043	1894411	5577232	527				76.6	82.6	83.5	71.3			6.0	44
1914	1895358	5582744	34				58.6	68.6	68.6	17.4			10.0	2
1881	1895271	5576725	1600	1.10E-04		1.00E-05	44	50.0	51.0	45		4.50E-04	6.0	133
1881	1895271	5576725	1456	4.66E-05		1.00E-05	44	50.0	51.0	45		4.50E-04	6.0	121
1880	1894914	5577675	1306				49.5	55.5	55.5	17.3			6.0	109
1838	1893885	5564137	357				2.74	8.8	11.9				6.1	30
1837	1894591	5564971	806				43	45.0	45.0	8.54			2.0	101
1836	1893998	5565080	67				33.86	61.6	73.2	33.86			27.8	2
1826	1891572	5580465	1400				56.69	68.7	75.0	40.23			12.0	78
1656	1895591	5569884	418				14	18.0	19.8	0			4.0	42
1518	1896641	5584220	147				51.16	55.2	65.8	33.23			4.0	15
1485	1897746	5587727	70				39.31	43.6	45.7	38.7			4.3	7
1475	1893206	5579093	275				46.33	52.4	52.4	45.105			6.1	23
1452	1895573	5577578	3129				47.85	55.2	55.2				7.3	235
1429	1888935	5570055	219				42.04	44.1	65.9	33.24			2.0	27
1426	1889640	5576143	177				38.1	44.2	75.3	25.91			6.1	15
1381	1887435	5564251	92				39.36	43.0	58.4	33.98			3.6	10
16765	1893210	5579094	1275	4.66E-05		1.00E-05	65	76	76	53		1.35E-04	11	122

Note: Bores with multiple values have values from multiple observation bores. Data for bore 16765 was provided via data from a consent application after the main dataset from HBRC was received. This bore is not shown on the maps in the report. However, it is located within the zone of higher transmissivity (>1,000 m^2/day).

APPENDIX 3

WELL INTERFERENCE ASSESSMENT

Well Group 0 – 9.99m

ObjectID	Point Sample - Grid value	NZTM_ Easting	NZTM_ Northing	Use1	Use2	Depth	Diameter	h_SWL	TopScreen1	BtmScreen1	Available head (m)	Seasonal variation (m)	Pump length (m)	Remaining Head (m)	Predicted DD (m)	as % remaining head	Comments
3827	-0.130088794	1888814	5561887	Domestic Water Supply	Stock Watering	0	200	0.00			0.00	1.62	0	-1.62	0.13	-8%	Spring
10920	-0.345826653	1899720	5572827	Irrigation		0		0.00			0.00	1.62	0	-1.62	0.35	-21%	Spring
10922	-0.324039179	1897499	5576482	Irrigation		0		0.00			0.00	1.69	0	-1.69	0.32	-19%	Spring
16356	-0.14228208	1896406	5570496			0.6	68	0.00	0.60	4.60	0.60	1.82	0	-1.22	0.14	-12%	<2m deep
16365	-0.132532123	1896166	5570478			1	68	0.00	1.00	5.00	1.00	1.82	0	-0.82	0.13	-16%	<2m deep
15031	-0.310688192	1897932	5577165	Unknown		1.4	100	0.00			1.40	1.70	0	-0.30	0.31	-102%	<2m deep
16358	-0.160244949	1896464	5570674			1.5	68	0.00	1.50	6.00	1.50	1.82	0	-0.32	0.16	-50%	<2m deep
16357	-0.155306544	1896197	5570879			1.55	68	0.00	1.55	6.05	1.55	1.83	0	-0.28	0.16	-56%	<2m deep
15667	-0.13264847	1900930	5577261			2		0.00			2.00	1.67	0	0.33	0.13	40%	<2m deep
2030	-0.029255423	1900108	5574841	Domestic Water Supply	Stock Watering	3	1000	-1.92			1.08	1.59	0	-0.51	0.03	-6%	Potentially inefficient
2732	-0.009453222	1894839	5565095	Stock Watering	Unknown	3.2	100	-1.20			2.00	1.70	0	0.30	0.01	3%	
10962	-0.295845217	1898987	5571262	Domestic Water Supply	Stock Watering	3.2	100	-2.07	8.00	10.00	1.13	1.76	0	-0.63	0.30	-47%	Potentially inefficient
15014	-0.332930379	1896881	5577266	Unused		3.3	150	-1.92			1.38	1.76	0	-0.38	0.33	-89%	Unused
15025	-0.374520854	1897096	5577818	Unused		3.3	1000	-1.92			1.38	1.77	0	-0.39	0.37	-97%	Unused
2747	-0.028823891	1884001	5576264	Irrigation	Unknown	3.6	750	-1.60	2.60	3.60	2.00	2.30	0	-0.30	0.03	-10%	Potentially inefficient
15028	-0.475655295	1896470	5579090	Groundwater sampling/monitoring	Unused	3.9	100	-1.92			1.98	1.84	0	0.14	0.48	342%	Unused/GW monitoring
4222	-0.066452495	1885562	5563087	Groundwater sampling/monitoring		3.97	100	-1.75	0.97	3.97	2.22	1.69	0	0.53	0.07	13%	GW Monitoring
15866	-0.084059072	1877285	5563499			4	1000	-1.92			2.08	1.95	0	0.13	0.08	66%	
2902	-0.357493441	1901041	5580364	Domestic Water Supply	Stock Watering	4.11	100	-1.45	2.11	4.11	2.66	1.80	0	0.86	0.36	42%	
4411	-0.028142957	1884031	5576228	Irrigation		4.5	840	-1.92			2.58	2.30	0	0.28	0.03	10%	
15023	-0.564958153	1896292	5579170	Groundwater sampling/monitoring	Unused	4.5	100	-1.92			2.58	1.85	0	0.73	0.56	77%	Unused/GW monitoring
4398	-0.335882209	1897467	5599635	Domestic Water Supply	Stock Watering	4.55	250	-0.80	3.20	4.20	3.75	1.80	0	1.95	0.34	17%	
5393	-0.01363486	1901621	5579337	Domestic Water Supply		4.6	200	-1.92	1.60	2.90	2.68	1.80	0	0.88	0.01	2%	
5899	-0.10404882	1895279	5570271			4.6	400	-1.92	2.60	4.60	2.68	1.83	0	0.85	0.10	12%	
15024	-0.535877265	1896338	5579170	Groundwater sampling/monitoring	Unused	4.6	100	-1.92			2.68	1.85	0	0.83	0.54	64%	Unused/GW monitoring
2310	-0.094468037	1891434	5562478	Domestic Water Supply	Stock Watering	4.7	1000	-1.50			3.20	1.64	0	1.56	0.09	6%	
5137	-0.394749752	1898841	5573230	Groundwater sampling/monitoring		4.7	100	-1.92	2.47	4.00	2.78	1.61	0	1.17	0.39	34%	GW Monitoring
1467	-0.026221611	1883422	5576482	Unknown	Unknown	4.87	150	-1.45	2.57	4.57	3.42	2.32	0	1.10	0.03	2%	
4227	-0.281682522	1893617	5587028	Groundwater sampling/monitoring		4.89	100	-1.60	1.80	4.40	3.29	2.16	0	1.13	0.28	25%	GW Monitoring
2368	-0.080172544	1882110	5565019	Stock Watering	Unknown	5	1000	-1.92			3.08	1.98	0	1.10	0.08	7%	
5529	-0.159332251	1891967	5576382	Exploratory Well		5	50	-1.92	2.50	5.00	3.08	1.98	0	1.10	0.16	14%	
5530	-0.157966787	1891964	5576326	Exploratory Well		5	50	-1.92	2.50	5.00	3.08	1.98	0	1.10	0.16	14%	
5531	-0.160965312	1892018	5576356	Exploratory Well		5	50	-1.92	2.00	5.00	3.08	1.98	0	1.10	0.16	15%	
5532	-0.282550312	1895261	5581232	Unknown		5	1200	-1.92			3.08	1.96	0	1.12	0.28	25%	
10993	-0.174178037	1899373	5574074	Domestic Water Supply	Groundwater sampling/monitoring	5	100	-1.82	4.82	6.34	3.18	1.47	0	1.71	0.17	10%	
15719	-0.014254591	1878558	5580610			5	1200	-1.92			3.08	2.44	0	0.64	0.01	2%	
15958	-0.185590264	1890357	5563965			5.04	100	-1.92	5.04	6.04	3.12	1.71	0	1.41	0.19	13%	
1357	-0.721436558	1904521	5585737	Domestic Water Supply	Unknown	5.18	100	-2.13	0.00	0.00	3.05	1.94	0	1.11	0.72	65%	
3092	-0.028816055	1884000	5576264	Domestic Water Supply	Groundwater sampling/monitoring	5.25	200	-2.50	2.75	5.25	2.75	2.30	0	0.45	0.03	6%	
2090	-0.083841573	1878736	5564955	Unknown	Unknown	5.5	1000	-1.92			3.58	2.54	0	1.04	0.08	8%	
2135	-0.128965832	1895555	5586716	Unknown	Unknown	5.5	1000	-2.15			3.35	2.12	0	1.23	0.13	10%	
2168	-0.141648359	1895040	5586535	Unknown	Unknown	5.5	1000	-1.92			3.58	2.12	0	1.46	0.14	10%	
2309	-0.133959467	1895464	5586756	Domestic Water Supply	Unknown	5.5	1000	-1.92			3.58	2.12	0	1.46	0.13	9%	
2322	-0.06155262	1884337	5564592	Domestic Water Supply	Stock Watering	5.5	1000	-1.20			4.30	1.84	0	2.46	0.06	3%	
16485	-0.235444628	1900477	5577146	Groundwater sampling/monitoring		5.5	150	-1.92	4.30	5.50	3.58	1.66	0	1.92	0.24	12%	
16504	-0.104638935	1879008	5562996			5.5	150	-1.92	4.30	5.50	3.58	1.43	0	2.15	0.10	5%	
16491	-0.054427297	1894469	5567402			5.6	150	-1.92	4.40	5.60	3.68	1.78	0	1.90	0.05	3%	
16774	-0.280149405	1900685	5578300			5.71	100	-1.92	4.71	5.71	3.79	1.71	0	2.08	0.28	13%	
16775	-0.1769833	1901107	5578089			5.72	100	-1.92	4.72	5.72	3.80	1.70	0	2.10	0.18	8%	
16776	-0.144325741	1901072	5577651			5.72	100	-1.92	4.72	5.72	3.80	1.70	0	2.10	0.14	7%	
10986	-0.084278342	1877298	5563497	Agriculture (not irrigation)		5.79	150	-1.92			3.87	1.95	0	1.92	0.08	4%	
4160	-0.229023833	1889814	5566121	Groundwater sampling/monitoring		5.9	100	-1.92	2.80	5.40	3.98	1.82	0	2.16	0.23	11%	
15026	-0.320689174	1896590	5576987	Stock Watering	Unused	6	100	-1.92			4.08	1.76	0	2.32	0.32	14%	
15027	-0.328300692	1897916	5576424	Stock Watering	Unused	6	100	-1.92			4.08	1.67	0	2.41	0.33	14%	
16346	-0.513717291	1897308	5579545			6	150	-1.92			4.08	1.83	0	2.25	0.51	23%	
16778	-0.096306899	1900671	5585337			6	50	-1.92	2.00	5.00	4.08	1.97	0	2.11	0.10	5%	
16253	-0.085154478	1878608	5564741	Groundwater sampling/monitoring		6.02	100	-1.92	4.78	6.02	4.10	2.47	0	1.63	0.09	5%	
1879	-0.005842661	1884407	5585432	Domestic Water Supply	Unknown	6.1	100	-0.38			5.72	2.33	0	3.39	0.01	0%	
15668	-0.169370493	1892576	5575912			6.12		-1.92			4.20	1.95	0	2.25	0.17	8%	

Well Group 0 – 9.99m

4693	-0.014257395	1901329	5574785	Groundwater sampling/monitoring		6.2	150	-1.92	4.10	5.10	4.28	1.70	0	2.58	0.01	1%	
16835	-0.105968665	1880320	5570200			6.2	50	-1.92			4.28	2.44	0	1.84	0.11	6%	
2132	-0.14605036	1895099	5586646	Domestic Water Supply	Unknown	6.3	1000	-1.92			4.38	2.13	0	2.25	0.15	6%	
15962	-0.198610452	1890605	5565541			6.35	100	-1.92	6.35	7.35	4.43	1.78	0	2.65	0.20	7%	
15936	-0.029149778	1901666	5575732			6.5	150	-1.92	4.80	6.50	4.58	1.80	0	2.78	0.03	1%	
15957	-0.249124596	1888756	5565193			6.6	100	-1.92	5.15	6.60	4.68	1.79	0	2.89	0.25	9%	
11006	-0.322719095	1897478	5576634			6.7	100	-1.92	5.42	6.40	4.78	1.70	0	3.08	0.32	10%	
15030	-0.294913275	1896258	5575499	Stock Watering		6.7	100	-1.92			4.78	1.75	0	3.03	0.29	10%	
2372	-0.283669974	1898914	5596844	Irrigation	Unknown	6.71	100	0.00	2.71	6.71	6.71	2.15	0	4.56	0.28	6%	
4620	-0.751934873	1896008	5578658	Groundwater sampling/monitoring		6.8	100	-1.92			4.88	1.84	0	3.04	0.75	25%	GW Monitoring
4695	-0.015833055	1898169	5569335	Groundwater sampling/monitoring		6.8	100	-1.74	5.00	6.20	5.06	1.76	0	3.30	0.02	0%	
15121	-0.459185708	1899567	5578633	Unused		6.8	80	-1.92			4.88	1.73	0	3.15	0.46	15%	
1468	-0.02417935	1883882	5576021	Unknown	Unknown	7	200	-0.92	3.00	7.00	6.08	2.31	0	3.78	0.02	1%	
10913	-0.130545711	1891376	5563129	Irrigation		7	5000	-1.92			5.08	1.67	0	3.41	0.13	4%	
10946	-0.04086998	1898416	5587738			7	200	-1.92			5.08	2.09	0	2.99	0.04	1%	
15013	-0.219502581	1889199	5572223	Unknown	Groundwater sampling/monitoring	7	1000	-1.92			5.08	2.04	0	3.04	0.22	7%	
16484	-0.070259443	1897409	5587588	Groundwater sampling/monitoring		7	150	-1.92			5.08	2.12	0	2.96	0.07	2%	
4743	-0.432371302	1895006	5578393	Groundwater sampling/monitoring		7.1	100	-1.92	5.10	7.10	5.18	1.88	0	3.30	0.43	13%	
10961	-0.267951338	1898779	5571041	Domestic Water Supply	Stock Watering	7.1	100	-1.22	6.13	7.04	5.88	1.77	0	4.11	0.27	7%	
1512	-0.07186834	1898576	5575136	Stock Watering	Unknown	7.13	300	0.00	3.13	5.13	7.13	1.57	0	5.56	0.07	1%	
10950	-0.253808572	1896038	5571925	Domestic Water Supply		7.2	110	-1.71			5.49	1.83	0	3.66	0.25	7%	
3590	-0.128137786	1899820	5574178	Domestic Water Supply	Stock Watering	7.3	100	-5.50			1.80	1.55	0	0.25	0.13	52%	
10915	-0.064505428	1884031	5564732	Irrigation		7.3	450	-1.92			5.38	1.86	0	3.52	0.06	2%	
4621	-0.369785829	1896637	5577668	Groundwater sampling/monitoring		7.4	100	-1.92			5.48	1.78	0	3.70	0.37	10%	
3690	-0.469456202	1900138	5579254	Domestic Water Supply		7.5	100	-4.30			3.20	1.75	0	1.45	0.47	32%	
16777	-0.156917588	1900736	5584635			7.5	50	-1.92	4.50	7.50	5.58	1.94	0	3.64	0.16	4%	
10925	-0.163570688	1892653	5575371	Irrigation		7.6	500	-1.92			5.68	1.94	0	3.74	0.16	4%	
10938	-0.118352272	1879907	5571322			7.6	375	-2.40	2.60	7.60	5.20	2.45	0	2.75	0.12	4%	
10973	-0.214758898	1900720	5577531			7.6	100	-3.05	5.28	6.19	4.55	1.68	0	2.87	0.21	7%	
16665	-0.06721059	1882958	5569239			7.73	100	-1.92	6.73	7.73	5.81	2.26	0	3.55	0.07	2%	
2744	-0.300957091	1897945	5576937	Domestic Water Supply	Stock Watering	8	100	-0.20	7.59	8.00	7.80	1.69	0	6.11	0.30	5%	
10960	-0.383463532	1897919	5573927	Domestic Water Supply	Stock Watering	8	100	-2.38			5.62	1.63	0	3.99	0.38	10%	
15872	-0.241332783	1888777	5564253			8	100	-1.92	7.00	8.00	6.08	1.74	0	4.34	0.24	6%	
16773	-0.331248149	1895071	5572906			8	100	-1.92	7.50	8.00	6.08	1.84	0	4.24	0.33	8%	
5135	-0.384760928	1898873	5573417	Groundwater sampling/monitoring		8.1	100	-1.92	6.04	7.36	6.18	1.57	0	4.61	0.38	8%	
4742	-0.515671982	1894212	5579226	Groundwater sampling/monitoring		8.16	100	-1.92	6.16	8.16	6.24	1.94	0	4.30	0.52	12%	
4744	-0.311145264	1894897	5580509	Groundwater sampling/monitoring		8.2	100	-10.74	6.16	8.16	-2.54	1.95	0	-4.49	0.31	-7%	GW Monitoring/ hSWL is deeper than well
5342	-0.477158324	1895262	5579231	Groundwater sampling/monitoring		8.4	100	-1.92			6.48	1.89	0	4.59	0.48	10%	
3673	-0.078235392	1898467	5575242	Domestic Water Supply	Stock Watering	8.7	150	-0.50	5.60	8.60	8.20	1.58	0	6.62	0.08	1%	
4781	-0.3050681	1895581	5577401	Groundwater sampling/monitoring		8.7	100	-4.10	5.70	8.70	4.60	1.83	0	2.77	0.31	11%	
15029	-0.333470327	1897106	5575349	Stock Watering		8.7	100	-1.92			6.78	1.69	0	5.09	0.33	7%	
5659	-0.067014694	1885476	5563034	Exploratory Well		8.8	50	-1.92	2.80	8.80	6.88	1.69	0	5.19	0.07	1%	
15362	-0.369977228	1896199	5574193			8.8	100	-1.92			6.88	1.76	0	5.12	0.37	7%	
16499	-0.372473178	1898231	5572395			8.95	100	-1.92	8.95	10.00	7.03	1.79	0	5.24	0.37	7%	
10929	-0.172192878	1892414	5576217			9	100	-3.00			6.00	1.96	0	4.04	0.17	4%	
15032	-0.336982014	1896885	5575032	Domestic Water Supply		9	75	-1.92			7.08	1.70	0	5.38	0.34	6%	
15672	-0.185727844	1892446	5572975			9	100	-1.92			7.08	1.93	0	5.15	0.19	4%	
16250	-0.124154589	1899808	5574191	Groundwater sampling/monitoring		9	100	-1.92	4.32	5.52	7.08	1.55	0	5.53	0.12	2%	
16771	-0.256000028	1894442	5574340			9	100	-1.92	8.50	9.00	7.08	1.85	0	5.23	0.26	5%	
5660	-0.06645478	1885601	5563026	Exploratory Well		9.8	50	-1.92	3.80	9.80	7.88	1.68	0	6.20	0.07	1%	
10935	-0.056076756	1893817	5564020			9.8	100	-1.92	8.04	9.75	7.88	1.68	0	6.20	0.06	1%	

Well Group 10 – 19.99m

ObjectID	Point Sample - Grid value	NZTM_Ea:	NZTM_No	Use1	Use2	Depth	Diameter	HStcWtrL	TopScreer	BtmScreen1	Available head (m)	Seasonal Variation (m)	Pump length (m)	Remaining Head (m)	Predicted DD (m)	as % remaining head	Comments
16173		1871605	5566711			10.01	100	-3.9	10.1	11.40	6.20	1.97	0	4.23	0	0%	
3175	-0.106420037	1880298	5570202	Stock Watering	Domestic Water Suppl	10.05	150	-3.2	4	10.05	0.80	2.46	0	-1.66	0.11	-6%	very shallow top screen/potentially inefficient
16770	-0.297310488	1894635	5573902			10.11	100	-3.9	9.61	10.11	5.71	3.50	0	2.21	0.30	13%	
4477	-0.196723963	1889093	5575720	Groundwater sampling/monitoring		10.2	100	-6.3	6.2	10.20	-0.10	4.34	0	-4.44	0.20	-4%	GW Sampling
16353	-0.031337623	1875164	5566712			10.2	125	-3.9	10.2		6.30	2.04	0	4.26	0.03	1%	
16489	-0.204911392	1894088	5574285			10.2	150	-3.9	10.2	11.50	6.30	3.79	0	2.51	0.20	8%	
3494	-0.0640603	1884517	5568179	Domestic Water S	Stock Watering	10.5	150	-3.2	5.35	10.50	2.15	2.37	0	-0.22	0.06	-29%	very shallow top screen/potentially inefficient
5343	-0.321225291	1896407	5577135	Groundwater sampling/monitoring		10.5	100	-3.9	10.5		6.60	4.84	0	1.76	0.32	18%	
15961	-0.200602856	1890381	5566647			10.5	100	-3.9	9.6	10.50	5.70	2.01	0	3.69	0.20	5%	
10905	-0.090456011	1895518	5570024			10.7	100	-1.04	8.2	9.78	7.16	1.80	0	5.36	0.09	2%	
16502	-0.130360983	1887629	5586252			11	150	-3.9	9.8	11.00	5.90	3.17	0	2.73	0.13	5%	
4228	-0.278047815	1893666	5587059	Groundwater sampling/monitoring		11.18	100	-10.35	8.4	11.20	-1.95	7.27	0	-9.22	0.28	-3%	GW Sampling/potentially inefficient/very deep hSWL
16500	-0.147572216	1897758	5570302			11.44	100	-3.9	10.27	11.44	6.37	1.27	0	5.10	0.15	3%	
16487	-0.438999299	1900352	5579269			11.5	150	-3.9	10.3	11.50	6.40	3.63	0	2.77	0.44	16%	
16503	-0.144757907	1890974	5563088			11.5	150	-3.9	10.3	11.50	6.40	1.65	0	4.75	0.14	3%	
2467	-0.402846492	1897819	5573427	Stock Watering	Unknown	11.57	100	-2.28	8.96	10.48	6.68	2.54	0	4.14	0.40	10%	
5356	-0.195483124	1889144	5575689	Groundwater sampling/monitoring		11.8	50	-3.9	5.8	11.80	1.90	4.34	0	-2.44	0.20	-8%	Potentially inefficient
1838	-0.050367857	1893885	5564137	Domestic Water S	Stock Watering	11.88	150	0.35	2.74	8.84	3.09	1.44	0	1.65	0.05	3%	
16479	-0.073292063	1883705	5566043	Groundwater sampling/monitoring		11.98	100	-3.9	10.74	11.48	6.84	2.10	0	4.74	0.07	2%	
3076	-0.524701387	1897594	5580050	Unknown	Groundwater sampling	11.99	150	-7.63	11.99		4.36	6.13	0	-1.77	0.52	-30%	GW Sampling/deep hSWL
16345	-0.387877748	1896860	5581052			12	150	-3.9	11	12.00	7.10	7.38	0	-0.28	0.39	-138%	Potenitally inefficient
1666	-0.075591897	1895218	5568823	Domestic Water S	Unknown	12.3	150	-1.22	9.14	11.58	7.92	1.65	0	6.27	0.08	1%	
3143	-0.067531462	1884224	5567824	Domestic Water S	Stock Watering	12.3	150	-1	6	10.00	5.00	2.32	0	2.68	0.07	3%	
2979	-0.497913534	1898532	5579677	Unknown	Groundwater sampling	12.4	150	-9.35	11	12.00	1.65	5.19	0	-3.54	0.50	-14%	GW Sampling
5502	-0.193495417	1889128	5575579	Exploratory Well		12.4	50	-3.9	6.5	12.40	2.60	4.30	0	-1.70	0.19	-11%	Potenitally inefficient
1655	-0.389951807	1898211	5572708	Domestic Water S	Stock Watering	12.5	150	-2.74	12.5		9.76	2.17	0	7.59	0.39	5%	
3421	-0.108815145	1880180	5570103	Domestic Water S	Stock Watering	12.6	150	-5.95	8.27	10.80	2.32	2.45	0	-0.13	0.11	-86%	Potenitally inefficient
10953	-0.260568774	1890080	5571104	Domestic Water Supply		12.7	100	-3.66	12.7		9.04	2.92	0	6.12	0.26	4%	
1414	-0.338541795	1899118	5581233	Domestic Water S	Unknown	12.8	100	-9.14	11.73	12.80	2.59	5.85	0	-3.26	0.34	-10%	Potentially inefficient
15637	-0.229714785	1889582	5565513	Groundwater sampling/monitoring		13		-3.9	10	13.00	6.10	1.93	0	4.17	0.23	6%	
10968	-0.325803444	1898417	5581833			13.1	150	-2.37	10.36	11.58	7.99	6.76	0	1.23	0.33	27%	
1872	-0.466350846	1899019	5578431	Agriculture (not i	Unknown	13.11	100	-1	12.2	13.11	11.20	4.16	0	7.04	0.47	7%	
15960	-0.191477827	1890678	5565026			13.2	100	-3.9	13.2	14.20	9.30	1.81	0	7.49	0.19	3%	
4622	-0.370319819	1896639	5577672	Groundwater sampling/monitoring		13.3	100	-3.9	13.3		9.40	5.08	0	4.32	0.37	9%	
10934	-0.175038005	1889814	5563119	Stock Watering		13.41	300	-4.2	12.12	13.41	7.92	1.70	0	6.22	0.18	3%	
2370	-0.059673645	1884912	5570025	Unknown	Unknown	13.6	150	-2.07	7	13.55	4.93	2.65	0	2.28	0.06	3%	
16247	-0.283407122	1890384	5571135			13.95	100	-3.9	12.45	13.95	8.55	2.91	0	5.64	0.28	5%	
4158	-0.229727601	1889582	5565514	Industrial (Commercial)		14	150	-3.9	14		10.10	1.93	0	8.17	0.23	3%	
15963	-0.192175448	1889590	5563502			14	100	-3.9	14	15.00	10.10	1.75	0	8.35	0.19	2%	
2809	-0.018164407	1882212	5584957	Domestic Water S	Stock Watering	14.2599	150	-9	10.59	14.25	1.59	2.96	0	-1.37	0.02	-1%	Potentially inefficient/deep hSWL
16249	-0.449385862	1892688	5578991			14.34	100	-3.9	13.09	14.34	9.19	6.78	0	2.41	0.45	19%	
1380	-0.461731407	1899555	5578643	Irrigation	Agriculture (not irrigat	15.19	250	-3.5	15.19		11.69	3.88	0	7.81	0.46	6%	
10954	-0.179807828	1898835	5574134	Domestic Water S	Stock Watering	15.2	100	-2.13	12.89	13.99	10.76	2.62	0	8.14	0.18	2%	
10984	-0.055217043	1898419	5575128			15.24	100	-3.66	12.17	13.08	8.51	3.11	0	5.40	0.06	1%	
5662	-0.278210958	1893683	5587022	Exploratory Well		15.5	50	-3.9	11.5	15.50	7.60	7.30	0	0.30	0.28	91%	
2907	-0.124958333	1891286	5562909	Domestic Water S	Stock Watering	15.54	150	-4	13.64	15.54	9.64	1.61	0	8.03	0.12	2%	
4456	-0.240853107	1888752	5564190	Groundwater sampling/monitoring		15.6	150	-6.56	12.6	15.60	6.04	1.84	0	4.20	0.24	6%	
15638	-0.176557311	1890982	5564395	Groundwater sampling/monitoring		16		-3.9	13	16.00	9.10	1.74	0	7.36	0.18	2%	
16501	-0.200708074	1892460	5572835			16	100	-3.9	14.83	16.00	10.93	3.31	0	7.62	0.20	3%	
10940	-0.039707954	1895615	5585635	Unknown	Unknown	16.2	100	-1.52	16.2		14.68	8.46	0	6.22	0.04	1%	
10955	-0.1283751	1878380	5570304			16.2	100	-2.13	16.2		14.07	2.38	0	11.69	0.13	1%	
1839	-0.093806621	1879700	5566686	Unknown	Unknown	17.06	300	-2.74	8.02	14.02	5.28	2.13	0	3.15	0.09	3%	
2583	-0.358362607	1898599	5581402	Domestic Water S	Unknown	17.67	100	-3.2	16.45	17.67	13.25	6.35	0	6.90	0.36	5%	
10909	-0.496352379	1899019	5578731			17.7	100	-3.2	15.48	16.76	12.28	4.29	0	7.99	0.50	6%	
2773	-0.208025701	1893715	5575728	Domestic Water S	Stock Watering	18	150	-7.1	12	18.00	4.90	4.65	0	0.25	0.21	84%	
10932	-0.090526909	1879708	5566219			18	100	-3.9	18		14.10	2.09	0	12.01	0.09	1%	
16373	-0.40540945	1900030	5580732			18.14	100	-3.9	16.84	18.14	12.94	4.90	0	8.04	0.41	5%	
4161	-0.229023833	1889814	5566121	Industrial (Commercial)		18.2	150	-6.37	15	18.00	8.63	1.99	0	6.64	0.23	3%	
1945	-0.092308213	1879908	5566519	Unknown	Unknown	18.28	100	-3.9	18.28		14.38	2.12	0	12.26	0.09	1%	

Well Group 10 – 19.99m

2071	-0.090255612	1880209	5566219	Agriculture (not i	Unknown	18.29	100	-3.6	8.23	12.19	4.63	2.10	0	2.53	0.09	4%	
3357	-0.229191496	1893505	5577449	Unknown	Unknown	18.29	100	-3.9	15.7	18.29	11.80	5.77	0	6.03	0.23	4%	
10933	-0.188882201	1889615	5563419			18.3	100	-2.2	18.3		16.10	1.74	0	14.36	0.19	1%	
1377	-0.162218178	1894483	5571016	Domestic Water S	Unknown	18.44	150	-2.29	14.48	18.44	12.19	2.32	0	9.87	0.16	2%	
5211	-0.390612849	1900702	5579478	Irrigation		18.5	300	-3.9	9	18.50	5.10	3.63	0	1.47	0.39	27%	
16097	-0.049060055	1884667	5570868			18.5	100	-3.9	6.5	18.50	2.60	2.77	0	-0.17	0.05	-28%	Potenitally inefficient/shallow screen
2396	-0.035936804	1894618	5566822	Domestic Water S	Unknown	18.58	100	-1.5	16.27	17.67	14.77	1.53	0	13.24	0.04	0%	
3426	-0.056501675	1884835	5564906	Domestic Water S	Stock Watering	19	100	-1.2	15.15	17.00	13.95	1.99	0	11.96	0.06	0%	
1957	-0.405575789	1900019	5580733	Domestic Water S	Stock Watering	19.2	100	0	19.2	0.00	19.20	4.90	0	14.30	0.41	3%	
10908	-0.380658264	1898618	5581233			19.2	100	-8.55	19.2		10.65	6.22	0	4.43	0.38	9%	
10911	-0.418119346	1899366	5578094	Irrigation	Agriculture (not irrigat	19.2	100	-8.55	19.2		10.65	3.82	0	6.83	0.42	6%	
5369	-0.179245945	1887597	5571653	Domestic Water Supply		19.3	100	-3.9	18	19.30	14.10	3.06	0	11.04	0.18	2%	
5424	-0.10776544	1899430	5582871	Exploratory Well		19.5	100	-3.9	18.5	19.50	14.60	6.58	0	8.02	0.11	1%	
1384	-0.225123884	1888014	5564419	Unknown	Unknown	19.53	150	-3.9	16.53	19.53	12.63	1.89	0	10.74	0.23	2%	
1656	-0.082970529	1895591	5569884	Irrigation	Unknown	19.8	250	-0.79	14	18.00	13.21	1.75	0	11.46	0.08	1%	
16248	-0.380558826	1895306	5583180	Groundwater sampling/monitoring		19.94	150	-3.9	18.74	19.94	14.84	9.93	0	4.91	0.38	8%	

Well Group 20 – 29.99m

ObjectID	Point Sample - Grid Value	NZTM_ Easting	NZTM_ Northing	Use1	Use2	Depth	Diameter	h_SWL	TopScreen1	BtmScreen1	Available Head (m)	Seasonal Variation (m)	Pump Length (m)	Remaining Head (m)	Predicted DD (m)	as % remaining head	Comments
5367	-0.439665841	1899126	5578096	Domestic	Water Sup	20	100	-4.17	17.50	19.50	13.33	6.32	1	6.01	0.44	7%	
10931	-0.090533189	1879709	5566220			20.1	200	-2.13	10.12	20.12	7.99	11.47	1	-4.48	0.09	-2%	Potentially inefficient
1944	-0.093032872	1879938	5566652	Domestic	Groundwa	20.6	200	-2.13	7.06	17.06	4.93	11.34	1	-7.41	0.09	-1%	Potentially inefficient
15670	-0.623274249	1892815	5584616			21		-4.17	21.00		16.83	10.89	1	4.94	0.62	13%	
15977	-0.224564622	1899469	5573884			21.21	100	-4.17	19.51	21.21	15.34	4.65	1	9.69	0.22	2%	
10995	-0.466350846	1899019	5578431	Agriculture (not irrig		21.34	100	-10.5	16.10	18.90	5.6	6.47	1	-1.87	0.47	-25%	Potentially inefficient/ very deep hSWL
16251	-0.21342182	1888442	5576277			21.48	100	-4.17	20.24	21.48	16.07	3.83	1	11.24	0.21	2%	
1379	-0.461334957	1899561	5578644	Irrigation	Groundwa	21.8	250	-3.4	15.80	21.80	12.4	6.56	1	4.84	0.46	10%	
4254	-0.241109482	1888241	5564409	Domestic	Stock Wat	22.06	50	-2	14.73	20.45	12.73	5.24	1	6.49	0.24	4%	
2533	-0.049141982	1898823	5588098	Domestic	Stock Wat	22.25		-0.6	22.25		21.65	10.00	1	10.65	0.05	0%	
10949	-0.140402704	1892116	5567022			22.3	100	-5.79	15.24	16.46	9.45	3.63	1	4.82	0.14	3%	
3496	-0.331146673	1897277	5583852	Domestic	Stock Wat	22.49	100	-4.9	22.49		17.59	9.16	1	7.43	0.33	4%	
1558	-0.162218178	1894483	5571016	Domestic	Groundwa	22.5	150	-5.35	22.50		17.15	3.13	1	13.02	0.16	1%	
10948	-0.602859567	1893949	5584422			22.6	100	-17.06	20.09	21.00	3.03	10.39	1	-8.36	0.60	-7%	Potentially inefficient/very deep hSWL
16411	-0.229971679	1886905	5576937			22.88	100	-4.17	16.89	22.88	12.72	4.90	1	6.82	0.23	3%	
16252	-0.062784589	1884059	5569027	Groundwater sampli		23.51	100	-4.17	22.27	23.51	18.1	1.30	1	15.80	0.06	0%	
16725	-0.105973605	1898965	5574410			23.8	100	-4.17	20.86	22.66	16.69	4.78	1	10.91	0.11	1%	
1376	-0.027859106	1896318	5568312	Irrigation	Groundwa	24.2	200	-0.9	20.05	25.19	19.15	1.79	1	16.36	0.03	0%	
15675	-0.068446472	1886433	5573934			24.25	150	-4.17	24.25		20.08	4.02	1	15.06	0.07	0%	
16331	-0.082443358	1881893	5569051			24.29	150	-4.17	24.29		20.12	5.38	1	13.74	0.08	1%	
3079	-0.161312627	1892014	5576378	Domestic	Stock Wat	24.38	100	-0.914	22.86	24.38	21.946	4.94	1	16.00	0.16	1%	
10921	-0.201990795	1898761	5574116	Waste Disposal (Coo		24.4	150	-4.17	24.40		20.23	4.65	1	14.58	0.20	1%	
3571	-0.064428694	1884226	5564399	Domestic	Stock Wat	24.7	100	-6.4	22.80	24.70	16.4	6.72	1	8.68	0.06	1%	
4163	-0.035125629	1899710	5574779	Irrigation		24.7	300	-0.35	7.00	10.00	6.65	4.99	1	0.66	0.04	5%	
4646	-0.192287756	1889690	5575890	Domestic	Stock Wat	24.75	100	-1.65	23.25	24.75	21.6	4.09	1	16.51	0.19	1%	
4780	-0.09303065	1879939	5566652	Stock Watering		25	150	-2.4	3.65	15.50	1.25	11.34	1	-11.09	0.09	-1%	Very shallow top screen?
10930	-0.060673106	1884911	5571223			25	100	-1.8	19.00	25.00	17.2	3.39	1	12.81	0.06	0%	
1383	-0.150263323	1896308	5570654	Irrigation	Unknown	25.1	300	-2.78	19.00	25.10	16.22	2.98	1	12.24	0.15	1%	
4949	-0.448279653	1898902	5580753	Domestic	Stock Wat	25.2	100	-4.17	25.20		21.03	7.54	1	12.49	0.45	4%	
4696	-0.015833055	1898169	5569335	Groundwater sampli		25.3	100	4	22.80	24.00	26.8	3.20	1	22.60	0.02	0%	
10904	-0.387362223	1895415	5583734			25.5	100	2.44	19.87	21.30	22.31	9.61	1	11.70	0.39	3%	
3664	-0.108824622	1900145	5574350	Domestic	Stock Wat	25.6	100	-8.02	14.03	25.60	6.01	4.88	1	0.13	0.11	82%	
10896	-0.382892465	1891213	5577829			25.6	100	-4.41	22.43	23.24	18.02	5.80	1	11.22	0.38	3%	
11005	-0.04300733	1884307	5586533			25.6	100	-11.28	18.26	19.78	6.98	11.02	1	-5.04	0.04	-1%	Potentially inefficient/deep hSWL
1458	-0.174178037	1899373	5574074	Domestic	Groundwa	25.9	100	-0.53	33.37	34.44	32.84	4.70	1	27.14	0.17	1%	
15863	-0.069620355	1883722	5565579			26	125	-4.17	23.45	26.00	19.28	6.32	1	11.96	0.07	1%	
16488	-0.553538332	1890368	5583649	Groundwater sampli		26	150	-4.17	23.40	24.44	19.23	11.55	1	6.68	0.55	8%	
16095	-0.154539677	1886853	5569343			26.1	100	-4.17	25.10	26.10	20.93	5.37	1	14.56	0.15	1%	
4008	-0.494032326	1899092	5578730	Domestic	Stock Wat	26.13	100	7.94	24.13	26.13	32.07	6.61	1	24.46	0.49	2%	
10937	-0.16761384	1892756	5575383			26.2	100	-4.17	26.20	26.20	22.03	4.58	1	16.45	0.17	1%	
15871	-0.18572389	1890351	5563964			26.2	100	-4.17	26.20	27.20	22.03	4.77	1	16.26	0.19	1%	
16858	-0.05522002	1885192	5565918			26.2	100	-4.17	23.30	26.20	19.13	5.26	1	12.87	0.06	0%	
2842	-0.169606832	1892414	5576128	Domestic	Unknown	26.5	100	-1.2	23.50	26.50	22.3	4.88	1	16.42	0.17	1%	
16880	-0.156843053	1891886	5576425			26.5	100	-4.17	25.20	26.50	21.03	4.95	1	15.08	0.16	1%	
10985	-0.342754454	1898217	5581833			26.52	100	-11.28	25.00	26.50	13.72	8.11	1	4.61	0.34	7%	
16406	-0.088187508	1893053	5564039			26.64	125	-4.17	26.64	28.04	22.47	4.02	1	17.45	0.09	1%	
5655	-0.114839866	1895328	5586422	Domestic	Water Sup	27	100	-4.17	22.30	23.60	18.13	10.52	1	6.61	0.11	2%	
1351	-0.167061421	1892114	5576428	Domestic	Unknown	27.13	100	-2.44	27.13		24.69	4.99	1	18.70	0.17	1%	
2522	-0.095578693	1895514	5586236	Domestic	Unknown	27.4	100	-9	23.77	27.43	14.77	10.42	1	3.35	0.10	3%	
5325	-0.055360179	1885184	5565918	Domestic	Water Sup	27.4	100	-4.17	25.60	27.40	21.43	5.26	1	15.17	0.06	0%	
5371	-0.44430363	1892574	5570882	Stock Watering		27.4	100	-4.17	25.88	27.38	21.71	3.44	1	17.27	0.44	3%	
2905	-0.088312867	1891616	5562619	Domestic	Stock Wat	27.43	150	-11.9	19.89	21.79	7.99	4.69	1	2.30	0.09	4%	
3843	-0.084032535	1898782	5575258	Irrigation	Unknown	28	300	-4.17	10.50	16.50	6.33	5.09	1	0.24	0.08	35%	
10970	-0.195718894	1895474	5592316			28	100	-4.17	28.00		23.83	11.00	1	11.83	0.20	2%	
1396	-0.250109614	1894170	5586699	Domestic	Agricultur	28.35	400	-19.51	26.67	28.35	7.16	10.91	1	-4.75	0.25	-5%	Potentially inefficient/deep hSWL
10978	-0.57346657	1893814	5584834			28.35	100	-9.44	21.88	22.82	12.44	10.58	1	0.86	0.57	67%	
10944	-0.067103441	1883849	5564496			28.5	100	-3.05	28.50		25.45	6.94	1	17.51	0.07	0%	
10957	-0.447459938	1892214	5578630			28.5	100	-6.71	21.77	22.86	15.06	6.59	1	7.47	0.45	6%	
1422	-0.131099168	1895214	5586536	Domestic	Unknown	28.65	100	-9.75	27.13	28.65	17.38	10.57	1	5.81	0.13	2%	

Well Group 20 – 29.99m

3441	-0.144717178	1891139	5576463	Domestic	Stock Wat	28.8	100	-3.22	28.50	28.80	25.28	4.80	1	19.48	0.14	1%					
16507	-0.092910743	1892933	5563971	Groundwater sampli		28.8	100	-4.17	27.56	28.80	23.39	4.07	1	18.32	0.09	1%					
4625	-0.157589718	1892238	5575949	Domestic	Stock Wat	28.9	100	0.2	25.90	28.90	26.1	4.76	1	20.34	0.16	1%					
3707	-0.163709287	1892456	5575903	Irrigation	Unknown	28.95	100	-4.17	26.63	28.95	22.46	4.77	1	16.69	0.16	1%					
2728	-0.172051808	1892454	5576168	Domestic	Unknown	29	100	-4.17	27.34	28.96	23.17	4.91	1	17.26	0.17	1%					
3714	-0.173761932	1892338	5576330	Domestic	Stock Wat	29	100	-2.8	23.71	25.56	20.91	4.98	1	14.93	0.17	1%					
4873	-0.042124876	1889627	5560454	Stock Watering		29	150	-4.17	16.83	28.83	12.66	5.67	1	5.99	0.04	1%					
16882	-0.118862234	1895561	5586561			29.5	100	-4.17	28.50	29.50	24.33	10.48	1	12.85	0.12	1%					
10951	-0.164029804	1891314	5576628			29.6	100	-3.23	28.23	28.90	25	4.94	1	19.06	0.16	1%					
15394	-0.204764169	1890086	5576705			29.7	100	-4.17	29.70		25.53	4.66	1	19.87	0.20	1%					
2454	-0.044457472	1901720	5580133	Irrigation	Unknown	29.8	100	7.62	28.40	29.80	36.02	7.00	1	28.02	0.04	0%					
5335	-0.036409181	1886888	5566276	Groundwater sampli		29.8	150	-4.17	28.76	29.76	24.59	5.00	1	18.59	0.04	0%					
2837	-0.064315661	1884573	5566100	Domestic	Stock Wat	29.85	100	-7.31	17.53	18.96	10.22	5.31	1	3.91	0.06	2%					
1398	-0.184662539	1887518	5567599	Domestic	Unknown	29.87	150	-1.06	29.87	0.00	28.81	4.95	1	22.86	0.18	1%					
2044	-0.091864239	1895868	5569942	Irrigation	Unknown	29.9	200	-1.45	13.70	15.50	12.25	2.61	1	8.64	0.09	1%					
2289	-0.109682466	1895855	5586496	Domestic	Stock Wat	29.9	100	-7.01	26.19	28.08	19.18	10.38	1	7.80	0.11	1%					

Well Group 30 – 39.99m

ObjectID	Point Sample - Grid Value	NZTM_ Easting	NZTM_ Northing	Use1	Use2	Depth	Diameter	h_SWL	TopScreen1	BtmScreen1	Available Head (m)	Seasonal Variation (m)	Pump Length (m)	Remaining Head (m)	Predicted DD (m)	as % Remaining Head	Comments
10942	-0.60587	1894364.253	5583516	Irrigation	Stock Wat	30	100	-6.37	32.77	34.17	26.40	7.42	1	17.98	0.61	3%	
2926	-0.15162	1890871.587	5563198	Domestic	Stock Wat	30.02	100	-14.15	1.53	28.03	-12.62	7.42	1	-21.04	0.15	-1%	very shallow top screen level?
1599	-0.16443	1892172.285	5576245	Domestic	Unknown	30.17	100	-1.67	28.17	30.17	26.50	7.42	1	18.08	0.16	1%	
1961	-0.13110	1895214.141	5586536	Unknown	Unknown	30.48	100	-9.15	30.48		21.33	7.42	1	12.91	0.13	1%	
3596	-0.07396	1892618.788	5562700	Domestic	Stock Wat	30.48	100	-6.37	30.48		24.11	7.42	1	15.69	0.07	0%	
2729	-0.08726	1881351.262	5565851	Domestic	Stock Wat	30.4899	100	-3.26	9.45	10.82	6.19	7.42	1	-2.23	0.09	-4%	Shallow top screen, potentially inefficient
10898	-0.04450	1898516.857	5585036			30.5	100	-9.44	27.58	28.65	18.14	7.42	1	9.72	0.04	0%	
10979	-0.57263	1893796.546	5584855			30.5		-6.37	26.15	27.55	19.78	7.42	1	11.36	0.57	5%	
10895	-0.06095	1889314.887	5560917			30.9	75	-14.6	16.50	30.90	1.90	7.42	1	-6.52	0.06	-1%	Deep SWL and shallow topscreen
2900	-0.13830	1891854.092	5564189	Domestic	Stock Wat	31	150	-14.3	28.18	31.00	13.88	7.42	1	5.46	0.14	3%	
4623	-0.19839	1888754.134	5575621	Domestic	Stock Wat	31	100	-6.37	29.70	31.00	23.33	7.42	1	14.91	0.20	1%	
2779	-0.16728	1892474.542	5575978	Domestic	Unknown	31.08		-1.21	5.18	25.90	3.97	7.42	1	-4.45	0.17	-4%	very shallow top screen level?
10906	-0.16345	1892354.455	5576008			31.1	100	2.13	26.22	27.86	28.35	7.42	1	19.93	0.16	1%	
1382	-0.06135	1886134.441	5564239	Irrigation	Unknown	31.4	150	-5.33	25.45	26.21	20.12	7.42	1	11.70	0.06	1%	
10952	-0.04310	1898516.926	5584735			31.4	100	-2.32	28.41	29.32	26.09	7.42	1	17.67	0.04	0%	
4452	-0.18145	1887910.688	5575096	Domestic	Stock Wat	31.41	100	-5.3	29.61	31.41	24.31	7.42	1	15.89	0.18	1%	
10943	-0.09041	1881709.3	5566920			31.5	100	-3	21.50	23.00	18.50	7.42	1	10.08	0.09	1%	
16836	-0.10551	1892680.63	5564208			31.6	300	-6.37	23.50	31.60	17.13	7.42	1	8.71	0.11	1%	
2911	-0.10557	1892677.629	5564205	Domestic	Stock Wat	31.7	200	-9.9	28.80	31.70	18.90	7.42	1	10.48	0.11	1%	
2901	-0.16226	1891148.667	5563937	Domestic	Stock Wat	32	150	-5.6	24.00	32.00	18.40	7.42	1	9.98	0.16	2%	
11003	-0.15697	1892081.253	5576096			32.3	100	0.61	28.92	30.75	29.53	7.42	1	21.11	0.16	1%	
15445	-0.16783	1892239.326	5576269			32.6	100	-6.37	30.80	32.60	24.43	7.42	1	16.01	0.17	1%	
17003	-0.16470	1892173.284	5576253			32.62	100	-6.37	31.42	32.62	25.05	7.42	1	16.63	0.16	1%	
10892	-0.16949	1892314.385	5576228			32.9	100	0	28.56	29.57	28.56	7.42	1	20.14	0.17	1%	
2102	-0.14448	1890245.411	5568426	Irrigation	Unknown	33	200	-6.37	33.00		26.63	7.42	1	18.21	0.14	1%	
5206	-0.12504	1895424.271	5586611	Domestic	Water Sup	33	100	-6.37	31.72	33.02	25.35	7.42	1	16.93	0.13	1%	
2543	-0.38856	1898902.471	5573322	Explorato	Unknown	33.1	300	-1.36	8.00	10.20	6.64	7.42	1	-1.78	0.39	-22%	very shallow top screen level?
15048	-0.16474	1892218.326	5576195	Groundwater sampli		33.1	100	-6.37	33.10		26.73	7.42	1	18.31	0.16	1%	
16014	-0.22712	1894219.814	5575545			33.21	100	-6.37	31.81	33.21	25.44	7.42	1	17.02	0.23	1%	
4154	-0.10059	1895848.639	5586336	Stock Wat	Domestic	33.3	100	-7.4	25.90	27.70	18.50	7.42	1	10.08	0.10	1%	
5829	-0.33406	1898363.606	5576030			33.38	100	-6.37	32.78	34.58	26.41	7.42	1	17.99	0.33	2%	
2898	-0.17397	1890900.485	5564089	Domestic	Stock Wat	33.53	150	-8.55	30.60	32.50	22.05	7.42	1	13.63	0.17	1%	
16806	-0.12918	1895127.101	5586444			33.89	100	-6.37	33.89		27.52	7.42	1	19.10	0.13	1%	
3349	-0.17208	1892433.472	5576193	Domestic	Stock Wat	34	100	2	25.92	27.92	27.92	7.42	1	19.50	0.17	1%	
10897	-0.12937	1899017.601	5583334			34.1	100	-4.57	28.96	30.48	24.39	7.42	1	15.97	0.13	1%	
10917	-0.17499	1892407.429	5576319	Irrigation		34.1	150	-6.37	28.80	34.10	22.43	7.42	1	14.01	0.17	1%	
10924	-0.06048	1884411.318	5564619	Public Water Supply		34.1	200	-5.5	19.40	34.10	13.90	7.42	1	5.48	0.06	1%	
1333	-0.58954	1893713.517	5584734	Agricultur	Unknown	34.14	100	-11.43	31.40	33.38	19.97	7.42	1	11.55	0.59	5%	
1395	-0.17537	1892514.52	5576228	Domestic	Unknown	34.44	100	-3.81	32.76	34.44	28.95	7.42	1	20.53	0.18	1%	
10992	-0.16823	1890426.181	5575908			34.44	100	-3.04	34.44		31.40	7.42	1	22.98	0.17	1%	
5319	-0.13383	1895494.283	5586766	Domestic	Water Sup	34.5	100	-6.37	29.50	30.80	23.13	7.42	1	14.71	0.13	1%	
5361	-0.15940	1892505.742	5575054			34.6	100	-6.37	33.10	34.60	26.73	7.42	1	18.31	0.16	1%	
10894	-0.05748	1880706.467	5578127			34.7	100	-6.37	10.36	11.35	3.99	7.42	1	-4.43	0.06	-1%	Shallow top screen, potentially inefficient
17032	-0.15187	1891569.878	5576249			34.7	100	-6.37	32.63	33.93	26.26	7.42	1	17.84	0.15	1%	
16370	-0.06036	1886752.462	5566628			34.75	150	-6.37	32.75	34.75	26.38	7.42	1	17.96	0.06	0%	
4765	-0.15807	1892108.27	5576102	Domestic	Stock Wat	35		-3.2	35.00		31.80	7.42	1	23.38	0.16	1%	
5188	-0.16754	1892523.586	5575926	Domestic	Water Sup	35	100	-6.37	30.00	31.50	23.63	7.42	1	15.21	0.17	1%	
1407	-0.05420	1895814.806	5585535	Domestic	Unknown	35.05	100	-6.37	27.89	29.26	21.52	7.42	1	13.10	0.05	0%	
4712	-0.15722	1891898.064	5576429	Fire-fighti	Domestic	35.85	100	-2.65	23.00	26.00	20.35	7.42	1	11.93	0.16	1%	
5898	-0.16542	1892305.401	5576116			35.95	100	-6.37	34.05	35.95	27.68	7.42	1	19.26	0.17	1%	
2910	-0.12496	1891285.893	5562909	Domestic	Stock Wat	35.97	150	-4	35.97		31.97	7.42	1	23.55	0.12	1%	
4049	-0.05104	1899528.643	5574873	Domestic	Stock Wat	36	300	-6.37	30.00	36.00	23.63	7.42	1	15.21	0.05	0%	
4485	-0.08442	1889540.97	5561392	Domestic	Stock Wat	36	150	-7.3	24.00	36.00	16.70	7.42	1	8.28	0.08	1%	
15479	-0.29852	1895379.386	5581613			36	100	-6.37	32.77	34.07	26.40	7.42	1	17.98	0.30	2%	
15997	-0.15751	1891384.872	5575650			36.1	150	-6.37	34.60	36.10	28.23	7.42	1	19.81	0.16	1%	
5987	-0.06715	1886429.597	5564423			36.4	100	-6.37	34.50	36.40	28.13	7.42	1	19.71	0.07	0%	
16434		1871520.464	5566540			36.41	125	-6.37	35.01	36.41	28.64	7.42	1	20.22	0.00	0%	
1847	-0.17966	1892414.393	5576528	Domestic	Unknown	36.57	100	-0.12	36.57		36.45	7.42	1	28.03	0.18	1%	
3448	-0.01289	1874490.276	5565712	Stock Wat	Agricultur	36.57	100	-8.1	34.82	36.57	26.72	7.42	1	18.30	0.01	0%	

Well Group 30 – 39.99m

11004	-0.31256	1892211.815	5587436			36.6	100	-28.65	27.80	28.71	-0.85	7.42	1	-9.27	0.31	-3%	Very deep SWL
4538	-0.16557	1892288.385	5576139	Domestic	Stock Wat	37	100	-0.9	30.32	31.52	29.42	7.42	1	21.00	0.17	1%	
2053	-0.17310	1892588.613	5576010	Irrigation	Unknown	37.2	100	-2.4	37.20	38.60	34.80	7.42	1	26.38	0.17	1%	
5359	-0.16272	1892220.341	5576126	Domestic	Water Sup	37.5	100	-6.37	36.00	37.50	29.63	7.42	1	21.21	0.16	1%	
5509	-0.15639	1892327.465	5575863	Domestic	Water Sup	37.5	100	-6.37	35.90	37.50	29.53	7.42	1	21.11	0.16	1%	
10899	-0.06068	1901320.592	5576730			37.5	100	-1	1.37	3.69	0.37	7.42	1	-8.05	0.06	-1%	very shallow top screen level?
10941	-0.23711	1888051.769	5569771	Unknown		37.5	150	-3.66	37.50		33.84	7.42	1	25.42	0.24	1%	
10889	-0.10027	1895914.686	5586336			37.6	100	-5.03	21.97	32.33	16.94	7.42	1	8.52	0.10	1%	
4772	-0.18695	1888936.36	5575089	Domestic	Stock Wat	38	150	-7.2	32.00	38.00	24.80	7.42	1	16.38	0.19	1%	
6714	-0.21574	1889414.525	5564119	Unknown	Unknown	38	200	-6.37	0.00	0.00	-6.37	7.42	1	-14.79	0.22	-1%	very shallow top screen level?
15664	-0.19569	1895474.838	5592317			38		-6.37	38.00		31.63	7.42	1	23.21	0.20	1%	
2077	-0.06018	1896735.583	5589134	Irrigation	Unknown	38.4	150	-0.3	24.10	35.70	23.80	7.42	1	15.38	0.06	0%	
4471	-0.14866	1891834.23	5575366	Domestic	Stock Wat	38.4	100	-3	30.57	32.37	27.57	7.42	1	19.15	0.15	1%	
1476	-0.12614	1895714.447	5586736	Domestic	Unknown	38.41	100	-9.14	37.04	38.41	27.90	7.42	1	19.48	0.13	1%	
4694	-0.01429	1901328.948	5574786	Groundwater sampli		38.6	150	-1.31	42.90	43.90	41.59	7.42	1	33.17	0.01	0%	
4156	-0.12585	1895165.131	5586432	Stock Wat	Domestic	38.8	100	-11.2	30.10	31.70	18.90	7.42	1	10.48	0.13	1%	
2082	-0.16306	1892227.345	5576129	Domestic	Unknown	38.91	100	-0.81	30.40	32.50	29.59	7.42	1	21.17	0.16	1%	
5173	-0.08918	1880918.245	5564348	Domestic	Stock Wat	39	100	-6.37	31.46	36.36	25.09	7.42	1	16.67	0.09	1%	
3581	-0.13359	1895118.083	5586493	Domestic	Stock Wat	39.13	100	-14	36.95	39.13	22.95	7.42	1	14.53	0.13	1%	
10981	-0.40677	1894014.646	5580631			39.3	100	-19.8	34.35	35.84	14.55	7.42	1	6.13	0.41	7%	
4271	-0.05110	1896855.638	5589256			39.4	250	-12	22.40	39.40	10.40	7.42	1	1.98	0.05	3%	
3770	-0.11172	1886211.202	5571944	Irrigation	Unknown	39.62	100	-25.5	37.92	39.62	12.42	7.42	1	4.00	0.11	3%	
10967	-0.05340	1897815.735	5587637			39.9	100	-7.19	31.52	32.46	24.33	7.42	1	15.91	0.05	0%	

Well Group 40 – 49.99m

ObjectID	Point Sample - Grid Value	NZTM_ Easting	NZTM_ Northing	Use1	Use2	Depth	Diameter	h_SWL	TopScreen1	BtmScreen1	Available Head (m)	Seasonal Variation (m)	Pump Length (m)	Remaining Head (m)	Predicted DD (m)	as % Remaining Head	Comments
3615	-0.070678836	1883511	5565269	Domestic	Stock Wat	40	150	-3.6	22.40	33.60	18.80	16.66	1	1.14	0.07	6%	
5699	-0.071889535	1883439	5565401	Stock Watering		40	150	-9.01	37.47	38.67	28.46	16.66	1	10.80	0.07	1%	
1447	-0.313767697	1888587	5594379	Domestic	Unknown	40.2	100	-9.01	39.00	40.20	29.99	16.66	1	12.33	0.31	3%	
10982	-0.105370856	1892716	5567122			40.2	100	-6.4	37.60	39.30	31.20	16.66	1	13.54	0.11	1%	
3487	-0.438903789	1892896	5578820	Domestic	Stock Wat	40.39	100	-12.96	40.39		27.43	16.66	1	9.77	0.44	4%	
4545	-0.167282118	1887341	5571738	Domestic	Stock Wat	40.48	125	-8.7	36.48	40.48	27.78	16.66	1	10.12	0.17	2%	
2324	-0.120130431	1895514	5586566	Domestic	Unknown	40.5	100	-9.01	29.02	30.82	20.01	16.66	1	2.35	0.12	5%	
4952	-0.156787641	1891234	5575779	Domestic	Stock Wat	40.5	100	-3.5	39.00		35.50	16.66	1	17.84	0.16	1%	
5140	-0.210293374	1892635	5577256	Domestic	Stock Wat	40.5	100	-9.01	38.50	40.50	29.49	16.66	1	11.83	0.21	2%	
2068	-0.136074429	1895227	5586617	Irrigation	Unknown	40.7	100	-9.1	40.70	42.80	31.60	16.66	1	13.94	0.14	1%	
1401	-0.066729001	1883081	5569185	Agricultur	Unknown	40.84	150	-16.6	36.73	40.84	20.13	16.66	1	2.47	0.07	3%	
4344	-0.171926308	1892346	5576269	Domestic	(Communa	41	100	1.1	32.34	34.54	33.44	16.66	1	15.78	0.17	1%	
17013	-0.15891854	1891317	5575623			41	150	-9.01	37.10	40.00	28.09	16.66	1	10.43	0.16	2%	
10977	-0.166110097	1891315	5566922			41.1	150	-3.66	38.13	39.96	34.47	16.66	1	16.81	0.17	1%	
4084	-0.057952049	1894881	5567947	Domestic	Stock Wat	41.2	150	-9.01	41.20		32.19	16.66	1	14.53	0.06	0%	
4996	-0.055711322	1884732	5571221	Irrigation		41.2	200	-9.01	34.00	40.00	24.99	16.66	1	7.33	0.06	1%	
5881	-0.127552198	1896004	5589390			41.22	100	-9.01	37.26	38.62	28.25	16.66	1	10.59	0.13	1%	
16402	-0.147087788	1892025	5575476			41.48	150	-9.01	38.58	41.48	29.57	16.66	1	11.91	0.15	1%	
4586	-0.167977658	1892220	5576299	Domestic	Stock Wat	41.7	100	-0.2	35.57	37.07	35.37	16.66	1	17.71	0.17	1%	
5521	-0.195993332	1894744	5589337	Domestic	Water Sup	41.9	150	-9.01	36.40	37.50	27.39	16.66	1	9.73	0.20	2%	
1482	-0.388107073	1895419	5583800	Irrigation	Unknown	42	250	-2.1	30.50	40.50	28.40	16.66	1	10.74	0.39	4%	
16627		1900122	5570537			42	100	-9.01	42.00		32.99	16.66	1	15.33	0.00	0%	
10966	-0.053301613	1897817	5587638			42.1		-7.92	35.92	41.10	28.00	16.66	1	10.34	0.05	1%	
5082	-0.289674926	1898105	5576505	Domestic	Stock Wat	42.5	100	-9.01	40.50	42.50	31.49	16.66	1	13.83	0.29	2%	
2251	-0.143078907	1890415	5568122	Domestic	Stock Wat	42.6	100	-7.62	35.57	38.68	27.95	16.66	1	10.29	0.14	1%	
2019	-0.180302403	1892915	5575828	Agricultur	Unknown	42.67	200	0.6	36.60	42.60	37.20	16.66	1	19.54	0.18	1%	
3082	-0.103747276	1881351	5562026	Domestic	Stock Wat	42.67	100	-23	42.67		19.67	16.66	1	2.01	0.10	5%	
10991	-0.168187375	1890427	5575908	Irrigation		42.67	150	-2.29	37.73	39.62	35.44	16.66	1	17.78	0.17	1%	
5724	-0.257973239	1895270	5575423	Stock Watering		42.7	100	-9.01	39.80	42.70	30.79	16.66	1	13.13	0.26	2%	
1433	-0.12023296	1895714	5586636	Unknown	Unknown	43.3	100	-9.01	41.50	43.30	32.49	16.66	1	14.83	0.12	1%	
3474	-0.148045067	1891921	5567040	Domestic	Stock Wat	43.5	100	-6.7	40.20	42.00	33.50	16.66	1	15.84	0.15	1%	
3593	-0.11235601	1895233	5586317	Domestic	Stock Wat	43.58	100	-15	41.88	43.58	26.88	16.66	1	9.22	0.11	1%	
15870	-0.198513163	1890608	5565541			44	100	-9.01	44.00	45.00	34.99	16.66	1	17.33	0.20	1%	
15935	-0.191447649	1890682	5565038			44	100	-9.01	44.00	45.00	34.99	16.66	1	17.33	0.19	1%	
10907	-0.047269759	1886212	5566320			44.1	100	-3.9	36.24	38.14	32.34	16.66	1	14.68	0.05	0%	
2002	-0.128888693	1895638	5570620	Unknown	Unknown	44.2	200	-0.82	7.60	11.60	6.78	16.66	1	-10.88	0.13	-1%	very shallow top screen
2931	-0.071554575	1886713	5563519	Stock Wat	Unknown	44.2	150	-12	23.16	40.84	11.16	16.66	1	-6.50	0.07	-1%	shallow top screen
15955	-0.241772706	1888761	5564254			44.24	100	-9.01	42.94	44.24	33.93	16.66	1	16.27	0.24	1%	
1439	-0.308973824	1892348	5587464	Domestic	Unknown	44.5	100	-38.1	37.04	38.56	-1.06	16.66	1	-18.72	0.31	-2%	Very deep SWL
6724	-0.228671883	1889254	5564676	Unknown	Unknown	44.5	200	-9.01	30.50	33.50	21.49	16.66	1	3.83	0.23	6%	
1837	-0.012229186	1894591	5564971	Unknown	Unknown	44.84	200	-3.05	43.00	45.00	39.95	16.66	1	22.29	0.01	0%	
6716	-0.245210968	1888504	5564069	Unknown	Unknown	45	200	-11.6	37.30	43.30	25.70	16.66	1	8.04	0.25	3%	
15954	-0.249062769	1888763	5565194			45	100	-9.01	43.15	44.15	34.14	16.66	1	16.48	0.25	2%	
10947	-0.108700224	1895314	5586336			45.1	100	-9.94	40.39	41.91	30.45	16.66	1	12.79	0.11	1%	
15869	-0.200351739	1890383	5566653			45.13	100	-9.01	44.23	45.13	35.22	16.66	1	17.56	0.20	1%	
16264	-0.190682666	1900746	5573503			45.2	100	-9.01	45.20		36.19	16.66	1	18.53	0.19	1%	
5486	-0.169450118	1892172	5576419	Domestic	Water Sup	45.4	100	-9.01	43.86	45.36	34.85	16.66	1	17.19	0.17	1%	
16079	-0.333580019	1897108	5575350			45.52	100	-9.01	43.72	45.52	34.71	16.66	1	17.05	0.33	2%	
1485	-0.049767186	1897746	5587727	Groundwa	Unknown	45.7	250	-8.77	39.31	43.57	30.54	16.66	1	12.88	0.05	0%	
2573	-0.107089	1895214	5586236	Domestic	Unknown	45.7	100	-13	43.30	45.70	30.30	16.66	1	12.64	0.11	1%	
1358	-0.49716299	1905321	5588440	Agricultur	Unknown	45.72	100	0	45.11	45.72	45.11	16.66	1	27.45	0.50	2%	
1390	-0.097697606	1895423	5586260	Domestic	Unknown	45.72	100	-9.9	44.20	45.72	34.30	16.66	1	16.64	0.10	1%	
1394	-0.181101655	1892673	5576316	Irrigation	Unknown	46.33	250	-5.48	34.45	46.33	28.97	16.66	1	11.31	0.18	2%	
1430	-0.183602303	1888469	5574925	Irrigation	Groundwa	46.33	200	-6.857	39.11	45.11	32.25	16.66	1	14.59	0.18	1%	
2579	-0.042948189	1881261	5578098	Stock Wat	Unknown	46.63	100	-22	37.19	46.63	15.19	16.66	1	-2.47	0.04	-2%	deep SWL
10900	-0.369261117	1903920	5590842			46.63	100	-9.01	4.27	5.79	-4.74	16.66	1	-22.40	0.37	-2%	Very shallow top screen
10963		1900721	5571726			46.8	100	-5.36	46.80	6.46	41.44	16.66	1	23.78	0.00	0%	
4285	-0.29536235	1888667	5569245	Irrigation		47	150	-9.01	46.00	47.00	36.99	16.66	1	19.33	0.30	2%	
3490	-0.113285237	1895744	5586528	Domestic	Stock Wat	47.01	100	-7.89	13.50	16.50	5.61	16.66	1	-12.05	0.11	-1%	Shallow top screen

Well Group 40 – 49.99m

15892	-0.035065048	1897202	5590624			47.8	200	-9.01	41.35	47.80	32.34	16.66	1	14.68	0.04	0%					
1532	-0.247859295	1889390	5570932	Irrigation	Unknown	48	150	-10.5	74.00	76.00	63.50	16.66	1	45.84	0.25	1%					
4378	-0.123521989	1895857	5586752	Domestic	Stock Wat	48	100	-12.1	46.20	47.50	34.10	16.66	1	16.44	0.12	1%					
2730	-0.484870799	1891874	5580097	Domestic	Unknown	48.15	150	-23.6	43.59	48.16	19.99	16.66	1	2.33	0.48	21%	deep SWL				
2736	-0.142749828	1895164	5586656	Domestic	Stock Wat	48.2	100	-14	47.24	48.16	33.24	16.66	1	15.58	0.14	1%					
6718	-0.230070555	1889411	5565095	Unknown	Unknown	48.4	200	-9.01	48.40	0.00	39.39	16.66	1	21.73	0.23	1%					
16363	-0.37345137	1896815	5574587			48.65	150	-9.01	45.75	48.65	36.74	16.66	1	19.08	0.37	2%					
3188	-0.036954085	1884119	5576336	Unknown	Unknown	48.8	100	-4.8	33.53	48.80	28.73	16.66	1	11.07	0.04	0%					
1762	-0.064208979	1886180	5563940	Public Wa	Unknown	48.9	150	-4.7	31.08	33.48	26.38	16.66	1	8.72	0.06	1%					
16371	-0.101396064	1893349	5569010			48.9	150	-9.01	46.70	48.90	37.69	16.66	1	20.03	0.10	1%					
3444	-0.012105785	1871854	5567208	Domestic	Stock Wat	49	100	-6.3	42.50	44.50	36.20	16.66	1	18.54	0.01	0%					
16567	-0.299183047	1895567	5577234			49.2	200	-9.01	48.00	49.20	38.99	16.66	1	21.33	0.30	1%					
4722	-0.177412596	1887512	5571583	Irrigation		49.3	200	-17.8	49.30		31.50	16.66	1	13.84	0.18	1%					
4912	-0.146079949	1891927	5575542	Domestic	Water Sup	49.5	100	-9.01	33.00	35.00	23.99	16.66	1	6.33	0.15	2%					
5978	-0.137034129	1895958	5587331			49.5	150	-9.01	38.80	41.70	29.79	16.66	1	12.13	0.14	1%					
4128	-0.061429994	1886138	5564233	Irrigation		49.6	150	-9.01	49.60		40.59	16.66	1	22.93	0.06	0%					
5389	-0.042346761	1898270	5591700	Domestic	Water Sup	49.6	150	-9.01	45.75	47.30	36.74	16.66	1	19.08	0.04	0%					
2903	-0.047461835	1884109	5573925	Stock Wat	Unknown	49.68	100	-1.6	8.23	10.23	6.63	16.66	1	-11.03	0.05	-0.4%	Shallow top screen				
10939	-0.047122765	1884109	5574025			49.7		-9.01	47.21	49.68	38.20	16.66	1	20.54	0.05	0%					
10959	-0.023324964	1898315	5591140			49.7	100	-23.77	21.88	23.07	-1.89	16.66	1	-19.55	0.02	-0.1%	deep SWL				

Well Group Plus 50m

Well No.	NZTM_Easting	NZTM_Northing	Use1	Use2	Depth	Diameter	h_SWL (m	TopScreen1	BtmScreen1	Available Head (m)	Seasonal Variation (m)	Pump Length (m)	Remaining Head (m)	Predicted DD (m)	as % Remaining Head	Comments
3437	1896078	5586838	Domestic Water	Stock Wateri	50	100	-10.5	46.0	47.5	35.5	6.23	1	28.27	6.45	22.81	
4004	1886017	5573599	Domestic Water	Stock Wateri	50	100	-23.8	43.7	45.7	19.9	4.85	1	14.00	0.87	6.18	
5377	1899604	5569774	Stock Watering		50	100	-12.17	5.8	7.1	-6.4	9.38	1	-16.77	0.27	-1.61	very shallow screen - not a deep well
5931	1900556	5571355			50	100	-12.17	50.0		37.8	7.67	1	29.16	0.00	0.00	
11002	1881776	5577248			50	100	-5.03	18.6	19.5	13.6	0.55	1	12.01	0.79	6.60	
10965	1904921	5587939			50.3	100	-8.53	50.3	9.8	41.8	1.95	1	38.82	6.21	16.01	
2749	1892487	5577952	Domestic Water	Groundwate	50.75	200	-6.47	43.0	49.0	36.5	17.93	1	17.60	1.61	9.15	
1900	1894569	5564756	Unknown	Unknown	50.94	250	-0.05	14.6	50.9	14.6	8.71	1	4.84	0.09	1.88	
1638	1881667	5559876	Domestic Water	Unknown	51	100	-38.4	43.0	51.0	4.6	-3.84	1	7.44	0.53	7.14	
1881	1895271	5576725	Irrigation	Unknown	51	250	-20.5	44.0	50.0	23.5	11.22	1	11.28	0.96	8.47	
4451	1888519	5575438	Domestic Water	Stock Wateri	51	100	-15.67	34.2	36.0	18.5	7.48	1	10.05	1.09	10.89	
2050	1884810	5571023	Exploratory Wel	Unknown	51.2	100	-2.32	19.0	51.2	16.7	6.94	1	8.74	0.71	8.16	
10945	1884709	5577527			51.8	100	-17.86	24.6	25.5	6.7	2.30	1	3.41	0.99	29.09	
2775	1891952	5576325	Domestic Water	Unknown	51.81		-12.17	4.0	50.6	-8.2	16.98	1	-26.19	1.27	-4.86	very shallow screen
1402	1891064	5572011	Stock Watering	Unused	52	200	-2.1	67.0	75.0	64.9	43.22	1	20.68	0.87	4.20	
4604	1894062	5566832	Domestic Water	Stock Wateri	52	200	-4.36	43.0	52.0	38.6	13.82	1	23.82	0.10	0.43	
5834	1892423	5580285			52.23	100	-12.17	50.4	52.2	38.3	15.87	1	21.39	2.09	9.78	
1475	1893206	5579093	Irrigation	Groundwate	52.42	200	-10.5	46.3	52.4	35.8	20.20	1	14.63	1.91	13.03	
3882	1896858	5589264	Irrigation		52.5	250	-8.3	44.5	51.5	36.2	4.97	1	30.23	8.04	26.59	
4566	1898683	5582866	Irrigation		53	300	-5.17	48.0	52.0	42.8	5.38	1	36.45	1.99	5.46	
5043	1887861	5570101	Stock Watering		53	100	-12.17	53.0		40.8	24.63	1	15.20	0.74	4.86	
1662	1885763	5577562	Domestic Water	Groundwate	53.04	100	-18.3	33.5	51.8	15.2	3.16	1	11.07	1.09	9.82	
5842	1888880	5582816			53.3	150	-12.17	41.1	53.3	28.9	8.62	1	19.31	2.00	10.36	
4612	1882873	5560659	Domestic Water	Stock Wateri	54	100	-1.5	35.3	36.6	33.8	-3.27	1	36.05	0.00	0.00	
5435	1899607	5569766	Stock Watering		54	200	-12.17	23.6	54.0	11.5	9.37	1	1.08	0.27	25.00	
3084	1882419	5568838	Domestic Water	Stock Wateri	54.2	150	-12.17	45.2	54.2	33.0	1.43	1	30.60	0.62	2.02	
16483	1896975	5589136			54.28	100	-12.17	52.3	54.3	40.2	4.97	1	34.19	7.99	23.36	
2348	1898291	5597424	Irrigation	Unknown	54.86	100	0	54.9	0.0	54.9	2.89	1	50.97	7.80	15.30	
3859	1878573	5572593	LU960169B		54.86	100	-26.6	25.7	54.9	-0.9	2.00	1	-3.94	0.66	-16.77	"inefficient" very low SWL
3434	1886806	5572145	Irrigation	Unknown	55	150	-15.5	48.0	54.0	32.5	11.83	1	19.67	0.82	4.15	
5419	1895646	5574173	Irrigation		55	300	-12.17	52.0	55.0	39.8	16.89	1	21.94	0.54	2.47	
1444	1878266	5567115	Domestic Water	Unknown	55.18	150	-12.8	55.2		42.4	-2.65	1	44.03	0.57	1.30	
1452	1895573	5577578	Irrigation	Groundwate	55.2	300	-21.37	47.8	55.2	26.5	8.53	1	16.95	0.96	5.67	
16023	1893716	5566926			55.39	100	-12.17	53.6	55.4	41.4	15.06	1	25.36	0.12	0.49	
1880	1894914	5577675	Irrigation	Unknown	55.5	250	-25.9	49.5	55.5	23.6	11.27	1	11.33	0.98	8.68	
4206	1898406	5574233	Irrigation		55.5	200	1.4	34.1	43.3	35.5	9.28	1	25.22	0.40	1.58	
4711	1895601	5586511	Fire-fighting	Domestic Wa	55.5	100	-14.85	53.5	55.5	38.6	6.65	1	31.00	5.87	18.93	
11000	1878107	5570121			55.5	75	-27.13	38.7	55.5	11.6	-1.93	1	12.50	0.62	4.98	
4472	1889861	5575578	Domestic Water	Stock Wateri	56	100	-9.06	50.9	52.7	41.8	10.66	1	30.18	1.07	3.55	
10987	1880409	5561517	Domestic Water	Stock Wateri	56.1	100	-30.5	56.1	50.1	25.6	-3.78	1	28.38	0.53	1.88	
16033	1893979	5589928			56.36	150	-12.17	53.5	56.4	41.3	5.53	1	34.76	7.56	21.75	
4150	1895509	5587336	Domestic Water	Stock Wateri	57	100	12.8	53.9	55.7	66.7	6.29	1	59.41	6.84	11.51	
5974	1886561	5573629			57	150	-12.17	57.0		44.8	5.41	1	38.42	0.88	2.29	
15437	1888604	5586127			57.17	100	-12.17	55.4	57.2	43.2	6.78	1	35.42	2.42	6.84	
10958	1897216	5583834			57.3	100	-6.1	50.3	51.2	44.2	6.67	1	36.50	2.28	6.25	
4512	1888756	5575180	Domestic Water	Stock Wateri	57.5	150	-17.32	53.5	55.4	36.2	8.96	1	26.22	1.08	4.11	
3594	1886396	5564703	Domestic Water	Stock Wateri	57.6	150	-10.5	51.6	57.6	41.1	0.73	1	39.37	0.47	1.20	
4654	1894618	5566947	Irrigation		58	200	-3.56	49.0	58.0	45.4	12.90	1	31.54	0.10	0.31	
16478	1886887	5566285	Groundwater sampling/moni		58	100	-12.17	56.8	58.0	44.6	3.50	1	40.08	0.50	1.24	

1861	1898922	5585027	Domestic Water	Groundwate	58.1	250	-0.52	38.7	42.7	38.1	4.87	1	32.28	3.71	11.48	
1381	1887435	5564251	Unknown	Unknown	58.36	200	-2.2	39.4	43.0	37.2	1.75	1	34.41	0.39	1.14	
16931	1886382	5564710			58.4	200	-12.17	52.4	58.4	40.2	0.72	1	38.51	0.47	1.23	
4133	1895685	5586518	Domestic Water	Supply	58.5	100	-12	53.8	55.6	41.8	6.60	1	34.18	5.95	17.41	
16441	1891739	5577813			58.5	150	-12.17	58.5	60.5	46.3	16.16	1	29.17	1.50	5.15	
10956	1878208	5570422			58.8	100	-14.33	17.5	19.2	3.1	2.00	1	0.13	0.63	482.65	
1697	1892806	5568279	Irrigation	Unknown	58.83	250	-6.1	17.7	20.4	11.6	24.59	1	-14.01	0.23	-1.61	"inefficient" very shallow top screen
15442	1900601	5583405			59	150	-12.17	57.7	59.0	45.5	3.61	1	40.92	1.95	4.75	
10927	1895414	5589438	Irrigation		59.3	150	-12.17	59.3		47.1	5.40	1	40.73	8.20	20.14	
16739	1896872	5589031			59.5	100	-12.17	57.6	59.5	45.4	5.04	1	39.39	8.01	20.33	
5522	1892815	5578809	Domestic Water	Supply	60	100	-12.17	53.7	55.3	41.5	19.76	1	20.77	1.86	8.94	
15755	1897306	5573747			60	300	-12.17	40.0	60.0	27.8	12.78	1	14.05	0.50	3.54	
16011	1895524	5586354			60	100	-12.17	56.8	58.6	44.6	6.78	1	36.84	5.64	15.31	
3140	1897027	5568353	Unknown	Unknown	60.4	100	-6.1	0.0	36.3	-6.1	12.84	1	-19.94	0.00	0.00	
4188	1872714	5567306	Domestic Water	Stock Wateri	60.4	100	-12.17	10.8	60.4	-1.3	2.00	1	-4.34	0.56	-12.79	"inefficient" very shallow top screen
2318	1884915	5570026	Exploratory Wel	Unknown	60.96		-12.17	61.0		48.8	7.62	1	40.17	0.69	1.72	
2369	1884811	5569622	Exploratory Wel	Unknown	61	100	-12.17	61.0		48.8	7.07	1	40.76	0.67	1.64	
4447	1887500	5574629	Domestic Water	Stock Wateri	61.5	100	-11.15	33.0	34.8	21.9	6.09	1	14.76	1.03	6.97	
2246	1898424	5580655	Irrigation	Unknown	61.7	250	-13	50.0	60.0	37.0	5.52	1	30.48	1.35	4.43	
4706	1891467	5582390	Irrigation		62	100	-31.2	53.0	61.0	21.8	12.07	1	8.73	2.16	24.78	Very deep SWL
4862	1890050	5582016	Domestic Water	Stock Wateri	62	200	-22.17	60.0	62.0	37.8	10.65	1	26.18	2.12	8.09	
15443	1897326	5573783			62.1	150	-12.17	60.5	62.1	48.3	12.66	1	34.67	0.50	1.43	
2592	1889713	5583146	Exploratory Wel	Unknown	62.48		-13.5	46.3	55.1	32.8	9.45	1	22.35	2.17	9.73	
3218	1891256	5578399	Unknown	Unknown	62.77	150	-27.2	51.8	61.0	24.6	15.01	1	8.59	1.67	19.41	
5150	1895961	5566425	Domestic (Comn	Stock Wateri	63	100	-12.17	63.0		50.8	10.53	1	39.30	0.00	0.00	
4243	1872982	5566093	Domestic Water	Stock Wateri	63.09	100	-3.5	34.9	63.1	31.4	2.00	1	28.39	0.00	0.00	
2136	1885447	5564759	Unknown	Unknown	63.5	200	-15	51.5	63.5	36.5	2.00	1	33.50	0.51	1.52	
2277	1897978	5580036	Irrigation	Unknown	64	250	-13	57.0	66.0	44.0	5.99	1	37.01	1.32	3.56	
2242	1899161	5579134	Irrigation	Unknown	65	250	-10	44.0	47.0	34.0	3.85	1	29.15	1.08	3.70	
15990	1886207	5565883			65.2	150	-12.17	63.5	65.2	51.3	1.78	1	48.55	0.51	1.05	
10964	1883108	5578427			65.8	100	-25.6	41.1	42.0	15.5	1.53	1	12.99	0.90	6.92	
1518	1896641	5584220	Unknown	Groundwate	65.83	200	13	51.2	55.2	64.2	7.00	1	56.16	2.34	4.17	
1429	1888935	5570055	Irrigation	Unknown	65.86	250	-3.65	42.0	44.1	38.4	34.50	1	2.89	0.74	25.60	Quite shallow screen
2276	1897717	5579631	Irrigation	Unknown	66	300	-9	44.0	50.0	35.0	6.22	1	27.78	1.28	4.61	
2531	1883289	5562816	Exploratory Wel	Stock Wateri	66	300	-6.02	48.0	66.0	42.0	2.00	1	38.98	0.53	1.35	
5515	1895692	5588811	Irrigation		66	300	-12.17	54.0	66.0	41.8	5.56	1	35.27	8.97	25.42	
5687	1899553	5578639	Irrigation		66	300	-12.17	54.8	66.0	42.7	3.14	1	38.52	0.73	1.90	
4994	1894092	5577416	Stock Watering		67.5	150	-12.17	67.5		55.3	14.95	1	39.38	1.12	2.84	
1914	1895358	5582744	Unknown	Unknown	68.6	200	-5.18	58.6	68.6	53.4	10.08	1	42.34	2.19	5.16	
16307	1878132	5569962			68.9	100	-12.17	68.9	70.1	56.7	2.00	1	53.73	0.62	1.15	
16498	1898231	5572395			69	100	-12.17	67.8	69.0	55.7	11.91	1	42.76	0.44	1.03	
3073	1894644	5592606	Domestic Water	Stock Wateri	69.19	100	-30.3	55.8	68.0	25.5	4.44	1	20.04	7.97	39.79	Very deep SWL
2278	1898466	5579717	Irrigation	Groundwate	69.5	250	-11	49.6	52.6	38.6	5.08	1	32.52	1.23	3.78	
1312	1892412	5587336	Domestic Water	Unknown	69.8	200	-27.43	63.8	69.8	36.4	7.19	1	28.18	5.30	18.80	
3722	1889592	5572175	Irrigation	Groundwate	70	300	-12.17	70.0		57.8	36.70	1	20.13	0.87	4.33	
4295	1898731	5587673	Irrigation		70	300	-12.17	70.0		57.8	4.54	1	52.29	7.16	13.70	
4950	1896927	5582491	Domestic Water	Stock Wateri	70	100	-12.17	62.0	64.0	49.8	7.86	1	40.97	2.19	5.35	
5670	1892496	5565872	Irrigation		70.5	100	-12.17	66.5	70.5	54.3	13.26	1	40.07	0.17	0.41	
1832	1894006	5580256	Unknown	Unknown	70.99	200	-18	63.0	71.0	45.0	13.19	1	30.80	2.09	6.80	
3483	1896114	5591139	Unknown	Unknown	71	150	-22	58.5	70.5	36.5	4.62	1	30.88	8.00	25.91	Very deep SWL

10971	1886310	5579529	Unused		71	100	-12.17	71.0		58.8	4.69	1	53.14	1.21	2.27	
16913	1884207	5568248			71	100	-12.17	63.5	71.0	51.3	3.93	1	46.40	0.61	1.32	
16782	1899303	5578022			71.5	300	-12.17	52.0	71.5	39.8	3.38	1	35.45	0.54	1.54	
3204	1897687	5581374	Unknown	Unknown	72.5	300	-13	62.0	65.0	49.0	6.90	1	41.10	1.81	4.41	
10928	1894116	5573627			72.6	100	-9.95	71.0	72.6	61.1	23.49	1	36.56	0.70	1.92	
4913	1887096	5571670	Irrigation		73	200	-12.17	73.0		60.8	15.65	1	44.18	0.79	1.80	
16492	1894468	5567403			73.03	150	-12.17	72.3	73.0	60.2	14.30	1	44.86	0.10	0.23	
1836	1893998	5565080	Unknown	Unknown	73.2	200	-7.02	33.9	61.6	26.8	9.73	1	16.11	0.09	0.57	
16930	1889357	5564341			73.24	200	-12.17	70.2	73.2	58.1	5.01	1	52.06	0.23	0.45	
10972	1877006	5570421			74.4	100	-12.17	74.4		62.2	2.00	1	59.23	0.00	0.00	
4656	1893704	5566631	Irrigation		74.8	200	-12.17	49.8	74.8	37.6	14.13	1	22.50	0.12	0.52	
1826	1891572	5580465	Irrigation	Groundwate	74.98	200	-22.86	56.7	68.7	33.8	14.58	1	18.25	2.11	11.56	
1426	1889640	5576143	Irrigation	Groundwate	75.28	250	-4.87	38.1	44.2	33.2	8.19	1	24.04	1.12	4.65	
6713	1889372	5565106	Unknown	Unknown	75.5	100	-5.2	75.5	0.0	70.3	6.93	1	62.37	0.25	0.40	
4568	1894456	5564292	Domestic Water	Stock Wateri	76	100	-10.3	76.0		65.7	7.94	1	56.76	0.00	0.00	
5671	1894072	5576264	Stock Watering		76	100	-12.17	70.7	72.7	58.5	16.05	1	41.44	1.02	2.47	
16765	1893210	5579094			76.05	300	-12.17	64.9	76.1	52.7	20.18	1	31.53	1.91	6.05	
5167	1899529	5582842	Irrigation		76.7	250	-12.17	69.4	76.7	57.2	4.49	1	51.74	1.84	3.56	
6723	1889264	5564670	Unknown	Unknown	76.81	200	-12.17	61.0	70.0	48.8	5.59	1	42.24	0.24	0.57	
4685	1889691	5575889	Irrigation		77	250	-10.55	76.0	77.0	65.4	8.51	1	55.94	1.09	1.95	
5344	1892498	5565918	Irrigation		77	300	-12.17	69.0	74.0	56.8	13.43	1	42.40	0.17	0.39	
16454	1884881	5579634			77	125	-12.17	29.0	77.0	16.8	3.26	1	12.57	1.10	8.76	
10969	1877806	5571422			77.1	75	-12.17	77.1		64.9	2.00	1	61.93	0.64	1.04	
6721	1889635	5564890	Unknown	Unknown	77.11	200	-18.37	61.6	67.7	43.2	6.71	1	35.48	0.23	0.66	
4061	1890478	5581321	Domestic Water	Stock Wateri	77.35	200	-12.17	77.3		65.2	11.82	1	52.36	2.12	4.06	
3870	1895977	5584310	Irrigation	Unknown	77.39	300	10	57.4	77.4	67.4	7.54	1	58.85	2.38	4.05	
3452	1890930	5571338	Unused	Unused	77.7	100	-3.8	71.1	72.7	67.3	49.03	1	17.27	0.84	4.89	
10890	1886185	5582190			77.7	100	-31.7	44.4	77.7	12.7	5.40	1	6.30	1.49	23.67	Very deep SWL
16490	1894088	5574285			78.5	150	-12.17	77.8	78.5	65.6	21.44	1	43.19	0.86	1.98	
4302	1886646	5573106	Irrigation		79	100	-35.8	73.8	76.8	38.0	6.98	1	30.07	0.86	2.85	
15458	1889388	5564757			79	200	-12.17	64.0	79.0	51.8	6.00	1	44.83	0.24	0.53	
3658	1879720	5559800	Domestic Water	Stock Wateri	79.25	100	-36	73.3	79.3	37.3	2.00	1	34.25	0.00	0.00	
16486	1900477	5577147	Groundwater sampling/moni		79.5	150	-12.17	78.3	79.5	66.1	1.61	1	63.52	0.34	0.54	
11001	1878106	5572623			80.2	75	-12.17	80.2		68.0	2.00	1	65.03	0.00	0.00	
16813	1889896	5564942			80.5	250	-12.17	71.5	80.5	59.3	7.26	1	51.07	0.23	0.45	
4450	1895580	5568257	Exploratory Well		81	340	-12.17	65.7	81.0	53.6	15.38	1	37.18	0.12	0.32	
5723	1898543	5585936			81	300	-12.17	61.5	81.0	49.3	4.98	1	43.30	4.34	10.03	
4110	1890247	5570750	Stock Watering	Unknown	81.2	300	-12.17	70.7	80.4	58.5	51.32	1	6.18	0.78	12.61	
2160	1896495	5586371	Exploratory Wel	Unknown	81.4	250	-3.44	81.4		78.0	6.18	1	70.78	5.70	8.05	
16477	1895377	5583147	Groundwater sampling/moni		82.42	100	-12.17	80.2	81.4	68.1	9.00	1	58.05	2.23	3.85	
6715	1889064	5564222	Unknown	Unknown	83	200	-14.76	68.0	74.0	53.2	4.33	1	47.91	0.24	0.50	
2043	1894411	5577232	Irrigation	Groundwate	83.5	250	6.4	76.6	82.6	83.0	13.76	1	68.24	0.99	1.46	
10983	1878508	5560516	Domestic Water	Stock Wateri	83.5	75	-28.04	83.5		55.5	2.00	1	52.46	0.00	0.00	
6712	1889246	5564625	Unknown	Unknown	84	150	-11.6	34.0	37.0	22.4	5.45	1	15.95	0.24	1.52	
16094	1886857	5569347			84.44	100	-12.17	83.4	84.4	71.3	15.91	1	54.36	0.71	1.30	
1947	1881710	5565719	Unknown	Unknown	85.34	100	-12.17	85.3		73.2	2.00	1	70.17	0.56	0.79	
2913	1903919	5590741	Domestic Water	Stock Wateri	85.34	100	-14.16	85.3		71.2	2.32	1	67.86	0.00	0.00	
3354	1878829	5561067	Domestic Water	Stock Wateri	85.34	150	-31.7	60.9	85.3	29.2	2.00	1	26.23	0.54	2.04	
3757	1878563	5562259	Domestic Water	Stock Wateri	85.34	100	-40	83.0	85.3	43.0	2.00	1	40.04	0.54	1.35	
6717	1888987	5564566	Unknown	Unknown	86	200	0.7	86.0		86.7	4.89	1	80.81	0.25	0.31	

4697	1890296	5571107	Groundwater sampling/moni		86.5	150	-7	84.5	86.5	77.5	52.48	1	24.02	0.81	3.39	
16879	1891887	5576428			87.12	150	-12.17	85.8	87.1	73.6	16.70	1	55.95	1.29	2.30	
1859	1894283	5580733	Irrigation	Unknown	87.5	250	-10	77.5	87.5	67.5	14.05	1	52.45	2.12	4.04	
16508	1895969	5579781			87.6	300	-12.17	85.6	119.6	73.5	9.81	1	62.64	2.00	3.19	
6719	1889909	5565432	Unknown	Groundwate	88.2	200	-2	30.0	36.0	28.0	8.81	1	18.19	0.24	1.32	
15939	1892276	5576307			89.19	100	-12.17	87.5	89.2	75.3	17.53	1	56.79	1.26	2.21	
16881	1895562	5586557			89.68	150	-12.17	88.7	89.7	76.5	6.65	1	68.86	5.87	8.52	
2933	1894023	5580255	Exploratory Wel	Unknown	90	300	-9	75.3	89.3	66.3	13.19	1	52.11	2.09	4.02	
10976	1875593	5565269			90.11	100	-22.5	90.1		67.6	2.00	1	64.61	0.55	0.86	
4672	1898948	5585643	Irrigation		90.9	300	-12.17	68.4	88.8	56.2	4.76	1	50.44	4.06	8.04	
4122	1895418	5583796	Irrigation		91.2	300	-12.17	70.0	73.0	57.8	8.42	1	48.41	2.33	4.82	
10988	1880009	5561817			92.28	75	-36.58	92.3		55.7	2.00	1	52.70	0.54	1.02	
16816	1894881	5578475			93	150	-12.17	90.1	93.0	77.9	11.94	1	64.99	1.36	2.09	
3866	1893975	5582014	Irrigation		94.5	200	-5.96	80.0	94.0	74.0	14.23	1	58.81	2.14	3.63	
10901	1903919	5590841			94.5	100	-12.17	94.5		82.3	2.32	1	79.01	0.00	0.00	
5425	1897691	5590212	Stock Watering		95	100	-12.17	93.3	95.0	81.1	4.42	1	75.71	8.14	10.76	
4923	1892501	5564759	Irrigation		96		-12.17	96.0		83.8	9.53	1	73.30	0.14	0.19	
16374	1891025	5587320			96.9	150	-12.17	71.9	96.9	59.7	7.09	1	51.64	4.85	9.40	
3774	1890300	5572513	Irrigation	Groundwate	97.5	300	-25.18	68.4	75.5	43.2	37.81	1	4.41	0.88	20.04	Very deep SWL
1915	1881558	5566665	Unknown	Unknown	97.53	100	-10	97.5		87.5	2.00	1	84.53	0.57	0.67	
1869	1894156	5574741	Unknown	Unknown	98	250	9.8	92.0	98.0	101.8	19.79	1	81.01	0.92	1.13	
2219	1893617	5579768	Irrigation	Unknown	98	250	-12.17	88.5	94.5	76.3	15.18	1	60.15	1.99	3.30	
4700	1894523	5581470	Groundwater sampling/moni		98	220	-2.65	98.0		95.3	15.19	1	79.16	2.13	2.69	
16587	1895152	5597796			98	100	-12.17	72.7	98.0	60.6	3.12	1	56.45	0.00	0.00	
10903	1880009	5561817			98.4	75	-19.51	29.9	98.4	10.4	2.00	1	7.39	0.54	7.24	
16713	1895726	5572774			98.82	300	-12.17	86.6	98.8	74.4	19.42	1	54.01	0.52	0.96	
4838	1887379	5565307	Irrigation		99.3	200	-17.96	80.4	99.3	62.4	3.04	1	58.39	0.41	0.70	
2259	1897718	5579331	Unknown	Unknown	102	300	-9	102.0	0.0	93.0	6.07	1	85.93	1.24	1.45	
4135	1887602	5571461	Domestic Water	Stock Wateri	102	150	-4	102.0		98.0	20.47	1	76.53	0.79	1.03	
16668	1895725	5572776			102	150	-12.17	96.5	97.5	84.3	19.42	1	63.90	0.52	0.81	
6722	1889238	5564075	Groundwater sa	Unknown	102.11	200	-43.73	102.1		58.4	4.30	1	53.08	0.23	0.43	
16317	1889683	5575888			103.5	250	-12.17	103.5	109.5	91.3	8.49	1	81.84	1.09	1.34	
4702	1892928	5563969	Groundwater sa	Exploratory \	105	150	-9.05	103.3	105.5	94.3	7.59	1	85.66	0.11	0.13	
16639	1889690	5575890			108	125	-12.17	107.0	108.0	94.8	8.50	1	85.33	1.09	1.28	
15353	1895548	5577979			109	65	-12.17	109.0		96.8	8.79	1	87.04	0.98	1.13	
2220	1893783	5579993	Irrigation	Groundwate	110	250	-11.4	81.5	94.5	70.1	13.44	1	55.66	2.04	3.67	
16817	1894879	5578463			110	250	-12.17	77.2	110.0	65.0	11.94	1	52.09	1.34	2.58	
4701	1897911	5576587	Groundwater sa	Exploratory \	111	150	-1.7	108.0	111.0	106.3	6.60	1	98.70	0.90	0.91	
4521	1889893	5573285	Irrigation		112	300	-3.6	112.0		108.4	27.60	1	79.80	0.92	1.15	
16408	1892693	5576292			114.53	250	-12.17	114.5	119.8	102.4	17.84	1	83.52	1.23	1.47	
16592	1898811	5590919			115.75	100	-12.17	193.2	211.2	181.0	3.90	1	176.09	8.44	4.79	
5707	1898101	5585510	Irrigation		117	300	-12.17	111.0	117.0	98.8	5.38	1	92.45	4.16	4.50	
5385	1888280	5563893	Stock Watering		117.6	100	-12.17	96.8	117.6	84.7	2.59	1	81.09	0.31	0.38	
4418	1891348	5582725	Irrigation		118.5	150	-27	115.4	117.5	88.4	11.57	1	75.88	2.18	2.87	
15020	1890294	5571104	Groundwater sampling/moni		119	32	-12.17	117.0	119.0	104.8	52.49	1	51.34	0.81	1.59	
3854	1891828	5566526	Irrigation	Unknown	121	250	-9.35	60.5	100.0	51.1	16.64	1	33.51	0.20	0.58	
5084	1891423	5581794	Irrigation		121	100	-12.17	116.2	118.0	104.0	12.72	1	90.31	2.14	2.37	
16428	1888457	5574904	Groundwater sampling/moni		122.8	100	-12.17	100.3	102.2	88.1	8.86	1	78.28	1.06	1.36	
3852	1889611	5570382	Irrigation	Groundwate	123	200	-11.8	115.0	121.0	103.2	42.81	1	59.39	0.75	1.27	
4729	1892274	5560770	Domestic Water	Stock Wateri	123	100	-2.14	123.0	123.0	120.9	2.40	1	117.46	0.00	0.00	

4764	1896353	5579075	Irrigation		123	300	-12.17	96.0	120.0	83.8	8.28	1	74.55	1.66	2.22
5373	1900087	5579032	Irrigation		123	100	-12.17	67.2	68.5	55.0	2.68	1	51.35	0.73	1.41
3702	1887644	5573215	Domestic Water	Stock Wateri	123.5	200	-25.9	114.5	123.5	88.6	8.95	1	78.65	0.88	1.12
4882	1891769	5572459	Irrigation		123.8	300	-10.1	109.5	123.8	99.4	37.27	1	61.13	0.87	1.43
16549	1894879	5573143			126.17	300	-12.17	126.2		114.0	21.98	1	91.02	0.53	0.59
4820	1888937	5570057	Irrigation		129	300	-12.17	123.0	129.0	110.8	34.52	1	75.31	0.74	0.98
2041	1891082	5568784	Irrigation	Unknown	130	200	-5.8	97.1	110.1	91.3	32.74	1	57.55	0.45	0.79
4761	1900489	5573732	Irrigation		130	300	-12.17	130.0		117.8	6.01	1	110.82	0.27	0.24
4934	1887581	5570259	Irrigation		130	300	-12.17	130.0		117.8	22.40	1	94.43	0.74	0.79
5445	1890301	5571106	Exploratory Well		130	100	-12.17	129.3	130.0	117.1	52.46	1	63.62	0.82	1.28
5586	1884667	5567526	Irrigation		131	300	-12.17	119.0	131.0	106.8	3.61	1	102.22	0.59	0.58
4593	1896642	5584217	Irrigation		134	300	17.5	111.6	129.0	129.1	7.00	1	121.10	2.34	1.93
4673	1890920	5582979	Irrigation		136.5	200	-12.17	113.5	123.5	101.3	10.88	1	89.45	2.20	2.46
4830	1894084	5576273	Irrigation		137	300	4.3	125.0	135.0	129.3	16.00	1	112.30	1.02	0.91
5498	1893721	5575604	Irrigation		139.7	250	-12.17	132.7	139.7	120.5	18.27	1	101.26	1.04	1.03
15938	1882853	5573882			141	150	-12.17	129.8	152.8	117.6	1.45	1	115.19	0.74	0.64
3104	1896503	5576591	Irrigation	Groundwate	142	300	6.4	92.0	94.0	98.4	8.77	1	88.63	0.93	1.05
15021	1894517	5581470	Groundwater sampling/moni		148.5	110	-12.17	148.5		136.3	15.21	1	120.12	2.13	1.77
4817	1888680	5580498	Domestic Water	Stock Wateri	150	200	-12.17	150.0		137.8	8.72	1	128.11	1.59	1.24
6720	1889625	5564890	Unknown	Unknown	150	200	-12.17	150.0	0.0	137.8	6.69	1	130.14	0.24	0.18
15431	1896453	5587889			150	250	-12.17	134.0	150.0	121.8	5.61	1	115.22	7.45	6.47
5427	1884623	5567526	Irrigation		152	100	-12.17	146.3	147.8	134.1	3.53	1	129.60	0.59	0.46
1946	1881209	5566520	Unknown	Unknown	152.4	100	-12.17	152.4		140.2	2.00	1	137.23	0.57	0.41
16563	1898976	5590999			153.5	200	-12.17	145.0	153.5	132.8	3.83	1	128.00	8.46	6.61
16562	1898811	5590919			154.57	100	-12.17	153.4	154.6	141.2	3.90	1	136.33	8.44	6.19
5497	1897384	5583557	Irrigation		157.1	300	-12.17	151.0	157.1	138.8	6.63	1	131.20	2.26	1.72
5591	1891706	5581548	Irrigation		162.5	100	-12.17	133.0	135.0	120.8	13.35	1	106.48	2.14	2.01
5392	1891736	5581595	Irrigation	Irrigation	163	300	-12.17	163.0		150.8	13.32	1	136.51	2.14	1.57
4659	1900473	5573713	Exploratory Well		180	100	-4.5	180.0		175.5	6.06	1	168.44	0.27	0.16
4631	1878233	5572504	Domestic Water	Stock Wateri	206	100	-12.17	206.0		193.8	2.00	1	190.83	0.00	0.00
5967	1893334	5564474			231	150	-12.17	231.0		218.8	8.69	1	209.14	0.11	0.05
5997	1893389	5564459			238	300	-12.17	238.0		225.8	8.64	1	216.19	0.10	0.05
4736	1897196	5576670	Irrigation		300	300	-12.17	300.0		287.8	7.58	1	279.25	0.92	0.33
4270	1890450	5568344	Irrigation		307	200	-12.17	307.0		294.8	28.94	1	264.89	0.46	0.17
4489	1888029	5572055	Irrigation		342	300	-13.4	48.4	72.0	35.0	20.97	1	13.03	0.83	6.39
10998	1883026	5569136	Exploratory Well		1059	660	-12.17	1059.0		1046.8	2.55	1	1043.28	0.63	0.06
10997	1891685	5576782	Exploratory Well		1573	5080	-12.17	1573.0		1560.8	15.90	1	1543.93	1.33	0.09

Summary of All Flagged Wells <50m

NZTM_ Easting	NZTM_ Northing	Well No.	Point Sample - Grid value	Use1	Use2	Depth	Diameter	h_SWL	TopScreen	BtmScreen	Available head (m)	Seasonal variation (m)	Pump length (m)	Remaining Head (m)	Predicted DD (m)	as % remaining head	Comments
1888814	5561887	3827	-0.13009	Domestic	Stock Wat	0	200	0.00			0.00	1.62	0	-1.62	0.13	-8%	Spring
1899720	5572827	10920	-0.34583	Irrigation		0		0.00			0.00	1.62	0	-1.62	0.35	-21%	Spring
1897499	5576482	10922	-0.32404	Irrigation		0		0.00			0.00	1.69	0	-1.69	0.32	-19%	Spring
1896406	5570496	16356	-0.14228			0.6	68	0.00	0.60	4.60	0.60	1.82	0	-1.22	0.14	-12%	<2m deep
1896166	5570478	16365	-0.13253			1	68	0.00	1.00	5.00	1.00	1.82	0	-0.82	0.13	-16%	<2m deep
1897932	5577165	15031	-0.31069	Unknown		1.4	100	0.00			1.40	1.70	0	-0.30	0.31	-102%	<2m deep
1896464	5570674	16358	-0.16024			1.5	68	0.00	1.50	6.00	1.50	1.82	0	-0.32	0.16	-50%	<2m deep
1896197	5570879	16357	-0.15531			1.55	68	0.00	1.55	6.05	1.55	1.83	0	-0.28	0.16	-56%	<2m deep
1900930	5577261	15667	-0.13265			2		0.00			2.00	1.67	0	0.33	0.13	40%	<2m deep
1900108	5574841	2030	-0.02926	Domestic	Stock Wat	3	1000	-1.92			1.08	1.59	0	-0.51	0.03	-6%	Potentially inefficient
1898987	5571262	10962	-0.29585	Domestic	Stock Wat	3.2	100	-2.07	8.00	10.00	1.13	1.76	0	-0.63	0.30	-47%	Potentially inefficient
1896881	5577266	15014	-0.33293	Unused		3.3	150	-1.92			1.38	1.76	0	-0.38	0.33	-89%	Unused
1897096	5577818	15025	-0.37452	Unused		3.3	1000	-1.92			1.38	1.77	0	-0.39	0.37	-97%	Unused
1884001	5576264	2747	-0.02882	Irrigation	Unknown	3.6	750	-1.60	2.60	3.60	2.00	2.30	0	-0.30	0.03	-10%	Potentially inefficient
1896470	5579090	15028	-0.47566	Groundwa	Unused	3.9	100	-1.92			1.98	1.84	0	0.14	0.48	342%	Unused/GW monitoring
1877285	5563499	15866	-0.08406			4	1000	-1.92			2.08	1.95	0	0.13	0.08	66%	
1901041	5580364	2902	-0.35749	Domestic	Stock Wat	4.11	100	-1.45	2.11	4.11	2.66	1.80	0	0.86	0.36	42%	
1896292	5579170	15023	-0.56496	Groundwa	Unused	4.5	100	-1.92			2.58	1.85	0	0.73	0.56	77%	Unused/GW monitoring
1896338	5579170	15024	-0.53588	Groundwa	Unused	4.6	100	-1.92			2.68	1.85	0	0.83	0.54	64%	Unused/GW monitoring
1898841	5573230	5137	-0.39475	Groundwater sampli		4.7	100	-1.92	2.47	4.00	2.78	1.61	0	1.17	0.39	34%	GW Monitoring
1893617	5587028	4227	-0.28168	Groundwater sampli		4.89	100	-1.60	1.80	4.40	3.29	2.16	0	1.13	0.28	25%	GW Monitoring
1895261	5581232	5532	-0.28255	Unknown		5	1200	-1.92			3.08	1.96	0	1.12	0.28	25%	
1904521	5585737	1357	-0.72144	Domestic	Unknown	5.18	100	-2.13	0.00	0.00	3.05	1.94	0	1.11	0.72	65%	
1897308	5579545	16346	-0.51372			6	150	-1.92			4.08	1.83	0	2.25	0.51	23%	
1896008	5578658	4620	-0.75193	Groundwater sampli		6.8	100	-1.92			4.88	1.84	0	3.04	0.75	25%	GW Monitoring
1899820	5574178	3590	-0.12814	Domestic	Stock Wat	7.3	100	-5.50			1.80	1.55	0	0.25	0.13	52%	
1900138	5579254	3690	-0.46946	Domestic	Water Sup	7.5	100	-4.30			3.20	1.75	0	1.45	0.47	32%	
1880298	5570202	3175	-0.10642	Stock Wat	Domestic	10.05	150	-3.2	4	10.05	0.80	2.46	0	-1.66	0.11	-6%	very shallow top screen/potentially inefficient
1889093	5575720	4477	-0.19672	Groundwater sampli		10.2	100	-6.3	6.2	10.20	-0.10	4.34	0	-4.44	0.20	-4%	GW Sampling
1884517	5568179	3494	-0.06406	Domestic	Stock Wat	10.5	150	-3.2	5.35	10.50	2.15	2.37	0	-0.22	0.06	-29%	very shallow top screen/potentially inefficient
1893666	5587059	4228	-0.27805	Groundwater sampli		11.18	100	-10.35	8.4	11.20	-1.95	7.27	0	-9.22	0.28	-3%	GW Sampling/potentially inefficient/very deep hSWL
1889144	5575689	5356	-0.19548	Groundwater sampli		11.8	50	-3.9	5.8	11.80	1.90	4.34	0	-2.44	0.20	-8%	Potenitally inefficient
1897594	5580050	3076	-0.5247	Unknown	Groundwa	11.99	150	-7.63	11.99		4.36	6.13	0	-1.77	0.52	-30%	GW Sampling/deep hSWL
1896860	5581052	16345	-0.38788			12	150	-3.9	11	12.00	7.10	7.38	0	-0.28	0.39	-138%	Potenitally inefficient
1898532	5579677	2979	-0.49791	Unknown	Groundwa	12.4	150	-9.35	11	12.00	1.65	5.19	0	-3.54	0.50	-14%	GW Sampling
1889128	5575579	5502	-0.1935	Exploratory Well		12.4	50	-3.9	6.5	12.40	2.60	4.30	0	-1.70	0.19	-11%	Potenitally inefficient
1880180	5570103	3421	-0.10882	Domestic	Stock Wat	12.6	150	-5.95	8.27	10.80	2.32	2.45	0	-0.13	0.11	-86%	Potenitally inefficient
1899118	5581233	1414	-0.33854	Domestic	Unknown	12.8	100	-9.14	11.73	12.80	2.59	5.85	0	-3.26	0.34	-10%	Potenitally inefficient
1898417	5581833	10968	-0.3258			13.1	150	-2.37	10.36	11.58	7.99	6.76	0	1.23	0.33	27%	
1882212	5584957	2809	-0.01816	Domestic	Stock Wat	14.2599	150	-9	10.59	14.25	1.59	2.96	0	-1.37	0.02	-1%	Potenitally inefficient/deep hSWL
1893683	5587022	5662	-0.27821	Exploratory Well		15.5	50	-3.9	11.5	15.50	7.60	7.30	0	0.30	0.28	91%	
1893715	5575728	2773	-0.20803	Domestic	Stock Wat	18	150	-7.1	12	18.00	4.90	4.65	0	0.25	0.21	84%	
1900702	5579478	5211	-0.39061	Irrigation		18.5	300	-3.9	9	18.50	5.10	3.63	0	1.47	0.39	27%	
1884667	5570868	16097	-0.04906			18.5	100	-3.9	6.5	18.50	2.60	2.77	0	-0.17	0.05	-28%	Potenitally inefficient/shallow screen
1879709	5566220	10931	-0.09053			20.1	200	-2.13	10.12	20.12	7.99	11.47	1	-4.48	0.09	-2%	Potentially inefficient
1879938	5566652	1944	-0.09303	Domestic	Groundwa	20.6	200	-2.13	7.06	17.06	4.93	11.34	1	-7.41	0.09	-1%	Potentially inefficient
1899019	5578431	10995	-0.46635	Agriculture (not irrig		21.34	100	-10.5	16.10	18.90	5.6	6.47	1	-1.87	0.47	-25%	Potentially inefficient/ very deep hSWL
1893949	5584422	10948	-0.60286			22.6	100	-17.06	20.09	21.00	3.03	10.39	1	-8.36	0.60	-7%	Potentially inefficient/very deep hSWL
1879939	5566652	4780	-0.09303	Stock Watering		25	150	-2.4	3.65	15.50	1.25	11.34	1	-11.09	0.09	-1%	Very shallow top screen?
1900145	5574350	3664	-0.10882	Domestic	Stock Wat	25.6	100	-8.02	14.03	25.60	6.01	4.88	1	0.13	0.11	82%	
1884307	5586533	11005	-0.04301			25.6	100	-11.28	18.26	19.78	6.98	11.02	1	-5.04	0.04	-1%	Potentially inefficient/deep hSWL
1898782	5575258	3843	-0.08403	Irrigation	Unknown	28	300	-4.17	10.50	16.50	6.33	5.09	1	0.24	0.08	35%	
1894170	5586699	1396	-0.25011	Domestic	Agricultur	28.35	400	-19.51	26.67	28.35	7.16	10.91	1	-4.75	0.25	-5%	Potentially inefficient/deep hSWL
1893814	5584834	10978	-0.57347			28.35	100	-9.44	21.88	22.82	12.44	10.58	1	0.86	0.57	67%	
1890872	5563198	2926	-0.15162	Domestic	Stock Wat	30.02	100	-14.15	1.53	28.03	-12.62	7.42	1	-21.04	0.15	-1%	very shallow top screen level?
1881351	5565851	2729	-0.08726	Domestic	Stock Wat	30.4899	100	-3.26	9.45	10.82	6.19	7.42	1	-2.23	0.09	-4%	Shallow top screen, potentially inefficient
1889315	5560917	10895	-0.06095			30.9	75	-14.6	16.50	30.90	1.90	7.42	1	-6.52	0.06	-1%	Deep SWL and shallow topscreen
1892475	5575978	2779	-0.16728	Domestic	Unknown	31.08		-1.21	5.18	25.90	3.97	7.42	1	-4.45	0.17	-4%	very shallow top screen level?
1898902	5573322	2543	-0.38856	Explorato	Unknown	33.1	300	-1.36	8.00	10.20	6.64	7.42	1	-1.78	0.39	-22%	very shallow top screen level?
1880706	5578127	10894	-0.05748			34.7	100	-6.37	10.36	11.35	3.99	7.42	1	-4.43	0.06	-1%	Shallow top screen, potentially inefficient
1892212	5587436	11004	-0.31256			36.6	100	-28.65	27.80	28.71	-0.85	7.42	1	-9.27	0.31	-3%	Very deep SWL
1901321	5576730	10899	-0.06068			37.5	100	-1	1.37	3.69	0.37	7.42	1	-8.05	0.06	-1%	very shallow top screen level?
1889415	5564119	6714	-0.21574	Unknown	Unknown	38	200	-6.37	0.00	0.00	-6.37	7.42	1	-14.79	0.22	-1%	very shallow top screen level?
1895638	5570620	2002	-0.12889	Unknown	Unknown	44.2	200	-0.82	7.60	11.60	6.78	16.66	1	-10.88	0.13	-1%	very shallow top screen
1886713	5563519	2931	-0.07155	Stock Wat	Unknown	44.2	150	-12	23.16	40.84	11.16	16.66	1	-6.50	0.07	-1%	shallow top screen
1892348	5587464	1439	-0.30897	Domestic	Unknown	44.5	100	-38.1	37.04	38.56	-1.06	16.66	1	-18.72	0.31	-2%	Very deep SWL
1881261	5578098	2579	-0.04295	Stock Wat	Unknown	46.63	100	-22	37.19	46.63	15.19	16.66	1	-2.47	0.04	-2%	deep SWL
1903920	5590842	10900	-0.36926			46.63	100	-9.01	4.27	5.79	-4.74	16.66	1	-22.40	0.37	-2%	Very shallow top screen
1895744	5586528	3490	-0.11329	Domestic	Stock Wat	47.01	100	-7.89	13.50	16.50	5.61	16.66	1	-12.05	0.11	-1%	Shallow top screen
1891874	5580097	2730	-0.48487	Domestic	Unknown	48.15	150	-23.6	43.59	48.16	19.99	16.66	1	2.33	0.48	21%	deep SWL
1884109	5573925	2903	-0.04746	Stock Wat	Unknown	49.68	100	-1.6	8.23	10.23	6.63	16.66	1	-11.03	0.05	-0.4%	Shallow top screen
1898315	5591140	10959	-0.02332			49.7	100	-23.77	21.88	23.07	-1.89	16.66	1	-19.55	0.02	-0.1%	deep SWL

Summary of All Flagged Wells >50m Deep

NZTM_Easting	NZTM_Northin	Well No.	Use1	Use2	Depth	Diameter	h_SWL (m	TopScreen1	BtmScreen1	Available Head (m)	Seasonal Variation (m)	Pump Length (m)	Remaining Head (m)	Predicted DD (m)	as % Remaining Head	Comments
1896078	5586838	3437	Domestic Water	Stock Wateri	50	100	-10.5	46.0	47.5	35.5	6.23	1	28.27	6.45	22.81	
1899604	5569774	5377	Stock Watering		50	100	-12.17	5.8	7.1	-6.4	9.38	1	-16.77	0.27	-1.61	very shallow screen - not a deep well
1884709	5577527	10945			51.8	100	-17.86	24.6	25.5	6.7	2.30	1	3.41	0.99	29.09	
1891952	5576325	2775	Domestic Water	Unknown	51.81		-12.17	4.0	50.6	-8.2	16.98	1	-26.19	1.27	-4.86	very shallow screen
1896858	5589264	3882	Irrigation		52.5	250	-8.3	44.5	51.5	36.2	4.97	1	30.23	8.04	26.59	
1899607	5569766	5435	Stock Watering		54	200	-12.17	23.6	54.0	11.5	9.37	1	1.08	0.27	25.00	
1896975	5589136	16483			54.28	100	-12.17	52.3	54.3	40.2	4.97	1	34.19	7.99	23.36	
1878573	5572593	3859	LU960169B		54.86	100	-26.6	25.7	54.9	-0.9	2.00	1	-3.94	0.66	-16.77	"inefficient" very low SWL
1893979	5589928	16033			56.36	150	-12.17	53.5	56.4	41.3	5.53	1	34.76	7.56	21.75	
1878208	5570422	10956			58.8	100	-14.33	17.5	19.2	3.1	2.00	1	0.13	0.63	482.65	"inefficient" very shallow top screen
1892806	5568279	1697	Irrigation	Unknown	58.83	250	-6.1	17.7	20.4	11.6	24.59	1	-14.01	0.23	-1.61	"inefficient" very shallow top screen
1895414	5589438	10927	Irrigation		59.3	150	-12.17	59.3		47.1	5.40	1	40.73	8.20	20.14	
1896872	5589031	16739			59.5	100	-12.17	57.6	59.5	45.4	5.04	1	39.39	8.01	20.33	
1872714	5567306	4188	Domestic Water	Stock Wateri	60.4	100	-12.17	10.8	60.4	-1.3	2.00	1	-4.34	0.56	-12.79	"inefficient" very shallow top screen
1891467	5582390	4706	Irrigation		62	100	-31.2	53.0	61.0	21.8	12.07	1	8.73	2.16	24.78	Very deep SWL
1888935	5570055	1429	Irrigation	Unknown	65.86	250	-3.65	42.0	44.1	38.4	34.50	1	2.89	0.74	25.60	Quite shallow screen
1895692	5588811	5515	Irrigation		66	300	-12.17	54.0	66.0	41.8	5.56	1	35.27	8.97	25.42	
1894644	5592606	3073	Domestic Water	Stock Wateri	69.19	100	-30.3	55.8	68.0	25.5	4.44	1	20.04	7.97	39.79	Very deep SWL
1896114	5591139	3483	Unknown	Unknown	71	150	-22	58.5	70.5	36.5	4.62	1	30.88	8.00	25.91	Very deep SWL
1886185	5582190	10890			77.7	100	-31.7	44.4	77.7	12.7	5.40	1	6.30	1.49	23.67	Very deep SWL
1890300	5572513	3774	Irrigation	Groundwate	97.5	300	-25.18	68.4	75.5	43.2	37.81	1	4.41	0.88	20.04	Very deep SWL

APPENDIX 4

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APPENDIX E –Shallow Groundwater Bores Assessment

06 August, 2021 ref: BGS201_08

Consents Planner
Hawkes Bay Regional Council
Private Bag 6006
Napier 4110

Dear Sir/Madam,

RUATANIWHA BASIN TRANCHE 2 APPLICATION
INVESTIGATION OF SHALLOW GROUNDWATER BORES IDENTIFIED IN ASSESSMENT OF WELL INTERFERENCE EFFECTS

As part of the Ruataniwha Basin Tranche 2 Application for a groundwater allocation, a Well Interference Assessment was completed in September 2020 by Lattey Group (Lattey). The potential effect of the proposed take was numerically modelled by Aqualinc (Weir, 2020) which resulted in a series of scenarios. The Lattey (2020) investigation reviewed groundwater wells across the basin, of which there are 703 as recorded by Hawkes Bay Regional Council (HBRC). The wells were categorised based on their recorded total well depths, with attention paid to wells within the 0 to 50 m depth below ground level (bgl) range which total 421. Of these, only fourteen wells were identified as requiring further investigation to ascertain if the wells may be adversely impacted by the proposed abstraction, or if the wells were no longer used, were inefficient or used for monitoring purposes.

1. INTRODUCTION

To investigate the potential effects of well interference on the wells within 50 m depth, the elevation of the top screen and static water level (SWL) were taken into consideration, along with adopted pump elevations to determine the available head of water. The predicted seasonal variation was also included in the assessment, determined from a review of state of the environment (SOE) wells' water levels recorded by HBRC over the past five years.

A contour map from numerical modelling the most likely effects scenario as a result of the proposed Tranche 2 groundwater abstraction was provided (refer Figure 1), which was overlain on the HBRC wells map. From this, predicted well interference values could be read off the map and applied to individual well locations across the basin.

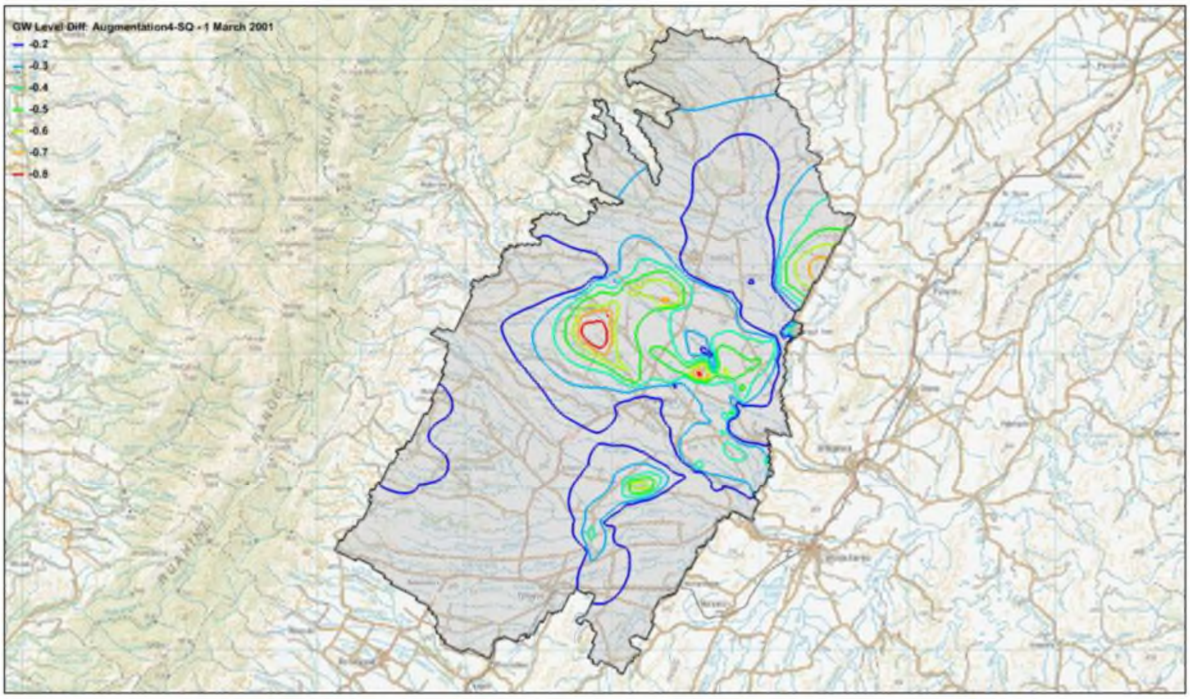


Figure 19: Difference in shallow (layer 1) groundwater levels at 1 March 2001 between status quo and augmentation scenario 4

Figure 1. Difference in Shallow (Layer 1) Groundwater Level of the Aqualinc Scenario 4 (Weir, 2020)

An unwritten rule estimates that if the predicted drawdown (as a result of the pumped well) within a neighbouring bore is greater than 20% of the remaining head in the bore, then there is a possibility that the neighbouring bore may be adversely impacted by the additional drawdown.

The investigation revealed a number of wells that could potentially be affected by the proposed Tranche 2 abstraction. The bores identified as being installed for environmental monitoring along with those deemed inefficient, where the depth of the pump is not sufficient to mitigate being adversely affected by well interference from pumping surrounding wells, were excluded from the assessment.

As a result of this assessment, fourteen wells were flagged as potentially being affected by the proposed abstraction of the groundwater allocation as modelled (Lattey, 2020), and further investigation was suggested to ascertain status of the bores. The following Report provides additional information on the shallow wells identified within the Well Interference Report (Lattey, 2020).

2. RESULTS OF WELL INTERFERENCE ASSESSMENT

The Lattey (2020) report managed the large number of wells identified within the basin by dividing them into groups based on depth. The well groups and number of wells associated with each group is shown in Table 1.

From the 110 bores drilled to within 9.99 m depth, initially 28 wells were identified as potentially being adversely affected (i.e., where the predicted drawdown as a percentage of remaining head is greater than 20%). Furthermore, the bore review identified 14 bores with negative values which could be considered as “inefficient”, 13 of which are wells that are 3.6 m deep or less, and one from a well with a recorded SWL that is deeper than the recorded well depths, so could be an error in the database.

The other 14 wells identified have values greater than 20%, with 7 of the wells which remain flagged within the 0 to 9.99 m depth range as circled in Table 1. A further 4 wells are included in the 10 to 19.99 m depth range and 3 in the 20 to 29.99 m depth. These bores have a greater than 20% value and their use is not specified or they are domestic or stockwater bores, where an adverse impact on the bores cannot be ruled out. Therefore, a field inspection and further investigation was required to confirm that the bores are still operational and being used, along with pump configuration.

Table 1. Summary of Flagged Wells (Lattey, 2020)

Well Group	Total No. Wells	Initially Flagged	Reduced	Comments
0-9.99m	110	28	7	"Inefficient" and monitor wells removed
10-19.99m	75	17	4	"Inefficient" and monitor wells removed
20-29.99m	75	10	3	"Inefficient" and monitor wells removed
30-39.99m	82	9	0	"inefficient" wells removed
40-49.99m	79	9	0	"inefficient" wells removed +1 deep SWL
+50m	236	--	--	Will have site specific review when T2 wells drilled
Unknown	46	--	--	If not "inefficient" and reach +30m unlikely to be affected
Totals	703	73	14	

The locations of flagged wells within the basin area are illustrated on the Aqualinc contour map presented as Figure 2 (Lattey, 2020).

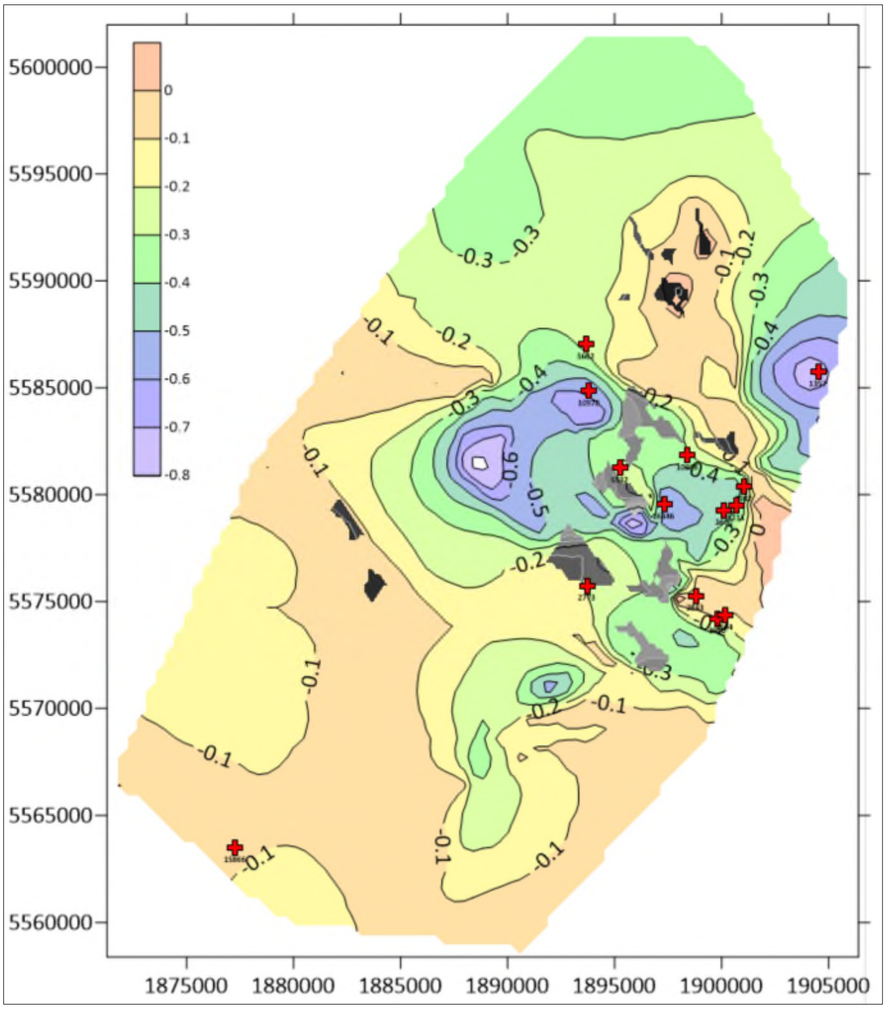


Figure 2. Locations of the Identified 14 bores.

The predicted well interference effect as a result of the proposed Tranche 2 abstraction is detailed in Table 2 (Lattey, 2020). The table provides detail on the bores, available head, pump length and seasonal variation which was determined from a review of state of the environment (SOE) wells, along with the numerical modelling predicted well interference at each bore location and an approximated estimate of remaining head.

Table 2. Predicted Well Interference within Identified Bores (Lattey, 2020)

	Predicted Well Interference within Flagged Bores (Lattey, 2020)							
Well No. (diam.)	**Depth (m)**	**SWL (m) datum**	**Screen Top (m)**	**Available head (m)**	**Seasonal variation (m)**	**Pump length (m)**	**Remaining head (m)**	**Predicted DD (m) (as % of Remaining Head)**
1357 (100mm)	5.18	-2.13	-	3.05	1.94	0	1.11	0.72 (65%)
2773 (150mm)	18.00	-7.10	12.00	4.90	4.65	0	0.25	0.21 (84%)
2902 (100mm)	4.11	-1.45	2.11	2.66	1.80	0	0.86	0.36 (42%)
3590 (100mm)	7.30	-5.50		1.80	1.55	0	0.25	0.13 (52%)
3664 (100mm)	25.60	-8.02	14.03	6.01	4.88	1	0.13	0.11 (82%)
3690 (100mm)	7.50	-4.30	-	3.20	1.75	0	1.45	0.47 (32%)
3843 (300mm)	28.00	-4.17	10.50	6.33	5.09	1	0.24	0.08 (33%)
5211 (300mm)	18.50	-3.90	9.00	5.10	3.63	0	1.47	0.39 (27%)
5532 (1200mm)	5.00	-1.92	-	3.08	1.96	0	1.12	0.28 (25%)
5662 (50mm)	15.50	-3.90	11.50	7.60	7.30	0	0.3	0.28 (93%)
10968 (150mm)	13.10	-2.37	10.36	7.99	6.76	0	1.23	0.33 (27%)
10978 (100mm)	28.35	-9.44	21.88	12.44	10.58	1	0.86	0.57 (66%)
15866 (1000mm)	4.00	-1.92	-	2.08	1.95	0	0.13	0.08 (62%)
16346 (150mm)	6.00	-1.92	-	4.08	1.83	0	2.25	0.51 (23%)

3. FIELD INSPECTION OF IDENTIFIED WELLS

The shallow wells flagged in the Lattey report were inspected in the field or landowners were contacted where available in order to gather additional information on well status. One site, being Well No. 5211 was not inspected as no contact with the landowner was able to be made.

Details of the identified bores are listed in Table 2, which includes grid reference, well and screen depth, aquifer, SWL and Use as recorded on the HBRC bore records. The landowners typically provided sufficient detail on pump and bore status. The bores that landowners advised as abandoned, not in existence or used soley for groundwater monitoring purposes are shaded grey.

Table 2. Details of Flagged Wells (source HBRC)

Details of Flagged Well within Ruataniwha Basin							
Well No. (diam.) Owner	**Grid ref (NZTM)**	**Well Depth (m)**	**Screen (m) bgl**	**Aquifer**	**SWL (m) datum**	**USE (1,2**	**Pump**
1357 (100mm)	1904521 5585738	5.18	-	bl/gr limestone	-2.13	domestic and stockwater supply	surface
2773 (150mm)	1893715 5575728	18.00	12.00-18.00	brown gravel	-7.10	domestic potable supply	surface
2902 (100mm)	1901041 5580364	4.11	2.11-4.11	blue/brown gravel	-1.45	domestic water supply	surface
3590 (100mm)	1899820 5574178	7.30	-	? blue limestone	-5.50	domestic and stockwater supply	surface
3664 (100mm)	1900145 5574351	25.60	14.03-25.60	brown, white limestone brown gravel	-8.02	domestic water supply	surface
3690 (100mm)	1900138 5579254	7.50	-	? medium red gravel	-4.30	domestic water supply	surface
3843 (300mm)	1898782 5575258	28.00	10.50-16.50	brown gravel	-4.17	pastoral farming irrigation	not used
5211 (300mm)	1900702 5579478	18.50	9.00-18.50	brown gravel	-3.90	cropping irrigation	unknown
5532 (1200mm)	1895261 5581232	5.00	-	grey gravel	-1.92	misc. industry wastewater: washwater	surface
5662 (50mm)	1893683 5587022	15.50	11.50-15.50	brown gravel	-3.90	expl drilling environmental	N/A
10968 (150mm)	1898418 5581833	13.10	10.36-11.58	coarse brown gravel	-2.37	stockwater supply	abandoned
10978 (100mm)	1893814 5584834	28.35	21.88-22.82	coarse gravel	-9.44	domestic supply	submersible
15866 (1000mm)	1877285 5563499	4.00	-	-	-1.92	domestic and stockwater supply	surface
16346 (150mm)	1895370 5574535	6.00	-	gravel	-1.92	expl. drilling environmental	N/A

The sites are described in detail as follows:

3.1 Well No. 1357, 1579 Argyll Road, Argyll

The shallow 100 mm diam. well was not closely inspected due to being unable to contact the landowner for access. The landowner later confirmed via telephone that the bore is 5.18 m deep and screened across a limestone aquifer (refer Figure 3). A surface pump is installed due to the shallow SWL and depth of the bore, which provides domestic and stock water.

Figure 3. Well No. 1357

3.2 Well No. 2773, 1396 Ongaonga Road, Ongaonga

The moderately shallow 150 mm diam. bore is screened across brown gravel from 12 to 18 m depth with a surface pump installed (refer Figure 4). The landowner advised that the well never runs dry, but sucks up gravels when pumped during the summer while providing a domestic water supply.

Figure 4. Well No. 2773

3.3 Well No. 2902, 103 The Brow, Waipawa

The shallow 100 mm diam. bore is drilled beside a spring-fed waterway that never dries up (refer Figure 5). The bore is screened from 2.11 to 4.11 m bgl with a surface pump installed (refer Figure 6). The landowner advised that the water levels remain stable within the bore, and provides a domestic water supply.

Figure 5. Well No. 2902 and nearby spring-fed stream

Figure 6. Well No. 2902 pump

3.4 Well No. 3590, 16 Swamp Road, Ongaonga

No screen details exist for the shallow 100 mm diam. bore which is drilled to 7.3 m depth. A surface pump is installed in the well (refer Figure 7) that provides a domestic and stockwater supply for several residences.

Figure 7. Well No. 3590

3.5 Well No. 3664, Stockade Road, Ongaonga

A surface pump is installed in the moderately shallow well that is screened from 14.03 to 25.60 m bgl across brown and blue gravels and limestone beds (refer Figure 8). The bore provides a domestic water supply.

Figure 8. Well No. 3664

3.6 Well No. 3690, 104 The Brow, Waipawa

A surface pump is used for the shallow 100 mm diam. bore which is drilled beside a spring-fed waterway that never dries up and retains a stable level (refer Figure 9). No screen details exist for the bore which is drilled to 7.5 m depth bgl. The water provides for a domestic supply.

Figure 9. Well No. 3690

3.7 Well No. 3843, 140 Swamp Road, Ongaonga

The moderately shallow, 300 mm diam. well was installed by previous landowners and has not been used by the current landowners. HBRC records show the bore is careened across brown gravels from 10.5 to 16.5 m depth bgl.

3.8 Well No. 5211, 11 The Brow, Waipawa

The HBRC records show that the moderately shallow, 300 mm diam. well is screened from 9 to 18.5 m depth bgl, and it is therefore likely that a surface pump is installed to abstract groundwater. No contact was made with the landowner; however, records indicate that the well is used for crop irrigation.

3.9 Well No. 5532, Hutts Aggregate Quarry, Waipawa River

The shallow 1200 mm diam. sump is installed to 5 m depth bgl. The bore owner confirmed that the well is installed beside the Waipawa River. The well is not currently used, but there is the intention to use the well in the near future with a surface pump, as it is critical for wastewater in aggregate production.

3.10 Well No. 5662, Holden Road, Tikokino

HBRC records show that the moderately shallow environmental bore is screened from 11.5 to 15.5 m bgl across brown gravel. Due to the bore being a monitoring well, there would likely be sufficient groundwater from which to complete sampling and it would not likely be adversely affected by the proposed take. However, several discussions were had with the bore owner, Central Hawkes Bay District Council (CHBDC) who are adamant the well does not exist. A search for the well in the field also did not find evidence of bore casing.

3.11 Well No. 10968, Tikokino Road, Tikokino

The landowner advised that the relatively shallow 150 mm diam. bore was abandoned several years ago due to stuck equipment down-hole.

3.12 Well No. 10978, 191 Glenalvon Road, Tikokino

HBRC records show that the domestic and stockwater supply bore is screened from 21.88 to 22.82 m depth bgl across brown clay which is logged from 21 to 23 m depth (refer Figure 10). The screen is likely to be placed across coarse gravel logged from 23 to 26 m depth. A new submersible pump has recently been installed in the well which was drilled in 1973 and supplies domestic water, while the landowner advised that the well water level occasionally falls below the pump level during the summer months due to greater demand.

Figure 10. Well 10978

3.13 Well No. 15866, Takapau

The 1000 mm diam. spring-fed, domestic supply well is recorded as being 4 m deep. The landowner indicates the source does not dry up and levels remain stable. A surface pump is installed at the bore.

3.14 Well No. 16346, Tikokino Road, Tikokino

The shallow 150 mm diam. bore is positioned at the hydraulically downgradient end of a cattle feedlot and is used as an environmental monitoring bore. Due to it being a monitoring well, there would likely be sufficient groundwater with which to complete sampling and it would not likely be adversely affected by the proposed take.

4. PREDICTED EFFECTS ON SHALLOW BORES

The updated Table 3 precludes the abandoned or those denoted as environmental monitoring bores, which leaves eleven wells to discuss, along with an estimate of how this may affect the bores.

Table 3. Remaining Bores that have the potential to be adversely affected.

Details of Flagged Well within Ruataniwha Basin						
Well No. (diam.) Owner	**Screen (m) bgl (aquifer)**	**SWL (m) datum**	**USE (1,2)**	**Pump**	**Predicted DD (m) (as % of Remaining Head)**	**Potential for adverse effect (Y/N)**
1357 (100mm)	(well is 5.18 m deep) (limestone)	-2.00	domestic & stockwater supply	surface	0.72 (65%)	Yes, due to large potential drawdown
2773 (150mm)	12.00-18.00 (brown gravel)	-7.10	domestic water supply	surface	0.21 (84%)	Yes, due to large potential drawdown, and that well currently pumps gravels during summer months
2902 (100mm)	2.11-4.11 (bl/brn gravel)	-1.45	domestic water supply	surface	0.36 (42%)	Yes, due to large potential effect on remaining head
3590 (100mm)	(well is 7.30 m deep) (? limestone)	-5.50	domestic & stockwater supply	surface	0.13 (52%)	Yes, due to large potential drawdown and the bore can run dry in the summer months.
3664 (100mm)	14.03-25.60 (brown, white limestone brown gravel)	-8.02	domestic water supply	surface	0.11 (82%)	Yes, due to large potential effect on remaining head
3690 (100mm)	(well is 7.50 m deep) (? red gravel)	-4.30	domestic water supply	surface	0.47 (32%)	Yes, due to large potential drawdown, even though the bore taps a spring-fed stream that has never run dry.
3843 (300mm)	10.50-16.50 (brn gravel)	-4.17	pastoral farming irrigation	not used	0.08 (33%)	Yes, due to large potential effect on remaining head (noting that the well is not currently used).
5211 (300mm)	9.00-18.50 (brn gravel)	-3.90	cropping irrigation	likely surface	0.39 (27%)	Yes, due to large potential drawdown and the potential effect on remaining head
5532 (1200mm)	(well is 5 m deep) (grey gravel)	-1.92	misc. industry wastewater: washwater	surface	0.28 (25%)	Possibly No, due to the water take abstracted adjacent to and within the bed of the Waipawa River.
10978 (100mm)	21.88-22.82 (gravel)	-9.44	domestic & stockwater supply	submersible	0.57 (66%)	Yes, due to large potential drawdown and potential effect on remaining head which may drop water level below pump.
15866 (1000mm)	(well is 4 m deep)-	-1.92	domestic water supply	surface	0.08 (62%)	Yes, due to large potential drawdown and the potential effect on remaining head

The lowering of groundwater levels as determined from the Aqualinc report (Weir, 2020) applied to the bores, along with knowledge of the bore status and pump configuration, infers that ten of the eleven wells would possibly experience adverse effects as a result of the proposed Tranche 2 take. However, the bore data for six of these wells indicate that well or screen depths are shallow (< 7.50 m depth) and do not have an adequate water column. It is therefore likely that these wells struggle already during periods of low groundwater levels.

The Well No. 5532 is described by the owner as a bore installed beside the river bed, and it is expected that the well is directly recharged by the Waipawa River. This is a local control on groundwater levels that the numerical model is unable to accommodate, and therefore the model's predicted lowering of 0.28 m is likely overstated.

5. SUMMARY

In September 2020, a Well Interference Assessment was completed by Lattey as part of the Ruataniwha Basin Tranche 2 Application for a groundwater allocation. The Lattey (2020) investigation reviewed groundwater wells across the basin, along with the potential effect of the proposed Tranche 2 take as numerically modelled by Aqualinc (Weir, 2020). A range of scenarios was provided by Aqualinc (Weir, 2020), and a contour map from numerical modelling of the most likely effects as a result of the proposed Tranche 2 groundwater abstraction was provided, from which predicted well interference values could be read off and applied to individual well locations.

The well review categorised bores based on their recorded total well depths, particularly the 421 wells within 50 m depth range. Of these, 14 bores were identified as requiring further investigation to ascertain if they may be adversely impacted by the proposed abstraction, or if the wells were no longer used, were inefficient or used for monitoring purposes.

A rule of thumb suggests that if predicted well interference (as a result of the pumped well) within a neighbouring bore is greater than 20% of the remaining head in the bore, then there is a possibility that the neighbouring bore may be adversely impacted by the additional drawdown. The 14 wells identified have values greater than 20% and their use was not specified or they are domestic or stockwater bores, where an adverse impact on the bores could not be ruled out. Therefore, a field inspection and further investigation of the bores was required to confirm that their status.

The shallow wells identified were inspected in the field or landowners were contacted where available in order to gather additional information on well status, apart from one site at Well Nos. 5211 where no contact was able to be made with the landowner.

The investigation determined that 3 of the 14 bores were either abandoned, not in existence or used as monitoring wells. Of the remaining 11 bores, the majority are shallow and provide domestic and stockwater, operated by surface pumps apart from the deepest Well No. 10978 which has a submersible pump.

Applying bore and aquifer data including screen elevation, SWL, seasonal variation, pump depth, and predicted well interference, only one of the 11 bores is thought unlikely to be adversely affected by the proposed Tranche 2 take. This is Well No. 5532, installed as a bore adjacent to the Waipawa River which is likely to be directly recharged by the river. This is a local control on groundwater levels that the numerical model is unable to accommodate, and therefore the model's predicted lowering of 0.28 m is likely overstated and therefore not regarded as an adverse effect on the bore.

The numerical modelling data suggests that the other ten bores may experience well interference of 25% to 84% of the Remaining Head of water, which may adversely affect security of supply to the landowners/occupiers. However, six of the ten bores are constructed relatively shallow, to depths <7.50 m, which results in a small available water column that is more sensitive to well interference.

6. REFERENCES

Hawkes Bay Regional Council website (www.hbrc.govt.nz).

Lattey Group, 2020: Ruataniwha Basin Tranche 2 Irrigation Water Permit Consent Application - Assessment of Well Interference Effects. Project No. J19220-Rep-01 T2-Wi. Lattey Group, Hastings, New Zealand.

Weir, J., 2020: Ruataniwha Basin: Tranche 2 Groundwater Modelling. Client Report Project No. WL18045 05/11/2020. Aqualinc Research Limited, Christchurch, New Zealand.

Report Limitations

This letter report is written based on conditions as they existed at the time of the study, and there is no interpretation made on potential changes that may occur across the sites or the verbal information provided by the landowners and occupiers. Subsurface conditions may exist across the project area that are not able to be detected or revealed by the investigation within the scope of the study, along with any incorrect information provided by the landowners/occupiers and are therefore not taken into account.

APPENDICES

APPENDIX A

Topo map illustrating SOE significant wetland areas

(*data sourced from HBRC and map generated by Aqualinc)*

A1.: Central & Southern Hawkes Bay area topo map with contours overlain demonstrating the Aqualinc (2020) difference in shallow (Layer 1) groundwater levels at March 2001 between status quo and augmentation Scenario 4 (Weir, 2020).

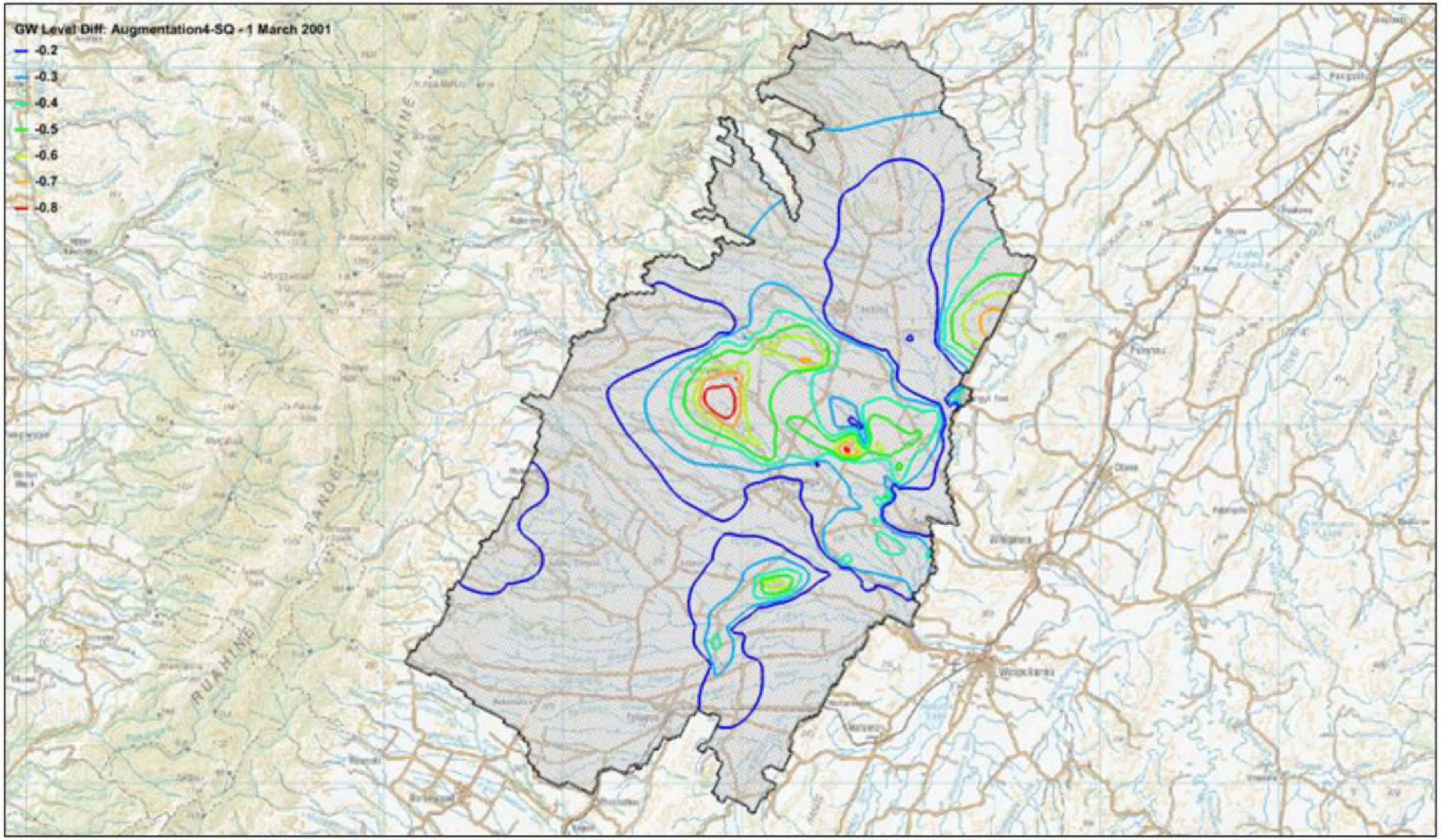


Figure 19: Difference in shallow (layer 1) groundwater levels at 1 March 2001 between status quo and augmentation scenario 4

APPENDIX B

Identified Wells bore logs

(*data sourced from HBRC online database*

B1: Well No. 1357 bore log

Well 1357

IDENTIFICATION

WQ Site:	
Easting:	1904521.139
Northing:	5585737.478
Method:	
Address:	'TE HEKA' ARGYLL, TE ONEPU RD,

WELL INFORMATION

Drill date:	19/01/1983
Driller:	Honnor Drilling Limited
Casing Diameter (mm):	100
Bore Depth (m)	
Well Depth (m):	5.18
Screen top (m):	0
Screen bottom (m):	0
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Aquifer Information

Inital Water Level	-2
Aquifer Condition	Confined
Aquifer Lithology	

Aquifer Test

Test Reliability	Unreliable
Specific Capacity	
Hydralic Conductivity	
Storativity	
Transmissivity	
Aquifer Thickness	
Number Of Pumping Steps	
Duration	
Maximum Draw Down	
Maximum Pumping Rate	
Report Number	
Bore No	1357

Bore Log (m)

Lithology	TOPSOIL with clay
From Depth	0
To Depth	2
Lithology	brown GRAVEL
From Depth	2
To Depth	2
Lithology	brown CLAY with limestone
From Depth	2
To Depth	3
Lithology	blue/grey LIMESTONE
From Depth	3
To Depth	5

B2: Well No. 2773 bore log

HAWKE'S BAY REGIONAL COUNCIL

Well 2773

IDENTIFICATION

WQ Site:	
Easting:	1893715.434
Northing:	5575727.936
Method:	
Address:	WAIPAWA-ONGA ONGA ROAD, WAIPAWA

WELL INFORMATION

Drill date:	31/05/1990
Driller:	Hill Well Drillers Ltd
Casing Diameter (mm):	150
Bore Depth (m)	
Well Depth (m):	18
Screen top (m):	12
Screen bottom (m):	18
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Aquifer Information

Inital Water Level	-7
Aquifer Condition	Unconfined
Aquifer Lithology	Gravels

Bore Log (m)

Lithology	TOPSOIL with gravel
From Depth	0
To Depth	0

Lithology	brown GRAVEL
From Depth	0
To Depth	18

B3: Well No. 2902 bore log

Well 2902

IDENTIFICATION

WQ Site:	
Easting:	1901040.693
Northing:	5580363.708
Method:	Hand-held GPS
Address:	TE ONEPU ROAD, ARGYLL

WELL INFORMATION

Drill date:	25/02/1991
Driller:	Baylis Brothers Limited
Casing Diameter (mm):	100
Bore Depth (m)	
Well Depth (m):	4.11
Screen top (m):	2.11
Screen bottom (m):	4.11
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Bore Consents

Consent Id	WP180666T
Consent Type	Ground-water consent
Use One	Cropping
Use Two	Irrigation

Aquifer Information

Inital Water Level	-1
Aquifer Condition	Unconfined
Aquifer Lithology	Gravels

Aquifer Test

Test Reliability	Unreliable
Specific Capacity	
Hydralic Conductivity	
Storativity	
Transmissivity	
Aquifer Thickness	
Number Of Pumping Steps	
Duration	2
Maximum Draw Down	
Maximum Pumping Rate	0
Report Number	
Bore No	2902

Bore Log (m)

Lithology	TOPSOIL
From Depth	0

To Depth	0

Lithology	red GRAVEL
From Depth	0
To Depth	1

Lithology	blue/brown CLAY
From Depth	1
To Depth	1

Lithology	blue/brown GRAVEL
From Depth	1
To Depth	4

B4: Well No. 3590 bore log

HAWKE'S BAY REGIONAL COUNCIL

Well 3590

IDENTIFICATION

WQ Site: 2878
Easting: 1899819.973
Northing: 5574177.986
Method:

Address: SWAMP ROAD, WAIPAWA

WELL INFORMATION

Drill date: 16/02/1995
Driller: Baylis Brothers Limited
Casing Diameter (mm): 100
Bore Depth (m)
Well Depth (m): 7.3
Screen top (m):
Screen bottom (m):
Open hole top (m):
Open hole bottom (m):

Water level access: Unknown

Bore Consents

Consent Id	LU950015B
Consent Type	Bore consent
Use One	Pastoral Farming
Use Two	Stockwater Supply

Aquifer Information

Inital Water Level	-6
Aquifer Condition	Unknown
Aquifer Lithology	Unknown

Bore Log (m)

Lithology	TOPSOIL
From Depth	0
To Depth	1

Lithology	brown CLAY (light)
From Depth	1
To Depth	1

Lithology	red GRAVEL (metal)
From Depth	1
To Depth	2

Lithology	brown CLAY
From Depth	2
To Depth	3

Lithology	red GRAVEL with clay (metal, bentonitic)
From Depth	3

To Depth	9

Lithology	brown CLAY with sand
From Depth	9
To Depth	14

Lithology	yellow LIMESTONE
From Depth	14
To Depth	15

Lithology	blue CLAY with limestone (light)
From Depth	15
To Depth	19

Lithology	blue LIMESTONE (hard)
From Depth	19
To Depth	22

Lithology	blue CLAY with shell
From Depth	22
To Depth	24

B5: Well No. 3664 bore log

HAWKE'S BAY REGIONAL COUNCIL

Well 3664

IDENTIFICATION

WQ Site:
Easting: 1900145.175
Northing: 5574350.167
Method:

Address: STOCKADE RD R D 2 ONGA ONGA

WELL INFORMATION

Drill date: 10/07/1995
Driller: Hill Well Drillers Ltd
Casing Diameter (mm): 100
Bore Depth (m)
Well Depth (m): 25.6
Screen top (m): 14.03

Screen bottom (m): 25.6
Open hole top (m):
Open hole bottom (m):

Water level access: Unknown

Bore Consents

Consent Id	LU950188B
Consent Type	Bore consent
Use One	Pastoral Farming
Use Two	Stockwater Supply

Aquifer Information

Inital Water Level	-8
Aquifer Condition	Confined
Aquifer Lithology	Other

Bore Log (m)

Lithology	TOPSOIL
From Depth	0
To Depth	0

Lithology	brown CLAY
From Depth	0
To Depth	1

Lithology	brown/red GRAVEL with clay (claybound)
From Depth	1
To Depth	3

Lithology	white CLAY
From Depth	3
To Depth	4

Lithology	brown CLAY

From Depth	4
To Depth	8
Lithology	brown CLAY with gravel (hard)
From Depth	8
To Depth	12
Lithology	brown LIMESTONE
From Depth	12
To Depth	13
Lithology	brown CLAY with sand (hard)
From Depth	13
To Depth	16
Lithology	brown LIMESTONE
From Depth	16
To Depth	17
Lithology	brown CLAY
From Depth	17
To Depth	18
Lithology	blue CLAY
From Depth	18
To Depth	18
Lithology	brown CLAY
From Depth	18
To Depth	19
Lithology	brown LIMESTONE
From Depth	19
To Depth	19
Lithology	brown CLAY with sand
From Depth	19
To Depth	20
Lithology	brown LIMESTONE with shell
From Depth	20
To Depth	21
Lithology	blue GRAVEL with shell
From Depth	21
To Depth	22
Lithology	brown LIMESTONE
From Depth	22
To Depth	22

Lithology	blue GRAVEL with shell
From Depth	22
To Depth	24

Lithology	white LIMESTONE
From Depth	24
To Depth	24

Lithology	blue CLAY with sand
From Depth	24
To Depth	26

B6: Well No. 3690 bore log

Well 3690

IDENTIFICATION

WQ Site:	2729
Easting:	1900138.258
Northing:	5579253.713
Method:	
Address:	11 ARGYLE EAST RD, WAIPAWA

WELL INFORMATION

Drill date:	09/08/1996
Driller:	Baylis Brothers Limited
Casing Diameter (mm):	100
Bore Depth (m)	
Well Depth (m):	7.5
Screen top (m):	
Screen bottom (m):	
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Yes

Bore Consents

Consent Id	LU950259B
Consent Type	Bore consent
Use One	Residential - Single property
Use Two	Potable Supply

Aquifer Information

Inital Water Level	-4
Aquifer Condition	Unknown
Aquifer Lithology	Unknown

Bore Log (m)

Lithology	coarse blue GRAVEL (boulders)
From Depth	0
To Depth	6
Lithology	blue/brown CLAY with silt
From Depth	6
To Depth	7
Lithology	medium red GRAVEL (metal)
From Depth	7
To Depth	10

B7: Well No. 3843 bore log

HAWKE'S BAY REGIONAL COUNCIL

Well 3843

IDENTIFICATION

WQ Site:	
Easting:	1898782.044
Northing:	5575257.571
Method:	Differential GPS
Address:	SWAMP ROAD, WAIPAWA

WELL INFORMATION

Drill date:	19/01/1996
Driller:	Hill Well Drillers Ltd
Casing Diameter (mm):	300
Bore Depth (m)	
Well Depth (m):	28
Screen top (m):	10.5
Screen bottom (m):	16.5
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Bore Consents

Consent Id	LU960099B
Consent Type	Bore consent
Use One	Pastoral Farming
Use Two	Irrigation

Aquifer Information

Inital Water Level	
Aquifer Condition	Unknown
Aquifer Lithology	Gravels

Bore Log (m)

Lithology	TOPSOIL
From Depth	0
To Depth	1

Lithology	brown CLAY
From Depth	1
To Depth	3

Lithology	blue GRAVEL
From Depth	3
To Depth	6

Lithology	brown GRAVEL (water bearing)
From Depth	6
To Depth	7

Lithology	brown CLAY

From Depth	7
To Depth	8
Lithology	brown GRAVEL (water bearing)
From Depth	8
To Depth	12
Lithology	brown CLAY with gravel
From Depth	12
To Depth	12
Lithology	brown GRAVEL (water bearing)
From Depth	12
To Depth	12
Lithology	brown CLAY with gravel
From Depth	12
To Depth	13
Lithology	brown GRAVEL (water bearing)
From Depth	13
To Depth	16
Lithology	brown CLAY with gravel
From Depth	16
To Depth	17
Lithology	brown GRAVEL (water bearing)
From Depth	17
To Depth	18
Lithology	brown CLAY
From Depth	18
To Depth	20
Lithology	brown GRAVEL
From Depth	20
To Depth	21
Lithology	brown CLAY
From Depth	21
To Depth	21
Lithology	brown/red GRAVEL
From Depth	21
To Depth	25
Lithology	brown CLAY
From Depth	25
To Depth	26
Lithology	blue CLAY
From Depth	26
To Depth	28

B8: Well No. 5211 bore log

HAWKE'S BAY REGIONAL COUNCIL

Well 5211

IDENTIFICATION

WQ Site:	
Easting:	1900701.622
Northing:	5579477.991
Method:	Hand-held GPS
Address:	103 ARGYLL EAST RD, WAIPAWA

WELL INFORMATION

Drill date:	21/09/2004
Driller:	Honnor Drilling Limited
Casing Diameter (mm):	300
Bore Depth (m)	96
Well Depth (m):	18.5
Screen top (m):	9
Screen bottom (m):	18.5
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Bore Consents

Consent Id	LU040215B
Consent Type	Bore consent
Use One	Cropping
Use Two	Irrigation

Consent Id	WP180666T
Consent Type	Ground-water consent
Use One	Cropping
Use Two	Irrigation

Aquifer Information

Inital Water Level	-5
Aquifer Condition	Confined
Aquifer Lithology	Gravels

Aquifer Test

Test Reliability	Unreliable
Specific Capacity	26
Hydralic Conductivity	1111
Storativity	
Transmissivity	10000
Aquifer Thickness	9
Number Of Pumping Steps	1
Duration	2
Maximum Draw Down	2
Maximum Pumping Rate	50
Report Number	230
Bore No	5211

Bore Log (m)

Lithology	brown GRAVEL with silt
From Depth	0
To Depth	7
Lithology	blue CLAY (greasy)
From Depth	7
To Depth	10
Lithology	brown GRAVEL (water bearing)
From Depth	10
To Depth	10
Lithology	brown GRAVEL with clay/silt
From Depth	10
To Depth	14
Lithology	brown GRAVEL (water bearing)
From Depth	14
To Depth	19
Lithology	brown CLAY
From Depth	19
To Depth	20
Lithology	brown GRAVEL (larger than previous gravel and slightly WB)
From Depth	20
To Depth	30
Lithology	fine brown GRAVEL (less water bearing)
From Depth	30
To Depth	34
Lithology	brown GRAVEL (water bearing)
From Depth	34
To Depth	36
Lithology	fine brown GRAVEL (less water bearing)
From Depth	36
To Depth	40
Lithology	brown GRAVEL (water bearing)
From Depth	40
To Depth	43
Lithology	brown GRAVEL with clay (little water)
From Depth	43
To Depth	51
Lithology	blue CLAY

From Depth	51
To Depth	52

Lithology	fine brown GRAVEL (little water)
From Depth	52
To Depth	54

Lithology	fine blue/brown GRAVEL (little water)
From Depth	54
To Depth	68

Lithology	blue SAND with peat/veg/wood/silt (traces of pumice)
From Depth	68
To Depth	96

B9: Well No. 5532 bore log

HAWKE'S BAY REGIONAL COUNCIL

Well 5532

IDENTIFICATION

WQ Site:	
Easting:	1895261.385
Northing:	5581232.095
Method:	Hand-held GPS
Address:	SH50, TIKOKINO

WELL INFORMATION

Drill date:	05/05/2006
Driller:	INFRACON LIMITED
Casing Diameter (mm):	1200
Bore Depth (m)	5
Well Depth (m):	5
Screen top (m):	
Screen bottom (m):	
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Bore Consents

Consent Id	LU060280B
Consent Type	Bore consent
Use One	Miscellaneous Industry
Use Two	Wastewater - Wash Water

Aquifer Information

Inital Water Level	
Aquifer Condition	Unconfined
Aquifer Lithology	Gravels

Aquifer Test

Test Reliability	Unreliable
Specific Capacity	13
Hydralic Conductivity	
Storativity	
Transmissivity	
Aquifer Thickness	
Number Of Pumping Steps	
Duration	300
Maximum Draw Down	2
Maximum Pumping Rate	20
Report Number	
Bore No	5532

Bore Log (m)

Lithology	grey GRAVEL
From Depth	0
To Depth	5

B10: Well No. 5662 bore log

Well 5662

HAWKE'S BAY REGIONAL COUNCIL

IDENTIFICATION

WQ Site:	
Easting:	1893682.943
Northing:	5587021.816
Method:	Hand-held GPS
Address:	HOLDEN ROAD, TIKOKINO

WELL INFORMATION

Drill date:	08/03/2007
Driller:	Baylis Brothers Limited
Casing Diameter (mm):	50
Bore Depth (m)	15.5
Well Depth (m):	15.5
Screen top (m):	11.5
Screen bottom (m):	15.5
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Yes

Bore Consents

Consent Id	LU070160B
Consent Type	Bore consent
Use One	Exploratory Drilling
Use Two	Environmental Purposes

Aquifer Information

Inital Water Level	-14
Aquifer Condition	Unconfined
Aquifer Lithology	Gravels

Bore Log (m)

Lithology	TOPSOIL with gravel
From Depth	0
To Depth	0

Lithology	brown GRAVEL
From Depth	0
To Depth	16

B11: Well No. 10968 bore log

HAWKE'S BAY REGIONAL COUNCIL

Well 10968

IDENTIFICATION

WQ Site:	
Easting:	1898417.493
Northing:	5581833.22
Method:	
Address:	WAIPAWA - TIKOKINO ROAD, WAIPAWA

WELL INFORMATION

Drill date:	12/12/1991
Driller:	Honnor Drilling Limited
Casing Diameter (mm):	150
Bore Depth (m)	
Well Depth (m):	13.1
Screen top (m):	10.36
Screen bottom (m):	11.58
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Aquifer Information

Inital Water Level	-2
Aquifer Condition	Unconfined
Aquifer Lithology	Gravels

Bore Log (m)

Lithology	TOPSOIL with gravel
From Depth	0
To Depth	0

Lithology	coarse brown GRAVEL
From Depth	0
To Depth	4

Lithology	red GRAVEL with clay (tight compact metal)
From Depth	4
To Depth	7

Lithology	brown GRAVEL
From Depth	7
To Depth	8

Lithology	coarse brown GRAVEL with clay (traces of clay)
From Depth	8
To Depth	13

B12: Well No. 10978 bore log

Well 10978

HAWKE'S BAY REGIONAL COUNCIL

IDENTIFICATION

WQ Site:	
Easting:	1893813.563
Northing:	5584834.302
Method:	
Address:	TIKOKINO

WELL INFORMATION

Drill date:	30/07/1973
Driller:	Honnor Drilling Limited
Casing Diameter (mm):	100
Bore Depth (m)	
Well Depth (m):	28.35
Screen top (m):	21.88
Screen bottom (m):	22.82
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Aquifer Information

Inital Water Level	-9
Aquifer Condition	Confined
Aquifer Lithology	Gravels

Bore Log (m)

Lithology	red GRAVEL with clay (metal)
From Depth	0
To Depth	19

Lithology	coarse red GRAVEL (metal)
From Depth	19
To Depth	21

Lithology	brown CLAY (firm)
From Depth	21
To Depth	23

Lithology	coarse GRAVEL with clay (water yielding, metal)
From Depth	23
To Depth	26

Lithology	brown CLAY (firm)
From Depth	26
To Depth	28

Lithology	red GRAVEL (water yielding, metal)
From Depth	28
To Depth	28

B13: Well No. 15866 bore log

HAWKE'S BAY REGIONAL COUNCIL

Well 15866

IDENTIFICATION

WQ Site:	
Easting:	1877285.248
Northing:	5563499.22
Method:	Hand-held GPS
Address:	5122 SH2 5122 SH2 Takapau

WELL INFORMATION

Drill date:	
Driller:	
Casing Diameter (mm):	1000
Bore Depth (m)	4
Well Depth (m):	4
Screen top (m):	
Screen bottom (m):	
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Aquifer Information

Inital Water Level	
Aquifer Condition	Confined
Aquifer Lithology	

B14: Well No. 16346 bore log

Well 16346

IDENTIFICATION

WQ Site:	
Easting:	1897308.177
Northing:	5579545.339
Method:	Hand-held GPS
Address:	1365 Tikokino Road, Waipawa

WELL INFORMATION

Drill date:	15/04/2015
Driller:	Honnor Drilling Limited
Casing Diameter (mm):	150
Bore Depth (m)	6
Well Depth (m):	6
Screen top (m):	
Screen bottom (m):	
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Bore Consents

Consent Id	LU150068B
Consent Type	Bore consent
Use One	Investigations
Use Two	Environmental Purposes

Aquifer Information

Inital Water Level	-4
Aquifer Condition	
Aquifer Lithology	

Bore Log (m)

Lithology	TOPSOIL
From Depth	0
To Depth	2

Lithology	GRAVEL
From Depth	2
To Depth	6

APPENDIX F - Proposed Resource Consent Conditions

RESOURCE CONSENT

Water Permit

In accordance with the provisions of the Resource Management Act 1991 (RMA), and subject to the attached conditions, the Hawke's Bay Regional Council (the Council) grants a resource consent for a discretionary activity to:

[Consent Applicant NAME]
[Address]

to take and use Tranche 2 groundwater to irrigate the following:

Consent Holder Name	Type of Crop	Area (ha)
Te Awahohonu Forest Trust	Pasture, crops and horticulture	850
Papawai Partnership	Pasture, crops and horticulture	320
Tuki Tuki Awa	Pasture, crops and horticulture	136
Plantation Road Dairies	Pasture, crops and horticulture	459
Springhill Dairies	Pasture, crops and horticulture	188
I & P Farming	Pasture, crops and horticulture	310
Buchanan Trust No.2	Pasture, crops and horticulture	230
Purunui Trust	Pasture, crops and horticulture	93

[Notes:

1. **The applicant seeks final conditions that allow for flexibility of use of any Tranche 2 water taken. This will allow crop rotations (temporary) and permanent transitions to other land uses. It is not possible at this stage to specify exactly when, and on what parcels of land that landuse change will occur. Any change in land use, to a less water demanding crop, will also allow a greater area of land to benefit from irrigation. This will increase the positive effects arising from the water take, while any effects will be addressed in the land use consent. The precise wording of these conditions will need to be further discussed with Council*.***

2. **While the draft conditions are presented in a collective form to ensure consistency and avoid duplication, the Applicants are requesting that individual water permits be granted to each applicant.]**

LOCATION

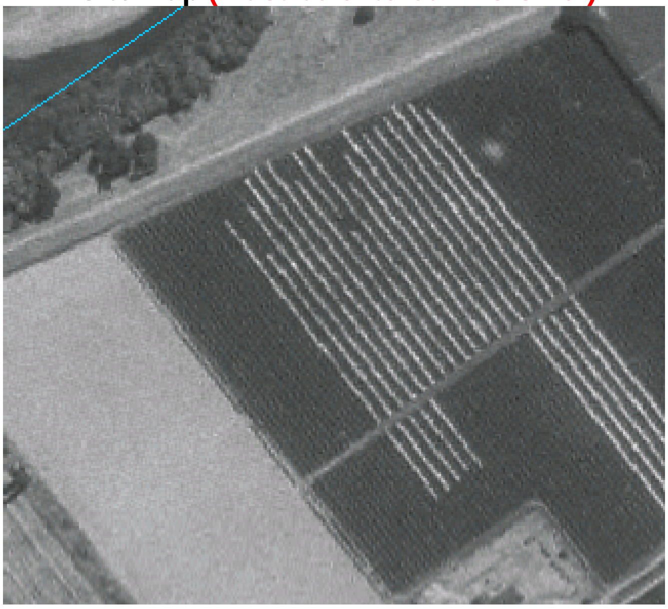
Address of site
[address]

Legal description
Site of use: [legal]
and as illustrated on the Site Map adjacent

LAPSING OF CONSENT
This consent shall lapse in accordance with section 125 of the RMA on [date] if it is not given effect to before that date.

CONSENT DURATION
This consent is granted for a period of 20 years commencing on 1 June [202X], and expiring on [date].

Site Map (must be entered in Gismo!)



Malcolm Miller
Manager Consents
REGULATION GROUP
Under authority delegated by Hawke's Bay Regional Council
[Date]

CONDITIONS

1. The site of the take shall be from Well no [insert] at map reference NZMG [easting / northing] and [legal description of site].

2. The rates of taking for irrigation and augmentation shall not exceed the following limits:

Consent Holder Name	Rate of take for irrigation (from all wells in combination) (L/s daily average)	Rate of take for augmentation (from all wells in combination) (L/s daily average)	Total rate of take (from all wells in combination) (L/s daily average)
Te Awahohonu Forest Trust	340	189	529
Papawai Partnership	126	24	150
Tuki Tuki Awa	94	5	99
Plantation Road Dairies	280	103	383
Springhill Dairies (formerly Ingleton Farms)	85	38	123
I & P Farming (formerly Abernethy Partnership)	115	22	137
Buchanan Trust No.2	91	51	142
Purunui Trust	43	14	57

3. The volume taken for irrigation and augmentation shall not exceed the following limits:

Consent Holder Name	Volume of take for Irrigation - from all wells in combination within the 12-month period (1 October to 30 September in consecutive calendar years) (m^3)	Volume of take for augmentation - from all wells in combination within the 12-month period (1 November to 31 October in consecutive calendar years) (m^3)	Total volume of take from all wells in combination in any 28-day period (m^3)	Total volume of take from all wells in combination within the 12-month period (1 October to 30 September in consecutive calendar years) (m^3)
Te Awahohonu Forest Trust	2,841,220	2,073,700	823,200	4,914,920
Papawai Partnership	1,010,817	464,700	304,552	1,475,517
Tuki Tuki Awa	678,100	29,100	228,480	952,400
Plantation Road Dairies	2,418,225	1,333,000	677,040	3,751,225

Consent Holder Name	Volume of take for Irrigation - from all wells in combination within the 12-month period (1 October to 30 September in consecutive calendar years) (m^3)	Volume of take for augmentation - from all wells in combination within the 12-month period (1 November to 31 October in consecutive calendar years) (m^3)	Total volume of take from all wells in combination in any 28-day period (m^3)	Total volume of take from all wells in combination within the 12-month period (1 October to 30 September in consecutive calendar years) (m^3)
Springhill Dairies (formerly Ingleton Farms)	588,313	416,900	205,950	1,005,213
I & P Farming (formerly Abernethy Partnership)	916,010	284,000	278,880	1,200,010
Buchanan Trust No.2	786,594	359,200	220,080	1,145,794
Purunui Trust	370,321	184,600	104,160	554,921
Total	**9,609,600**	**5,145,700**	**2,842,342**	**15,000,000**

4. Prior to 1 September each year, the consent holder shall notify Council (Manager Compliance) in writing what percentage of the total consented area has been developed for irrigation with the consented Tranche 2 groundwater, what maximum seasonal volume of consented Tranche 2 groundwater will be taken to irrigate the developed area, and what associated augmentation rate will be applied over the next water year (1 October to 30 September).

   This condition shall apply until such time as the entire consented area has been developed for irrigation and the maximum seasonal volume of consented Tranche 2 groundwater can be taken to irrigate the total developed area.

   [Note: This condition does not apply to Tuki Tuki Awa]

5. The taking of Tranche 2 groundwater for irrigation by Tuki Tuki Awa shall only occur when their existing surface water take (Consent No. WP XXX) is restricted due to low flow bans on the Tukituki River.

6. Should at any stage a consent holder intend to drill a new well for the purpose of taking water for irrigation and/or augmentation authorised by this consent, having first obtained the necessary bore permit (RRMP Rule 1 or 2) and having subsequently drilled the well the consent holder shall thereafter apply for a change of consent conditions under s127 of the RMA (or its successor) to add the well to Condition X and shall at that time also submit a report from a suitably qualified expert to the Council (Manager Compliance) (or nominee) that includes the following information:

   a) Details of the new well, including its depth, location, screening and static water level;

   b) An assessment of potential adverse (well interference) effects of take(s) from the well(s) on neighbouring groundwater users within a 2 km radius of each well; and

c) Results of a pump test that demonstrates that the well can sustain the intended rate of take.

7. A water meter with a data logger and telemetry unit(s) compatible with the Council's telemetry system shall be installed on each well used for irrigation and/or augmentation prior to the use of the well for those purposes, and be operated and maintained to measure the volume of water taken to an accuracy of +/- 5%.

8. The device(s) required by Condition 7 shall be installed and maintained in accordance with the Council's *"Technical Specifications and Installation Requirements for Flow Meters" (February 2010)* (See Advice Note I).

9. Water take and use data supplied to the Council in accordance with conditions of this consent shall be collected by a water measuring device or system that has been verified by a suitably qualified person to be accurate to within +/-5% at that point of take within the following time periods:

a) For existing devices or systems: within the previous 5 water years (water year is 1 October - 30th September); or,

b) For new devices or systems: before the end of the first water year (ending 30 September) for that water permit.

10. All water measuring devices or systems shall be re-verified by a suitably qualified person as accurate to within +/-5% within a maximum of 5 years from the date of the previous verification.

11. Where a portable pump is used to take water as authorised by this consent, both the water meter and telemetry devices must be installed, operated and maintained in accordance with the Council's Technical Publication "HBRCs Requirements for the use of Portable pumps used to report water use" (February 2013) (see Advice Note I).

12. The telemetry unit(s) shall record the rate and volume of take every 15 minutes. Each 15 minute interval of data shall be date and time stamped with the New Zealand Standard Time at the end of the 15 minute interval.

13. Data shall be transmitted to the Council's telemetry system at least once per day.

14. The telemetry unit(s) shall be installed so as to provide an accurate record of the flow meter data by a suitably qualified person. A record of installation shall be provided to the Council (Manager Compliance) in writing using the Council's "Telemetry Installation Form" within one week of installation of the new or reinstalled unit(s) having occurred (see Advice Note I).

15. A manual water meter reading shall be taken during the month of September each year. The water meter reading and the date and time the reading was taken shall be provided in writing to the Council (Manager Compliance) prior to 10 October each year.

Advice note: It is recommended that a photograph of the meter, with the meter reading clearly visible, is also provided at the same time as the reading required by condition 15.

16. Where the telemetry equipment fails, the consent holder shall notify the Council (Manager Compliance) of the failure within 3 working days, shall read the water meter at daily intervals and shall provide the Council with a record of the following:

a) The meter reading (in cubic metres); and,

b) The daily volume of water taken (in cubic metres); and,

c) The date and time of each reading.

This information shall be supplied no later than 7 days after the end of each calendar month. Where the telemetry equipment is returned to full operation, the information shall instead be supplied within 7 days of this return to full operation occurring.

17. The consent holder shall, upon request by the Council (Manager Compliance), supply details of the crop type and areas irrigated under this consent.

18. The consent holder (except Tuki Tuki Awa) shall commence the discharge of augmentation water (sourced from Tranche 2 groundwater taken in accordance with this consent) when the Council provides notification that the low flow rate at any of the following river sites is triggered:

River	Low Flow Rate (L/s)
Waipawa River at RDS/State Highway 2	2,725
Tukituki River at Tapairu Road	2,360
Tukipo River at State Highway 50	155
Tukipo River at Ashcott	1,085
Mangaonuku River at Upstream of the Waipawa River Confluence	1,295

Augmentation shall be undertaken regardless of whether the consent holder is irrigating at the time, using Tranche 2 groundwater authorised by this consent.

19. Tuki Tuki Awa shall discharge augmentation water (sourced from Tranche 2 groundwater authorised by this consent) when, and for the duration that, they are using Tranche 2 groundwater for irrigation authorised by this consent.

20. Augmentation required under Conditions 18 and 19 shall be discharged at the following relevant minimum rates and locations:

Consent Holder Name	Augmentation Discharge Location	Minimum Rate of Augmentation Discharge (L/s daily average)
Te Awahohonu Forest Trust	Mangaonuku Stream	189
Papawai Partnership	Discharge to shallow groundwater well adjacent to the Waipawa River	24
Tuki Tuki Awa	Tukituki River	5
Plantation Road Dairies	Kahahakuri Stream	103
Springhill Dairies (formerly Ingleton Farms)	Mangaonuku Stream	38

I & P Farming (formerly Abernethy Partnership)	Discharge to unnamed stream, tributary of the Tukituki River	22
Buchanan Trust No.2	Ongaonga Stream	51
Purunui Trust	Waipawa River	14

21. The consent holders (except Tuki Tuki Awa) shall cease augmentation when either:

 a) the flow rates at all river sites exceeds the low flow rates identified under Condition 18; and/or

 b) the volume of augmentation has reached the maximum volume of take for augmentation for the relevant 12-month period allowed under Condition 3.

22. No water shall be taken during “no take” periods specified by the Council for the purpose of obtaining accurate hydrological measurements, provided that:

 a) the “no take” period specified by Council is no longer than twenty four (24) hours in duration; and,

 b) the Council gives at least 7 days’ notice to the consent holder of the start and finish time of the “no take” period; and,

 c) consecutive “no take” periods are separated by an interval of at least 14 days.

23. All works and structures relating to this resource consent shall be designed and constructed to conform to best engineering practices and at all times maintained to a safe and serviceable standard.

24. The consent holder shall undertake all operations in accordance with any drawings, specifications, statements of intent and other information supplied as part of the application for this resource consent. In the event that there is conflict between the information supplied with the application and any consent condition(s), the condition(s) shall prevail.

25. Where spray filling and/or fertigation or injection of agrichemicals into the irrigation system (chemigation) is to occur, the consent holder shall ensure that the irrigation system is designed, constructed and maintained in accordance with the Irrigation New Zealand “*New Zealand Guideline for the Safe Management of Irrigation Systems with Effluent, Fertiliser and/or Agrichemical Injection*” (28/02/14) (see Advice Note VI) and to prevent the movement of contaminants into groundwater or surface water. The consent holder shall provide the details and specifications of the back flow prevention device/system at the request of the Council (Manager Compliance).

26. If an event occurs on-site that may lead to contamination of groundwater or surface water the Consent Holder shall notify the <insert name of registered drinking water supply> and the Hawke’s Bay Regional Council (Manager Compliance) of the event as soon as reasonably practicable after the event occurs.

 Advice Note: Such an event might include for example a chemical or effluent spill. The <name of registered drinking water supply> can be contacted on <insert phone number>. The Regional Council 24 hour Pollution Hotline should also be contacted on 0800 108 838.

27. To minimise the risk of contaminants entering groundwater, the consent holder shall:

a) Ensure that well headworks are constructed and maintained to prevent any leakage and/or movement of water or contaminants between the ground surface and groundwater, and shall ensure that there are no openings through which contaminants might enter the well. This shall include (but not be limited to) ensuring that there are no gaps around any pipework and/or cables at the wellhead.

b) Ensure that the well is maintained and serviced by a suitably qualified and experienced person at a frequency suitable for ensuring that condition 13(a) is met, and provide records of this maintenance and servicing to the Council (Manager Compliance) upon request.

c) In the absence of sufficient records to demonstrate to the satisfaction of the Council (Manager Compliance) that condition 13(a) is met, the consent holder, upon request by the Council (Manager Compliance), shall engage at their cost a suitably qualified and experienced person to inspect and certify that the wells(s) meet the requirements of condition 13 (a). The certification shall be provided to the Council (Manager Compliance) within 7 days of its receipt.

Advice note: For the purposes of this condition, an acceptable "suitably qualified and experienced person" is a professional well driller or well engineer (or equivalent), with demonstrable experience in the field of wellhead security, design, construction and maintenance.

REVIEW OF CONSENT CONDITIONS BY THE COUNCIL

The Council may review conditions of this consent pursuant to sections 128, 129, 130, 131 and 132 of the RMA. The actual and reasonable costs of any review undertaken will be charged to the consent holder (unless specified otherwise), in accordance with section 36 of the RMA.

Times of service of notice of any review: During the month of May, in any year.

Purposes of review:

To deal with any adverse effect on the environment which may arise from the exercise of this consent, which it is appropriate to deal with at that time or which became evident after the date of issue;

To require that the installation and reading of the water-measuring device or water meter data reporting system is consistent with any policies or rules in a regional plan, a National Environmental Standard;

To modify any monitoring programme, or to require additional monitoring if there is evidence that current monitoring requirements are inappropriate, in accurate or inadequate;

To ensure that the rate and volume of water authorised by the consent is consistent with actual water needs for an efficient take and is physically able to be taken;

To modify or add any condition to ensure that water is allocated in accordance with an operative plan;

To modify and/or add conditions of consent in order to ensure that it is consistent with the operative provisions of a regional plan. This shall include (but not be limited to) conditions specifying any maximum or minimum levels, minimum flows and associated implementation timeframes, and/or abstraction rates or volumes (including allocation limits) (see Advice Note)

REASONS FOR DECISION

The effects of the activity on the environment will not be more than minor. Granting the consent is consistent with the purpose and principles of the RMA, the requirements of any relevant NPS, Regulations, NES regulations and with all relevant plans and policies.

ADVICE NOTES

Water Meter Technical Specifications

I. The following documents are available from the Council's website "*Technical Specifications and Installation Requirements for Flow Meters*" (February 2010) (www.hbrc.govt.nz/services/water/water-metering/meters/) and "*HBRCs Requirements for the use of Portable pumps used to report water use*" (February 2013) (www.hbrc.govt.nz/assets/Document-Library/Technical-Publications/Technical-Specifications-and-Installation-Requirements-for-portable-pumps-March-2013.pdf). The *Telemetry System Installation Form* is provided to telemetry installers by the Council upon request.

Water Take Records

II. Where no water is taken over an extended period the Council (Manager Compliance) may authorise that records be provided at intervals exceeding one month

Notification of Changes to Details

III. It is the responsibility of the consent holder to inform the Council (Manager Consents) if any details regarding this consent change, including any sale / purchase of the property and any change to contact details.

Spray filling, Fertigation and Chemigation

IV. The guideline referred to in condition 17 is available from the Irrigation New Zealand website (www.irrigationnz.co.nz). An appropriate backflow prevention mechanism for spray filling might include (but not be limited) the maintenance of an air gap between the inflow pipe and the receiving spray fill tank.

Water Quality Testing

V. It is the responsibility of the consent holder to ensure that the water abstracted under this resource consent is of suitable quality for its intended use. Where water is to be used for human consumption, the consent holder should have the water tested prior to use and should discuss these requirements with a representative of the Ministry of Health and should consider the following Drinking Water Standards (see link below): https://www.health.govt.nz/system/files/documents/publications/drinking-water-standards-2008-jun14.pdf

MONITORING NOTE

Routine monitoring

Routine monitoring inspections will be undertaken by Council officers at a frequency of no more than once every year to check compliance with the conditions of the consent. The costs of any routine monitoring will be charged to the consent holder in accordance with the Council's Annual Plan of the time.

Non-routine monitoring

"Non routine" monitoring will be undertaken if there is cause to consider (e.g. following a complaint from the public, or routine monitoring) that the consent holder is in breach of the conditions of this consent. The cost of non-routine monitoring will be charged to the consent holder in the event that non-compliance with conditions is determined, or if the consent holder is deemed not to be fulfilling the obligations specified in section 17(1) of the RMA shown below.

Section 17(1) of the RMA states:

> *Every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried on by or on behalf of the person, whether or not the activity is carried on in accordance with*
>
> *a) any of sections 10, 10A, 10B, and 20A; or*
>
> *b) a national environmental standard, a rule, a resource consent, or a designation.*

Consent Impact Monitoring

In accordance with section 36 of the RMA (which includes the requirement to consult with the consent holder) the Council will levy additional charges for the cost of monitoring the environmental effects of this consent, either in isolation or in combination with other nearby consents. Any such charge would generally be set through the Council's Annual Plan process.

DEBT RECOVERY

It is agreed by the consent holder that it is a term of the granting of this resource consent that all costs incurred by the Council for, and incidental to, the collection of any debt relating to this resource consent, whether as an individual or as a member of a group, and charged under section 36 of the RMA, shall be borne by the consent holder as a debt due to the Council, and for that purpose the Council reserves the right to produce this document in support of any claim for recovery.

CONSENT HISTORY

Consent No.	Date	Event	Relevant Rule	Relevant Plan
	Xx/xx/xxx	Consent initially granted	55	Regional Resource Management Plan