Memorandum

08 December 2020

To	Jayben Lister		
Copy to			
From	Rikito Gresswell, Paul Hamer	Tel	+61 3 86878877
Subject	Numerical modelling of groundwater abstraction scenario	Job no.	12521429

1 Introduction

This document details the findings of an additional groundwater modelling scenario undertaken to assess the areas of influence of increased groundwater abstraction from future water supply bores at the Hotham Bauxite project. The assessment utilises the existing numerical groundwater model developed for the project, which has been calibrated to long term monitoring data and used to quantify the potential project-induced impacts associated with the future mining/clearing activities. Detailed descriptions of model design, calibration and prediction are documented in GHD 2020, including model uncertainty and limitations.

2 Model set up

For the purpose of this assessment, a total of 11 groundwater abstraction bores have been incorporated into the groundwater model. The location and rate of abstraction for each bores are summarised in Table 1. Water supply investigations will be required to verify the yield and resource (Table 1), as there is no guarantee of the proposed/required yields at the locations selected.

Abstraction is assigned to layer 3 of the model, representing the upper (more permeable) part of the bedrock aquifer where the majority of existing pumping bores are assigned. Abstraction has also been distributed to the overlying (shallow) aquifer to maximise the potential for achieving the required yield at each bore. This partitioning of abstraction to more than one aquifer has been achieved using MODFLOW-USG's Connected Linear Network (CLN) package, in a manner similar to the Multi- Node Well package of MODFLOW2000. This effect is analogous to bores having long screen/slotted casing intersecting more than one aquifer to maximise the yield.

The predictive modelling scenario, as documented in GHD 2020, has been re-run with the additional abstractions incorporated (continuing until the end of 2039). As per the previous modelling, the model outputs are compared against a base case scenario - that is without any further mining and abstraction, to quantify their incremental effects. This means the model predicts positive groundwater level drawdown in areas where the water table is lowered by abstraction and negative groundwater level drawdown in areas where the water table is raised by enhanced recharge due to clearing.

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The effect of groundwater abstraction has been quantified using the following two realisations of the model:

- *Predictive model* – calibrated towards the lower end of the plausible range of hydraulic conductivity and recharge.
- *Alternative model* - calibrated towards the upper end of the plausible range of hydraulic conductivity and recharge.

Table 1 Future groundwater abstraction bores and rates (supplied by South32)

Site location	Site name	Easting (GDA94 Z50)	Northing (GDA94 Z50)	Abstraction rate (m3/d)
Nullaga / BGM	C/20	443177	6372939	78.5
	D/20	443055	6372892	78.5
	E/20	443119	6372892	78.5
	L/20	445631	6373064	78.5
	T/20	442970	6372890	78.5
	U/20	445583	6373089	78.5
Nullaga JV	C/19	443871	6368082	156.2
	F/19	443862	6368199	156.2
Hotham West JV	D/19	444087	6360372	104.1
	E/19	444603	6357869	104.1
	G/19	444219	6358799	104.1

3 Results

Figure 3-1 and Figure 3-2 present the contours of maximum water table changes due to mining and abstraction (compared to a base case of no mining), for the predictive model and alternative model respectively.

These contours are effectively identical to the contours of maximum change caused by mining presented in the previous modelling report (GHD 2020) except that zones of positive drawdown are now simulated around the location of abstraction bores where the water table has been lowered.

The figures provide indications of the maximum area of influence of abstraction, which partly offsets the mounding of the water table resulting from enhanced recharge due to clearing. This means abstraction has the potential to locally lessen the impact of clearing, for example by minimising the small increase in baseflow to the Hotham River as shown in Figure 3-3.

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The modelling indicates that not all of the applied abstraction rates could be sustained by the predictive model, particularly given that is calibrated towards the lower end of recharge and hydraulic conductivity (lower groundwater yields). This is highlighted in Figure 3-4, which shows that there is insufficient hydraulic conductivity in the predictive model to sustain abstraction at 5 bores (although more than 85% of the applied abstraction is sustained at 3 of these bores).

For the alternative model, with higher hydraulic conductivity, all of the applied abstraction is sustained. As previously mentioned, in reality the water supply potential of the aquifers at the location of abstraction bores would not be known until more detailed field investigations are undertaken to confirm the resource and an improved understanding of the areas of influence (groundwater drawdown extent). Nonetheless, the modelling demonstrates that the predicted areas of influence of abstraction from the two realisations of the model are broadly similar (Figure 3-1 and Figure 3-2).

I trust that we have supplied sufficient information for your requirements. Please feel free to contact us if you have any questions or require clarifications.

Regards

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Senior Hydrogeologist

References:

- GHD 2020, South32 Worsley Alumina Py Ltd, Groundwater supporting studies, numerical groundwater modelling, prepared for South32, December 2020 (GHD ref: 12521429).

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Figure 2-1 Predictive model – predicted maximum change in water table

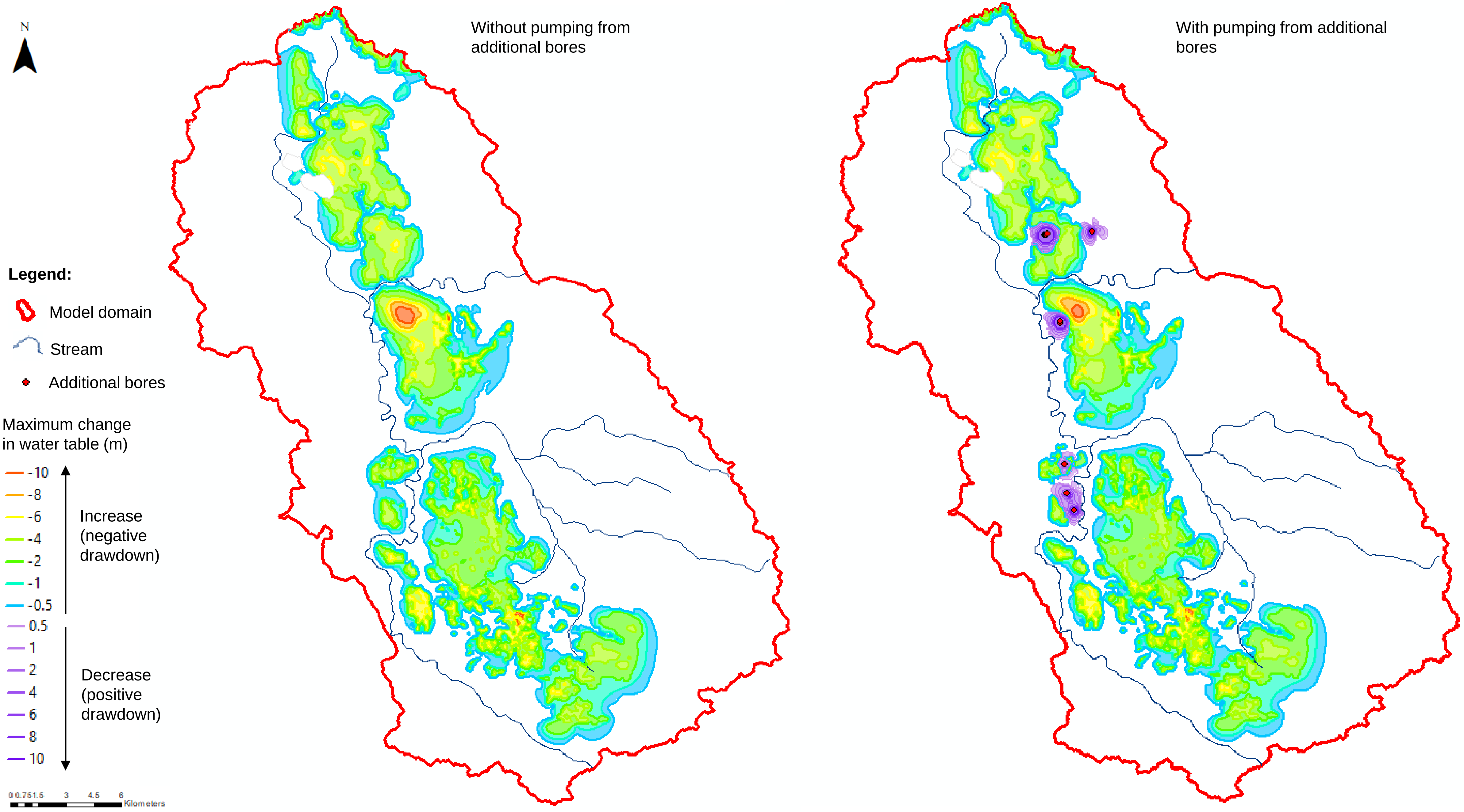


Figure 2-2 Alternative model – predicted maximum change in water table

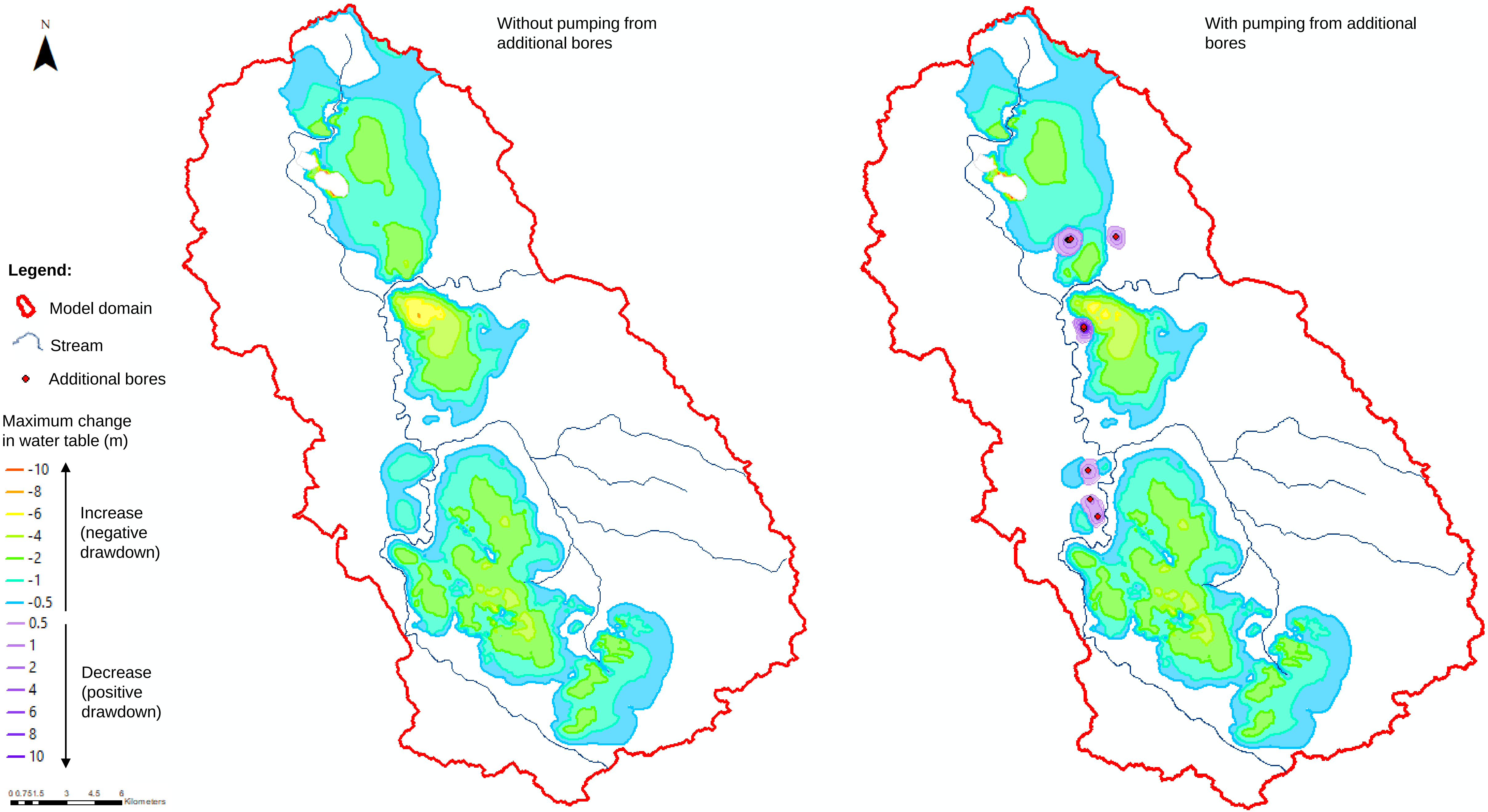


Figure 3-3 Example of abstraction effect on baseflow (predictive model)

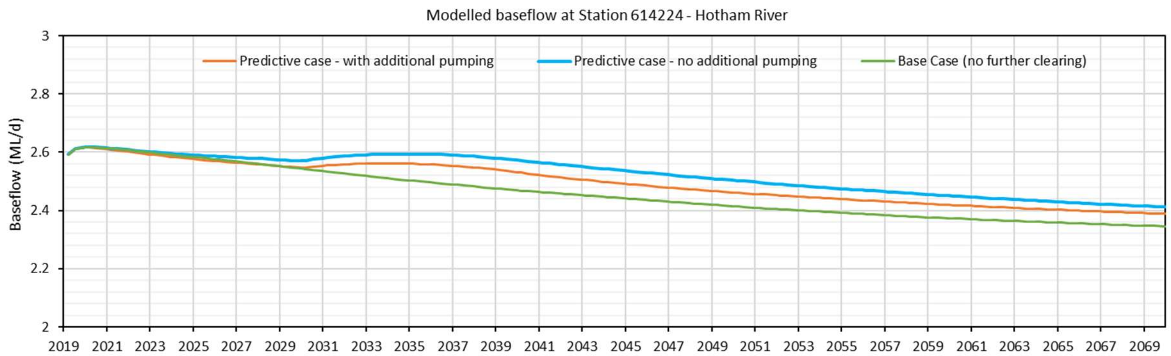
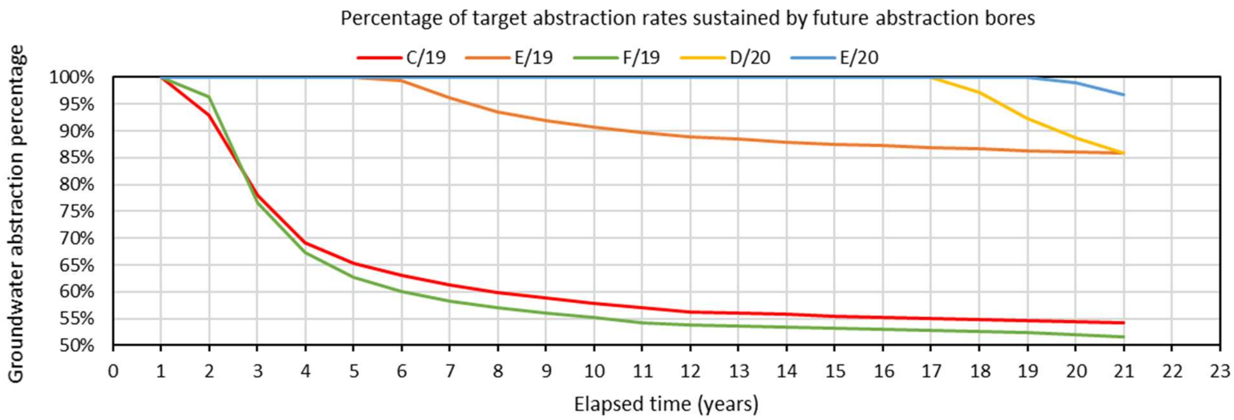


Figure 3-4 Reduction in modelled abstraction rates (predictive model)



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