

Internal Memo

To	Brydon Hughes (Liquid Earth Limited)	Date	16 May 2019
From	Jon Williamson & Jake Scherberg (Williamson Water & Land Advisory)	Project No	WWA0068
Subject	Aupouri Aquifer Groundwater Model Lateral Migration Analysis for Pumping and Naturalised Scenarios		

1. Introduction

WWLA has undertaken a lateral migration analysis using outputs from the Aupouri Aquifer Groundwater Model (AAGWM) to identify areas of potential concern for saline intrusion and the possible effects of groundwater extraction in terms of saline intrusion along the east and west coasts of the Aupouri Peninsula. Details of lateral migration assessment are provided in WWLA 2019¹.

2. Lateral Migration Analysis

The Ghyben-Herzberg relation was used to back-calculate the minimum hydraulic head required to maintain the saline interface below the shellbed aquifer (i.e. the lateral migration “Trigger Level” (TL)) based on the estimated depth to the basement rock at the coastal margins.

Simulated groundwater levels at selected points along the east and west coasts were compared to calculated TL's. The difference between the groundwater level and TL is the head residual, which is used in the analysis and discussed in the results section below.

The simulated groundwater levels comprise 90-day rolling averages to account for the delayed osmotic response for saline intrusion to be initiated following the onset of reduced groundwater pressures during summer. The lowest groundwater levels from the 58-year historical record occurred on 30 April 2010, corresponding to the end of the 2010 irrigation season.

Two model scenarios were undertaken:

1. **Naturalised** – Model is run with no groundwater extraction
2. **Proposed Extraction** – All proposed consented and proposed groundwater takes as of 15/4/2019 are included.

¹ Williamson Water & Land Advisory (2019). Aupouri Aquifer Groundwater Model-Factual Technical Report. Consultancy report prepared for interested parties and the public.

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3. Results

Figure 1 to Figure 4 present map tiles progressing from north to south of the saline intrusion results (head residuals in meters) at regularly spaced analysis points around the coastline.

Positive residual indicates that simulated head is greater than the TL, whereas a negative value indicates potential saline intrusion. The residual from the Proposed Extraction Scenario is shown as the primary label for each point, with the Naturalised Scenario residuals in parentheses.

The results are summarised for each figure in **Table 1**.

Table 1. Summary of saline intrusion results.

Fig.	Location	West Coast	East Coast
1	Northern Tile – Ngataki to Pukenui	In the north, heads reside below the TL, which may signal localised saline intrusion potential. However, this is i) an area of limited groundwater and geological data (basement is inferred to be shallow), ii) limited groundwater utilisation with forestry as the primary land use; and iii) not impacted by the proposed pumping (i.e. both scenarios are similarly negative).	In the area north of Henderson Bay, simulated groundwater heads are below the TL at some locations, however shellbed aquifer is very thin or absent in this area and there is limited groundwater use. Simulated heads are the same for the naturalised and proposed extraction scenarios indicating that groundwater heads are not impacted by the proposed pumping. Potential saline intrusion is also indicated at the top of the Houhora Harbour due to shallow basement rock in the area. Groundwater heads are above the TL along the majority of the inlet. Pumping has negligible impact in the area of potential concern.
2	Mid-East Tile – Houhora to Motutangi	Potential saline intrusion is not indicated in this area. Simulated groundwater head ranges from 1.5 to 6 m above the TL.	The margin of Houhora Heads, shown in an inset map, is an area that is potentially vulnerable to saline intrusion largely due to shallow basement rock. The proposed pumping has a minimal impact on the simulated groundwater levels. South of Houhora Heads groundwater levels are above the TL until the coastal margin adjacent to Kaimaumu wetland.
3	Southeast Tile – Kaimaumu Wetland to Awanui	No west coast points are shown in this tile.	Groundwater levels are below the TL along the coast adjacent to Kaimaumu Wetland though proposed pumping has a negligible impact on groundwater levels. In the Paparore and Waipapakauri areas groundwater levels remain above the TL, however the wetlands in the southeast portion of the tile may have potential for saline intrusion. Groundwater use, and pumping effects are minimal in this area.
4	South Tile – Awanui to Ahipara	Groundwater levels in this tile remains above the TL at all points on this tile. Pumping impacts are predicted adjacent to the Sweetwater and FNDC bores, however sufficient groundwater pressure remains to avert saline intrusion.	The only east coast points shown in this tile are included in the discussion of Tile 3.

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3.1.1 Areas Sensitive to Saline Intrusion

There are areas where simulated groundwater levels are below the TLs for potential saline intrusion, indicated by negative residuals in **Figures 1 to 4**. However, in all cases these occur under both the Naturalised and Proposed Extraction scenarios. This indicates that the potential saline intrusion is related to factors other than pumping, for example:

- In the area around Houhora Heads the negative residuals are a result of shallow basement rock and associated low TLs for potential saline intrusion.
- In the northwest portion of the model there is minimal borelog information to inform the physical representation of geologic layers in the model and hence relatively high uncertainty in this area. There is also minimal, if any, groundwater demand in this area, as is reflected by simulation results where the difference in residuals for the Proposed extraction and Naturalised scenarios is 0.01 m or less.

The area of potential greatest impact is the Sweetwater area, where predicted drawdown along the coast is slightly over 1 m. This is primarily due to a large groundwater takes associated with the FNDC bores for Kaitaia, in combination with the Sweetwater Farms existing and proposed takes, and Elbury Holdings proposed take. With proposed extraction, groundwater levels are a minimum of 1.06 m above the TL for the driest time in the 58-year simulation.

It is apparent when comparing residuals from the two scenarios that pumping has less impact in the most sensitive areas, because these tend to be in estuaries and areas likely to be saline under natural conditions and therefore not targeted for development.

4. Conclusion

The AAGWM has been applied to perform an investigation of the effect of pumping on the lateral migration of seawater into the Aupouri aquifer. The analysis focussed on the single driest time period or conditions over the 58-year simulation period and has highlighted that:

- the greatest impacts are predicted where there is sufficient groundwater pressure to avert saline intrusion; and
- some areas are potentially sensitive, but these areas are not significantly impacted by the proposed pumping typically being isolated coastal areas.

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Figure 1. Saline Intrusion potential – residual head (Ngataki to Pukenui).

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Figure 2. Saline Intrusion potential – residual head (Houhora to Motutangi).

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Figure 3. Saline Intrusion potential – residual head (Kaimaumau Wetland to Awanui).

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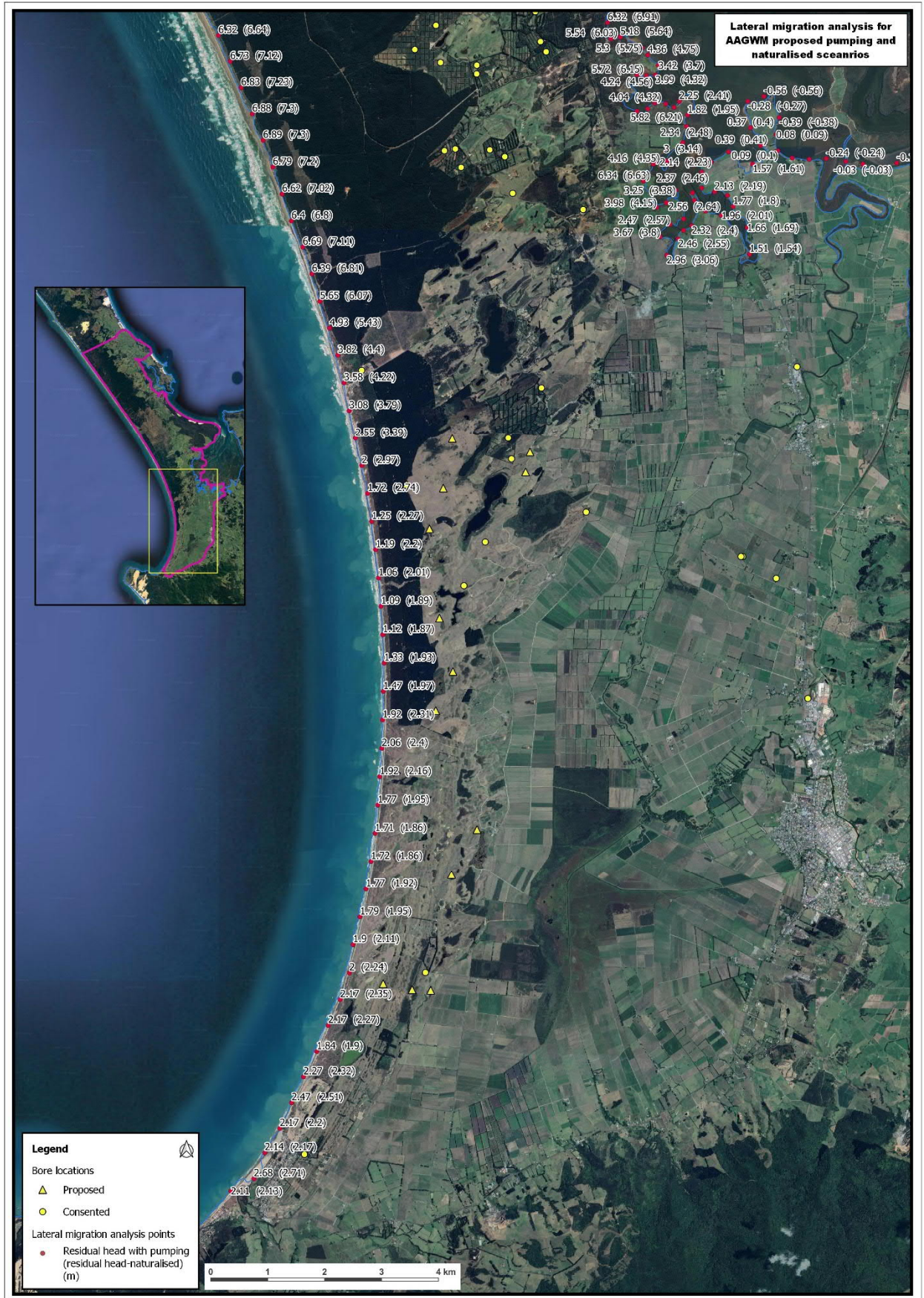


Figure 4. Saline Intrusion potential – residual head (Awanui to Ahipara).