**Before the Independent Commissioners of the Northland Regional Council (NRC)**

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| In the Matter of | the Resource Management Act 1991 |
| And | |
| In the Matter of | applications by members of the Aupōuri Aquifer Water Users Group for 24 new groundwater takes from the Aupōuri Aquifer subzones: Other, Waihopo, Houhora, Motutangi, Waiparera, Paparore, Sweetwater |

Statement of Evidence of

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**Kenneth B. (Keg) Alexander**

For the Ministry of Education

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Dated: 21 August 2020

## 1. INTRODUCTION AND EXPERIENCE

**1.1** My full name is Kenneth Bower Alexander. I am a Senior Associate – Hydrogeology at Beca Ltd and have been engaged by the Ministry of Education to provide groundwater technical review of the Aupōuri Aquifer Water Users Group (AAWUG) consent application.

**1.2** I have a Bachelor of Science (BSc) in Geology from Virginia Tech (1988) and a Master of Arts (M.A.) in Geological Sciences from the University of Texas at Austin (1990). I am a Certified Professional Geologist (No. 10594) in accordance with the requirements of the American Institute of Professional Geologists (AIPG), the only international organization that certifies the competence and ethical conduct of geological scientists. I am also a California Certified Hydrogeologist (No. 512).

**1.3** I have nearly 30 years' post-graduate experience in geological and hydrogeological investigations and analysis. I have worked as a consulting hydrogeologist for several environmental and engineering consulting firms in the US and, since 2008, New Zealand. I have managed a wide variety of hydrogeologic surveys, environmental assessments, focused contaminant investigations, and multi-year environmental remediation and water supply projects.

**1.4** Since joining Beca in 2019, I have provided independent technical review of consent applications for groundwater take and dewatering projects (Auckland Council and Bay of Plenty Regional Council). These reviews typically include evaluation of methods of aquifer analysis and effects of drawdown on nearby bores and surface water, assessment of risk for potential saltwater intrusion, and preparation of s92 queries for additional technical information from applicants.

## 2. CODE OF CONDUCT

**2.1** My qualifications as an expert are set out above. I confirm that I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014. I have complied with the Code of Conduct in preparing this evidence. Except where I state that I am relying on the evidence of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

## 3. SCOPE OF EVIDENCE

**3.1** The evidence I have been asked to prepare by the Ministry of Education relates to the AAWUG application for 24 separate applicants to take groundwater from the Aupōuri Aquifer in Northland. These applications have been combined by Northland Regional Council (NRC) due to the potential cumulative effects these water takes will have on the aquifer and surrounding consented water takes.

**3.2** There is a potential impact on the Ministry's property as seven rural schools in Northland rely on groundwater takes from the Aupōuri Aquifer as their main source of water, namely:

- Ngataki School
- Pukenui School
- Waiharara School
- Paparore School
- Awanui School
- Pukepoto School
- Ahipara School

**3.3** I have reviewed the recent (August 2020) NRC Section 42A Staff Report on the proposed draft conditions of consent and groundwater monitoring and contingency plans. The objective of my review was to evaluate if the proposed conditions and groundwater monitoring plans in the NRC Staff Report met the conditions requested by the Ministry in November 2019 to help safeguard the quantity and quality of the water supply for the seven rural schools.

**3.4** The proposed conditions of consent include extensive monitoring requirements. The area of interest, the Aupōuri Peninsula, has been divided into three geographic sub-regions – the Northern, Middle, and South-western groups. Each group has a specific Groundwater Monitoring and Contingency Plan (GMCP). The GMCP sets out the procedures by which the proposed abstractions will be monitored and managed to ensure compliance.

**3.5** The GMCP for each group includes the requirements for staged implementation of groundwater extraction, groundwater monitoring programmes, groundwater level and groundwater quality (salinity) triggers, and contingency plans. Mitigation and remediation measures are based on the breaching of trigger levels (TL1 similar to Alert levels, and TL2 similar to Alarm levels) for both groundwater levels and salinity.

**3.6** My evidence will address the potential effects on the school's water takes and the sufficiency of the GMCPs to monitor and mitigate adverse effects on school bores. I will also present recommendations to manage the risk that the groundwater levels and groundwater quality (salinity) of the school bores could be impacted by the proposed abstractions.

## 4. SUMMARY OF EVIDENCE

**4.1** Management of groundwater resources should take into account that, although individual consents pumping from deeper aquifers may cause very small changes in the level of the water table in shallow aquifers, over time those deeper abstractions can eventually affect the water table level and change recharge or discharge components of the system, such as stream and spring flows. The magnitude and location of these changes is dependent on the location of the groundwater takes, their depth, and the hydrogeological properties of the system.

**4.2** The Aupōuri Aquifer consists of unconsolidated sedimentary deposits that can be broadly classified into two primary hydrostratigraphic units:

- The upper unit comprising 40 to 120 m of fine-grained sands and silts hosts a low-yielding unconfined aquifer (**the shallow aquifer**)

- In many areas, the lower 5 to 30 m of the sedimentary sequence (overlying the basement rock) comprises fine to medium sand containing a high percentage of relatively coarse shell fragments (**the deeper shell bed aquifer**). These deposits exhibit significantly higher permeability than the overlying sands so are typically the target for larger-scale groundwater development.

**4.3** While there is no well-defined, laterally continuous confining layer that separates the two units, the occurrence of numerous, low-permeability layers within the sand deposits collectively provide a degree of confinement to the deeper shell bed aquifer. As a result, the deeper shell bed aquifer is best characterized as a semi-confined aquifer[1] that exhibits varying degrees of hydraulic connection to the overlying sand deposits (including the shallow aquifer) depending on the local geologic setting.

[1] A semi-confined, or leaky, aquifer means that there is some vertical movement of groundwater through the overlying low-permeability layers. Abstraction from deep bores means that leakage develops over a wide area.

**4.4** The school bores are all screened in the shallow aquifer except for the Paparore School bores, which are likely screened in the deeper shell bed aquifer. All the proposed applicant bores will be screened in the deeper shell bed aquifer. The location of the school bores and proposed bores are shown in Figure 1 below.


***Figure 1: Approximate location of proposed bores (orange dots) and location of school bores in the Aupōuri Peninsula (scale 1:250,000)***

**4.5** Proposed groundwater takes within a 2 km radius of a school bore[2] have the potential to affect the bore's ability to draw water (especially shallow bores). The Ministry would like to ensure that the proposed water takes do not adversely affect the ability of any of the above-mentioned schools to access water from their bores, nor affect the quality of water in the school bores. Although each application assessed interference from their proposed pumping on neighbouring bores, the assessment of effects was mainly performed for the bores screened in the deeper shell bed aquifer. The assessment has not specifically assessed effects on the shallow aquifer from which six of the seven school bores draw water from.

**4.6** The Staff Report includes GMCPs for each geographic sub-region of the Aupōuri Peninsula. Overall, I consider the proposed GMCPs are relevant and robust, and meet the objectives of avoiding the adverse effects associated with saltwater intrusion into the Aupōuri Aquifer and lowering the groundwater levels in existing bores.

**4.7** I make the following comments for each of the seven rural schools with reference to the maps below showing the school location and proposed monitoring and production bores (Figures 2 – 4).

**4.8** **Ngataki School** has an 18-m deep bore screened in the shallow aquifer. The nearest proposed applicant abstraction bores are Henderson Bay Avocados, located about 1.4 km to the east of the school and Far North Avocados, located about 1.9 km to the east of the school (Figure 2). Proposed monitoring bore "Waihopo Level/Quality" is tentatively planned to be located about 3 km from the school. According to the proposed GMCP, this bore will be completed in the deeper shell bed aquifer and monitored monthly for water levels and quarterly for salinity indicators (electrical conductivity). The proposed production bores will be completed in the deeper shell bed aquifer and monitored monthly. However, there are no nearby shallow bores proposed in the GMCP to monitor groundwater levels in the shallow aquifer near Ngataki School. I consider that monitoring of the shallow aquifer is also required to confirm that it is not affected by abstraction from the deeper shell bed aquifer at the applicant's proposed bore locations.

[2] The 2 km distance is based on the predicted drawdown within 2 km of the proposed take locations as modelled under both Scenario 2 and Scenario 3 conditions in Appendix B of the WWLA AEE (2020).

**4.9** **Pukenui School** has a 30-m deep bore screened in the shallow aquifer. The school is approximately equidistant (about 1 km) from three proposed applicant abstraction bores (all from the deeper shell bed aquifer): S&L Blucher, Te Raite Station, and A Matthews (Figure 2). An existing monitoring bore in the deeper shell bed aquifer, named "Fishing Club", is located about 0.7 km to the east of the school. Two proposed monitoring bores (shallow aquifer and deeper shell bed aquifer) are planned for "Lamb Road", approximately 1 km to the west. In addition, there are two proposed sentinel bores ("NRC Waterfront") located about 1 km to the east. I concur that the proposed monitoring requirements outlined in the GMCP for the shallow and deep sentinel bores ("NRC Waterfront") will provide sufficient monitoring of the shallow groundwater levels and saline intrusion risk for the Pukenui School bore.

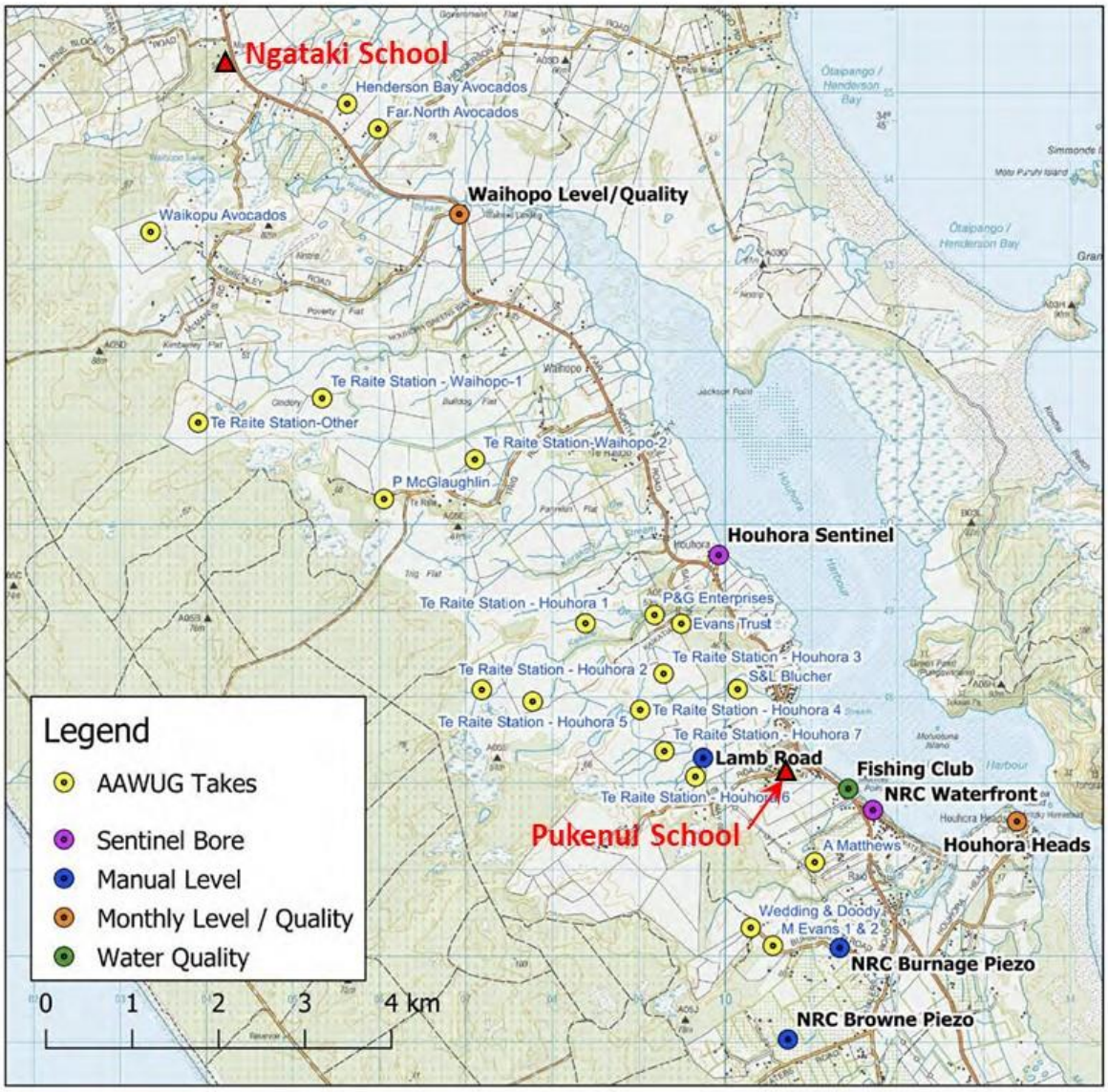


***Figure 2: Monitoring and production bore location map for the Northern sub-region (with school locations marked by red triangles. Map modified from GMCP for the northern sub-area (July 2020).***

**4.10** **Waiharara School** has a 38-m deep bore screened in the shallow aquifer. The nearest proposed applicant abstraction bore is Mate Yelavich & Co, located about 0.2 km to the south (Figure 3). The nearest proposed monitoring bore is "Norton Road", a new sentinel bore tentatively located about 3 km to the east and completed in the deeper shell bed aquifer. Other nearby sentinel bores (Kaimaumau Rd and Paparore) will be completed in both the shallow and deeper shell bed aquifers. These sentinel bores are sufficient to monitor for saline intrusion. However, there are no nearby shallow bores proposed in the GMCP to

monitor groundwater levels in the shallow aquifer near Waiharara School. I consider that monitoring of the shallow aquifer, closer to the production bore, is warranted to confirm that it is not affected by abstraction from the deeper shell bed aquifer at the proposed Yelavich bore, located about 200 m (and perhaps less) across Katavich Road.

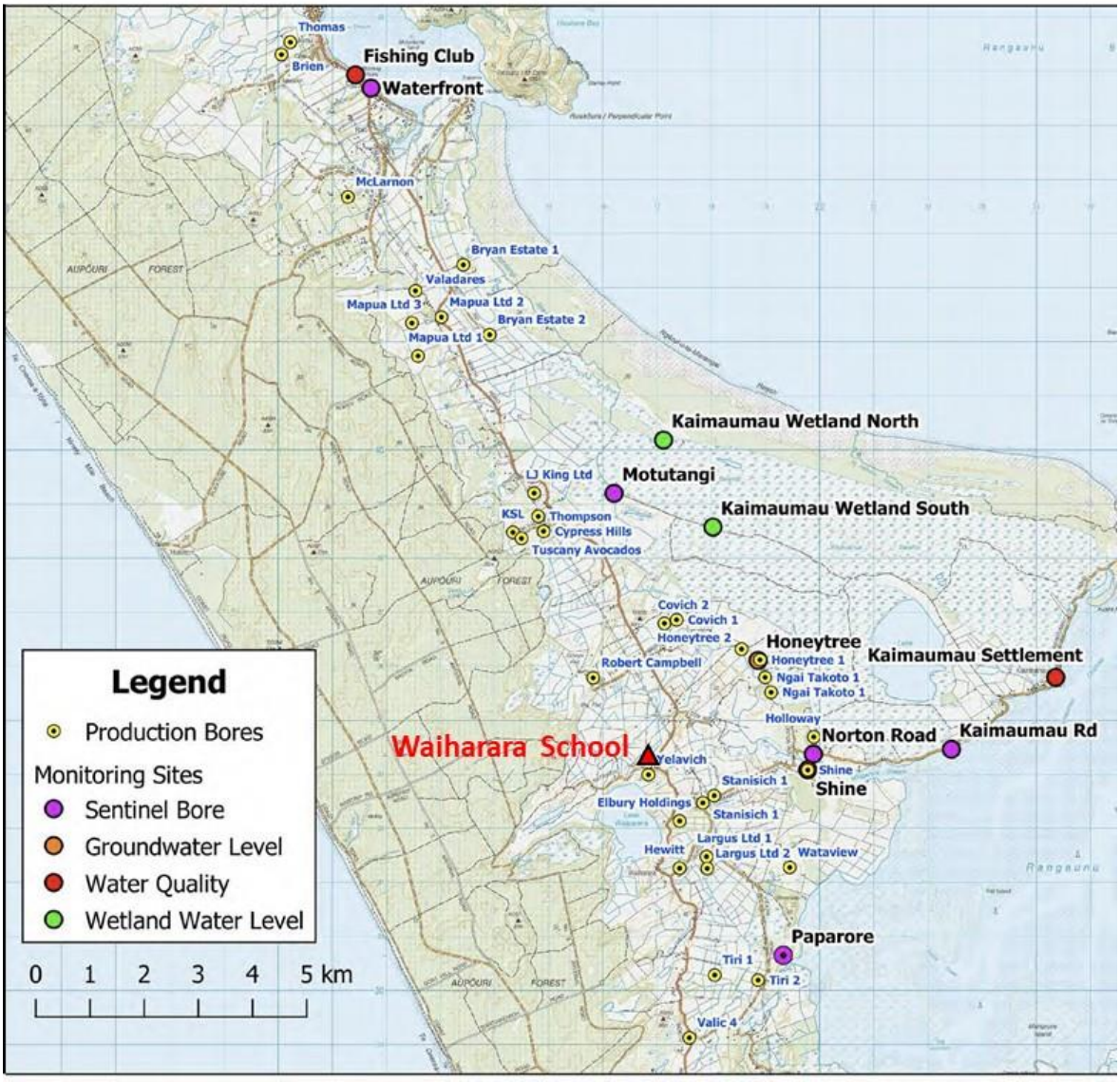


***Figure 3: Monitoring and production bore location map for the Middle sub-region (with school locations marked by red triangles. Map modified from GMCP for the middle sub-area (July 2020).***

**4.11** **Paparore School** has two bores (94 m and 101 m deep) presumed to be screened in the deeper shell bed aquifer. The nearest proposed applicant abstraction bores are more than 2.5 km to the south, Sweetwater 5 and Elbury Holdings (Figure 4). A proposed monitoring bore, "Waipapakauri Quality", is tentatively planned to be located near the coast and completed in the deep shell bed aquifer. This bore will provide saline intrusion monitoring for the school bores. I concur that the proposed abstraction from more than 2.5 km away will have less than minor effects on the groundwater levels at the school and the proposed monitoring described in the GMCP is sufficient to monitor any effects of saline intrusion.

**4.12** **Awanui School** has a 30.45-m deep bore screened in the shallow aquifer. The nearest proposed applicant extraction bore is more than 4.5 km away to the west (Figure 4). No effects on the shallow groundwater levels at the school are expected from the proposed abstractions.

**4.13** **Pukepoto School** has a 42-m deep bore screened in the shallow aquifer. The nearest proposed applicant extraction bore is more than 3.5 km away to the northwest (Figure 4). No effects on the shallow groundwater levels at the school are expected from the proposed abstractions.

**4.14** **Ahipara School** has two bores (10 m and 20 m deep) screened in the shallow aquifer. The nearest proposed applicant extraction bore is more than 4.5 km away to the north (Figure 4). No effects on the shallow groundwater levels at the school are expected from the proposed abstractions. However, the school bores are located only 0.8 km from the coast and are at risk to saline intrusion.


***Figure 4: Monitoring and production bore location map for the South-western sub-region (with school locations marked by red triangles. Map modified from GMCP for the south-western sub-area (July 2020). No scale provided.***

## 5. RECOMMENDED ACTIONS

**5.1** **Ngataki School** – Because the school bore is located within 2 km of two proposed abstraction bores, and there are no shallow monitoring bores nearby, I recommend that the Ngataki School shallow bore be included in the proposed GMCP for the northern sub-region as one of the scheduled monitoring bores requiring monthly monitoring of water levels and quarterly monitoring of salinity indicators (electrical conductivity).

**5.2** **Waiharara School** – Because the school bore is located only about 200 m (or closer) from the proposed Yelavich abstraction bore, and there are no shallow monitoring bores nearby, I recommend that the Waiharara School shallow bore be included in the proposed GMCP for the middle sub-region as one of the scheduled monitoring bores requiring monthly monitoring of water levels and quarterly monitoring of salinity indicators (electrical conductivity).

**5.3** **Ahipara School** – The school bores are located about 800 m from the coast and are at risk from saline intrusion. I recommend that the Ahipara School bores be included in the proposed GMCP for the south-western sub-region (Table 6) as one of the salinity indicator monitoring bores to provide additional monitoring of any changes in the shallow aquifer salinity.

**5.4** **Alternative sources of drinking water** – All three GMCPs include a contingency plan in the event of a TL2 exceedance. The mitigation measures include immediately reducing groundwater abstraction rates by 50% and, if the salinity indicators or groundwater levels continue to exceed the TL2 for 21 days, then the abstraction flow rates must be reduced to 25%. The Council will then commission a review with a longer-term program of mitigation measures. One measure is to provide "*temporary water supplies to any affected parties in the event that chloride concentrations exceed 250 mg/L (based on NZ Drinking Water Standards)*." If a school bore is impacted by saline intrusion such that chloride levels exceed 250 mg/L, then the bore may not be able to be used in the future for drinking water once saline water has mixed with groundwater. I recommend that additional details be added to the GMCPs to explicitly state that in the event a school bore is impacted by saline intrusion such that chloride levels exceed 250 mg/L then the consent holders should immediately provide temporary water supplies to the school until a **permanent** alternative source of water for the affected school can be provided at the consent holder's expense.

## 6. CONCLUSIONS

**6.1** Management of groundwater resources should take into account that, although individual consents pumping from deeper aquifers may cause very small changes in the level of the water table in shallow aquifers, over time those deeper abstractions can eventually affect the water table level and change recharge or discharge components of the system, such as stream and spring flows. The magnitude and location of these changes is dependent on the location of the groundwater takes, their depth, and the hydrogeological properties of the system.

**6.2** This is why it is critical that groundwater level monitoring as well as salinity monitoring with appropriate trigger levels should be undertaken by the applicants on both the shallow and deeper shell bed aquifers to verify the envelope of effects predicted in their assessment of effects.

**6.3** Even though the proposed GMCPs are comprehensive, I believe that additional recommended actions are required to verify that the proposed water takes do not adversely affect the ability of any of the seven rural schools to access drinking water from their bores. The recommended actions are relatively small and prudent additional requirements to the proposed GMCPs and would help safeguard the quantity and quality of the water supply for the seven rural schools.

**Kenneth Bower Alexander**
**21 August 2020**