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

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 new groundwater takes from the Aupōuri Aquifer subzones: Other, Waihopo, Houhora, Motutangi, Waiparera, Paparore, Sweetwater.

Statement of Supplementary Evidence of

Jon Williamson

for the Aupōuri Aquifer Water Permit Applicants

Dated: 28 September 2020

Contents

1. Introduction

1. This document comprises brief supplementary evidence responding to The Commissioner's Minute and Direction #2 dated 07/09/20 and comprises sections addressing the following matters:

   (a) Hydraulic Connection Category Assessment in Accordance with Policy H.5;

   (b) General Head Boundaries;

   (c) Basement Topography;

   (d) Drawdown at FNDC Bores;

   (e) Material Compressibility for Subsidence; and

   (f) Water Requirement for Valic and Wataview Orchards.

2. Hydraulic Connection Category Assessment in Accordance with Policy H.5.

2. The Commissioners asked for an assessment of each application in terms of their "Hydraulic Connection Category" with respect to Policy H.5 of the Proposed Regional Plan for Northland (pRPN).

3. This was undertaken using simulated stream and drain baseflow data from the Aupōuri Aquifer Groundwater Model (AAGWM) on a catchment by catchment basis. Stream depletion was calculated as the difference in stream or drain baseflow between the Naturalised Scenario and Scenario 2 (consented and proposed pumping) in each catchment.

4. The contribution of each individual groundwater take to stream depletion in each catchment was assessed in a cumulative sense as a starting point (i.e. with all existing and proposed AAWUG takes at full operation).

5. The stream depletion effect that was attributable to each bore was back calculated from the total catchment stream depletion using NRC's cross boundary effects methodology. Except in this analysis, catchment boundaries were substituted for sub-aquifer management boundaries. The portion of each catchment's stream depletion attributed to individual bores was based on the radius of influence of a given bore and weighting to reflect differing rates of take.

6. The results of this stream depletion analysis are summarised in **Table 1** and shown on **Figure 9** with two key metrics:

   (a) ***Catchments*** – the maximum volume of daily stream depletion normalised by median flow (m^3/day); and

   (b) ***Bores*** - the maximum stream depletion as a proportion of total abstraction from that bore (%).

7. **Figure 9** also highlights those catchments that are ephemeral.

Table 1. Summary of maximum summer stream depletion effects.

AAWUG Applicant Bores	Application Number	Depletion Volume	Abstraction Volume	Percent Depletion
		(m^3/day)		
Waikopu Avocados-consented & proposed	APP.040601.01.01	251	1,000	25%
Tiri 1	APP.040361.01.01	476	1,938	25%
Robert Campbell	APP.040386.01.01	815	3,350	24%
Valic	APP.040362.01.01	273	1,158	24%

AAWUG Applicant Bores	Application Number	Depletion Volume	Abstraction Volume	Percent Depletion
		(m³/day)		
Bryan Esate-2	APP.040919.01.01	223	1,000	22%
Tiri 2	APP.040361.01.01	423	1,938	22%
M Evans	APP.040979.01.01, APP.040558.01.01	244	1,475	17%
Bryan Esate-1	APP.040918.01.01	82	500	16%
Te Raite Station_other	APP.039859.01.02	239	1,606	15%
D. Wedding & Doody	APP.039644.01.01	342	2,375	14%
Sweetwater-2	APP.020995.01.04	522	3,697	14%
Sweetwater-10	APP.020995.01.04	125	890	14%
Sweetwater-9	APP.020995.01.04	205	1,526	13%
Sweetwater-1	APP.020995.01.04	673	5,360	13%
Sweetwater-14	APP.020995.01.04	118	989	12%
Sweetwater-8	APP.020995.01.04	178	1,526	12%
Ellbury Holdings-Sweetwater-1	APP.020995.01.04	103	938	11%
Sweetwater-7	APP.020995.01.04	166	1,526	11%
Ellbury Holdings-Sweetwater-2	APP.020995.01.04	102	938	11%
Sweetwater-13	APP.020995.01.04	99	989	10%
Sweetwater-11	APP.020995.01.04	88	890	10%
Sweetwater-5	APP.020995.01.04	132	1,526	9%
Sweetwater-3	APP.020995.01.04	277	3,265	8%
Te Raite Station-Waihopo 1	APP.039859.01.03	46	551	8%
Sweetwater-6	APP.020995.01.04	119	1,526	8%
Sweetwater-12	APP.020995.01.04	67	989	7%
P McGlaughlin	APP.041211.01.01	42	700	6%
Te Raite Station-Houhora-2	APP.039859.01.01	92	1,606	6%
Sweetwater-4	APP.020995.01.04	68	1,526	4%
Yelavich	APP.039841.01.02	19	450	4%
Te Raite Station-Houhora-3	APP.039859.01.01	42	1,009	4%
Te Raite Station-Waihopo 2	APP.039859.01.03	22	551	4%
Te Raite Station-Houhora-1	APP.039859.01.01	62	1,652	4%
Te Raite Station-Houhora-4	APP.039859.01.01	34	1,009	3%
J Evans	APP.040121.01.01	53	1,675	3%
Te Raite Station-Houhora-7	APP.039859.01.01	21	918	2%
Henderson Bay Avocados	APP.017428.02.01	4	191	2%
Te Raite Station-Houhora-5	APP.039859.01.01	16	918	2%
Te Raite Station-Houhora-6	APP.039859.01.01	16	918	2%
Far North Avocados (Blake Powell)	APP.040600.01.01	4	240	2%
Tuscany Avocados	APP.040130.01.01	4	375	1%
Avokaha Ltd	APP.008647.01.06	2	230	1%
KSL Ltd	APP.039628.01.04	3	250	1%
Wataview	APP.040363.01.01	2	225	1%

AAWUG Applicant Bores	Application Number	Depletion Volume	Abstraction Volume	Percent Depletion
		(m^3/day)		
S. & L. Blucher	APP.040652.01.01	3	720	0%
A. Matthews	APP.040397.01.01	0	95	0%
P&G Enterprises	APP.040231.01.01	0	350	0%

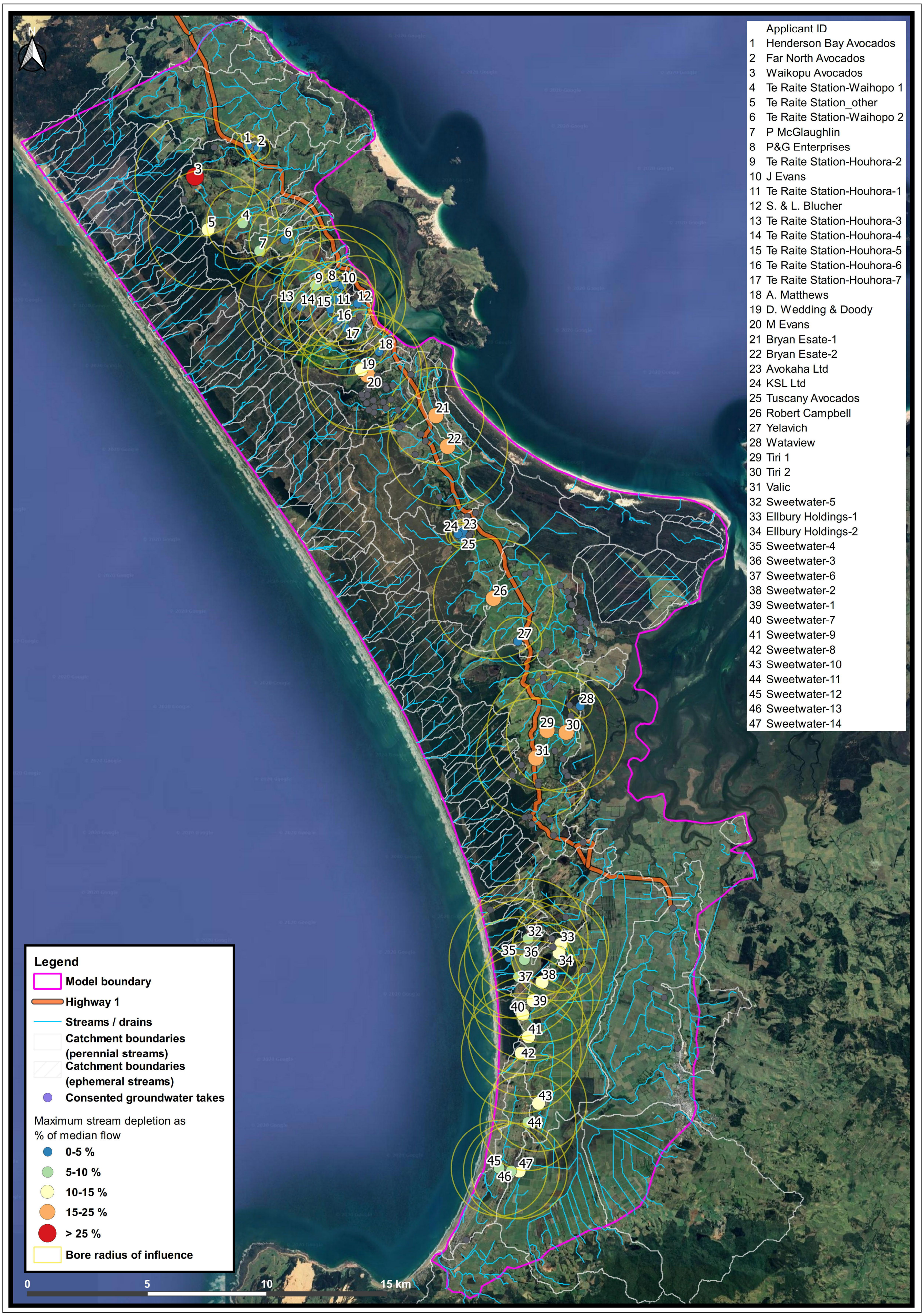

Figure 1. Map showing applicant bore stream depletion and catchment boundaries.

8. The analysis considers the level of stream depletion that materialised after the largest pumping season during the 59-year model simulation period, which occurred in April 2010. This date is consistent with the maximum drawdown presented in the AEE.

9. As can be seen in **Table 1** and **Figure 9** the level of maximum (worst case) stream depletion attributable to each bore ranges from 0% to 25%. The average and median stream depletion effect of all bores at this point in time (end of very dry summer) is 8.2% and 4.7%, respectively.

10. Policy H.5 (as shown in **Figure 9**) indicates that where the calculated stream depletion effect is less than 40 percent of the abstraction rate, the bore is classified as "Other", which means it has neither a Direct, High, or Moderate degree of connection with surface water. The management approach for these bores is as follows:

    (a) The calculated surface water depletion effect is not included in the surface water allocation regime set in Policy H.4 Environmental flows and levels; and

    (b) The take is not subject to surface water minimum flows and water levels.

11. Therefore, it can be concluded that the level of stream depletion effect that Mr Baker raised in paragraphs 43 to 49 of his Evidence in Chief are within acceptable limits and do not need to be considered as part of the surface water allocation.

12. I understand there have been no appeals against Policy H.5 and it can therefore be considered fully operative.

H.5 Managing groundwater and surface water connectivity

Table 27: Classifying and managing groundwater and surface water connectivity

Hydraulic Connection Category	Classification	Pumping Schedule	Management Approach
Direct	Where the calculated surface water depletion effect is assessed as greater than 90 percent of the abstraction rate determined by the pumping schedule.	Abstraction rate equivalent to the maximum seven-day volume averaged over seven days. Pumping duration of seven days continuous abstraction.	The groundwater take will be managed as an equivalent surface water take for allocation purposes and subject to minimum flows and water levels set in H.4 Environmental flows and levels.
High	Where the take is not classified as having a direct hydraulic connection and the calculated surface water depletion effect is greater than 60-percent of the abstraction rate determined by the pumping schedule.	Abstraction rate equivalent to the maximum seven-day volume averaged over seven days. Pumping duration is calculated as follows: For takes with a pumping duration of less than 150 days, the maximum continuous period of abstraction at the abstraction rate, until the seasonal volume is fully utilised. For takes with a pumping duration in excess of 150 days, a pumping duration of 150 days will be assumed.	The calculated surface water depletion effect is included in the surface water allocation regime set in H.4 Environmental flows and levels. The remainder of the seasonal volume is managed as groundwater allocation. Takes with a daily average abstraction rate greater than 1 L/s are subject to relevant minimum flows water and levels set in H.4 Environmental flows and levels.
Moderate	Where the take is not classified as having a direct hydraulic connection and the calculated surface water depletion effect is between 40 percent and 60 percent of the abstraction rate determined by the pumping schedule.	Abstraction rate equivalent to the seasonal volume divided by the nominal duration of the pumping season. Duration of abstraction based on nominal duration of pumping, up to a maximum of 150 days.	The calculated surface water depletion effect is included in the surface water allocation regime set in H.4 Environmental flows and levels. The take is not subject to surface water minimum flows and water levels.
Other	Where the take is not classified as having a direct hydraulic connection and the calculated surface water depletion effect is less than 40 percent of the abstraction rate determined by the pumping schedule.	Abstraction rate equivalent to the seasonal volume divided by the nominal duration of the pumping season. Duration of abstraction based on nominal duration of pumping, up to a maximum of 150 days.	The calculated surface water depletion effect is not included in the surface water allocation regime set in H.4 Environmental flows and levels. The take is not subject to surface water minimum flows and water levels.

The following requirements will assist implementation of Policy D.4.11 Integrated surface water and groundwater management:

1) An assessment of hydraulic connection will be supported by a conceptual hydrogeological model that characterises the nature of local surface water/groundwater interaction. Estimation of the magnitude of surface water depletion will be undertaken using relevant analytical or numerical assessment techniques which are suitable for application in the hydrogeological setting identified;
2) Representative hydraulic properties for assessment of the magnitude of surface water depletion will be derived from aquifer testing as well as assessment of representative values from the wider hydrogeological environment;
3) Waterbodies characterised as ephemeral will be excluded from consideration of surface water depletion effects; and
4) Assessment of surface water depletion effects will take into account any non-consumptive component of the groundwater take.

Figure 2. Policy H.5 from pRPN.

3. General Head Boundaries

13. The Commissioners raised a question about the use of the MODFLOW general head boundary (GHB) within the cells in deeper model layers at the coast. As explained at the Hearing, the GHB condition was selected because it enables simulation of external water transfers to or from hydraulically connected water bodies that are outside the model domain. GHBs are typically used rather than extending the model to explicitly simulate a water body feature when:

    (a) There is no interest in the area outside the model domain (i.e. what is important is what happens inside the model domain); and

    (b) Model efficiency can be significantly increased by excluding the area of low interest (i.e. reduced complexity and run times).

14. With respect to this project, in addition to the above, other reasons for excluding explicit simulation of the offshore area included:

    (a) There are no measured material properties or data points for calibration in that area; and

    (b) There are no affected parties in that area hence inclusion would not add any value to our evaluation processes.

15. The GHB boundary condition comprises two parameters: i) water body elevation and ii) hydraulic conductance. The elevation parameter is used to set the elevation of the water body outside the model domain, and the conductance parameter is used to govern the degree of connection between the model domain and the external water body.

16. The flow direction across the GHB is relative to groundwater elevation in the model cell where the GHB is assigned and the elevation in the external source (i.e. from high elevation to low elevation). The rate of flow is regulated by the hydraulic conductance.

17. **Figure 3** provides a schematic of the GHB functionality used in the Aupōuri Aquifer Groundwater Model (AAGWM). In this case the GHB elevation was set to 0 mAMSL, which is representative of the ocean water level. The conductance term was reduced in value progressively with depth (model layers) in a relative sense to represent in a bulk sense the flow path from the model boundary to the seabed and the increasingly dense saltwater impeding freshwater flow. Tuning of this bulk parameter allows simulated groundwater pressure to manifest in the deeper model layers to match that what is observed at the coastal nested piezometers, as exemplified by the groundwater levels shown in **Figure 3**.

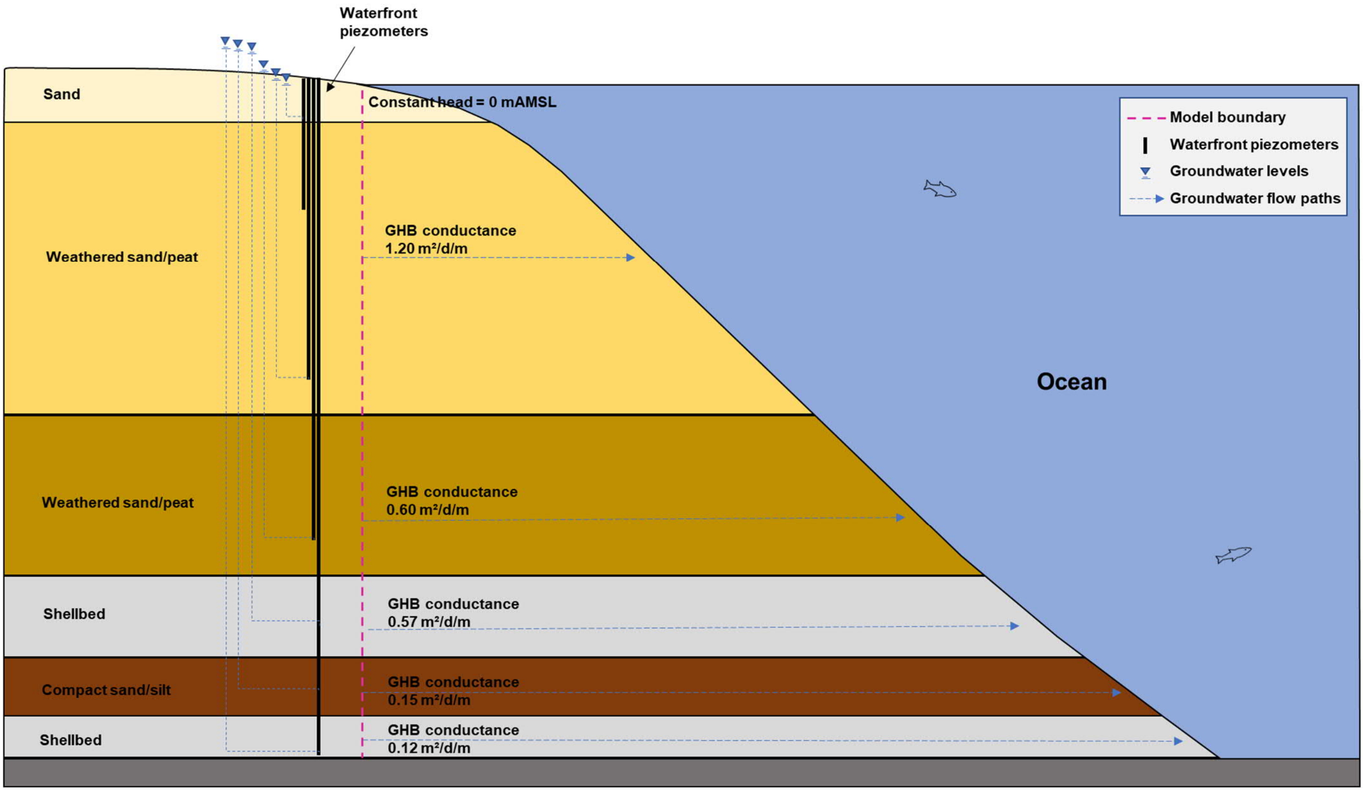

Figure 3. Schematic showing the use of coastal GHBs in the AAGWM.

18. The Commissioners asked for time series plots across the GHB near high risk areas. In response to this, hydrographs from each model layer of simulated discharge and groundwater levels corresponding to selected model cells at key high-risk coastal locations (Houhora Waterfront, Houhora Heads, Kaimaumau Settlement, Awanui River Mouth, Sweetwater) are provided in **Figure 4** to **Figure 8**. The locations of cells selected and their dimensions[1] are summarised in **Table 2**.

Table 2. Summary of GHD flux and groundwater level cell analysis.

Location	Description	Cell Width (m)	Surface Elevation (mAMSL)	Layer Base Elevation (mAMSL)					
				L1	L2	L3	L4	L5	L6
Houhora Waterfront	Waterfront monitoring piezometers	194.3	5.8	-2.0	-36.5	-58.5	-64.2	-68.6	-70.6
Houhora Heads	Eastern tip of Houhora Heads	188.5	2.8	-2.0	-35.0	-57.0	-63.0	-64.0	-68.6
Kaimaumau Settlement	Kaimaumau Settlement	187.7	3.4	-2.0	-20.1	-42.1	-46.6	-58.0	-66.0
Awanui Mouth	Mouth of Awanui River	141.8	0.5	-2.0	-14.9	-32.9	-33.9	-34.9	-36.9
Sweetwater	West coast - west of FNDC bores	199.4	3.6	-2.0	-23.6	-45.6	-56.0	-59.6	-75.2

[1] Cell dimensions have been provided to give context to the different discharge rates, which on face appear to be larger at larger cells, but upon normalising to the cell dimension may not be the case.

Hydrographs of GHB coastal discharge (A) and groundwater level (B).

A. B.

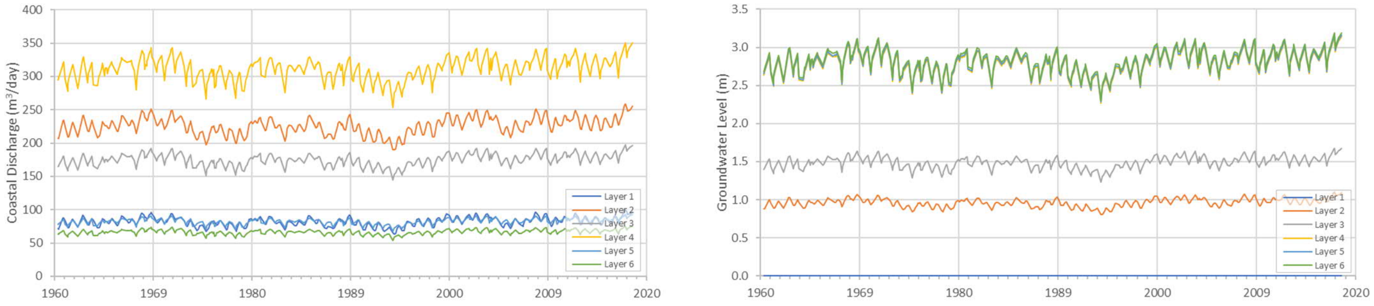

Figure 4. Houhora Waterfront.

A. B.

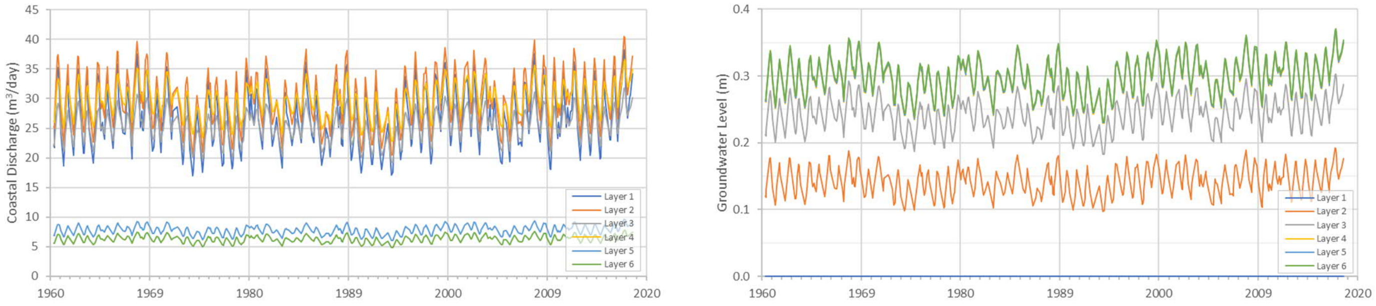

Figure 5. Houhora Heads.

A. B.

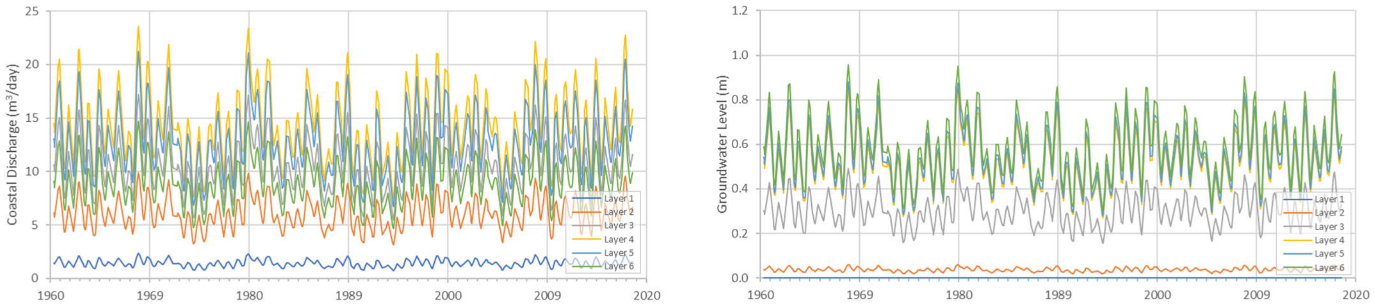

Figure 6. Kaimaumau Settlement.

Hydrographs of GHB coastal discharge (A) and groundwater level (B).

A. B.

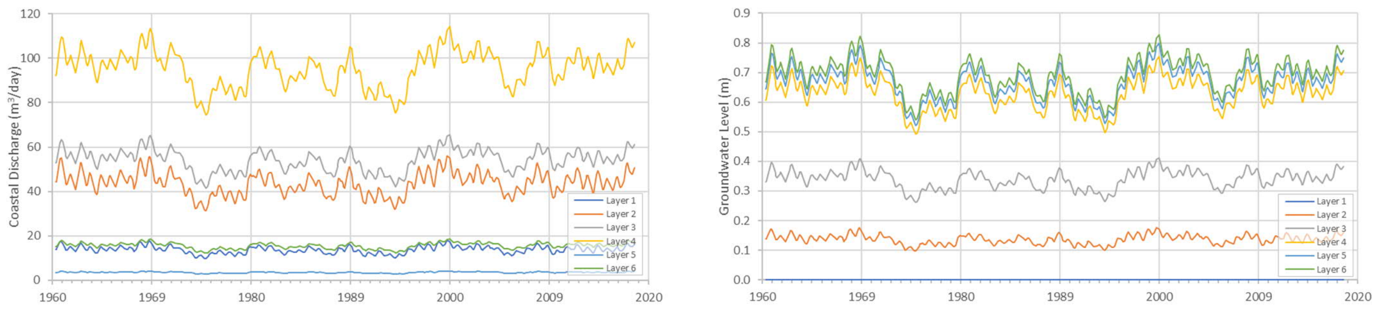

Figure 7. Awanui Mouth.

A. B.

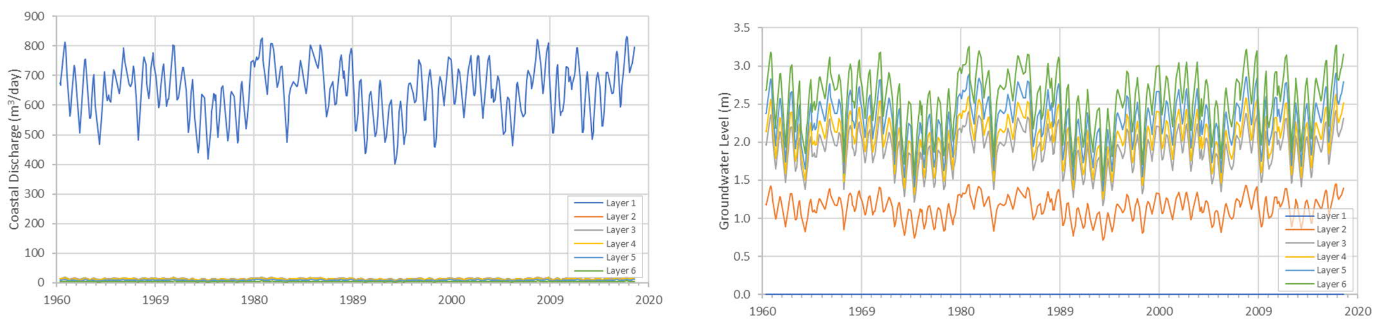

Figure 8. Sweetwater.

19. The key points to note from the hydrographs are as follows:

(a) ***Coastal Discharge*** – is always maintained as a positive outflow even during periods of low groundwater level. The partitioning of flow between the various model layers is typically greater in the top shellbed (Layer 4) and the lower part of the sand aquifer (Layer 3), except for at Sweetwater where the unconfined shallow aquifer (Layer 1) has far greater flow than the other layers. This is consistent with observations of groundwater seepage along 90-Mile Beach, albeit anecdotal information suggests these have declined since afforestation occurred[2].

(b) ***Groundwater Level*** – progressively decreases from deep to shallow.

[2] Landuse change in the forestry blocks has not been included in the current version of the model.

4. Basement Topography

20. The evidence presented at the hearing by Mr Alan Nunns raised concerns in regard to disparity between the basement elevation used in the WWLA model compared to the Lincoln AgriTech (LAT) model (2015).

21. **Figure 9** shows the difference in elevation of the basement rock in the LAT relative to the AAGWM. Negative contour values indicate areas where the LAT model is lower (AAGWM model is higher), while positive contour values indicate areas where the LAT model is higher (AAGWM is lower).

22. The largest difference is associated with an apparent fault that LAT show running through the model area with a bearing of approximately 300°, where basement rock is shown to be significantly deeper to the west of the fault.

23. The AAGWM applies a basement elevation that was interpolated from bore logs and rock outcrop such as in the Rangaunu Harbour on the opposite side to Kaimaumau Settlement. However, the AAGWM applied no reference to the fault and the reason for this was that the borelogs show no evidence of any fault in this area. This finding seems consistent with Mr Nunn's own comment, as follows:

"However, I consider it unlikely that there is a large distinct fault scarp along the boundary between the Mt Camel and Caples terrane (LA2015) because the terrane collision would have occurred at least 23 million years ago and there would have been ample opportunity for a fault scarp to be degraded."

24. **Figure 10** provides a map showing the location of bore logs in relation to the assumed position of the fault line. Bores that extend to the basement rock are shown with blue markers and bores that extend into the shell bed, and therefore close but not necessarily to the basement rock, are shown with green markers[3].

25. The inset map highlights an area where the LAT interpretation indicates a 70 to 100 m downward throw to the west of the fault, while to the east of the fault the two models have relative agreement. Bore log data in this area shows a relatively consistent elevation of the basement formation across the fault at around 70 m (+/- 5 m).

26. There is no obvious expression of the fault within the sedimentary aquifer. The only marked transition in geology exposed at the surface within the area is associated with Houhora Harbour. On one side of the harbour the sediment of the Aupouri Aquifer is approximately

[3] The values shown by each bore are the elevation of the base of the bore in mAMSL (as opposed to the contour values, which are the difference in basement elevation between the AAGWM and the LAT model).

70-80 m thick, while hard rock outcrops on the other side less than 1 kilometre away. In surface hydrological systems linear drainage features are often associated with structural weaknesses in the underlying geology.

27. It is worth noting that the AAGWM represents a more conservative basement analysis with respect to the objective of the model (i.e. groundwater sustainable yield and effects analysis) because the aquifer material west of the fault is thinner (shallower) than in the LAT model. Thinner aquifer material (with similar hydraulic properties) implies a relatively lower overall transmissivity, which would exacerbate drawdown effects in comparison to a model with deeper shellbed and basement.

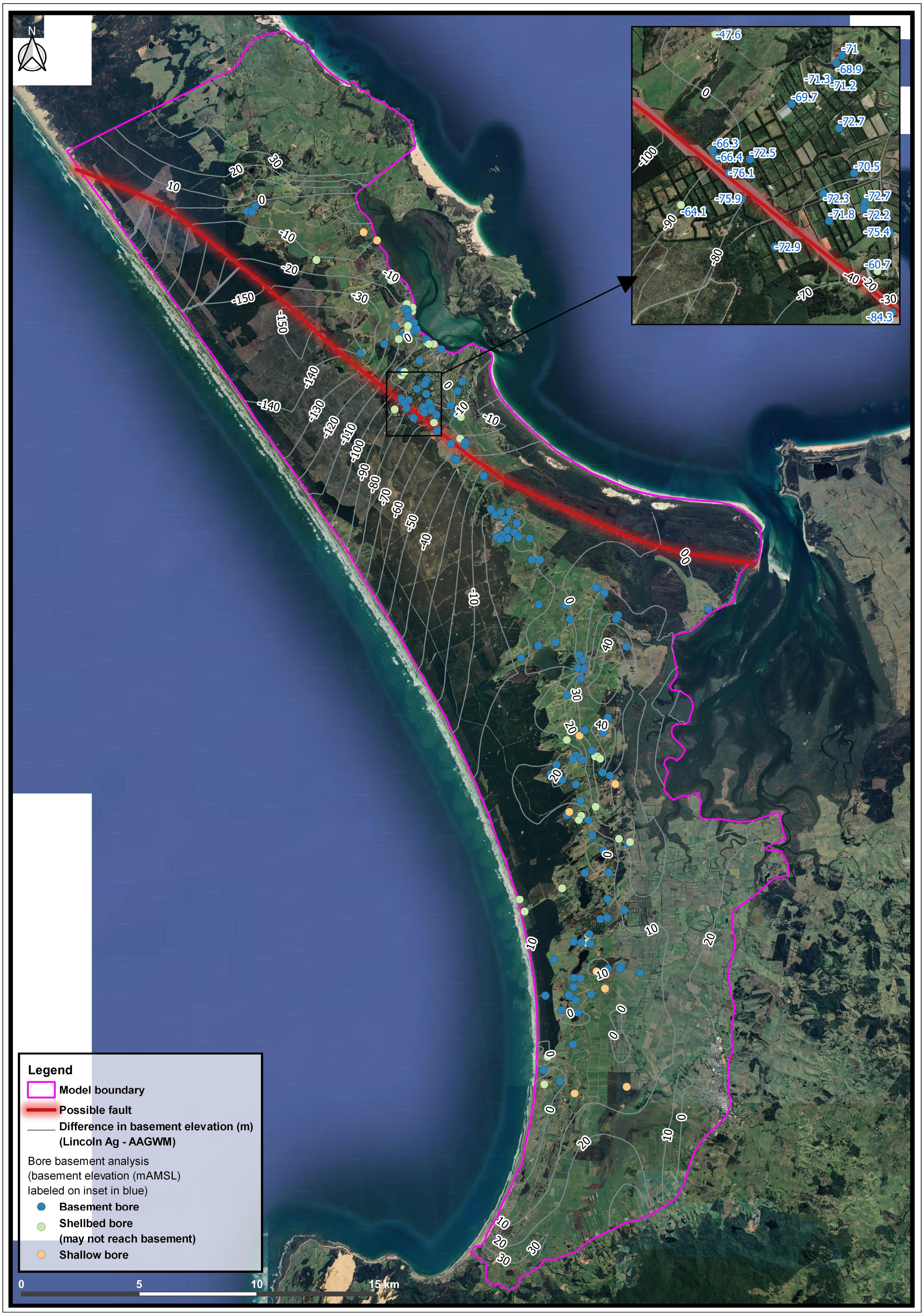

Figure 9. Basement topography difference between AAGWM and Lincoln AgriTech model.

5. Drawdown at FNDC Bores

28. The Commissioner's requested specific information on the predicted cumulative drawdown at the FNDC bores, and in particular a comparison between the AEE and Table 1 Drawdown Assessment of the PDP peer review document dated 20 September 2018[4].

29. The AEE stated that cumulative drawdown with all bore pumping at the FNDC bores would be approximately 14 to 20 m (depending on scenario considered). Hydrographs representing the predicted variation in cumulative drawdown over time with and without the FNDC bores operating are shown in **Figure 10**. However, these graphs represent the drawdown in the aquifer adjacent to the bore and do not account for bore hydraulics, which add to the drawdown measured within a bore.

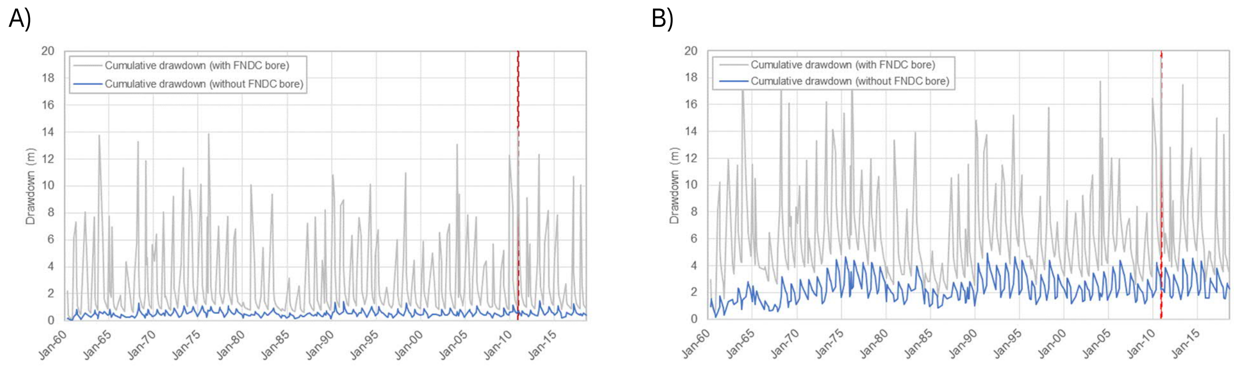

Figure 10. Modelled cumulative drawdown with and without FNDC bores pumping for A) Scenario 2 and B) Scenario 3.

30. PDP (Table 1) indicated that the estimated drawdown in both bores (PW1 and PW2) when pumping at 2,500 m^3/day (each) is approximately 40 m based on test pumping and drawdown measured in the production bore PW1. The report also indicates that the available drawdown in PW1 and PW2 are approximately 46 m and 41.5 m, respectively.

31. To consider whether the available drawdown at FNDC bores PW1 (constructed) and PW2 (to be constructed September 2020) is adequate, the cumulative impact was assessed using the AAGWM with the FNDC bores turned off (**Figure 10**). Adding the measured bore drawdown from the test pumping (40 m) to the maximum simulated cumulative drawdown without FNDC bores pumping (~5 m) indicates that total drawdown will be approximately 45 m.

32. The above analysis indicates that there is adequate available drawdown in the FNDC bores to meet the consented volume based on the modelling alone, but there are also practical considerations that make this analysis very conservative as discussed below.

[4] Pattel Delamore & Partners, 2018. Technical Review of Elbury Holdings Consent Application. Letter prepared for far North District Council.

33. I indicated to the Commissioners at the hearing that PW2 had recently been designed and was about to be constructed in mid-September. The design of PW2 is different to PW1 and was based on recently constructed large orchard bores in the Aupōuri Aquifer that are achieving significantly greater yields of between 60 L/s to 70 L/s (5,185 to 6,050 m^3/day), with similar levels of drawdown as measured by PDP as shown in **Figure 11**. The specific capacity (yield per meter drawdown) of these orchard bores is approximately 135 m^3/day/m, which implies that with a similar design, the drawdown anticipated with the lesser flow rate of 2,500 m^3/day will be slightly less than half that measured in PW1.

34. The key design differences in the bore design are summarised in **Table 3** and **Figure 12,** and include increases:

(a) in bore diameter from 250 mm to 350 mm; and

(b) screen diameter from 200 mm to 300 mm.

35. The screen aperture for PW2 has also been reduced to 0.25 mm because PW1 is discharging unacceptable levels of fine sand creating turbidity issues affecting treatment for potable supply. Based on my experience in this area, 0.25 mm aperture screens are needed to mitigate the passing of fine sands regardless of the particle grain size analysis in the screen zone within shellbed, hence the aperture is consistent with recently constructed large orchard bores.

36. The available drawdown in PW2 will be approximately 49 m assuming, an 8 m freeboard, which was based on allowances of 3 m for pump, 3 m for seasonal groundwater level fluctuation, and 2 m submergence for cavitation effects.

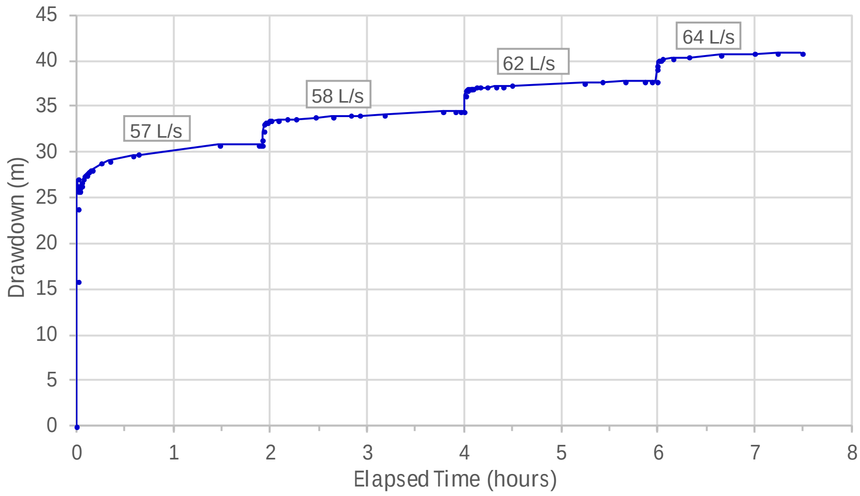

Figure 11. Drawdown in Sweetwater Station PB2 (December 2017).

Table 3. Bore design comparison PW1 (As-Built) and PW2 (Specimen).

Bore design	PW1	PW2 (BH4)
Depth (m)	97.5	102
Casing Diameter (mm)	250	350
Casing Depth (m)	79.4	82.0
Screen depth: from-to (m); aperture (mm)	81-86.5 (5.5 m @ 1.5 mm) 89-92 (3 m @ 0.2 mm) 92-94 (2 m @ 1 mm) 94-96 (2 m @ 0.15 mm)	83-84.5 (1.5 m @ 0.25 mm) 89-100 (11 m @ 0.25 mm)
Total screen open area (m)	12.5	12.5
Screen diameter (mm)	200	300
Water level (mBGL) (May 2011)	22	25
Available drawdown (m)	~49	~49

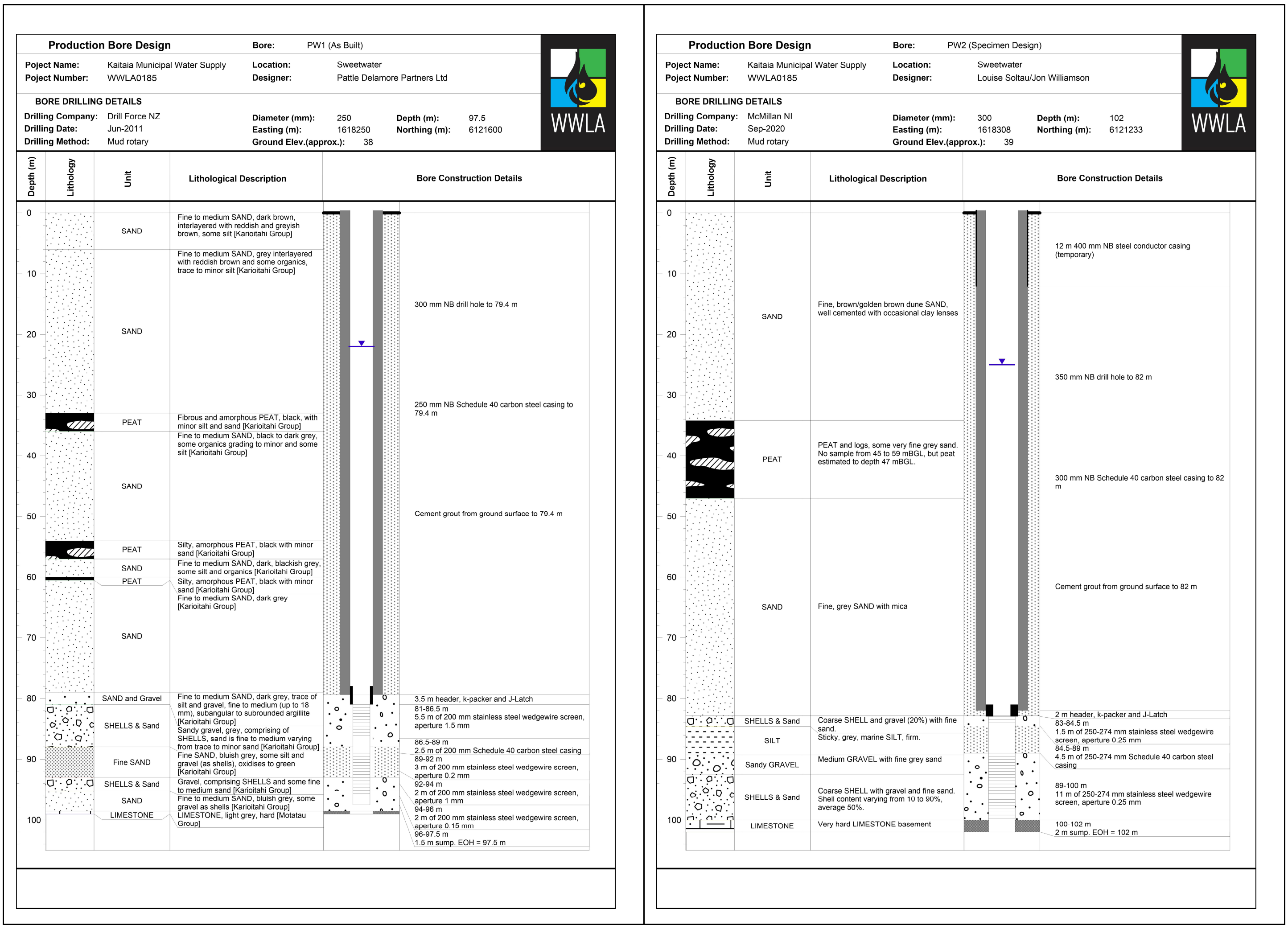

Figure 12. Production bore details for FNDC PW1 and PW2.

6. Material Compressibility for Subsidence

37. At the hearing the Commissioners requested a review of compressibility values used for settlement analysis with respect to peat, clay, and other materials. The context was in relation to the thick peat deposit encountered in the Sweetwater area surrounding the FNDC bores.

38. For the purposes of addressing this question, the borelog for PW2 presented in **Figure 12** was used as an example case. This was selected because it has a large peat deposit extending approximately 13 m from 34 m to 47 mBGL.

39. Of all the materials encountered at the site, peat is potentially the most susceptible material type to vertical subsidence from depressurisation, as summarised in **Table 4.** Smaller modulus of elasticity values represents larger compression potential and vice versa.

Table 4. Summary of range in modulus of elasticity values for Sweetwater material types.

Material Type	Modulus of Elasticity (kPa)
Surficial Peat	100-500
Clay (plastic to stiff)	500-8,000
Sand (loose)	1,000-20,000
Sand (dense)	49,000-78,000
Shellbed (sandy gravel dense)	100,000-200,000

40. However, there are two mitigating factors with respect to subsidence in this area:

(a) Depressurisation in the shallow aquifer where the peat characteristics are likely to be unconsolidated (similar to that described in **Table 4**) are relatively small;

(b) The peat encountered at depth is described as amorphous[5], which means it has already been subject to decomposition and overburden compaction;

(c) The peat unit also comprises silt, sand and logs, which have much higher modulus of elasticity than uncompacted peat; hence

(d) the modulus of elasticity assigned to the peat at a depth of 34 m to 47 mBGL was mid-way between peat and stiff clay.

[5] A type of peat in which the original structure of the plants has been destroyed as the result of decomposition of the cellulose matter. It is heavy, compact, and plastic when wet.

41. Analysis was undertaken using the layer structure and material properties described in **Table 5**. This gave a vertical subsidence at the bore of 0.4 m. With distance from the bore, the subsidence potential decreases due to the reduction in drawdown.

42. The analysis assumes that the worst-case drawdown, which is a snapshot taken for a single point in time take at the end of a drought and heavily pumping season is held in perpetuity. Therefore, the analysis is considered conservative and given the potential impact is localised around the bore, I do not see this level of impact of consequence.

Table 5. Layer structure of Sweetwater subsidence analysis.

			Modulus of Elasticity	**Material Porosity**	**Water Content**	**Specific Weight**	**Thickness Before Drawdown**	**Drawdown**	**Thickness After Drawdown**
Type	**Layer**	**Material**	**(kPa)**	**(-)**	**(-)**	**(kN/m^3)**	**(m)**	**(m)**	**(m)**
Unconfined	1-Unsaturared	Sand	10,000	0.25	0.08	14	18.7	2.4	21.1
	1-Saturated	Sand	50,000	0.25	0.25	14	15.3		12.9
Confined	2	Peat	3,900	0.4	0.4	5.9	13	6.2	13
Confined	3	Sand	50,000	0.25	0.25	16	36	11	36
Confined	4	Shellbed	100,000	0.2	0.2	18	17	19.3	17

7. Water Requirement for Valic and Wataview Orchards

43. The Commissioners have asked for comment on the evidence of Mr Fulton with regard to the water requirements for Valic Orchard (APP.040362.01.01) and Wataview Orchard (APP.040363.01.01).

44. Firstly, in a general sense with regard to the calculation of canopy area, Mr Fulton says that "there is no consistent methodology being used across the industry". This in itself party explains the divergent views on water requirements per unit area.

Valic Orchard

45. Valic Orchard used only approximately 62% of their full existing entitlement over the 2019/2020 summer which was by my calculation a drought event with approximately a 17-year recurrence interval. This is explained by two facts:

    (a) 20 ha (15%) of the orchard is currently undeveloped; and

    (b) The orchard is carrying out a stag horning process on 10% of the orchard per season. This is where tops of the trees are cut out in December each year to reduce the heights of trees to facilitate efficient harvesting. A consequence of this is that these areas are not irrigated for the following 3 months, which is during the peak application time.

46. In regards to the additional volume being sought under these consents, I have approval from Valic Orchard to share the following information. Valic have a conditional sale and purchase agreement with Mr. Hugh Atkin the owner of the neighbouring 50 ha farm (legal descriptions Sections 56, 58, 59, 70, 71, and 73 Block VII Opoe Survey District). The agreement is subject to obtaining the additional water take consents being sought. As such, entry of these legal descriptions as use areas can be inserted into the consent and should be considered as a part of the overall efficiency of use of the quantity of water applied for.

Wataview Orchard

47. Wataview orchard maintain they need more water than Mr Fulton's recommended 32 m^3 per canopy hectare per day. This is because of the unique soils and aspect in certain parts of the orchard i.e. the soils that require higher rates are loose sands on steep north facing slopes.

48. **Table 6** provides a summary of the calculated water requirements. The original application was based on figures provided by the previous owner of the orchard, which was premised on irrigation of the entire property area. However, the current owners recognise some areas

are unsuitable for planting as indicated in Mr Fulton's evidence, and agree to reduce their application (APP.040363.01.01) from 33,750 m^3/annum to 20,000 m^3/annum.

Table 6. Summary of Wataview's revised water requirements.

	Canopy Area (ha)	**Soils**	**Daily Req. (m^3/day/ha)**	**Daily Vol (m^3/day)**	**Annual Volume (m^3)**
Planted	10	Consolidated sands	40	400	40,000
Planted	2	Steep dune sands	50	100	10,000
To be planted	3.4	Steep dune sands	50	170	17,000
Frost fighting					3,000
Total	**15.4**			**670**	**70,000**
				Current Consent	50,000
				Application	33,750
					83,750
				Change Application to:	20,000