BEFORE THE NORTHLAND REGIONAL COUNCIL

under:	the Resource Management Act 1991
in the matter of:	Resource consent applications by the Te Aupouri Commercial Development Ltd, Far North Avocados Ltd, P McLaughlin, NE Evans Trust & WJ Evans & J Evans, P & G. Enterprises (PJ & GW Marchant), MP Doody & DM Wedding, A Matthews, SE & LA Blucher, NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan Valadares & D Bryan (Property No 1), MV Evans (Property No 2), MV Evans (Property No 1), Tuscany Valley Avocados Ltd (M Bellette), NA Bryan Estate, SG Bryan, CL Bryan, KY Bryan Valadares & D Bryan (Property No 2), Tiri Avocados Ltd, Valic NZ Ltd, Wataview Orchards (Green Charteris Family Trust), Mate Yelavich & Co Ltd, Robert Paul Campbell Trust, Elbury Holdings Ltd (C/-K J & F G King) for new groundwater takes from the Aupouri aquifer subzones: Houhora, Motutangi and Waiharara and applications by Waikopu Avocados Ltd, Henderson Bay Avocados Ltd, Avokaha Ltd (c/- K Paterson & A Nicholson), KSL Ltd (c/- S Shine), Te Rarawa Farming Ltd and Te Make Farms Ltd for increased existing consented takes from the Aupouri aquifer subzones: Houhora, Motutangi, Sweetwater and Ahipara.

Statement of evidence of **James Mitchell Blyth** for the Director-General of Conservation

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STATEMENT OF EVIDENCE OF JAMES MITCHELL BLYTH

QUALIFICATIONS AND EXPERIENCE

1 My full name is James Mitchell Blyth

2 I am a Director and Water Resource Scientist at Taylor Collaborations Limited (‘Collaborations’), an applied science consulting firm.

3 I hold a Master of Science (MSc) Degree with first class honours from the University of Waikato.

4 I am a Certified Environmental Practitioner (CEnvP) under the Environmental Institute of Australia and New Zealand (EIANZ).

5 I have ~12 years of work experience, at roles within regional councils, industry (mining) and consulting. This experience covers a range of water sciences, including water quality, water resources, hydrology, hydraulics and wetlands. In particular, throughout my career I have had numerous involvements in water balance and catchment hydrological and water quality models.

6 I am familiar with the Kaimaumau-Motutangi wetland complex having scoped and installed the Department of Conservation water level monitoring sites in 2017 and contributed to the Motutangi-Waharara Water Users Group (MWWUG) water take hearings in 2018.

CODE OF CONDUCT

7 I have read and agree to comply with the Code of Conduct for Expert Witnesses produced by the Environment Court 2014 and have prepared my evidence in accordance with those rules. My qualifications as an expert are set out above.

8 I confirm that the issues addressed in this brief of evidence are within my area of expertise.

9 I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed. I have specified where my opinion is based on limited or partial information and identified any assumptions I have made in forming my opinions

SCOPE OF EVIDENCE

10 My evidence will address the following information from Williamson Water & Land Advisory (WWLA):

11 A detailed review of the '**Kaimaumau Wetland Modelling Report_rev3'** (here after referred to as the 'modelling report')

12 A high-level review of '**Jon Williamson - AAWUG Hearing Evidence'**, primarily focussing on hydrological assumptions in the Wildlands Consulting report (Attachment B). The modelling report is included in this evidence as Attachment A

13 These reviews and drafting of evidence were undertaken with short timeframes, so observations have been summarised. Further time for considering the modelling report would assist in setting out what conclusions may (or may not be) drawn from the model, and assessing level(s) of uncertainty. (It is the author's understanding that the modelling report has only recently been provided to DOC).

Review of the WWLA 'Modelling Report'

14 WWLA have developed a water balance for a sub-group of the 'big users' of the Motutangi-Waiharara Water User Group (MWWUG), in order to predict possible effects of pumping on Kaimaumau Wetland and support the move to stage 2 abstraction volumes under the granted resource consents.

15 WWLA uses their own in-house modelling software. While I have not used this software before, the fundamental principles for undertaking a water balance seem appropriate.

16 Water balances like WWLA's are often not spatially explicit; it is common to undertake a bucket type approach when developing a water balance for lakes or wetlands.

   a. A typical water balance model will however utilise spatially explicit inputs, such as surface areas and storage volumes, with calibration undertaken at various locations within the site capturing a range of hydrological variables (for example, inflow and outflow points or various water level monitoring sites within the wetland).

17 Conceptualisation of the wetland prior to developing a water balance is a fundamental process that will influence the calibration and model development.

18 A typical wetland water balance would consider inputs and outputs expressed in Figure 1.

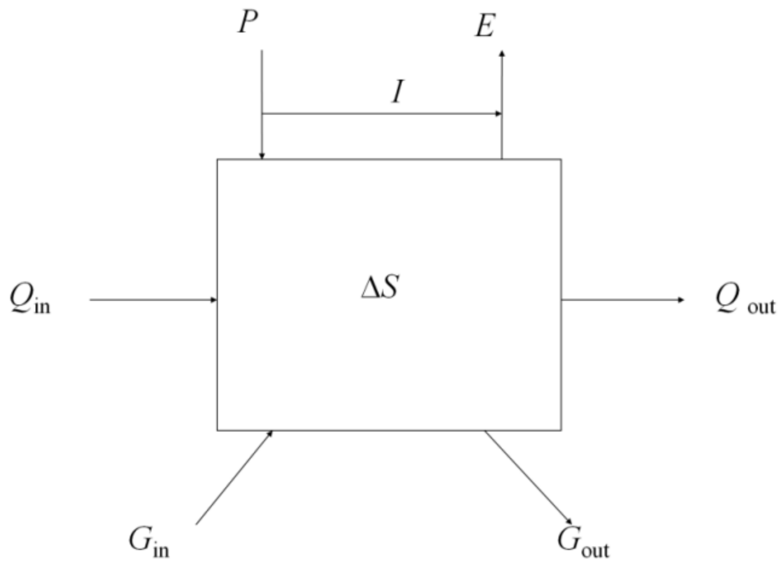

Figure 1. Water balance model for a wetland (Campbell & Jackson 2004). P= precipitation, Qin= surface inflows, Gin= groundwater inflows, E= evaporation (open water and evapotranspiration), I= interception loss from foliage, Qout= surface outflows, Gout = groundwater outflows, ∆S= change in storage of a wetland

19 An important consideration of the WWLA water balance model is the lack of inclusion of any groundwater inflows. The model conceptualises the wetland as rainfed only, with losses occurring from evaporation, overflows and seepage (the latter equivalent to *Gout* in Figure 1). Seepage in this situation is expected to occur to internal drains and streams, which could be considered to represent baseflow contributions except during periods of high water levels also leading to overland flow (*Qout*).

20 The exclusion of any groundwater inputs into the model means the calibration of simulated water levels to observed data will be influenced more strongly by other parameters within the water balance, particularly seepage and evaporation.

   a. Seepage is represented in the WWLA model as porosity of peat, with seepage increasing when water levels are higher. Importantly, the amount of seepage versus the water level height (presented in Figure 4 and Figure 5 of the modelling report) is based on simulations from the Aupouri Aquifer Groundwater Model (AAGWM). It is this author’s understanding this AAGWM also conceptualises the wetland as rainfall fed.

21 The WWLA model also utilises a wetland spatial area (fixed) of 3,461 ha. The delineation of this wetland area is not clear. Hicks et al. 2001 indicates the Scientific Reserve (which encompasses the majority of the calibration points) is 955 ha, with the wider Conservation Area an additional 2,312 ha.

   a. This would provide a total wetland area of 3,267 ha over an expansive area > 8 km long, including coastal dunes that are also downgradient of the modelling reports calibration sites. See Figure 2. The FENZ wetland mapping for New Zealand delineates a wetland area of only 2,931 ha for the Kaimaumau-Motutangi wetland complex

b. Consideration of this expansive system in a single water balance model being used to predict water levels could be difficult, due to natural topographic gradients and hydrological variations across different wetland systems. In addition, the large catchment area results in a significantly greater rainfall and evaporation component influencing the water levels of the calibration sites, of which there is no indication that all or some of the Conservation Area (see Figure 2) influences water levels at these sites.

c. Water level monitoring across the wetland would help identify shallow groundwater flow directions and highlight both surface and groundwater catchment areas contributing to different parts of the wetland, however the author understands this information is not available due to limited monitoring sites.

d. A smaller catchment area would require model recalibration, and unless the influence of rainwater and evaporation is linear to wetland size, may affect the calibration of water levels.

Figure 2. Wetland extent (2,931 ha) at Kaimaumau-Motutangi. From the Freshwaters of New Zealand (FENZ) national geospatial data on the extent of wetlands. Approximate locations of calibration sites are indicated alongside Northland Regional Council monitoring sites Kaimaumau Wetland (KW) North and South.

22 Calibration of the WWLA model occurs at four sites, KM3 and KM4 and KM7 and WWLA.

23 Verification of simulated water levels occurs at KM7, WWLA, and also the Wetland North and Wetland South standpipes. No figure is presented of Wetland North or South monitoring locations, however page 255 of the application REQ.596300 '**S42A Hearings Report'** identifies these locations (approximated in Figure 2).

24 Model performance or calibration fit for water levels, such as the error, standard deviation or Percent Bias (PBIAS), has not been presented and compared to published modelling literature values. So generalised conclusions about its performance by WWLA are subjective.

25 Figures 8, 9 and 11 of the modelling report do indicate an accurate simulation of the receding water levels over summer, particularly for the January – April 2020 periods, when compared to observed data. This is relevant for sites KM7, WWLA, Wetland North and Wetland South.

  a. However, Wetland North (an area of standing water) does appear to diverge from the water level recession occurring at sites WWLA and Wetland South (see Figure 3) in February 2020. In November/December 2020, WWLA has a higher water level than Wetland North monitoring site, ~1,000 m away. By February 2020, the water level gradient has reversed, with a higher water level (~10 cm) evident at Wetland North.

  b. This higher water level could be due to a range of possible factors, such as localised topography draining water to this location, or due to additional inputs not captured in the modelling (such as groundwater inflows). However it highlights this area of the wetland may have a different hydrological conceptualisation than the WWLA water balance model, given it is subject to greater open water evaporation losses than at KM7 and WWLA, yet maintains a higher water level over the peak of a drought.

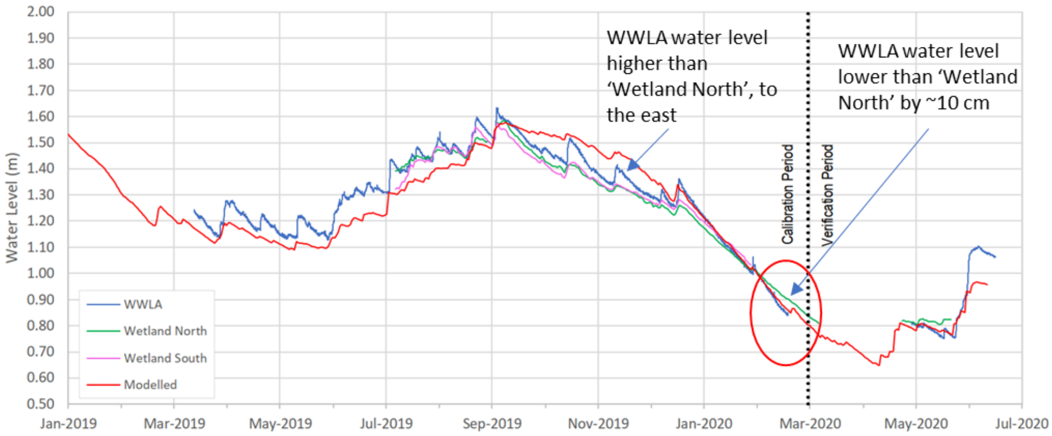

Figure 3. Water level calibration and verification at WWLA, Wetland North and Wetland South (adapted from Figure 11 of the modelling report).

26 A generally poor calibration at monitoring sites KM3 and KM4 (except for November– February 2020, see Figure 4) was described by WWLA in the modelling report as:

a. *Water levels recorded in the standpipes adjacent to the drains do not recede as much as are modelled. As alluded to above, this is probably due to flow in the streams maintaining water levels in the margin adjacent to the stream during dry periods*

b. Based on Figure 20, page 257 of the **S42A Hearings Report**, drain water levels at KM2 (drain logger) are between 0.4 and 0.6 m below KM3 throughout the majority of the year (including summer), indicating that the drain does not maintain water levels at these sites.

c. Sites KM2, KM3 and KM4 were installed in 2017 at this location by the Department of Conservation due to presence of the large standing water body to the east, which based on aerial imagery looks to have possible connection with the Wetland North monitoring site.

d. Figure 4 presents the modelled versus observed water levels at this site, showing a poor prediction of water levels over some winter periods and for a large portion of the 2019 year. As mentioned in line 26, the best modelled fit occurs during the 2020 summer recession, however noticeably, the observed water levels at KM3 plateau through February and March while modelled water levels continue to decline.

e. It is unclear if this is due to water levels dropping below the transducer, and no records from KM4 (further inland) have been presented for this period.

f. Data at KM3 and KM4 should be investigated further to see if their water levels were maintained through February – April 2020 at the peak of the drought.

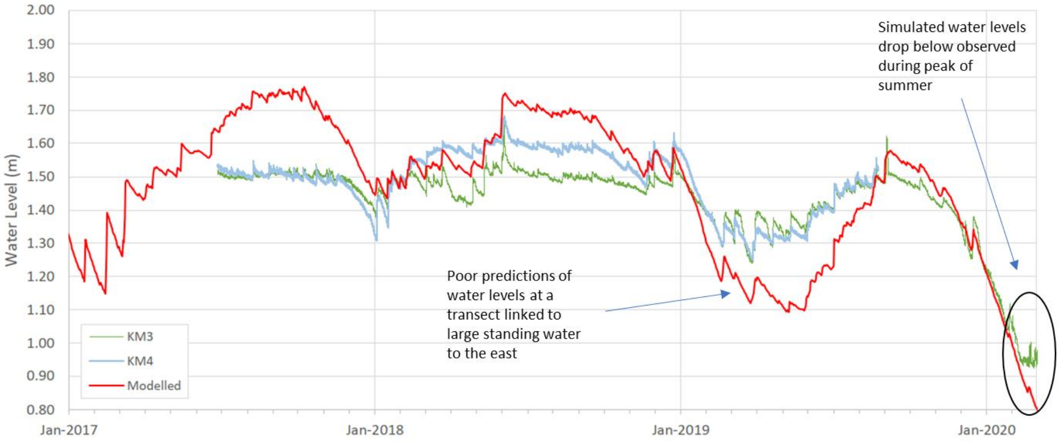

Figure 4. KM3 and KM4 water levels compared to WWLA simulations (adapted from Figure 9 of the modelling report).

27 The four primary calibration and verification sites (KM7, WWLA, Wetland North and Wetland South) focussed on in the modelling report cover a relatively localised portion of the wetland, concentrated in the Scientific Reserve (see Figure 2).

a. A typical calibration would consider the simulated water levels (and flows at inflow or outflow locations) across a range of sites, providing the ‘spatial coverage’ for a non-spatial water balance model. By comparing the simulated water levels to observed data at multiple locations around the wetland (particularly given the site is 3,416 ha over >8 km extent) would help confirm the conceptualisation by WWLA of the wetland being rainfed at all locations.

b. While comparisons have been made at four locations, this may only cover <20% of the wetland extent.

c. Any indications of changes across un-assessed sites within the wetland in hydrological inputs (such as groundwater contributions) or outputs (such as seepage or evaporation variances) would be identified through a divergence of the simulated wetland water levels to observed data.

28 Whilst the model calibration generally shows a suitable fit capturing water level recession for January – April 2020, other factors influencing the calibration need to be considered. WWLA model utilises a simplified approach to partition evaporation losses from open water and evapotranspiration (from wetland vegetation), based on a water level height of 1.4 m. This is appropriate to provide some means of determining greater water losses that would occur from an open water environment, however:

a. This assumes that across the modelled 3,416 ha wetland when water levels reach 1.4 m, any water above this is considered to be ponded and subject to higher rates of open water evaporation.

b. Wetland topography can be highly variable depending on plant communities, particularly where peat forming species such as *Empodisma* establish and can shrink and expand with the water table.

c. Adopting a fixed value of 1.4 m may over or underestimate the open water evaporation occurring.

d. Figure 10a of the modelling report indicates that water levels greater than 1.4 m occur primarily over winter, with summer generally dropping below this level. However, it is this authors understanding that open water exists year round at Wetland North monitoring site, potentially indicating evaporation over this area may be under-estimated.

29 Sensitivity analysis was undertaken by modifying evaporation rates only for canopy transpiration, not the ‘cut off’ level of 1.4 m that influences open water evaporation. Further analysis of the sensitivity of the model to this variable should be considered as it may be influencing evaporation losses.

30 The modelling report considers the pumping effects on water levels and the water balance of Kaimaumau Wetland. This utilises the AAGWM, which is presumed to have a similar conceptualisation of the wetland as being rainfall fed.

31 Average and maximum pumping losses (~867 to 2,224 m^3/d respectively) from the wetland appear to be relatively small when compared to the water balance and the average rainfall and evaporation daily rates of 116,000 and 90,000 m^3/d, respectively.

a. However, if the water balance was modified to a smaller catchment area representing the Scientific Reserve (~30% of the area modelled) that is the focus of the calibration and verification monitoring sites, the subsequent rainfall and evaporation components would be noticeably smaller.

b. Pumping losses would also be proportionately smaller as they are considered to be an average of the wetland extent, however, currently do not account for any localised groundwater contributions that could be entering the wetland.

c. If groundwater was inflowing to the wetland near the ‘Wetland North’ or KM3 and KM4 monitoring sites (or other locations around Kaimaumau to the east that have little monitoring data), pumping may have a greater influence on water level drawdown at localised areas than what has been considered in the AAGWM and Water Balance model.

Review of Jon Williamson - AAWUG Hearing Evidence – Wildlands Report

32 Whilst I have not comprehensively reviewed this evidence, I have reviewed Attachments A and B. The inferences highlighted by Mr Williamson relate to the hydrological function of Kaimaumau Wetland.

33 The conclusions by Wildlands Consultants that the wetland is rainfed has not been supported by any evidence and appear to be made in absence of the previous 2018 hearing and ongoing groundwater monitoring programme which seeks to validate this assumption. Subsequently, their wetland condition index assessment then scores catchment factors highly (such as water quality, connectivity and catchment modification) on the basis of the rainfed assumption.

34 No water quality analysis has been conducted, and near transect line A, a large deeply incised drain dissects the wetland, which is influencing hydrology and thus components of their condition assessment.

CONCLUSION

35 The large wetland extent considered in the modelling (that is potentially over-estimated at 3,416 ha), with calibration and verification at a cluster of water level sites within the scientific reserve (~955 ha), may be resulting in a greater contribution of rainfall, evaporation and seepage losses in the wetland water balance totals and influencing the calibration at these sites.

   a. Whilst there may be a linear relationship between catchment area and evaporation losses (considered to be the primary water loss mechanism), this cannot be confidently determined until the calibration is re-assessed for a smaller catchment, or justification of how this large catchment is directly linked to water levels at the monitoring sites.

36 The lack of inclusion of any groundwater inputs as part of the conceptualisation and calibration process means there is no evaluation of whether any groundwater inputs could be present.

   a. For example, a groundwater input could be simulated in the water balance model. Re-calibration could modify other parameters such as the catchment area, evaporation canopy losses, maximum level for open water evaporation (currently set at 1.4 mRL) and seepage rate versus water levels.

   b. This may show whether a calibration is still possible with groundwater inputs occurring.

37 Even a small groundwater contribution (i.e. 5–10% of the water balance inflows) may be important to parts of the wetland over the driest periods in summer, when demand from abstraction for irrigation would be the greatest.

38 In my view, a generally poor model performance when simulating water levels at KM3 and KM4 (close to an area of standing water), and higher observed water levels evident at the Wetland North and potentially KM3 and KM4 monitoring sites in February/March 2020 (when compared to WWLA), shows that the mosaic of wetland types within Kaimaumau may not be adequately represented by the generalised water balance model for the entire wetland.

   a. Additionally, the water level gradient between WWLA and Wetland North appears to have reversed over summer and that the Wetland North area may have additional water inputs, or lower seepage rates that offset the higher evaporation that would be occurring in an open water environment.

39 In my view, monitoring to date is beginning to help inform our understanding of the hydrological function of the wetland complex, but Kaimaumau-Motutangi is a complex system and our knowledge is not comprehensive.

References

Campbell, D. & Jackson, R. 2004, 'Hydrology of wetlands', in J. Harding, P. Mosley, C. Pearson & B. Sorrell (ed.), Freshwaters of New Zealand, New Zealand Hydrological Society INC and New Zealand Limnological Society INC., Christchurch, New Zealand, pp. 20.1-20.14

Hicks, D.L., Campbell, D.J., & Atkinson, I.A.E. 2001. Options for Managing the Kaimaumau Wetland, Northland, New Zealand. Science for Conservation 155.