

In the Environment Court
At Auckland

ENV-2021-AKL-000104
ENV-2021-AKL-000105
ENV-2021-AKL-000106

I te Kōti Taiao o Aotearoa
KiTāmaki Makaurau

Between

**TE TAIWHENUA O HERETAUNGA, TE RUNANGANUI O
HERETAUNGA, TE MANAAKI TAIAO O HERETAUNGA AND NGATI
KAHUNGUNU IWI INCORPORATED**

**ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW
ZEALAND INCORPORATED and**

THE MĀORI TRUSTEE

Appellants

And

HAWKE'S BAY REGIONAL COUNCIL

Respondent

**EVIDENCE IN CHIEF OF JENS HAYE REKKER ON BEHALF OF HAWKE'S BAY
REGIONAL COUNCIL**

Geology

11 August 2023

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1. INTRODUCTION

1.1 My full name is Jens Haaye Rekker and I am Principal Hydrogeologist with Kōmanawa Solutions Ltd working on behalf of the Hawke's Bay Regional Council (**HBRC or Council**) to prepare geological, natural character, subterranean water and karst water body evidence in relation to Proposed Change 7 to the Hawke's Bay Regional Resource Management Plan (**PC 7**).

1.2 I hold a Bachelor of Science and Postgraduate Diploma in Science with Credit and equivalence to second class, first division Honours, within Geology obtained from Otago University in 1990 and 1991, respectively. I have specialised in the intersection of the disciplines of geology and hydrology, primarily as a hydrogeologist, geohydrologist or groundwater scientist, including 30 years in private industry, research and regional council roles. More recently, I filled a role assessing and modelling catchment hydrology at Otago Regional Council (2020-21), while also bridging the fields of geohydrology and instream hydrology relevant to aquatic biota at Otago Regional Council. I have also served as an expert witness to extended pre-hearings and hearings before the Environment Court over Plan Change 5A of the Otago Regional Plan: Water concerning the Lindis River integrated water management (minimum flows and catchment group consent applications, 2015-16).

1.3 I have extensive experience in utilising geological and hydrological science to inform the management of water resources from quantitative and water quality perspectives. This includes the development of water or land & water plans, and plan changes, including Canterbury Plan Change 2 over the Waimakariri Zone; Otago Region Plan Changes 1C (water allocation & use), 4A (Groundwater & North Otago Volcanic Aquifer), 6A (Water Quality) and 4B (Groundwater allocation) of the Otago Regional Plan – Water; and the Proposed Otago Land & Water Regional Plan. I have conducted numerous basin wide water budget assessments and computer model projects in support of optimal water resource or nutrient management.

1.4 I have had an involvement in National Water Conservation Orders (**NWCO**), including Order applications made under the Water and Soil Conservation Act 1967 such as the Ahuriri River heard before the Planning Tribunal in August 1989. I have

also been a figure in the application for an NWCO over the Kawarau River and contributing waters in 1991, hearing of the Motueka and Riwaka rivers in 1991 and as a groundwater expert for the Oreti River Ministry for the Environment hearing in 2007 under the Resource Management Act 1991. These NWCO involvements have given me a good understanding of thresholds for outstanding values, regional and national significance of said values.

1.5 I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023 and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person.

1.6 The key documents I have used, or referred to, when preparing my evidence are:

- (a) Cameron S; Gusyev M; Meilhac C; Minni G; and Zemansky G. 2011. Pseudo-transient groundwater-stream interaction model for determination of the effect of groundwater abstraction on spring-fed stream flow in the Poukawa Basin, Hawke's Bay. GNS Science Report 2011/07, October 2011, Lower Hutt.¹
- (b) Department of Internal Affairs. 2017. Report of the Havelock North drinking water inquiry: Stage 1. The Department of Internal Affairs, Wellington. ISSN. 978-0-473-39743-2.²
- (c) Dravid P.N.; and Brown L.J. 1997. Heretaunga Plain Groundwater Study. Institute of Geological & Nuclear Sciences and Hawke's Bay Regional Council, May 1997, Napier.³

1 <https://www.hbrc.govt.nz/assets/Document-Library/Projects/TANK/TANK-Key-Reports/Groundwater-model-for-assessing-effects-on-Poukawa-Basin-2011.pdf>.

2 [https://www.dia.govt.nz/vwluResources/Report-Havelock-North-Water-Inquiry-Stage-1/\\$file/Report-Havelock-North-Water-Inquiry-Stage-1.pdf](https://www.dia.govt.nz/vwluResources/Report-Havelock-North-Water-Inquiry-Stage-1/$file/Report-Havelock-North-Water-Inquiry-Stage-1.pdf).

3 <https://www.hbrc.govt.nz/assets/Document-Library/Projects/TANK/TANK-Key-Reports/Heretaunga-Plains-Groundwater-Study-1997.pdf>.

- (d) Francis, D. (2001) Subsurface geology of the Ruataniwha Plains and relation to hydrology. Technical report. Geological Research Ltd, Lower Hutt. New Zealand.⁴
- (e) Geoscience Society of New Zealand. 2019. Best Practice guide: Outstanding Natural Features, What are they and how should they be identified. How their significance might be assessed and documented? Geoscience Society of New Zealand Miscellaneous Publication No. 154, June 2019. 25 pages. ISSN 2230-4495.⁵
- (f) Keesing, V. 2022. Ruataniwha Small streams & wetlands: Ecological assessment of potential effects related to deep water harvesting. Report prepared by Boffa Miskell Limited for Tranche 2 water take collaborative group.⁶
- (g) O'Shaugnessy, H.J. 1988. The Poukawa catchment water and soil resource management plan. Hawke's Bay Regional Council, Napier.
- (h) Rakowski, P. 2018. Heretaunga Aquifer Groundwater Model, Scenarios Report. Hawkes Bay Regional Council Environmental Science – Groundwater Report RM18-32 – 5018, August 2018, Napier. 134 pages. ISSN2324-4135.⁷
- (i) Weir, J.J. 2013. Evidence in Chief of Julian James Weir for Ruataniwha Water Users Group (Groundwater Modelling). Board of Inquiry into applications made by Hawkes Bay Regional Council and Hawkes Bay Regional Investment Company Ltd in relation to the Tukituki Catchment Proposal, 7 October 2013 for the Ruataniwha Water Users Group, Napier.⁸

4 <https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/4819-RM16-33-Groundwater-flow-pattern-in-the-Ruataniwha-Plains.pdf>.

5 <https://www.researchgate.net/publication/333457334>.

6 <https://www.hbrc.govt.nz/assets/Document-Library/Consents/Notified-Consents/Groundwater-Takes-Ruataniwha-Basin-Tranche-2/July-reports/BM211014-Ruataniwha-tranche-2-aquatic-effects-report-final-V8-220721.pdf>.

7 <https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/5018-Heretaunga-Aquifer-Groundwater-Model-Scenarios-Report-final.pdf>.

8 <https://www.epa.govt.nz/assets/FileAPI/proposal/NSP000028/Evidence-Submitters-evidence/d05d677bb7/Ruataniwha-Water-Users-Group-Evidence-Julian-Weir.pdf>.

- (j) Wilding, T. 2018. Heretaunga Springs. Gains and losses of stream flow to groundwater on the Heretaunga Plains. Hawkes Bay Regional Council Environmental Science – Hydrology Report RM18-13 – 4996, June 2018, Napier. 92 pages. ISSN 2324-4135.⁹
- (k) The Council’s preferred version of the provisions filed with the Court on 13 July 2023.
- (l) The appeals of:
 - (i) Te Taiwhenua o Heretaunga, Te Runanganui o Heretaunga, Te Manaaki Taiao o Heretaunga and Ngāti Kahungunu Iwi Incorporated (**TToH et al.**);¹⁰
 - (ii) Royal Forest and Bird Protection Society of New Zealand Incorporated (**Forest and Bird**);¹¹ and
 - (iii) Te Tumu Paeroa - the Māori Trustee.¹²
- (m) Heretaunga Aquifer – Summary of Values for Proposed Plan Change 7. August 2020.¹³
- (n) Karamu River – Summary of Values for Proposed Plan Change 7. August 2020.¹⁴

⁹ <https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/4996-Heretaunga-springs-June-2018.pdf>.

¹⁰ Appeal of Te Taiwhenua o Heretaunga, Te Runanganui o Heretaunga, Te Manaaki Taiao o Heretaunga and Ngāti Kahungunu Iwi Incorporated to the Proposed Plan Change 7 to the Hawke’s Bay Regional Policy Statement, 3 August 2021. [PPC7-Notice-of-appeal-by-Te-Taiwhenua-o-Heretaunga-and-Ngati-Kahungunu-Iwi-Incorporated.pdf](https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/20210806-Notice-of-appeal-by-Te-Taiwhenua-o-Heretaunga-and-Ngati-Kahungunu-Iwi-Incorporated.pdf) (hbrc.govt.nz).

¹¹ Appeal of Royal Forest and Bird Protection Society of New Zealand Incorporated to the Proposed Plan Change 7 to the Hawke’s Bay Regional Policy Statement, 5 August 2021. [Notice-of-Appeal-HBRC-PC7-Forest-Bird-FINAL.PDF](https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/20210806-Notice-of-appeal-on-HBRC-PC7-on-behalf-of-The-Maori-Trustee.pdf).

¹² Appeal of The Māori Trustee to the Proposed Plan Change 7 to the Hawke’s Bay Regional Policy Statement, 6 August 2021. [20210806-Notice-of-appeal-on-HBRC-PC7-on-behalf-of-The-Maori-Trustee.pdf](https://www.hbrc.govt.nz/assets/Document-Library/Publications-Database/20210806-Notice-of-appeal-on-HBRC-PC7-on-behalf-of-The-Maori-Trustee.pdf).

¹³ <https://www.hbrc.govt.nz/assets/Document-Library/Outstanding-Water-Bodies/3.-Values-reports/Heretaunga-Aquifer-ID2-Summary-of-Values-Aug-2020-5482.pdf>.

¹⁴ <https://www.hbrc.govt.nz/assets/Document-Library/Outstanding-Water-Bodies/3.-Values-reports/Karamu-River-ID3-Summary-of-Values-Aug-2020-5480.pdf>.

- (o) Ruataniwha Aquifer – Summary of Values for Proposed Plan Change 7. August 2020.¹⁵
- (p) Ngaruroro River and Estuary – Summary of Values for Proposed Plan Change 7. August 2020.¹⁶
- (q) The Council’s section 32 summary report.¹⁷
- (r) The Decision Report of the Independent Hearing Panel Proposed Plan Change 7, June 2021, including Appendix 1: Decisions Version of Proposed Plan Change 7.¹⁸

1.7 I have reviewed the final draft evidence of the following experts filed alongside this geology evidence for the Council:

- (a) Dr Andy Hicks, evidence in chief (ecology), dated 11 August 2023;
- (b) Dr Greg Ryder, evidence in chief (ecology), dated 11 August 2023;
- (c) Antoine Coffin, evidence in chief (spiritual and cultural values), dated 11 August 2023;
- (d) Rob Greenaway, evidence in chief (recreation), dated 11 August 2023;
and
- (e) Belinda Harper, evidence in chief (planning), dated 11 August 2023.

15 <https://www.hbrc.govt.nz/assets/Document-Library/Outstanding-Water-Bodies/3.-Values-reports/Ruataniwha-Aquifer-ID25-Summary-of-Values-Aug-2020-5504.pdf>.

16 <https://www.hbrc.govt.nz/assets/Document-Library/Outstanding-Water-Bodies/3.-Values-reports/Ngaruroro-River-ID18-Summary-of-Values-Aug-2020-5497.pdf>.

17 <https://www.hbrc.govt.nz/assets/Document-Library/Outstanding-Water-Bodies/1.-Other-supporting-information/Section-32-Evaluation-Report.pdf>.

18 <https://www.hbrc.govt.nz/assets/Document-Library/Outstanding-Water-Bodies/Decision-of-the-Independent-Hearing-Panel-PC7.pdf>

2. SCOPE OF EVIDENCE

2.1 My evidence addresses the following matters:

- (a) the background to Plan Change 7 (**PC7**), to the extent it is relevant to my evidence;
- (b) the PC7 outstanding water body (**OWB**) identification Screening Criteria;
- (c) the following relief sought in the appeal TToH et al.:
 - (i) Amendments to the OWB Identification Screening Criteria so that:
 - A. "natural character" is inclusive of "natural functions and processes", "integrity of aquifer recharge" and "natural spring flows"; and
 - B. the natural character value, includes natural form, natural function and integrity of recharge, so that aquifer recharge, spring flows from aquifers that replenish streams, and the cleansing services that aquifers provide, are included as aspects of natural character.
 - (ii) To reinstate into Schedule 25 the Heretaunga Aquifer for the following outstanding values:
 - A. Ecology: Groundwater dependent ecosystems.
 - B. Geology: Hydrological.
 - C. Natural character: Integrity of aquifer recharge.

- (iii) To reinstate into Schedule 25 the Ruataniwha Aquifer for the following outstanding values:
 - A. Ecology: Groundwater dependent ecosystems.
 - B. Geology: Hydrological.

- (iv) To reinstate into Schedule 25 the Karamū River for the following outstanding values:
 - A. Geology: Hydrological.
 - B. Natural character: Natural spring flow.

- (v) To reinstate into Schedule 25 the Makaroro River for the following outstanding values:
 - A. Geology: Hydrological.

- (vi) To reinstate into Schedule 25 the Lower Ngaruroro River for the following outstanding values:
 - A. Geology: Hydrology.
 - B. Natural character: Hydrological functions and processes, integrity of aquifer recharge.

- (d) Relevant information and assessment on each water body.

3. EXECUTIVE SUMMARY

3.1 The key conclusions reached in my evidence are that:

- (a) As per the PC7 framework, to qualify as outstanding, a water body must meet the Screening Criteria for the relevant value set and the definition of 'outstanding'. I refer to the evidence of Belinda Harper who notes this process is set out in Part 1 of Schedule 25.
- (b) The Natural Character, Geological, and Karst system / Subterranean waters value sets within the OWB identification Screening Criteria, as contained in the HBRC preferred version filed with the Court on 13 July 2023, are fit for purpose. The Screening Criteria appropriately assists with the identification of OWBs in Hawke's Bay Region.
- (c) The relief sought by TToH et al. that "natural character" include "natural functions and processes", "integrity of aquifer recharge" and "natural spring flows" in relation to replenishment of streams and the cleansing services of water's passage through the ground does not need to be specified in the Screening Criteria. These additional characteristics are already included in the "flow" and "water quality" characteristics listed in the Part 1 – Outstanding Water Body Identification Screening Criteria for Natural Character, so require no further specification.
- (d) The relief sought for the identification of the Heretaunga Aquifer, Ruataniwha Aquifer, Karamū River, lower Ngaruroro River and Makaroro River for outstanding geological values, mostly hydrological, requires a finding that the geology values as specified in appeals are conspicuous, eminent and/or remarkable in the Hawke's Bay context. I have not found evidence that I consider would support such a finding.

- (e) The relief sought for the identification of the Heretaunga Aquifer, Karamū River, and lower Ngaruroro River for outstanding natural character, requires a finding that the natural character of these water bodies as specified in appeals is conspicuous, eminent and / or remarkable in the Hawke's Bay context. The Heretaunga Aquifer, Karamū River and Ngaruroro River have a functional link, as the Lower Ngaruroro River provides the bulk of Heretaunga Aquifer recharge, and the Karamū catchment streams, creeks, springs and wetlands are the default water bodies of aquifer outflow as seepage.
- (f) Due to the public water supply and irrigation contained on and under the Heretaunga Plains, the water bodies have natural character that is adversely affected by modification, development, discharges and water takes. In my opinion, the Heretaunga Aquifer does not have outstanding natural character.
- (g) The Makaroro River has some features of geological and geomorphological uniqueness. However, in the context of the Screening Criteria the water body does not meet the criteria for conspicuousness, eminence or high importance in the New Zealand Geopreservation Inventory set out for water bodies within the Geological value set.
- (h) The Karamū River catchment does not contain groundwater dependent features which meet the Screening Criteria. As such, neither the Heretaunga Aquifer nor the Lower Ngaruroro River qualify for outstanding status.

4. BACKGROUND to PC7

- 4.1** PC7 is a change to Hawke's Bay's Regional Policy Statement (**RPS**) to include a list of the region's OWBs, together with a framework which prescribes a high level of protection for these water bodies in future plan making.

- 4.2** PC7 limits outstanding values to cultural and spiritual, recreation, landscape, geology, natural character and ecology values.
- 4.3** PC7 requires values to be outstanding in a regional context.
- 4.4** PC7 specifies that, to qualify as outstanding, a water body must meet the screening criteria for the relevant value set and the definition of 'outstanding'.

5. PC7 SCREENING CRITERIA – GEOLOGY

- 5.1** I refer to paragraph 13.1 of Belinda Harper's evidence where she notes that the appellants have not specifically sought any amendments to the geology value set.
- 5.2** The screening criteria in the Council's preferred version of PC7 reads:

For a water body to have outstanding geology values it must meet all matters in List A.

List A

- (a) The geomorphological, geological or hydrological feature is dependent on the water body's condition and functioning.
- (b) The geology values are conspicuous, eminent and/or remarkable in the context of the Hawke's Bay Region.
- (c) The geomorphological, geological or hydrological feature is classified as Class A on the New Zealand Geopreservation Inventory.
- (d) Evidence is provided in support of outstanding geology values by way of an expert assessment or independent evidence sources.

Comments on Screening Criteria – Geology

- 5.3** In my opinion, the Screening Criteria – Geology sets out a measured and balanced approach that assists with the identification of those water bodies in Hawke's Bay Region with outstanding geological features. I note:

- (a) Clear links are made to the geomorphological, geological or hydrological features and the dependence of these features to the water body's condition or function.
- (b) Criteria are specified to ensure geological features of a water body are conspicuous, eminent and/or remarkable which is consistent with the definition of outstanding.
- (c) The national Geopreservation Inventory is referenced, which assists with the identification of prominent geological aspects of the feature(s) that associate with the water body.
- (d) The national Geopreservation Inventory includes specification of the importance of various features into three bands; A, B and C that can be correlated with international, national and regional importance, respectively.
- (e) The importance of classification in the national Geopreservation Inventory allows screening criterion referencing it to filter for international and national importance attached to the feature in question.

6. PC7 SCREENING CRITERIA – KARST SYSTEM / SUBTERRANEAN WATERS

6.1 I refer to paragraph 13.1 of Belinda Harper's evidence where she notes that the appellants have not specifically sought any amendments to the Karst system / Subterranean waters value set.

6.2 The Screening Criteria in the Council's preferred version of PC7 reads (red strikethrough / underline highlighting the changes since the Decisions version):

For a karst system and/or subterranean waters is to have outstanding values where it **must** meet: ~~the following is met:~~

- at least one matter in List A; and

- all matters in List B.

List A

- (a) A specialised high quality experience present in few other water bodies in the region.
- (b) Wild and/or scenic values that contain distinctive qualities which 'stand out' and are present in few other water bodies in the region.
- (c) Unique or unusual scientific or ecological values present in few other water bodies in the region.

List B

- (a) International or national reputation and/or high non-local usage.
- (b) Evidence is provided in support of outstanding values.

Comments on Screening Criteria – Karst system / Subterranean waters

6.3 In my opinion, the Screening Criteria – Karst system / Subterranean waters set out a measured and balanced approach that assists with the identification of karst systems or subterranean waters, such as aquifer systems, in the Hawke's Bay Region that merits an outstanding status. I note:

- (a) Clear links are made within the Screening Criteria to the various aspects of karst systems and subterranean waters, such as wilderness, scenic, or recreational / tourist caving experiences that can make a karst system or subterranean waters outstanding.
- (b) Other measures refer to the high values of the subsurface features that stand out or are exceptional in a wider national or even international context.

7. PC7 SCREENING CRITERIA – NATURAL CHARACTER

7.1 The screening criteria in the Council's preferred version of PC7 reads (red strikethrough / underline to indicate difference from Decisions version):

For a water body to have ~~has~~ outstanding natural character values ~~where~~ it must ~~meets~~ all matters in List A.

List A

- (a) The water body is highly natural with little or no human modification, including to the flow, bed and riparian margins, water quality, flora and fauna, within a largely indigenous landscape.
- (b) The natural character values are conspicuous, eminent and/or remarkable in the context of the Hawke's Bay Region.
- (c) Evidence is provided in support of outstanding natural character values by way of an expert assessment or independent evidence sources.

Comments on Screening Criteria – Natural Character

7.2 In my opinion, the Screening Criteria – Natural Character sets out a measured and balanced approach that assists with the identification of those water bodies in Hawke's Bay Region with natural character values that merit an outstanding status.

I note:

- (a) The criteria allow factors of wildness, remote setting and / or high levels of preservation of the original characteristics of the environs to the water body to be considered as a distinct value set for OWBs.
- (b) Criteria are specified to ensure the natural character values of the water body are conspicuous, eminent and / or remarkable which is consistent with the definition of outstanding.

7.3 TToH et al. have sought amendments to the OWB Identification Screening Criteria so that "natural character" is inclusive of "natural functions and processes", "integrity of aquifer recharge" and "natural spring flows", and so that the natural

character value includes natural form, natural function and integrity of recharge, so that aquifer recharge, spring flows from aquifers that replenish streams, and the cleansing services that aquifers provide are included as aspects of natural character.

- 7.4** In my opinion, these matters do not need to be specified in the screening criteria. These additional characteristics are already included in the “flow” and “water quality” characteristics listed in the Part 1 – Outstanding Water Body Identification Screening Criteria for Natural Character. Therefore, they require no further specification. To include them would result in duplication and muddying of the application of the criteria.

8. GENERAL COMMENTS ON METHODOLOGY

- 8.1** I understand that the PC7 Independent Hearing Panel considered candidate water bodies for inclusion in Schedule 25 to determine those water bodies that clearly qualified as an OWB. The Independent Hearing Panel did this by:

- (a) testing each candidate water body against the Screening Criteria;
- (b) considering the definition of ‘outstanding’;
- (c) considering information set out in submissions; and
- (d) considering information provided as part of expert and lay evidence.

- 8.2** I have reviewed Appendix 2 of the Independent Hearing Panel’s decision report, particularly Part 1 – Outstanding Water Body Identification Screening Criteria and concentrating on the following value sets: –

- (a) Geology;
- (b) Karst System / Subterranean waters; and

(c) Natural Character.

- 8.3** These screening criteria are intended to assist with the identification of OWBs in Hawke's Bay.
- 8.4** The need to split the screening criteria into value sets introduces challenges in deciding which value set is most appropriate for certain classes of water bodies, such as aquifers. TToH et al. have sought the addition of aquifers, aquifer recharging water bodies and groundwater seepage dependent water bodies into Schedule 25; citing the Geology and Natural Character (relevant to this evidence) value sets. I note the Karst System / Subterranean waters value set has not been cited in appeals.
- 8.5** In my opinion, unless there are compelling reasons to screen groundwater-related water bodies within the Geology value set criteria, the Karst system / Subterranean waters would be the most appropriate value set to assess a water body that is or includes an aquifer or other water sources below the ground. This would leave the Geology value set for instances of water bodies associated with conspicuous (i.e., visible and generally above ground) or having remarkable geological strata, geological structures, geological sedimentary features, landforms or other unique geoscientific features.

Site Visits

- 8.6** I completed site visits on 7 August 2023 to the Heretaunga Plains, Karamū catchment, Ruataniwha Plains, Waipawa catchment (access to the Makaroro River was impeded by flood damage) and the lower Ngaruroro River, specific to the consideration of PC7 OWBs.

9. ASSESSMENT OF WATER BODIES SOUGHT TO BE ADDED BY APPELLANTS

The Heretaunga Aquifer

9.1 The Heretaunga Aquifer has been requested for inclusion in Schedule 25 for the following outstanding values:

- (i) Ecology: Groundwater dependent ecosystems.
- (ii) Geology: Hydrological.
- (iii) Natural character: Integrity of aquifer recharge.

Description of the Heretaunga Aquifer

9.2 The Heretaunga Aquifer is largely invisible to mundane observation. The aquifer lies beneath the soils of the Heretaunga Plains and the aquifer comprises the saturated geologic materials, including silt, sand and gravel mixtures, sufficiently porous to conduct groundwater. The aquifer is inferred and known from material samples obtained during drilling, or by the hydrological phenomena such as groundwater seepage into some low points and the tendency of water courses to increase flow without runoff when crossing the seepage zones of the aquifer. The aquifer is also inferred and known from the ability of pipes driven or drilled into the aquifer (i.e., wells or bores) to produce copious flows of water when pumped or allowed to overtop under natural (artesian) groundwater pressures.

9.3 The Heretaunga Aquifer has generally high transmissivity (ranging from 1,000 to 20,000 square metre per day) through highly permeable material and significant depth of saturated materials (combined thickness up to 120 m). This means the sandy gravel layers within it conduct water at relatively high rates from areas of higher elevation (>25 m Above Mean Sea Level, AMSL) to lower elevation (<12 m AMSL). The seepage zones mostly coincide with tributaries of Karamū River (the largest of which are Raupare Stream, Irongate Stream and Mangateretere Stream).

- 9.4** The lower Ngaruroro River loses approximately 5 cubic metres per second (or 5,000 litres per second) of its flow rate into the aquifer upstream of the State Highway 50 crossing at Fernhill. Approximately 2.8 cubic metres per second (or 2,800 litres per second) of seepage reports to the bottom end of the Karamū River immediately upstream of the tidal zone in Clive River. The remainder of 2.2 cubic metres per second or more is inferred to be captured by water bores or flow offshore to submarine springs.
- 9.5** The 1994-95 Heretaunga Aquifer water balance (Dravid & Brown, 1997) indicates that for the aquifer outflows of the landward portion of the aquifer, 35% was bore pumping while 65% was spring seepage, mostly in the Karamū catchment. This water budget also suggested that submarine spring discharge was a small part of the overall water budget, perhaps 1.5%.
- 9.6** Almost a side note compared to the dominance of the Ngaruroro River recharge, the lower Tukituki River contributes about 14% of the Heretaunga Aquifer water budget recharge in the last 8 kilometres of its course to the river mouth at Haumoana. This may be more significant to the seepage gains experienced by the Karituwhenua, Karamū and Mangateretere streams adjacent to the Tukituki River. Significantly, rainfall recharge was estimated to contribute only 2.5% to the aquifer-wide water balance from soil drainage in the unconfined portion of the aquifer to the northwest. The Tūtaekurī – Waimate Stream losses also contribute to the northern parts of the Heretaunga Aquifer, promoting seepage in these areas.
- 9.7** Large extent, high volume aquifers such as the Heretaunga Aquifer occurring beneath high productivity grazing, cropping and horticultural soils in a seasonally dry temperate climate are frequently the sites of significant groundwater extraction for irrigation, and to supply the area's population. In this context, the Heretaunga Aquifer is a critical water resource in terms of quantity and water quality.
- 9.8** The seepage areas of the Heretaunga Plains are covered in further detail in my evidence in chief for the Karamū River.

Comments on whether the Heretaunga Aquifer provides outstanding natural character, geology and/or ecology values

Natural character values

9.9 The natural character of the Heretaunga aquifer has been impacted by human modification. Drilling & bore installations, land drainage lowering unconfined water tables, groundwater abstraction amounting to a third of the water budget lowering groundwater levels, and contamination of shallower parts from depths up to 25 m below ground level have significantly affected the natural character of the aquifer system. The nature of main groundwater contaminants anticipated or observed to affect the Heretaunga Aquifer groundwater quality are nitrogen, faecal bacteria, viruses and persistent organic pollutants.

9.10 The groundwater abstraction has had a great effect on the groundwater levels / pressures, the amount of additional recharge required to be pulled from connected surface water, and the quantity of surface seepage back into the water courses of the Heretaunga Plains. As a result of the loss of surface seepage, the Heretaunga Aquifer and Plains have lost fens and wetlands recorded in historic accounts or maps of the Heretaunga Plains. Land cover changes and drainage associated with urbanisation, land use intensification and loss of surface seepage have resulted in a substantial loss of natural character in terms of removing natural hydrological features of the Plains and the associated land cover.

9.11 Simulation of historic recorded bore water abstraction using a calibrated and optimised groundwater computer model (Rakowski, 2018) estimated historic water abstraction had the following effects:

- (a) additional depletion of the Ngaruroro River flow of up to 46%;
- (b) additional depletion of the Tukituki River flow of up to 18%; and
- (c) additional depletion of the Tūtaekurī River flow of up to 6%.

- 9.12** As outlined in the description of the Heretaunga Aquifer, the Ngaruroro, Tukituki and Tūtaekurī rivers each have a role in the hydrological exchange of waters between surface water and groundwater. Changes to the water budget and groundwater pressures of the aquifer caused by groundwater abstraction have an estimable effect surface water flow rates.
- 9.13** The simulations of historical abstraction from the Heretaunga Aquifer also showed that historic levels of groundwater abstraction were estimated to have led to 65% of Karamū River System flow loss through reduced seepage and spring flow. Groundwater levels in the Heretaunga Aquifer were affected by historic groundwater abstraction too, with summertime groundwater level decline (also known as drawdown) ranging between 0.5 metres and 4.5 metres. Wintertime drawdown is generally much less due to the temporal absence of irrigation pumping, ranging between 0.5 metres and 2.5 metres (Rakowski, 2018). The HBRC’s groundwater scientists have indicated they believe the magnitude of these drawdown effects on groundwater levels to be stabilising to an equilibrium in recent years. As a result of the persistent drawdown effects on the Heretaunga Aquifer, the natural character has been affected because the aquifer exhibits fewer characteristics associated with groundwater systems in their natural state. The aquifer is more responsive to impulses caused by consumptive water use, such as pumping-related drawdown, compared to natural impulses, such as seasonal recharge patterns.
- 9.14** The Heretaunga Aquifer has been significantly modified and the resulting landscape is not dominated by indigenous land cover, therefore the Heretaunga Aquifer, in particular its integrity of aquifer recharge, does not meet the criterion Natural Character criterion (a) of List A described as “little or no human modification, including to the flow, bed and riparian margins, water quality, flora and fauna, within a largely indigenous landscape”.
- 9.15** The Heretaunga Aquifer also does not contain any conspicuous, eminent and / or remarkable natural character values in the context of Hawke’s Bay, in my opinion. I consider that one relevant example of a remarkable character value is “blue springs.” “Blue springs” are identifiable zones of unusually large extent for

seepages, vigorous spring flow, high water clarity, associated macrophytes (typically flowering aquatic plants) and overall attractiveness to people. There are no instances in the Heretaunga Plains of 'blue springs' being present with remarkable scientific or scenic characteristics. Other examples of conspicuous natural character in the Hawke's Bay are the accumulation of seepage fed wetlands such as Pekapeka Wetlands in the Poukawa catchment where hydrological and biotic processes combined to produce notable scientific or scenic characteristics. The Heretaunga Aquifer does not have any of these conspicuous natural character values. In most instances the significant quantities of groundwater seepage are diffuse, leading to incremental gains in stream or river flow rate, which detracts from the conspicuousness of the seepage. As a result, the Heretaunga Aquifer does not meet criterion (b) in the outstanding natural character value set.

Geology values

- 9.16** As per my findings above in Paragraph 8.5 I consider it most appropriate for the Heretaunga Aquifer to be assessed against the Karst system / Subterranean waters value set. However, for completeness and to address the appellant's requests I have referred to both value sets.
- 9.17** I do not consider that the Heretaunga Aquifer has outstanding natural geological values to merit its inclusion in Schedule 25.
- 9.18** The pattern of surface water recharge at the Ngaruroro River, Tukituki River and Tūtaekurī – Waimate Stream, throughflow within sandy, cobbly gravel material accumulated in a tectonic basin and seepage discharge in lower catchment creeks, springs, drainage schemes or wetlands is a hydrological pattern to be seen throughout the gravel braided river catchments on the eastern coasts of the North and South Island. Accordingly, the hallmarks of this hydrological pattern are not unique.
- 9.19** The Heretaunga Aquifer is large and is the centre of a significant urban – primary production conurbation in the Hawke's Bay context, however the aquifer lacks any conspicuous, eminent and/or remarkable geology values in the context of the

Hawke's Bay region. Such values would require the presence of specific features such as, but not limited to, "blue springs" or remarkable seepage fed wetlands, and I am not aware of any of these achieving any eminence in the Hawke's Bay context within or on the aquifer.

9.20 The Heretaunga Aquifer has no geomorphological, geological or hydrological feature which is classified as Class A on the NZ Geopreservation Inventory falling on or within the aquifer or Heretaunga Plains.

9.21 Given the relative national and even regional abundance of geological features such as the Heretaunga Aquifer and lack of specific features that would cross the threshold into conspicuous, eminent and/or remarkable geology values in the context of the Hawke's Bay region, neither the Karst system / Subterranean waters Screening Criteria or the Geology Screening Criteria are not met by the Heretaunga Aquifer.

Ecology values

9.22 I have reviewed the information available about the Heretaunga Aquifer, including the information summarised in the Heretaunga Aquifer Summary of Values report August 2020, and have not seen any information that identifies outstanding ecology values that would enable those values to meet the threshold of the ecology value set of the Screening Criteria.

Conclusion

9.23 As mentioned above TToH et al. has requested that the Heretaunga Aquifer be included in Schedule 25 for outstanding geology values for its hydrological connections, outstanding natural character values for its integrity of aquifer recharge and outstanding ecology values for its groundwater dependent ecosystems. I have considered these aspects against the screening criteria for the Karst system / Subterranean waters, natural character, geology and ecology value sets, and note that in my professional opinion, because the Heretaunga Aquifer is highly modified, does not contain any conspicuous, eminent and/or remarkable

natural character or geology values, and there is no evidence that the groundwater dependent ecosystems are outstanding in the context of the screening criteria and the Hawkes Bay region, it does not meet the screening criteria for Karst system / Subterranean waters, natural character, geology or ecology value sets, so does not meet the threshold of an OWB.

The Ruataniwha aquifer

9.24 The Ruataniwha Aquifer has been requested for inclusion in Schedule 25 for the following outstanding values:

- (a) Ecology: Groundwater dependent ecosystems.
- (b) Geology: Hydrological.

Description of the Ruataniwha Aquifer

9.25 The Ruataniwha Basin is a tectonic basin between the active Mohaka and Ruahine Range-front faults to the northwest, and faulted folding to the southeast. The Ruahine Range front forms the backdrop to the basin, while a series of Miocene to Pliocene uplifted marine sediments lie across the courses of the Waipawa and Tukituki rivers constraining their water course into gorges, and truncating the permeable younger granular (sands, gravels and admixtures) that form the Ruataniwha aquifer system.

9.26 Streams of the Tukituki – Waipawa catchments crossing the Ruataniwha Aquifer include Mangamate, Mangamauku, of the Mangaonuku River catchment; Makaroro River of the Waipawa River catchment; Kahahakuri, Avoca, and Mangatewai of the Tukipo River catchment; Makaretu, Pōrangahau and Maharakeke of the Tukituki catchment. All of these streams and rivers crossing the Ruataniwha Basin lose and gain water in exchange with the Ruataniwha aquifer system with total basin surface water flux of over 500 million cubic metres per annum (Weir, 2013). In addition, the aquifer system receives recharge that varies

in accordance with climate fluctuations and irrigation losses but has been estimated at 415 million cubic metres per annum (Weir, 2013).

- 9.27** The Ruataniwha Basin is infilled with sequences of alluvial gravel from the Quaternary period, and with intermittent clay layers of different thicknesses. The top of the basin infill is composed of the more permeable young gravel layer from the late Pleistocene and Holocene epochs, draped over an older gravel sequence termed the “Salisbury Gravel” from the early Pleistocene. The Salisbury Gravels are predominant in the northwest of the Ruataniwha Basin. The gravel layers are considered to be separated vertically from each other by clay aquitards¹⁹. The total depth of all Pleistocene – Holocene gravel deposits ranges from 0 m to 360 m, with the deepest being found beneath the core of the basin and below the Tukituki River.
- 9.28** The Ruataniwha Aquifer comprises a substantial groundwater resource, which is also sustainably replenished by stream and river losses occurring after the range-front contact with the Pleistocene – Holocene gravel deposits, plus land-surface recharge across the plains surface. Groundwater seepage tends to be restricted to the south eastern margins of the basin, particularly concentrated around or into rivers exiting the Ruataniwha Plains in gorges, namely the Tukituki and Waipawa rivers.
- 9.29** Large extent, high volume aquifers such as the Ruataniwha Aquifer occurring beneath high productivity grazing and cropping soils in a seasonally dry temperate climate are frequently the sites of significant groundwater extraction for irrigation, and to supply the area’s population. In this context, the Ruataniwha Aquifer is a critical water resource in terms of quantity and water quality.
- 9.30** The natural character of Ruataniwha Aquifer has been impacted by drilling & bore installations, land drainage lowering phreatic water tables, groundwater abstraction lowering groundwater levels, and contamination of shallower parts of the aquifer system. The nature of main groundwater contaminants anticipated or

¹⁹ Aquitard is usually a horizontal layer that divides aquifer as a semi-permeable layer. An aquitard allows leakage between aquifers in the direction and rate of leakage dictated mostly by the groundwater gradient and also the aquitard vertical hydraulic conductivity (permeability).

observed to affect the Ruataniwha Aquifer groundwater quality include nitrogen, faecal bacteria, viruses and persistent organic pollutants

Comments on whether the Ruataniwha Aquifer provides outstanding geology and/or ecology values

Geology values

- 9.31** As per my findings above in Paragraph 8.5 I consider it more appropriate for the Ruataniwha Aquifer to be assessed against the Karst system / Subterranean waters value set. However, for completeness and to address the appellant's requests I have referred to both value sets.
- 9.32** TToH et al. has requested that the Ruataniwha Aquifer be included in Schedule 25 for outstanding geology values for its hydrological connections. I do not consider that the Ruataniwha Aquifer has outstanding natural geological values to merit its inclusion in Schedule 25.
- 9.33** I have reviewed geological mapping, aerial photography, relevant reports and other evidence such as the Geopreservation Inventory, including the information summarised in the Ruataniwha Aquifer Summary of Values report August 2020, in forming the view that the Ruataniwha Aquifer does not have any geomorphological, geological or hydrological features dependent on the water body's condition and functioning.
- 9.34** All current indications are that groundwater return from the aquifer to the Ruataniwha Plains' streams and rivers diffusely, without prominent 'blue springs' or remarkable groundwater fed wetlands. A survey (Keesing, 2022) of small streams and wetlands undertaken in 2022 targeting aquatic environments more likely to have hydraulic connection to the Ruataniwha Aquifer found no indications of conspicuous, eminent and/or remarkable features in the Hawke's Bay context.

9.35 The Ruataniwha Aquifer has no geomorphological, geological or hydrological feature which is classified as Class A on the NZ Geopreservation Inventory falling on or within the aquifer or Ruataniwha Plains.

9.36 Given the relative lack of national and even regional geological features within the Ruataniwha Aquifer and similar lack of specific features that would cross the threshold into conspicuous, eminent and/or remarkable geology values in the context of the Hawke's Bay region, neither the Karst system / Subterranean screening criteria or Geology Screening Criteria are met by the Ruataniwha Aquifer. Without conspicuous, eminent and / or remarkable feature(s) of this type, I do not support the aquifer's inclusion in Schedule 25.

Ecology values

9.37 I have reviewed the information available about the Ruataniwha Aquifer, including the information summarised in the Ruataniwha Aquifer Summary of Values report August 2020, and have not seen any information that identifies outstanding ecology values that would enable those values to meet the threshold of the ecology value set of the Screening Criteria.

Conclusion

9.38 In my professional opinion, the Ruataniwha Aquifer does not meet the screening criteria for the Karst system / Subterranean waters value set or for the geology value set because there are no unique geological, geomorphological or hydrological features dependent on the aquifer's condition and functioning. The Ruataniwha Aquifer also does not contain any geomorphological, geological or hydrological feature which is Class A in the NZ Geopreservation Inventory. Finally, there is insufficient evidence to indicate that there are groundwater dependent ecosystems which would be regionally outstanding for ecology values in the screening criteria. In conclusion, the Ruataniwha Aquifer does not meet the threshold of an OWB in terms of the screening criteria for geology or ecology value sets.

The Karamū River

9.39 The Karamū River has been requested for inclusion in Schedule 25 for the following outstanding values:

- (i) Geology: Hydrology.
- (ii) Natural character: Natural spring flows.

Description of the Karamū River

9.40 The Karamū River system comprises about eleven tributary streams and the river's hydrology is dominated in terms of volume by diffuse upward seepage of groundwater from the underlying Heretaunga Aquifer. Less common is the runoff of catchment flows from fringing hills.

9.41 The river system includes hillslope catchments of late Pliocene limestone in the Te Mata Peak – Mt Erin Range, Kaokaoroa Range and Raukawa Range. These hill catchments, including the Mangarau, Herehere, Poukawa, Awanui and Paritua streams receive seepage and spring flow from peripheral limestone groundwater systems perched above the Heretaunga Aquifer.

9.42 The surface expressions of the Heretaunga Aquifer in the Karamū catchment includes point springs, spring-fed streams and diffuse seepage to the Tūtaekurī Waimate Stream and Karamū River tributaries, particularly the lower level streams over the confined area of the aquifer with its artesian upward hydraulic gradients. The diffuse seepage areas include the Paritua – Karewarewa stream system, which includes a zone of springs and seepage between Bridge Pā to Pakipaki, albeit at lower seepage rates than lower elevation seepage zones such as Raupare Stream.

9.43 My understanding is that, while eleven tributaries of the Karamū River with flow measurement sites have measurable diffuse seepage, diffuse seepage in the Karamū River main stem more than doubles baseflow as far as the flow measurement site at Karamū Floodgates. Much of the seepage is associated with

willow wetlands to either side of drains or the river. Instances of a low flow point spring with 'boiling sands'²⁰ was noted by regional council staff in March 2014 (Wilding, 2018). Additional boiling sands point springs are located in the Raupare sub-catchment between Raupare Road and Twyford Road, Twyford (Wilding, 2018).

- 9.44** Recent analysis of groundwater hydrology and isotopic and physio-chemical tracers (Wilding, 2018) suggests that some of the seepage arising in the Karamū River downstream of Havelock North and upstream of Clive River originates from the losses of the Lower Tukituki River. The Tukituki River source is also attached to the seepage flows of Mangateretere Stream east of Havelock North. The groundwater system in the Mangateretere Stream sub-catchment has in the past been ascribed to a compartment of the Heretaunga Aquifer or separate aquifer dubbed Te Mata Aquifer (Department of Internal Affairs, 2017) otherwise named the 'Tukituki Aquifer' (Dravid & Brown, 1997).
- 9.45** The Karamū River catchment has a significant valley sub-catchment outside the Heretaunga Plains as Poukawa Stream, including the hydrological features of Pekapeka Wetland and Lake Poukawa. A groundwater system in very loose connection with the Heretaunga Aquifer extends between the Kaokaoroa and Raukawa ranges comprising low bulk permeability marine sediments and structurally within the Poukawa Fault Zone. The basin infill materials are Pleistocene – Holocene alluvium and palustrine (wetland) sediments.
- 9.46** In addition to the alluvial / palustrine sediments, the basin is also associated with a peripheral limestone aquifer in which groundwater flows within solution voids²¹.
- 9.47** The surface water connection of the upper Poukawa sub-catchment including Lake Poukawa to Awanui Stream at Pakipaki is recent and artificial. An open drain was dug to join it to the Poukawa Stream and Pekapeka Wetlands in 1931 (Cameron et al, 2011). The Poukawa Basin exits into the Karamū River system via a very narrow neck of valley floor near Pekapeka Wetlands, and approaches an internally draining

²⁰ Boiling sands springs are springs in which the fine particle water clarity is high, the water column has a sand base or bed and the inflowing seepage water causes the sand grains to 'boil', being lifted by higher velocity water and dropping out onto the sands below once the velocity dissipates.

²¹ Situation voids include cavities, caverns or caves within the limestone.

basin periodically during periods of high evaporation. This results from actual evapotranspiration and open water evaporation rates approaching 100 litres per second of evaporation depth in a typical December (O’Shaughnessy, 1988) when median basin outflow measured at Awanui flume is only 100 – 150 litres per second (Wilding, 2018).

- 9.48** The Pekapeka Wetlands in the lower reaches of Poukawa Stream are considered to be the result of low gradient in the Poukawa Stream leading to relative stagnation of surface flow in the wetland zone, although seepage from surrounding limestone-hosted groundwater is also thought to be received at the wetland (Cameron et al, 2011). There are no indications that the main compartment of the Ruataniwha Aquifer contributes to the hydrology of the Pekapeka Wetlands.

Comments on whether the Karamū River provides outstanding natural character and/or geology values

Natural character

- 9.49** The Karamū catchment occupies most of the Heretaunga Plains south of the Ngaruroro River. The natural character of the Heretaunga Plains has been extensively modified by intensive horticulture, cropping and the urban areas of Flaxmere, Hastings and Havelock North, which cover significant portions of the plain surface. These land uses require conditions that are inconsistent with wetlands or seepage sites, so land modification has removed or greatly reduced their size. Much of the original wetlands, meandering streams and springs across the catchment have been drained, constrained, and rectified with earthworks since settlement began in the late 1800s. Saturation water levels have been significantly reduced across the Heretaunga Plains. The inland wetlands of the once extensive groundwater fed wetlands of the Pakowhai area mapped in the mid - late 1800s are now largely gone and seepage zones and willow wetlands are the sole remnants. Consequently, the Karamū catchment is much modified in the manner outlined in forgoing sentences, so values of natural character are vestigial or absent from much of the river catchment over the Heretaunga Aquifer.

9.50 The Karamū River catchment lacks conspicuous, eminent and / or remarkable wetlands, resurgences or springs from underlying groundwater to gain regionally or nationally significant status in terms of criterion (b), nor does the catchment have natural character specified as “little or no human modification, including to the flow, bed and riparian margins, water quality, flora and fauna, within a largely indigenous landscape” in criterion (a) of List A. The Karamū River catchment has been significantly modified and the resulting landscape is not dominated by indigenous land cover. Therefore, the catchment does not meet the screening criteria for outstanding natural character values.

Geology

9.51 The Karamū River catchment is the centre of a significant urban – primary production conurbation in the Hawke’s Bay context. However, the catchment lacks any conspicuous, eminent and / or remarkable geology values in the context of the Hawke’s Bay region. Such values would require the presence of specific features such as, but not limited to, “blue springs” or remarkable seepage fed wetlands. I am not aware of any such features achieving any eminence in the Hawke’s Bay context within the catchment.

9.52 The Karamū River catchment upon the Heretaunga Plains has no geomorphological, geological or hydrological feature which is classified as Class A on the NZ Geopreservation Inventory falling on or within the aquifer or the Heretaunga Plains.

9.53 Given the relative national and even regional abundance of geological features within the Karamū River catchment and lack of specific features that would cross the threshold into conspicuous, eminent and/or remarkable geology values in the context of the Hawke’s Bay region, the Karamū River catchment does not meet the screening criteria for outstanding geology values.

Conclusion

9.54 In my professional opinion, the Karamū River does not meet the threshold of an OWB. It does not meet the screening criteria for the natural character or geology value sets developed for the Hawke's Bay Region due to the urban and primary production land cover, significant abstractive impact on the underlying aquifer and lack of remarkable geomorphological, geological or hydrological features within the catchment.

The Makaroro River

9.55 The Makaroro River has been requested for inclusion in Schedule 25 for the following outstanding values:

- (a) Geology: Hydrological.

Description of the Makaroro River

9.56 The Makaroro River is a major tributary of the Waipawa River in the Tukituki catchment. Mean flow is approximately 2.2 cubic metres per second and a Mean Annual Low Flow (7-day) of 0.41 cubic metres per second. The Makaroro River has few named tributaries, primarily Gold Creek and Dutch Creek.

9.57 The geology of the Makaroro catchment is a repeating sequence of Jurassic greywacke and argillite of the Torlesse Supergroup (Mesozoic basement rocks) followed by Pliocene sandstone and siltstone of the Mangaheia Group (Late Tertiary marine sediments). The river rises in the Ruahine Ranges on greywacke and argillite basement rocks, passing onto Tertiary marine sediments at the Gold Creek confluence due to the action of the Ruahine Fault. The river flows east for about four kilometres in the Tertiary sediment block before encountering the Mohaka Fault, which truncates the tertiary sediments. The vertical displacement action of the Mohaka Fault uplifts the greywacke and argillite basement rocks and the river meanders approximately south and east over nine kilometres before emerging from a bedrock gorge onto Holocene alluvium overlying Tertiary marine

sediments. The Makaroro River travels a further four kilometres over alluvium to its confluence with the Waipawa River.

9.58 The Makaroro River becomes a gravel bed river within four kilometres of its headwaters and a braided gravel bed river from the Gold Creek confluence. It passes into a gravel floored, deepening gorge after crossing the Mohaka Fault and onto greywacke and argillite basement rocks. Paradoxically, the gorge meanders with sinuous loops characteristic of a meandering river in soft fluvial geology. Passing out of the basement rock geology, the river continues a meandering morphology to its confluence with the Waipawa River. It is inferred that the pronounced meandering into basement rock is an example of antecedent drainage where meandering was established in overlying soft sediments and became overprinted into harder rock through progressive downward erosion.

9.59 The Makaroro River passes through a mixture of native vegetation, plantation forestry and farmland supporting mostly extensive grazing. The river flows through conservation land from its headwaters to the Gold Creek confluence.

9.60 The various tributaries of Ohara Stream; Kaumatua, Jumped Up, Tarapeka, Mathews, and Hill streams plus Ohara Stream itself traverses the same geological strata and structures as the streams flow east and north towards the Ngaruroro River. The Ohara catchment shares a catchment divide with Makaroro River and displays much the same morphological features as the Makaroro River, including antecedent meandering over greywacke and argillite basement rocks.

Comments on whether the Makaroro River provides outstanding geology values

Geology

9.61 In my opinion, the Makaroro River does not meet the screening criteria for the geology value set and therefore does not have outstanding natural geological values so does not meet the threshold of an OWB.

9.62 The Makaroro River has features of antecedent meandering patterns that were attributable to tectonic uplift but these geomorphic patterns are not dependent on the continuance of the river's hydrological condition and functioning. These patterns are seen elsewhere in the Hawke's Bay region and the Mohaka Fault block, at Ohara Stream in the Ngaruroro River catchment, for instance, so they cannot be considered conspicuous, eminent and/or remarkable.

9.63 The Makaroro River or the Makaroro catchment do not feature in the NZ Geopreservation Inventory at an importance class of A.

Conclusion

9.64 In my professional opinion, the Makaroro River has a notable waterscape in its responses to formation processes in a tectonically, dynamic environment. However, this function is in my opinion not sufficient to elevate the Makaroro River to OWB status because the features are readily available in other nearby watersheds, so the Makaroro River does not contain geology values that are conspicuous, eminent and / or remarkable in the Hawke's Bay region. Such geological features that are attached to the river are not sufficiently notable to elevate the river to outstanding in the Hawke's Bay context. It also does not meet the geology value set contained in the screening criteria for outstanding geology values because the Makaroro catchment does not feature in the NZ Geopreservation Inventory, let alone at an A Class of importance. Therefore it is not an OWB in my view.

The lower Ngaruroro River

9.65 The Ngaruroro River downstream of Whanawhana has been requested for inclusion in Schedule 25 for the following outstanding values:

(i) Natural character: Hydrological functions and processes, integrity of aquifer recharge.

(ii) Geology: Hydrology.

Description of the lower Ngaruroro River

- 9.66** The geology of the lower Ngaruroro River includes, Jurassic greywacke and argillite of the Torlesse Supergroup (Mesozoic basement rocks) followed by Pliocene sandstone and siltstone of the Mangaheia Group (Late Tertiary marine sediments). The lower Ngaruroro River rests within an active braidplain and remnants of past braidplains within the river's current floodplain. The depths to the base of Late Tertiary sediments become shallow under the braidplain in places and impinge on the subsurface flows within braidplain alluvium, as occurs at Roys Hill. Despite these pinch points, the Ngaruroro River is in hydraulic connection with the Heretaunga Aquifer as the river flows across the northern flank of the aquifer. The lower river makes significant water exchanges with the aquifer, including an average 5,000 litres per second recharge of the aquifer in the Maraekakaho areas and downstream to Fern Hill, while receiving seepage from the aquifer towards the tidal affected reaches and into the Clive River diversion near the mouth.
- 9.67** The Ngaruroro River's active braidplain is up to 500 m wide and the separate braid channels may number up to six channels, particularly in the reaches to either side of Maraekakaho. The river carries substantial volumes of terrestrial sediments and has had a large role in its geological history with infilling the tectonic basins such as the Ngaruroro Fault Zone and the Heretaunga Basin with coarse sediment.
- 9.68** The wide multi-channel braidplain river complexes are considered environmentally and scenically valuable internationally, but are relatively common in countries like Russia (Siberia), Alaska (USA), western Canada, India and New Zealand. New Zealand has many examples analogous to the Lower Ngaruroro in Canterbury, Marlborough, Wellington, Hawke's Bay and Bay of Plenty, plus notable examples in Otago and Southland. Hawke's Bay region has the Tukituki, Waipawa, and Tūtaekurī rivers with significant lengths of braidplains, in addition to the Ngaruroro.

Comments on whether the lower Ngaruroro River provides outstanding natural character and/or geology values

Natural character

9.69 The lower Ngaruroro River has been modified by flood protection works, partial or complete diversions, gravel extraction for the aggregate resource and floodplain encroachment by flood embankments and other structures. The modification has resulted in the lower Ngaruroro River becoming increasingly confined to a permanent floodway for all but extreme flooding events, which has adversely affected its hydrological function in recharging the Heretaunga Aquifer and the river's ability to rework its braided gravel bed. Therefore I am of the opinion that the lower Ngaruroro River does not meet the threshold of being a water body that is highly natural with little or no human modification.

9.70 The natural character values of the lower Ngaruroro River are significantly affected by flood control, infrastructural crossings, invasive exotic plant species and gravel extraction. As a result, the active braid plain is currently narrower and more constrained relative to its natural state and has a narrower zone of river dynamics such as braiding or groundwater interactions. Therefore, I am of the opinion that the lower Ngaruroro River does not meet the threshold of conspicuous, eminent and/or remarkable natural character values in the Hawke's Bay context.

9.71 The Ngaruroro River downstream of Whanawhana Cableway is a good example of a braided gravel river, but due to its passage through modified landscapes with urbanisation and intensification of landcover for primary production, does not meet the criteria for natural character in terms of the OWB identification criteria for the natural character value set.

Geology

9.72 In my opinion, the lower Ngaruroro River does not have outstanding natural geology values.

- 9.73** The lower Ngaruroro River has a high flow rate upstream catchment and a permeable gravel base in hydraulic connection with the underlying Heretaunga Aquifer. The river is essential in the average 5,000 litres per second of recharge provided to the Heretaunga Aquifer. However, the geomorphological features such as the large gravel braid plain and recharge contributions to the Heretaunga Aquifer are not sufficient to meet the screening criteria for identification of OWBs in the geological value set.
- 9.74** The lower Ngaruroro River does contain any compelling indications of including conspicuous, eminent and/or remarkable geology values nor does it meet other screening criteria in the geology value set.
- 9.75** The Ngaruroro River from grid reference V21/140-740 downstream to Ohiti Pa (opposite Roys Hill) is classed B in terms of importance within the NZ Geopreservation Inventory, and hence does not meet the class A importance specified in the screening criteria.
- 9.76** In the absence of conspicuous, eminent and/or remarkable geology values or satisfaction of other screening criteria in the geology value set, the lower Ngaruroro River is not identifiable as an OWB.

Conclusion

- 9.77** In my professional opinion, the large-scale braidplain in the lower Ngaruroro River does not meet the screening criteria for the geology value set because other braided gravel rivers and braid plains hold similar or higher values within the Hawke's Bay region and nationally. The Ngaruroro River between Maraekakaho and Fern Hill is indeed important in sustaining the groundwater flow through the Heretaunga Aquifer, which is a regionally critical water resource for public water supply and irrigation of intensive primary production over the Heretaunga Plains. However, this function is in my opinion not sufficient to elevate the lower Ngaruroro River to OWB status for natural character or geology values because the recharge to the aquifer does not result in natural character or geological value set features crossing the threshold into OWB status.

10. CONCLUSION

- 10.1** In my opinion, none of the water bodies requested for inclusion in Schedule 25 as part of relief sought in appeal and citing geological (hydrological), or natural character, or Karst system / Subterranean waters value sets, cross the threshold of conspicuous, eminent and / or remarkable in terms of the Screening Criteria developed to identify OWBs in the Hawkes Bay Region.

Jens Haaye Rekker

Date: 11 August 2023

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Appendix A – New Zealand Geopreservation Inventory Extracts

Importance A Outstanding Natural Landforms in New Zealand Geopreservation Inventory

NZGPI #	Name	Significance	Description	Locality
442	Poukawa pseudo flatiron	Only known occurrence in New Zealand.		South side of State Highway 2, 3 km south of Pakipaki.
593	Cape Kidnappers Pleistocene sedimentary rocks and sea cliffs	Shear colourful cliffs cut into clearly stratified mudstone and sandstone with prominent rock banding, including some prominent fault displacement. The most spectacular cliffs in Hawkes Bay.	Thick conformable succession of conglomerate, tephra, estuarine mudstone, indicating glacio-eustatic sea level changes.	Cape Kidnappers
682	Waipatiki Beach glacio-eustatic sequence	This site is important for the preservation of rapid depth changes caused by glacio-eustatic sea level changes.	The sequence is the same as in Devils Elbow section; better exposed but not so accessible.	Waipatiki Beach
170	Devils Elbow Plio-Pleistocene sediments	Easily accessible section, important for the preservation of rapid depth changes caused by glacio-eustatic sea level changes. Most diverse Nukumaruan macrofauna in New Zealand.	Uncemented, massive and bioturbated, blue-grey sandy silt, grading up section into muddy, fine siliciclastic sand.	Devils Elbow Road, Hawke Bay: main Napier, Wairoa highway
1453	Mangahouanga Stream Cretaceous vertebrate fossils	First, and to date the only, record of terrestrial dinosaurs found in New Zealand. Rich and diverse Cretaceous vertebrate fossils in concretions, including New Zealand's only known dinosaurs and New Zealand's oldest known fossil insect, as well as fossil		Tributary of Te Hoe River, Napier-Taupo Road, stretching 4.8 km along Mangahouanga Stream.
1449	Mahia Peninsula Holocene and Late Pleistocene marine terraces	The best preserved and most easily seen sequence of uplifted late Quaternary marine terraces in New Zealand.	Sequence of well-preserved uplifted marine terraces of Holocene to late Pleistocene age.	Mahia Peninsula

Importance B Outstanding Natural Landforms in New Zealand Geopreservation Inventory

NZGPI #	Name	Significance	Description	Locality
3013	Porangahau en echelon sand dunes and cross-cutting strand lines	A rare cross-cutting relationship of a series of en echelon sand dunes and estuarine strand lines.	Embayment is filled with a Holocene ESE-trending relict foredune system	Seaward of Blackhead Road, from Blackhead Point to 1 km south of intersection with Hunter Road
3329	Porangahau melange	One of most extensive and easily accessible exposure	Coastal cliffs and shore platform exposures	Cliffs at south end of Porangahau Beach
511	Te Uri Stream Paleogene holostratotypes	Holostratotype of Teurian, Waipawan, Mangaorapan, Heretaungan and Porangan Stages		Te Uri Stream
489	Tangaruhe Stream Cretaceous foraminiferal fossil locality	Best preserved and most diverse Ngaterian foraminiferal faunas		2 km length of stream course in Tangaruhe Stream
443	Pourerere Miocene microfossils	Horizon with extremely rich, warm-water Waiauian foraminiferal fauna		Intertidal rock platform at Pouanui Point
550	Waipawa Paleogene microfossils	Hypostratotype of Teurian, Waipawan, Mangaorapan and Heretaungan		Outskirts of Waipawa
2152	Tukituki Thrust	Exposure of the range boundary fault of the Ruahine Range.	Greywacke basement thrust over Pleistocene rocks.	Eastern Ruahine Range
1383	Hinemahanga Rocks basalt islets	Part of a continuous sheet of basalt now broken into islets, significant because they are olivine basalt representing MORB currently being subducted under Upper Cretaceous sediments. One of only two known significant occurrences of Red Island Volcanics.	Pillow lavas with interstitial limestones. Local copper mineralisation.	even islets 1 km offshore from Kairakau beach settlement.
449	Pukehou Stream Cretaceous microfossils	Most prolific Haumurian nannofossil and foraminiferal microfauna locality in New Zealand.		Immediately west of Napier-Wellington main road, near small waterfall, 8 km north of Waipawa.
1072	Lake Poukawa Holocene swamp	Rich subfossil bird bones and human occupation deposits. Lake and swamp act as a source of baseflow to feed scenic Pekapeka Wetland downstream.		East of State Highway 2, 20 km south of Hastings.
2131	Te Apiti thrust zones, Waimarama Beach	Excellent exposure of a complex, amalgamated thrust zone system.	Shore platform and coastal cliff exposures of a thrust zone system, representative of accretionary slope structure, on the Hikurangi Margin.	South from Waimarama Beach
1113	Mt Kahuranaki klippe	Physiographically and structurally unique in New Zealand	An allochthonous mass 3 km long, 2 km wide, displaced from hinge of Elsthorpe anticline.	20 km south of Hastings on Kahuranaki Road.
392	Ohara Depression deformed Pliocene fossils	Chlamys delicatula fauna demonstrating large transcurrent fault offset.		Sentry Box Hill, Mangleton Road
1918	Maraetotara Falls historic hydro-electricity power stations	Two of the earliest examples of hydro-electric power generation in New Zealand.	Centred on Maraetotara Falls, an isolated river flowing over thick beds of limestone and sandstone forms the setting for two of the oldest hydro-electric projects in the country.	16 km south of Havelock North

NZGPI #	Name	Significance	Description	Locality
3010	Ocean Beach dune fields, southern Hawkes Bay	The most extensive dune fields on the East Coast of the North Island, outside Northland. The last significant wilderness beach landscape in Hawkes Bay.	Two extensive adjacent areas of sand dunes covering half the coastline, and up to 500 m inland, between Ocean Beach and Cape Kidnappers.	4–10 km north of Ocean Beach settlement, southern Hawkes Bay coast.
351	Milton Road Pliocene macrofossils	A diverse limestone macrofauna including a unique Ross Seal jaw and type locality of <i>Phialopecten triphooki</i> .		Napier, along Milton Road, north face of Napier Hill, facing port.
1260	Ahuriri Lagoon 1931 uplifted seafloor and islet	Small islet from pre 1931 now sitting in the middle of uplifted farmed grassland which was formerly the intertidal lagoon floor.	Former intertidal rocks around the islet contain rock borer holes.	Waputerangi Island, 2km west of Napier Airport.
972	Ahuriri Lagoon uplifted entrance channel fossils	Best illustration of 2.5 m of uplift during the 1931 Napier Earthquake, in the form of in-situ subtidal bivalves (<i>Ruditapes</i>) in life-position in channel bottom gravelly sand now exposed at high tide level.	In-situ bivalves exposed in the low high-tidal bank alongside the present entrance channel into the remnant Ahuriri Lagoon.	North side of entrance channel, adjacent to board walk through uplifted salt marsh, 500 m west of former main road bridge, Napier.
1973	Mt Miroroa thrust and deformed Plio-Pleistocene fauna	An example of northward thrusting in the East Coast deformed belt. <i>Chlamys delicatula</i> fauna demonstrating large transcurrent fault offset and greywacke overthrust.	A large area of Plio-Pleistocene sediments overthrust on greywacke basement	2 km off Napier-Taihape Road
1866	Kaweka Range overthrust	Example of greywacke overthrust onto Tertiary rocks.	Exposure of the overthrust is best seen in Pinnacle stream.	Eastern Kaweka Range.
2527	Matangimomoe earthquake slip	Very large rotational crown scarp preserved from an earthquake initiated coastal slip.		Seaward side of Matangimomoe Trig.
2025	Pohokura Anticline	Example of fault-propagation fold.	Fault propagation fold, with well exposed hinge (V19/405323) showing fold geometry. The structure covers many square kilometers.	Waitere Station, western Hawkes Bay. Hinge exposure in a tributary of the Mohaka River, 3 km south of Pohokura Road.
356	Mohaka River Pliocene section	Continuous sequence with many rich macrofaunas and microfaunas.		Forty kilometres continuous exposure along river bank, accessible by boat only. Road bridge locality given below.
1105	Mohaka River alluvial terraces	A sequence of at least four well defined alluvial terraces recording the various ages of alluvial landforms related to eustatic and tectonic sea level changes.		Extending from mouth of Mohaka River upstream at least 10 km.
1661	Te Awa-Awa synsedimentary slide	One of the most spectacular examples of a synsedimentary slide in New Zealand.	150 m of exposure of a 10 m thick horizon of slump folded and thrust strata in the top of cliffs.	250 m east of Te Awa-Awa Stream mouth, 2 km east of the Mohaka River mouth.
317	Mahia Peninsula tombolo	One of the largest sand tombolos in New Zealand.	Connects Mahia Peninsula to the mainland.	10 km east of Nuhaka, northern Hawkes Bay
2510	Opoutama salt water and gas seep	One of best and most easily accessible examples of natural seeps of saline water and hydrocarbon gas in New Zealand.	Several areas on the flat and lower hillsides with salt water seeps and moss and mud and small pools.	2 km due north of Opoutama township
2529	Opoutama mud volcano and gas seep	One of best examples of a mud volcano on east coast.	Decent mound and bare patches where saline water inhibits pasture growth.	On spur crest above true left side of Opoutama Valley

NZGPI #	Name	Significance	Description	Locality
2575	Kopuawhara mud volcano	One of the best examples of a mud volcano on the east coast.		On east side of Waiau Stream, 800 m south of Kopuawhara disaster memorial, 2.5 km north of end of Kopuawhara Road.
1873	Kopuawhara flood disaster site	Site of the largest loss of life during a flood, in New Zealand.	Site of No.4 Public Works Department construction camp (for the Napier - Gisborne railway), swept away in a flood in February 1938, with the loss of 21 lives.	12 km north of Opoutama.
1090	Mangapoike cuestras	One of few examples of cuestras in the North Island. There are at least three distinct cuestras.		Confined to an area between State Highway 35 and 10 km to the east, in northern Hawkes Bay.
2260	Mangapoike River Pliocene section, Wairoa	Excellent exposure through limestone. Lectostratotype of Opoitian Stage in New Zealand.	Unconformity exposed where 5 m-thick Waipipian limestone overlies 400+m-thick late Opoitian limestone, forming top of the section of the opoitian Stage.	Haupatanga Gorge, Mangapoike River, tributary of the Wairoa River.
1078	Lake Waikaremoana	The largest debris-dammed lake in the region. A scenic lake with original vegetation and no erosion.		60 km NW of Wairoa on State Highway 38.
2632	Mokau Falls	Spectacular waterfall over near horizontal bedded Miocene sedimentary rocks. Tourist attraction on Lake Waikaremoana Rd.		Flows under road bridge and over falls at head of deep amphitheatre.