BEFORE THE TASMAN DISTRICT COUNCIL

IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	Resource Consent Applications RM150576 and others
BY	Harakeke 2015 Limited
	Applicant

EVIDENCE OF IAIN BRUCE CAMPBELL

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1 My name is Iain Bruce Campbell and I am a soil scientist and have worked as such for more than 50 years. I initially worked for the New Zealand Soil Bureau Division of the DSIR and for the past 25 years I have worked in a private capacity (Land & Soil Consultancy Services) as a research scientist and consultant, undertaking soil mapping and soil sampling within the Nelson and Marlborough Districts. I hold the degrees of B Sc. and M Sc. Hons in geology and D Sc. in Soil Science.

2 I have read the Code of Conduct for Expert Witness Court Practice Notes 2014. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from opinions expressed.

INTRODUCTION

3 At the request of Harakeke 2015 Limited, an examination of the soils of 169ha of land at Tasman in the vicinity of Horton Road, Marriages Road and Aporo Road was undertaken during August and September 2014 as part of a land evaluation for this rural subdivision proposal.

4 The area comprises three blocks of land (17 titles) with a broadly similar topographic configuration and forms part of the geomorphic feature known as the Moutere Depression *(Campbell & Johnston 1992).* The Moutere Depression is a lowland area that extends from the Nelson Lakes to Tasman Bay and it comprises a thick deposit of outwash gravels, the Moutere Gravel Formation, which dates from Late Tertiary time. Subsequent land forming processes have resulted in an intensively dissected landscape dominated by ridges and gullies, with deep weathering into the underlying gravels. The veneer of surface soil on the Moutere Gravel Formation in the northern part of the region comprises the Mapua soil type, which was first defined in the survey of the soils of Waimea County *(Chittenden et al. 1966).* Within the Mapua soil landscape system, valley floors have been infilled with alluvium that is derived from erosion of Moutere Gravel materials and the overlying Mapua soils, and the soils mapped on these valley floors have been identified as the Braeburn soil type in the Waimea County survey.

5 The soil examination at Tasman consisted of three parts; the first a general land examination to confirm the main landscape units with which the soils are intimately related, the second a detailed appraisal of the soil and topographic relationships and an assessment of the soils and soil properties from 112 soil auger observations across the range of slope and aspect classes within the principal landform units, and the third, a detailed examination of representatives of the soil types that were identified, from 20 deep pits, that were located to illustrate the main soil variability found across the area.

6 The soils were described according to criteria set out in manuals that give the designated standards for soil description within New Zealand. (*The Soil Description Handbook (Milne et al. 1995)* and the *New Zealand Soil Classification (Webb and Lilburne 2011).* Key elements for the present soils examination are the criteria for the soil drainage classes, depth of soil to the underlying Moutere Gravel material and soil physical properties that are related to permeability and plant root penetration. Soil slope is an important accessory criterion as it is closely related to erosion susceptibility and also practical aspects of land management.

SOILS

7 The survey revealed that 5 distinct groupings of soils are present within the area examined, as shown on the accompanying soil map (Sheet H2 GB). They are Mapua soils (map symbol Mp, brown colour on the soil map), Mapua Hill soils (map symbol MpH, brown colour on the soil map), Mapua X soils (map symbol MpX, light blue colour on the soil map), and Braeburn X soils (map symbol BnX, dark blue colour on the soil map) and Anthrophic soils (map symbol An, dark blue on the soil map). The numbers that are shown on the soil map are the locations of the auger observations (+) and soil inspection pits (▯). Detailed descriptions and images of the soils that were examined in the inspection pits are given in the Appendix.

Mapua soils (Mp)

8 As shown on the soil map (Sheet H2 GB), the Mapua soils cover 110 ha or 65% of the area and occur on the flat to gently undulating (0-3º), undulating (4-7º) and rolling land (8-15º) of the dissected Moutere Gravel Formation landscape (Sheet H5 of the graphics bundle). The predominant aspect for Mapua soils is between northeast to northwest (Sheet H6 GB) (56%), the remainder having a west or easterly aspect with a smaller proportion lying between east and southwest.

9 Mapua soils in the Harakeke 2015 Limited property are typical of the Mapua soils found elsewhere in the region. Topsoils are weakly structured and moderately deep (average 18cm), while textures range from sandy loam to clay loam. The subsoils have clay, clay loam or sandy clay loam textures with mottle patterns (brown and grey colours) within the upper 20-80cm of the soil profile that indicate periods of oxidising and reducing conditions due to slow movement of water through the soil. The soil drainage class is moderately well drained. A few stones may be present through the soil profile and these are commonly residual, hardened, or oxidised relic clasts, remaining from the initial gravelly parent material. The subsoil has a predominantly medium to coarse blocky structure (sometimes weakly prismatic) that is firm to very firm, dense and with few fine pores, consequently moisture and root penetration are restricted and largely occur along the planes formed by the soil aggregates. Shrinkage during summer drying allows roots and colloidal material (fine clay and organic matter) to penetrate to moderate depths in the subsoil but swelling during wet periods reduces the penetrability and restricts drainage. The deeper subsoil (average depth 70cm) comprises *in situ* weathered Moutere Gravel material. This is generally only weakly structured or structureless and less compact than the overlying clayey subsoil. The textures are sandy clay to sandy clay loam, reflective of original character of the Moutere Gravel material and physically, the material has a pattern of coarse mottles that is related to weathering of the stones. The stones are usually completely altered while commonly retaining their original shape and identity (termed ghosts).

10 Across the landscape, the properties of the Mapua soils vary. Topsoil thickness ranges from 9-25cm due to erosion and over-thickening from down slope sediment movement. The intensity of mottling also varies across the landscape, mainly in relation to topographic differences, but only occasionally result in a change in the soil drainage class. The depth to underlying weathered Moutere Gravel was found to vary from between 40cm and 110cm, with the effective rooting depth varying by the same range.

The versatility rating of the Mapua soils is classed as moderate to low versatility (class 2-3 Table 1).

Mapua Hill soils (MpH)

11 Mapua Hill soils cover approximately 2 ha and are separated from Mapua soils solely on the basis of slope (strongly rolling, downlands hill country 16-20º, moderately steep, hill country 21-25º *Lynn et al. 2009).* Slope is a significant factor in assessing soil versatility since it restricts the use of machinery for crop management while the risk of erosion is significantly increased.

12 Mapua Hill soils were found to differ little from Mapua soils in respect of their physical properties except that topsoils were thinner (average 15cm thickness) while the thickness of soil over weathered Moutere Gravel was less than elsewhere and averaged 63cm. The influence of increased slope and erosion risk and somewhat shallower rooting depth result in Mapua soils being assessed as having a low soil versatility rating (class 3-4 Table 1).

Mapua X soils (MpX)

13 Mapua X soils were identified as the soils on toe slopes (predominantly flat to gently undulating 0-3º slope class) and gully bottoms (undulating 4-7º slope class) of the dissected Mapua soil landscape system. The toe slopes are broad while the Mapua X soils in the gully bottoms are narrow, sometimes less than 10m wide. The soils on these surfaces have a significant soil drainage impediment (imperfectly to poorly drained class) and probably remain wet throughout the winter months. They occupy 28 ha in the Harakeke 2015 Limited survey area.

14 In the early survey of the Soils of Waimea County, soils with imperfect to poor drainage within the Mapua soil landscape system were not identified. Recent work by Landcare Research elsewhere within the Mapua soil landscape system has separated imperfectly drained soils on Moutere Gravel materials as Neudorff soils *(Landcare Research S-map soil report).* As at present no definite correlation with the soils identified elsewhere as Neudorff has been made, so for the present investigation, the imperfectly drained soils in the Mapua soil landscape system at the Harakeke 2015 Limited property are referred to as Mapua X soils.

15 Mapua X soils resemble Mapua soils but differ in that they commonly having a weakly developed brownish sandy loam topsoil of variable thickness (range 15-60cm) overlying a blackish buried former topsoil, The upper brownish soil horizon represent sediments that have accumulated on the lower lying surfaces, being derived from erosion of the soils on the slopes above. It was recorded in 60% of the observations of Mapua X soils and thus gives an indication of the widespread extent of past soil erosion and movement of sediment from the higher to the lower surfaces under early land use management. The underlying clayey textured subsoil is characterised by extensive grey or whitish and brown mottling indicative of the imperfect soil drainage class. A watertable was present in many of the observation sites at the time of inspection.

16 Compared with Mapua soils, the versatility of Mapua X soils is restricted by the imperfect soil drainage, with longer periods of soil wetness and waterlogging also restricting trafficability and workability. Indications of these conditions were given by

extensive stock pugging that was observed at the surface of these soils in some places. Mapua X soils are assessed as having a low versatility (class 3-4, Table 1).

Braeburn X soils (BnX)

17 Braeburn soils were first identified in the 1966 soil mapping of Waimea County as soils on valley floors associated with the Mapua soil landscape system. They occur chiefly in the Moutere Valley but are present in other smaller valleys. These soils have formed from alluvium derived from weathering and erosion of Moutere Gravel materials and the Mapua soils. The fluvial systems on these valley floors are complex and include sediments of differing ages, textures and drainage characteristics hence, wide variations in the mapped Braeburn soil class can be expected. Two soil types identified in the Waimea County soils report were Braeburn clay loam and Braeburn sandy loam. Although they are described as being strongly and moderately gleyed and said to be poorly drained, the extensive use of these soils in the Moutere Valley for agriculture and horticulture, together with a few recent observations, suggests that the drainage class for Braeburn soils as described may be imperfectly to moderately well drained. Poorly drained soils within the Harakeke 2015 Limited survey area are probably atypical and are therefore distinguished from Braeburn soils as Braeburn X soils.

18 Soils on the alluvial surfaces within the Harakeke 2015 Limited property cover 27 ha on flat to slightly undulating land that is poorly drained. The watertable fluctuates and at the time of observation was at or close to the surface, with surface water persisting after periods of rain. The watertable lowers to variable depths over drier months. Below the topsoil, Braeburn X soils are characterised by predominantly white to grey subsoil colours resulting from prolonged reducing conditions. Reddish coloured mottles at variable depths and sometimes with dark brown concretions forming an indistinct iron pan may be present. The soils vary considerably with buried topsoils and textural variation in places indicating additions of alluvium from recent flooding events. With the poor drainage, low permeability and nutrients, low trafficability, low workability and waterlogging status and the flooding potential, Braeburn X soils are assessed as having low soil versatility (class 3-4, Table 1).

Anthropic soils (An)

19 Anthropic soils are soils that have been formed by direct human activity with mixing of soil materials resulting in loss of their original character, The soils identified as Anthropic on the Harakeke 2015 Limited property occupy 1.5 ha near Marriages Road and have been formed as a result of the excavation of soil and subsurface materials when a water storage pond was created, the excavated materials being spread over adjacent land. The Anthropic soils have a thin (<10cm) weakly developed gravelly topsoil with subsoils comprising mixed greyish and brownish gravelly silt loam over compact gravel. Disturbance and replacement of soil materials typically results in loss of natural soil properties and these soils are assessed as having a low soil versatility (class 3-4 Table 1).

SOIL/LAND SUITABILITY ASSESSMENT

20 The purpose of land evaluation is to rate the quality of the land and soils within an area to provide an objective basis for land use decisions. In the past, Land Use Capability (or LUC *NWASCO 1979)* has been used with assessments made within an eight-category system. However, the criteria used in this system are poorly defined and a limited number of attributes were used in LUC assessments.

21 The concept of using soil versatility as a means of rating arable land was advanced by *Molloy, (1988)* who proposed ten specific soil criteria to distinguish soils and land within specific classes. A highly versatile soil is one that is capable of growing a wide range of crops suited to their particular climate while on a soil with low versatility, the range of uses are restricted due to unfavourable soil properties. A similar approach was utilised by *Agriculture New Zealand (1994)* in a *Classification System For Productive Land In The Tasman District* with the soils of the region being assigned within an eight-class system similar to that of the LUC. Under this scheme, Mapua and Braeburn soils were assigned to class B, as suitable for semi-intensive horticulture.

22 A comprehensive system for the evaluation of land was proposed by *Webb and Wilson (1995)* and included a set of parameters with critical values used to define class limits for suitability/versatility. They included topography, potential rooting depth, effective rooting depth, soil penetration resistance, profile available water, soil wetness, topsoil strength, stoniness, soil nutrient content, erosion severity and flood return interval. Climatic factors were also included for consideration when making regional assessments. Relative ratings are derived through ranking the various qualities in relation to one another in order to determine the suitability/versatility ratings. Accurate ratings however require physical laboratory measurements for some of the qualities.

23 The soil versatility ratings for the soils on the Harakeke 2015 Limited property are shown in Table 1, the criteria used for the ratings being similar to those outlined by Webb and Wilson with each property assessed on a 5 point scale.

24 In recent soil surveys in the Takaka Valley and on the Waimea Plains, soil versatility has been evaluated using the parameters listed in Table 1 and two soils from these areas, the *Rameka soil in Golden Bay* and the *Waimea soil on the Waimea Plains* are included in Table 1 to provide a guide for comparing the soils on the Harakeke 2015 Limited property. These recent soil surveys have shown that there is very little soil that can be categorised as highly versatile (0-1 class) within the Nelson region and that the majority of the soils on the Waimea Plains fall within the second class (1-2 moderate to high versatility). Soil versatility assessments do not take into account economic factors as these can change quickly depending on demand for specific crops. A low versatility rating does not exclude a soil being used for some specific productive use, but it usually indicates that more expensive or technical measures may be required in order to achieve a productive level that would be considered satisfactory.

RESPONSE TO SUBMITTERS

25 It was observed in the 21 objector statements concerning the loss of productive land that one objector (1) considered that the development would not impact on productive

loss, while another objector (72) considered that the assessment of productive land is not comprehensive and that more detailed analyses, including mapping was required.

26 The soil survey, which included 112 recorded auger observations and 20 recorded detailed examinations from deep pits gives an observation frequency of one observations per 1.28 ha. Along with numerous unrecorded observations and also terrain analysis from aerial photos, this provides an ample basis for what would be described as a detailed soil survey. It is unlikely that additional field observation s would significantly change the resolution of the soil pattern. Neither would any additional data analysis (or chemical analyses) provide further useful insight into the productive assessments of the soils.

COMMENT ON LAND PRODUCTIVITY REPORT BY TASMAN DISTRICT COUNCIL

27 There are three issues in the Tasman District Council Land Productivity Report that will be addressed. These are the land productivity classification, the 1994 Classification system of Productive Land in Tasman District and the 2011 review of the 1994 TDC Land Productivity report for the Mapua soils.

28 As stated in paragraph 23, my assessment of the soils was based on the work of Webb and Wilson (1995) who outlined a list of characteristics for the evaluation of rural land. They state that 'no single classification can have universal applicability for all rural uses, as specific land uses require specific classifications.' This is a statement which I think all soil scientists would readily agree with. Webb and Wilson list a number of soil properties for use in assessments, these being capable of being evaluated on a points scale. They also list a number of other attributes (for example, soil temperatures, frost severity, frost free period, growing degree days, cool-season requirements, sunshine hours, soil water deficit/surplus) which are not soil properties, so their classification system is a *land classification system*, not a *soil classification system.* Mr Bealing has added additional land related information over the soil pattern and thus produced a *land classification* for the Harakeke property.

29 The system that I have employed is strictly a system for grouping soils on the basis of their observable *soil limitations* and it differs from the Webb and Wilson proposal in aggregating and averaging the assigned scores for key soil properties. This approach is robust and more useful than just providing a list of evaluated soil properties, because the class limits are defined and the rankings for individual soils are consistent. Faced with a list of soils with a range of known and defined limitations, how does one go about assigning the soils into specific land use classes? Without defined parameters, the judgements become subjective and often coloured by what crops are seen to be growing at the time. In my opinion, land evaluation should be multi-stage process of which the soil evaluation is just the first step.

30 The 1994 Classification system of Productive Land in Tasman District is a document that was prepared very much as a desk exercise and on a limited budget. It has been an important document for the TDC in that it provided some consistency around the land management issues with which they have to deal. However, the compilation of this land classification was based on limited published soil information, most of which was a

generalised scales (1:250,000 and 1:125,000 1960 soil maps) with little supporting technical details about soil properties and it relied heavily on undocumented local knowledge of the authors. Complementing the soils information were various other attributes pertaining to land (for example, altitude, climate, rainfall, length of growing season etc.) with the designation of the various classes to some extent being influenced by what was seen to be practicable for a range of land uses at the time. The Mapua soils, with their obvious capacity for production of non-cultivation type tree or vine crops etc. were included in land class B.

31 Detailed soil surveys of arable lands in the Takaka Valley and Waimea Plains since 2005 have been carried out for the TDC during the course of which I have made observations from more than 7000 sites. This systematic collection and recording of data has allowed a comprehensive evaluation of the soils to be made and has provided a much clearer picture of the soil properties that impact on soil versatility and productive capacity in this region. In Table 2 of my evidence, the difference between two alluvial soils and the Mapua soil at Harakeke Properties is illustrated and shows that the impediments in the Mapua soil are significantly greater than for the soils in the other two classes.

32 The listing of the Mapua soil in the third category (moderate to low versatility) does not in any way diminish the importance or significance of this soil within the Nelson District. The classification expresses what is obvious from the land use history; that the Mapua soil type is unsuitable for intensive use for a wide range of horticultural uses but is well suited for intensive use for a narrower range of horticultural crops. Unlike the extensive areas of deep loamy soils of Canterbury, Southland and the volcanic lands of the North Island, soils that can be grouped in the first category (highly versatile) are rare in the Nelson region, so the Mapua soils assume a greater significance in respect of the regions land resources.

33 The 2011 review of the Land Productivity Report by Landcare Research for the TDC does not appear to be based on any new soils information, it did not consider soil properties and it made no comparisons with other soils in the district. It was based mainly on LIDAR (radar images that produce accurate ground surface definition) which gave a very detailed picture of the differing slope classes for the Mapua soils. LIDAR data was also used to produce a soil temperature zoning within the area that was studied with two soil temperature classes being differentiated. The report recommended that there be a subgroup of soils classed as B in the TDC 1994 Landuse (Class B') which encompassed soils with poor drainage.

SUMMARY

34 Five separate soil groupings were identified and mapped on the 169 ha Harakeke 2015 Limited property near Tasman. The predominant soil is the Mapua type (65% of the area), which although varying to some degree due to topography, was assessed as having a moderate to low versatility (class 2-3) for arable use. Two of the soils that are identified (Mapua X and Braeburn X) have similarities with, but differ from the established soil types, but as there has been no formal correlation, they are not given separate names. These soils are assessed as having a low versatility (class 3-4) for arable use. A small area of soil is classed as anthropic and has been formed through human

disturbance. The assessments of soil versatility provide a measure of the relative value of the soils for arable use.

REFERENCES

Agriculture New Zealand 1994. Classification system of productive land in Tasman District. Contract report prepared for Tasman District Council by Agriculture New Zealand MAF, Richmond, Nelson.

Campbell IB, Johnston MR. 1982. Nelson and Marlborough. In: Landforms of New Zealand *Eds*. Soons JM, Selby MJ. Longman Paul Ltd. Auckland. 392p.

Chittenden ET, Hodgson L. Dodson KJ 1966. Soils and Agriculture of Waimea County, New Zealand. NZ Soil Bureau Bulletin 30. 66p.

Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF, 2009. Landuse capability handbook- a New Zealand handbook for the classification of land 3rd ed. Hamilton, AgResearch; Lincoln Landcare Research; Lower Hutt, GNS Science. 163p.

Milne, JDG, Clayden B, Singleton PL, Wilson AD. 1991. Soil description handbook. Lower Hutt, DSIR Land Resources. 133p.

Molloy L. 1988. Soils in the New Zealand Landscape; The Living Mantle. Mallinson Rendel Publishers Ltd. Wellington New Zealand. 239p.

National Water and Soil Conservation Organisation (NWASCO) 1975-1979. New Zealand Land Inventory Worksheets: 1:63 360. Wellington, National Water and Soil Conservation Organisation.

S-map Soil Report. October 2014. Landcare Research Manaaki Whenua.

Webb TH. Lilburne LR. 2011. Criteria for defining the soil family and soil sibling: the fourth and fifth categories in the New Zealand Soil Classification. Landcare Research Science Series 3. Manaaki Whenua Press, Landcare Research. 38p.

Webb TH, Wilson AD, 1995. A manual of land characteristics for evaluation of rural land. Landcare Research Science Series 10 32p.

APPENDIX 1

Detailed soil descriptions from excavated pits.

Table 1 Soil versatility ratings for soils in Harakeke 2015 Limited Property, with assessments for two other soils (Rameka and Waimea) in the Nelson region for comparison.

Soil Name	*Rameka*	*Waimea*	Mapua	Mapua Hill	Mapua X	Braeburn X	Anthropic
Topography	1	1	2	4	2	1	1
Drainage	1	1	2	2	3	4	3
Profile available water	1	1	2	3	2	3	4
Permeability	1	2	3	3	4	4	4
Stoniness	1	1	2	2	2	2	4
Effective rooting depth	1	1	3	3	3	4	4
Trafficability	1	2	2	5	4	4	3
Workability	1	2	3	5	4	4	3
Waterlogging	1	1	2	1	4	4	3
Nutrients	1	2	4	4	4	5	5
Erosion/flooding	1	1	3	4	2	3	1
Average Score	1	1.4	2.5	3.3	3.1	3.5	3.2

1 **Highly Versatile**
1-2 **Moderate to High Versatility**
2-3 **Moderate to Low Versatility**
3-4 **Low Versatility**
>4 **Non Versatile**

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