7 December 2021

Fiona Morton
Senior Consultant Planner
Horizons Regional Council
Private Bag 11025
Manawatū Mail Centre
PALMERSTON NORTH 4442

fiona.morton@horizons.govt.nz

Dear Fiona

Application APP-2020203164.01 – Grenadier Limited, 765 Muhunoa West Road, Ōhau

We refer to previous correspondence requesting clarification of ecological information and further iwi consultation and archaeological input for the above application.

Please find attached the further information agreed at the meeting between the Applicant's ecologist, coastal geomorphologist and hydrogeologist and Horizon Regional Council's (**HRC**) ecological consultant of 2 November 2021.

We enclose:

- Boffa Miskell memorandum dated 22 November 2021 providing details of (a) vegetation plots and (b) detailed katipo spider searches in specified areas;
- Joint memorandum dated 2 December from Boffa Miskell ecologists and the golf course construction manager relating to the potential effect of nutrient enriched water into identified wetlands; and
- Bay Geological Service Limited letter dated 2 December 2021 providing data and assessment of the hydraulic gradient across the project area.

In relation to the agreed skink survey work, we understand the project ecologist, Dr Keesing of Boffa Miskell, will report directly to HRC's consultant ecologist on the findings of those surveys once complete.

We have been in touch with the project archaeologist (Mary O'Keefe). Mary has considered your letter and provided her opinion that it is important to seek an archaeological authority when the conditions of resource consent are known. The archaeological report has been written in an integrated way covering both RMA and Heritage NZ legislation.

The Applicant's cultural advisor has been in touch with Mr Fryer and the applicant has made significant efforts in further iwi consultation, including engaging with the parties listed in your letter dated 29 October 2021. This consultation is on-going and we will report on the results of this once further meetings have been conducted.

We trust the attached information resolves the relevant outstanding issues and will provide the residual information (relating to iwi consultation and the agreed skink survey) in due course.

Yours sincerely

LAND MATTERS LIMITED

Tom Bland
Senior Planner
Tel: 021 877 894
Email: tom@landmatters.nz

Boffa Miskell

Memorandum

☐ **Auckland**
PO Box 91250, 1142
+64 9 358 2526

☐ **Hamilton**
PO Box 1094, 3240
+64 7 960 0006

☐ **Tauranga**
PO Box 13373, 3141
+64 7 571 5511

☑ **Wellington**
Level 4
Huddart Parker Building
1 Post Office Square
PO Box 11340, 6142
+64 4 385 9315

☐ **Christchurch**
PO Box 110, 8140
+64 3 366 8891

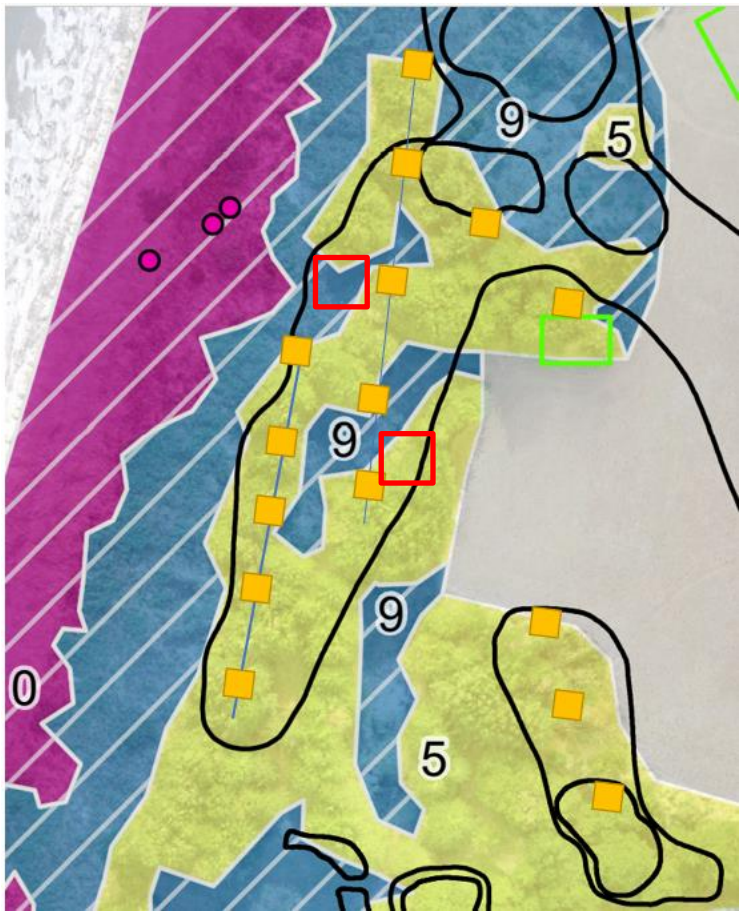
☐ **Queenstown**
PO Box 1028, 9348
+64 3 441 1670

☐ **Dunedin**
PO Box 657, 9054
+64 3 470 0460

Attention:	Bryce Holmes – For Grenadier Limited
Company:	Grenadier Limited – C/- Land Matters Limited
Date:	22.11.2021
From:	Dr Vaughan Keesing

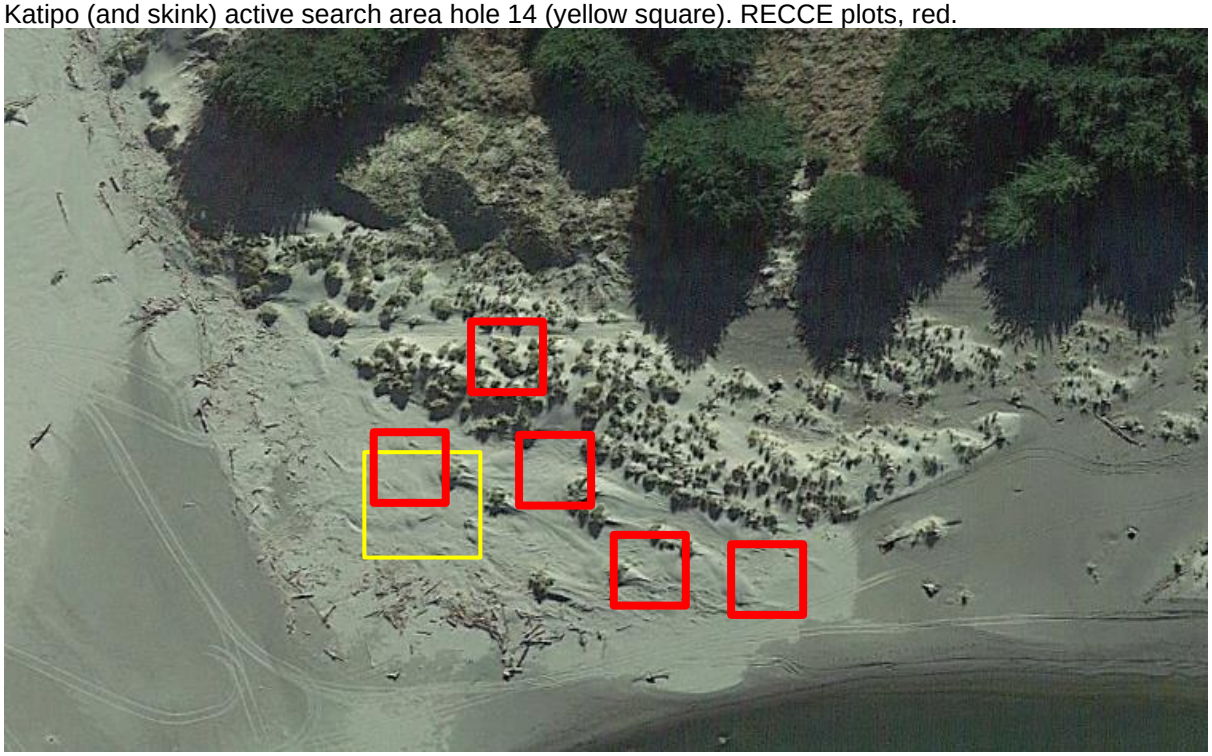
This memorandum has been prepared for the benefit of the project team and technical reviewers for the ecological information for activities involved with the Douglas Links Golf Course proposal. It has been provided to build on and add to the knowledge base in our earlier reports and also the Horizons site visit report following an inspection in June 2020. That Horizons report helpfully mapped general areas (desktop mapping) that may be considered Schedule F areas. The report noted the assessment was not comprehensive and, because the mapping was desktop, the reviewer has asked that specific data be collected by plot so that the schedule F mapping is more specific. This memorandum provides further data and builds upon earlier reports by Horizons and Boffa Miskell.

In discussion regarding the various reports and data on specific areas of the AEE, and in regard to schedule F boundary and ecological values for the proposed Ohua golf course, there was an agreement during our last constructive meeting with Horizons ecological reviewer that 15 vegetation 10mX10m RECCE plots would be undertaken in areas of Council reviewer's concern in regard to the BML's schedule F (horizons one plan) boundary (which was noted then as a precautionary line). And in terms of the presence of katipo in the knobbly rush and hole 14 "active" dune areas. These areas were to receive detailed searches (20m by 20m areas at three locations - two in hole 17 area and one in hole 14 area). The agreed work was laid out in the following maps:



Orange squares represent RECCE plots, red squares katipo searches.

Katipo (and skink) active search area hole 14 (yellow square). RECCE plots, red.



The above photo does not represent the current vegetation and the plots the proposed golf extent – The following is a better determination of area involved in the search and the proposed hole 14 area.

The following map shows the actual survey undertaken at hole 14.

Survey and Results

On the 18th November 2021 during fine weather, two BML ecologists went on site and undertook the agreed katipo searches and RECCE plots in the agreed areas. They used ARCGIS maps and ipads with GPS capabilities to ensure they were searching and undertaking plots in the correct areas. Photos were taken to visually show results.

Hole 14

Hole 14 was initially and precautiously mapped as “active dune” because at the scale of mapping undertaken. The edge of the proposed hole however, was initially reduced and moved inland purposefully to avoid the active sand and spinifex areas. What was not evident on the mapping is that the areas actually involved were weed dune slacks. Plots 1-5 (Table 1) represent the vegetation cover of the proposed hole. All of the plots (and indeed the area as a whole) is dominated by lupin over hairtail. The proportion of native plant cover is Ca 1% and there are plentiful weed species. The vegetation bears no resemblance to the predominantly native foredune further out. Photo 1 illustrates the lupin and the boundary of the hole proposed. There is also a modicum of rubbish present in the form of an old couch, bottles and Styrofoam boxes etc in the lupin.

The two 20mX20m grid fauna searches were undertaken and involved searching between 40 and 60 specific habitat cover items (driftwood and human refuge) and 40 lupin basal stems in each grid. No katipo were found in the affected area but two katipo were found in drift wood outside the area adjacent to an old stove and other rubbish to the east. These areas are not subject to any proposed activities and will be unaffected by the proposal. We note their presence for completeness.

Figure 1. Hole 14 encompasses only the lupin and hairs tail area adjacent to the macrocarpa canopy.

Figure 2. The comparison between the active dune and natural vegetation and the back hollow full of lupin.

From these data, we are able to more accurately map the vegetation and have taken this opportunity to do so as a section 92 response and this vegetation map supersedes the AEE map. The vegetation is not active dune but 6a exotic scrub (lupin).

This area has negligible to low ecological value with limited habitat value and no indications of any at risk or threatened species. The grid searches did not uncover any skink species or katipo despite the season and weather being conducive for active searching to uncover any.

The entire loss of this small area given the extent of similar exotic shrub and shrub site wide can be viewed as a low magnitude of effect to a low or negligible value habitat resulting (EIANZ 2018) in a very low level of effect - or a much less than minor effect.

Hole 15

This short hole was shown to be in type 5, macrocarpa (as a tall and expansive canopy), and the reviewer voiced a concern about a lack of evidence as to the under story in this community. The plot data was requested to factually determine any Schedule F values and areas.

The AEE stated that the under tier was: "*The groundcover was largely bare, open ground with dropped branches and leaf litter from the macrocarpas, otherwise very sparse.* " - "*Under the canopy very little vegetation was present, with no subcanopy species and varying degrees of cover from New Zealand spinach, more prominent toward the dunes, occasional diversity of Asplenium sp. (A. appendiculatum, A. flabellifolium, A. flaccidum, A. oblongifolium, and A. polyodon), low Coprosma repens, houndstongue (Microsorum pustulatum), Paesia scaberula, Glen Murray tussock* [*Carex flagllifera*]*, and shaking brake (Pteris tremula) were present, rarely scattered throughout, more condensed toward light edges*." and,

"*Where macrocarpa met the margins of grassland, there were pockets of silver poplar over rank grass and gorse, with occasional kānuka seedlings, lucerne, tree lupin, and pampas grass. Where macrocarpa met stable duneland communities, native spinach, knobby clubrush, lupin, Gazania sp. and Arctois stoechadifolia were present. The community is growing on duneland sands but is almost entirely exotic*".

The plots 6-9 (Table 1) undertaken in the area show the accuracy of the AEE (i.e. very accurate). The great majority of macrocarpa and pine canopy areas are largely barren underneath with occasional ferns and very sparse beach spinach. While the spinach is an “At risk” naturally uncommon (EF, SO, Sp) (extreme fluctuations, secure overseas and sparse) species ,under the EIANZ protocol a species with an at risk status other than declining has a “moderate value” – despite the spareness of the spinach under the 90-100% cover of the macrocarpa (and the only reason it is on site is the canopy cover) this moderate value does not raise the habitat value above low.

The data in the AEE and now in plots 6-9 reinforces that this area cannot be identified as a Schedule F area.

Figure 3 Under pine and macrocarpa canopy, little vegetation in the ground and middle tiers.


.0

Figure 4. A small are of hounds tongue under the dense pine canopy.

Figure 5. A slight canopy opening allows boarder panic grass and flat weeds and occasional shining spleenwort and hanging spleenwort and hounds tongue fern.

While on site (at both hole 15 and 17) we also undertook some plots in the ”Type 9” blue areas of the initial vegetation map, called knobbly club rush areas. We did this because it was clear that the initially assessment areas had been done so on a precautionary basis and had tried to reflect to a degree in favour of the native back dune components. With plot data it became very evident that in many areas knobbly club rush was not a prominent component of much of these dune hollows between macrocarpa covered dune

ridges. Some areas were almost exclusively exotic grass and lupin. Plots 9, 11, 13, 15 show the vegetation cover of these inter ridge hollows. Using the 20/50 dominance protocol these communities are best described as exotic grasses and lupin and only the community of plot 17 (80% knobbly club rush) is in fact the valued back dune native rush community). Plot 13 represents a knobby club rush lupin pasture mix.

Figure 6. A lotus/ Yorkshire fog dune hollow (Plot taken here)

Hole 17

This longer area of macrocarpa and pine with dune hollow areas of “knobbly club rush” is described in the AEE accurately and again here by plots 10-17. The macrocarpa ridges are accurately described and as Hole 15 are largely bare ground or heavy pine needles and occasional a small carpet of hounds tongue and sparse beach spinach. As Hole 15 we have adjusted the mapped vegetation to take better account of the plot data results. This has resulted in removing several of the small dune hollow “knobbly rush” areas which are better reflected by exotic grasses, lupin, blackwood, Pampas etc.

Two 20m by 20m grids were searched, one in community type 5 and one in type “9”. There was no habitat opportunity in type 5 (under macrocarpa). There was very little to no woody debris or other refugia and searching was a crawl through the grasses and lupin searching bases of tussock grasses and lupin. The community 9 search took 1 hour. There was no sign of katipo or lizards.

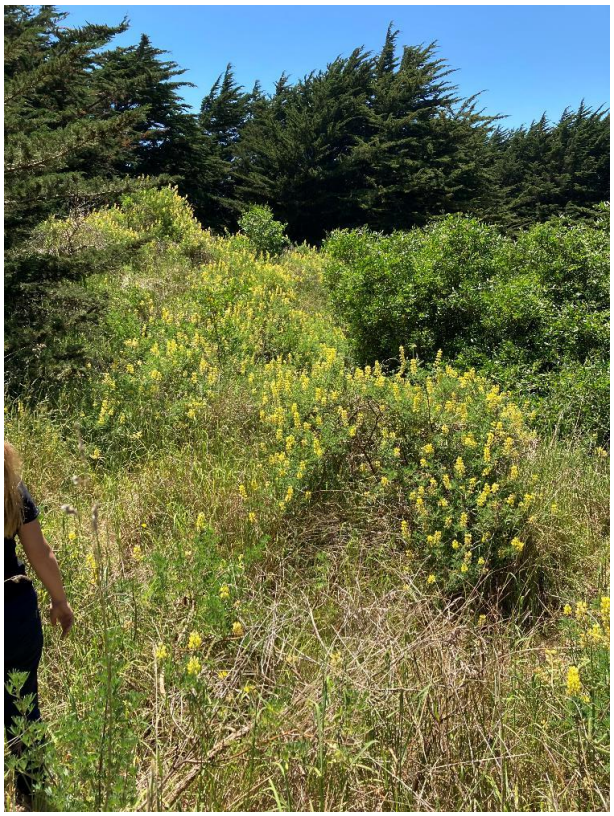


Figure 7. Initially referred to as knobbly rush but actually dominated by lupin and exotic grasses

Figure 8. Occasional beach spinach under macrocarpa and bare spoils

Figure 9. Initially referred to as knobbly rush dune hollows but actually mostly exotic grasses and lupin

Figure 10 Typical cover under the dominant macrocarpa/pine campy for much the dune ridges.

Figure 11. A rare Hounds tongue cover under macrocarpa.

Figure 11. Knobby rush dune hollow

Table 1 RECCE plot data

				Hole 14 -active dune area					Hole 5				Hole 17							
Plant taxa in plots		Conservation status	exotic/native	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
beach spinach	Tetragonia tetragonoides	At Risk – Naturally Uncommon	N							3			1		5					
blackwood			E											2		5				
cocksfoot			E											40		10		5		10
Cleavers			E													1				
crested dogs tail			E											20				1		
dandelion			E	10	5	10	5	2		2				2		5		3		1
fleabane	Conzya sumattensis		E	2	1	1	1	1		1										
hairs tail			E	20	40	20	30	20		1						5				
hanging spleenwort			N						1	2								2		
hawkebit			E	1	1	1	1	1												
hounds tongue fern			N						3	10				1				60		80
knobbly club rush			N	0	1	5	2	1		1						30		5		
lotus			E	1	0	0	0	0				70								
lupin			E	40	60	70	70	70				1		30		20				10
macrocarpa			E						90	95	95	0	100		100					
marram grass			E	5	0	1	1	1												
moss			N											10						
night shade	Solanum chenopdioides		E	0	1	0	0	0		1										
pampas			E	0	1	0	0	0												
pine			E				10													
pohuehue	mue complexa		N											1						
purple groundsel	Senecio elegans		E	3	0	1	1	1		1										
radiata pine			E																	

ragwort			E							2										
Rautahi	Carex geminata		N									1								
sand bindweed			N	1																
Glen Murray tussock	Carex flagellifrea		N																	
shining spleenwort			N						2					1				10		
silver poplar			E						1											
boarder panic grass	Entolasia marginata		E							10								5		
tall fecue			E	0	0	0	5	0				5				15				
tall oat grass			E	0	0	0	0	1						2						
taupata			N																	
vetch			E															1		
Yorkshire fog			E									40								
bare unvegetated surface				17				2	94	66	100		99		95	10	100	10	100	
			cover sum	100	110	109	126	100	101	100	100	117	100	109	100	101	100	102	100	101
			proportion native (%)	1	1	5	1.6	1.0		47		1	1	12	5	33		75		79
			proportion exotic (%)	99	99	95	98.4	99		53		99	99	88		67		25		30
			cover canopy	0	0	0	0	0	90	95	95	0	100	0	100	0	100	55	100	0

Table 2 Dominant vegetation cover descriptions

Plot numbers	1-5	6-8	9	10	11	12	13	14	15	16	17
20/50 plot dominance	lupin/hairs tail	bare ground	Lotus/ Yorkshire fog	bare ground	cocksfoot/lupin/crested dogs tail	bare ground	knobbly club rush/lupin	bare ground	hounds tongue fern	bare ground	knobbly club rush

Out comes and conclusions

Community 5 was presented well in the AEE and is not representative in canopy or middle or ground tier of the expected native dune ridge and dune hollow communities. This is unsurprising given the extensive long-term levels of modification. These areas do not fit schedule F criteria for while they have the geo-morphology of dune and dune hollow, they do not have the appropriate native vegetation of those communities, and are and will continued to be outside of the schedule F boundary. Furthermore, the plot and photo data show that the areas within the wider type 5 which were initially labelled type 9 knobbly club rush are not those but are actually exotic scrub and shrub and the map changes (Appendix 1) now reflect this. Hole 14, active dune area is now recognised by plots as exotic scrub (lupin) and has virtually no representativeness value and is properly reflected in the mapping (Appendix 1) and a new assessment of effect is presented which is an overall level of very low. No katipo were found in area 14 or the wider grid searches in other areas (katipo were found in wood debris outside of the subject area).

No lizards were found or seen and it remains strongly the observation that the heavy mouse and hedgehog populations observed in the critapics as well as the history of site modification, and absence in any in the initial survey method undertaken, is because there are only very low populations of northern grass skink and no other taxa. This presence (northern grass skink) in low abundance does not result in a value change from that already expressed, what it does is cause a need through the wildlife act to salvage these lizards if their habitat is to be sufficiently disturbed.

The impacts of the golf course as proposed are less than minor the level of effect on all communities affected is very low.

Appendix 2 overlays the new vegetation map and plots with the proposed restoration efforts it can be seen here (and in response to the reviewer’s question) that the restoration is in in largely exotic low value communities and not in any valued indigenous dominated areas. This ensures the outcomes of the restoration are truly site beneficial and progressing communities that otherwise have not and would not gain additional indigenous dominance or habitat value.

Notable plant
- Kanuka
- Sand daphne

Course design
- Golf Fairways
- Building Outline

Vegetation communities
- 1,Grazed grassland
- 10,Spinifex active duneland
- 11,Wetland
- 12,Saltmarsh
- 2,Rank grassland
- 3a,Mixed wattle treeland
- 3b,Mixed pine treeland
- 4a,Poplar treeland
- 4b,Poplar treeland over exotic scrub
- 5,Macrocarpa
- 6a,Exotic scrub
- 6b,Exotic scrub under pine
- 7,Exotic native mix
- 8a,Kanuka treeland
- 8b,Thin kanuka treeland
- 9,Knobby clubrush stable duneland
- Katipo search area
- Vegetation plots

Boffa Miskell

www.boffamiskell.co.nz

0 100 m

1:5,000 @ A3

Data Sources: BML, Sourced from the LINZ Data Service and licensed for re-use under the Creative Commons Attribution 4.0 New Zealand licence , Land Matters

Projection: NZGD 2000 Wanganui Circuit

DOUGLAS LINKS OHAU

Schedule F Vegetation and course

Date: 24 November 2021 | Revision: 1

Plan prepared for Landmatters Limited by Boffa Miskell Limited

Project Manager: Vaughan.Keesing@boffamiskell.co.nz | Drawn: KMa | Checked: VKe

Map 1

Notable plant
- Kanuka
- Sand daphne

STABLE DUNE BUFFER REVEGETATION

ACTIVE FOREDUNE MANAGEMENT

SALT MARSH AND WETLAND MANAGEMENT

COASTAL DUNE SHRUBLAND AND TREELAND

- Katipo search area
- Vegetation plots
- Golf Fairways
- Building Outline

Vegetation communities
- 1,Grazed grassland
- 2,Rank grassland
- 3a,Mixed wattle treeland
- 3b,Mixed pine treeland
- 4a,Poplar treeland
- 4b,Poplar treeland over exotic scrub
- 5,Macrocarpa
- 6a,Exotic scrub
- 6b,Exotic scrub under pine
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- 9,Knobby clubrush stable duneland
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- 11,Wetland
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0 100 m

1:5,000 @ A3

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Projection: NZGD 2000 Wanganui Circuit

DOUGLAS LINKS OHAU

Proposed restoration overlay

Date: 24 November 2021 | Revision: 1

Plan prepared for Landmatters Limited by Boffa Miskell Limited

Project Manager: Vaughan.Keesing@boffamiskell.co.nz | Drawn: MBr | Checked: HHu

Map 2

Boffa Miskell

Memorandum

☐ **Auckland**
PO Box 91250, 1142
+64 9 358 2526

☐ **Hamilton**
PO Box 1094, 3240
+64 7 960 0006

☐ **Tauranga**
PO Box 13373, 3141
+64 7 571 5511

☑ **Wellington**
Level 4
Huddart Parker Building
1 Post Office Square
PO Box 11340, 6142
+64 4 385 9315

☐ **Christchurch**
PO Box 110, 8140
+64 3 366 8891

☐ **Queenstown**
PO Box 1028, 9348
+64 3 441 1670

☐ **Dunedin**
PO Box 657, 9054
+64 3 470 0460

Attention:	Bryce Holmes
Company:	Grenadier Limited – C/- Land Matters
Date:	2.12.2021
From:	Dr Vaughan Keesing & Mr Brendan Allen
Message Ref:	Ohau, Golf course water nutrient and wetlands

Dear Sir

We are aware of a reviewer question (BECA: Mr Whiteley) related to the potential for the golf course turf management to release nutrient enriched water into either the small raupo “pot” wetland or the Ohau river edge saltmarsh. In the first instance we responded verbally during a workshop that that probability was extremely low given the golf courses removal of the existing farm pasture management in regard to fertiliser, but also given the types of wetland present and the buffer distance from aerial or surface discharge, any such effect was highly unlikely.

We follow that verbal assurance with this memorandum.

Mr Allen, who has Horticulture and Amenity Turf Management qualifications and 25+ years of practical experience, has considered the golf course greens and fairways he will build and how they will be managed.

He relates that the topography of the course and the prevailing winds are a factor in the potential for loss of nutrient to non-target areas (wetlands) - as well as construction sediment (sand) loss. The latter he relates is standard and simple to mitigate and it is only windblown material that may be of concern to the salt marsh given the buffer of land between the feature and activity. He relates that the type and quantity and delivery system of fertiliser is an important factor in terms of the risk of loss of nutrient from its intended destination. He reminds that the economics of wasting nutrient (fertiliser), if it was to be lost from its intended target vegetation, is a consideration. Mr Allen also reminds us that the application of fertiliser under the golf regime only affects 30ha (tees, greens and fairways) not the entire farm area and so much of the land will no longer receive fertiliser. In short the quantities of fertiliser used and the methods of use in golf course management, as compared to the old farm system, means a likely reduction in non-target nutrient spread and quantity.

In essence the query seems to be about the potential for spray irrigated nutrient addition getting to and adversely affecting the two wetland features. Mr Allen is of the opinion that any runoff (from irrigation) will be minimal due to the sandy soils high infiltration and percolation rate (soil/sand hydraulic conductivity of 345-413mm/hr).

It should be remembered that the potential for an effect site wide is also more than balanced (positively) by the removal of grazing cattle and pastural management practices from the site. This will have a direct benefit to the raupo wetland where stock and wild animals can be seen to access and wallow and graze in it.

Mr Allen says that Grenadier’s golf construction team will use the sandy soils and contours with only minor contouring changes, so there will be no significant change in runoff direction or rate compared to the current situation (and little risk of “sediment” loss at construction).

Golf course management proposes to use Fescue grass varieties chosen for this links golf course which thrive under low moisture conditions. This means soil volumetric moisture percentages of less than 25%,

which leaves significant room for infiltration rather than runoff. Standard golf course maintenance practices such as coring, spiking, and vertidraining will be regularly used to maintain consistency of water infiltration to maximise turfgrass health. All this means the risk of run off or shallow ground water leaching to either wetland is virtually zero. This is further reinforced by the project hydrogeologists in their letter dated 2 December 2021.

During the summer low rainfall period Grenadier will be irrigating the turfgrass to keep it healthy and to a standard required to meet high player expectations. However, over irrigation to the point of runoff produces undesirable soft playing surfaces totally incompatible with links golf.

The Fescue grass variety to be used requires minimal fertilizer inputs to establish and maintain. A preliminary site soil test result from the NZ Sports Turf Institute via Hills Laboratories has shown sufficient existing levels of Calcium, Magnesium and Potassium to grow Fescue. Should Grenadier need to apply corrective fertiliser, this would take the form of stable granular fertilisers applied immediately prior to seeding and incorporated into the soil surface, making nutrient runoff extremely unlikely.

The authors note that excessive nutrient application to fescue grasses has a negative effect by creating an environment better suited to weed competition. Links grasses are fertilized only to maintain cover, not lushness or colour etc. Any excess growth would mean extra mowing – unlike a farming or cropping situation there is no commercial gain from dry matter production.

Phosphorus is generally considered the nutrient of greatest concern for wetlands. Fescues can be established with negligible levels of Phosphorus and maintained with almost none. It is highly likely that the conversion from farmland to golf course will see a significant reduction in the use of Phosphorus.

In short, the golf course management will result in less fertiliser additions of “better” fertiliser types applied in better ways than the historic farming management and thus cause no change in drainage pattern and probably less periodic artificially increased nutrient influxes to either wetland.

This discussion leads then to consideration of the sensitivity of the small raupo swamp pot and the Bolboschoenus/raupo saltmarsh.

As related in the AEE, the saltmarsh follows a gradient from the eastern upper edge with exotic scrub and rank pasture with flax, lupin, pampas, and gorse, and occasional cabbage trees. This provides a buffer in excess of 30m (vertical not land distance) from the fenced pasture which was pine forest several years ago and 25m from the nearest green/fairway. This edge graduates into rushland containing large swathes of raupō, *Bolboschoenus caldwellii*, threesquare, sea rush with lower proportions of oioi, marsh ribbonwood, *Schoenoplectus pungens*. This then grades into a low herbaceous more salt orientated assemblage. The feature is not intact and there are numerous drier pasture ingresses and edges of weeds etc, but as a whole the feature is one of the larger salt marshes in the district.

The hydrological drivers are the lower river terrace shallow ground water and the Ohau River (the supply of water) and the salt intrusion from tidal flows, as is evidenced by the species of plant and their distributions. Ms Johansen corroborates this view with her ground water flow direction report. Surface rains that fall on the sloped land from the pasture to the river do flow into the wetland and the profile (using Goole earth topology tool, Figure 1) shows a steady slope of around 4% from the pastural flats to the river. However, that water passes through a fully vegetated rank grass and weed land which at 20-30m is well in excess of stormwater management buffer filtration dimensions (length) (Auckland Regional Council 2003; Cunningham et al. 2017; Lewis et al. 2015; Auckland Council, n.d.). That is “clean” water only reaches the saltmarsh from the farmed land.

Figure 1. 2018 google image of the saltmarsh and Google topographical profile

Mr Allen does not predict a nutrient increase potential based on his expertise and proposed management of the golf course. But if there was what would be the response of the salt marsh?

Tanner (Tanner 1994, 1995) considered a range of wetland plants (Schoenoplectus and Bolboschoenus included) as species that might be capable of supplying water treatment, and so tolerant of, and able to make use of increased nutrient. These are plants found in the salt marsh.

Raupo, Schoenoplectus and Bolboschoenus are rapid biomass accumulators responding to changing nutrient availability seasonally and utilising available nutrient. If there was additional nutrient - and that appears very unlikely, the dominant raupo-Bolboschoenus community would “consume” it. Both these species appear to translocate seasonally their nutrient resource accumulated into the roots as their above ground green material “dies off” for winter. This makes them very competitive when spring returns. (Tanner 1995). Schoenoplectus also responds well with increased reed density the result.

If anything, an increase in nutrient into the majority of the wetland would favour Bolboschoenus and raupo dominance and Schoenoplectus presence over wet pasture and weeds (given the hydrology also present).

There are a number of publications of coastal salt marsh decline related to eutrophication (e.g. Deegan etal. 2012) but these north American examples relate to a single species (Spartina) whereby the nutrient causes the root-shoot ratio to greatly favour shoots and the result is plant loss (detachment) from lack of roots in mud channels affected by tidal flow leading to channel erosion and open water, not community change related to plant assemblage change.

Raupo freshwater wetland

The “pot” is surrounded entirely by pampas grass, lucerne, gorse, and coastal wattle. The interior is raupō (*Typha orientalis*) dominated, approximately 6 m x 6 m, with Isolepis (*Isolepis prolifera*) surrounding the raupō in a ~2m wide radius. One 2 x 2 m area of deep mud, which is open water during wet times, is entirely covered by *Lemna disperma*.

This three species natural wetland is an induced swamp in which three very tolerant, successful eutrophic oriented wetland species dominate. Raupo is well known to be “nutrient hungry” and will utilise high nutrient levels to accrue seasonally large biomass increases (Pegman & Ogden 2005). Isolepis is similar, rapidly increasing in biomass with nutrient availability (and the absence of stock) (Greenway & Lucus 2010). Simple wetlands of this nature are not sensitive and tolerate wide environmental conditions, but the prediction is that neither the amount or quality of water will appreciably change and if there is a nutrient change it will be a decrease rather than an increase.

Conclusion

The proposed golf course development and management will most likely result in a better water and fertiliser regime, more suited to the persistence of both wetlands through removal of stock grazing, management of weeds, removal of periodic ad hoc fertilisers, and better managed irrigation, all while being cognisant of those wetland features and the need to sustain their condition in a way standard farming does not.

We jointly consider any adverse effect on the Raupo freshwater wetland and saltmarsh as a result of nutrient change to be negligible. Conversely, and without taking a positive versus negative balancing approach, there will be substantial ecological benefits from the activities which are more akin to a ‘natural system’ on site when compared to the current use.

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Bay Geological Services Ltd
A C Johansen
RD6
Napier 4186

mobile: +64 275 014 984
email: *baygeological@xtra.co.nz*

2 December, 2021 ref: BGS258_02c

Grenadier Limited
c/- Tom Bland/Bryce Holmes
Land Matters Limited
20 Addington Road
RD1
Otaki 5541

Dear Tom and Bryce,

DOUGLAS LINKS APPLICATION FOR GROUNDWATER RESOURCES
765 MUHUNOA WEST ROAD, OHAU

Further to online discissions held with Horizons and the selected peer reviewers (Beca) with regard to the Douglas Links Application, a query was presented around the hydraulic gradient across the project area. To investigate this, a request was raised with Horizons Regional Council (Horizons) for groundwater bore static water level data (SWL) across greater Muhunoa West Road area. The information was provided; however less than half the recorded bores included a SWL, although the result of the SWL analysis did not have a dramatic influence on the outcome.

The council online GIS General Viewer map was also referred to in order to locate bores with available SWL data.

1. HYDROGEOLOGICAL SETTING

The volume of rainfall runoff in comparison to that entering a groundwater system is a function of the hydrogeological properties of the geological formations, primarily permeability and porosity of the near-surface strata. In low permeability strata, surface water runoff typically drains in directions aligned with the topographic gradient.

The surface geology at the coast is mapped as a series of Quaternary sand deposits form adjacent to the coastline (Begg and Johnston 2000, Morgenstern et al 2019). The Ohau drainage pattern is NE-SW, aligned with the tectonic structure of the area, with flow toward the northwest.

2. HYDRAULIC GRADIENT

A review of surrounding groundwater bores within close vicinity of the new Douglas Links Well was completed in order to study shallow bores' SWL and map the hydraulic gradient. A number of bores within 3 km of the Douglas Links well site was identified with the assistance of Horizons online map and data provided by the groundwater scientist. Of the thirty-nine wells mapped within a 3 km radius including the Pumped Well, seventeen bores record SWL's; however, nine wells are either flowing artesian or screened over a deep aquifer. Eight of the bores provide information on shallow unconfined water levels, and these are used to map the hydraulic gradient, taking into consideration site elevations, with the resulting measurement in metres above mean sea level (m amsl). A copy of the bore details is provided in Appendix A.

The spring SWL of the pumped Well recorded early on during the drilling process when the bore had just penetrated the shallow unconfined aquifer was -10.58 m, and the approximate elevation of the site is estimated as 25 m amsl (referenced from the LINZ topomap). Therefore, the water table lies at approximately 14.42 m amsl.

The bores located across the sand dunes adjacent to the coastline and NNE of the Pumped Well record water levels ranging from 14.4 to 16.3 m amsl. The water level data are shown in yellow on the map presented as Figure 1 (and included as Appendix B), which suggests a largely consistent set of water levels through the sand dune material. Due to the lack of triangulation typically provided by multiple data points, a definitive hydraulic gradient cannot be identified; however, a potentiometric slope likely exists toward the northwest.

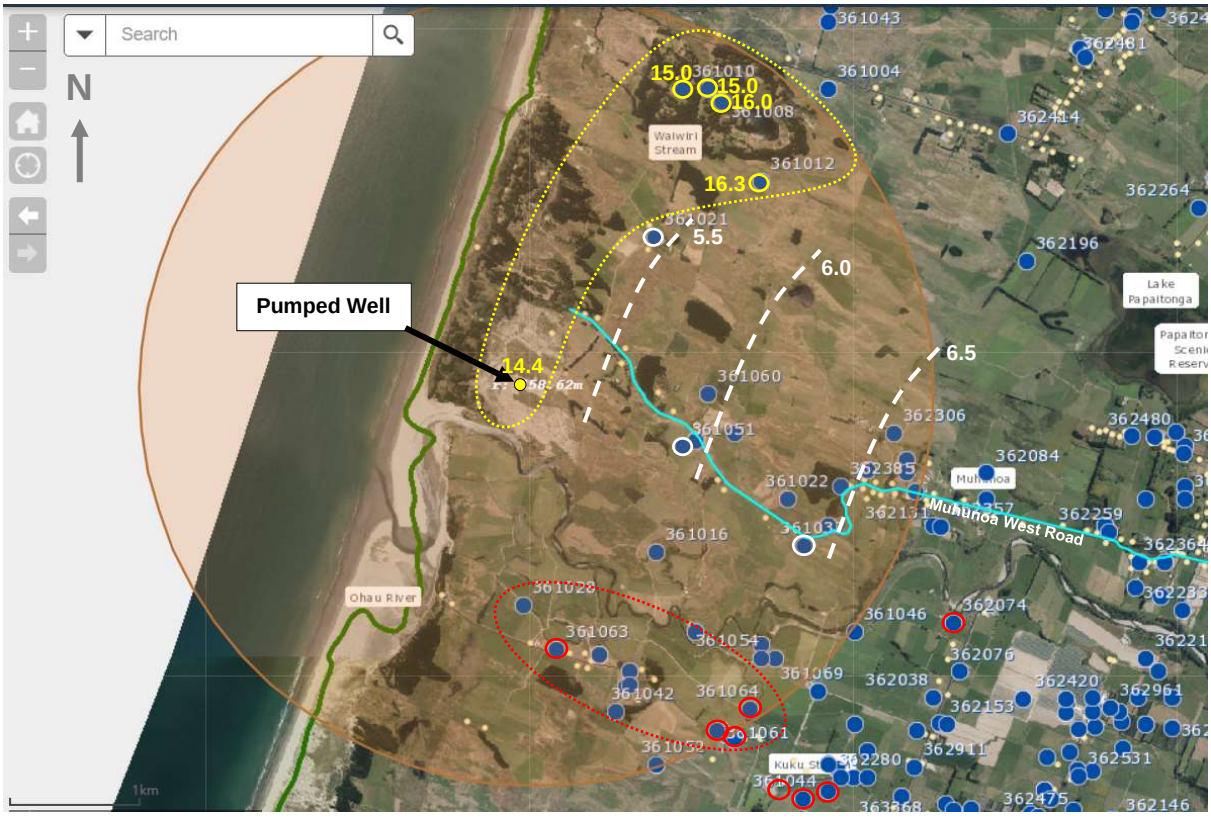

Figure 1: Horizons wells map showing wells within 3 km of Douglas Links well site.

To the east of the sand dunes, shallow groundwater bores drilled across the lower elevation Quaternary alluvial terrace provide SWL's that range from -2.80 to -4.10 m below ground level (bgl) and reflect water levels within the nearby Ohau River.

The data also infer an approximate potentiometric slope direction toward the NW (shown as white dashed lines in Figure 1). The bore data indicate water levels falling approximately 0.5 m over about 1 km toward the coast, although this is an estimate, it establishes an estimate commensurate with the matter at issue.

On the true left bank of the Ohau River, and south of the project area, the available water level data exhibits artesian aquifer conditions in confined shallow to deep bores, as displayed in red on Figure 1. Due to the groundwater being trapped in artesian aquifers beneath low permeability strata, the data points do not provide information on hydraulic gradient contouring, and there is no clear evidence of a dominant potentiometric slope across this area.

However, it is understood that the issue is one of groundwater being potentially infiltrated with nutrient-rich water from the surface, thereby contributing to a possible impact on the salt marsh adjacent to the Ohau River. In our view, the ecologists are better placed to assess any impact on the values of the salt marsh, but our findings show that the direction of any subsurface flow is more likely away from the salt marsh (i.e., toward the northwest).

Yours sincerely,

Alexandra Johansen
Principal Geologist/Hydrogeologist BSc (Hons)
Bay Geological Services Ltd

3. REFERENCES

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Report Limitations

This S92 response is written based on conditions and information as provided by third parties at the time of the desktop study. No interpretation is made on potential changes that may occur across the site or incorrectly reported by third parties. Subsurface conditions may exist across the site that are not able to be detected or revealed by the study within the scope of the project, and are therefore not taken into account in this response. Furthermore, statements included within this response are assumptions made for the purposes of providing interpretations of site geology and hydrogeology.

APPENDICES

APPENDIX A

Details for Surrounding Bores

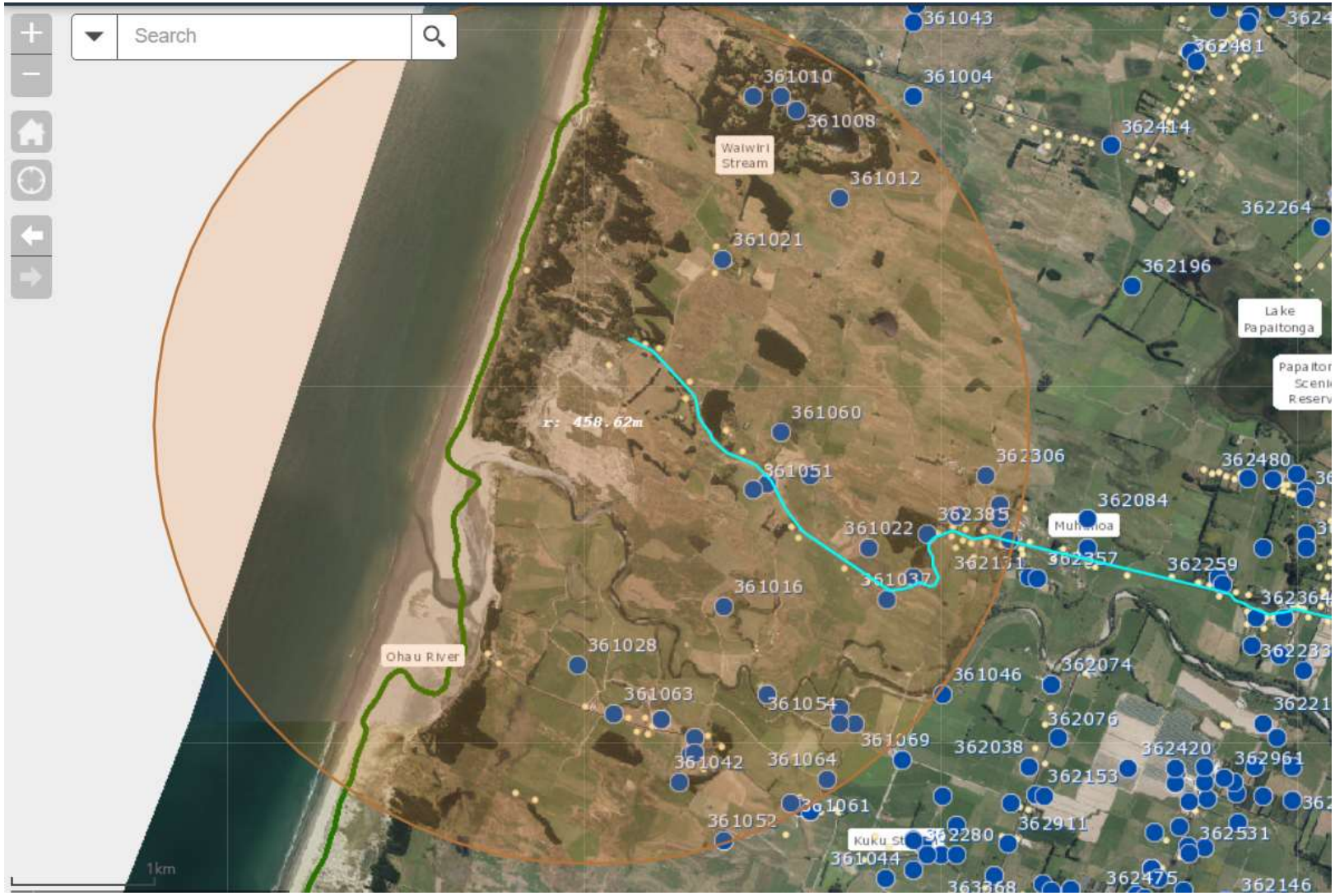
(Horizons)

id	Distance	Station_ Name_	elevation	depth	purpose_	Depth to Water	gwl(masl)	artesian	Screen ID	Screen fro	Screen to	Screen dia	Screen slo	Status	installation_date	owner	property_street_addr	Permit	Daily Max	Annual Ma	transmissi	specific_storage	swl date
361051	1198		20.00	45.80		-0.60	19.4	No	1	39.8	45.8	6	0.008		9/01/2003	Tahamata Corp	MUHUNOA WEST RD				86		9/01/2003
361041	1283		9.16	36.70		-3.70	5.463	No	1	33.7	36.7	4	0.006	Active	4/12/1989	CJ & Bossley - New					41		4/12/1989
361003	1290		8.70	10.00		-2.80	5.896	No						Active		C Bossley Old							1/01/1900
361060	1356		14.00	25.00												Easton							
361016	1471		11.00													Easton							
361028	1521		6.00													??Mata							
361030	1569		14.00													Easton							
361021	1580		7.42	24.00		-2.00	5.418	No	1	22	24	5	0.007		3/03/1988	JA& Shaw					23		3/03/1988
361063	1865		5.00	33.21	Irrigation	2.46	7.46	Yes	1	28.71	33.21	10			1/01/2011	Tahamata Incorporati	Kuku Beach Road	105735	4098	410770			26/01/2011
361027	1968		5.09	26.00		3.00	8.088	Yes							28/08/1972	L Richardson							28/08/1972
361022	2082		14.00	20.00												Tait							
361025	2129		9.00	9.00																			
361014	2156		6.00	5.00												A Honore No7							
361039	2250		5.00	20.00												T Marshall							
361020	2252		7.06	18.00												Haines BrosNo7							
361037	2331		10.41	10.74		-4.10	6.31	No	1	7.74	10.74	6	0.006		21/03/1997	J Haines					46		21/03/1997
361042	2410		8.00													G Kidd No1							
361012	2429	Levin STP Po	19.31	23.00	Monitoring	-3.00	16.31	No							13/07/1984	Horowhenua District Council					10		13/07/1984
362385	2434		7.00													H Richards							
361024	2435		9.00	5.00												Haines BrosNo6							
361036	2528		9.00	9.00												Haines BrosNo2							
361054	2601		9.00	9.00												Haines BrosNo1							
361079	2601		19.80	63.16	Farm supply	-1.00	18.805	No						Active	16/06/2021	Bryant	432 Muhunoa West Road						16/06/2021
361011	2604		9.46	62.00		0.60	10.06	Yes							13/09/1974	Denton (Ex Davies)					38		13/09/1974
361010	2645	Levin STP Po	16.00		Monitoring	-1.00	15	No								Horowhenua District Council							1/01/1900
361048	2669		9.00	9.00												Haines BrosNo3							
361008	2704	Levin STP Po	17.00		Monitoring	-1.00	16	No								Horowhenua District Council							1/01/1900
361006	2738	Levin STP Po	17.00		Monitoring	-2.00	15	No								Horowhenua District Council							1/01/1900
362306	2763		13.00	65.00												Siddall & Sons No2							
361064	2839		6.80	19.00		3.60	10.399	Yes								G Kidd No4							1/01/1900
361061	2846		15.00	19.90	Farm supply	0.70	15.7	Yes	1	18.41	19.9	6	0.15		9/06/2009	Tahamata Corporatio	Kuku Beach Road, Ohau						9/06/2008
361052	2882		15.00													G Kidd No2							
362166	2885		13.00	58.00												A Hooper							
361045	2900		7.58	19.75		0.50	8.08	Yes	1	18.22	19.75	6	0.15		14/09/1999	J Palliser					649		14/09/1999
362383	2901		12.00													RC Chapman							
361058	2961		9.00	14.00												G Kidd No3							
362131	2989		10.72	56.40											2/09/1968	B&E Hale							
361046	2997		10.00	9.00												Haines							

APPENDIX B

Horizons Wells Map

(2 km radius)


Search
361043
362481
361010
361004
361008
362414
Waiwiri Stream
361012
362264
361021
362196
Lake Papaitonga
r: 458.62m
361060
362306
362480
361051
362084
362385
361022
362357
362259
361016
361037
Ohau River
361028
362074
361046
361063
361054
362076
361069
362038
362420
362961
361042
361064
362153
361061
361052
362911
362531
Kuku St
362280
361044
362475
362146
1km