Geotechnical Assessment for Resource Consent

Southland Wind Farm, Southland

RILEY

Geotechnical Assessment for Resource Consent
Southland Wind Farm, Southland

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1.0	Final	22 August 2023
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Appendices

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1.0 Introduction

This report has been prepared by Riley Consultants Ltd (Riley) at the request of Contract Energy Ltd (Contact Energy). It details the geotechnical assessment undertaken for a proposed new wind farm location in hill country approximately 15km east of Wyndham, Southland. This report is intended to support a ca. 2025 Resource Consent application, being compiled by others, for the proposed development, and supersedes any previously issued versions.

To support the resource consent application, Riley has also been engaged to assess and report on civil engineering matters including construction effects and management. The assessment is primarily outlined in an evidence-style Technical Assessment of Construction Effects document (dated July 2025), and referenced this geotechnical assessment and the following:

- Mimihau Hydrological Monitoring Site Visit (29-30 March 2023) - Riley Ref: 220372-A, dated 13 September 2023.
- Hydrology Assessment Mimihau Stream Catchment - Riley Ref: 220372-D, Issue 2.0, dated 12 December 2023.
- Hydrometric Data Assessment Hydrological Monitoring – Mimihau Stream - Riley Ref: 220372-H, dated 5 June 2025.
- Stream Crossing Preliminary Design Report - Riley Ref: 220372-C, Issue 2.0, dated 14 July 2025.
- Draft Construction Environmental Management Plan – Riley Ref: 220372-F, Issue 0.2, dated 24 June 2025.

1.1 Proposed Development

- The development consists of a total of 55 No. wind turbine generators (WTG), and approximately 73km of access track (new and upgrade of existing forest access tracks).
- Earthworks is required to construct access tracks entering and within the Site – with paved widths between 6m and 8m. The tracks will predominantly be surfaced with a higher-quality pavement aggregate (Riley Dwg: 220372-201 in Appendix F for current WTG location and access road alignments)[1].
- Earthworks is required to form hardstand platforms at each WTG location for storage and assembly of each turbine tower.
- The main heavy transporter route is likely to be into the north-east corner of the Site, through the Port Blakely Forest (off Davidson Road West/Kaiwera Downs Road). Note, Riley's route assessment along the Port Blakely Forest has been a desk study exercise only.

[1] We understand the current WTG locations are preliminary and subject to confirmation during detailed design.

- The current site access from Wyndham ends on Thornhill Road, off Venlaw Road, which leads up the dip-slope into the mid-elevations of Jedburgh Station (Figure 1).

1.2 Aims and Objectives

The primary aims of this assessment are to develop a geotechnical model (ground profile of soil and rock conditions including lateral and vertical variability, and groundwater conditions) and assess key geotechnical considerations and constraints on the development. The latter items are primarily discussed in Section 8.0.

2.0 Scope of Work

Riley has undertaken the following tasks to address the project objectives:

- Desktop review of:
  - Published regional topographic and geological maps and bulletins.
  - Relevant in-house data from Riley's library and readily available historic projects.
  - Five geotechnical machine cored boreholes (BH101 to BH105 – to depths of 20m) that McNeill Drilling Ltd completed in April/May 2011[2]. Data was accessed via the New Zealand Geotechnical Database (NZGD) and logs and core photographs are included in Appendix B.
  - Ground-surface features evident on a high-resolution (1m grid) hillshade rendering of digital elevation model (derived from a regional LiDAR survey[3]). Inferred and mapped features are shown on Riley Dwg: 220372-206 included in Appendix F.
- Field Mapping

  Engineering geological mapping of selected exposures (outcrops, track cuts and existing small borrow areas) was undertaken on 20 October 2022 and in the week commencing 19 February 2023. The February 2023 mapping focused on geological exposures at selected road cuts within the Venlaw Forestry block. This provided information on the near-surface ground profile (typically 2m to 5m depth) across this section of the Site. Annotated photographs of selected outcrops, and geological structural data recorded, are kept on file and available upon request.
- Subsurface Investigations

  Machine test pits (14 No. i.e. TP101 to TP114), using a 16t hydraulic excavator and toothed rock bucket with a single tine ripping attachment where necessary (February 2023). Test pits were excavated to a maximum target depth of 5.5m or terminated earlier due to practical refusal. In-situ soil strength tests were undertaken at selected locations, and in appropriate soils, using a Scala penetrometer and/or hand shear vane. TP logs with associated photographs and Scala penetrometer (SC) test results are included in Appendix C, and should be read in conjunction with Riley logging terminology and standard abbreviations included in Appendix A.

[2] We understand the ca. 2011 boreholes were completed as part of an historic wind farm assessment in this area.

[3] LiDAR = aerial flown Light Direction and Range survey flown between 2020 and 2021. This survey is currently available from the LINZ data website, but we worked initially on an advance release of this survey provided in early 2023 by the Client.

Tests pits were carried out within the Jedburgh Station, and (as noted above) near-surface geology in Venlaw Forest was primarily assessed using road cuts.

No deep investigations (i.e. machine boreholes) have been procured for this assessment. Rather we have relied upon mapping and the historic borehole logs at this Site to inform the deeper ground model (see above). The location of subsurface investigations (TPs and ca. 2011 BHs), along with mapping waypoints (outcrop ID's), are shown on Riley Dwgs: 220372-202 and -203 in Appendix F.

- Laboratory Testing – Bulk disturbed samples were collected from selected test pits and outcrops for laboratory testing. Test results are included in Appendix D.
- Assessment of Geotechnical Considerations and Constraints – Refer Section 8.0.

2.1 Additional Geotechnical Investigations - ca. 2024

In 2024 Contact engaged Riley to undertake a next stage of geotechnical investigations for the project (Stage 2). The 2024 geotechnical investigations included additional subsurface work in readily accessible areas of the proposed development in the Venlaw Forest, and intermediate to lower elevations of Jedburgh and Glencoe farms. No subsurface work was undertaken around the Jedburgh Plateau during the Stage 2 investigations.

Riley has drafted a Geotechnical Factual Report (GFR) for SWF. This is a single/standalone document that contains all existing relevant geotechnical information for the project, including.

- Historic borehole logs (ca. 2011).
- Results from Riley's initial geotechnical investigation ca. 2023 (which have been primarily relied upon to develop the geotechnical model and interpretative assessment outlined below).
- Scope and results from the Stage 2 (ca. 2024) investigations. Key work undertaken included;
    - Machine test pits.
    - Machine boreholes – with installation of either standpipe piezometers, or grouted PVC pipe to allow downhole seismic profiling (see below).
    - In-situ strength tests in appropriate cohesive and non-cohesive soils.
    - Sampling of selected soil and rock encountered and scheduling selected laboratory tests,
    - Geophysical surveys (electrical resistivity lines, and downhole shear wave profiles in pipes grouted into selected boreholes)

To date, Contact has not engaged Riley to incorporate the findings from the Stage 2 investigations into our interpretative geotechnical assessment. We understand that Contact intends to undertake the next phase of geotechnical interpretation and assessment, once Resource Consent is confirmed for the project. From our initial (broader-level) appraisal of the Stage 2 results we do not consider that the findings will either materially or detrimentally alter the current/resource consent level assessment and conclusions (outlined below).

3.0 Site Location and Layout

The Site is located across three properties (refer Table 1). The regional location and topographic setting of the Site is shown on Figure 1 and Riley Dwgs: 220372-200 and -201, with the latter drawing also showing the extent of the proposed development.

Table 1: Property Name (for Report Reference) and Associated Descriptions

Property Name	Property Address	Legal Description (Title – Appellation)	Approximate Land Area (Hectares)	Proposed No. WTG
Jedburgh Station	248 Venlaw Road, Oware	SL9D/824 - 1/1, Section 3 Block IX Slopedown Survey District	2,659	34
Venlaw Forest	794 Venlaw Road, Oware	407674 – 1/1, Lot 1 Deposited Plan 12509	2,727	18
Glencoe Station	232 Campbell Road, Oware	SL9B/866 - 1/1, Section 61-62 Block III Wyndham Survey District	495	3

Source: Land Information New Zealand - https://data.linz.govt.nz/search/, accessed 14 April 2023
WTG = wind turbine generators.

Ground elevations across the Site typically range between RL 200m to the north (valley floor) up to RL 630m along the south ridgeline. Four distinct high points along the southern strike-ridge are an 'unnamed high point' (south-west corner – RL 634m), Mokoreta (RL 713m), Puke Mimihau (RL 664m), and The Cairn (RL 658m) (refer Riley Dwg: 220372-200).

The neighbouring properties to the south and in parts to the north and west include various parcels administered by the Department of Conservation typically referred to as part of the Catlins State Forest Park. These areas are predominantly on steeper south-facing land (back-slopes), predominantly covered in dense native vegetation.

3.1 Site Access

Two access routes are proposed for heavy construction vehicles to the Site:

- As noted above Thornhill Road, off Venlaw Road, which leads up the dip-slope into Jedburgh Station - terminating at approximately 380m elevation (Figure 1 and Figure 3). This is the current, and likely to be a secondary site access point for construction.

- An upgraded route through Port Blakely Forest, which is a neighbouring property to the north-east of the Venlaw Forest (refer Riley Dwg: 220372-200 and Figure 1). This would provide access for certain over-dimension component loads for the turbines and would be accessed via the Kaiwera Downs Road (off State Highway SH93). This access will also be used for access during civil construction works.

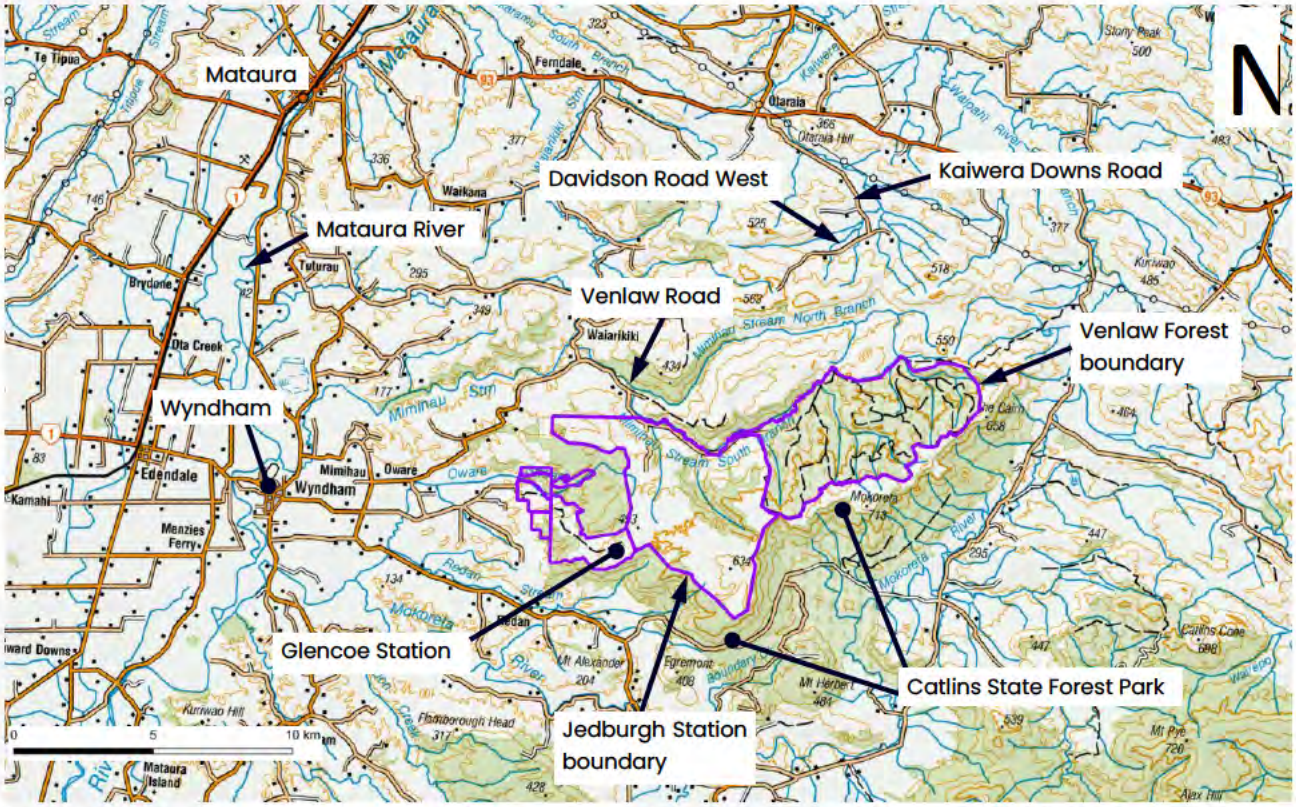


Figure 1: Annotated Location Plan (base map extracted from NZ topo250 Map)

4.0 Regional Geology

The published regional-scale geology map indicates the Site is underlain by bedrock consisting of fossiliferous sandstone, mudstone, with minor shell beds which are correlated to the Ferndale Group of the Murihiku Supergroup (GNS, 2003[4]). Refer Riley Dwgs: 220372-204 and -205, which contain exerts from the QMAP sheet.

The sedimentary rocks were originally deposited in a marine environment ca. 165Ma (Jurassic period) and have since been consolidated and subject to low-grade metamorphism. Ancient compressional tectonics folded the Murihiku Supergroup about a current north-west to south-east trending axis to form the regional-scale Southland Syncline (Figure 2). The geometry of the Southland Syncline is asymmetrical – with bedding in the southern limbs inclined gently to the north and steep to very steep bedding north of its axis. Compressional tectonics associated with the plate boundary formation (i.e. Alpine Fault) during the late Miocene and Pliocene has resulted in the present-day elevation of the Site (GNS QMAP). The geology and tectonic history have significantly contributed to large scale landscape features such as 'strike-ridges', 'dip-slopes' and 'back-slopes' which are illustrated in Figure 2.

[4] Turnbull, I.M., Allibone, A.H. (compilers) 2003: Geology of the Murihiku area: scale 1:250,000. Lower Hutt: Institute of Geological & Nuclear Sciences, 1:250,000 geological map 20. 74 p. + 1 folded map

The local bedding orientations indicate there are site-scale geological structures with antiform[5] and synform[6] axes intersecting the Site. The orientation of the antiform and synform axis are sub-parallel (sympathetic) to the Southland Syncline axis.

5.0 Site Description and Geomorphology

Key topographic features of the Site are shown on Riley Dwgs: 220372-200 and -206 and Figures 1 to 12, and include:

- The key geomorphic features at the Site are controlled by/reflect the underlying geological material and structure – including asymmetric valley slopes, strike-ridges, dip-slopes, back-slopes, locally deeply incised and eroded valleys approximately subparallel to the dip-slope direction.
- The Site is located on north-west facing dip-slopes. The southern (up-slope) margin of the Site is adjacent to a strike-ridge (highest peak, Mokoreta – RL 713m). The dip-slopes are generally inclined between 10° and 15° to the north-west.
- The dip-slopes are variably incised, and eroded into, by varying sized gullies/valleys and streams. A deep and steep-sided gully bisects the Jedburgh Station. The head of this unnamed gully rises to form a broad depression in the strike-ridge (i.e. between WTG JED-29 and JED-30). This area is important for the development as it is the location of the access track that links most of the Jedburgh Station turbines to those in the north-east and the Venlaw Forest (Figure 6).
- The more prominent 'examples' of dip-slopes are present at the south-west (Jedburgh Station) end of the Site. Remnant dip-slopes, which are generally more incised and dissected, by streams and gullies, are evident in the middle and north-east end of the Site (Venlaw Forest) being broadly incised by the splaying heads-gullies of the Mimihau Stream North and South Branches.
- Site-scale lineaments have been noted and are likely to reflect preferential erosion along weaker geological structures, (i.e. laterally persistent defects and inactive faults in the rock mass).
- Moderately to steeply inclined south and west facing back-slopes are generally covered by dense low to medium height native vegetation (possibly where slopes are/were less favourable to farming development due to their inclination and solar aspect).
- The northern (lower hillslopes) of Jedburgh Station are predominantly cleared pasture with regenerating scrub (manuka/kanuka) in numerous relatively shallow gullies that bisect the dip-slope. The southern/elevated parts have a dense cover of regenerating native bush (manuka/kanuka).

[5] Antiform – A topographic feature comprising sedimentary layers in a convex formation but where the younging-direction of the sedimentary sequence is uncertain. 'Younging-direction' is the direction in which a sequences/strata gets younger.
[6] Synform - A topographic feature comprising sedimentary layers in a concave formation but where the younging-direction of the sedimentary sequence is uncertain.

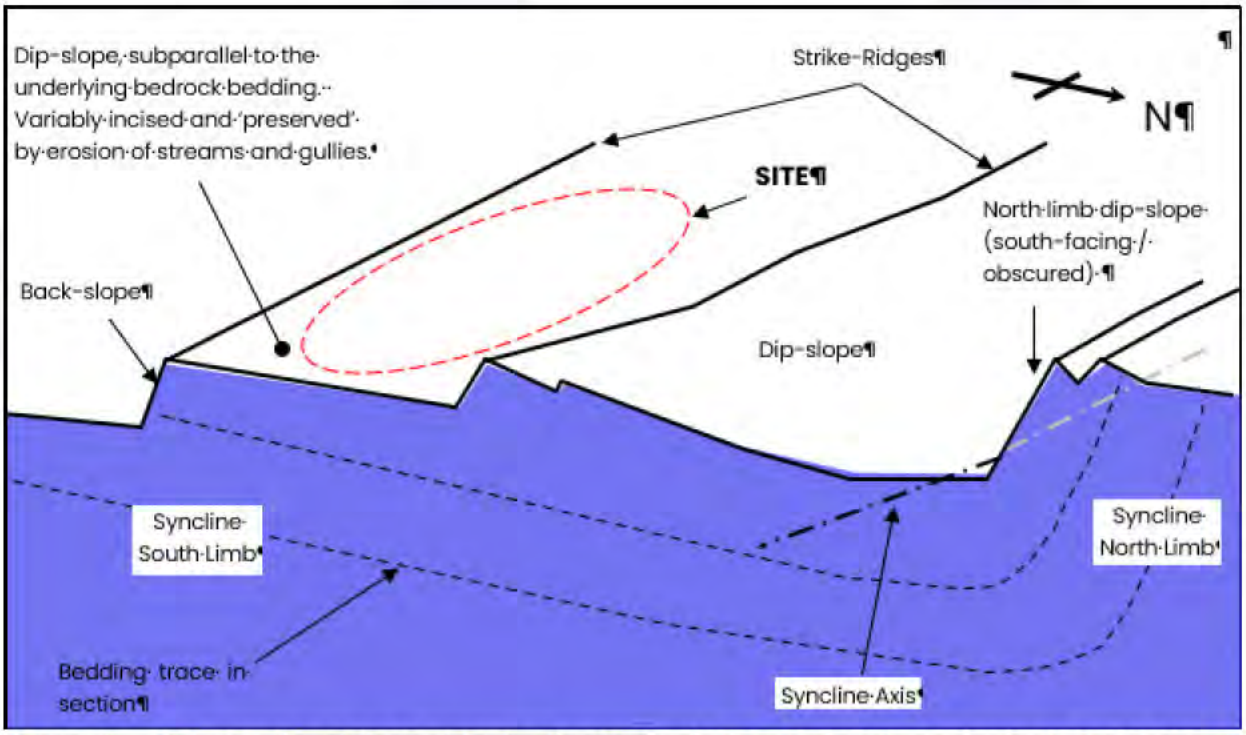


Figure 2: Schematic oblique block diagram of the regional geological structure and geomorphic features of Southland Syncline

- A roughly triangular-shaped plateau-like area is present in the south (highest elevation) of Jedburgh Station. In this area the hillslopes and gullies are subdued, broad, and sinuous, but are generally inclined to the west and south-west (a notable difference from the general north direction of the dip-slopes). Key geomorphic and inferred geotechnical features of the plateau are illustrated in the annotated oblique sketch diagrams included in Appendix E.

  An approximately 20m to 40m step in the hillslope (down on the north side) is noted along the north margin of the plateau-like area. This is aligned with a notable lineament and west flowing large gully. These are inferred to be an ancient and inactive bedrock fault.

  The plateau-like area generally has a low-high scrub and sub-alpine vegetation cover.

- 'Wet-areas' were observed locally across the tops of the plateau-like area during our site visits. The wet-areas generally have a cover of very low-height vegetation, and free surface-water was also observed.

  The 'wet-areas' we noted appear to be within or close to specific 'wetland' areas that have been mapped by ecological experts engaged for the project. Four machine test pits were completed at the plateau-like area (TP111 to TP113) to assess the ground conditions in these areas, with TP111 and TP112 located near areas classified as 'wetlands', to investigate the conditions at these locations/areas.

- The Venlaw Forest, in the north-east half of the Site, is predominantly covered with plantation trees with lesser areas of low-elevation scrub and secondary native regrowth in the base of gullies. The Venlaw Forest boundary is generally a few hundred metres north/down-slope of the strike-ridge. Well-maintained existing roads provide ready vehicle access throughout the forest.

- A limited number of slope instability features have been noted at and around the Site – primarily from our desk study review of maps and the LiDAR DEM surface. Five potential landslides have been noted (including scarp features and associated debris lobes of varying size and volume). One feature (landslide 'A') is also shown on the QMAP (GNS, 2003). The location of the landslides is shown on the Riley Dwg: 220372-205.

  Refer to Section 8.1 for further details of our assessment of the slope stability findings and our assessment.

6.0 Laboratory Tests

Civil laboratory tests have been specified on selected soil and lower-strength bedrock samples, i.e. classification grading, Atterberg limits, moisture content, earthworks compaction, thermal resistance. Aggregate tests have been undertaken on two selected higher-strength 'blue-rock' samples collected from existing borrows at Jedburgh Station (outcrop ID 'OC-V') and in the Venlaw Forest (i.e. outcrop ID 'OC-R') (refer Section 7.1.4). A summary of the test results is shown on Table 2, and the laboratory test results are included in Appendix D.

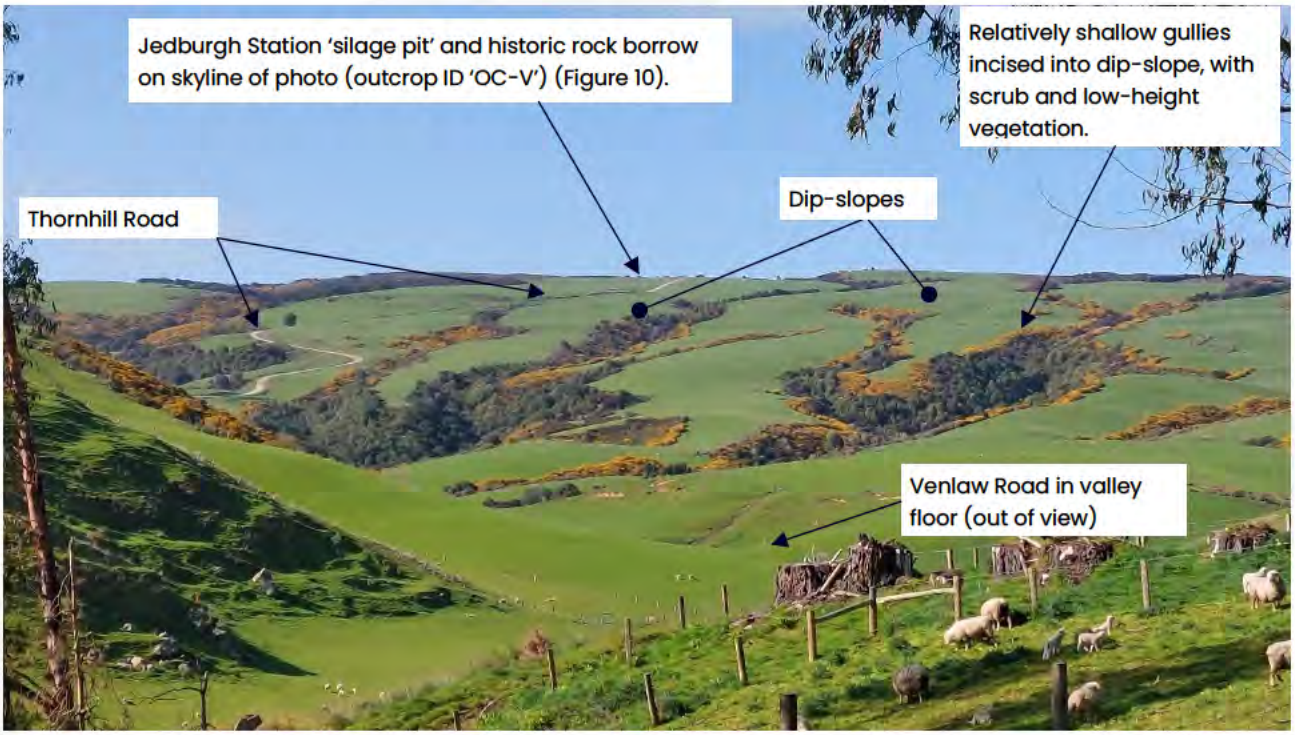


Figure 3: Photo of Lower Elevation Dip-Slopes at Jedburgh Station, and Thornhill Road (Oct 2022 – looking SSE)

Table 2: Summary of Laboratory Test Results

Sample Source/ID		TP105	TP108	TP120	Jedburgh Station Borrow OC-V	Venlaw Forest Borrow OC-R
Laboratory Reference		23/1371	23/1371	23/1371	23/1746	23/1747
Depth (m)		4.3 to 4.5	3.2 to 3.5	2.5 to 2.7	0.0	0.0
Description		Silty SAND with minor gravel and trace clay	Silty SAND with minor gravel and trace clay	Gravelly COBBLES with some sand and minor silt	Rock - Sandstone	Rock - Sandstone
Natural moisture content (%)		33.7	41.1	17.7		
Particle Size Distribution - Percent passing by mass (%)	Silt & Clay	37	34	7	-	-
	Sand	92	99	21	-	-
	Gravel	100	100	49	-	-
	Cobble	-	-	100	-	-
Atterberg Limits	Liquid Limit (LL)	N/A	N/A	-	-	-
	Plastic Limit (PL)	NP	NP	-	-	-
	Plasticity Index (PI)	NP	NP	-	-	-
Compaction	Max. Dry Density (t/m^3)	1.36	1.28	1.58		
	OMC (%)	31	36	22		
Reported CBR Value (Soaked)		2	2		-	-
Estimated Crushing Resistance (kN)		-	-	-	270	140
Weathering Resistance Quality Index		-	-	-	AA	CB
Thermal Resistivity (°C.m/W)		0.89 - 3.49	0.83 - 3.20	-	-	-

Notes:
N/A = Not Applicable
NP = Non-Plastic
OMC = Optimum moisture content

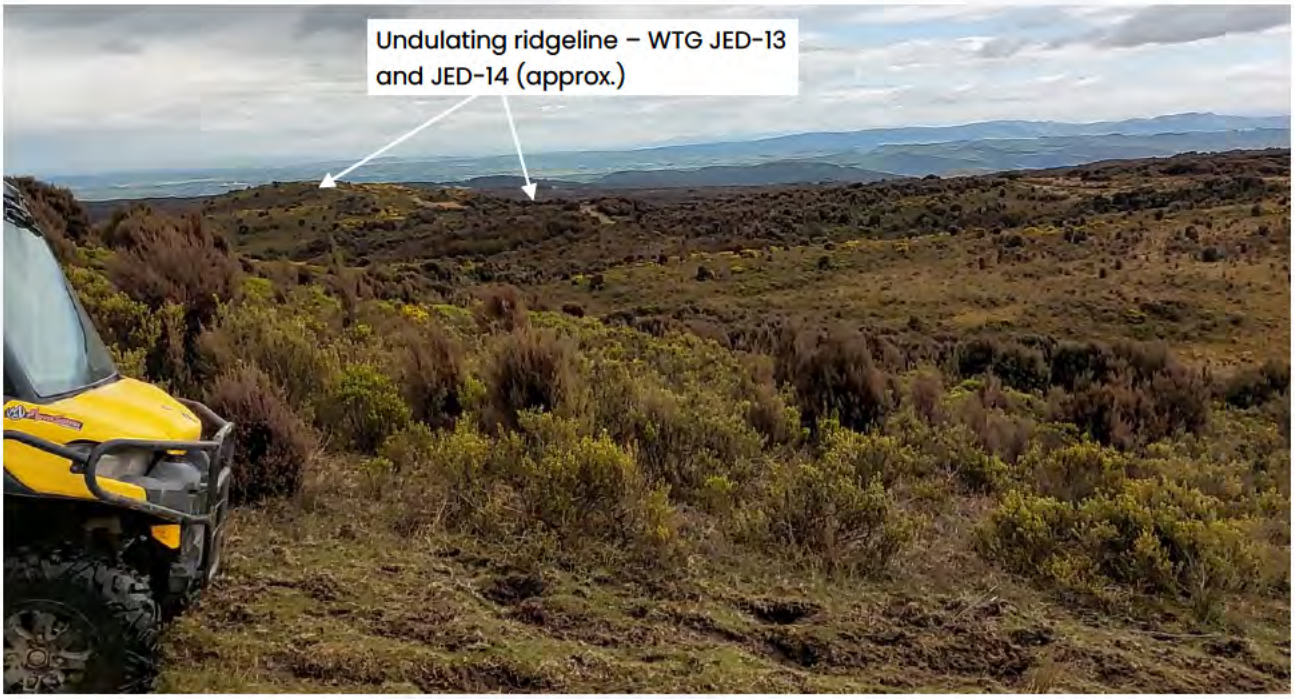


Figure 4: Photo of Jedburgh Station, looking west along the gully that defines the north limit of the high-elevation plateau-like area (Oct. 2022 – close to the future-position of TP110)

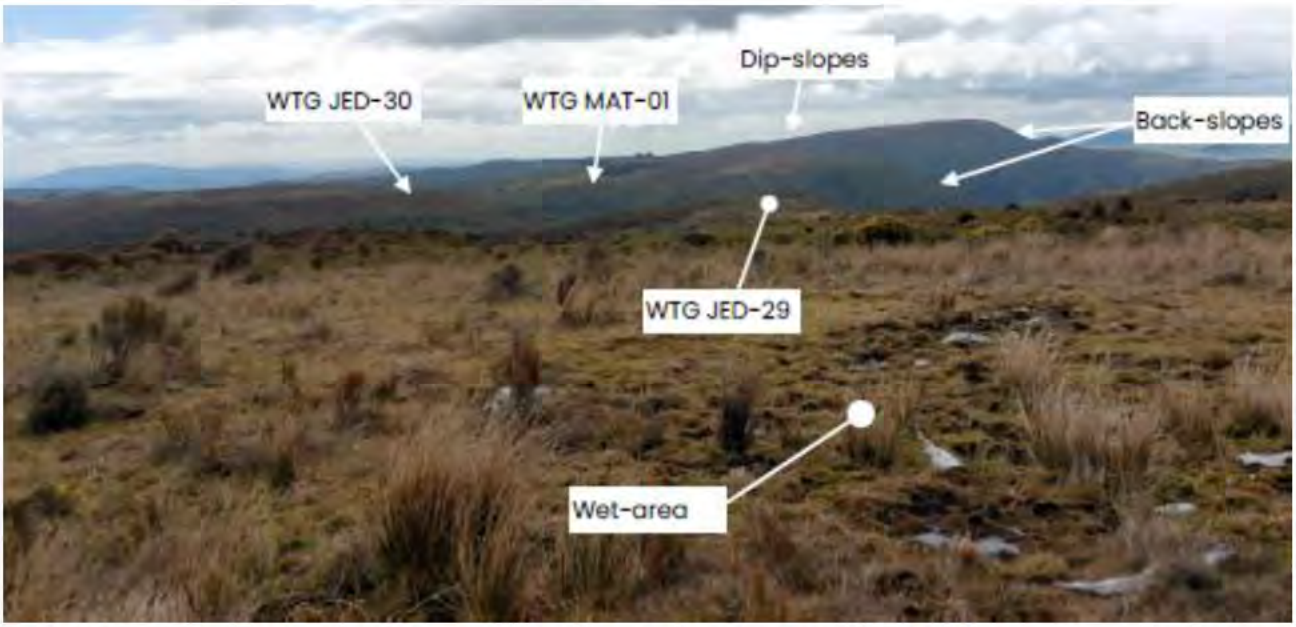


Figure 5: Photo of Jedburgh Station close to WTG JED-25, facing east along the strike-ridge (Oct. 2022)

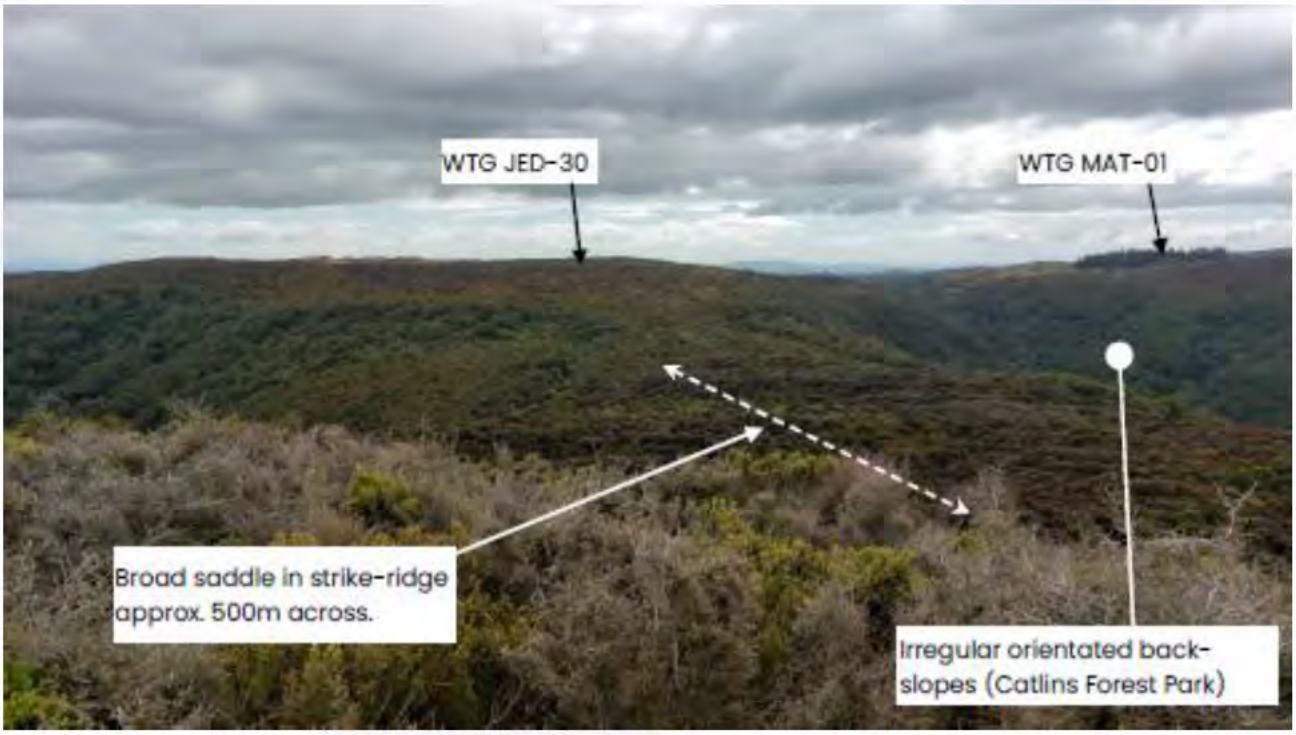


Figure 6: Photo of Jedburgh Station from WTG JED-29, looking north-east across a broad saddle in the strike-ridge formed at the head of a deep unnamed gully incised up to 200m elevation into the dip-slope (Oct. 2022).

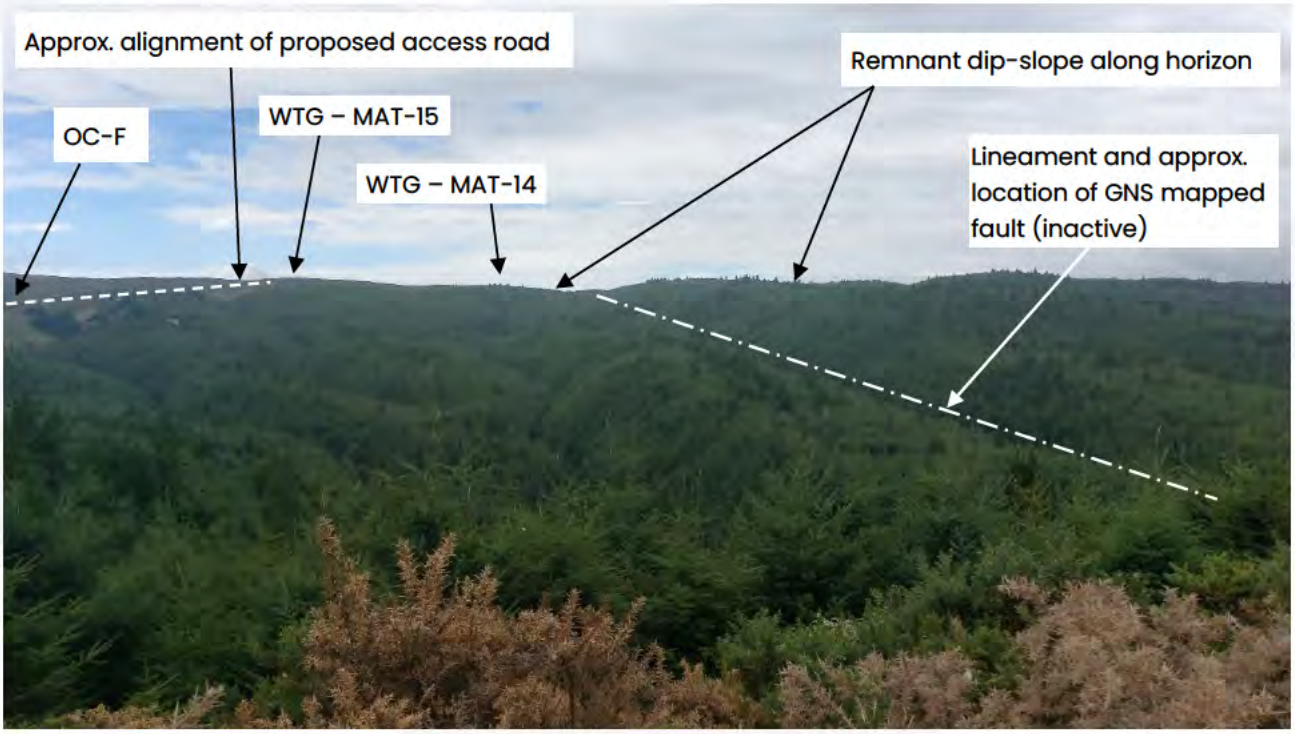


Figure 7: Photo from waypoint OC-I, east end of Venlaw Forest facing south-west. View across the head-waters of the Mimihau Stream (North Branch) which is relatively deeply incised - with only remnants of the dip-slopes preserved in relatively narrow ridgelines between catchments (Feb. 2023).

7.0 Geotechnical Conditions

7.1 Ground Profile

The ground investigation and assessment indicate significant lateral, and vertical geological variability is present across short distances (i.e. a few ten to hundreds of metres) at the Site. At a broad (site-wide) scale the ground profile that is relevant to the development consists of:

- Unconsolidated near-surface 'soils' – which could include fill, topsoil, and colluvium on the hillslopes. Apart from topsoil, these materials have a patchy distribution and where present, typically total less than approximately 2m depth and overlie bedrock.
- Bedrock – consisting of variably weathered sandstone and locally interbedded siltstone that is correlated to the Ferndale Group of the Murihiku Supergroup (ref. GNS, QMAP 2003). Two geotechnical bedrock profiles differentiated for this assessment are (refer Sections 7.1.3 and 7.1.4):
    a. 'Lower-strength' (and generally more-weathered) bedrock.
    b. 'Higher-strength' and less-weathered bedrock (which is informally referred to as 'blue-rock'). This generally underlies the lower-strength bedrock.

Further details on the soils and bedrock conditions anticipated at the Site are provided below.

7.1.1 Deep and Shallow Ground Sequences

Two general ground sequences, comprising varying thicknesses of soils and bedrock profiles, are differentiated at the Site for the purposes of this assessment (refer Riley engineering geology plans – Dwgs: 220372-207 to -209):

a. 'Deep mantle' – where the cumulative thickness of soils and lower-strength bedrock form a relatively 'deep mantle' to over 6m depth. This is inferred to be the predominant sequence across the west and mid-sections of the proposed development, (i.e. Jedburgh Station to the middle of Venlaw Forest, i.e. WTG MAT-08).

b. 'Shallow mantle' – where the combined thickness of soils and/or lower-strength bedrock profile is approximately 1m to 2m, and locally up to 4m (BH01) (i.e. relatively shallow depth to the top of blue-rock). Key areas within the Site where the 'shallow mantle' sequence is anticipated include:
    - The north-east half of Venlaw Forest (although there may be some notable areas of 'deep mantle' sequence within this area).
    - The high elevation plateau-like area at Jedburgh Station.
    - Locally along the mid and lower dip-slopes at the Site (refer Section 7.1.4).

Note: the deep and shallow mantle sequences present a generalised geotechnical model that are considered adequate for this Resource Consent level assessment. The deep and shallow mantle sequences are differentiated to facilitate description and discussion of a relatively complex and spatially variable geology across an extensive Site. The nature and extent of the geological profiles will be refined and amended during detailed design and construction monitoring.

7.1.2 Unconsolidated Near-Surface Soils

Near-surface soils and conditions anticipated at the Site are detailed in Table 3.

7.1.3 Lower-Strength Bedrock

In general, the near-surface soils are underlain by a mantle of lower-strength, and more-weathered, bedrock. This rock is typically very weak to weak, but locally extremely weak[7] (TP104 to TP106) and moderately strong examples are encountered. Figure 8 shows an approximately +4m thick exposure of lower-strength bedrock in a Venlaw Forest road cut.

Figure 8: Photo of Venlaw Forest road cut, waypoint 'OC-X2'. Exposure of 'lower-strength' bedrock consisting of very weak to weak sandstone with closely to very closely spaced joint sets – exposed in an over 4m high, moderately inclined cut slope (dashed area showing enlargement photo below).

[7] The extremely weak bedrock can be difficult to differentiate from overlying soils such as colluvium, and being more susceptible to erosion is likely to have been a source for the colluvium.

Table 3: Summary of Unconsolidated Near-Surface Soils

Unit	Typical Description	General Distribution and Thickness	In-Situ Tests		Comments
			Undrained Shear Strength	Scala Pen. (blows/ 100mm)	
Topsoil (*TS*)	Dark brown SILT, minor sand, typically trace organics and rootlets. Locally trace to minor amorphous organics/peaty zones (i.e. less than 20%), peat inclusions, and vegetation/rootlets (i.e. TP108, TP109 and TP114).	Ubiquitous across the Site. Ranges between approx. 0.1m to 0.7m thick, but typically less than 0.3m. Thinner deposits anticipated in the Venlaw Forest. Conversely, thicker deposits anticipated beneath the mid to higher elevations, and around the plateau-like area of Jedburgh Station.	-	-	
Fill (*Fl*)	Variable composition – from silt, clay or sand dominated to coarser rock fill. Generally considered non-engineered as deposits have uncertain and variable composition and compaction control.	Variable thickness and distribution. Generally, less than 1m to 1.5m underlying existing site roads and outside fill-shoulders (particularly in the Venlaw Forest). Thicker deposits in culverted gully crossings in the forest (i.e. 3m to 6m thick).	-	-	Likely to exhibit variable engineering compaction and quality control.
Recent Alluvium (*Qla*)	Deposited by confined water channel (gully stream or river). Not encountered by test pits. Anticipated to consist predominantly gravel and sand, with finer grained silt and clay.	Relatively thin deposits underlying larger gullies and main streams. Not encountered in subsurface investigations and not expected to be significant material encountered during construction of access roads of WTG platforms.	-	-	Inferred from geomorphology and general site observations. Unlikely to be encountered by majority of development works.
Colluvium (*Col*)	Mixed composition typically light yellowish-brown and ranging between a SILT, sandy SILT to silty SAND. Cohesive types (i.e. silts) are generally low plasticity. Some subordinate clay is anticipated, and locally subordinate angular gravels and cobbles may be present (particularly in the Venlaw Forest). Can be difficult to distinguish geologically from any underlying in-situ residual and completely weathered bedrock.	Not ubiquitous, but a common component of the near-surface 'soil' mantle across the Site. Generally, less than approx. 2m thick. Colluvium was encountered to depths of 1.1m (TP105) to 2.3m (TP103) with 0.6m thick layers at TP101 and TP107.	Peak = 75 to 90kPa Residual = 17 to 20kPa	0 to 9 (TP101, TP103-TP107)	May include deposits/component of wind-blown silt and fine sand (loess) deposited during the last glacial period.

Note: Soil units are not separately differentiated on the attached engineering geology plans.

The rock encountered within a few metres of the ground-surface is typically highly to moderately weathered, with increased weathering classes present locally (residual to completely weathered such as TP107). A normal weathering profile (i.e. reduced weathering with increasing depth) is generally present, and there are local observations of less-weathered core-stones (boulders to cobble size) within a more-weathered matrix. Inverted weathering profiles are very locally encountered (i.e. where a higher weathering class overlies less-weathered bedrock – such as at TP107). The weathering is anticipated to vary laterally over short distances – possibly reflecting changes in original sedimentary bedding composition and/or the influence of structure or rock mass defects.

The base of this lower-strength bedrock mantle varies significantly across the Site but typically ranges between approximately 1m and 8m below ground level (bgl), and in the extreme up to 16m depth (BH03).

The rock mass is primarily developed by intersecting, orthogonal, steeply, and gently inclined joint sets. These typically generate 50mm to 250mm blocks. Locally zones of closer spaced fractures (less than 20mm) are anticipated, which probably reflect deformation along sheared and crushed zones (ancient and geologically inactive bedrock faults).

7.1.4 Higher-Strength Bedrock

This bedrock profile predominantly consists of moderately strong to very strong and less-weathered, (i.e. moderately, slightly to unweathered – MWx, SWx, and UWx) material.

Rock mass and defects are like those for the 'lower strength' bedrock. However, in general wider-spaced joints, producing approximately 300mm to 1m-diameter blocks, are anticipated in the higher-strength bedrock (Figure 9 to Figure 11).

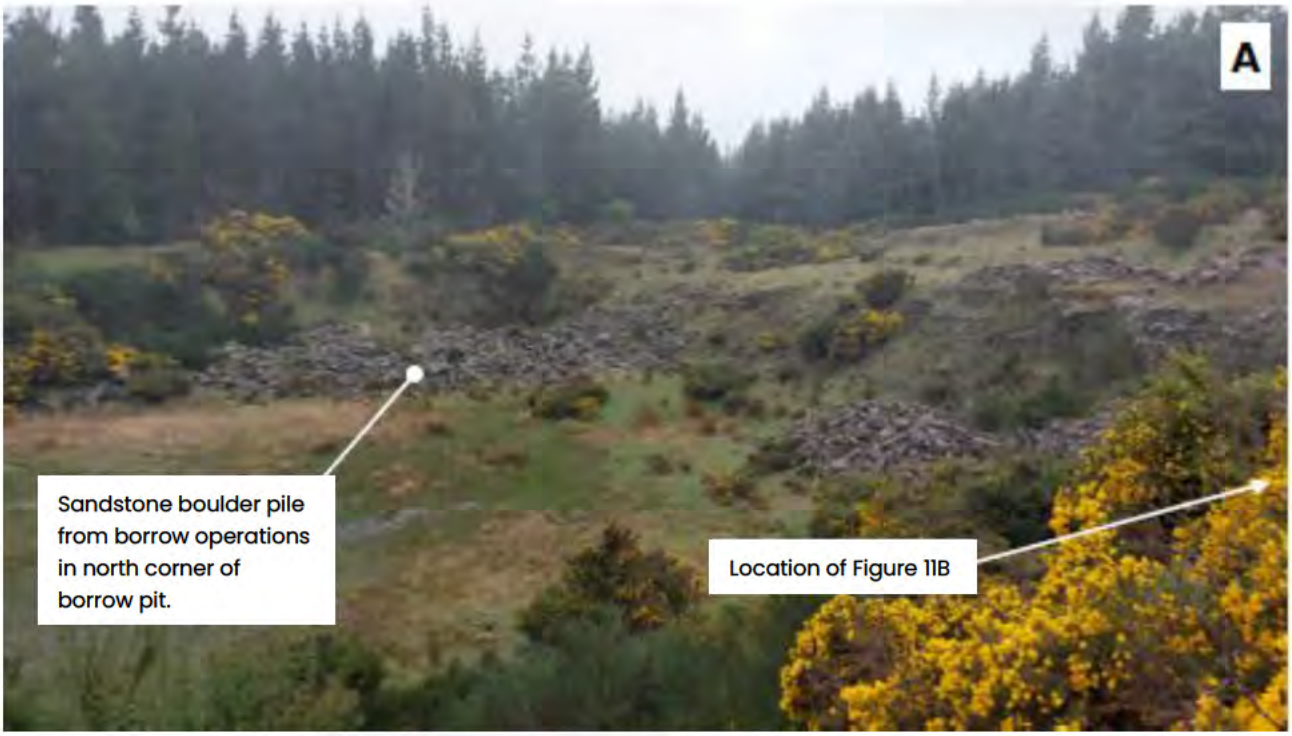
There are limited natural exposures of the higher-strength bedrock. It was observed, in the invert of the Mimihau Stream (South Branch) from Venlaw Road, and in the base of tributary gullies near the main Mimihau Stream valley. It was also observed locally on the margin of the high elevation plateau-like area at the Jedburgh Station (Figure 9, just north of WTG JED-28).

It is also locally exposed in cut slopes along Venlaw Road east (upstream) of Thornhill Road intersection. Two key cut exposures where higher-strength bedrock is near to the ground-surface (i.e. 'shallow mantle' sequence) within the Site are:

- Venlaw Forest historic rock borrow area – refer outcrop ID 'OC-R'.
- Jedburgh Station historic rock borrow area (silage pit) – refer outcrop ID 'OC-V'.

Figure 9: Photo of natural exposure of moderately strong to strong sandstone boulders ('blue-rock') on the strike-ridge at the south end of Jedburgh Station (just north of WTG JED-28) (Oct. 2022).

Figure 10: Photo of higher-strength bedrock in the east wall of an historic Jedburgh Station rock borrow area (silage pit), underlying approx. 1.5m of soil. Note bedding dipping approx. 10° to north subparallel to general dip-slope (waypoint ID 'OC-V') (Oct. 2022).



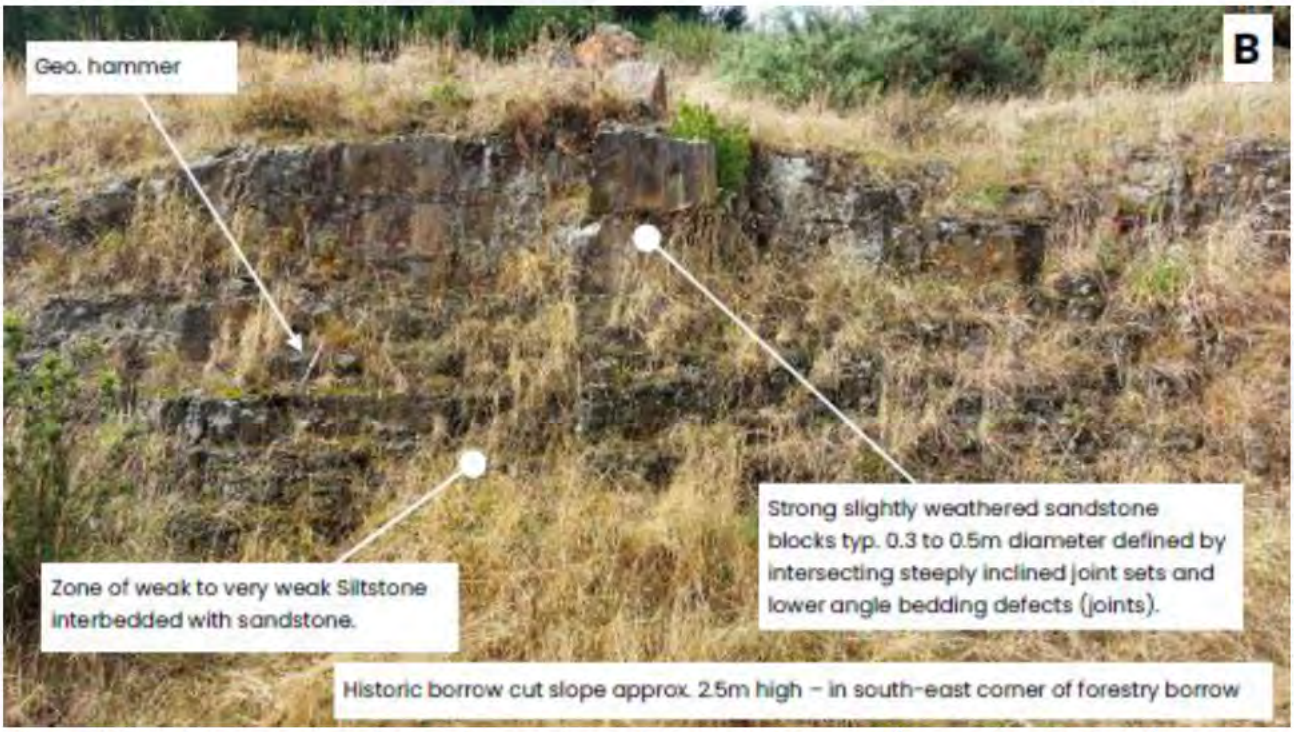


Figure 11A and 11B: Photos of historic rock borrow in Venlaw Forest (waypoint ID 'OC-R') exposing higher-strength bedrock. The borrow is approximately 60m x 80m and 4 to 5m deep (Figure 11A). Approximately 2m of lower-strength soil or bedrock was stripped to expose the top of higher-strength bedrock. Figures 11A and 11B were taken on 20 October 2022 and 21 February 2023, respectively.

7.2 Groundwater

Key observations and comments include:

- The groundwater regime at the Site is expected to be dominated by defects in the bedrock, with flows generally occurring along relatively higher permeability defects or interconnecting defects. As a result, the groundwater regime may be relatively complex vertically and laterally. We anticipate that the fundamental groundwater table is many metres below the ground level. This is supported by the absence of groundwater within the five machine boreholes that were each drilled to 20m depth. Perched water tables may be present locally at shallower depths in the bedrock. These could be potentially present above lower permeability siltstone (and/or zones of sandstone) with tight/low-permeability defects.
- Significant groundwater flows are not expected during bulk earthworks for the access road, turbine platform or turbine foundation excavations. Any seepage flows from perched water tables in bedrock are anticipated to reduce quickly and be managed during construction by surface drainage, or limited use of submersible pumps (i.e. in foundation excavations).
- The test pits generally did not encountered groundwater, (i.e. saturated ground or seepages). However, minor near-surface seepages were encountered in test pits on or near the Jedburgh plateau-like area (TP107, and TP109 to TP113). The seepages were generally at a shallow depth i.e. typically between 0.2m bgl (TP107) to 0.7m bgl (TP110). It is inferred that these seepages are issued from water tables perched on, and generally underlain by, inferred lower-permeability bedrock (i.e. higher-strength bedrock – Section 7.1.4.).

7.3 Faults and Folds

Faults mapped at and near the Site are geologically inactive (i.e. no movement within the last 125,000 years).

Several topographic lineaments have been identified at the Site (Riley Dwgs: 220372-205 and –206 included in Appendix F). These are inferred to be predominantly related to preferential weathering and erosion along steeply inclined large-scale structural defects/faults in the bedrock (continuous laterally for many hundreds of metres to kilometres). GNS have mapped an inactive fault intersecting the east part of the Site, which coincides with a long north-east to south-west trending lineament (refer lineament between WTG MAT-12 and MAT-14, Riley Dwg: 220372-206). The large-scale mapped structures generally align with deeper incised valleys. These areas are expected to be more associated with crushed zones and deeper weathering profiles within the rock mass (OC-H1 to OC-H4). Similarly, the test pit excavations TP105 to TP108 encountered 3.0m to 5.0m of soils/highly weathered material and are located near to an inferred lineament.

Subtle undulations in mapped bedding orientations suggest that at least two macro-scale gentle/open folds in the bedding across the Site – each with approximately north-west to south-east aligned fold axes. This is in general accordance with the QMAP (GNS, 2003).

Neither the faults, or folds, are likely to be a significant consideration for the proposed development, although as discussed above the rock and rock mass ground conditions nearer to the faults/lineaments may be associated with deeper weathering profile and relatively lower rock mass strength.

There is no evidence of recent or historic seismic activity (i.e. displacement) on the fault mapped through the Site or those mapped nearby.

8.0 Geotechnical Assessment

8.1 Slope Stability

8.1.1 General

We conclude that there is limited evidence of existing slope instability at the Site, and that with appropriate engineering design and construction works slope instability is not anticipated to be a significant consideration or constraint for the proposed development.

A limited number of possible landslides have been identified (refer Riley Dwgs: 220372-206, -208 and -209 included in Appendix F). This is based on desk top review of maps and the high-resolution DEM, although landslide 'A' is also identified on the regional QMAP (GNS, 2003) (refer Riley Dwg: 220372-205). The geomorphic basis of identifying the possible landslide features is considered sufficient for this assessment. This is supported by the low frequency of landslides noted and because none of the features (headscarp or debris) currently intersect either a proposed WTG or access road (although 'A', 'E', and 'G' are relatively close).

Detailed design should confirm the nature and characteristics (and presence) of slope instability at the Site, including the possible features identified (see below). This should consider treatment measures to either avoid or increase the stability of any features that are identified during detailed design to potentially affect, or de-stabilised by, the development.

8.1.2 Shallow-Seated Landslides

Possible shallow-seated existing natural landslides are not a significant feature at the Site. Such features generally have movement surfaces that are within a few metres of the ground-surface, and predominantly in lower-strength soils, and to a lesser extent bedrock. This type of slope instability is not anticipated on the gently inclined dip-slopes but could be present in moderate to steeper inclined gully side-slopes.

8.1.3 Rockfall

Rockfall instability (involving the collapse of steep hillslopes or bluffs along defects in competent bedrock exposed at/near the ground-surface). One possible rockfall (landslide ID 'H') is mapped close to the main strike-ridge in the headwaters of the Mimihau Stream South Branch. This location is at least 1.5km from the proposed development. The relative absence of bedrock exposures at the ground-surface indicates that rockfall instability is not a significant hazard at the Site.

8.1.4 Deeper-Seated Landslides

Eight possible deeper-seated landslides are mapped within or near the Site. Deeper-seated denotes features where the movement surface is anticipated to be greater than approximately five metres and possibly up to many tens of metres below the ground-surface (i.e. predominantly in bedrock). These landslides are noted on Riley Dwgs: 220372-206, -208 and -209 (landslide ID 'A' to 'G').

The possible deeper-seated landslides are inferred to be ancient and likely to have last moved during, or soon after, the last glaciation – when accelerated erosion and downcutting of gullies and streams would likely have removed toe support and initiated movement.

Most of the possible landslides are a few hundred to few thousand cubic metres of debris, and are located on the dip-slope, or gullies incised into the dip-slope. Debris is mapped at all possible landslides – suggesting that movement has not resulted in rapid reduction in shear strength (and evacuation) along the movement surface. Also, no evidence of recent regression of the headscarps has been observed. This suggests the debris features (debris and headscarps) are meta-stable under the current geotechnical conditions.

Features on the dip-slope may have movement surfaces along weaker and horizontally persistent defects subparallel to the gentle north-west to north bedding (i.e. bedding shears).

8.1.5 Stability of Back-Slopes

Instability of steeper back-slopes is not considered a significant hazard or consideration for the development.

Most of the Venlaw Forest property boundary is slightly down-slope of the Site strike-ridge, which acts as a 'legal' setback from the strike-ridge and back-slope in this area. The development (WTG and access tracks) gets closest to the lip of the back-slope in Jedburgh Station (between WTG JED-17, and JED-27 to JED-30) (Figure 12).

One possible deeper-seated landslide (ID 'G') is noted along the back-slope of Jedburgh Station between WTG JED-27 and JED-17. This inferred feature is approximately 500m wide (subparallel to the strike-ridge), with an estimated debris volume of a few thousand cubic metres. The inferred debris lobe is only partially displaced (i.e. not completely evacuated from the source area). The headscarp is a few tens of metres from the nearest road or WTG. No ground-cracks or evidence of recent ground movement was observed in this area, or north along the strike-ridge to WTG JED- 29.

No evidence has been encountered to preclude the proposed access road or WTG's near to the strike-ridge. However, it would be prudent, during detailed geometric design and layout, to set the works as far back from the lip of the back-slope (considering other environmental and civil engineering constraints etc.). Selected deep investigations should be considered during detailed design as part of confirming the degree of hazard and consideration slope stability is to the proposed development and develop appropriate mitigation measures (if any).

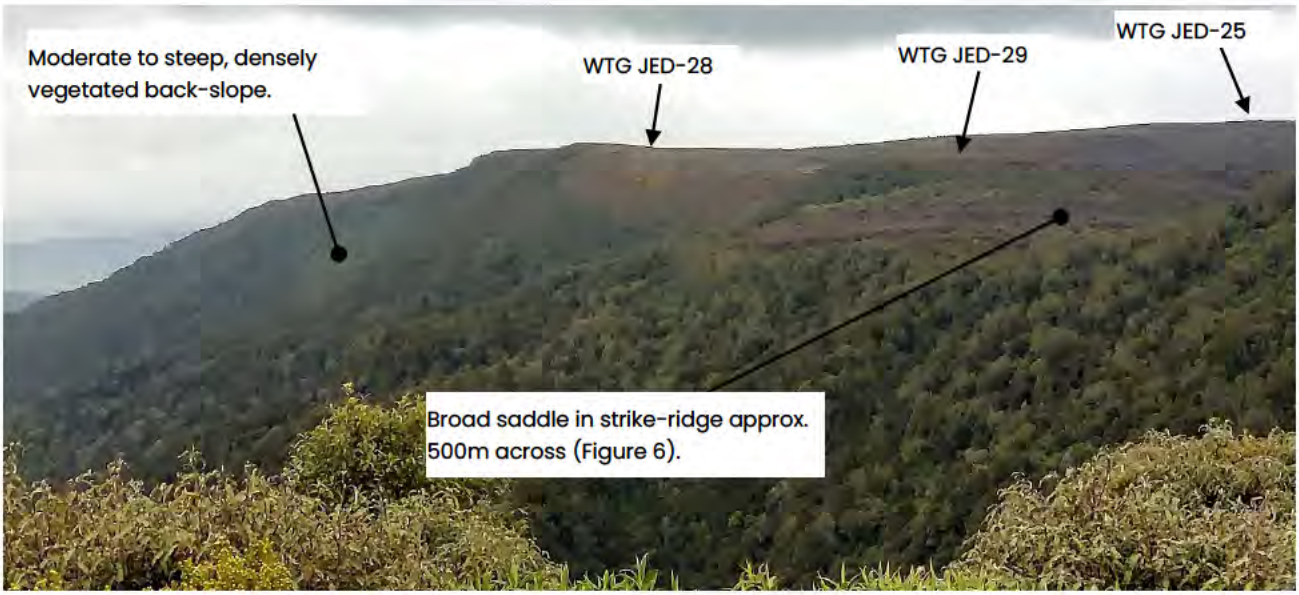


Figure 12: Photo looking south-west along the back-slope (left of frame) at Jedburgh Station. Taken from near to WTG MAT-01. WTG positions are approximate (Oct. 2022).

8.2 Seismicity

As noted above, there are no active faults mapped at or near the Site. The closest active faults shown on the QMAP (GNS, 2003) geological map are:

- Blue Mountain No. 1 Fault – located approximately 35km north-east.
- Clifton Fault – located approximately 38km north-east.
- Settlement Fault – located approximately 50km east.

The site is approximately 250km east of the major Fiordland Subduction Zone and Alpine Fault, which are the sources for a majority of the seismic hazard in the Southland region.

The New Zealand Seismic Hazard Model 2022 Revision indicates that the Site would be subject to a peak ground acceleration of between 0.2g and 0.3g during a 1 in 500-year event (for an Importance Level IL2 structure, i.e. domestic dwelling). Therefore, the seismic hazard at the Site is relatively low in New Zealand terms.

8.3 Liquefaction

Liquefaction typically occurs in lower strength, sand-dominated, and saturated soils under cyclic loading (i.e. large and long-duration earthquakes). Liquefaction of soil units is a very low to negligible risk to the proposed development. The composition of the soil units renders them of low to negligible susceptibility to liquefaction and in addition groundwater levels at the Site, are typically many metres below the ground surface.

8.4 Wet-Areas

Ecologists engaged by Contact Energy have identified 'high-value' areas at the Site and further differentiated 'wetland' areas within this classification (refer Riley Dwgs: 220372-206 to -209). The ecological wetland areas are predominantly located at the mid to higher-elevations of Jedburgh Station (around the plateau-like area in the south of the farm).

It is likely that many of the 'wet-areas' Riley noted during our fieldwork coincide with the ecological high-value wetland areas.

Some variability in the subsurface ground profile across the ecological wetlands is anticipated. In general, we anticipate a relatively thick organic-rich topsoil, i.e. up to approximately 0.7m (TP109) and typically less than 0.5m. The key pre-requisite geotechnical condition for the wetland appears to be low-permeability bedrock conditions (but soils may be present too) at shallow depth, which results in a near-surface perched water table (refer to groundwater description and discussion in Section 7.2).

As instructed, geometric design of access tracks have tried to avoid mapped wetlands for access tracks or turbine platforms. However, considering the Site topography, conditions may dictate practicable geometric alignments that cannot completely avoid all ecological wetland(s). Additional assessment may be required to confirm the ground and groundwater conditions at ecological wetlands and the impacts from the proposed development works (if any). 'Soft' and 'hard' engineering measures could be considered to reduce any identified impacts.

8.5 Earthworks

8.5.1 General

Earthwork cuts and fills will be required to provide access tracks that can accommodate construction equipment and oversized turbine delivery vehicles. Earthworks are expected, to:

- Upgrade existing public roads in the Site (Thornhill Road).
- Provide access tracks within the Site – of suitable horizontal and vertical geometry and grades to accommodate the over-dimension WTG component loads (particularly the blades).

Riley has undertaken a conceptual geometric design for Site access tracks and preliminary platform layout, with the latest update ca. June 2025 (refer to the 1000-series civil engineering drawings outlined in the Riley Dwg List Sheet: 220372-1000, dated June 2025).

The dip-slope inclination is generally favourable to lowering the earthworks (cut and fill) volumes required for the access tracks. In general, the access tracks have been located on broader ridgelines within the dip-slopes and where possible avoid gullies to reduce the earthworks volumes and civil engineering requirements.

Cut and fill depths for access tracks are generally less than a few metres across Jedburgh Station, Glencoe Station, and the west half of the Venlaw Forest. Cuts and fills can be up to approximately 6m where the tracks track around the side of a steeper gully hillslope.

Road cuts up to 10m may be required in the east of the Venlaw Forest, particularly to allow the access road to traverse in and out of the gully to cross the Mimihau Stream South Branch, (between WTG MAT-08 and MAT- 09).

Cuts and fill depths for the road and WTG platform hardstand formation levels vary substantially across the Site. These depths can be as low as 1m to 2m and up to 6m to 8m. This is influenced by the local topography at a WTG but is also significantly influenced by the orientation of the platform relative to the hillslope (cuts and fill depths are generally lower when the long axis of the WTG platform can be orientated subparallel to the existing ground contours).

8.5.2 Earthworks Excavation and Cut/Fill Slopes

- We expect that unconsolidated soils (beneath topsoil strip) and lower-strength bedrock (refer Section 7.1.3) will be readily excavated with appropriately sized diggers (i.e. 20t to +30t) using rock buckets. The contractor may elect to undertake pre-ripping of corestones or local higher-strength bedrock horizons to maintain, or increase, productivity.
- A relatively small proportion of the higher-strength bedrock may be productively excavated with larger excavators +/- limited pre-ripping – particularly rock with closer spaced defects. In our experience extensive pre-excavation works becomes necessary to maintain or increase productivity where the defects exceed around 0.3m to 0.5m spacing. This includes large excavator or bulldozer mounted single tine pre-ripping, or hydraulic rock breaking using a large excavator.

  Rock blasting may also be appropriate/necessary in higher-strength rock where wider spaced defects are present (i.e. greater than approximately 0.6m). The selection of pre-excavation techniques is site, and contractor, specific and can be influenced by the volume and depth of bedrock that requires excavation to achieve formation level.

  A preliminary assessment of the ability to excavate rock using empirical methods may be appropriate to inform tender and detailed design and may be supplemented with specific ripping and excavation trials of higher-strength bedrock.
- Cut/fill operations are optimized during tender and detailed design to the soil profile with preference given to maintaining cuts where possible. Preliminary cut and fill batter slopes are provided in Table 4.

Table 4: Preliminary Cut and Fill Batter Slopes (Subject to Confirmation During Detailed Design)

Batters	(V:H)	Inclination +/- horizontal (°)
Cut – Near-surface soils (includes Residual to Highly weathered rock)	1 : 1.75	30
Cut – Lower-Strength Bedrock profile (i.e. very weak to weak)	1 : 1	45
Cut – Higher-strength bedrock profile (i.e. mod. strong to strong)	2 : 1	63
Fill (engineered soil and rock fill)	1 : 3	18

- The preliminary design suggests overall permanent cut heights up to 7m and fills up to 6m may be required for the access tracks. The greatest heights of cut and fill around the proposed turbine platforms are generally 3m to 4m. The proposed turbine platforms are typically oriented to minimise filling.
- Where filling is necessary, the stability of the fill material in relation to the overall slope should be considered. This may involve the removal of unsuitable material, (i.e. organics, or lower strength soil or rock), appropriately keying the base of fill into the slope, adequate compaction, and moisture conditioning of the fill. Drainage within the fill may also need to be considered to ensure suitable factors of safety are achieved for the fill.
- Rock batters may not require benching.
- Local spalling and wedge failures may occur from the batter slopes, particularly where joint and cut slope orientations are adverse. This is not anticipated to be a major consideration to an appropriately experienced contractor or for the development.
- Existing steeply inclined cuts standing at 55° to 60° on-site within soils have been noted during the site mapping. This suggests the proposed batter angle may be reasonably conservative for the Site soils.

8.5.3 Anticipated Conditions Across the Site

A site-specific assessment of the anticipated ground conditions, and geotechnical considerations, for individual WTG or access road sections is not detailed in this report. Guidance on the general anticipated conditions across the Site is provided in Table 5.

Table 5: Anticipated General Ground Conditions Across the Site

Geotechnical Sequence [1]	General Anticipated Ground Conditions	
	Road Earthworks and WTG Hardstands	WTG Foundations
Deep mantle	Unconsolidated soils and a lower-strength bedrock profile are expected in the majority of road and platform cuts across these areas. Engineered fill can be founded on approved soils and lower-strength bedrock.	Predominantly soils or lower-strength bedrock anticipated from hardstand to foundation invert across these areas of Site.
Shallow mantle	Higher-strength bedrock anticipated at shallow depth across these areas, i.e. predominantly in north-east end of Venlaw Forest and at/near the plateau-like area at Jedburgh Station.	High percentage of foundation excavations, (i.e. from hardstand level to foundation invert) anticipated to be through higher-strength bedrock. Some lower-strength bedrock and soils are likely to be encountered.

Notes:
1. Refer Section 7.0 and Riley Dwg: 220372-207 to -209 for discussion of geotechnical units and anticipated extent across the Site.

8.5.4 Earthworks Materials

Engineered fill will be required for access tracks and platforms. All cut materials except topsoil and organics can be used for bulk fill (i.e. soils, lower-strength bedrock, and higher-strength bedrock).

The earthworks will be undertaken in accordance with the detailed design, earthworks specification, and quality control programme. Some conditioning and moisture control work (i.e. drying) of colluvium may be necessary to use this material for bulk fill. Rock fill blocks may need breaking/screening to conform to grading specifications.

Better quality bedrock fill may be selected and used as a rock fill cap to bulk earthwork fill across the hardstands and where weaker and finer-grained subgrade soils are present.

Preliminary compaction tests on selected soils indicate that these will be suitable as engineered fill, with minor conditioning of moisture content. Further sampling and laboratory tests on soil and rock materials will be conducted as the project progresses during detailed design.

8.5.5 Layout of Access Tracks and Platforms

Access tracks and turbine foundations should wherever practicable be kept close to the higher ground along the dip-slopes and ridgelines. This is likely to minimise the degree/volumes of cut and fill required to achieve design grades and horizontal curves.

The potential for earthworks cut to remove toe support from hillslopes should be assessed during detailed design in conjunction with confirmation of the access road and turbine layout.

8.5.6 Turbine Foundations

We anticipate that turbine foundations will be a reinforced concrete pad (in our experience these can be approximately 20m-diameter and up to 3m deep below the surrounding platform level). Ground conditions may vary in places but foundations on the rock will have adequate bearing strength and acceptable settlement. For foundations on soils either lowered bearing capacity can be applied or undercut to more competent material if this option is available. Foundations will be confirmed during detailed design.

8.6 Aggregates

Specialist aggregates will be required during construction. Two main aggregate uses include:

- Road pavements, including basecourse (surfacing layer) and the underlying sub-base layers.
- Concrete.

8.6.1 Pavement Aggregate for Site Tracks and Platforms

Site-won competent blue-rock sandstone, encountered during excavations for tracks, WTG platforms, and turbine foundations, is expected to produce pavement aggregate suitable for use on Site tracks and WTG platforms (refer Section 7.1.4). However, blue-rock may not be encountered in significant quantities during the bulk earthworks to provide all the pavement aggregate for the wind farm (subject to confirmation during detailed design). In this instance suitable imported pavement will be required to supplement, or provide all, the pavement aggregate requirements during construction. The civil engineering assessment for this resource consent application conservatively assumes that all pavement aggregate is imported. Details of potential off-site pavement aggregate quarries are provided in Riley's civil engineering report (which accompanies this geotechnical assessment).

As noted above preliminary laboratory aggregate tests undertaken on selected samples from existing borrows in the Jedburgh Station and Venlaw Forest support this assessment (Section 6.0). Selected Site-won blue-rock is expected to readily satisfy pavement aggregate crushing resistance requirements but can have poorer durability (weathering) characteristics. Such characteristics are known for Murihiku Supergroup terrane rocks in Southland. However, this does not necessarily prevent use of selected blue-rock for Site-won pavement aggregate. We understand that increased frequency of period maintenance may be required after construction is completed.

Mobile crushing and screen plant(s) will be required to process excavated blue-rock sandstone to products, i.e. general all passing 65mm (GAP65) or GAP40 material. Careful selection and grade control will be required to provide a consistent and quality aggregate. Siltstone interbeds in the bedrock are unlikely to provide suitable and durable aggregate and would need to be generally separated from the sandstone (if encountered) during excavation.

8.6.2 Concrete Aggregate Supply

Site-won aggregate (from blue-rock) is not considered suitable for structural concrete or the WTG foundations at the Site. Concrete aggregate (coarse aggregate and sand) will all need to be imported from suitable nearby quarries.

8.7 Surplus Fill Disposal Sites

Geometric design of access tracks and turbine hardstands should aim to balance cut and fill volumes. However, it is anticipated that several surplus fill disposal sites (SFDS) will be required across the Site during construction, for surplus and any unsuitable fill.

In our experience gully heads close to the areas of surplus fill – provide the most efficient storage volumes for footprint. However, we understand that environmental considerations are restricting the use of gully head SFDS. Notwithstanding this we provide the following general, and geotechnically focused comments.

Key design and construction principles for gully head SFDS include:

- After undertaking appropriate erosion and sediment control preparatory works and site stripping, a specifically designed engineered embankment would be constructed, using selected fill, at the toe of the surplus gully fill.
- Adequate subsoil drainage measures shall be installed to ensure pore pressures in the in-situ and fill material do not increase to levels where the slope stability of the fill site is dangerously reduced. Such measures should include placement of surface cut-off channels above the fill areas and subsurface drains. Infilling behind the toe embankment is undertaken by placing the surplus material in maximum lifts and track rolling (i.e. this is non-engineered fill). The top/finished fill surface should be uniformly sloped (i.e. generally flatter than 1V:10H) to convey stormwater from the areas and prevent water ponding on the filled ground surface.

SFDS could also be established at selected dip-slope locations (i.e. not involving gully heads). This type of SFDS is not preferred, from a geotechnical perspective, as they are less efficient (i.e. a dip-slope type SFDS would require significantly greater earthworks disturbance through topsoil stripping, and erosion and sediment control work, for the same fill volume compared to a gully head type SFDS).

The location, general design features and specification for SFDS should be confirmed during detailed design. Ideally, any SFDS should be at practicable location(s) to minimise haul distances from source areas.

9.0 Conclusions and Recommendations

Riley has undertaken a feasibility level geotechnical site investigation and assessment for the Southland Wind Farm, accessed from Venlaw Road. Key findings and conclusions include:

- No geotechnical fatal flaws have been identified with respect to the proposed development.
- Ground conditions vary laterally and vertically across the Site. The ground profile consists of variable sequences of near-surface 'unconsolidated soils' underlain by more-weathered 'lower-strength' bedrock. These units are underlain by less-weathered 'higher-strength' bedrock (also referred to as 'blue-rock').

  Two ground sequences differentiated include:

  - 'Deep mantle' – where the cumulative thickness of soils and lower-strength bedrock form a relatively 'deep mantle' to generally over 6m depth. This is inferred to be the predominant sequence across the west and mid-sections of the proposed development (Jedburgh Station, Glencoe Station, through to the middle of Venlaw Forest, WTG MAT-08).
  - 'Shallow mantle' – where the combined thickness of 'soils' and/or lower-strength bedrock profile is approximately 1m to 2m and locally up to 4m (i.e. higher-strength bedrock is likely to be encountered typically within a couple of metres of the ground-surface).

- To date, Contact has not engaged Riley to incorporate the additional/ca. 2024 investigations into the interpretative geotechnical assessment for the development. We understand that Contact intends to undertake the next phase of geotechnical interpretation and assessment, once Resource Consent is confirmed for the project. However, from our initial (broader-level) appraisal of the findings we do not consider that these will materially, and detrimentally, alter our current assessment and conclusions.
- Locally 'perched' (i.e. shallow depth below ground-surface) groundwater zones may be encountered during construction. However, the general groundwater table, which is primarily controlled by water seeping through defects (cracks) in bedrock, is expected at many metres to tens of metres below the ground-surface. Groundwater inflows to cuts are not expected to be a significant consideration for the development.

  Localised near-surface perched aquifers are anticipated at the Site (predominantly southern parts of the Jedburgh Station). These are likely to be predominantly present over low permeability bedrock (and to a lesser degree soils). These are inferred to relate to 'wet-areas' we observed at the ground-surface, and to 'high-value' wetland areas mapped separately by ecologists.
- There is limited evidence of existing slope instability at the Site, and with appropriate engineering design and construction works the development should not result in any effective reduction in the slope instability. Areas where the access tracks and turbines are located close to existing moderate to steep hillslopes should be focus areas during detailed design.
- No active faults have been mapped within the Site footprint, and the seismic hazard at the Site is relatively low in New Zealand terms.
- Liquefaction of low-strength and saturated soils is not considered to be a risk at this Site. The general groundwater table is many metres below the ground-surface, and the composition of the soils indicate a low to negligible susceptibility to liquefaction also.
- Bulk earthworks cuts for most access roads and turbine platforms are expected to predominantly encounter soils and lower-strength bedrock (i.e. deep-mantle sequence). Higher-strength bedrock is anticipated to be encountered near to the ground surface around the plateau-like area at the south end of Jedburgh Station, and in the north-east of the Venlaw Forest.
- We expect that unconsolidated soils and lower-strength bedrock will be readily excavated with appropriately sized diggers (i.e. 20t to +30t) using rock buckets. The Contractor may elect to undertake pre-ripping of corestones or local higher-strength bedrock horizons to maintain, or increase, productivity.

  Heavy pre-excavation works will be necessary to productively excavate some of the stronger rock with wider spaced defects (i.e. where defects in the higher-strength bedrock exceed approximately 0.3m to 0.5m spacing). Such measures include heavy pre-ripping (i.e. single tine on large excavator or bulldozer) or a hydraulic rock breaker attachment on a large excavator.

Pre-excavation blasting works may also be appropriate/necessary to efficiently excavate higher-strength rock where wider spaced defects are present (i.e. greater than approximately 0.6m). Blasting works may also be required to win blue-rock pavement aggregate from on-Site borrows (if any).

The selection of pre-excavation techniques is site, and contractor, specific and can be influenced by the volume and depth of bedrock that requires excavation to achieve formation level.

- Engineered fill will be required for access tracks and platforms. All cut materials except topsoil and organics can potentially be used for bulk fill (i.e. soils, lower-strength bedrock, and higher-strength bedrock). The earthworks will be undertaken in accordance with the detailed design, earthworks specification, and quality control programme. Some moisture control works, (i.e. drying) may be necessary with colluvium to achieve close to optimum moisture content. Rock fill blocks may need breaking to conform to grading specifications for this material.

  We anticipate that turbine foundations will be a reinforced concrete pad (in our experience these can be approximately 20m-diameter and up to 3m below the surround WTG platform level). Foundations on the rock will have adequate bearing strength and acceptable settlement. For foundations on soils either lowered bearing capacity can be applied or undercut to more competent material if this option is available. For soil type material foundation stiffness may be a constraint and would require specific consideration in design. Foundations will be confirmed during detailed design.

- Site-won competent blue-rock sandstone, encountered during excavations for tracks, WTG platforms, and turbine foundations, is expected to produce pavement aggregate suitable for use on Site tracks and WTG platforms (refer Section 7.1.4). However, blue-rock may not be encountered in significant quantities during the bulk earthworks to provide all the pavement aggregate for the wind farm (subject to confirmation during detailed design). In this instance suitable imported pavement will be required to supplement, or provide all, the pavement aggregate requirements during construction. The civil engineering assessment for this resource consent application conservatively assumes that all pavement aggregate is imported and includes details of potential off-site quarry sources and estimates of truck and trailer unit movements for imported pavement aggregate.
- All concrete aggregates will need to be imported from suitable nearby quarries.
- Surplus fill disposal sites will be required during construction at many locations across the Site. These should be constructed to a general design and specification confirmed during detailed design (including surface and subsoil drainage). The location of any surplus fill disposal sites should be a practicable location(s) to minimise haul distances from source areas.

9.1 Recommendations for Additional Geotechnical Investigations

Additional investigations are recommended to support and enable the next stage(s) of design e.g. Tender Design then Detailed Design. The purpose of these additional investigations is to confirm the ground and groundwater conditions, and horizontal and vertical variability across the Site, and allow a refined assessment of design and specification of various CBoP and EBoP elements (including temporary and permanent works). The investigation programme should be developed and spaced to allow appropriate assessment of existing and new Site access tracks (including farms and forests), turbine platforms and foundations, transmission route tracks and towers, and compounds and foundations for construction (temporary) and permanent plant and facilities. Investigation types that Contact could consider, and which may be best undertaken in stages, include (but may not be limited to):

- Geological mapping of exposures across the Site (possibly up to one week in the field for experienced engineering geologist(s) – considering the size of the Site).
- Machine test pits along the access tracks and at many of the turbine locations. The location and spacing of pits along the road should be sufficient to adequately resolve the geotechnical conditions, i.e. there may be sections where pits are required at greater or lesser frequency.
- Deep machine cored boreholes – generally across many of the turbine locations, (i.e. to depths of approximately 20m).
- Cored boreholes to investigate the subsurface consistency of potential on-Site blue-rock borrow locations.
- Machine cone penetration test (CPT) soundings. These are more appropriate through deeper sequences of soil and weakest rock.
- Field earthworks cut and fill compaction trials. Field trials of plate bearing tests (PBT) on in-situ and preliminary design rock cap and pavements. This will confirm the suitability of the design and allow value engineering of pavement thickness to be undertaken.
- Laboratory tests on selected soil and rock (i.e. classification, compaction, California Bearing Ratio) to inform pavement design, etc.
- Geophysics techniques (ground-surface and downhole) image variability and consistency of the ground and geotechnical conditions along the route and/or at turbine locations Geophysics can provide a useful 'infill' investigation between subsurface investigation locations but requires calibration with subsurface investigations (test pits and boreholes).

Some of the above investigations have been progressed across the Site by the Stage 2 programme Contact commissioned in 2024.

10.0 Limitation

This report has been prepared for Contact Energy Limited (Contact), to inform the Expert Consenting Panel's consideration of Contact's application for approvals under the Fast-track Approvals Act 2024 and any subsequent regulatory processes.

Recommendations and opinions in this report are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

During excavation and construction, the Site should be examined by an engineer or engineering geologist competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. It is possible that the nature of the exposed subsoils may require further investigation, and the modification of the design is based upon this report.

Riley Consultants Ltd would be pleased to provide this service to Contact Energy Ltd and considers that the project would benefit from such continuity. In any event, it is essential that Riley Consultants Ltd is contacted if there is any variation in subsoil conditions from those described in the report as it may affect the design parameters recommended in the report.

Appendix A

Logging Explanation and Abbreviations

RILEY

Christchurch:
22 Moorhouse Ave. Addington, Christchurch 8011
PO Box 4355, Christchurch 8140
Tel. 03 379 4402 Email: rileychch@riley.co.nz

Auckland:
4 Fred Thomas Drive, Takapuna, Auckland 0622
PO Box 100253, North Shore, Auckland 0745
Tel. 09 489 7872 Email: riley@riley.co.nz

GEOTECHNICAL AND GEOLOGICAL INFORMATION

SOIL TYPES AND SYMBOLS


FILL


TOPSOIL


SILT


SAND


GRAVEL


CLAY


PEAT


GROUNDWATER LEVEL


10,11,10

SCALA PENETROMETER
LAST 3 NUMBER OF BLOWS PER 50mm INCREMENT

ROCK TYPES AND SYMBOLS


SANDSTONE


SILTSTONE


MUDSTONE


LIMESTONE


BASALT


TUFF


IGNIMBRITE


GREYWACKE

SOIL STRENGTH CLASSIFICATION

FINE GRAINED COHESIVE SOILS

TERM	FIELD IDENTIFICATION	UNDRAINED SHEAR STRENGTH (KPa)
Very Soft (Vs)	Exudes between fingers when squeezed.	<12
Soft (S)	Easily indented by fingers.	12 – 25
Firm (F)	Indented only by strong finger pressure.	25 – 50
Stiff (St)	Indented by thumb pressure.	50 – 100
Very Stiff (VSt)	Indented by thumbnail.	100 – 200
Hard (H)	Difficult to indent by thumbnail.	200+

SPT & SCALA PENETROMETER RESULTS

TERM	SPT VALUE No. of BLOWS/300mm	SCALA PENETROMETER No. of BLOWS/100mm
very dense	>50	17+
dense	30 – 50	7 – 17
medium dense	10 – 30	3 – 7
loose	4 – 10	1 – 3
very loose	0 – 4	0 – 2

ROCK STRENGTH CLASSIFICATION

TERM		FIELD IDENTIFICATION	UNCONFINED UNIAXIAL COMPRESSIVE STRENGTH (MPa)
Extremely weak	(EW)	Indented by thumbnail.	< 1
Very weak	(VW)	Crumbles under firm blows with point of geological hammer. Can be peeled with pocket knife.	1 – 5
Weak	(W)	Difficult to peel with pocket knife.	5 – 20
Moderately strong	(MS)	Cannot be scraped or peeled with pocket knife.	20 – 50
Strong	(S)	More than one blow of geological hammer to fracture.	50 – 100
Very strong	(VS)	Many blows of geological hammer to break.	100 – 250
Extremely strong	(ES)	Can only be chipped with geological hammer.	250+

MOISTURE CONDITION

Dry (D)	Looks and feels dry; powdery and friable.
Moist (M)	Feels cool; darkened in colour; no free water when remoulded.
Wet (W)	Feels cool; darkened in colour; free water forms on hands.
Saturated (S)	Free water is present on sample.

SAMPLE TYPES


UNDISTURBED


MACHINE AUGER DISTURBED

HAND AUGER DISTURBED


STANDARD PENETRATION TEST (solid cone)


STANDARD PENETRATION TEST (hollow cone)

DRILLING METHOD

OB	OPEN BARREL
TT	TRIPLE TUBE
WB	WASH BORE
SH	UNDISTURBED SHELBY TUBE
RC	ROCK CORE
SPT	STANDARD PENETRATION TEST

FIELD TESTS

V	SHEAR VANE (corrected to BS:1377)
R	REMOULDED STRENGTH
P	POCKET PENETROMETER
CH	CLEGG HAMMER

INFORMATION BASED ON THE NZ GEOTECHNICAL SOCIETY INC. GUIDELINES FOR THE CLASSIFICATION AND DESCRIPTION OF SOIL AND ROCK FOR ENGINEERING PURPOSES

NZ GEOTECHNICAL SOCIETY INC

ROCK > field guide sheet

FIELD DESCRIPTION OF ROCK

SEQUENCE OF TERMS – weathering – colour – fabric – rock name – strength – discontinuities – additional

SCALE OF ROCK MASS WEATHERING

Term	Grade	Abbreviation	Description
Unweathered (fresh rock)	I	UW	Rock mass shows no loss of strength, discolouration or other effects due to weathering. There may be slight discolouration on major rock mass defect surfaces or on clasts.
Slightly Weathered	II	SW	The rock mass is not significantly weaker than when fresh. Rock may be discoloured along defects, some of which may have been opened slightly.
Moderately Weathered	III	MW	The rock mass is significantly weaker than the fresh rock and part of the rock mass may have been changed to a soil. Rock material may be discoloured and defect and clast surfaces will have a greater discolouration, which also penetrates slightly into the rock material. Increase in density of defects due to physical disintegration.
Highly Weathered	IV	HW	Most of the original rock mass strength is lost. Material is discoloured and more than half the mass is changed to a soil by chemical decomposition or disintegration (increase in density of defects/fractures). Decomposition adjacent to defects and at the surface of clasts penetrates deeply into the rock material. Lithorelicts or corestones of unweathered or slightly weathered rock may be present.
Completely Weathered	V	CW	Original rock strength is lost and the rock mass changed to a soil either by decomposition (with some rock fabric preserved) or by physical disintegration.
Residual Soil	VI	RS	Rock is completely changed to a soil with the original fabric destroyed (pedological soil).

ROCK STRENGTH TERMS

Term	Field Identification of Specimen	Unconfined uniaxial compressive strength q_u (MPa)	Point load strength $I_{s(50)}$ (MPa)
Extremely strong	Can only be chipped with geological hammer	> 250	>10
Very strong	Requires many blows of geological hammer to break it	100 – 250	5 – 10
Strong	Requires more than one blow of geological hammer to fracture it	50 – 100	2 – 5
Moderately strong	Cannot be scraped or peeled with a pocket knife. Can be fractured with single firm blow of geological hammer	20 – 50	1 – 2
Weak	Can be peeled by a pocket knife with difficulty. Shallow indentations made by firm blow with point of geological hammer	5 – 20	<1
Very weak	Crumbles under firm blows with point of geological hammer. Can be peeled by a pocket knife	1 – 5	
Extremely weak (soil description required)	Indented by thumb nail or other lesser strength terms used for soils	<1	

Note: • No correlation is implied between q_u and $I_{s(50)}$

SPACING OF DEFECTS/ DISCONTINUITIES

Term	Spacing
Very widely spaced	>2 m
Widely spaced	600 mm – 2 m
Moderately widely spaced	200 mm – 600 mm
Closely spaced	60 mm – 200 mm
Very closely spaced	20 mm – 60 mm
Extremely closely spaced	<20 mm

APERTURE OF DISCONTINUITY SURFACES

Term	Aperture (mm)	Description
Tight	Nil	Closed
Very Narrow	> 0 – 2	
Narrow	2 – 6	
Moderately Narrow	6 – 20	Gapped
Moderately Wide	20 – 60	Open
Wide	60 – 200	
Very Wide	> 200	

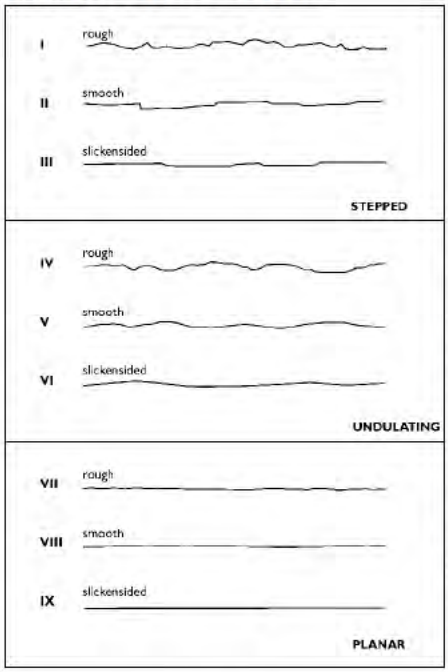
BEDDING THICKNESS TERMS

Term	Bed Thickness
Thinly laminated	< 2 mm
Laminated	2 mm - 6 mm
Very thin	6 mm - 20 mm
Thin	20 mm - 60 mm
Moderately thin	60 mm - 200 mm
Moderately thick	0.2 m - 0.6 m
Thick	0.6 m - 2 m
Very thick	> 2 m

BEDDING INCLINATION TERMS

Term	Inclination (from horizontal)
Sub-horizontal	0° – 5°
Gently inclined	6° – 15°
Moderately inclined	16° – 30°
Steeply inclined	31° – 60°
Very steeply inclined	61° – 80°
Sub-vertical	81° – 90°

ROUGHNESS AND APERTURE



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NZ GEOTECHNICAL SOCIETY INC

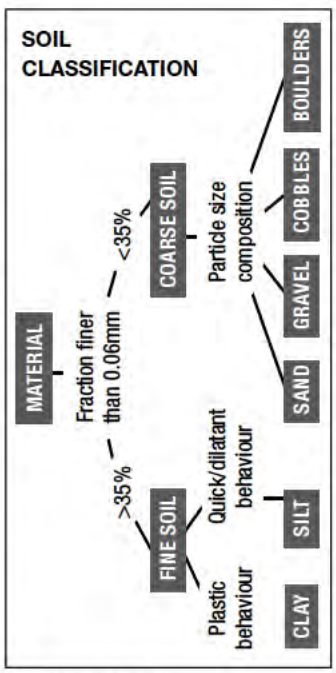
SOIL > field guide sheet

FIELD DESCRIPTION OF SOIL

SEQUENCE OF TERMS – fraction – colour – structure – strength – moisture – bedding – plasticity – sensitivity – additional

GRAIN SIZE CRITERIA

TYPE	COARSE								FINE		ORGANIC
	Boulders	Cobbles	Gravel			Sand			Silt	Clay	Organic Soil
			coarse	medium	fine	coarse	medium	fine			
Size Range (mm)	200		60	20	6	2	0.6	0.2	0.06	0.002	
Graphic Symbol											



PROPORTIONAL TERMS DEFINITION (COARSE SOILS)

Fraction	Term	% of Soil Mass	Example
Major	(….) [UPPER CASE]	≥ 50 [major constituent]	GRAVEL
Subordinate	(….) y [lower case]	20 – 50	Sandy
Minor	with some … with minor …	12 – 20 5 – 12	with some sand with minor sand
	with trace of (or slightly)…	< 5	with trace of sand (slightly sandy)

DENSITY INDEX (RELATIVE DENSITY) TERMS

Descriptive Term	Density Index (R_D)	SPT "N" value (blows / 300 mm)	Dynamic Cone (blows / 100 mm)
Very dense	> 85	> 50	> 17
Dense	65 – 85	30 – 50	7 – 17
Medium dense	35 – 65	10 – 30	3 – 7
Loose	15 – 35	4 – 10	1 – 3
Very loose	< 15	< 4	0 – 2

Note: • No correlation is implied between Standard Penetration Test (SPT) and Dynamic Cone Test values.
• SPT "N" values are uncorrected. • Dynamic Cone Penetrometer (Scala)

CONSISTENCY TERMS FOR COHESIVE SOILS

Descriptive Term	Undrained Shear Strength (kPa)	Diagnostic Features
Very soft	< 12	Easily exudes between fingers when squeezed
Soft	12 – 25	Easily indented by fingers
Firm	25 – 50	Indented by strong finger pressure and can be indented by thumb pressure
Stiff	50 – 100	Cannot be indented by thumb pressure
Very stiff	100 – 200	Can be indented by thumb nail
Hard	200 – 500	Difficult to indent by thumb nail

ORGANIC SOILS/ DESCRIPTORS

Term	Description
Topsoil	Surficial organic soil layer that may contain living matter. However topsoil may occur at greater depth, having been buried by geological processes or man-made fill, and should then be termed a buried topsoil.
Organic clay, silt or sand	Contains finely divided organic matter; may have distinctive smell; may stain; may oxidise rapidly. Describe as for inorganic soils.
Peat	Consists predominantly of plant remains. ***Firm***: Fibres already compressed together ***Spongy***: Very compressible and open stucture ***Plastic***: Can be moulded in hand and smears in fingers ***Fibrous***: Plant remains recognisable and retain some strength ***Amorphous***: No recognisable plant remains
Roolets	Fine, partly decomposed roots, normally found in the upper part of a soil profile or in a redeposited soil (e.g. colluvium or fill)
Carbonaceous	Discrete particles of hardened (carbonised) plant material.

MOISTURE CONDITION

Condition	Description	Granular Soils	Cohesive Soils
Dry	Looks and feels dry	Run freely through hands	Hard, powdery or friable
Moist	Feels cool, darkened in colour	Tend to cohere	Weakened by moisture, but no free water on hands when remoulding
Wet			Weakened by moisture, free water forms on hands when handling
Saturated	Feels cool, darkened in colour and free water is present on the sample		

PLASTICITY (CLAYS & SILTS)

Term	Description
High plasticity	Can be moulded or deformed over a wide range of moisture contents without cracking or showing any tendency to volume change
Low plasticity	When moulded can be crumbled in the fingers; may show quick or dilatant behaviour

GRADING (GRAVELS & SANDS)

Term	Description	
Well graded	Good representation of all particle sizes from largest to smallest	
Poorly graded	Limited representation of grain sizes - further divided into:	
	Uniformly graded	Most particles about the same size
	Gap graded	Absence of one or more intermediate sizes

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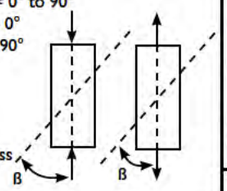
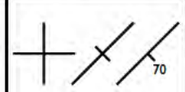
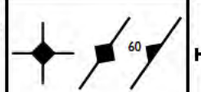
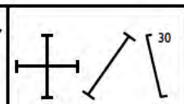
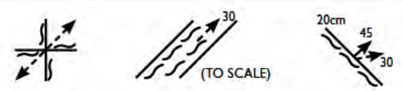
Table 3.6 Range of Geological Features that Form Discontinuities (or defects) in Rock Masses

TERM[1] GENERAL / SPECIFIC	LAYERING (LAYER) [2]			FRACTURES AND FRACTURED ZONES		WEAK SEAMS OR ZONES		
	BEDDING	FOLIATION	CLEAVAGE	JOINT	SHEARED ZONE	CRUSHED SEAM/ZONE	DECOMPOSED SEAM/ZONE	INFILLED SEAM/ZONE
PHYSICAL DESCRIPTION	Arrangement in layers, of mineral grains of similar sizes or composition, and/or arrangement of elongated or tabular minerals, near parallel to one another, and/or to the layers. Generally no microfractures	Discontinuous microfractures may be present, near parallel to the layering		A discontinuity or crack: planar curved or irregular across which the rock has little tensile strength. The joint may be open (filled with air or water) or filled by soil substances or by rock substance which acts as a cement. Joint surfaces may be rough, smooth or slickensided.	Zone, with roughly parallel planar boundaries, of rock material intersected by closely spaced (generally <50mm) joints and/or microscopic fracture (cleavage) planes. The joints are at small angles to the zone boundaries; they are slightly curved and divide the mass into unit blocks of lenticular or wedge shape. Their surfaces are smooth or slickensided. Type R ranging to Type S → Joints tightly closed, cemented but cements (usually chlorite or calcite) are weaker than the rock substance. / Joints are cemented but either coated with soil substances or are open, filled with air and/or water.	Zone with roughly parallel planar boundaries, composed of disoriented, usually angular fragments of the host rock substance. The fragments may be of clay, silt, sand or gravel sizes or mixtures of any of these. Some minerals may be altered or decomposed but this is not necessarily so. Boundaries commonly slickensided.	Zone of any shape, but commonly with roughly parallel planar boundaries in which the rock material is discoloured and usually weakened. The boundaries with fresh rock are usually gradational. Geological structures in the fresh rock are usually preserved in the decomposed rock. "Weathered" and "altered" are more specific terms.	Zone, of any shape, but commonly with roughly parallel planar boundaries composed of soil substance. May show layering roughly parallel to the zone boundaries. Geological structures in the adjacent rock do not continue into the infill substance.
ENGINEERING PROPERTIES [3,4]	• Where uniformly developed in a rock substance any of these types of structure render that rock substance anisotropic in its behaviour under stress • Comprehensive strengths and initial shear usually { min when ß = 30° to 45° / max when ß = 0° to 90° • Tensile strength usually { max when ß = 0° / min when ß = 90° Deformation Modulus usually higher for ß = 0° than for ß = 90° When not uniformly developed, these structures represent defects in the rock mass i.e. as individual layers or layered zones. 			• Tensile strength low/zero • Sliding resistance depends upon properties of coatings or cement and/or condition of surfaces PARAMETERS c Cohesion of coating/cement/ wall-rock Ø Friction angle of coating/ cement/ wall-rock i Angle of roughness of surface k_n Normal stiffness k_s Tangential stiffness	• Rock properties, very fissile rock mass • When excavated forms GRAVEL / • SOIL properties, GRAVEL • Both types show extreme planar anisotropy. Lowest shear strength in direction of slickenslides, in plane parallel to boundaries.	• SOIL properties either cohesive or non-cohesive • Usually shows planar anisotropy; lowest shear strength in direction of slickensides in plane parallel to boundaries	• Extremely decomposed seam has SOIL properties usually cohesive but may be non-cohesive • Mostly very compact except when soluble minerals removed • Slightly to highly decomposed substances. ROCK properties but usually lower strengths than the fresh rock substance.	• SOIL properties, usually cohesive but may be non-cohesive.
	Engineering properties commonly different from place to place especially where the defect passes through several different rock substance types.							
EXTENT	Usually governed by the thickness and lateral extent of the rock substance or mass containing the defect. May occur in a zone continuous through several different rock substance types.			From 10mm to 50m or more, depends on origin.	Generally large (50m to many km)		Weathered zones related to present or past land surface limited extent. Altered zones occur at any depth.	Usually small, limited to mechanically weathered zone. Can be great in rocks subject to solution.
ORIGIN (USUALLY CONTROLS EXTENT)	Deposition in layers	• Viscous flow • Crystal grown at high pressures and temperatures • Shearing under high confining pressure	• Shearing during folding or faulting • Consolidation compaction	• Shearing, extension or torsion failure, arising from faulting, folding relief of pressure, shrinkage due to cooling or loss of fluid	FAULTING • Shear failure by small displacements along a large number of near-parallel intersecting planes • The different strengths of types R and S are usually due to a) Different depths of rock cover at the time of faulting, or b) Later cementation, or c) Later mechanical weathering / • Failure by large movement within narrow zone • Generally formed at shallow depth (<3000m)		• Decomposition of minerals, removal or rupture of cement, due to circulation of mineralized waters usually along joints, sheared zones or crushed zones	• Cohesive soil carried into open joint or cavity as a suspension in water • Non-cohesive soil falls or washes in
DESCRIPTION REQUIRED	Bed thickness, grain types and sizes / Ease of splitting and nature of fracture faces	Fabric description and spacing and extent of microfractures		Shape, aperture, surface condition, coating, filling, extent	Zone width, shape and extent Pattern of joints or micro-fractures and resulting shape and size of unit blocks. Standard description of joints.	Degree of Decomposition Standard description of soil or rock substance		
ASSOCIATED DESCRIPTION ETC	Graded –, discord –, and slump-bedding; other primary structures: facing, attitudes and lineations	Attitude of planes and of any linear structure extent		Spacing, attitude of joint and/of slickenslides	Attitude of zone. Direction of slickenslides and amount, direction, and sense of displacement. Type of fault. History of past movements. Any modern activity. Likelihood of future movements. The terms "major" and "minor" fault are defined whenever used. The definitions are made on the basis of a) width and nature of the fault materials b) significance to the project.		Attitude of zone. Classify as weathered or altered if possible and determine origin, and defect or defects influencing decomposition.	Attitude of zone. Type of defect which is infilled, origin of infill substance.
		Allocate to set determine origin type						
MAP SYMBOLS (TO RIGHT SYMBOLS IN SEQUENCE HORIZONTAL, VERTICAL, DIPPING)								

NOTES

1. The actual defect is described, not the process which formed or may have formed it e.g. "sheared zone" not "zone of shearing", the latter suggests a currently active process.
2. The terms "layering", "bedding" etc are used as the main headings on this portion of the table instead of "layer", "bed" etc. This is for convenience in descriptions and other notes, allowing them to refer to both rock substances and masses.
3. These notes refer to the engineering properties of the defect type, not those of the rock mass containing the defect.
4. In general each rock defect is more permeable than the substance in which it occurs, and the defect strength becomes lower with increase in water content/pressure.

Adapted from Stapledon (1973).

3.2.6.10 Block Size and Shape

The size of blocks bound by discontinuities can be described using the terms in Table 3.10.

Table 3.10 Description of Block Size in the Rock Mass

Term	Average Dimension
Very Small	< 60 mm
Small	60 – 200 mm
Medium	200 – 600 mm
Large	600 mm – 2 m
Very Large	> 2 m

The shape of blocks is dependent on the spacing of discontinuities and the relative persistence of the different discontinuity sets. On weathering, block shape alters by rounding of block edges. Terms given in Table 3.11 can be used to describe rock block shape.

Table 3.11 Rock Mass Block Shape

Block Shape	Discontinuity Arrangement
Polyhedral	Irregular discontinuities without arrangement into distinct sets, and of small persistence
Tabular	One dominant set of parallel discontinuities (eg bedding planes), with other non-continuous discontinuities; block length and width >> thickness
Prismatic	Two dominant sets of discontinuities orthogonal and parallel, with a third irregular set; block length and width >> thickness
Equidimensional	Three dominant orthogonal sets of discontinuities, with some irregular discontinuities
Rhomboidal	Three or more dominant, mutually oblique sets of discontinuities; oblique shaped equidimensional blocks
Columnar	Several (usually more than three) sets of continuous, parallel discontinuities crossed by irregular discontinuities; length >> other dimensions

3.2.6.11 Rock Name

The most common rock names are given in Table 3.12 although more common usage is limited to the names in uppercase. The table follows general geological practice, and the inclusion is intended as a guide only as geological training is required for satisfactory identification. It must be remembered that engineering properties cannot be inferred from rock names.

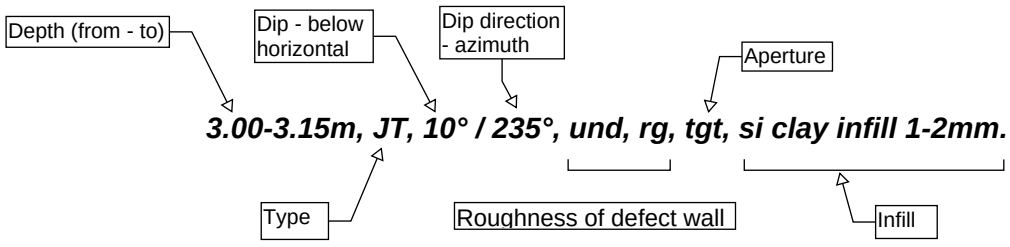
3.2.6.12 Additional Features and Geological Information

This includes all additional relevant information such as the name of the geological unit. Additional information may be particularly important when describing weathered rocks that have the properties of soils (e.g. residual soils). In such cases a description of the material as a soil (Section 2.0) should also be given.

Abbreviation	Explanation
	Fabric, and rock defects and structure
bdg	bedding
BP	bedding parting (joint subparallel to bedding plane)
brk	break
CT *or* ct	coating
cont	contact
dpg	dipping
foltn	foliation
infl	infill
JT *or* Jt	joint
jtd	jointed
lm-sn	limonite-stained
mg-sn	mangansese-stained
pentg	penetrating
pll	parallel
subpll	subparallel
sm	smooth
sp	spaced
spg	spacing
str	strong
svl	several
wls	walls
	Defect spacing
VWSP	very widely spaced
WSP	widely spaced
MWSP	moderately widely spaced
CSP	closely spaced
VCSP	very closely spaced
ECSP	extremely closely spaced
	Defect roughness and aperture
ST	stepped
UN	undulating
PL	planar
RG	rough
SM	smooth
SL	slickensides
	Colouring
bl-gr	bluish grey
blk	black
discl	discoloured
or-br	orange-brown
	Weathering
RWx	residual weathered
CWx	completely weathered
HWx	highly weathered
MWx	moderately weathered
SWx	slightly weathered
UWx	unweathered

Abbreviation	Explanation
	General
ac	acute
ch	chainage (distance along road alignment)
cl	close/closely
comm	comment
dlr	driller
gntly	gently
incld	inclined
int	internal
lwr	lower
mnr	minor
mod	moderately
mlt	multiple
obl	oblique
orthg	orthogonal
predom.	predominantly
sa	sand
si	silt
stp	steep/steeply
typ	typically
upr	upper
v.	very
BH	machine cored, rotary, water flushed, borehole
DN	nominal diameter (of pipe)
Dwg	drawing
d/s	downstream
EOH	end of borehole
GL	ground-level
LHS	left hand side
mbgl	metres below ground level (depth)
N/A	not applicable
RHS	right hand side
RL m (or mRL)	reduced level in metres of existing or proposed ground-
u/s	upstream
TP	machine test pit (hydraulic excavator)
GAP	general all passing (aggregate)

Defect description sequence explanation:



Appendix B

Machine Borehole Logs ca. 2011 (BH01 – BH05)

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH01
Hole Location:

SHEET 1 OF 2

PROJECT: Slopedown Windfarm | LOCATION: Venlaw Forest, Wyndham, Southland | JOB No: 27464.001

CO-ORDINATES 5426696
2214921

R.L. m

DATUM

DRILL TYPE: UDR600

DRILL METHOD: Rotary Core

DRILL FLUID:

HOLE STARTED: 11/4/11
HOLE FINISHED: 12/4/11
DRILLED BY: McNeill Drilling
LOGGED BY: JMH CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	DEPTH (m)	CORE RECOVERY (%)	METHOD	MOISTURE CONDITION / WEATHERING	ENGINEERING DESCRIPTION
1Fill	0				Weathered sandstone derived FILL, orange brown. Loose.
TOPSOIL					Peaty, organic SILT, black.
FERNDALE GROUP SANDSTONE	1	99	HQ3	MW	Moderately weathered, light brown with black staining, moderately thin bedding, medium to fine SANDSTONE. Weak.
		100	HQ3	MW	JOINTS are typically, dip 30-90 below horiz, planar to irregular, rough to smooth, tight to open, clean.
	2			MW	BEDDING is typically 10-30 below horiz, planar to stepped, rough to smooth, tight to open, clean.
		100	HQ3	MW	...0.5-0.6 m, zone of extremely closely spaced and very closely spaced fractures
				MW	...0.6-0.8 m silty band
2	3			MW	...3.1-3.3 m, zone of extremely closely spaced and very closely spaced fractures
		100	HQ3	MW	Moderately weathered, grey brown with red black staining, moderately thin bedding, fine SANDSTONE. Weak.
	4			MW	
				UW	Unweathered, blue grey, fine SANDSTONE. Strong.
		100	HQ3	UW	
				HW	Highly weathered, brown with red black staining, fine SANDSTONE. Very weak.
	5			UW	Unweathered, blue grey, moderately thin bedding, fine SANDSTONE. Strong.
		100	HQ3	UW	
				SW	Slightly weathered, brown grey to grey blue, moderately thick bedding, fine SANDSTONE. Moderately strong.
3	6			SW	...5.7-5.9 m, silt bed
		100	HQ3	UW	Unweathered, blue grey with red staining, moderately thin bedding, medium SANDSTONE. Strong.
				UW	
	7			UW	
				SW	Slightly weathered, grey to light brown with red black staining, moderately thin bedding, medium SANDSTONE. Moderately strong.
		100	HQ3	SW	
				SW	...7.4-7.6 m, zone of extremely closely spaced and very closely spaced fractures
	8			SW	
4				UW	Unweathered, blue with some red and orange staining, moderately thin bedding, medium SANDSTONE. Strong.
		100	HQ3	UW	
	9			UW	
				UW	
		100	HQ3	UW	
	10				

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

SHEAR STRENGTH (kPa): 10 25 50 100 200
COMPRESSIVE STRENGTH (MPa): 1 5 20 50 100 200
DEFECT SPACING (mm): 500 200 60 20 6

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 22/9/11

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH01
Hole Location:

SHEET 2 OF 2

PROJECT: Slopedown Windfarm | LOCATION: Venlaw Forest, Wyndham, Southland | JOB No: 27464.001

CO-ORDINATES 5426696
2214921

R.L. m

DATUM

DRILL TYPE: UDR600

DRILL METHOD: Rotary Core

DRILL FLUID:

HOLE STARTED: 11/4/11

HOLE FINISHED: 12/4/11

DRILLED BY: McNeill Drilling

LOGGED BY: JMH CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 500 100 50 10

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

Depth	Core recovery (%)	Method	Moisture / Weathering	Description
11	100	HQ3	MW	Moderately weathered, brown grey, moderately thin bedding, SILTSTONE. Weak.
			UW	
			SW	Unweathered, dark blue grey with red orange staining, moderately thin bedding SILTSTONE. Moderately strong.
			SW	
			SW	Slightly weathered, light grey with red black staining, moderately thick bedding, fine SANDSTONE. Moderately strong.
			SW	
			SW	
			UW	Slightly weathered, blue grey with orange staining, moderately thin bedding SILTSTONE. Weak.
12			UW	
			SW	Unweathered, blue grey with red orange staining, moderately thick bedding, medium SANDSTONE. Strong. ...11.9-12.0 m, 100 mm SILTSTONE band.
			SW	
			SW	Slightly weathered, brown grey, moderately thin bedding SILTSTONE. Moderately strong.
13	100	HQ3	SW	
			MW	Slightly weathered, light brown with dark red staining, moderately thick bedding, medium SANDSTONE. Moderately strong to weak.
			MW	
			MW	
			MW	Slighly weathered, dark grey brown, moderately thin bedding SILTSTONE. Moderately strong.
14			MW	
			MW	Moderately weathered, dark brown, moderately thin bedding, medium SANDSTONE. Weak. ...13.5-13.63 m, extremely weak.
			MW	
			MW	
15	100	HQ3	SW	Moderately weathered, brown grey, moderately thick bedding SILTSTONE. Weak to very weak. ...14.2-14.3 m, fine to medium SANDSTONE band.
			SW	Slightly weathered, light brown, moderately thick bedding, fine SANDSTONE. Moderately strong.
16			SW	
			SW	
			SW	
			SW	
17	100	HQ3	SW	
			SW	
			HW	Highly weathered, black brown, moderately thin bedding, medium to coarse SANDSTONE. Extremely weak (medium dense soil). Zone of extremely closely spaced and very closely spaced fractures.
18			SW	
			SW	Slightly weathered, red dark brown with some orange black staining, moderately thick bedding, medium SANDSTONE. Moderately strong to weak.
			SW	
			SW	
			SW	...17.8-17.93 m, zone of extremely closely spaced and very closely spaced fractures ...18.4-18.5 m, zone of extremely closely spaced and very closely spaced fractures
19	100	HQ3	SW	
			SW	
			SW	Slightly weathered, light brown grey, fine SANDSTONE. Moderately strong.
20			SW	

5 6 7

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 22/9/11

BH1 Core Photos:

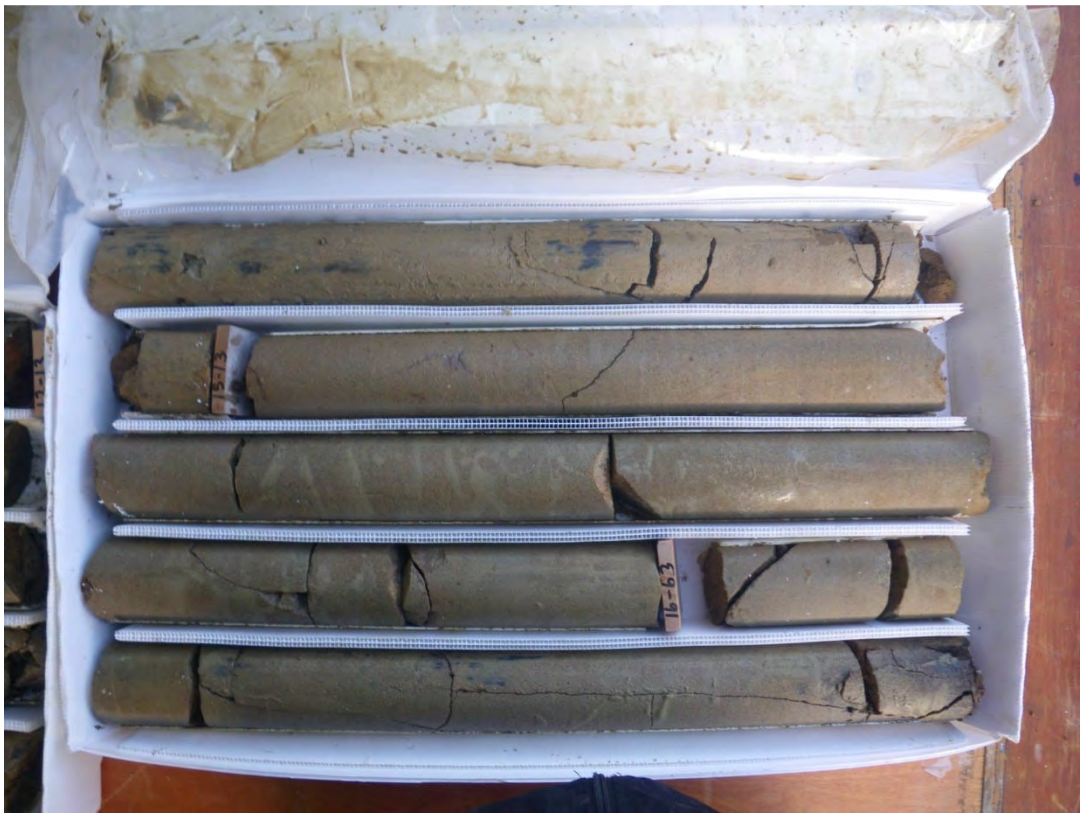
BH1 0-3 m

BH1 3-6 m

BH1 6-8.81 m

BH1 8.81-11.61 m

BH1 11.61-14.53 m



BH1 14.53-17.4 m

BH1 17.4-20 m

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH02
Hole Location:

SHEET 1 OF 2

PROJECT: Slopedown Windfarm		LOCATION: Venlaw Forest, Wyndham, Southland	JOB No: 27464.001
CO-ORDINATES	5425615 2211762	DRILL TYPE: UDR600	HOLE STARTED: 12/4/11
R.L.	m	DRILL METHOD: Rotary Core	HOLE FINISHED: 14/4/11
DATUM		DRILL FLUID:	DRILLED BY: McNeill Drilling
			LOGGED BY: JMH CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 500 100 50 10

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

1	FILL															Sandstone derived FILL, dark brown. Loose.
	FERNDALE GROUP SANDSTONE	None Encountered	100	HQ3					1		MW					Moderately weathered, brown, moderately thick bedding, fine SANDSTONE. Weak.
											MW					JOINTS are typically, dip 40-90 below horiz, planar to irregular, rough to smooth, tight to open, clean. 1
											MW					
											UW					BEDDING is typically 10-20 below horiz, planar to slight curve, rough to smooth, tight to open, clean.
											SW					
											SW					
			100	HQ3					2		SW					Unweathered, grey with orange staining, thick bedding, fine to medium SANDSTONE. Moderately strong. 2
											SW					
											MW					Slightly weathered, light brown, moderately thin bedding , medium SANDSTONE. Weak.
2																
			93	HQ3					3		MW					Slightly weathered, grey light brown, moderately thin bedding, interbedded SILTSTONE with SANDSTONE. Weak. 3
											MW					Moderately weathered, light brown, thick bedding, fine SANDSTONE. Weak.
																...2.9-3.0 m, 100 mm SILTSTONE band
																...3.2-3.3 m, 100 mm SILTSTONE band
			75	HQ3					4		MW					Moderately weathered, light brown, thick bedding, SILTSTONE. Weak. 4
											SW					Moderately weathered, light brown, thick bedding, medium SANDSTONE. Weak.
											SW					Slightly weathered, brown grey, moderately thin bedding SILTSTONE. Weak.
			100	HQ3					5		SW					...4.4-4.5 m, zone of extremely closely spaced and very closely spaced fractures 5
											SW					Slightly weathered, grey brown, moderately thin bedding, fine to medium SANDSTONE. Weak.
3																...4.8 m, 100 mm SILTSTONE band
																...5.2 m, 100 mm SILTSTONE band
			98.7	HQ3					6		SW					Unweathered to slightly weathered, grey brown, moderately thin bedding, SILSTONE. Moderately strong to weak. 6
											SW					Slightly weathered, grey brown, moderately thick bedding, fine to medium SANDSTONE. Weak to moderately strong.
									7		SW					...6.74 m, 100 mm SILTSTONE band 7
			100	HQ3					8		SW					Slightly weathered, brown grey, moderately thin bedding, medium SANDSTONE. Moderately strong. 8
4											SW					
									9		UW					Unweathered, grey, moderately thin bedding, fine SANDSTONE. Moderately strong. 9
			100	HQ3							UW					
											UW					...9.05-9.1 m, zone of extremely closely spaced and very closely spaced fractures
									10		UW					

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 21/9/11

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH02
Hole Location:

PROJECT: Slopedown Windfarm | LOCATION: Venlaw Forest, Wyndham, Southland | JOB No: 27464.001

CO-ORDINATES 5425615
2211762

R.L. m

DATUM

DRILL TYPE: UDR600

DRILL METHOD: Rotary Core

DRILL FLUID:

HOLE STARTED: 12/4/11
HOLE FINISHED: 14/4/11
DRILLED BY: McNeill Drilling
LOGGED BY: JMH CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | WEATHERING MOISTURE CONDITION | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) | COMPRESSIVE STRENGTH (MPa) | DEFECT SPACING (mm)

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

Depth (m)	Core recovery (%)	Method	Weathering	Engineering description
11	100	HQ3	SW	Slightly weathered, grey to light grey, moderately thin bedding, fine SANDSTONE with minor interbedded SILTSTONE. Moderately strong.
			SW	
			SW	
			SW	
	98	HQ3	SW	
			SW	
			SW	
12			SW	Slightly weathered, light grey, moderately thin bedding SILTSTONE. Weak.
			SW	Unweathered, grey, thin bedding, fine SANDSTONE. Moderately strong.
	100	HQ3	SW	Slightly weathered, light grey, thick bedding, fine SANDSTONE. Moderately strong.
13			SW	
	100	HQ3	SW	
14			SW	Slightly weathered, light grey, thick bedding, silty SANDSTONE. Moderately strong.
			SW	...14.3-14.4 m, zone of extremely closely spaced and very closely spaced fractures
	100	HQ3	SW	...15.1-15.26 m, zone of extremely closely spaced and very closely spaced fractures
15			SW	
			UW	Unweathered, grey, moderately thick bedding, fine to medium SANDSTONE. Strong.
	100	HQ3	UW	...15.7-15.8 m, zone of extremely closely spaced and very closely spaced fractures with 100 mm SILTSTONE band
16			UW	
			UW	
			UW	Unweathered, grey, moderately thick bedding SILTSTONE with minor interbedded fine SANDSTONE. Moderately strong.
17	100	HQ3	UW	Unweathered, grey, moderately thick bedding, silty, fine to medium SANDSTONE. Strong.
			UW	
18			UW	Unweathered, grey, moderately thin bedding, interbedded SILTSTONE and fine SANDSTONE. Moderately strong.
	100	HQ3	UW	Unweathered, grey, moderately thickly bedding, fine SANDSTONE. Moderately strong.
19			UW	
			UW	Unweathered, grey, moderately thick bedding, fine SANDSTONE. Strong.
	100	HQ3	UW	...19.4-19.5 m, zone of extremely closely spaced and very closely spaced fractures
20				

5 6 7

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 21/9/11

BH 2 Core Photos:

BH2 0-3 m

BH2 3-5.82 m

BH2 5.82-8.78 m

BH2 8.78-11.64 m

BH2 11.64-14.5 m

BH2 14.5-17.48 m

BH2 17.48-20 m

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH03
Hole Location: SW of forest block, Turbine 100
SHEET 1 OF 2

PROJECT: Slopedown Windfarm | LOCATION: Venlaw Forest, Wyndham, Southland | JOB No: 27464.001

CO-ORDINATES 5424123 2209543 | DRILL TYPE: UDR600 | HOLE STARTED: 14/4/11

DRILL METHOD: Rotary Core | HOLE FINISHED: 18/4/11

R.L. m | DRILLED BY: McNeill Drilling

DATUM | DRILL FLUID: | LOGGED BY: JMH | CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	WEATHERING / MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
FILL		None Encountered	70	HQ3					0			M					Silty GRAVEL, brown grey. Loose to medium dense, moist. Quarried sandstone used for roading fill.
FERNDALE GROUP SANDSTONE			100	HQ3					1			HW					Highly weathered, orange brown with black staining, bedded, fine to medium SANDSTONE. Extremely weak (medium dense soil strength). ....1.7 m, 100 mm SILTSTONE band JOINTS are typically, dip 40-90 below horiz, planar to irregular, rough to smooth, tight to open, infilled. BEDDING is typically 10-20 below horiz, planar, rough, tight to open, infilled.
			40	HQ3					2			HW					
			82	HQ3					3			HW					
2			90	HQ3					4			HW					Moderately weathered, orange brown with black staining, thin bedded, silty, fine to medium SANDSTONE. Extremely weak.
			100	HQ3					5			MW					Moderately weathered, orange brown, bedded SILTSTONE. Very weak. ...5.4-7 m, zone of extremely closely spaced and very closely spaced fractures
			82	HQ3					6			MW					Highly weathered, orange grey, bedded SILTSTONE. Extremely weak. Moderately weathered, brown grey, bedded SILTSTONE. Extremely weak. Highly weathered, brown grey to dark grey with some orange staining, bedded SILTSTONE. Extremely weak to very weak.
3			75	HQ3					7			HW					Moderately weathered, grey with some orange, bedded SILTSTONE. Weak.
			90	HQ3					8			MW					Moderately weathered, brown grey with red black staining, bedded, fine to medium SANDSTONE. Weak.
			92	HQ3					9			MW					Moderately weathered, light brown with some black staining, bedded, fine to medium SANDSTONE. Weak to moderately strong. ...from 8.5-9.2 m, red black staining
									10								

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 21/9/11

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH03
Hole Location: SW of forest block, Turbine 100
SHEET 2 OF 2

PROJECT: Slopedown Windfarm | LOCATION: Venlaw Forest, Wyndham, Southland | JOB No: 27464.001

CO-ORDINATES 5424123 2209543 | DRILL TYPE: UDR600 | HOLE STARTED: 14/4/11

R.L. m | DRILL METHOD: Rotary Core | HOLE FINISHED: 18/4/11

DATUM | DRILL FLUID: | DRILLED BY: McNeill Drilling | LOGGED BY: JMH | CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 500 200 60 20

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

DEPTH (m)	CORE RECOVERY (%)	METHOD	MOISTURE CONDITION / WEATHERING	DESCRIPTION
11	100	HQ3	MW	Moderately weathered, brown with black staining, moderately thick bedding, fine to medium SANDSTONE. Weak.
12	48	HQ3	HW	Highly weathered, brown, bedding, fine to medium SANDSTONE. Very weak.
13	100	HQ3	MW	..12.5-13.45 m, zone of extremely closely spaced and very closely spaced fractures
14	89	HQ3	MW	Moderately weathered, red brown, moderately thick bedding, fine to medium SANDSTONE. Weak.
15	100	HQ3	MW	...14.5-14.9 m, zone of extremely closely spaced and very closely spaced fractures
16	100	HQ3	SW	Moderately weathered, red brown with black staining, moderately thick bedding, fine to medium SANDSTONE. Weak.
17	100	HQ3	UW	...14.87 m, thin section of approx. 30 mm clay-like fine material
18	100	HQ3	UW	Slightly weathered, light brown to light grey with black staining, moderately thick bedding, fine to medium SANDSTONE. Moderately strong to strong.
19	89	HQ3	UW	Unweathered, blue grey, moderately thick bedding, fine to medium SANDSTONE. Strong.
20				

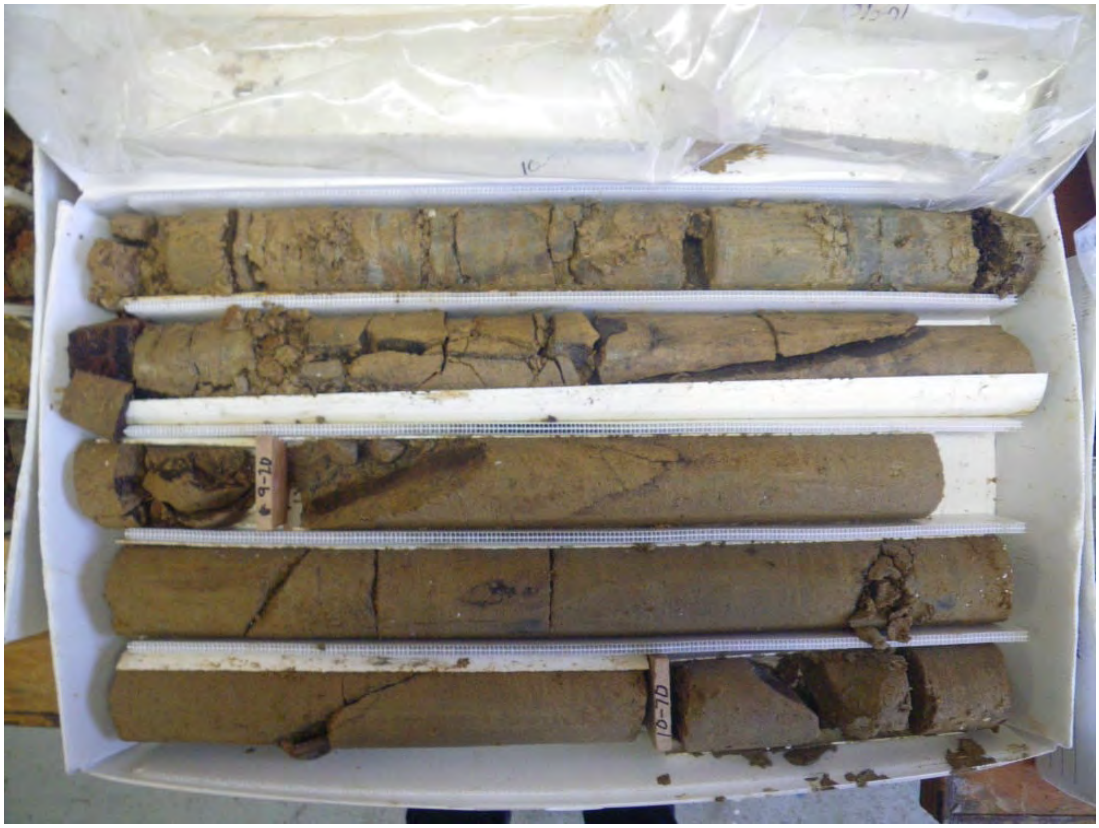
T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 21/9/11

BH3 Core Photos:

BH3 0-4.25 m

BH3 4.25-7.69 m



BH3 7.69-10.9 m

BH3 10.9-14.3 m

BH3 14.3-17.27 m

BH3 17.27-20 m

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH04
Hole Location:

SHEET 1 OF 2

PROJECT: Slopedown Windfarm | LOCATION: Venlaw Forest, Wyndham, Southland | JOB No: 27464.001

CO-ORDINATES 5421933 2206850 | DRILL TYPE: CS1000 | HOLE STARTED: 29/4/11

R.L. m | DRILL METHOD: Rotary Core | HOLE FINISHED: 30/4/11

DATUM | DRILL FLUID: | DRILLED BY: Speight Contracting | LOGGED BY: JMH | CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
1FILL		None Encountered	90	HQ3					1			M					Sandy GRAVEL, brown. Medium dense, moist.
FERNDALE GROUP SANDSTONE												HW					Highly weathered, brown, moderately thin bedding, fine to medium SANDSTONE. Very weak. ...0.6 m, 100 mm SILTSTONE band JOINTS are typically, dip 50-90 below horiz, planar to slightly curved, rough to smooth, tight to open, clean. BEDDING is typically 10-20 below horiz, planar to slightly curved, rough, tight to open, clean.
									2			HW HW HW HW HW HW HW					
2			100	HQ3					3			SW UW UW UW					Highly weathered, orange brown, thin bedding SILTSTONE. Very weak. ...1.8-1.9 m, zone of extremely closely spaced and very closely spaced fractures ...1.9-2.1 m, 200 mm SILTSTONE band ...2.0-2.3 m, zone of extremely closely spaced and very closely spaced fractures ...2.5-2.7 m, zone of extremely closely spaced and very closely spaced fractures ...2.75-2.95 m, 200 mm SILTSTONE band ...3-3.2 m, zone of extremely closely spaced and very closely spaced fractures
									4			UW UW					Slightly weathered, grey with brown staining, moderately thick bedding, sandy SILTSTONE. Moderately strong.
									5			UW UW UW UW					Unweathered, light grey, thin bedding, fine SANDSTONE. Strong. ...3.9 m, Iron staining in joints and fractures causing zone of extremely closely spaced and very closely spaced fractures due to corrosion
												UW					Unweathered, light grey, thin bedding, fine SANDSTONE. Strong.
3			100	HQ3					6			UW MW UW					Unweathered, light grey, thick bedding, fine SANDSTONE. Strong.
																	Moderately weathered, brown grey, thin bedding, fine SANDSTONE. Moderately strong.
									7								Unweathered, grey, thick bedding, fine SANDSTONE. Strong.
									8			UW					
									9			UW					
4			100	HQ3													
									10			UW SW					

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 21/9/11

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH04
Hole Location:

SHEET 2 OF 2

PROJECT: Slopedown Windfarm | LOCATION: Venlaw Forest, Wyndham, Southland | JOB No: 27464.001

CO-ORDINATES 5421933 2206850 | DRILL TYPE: CS1000 | HOLE STARTED: 29/4/11

R.L. m | DRILL METHOD: Rotary Core | HOLE FINISHED: 30/4/11

DATUM | DRILL FLUID: | DRILLED BY: Speight Contracting | LOGGED BY: JMH | CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) <1 1 5 20 50 100 250 | DEFECT SPACING (mm) 500 100 50 10

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

								11			UW						Slightly weathered, grey with orange staining, moderately thin bedding SILTSTONE. Moderately strong.
											UW						Unweathered, grey, thick bedding, fine SANDSTONE. Strong.
											UW						Unweathered, grey, thick bedding SILTSTONE. Moderately strong.
5		95	HQ3					12			UW						Unweathered, grey, thick bedding, fine SANDSTONE. Strong.
											UW						
								13			UW						
											UW						
								14			UW						
											UW						
											UW						
6		100	HQ3					15			UW						Unweathered, grey, thick bedding, fine SANDSTONE with interbedded minor SILTSTONE. Moderately strong.
											UW						Unweathered, grey, thick bedding, fine SANDSTONE. Strong.
								16			UW						
											UW						
								17			UW						
											UW						
7		87	HQ3					18			UW						
											UW						
								19			UW						Unweathered, grey, moderately thick bedding, fine SANDSTONE. Strong. ...18.7 m, less than 20 mm SILTSTONE band ...18.8 m, less than 20 mm SILTSTONE band ...19 m, less than 20 mm SILTSTONE band N.B. bedding defects at each siltstone band
								20									

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 21/9/11

BH4 Core Photos:

BH4 0-3.2 m

BH4 3.2-6.2 m

BH4 6.2-9.2 m

BH4 9.2-12.2 m

BH4 12.2-15.2 m

BH4 15.2-18.2 m

BH4 18.2-20 m

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH05
Hole Location:

SHEET 1 OF 2

PROJECT: Slopedown Windfarm		LOCATION: Venlaw Forest, Wyndham, Southland	JOB No: 27464.001
CO-ORDINATES	5420646 2207798	DRILL TYPE: CS1000	HOLE STARTED: 1/5/11
		DRILL METHOD: Rotary Coring	HOLE FINISHED: 1/5/11
R.L.	m		DRILLED BY: Speight Contracting Ltd
DATUM		DRILL FLUID:	LOGGED BY: JMH CHECKED: FAW

GEOLOGICAL								ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL		None Encountered															Peaty, organic SILT. Black.
FERNDALE GROUP SANDSTONE			80	HQ3					1			HW					Highly weathered, orange brown, thin bedding, silty, fine and medium SANDSTONE. Extremely weak to very weak (some residual soil, medium dense soil strength). JOINTS are typically, dip 50-90 below horiz, planar to slightly curved, rough to smooth, tight to open, clean. BEDDING is typically 10-20 below horiz, planar to slightly curved, rough, tight to open, clean.
									2			MW					Moderately weathered, orange grey, moderately thin bedding, medium SANDSTONE. Weak.
2			100	HQ3					3			SW					Slightly weathered, green grey, moderately thin bedding, fine to medium SANDSTONE. Moderately strong.
									4			MW SW					Moderately weathered, orange grey, thin bedding, medium SANDSTONE. Weak. Slightly weathered, orange green grey, moderately thick bedding, fine SANDSTONE. Moderately strong.
									5			UW					Unweathered, grey, thick bedding, fine SANDSTONE. Strong.
3			89	HQ3					6			SW MW					Slightly weathered, green grey, thick bedding, medium SANDSTONE. Moderately strong. Moderately weathered, orange brown, thick bedding, medium SANDSTONE. Moderately strong.
									7			HW					Highly weathered, orange brown, thin bedding, silty, fine to medium SANDSTONE. Extremely weak. Fracturing associated with EW strength, crushed zone, fine sand and gravel 30 mm wide.
									8			UW					Unweathered, grey, moderately thick bedding, medium SANDSTONE. Moderately strong.
									9								Unweathered, grey, moderately thick bedding, fine SANDSTONE interbedded with minor SILTSTONE. Moderately strong.
4			94	HQ3					10			UW					

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 21/9/11

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH05
Hole Location:

PROJECT: Slopedown Windfarm | LOCATION: Venlaw Forest, Wyndham, Southland | JOB No: 27464.001

CO-ORDINATES 5420646 2207798 | DRILL TYPE: CS1000 | HOLE STARTED: 1/5/11

R.L. m | DRILL METHOD: Rotary Coring | HOLE FINISHED: 1/5/11

DATUM | DRILL FLUID: | DRILLED BY: Speight Contracting Ltd | LOGGED BY: JMH | CHECKED: FAW

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.

FLUID LOSS | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | R.L. (m) | DEPTH (m) | GRAPHIC LOG | CLASSIFICATION SYMBOL | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 50 100 250 | DEFECT SPACING (mm) 500 100 50 10

SOIL DESCRIPTION
Soil type, minor components, plasticity or particle size, colour.

ROCK DESCRIPTION
Substance: Rock type, particle size, colour, minor components.
Defects: Type, inclination, thickness, roughness, filling.

Depth (m)	Core recovery (%)	Method	Moisture condition / weathering	Description
11	77	HQ3		Unweathered, grey, thick bedding, fine SANDSTONE. Strong.
				Unweathered, grey, thick bedding, fine SANDSTONE. Strong.
				Unweathered, grey, thick bedding, silty, fine to medium SANDSTONE. Strong.
				Unweathered grey, moderately thin bedding, fine SANDSTONE interbedded with minor SILTSTONE. Strong. ...11.3-11.4 m, zone of extremely closely spaced and very closely spaced fractures
12			SW	Slightly weathered, grey, thick bedding, fine to medium SANDSTONE. Moderately strong.
5				
13			UW	Unweathered, grey, thick bedding SILTSTONE. Moderately strong. ...12.7 m, zone of extremely closely spaced and very closely spaced fractures
14				Unweathered, green grey, moderately thin bedding, medium SANDSTONE. Moderately strong. ...12.8-13.6 m, zone of extremely closely spaced and very closely spaced fractures
15	98	HQ3	UW	Unweathered, grey, moderately thick bedding, fine SANDSTONE. Strong.
6				
16				
17			UW	
			UW	Unweathered, grey, thin bedding SILTSTONE. Moderately strong.
18	97	HQ3		Unweathered, grey, moderately thick bedding, fine SANDSTONE. Strong.
7				
19				
20				

T+T DATATEMPLATE.GDT elb

BORELOG SLOPEDOWN LOGS.GPJ 21/9/11

BH5 Core Photos:

BH5 0-3.2 m

BH5 3.2-6.2 m

BH5 6.2-9.6 m

BH5 9.6-12.8 m

BH5 12.8-16 m

BH5 16-18.6 m

BH5 18.6-20 m

Appendix C

Test Pit Logs and Photographs ca. 2023 (TP101 - TP114) and Scala Penetrometer (SC) profiles

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP101

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	22 Feb 2023	381m	E 1294965, N 4862680

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	4.75m	Target Depth	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results	Backfill / Install
380.65	0.35	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium. [TOPSOIL]							
380.40	0.60	COLLUVIUM		SILT, with some sand; yellowish brown. Firm; moist; sand, fine to medium. [COLLUVIUM]							
380.10	0.90	FERNDALE GROUP OF MURIHIKU SUPERGROUP		CWx; brownish orange; indistinctly bedded; SANDSTONE; ext. weak. In-situ: SILT, some sand, minor gravel; sand, fine to coarse; gravel, sub-angular, sandstone, fine to medium; moist. [FERNDALE GROUP OF MURIHIKU SUPERGROUP]			0.60-0.90m: SUMMARY: VCS to CS remnant joints 0.90-4.75m: SUMMARY: Bdg 'partings', and typ. two intersecting/orthogonal sub-vertical jt sets, VCS to CS, pers 0.1m to 1m+, planar to undulating, smooth, typ. tight, black staining, - Bdg, typ. v.thin to thin, 5°>160-200 - Jt Set 1: 80°>080 - Jt Set 2: 80°>110 - Blocks: Tabular, typ. 10 to 70mm (locally 250mm max dia.)	Not Encountered		2, 1, 3 2, 3, 2 3, 12, 17	
				HWx; brownish orange with black streaks; interbedded MUDSTONE and SANDSTONE; weak; v.thin to thin bedding, sub-horizontal, typ. 0-5>160-200.							
376.25	4.75			4.50m: Grades to mod. strong							
				END OF HOLE: 4.75m (Target Depth)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 080°

1.1m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [x] None
- [ ] Slow Seep
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator		AvD	EBL

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Client	ROARING40'S LTD	**Pit ID:**	TP101	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	22-Feb-2023	
Notes:	1) Stable on all sides. 2) No groundwater encountered.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	4.75	
Project No.	220372	**Terminated Due To:**	Target Depth	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP102

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	23 Feb 2023	466m	E 1293790, N 4861038

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	3.50m	Practicable Refusal	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil / Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results	Backfill / Install
466.65	0.35	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium. [TOPSOIL]							
	0.5	FERNDALE GROUP OF MURIHIKU SUPERGROUP		CWx to RWx; brownish orange; indistinctly bedded SANDSTONE; ext. weak; remnant rock fabric detected. In-situ: SILT, trace to minor clay, trace gravel; stiff to very stiff; gravel, fine to medium, sub-angular, sandstone. [FERNDALE GROUP OF MURIHIKU SUPERGROUP]						2, 2, 2 2, 1, 2 2, 3, 4 4, 3, 4 3, 2, 4 17 V=114 R=33	
464.50	1.50			HWx; brownish grey to greyish brown; indistinctly bedded SANDSTONE; weak.							
463.50	2.50			MWx, greyish brown, SANDSTONE, moderately thick bedding, sub-horizontal, mod. strong to strong. 3.00m: Single tine ripper used - easy penetration. Local concretionsup to 300mm.			2.50-3.50m: SUMMARY: VCS to CS joints, planar, rough, typ. tight. - Blocks: Tabular, typ. 10 to 300mm	Not Encountered			
462.50	3.50			END OF HOLE: 3.50m (Practicable Refusal)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.5m

Dug towards 090°

1.1m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [x] None
- [ ] Slow Seep
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator	GEO105	AvD	EBL

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Client	ROARING40'S LTD	**Pit ID:**	TP102	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	23-Feb-2023	
Notes:	1) Local pit wall collapse below 2.50m depth. 2) No groundwater encountered.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	5.50	
Project No.	220372	**Terminated Due To:**	Practicable Refusal	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP103

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	22 Feb 2023	434m	E 1294794, N 4861525

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	4.90m	Target Depth	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil / Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results	Backfill / Install
433.58	0.42	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium. [TOPSOIL]							
	0.5			0.40m: 10-20mm thick iron pan; hard.							
		COLLUVIUM		SILT, with some sand, with trace clay; yellowish brown. Stiff; moist; low plasticity; sand, fine to medium. [COLLUVIUM]						V=90 R=17; 1, 0, 1 / 1, 1, 1 / 2, 2, 2 / 3, 5, 8 / 9, 12, 14 / 17	
	1.0										
	1.5										
	2.0										
431.76	2.30			HWx; brownish grey to greyish brown; indistinctly bedded SANDSTONE; very weak. In-situ: Sandy GRAVEL, some cobbles; sand, fine to coarse; gravel, medium to coarse, sub-angular, sandstone; cobbles, sub-angular. [FERNDALE GROUP OF MURIHIKU SUPERGROUP]				Not Encountered			
431.10	2.90	FERNDALE GROUP OF MURIHIKU SUPERGROUP		MWx, greyish brown, indistinctly bedded SANDSTONE, mod. strong.			2.90-4.90m: SUMMARY: Typ. multiple intersecting/orthogonal sub-vertical jt sets, VCS to CS, pers 0.1m to 1m+, planar to undulating, rough, typ. tight: - Jt Set 1: 90°>040 - Jt Set 2: 90°>320 - Blocks: Tabular, typ. 10 to 300mm (locally 500mm max dia.)				
	3.0										
	3.5										
	4.0										
	4.5										
429.10	4.90										
	5.0			END OF HOLE: 4.90m (Target Depth)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 270°

1.1m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [✓] None
- [ ] Slow Seep
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator	GEO105	AvD	EBL

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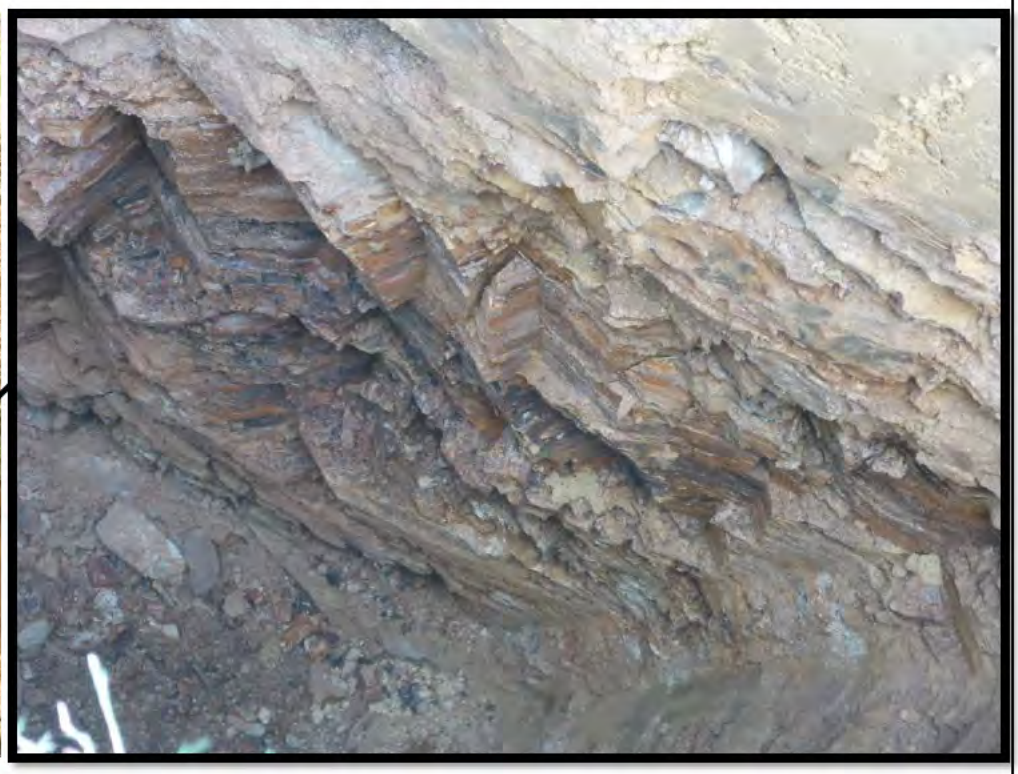

Client	ROARING40'S LTD	**Pit ID:**	TP103	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	22-Feb-2023	
Notes:	1) Stable on all sides. 2) No groundwater encountered.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	4.90	
Project No.	220372	**Terminated Due To:**	Target Depth	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP104

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	22 Feb 2023	496m	E 1294675, N 4860831

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	4.50m	Target Depth	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results (Depth (m))	Backfill / Install
495.70	0.30	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium. [TOPSOIL]						3, 2, 2 (0.5)	
495.50	0.50	COLLUVIUM		SILT, with some sand, trace fine to medium gravel, trace clay; yellowish brown. Stiff; moist; low plasticity; sand, fine to medium [COLLUVIUM]			0.50-4.50m: SUMMARY: Bdg 'partings', and typ. two intersecting/orthogonal v.steep to sub-vertical jt sets, VCS to MWS, pers 0.1m to 1m+, planar to undulating, rough, typ. tight - Bdg, typ. v.thin to thin, 5°>020 - Jt Set 1: 90°>150 - Jt Set 2: 70°>220 - Blocks: Prismatic, typ. 50 - 250mm.	Not Encountered		2, 2, 1 (1.0) 1, 1, 1 (1.5) 1, 0, 0 (2.0) 1, 2, 1 (2.5) 5, 9, 12 (3.0) 10, 7, 6 (3.5) 4, 5, 3 (4.0) 4, 4, 4 (4.5) 5, 5, 5 4, 4	
	0.5			HWx, locally MWx, brownish orange, indistinctly bedded SANDSTONE, ext.weak, locally v. weak to weak [FERNDALE GROUP OF MURIHIKU SUPERGROUP]							
	1.0	FERNDALE GROUP OF MURIHIKU SUPERGROUP									
	1.5										
	2.0										
	2.5										
	3.0										
	3.5										
	4.0										
491.50	4.50								4.30 - 4.50m, ~60kg		
	4.5			END OF HOLE: 4.50m (Target Depth)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 105°

1.1m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [x] None
- [ ] Slow Seep
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator		AvD	EBL

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Client	ROARING40'S LTD	**Pit ID:**	TP104
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	22-Feb-2023
Notes:	1) Stable on all sides. 2) No groundwater encountered.	**Plant:**	16t exc. Toothed Bucket
		Pit Toe Depth (m):	4.50
Project No.	220372	**Terminated Due To:**	Target Depth

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP105

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	22 Feb 2023	497m	E 1294203, N 4860065

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	4.80m	Target Depth	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results (Depth (m))	Backfill / Install
496.70	0.30	TOPSOIL	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium. [TOPSOIL]							
			0.28m: 10mm thick iron pan; hard							
	0.5	COLLUVIUM	SILT, with some sand, with trace clay; yellowish brown. Stiff; moist; low plasticity; sand, fine to medium. [COLLUVIUM]							
495.90	1.10	FERNDALE GROUP OF MURIHIKU SUPERGROUP	HWx, locally MWx, brownish orange, SANDSTONE, mod. thin, gently inclined bedding, ext.weak, locally v. weak to mod. strong [FERNDALE GROUP OF MURIHIKU SUPERGROUP]			1.10-4.80m: SUMMARY: Bdg 'partings', and typ. multiple intersecting jt sets, VCS to CS, planar, rough, typ. tight: - Bdg, typ. v.thin, 10-20°>000 - Blocks: Prismatic, typ 50 to 300mm (locally 350mm max dia.)	Not Encountered		1, 2, 1 1, 2, 2 2, 3, 3 4, 0, 0 1, 5, 5 7, 8, 8 V=76 2, 2, 4 R=20 8, 2, 3 9, 17 UTP	
	2.60m: Grades weak to mod. strong.									
	3.80m: Grades to mod. strong									
	4.00m: Single tine ripper used - easy penetration.									
492.20	4.80		END OF HOLE: 4.80m (Target Depth)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 270°

1.2m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [✓] None
- [ ] Slow Seep
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator	GEO105	AvD	EBL

Printed: 11/05/2023 8:58:57 am

Client	ROARING40'S LTD	**Pit ID:**	TP105	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	22-Feb-2023	
Notes:	1) Local pit wall collapse below 2.0m depth. 2) No groundwater encountered.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	4.8	
Project No.	220372	**Terminated Due To:**	Target Depth	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP106

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	23 Feb 2023	519m	E 1295650, N 4860140

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	4.30m	Pit Collapse	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results (Depth (m))	Backfill / Install
518.70	0.30	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium. [TOPSOIL]						2, 1, 2 1, 2, 3 3, 3	
	0.5	COLLUVIUM		SILT, with some sand, with minor clay; yellowish brown. Stiff; moist to wet; low plasticity; sand, fine to medium. [COLLUVIUM] 0.40m: 20mm thick iron pan; hard						V=84 R=19	
	1.0									V=58 R=15	
	1.5									1, 0, 1 1, 2, 2 1, 2, 3 7, 7, 4 9, 10, 8 11, 16, 12 13	
517.20	1.80	FERNDALE GROUP OF MURIHIKU SUPERGROUP		HWx; brownish grey to greyish brown; SANDSTONE; thin bedding ext.weak. In-situ: Sandy GRAVEL, some cobbles, trace clay; sand, fine to coarse; gravel, medium to coarse, angular, sandstone; cobbles, angular. [FERNDALE GROUP OF MURIHIKU SUPERGROUP] 2.00m: Grades to weak to v. weak.			1.80-4.30m: SUMMARY: Bdg partings and multiple intersecting sub-vertical jt sets, ECS to VCS, planar, rough, typ. tight - Bdg, typ thin, sub-horizontal - Most prominent Jt Set: 90°>210. - Blocks: Prismatic, typ. 50 to 180mm.	Not Encountered			
514.70	4.30			END OF HOLE: 4.30m (Pit Collapse)							
	4.5										

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Unstable

5.0m

Dug towards 140°

1.1m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [x] None
- [ ] Slow Seep
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator	GEO105	AvD	EBL

Printed: 11/05/2023 8:58:59 am

Client	ROARING40'S LTD	**Pit ID:**	TP106	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	23-Feb-2023	
Notes:	1) Pit wall collapse below 1.0m depth. 2) No groundwater encountered.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	4.30	
Project No.	220372	**Terminated Due To:**	Pit Collapse	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP107

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	23 Feb 2023	574m	E 1296582, N 4859991

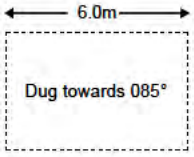
Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	5.50m	Target Depth	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results (Depth (m))	Backfill / Install
573.65	0.35	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium. [TOPSOIL]						1, 2, 1 2, 2, 4 17	
573.40	0.60	COLLUVIUM		0.30m: Slow seep from north wall. SILT, with some sand, with minor clay; yellowish brown. Firm; moist to wet; low plasticity; sand, fine to medium. [COLLUVIUM]			0.60-2.00m: SUMMARY: Multiple VCS jts, planar, rough, typ. tight				
572.00	2.00	FERNDALE GROUP OF MURIHIKU SUPERGROUP		HWx, brownish orange, indistinctly bedded SANDSTONE, ext. weak. In-situ: Silty fine to coarse GRAVEL, loose, angular. [FERNDALE GROUP OF MURIHIKU SUPERGROUP] 1.20m: Grades to medium dense. CWx, yellowish brown, indistinctly bedded SANDSTONE, ext. weak. In-situ: Silty fine to medium SAND, loose to medium dense, moist.			2.00-5.50m: SUMMARY: ECS to VCS remnant jts		3.20 - 3.50m, ~60kg	2, 4, 3 4, 3, 5 5, 5, 4 3, 2, 3 2, 3, 3 2, 2, 3 2, 2	
568.50	5.50			END OF HOLE: 5.50m (Target Depth)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Unstable



Explanations:
- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep (@0.30m)
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator		AvD	EBL

Printed: 11/05/2023 8:59:02 am

Client	ROARING40'S LTD	**Pit ID:**	TP107	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	23-Feb-2023	
Notes:	1) Local pit wall collapse between 0.3m to 3.50m. 2) Slow groundwater seep at 0.3m depth along northern pit wall.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	5.50	
Project No.	220372	**Terminated Due To:**	Target Depth	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP108

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	23 Feb 2023	584m	E 1297360, N 4859870

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	3.80m	Target Depth	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil / Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results	Backfill / Install
583.50	0.50	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium; minor amorphous peat inclusions. [TOPSOIL]						1, 1, 1 1, 1, 2 2, 2, 3 3	
583.38	0.62	FERNDALE GROUP OF MURIHIKU SUPERGROUP		RWx, dark grey, indistinctly bedded SANDSTONE, ext. weak. In-situ: Silty CLAY; Firm; moist; high plasticity. [FERNDALE GROUP OF MURIHIKU SUPERGROUP]							
583.10	0.90			0.60m: 10 to 20mm thick iron pan; hard.						V=73 R=15	
	1.0			In-situ: SILT, with some clay; yellowish brown. Stiff; moist; low plasticity.						UTP	
582.40	1.80			CWx, yellowish brown, light grey mottles, indistinctly bedded SANDSTONE, ext. weak. In-situ: Silty fine to medium SAND, loose, moist.						1, 1, 0 1, 2, 2 3, 3, 3 4, 6, 4 4, 6, 17	
	2.0			HWx, brownish orange, SANDSTONE, thin bedding, typ sub-horizontal, ext. weak. In-situ: Silty SAND, loose, moist; sand, fine to coarse.							
581.50	2.50						2.30-3.80m: SUMMARY: Bdg partings and multiple intersecting sub-vertical jt sets, ECS to CS, perst. 2m +, planar, rough, typ. tight - Bdg, typ thin, sub-horizontal - Most prominent Jt Set: 80°>165 - Blocks: Prismatic, locally tabular, typ. 50 to 350mm.	Not Encountered			
	3.0			MWx, brownish orange, SANDSTONE, typ. thin to mod.thin, sub-horizontal bedding, mod. strong to strong.							
580.20	3.80			3.60m: Single tine ripper used - easy penetration; inferred mod. strong							
				END OF HOLE: 3.80m (Target Depth)							
	4.0										
	4.5										

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 255°

1.1m

Explanations:

- Scala Penetrometer Tests: Raw data in blows per 50mm
- Vane Shear Strength (kPa): V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [x] None
- [ ] Slow Seep
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
NOT TO SCALE	K2 Kontracting Ltd	16t Excavator	GEO105	AvD	EBL

Printed: 11/05/2023 8:59:04 am

Client	ROARING40'S LTD	**Pit ID:**	TP108	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	23-Feb-2023	
Notes:	1) Stable on all sides. 2) No groundwater encountered.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	3.80	
Project No.	220372	**Terminated Due To:**	Target Depth	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP109

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	23 Feb 2023	583m	E 1297069, N 4860147

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	2.75m	Practicable Refusal	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results	Backfill / Install
	0.0	TOPSOL	TS	SILT, with minor sand; dark brown. Firm; wet to saturated; sand, fine to medium; minor amorphous peat with sulphurous odor. [TOPSOIL]						1, 0, 0 0, 0, 3 5, 11, 17	
582.28	0.72			0.70m: 20mm thick iron pan; hard.							
582.05	0.95	FERNDALE GROUP OF MURIHIKU SUPERGROUP		HWx, greyish brown, indistinctly bedded SANDSTONE, ext weak, loc weak to v.weak [FERNDALE GROUP OF MURIHIKU SUPERGROUP]			0.95-2.75m: SUMMARY: Bdg partings and multiple intersecting sub-vertical jt sets, VCS to CS, perst. 1m +, planar, rough, typ. tight - Bdg, typ thin, sub-horizontal - Jt Set 1: 90°>070 - Jt Set 2: 90°>120 - Blocks: Prismatic, typ 50 to 350mm				
	1.0			MWx, brownish orange, grey mottles, SANDSTONE, typ. thin, sub-horizontal bedding, weak.							
	1.5										
	2.0										
	2.5			2.40m: Single tine ripper used, inferred mod. strong							
580.25	2.75			END OF HOLE: 2.75m (Practicable Refusal)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.5m

Dug towards 160°

1.1m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- None
- Slow Seep (@0.30m)
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator		AvD	EBL

Printed: 11/05/2023 8:59:06 am

Client	ROARING40'S LTD	**Pit ID:**	TP109	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	23-Feb-2023	
Notes:	1) Stable on all sides. 2) Slow groundwater seep encountered at 0.3m depth.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	2.75	
Project No.	220372	**Terminated Due To:**	Practicable Refusal	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP110

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	23 Feb 2023	608m	E 1297264, N 4859744

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	1.80m	Practicable Refusal	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results	Backfill / Install
607.65	0.35	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium; trace to minor rootlet inclusions. [TOPSOIL]							
607.20	0.80	FERNDALE GROUP OF MURIHIKU SUPERGROUP		CWx to RWx, yellowish brown, SANDSTONE, ext. weak. Gravelly SILT; gravel, fine to medium, angular, sandstone. [FERNDALE GROUP OF MURIHIKU SUPERGROUP]							
606.20	1.80			MWx, locally SWx, bedded SANDSTONE, typ. v.thin to thin, sub-horizontal bedding, v. strong. 0.80m: Slow seep into pit. 0.90m: Single tine ripper used - difficult to penetrate			0.80-1.80m: SUMMARY: Bdg partings and multiple intersecting sub-vertical jt sets, VCS to CS, planar to undular, rough, typ. tight, iron stained - Bdg, typ 5-10°>005 - Jt Set 1: 80-90°>040 - Jt Set 2: 80-90°>120; perst. 2m+ - Jt Set 3: 70°>080; perst. 1m -Blocks: Prismatic, typ. 50 to 400mm (locally 600mm max dia.)			1, 4, 10 7, 6, 11 14, 17	
				END OF HOLE: 1.80m (Practicable Refusal)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 200°

1.9m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [ ] None
- [x] Slow Seep (@0.70m)
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator		AvD	EBL

Printed: 11/05/2023 8:59:08 am

Client	ROARING40'S LTD	**Pit ID:**	TP110	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	23-Feb-2023	
Notes:	1) Stable on all sides. 2) Slow groundwater seep encountered at 0.7m depth.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	1.80	
Project No.	220372	**Terminated Due To:**	Practicable Refusal	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP111

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	24 Feb 2023	606m	E 1297975, N 4858502

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	2.60m	Practicable Refusal	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil / Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results	Backfill / Install
606.30	0.70	TOPSOIL	TS	Sandy SILT; dark brown. Firm; moist to dry; sand, fine to medium. [TOPSOIL] 0.45m: Slow seep into test pit						1, 1, 3 7, 17, 17 17	
603.40	2.60	FERNDALE GROUP OF MURIHIKU SUPERGROUP		MWx, brownish orange, SANDSTONE, typ mod. thin, sub-horizontal bedding, mod. strong to strong. [FERNDALE GROUP OF MURIHIKU SUPERGROUP] 1.00m: local SWx concretion's 150-200mm dia. 2.20m: Single tine ripper used - easy penetration.			0.50-2.60m: SUMMARY: Bdg partings and multiple intersecting sub-vertical jt sets, VCS to MWS, planar to undular, rough, typ. tight, locally iron stained - Bdg, typ 5°>240 - Jt Set 1: 80-90°>150 - Jt Set 2: 80-90°>200 - Blocks: Prismatic, typ. 50 to 350mm (locally 1100mm max dia.)				
				END OF HOLE: 2.60m (Practicable Refusal)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

4.0m

Dug towards 075°

2.0m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate

Moisture: M = moist; W = wet; S = saturated

Groundwater:

- None
- Slow Seep (@0.45m)
- Rapid Inflow
- Standing Water Level
- Inflow
- Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
NOT TO SCALE	K2 Kontracting Ltd	16t Excavator		AvD	EBL

Printed: 11/05/2023 8:59:10 am

Client	ROARING40'S LTD	**Pit ID:**	TP111	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	24-Feb-2023	
Notes:	1) Stable on all sides. 2) Slow groundwater seep at 0.45m depth.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	2.60	
Project No.	220372	**Terminated Due To:**	Practicable Refusal	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP112

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	24 Feb 2023	628m	E 1297549, N 4859132

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	1.10m	Practicable Refusal	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results	Backfill / Install
627.50	0.50	TOPSOIL	TS	SILT, with minor sand; dark brown. Soft; wet; sand, fine to medium; some amorphous peat. [TOPSOIL] 0.40m: Slow seep into test pit.				◁			
627.40	0.70	FERNDALE GROUP OF MURIHIKU SUPERGROUP		RWx, light greyish brown, indistinctly bedded SANDSTONE, ext. weak. In-situ: SILT, with some clay; Firm; moist to wet; low plasticity. [FERNDALE GROUP OF MURIHIKU SUPERGROUP]							
				SWx, locally MWx, greyish brown, SANDSTONE, typ. thin to mod. thin, sub-horizontal bedding, strong to v. strong. 0.90m: Single tine ripper used - very difficult to penetrate.			0.70-1.10m: SUMMARY: Bdg partings and multiple intersecting sub-vertical jt sets, VCS to MWS, planar to undular, rough, typ. tight, locally iron stained - Bdg, typ 5-10°>275 - Most prominent Jt Set: 80-90°>255; perst. 1m+ - Blocks: Prismatic, locally tabular, typ. 50 to 250mm.				
626.90	1.10			END OF HOLE: 1.10m (Practicable Refusal)							

Depth ticks: 0.5, 1.0, 1.5

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 340°

2.0m

Explanations:
- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:
- None
- Slow Seep (@0.40m)
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:
- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:
1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator		AvD	EBL

Printed: 11/05/2023 8:59:12 am

Client	ROARING40'S LTD	**Pit ID:**	TP112	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	24-Feb-2023	
Notes:	1) Stable on all sides. 2) Slow groundwater seep at 0.4m depth.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	1.10	
Project No.	220372	**Terminated Due To:**	Practicable Refusal	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP113

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	24 Feb 2023	619m	E 1298139, N 4859276

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	1.60m	Practicable Refusal	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil | Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results (Depth (m))	Backfill / Install
618.70	0.30	TOPSOIL	TS	SILT, with minor sand; dark brown. Soft; moist to wet; sand, fine to medium. [TOPSOIL] 0.20m: Slow seep into test pit.				◁		1, 0, 3 12, 17	
618.50	0.50	FERNDALE GROUP OF MURIHIKU SUPERGROUP		HWx, brownish orange, indistinctly bedded SANDSTONE, v. to ext. weak. [FERNDALE GROUP OF MURIHIKU SUPERGROUP]			0.35-1.60m: SUMMARY: Bdg partings and multiple intersecting sub-vertical jt sets, VCS to MWS, planar to undular, rough, typ. tight, locally iron stained - Bdg, typ 5°>335; mod. thin to thick - Jt Set 1: 80-90°>075 - Jt Set 2: 80-90°>185 - Blocks: Tabular, locally prismatic, typ. 300 to 500mm (locally 1100mm max dia.)				
	0.5			MWx, locally SWx, greyish brown, orange mottles, SANDSTONE, typ. thin to mod. thin, sub-horizontal bedding, mod-strong to strong.							
	1.0										
617.70	1.30			SWx, bluish grey, SANDSTONE, typ. mod. thin, sub-horizontal bedding, v. strong. 1.40m: Single tine ripper used - very difficult to penetrate							
	1.5										
617.40	1.60			END OF HOLE: 1.60m (Practicable Refusal)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 220°

2.0m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- None
- ✓ Slow Seep (@0.20m)
- Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator		AvD	EBL

Printed: 11/05/2023 8:59:14 am

Client	ROARING40'S LTD	**Pit ID:**	TP113	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	24-Feb-2023	
Notes:	1) Stable on all sides. 2) Slow groundwater seep at 0.2m depth.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	1.60	
Project No.	220372	**Terminated Due To:**	Practicable Refusal	

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TEST PIT LOG

Project:	Site Location:	Pit Location:	No.:
Southland Wind Farm	Venlaw Road 794, Southland	Refer to Site Plan	TP114

Project No.:	Date Excavated:	Ground Level (m):	Co-ordinates (NZTM):
220372	24 Feb 2023	612m	E 1297879, N 4859093

Client:	Pit Depth:	Reason Terminated:	Sheet:	Status:
Roaring 40's Wind Power Ltd.	3.20m	Target Depth	1 of 1	FINAL

Elevation (m)	Depth (m)	Geological Unit	Legend	Geological Description (In accordance with NZGS Guidelines (2005) Refer to appended Information sheet and abbreviation explanation)	Weathering	Field Strength (Soil / Rock)	Defect Description (In accordance with NZGS Guidelines (2005); Refer to appended Information sheet and abbreviation explanation)	Groundwater	Samples	In-Situ Testing Data/Results (Depth (m))	Backfill / Install
611.50	0.50	TOPSOIL	TS	SILT, with minor sand; dark brown. Firm; moist; sand, fine to medium; minor peat and colluvium inclusions. [TOPSOIL]						1, 2, 1 1, 1, 2 5, 5, 5 6, 1, 0 0, 1, 3 2, 2, 3 8, 12	
	1.0	FERNDALE GROUP OF MURIHIKU SUPERGROUP		HWx, brownish orange, indistinctly bedded SANDSTONE, ext. weak. In-situ: Gravelly sandy SILT, stiff, gravel, fine to coarse, sub-angular, sandstone; sand, fine to coarse; loose to medium dense. [FERNDALE GROUP OF MURIHIKU SUPERGROUP]			0.50-2.00m: SUMMARY: VCS to CS remnant jts	Not Encountered			
610.00	2.00			MWx, Greyish brown, indistinctly bedded SANDSTONE, v. weak.			2.00-3.20m: SUMMARY: Typ. multiple intersecting jts, VCS, planar, rough, local iron staining - Blocks: Prismatic, typ. 50 to 250mm (locally 300mm max dia.)		2.50 - 2.75m, ~75kg		
608.80	3.20			END OF HOLE: 3.20m (Target Depth)							

SKETCHES / PHOTOS

LOCATION PLAN

Stability: Stable

5.0m

Dug towards 100°

1.2m

Explanations:

- Scala Penetrometer Tests Raw data in blows per 50mm
- Vane Shear Strength (kPa) V=Peak, R=Residual, UTP=Unable to penetrate
- Moisture: M = moist; W = wet; S = saturated

Groundwater:

- [x] None
- [ ] Slow Seep
- [ ] Rapid Inflow
- Standing Water Level
- Inflow / Outflow

Backfill:

- Bentonite
- Grout/concrete
- Spoil/arisings
- Filter sand

Remarks:

1. Co-ordinates based on handheld GPS, and elevations based on DEM model of site; both subject to survey confirmation.
2. Excavated with 16t (Hitachi) excavator equipped with 1.1m wide toothed bucket and single-tine ripper.
3. Where no in-situ testing undertaken, material strength terms are based on field description (NZGS).
4. Defect and bedding orientations (where applicable) are presented as dip (from horizontal) and dip direction (azimuth).
5. Backfill method: in layers compacted with excavator bucket, topsoil reinstated, surface track-rolled.

All dimensions in metres NOT TO SCALE	Contractor:	Machine Type:	Shear Vane ID:	Logged By:	Checked By:
	K2 Kontracting Ltd	16t Excavator		AvD	EBL

Printed: 11/05/2023 8:59:17 am

Client	ROARING40'S LTD	**Pit ID:**	TP114	
Project Title	SOUTHLAND WIND FARM 100-SERIES - MACHINE INSPECTION PIT PHOTOS	**Date:**	24-Feb-2023	
Notes:	1) Stable on all sides. 2) Slow groundwater seep at 2.55m depth.	**Plant:**	16t exc. Toothed Bucket	
		Pit Toe Depth (m):	3.20	
Project No.	220372	**Terminated Due To:**	Target Depth	

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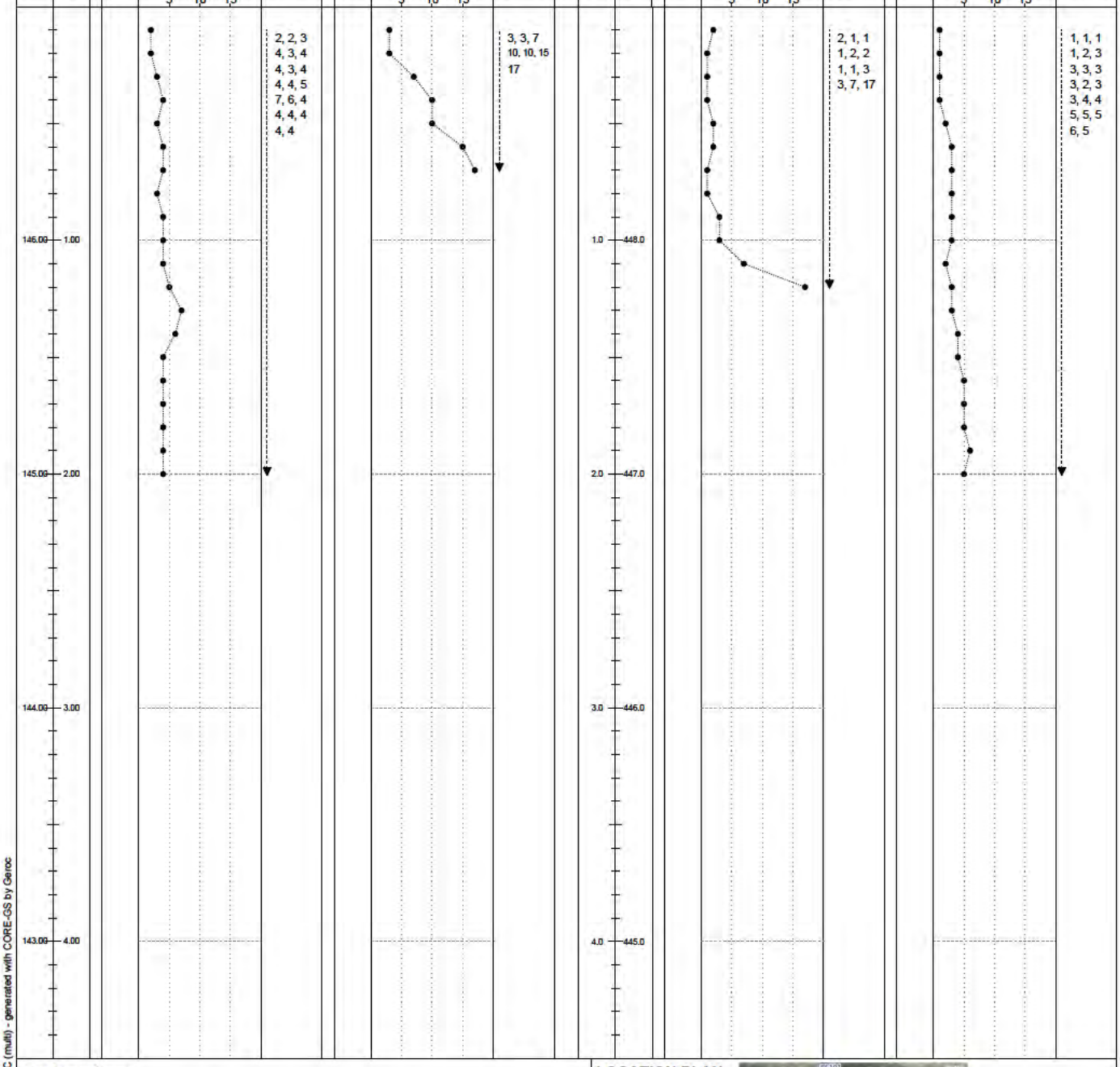
SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
220372	Southland Wind Farm	Venlaw Road 794, Southland	1 of 1

Client:	Co-ordinate System:	Elevation Datum:
Roaring 40's Wind Power Ltd.	NZTM	(m):

Test ID:	SC101	SC102	SC103	SC104
Date:	24 Feb 2023	24 Feb 2023	24 Feb 2023	22 Feb 2023
Logged By: / Checked By:	AvD / EBL	AvD / EBL	AvD / EBL	AvD / EBL
Co-ordinates (NZTM):	E 1294030, N 4864417	E 1294181, N 4863847	E 1294189, N 4862726	E 1294708, N 4861193



Explanations:

▼ Scala Penetrometer Tests

Note: Data typically recorded as blows per 50mm; may be converted to to blows per 100mm in some instances (as indicated at top of plot).

Remarks

1. Co-ordinates based on handheld GPS subject to survey confirmation.

LOCATION PLAN

NOT TO SCALE

Printed: 11/05/2023 9:07:54 am

RILEY CONSULTANTS LTD, REPORT: RILEY SC (multi) - generated with CORE-GS by Geroc

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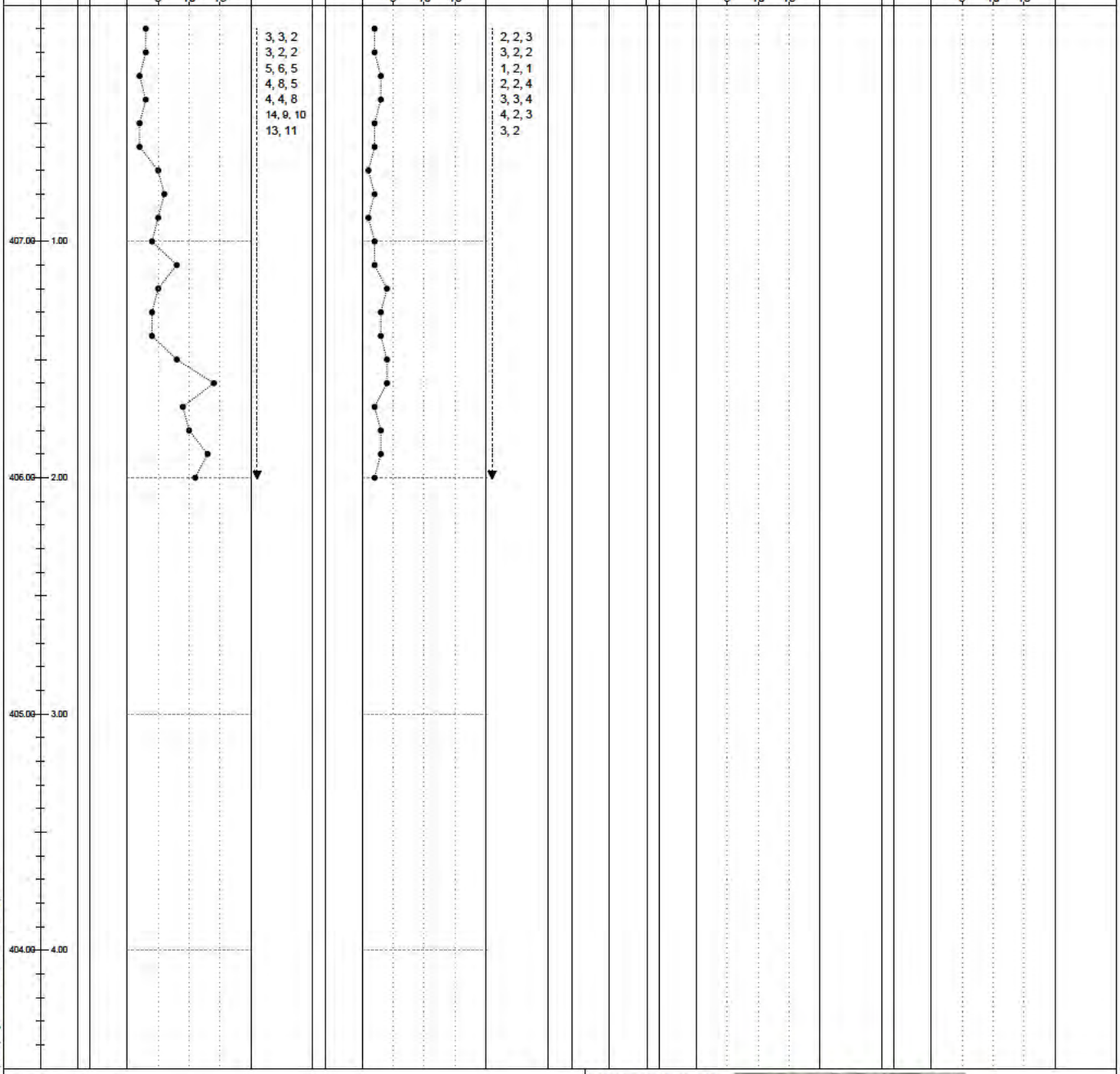
SCALA PENETROMETER TESTS

Project No.:	Project Name:	Project Location:	Sheet:
220372	Southland Wind Farm	Venlaw Road 794, Southland	1 of 1

Client:	Co-ordinate System:	Elevation Datum:
Roaring 40's Wind Power Ltd.	NZTM	(m):

Test ID:	SC105	SC106	Test ID:		
Date:	24 Feb 2023	24 Feb 2023	Date		
Logged By: / Checked By:	AvD / EBL	AvD / EBL	Logged By:		
Co-ordinates (NZTM):	E 1294058, N 4861857	E 1294197, N 4863764	Co-ordinates (NZTM):	,	,



Explanations:

▼ Scala Penetrometer Tests

Note: Data typically recorded as blows per 50mm; may be converted to to blows per 100mm in some instances (as indicated at top of plot).

Remarks

1. Co-ordinates based on handheld GPS subject to survey confirmation.

LOCATION PLAN

NOT TO SCALE

Printed: 11/05/2023 9:08:30 am

Appendix D

Laboratory Test Results

Central Testing Services
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Reference No: 23/1371

Date: 16 May 2023

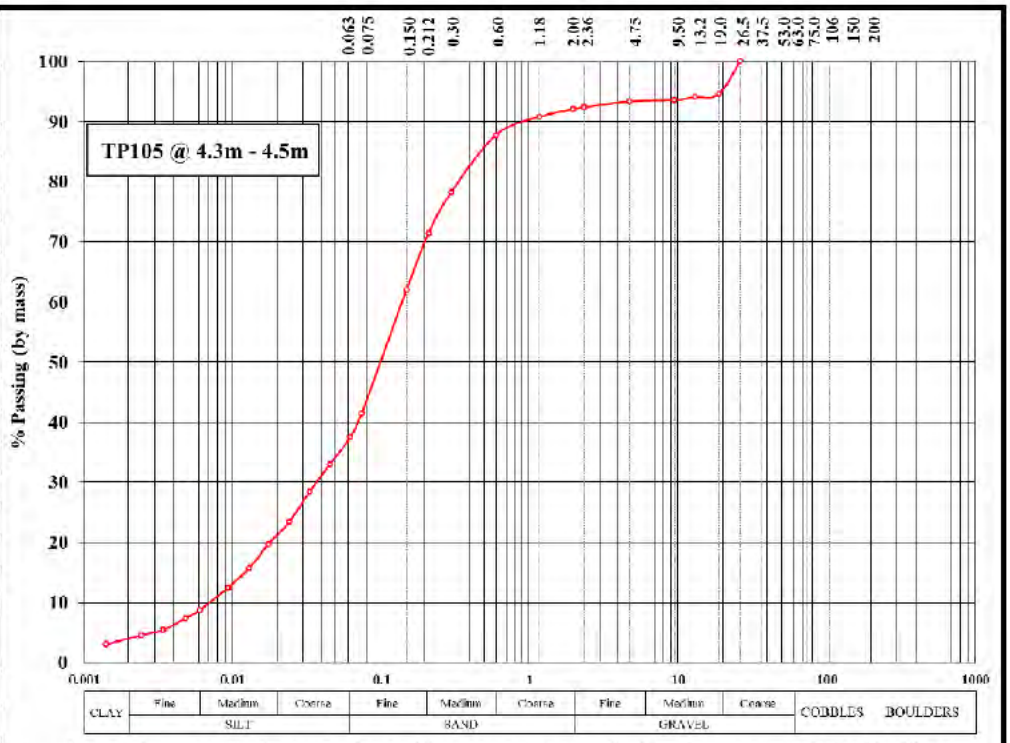
TEST REPORT – MIMIHAU WIND FARM

Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigations**		
Sample Description:	**Silty SAND with minor gravel and trace of clay**	**Client Ref. No:**	**230372**
Sample Source: (cs)	**Venlaw Road, Southland - TP105**	**Sample Depth: (cs)**	**4.3m - 4.5m**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method: (cs)	**Test Pit**	**Date Requested:**	**4-Apr-23**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	100
19.0	94
13.2	94
9.50	94
4.75	93
2.36	92
2.00	92
1.18	91
0.60	88
0.30	78
0.212	71
0.150	62
0.075	41
0.063	37

Fraction Size	Interpolated % Passing
60 µm	37
20 µm	21
6 µm	9
2 µm	4



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	60.0 mm to 20.0 mm	5	Fine Sand	200 µm to 60 µm	33
Medium Gravel	20.0 mm to 6.0 mm	2	Coarse Silt	60 µm to 20 µm	16
Fine Gravel	6.0 mm to 2.00 mm	1	Medium Silt	20 µm to 6 µm	12
Coarse Sand	2.00 mm to 600 µm	4	Fine Silt	6 µm to 2 µm	5
Medium Sand	600 µm to 200 µm	18	Clay	< 2 µm	4

WATER CONTENT& PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4

Water Content As Received:	**33.7 %**
Liquid Limit: (LL)	**Not Applicable (N/A)**
Plastic Limit: (PL)	**Non - Plastic (NP)**
Plasticity Index: (PI)	**Non - Plastic (NP)**

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.*
- *This report may not be reproduced except in full.*

Tested By: CP, BG, KH, ND, CJ & LS

Date: 19-Apr-23 to 16-May-23

Checked By: [redacted]

ACCREDITED IANZ TESTING LABORATORY №434

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 23/1371

Date: 16 May 2023

TEST REPORT – MIMIHAU WIND FARM

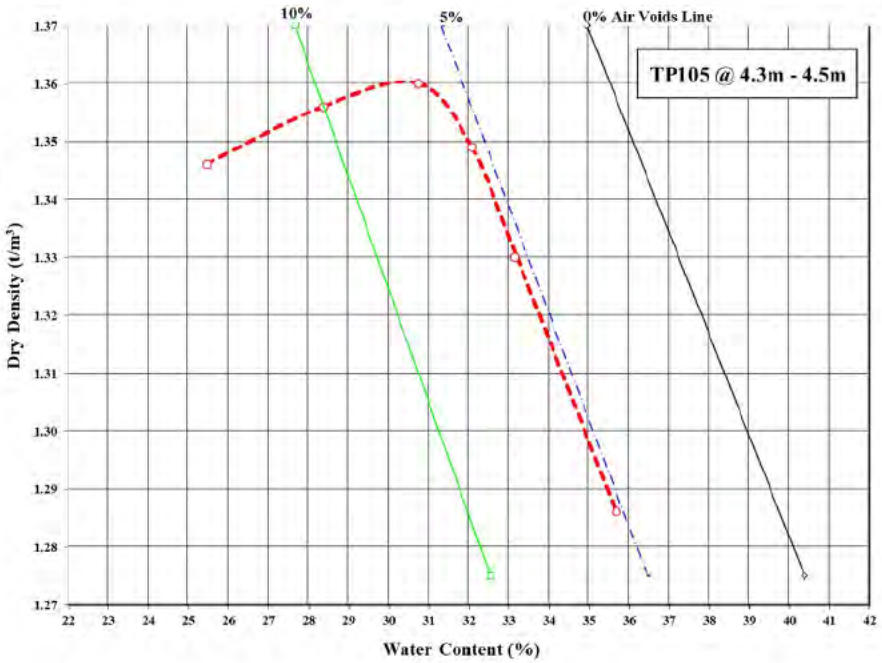
Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigations**		
Sample Description:	**Silty SAND with minor gravel and trace of clay**	**Client Ref. No:**	**230372**
Sample Source: (cs)	**Venlaw Road, Southland - TP105**	**Sample Depth: (cs)**	**4.3m - 4.5m**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method: (cs)	**Test Pit**	**Date Requested:**	**4-Apr-23**

SOLID DENSITY & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.7.1 & 4.1.1
DRY DENSITY & ABSORPTION - NZS 3111:1986, Test 12

% Retained (+19.0mm Fraction)	**6.0 %**
Dry Density: (+19.0mm Fraction)	**2.08 t/m^3**
Absorption (+19.0mm Fraction)	**9.2 %**
Solid Density: (-19.0mm Fraction)	**2.63 %**
Maximum Dry Density: (-19.0mm Fraction)	**1.36 t/m^3**
Optimum Water Content: (-19.0mm Fraction)	**31.0 %**

Notes:

- *The sample was received in a natural state.*
- *The material tested in the NZ Standard Compaction test was the fraction passing a 19.0mm test sieve.*
- *The air voids lines were calculated from the tested solid density above.*



Notes:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.*
- *This report may not be reproduced except in full.*

Tested By: CP, BG, KH, ND, CJ & LS

Date: 19-Apr-23 to 16-May-23

Checked By: [redacted]

ACCREDITED IANZ TESTING LABORATORY №434

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 23/1371

Date: 16 May 2023

TEST REPORT – MIMIHAU WIND FARM

Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigations**		
Sample Description:	**Silty SAND with minor gravel and trace of clay**	**Client Ref. No:**	**230372**
Sample Source: (cs)	**Venlaw Road, Southland - TP105**	**Sample Depth: (cs)**	**4.3m - 4.5m**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method: (cs)	**Test Pit**	**Date Requested:**	**4-Apr-23**
Test Method:	**NZS 4402:1986, Test 6.1.1**		

Description:	**LABORATORY CBR RESULTS**
Condition of Sample:	**Soaked**
Surcharge Mass: (kg)	**4.0**
Time Soaked:	**6 days**
Swell: (%)	**0.0**
Water Content as Compacted: (%)	**34.8**
Water Content From Under Plunger: (%)	**34.4**
Dry Density As Compacted: (t/m^3)	**1.30**
CBR Value @ 2.5 mm Penetration:	**1.0**
CBR Value @ 5.0 mm Penetration:	**2.0**
Reported CBR Value:	**2.0**

Note:

- *The material was received in a natural state.*
- *The material tested was the fraction passing the 19.0mm test sieve.*
- *The sample was compacted to NZ standard compaction.*
- *The rate of penetration was 1.00 mm / min.*

Notes:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.*
- *This report may not be reproduced except in full.*

Tested By: CP, BG, KH, ND, CJ & LS

Date: 19-Apr-23 to 16-May-23

Checked By: [redacted]

ACCREDITED IANZ TESTING LABORATORY №434

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 23/1371

Date: 16 May 2023

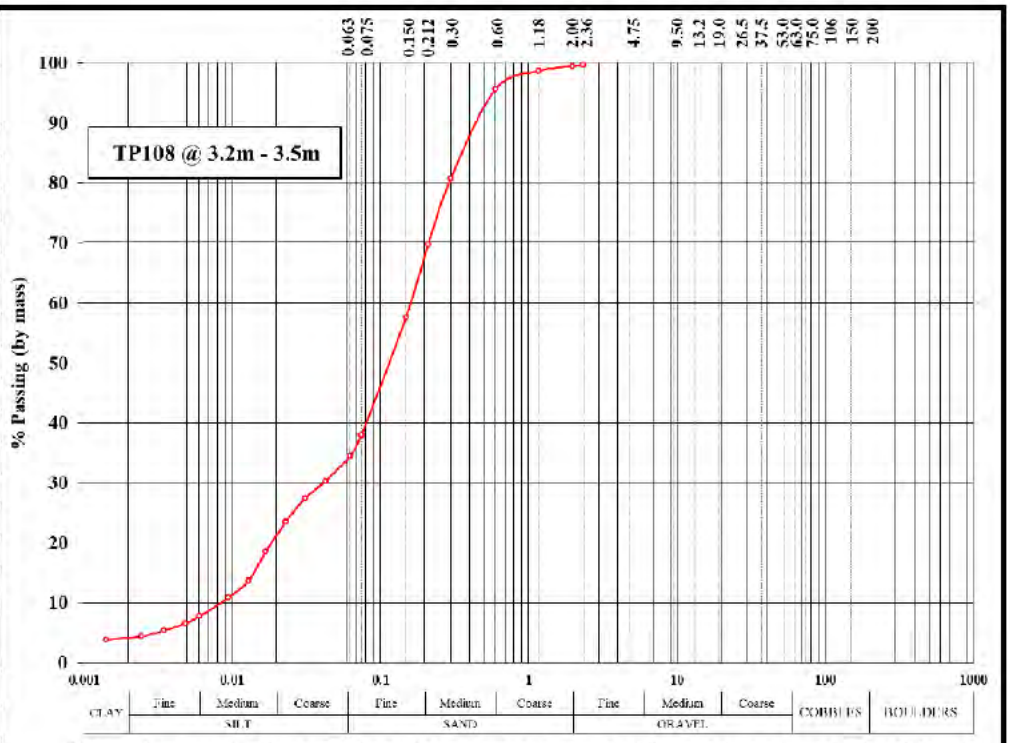
TEST REPORT – MIMIHAU WIND FARM

Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigations**		
Sample Description:	**Silty SAND with trace of gravel and trace of clay**	**Client Ref. No:**	**230372**
Sample Source: (cs)	**Venlaw Road, Southland - TP108**	**Sample Depth: (cs)**	**3.2m - 3.5m**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method: (cs)	**Test Pit**	**Date Requested:**	**4-Apr-23**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	
2.36	100
2.00	99
1.18	99
0.60	96
0.30	81
0.212	70
0.150	58
0.075	38
0.063	34

Fraction Size	Interpolated % Passing
60 µm	34
20 µm	21
6 µm	8
2 µm	4



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.0. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	60.0 mm to 20.0 mm	-	Fine Sand	200 µm to 60 µm	33
Medium Gravel	20.0 mm to 6.0 mm	-	Coarse Silt	60 µm to 20 µm	13
Fine Gravel	6.0 mm to 2.00 mm	1	Medium Silt	20 µm to 6 µm	13
Coarse Sand	2.00 mm to 600 µm	3	Fine Silt	6 µm to 2 µm	4
Medium Sand	600 µm to 200 µm	29	Clay	< 2 µm	4

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4

Water Content As Received:	**41.1 %**
Liquid Limit: (LL)	**Not Applicable (N/A)**
Plastic Limit: (PL)	**Non - Plastic (NP)**
Plasticity Index: (PI)	**Non - Plastic (NP)**

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

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Tested By: CP, BG, KH, ND, CJ & LS

Date: 19-Apr-23 to 16-May-23

Checked By: [redacted]

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Reference No: 23/1371

Date: 16 May 2023

TEST REPORT – MIMIHAU WIND FARM

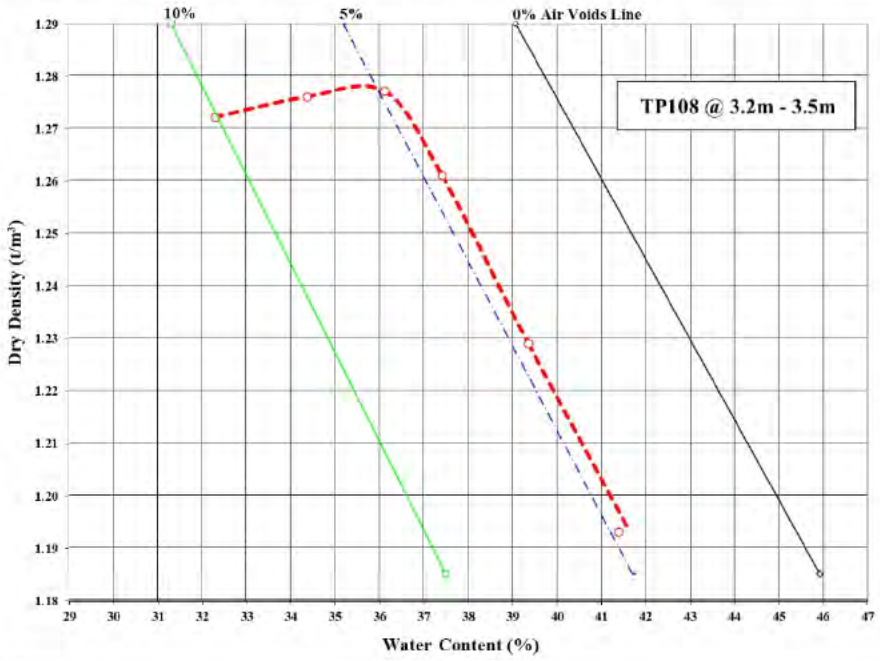
Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigations**		
Sample Description:	**Silty SAND with trace of gravel and trace of clay**	**Client Ref. No:**	**230372**
Sample Source: (cs)	**Venlaw Road, Southland - TP108**	**Sample Depth: (cs)**	**3.2m - 3.5m**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method: (cs)	**Test Pit**	**Date Requested:**	**4-Apr-23**

SOLID DENSITY & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.7.1 & 4.1.1

% Retained (+19.0mm Fraction)	**0.0 %**
Solid Density:	**2.60 %**
Maximum Dry Density:	**1.28 t/m^3**
Optimum Water Content:	**36.0 %**

Notes:

- *The sample was received in a natural state.*
- *The material tested in the NZ Standard Compaction test was whole soil.*
- *The air voids lines were calculated from the tested solid density above.*



Notes:

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Tested By: CP, BG, KH, ND, CJ & LS

Date: 19-Apr-23 to 16-May-23

Checked By: [redacted]

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Reference No: 23/1371

Date: 16 May 2023

TEST REPORT – MIMIHAU WIND FARM

Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigations**		
Sample Description:	**Silty SAND with trace of gravel and trace of clay**	**Client Ref. No:**	**230372**
Sample Source: (cs)	**Venlaw Road, Southland - TP108**	**Sample Depth: (cs)**	**3.2m - 3.5m**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method: (cs)	**Test Pit**	**Date Requested:**	**4-Apr-23**
Test Method:	**NZS 4402:1986, Test 6.1.1**		

Description:	**LABORATORY CBR RESULTS**
Condition of Sample:	**Soaked**
Surcharge Mass: (kg)	**4.0**
Time Soaked:	**6 days**
Swell: (%)	**0.0**
Water Content as Compacted: (%)	**39.3**
Water Content From Under Plunger: (%)	**38.8**
Dry Density As Compacted: (t/m^3)	**1.22**
CBR Value @ 2.5 mm Penetration:	**1.5**
CBR Value @ 5.0 mm Penetration:	**2.0**
Reported CBR Value:	**2.0**

Note:

- *The material was received in a natural state.*
- *The material tested was the fraction passing the 19.0mm test sieve.*
- *The sample was compacted to NZ standard compaction.*
- *The rate of penetration was 1.00 mm / min.*

Notes:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.*
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Tested By: CP, BG, KH, ND, CJ & LS

Date: 19-Apr-23 to 16-May-23

Checked By: [redacted]

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Reference No: 23/1371

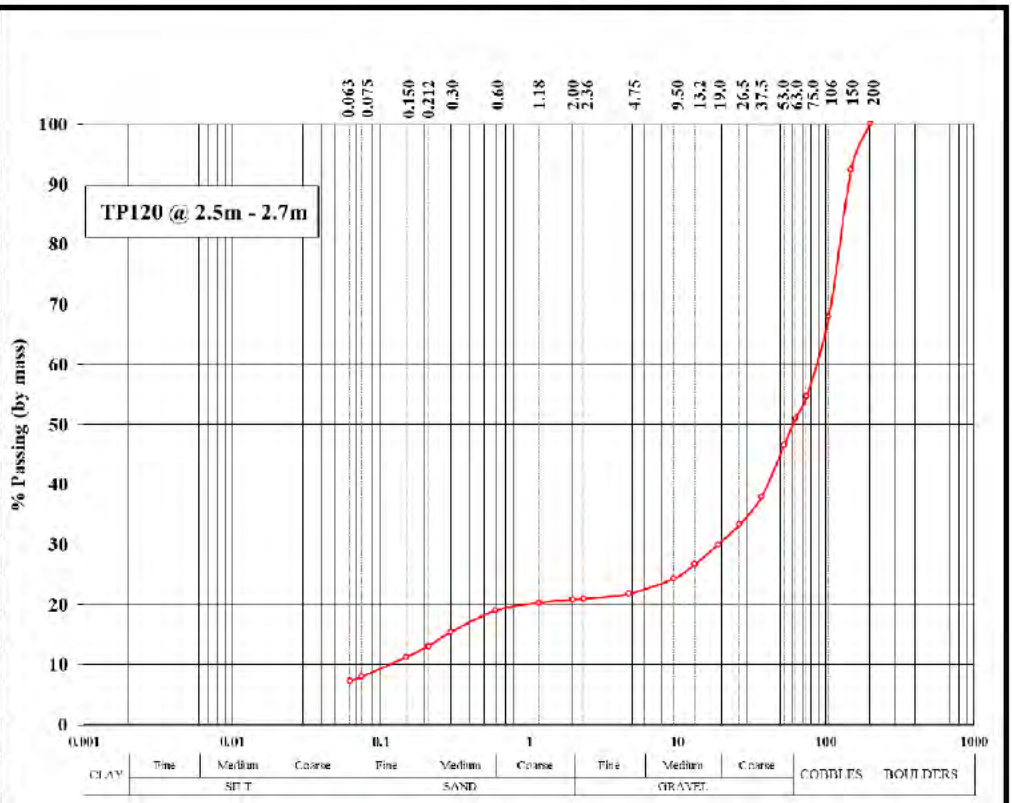
Date: 16 May 2023

TEST REPORT – MIMIHAU WIND FARM

Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigations**		
Sample Description:	**Gravelly COBBLES with some sand and minor silt**	**Client Ref. No:**	**230372**
Sample Source: (cs)	**Venlaw Road, Southland - TP120**	**Sample Depth: (cs)**	**2.5m - 2.7m**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method: (cs)	**Test Pit**	**Date Requested:**	**4-Apr-23**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
200.0	100
150.0	92
106.0	68
75.0	55
63.0	51
53.0	47
37.5	38
26.5	33
19.0	30
13.2	27
9.50	24
4.75	22
2.36	21
2.00	21
1.18	20
0.60	19
0.30	15
0.212	13
0.150	11
0.075	8
0.063	7



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

Notes:

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Tested By: CP, BG, KH, ND, CJ & LS

Date: 19-Apr-23 to 16-May-23

Checked By: [redacted]

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Reference No: 23/1371

Date: 16 May 2023

TEST REPORT – MIMIHAU WIND FARM

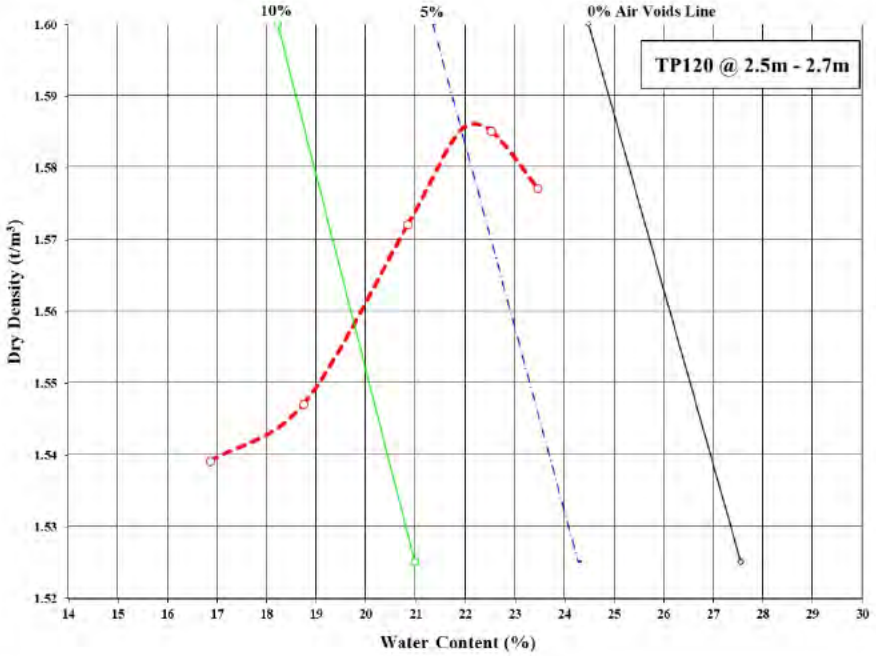
Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigations**		
Sample Description:	**Gravelly COBBLES with some sand and minor silt**	**Client Ref. No:**	**230372**
Sample Source: (cs)	**Venlaw Road, Southland - TP120**	**Sample Depth: (cs)**	**2.5m - 2.7m**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method: (cs)	**Test Pit**	**Date Requested:**	**4-Apr-23**

WATER CONTENT, SOLID DENSITY & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.1, 2.7.1 & 4.1.1
DRY DENSITY & ABSORPTION - NZS 3111:1986, Test 12

% Retained (+19.0mm Fraction)	**70.0 %**
Water Content: ("All In" As Received)	**17.7 %**
Dry Density: (+19.0mm Fraction)	**1.90 t/m^3**
Absorption (+19.0mm Fraction)	**11.3 %**
Solid Density: (-19.0mm Fraction)	**2.63 %**
Maximum Dry Density: (-19.0mm Fraction)	**1.58 t/m^3**
Optimum Water Content: (-19.0mm Fraction)	**22.0 %**

Notes:

- *The sample was received in a natural state.*
- *The material tested in the NZ Standard Compaction test was the fraction passing a 19.0mm test sieve.*
- *The air voids lines were calculated from the tested solid density above.*



Notes:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.*
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Tested By: CP, BG, KH, ND, CJ & LS

Date: 19-Apr-23 to 16-May-23

Checked By: [redacted]

Approved Signatory

[redacted]

A.P. Julius
Laboratory Manager

ACCREDITED IANZ TESTING LABORATORY №434

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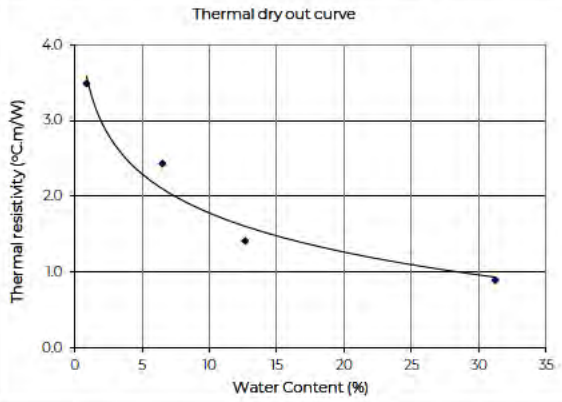
THERMAL RESISTIVITY TEST REPORT

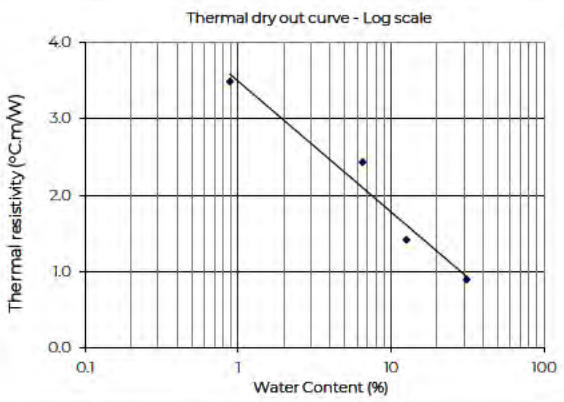
Project :	Mimihau Wind Farm Investigations
Location :	Mimihau Wind Farm
Client :	Central Testing Services
Contractor :	n/a
Sampled by :	Unknown
Date sampled:	Unknown
Sampling method:	Test Pit
Sample history:	As received (wetted up)

Project No:	5-22000.32
Sample No:	OR2634/1
Client Ref:	23/1371

Test Results

WSP Sample No:			OR2634/1A	OR2634/1B	OR2634/1C	OR2634/1D	-	-
Sample source:			TP105 4.3 - 4.5m				-	-
Sample description:			Silty SAND with minor gravel and trace of clay				-	-
Water content		%	31.2	12.7	6.5	0.88	-	-
Thermal Resistivity		°C.m/W	0.89	1.41	2.43	3.49	-	-
Water content (as rec'd)	w	%	19.8	←	←	←	-	-
Bulk density	ρ	t/m^3	n/a	←	←	←	-	-
Dry density	ρ_d	t/m^3	n/a	←	←	←	-	-
Compacted water content		%	31.2	←	←	←	-	-
Compacted bulk density	ρ	t/m^3	1.69	←	←	←	-	-
Compacted dry density	ρ_d	t/m^3	1.29	←	←	←	-	-
Compaction percent (NZ Std)		%	95	←	←	←	-	-





Test Methods		Notes
Water content	NZS 4402:1986 test 2.1	Intermediate water contents calculated by mass loss.
Thermal resistivity	Thermal resistivity testing is carried out in accordance with ASTM D5334-14. The detailed methodology includes in-house technical developments and improvements.	Thermal dry out curve line is MS-Excel calculated logarithmic scale of best fit and valid for the stated range tested # Target density = 95% MDD using client supplied data (MDD = 1.36 t/m3 OWC = 31.0%, NZ Std hammer). Compacted specimen size(mm) 130Ø x 338 100% passing 4.75mm. All information supplied by client.

Date tested: 05/05 - 13/06/2023

Reported by: ZJF

Date reported: 16/06/2023

WSP New Zealand Limited
WSP Research & Innovation Centre
Quality Management Systems Certified to ISO 9001

33 The Esplanade, Petone, 5012
PO Box 30 845, Lower Hutt, 5040
New Zealand

Telephone +64 4 587 0600
Facsimile +64 4 587 0604
Website www.wsp.com/en-nz

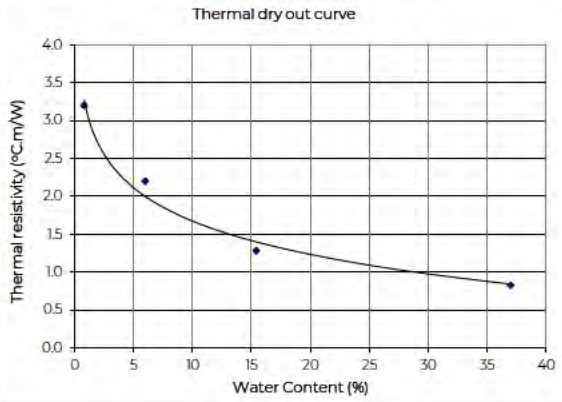
THERMAL RESISTIVITY TEST REPORT

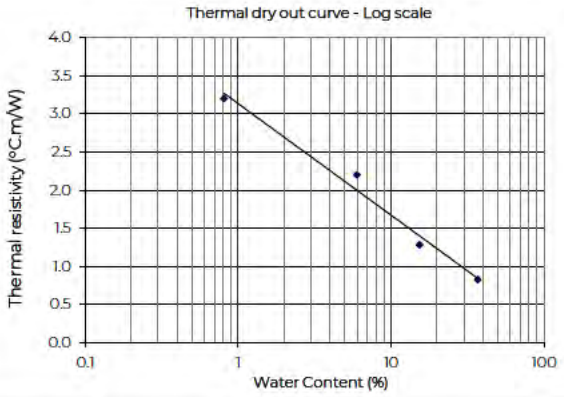
Project :	Mimihau Wind Farm Investigations
Location :	Mimihau Wind Farm
Client :	Central Testing Services
Contractor :	n/a
Sampled by :	Unknown
Date sampled:	Unknown
Sampling method:	Test Pit
Sample history:	As received (wetted up)

Project No:	5-22000.32
Sample No:	OR2634/2
Client Ref:	23/1371

Test Results

WSP Sample No:			OR2634/2A	OR2634/2B	OR2634/2C	OR2634/2D	-	-
Sample source:			TP108 3.2 - 3.5m				-	-
Sample description:			Silty SAND with trace of gravel and trace of clay				-	-
Water content		%	37.0	15.4	6.0	0.81	-	-
Thermal Resistivity		°C.m/W	0.83	1.28	2.20	3.20	-	-
Water content (as rec'd)	w	%	37.0	←	←	←	-	-
Bulk density	ρ	t/m^3	n/a	←	←	←	-	-
Dry density	ρ_d	t/m^3	n/a	←	←	←	-	-
Compacted water content		%	37.0	←	←	←	-	-
Compacted bulk density	ρ	t/m^3	1.67	←	←	←	-	-
Compacted dry density	ρ_d	t/m^3	1.22	←	←	←	-	-
Compaction percent (NZ Std)		%	95	←	←	←	-	-





Test Methods		Notes
Water content	NZS 4402:1986 test 2.1	Intermediate water contents calculated by mass loss.
Thermal resistivity	Thermal resistivity testing is carried out in accordance with ASTM D5334-14. The detailed methodology includes in-house technical developments and improvements.	Thermal dry out curve line is MS-Excel calculated logarithmic scale of best fit and valid for the stated range tested # Target density = 95% MDD using client supplied data (MDD = 1.28 t/m3 OWC = 36.0%, NZ Std hammer). Compacted specimen size(mm) 130Ø x 288 100% passing 4.75mm. All information supplied by client.

Date tested: 05/05 - 08/06/2023

Reported by: ZJF

Date reported: 16/06/2023

WSP New Zealand Limited
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P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 23/1746

Date: 24 May 2023

TEST REPORT – MIMIHAU WIND FARM INVESTIGATIONS

Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigation**		
Sample Description:	**Rock - Sandstone**	**Client Order No:**	**230372**
Sample Source: [cs]	**JS Quarry**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method:	**Unknown**	**Date Requested:**	**14-April-23**
Sample Specification:	**TNZ M/4:2006, Specification for Basecourse Aggregates**		

CRUSHING RESISTANCE - NZS 4407:2015, Test 3.10	
Specified Load:	**130 kN**
% Passing 2.36 mm Test Sieve:	**2.7 %**
Crushing Resistance Compliance:	**Greater Than Specified Load**
Estimated Crushing Resistance:	**270 kN** [1]

Specification Notes:

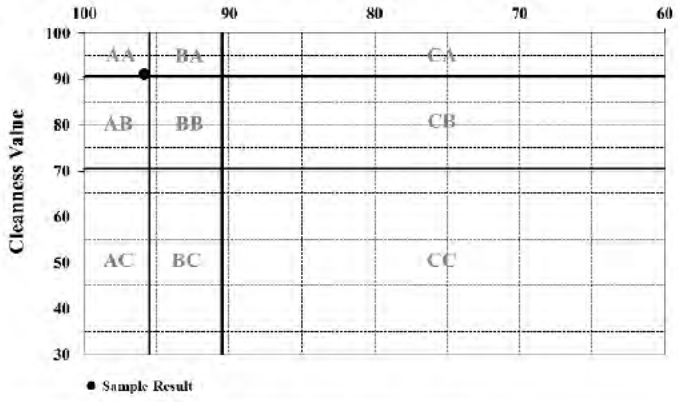
To comply with the requirements of TNZ M/4:2006 (Basecourse) an aggregate must produce less than 10% fines under a load of 130 kN.

[1] The estimated crushing resistance is a derived result from NZS 3111:1986, Test 14. IANZ endorsement does not apply to this value.

WEATHERING RESISTANCE (NZS 4407:2015, Test 3.11)	
% Retained on 4.75 mm Test Sieve:	**96**
Cleanness Value:	**91**
Weathering Resistance Quality Index:	**AA**

Specification Notes:

To comply with the requirements of TNZ M/4:2006 (Basecourse) an aggregate must have a weathering resistance quality index of AA, AB, AC, BA, BB or CA.



DENSITY & ABSORPTION OF COARSE AGGREGATE - NZS 3111:1986, Test 12	
Test Description	**Sample Results**
Density SSD Basis:	**2640 kg/m^3**
Density Dry Basis:	**2600 kg/m^3**
Absorption:	**1.4 %**

Additional Notes:

- *The sample was received in a natural state.*
- *Information contained in this report which is Not IANZ Accredited relates to the estimated crushing resistance, the client supplied information [cs] and sampling.*
- *This report may not be reproduced except in full.*

Tested By: L.T. Smith & K. Hipkins **Date:** 5 to 21-May-23 **Checked By:** [redacted]

Approved Signatory

[redacted]

A.P. Julius
Laboratory Manager

ACCREDITED IANZ TESTING LABORATORY №434

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 23/1747

Date: 24 May 2023

TEST REPORT – MIMIHAU WIND FARM INVESTIGATIONS

Client Details:	**Riley Consultants Ltd, P.O. Box 4355, Christchurch**	**Attention:**	**E. Ladley**
Job Description:	**Mimihau Wind Farm Investigation**		
Sample Description:	**Rock - Sandstone**	**Client Order No:**	**N/A**
Sample Source: (cs)	**Matariki Quarry**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method:	**Unknown**	**Date Requested:**	**14-April-23**
Sample Specification:	**TNZ M/4:2006, Specification for Basecourse Aggregates**		

CRUSHING RESISTANCE - NZS 4407:2015, Test 3.10	
Specified Load:	**130 kN**
% Passing 2.36 mm Test Sieve:	**9.1 %**
Crushing Resistance Compliance:	**Greater Than Specified Load**
Estimated Crushing Resistance:	**140 kN** (1)

Specification Notes:

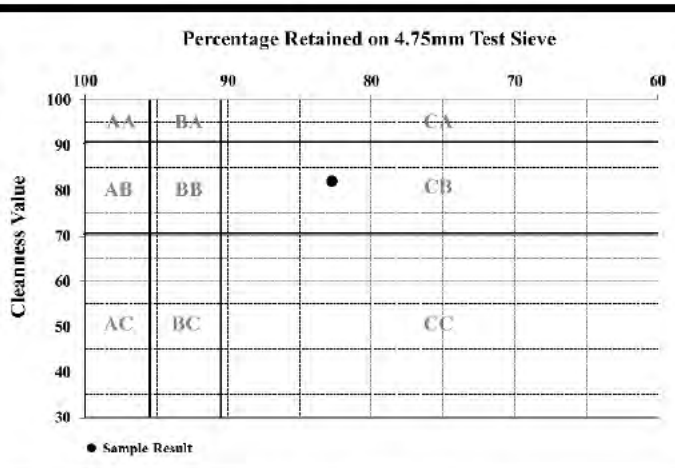
To comply with the requirements of TNZ M/4:2006 (Basecourse) an aggregate must produce less than 10% fines under a load of 130 kN.

(1) The estimated crushing resistance is a derived result from NZS 3111:1986, Test 14. IANZ endorsement does not apply to this value.

WEATHERING RESISTANCE (NZS 4407:2015, Test 3.11)	
% Retained on 4.75 mm Test Sieve:	**83**
Cleanness Value:	**82**
Weathering Resistance Quality Index:	**CB**

Specification Notes:

To comply with the requirements of TNZ M/4:2006 (Basecourse) an aggregate must have a weathering resistance quality index of AA, AB, AC, BA, BB or CA.



DENSITY & ABSORPTION OF COARSE AGGREGATE - NZS 3111:1986, Test 12	
Test Description	**Sample Results**
Density SSD Basis:	**2510 kg/m^3**
Density Dry Basis:	**2410 kg/m^3**
Absorption:	**4.2 %**

Additional Notes:

- *The sample was received in a natural state.*
- *Information contained in this report which is Not IANZ Accredited relates to the estimated crushing resistance, the client supplied information (cs) and sampling.*
- *This report may not be reproduced except in full.*

Tested By: L.T. Smith **Date:** 7 to 23-May-23 **Checked By:** [redacted]

Approved Signatory

[redacted]

A.P. Julius
Laboratory Manager

ACCREDITED IANZ TESTING LABORATORY №434

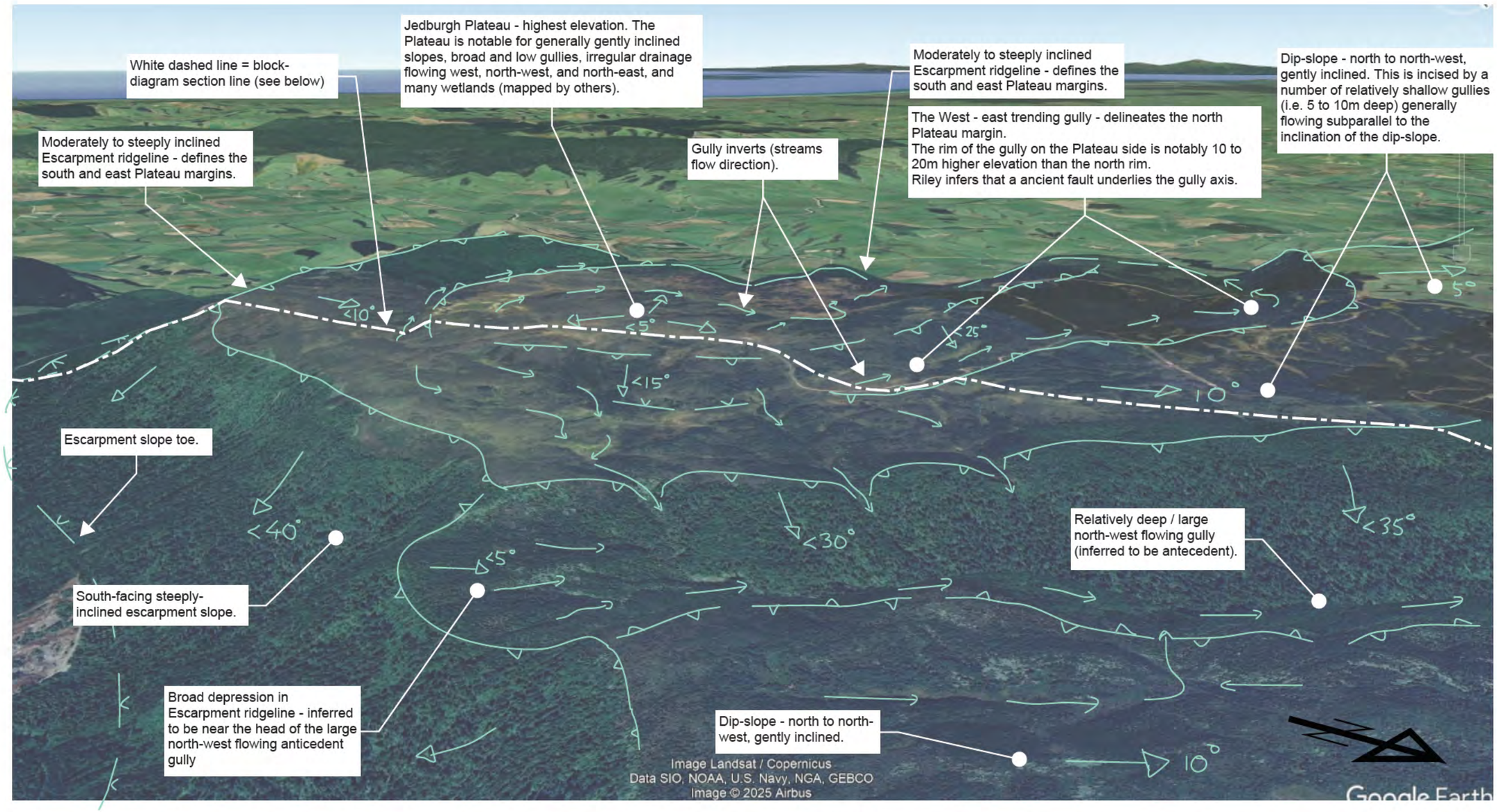
Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Appendix E

Jedburgh Plateau – Oblique Geomorphic and Geotechnical Sketch Diagrams

Project: Southland Wind Farm
Title: Oblique Annotated Geomorphic Diagram - Jedburgh Plateau (Google Earth base)
Date: 15 July 2025 By: EBL

SKETCH No.:SK2501



Notes:
1. To be read in conjunction with the geotechnical block diagram (Sketch No.: Sk2502).
2. Sketch is not to scale (N.T.S.).

Project: Southland Wind Farm
Title: Geotechnical Block Diagram - Jedburgh Plateau
Date: 15 July 2025 By: EBL

SKETCH No.:SK2502

Jedburgh Plateau - highest elevation. The Plateau is notable for generally gently inclined slopes, broad and low gullies, irregular drainage flowing west, north-west, and north-east, and many wetlands (mapped by others).

Moderately to steeply inclined Escarpment ridgeline - defines the south and east Plateau margins.

Moderately to steeply inclined Escarpment ridgeline - defines the south and east Plateau margins.

The West - east trending gully - delineates the north Plateau margin.
The rim of the gully on the Plateau side is notably 10 to 20m higher elevation than the north rim.
Riley infers that a ancient fault underlies the gully axis.

Dip-slope - north to north-west, gently inclined. This is incised by a number of relatively shallow gullies (i.e. 5 to 10m deep) generally flowing subparallel to the inclination of the dip-slope.

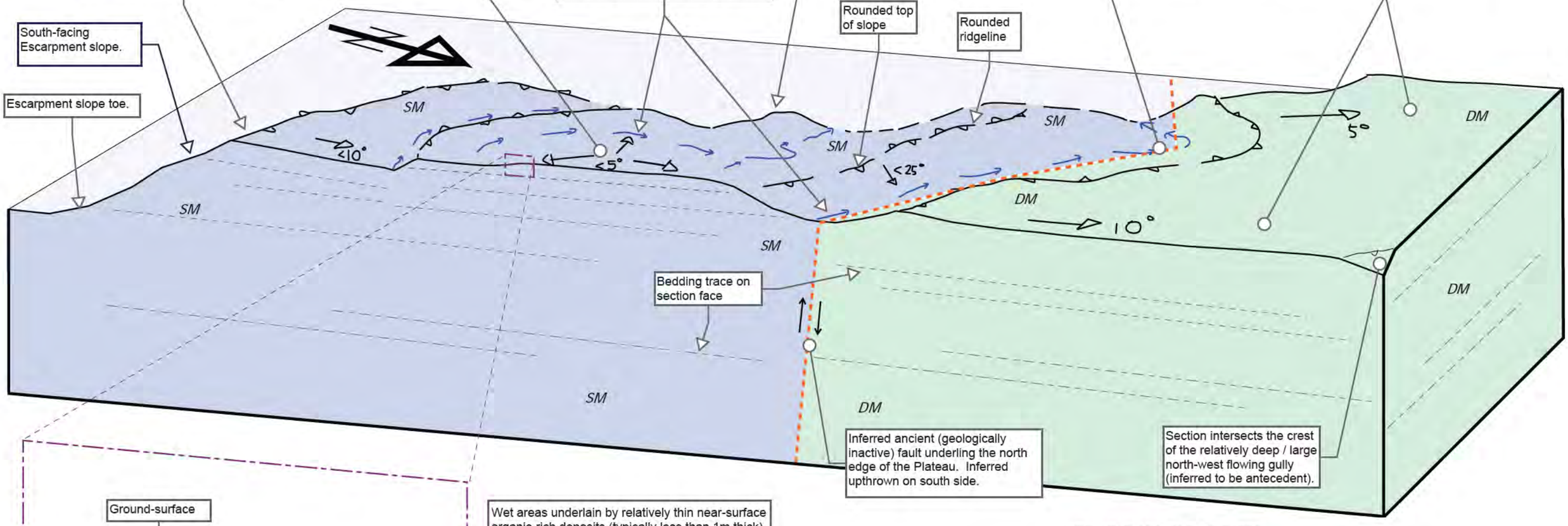
Gully inverts (streams flow direction).

Rounded top of slope

Rounded ridgeline

South-facing Escarpment slope.

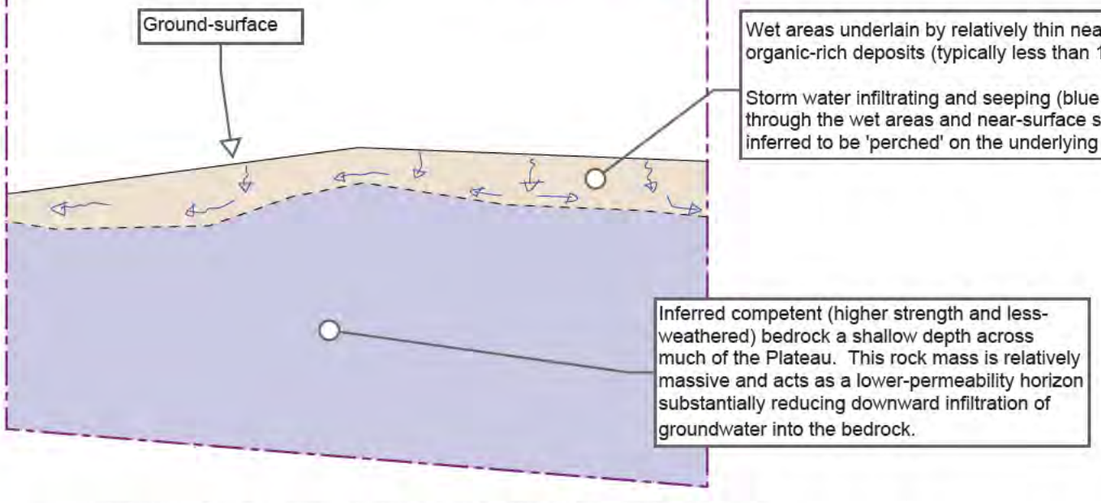
Escarpment slope toe.



Bedding trace on section face

Inferred ancient (geologically inactive) fault underling the north edge of the Plateau. Inferred upthrown on south side.

Section intersects the crest of the relatively deep / large north-west flowing gully (inferred to be antecedent).



ENLARGED SKETCH OF GENERALISED NEAR-SURFACE GEOTECHNICAL CONDITIONS AT PLATEAU (N.T.S.)

GEOLOTECHNICAL SEQUENCES

DM — **DEEP MANTLE**
THE CUMULATIVE THICKNESS OF UNCONSOLIDATED NEAR-SURFACE 'SOILS' AND LOWER-STRENGTH BEDROCK FORM A RELATIVELY 'DEEP MANTLE' GENERALLY OVER 6m DEPTH

SM — **SHALLOW MANTLE**
WHERE THE COMBINED THICKNESS OF 'SOILS' AND/OR LOWER-STRENGTH BEDROCK PROFILE IS APPROXIMATELY 1m TO 2m AND LOCALLY UP TO 4m (E.G. BH01) (I.E. RELATIVELY SHALLOW DEPTH TO THE TOP OF BLUE-ROCK).

Legend extracted from Riley Dwg: 220372-207 Rev. 3 dated 11 July 2025

Notes:
1. Block-diagram geotechnical conditions are inferred and subject to confirmation during detailed design. The sketches should be read in conjunction with our Geotechnical Assessment for Resource Consent, Riley Ref: 220372-B Issue 3.0, dated 15 July 2025, and are not to scale (N.T.S.).
2. For indicative location of the block diagram long axis refer to Sketch 2501 above.
2. Any recommendations and opinions in these sketches are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

Appendix F

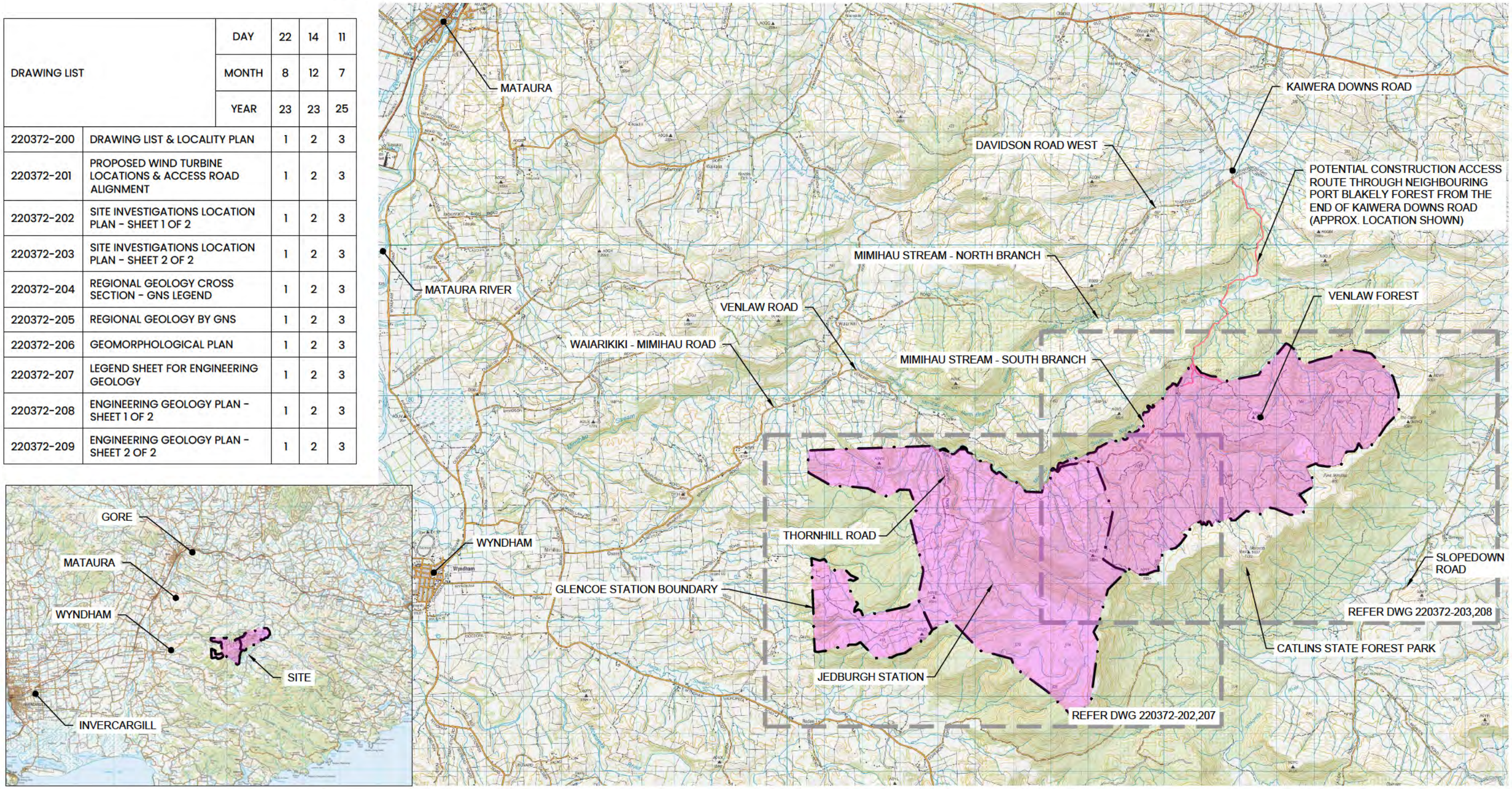
Riley Dwgs:
220372-200 to -209

CONTACT ENERGY

SOUTHLAND WIND FARM

GEOTECHNICAL ASSESSMENT FOR RESOURCE CONSENT DRAWINGS - JULY 2025

DRAWING LIST		DAY	22	14	11
		MONTH	8	12	7
		YEAR	23	23	25
220372-200	DRAWING LIST & LOCALITY PLAN		1	2	3
220372-201	PROPOSED WIND TURBINE LOCATIONS & ACCESS ROAD ALIGNMENT		1	2	3
220372-202	SITE INVESTIGATIONS LOCATION PLAN - SHEET 1 OF 2		1	2	3
220372-203	SITE INVESTIGATIONS LOCATION PLAN - SHEET 2 OF 2		1	2	3
220372-204	REGIONAL GEOLOGY CROSS SECTION - GNS LEGEND		1	2	3
220372-205	REGIONAL GEOLOGY BY GNS		1	2	3
220372-206	GEOMORPHOLOGICAL PLAN		1	2	3
220372-207	LEGEND SHEET FOR ENGINEERING GEOLOGY		1	2	3
220372-208	ENGINEERING GEOLOGY PLAN - SHEET 1 OF 2		1	2	3
220372-209	ENGINEERING GEOLOGY PLAN - SHEET 2 OF 2		1	2	3



REGIONAL LOCATION PLAN
N.T.S.

NOTE: BASE MAPS SOURCED FROM LINZ

SITE LOCATION
SCALE 1:100 000

1000 0 2000 4000m
SCALE 1:100000

RESOURCE CONSENT

REV	DATE	ISSUE	BY
3	11.07.25	RESOURCE CONSENT	JM
2	14.12.23	RESOURCE CONSENT	ZL
1	22.08.23	ISSUED FOR RESOURCE CONSENT	ZL

PREP. BY	REVD. BY
EL	DT
APPROVED FOR ISSUE	
D TATE	

RILEY www.riley.co.nz

contact

CLIENT	CONTACT ENERGY
ADDRESS	VENLAW ROAD 794, SLOPEDOWN, SOUTHLAND
PROJECT	SOUTHLAND WIND FARM
SHEET TITLE	DRAWING LIST & LOCALITY PLAN

CADFILE	220372-200.dwg
SCALE (A3)	1:50
ORIG. SHEET SIZE	A3
DRAWING No.	220372-200
REV.	3

MIMIHAU STREAM

MIMIHAU STREAM - NORTH BRANCH

MIMIIHAU STREAM - SOUTH BRANCH

THORNHILL ROAD

JEDBURGH STATION

GLENCOE STATION

POSSIBLE ACCESS ROUTE FOR TURBINE COMPONENTS - THROUGH PORT BLAKELY FOREST OFF DAVIDSON ROAD WEST. NOTE THIS ROUTE HAS NOT BEEN VISUALLY OBSERVED ON SITE BY RILEY GEOTECHNICAL ENGINEERS.

MIMIHAU STREAM - NORTH BRANCH

MIMIHAU STREAM - SOUTH BRANCH

JED-01
JED-02
JED-03
JED-04
JED-05
JED-06
JED-07
JED-08
JED-09
JED-10
JED-11
JED-12
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JED-14
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JED-31
JED-32
JED-33
JED-34

GLE-01
GLE-02
GLE-03

MAT-01
MAT-02
MAT-03
MAT-04
MAT-05
MAT-06
MAT-07
MAT-08
MAT-09
MAT-10
MAT-11
MAT-12
MAT-13
MAT-14
MAT-15
MAT-16
MAT-17
MAT-18

500 0 1000 2000m
SCALE 1:50000

LEGEND

- SITE PROPERTY BOUNDARIES
- EXISTING 20m CONTOURS (LINZ)
- WATER COURSE (LINZ)
- PROPOSED ACCESS TRACKS
- PROPOSED WTG LOCATIONS
- COMBINED HIGH VALUE ECOLOGICAL AREAS AND WETLANDS

EXISTING ROADS

- PUBLIC
- PRIVATE
- PROPOSED CONSTRUCTION ACCESS THROUGH PORT BLAKELY FOREST

NOTE:

1. BASE HILLSHADE EXTRACTED FROM GNS MAPS.

RESOURCE CONSENT

REV	DATE	ISSUE	BY
3	7.06.25	RESOURCE CONSENT	JM
2	14.12.23	RESOURCE CONSENT	ZL
1	22.08.23	ISSUED FOR RESOURCE CONSENT	ZL

PREP. BY: EL | REVD. BY: DT

APPROVED FOR ISSUE: DRAFT

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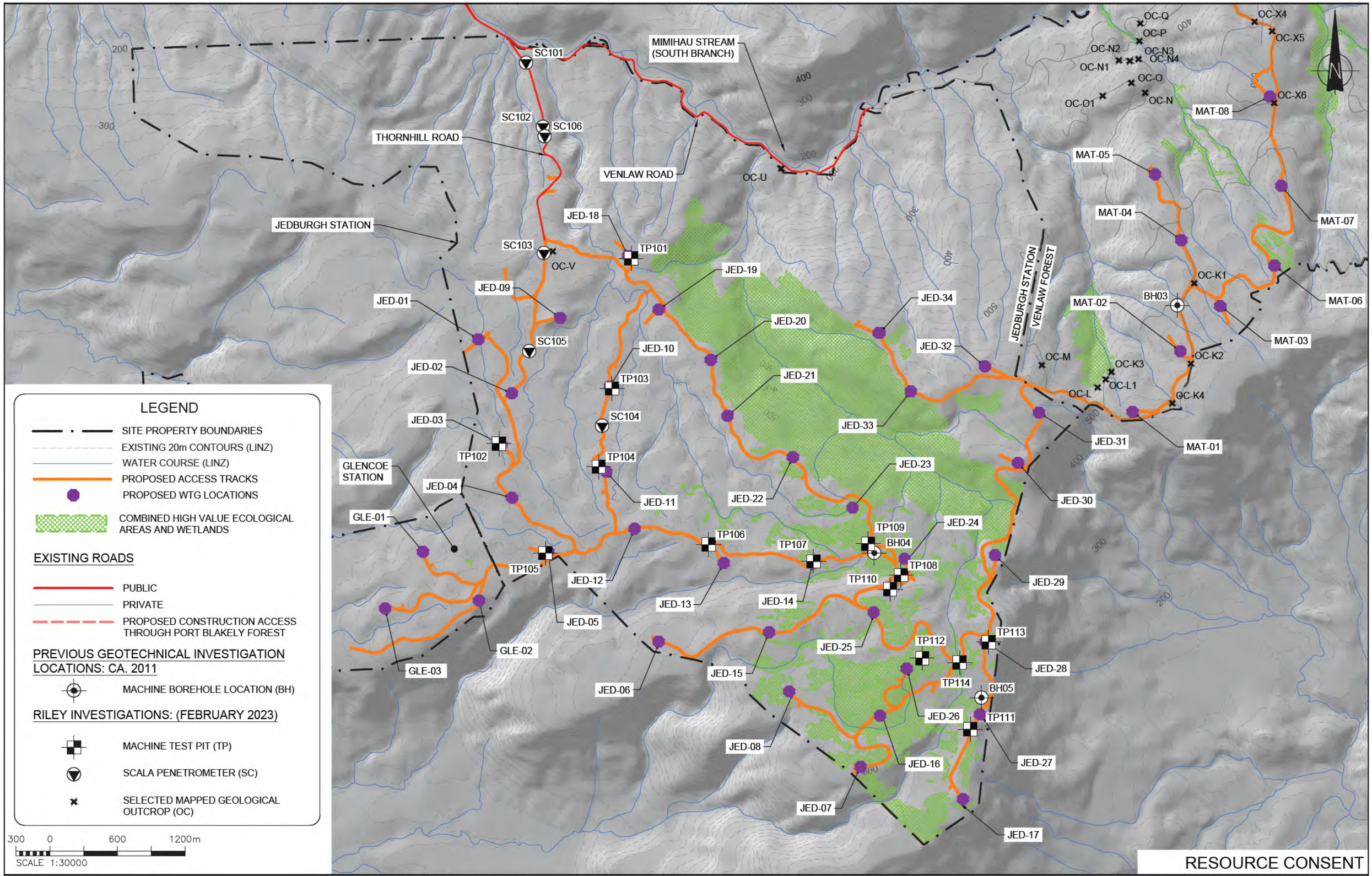
CLIENT	CONTACT ENERGY
ADDRESS	VENLAW ROAD 794, SLOPEDOWN, SOUTHLAND
PROJECT	SOUTHLAND WIND FARM
SHEET TITLE	PROPOSED WIND TURBINE LOCATIONS & ACCESS ROAD ALIGNMENT

CADFILE	220372-201-203_205-209.dwg
SCALE (A3)	1:50000
ORIG. SHEET SIZE	A3
DRAWING No.	220372-201
REV.	3



LEGEND

- SITE PROPERTY BOUNDARIES
- EXISTING 20m CONTOURS (LINZ)
- WATER COURSE (LINZ)
- PROPOSED ACCESS TRACKS
- PROPOSED WTG LOCATIONS
- COMBINED HIGH VALUE ECOLOGICAL AREAS AND WETLANDS

EXISTING ROADS

- PUBLIC
- PRIVATE
- PROPOSED CONSTRUCTION ACCESS THROUGH PORT BLAKELY FOREST

PREVIOUS GEOTECHNICAL INVESTIGATION LOCATIONS: CA. 2011

- MACHINE BOREHOLE LOCATION (BH)

RILEY INVESTIGATIONS: (FEBRUARY 2023)

- MACHINE TEST PIT (TP)
- SCALA PENETROMETER (SC)
- SELECTED MAPPED GEOLOGICAL OUTCROP (OC)

300 0 600 1200m

SCALE 1:30000

RESOURCE CONSENT

REV	DATE	ISSUE	BY
3	7.06.25	RESOURCE CONSENT	JM
2	14.12.23	RESOURCE CONSENT	ZL
1	22.08.23	ISSUED FOR RESOURCE CONSENT	ZL

PREP. BY	REVD. BY
EL	DT

APPROVED FOR ISSUE

DRAFT

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CLIENT	CONTACT ENERGY
ADDRESS	VENLAW ROAD 794, SLOPEDOWN, SOUTHLAND
PROJECT	SOUTHLAND WIND FARM
SHEET TITLE	SITE INVESTIGATIONS LOCATION PLAN - SHEET 1 OF 2

CADFILE	220372-201-203_205-209.dwg
SCALE (A3)	ORIG. SHEET SIZE
1:30000	A3
DRAWING No.	REV.
220372-202	3

POTENTIAL WIND FARM COMPONENT TRANSPORT ROUTE THROUGH PORT BLAKELY FOREST

OC-S1 OC-S OC-T MAT-09 MAT-10 OC-D MAT-13 OC-C OC-H4 OC-I OC-I1 OC-H2 OC-H3 OC-H1 OC-H MAT-18 MAT-17 MAT-16 OC-X1 OC-X2 OC-X3 OC-R1 OC-R OC-A OC-B BH02 BH01 OC-Q OC-P OC-X4 OC-X5 OC-N2 OC-N3 OC-N4 OC-N1 OC-O OC-O1 OC-N OC-X6 MAT-08 MAT-11 MAT-12 MAT-14 OC-E MAT-15 OC-F1 OC-G OC-F3 OC-F2 OC-F OC-F4 MAT-05 OC-J OC-J1 OC-K MAT-04 MAT-07 OC-K1 BH03 MAT-06 MAT-02 MAT-03 OC-K2 OC-M OC-K3 OC-L1 OC-L OC-K4 JED-34 JED-32 JED-33 JED-31 MAT-01 JED-23 JED-30 JEDBURGH STATION VENLAW FOREST VENLAW FOREST

300 0 600 1200m
SCALE 1:30000

LEGEND

- SITE PROPERTY BOUNDARIES
- EXISTING 20m CONTOURS (LINZ)
- WATER COURSE (LINZ)
- PROPOSED WTG LOCATIONS

EXISTING ROADS

- PUBLIC
- PRIVATE
- PROPOSED CONSTRUCTION ACCESS THROUGH PORT BLAKELY FOREST

PROPOSED ACCESS TO WTG SITES

- PROPOSED ACCESS TRACKS

PREVIOUS INVESTIGATIONS: CIRCA 2011

- MACHINE BOREHOLE LOCATION (BH)

RILEY INVESTIGATIONS: (FEBRUARY 2023)

- TEST PIT LOCATION (TP)
- SCALA LOCATION (SC)
- OUTCROP LOCATION (OC)

RESOURCE CONSENT

REV	DATE	ISSUE	BY
3	7.06.25	RESOURCE CONSENT	JM
2	14.12.23	RESOURCE CONSENT	ZL
1	22.08.23	ISSUED FOR RESOURCE CONSENT	ZL

PREP. BY	REVD. BY
EL	DT

APPROVED FOR ISSUE

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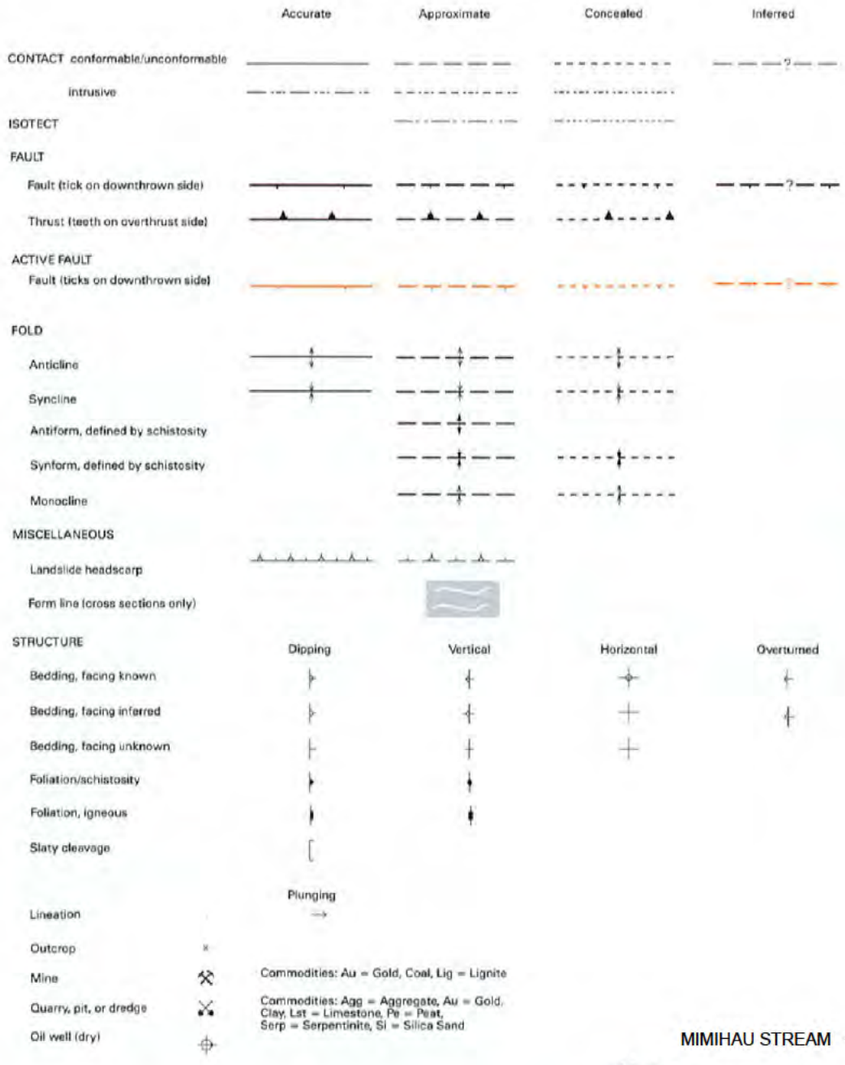
contact

CLIENT	CONTACT ENERGY
ADDRESS	VENLAW ROAD 794, SLOPEDOWN, SOUTHLAND
PROJECT	SOUTHLAND WIND FARM
SHEET TITLE	SITE INVESTIGATIONS LOCATION PLAN - SHEET 2 OF 2

CADFILE	220372-201-203_205-209.dwg
SCALE (A3)	ORIG. SHEET SIZE
1:30000	A3
DRAWING No.	REV.
220372-203	3

GEOLOGICAL SYMBOLS



GEOLOGICAL LEGEND

GLACIAL, FLUVIOGLACIAL, FLUVIAL AND ASSOCIATED DEPOSITS

UNCONSOLIDATED SAND, GRAVEL AND MUD IN MODERN FLOOD PLAINS (Q1a); GRAVEL AND SAND IN ACTIVE ALLUVIAL FANS (Q1a).

UNDIFFERENTIATED, GENERALLY WEATHERED SAND AND GRAVEL IN TERRACES (uQa) AND FANS (uQa) IN TRIBUTARY CATCHMENTS, AND ON STEWART ISLAND.

GRAVEL, SAND AND MUD IN LOW TERRACES (Q2a); GRAVEL AND SAND IN INACTIVE FANS (Q2a).

GRAVELLY SAND (MANAPOURI SAND) IN WAIAU CATCHMENT (Q3a).

SLIGHTLY WEATHERED GRAVEL AND SAND IN INTERMEDIATE TERRACES (Q4a); WEATHERED GRAVEL IN DISSECTED FAN REMNANTS (Q4a). LOESS DUNE FIELDS NORTH OF GORE (Q4e).

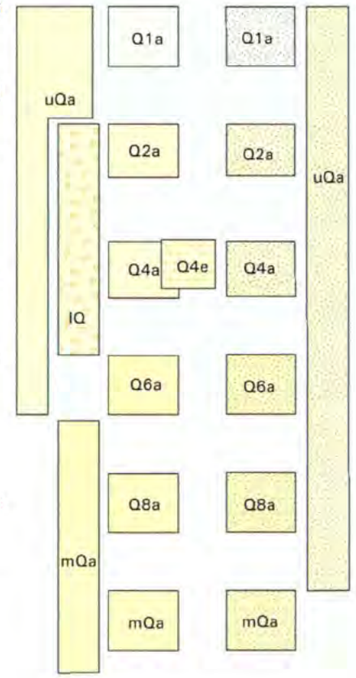
EXTENSIVE LAMINATED SAND PLAINS IN FRESHWATER VALLEY, STEWART ISLAND; SAND APRONS WITH BRECCIA INTERBEDS AND THIN PEAT BANDS ADJACENT TO RUGGEDY MOUNTAINS AND MASON BAY (IQ).

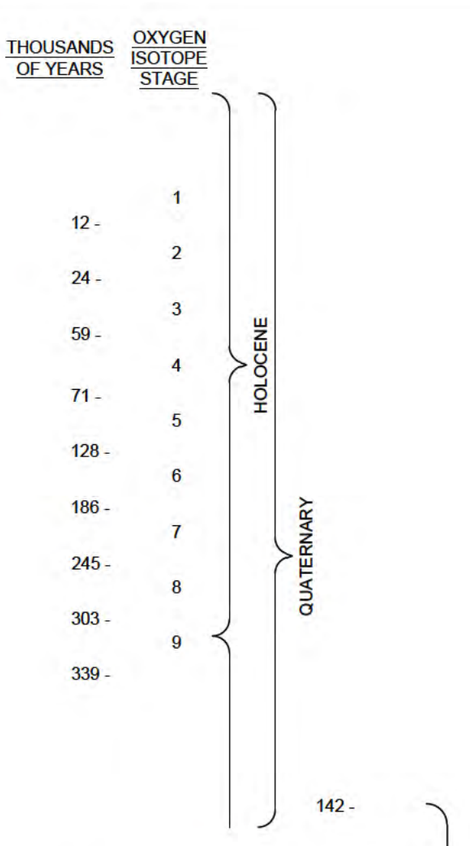
WEATHERED SAND AND GRAVEL IN HIGH TERRACES (Q6a); WEATHERED GRAVEL IN ASSOCIATED HIGH FAN REMNANTS (Q6a).

WEATHERED CLAYEY SAND AND GRAVEL IN HIGH TERRACE REMNANTS (Q8a); WEATHERED CLAYEY SANDY GRAVELS IN ASSOCIATED FAN REMNANTS (Q8a).

GRAVEL, SAND, AND SILT IN NORTHERN FRESHWATER VALLEY (mQa).

DEEPLY WEATHERED CLAYEY SAND AND GRAVEL IN TERRACE REMNANTS (mQa), INCLUDING WIDESPREAD KAMAHI TERRACE IN EASTERN SOUTHLAND; DEEPLY WEATHERED FAN GRAVELS (mQa).





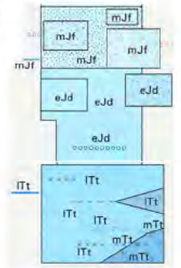
MURIHIKU TERRANE
MURIHIKU SUPERGROUP

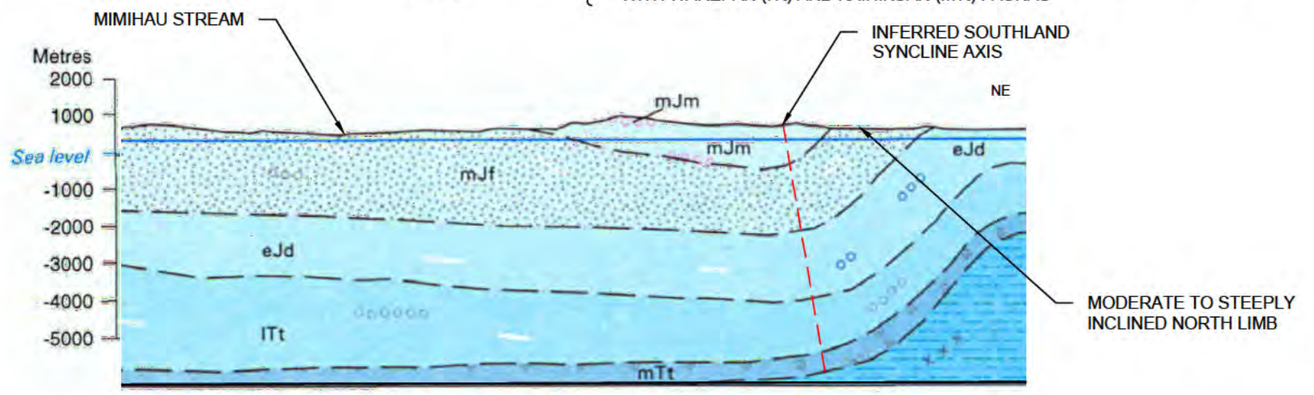
REGIONAL GEOLOGICAL BEDROCK UNIT UNDERLYING SITE

FERNDALE GROUP
FOSSILIFEROUS SANDSTONE AND MUDSTONE WITH MINOR SHELLBEDS AND CONGLOMERATE (mJf); MUDSTONE (mJf) AND CONGLOMERATE (mJf) LOCALLY DOMINANT, INCLUDING McPHEE COVE CONGLOMERATE (mJf) SHOWN WITH BROWN PATTERN

DIAMOND PEAK GROUP
FOSSILIFEROUS SANDSTONE, SUBORDINATE MUDSTONE AND MINOR TUFF AND CONGLOMERATE (eJd); CONGLOMERATE (eJd) AND SILTSTONE (eJD) LOCALLY DOMINANT

TARINGATURA GROUP
FOSSILIFEROUS SANDSTONE, MUDSTONE, TUFF, SHELLBEDS AND CONGLOMERATE (ITt); EXTENSIVE CONGLOMERATE (mTt, ITt) AND TUFF (mTt, ITt) HORIZONS; STRATA WITH WAREPAN (ITt) AND KAIHIKUAN (mTt) FAUNAS





REGIONAL GEOLOGY CROSS SECTION WITH RILEY ANNOTATIONS

SCALE : N.T.S

A
FY

NOTES:

EXTRACTED FROM GNS MAPS

BIBLIOGRAPHIC REFERENCE

Turnbull, I.M.; Allibone, A.H. (compilers) 2003: Geology of the Murihiku area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 20. 1 sheet and 74 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.

RESOURCE CONSENT

REV	DATE	ISSUE	BY
3	11.07.25	RESOURCE CONSENT	JM
2	14.12.23	RESOURCE CONSENT	ZL
1	22.08.23	ISSUED FOR RESOURCE CONSENT	ZL

PREP. BY: EL | REVD. BY: DT
APPROVED FOR ISSUE: D TATE

RILEY www.riley.co.nz

contact

CLIENT	CONTACT ENERGY
ADDRESS	VENLAW ROAD 794, SLOPEDOWN, SOUTHLAND
PROJECT	SOUTHLAND WIND FARM
SHEET TITLE	REGIONAL GEOLOGY CROSS SECTION - GNS LEGEND

CADFILE	220372–204.dwg
SCALE (A3)	1:50
ORIG. SHEET SIZE	A3
DRAWING No.	220372-204
REV.	3

MATAURA

WYNDHAM

SOUTHLAND SYNCLINE AXIS

GNS NOTED LANDSLIDE DEBRIS AREA (REFER 'LANDSLIDE A' RILEY DWG -206 & -209)

GNS FAULT INACTIVE

VENLAW FOREST

GNS-MAPPED FOLD AXES ON SOUTHERN SYNCLINE LIMB AND SYMPATHETIC TO SOUTHLAND SYNCLINE AXIS

GLENCOE STATION

JEDBURGH STATION

LINEAMENT

NOTE:

1. LEGEND IN DWG 220372-204

EXTRACTED FROM GNS QMAP (2003)

BIBLIOGRAPHIC REFERENCE

Turnbull, I.M.; Allibone, A.H. (compilers) 2003: Geology of the Murihiku area. Institute of Geological & Nuclear Sciences 1:250 000 geological map 20. 1 sheet and 74 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.

1000 0 2000 4000m

SCALE 1:100000

RESOURCE CONSENT

REV	DATE	ISSUE	BY
3	7.06.25	RESOURCE CONSENT	JM
2	14.12.23	RESOURCE CONSENT	ZL
1	22.08.23	ISSUED FOR RESOURCE CONSENT	ZL

PREP. BY	REVD. BY
EL	DT

APPROVED FOR ISSUE

DRAFT

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contact

CLIENT	CONTACT ENERGY
ADDRESS	VENLAW ROAD 794, SLOPEDOWN, SOUTHLAND
PROJECT	SOUTHLAND WIND FARM
SHEET TITLE	REGIONAL GEOLOGY BY GNS

CADFILE	220372-201-203_205-209.dwg
SCALE (A3)	ORIG. SHEET SIZE
1:100000	A3
DRAWING No.	REV.
220372-205	3

LEGEND

- PROPERTY BOUNDARY
- EXISTING 20m CONTOURS
- WATER COURSE
- EXISTING PRIVATE ROAD
- EXISTING PUBLIC ROAD
- PROPOSED ACCESS TRACKS
- LINEAMENT
- STRIKE-RIDGE
- BS — BACK-SLOPE (TYPICALLY MODERATELY TO STEEPLY INCLINED)
- DI — VALLEYS RELATIVELY DEEPLY INCISED INTO DIP-SLOPE
- DS — DIP-SLOPE
- A — POSSIBLE ANCIENT LANDSLIDE WITH PARTIALLY DISPLACED DEBRIS LOBE (PREDOMINANTLY DEEPER-SEATED BEDROCK FEATURES, AND INCLUDES POSSIBLE ROCKFALL-ID 'H')

RILEY INVESTIGATIONS: (FEBRUARY 2023)

- TEST PIT LOCATION (TP)
- SCALA LOCATION (SC)
- OUTCROP LOCATION (OC)

HISTORIC VENLAW FOREST ROCK BORROW PIT

HISTORIC JEDBURGH STATION ROCK BORROW (SILAGE PIT)

JEDBURGH STATION

PLATEAU-LIKE APPROX. TRIANGULAR AREA IN THE SOUTH/HIGHER ELEVATION OF JEDBURGH STATION

VENLAW FOREST

MIMIHAU STREAM NORTH BRANCH

MIMIHAU STREAM SOUTH BRANCH

SC101 SC102 SC103 SC104 SC105 SC106

TP101 TP102 TP103 TP104 TP105 TP106 TP107 TP108 TP109 TP110 TP111 TP112 TP113 TP114

BH01 BH02 BH03 BH04 BH05

A B C D E F G H

NOTE:

1. EXTENT OF AREAS IS APPROXIMATE AND SUBJECT TO CONFIRMATION DURING DETAILED DESIGN AND/OR CONSTRUCTION.

500 0 1000 2000m

SCALE 1:50000

RESOURCE CONSENT

REV	DATE	ISSUE	BY
3	7.06.25	RESOURCE CONSENT	JM
2	14.12.23	RESOURCE CONSENT	ZL
1	22.08.23	ISSUED FOR RESOURCE CONSENT	ZL

PREP. BY	REVD. BY
EL	DT
APPROVED FOR ISSUE	
DRAFT	

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CLIENT	CONTACT ENERGY
ADDRESS	VENLAW ROAD 794, SLOPEDOWN, SOUTHLAND
PROJECT	SOUTHLAND WIND FARM
SHEET TITLE	GEOMORPHOLOGICAL PLAN

CADFILE	220372-201-203_205-209.dwg
SCALE (A3)	ORIG. SHEET SIZE
1:50000	A3
DRAWING No.	REV.
220372-206	3

LEGEND

EXISTING FEATURES

- PROPERTY BOUNDARY
- EXISTING 20m CONTOURS
- WATER COURSE
- EXISTING PUBLIC ROAD
- EXISTING PRIVATE ROAD

PROPOSED DEVELOPMENT

- PROPOSED WTG LOCATIONS
- PROPOSED ACCESS TRACKS
- PROPOSED CONSTRUCTION ACCESS THROUGH PORT BLAKELY FOREST

GEOTECH INVESTIGATIONS AND FEATURES

- TEST PIT LOCATION (TP)
- SCALA LOCATION (SC)
- OUTCROP LOCATION (OC)
- COMBINED HIGH VALUE ECOLOGICAL AREAS AND WETLANDS
- A — INFERRED POSSIBLE ANCIENT BEDROCK LANDSLIDE WITH DEBRIS (PARTIALLY DISPLACED)

GEOLOGY AND GEOMORPHOLOGY

- LINEAMENT
- ANCIENT LANDSLIDE HEADSCARP
- FAULTS (GEOLOGICALLY INACTIVE)
- SUB-HORIZONTAL BEDDING
- 5° — BEDDING + DIP BELOW HORIZONTAL
- 85° — JOINT + DIP BELOW HORIZONTAL

GEOLOGY

UNCONSOLIDATED NEAR-SURFACE 'SOILS':

CAN INCLUDE NON-ENGINEERED FILL, TOPSOIL, AND COLLUVIUM ON THE HILLSLOPES. APART FROM TOPSOIL, THESE MATERIALS HAVE A VARIABLE / PATCHY HORIZONTAL DISTRIBUTION, AND WHERE PRESENT TYPICALLY TOTAL LESS THAN APPROXIMATELY 2m DEPTH.

BEDROCK:

UNDERLIES 'SOILS' AND CONSISTS OF VARIABLY WEATHERED SANDSTONE AND LOCALLY INTERBEDDED SILTSTONE THAT IS CORRELATED TO THE FERNDALE GROUP OF THE MURIHIKU SUPERGROUP (REF. QMAP 2003). TWO GEOTECHNICAL BEDROCK PROFILES DIFFERENTIATED FOR THIS ASSESSMENT ARE;

- LOWER-STRENGTH (AND GENERALLY MORE-WEATHERED) BEDROCK.
  THIS ROCK MATERIAL IS TYPICALLY VERY WEAK TO WEAK, BUT LOCALLY EXTREMELY WEAK (E.G. TP104 TO TP106). THE ROCK IS TYPICALLY CLASSIFIED AS HIGHLY TO MODERATELY WEATHERED ALTHOUGH INCREASED WEATHERING CLASSES ARE PRESENT LOCALLY (E.G. RESIDUAL TO COMPLETELY WEATHERED SUCH AS TP107). A NORMAL WEATHERING PROFILE (E.G. REDUCED WEATHERING WITH INCREASING DEPTH) IS PREDOMINANTLY ENCOUNTERED.

  THE ROCK MASS IS PRIMARILY DEVELOPED BY INTERSECTING, ORTHOGONAL, STEEPLY AND GENTLY INCLINED JOINT SETS. THESE TYPICALLY GENERATE 50mm TO 250mm BLOCKS. LOCALLY ZONES OF CLOSER SPACED FRACTURES (E.G. LESS THAN 20mm) ARE ANTICIPATED, WHICH PROBABLY REFLECT INCREASED DEFORMATION ALONG SHEARED AND CRUSHED ZONES (E.G. ANCIENT AND INACTIVE BEDROCK FAULTS).

- HIGHER-STRENGTH BEDROCK (E.G. LESS-WEATHERED 'BLUE-ROCK').
  THIS BEDROCK PREDOMINANTLY CONSISTS OF MODERATELY STRONG TO VERY STRONG AND LESS-WEATHERED (E.G. MODERATELY, SLIGHTLY TO UNWEATHERED - MWx, SWx AND UWx) MATERIAL.

  ROCK MASS AND DEFECTS ARE SIMILAR TO THAT 'LOWER STRENGTH' BEDROCK. HOWEVER, IN GENERAL WIDER-SPACED OF JOINTS, PRODUCING APPROXIMATELY 300mm TO 1m DIAMETER BLOCKS, ARE ANTICIPATED IN THE HIGHER-STRENGTH BEDROCK (REFER FIGURE 9 TO FIGURE 10).

  THERE ARE LIMITED NATURAL EXPOSURES OF THE HIGHER-STRENGTH BEDROCK AT THE SITE, AND ITS LOCALLY OBSERVED IN THE INVERT OF LARGE STREAMS AND GULLIES. IT IS LOCALLY EXPOSED IN CUT SLOPES ALONG VENLAW ROAD (EAST OF THE INTERSECTION WITH THORNHILL ROAD) AND IN EXISTING ROCK BORROWS ACROSS THE SITE.

GEOLOTECHNICAL SEQUENCES

DM — **DEEP MANTLE**
THE CUMULATIVE THICKNESS OF UNCONSOLIDATED NEAR-SURFACE 'SOILS' AND LOWER-STRENGTH BEDROCK FORM A RELATIVELY 'DEEP MANTLE' GENERALLY OVER 6m DEPTH

SM — **SHALLOW MANTLE**
WHERE THE COMBINED THICKNESS OF 'SOILS' AND/OR LOWER-STRENGTH BEDROCK PROFILE IS APPROXIMATELY 1m TO 2m AND LOCALLY UP TO 4m (E.G. BH01) (I.E. RELATIVELY SHALLOW DEPTH TO THE TOP OF BLUE-ROCK).

RESOURCE CONSENT

REV	DATE	ISSUE	BY
3	11.07.25	RESOURCE CONSENT	JM
2	14.12.23	RESOURCE CONSENT	ZL
1	22.08.23	ISSUED FOR RESOURCE CONSENT	ZL

PREP. BY	REVD. BY
EL	DT

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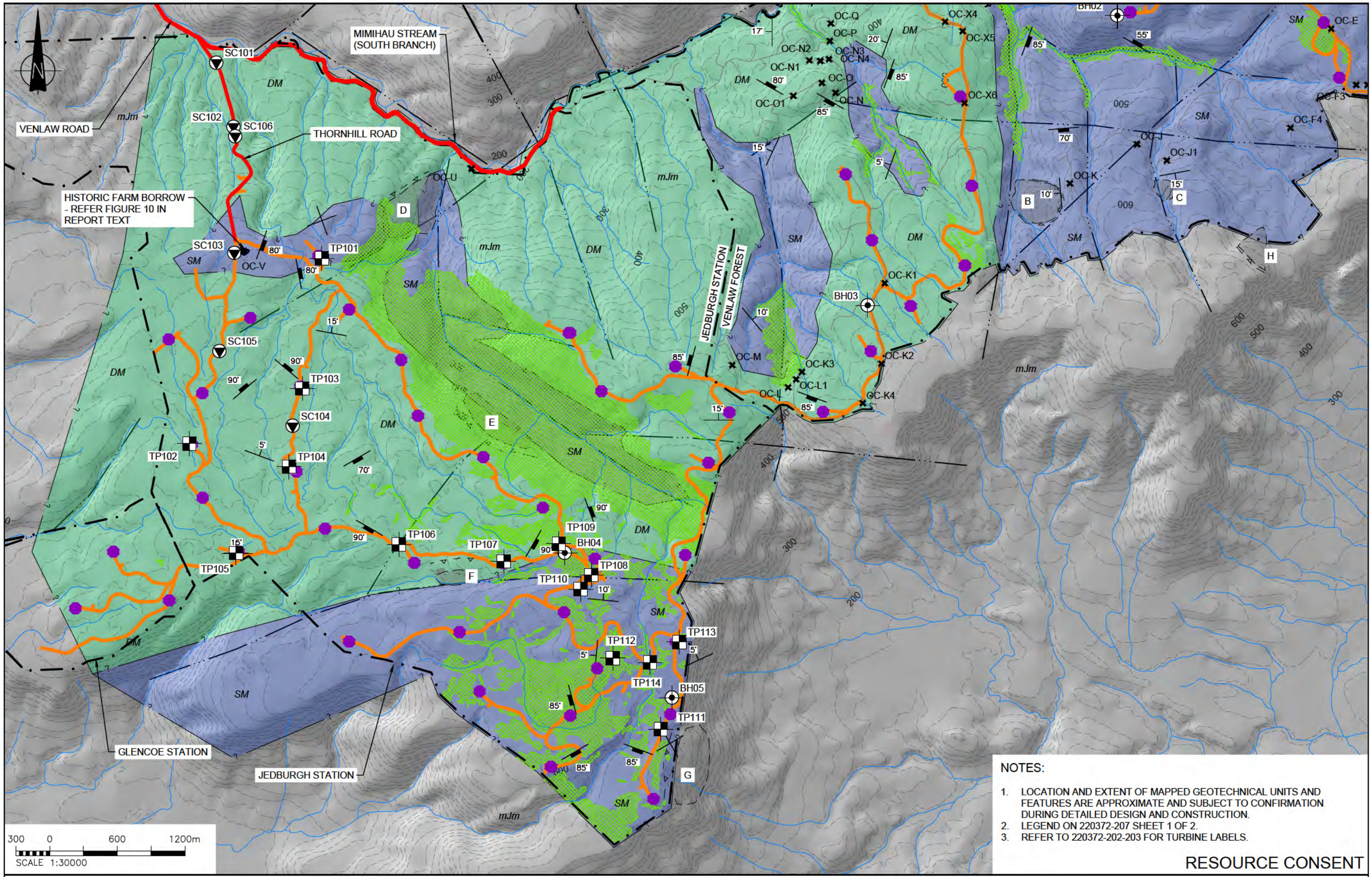
ADDRESS	VENLAW ROAD 794, SLOPEDOWN, SOUTHLAND
PROJECT	SOUTHLAND WIND FARM
SHEET TITLE	LEGEND SHEET FOR ENGINEERING GEOLOGY

CADFILE	220372-201-203_205-209.dwg
SCALE (A3)	ORIG. SHEET SIZE
N.T.S	A3
DRAWING No.	REV.
220372-207	3



NOTES:

1. LOCATION AND EXTENT OF MAPPED GEOTECHNICAL UNITS AND FEATURES ARE APPROXIMATE AND SUBJECT TO CONFIRMATION DURING DETAILED DESIGN AND CONSTRUCTION.
2. LEGEND ON 220372-207 SHEET 1 OF 2.
3. REFER TO 220372-202-203 FOR TURBINE LABELS.

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SHEET TITLE	ENGINEERING GEOLOGY PLAN - SHEET 1 OF 2

CADFILE	220372-201-203_205-209.dwg
SCALE (A3)	ORIG. SHEET SIZE
1:3000	A3
DRAWING No.	REV.
220372-208	3

SLIGHTLY TO UNWEATHERED BEDROCK EXPOSED AT SHALLOW DEPTH IN HISTORIC FOREST BORROW PIT

HISTORIC ROCK BORROW PIT IN FOREST. REFER FIGURE 11 IN REPORT TEXT

MIMIHAU STREAM - NORTH BRANCH

MIMIHAU STREAM - SOUTH BRANCH

VENLAW FOREST

JEDBURGH STATION

VENLAW FOREST

OC-S1 OC-S OC-T OC-A OC-B OC-C OC-D OC-E OC-F OC-F1 OC-F2 OC-F3 OC-F4 OC-G OC-H OC-H1 OC-H2 OC-H3 OC-H4 OC-I OC-I1 OC-J OC-J1 OC-K OC-K1 OC-K2 OC-K3 OC-K4 OC-L OC-L1 OC-M OC-N OC-N1 OC-N2 OC-N3 OC-N4 OC-O OC-O1 OC-P OC-Q OC-R OC-R1 OC-X1 OC-X2 OC-X3 OC-X4 OC-X5 OC-X6

BH01 BH02 BH03

A B C H

mJm DM SM

NOTES:

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300 0 600 1200m
SCALE 1:30000

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SHEET TITLE	ENGINEERING GEOLOGY PLAN - SHEET 2 OF 2

CADFILE	220372-201-203_205-209.dwg
SCALE (A3)	ORIG. SHEET SIZE
1:3000	A3
DRAWING No.	REV.
220372-209	3

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