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Geotechnical Report
Long Gully Wind Farm
For Windflow Technology

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Contents

1. Introduction

Windflow Technology and Mighty River Power are proposing to construct a new wind farm at Long Gully, on the hills south of Brooklyn and Karori, Wellington (see Figure 1). An initial investigation was completed for a 28 wind turbine proposal (see Draft Geotechnical Report issued Dec 2008), but Windflow deleted three turbines and moved some locations in response to various issues in our draft report. This report relates to the current 25 turbine proposal, with 17 turbines on the ridge to the south of Long Gully (Hawkins Ridge) and 8 turbines on the ridge to the north of Long Gully. It is intended to support a resource consent application.

Windflow Technology has commissioned Aurecon New Zealand to carry out the geotechnical investigation and to provide advice on foundation options and earthworks. This report presents the results of our investigations and recommendations for site development.

2. Investigations

The objective of the investigation was to investigate ground conditions in order to assess the founding conditions for proposed turbines, and to make recommendations on earthworks.

The scope of the work was:

- A walkover of the site;
- Scala probe testing at selected proposed turbine locations;
- Analysis and review of geotechnical test information and the preparation of this report.

The site walkover was carried out on 3 and 5 November 2008 by a senior engineering geologist and a geotechnical engineer from Aurecon New Zealand. It comprised a visual assessment of each proposed turbine location and general assessment of the soil and rock exposed in roading cuts. Notes from the site walkover (including some information added after Scala probe testing) are provided in Table 1 in Section 3. Photographs of the proposed turbine locations are provided in Appendix B.

Scala probes were carried out at each of the original proposed turbine locations where in situ rock was not observed at the surface during the site walkover. However the relocated turbine locations have not been tested, as most of them are close to existing test locations and the available information can be extrapolated with an acceptable degree of confidence for a preliminary investigation.

The Scala probes were used to provide a qualitative indication of soil strength and density, and to assist in the assessment of the depth to rock. The Scala probe logs are given in Appendix C with test locations shown on the plans in Appendix A.

The proposed sites were located using a Global Positioning System instrument with a horizontal accuracy of plus or minus 5m, using co-ordinates provided by Windflow Technology on 2 October 2008.

3. Site Conditions

3.1 General Site Description

The site of the proposed wind farm is located on two ridges either side of Long Gully, south of the suburbs of Karori and Brooklyn in Wellington City (see Figure 1 and the sheets in Appendix A). There are several points of access, the most convenient being from Brooklyn via the existing Meridian wind turbine and past the radar station on Hawkins Hill.

The topography is steep, with slopes up to 35 degrees common. The vegetation is generally grass, tussock or scrub.

The current usage of the site is as farmland, with occasional cattle, goats and deer observed during the investigations. There are various small structures spread across the site, including one or two small houses, a cell phone tower, several anemometers, and other miscellaneous structures. In addition, at the entry to the site there is a large radar station at the top of Hawkins Hill.

There have been extensive roading earthworks carried out on the site that were authorised by resource consents already held by the land owner. These earthworks include cuts up to several metres high and fills up to several metres deep. The access road is sealed until just east of Site 1, and thereafter is a gravel road. All of the turbine sites could be relatively easily accessed during the investigation with a two wheel drive vehicle.

3.2 Regional Geology

The geology of the Wellington area has been mapped and described in the 1:50,000 scale Geological Map of New Zealand – Sheet 22 – Wellington Area map (Begg and Mazengarb, 1996). This map indicates that "*alternating cm-m bedded sandstone/argillite …*" underlies the majority of the site. It also indicates that a thin band of "*coloured argillite, chert and/or basalt*" runs through Site 8, Site 9, and the road between Site 14 and Site 15.

A number of active and inactive faults lie near the site, the most important of which is the active Wellington Fault, which lies in the base of Long Gully in the centre of the site. As all the proposed turbine sites are on the ridges, the closest turbine site is about 300m from the fault. Published information indicates that movement of the Wellington Fault has a recurrence interval of 500 to 700 years, with a probability of rupture of approximately 10% in the next 50 years.

3.3 Subsurface Conditions

The Scala probes and our visual inspections indicate that the ridges on which the turbines will be sited are underlain by a layer of gravelly or silty colluvium of varying depth, probably including some loess, overlying weathered greywacke sandstone rock. The colluvium layer is generally up to 2m deep on the ridgelines, but can be considerably deeper in valleys and saddles. There are also some areas of fill, derived from greywacke, up to several metres deep, placed to form the roads. Our findings are thus broadly consistent with the indications of the geological map, although the thin band of argillite, chert and basalt indicated on the map was not observed during our investigation.

Of the two ridges on which the turbine sites are located, the northern ridge is noticeably more rounded and broader topped than the southern ridge (Hawkins

Ridge). The rock in the cuts on the northern ridge is also noticeably more broken and/or weathered than on Hawkins Ridge, which is consistent with its more rounded nature.

Site specific observations and comments are presented for each proposed turbine location in Table 1. The table contains information on the general site topography and the geology noted during the site walkover and inferred from the investigations. Some comments are provided on the accessibility of the turbine sites from the existing road or track, being defined as follows. Sites with “easy” access are on or close to the road while sites described as “moderate” are a short distance away from the road with up to a few metres of height difference. Sites described as “difficult” are at least 5m higher or lower than the road and will probably need a new track formed to gain access. An engineering solution for “difficult” sites should be achievable however.

Table 1. Topography, Geology and Access at each Turbine Site

Site No	Topography	Geology	Ease of access from existing tracks
	Hawkins Ridge		
1	20 degree slope to the north	Rock at surface	Difficult (6m above road)
2	20 degree slope to the west	Perhaps 100mm or 200mm of topsoil overlying rock	Difficult (12m above road)
3	20 degree slope to the southwest.	Rock at surface	Moderate
4	Flat, 4m wide ridge top a few metres above the road.	Rock at surface	Moderate
5	On or by a little knob just above road. Fairly flat surrounds	Rock at surface	Moderate
6	On a little knob	Rock at surface	Difficult (4m-6m above road)
7	In a flat 15m wide saddle	1m to 1.5m of colluvium (possibly with some road filling) overlying rock.	Easy
8	30m wide flat ridge top, above a high cut	Rock at surface	Difficult (6m-8m above road)
9	30m wide flat surface above a 2.5m high cut above the road.	Rock within 0.5m of surface	Moderate
10	On a 15 degree north facing slope 15m-20m from the road.	Rock at surface	Easy
11	20 degree slope to the southeast	Rock at surface	Easy
12	At the base of a fill batter 1m to 4m high and 20m-30m long.	Rock within 0.5m of surface	Easy
13	On a flat short saddle right on the road	Rock within 0.5m of surface	Easy
14	On flat grassy platform near road	Probably very shallow rock (rock at surface in road cuts about 10m away).	Easy
15	Gently sloping grass platform	Rock at surface	Easy
16	On a 15 degree slope covered with scrub	About 1m of colluvium overlying rock	Moderate
17	Wide flat platform	Rock at surface	Easy

Table 1 continued.

Site No	Topography	Geology	Ease of access from existing tracks
	Ridge to North of Long Gully		
18	On a 20 degree grass covered slope 15m from road.	1m of colluvium over rock.	Easy
19	On a 5 degree slope south of the track.	1.5m of colluvium over rock.	Easy
20	On the side of a gully	Probably 2m of colluvium over rock.	Easy
21	A flat saddle, grass covered, just off the track.	1m of colluvium over rock.	Easy
22	Grassed gently sloping ridge top just off road.	0.5m of colluvium over rock.	Easy
23	In a slight, long, saddle; a 15m wide flat ridge. On track. Grassed.	Rock exposed at surface	Easy
24	In the same saddle as 24, now sloping at 10 degrees. Grassed. Just off track.	0.5m of colluvium over rock.	Easy
25	On top of a hill relatively flat.	2m-2.5m of colluvium over rock.	Difficult

3.4 Groundwater

No groundwater was observed during the investigation, which had a maximum penetration below ground level of 2.2m. As the turbine sites are located mostly on ridge tops and there are long and steep slopes either side of the ridges, the groundwater table is expected to be relatively deep and probably located well below the base of the turbine foundations.

4. Engineering Considerations

4.1 General

The proposed development comprises construction of up to 25 “Windflow 500” turbines. The turbines have 520 kW nominal power, a height to nacelle of 30m and a rotor blade diameter of 33.2m. Based on the Windflow Specification for Tower Design (S530.5, dated 18 December 2006), we understand that the maximum factored loads are:

- Overturning Moment 4,200 kNm
- Shear Force 135 kN

We understand that Windflow favours the use of bored monopile foundations for the turbines. Pad foundations require a greater extent of excavation, although their design is simpler to change in the event of unexpected ground conditions. This report addresses both foundation options.

As part of site development, the following supporting works will have to be carried out:

- One crane pad at each turbine site for lifting operations and for storing equipment and material. The platform will be flat and typically consists of a widening of the track to about 7m width over a length of 20m. The turbine is accessed within a 10m arc of the crane’s reach from the centre of this pad area.
- Localised upgrading of existing roads and tracks to allow the passage of heavy haulage trucks. Although the existing roads and tracks are of a high quality for a farm, it is anticipated that widening or regrading may be needed in places, particularly at the southern end of the site from Site 13 to Site 17, and at the northern end from Site 18 to Site 25. Details of upgrading are presented on a turbine by turbine basis in the Civil Engineering report for the site (refer Aurecon New Zealand Civil Report, dated February 2009)
- Creation of new roads between the existing roads and the turbine sites. Although some turbines sites are within a few metres of the existing roads, others are up to 30m from the existing roads.
- Possible construction of a small bridge type structure or retaining wall near the radar station to allow passage of haulage trucks around a tight turn.

The major geotechnical issues regarding safely and economically developing the site are:

- Piled foundation parameters;
- Shallow foundation parameters;
- Recommendations on cuts and fills, and other earthworks matters;
- Identification of areas as potential sites for spoil disposal;
- Recommendations on the bridge / retaining wall at the radar station;

Each of the aspects is discussed in detail below.

4.2 Piled Foundations

The turbine locations investigated are underlain by a thin layer of colluvium overlying weathered greywacke rock, and hence monopiles are considered to be a feasible foundation solution at this site. It is anticipated that large diameter bored concrete piles will be used. The depths and diameters of the piles will depend on the results of lateral structural analysis, which lies outside the scope of this report, but as an indication, the wind farm at Te Rere Hau (near Palmerston North), which used the same turbines and in broadly similar geological conditions to Long Gully, had piles founded at depths of between 7m and 10m, and pile diameters of 2.4m. For descriptions of the pile investigations, design and construction at Te Rere Hau, refer to “MASW profiling to obtain elastic moduli models for wind turbine foundation design – Te Rere Hau Windfarm”, by Dominic Mahoney (Aurecon New Zealand, Christchurch). Our preliminary analysis suggests that similar pile lengths and diameters will be required at Long Gully.

For the purposes of short-term (i.e. wind loading) lateral analysis, we recommend the following preliminary parameters:

Table 2. Geotechnical parameters for pile lateral analysis

Material	Density (kN/m^3)	Cohesion (kPa)	Friction angle (degrees)	Young’s modulus (E) (MPa) *	Poisson’s ratio (□)
Colluvium (gravelly silt) or fill	18	5	30	20	0.35
Highly or moderately weathered greywacke (5m or less below ground)	20	5	37	100	0.35
Highly or moderately weathered greywacke (more than 5m below ground)	20	5	37	300	0.35
Unweathered or slightly weathered greywacke	24	20	37	400	0.25

** small strain value of E. Generally the E value of soils reduces with increasing strain (strain softening), which should be taken into account should the deflection at any given level exceed say 2mm-3mm.*

The depth of colluvium (and/or fill) varies from 0m to 2m, and the designer should use the depths provided in Table 1 for location-specific design. In places where there is a significant layer of colluvium or fill (say thicker than 0.5m), it may be beneficial to remove this layer prior to pile construction, as it is likely that a significant amount of lateral deformation will occur in the softer, upper, layers.

The ease of piling will be significantly affected by the degree of rock weathering with blue-grey unweathered rock being very difficult to pile into. The depth to unweathered rock is unknown at turbine locations, although it was observed occasionally in road-side cuts. Contractors should be made aware of the possibility of encountering slightly weathered or unweathered greywacke as they would require heavy and/or specialised equipment to excavate it.

Table 2 presents preliminary geotechnical values, based on site visual inspections, a limited level of testing, and experience with other, similar, sites. Because of the limited extent of testing to date, the values are considered to be conservative. As the turbines are of high value and are sensitive to lateral deformation, we recommend that further testing be carried out to minimise the risk of excessive lateral deformations. Also, further testing is likely to result in a more economical design as it may indicate that higher E values can be used than those presented in Table 2. We recommend the following programme of further testing and construction observation (similar in nature to that carried out at Te Rere Hau):

- All turbine sites should be tested using Spectral Analysis of Surface Waves (SASW), a geophysical technique that indirectly measures the shear wave velocity, from which a profile of Young's modulus (effectively the stiffness of the ground) versus depth can be readily calculated for each individual turbine site. SASW is a non-intrusive test carried out by geophones at the ground surface, and testing at one site could be carried out in a few hours. Testing at each site is considered to be necessary as the stiffness of weathered greywacke can be highly variable. The SASW testing will be of a higher value if it can be carried out after the final construction platform has been prepared, as the exact foundation material would be tested in this case.

- SASW readings should be calibrated by at least two boreholes, one on each of the ridge lines, to depths at least as deep as the proposed pile depth plus two pile base diameters. The boreholes should be drilled with triple tube core barrels and full core recovery. The borehole logs would provide the locations of the changes in layering between colluvium, weathered rock, and unweathered rock, allowing the SASW measurements to be interpreted more accurately.

- Depending on the results of the SASW and the boreholes, there may also be value in carrying out a full-scale lateral load test on a constructed pile, to further calibrate the geotechnical testing and parameters.

- All pile holes should be inspected by a geotechnical engineer or engineering geologist to confirm the design assumptions and confirm (or alter) the proposed founding depth and diameter. The engineer/geologist could either be on site during the excavation of the pile holes, or clearly labelled bag samples, containing at least 10kg of excavated material collected at 1m vertical intervals during piling, should be taken by the contractor to allow later inspection.

4.3 Shallow Foundations

Although we understand that Windflow favours pile foundations because of their lower cost and lesser environmental footprint, they have requested that we also provide comments on shallow foundations. Because of the competent nature of the surficial soils in general, it would be feasible to found the turbines on shallow pad footings. Pad footings tend to require a larger volume of earthworks, and are hence often more expensive, and have a higher environmental impact, than pile foundations. However they are analytically simpler to design and their design is historically generally less sensitive to unexpected ground conditions exposed during construction.

Pads should be founded in highly weathered (or less weathered) rock, and design can be carried out using the parameters provided in Table 2. An ultimate rupture bearing capacity of 2000 kPa can be used, in conjunction with the following reduction factors:

Ultimate Limit State	0.5
Serviceability Limit State	0.33

We would anticipate pad foundations in the order of 8m by 8m square, and 1m to 2m deep, depending on the depth to rock. Similarly to pile foundations, the parameters provided are preliminary, and we recommend the following programme of further testing and construction observation:

- All the turbine sites should be tested using Spectral Analysis of Surface Waves (SASW).

- SASW readings should be calibrated by at least two boreholes, one on each of the ridge lines, to depths at least as deep as the proposed foundation depth plus a depth equal to the proposed foundation width.

- All pad foundations should be inspected by a geotechnical engineer or engineering geologist to confirm the design assumptions and confirm (or alter) the proposed founding depth, foundation size and location.

4.4 Seismic Considerations

The site is in a seismically active zone and the structural engineer should take seismic loading conditions into account as follows. However, due to the relatively low mass of the turbines, we do not anticipate that seismic loading will cause any particular difficulties in the design of either piled or pad foundations.

4.4.1 Site Flexibility

The site stratigraphy comprises generally a thin layer of colluvium overlying weathered and unweathered rock. We therefore consider that the site subsoil category in terms of NZS 1170.5:2004 Clause 3.1.3 is Class B (Rock).

4.4.2 Near Fault Effects

The proposed turbine sites all lie within 1km of the Wellington Fault which is listed in Table 3.6 of NZS1170.5:2004 as a major fault. The structural engineer will therefore have to consider near fault effects in accordance with Clause 3.1.6 of NZS1170.5:2004.

4.5 Earthworks

Cuts and fills will be required to form new or altered roads, and crane pads, as described in Section 4.1. Recommendations on cuts, fills, and stormwater and sediment control are presented below.

4.5.1 Cuts

Cut Materials

Cuts up to 3m or 4m deep are likely to be in either silty or gravelly colluvium (with some loess) or highly weathered rock. Silty colluvium or loess is difficult to compact and has relatively little strength. We therefore recommend at this stage that all loess/silty soils be cut to waste wherever practicable.

We anticipate that the rock underlying the surficial soils will generally be suitable for filling. We also anticipate that the rock will be easy to excavate with conventional earth moving equipment as it is generally highly to moderately weathered and pervasively fractured and shattered. However, some of the less weathered/fractured rock may require ripping.

Cut Slopes

We recommend that permanent cut slopes should not be steeper than 0.75H:1V (53 degrees from horizontal) in rock and at 1H:1V (45 degrees) in the overlying soils. Cuts at these angles should be stable although there is a risk that in areas of more shattered and sheared rock flatter slopes may be required.

There is a possibility that a structural solution such as anchors, shotcrete or rockfall protection netting will be required in some areas and hence all cuts should be inspected during construction by an experienced geotechnical engineer or engineering geologist to confirm their stability.

We make the following recommendations for all cuts:

- Cuts should be inspected by a geotechnical engineer as work proceeds to confirm the acceptability of the actual slopes;

- The surficial silty soils will be vulnerable to erosion and fretting. They should therefore be hydroseeded or otherwise protected as soon as practicable. Grass or tussock growth in silty soils should be possible, but would be very limited in cuts into weathered rock. There are no areas of the site that pose a particular erosion risk and generally speaking there will be little silty soil near ridge tops with more expected in gullies and saddles;

- Seeps exposed in the cut faces may lead to slumping and possibly small muddy flows. Such seeps will need treating by surface and/or subsurface drains, or some other site specific measures to protect the roads or turbines;

- Stormwater from ground above the proposed cuts should be picked up and discharged around or down the face in a controlled manner to minimise erosion of the cut faces. This is particularly important where there is a significant thickness of loess as these soils are very vulnerable to erosion;

- A small catch fence may be required at the bottom of some larger cuts to protect the road below from occasional boulders or pieces of rock loosened by fretting or erosion. Alternatively, an approach whereby acceptance of ongoing maintenance and works to clear any such debris could be adopted.

A higher rate of fretting can be expected immediately after cutting as the new slope “settles” down.

4.5.2 Fills

Fill Slopes

At this stage, we understand that fill depths are not likely to exceed 2m or 3m. We recommend that permanent fill slopes should not be steeper than 2H:1V (26 degrees from horizontal) in fills derived from highly weathered (or less weathered) greywacke.

Filling should generally be carried out in accordance with NZS4431 with appropriate on site quality control.

A range of soil types, and weathered rock, will be encountered and care will be required to develop appropriate compaction standards. Soil and rock fill will probably be dry of optimum moisture content and will require wetting up to avoid excessive dust and to allow compaction to maximum density.

There may be a number of relatively thin fills with depths say in the order of 1m. All 2H:1V fills will need to be benched into rock or competent gravelly colluvium and a significant amount of stripping of vegetation and soil may be required. In our experience with shallow fills, the volume of stripping is disproportionately large compared with the volume of fill to be placed and it may be more cost effective and less disruptive to use small retaining areas in selected locations rather than long shallow fills.

Benching and Drainage of Fills

Subsoil drains will be required under the base of fills along the line of any existing gullies. The pipes should be generously sized to accommodate likely flows and strong enough to carry the potentially high soil loads from the fills. They should discharge clear of the toe of the fills in a controlled fashion.

Drainage should be laid along benches wherever seeps are encountered.

Benching to key the fills into the ground is required wherever the existing ground slope is steeper than 4H:1V.

4.5.3 Stormwater

Stormwater runoff from the roads should be discharged in a controlled manner. The objective should be to maintain the flows within any catchment to approximately the same as before development. It is therefore preferable to have stormwater discharging into gullies at regular intervals rather than allowing stormwater volumes to accumulate into a single discharge point.

4.5.4 Sediment Control

Surficial silty soils are likely to be prone to erosion, particularly in newly exposed cut batters. To minimise the extent of erosion, the following measures should be carried out:

- Minimise the extent of cutting, particularly in areas likely to have a significant soil cover;
- Hydroseed or otherwise protect cut faces as soon as practicable after cutting;
- Use measures such as keeping vegetated strips, placing silt fences at frequent intervals to collect sediment, and installing cut-off drains to control overland flow.

4.5.5 Spoil Disposal Areas

There will be a requirement for excess cut material to be dumped into spoil disposal areas; please refer to Aurecon New Zealand Civil report for details on spoil disposal.

Where fills are placed near the edge of existing slopes, careful consideration of slope stability will be required.

4.6 Bridge or Retaining Wall near Radar Station

The road turns sharply to the left immediately after the radar station at the entry to the site. The road is narrow at this point due to the radar building on the left and a concrete wall (for wind protection of the radar station) on the right, and long haulage trucks are unlikely to be able to turn left around this corner. A detailed topographical survey of this area has been carried out, and the Civil engineering assessment outlines options for addressing the issues. Among the options is a small bridging structure of some form out over the slope on the right hand side of the road to provide the necessary turning radius. The required structure could be a bridge, or alternatively, a retaining wall could be constructed a few metres to the right of the existing road, and backfill placed behind the retaining wall.

Both the bridge and the retaining wall options appear feasible at this stage, but careful design of the foundations will be required because of the sloping ground. The bridge could be supported on timber or concrete piles, which would have to extend at least 2m into weathered rock to provide fixity and to minimise the risk of the piles "kicking out" downhill. With a retaining wall, timber poles are the most feasible option, with the embedment into weathered rock likely to be approximately 1.5 times the height of the wall. Tiebacks or ground anchors would probably be required if the wall was greater than about 3m high.

Further geotechnical input will be required, once the heights and type of bridge / retaining wall are determined, if either of those are options to be pursued.

5. Conclusions

- The proposal is for up to 25 wind turbines, 17 on the ridge to the south of Long Gully (Hawkins Ridge) and 8 on the ridge to the north of Long Gully.
- The proposed turbine locations are generally underlain by a thin layer of either colluvium or fill, up to 2m deep, overlying highly weathered greywacke rock. At some sites the weathered rock outcrops at the surface.
- No groundwater was encountered during the investigation.
- The ground conditions are suitable for piled foundations. As a preliminary indication, reinforced concrete piles of between 7m and 10m depth, and 2.4m in diameter, are likely to be feasible, however this will have to be confirmed by detailed lateral analysis.
- The ground conditions are also suitable for shallow pad foundations. As a preliminary indication, reinforced concrete pads of 8m long, 8m wide and 1m to 2m deep, are likely to be feasible, however this will have to be confirmed by detailed structural analysis.
- For both piled and pad foundations, the removal of the layers of colluvium and/or fill would reduce the expected rotation of the tower.
- For both piled and pad foundations, we recommend a further testing program that includes Spectral Analysis of Surface Waves geophysical testing, boreholes, full-scale load testing (in the case of piles), and construction inspections by a geotechnical professional. The objectives of the testing program are to confirm preliminary assumptions and reduce pile foundation size if possible.
- Although wind conditions are likely to be the overriding factor, the structural engineer should take into account the seismically active nature of the site.
- Some earthworks including cuts and fills are likely to be required for the construction of new roads, improving existing roads, and for the crane pads.
- Recommended maximum slopes for cuts in rock are 0.75H:1V (53 degrees) and 1H:1V (45 degrees) in soil. All cuts should be inspected by a geotechnical engineer to confirm their stability. Silty soils may be vulnerable to erosion and cuts in silty soils should be protected.
- Recommended maximum slope for fills derived from rock is 2H:1V (26 degrees).
- Stormwater runoff from the roads should be discharged in a controlled manner.
- Please refer to Aurecon New Zealand Civil report for details on spoil disposal.
- A small bridge or retaining wall may be required near the radar station. It is expected that these could be readily founded on timber or concrete piles.

6. Limitations

We have prepared this report in accordance with the brief as provided. The contents of the report are for the sole use of the Client and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without our prior review and agreement.

The recommendations in this report are based on data collected at specific locations and by using suitable investigation techniques. Only a finite amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it must be appreciated that actual conditions could vary from the assumed model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

Subsurface conditions, such as groundwater levels, can change over time. This should be borne in mind, particularly if the report is used after a protracted delay.

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Figures

Figure 1 – Site Location Plan

Appendix A

Proposed Turbine Sites and Investigation

Appendix B

Site Photographs

Appendix C

Scala Probe Logs

(Note that Scala Probe numbers refer to Turbine Sites. E.g. SP7 was carried out at Turbine Site 7)