17 October 2018

170514-1

Kaimai Windfarm Limited
C/- Ventus Energy
Private Bag 300987
Albany
AUCKLAND 0752

Dear Sirs,

GEOTECHNICAL RESPONSE TO REQUESTS FOR ADDITIONAL INFORMATION
PROPOSED WINDFARM - ROTOKOHU ROAD, PAEROA
APPLICATION NO: APP139668

At your instruction, we have undertaken an assessment of the geotechnical items contained in the Request for Additional Information by Waikato Regional Council (WRC), dated 30 July 2018. KGA has previously prepared a geotechnical report for the proposed windfarm (Ref 8888-6B, dated 14 June 2018) which was submitted as part of the Resource Consent for the project.

Our response to the relevant geotechnical Items is discussed below.

Item 4 – Clean Fill Activities

The clean fills are proposed to be located within gullies and existing hollows on the site. The proposed clean fills are generally on more gently sloping land and away from areas showing evidence of historical instability or current surface instability. The choice of the gently sloping areas of low instability potential for locating the clean fills is intended to minimise any risks associated with placing fill on steep areas and increased potential to re-active existing shear failure surface. We also note the following:

- The final grade of the clean fill will be determined on an individual basis at each clean fill site at detailed design stage to ensure long term stability.
- Additional ground investigations will be undertaken to assess potential for any existing relic shear surface and nature of any underlying soft soils as part of the detailed design.
- Relevant geotechnical measures will be incorporated at detailed design to ensure long term stability of the clean fill areas. Such measures could include drainage measures to control water percolating into the clean fill, base drainage to control groundwater levels and/or retaining structures if the fill is not contained within the gullies, although we understand that retaining structures are unlikely to be required.
- The formation of each cleanfill will involve the removal of any weak, unsuitable material in the base of the gullies prior to the installation of drainage to manage groundwater levels. The clean fill area will be benched prior to fill placement and the fill will be track rolled into place in layers to a pre-agreed degree of rolling/compaction.
- Design will generally be in line with WasteMINZ(2018) Technical Guidelines for Disposal to Land.

Item 5 Point 1 – Suitability of Excavated Material for Reuse

The soils across the site comprise silt and clay which will be suitable for reuse on site as engineered fill. Site specific testing of proposed site won fill will be undertaken to inform handling, placement and compaction methodology. Specifications for fill placement will be provided as part of the detailed design stage. We also note the following:

- As per the geotechnical report, all turbines are located on excavated ground and no fill is predicted under these structures.
- Only well graded granular fill is to be used for the substation. The additional testing regime will include tests to assess the conformance of site won gravels for use as engineered fill under substation foundations.
- Any unsuitable site won fill will be disposed of in clean fill sites.

Item 5 Point 2 – Quarry Sites

This is being addressed by Tektus Consultants Limited (Tektus).

Item 5 Point 3 and 4 – Clean Fill Stability

We have been provided with plans showing proposed clean fill areas, prepared by Tektus, attached. We understand that there are many potential clean fill areas proposed and the areas are located across different parts of the site to minimise tracking of material and minimise the overall size of the clean fills.

The proposed clean fills have been positioned in gullies or hollows across the site. The proposed lateral extent and the depth of fill will vary between the different clean fill sites, as does the grade of the existing gullies to be filled.

The northern portion of the site is better suited for clean fill areas as the topography is more gently sloping. There is also less evidence of historical instability and on-going shallow surface creep. Due to this, most clean fill areas have been located in the northern portion of the site. A number of locations have also been identified for potential clean fill areas in the southern portion of the site on the more gently sloping areas. These areas are considered suitable for fill based on the existing slope grade, but the lateral extent and overall depth of fill will likely be less.

We have been provided with four representative clean fill sites from Tektus which have been assessed for long term stability. The maximum depth of fill is approximately 10m for proposed clean fill 1, with the steepest front face grade of 1 vertical on 4 horizontal at proposed clean fill 2.

The clean fills that have been analysed are annotated on the Site Plan provided by Tektus (attached) and the existing and finished ground profile of the clean fills are shown on the attached Cross Sections. The ground profile and groundwater levels have been assumed based on subsurface information from the general area surrounding the clean fill site.

Analysis of ground stability on each of the sections was undertaken using the computer based program “SLIDE” by Rocscience under the Spencer analysis method.

The seismic analyses have been undertaken based on a horizontal seismic coefficient of 0.28g, calculated in accordance with the Earthquake Geotechnical Engineering Practice Module 1, with reference to NZS1170.0.2002 and NZS1170.5:2004. The clean fills are considered to be Importance Level 2 as they are not supporting any of the proposed turbines and are not considered a risk to the proposed turbines in the event of failure in a seismic event.

The geotechnical parameters used in the analysis are shown in Table 1

Table 1: Geotechnical Parameters Used in Stability Analysis

Stratum	Bulk Unit Weight γ (kN/m³)	Effective Stress Parameters	
		Cohesion c´ (kPa)	Angle of Friction, Ø´ (deg)
Proposed Bulk Fill	18	3	25
Coromandel Group Deposits – Stiff Soil	18	5	30
Coromandel Group Deposits – Very Stiff Soil	18	7	35
Coromandel Group Deposits - Rock	18	25	50

The results or the stability analyses are shown in Table 2. An acceptable factor of safety was met under each set of conditions. Printouts of the stability analyses are appended.

Table 2: Factor of Safety obtained in Stability Analysis of Clean Fill Sites

	Factor of Safety		
	Estimated Groundwater	Raised Groundwater	Seismic
Required by Council	1.5	1.3	1.0
Clean Fill Site 1	4.0	3.1	1.1
Clean Fill Site 2	2.4	1.9	1.0
Clean Fill Site 3	2.7	2.3	1.1
Clean Fill Site 4	3.9	2.7	1.3

Based on the representative cross sections analyses, the proposed clean fills are expected to be stable. We note that the current assessment is simplified and assumes uniform ground conditions in the underlying soils with no relic failure surfaces to cause non-circular type failure as we do not have sufficient geotechnical information to accurately model such failure. Further assessment will be undertaken at each clean fill site at detailed design stage, including a walkover inspection of the site, site specific investigation and stability analyses to confirm stability. The detailed design will also assess the potential for translational and compound type failure, and propose remediation strategies to minimise failure where considered necessary.

Following detailed design, a specification will be prepared that will document minimum acceptable standards during construction to ensure that the clean fill sites are stable and do not adversely affect the integrity of existing slopes. Such construction practices will include removal of all topsoil, appropriately benching the fill, lightly compacting the fill, installation of surface drainage measures to minimise saturation of the fill and/or incorporation of basal drainage where considered necessary. Details will be discussed at detailed design stage.

Item 5 Point 5 – Lattice Transmission Towers

The proposed transmission towers are located in the southern extent of the site near to the proposed substation and Turbine 24. The exact location has not yet been determined, but the towers will be located on the ridge line or upper side slopes. The ground surface in the general location of the transmission towners is gently to moderately sloping. We recommend that the platform for the transmissions be formed by excavation alone, and where practicable, located on land that is more gently sloping.

The ground conditions in this area are expected to comprise very stiff to hard Coromandel Group Volcanic soils to approximately 6m to 7m depth.

No plans of the transmission towers have been provided to us, but they are expected to be founded on piles taken down through the soil and into the underlying rock. We consider that the use of piles is likely to be more cost effective for the size of towers than an equivalent shallow foundation.

The final foundation solution will be determined at detailed design which will also include overall global stability analysis for the tower foundations.

Item 5 Point 6 - Substation

The proposed substation is to be constructed on a raised fill platform. The fill is locally up to approximately 11m thick and is to grade into the existing ground surface at grades of between 1 vertical on 1 horizontal and 1 vertical on 2 horizontal. The proposed batter grades are too steep to stand unsupported and we recommend that the batter slopes be formed as reinforced soil slopes.

Stability analyses show that under static conditions, an acceptable factor of safety could be met with reinforcing over the front face only.

However, an acceptable factor of safety could not be met under seismic conditions. The reinforcing was extended across the entire width of the fill platform at 0.5m spacing and an acceptable factor of safety was achieved. The seismic analyses have been undertaken based on a horizontal seismic coefficient of 0.37g, calculated in accordance with the Earthquake Geotechnical Engineering Practice Module 1, with reference to NZS1170.0.2002 and NZS1170.5:2004. The substation is considered as an Importance Level 3 (IL3) structure.

Based on our analysis, we therefore recommend that the entire substation fill platform is constructed as a reinforced earth embankment. Printouts of the stability analyses are appended.

At detailed design stage, once the final details of the substation and finished ground profile are known, further stability analyse will be undertaken for the design of the reinforced substation platform. This will include design optimisation in terms of the geogrids types and maximum acceptable spacings.

We trust the above has addressed the questions by Council. If you require any further information, do not hesitate to contact us.

Yours faithfully,
p.p. KGA Geotechnical Group Limited

Jacqui McCord	**Robert Kamuhangire**	**Abilio Nogueira**
BSc (Geology)	BSc (Civil Hons), MSc (Geo), CPEng	MSc (Eng. Geol.)
Geologist	Senior Geotechnical Engineer	Director

Attachments:

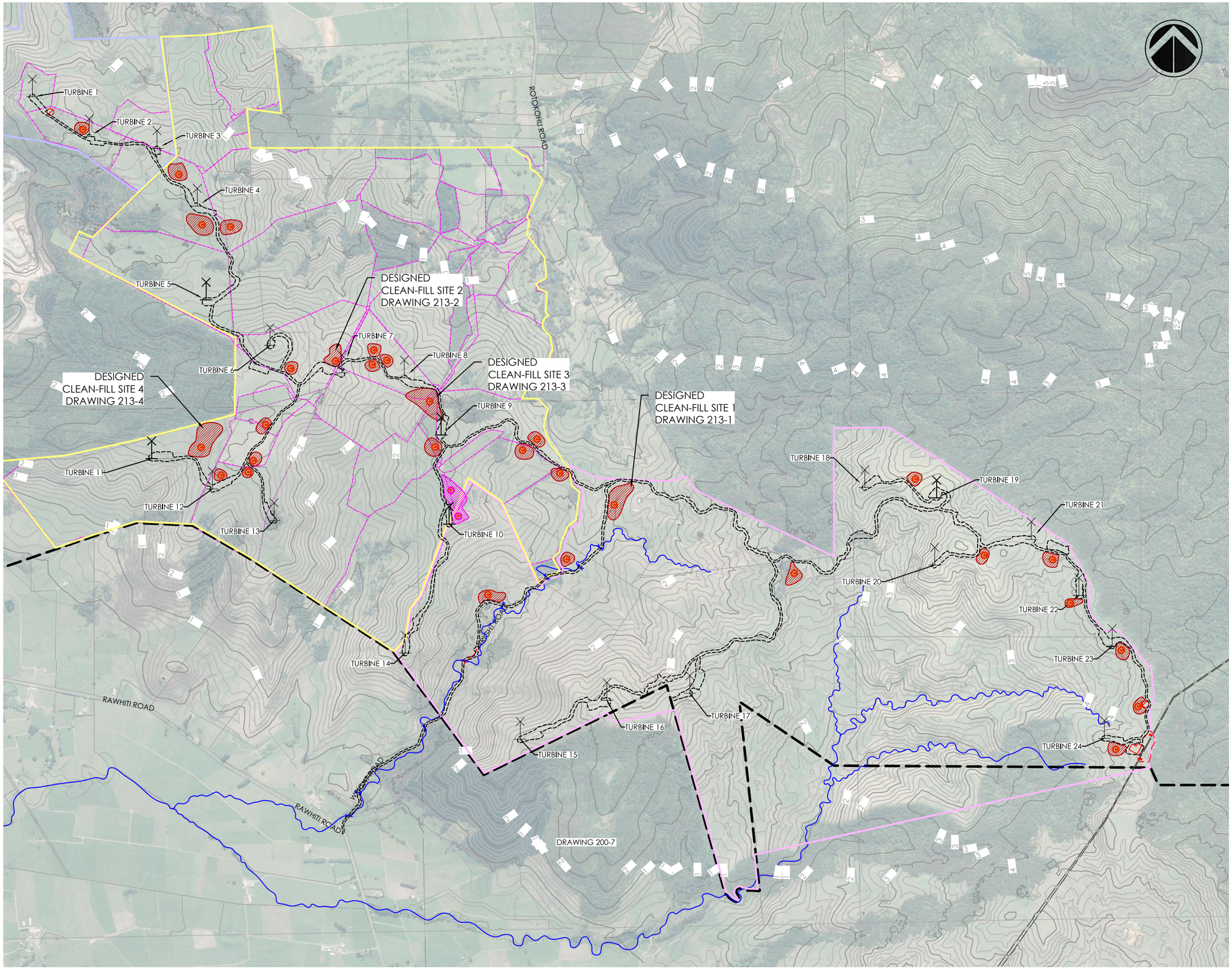
Plans by Tektus

Cross Sections for Clean Fill Sites 1 to 4

Appendix :

Stability analysis for Clean Fill Sites 1 to 4

Stability analysis for Substation



Notes:

1. FOR INFORMATION PURPOSES ONLY.

2. BOUNDARIES, CONTOURS AND OTHER BASE INFORMATION SHOWN IS INDICATIVE ONLY AND PRIMARILY INFORMED BY AERIAL LIDAR SURVEY BY SYNERGY POSITIONING SYSTEMS LTD IN APRIL 2016.

3. COORDINATES SHOWN ARE IN TERMS OF MT EDEN 2000 CIRCUIT AND LEVELS ARE RELATIVE TO THE AUCKLAND 1946 VERTICAL DATUM.

4. THE PROPOSED ROAD ALIGNMENT, TURBINE PLATFORMS, AND OVERALL EARTHWORKS ARE BASED ON AN INDICATIVE ROAD ALIGNMENT AND REMAIN SUBJECT TO DETAILED DESIGN.

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- INDICATIVE CLEANFILL SITE
- EXISTING CULVERT
- PROPOSED UPGRADED CULVERT
- STREAM (WRC REGIONAL MAP)

REV:	DESCRIPTION:	BY:	DATE:
A	ADDITIONAL PLAN FOR S92 RESPONSE	LT	27.09.18

STATUS: RESOURCE CONSENT

TEKTUS Consultants Ltd
PO Box 80212 Green Bay
Auckland 0643 NZ
p. 09 827 1191
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CLIENT: VENTUS ENERGY (NZ) LTD
10/215 ROSEDALE ROAD, ALBANY
AUCKLAND 0632

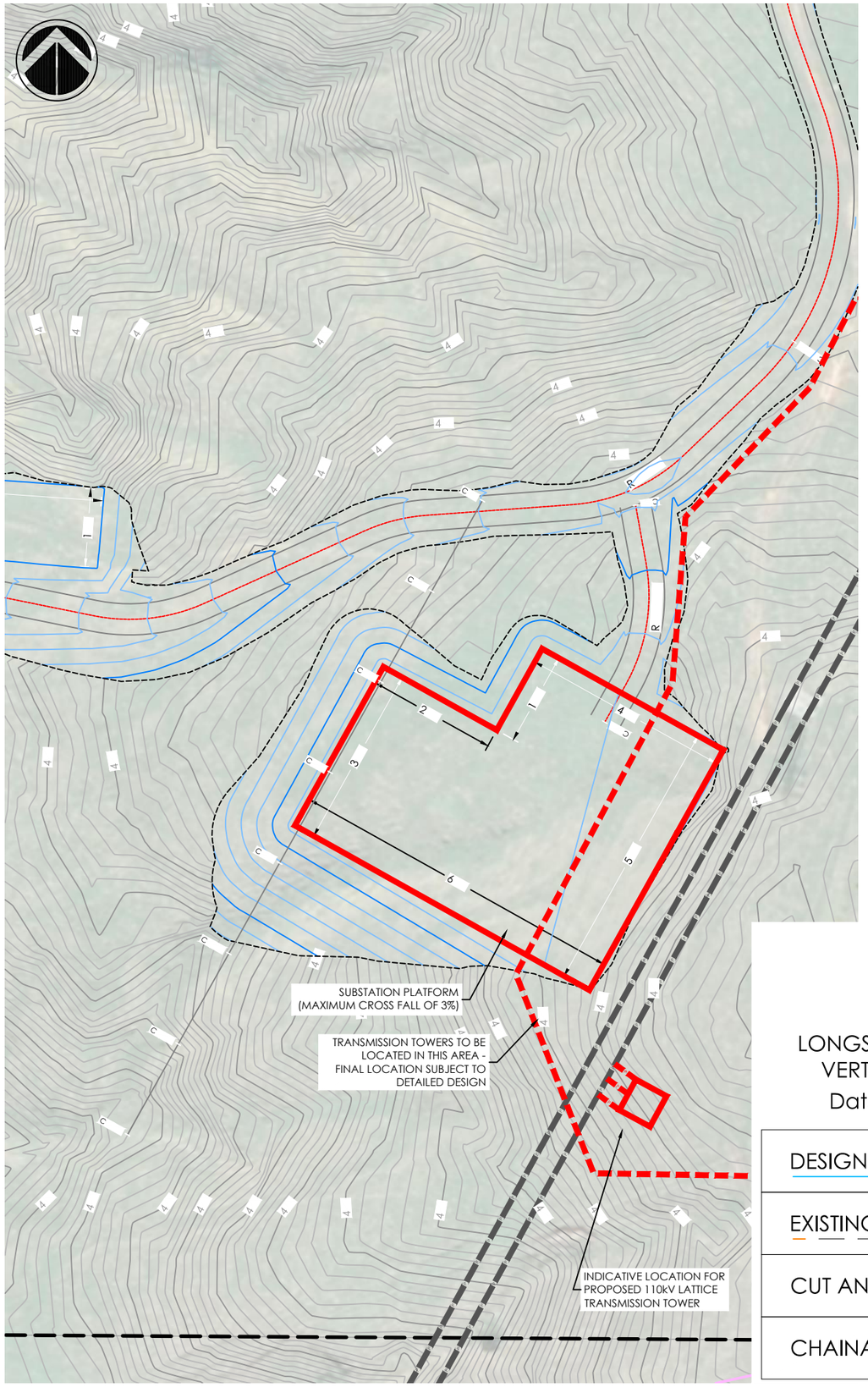
SURVEYOR: SYNERGY POSITIONING SYSTEMS LTD
3/52 ARRENWAY DRIVE, ALBANY,
AUCKLAND 0632

SITE: KAIMAI WIND FARM
ROTOKOHU ROAD, PAEROA

TITLE: PRELIMINARY CIVIL ENGINEERING DRAWINGS

SUBTITLE: PROPOSED CLEAN-FILL OVERVIEW

SCALE AT A3:	DATE:	DRAWN:	CHECKED:
1:20000	27.09.18	LT	JT
PROJECT NO:	DRAWING NO:		REVISION:
T15022	213		A



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4		-6.000	-4.000
5		-4.000	-2.000
6		-2.000	-1.000
7		-1.000	0.000
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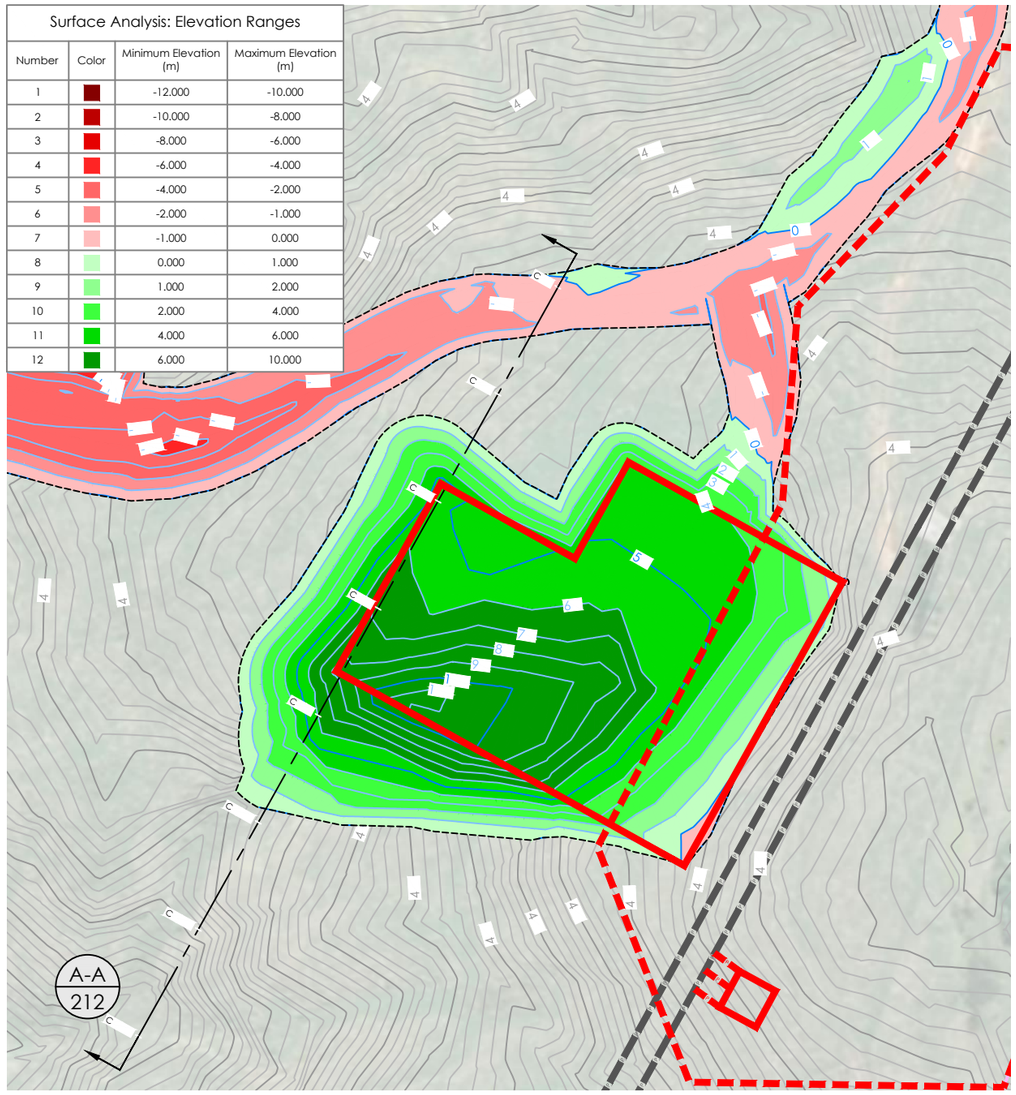
12		6.000	10.000



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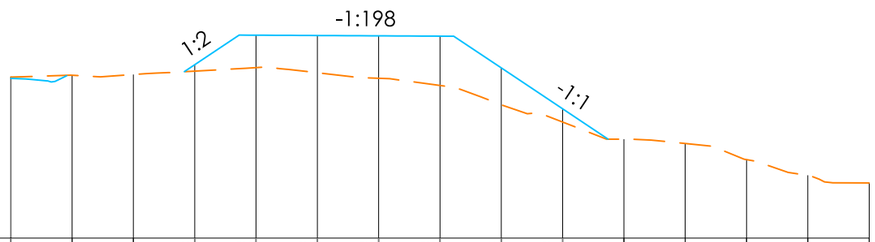
Datum 450.00



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CUT AND FILL	-0.19			1.03	5.29	6.07	6.92	8.03	6.02	2.16					
CHAINAGE	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140

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REV:	DESCRIPTION:	BY:	DATE:
B	S92 RESPONSE UPDATE	LT	27.09.18
A	RESOURCE CONSENT	JT	15.06.18

STATUS: RESOURCE CONSENT

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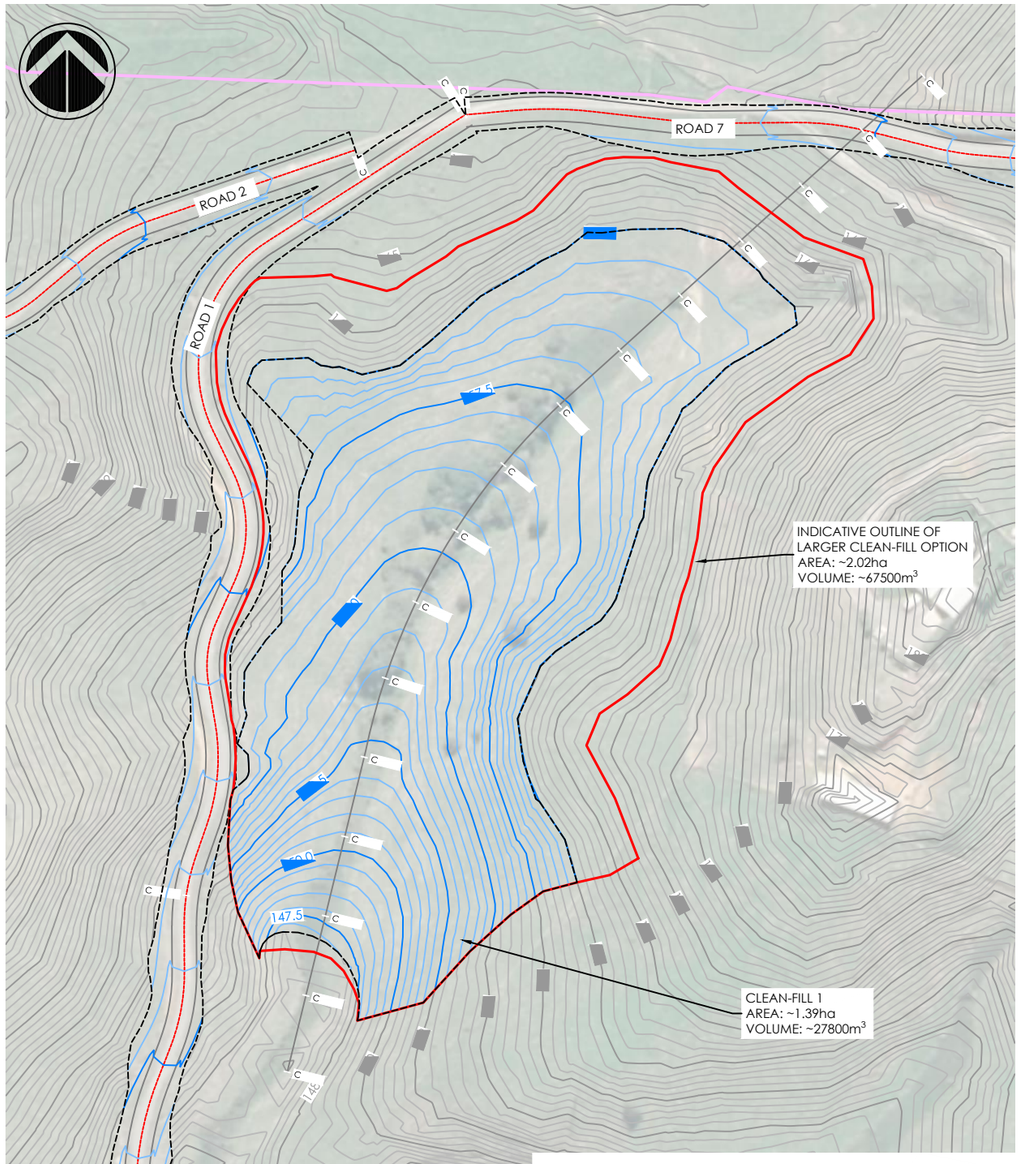
AUCKLAND 0632

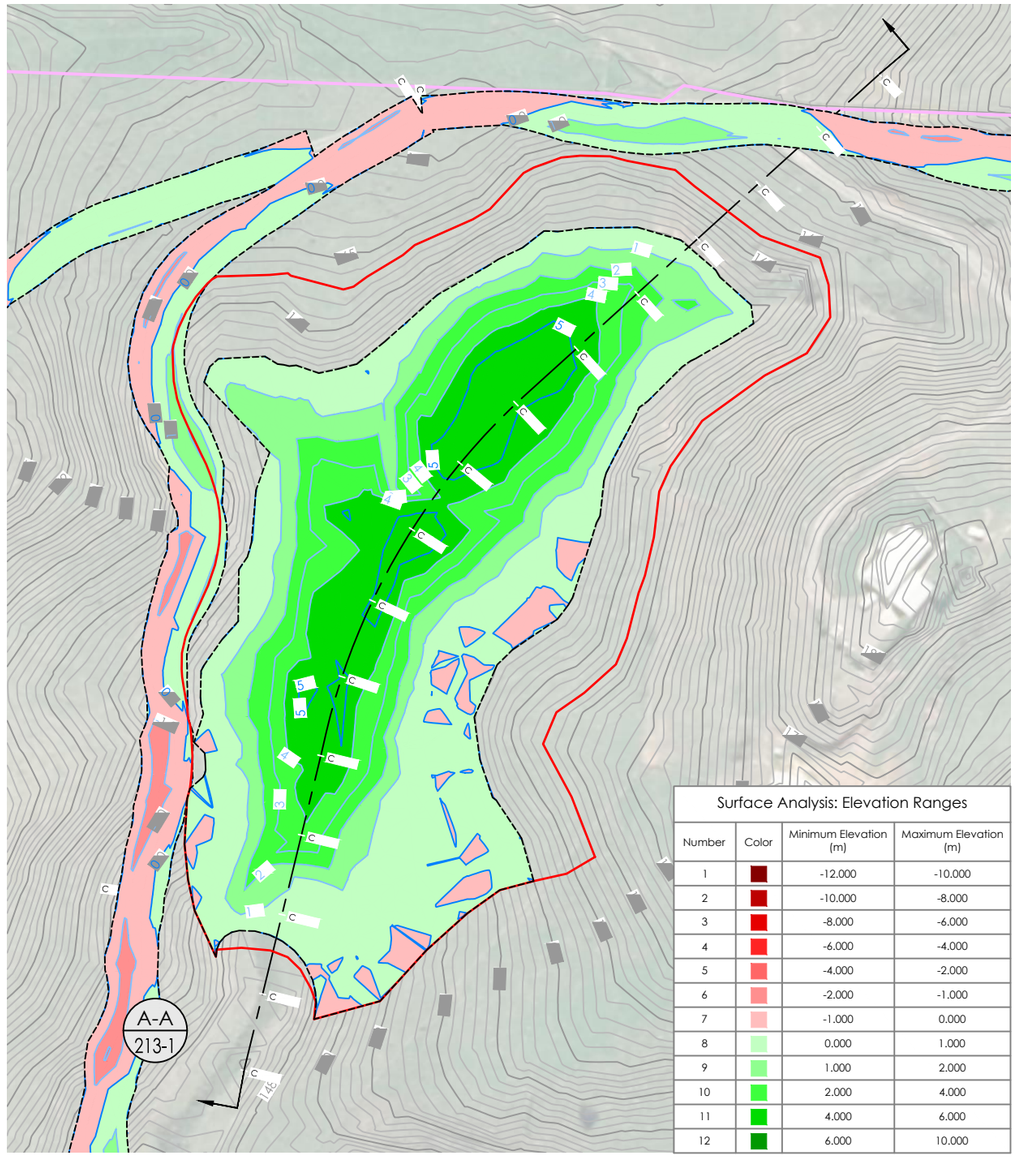
SITE: KAIMAI WIND FARM
ROTOKOHU ROAD, PAEROA

TITLE: PRELIMINARY CIVIL ENGINEERING DRAWINGS

SUBTITLE: PROPOSED SUBSTATION PLATFORM

SCALE AT A3:	DATE:	DRAWN:	CHECKED:
1:1000	15.06.18	JT	JT
PROJECT NO:	DRAWING NO:		REVISION:
T15022	212		A





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7		-1.000	0.000
8		0.000	1.000
9		1.000	2.000
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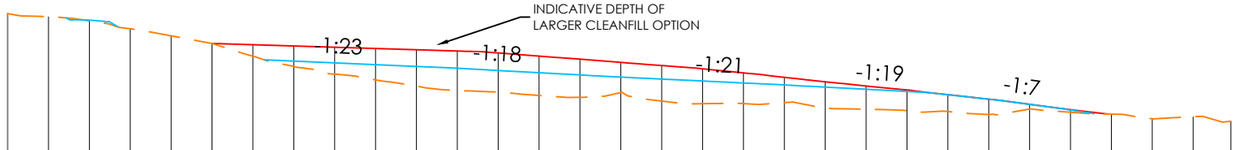
11		4.000	6.000
12		6.000	10.000

CLEANFILL-1
VERT EXAG 1:1
Datum 135.00



DESIGN LEVELS								159.69	159.26	158.82	158.39	157.95	157.40	156.85	156.31	155.79	155.30	154.83	154.35	153.86	153.34	152.82	152.28	151.46	150.38	149.12	147.76				
EXISTING LEVELS	171.30	170.59	169.53	167.60	165.86	164.01	160.89	158.37	156.49	155.11	153.59	152.47	152.13	151.29	150.83	152.00	149.92	149.29	149.30	149.54	148.18	147.92	147.58	147.38	146.65	147.97	147.21	146.73	145.61	146.10	145.00
CUT AND FILL								1.32	2.77	3.72	4.80	5.48	5.27	5.56	5.48	3.79	5.38	5.54	5.05	4.32	5.16	4.90	4.70	4.09	3.73	1.15	0.55				
CHAINAGE	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	299

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SITE: KAIMAI WIND FARM
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TITLE: PRELIMINARY CIVIL ENGINEERING DRAWINGS

SUBTITLE: PROPOSED CLEAN-FILL SITE 1

SCALE AT A3:	DATE:	DRAWN:	CHECKED:
1:1500	27.09.18	LT	JT

PROJECT NO:	DRAWING NO:	REVISION:
T15022	213-1	A