KAIMAI WIND FARM

Kaimai Wind Farm

Construction Report

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Executive Summary

Kaimai Wind Farm Ltd (KWF) propose to construct a wind farm of approximately 100MW capacity on the Kaimai Ranges. The Kaimai Wind Farm site is approximately 10 km to the North of Te Aroha. The site is characterised by grassed rolling hills, and ranges from 250m to 450m above sea level. It is covered by exotic grazing grasses and adapted weed species. The topography is generally suitable for a wind farm development if appropriate contours are followed for roading and turbine locations.

This document outlines the methodology for construction of the Kaimai Wind Farm project, and provides evidence that this development is practicable, and can be constructed in a conventional and conservative way.

In the preparation of this report the following documents have considered and incorporated as necessary:

1. Memorandum – Kaimai Turbine Dimensions – rev 4; 21 May 2018; Kaimai Windfarm Ltd
2. Civil Engineering Drawings – Resource Consent Issue; Rev A; Tektus Consultants; Jun 2018
3. Civil Engineering Peer Review; May 2018; Tiaki Consultants
4. Geotechnical Engineering Investigation; June 2018; KGA Geotechnical

The Kaimai Site consists of a predominantly south-west facing ridgeline, and a lower plateau on the west side of the ridgeline, both are suitably aligned to the wind resource. The site is logically split into upper and lower sub sites, with the proposed upper turbines being lower in hub height and smaller in rotor diameter. The turbine locations would logically follow the sites' ridgelines and more prominent topography. The planned access utilises existing pre-formed agricultural access roads where possible, with some new construction required to reach actual turbine locations. No new stream crossings are required over the existing crossings.

KWF has carried out extensive wind monitoring on the site using various tall wind monitoring masts in previous years, obtaining suitable wind data to calculate energy yield estimates. A number of the proposed Turbine sites have an average wind speed of 9.5 m/s on the upper site and 7.5 m/s on the lower site, in addition turbulence levels are relatively low. This high quality data provides a high level of confidence in its application as a key input to the wind turbine foundation design.

A geotechnical investigation has been carried by KGA Consultants during 2017 which involved a site walkover in conjunction with drilled boreholes at key locations. The outcome of the assessment was that the site is relatively stable, with no large remediation or stabilisation work required. The civil construction is therefore conventional in design and straightforward.

The default foundation design modelled is a gravity foundation, which is the most conservative approach. A nominal diameter of 23m is allowed for the purposes of civil design and earthworks volume estimation.

The preferred crane for use at the site was chosen as a mobile (rubber tyred) Leibherr 1750. This crane can easily maneuver around tight corner situations which is required for a few of the turbine locations, notably turbines 11, 13, 15, 16 and 18. The crane can also travel easily to site on conventional roads as found in the general area.

The civil designer has allowed for various arrangements of crane platform, laydown areas (where possible) and foundation locations. Some of the tighter locations will require the installation crane "picking" the turbines directly from the transporter equipment rather than off a laydown area. This is feasible, however it does increase the construction time to fully erect a turbine. The preference where possible is to allow for a laydown area next to the foundation where turbine components can be placed and prepared as necessary for installation.

A new sub-station would be required to connect into the Transpower network. The platform allowed for the sub-station is based upon a design received from Siemens (developed for an Australian wind farm site of similar capacity). Detailed design is to follow actual requirements dictated by Transpower, so the final actual arrangement of buildings and components and equipment may vary to some degree. A design envelope approach is therefore taken on the sub-station works. The construction approach is to allow for a stable and strong platform on which any of the sub-station infrastructure can be placed. Any components with cooling fluid (for example transformers) shall be covered and bunded (to allow a reservoir of the component fluid volume, plus 30% contingency). A cover shall prevent rain entering the bunded area to prevent the potential danger of overtopping with rainwater.

There are also three larger laydown areas planned where component transporters can be parked, turbine components stored, and worker and management facilities can be established. This is a sensible approach which allows more orderly management of the various components required to be delivered to the turbine sites.

Two internal turn around areas allow for transporters are proposed in order to allow the vehicles to safely turn in, and also exit the longer internal roads.

Contents

Figures

Associated Reports

- Geotechnical Investigation; KGA
- Siltation Management Report; Civil Engineering Services
- Civil Engineering Drawings; Tektus
- Traffic Management; Gray Matters
- Civil Engineering Peer Review; May 2018; Tiaki Consultants
- Memorandum - Kaimai Turbine Dimensions – rev 4; 21 May 2018; Kaimai Windfarm Ltd
- Civil Engineering Drawings - Resource Consent Issue; Rev A; Tektus Consultants; Jun 2018

1. Introduction

This report lays out the general construction methodology for the proposed 24 turbine Kaimai Wind Farm project. Wind Farm design approaches are now very well established given the large number of projects complete worldwide, and fit into the conventional box of construction methodologies. However every site has particular nuances, especially hill sites due to terrain challenges. Therefore some level of customisation is appropriate.

2. Construction Aspects

This section outlines various key components of the construction of the proposed Kaimai Wind Farm.

2.1. Work Schedules

In order to reduce noise and traffic impacts on the local community, construction activity is nominally planned to be within the hours of 7:30am until 6pm. Some preparatory work may be carried out between the hours of 6:30am unit 7:30am, and 6pm until 8pm, however noise will be kept to a minimum at these times.

Longer hours may be required at limited periods throughout the turbine installation phase where cranes may need to start earlier, or finish later due to weather conditions, and the fact that lifting procedures must be completed once started. Noise from crane operations is typically much less than that of road construction or quarrying operations so this exception is considered to be a reasonable condition.

2.2. Turbine Foundations

The wind turbines are generally located close to or on the ridgelines, or on the upper side slopes. The positions are given within a 20m radius of potential locations to allow for site specific micro-siting..

Geotechnical studies show that the site is blanketed by silt and clay with possible boulder inclusions, and underlain with andesite rock below. The approximate depth to rock varies across the site from approximately 1m depth to in excess of 7m depth. At all locations, earthworks will be required to form a level platform for the turbine. This will include either lowering ridgelines or excavation into slopes. Depending on the final depth of excavation to form the level platforms, it is likely that some turbines will be located on rock, some on soil and some on a combination of rock and soil.

The foundations will be formed solely on virgin material, rather than fill, as the steepness of some sites mean that any fill has the potential of subsiding.

Where the underlying substrate is a mixture of soil and rock, either piles down to bedrock will be used in the soil portion of the foundation or the excavation will continue until bedrock is reached. This design approach prevents the possibility of differential settlement of turbine foundations.

The turbine foundations are nominally constructed approximate 2.5m to 3.5m below ground surface. Where located in soil, the ground is able to provide an ultimate un-factored bearing capacity of 500kPa. Detailed soil bearing calculations will be undertaken for each foundation site based upon additional geotechnical investigation.

The turbine foundations will be constructed from reinforced concrete, and are designed to withstand gust conditions and structural loadings as specified by New Zealand building codes. The proposed wind turbines have been assessed as a Level 3 structure in accordance with Table 3.2 of NZS1170.0:2002 as they are a power generating facility. The design life is based on 50 years. The exact size of the bases will be determined following a detailed design process once the turbine section is finalised, and a further detailed geotechnical site investigation is undertaken in light of specific engineering details arising from the final turbine selection. However, an indicative size for a conservative gravity foundation for the proposed turbines is 23 x 23m. An indicative foundation design is illustrated in Appendix 1. A margin of 1.5m over and above the foundation perimeter is allowed for over excavation and placement of formwork. Nominally the shape will be octagonal which is easier to construct than a circle and is more efficient than a square shape (for larger foundations).

The overlying soil and rock will be excavated down to a firm base from which the foundations are constructed from. The civil design drawings and earthworks quantities have allowed for this excavation. The excavation is initially capped by a blinding layer of concrete to be laid onto the excavation substrate to provide a firm base to construct the foundations.

Backfill (engineered and compacted to the required density) will be placed over the foundation pad once the concrete work is complete and sufficiently cured. The backfill provides an integral and important counterbalance component to stabilise the foundation over and above support provided by the concrete foundation alone. The finished level of the backfill would be consistent with the surrounding land.

The indicative foundation provided in Appendix 1 is for a 109m rotor diameter turbine, and is 19m in diameter. The nominal increase in foundation size to support a 160m diameter turbine with a 132m hub height represents an upscale to 23m in diameter. Some level of optimisation is possible following the detailed geotechnical investigation, upon which the foundation size may be reduced where strong and consistent rock, or sufficiently firm soils are encountered.

KGA Geotechnical have conducted a preliminary site assessment with regards to turbine foundations and roading. The assessment recommends that turbine locations are located as centrally as possible on ridgelines, to avoid side slopes and instability features. This work fed into the initial layout assessment, and formed a basis for the eventual positioning of the turbines.

Some of the turbine sites may be more prone than others to potential instability, once the final turbine selection is made any concerns can be remedied by standard engineering works such as retaining or specific foundation recommendations.

Cut faces around the turbine sites are limited to a grade no steeper than 1:1.5 to maintain stability. Retaining walls may be required to support cut faces where steep batters are required. No spoil will be stockpiled above steeply sloping ground so as not to negatively impact slope stability.

2.3. General Laydown Areas

Three component and construction storage areas around the site have been allowed for. These areas will be used for storing the various turbine components while awaiting the erection sequence. In addition, construction machinery, construction equipment, temporary offices, and fuel tanks will be temporarily stored on these sites.

These sites will be suitably finished with the appropriate grade of aggregate to enable all weather operation, and to prevent potential water runoff.

2.4. Crane Pads

Adjacent to turbine foundations, a compacted 1m deep aggregate crane pad will be required, dimensions will vary for each turbine site as a function of topography and turbine size. The crane pads allow for safe setup and operation of the crane.

An additional laydown area will be provided adjacent to the crane pad for component laydown, where the topography and space constraints allow. Some of the turbine sites are constrained due to steep terrain, for example turbines 3, 5, 6. In these situations the turbine component shall be picked directly from the component transporter by the crane as required by the turbine erection process. This method does however results in a longer overall construction time as individual loads need to be marshalled in a constricted area, resulting in longer crane hire time, so this approach is used sparingly.

The most economically optimal option is to have a larger lay down area, however this is normally only suitable for flatter wind farm sites. The civil design drawings illustrate a detailed arrangement of each foundation area, including laydown areas (if any), and crane pads.

2.5. Site Electrical Cables and Overhead Lines

The nominal operating voltage of the turbines is 750 volts at the generator terminals, although this does vary depending on the turbine model. The generator voltage is subsequently transformed by an internal turbine transformer to the higher voltage of 33kV for efficient distribution around the site. The turbine interconnecting cables will be laid underground apart from two sections, and will terminate at the new sub-station. The cables will generally follow the road alignment.

The preferred method of cable installation is by multiple specialised cable laying machines. These machines are easily able to cut through coherent rock to form a neat and stable trench, while laying the cable in the trench simultaneously. Backfill will be specially selected to ensure it has the correct thermal properties to facilitate heat dissipation from the cables. A protective strip shall be laid over the cables alerting excavator operators in the future to the presence of underground cables.

The wind farm distribution network connection will involve two sections of overhead line that will run in the general vicinity of proposed turbine 14 to turbine 5, and from turbine 17 to the proposed sub-station. This proposal is to avoid laying cable in difficult terrain which might compromise slope stability

2.6. Sub-Station and Control Building

A compound will be required for the electrical control building (up to 5m high) and the associated sub-station equipment up to 12m high). A typical sub-station layout is shown in Appendix 2, this has been provided by Siemens for a 132kV connection in Victoria, similar to that of the proposed project. The function of the control building is to house monitoring and control equipment for the wind turbines, and to facilitate the transmission of electricity into the Transpower network. External electrical equipment will include switchgear, transformers, overhead gantry's and associated bus-bars. Transpower must approve the detailed design of the sub-station, and there is defined approach to arrive at the final design. Appropriately the design criterial will be completed once the final turbine selection has been made (post consenting). Therefore, KWF propose an envelope approach, and allowance has been made for a conservative platform design basis that can accommodate the infrastructure at every location, for example the control building may be moved to the opposite side of the substation platform. The compound will be secured against unauthorised access by a 2.4 m high fence and locked gates. Transpower shall have access to the compound (and have land rights for the locations where key equipment are located) however the sub-station will be owned by KWF.

2.7. 110kV Pylons

Two 110kV pylons will be installed to connect the new sub-station into the exiting overhead lines. The detailed design phased in collaboration with Transpower, will define the exact locations of these towers. For the purpose of consenting an envelope approach has been allowed for, whereby the towers may be installed within the area outlined by the dashed red line referenced on Drawing 212. Indicative tower options are illustrated below, with dimensions in metres:

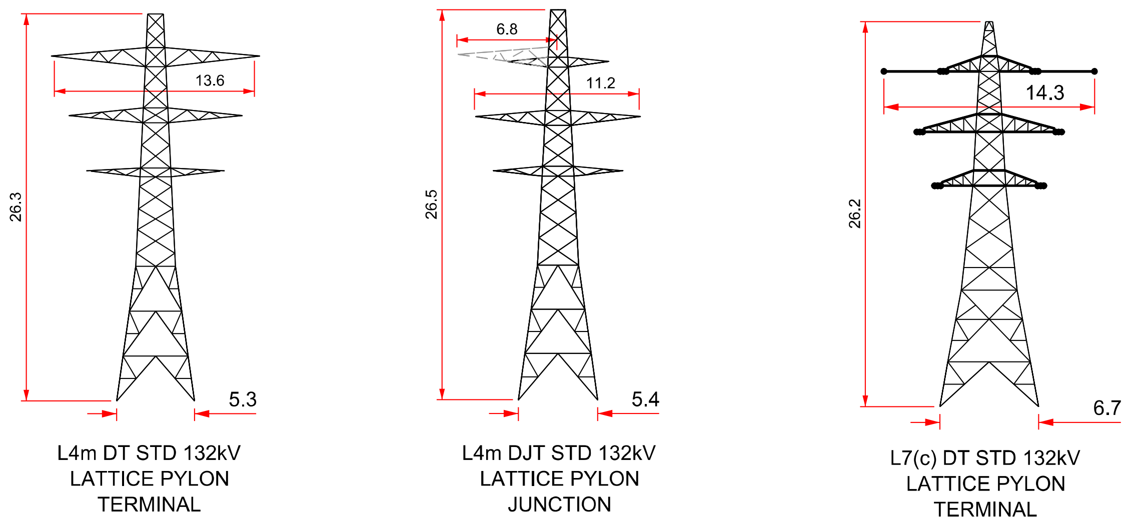


Figure 1: Indicative 110kV Pylons

2.8. Site Entrance

There are two proposed access points to the site, one from Rawhiti Road and one from Rotokohu Road, off Taumatatotoara West Road. Access details are illustrated via photographs in Figure 7 through Figure 19. The traffic generation and management aspects are covered in detail by a report issued by Gray Matters Ltd.

The proposed principal access is via Rawhiti Road, and which will be upgraded to allow for all turbine components and heavy trucks, especially articulated vehicles. Smaller trucks, for example concrete trucks may enter via Rotokohu Road. The site entrance at Rotokohu Road in itself does not require upgrading for access for light trucks and light vehicles. However, it will be upgraded and widened to allow for the passage of turbine component transporters originating from the Denize Brothers farm on route to the Rotokohu Farms (Thorpe Family) farm.

The entrance way from Rawhiti Road is already relatively wide, and has good approaches, however it may require minor expansion and ground strengthening to allow the turbine component transporters to safely turn onto the site.

A full traffic management plan will be furnished to the NZTA, and relevant district and local authorities for approval prior to the commencement of any construction activities. This plan will be finalised and submitted once final details are known in regards to plant dimensions and weights, which are based around final turbine choice.

2.9. Existing Electrical and Telecommunications Lines

An independent telecoms operator (Lightwire Ltd) has a small facility in the general vicinity of turbine no. 7. This site will be moved to the side during construction and then placed in an appropriate location once the turbine is installed. No existing electricity infrastructure shall be affected.

2.8 Fencing

Some fences and gates will be re-positioned to allow the construction of the road network. The northern two landowners have requested mapping to determine how to manager stock and the fencing realignment. These two maps are shown in Appendix 3.

2.9 Cable Laying

As the bulk earthworks is completed and a basecourse is laid for the access roads, specialist mechanical cable layers will be brought in to lay the reticulation network. The cable shall be brought to site in drums to be loaded into the cable laying machinery. The cable trench is then backfilled automatically as part of the laying process, an example is available at the following web address:

http://www.blackley.co.nz/project/cable-laying-te-uku-wind-farm/

3. Site Roads

This section outlines various aspects of roads required for the construction of the proposed Kaimai Wind Farm. The new site road will typically be 6m wide, and slightly wider on corners, to allow for the greater turning radius of the mobile crane and transporters.

Mostly, the road will follow existing access farm tracks which generally follow the local topographic high points and ridgelines. This simplifies the construction greatly as only a few larger excavations are required, and only 4 significant culverts are required (some of which are existing). Photos of the existing culverts are shown in Appendix 4, in addition to the general methodology drawings for the construction. Two of the existing culverts are recommended for to bring their capacity up to a minimum of a 2 year storm event. The remaining culvert crossings will be inspected by a structural engineer prior to commencement of construction and transit of associated heavy traffic. Additionally, the ability of existing culvert crossings to be overtopped and act as a causeway during larger storm events will be assessed.

Design drawings illustrate that generally the access ways can be formed with excavation and filling operations of no greater than approximately 2m depth. However, there are localised sections where excavation up to approximately 10m depth is required, and filing to approximately 7m in depth. The areas of maximum cut and fill generally correspond to turbine sites, as well as localised areas along the access way. The proposed batter slopes for the access way are generally no steeper than 1 vertical on 1.5 horizontal, but in some areas are as steep as 1 vertical on 1 horizontal. The following recommendations are followed for cut and fill batters:

- Cut batters are no steeper than 1 vertical on 1.5 horizontal.
- For cut faces steeper than 1 vertical on 1.5 horizontal and in excess of 1m high, site specific investigation will be undertaken.
- Fill batters are no steeper than 1 vertical on 2 horizontal.

The insitu rock material is sufficient to support the transporters without special treatment. The road will be designed to allow passage of a 70m long transporter. The heaviest component which the road will have to support will be the nacelle which will weigh up to approximately 90 tonnes, the maximum transporter axle load will be nominally 15 tonnes. The maximum gradient on the road will be 1 in 6 (approximately 17 degrees slope) to avoid excessive inclines for heavy equipment. Generally, the road layout has been developed to ensure stability both in the construction and the operation phases.

The transportation operator has now advised that the maximum gradient for haulage of components is 1:4.2 (approximately 24 degrees slope). Consequently, special treatment of the surface and multiple prime mover units will be required to maintain traction on the steeper road sections.

The following diagram illustrates the general road structure:

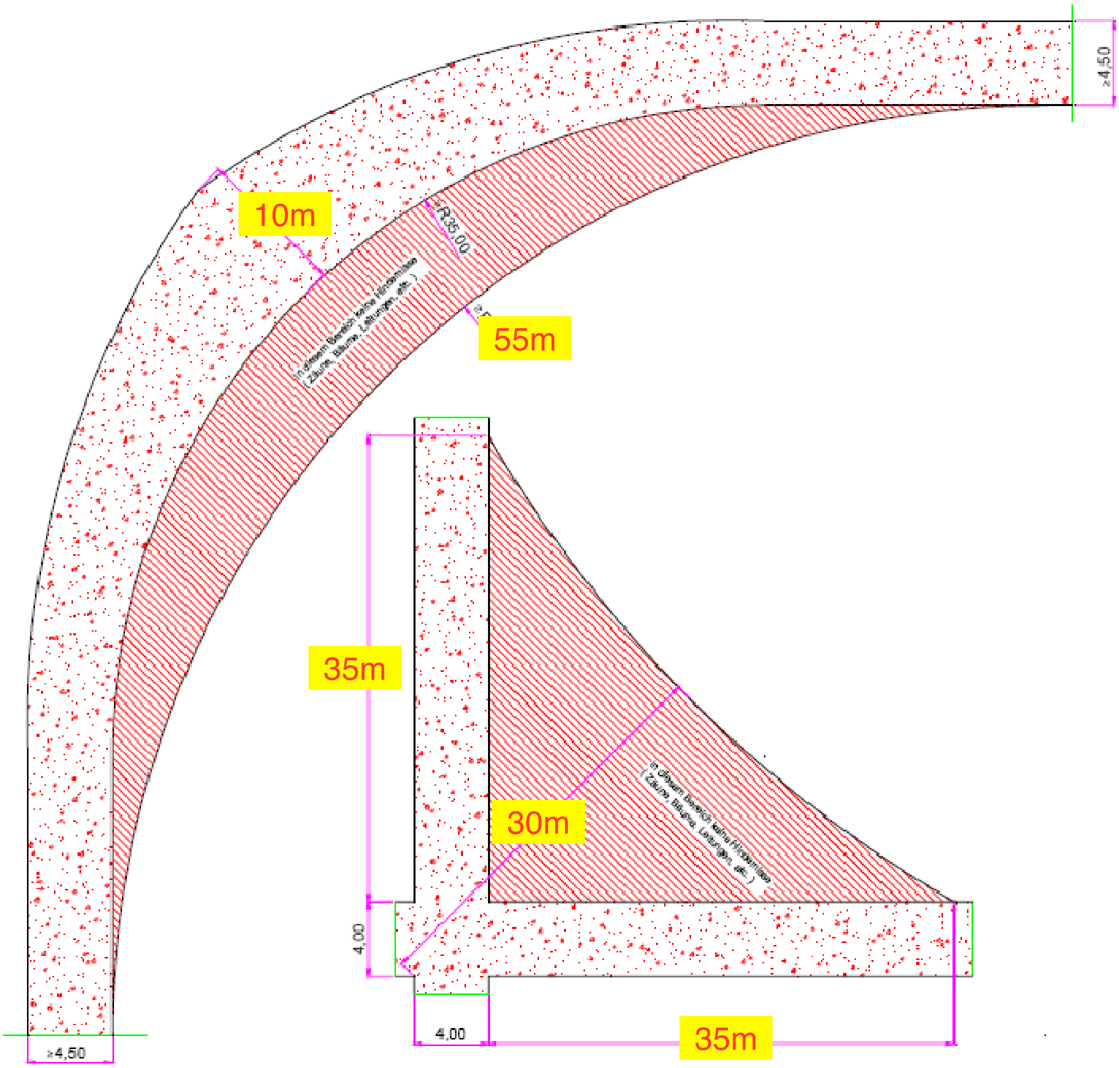


Figure 2: Access Road Corner Detail

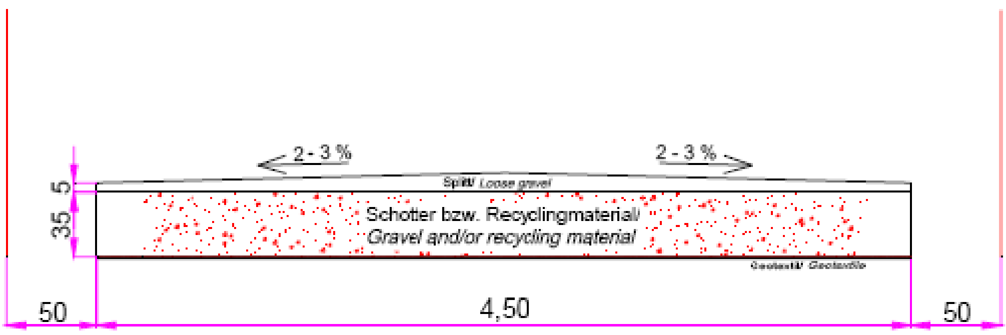


Figure 3: Access Road Structure

Some aggregate, particularly sub-base material, required for the roads will be sourced from material won on site, as there are a number of excavation areas that contain rock overburden. This process of reuse will exploit the local rock, and reduce the requirement for importing additional material together with the associated increase in traffic. The brought-in aggregate for the road surface is likely to come from any one of a number of local quarries.

The geotechnical studies to date have found that generally, the excavation required for the access way is less than approximately 2m in depth, and that the volume of aggregate won is expected to be relatively low.

Overall, appropriate access to the Kaimai Site for both the construction phase, and the ongoing operational phase can be achieved in a relatively straightforward manner.

The wind farm roads will require periodic maintenance after the construction phase, this will be limited to re-shingling in certain areas, and periodic grading. Access of large equipment for O&M operations will be sporadic, with no more than one movement likely per year for actions such as gearbox replacement. It's likely there could be a number of years without any heavy machinery access required. There will be relatively constant daily light vehicle travel, however these movements will have very little impact on the road structure given the initial build standard. Control of revegetation of the road way by exotic grasses and weeds is likely to form the largest aspect of maintenance. No long term maintenance is required on public roads as a result of the wind farm construction.

3.1. Excavated Road Construction Methodology

1. The topsoil along the route of the tracks will be stripped and removed, or temporarily stored for post construction remediation.

2. Excavation for site tracks, crane pads, and laydown areas will closely follow the topsoil strip and will be taken down to suitable soil formation or bedrock. Where traverse sloping ground is encountered a cut and fill construction will be adopted with stone generated from the cutting of the uphill batters and drainage channels being used to form the road embankments to the downhill side of the track (see Figure 4).

3. Each layer will be compacted and shaped in order to provide a road profile and finish suitable to accommodate the turbine construction, delivery, and service vehicles.

4. A drainage channel will be formed between the toe of the uphill batter and the edge of the road. This will intercept any rainwater runoff, which will then be directed under the road via appropriate sized pipes or culverts into existing drains where available. Where necessary, additional culverts will be installed to maintain the site hydrology.

Typical Cross Section through EXCAVATED Road Construction

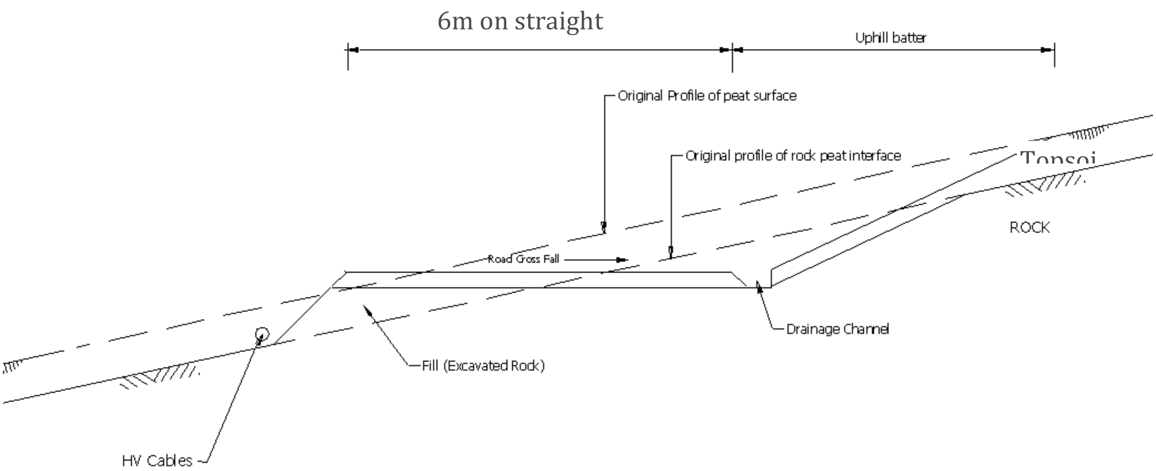


Figure 4 - Excavated Road Construction

3.2. Good Construction Practice Examples

Figure 5 provides an example of good construction practice from a recently completed windfarm. This approach combined with a well-managed and organised site significantly reduces the risk of construction mishaps. The run-off will be controlled where practicable as recommended by the Civil Engineering Services report entitled: "Proposed Kaimai Windfarm; Roading and Turbine Site Earthworks; Siltation Mitigation Proposals". This report also references the "Erosion and Sediment Control" requirements as issued by the Waikato Regional Council, which will be necessarily complied with during the construction and operation phases of the development.

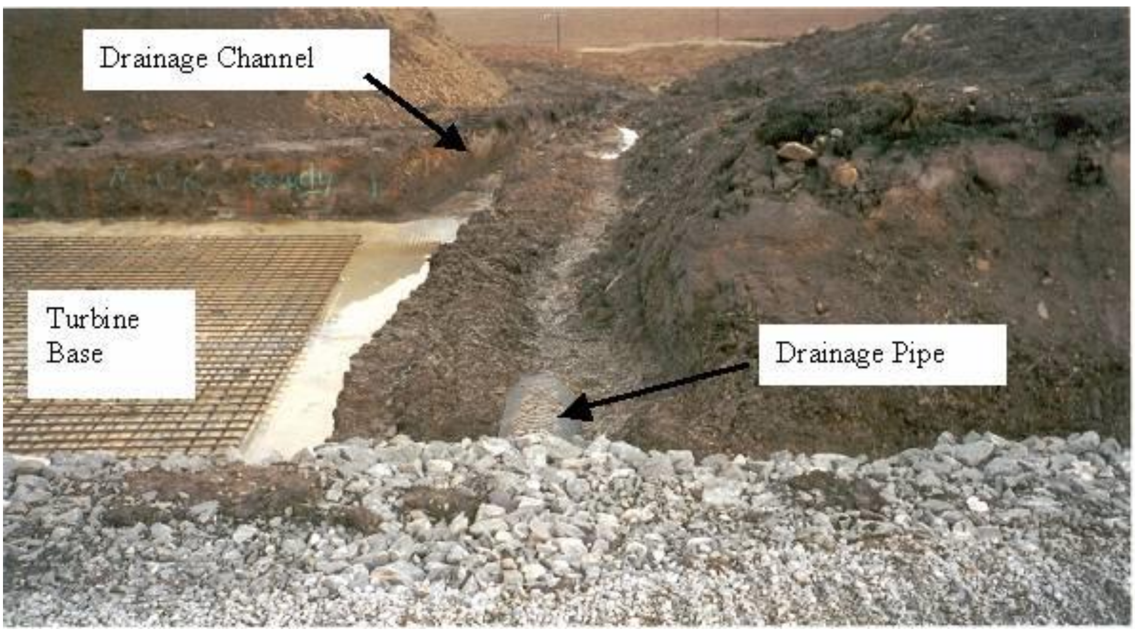


Figure 5 - Good Drainage Practice

3.3. Vegetation Reinstatement

Re-grassing of the disturbed areas on-site is a suitable reinstatement measure given the sites low ecological sensitivity bought about by the extensive farming activity carried out on the site over many years. The site therefore will then be returned to a similar state as per before the commencement of construction. The reinstatement will occur when road construction is completed. Hydroseeding is the most practical option to achieve good results, especially on undulating terrain, traditional seed drilling or broadcasting may also be performed on the flatter areas. KWF will carefully follow the requirements of the Waikato Regional Council document entitled: "Erosion and Sediment Control" throughout the remediation process.

3.4. Temporary Facilities

The first construction operation will be to begin construction of the road network. The contractor will be permitted to erect a pre-fabricated site office and canteen for the use of site staff during construction. The contractor will be required to provide their own chemical on-site toilet facilities, which will be cleaned and emptied on a regular basis. These facilities shall be located at one or all 3 of the construction laydown areas as show on the drawings: "Proposed Wind Farm; Civil Engineering Assessment" by Tektus Consultants.

3.1. Materials

The following sections outline the required construction materials, a summary of quantities is shown in Appendix 5.

3.1.1. Concrete

The turbine bases will be constructed from steel reinforced concrete, the approximate volume of each base will be approximately 540 m^3. Concrete requirements for the sub-station will be relatively small at an estimated volume of 50 m^3. Therefore in total an estimated volume of 13,000m^3 will be required for the 24 turbines plus the substation. The typical capacity of a concrete truck is 6 m^3 so a total of around 2,200 concrete truck return journeys will be required.

Concrete can be sourced directly from existing batching plants at Paeroa, Waihi and/or Morrinsville. This would result in concrete trucks entering site either via Rotokohu Road or Rawhiti Road, depending on the concrete batch availability and pricing. Concrete truck movements will be clustered around the individual concrete pours of each foundation, as opposed to there being a constant frequency of truck movements over the period of foundation construction.

As a second option for sourcing concrete is to establish a batching plant on site. This has the advantage that material can be stockpiled ahead of a large foundation pour thereby reducing the concentration of vehicles on public roads during a large concrete pour.

The decision regarding which option to choose will be made once the design detail is finalised and the concrete pours can be planned in more detail.

3.1.2. Aggregate

It is estimated that a maximum of 53,000m^3 of finishing aggregate will be needed for the on-site roads. KWF has allowed that this will all imported entirely from offsite sources. However, some of this volume will be won on site during the excavation and road cut phases (and crushed on site) so the final volume required to be imported from off-site will be less. On-site aggregate material will be used wherever possible in the road construction to minimise the economic cost of the project, and also reduce the impact of transportation (noise/dust etc). Examples of small rock outcrops are evident in local public road cuttings, similar cuttings can likely provide a source of on-site aggregate, principally for the sub-base.

The roading aggregate surface material will be sourced from local quarries such as the Tirohia quarry adjacent to the site.

Allowing an average payload of 12m^3 the total transport movements for the import of roading aggregate would top out at 4,410 round trips.

In addition to rock won during excavation, there are a number of potential aggregate pits identified on the site from the investigation process. These are shown on the Civil Drawings that accompany the AEE. As stated, it is KWFs preference to source aggregate on site as the cost is lower, and the effects on neighbours though reduced truck movements is reduced.

3.1.3. Spoil Material

An earthworks volume calculation was carried out by Tektus engineers based upon findings from the road alignment design, and the Geotechnical study carried out by KGA Consultants.

From roadside observations and geotechnical drilling, the geotechnical investigations estimates were calculated by Tektus based on the cut and fill requirements. Total cut volume is calculated as 900,000m^3, total engineered fill is calculated as 113,500m^3.

Excess subsoil and/or rock from the turbine excavations will be used as fill for the access road construction where appropriate. It is calculated that a surplus of material will arise from the required cut and fill operations, this will be used to fill natural depressions to the benefit of the landowners. Some of the larger fill areas are shown on Site Plan with the Civil Engineering Design Drawings by Tektus.

Prior to the placement of clean fill, the sites will be stripped of topsoil and the area benched. The fill is then nominally track rolled into place. Following the completion of filling, topsoil will be spread and the area reseeded with grass as soon as possible. The final grade of the clean fill will be site specific depending on site topography, depth of fill and extent of filling. For preliminary design purposes an overall fill grade of no steeper than approximately 1 vertical on 3 horizontal will be applied.

The topsoil spoil will be stored in well-drained locations for reuse. Following construction of the wind farm the stored topsoil will be used to reinstate some disturbed areas such as local aggregate pits, road verges, base edges, and surplus fill areas.

3.1.4. Reinforcing Steel

Steel is required to reinforce the concrete turbine foundations. Typically the reinforcing steel is cut and pre-bent at the supply yard (likely in Hamilton or Auckland) and trucked to site on flatbed trucks. The indicative foundation plans call for 38 tonnes of steel per foundation plus 5 tonnes for cables, conduits, earthing etc; the total reinforcing steel requirement is therefore 1,000 tonnes.

The substation will also require a relatively small amount of reinforcing steel for its construction, this is estimated as 5 tonnes in total.

3.1.5. Cables

Cable and overhead lines (supplied on large rolls) shall be delivered to site via flatbed trucks, and subsequently unloaded at key points along to site as required taking account of the planned construction sequence.

4. Craneage

A large mobile crane of up to 1,750 tonnes lifting capacity will be used for the turbine installation, details are available in Appendix 6. The heaviest lift will be the nacelle at approximately 90 tonnes, the load must be lifted up to a height of 135m to mount on top of the turbine tower, which is within the machine's capability.

The crane body width when fully compacted and ready for road transportation is 3.0m, therefore no special allowance is required for public road transportation.

The arm spread of the crane will require an area of approximately 16m x 16m to operate. An 18m x 18m allowance has been made of for the crane pad adjacent to each turbine base, and is shown in the construction drawings.

This crane due to its flexible design layout can easily maneuver in space restricted situations, this is an important requirements for a number of turbine locations, notably turbines 11, 13, 15, 16 and 18.

Appendix 1 – Indicative Foundation Design

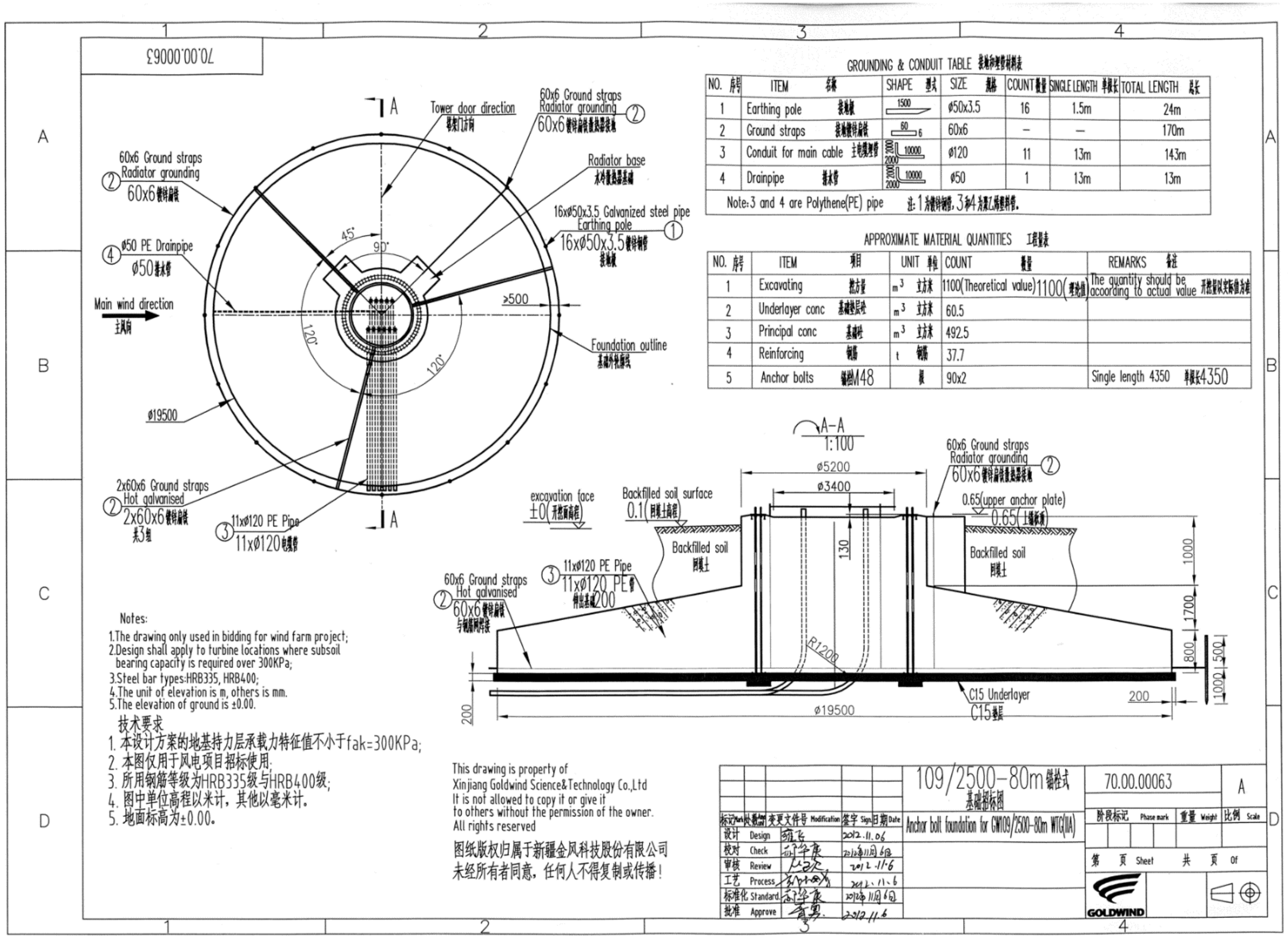
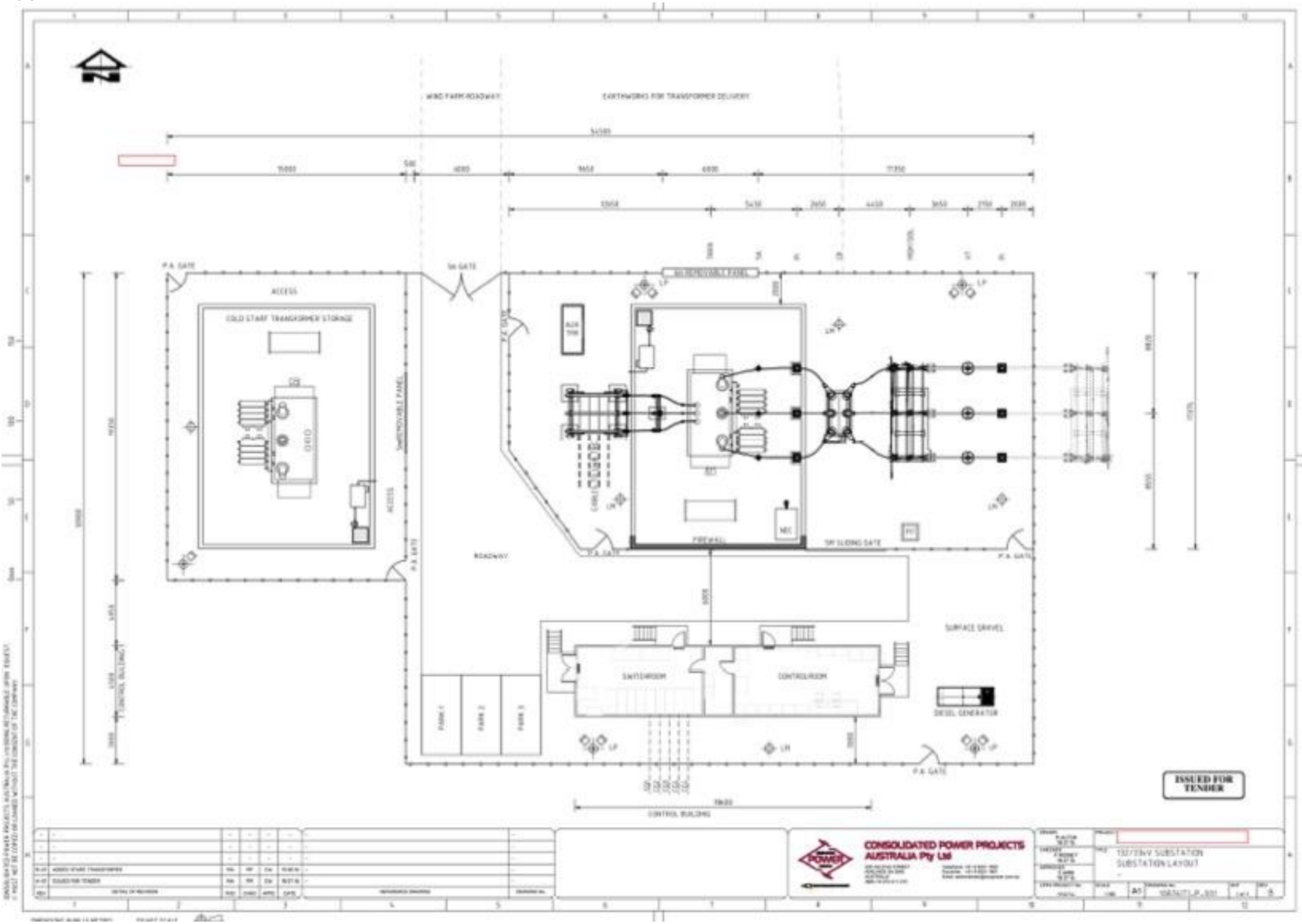


Figure 6: Indicative Foundation Design

Appendix 2 – Indicative Substation Plans



Appendix 3 – Existing Access and Culvert Photos

Figure 7: Site Entrance

Figure 8: Site Entrance

Figure 9: Existing Farm Track

Figure 10: Existing Farm Track - no Metalling

Figure 11: High quality Farm Metalled Track

Figure 12: Existing Access Road Showing Culvert

Figure 13: Existing Culvert

Figure 14: Existing Culvert

Figure 15: Main Access Track

Figure 16: Main Access Track - Uphill Section

Figure 17: Main Access Track

Figure 18: Road Layout Process – Note Alignment Markers

Figure 19: Road Layout Process – Note Alignment Markers

Appendix 4 – Site Fencing

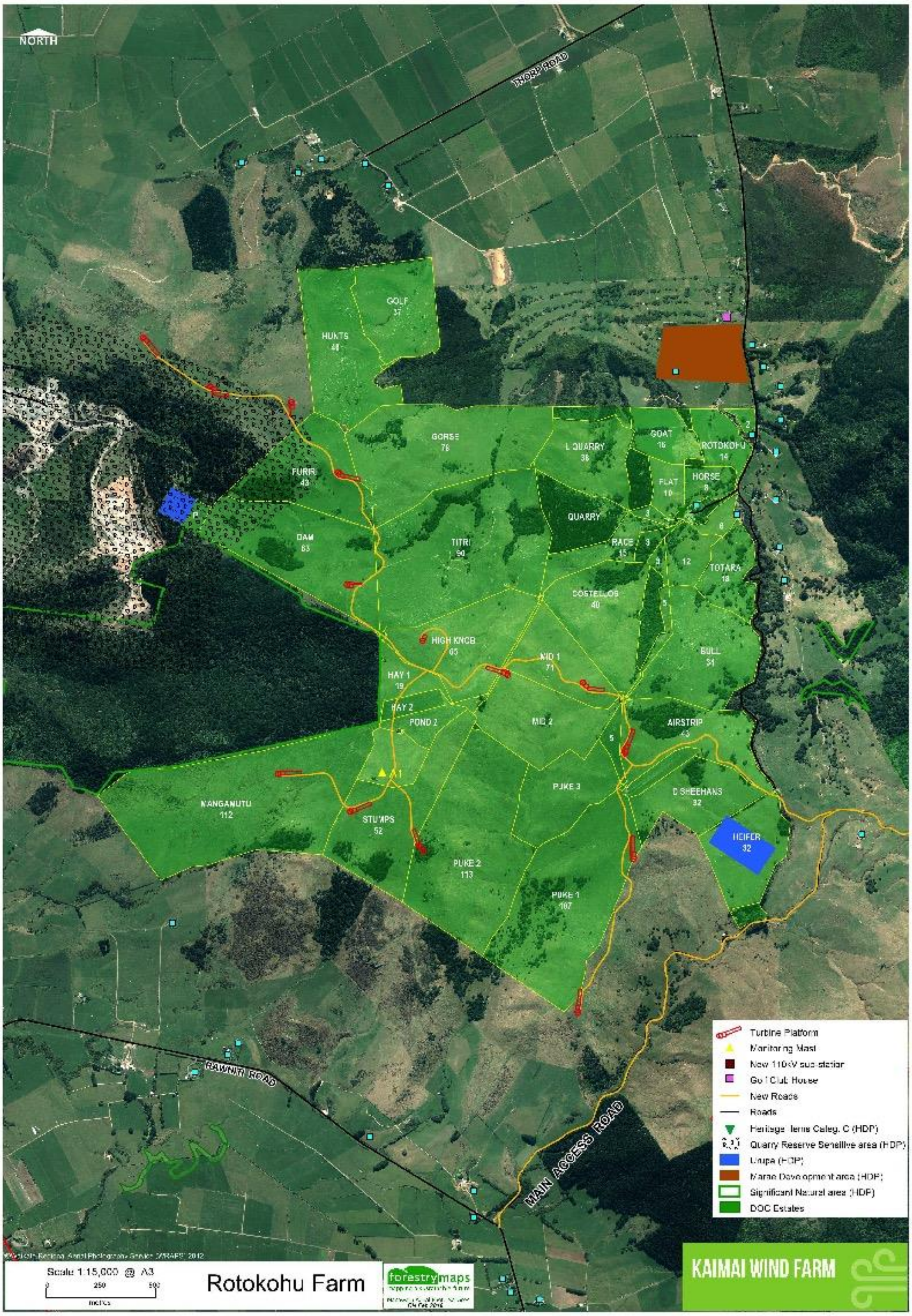


Figure 20: Fencing Layout

Appendix 5 - Typical Culvert Arrangement

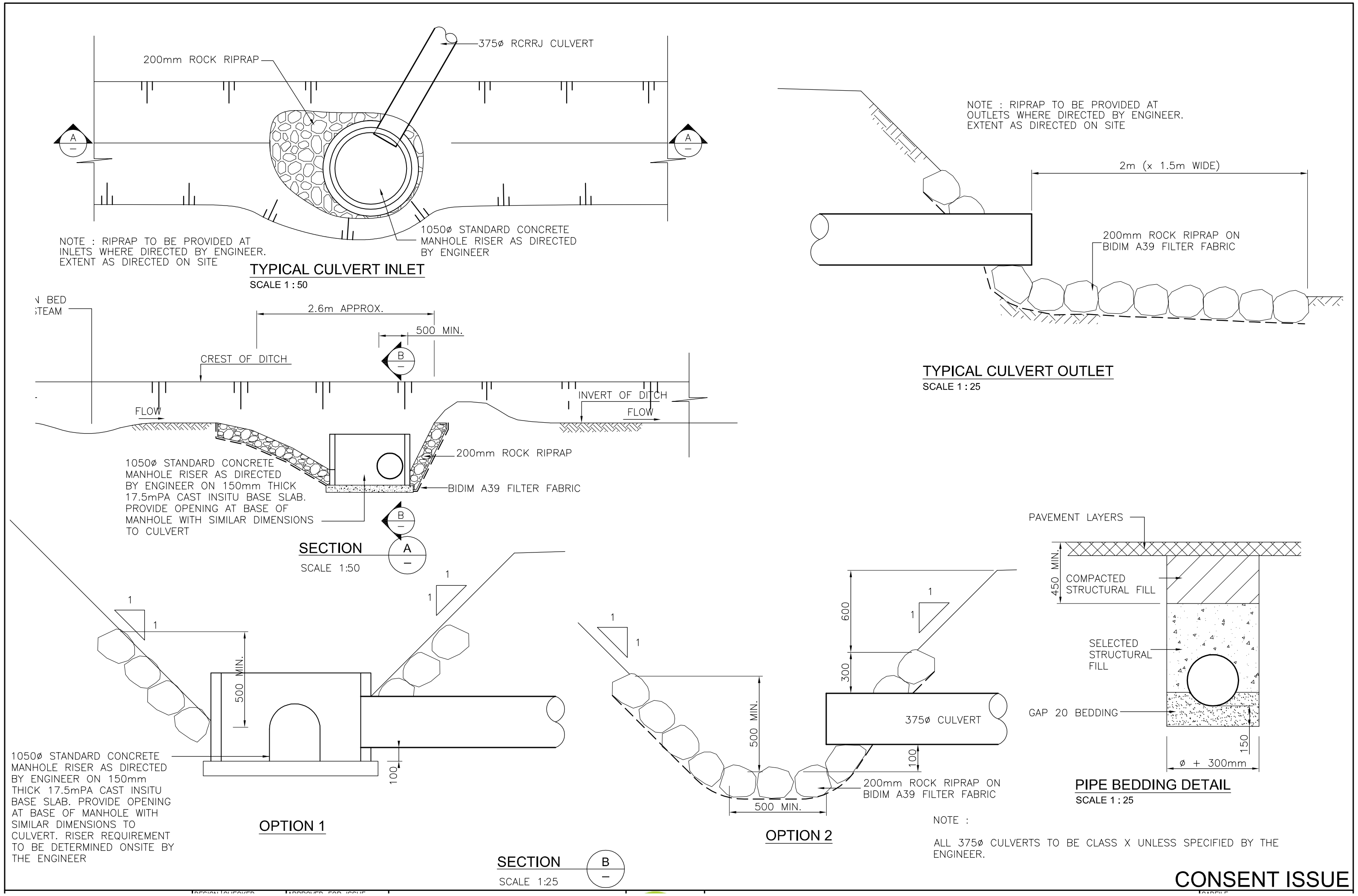


Figure 21: Culvert Design

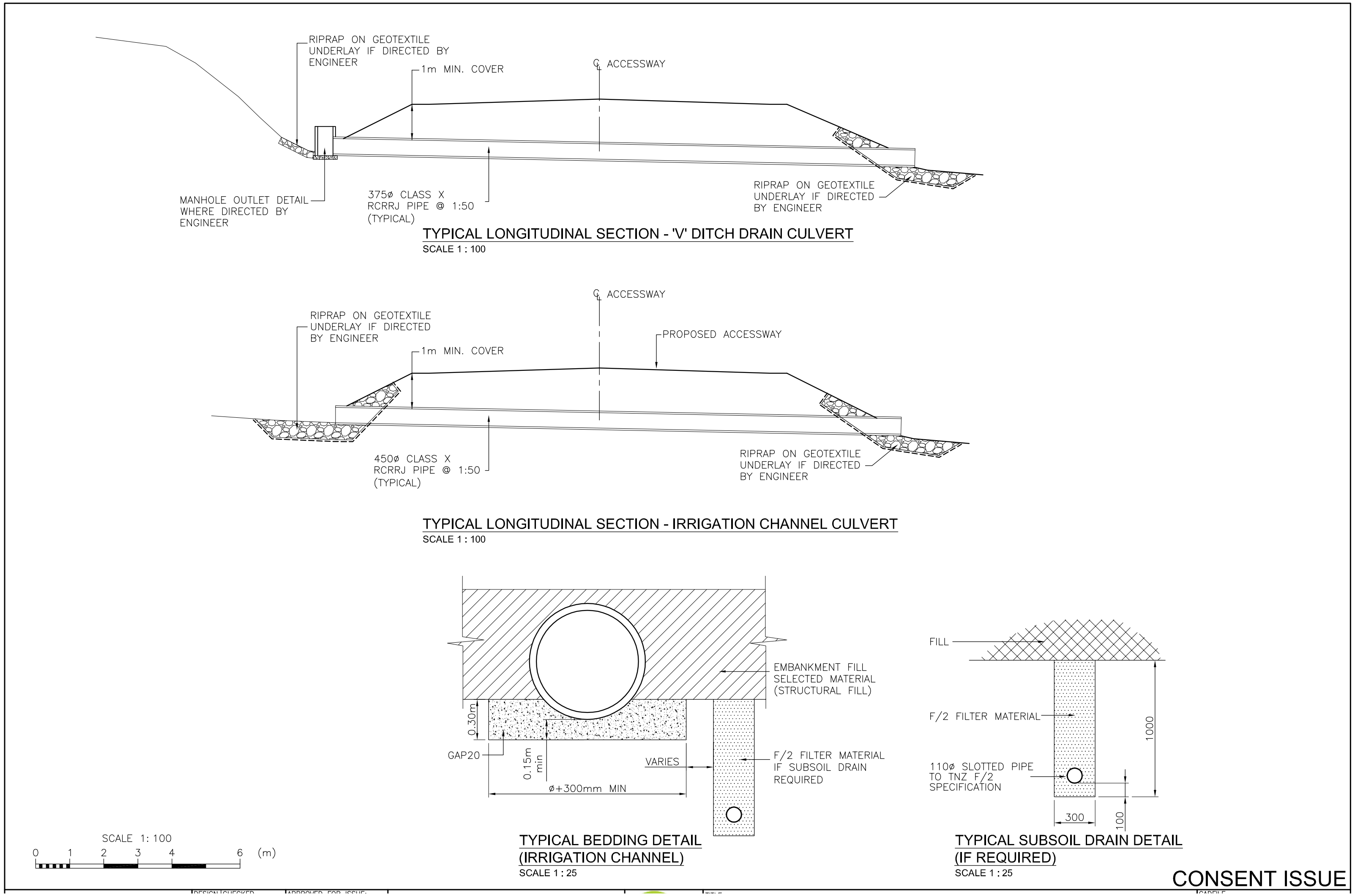


Figure 22: Culvert Design

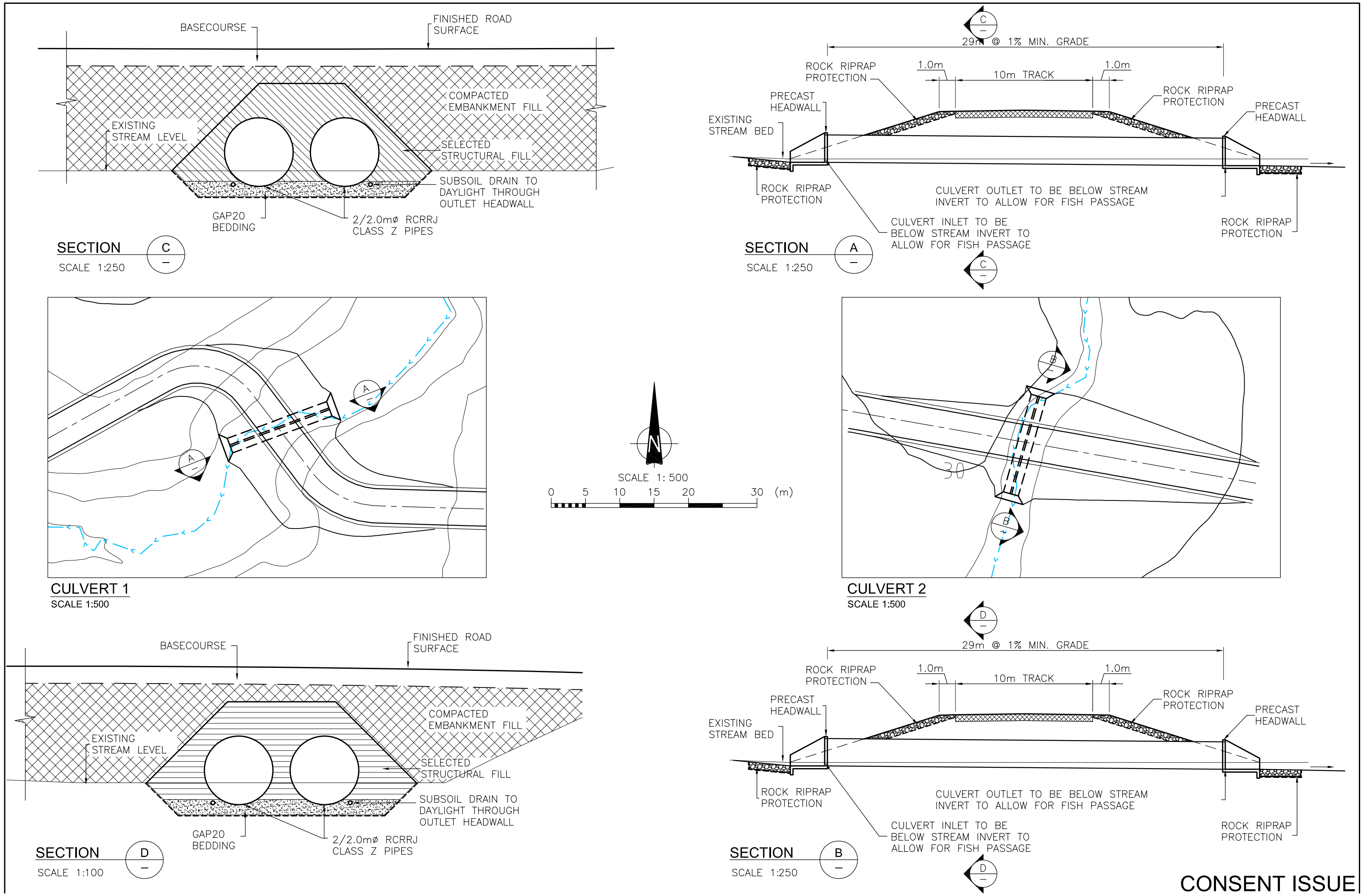


Figure 23: Culvert Design

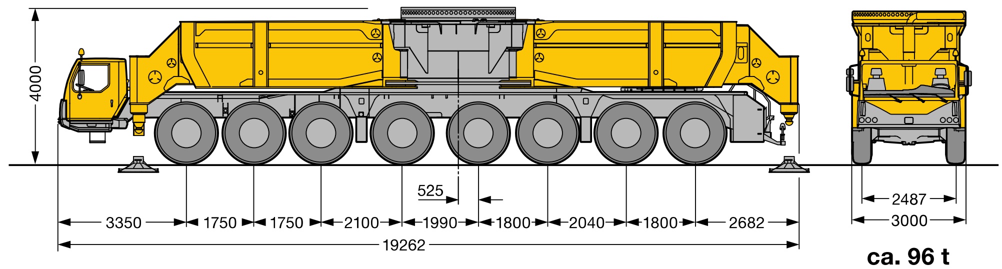
Appendix 6 - Heavy Traffic Movements

Heavy Traffic Movements							
Foundations (goldwind foundatic							
	No.	Volume (m3)			Truck volume (m3 or t)		
Concrete	24	550	13200		6	2200	
		(t)					
Steel	24	38	912		10	91.2	
		(t)					
Conduit, bolts, earthing e	24	5	120		10	12	
Total							2303
Electrical							
	no.						
Transformers - individual	24					24	
	no.						
Transformers - main	1					1	
	km	km/roll	rolls				
Cable	19	0.5	38			38	
Switchgear - sub station						5	
		components					
Cable Layer	1	5	5			10	
	m	m2					
Backfill (thermal grading)	18900	0.3	5670		12	472.5	
	Building:	parts					
Buildings - Sub Station	2	2	4			4	
Switchgear - turbines						10	
33kV overhead Line - poles and wire						10	
							575
Crane							
Crane body, counterweights etc						10	
Minor Crane						3	
							13
Earthmoving and Aggregate							
	m	m2	m3				
Finishing Grade to roads	18900	2.8	52,920		12	4410	
	Units	Seasons					
Excavators, trucks, bulld:	75	2	150			150	
							4560
Turbines							
Blades	24	3	72			72	
Nacelle	24	2	48			48	
Towers	24	4	96			96	
Hub	24	1	24			24	
Miscellaneous	24	2	48			48	
							288
Various							
Conduit, Fixings, Piles, Pipes, Tools, etc etc						50	
							50
Total							7789
Contingency	1.1						**8568**

Table 1: Key Quantities and Movements

Appendix 7 – Main Crane Specifications

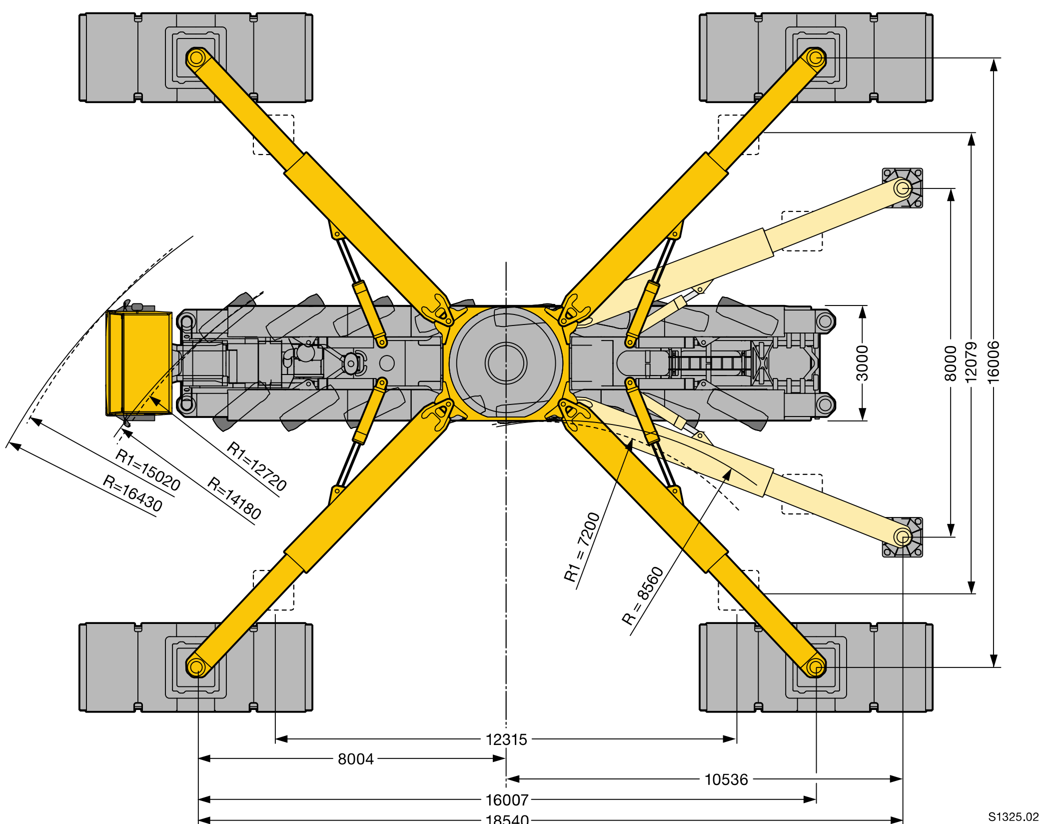
Maße
Dimensions
Encombrement • Dimensioni
Dimensiones • Габариты крана



ca. 96 t

Bei Straßenfahrt hintere Klappholme 300 mm ausgefahren.
On-road travel rear outriggers 300 mm extended.
Pour déplacement sur route sortir les poutres de calage arrières de 300 mm.

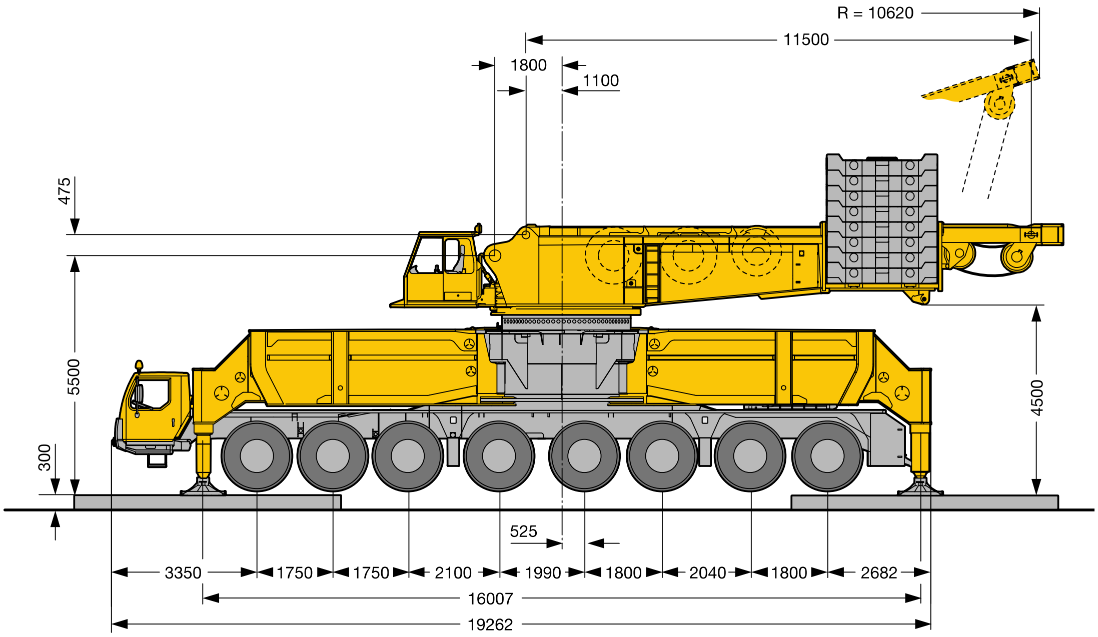
Durante la movimentazione su strada i travi stabilizzatori posteriori arrivano fino a 300 mm.
Para circular en carretera los largueros de apoyo traseros deben de estar extraidos 300 mm.
В транспортном положении задние опорные балки выдвинуты на 300 мм.

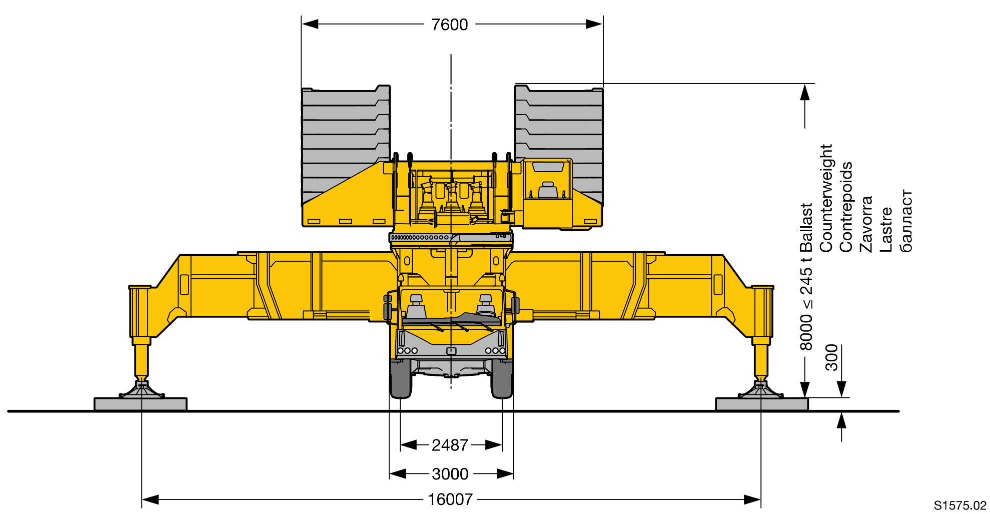


R_1 = Allradlenkung · All-wheel steering · Direction toutes roues · Tutti gli assi sterzanti · Dirección en todos los ejes · Поворот всеми колесами

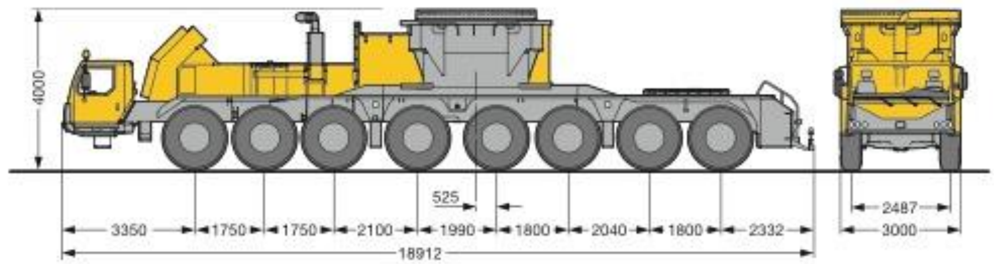
Achse · Axle Essieu · Asse Eje · мост	1	2	3	4	5	6	7	8	Gesamtgewicht t · Total weight t Poids t · Peso totale t Peso t · Вес т
t	12	12	12	12	12	12	12	12	96 t

Maße
Dimensions
Encombrement • Dimensioni
Dimensiones • Габариты крана

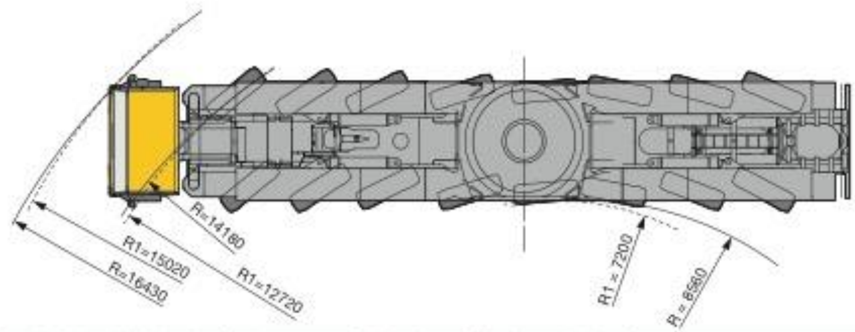




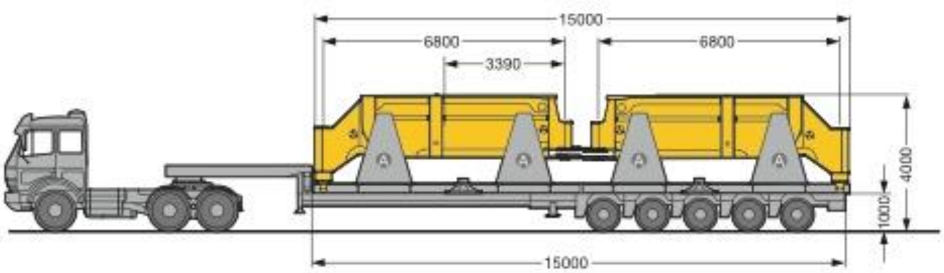
Maße
Dimensions
Encombrement • Dimensioni
Dimensiones • Габариты крана



ca. 48 t

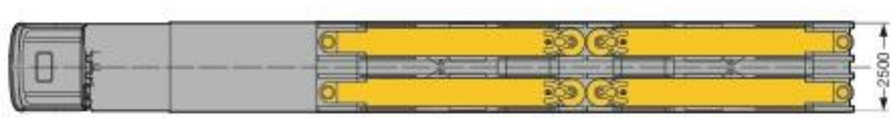


R_1 = Allradlenkung · All-wheel steering · Direction toutes roues · Tutti gli assi sterzanti · Dirección en todos los ejes · Поворот всеми колесами



Ⓐ = Nicht im Lieferumfang enthalten · not included in the scope of delivery · non compris dans le descriptif de livraison · non incluso nella fornitura
No incluido en volumen de entrega · не входит в объём поставки

4 x 12 t



S1326.01

Achse · Axle Essieu · Asse Eje · мост	1	2	3	4	5	6	7	8	Gesamtgewicht t · Total weight t Poids t · Peso totale t Peso t · Вес т
t	6,5	6,5	6,5	6,5	5,5	5,5	5,5	5,5	48

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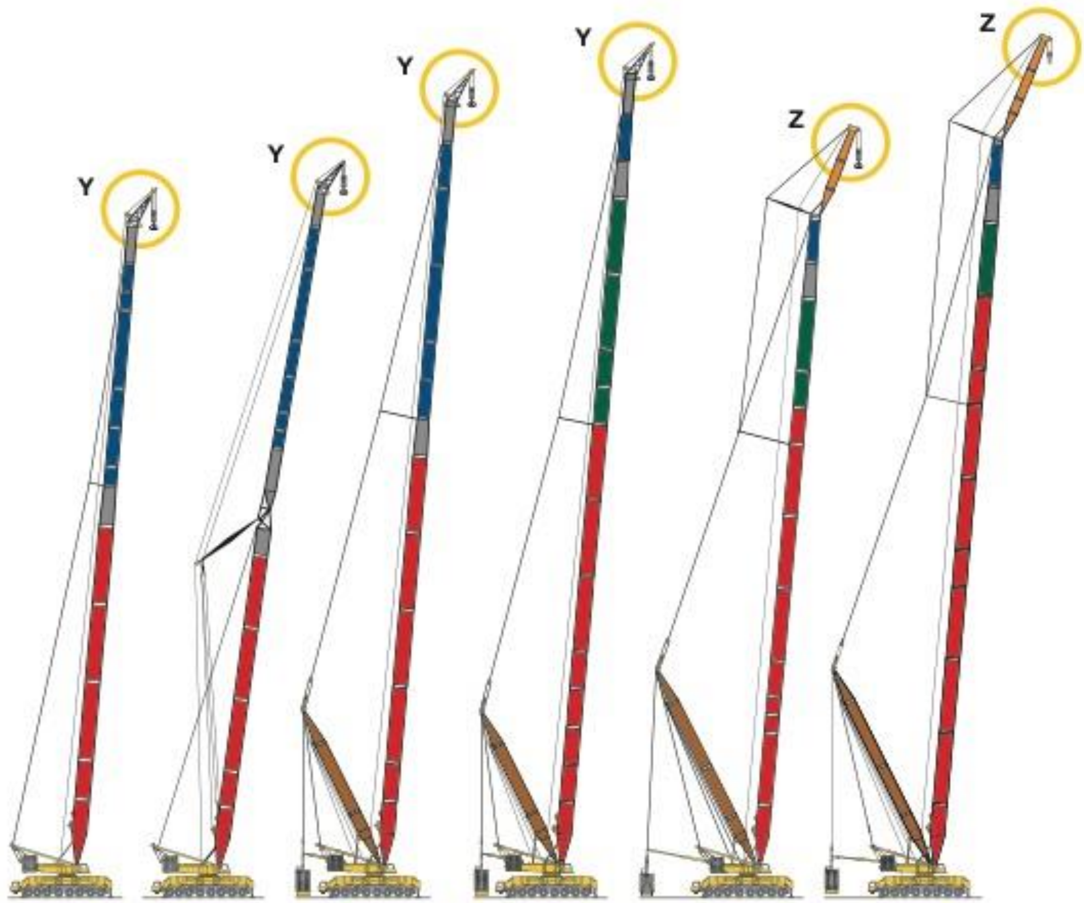
Auslegersysteme
Boom/jib combinations
Configurations de flèche · Sistema braccio
Sistemas de pluma · Стреловые системы



SL8HS	SLK	SL8DHS	SL7DHS	SL9D2FB	SL12D2FB
SL 70 m – 115 m HS 6 m	SLK 108,5 m – 133 m	S 105 m -140 m D 31,5 m HS 6 m	S 105 m -147 m D 31,5 m HS 6 m	SL 119 m - 136 m F 12 m - 18 m D 42 m	SL 112 m - 140 m F 12 m - 21 m D 42 m
70 – 72	73 – 74	75 – 76	77 – 78	79 – 80	81 – 82

S1914.03

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