3. Project Description

This section of the EA provides a detailed description of the works associated with the construction and operation phases of the proposed Capital Wind Farm development, including the grid connection. The main components of the wind farm project will involve the installation of:

- 63 wind turbines located in three distinct groups
- a substation and a facilities building
- underground electrical and control cables
- sections of 33,000 volt overhead transmission line
- access tracks to turbine sites and substation
- four meteorological towers
- temporary construction facilities (including a site office, temporary and permanent meteorological masts, mobile concrete batch plant, quarry and crushing facility)

The project design is well advanced and its planning has been responsive to the outcomes of community consultation, environmental studies and tender analysis. It should be noted that the detail of the project may nevertheless vary slightly, as the design is refined following completion of site investigations, the planning reviews and conditions of approvals and confirmation of the process for the implementation stage. Subject to gaining development consent, the final design will be subject to further regulatory review as part of the Construction Certificate Approval process.

3.1 Wind Farm Layout

The wind farm spans about 10 kilometres from north to south and about 6 kilometres from east to west with the 63 wind turbines located in three distinct groups as shown in Figure 1.4 and outlined below.

Table 3.1 - Wind Farm Groups

Turbine Group	Number of Turbines	General Location	Access
Groses Hill	17	North-West Group adjacent Lake George	From West Leg Road off Taylors Creek Road
Hammonds Hill	29	Between Ellenden Group & Tarago Road	From Taylors Creek Road near 'Nardoo'
Ellenden	17	Western Group adjacent Lake George	Via Hammonds Hill Group
Substation	0	South of Hammonds Hill	From Tarago Road
Total	63		

The layout has been developed in conjunction with the turbine selection to take account of the following main technical and environmental considerations:

- to maximise the wind farm electrical output
- maintain turbine spacings to minimise turbulence and airflow interactions between turbines
- avoid locations with unacceptable impacts on the flora and fauna and Aboriginal heritage values of the site
- to reduce the wind farms visual impact
- achieve acceptable noise levels at adjacent residences
- accessibility in relation to the ability to deliver and construct large turbine components
- to achieve a wind farm scale required for project viability

It is considered that the proposed layout provides the optimum arrangement to address the above factors.

While the total extent of the installed wind farm will be dispersed over an area of about 12 square kilometres, the actual area occupied by wind turbine equipment is only about six hectares for the turbine footings and associated hard-stands required for the turbine construction. The substation involves an additional one to two hectares. The access tracks for the project require about 16 hectares, some of which involve upgrading of existing tracks.

The area associated with overhead lines and underground cables will still enable the current grazing activities to continue. Temporary construction facilities will be removed and land restored once the construction has been completed. The estimated footprint of the areas required for the component parts of the wind farm development are shown in Table 3.2.

Table 3.2 – Extent of the Development

Project component	Approximate Dimensions	Estimated Area (hectare)	
		Long Term	Temporary
Turbine footings (63)	Each 15 by 15 metres	1.5	0
Turbine assembly hardstand areas	Each 20 by 30 metres	4	2
Substation	160 by 70 metres	1.5	0
Facilities building	20 by 20 metres	Included with substation	
Access tracks – upgraded	5 metres wide by 33 km	16.5	26.4
33,000 volt underground cables	1 to 2m wide by 20 km	3	-
33,000 volt overhead line	12 kilometres by 20 metres	24	-
Temporary construction facilities			
Site Office	50 by 100 metres		0.75
Mobile Batch Plant (2)	70 by 70 metres		1
Quarry and crushing facility	100 by 100 metres		1.5
Totals		64	6

Note: Cable and overhead line routes may carry more than one circuit.

The details of each of the component parts of the development are described in the following sections and in the associated figures. An outline of the construction and operational phases of the development is also provided in Section 3.7. The expected time frame for the construction of the wind farm is about 8 months.

3.2 Wind Turbines

Each wind turbine will comprise several main component parts as described below. A schematic illustration of the proposed wind turbine proportions is shown in Figure 1.3.

Tower: The supporting structure will be a tapered steel tower fitted with internal ladder. Its height will be about 80 metres and its approximate diameter will be 4.5 metres at the base and 2.5 metres at the top. To facilitate its production and transport, the towers will be

manufactured in four sections which are assembled on-site. The tower will be installed on a stub section installed in the footing.

Footing: The tower will be located on a reinforced (octagonal) concrete footing with a diameter of about 15 metres and approximately 1.3 metres thick. The base of the footing will be about 2 to 3 metres below ground level and the area above it will be backfilled with soil and grassed. An alternative arrangement could involve the top of the footing at some sites being above ground where strong rock is encountered prior to the target depth being reached during excavation.

Turbine: Each turbine will be of the 3-bladed type with a blade diameter of 88 to 90 metres and a swept area of 6,082 – 6,363 m^2. The turbines will be able to rotate at about 15.5 revolutions per minute when operating. The blades will typically be constructed of fibre reinforced plastic resin and will be attached to a steel hub and shaft. Metallic conductors will be incorporated within the blades to conduct lightning strikes to earth. The turbine hub height will be about 80 metres above the ground.

Nacelle: The nacelle is the housing, constructed of steel and fibre reinforced plastic that is mounted on top of the tower. Its dimensions are about 6 metres long and about 3 metres in height. The nacelle encloses a gearbox, generator, motors, brakes, electronic components, wiring and hydraulic and lubricating oil systems. This cover protects the enclosed components from the various weather conditions and also provides noise damping for the mechanical and electrical parts.

Motors within the nacelle are used to turn the turbine to face the wind and to adjust the pitch of the turbine blades. Weather monitoring equipment located on the top of the nacelle will provide data on wind speed and direction for the automatic operation of the turbine. The generators typically generate electricity at 690 volts, which is raised to 33,000 volts by the generator transformer that will be located adjacent to the base of the tower on a concrete pad.

The turbines will be of the “upwind” design, which means that they will have a control system that faces the rotor into the wind such that the turbine is upwind of the supporting tower. It is proposed to finish the turbines and supporting structures with a matt white colour for the reasons described in Section 6 and Appendix C.

3.2.1 Wind Turbine Operation

A wind turbine converts wind energy into electrical energy. Wind blowing across the blades causes rotation of the rotor that is connected via a gearbox to a generator that produces the electrical output. The gearbox increases the rotation speed to about 1550 revolutions per minute. The output is generated at 690 volts which is then stepped up to 33,000 volts by the generator transformer to be located on a concrete pad near the base of the tower.

The wind turbines will be designed to operate automatically whenever wind conditions permit, i.e. when wind speeds are between 4 and 25 metres per second (Table 3.3). When wind speeds exceed the wind turbine cut-out speed (25 metres per second) the turbines will stop so as to prevent turbine damage. Additionally, no generation occurs below the start–up wind speed of 4 metres per second). The typical wind speeds for operation of the wind turbines selected for the Capital Wind Farm are shown in the Table 3.3.

Table 3. 3 - Indicative Wind Speeds for Turbine Operational Mode

Operating Stage	Wind Speed (metres/second)	Wind Speed (kilometres/hour)
Does not generate	Less than 4	Less than 14.4
Start-up wind speed	4	14.4
Rated wind speed	14	50.4
Cut-out wind speed	25	90
Does not generate	Greater than 25	Greater than 90
Survival wind speed	60	216

The turbine start-up and cut-out speeds may be varied to alter the turbine noise impacts. Depending on the results of post commissioning noise studies, the start-up wind speed may be increased for one or more turbines in the Groses Hill Group of turbines if required (Section 10.10). The assessment is based on variable speed turbines.

The wind turbines will have a rotation speed of about 15.5 revolutions per minute (i.e. each blade will rotate through 360^0 every 4 seconds).

While the wind farm is set for automatic operation, its size requires a small number of permanent staff to be located on site. These staff may be assisted by periodic site visits by inspection and maintenance specialists.

3.3 Electrical Works

The project electrical works, other than those incorporated in the wind turbine structures, will include generator transformers, underground cables, one or more overhead line(s), switchgear, earthing systems and a substation. Electrical works for the grid connection are outlined in section 3.7. The electrical works for the wind farm will involve:

- 63 padmount transformers, one at each turbine site
- about 20 kilometres of 33,000 volt underground cables
- about 20 kilometres of control cables
- about 12 kilometres of 33,000 volt overhead lines
- a 33,000 to 330,000 volt substation including a 160 MVA rated transformer
- 33,000 and 330,000 volt switchgear
- short sections of overhead 330,000 kV line and an additional steel lattice tower for grid connection
- control and communications equipment to be located in the facilities building

The generator voltage, nominally 690 volts, is increased to 33,000 volts by the generator transformer located close to the base of the turbine's supporting tower. The output from each of the turbine generator transformers will be directed to 33,000 volt underground cables that link turbines within each group. Underground cables and overhead transmission lines will be used to link the turbine groups to the substation. A schematic arrangement of the underground cables and the overhead line(s) is shown on Figure 3.1.

The component electrical works are described in the following sections.

3.3.1 Generator transformers

The generator (padmount) transformers will be located near the base of the towers on a small concrete slab. Their dimensions will be dependent on the supplier but will be of the order of 2.5 metres long by 3 metres wide and 2.2 metres high. Colour will be a low visibility shade of

green due to their low height and position in generally grassed paddocks. They may be oil filled or a dry type, depending on the turbine equipment supplier. If oil filled transformers are used, containment measures will be incorporated to prevent any oil loss reaching local watercourses.

3.3.2 Underground cables

Underground power cables will be used within each turbine group to connect each of the turbines and to transmit the generated output either direct to the substation or to an overhead line linking to the substation. The cable routes will be generally between turbines and where possible would be located alongside access tracks to minimise site disturbance. In practical terms this can be difficult to achieve in all cases. It is most economic for cables to be routed by the most direct route while tracks are required to be designed to suit local grades and provide sufficient curvature and width for vehicles of lengths up to 50 metres, which could require a less direct route. In some cases, two or more power cables will be placed side by side along the same route. Control cables that enable monitoring and control of turbine operation will be co-located in trenches for the power cables.

Cable routes between the turbine groups and the substation are shown on Figure 1.4. They have been developed based on a range of considerations such as minimising route length, the ease of excavation, ground stability and environmental sensitivities such as flora and fauna or heritage considerations.

The installation of buried earthing conductors and electrodes will also be required in the vicinity of the turbines, the facilities building and the substation.

3.3.3 Internal Overhead Transmission Line

About 12 kilometres of 33,000 volt overhead line is proposed to connect the Groses Hill Turbine Group and the substation. The output of the Ellenden and Hammonds Hill Groups may also be connected via this line to the substation.

The overhead 33,000 volt transmission line will be supported on either concrete or wood pole structures. The northern section is likely to be a single circuit line, while a double circuit may be used for the section of the overhead line between the Ellenden Group and the substation. Control cables would be strung on the poles of the internal 33,000 volt overhead line located between the Groses Hill Group and the substation. An overhead line is also proposed to connect the Hammonds Hill Group to the Substation. Use of trenching for an underground cable down the eastern side of the Hammonds Hill/Big Hill ridge is not favoured due to the steepness of the slope and instead it is proposed that part of the Hammonds Hill Group also be connected by the overhead line.

Each supporting structure for the 33,000 volt overhead line will involve a single wood or concrete pole. These poles may be about 18 metres in length with the basal 2.5 metres below ground. Spacing of poles will vary with topography but on average could be in the order of 100 metres apart. The conductors may be about 30 mm in diameter.

The general route of the 33,000 volt overhead line from the Groses Hill to the substation (see Figure 1.4) has been chosen for its low visual impact, to minimise clearing of trees and to avoid areas of archaeological sensitivity. Most of the line will not be visible from the closest public roads or neighbouring properties. The overhead line will involve significantly less ground disturbance than an underground cable system.

3.3.4 Substation

The proposed location of the substation is in a valley to the southeast of the Hammonds Hill Group of turbines and to the west of Dry Creek (Plate 3.1). The general location has been chosen after consideration of its proximity to the existing 330,000 volt overhead line, its low visibility from surrounding public viewpoints and to avoid an area of potential archaeological sensitivity. A low ridgeline to the south of the substation site will limit its visibility from the Tarago to Bungendore Road.

The substation access will require upgrade of an existing track from the Tarago to Bungendore Road, which will facilitate access for construction and ongoing operations and maintenance at the substation. A new access track will be constructed to connect the substation and Hammonds Hill Group of turbines.

In addition to the above considerations the final location of the substation and the arrangement for the connection to the existing 330,000 volt overhead line will be determined in conjunction with TransGrid. The construction arrangement could involve an additional steel lattice tower within or adjacent to the existing line, or smaller overhead structures.

The substation will occupy an area approximately 160 metres by 70 metres and will be surrounded by a 2 metre high security fence, surmounted by four strands of barbed wire. It will be divided into the 33,000 volt and 330,000 volt yards. The substation arrangement will include an array of busbars, circuit breakers, isolators and various voltage and current transformers as agreed with TransGrid. A buried earth grid will be installed within the substation area. The ground surface within the substation enclosure will be covered partly with crushed rock and partly by concrete slabs. The substation may include small buildings to house control equipment, switch gear, capacitors and batteries. A conceptual layout is shown in Figure 3.2.

A single transformer, nominally of about 135 MVA capacity, together with ancillary equipment will be located between the yards to step-up the voltage from 33,000 to 330,000 volts. As the transformer may contain in the order of 50,000 litres of oil, provision will be made in the design for primary and secondary containment of any oil that may leak or spill from the transformer or its associated components. This would be likely to involve a constructed bund around the transformer and a spill oil retention basin outside the substation compound.

3.3.5 Facilities Building

A facilities building approximately 20 metres by 20 metres will be constructed adjacent to the substation to house instrumentation, electrical and communications equipment, routine maintenance equipment and stores, a small work area and staff amenities.

The structure is proposed to be a slab on ground construction with steel frame, metal or brick walls and a sheet steel roof. It will be of sturdy construction, suitable for the weather conditions it will be exposed to and will be compatible with the rural environment. Roof drainage will be collected for domestic use. A septic system or composting toilet system that complies with the local Council requirements will be installed to treat the small amount of waste water produced.

3.4 Site Access Works

The general access to the project locality will be via the Goulburn to Tarago Road as described in Chapter 9. As the wind farm will comprise three separate turbine groups and the substation site there will be a number of access points as indicated in Table 3.4 and as shown on Figure 1.4.

Plate 3.1 – Substation Site and Existing 330,000 kV Transmission Line West of Dry Creek

Table 3.4 - Summary of Access to Wind Farm Site

Turbine Group	Primary Access	Entrance point	Provisions
Groses Hill	Taylors Creek Road, north end	South end of Western Leg off Taylors Creek Road	Minor road works, new entrance and access track
Hammonds Hill	Taylors Creek Road	3.6 km west of intersection with Tarago Bungendore Road, near Nardoo.	Upgrade entrance and Taylors Creek Road. New access tracks formed.
Ellenden	Via Hammonds Hill Group	As per Hammonds Hill	New access track between Hammonds Hill and Red Hill. Minor clearing and access track construction.
	Alternative via Currandooley,	Via Currandooley access road	Existing track. Bridges reviewed and road straightening in places.
Substation	Tarago/ Bungendore Road	3 km south of Mt Fairy Road intersection	Existing entrance upgraded. Dry Creek crossing upgraded.

The proposed entrances to the wind farm site from the public roads will be designed to allow long vehicles to enter and leave the site safely without disrupting local traffic. Preliminary discussions on the locations for entrances have been undertaken with landowners and Council and further consultation will be undertaken to confirm the final design. Aspects considered for safe access to site have included the location of the entrance, provision of signage and where necessary, use of escort vehicles to warn approaching vehicles. Once the wind farm is operational, a lockable gate will be installed at each entrance at a point set back from the road.

The on-site access tracks that are required for construction and ongoing operation of the wind farm will be unsealed formations, about 5 metres in width with suitable drainage. Construction of the access tracks will involve clearing of pasture and some clearing of trees, designed to ensure that grades are suitable, bends have sufficient radius and include drainage works as required. During construction an additional width of up to 10 metres will be required to allow a 'crawler' crane and oversize vehicles to travel between turbine sites. Following construction, the tracks will be reduced to a 5 metre width.

The proposed arrangement of tracks is shown in Figure 1.4, which includes existing tracks and new tracks. Parts of the existing tracks will require minor upgrades.

Tracks along each of the ridges will provide access to all turbine sites for construction, operation and maintenance. All grades will be designed to suit the proposed traffic and site conditions. The final locations of tracks will be determined based on design considerations, including grades, slope stability, erosion hazard, visibility and environmental constraints. Upgraded and new access tracks will improve access for the landowners around their properties.

A new section of access track is proposed between the Hammonds Hill Group and the Ellenden Group of turbines to enable delivery of plant and materials to the Ellenden Group by the shortest route. While there is an existing track, it winds through remnant woodland that would require some clearing and is moderately eroded. It is considered unsuitable for upgrading due to its location and greater environmental impact if upgraded.

A review of route options has identified a preferred route which minimises clearing and that uses the proposed track along the Hammonds Hill/Big Hill ridgeline and then leads north-west towards Governors Hill as shown on Figure 1.4. The final route has been determined in conjunction with an ecologist to ensure that any impact on the woodland is minimised.

Access to the substation site can be gained using an existing track. The track requires upgrading, removal of three trees near the Bungendore Road, some trimming of trees alongside the track and minor earthworks to upgrade the crossing of Dry Creek. None of the oversize vehicles transporting turbine equipment will access the site via this route. A minor track will link the substation site and the Hammonds Hill Group. This track will not be used for delivery of large equipment but can be used for access by operations and maintenance staff.

Some additional temporary tracks may also be required for construction of the overhead transmission line, cable routes and for access to any erosion control sites. The erosion control sites will enable the beneficial utilisation of any excess rock excavated from turbine footings and will be chosen based on availability of excess material, the need for erosion repair, and minimising the distance for material transport.

Several sections of access track will need to be benched into the sides of steep slopes and will require suitable batters that will require stabilisation to prevent erosion.

Overall, every effort will be made to ensure that access tracks are:

- minimised in length
- located along the routes of existing tracks where possible
- located where clearing of vegetation is minimised
- constructed with due regard to erosion, sediment control and drainage
- positioned and designed, as far as possible, to reduce visual impacts
- if not required for the ongoing operation and maintenance of the works, removed and revegetated on completion of the construction phase

3.5 Utility Services

The proposed development will be connected to TransGrid's existing 330,000 volt transmission system.

A telephone connection to the proposed facilities building, involving multiple telephone lines will be provided to enable remote monitoring and control of the wind farm. Mobile phone coverage is available on most of the ridges but is limited in the valleys. While the wind farm will not rely on this form of communication, it is expected that construction teams will use mobile phones and radios.

Water will be provided to the proposed facilities building from a storage tank that will collect roof drainage. An approved septic system or composting system will be installed to treat the minor quantities of waste water. The proponent will be responsible for removal of all other wastes from the site.
A radio link may also be installed for the substation communications.

3.6 Ongoing Wind Monitoring

Renewable Power Ventures has two guyed wind monitoring towers on site, located as indicated in Table 3.5. The locations of the two existing on-site monitoring towers are shown on Figure 1.4.

Table 3.5 - Details of Wind Monitoring at the site

Tower	Approx. Location	Height (m)
Sunnybrook	2 kilometres south of Groses Hill	65
Hammonds Hill	600 metres south of Hammonds Hill	80

In order to monitor the ongoing performance of the wind turbines and comply with future wind forecasting and dispatch requirements, it will be necessary to replace the existing wind monitoring towers with four 80m wind-monitoring towers. Construction of each monitoring tower involves constructing four small footings, erecting the monitoring mast and installing instruments. The towers do not require an external power supply.

Temporary wind monitoring towers will also be established for site calibration purposes at four to six sites prior to turbine construction, and will be removed as construction commences at the respective sites. The locations of the permanent wind monitoring towers are shown in Table 3.6 below.

Table 3.6 – Locations of Proposed Permanent Wind Monitoring Towers

Tower status	Tower Number	Location (MGA)	
		Easting	Northing
Permanent Monitoring Tower	Site 1	725556	6113259
	Site 2	724879	6108639
	Site 3	728962	6113990
	Site 4	724821	6108454

3.7 Overview of Connection to the Electricity Grid

Renewable Power Ventures has identified the existing TransGrid 330,000 volt steel tower transmission line that passes to the south of the project area as being the only feasible connection for the Capital Wind Farm. The line runs between Canberra and Kangaroo Valley and its route at the wind farm locality is generally east-west and to the south of the Hammonds Hill Group of turbines as shown in Figure 1.4.

Consultation has been undertaken with TransGrid to determine the requirements for connecting to the existing 330,000 volt line. TransGrid has indicated that its existing 330,000 volt network has sufficient capacity to accept the output of the wind farm without augmentation.

A connection application has been submitted to TransGrid in accordance with Code requirements for connection into TransGrid's 330,000 volt line and a number of associated technical studies are being carried out.

3.7.1 Proposed Transmission Connection Works

The 330,000 volt yard of the substation could form part of modifications to the existing line that would be required to facilitate the grid connection. This would involve the existing line being routed through the substation's 330,000 volt yard via an arrangement to be agreed with TransGrid. The connection arrangement is likely to include busbars, circuit breakers, isolators, switching and protection devices and other necessary equipment.

If short sections of 330,000 volt overhead line are used to connect the existing line to the substation, then their location may be determined by the existing tower structure locations. Depending on the design, there could also be the need for new steel lattice tower structure(s) either within the existing line or between the existing line and the substation.

Connection to the electricity grid may require the existing Canberra to Kangaroo Valley 330,000 volt transmission line to be taken out of service for one or more short periods but the interruption is not expected to affect local customers, who receive their supply via the local distribution network. The connection will be carried out in accordance with TransGrid's normal procedures for maintenance works involving interruptions to supply.

3.7.3 Connection Approvals Process

Connection of the Capital Wind Farm to the grid at 330,000 volts is considered here as an integral part of the development activities and is assessed in conjunction with the Wind Farm Development Application under Part 3A of the EP&A Act 1979. TransGrid may also choose to undertake a separate assessment of the necessary transmission line works under Part 5 of the EP&A Act, 1979.

3.8 Wind Farm Development Phases

Provided that Development Consent and the associated approvals are obtained, the phases of the project indicated in Table 3.7 will be undertaken.

Table 3. 7 - Wind Farm Development Phases – Planning Approval to Operation

EA Section	Phase	Description	Approximate Duration
3.8.1	Pre Construction Planning and Construction Certificate Approval	Review of contract arrangements for civil works, equipment supply and electrical works. Submission of Construction Certificate Application, review and certification.	3 months
3.8.2	Construction	Establishment, access works, mobile concrete batching plant, foundation works, equipment delivery, erection of turbines and meteorological masts, Substation and facilities building, installation of underground cabling and overhead line. Wind Farm connection works	8 months
3.8.3	Commissioning	Connection to Grid. Performance assessment of equipment to ensure compliance with specification	2-3 months (partly overlapping construction)
3.8.4	Operation	Generation and supply of electricity to the grid	About 25 years
3.8.4	Maintenance	Monitoring of equipment, lubrication, cleaning, repairs, replacement of worn or broken parts, maintenance of access tracks.	Periodic and as required
3.8.5	Decommissioning or equipment replacement at the end of life (25 yrs)	Removal of equipment and restoration of site or, Replacement with newer equipment subject to any approvals required.	At completion of operating life of wind farm.

3.8.1 Pre-Construction Arrangements & Construction Certificate

Once approvals have been obtained, the final design and construction arrangements will, if necessary, be updated to address the consent conditions. This stage would also take account of geotechnical investigations, updated wind resource monitoring and revised energy modelling. However any changes at this stage would be expected to be minor.

The Project Environmental Management Plan (EMP) as outlined in Section 15 and the Statement of Commitments will be developed in accordance with the Department of Planning (DoP) Guideline for Preparation of Environmental Management Plans and will be finalised prior to construction. The Project EMP will be referenced by the Contractor for the required construction works and equipment supply to ensure compliance and achieve the project environmental objectives. Any Sub-Contractor will also be required to produce a specific Construction Environmental Management Plan to address management of its component of the project construction works.

A Construction Certificate application will be lodged with the Consent Authority. Some aspects of project design will be subject to review by approved certifiers.

3.8.2 Construction Activities

The construction of the wind farm will occur over a period of about 8 months. It will include activities such as site establishment, earthworks for access tracks and footings, erection of the 63 turbines and 4 permanent and 4-6 temporary meteorological towers, construction of the substation and one or two overhead 33,000 volt transmission line(s), and installation of underground cables. The latter stage of the construction will involve connection of the wind farm to the existing 330,000 volt transmission system via the substation and restoration of the site.

The construction works are likely to progress sequentially through the different turbine groups over the 8 month period. Section 3.9 provides details of the above construction activities and Section 15.2.1 addresses the management of construction environmental impacts.

3.8.3 Wind Farm Commissioning

Pre-commissioning checks will be carried out on the high voltage electrical equipment prior to connection to the TransGrid transmission network. When the wind farm's electrical system has been "back energised", the wind turbines will be commissioned and put into service. For construction purposes, the wind turbine array will be broken up into groups of about nine turbines, construction and commissioning of each group being undertaken consecutively. The wind farm's generating capacity will therefore progressively come 'on-stream' as each group of turbines is commissioned.

The commissioning process will include assessment of performance and compliance with the equipment specifications. The operation of the various components will be tested to ensure the wind farm's safe and reliable operation and equipment compliance with contract specifications and environmental requirements. Commissioning will commence after the substation and connection works have been largely completed so that the output can be progressively fed into the grid.

Due to progressive commissioning of the turbine groups, some turbines will be commissioned and operational while others are still being constructed.

3.8.4 Operation and Maintenance of the Wind Farm

Once commissioned, the wind farm will operate with a small on-site work force of eight (8) staff. Additional visits by other technical staff will be made where assistance is required for inspection and maintenance. Staffing will be managed to ensure continued safe and reliable operation. An Operational Environmental Management Plan will be implemented as outlined in Section 15.2.2.

3.8.5 Decommissioning or Replacement of Wind Turbine Equipment

At the end of its economic life the wind turbine equipment will either be replaced with comparable new equipment or the wind farm would be decommissioned. Decommissioning will involve dismantling and removal of the above-ground equipment and site rehabilitation. Access tracks may be retained depending on the landowner's wishes.

3.9 Construction Impacts

This section of the EA describes the works to be undertaken during the construction stage of the project, a brief introduction to their potential impacts and the management measures to be incorporated to mitigate them. Additional details of the potential impacts and their management are provided in the following sections dealing with the respective environmental issues.

3.9.1 Construction Activities

The construction phase of the proposed development would take approximately eight months. The actual duration of construction works may vary depending upon the scheduling of activities such as site access and any delays that may be encountered due to factors such as unfavourable weather conditions or supply of equipment or materials.

The principal activities involved in the construction phase will include the following:

- initiation of community notification/awareness program for construction activities
- site establishment (temporary facilities including site office, mobile batch plant, equipment storage areas and quarry and crushing facility)
- transport of people, equipment and materials to the site by local roads
- earthworks for:
    - access track construction
    - turbine and substation footing construction
    - cable trenches
- site office and batch plant
- quarry site and crushing plant
- erection of four permanent and four to six temporary wind monitoring towers and removal of the two existing towers
- erection of 63 turbines and supporting structures
- underground cable and generator transformer installation
- overhead 33,000 volt transmission line construction
- substation construction and testing
- construction of the facilities building
- grid connection works
- commissioning of the wind farm
- removal of temporary facilities and restoration of the site

The above activities are described in the following sections.

3.9.2 Community Construction Awareness Program

Prior to the commencement of the site construction activities, a program of community awareness initiatives will be implemented. Information will be disseminated to the local community by local newspapers and direct mail out to advise them of the nature of the construction activities, their timing and potential impacts. Contact details will be provided for individuals to gain further information or if required to express concerns or complaints.

Updates on the progress of construction works and relevant impacts will be provided during the construction period.

3.9.3 Site Establishment

The construction phase will involve up to about 50 staff working on the site at any time. Much of the work will take place outdoors at various locations on the site and the contractor will also require a temporary site office, storage facilities and two mobile concrete batching plants.

Site Office: The contractor's temporary site office will be located adjacent to Taylors Creek Road at the entrance to the Hammonds Hill Group. The site office may include several demountable buildings, an amenities block and portable pump-out toilet facilities which will be located on the site for the duration of construction work. A typical wind farm construction site office is shown in Plate 3.2. Arrangements will be made for power and communications at the main site office. Sufficient parking will be provided to allow for the expected usage.

One or more additional smaller temporary office facilities may also be constructed at locations distant from the main facility (Substation site, Ellenden and/or Groses Hill Group) to provide temporary shelter for workers and temporary storage areas at these locations, if required.

Construction staff will be accommodated away from the construction site and camping on site will not be permitted.

Mobile Concrete Batching Plant: Two mobile concrete batching plants will be used to produce the concrete required for the project. They will each occupy an area of approximately 50 by 50 metres and are likely to consist of a trailer mounted concrete mixer, cement bins, sand and aggregate stockpiles and a storage container for various equipment and tools. A typical batch plant is shown in Plate 3.3.

The batch plants will be powered by diesel generator and will each have a production capacity of approximately 50 m^3/hour. Due to the distribution of the turbine groups across the project area, the batching plant may be shifted as required between two or three sites during the construction period. The nominated sites are located, at the entrance to the Hammonds Hill Group near the site office, at the south end of West Leg Road near the Groses Hill Group and perhaps at a location to the east of the Ellenden Group (see Figure 1.4). Each site has been selected for convenience of access and distribution of the concrete, to be distant from neighbouring residences and to avoid areas of environmental sensitivity.

Plate 3.2 Typical Site Office and Storage Area

Plate 3.3 Typical Portable Concrete Batch Plant

Quarrying and Crushing Facility: A supply of road base material will be required for construction of access tracks to turbine sites and the substation. It is proposed that this be sourced from the properties on which the wind farm will be located. This will avoid the need for aggregate material to be transported to the site. Part of the road base requirement may be sourced from material extracted from turbine footings but the bulk is expected to be obtained from an on-site quarry.

The site proposed for quarrying of road base material is at the east of the Ellenden Group near Turbine 34 as shown on Figure 1.4 and has been selected due to the suitability of rock material at the site, proximity to where the material will be used, lack of environmental constraints and with landowner agreement.

3.9.4 Earthworks for Access Works

As discussed in Section 3.3, there will be three principal access points to the works. The northern part of Taylors Creek Road will provide a primary access. The West Leg off Taylors Creek Road will provide access to the Groses Hill group of turbines. The entrance to the Hammonds Hill and Ellenden Groups will be from Taylors Creek Road at a point about 3.6 kilometres west of the intersection with the Tarago to Bungendore Road. The substation will be accessed from the Tarago to Bungendore Road.

On-site access track construction will involve grading and removal of topsoil as required, to provide a 5 metre wide formation, placing and compacting of suitable gravel roadbase and the provision of minor drainage works. Some additional clearing may be required along access tracks to turbine sites to allow travel by a 'crawler' crane that may be up to 10 metres wide.

Due to the nature of the loads being delivered to the site, special consideration will be given to access track gradients and layout geometry to ensure safe access in and around the site for long, heavy vehicles. The maximum access track grade required for the type of vehicles involved is 12 degrees.

In designing the access tracks, particular attention will be given to the management of stormwater drainage to minimise erosion and sediment transport. The site works contractor will be required to formulate a site specific Erosion and Sediment Control Plan prior to any works commencing on site.

Excavated topsoil will be stockpiled during the construction of the access tracks and later used in the rehabilitation of the site. The stockpiles will be stabilised to prevent dust generation and loss of material. If necessary, the stockpiles will be situated in a sheltered location. Weed control measures will be incorporated in all earthworks and rehabilitation of disturbed areas.

At the conclusion of the construction phase tracks not required for subsequent operation and maintenance of the wind farm will be restored and revegetated.

3.9.5 Earthworks for Footing Construction

Whilst the detailed footing design is yet to be finalised, it is estimated that the excavation for each turbine footing will be approximately 15 metres by 15 metres and up to 2 to 3 metres deep. Excavation for the turbine footings will be carried out by mechanical equipment. Depending upon individual site geology, it can be necessary to use controlled low level blasting, but this will be avoided if possible. In these cases, a shallower excavation and a raised footing together with rock bolts can be used to provide a suitable footing.

Each footing will be a reinforced concrete pad poured against natural ground or formwork. The concrete pad will be about 1 to 1.5 metres thick and will be covered by soil and grass. It is expected that the concrete will be produced on-site and transported to each footing in conventional agitator trucks. This will avoid a large fleet of agitator trucks needing to use local roads during pouring of concrete. Despite this measure, some use of local roads may be required by agitator trucks over short periods.

Topsoil from the excavation will be stockpiled separately adjacent to the excavation. It will be used for backfilling over the constructed footing with the excess being evenly spread around the disturbed turbine site. Excavated material will be used to prepare a level hard stand area for the large crane required for erection of the turbine. Hard stand areas at the turbine sites will be retained to enable a crane to be brought back to site and for laying down turbine components, should maintenance be required. Any excess excavated material may be utilised elsewhere on the property (in consultation with the landowner) to rehabilitate existing areas of erosion. Rehabilitation of the disturbed areas will be undertaken at the completion of construction to prevent site erosion.

3.9.6 Earthworks for Underground Power and Control Cables

Where underground cables are installed, they will be buried in trenches, generally about one metre in depth to give a minimum cover of 0.75 metres. The width of the trenches for individual cables will be about 0.5 to 0.75 metres with power cables and control cables being installed in the same trench. In some cases two or more cables may be placed side by side requiring wider trenches.

The excavation methods will vary based on the rock types encountered. At this stage it is expected that the bulk of the trenching will be undertaken by a hydraulic rock breaker and excavator. The time that trenches are open will be minimised and they will be backfilled and compacted using excavated material.

Marker tapes will be placed above the buried cables at about 20 centimetres below ground level in accordance with the relevant standards to identify the presence of the cables if the areas were ever subject to excavation in the future. Marker posts will also be installed on the surface at regular intervals to indicate the presence of buried cables below.

Any surplus material will be distributed over the surrounding area to blend in with the natural landform and will be revegetated. All trenches will be installed and backfilled with due consideration to the site erosion and sediment control plan. In particular, where trenches are oriented down slopes, measures will be incorporated to slow stormwater flows and prevent scouring of the open trench or disturbed ground prior to re-establishment of grass cover.

Turbine Erection

Turbine erection will involve one or more large mobile cranes, together with the transport of large equipment components to the site in advance of erection. The component parts will be temporarily stored on assembly hard-stands at the turbine sites.

Details of typical component parts required for assembly of the wind turbines are listed in Table 3.8.

Table 3.8 – Details of Suzlon 2.1 MW Wind Turbine Components

Item	No. of parts per turbine	Total number of parts (63 turbines)	Approximate weight of each part (tonnes)	Approximate length of each part (m)
Tower	4 sections per tower	252	41	12 to 25
Nacelle	1 part	63	67	6
Turbine blades	3 blades	189	10	44

The turbine supporting towers will be bolted to a stub section embedded within the footings that will be constructed in advance of tower erection. The nacelles (housing the generating units) will also be delivered during this phase and lifted onto the towers using a large crane and secured.

It is generally possible to erect two of the towers and the nacelles in a single day.

The turbine blades are about 44 metres in length and weigh about ten tonnes. It is customary for the turbine blades to be assembled on the ground and then lifted by large crane and attached to the shaft housed within the nacelle. All lifting operations are dependent on favourable wind conditions and extended periods of unfavourable weather can extend construction times.

Following completion of the footings, the erection of each tower, nacelle and turbine may be completed over a relatively short time, or up to several weeks depending on suitable weather conditions occurring.

A hardstand area will be formed at each turbine site to provide a relatively flat bench that the large crane will be located on. As far as possible, the hardstand will be formed using material excavated from the footing. At some turbine sites there may be a need for minor earthworks to provide additional fill. Lay down and assembly space is also required for the component parts prior to them being lifted into place. This is additional to the area required for the crane. Most of the turbine sites for the Capital Wind Farm are relatively flat with sufficient space for the construction operations. However, several are constrained and may require special erection procedures.

The typical arrangement of the construction hardstand area required at each turbine site is shown in Figure 3.4. It includes provision for a main crane, a tailing crane and a component assembly area.

3.9.8 Overhead 33,000 Volt Transmission Line

An overhead 33,000 volt transmission line is proposed to link the Groses Hill and Ellenden Groups of the wind farm to the substation. The general route is shown in Figure 1.4. The final route will be selected in conjunction with detailed site assessment and engineering design. Where necessary, relevant specialists will be consulted to ensure that impacts are minimised. The construction of the line will involve excavation of footings for posts and stringing of the conductors.

3.9.9 Substation

Construction of the 33,000/330,000 volt substation will include the clearing and levelling of an area of about 160 by 70 metres, construction of footings, a concrete oil containment bund for the large transformer and installation of the necessary structures and component parts. Secondary containment at the substation is likely to involve an earth dam with underflow discharge. The secondary containment pond will be located down-slope of the substation and sized to enable capture of the full amount of oil that could be lost from the main transformer.

The transport of equipment from the main access road involves a relatively short length of access track, most of which already exists. The existing crossing of Dry Creek will require upgrading to enable delivery of the substation plant items. None of the oversize vehicles delivering turbine parts will access the site by this route.

Other aspects of the construction will include a surface layer of crushed rock approximately 120 millimetres thick and a buried “earth grid”. Lightning protection masts will also be installed.

3.9.10 Facilities Building and Equipment Storage Area

A facilities building will be constructed at the substation site. Preparation of footings will be done in conjunction with the substation construction. A septic system or composting system will be installed to treat the small amount of waste water produced within the building. The construction of the building will have relatively minor impacts that will be managed in conjunction with the substation construction.

In addition, an area will be included for the storage of spare parts.

3.9.11 Removal of Temporary Facilities and Restoration of the Site

Following construction and commissioning of the wind farm, the site will be restored by removal of contractor's facilities, including the batch plant and any wastes or surplus materials, removal and restoration of any temporary construction tracks and ongoing maintenance of any land stabilisation until adequate ground cover is established. Management of weeds in the disturbed areas will be integrated with the site restoration.

3.10 Environmental Management of Construction Impacts

Best practice environmental management requires that the environmental issues associated with construction projects are identified and managed in accordance with an Environmental Management Plan (EMP). A project EMP will be developed that addresses the DoP Guideline for preparation of EMPs. The process for construction environmental management is described in Section 15.2.1.

The principal environmental issues typically associated with construction works for wind farm developments include:

- construction traffic management
- constraints on the location and extent of site earthworks
- soil and water management
- dust control for road construction and soil stockpiles
- management of quarrying activities and associated crushing plant
- management of issues associated with concrete batch plant
- construction noise controls
- fuel storage and handling
- waste storage, handling and disposal
- bush fire prevention
- coordination with property owners and effects on stock
- weed control and site restoration

Specific aspects of these issues are outlined in the following sections and the process for their management is outlined in Section 15.2.1.

3.10.1 Construction Traffic

The proposed access for the wind farm project has been described in Section 3.3. A comprehensive review of traffic issues is provided in Appendix I and summarised in Section 9 of the EA. Key points for management are outlined here.

During construction, traffic will be generated by the delivery of materials and equipment as well as by the construction workforce of about 50 persons going to and from the site on a daily basis. Table 9.1 provides a list of the types of vehicles involved in the construction stage. As shown in the table there will be over 8,000 one-way trips by trucks and about 9,000 one-way trips by cars over the construction period.

Some of the required equipment and materials will be delivered on trucks that are typically classified as, Overmass, Oversize or both. Such vehicles will require special permits and/or escorts to operate on public roads. Given the nature of such vehicles (up to 50m in length) some disruption to local traffic flows could be experienced on some sections of the roads surrounding the site especially where manoeuvrability is restrictive. The movement of vehicles will be timed to minimise their impact on local traffic.

On a regular daily basis, the majority of extra traffic movements will be due to employee traffic and involve cars and small commercial vehicles.

To minimise disruption to local traffic and ensure community safety, a Traffic Management Plan for the use of the public roads by construction vehicles will be prepared in consultation with the local Traffic Management Committee and implemented as part of project management.

The construction traffic generated by the project also has the potential to impact on the physical condition of the lesser standard local roads. The condition of the existing road and factors such as weather and time of year will most likely determine the extent of any damage. For Taylors Creek Road it is possible that damage may result from the increased passage of heavy vehicles and that maintenance will be required during the construction period. An agreement is being negotiated between Palerang Council and the proponent for a significant contribution toward improvements to local road works.

Tracks within the site will be constructed and maintained to suit the type of vehicular traffic and the intensity of use during the construction stage. Erosion and sedimentation measures will be incorporated in the design of the tracks and the conduct of the earthworks. Clearing of vegetation will be minimised and, where necessary, an ecologist will be engaged to confirm the suitability of the final location of access tracks in sensitive parts of the site.

3.10.2 Constraints on the location and extent of Site Earthworks

The extent of the site works will be constrained to prevent excessive clearing and site disturbance and to ensure that identified areas of environmental or heritage sensitivity are not impacted. These constraints will be shown on construction plans and where warranted identified on the ground, by flagging, fencing or similar effective means.

3.10.3 Soil and Water Management Including Dust Control

A Soil and Water Management Plan (SWMP) will be prepared for the project in consultation with DoP and Department of Natural Resources (DNR). Requirements of the SWMP will be incorporated into the relevant earthworks. The contractors will be required to undertake the work in accordance with the SWMP and also to prepare their own detailed plans for erosion and sediment control relative to their works. They will also be required to implement and maintain the necessary procedures and measures to prevent and control any adverse effects. Approval of the contractors' detailed erosion and sediment control plans by the project owner or its representative will be a prerequisite to the commencement of contract works.

In general terms, the work will be designed to minimise land degradation and the contractor will be required to carry out the whole of the work to avoid erosion and sedimentation within the site, surrounding areas, watercourses and streams. Management of wind or rain erosion of soil stockpiles and bare soil and prevention of dust generation and sediment discharge will be incorporated in the SWMP. An outline of the soils at the site and erosion and sediment control measures is provided in Section 5.5.

3.10.4 Management of Construction Noise

Construction noise is addressed in Section 10 of the EA and Appendix H2. Noise sources will be associated with traffic movements, use of mobile plant and cranes on site, excavation of footings and trenches, operation of the concrete batch plant and quarrying and crushing activities. The noise at any location will be temporary and, in most cases, distant from surrounding residences. The impact of much of the construction on surrounding neighbours is therefore likely to be low. However, times of working will be limited to avoid noisy operations occurring outside day-time hours. There may be a need to undertake some activities outside normal daylight working hours due to practicalities of the specific tasks. Such tasks may include:

- Erection of towers and turbine structures during favourable low wind conditions in early morning or late evening
- Completion of concrete pour in a single day, but extending beyond normal working hours

Where there is a requirement to work outside normal hours consideration will be given to the distance from neighbouring residences and potential noise impact. Approval will be sought for such operations.

Consideration of vehicle noise impacts will also be addressed during the development of the Traffic Management Plan.

3.10.5 Excavation of Rock

Excavation of rock will be undertaken by earthmoving equipment or rock breakers. Should any controlled low level blasting be required, it will be undertaken in accordance with all relevant statutory requirements.

3.10.6 Fuel and Oil Storage and Handling

In the event of the contractor storing diesel fuel and/or oil on site, it will be stored in a suitably bunded area. Handling procedures will be defined in the project EMP.

3.10.7 Waste Management and Disposal

The principal wastes to be disposed of will consist of surplus topsoil, surplus excavated material, packaging material and general construction debris.

- Surplus topsoil will be spread on the site to blend in with the natural landform and will be revegetated
- Surplus excavated material will be disposed of on the relevant property at one or more locations as agreed with the property owner. Disposal sites will be finished with topsoil and revegetated. Where feasible, existing erosion areas will be selected for backfill and treatment.
- Subject to the Council's agreement, it is proposed to dispose of packaging material, general construction debris and all other waste at either the Queanbeyan or Goulburn waste disposal area. Where feasible, recyclable items such as waste oil will be separated and directed to an appropriate local facility. Any putrescible general waste material will be stored in sealed containers until it is removed from site.
- Disposal of sullage from any of the contractor's pump out toilet facilities will be to the local Tarago, Bungendore or Goulburn treatment plant or other suitable facility as agreed with the respective Councils.
- Any waste oil arising from equipment servicing will be stored in sealed containers in a covered and bunded area until it can be removed off site to a suitable waste oil facility.

3.10.8 Bush Fire Prevention

Measures to mitigate the risk of initiating bush fires will include the exclusive use of diesel fuel by construction vehicles, implementation of procedures for hot-work activities and adoption of response measures to control any incident. It is proposed that the Rural Fire Services be consulted in regard to the adequacy of the bushfire prevention measures for the project. The management of the bush fire risk is addressed in Section 12.5 of the EA.

3.10.9 Coordination with Property Owners

Renewable Power Ventures will consult with the respective landowners regarding the on-site impacts of the construction stage of the project. Some changes to normal grazing activities are expected but these are only likely to affect a relatively small part of the land at any one time and be a temporary impact.

3.10.10 Site Safety during Construction

The safety issues for the project are addressed in Chapter 12. In respect of construction, the main issues relate to the movement of oversize vehicles around the site, staff working at heights and the use of mobile plant. The safety of the workforce will be managed by the implementation of strict work procedures, good design of site tracks and regular maintenance. Access tracks will include adequate area for turning vehicles and areas to allow vehicles to pass safely.

In the event of accident, communication to ambulance or medical services will be by phone and/or radio.