3 Description of the Proposed Development

3.1 Introduction

3.1.1 The proposed Tom na Clach Wind Farm Extension (hereafter known as the 'Proposed Development') and the central grid reference for the site is 287153 (Easting), 834447 (Northing) and is largely located on Cawdor Estate. The existing access track for the Operational Scheme, which will be utilised for the Proposed Development, partly falls within Lethen Estate on the eastern side of the Proposed Development.

3.1.2 The Proposed Development site boundary lies approximately 7 km north-east of Tomatin and west of the B9007. It comprises upland moorland located adjacent to 'Tom nan Clach' hilltop in the immediate west, and immediately adjacent to Tom nan Clach Wind Farm (the 'Operational Scheme', see **Figure 3.1** showing interaction with the Proposed Development). Cawdor Estate is managed on a long-term basis primarily for forestry, agriculture, conservation and sustainability. The elevation of the Proposed Development ranges from 310 m to 550 m above ordnance datum (AOD). The site occupies an area of approximately 3.98 km^2, and the development site boundary is shown in **Figure 1.0** and the wider geographical context in **Figure 1.1**.

3.1.3 The application has been prepared under the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 for planning permission for a wind farm development comprising the erection of 7 wind turbines together with one temporary construction compound, one proposed borrow pit, permanent hard standings adjacent to the wind turbines for construction, access tracks, underground cables between turbines, an onsite substation, control building, maintenance building with welfare facilities and battery energy storage system (BESS).

3.1.4 The operational lifetime of 40 years from the first date of final commission. During construction, which would last approximately 14 months (see Section 3.4.1), a temporary construction compound will be required to house a site office and welfare facilities. Decommissioning will take approximately 6 months (see Section 3.8).

3.1.5 The purpose of the scheme is the generation of electricity which for the Proposed Development is based on 7 wind turbines. For the purpose of this planning application, we have assumed that the turbines will have a capacity of up to 4.5 MW (based on the Vestas V136 turbine), giving a total installed capacity of up to 31.5 MW.

3.1.6 This section of the EIA Report defines the development in detail and it is this description that has been assessed in the remainder of the scheme. The Applicant has identified the following scheme, including the mitigation measures outlined in each of the technical chapters, as the basis for the planning application.

3.2 Proposed Development layout

3.2.1 The layout of the Proposed Development is shown in **Figure 3.0** with the approximate centre of the turbine cluster located at 287153 (Easting) 834447

(Northing). Table 3.1 specifies the expected grid reference (Easting & Northing) for each of the proposed turbines and hub/tip height.

Table 3.1 Proposed Development Turbine grid reference

Turbine No.	X(East)	Y(North)	Hub Height	Tip Height
1	287046	835418	82m	149.9m
2	287546	835407	82m	149.9m
3	287203	834826	82m	149.9m
4	286951	834149	82m	149.9m
5	286341	833716	82m	149.9m
6	287624	834318	82m	149.9m
7	287070	833723	82m	149.9m

3.2.2 **Figure 3.1** also shows the possible locations of the infrastructure necessary for the wind development. In summary the following locations were identified:

- One main site compound E 287219 N 834937;
- One control building/substation/BESS at E 285844 N 834192; and
- One Borrow Pit at E 289581, N 835750.

Micro-siting

3.2.3 Current knowledge of the ground conditions at the Proposed Development is based on desk top studies and preliminary site investigations. These will need to be verified by more detailed pre-construction ground investigations which may result in minor adjustments to turbine locations due to environmental or technical constraints. The Applicant has used AutoCad Civil 3D Modelling to assist in the design and layout of the Proposed Development, to ensure deliverability. For this reason, an area of +/- 50m has been included surrounding the proposed turbine locations, this is referred to as micro-siting. The micro-siting area has been taken into consideration throughout the technical and environmental assessments completed as part of the EIA Report for the Proposed Development.

Wind turbines

3.2.4 A diagram of a typical wind turbine is shown in **Figure 3.2**. This is a typical horizontal axis wind turbine comprising four main components: a rotor (consisting of a hub and 3 blades), a nacelle (containing the generator and gearbox), to which the rotor is mounted, a tower and a foundation. The specific choice of turbine will be subject to tender, based on commercial and technical criteria. The chosen turbine will have a maximum blade tip height of 149.9m.

3.2.5 The wind turbines will convert the kinetic energy of the wind into electrical energy, the air passing over the blades causing them to rotate. This low-speed rotational motion of the blades is converted into electrical energy using a generator located inside the nacelle.

3.2.6 A transformer then steps up the voltage to 33kV which is then fed into the control building via underground electrical cabling linking all of the turbine unit transformers. The turbine transformers will be located within the nacelle or tower of the turbine.

3.2.7 The electricity generated by the wind farm will be metered in the control building and fed into the electricity distribution network to which it is connected.

3.2.8 The turbine dimensions will vary depending on turbine selected. For the purposes of the EIA Report, the Vestas V136 (4.5 MW) was used as a reference wind turbine. A proposed tip height of 149.9m have been chosen (refer to Table 3.1, which also included proposed hub height). Blades will rotate at approximately 6.5 – 12.1 revolutions per minute (rpm), generating power for wind speeds between 3-28 m/s. At speeds greater than this, the turbine reduces power output by pitching the blades out of the wind to protect the turbine from damage caused by high wind speeds. These very high wind conditions usually prevail for only ~1% of the year.

On-site access tracks

3.2.9 A total of approximately 4km of new onsite access roads will be constructed. Owing to the size of some of the turbine components, all on-site access tracks will have to be a minimum of 5m wide with some additional localised bend widening to a maximum of approximately 13m.

3.2.10 The proposed alignment of access tracks, developed through desk, study has sought to:

- minimise the overall track length; and
- avoid identified constraints (areas of deep peat, waterbodies, ecological features etc.).

Crane hardstanding

3.2.11 Each wind turbine requires an area of hardstanding to be built adjacent to the turbine foundation. This provides a stable base on which to lay down turbine components ready for assembly and erection, and to site the cranes necessary to lift the tower sections, nacelle and rotor into place.

3.2.12 Surface vegetation and soil will be removed from the area of the crane pad and laid on the surrounding undisturbed vegetation until required for reinstatement. The area will then be covered with geo-grid overlain with compacted stone to approximately 600mm depth, dependent on ground conditions and load capacity.

3.2.13 The crane hardstanding will be left in place following construction in order to allow for the use of similar plant should major components need replacing during the operation of the wind farm. These could also be utilised during decommissioning at the end of the wind farm's life. The total area of hard standing at each turbine location, including the turbine foundations and the crane pad will be approximately 2000m^2. A diagram of a typical crane hardstanding is shown in **Figure 3.3**.

Construction

3.2.14 One main site compound will be constructed for the development site. An allowance of 100m x 150m for the compound has been considered. The location of the compound is shown in **Figure 3.0**. A diagram of a typical construction compound is shown in **Figure 3.4**.

3.2.15 Surface vegetation, peat and soil will be removed from the area of the compounds and laid on the surrounding undisturbed vegetation / kept in peat storage areas until required for reinstatement, post-construction. The area will then be overlain with compacted stone to approximately 600mm depth depending on ground conditions.

Control building, Compound and Welfare Facilities

3.2.16 The turbines will be connected through suitable switchgear to be installed in a control building on-site. The substation compound will comprise a hard standing with maximum dimensions of approximately 66m x 30m and a single storey building approximately 26m x 6m which will house switchgear, metering, protection and control equipment as well as welfare facilities. **Figure 3.5** provides an illustration of the control building and compound. The envisaged location of the control building and main site compound is shown in **Figure 3.0**.

Watercourse and service crossings

3.2.17 While every attempt has been made to avoid watercourse crossings, it was necessary for the on-site access tracks to cross local watercourses in order to reach the proposed wind turbine locations. Four watercourse crossings have been included in the Proposed Development design; they are shown on **Figure 13.6a**. Details of the proposed type of watercourse crossing are provided in Section 3.4.40.

Electrical connections on-site

3.2.18 The wind energy development will be connected into the national transmission system at 33kV. An application for connection to the Distribution Network Operator, SSE, has been submitted by the Applicant for the Proposed Development, and this will enable to project to connect to the local grid network. If required, the grid connection will be subject to a separate planning application and it is likely the proposed wayleave route will run in parallel to the existing electrical infrastructure which were built for the Operational Scheme (see **Figure 3.12**).

3.2.19 The connection point into the grid will be at the existing Boat of Garten substation via approximately 31km of underground cable from the on-site 33kV substation at the Proposed Development, as shown in **Figure 3.12**.

Borrow pits

3.2.20 The borrow pit used for the Operational Scheme is intended to be reopened for the Proposed Development. Geotechnical investigation works, carried out for the Operational Scheme, strongly suggest there is sufficient winnable material available here for the construction of the Proposed Development. The potential borrow pit location is shown in **Figure 3.1**. The estimated volume of material available from the borrow pit is identified in Table 3.5.

Wind turbine foundations

3.2.21 The wind turbines will be installed on foundations of stone and concrete. A diagram of a typical wind turbine foundation is shown in **Figure 3.6**.

3.2.22 Construction of turbine foundations will involve the excavation of soil and subsoil to expose the underlying load bearing strata or bedrock, any topsoil and other vegetation removed will be laid on the surrounding undisturbed vegetation until required for reinstatement.

Operational land take

3.2.23 The total operational land take (development footprint) is shown in Table 3.2 below.

Table 3.2 Footprint area by component

Component	**Area (ha)**
Tracks	2.9
Crane Pads/Turbine Base	43.1
Substation, Control Building and Compound (inc. BESS)	1.5
Borrow Pit	3.38
Temporary Construction Compound	1.5
Total Land Take	**52.38**

3.3 Site Access

Off-site highway access works and HGV delivery route

3.3.1 Due to the abnormal size and loading of wind turbine delivery vehicles, it is necessary to review the public highways that will provide access to the site to ensure they are suitable, and to identify any modifications required to facilitate access. The findings of a Route Survey Report (**Appendix 7.A**), discussed in more detail in **Chapter 7: Traffic & Transport**, was undertaken to review potential access routes and confirms the Vestas V136 turbine could be delivered to site subject to appropriate mitigation measures.

3.3.2 Based on the delivery route used for the Operational Scheme, the preferred option would be to transport the turbine components from North Longman Quay, Inverness Harbour, which is located over 85 km (by road network) south-east to the Proposed Development.

3.3.3 The proposed, utilising the same route for delivery for both the Operational Scheme, is as described:

- Exit Inverness Harbour and turn left onto Stadium Road;
- Join the A9 southbound via Longman Roundabout;
- Continue south on the A9 before turning left onto the A95;
- Continue south on the A9 before turning left onto the A95;
- Continue on the A95 to Granton on Spey where they will utilise the Inverallan Roundabout to complete a ‘U-turn’;
- Continue west on the A95 before turning right onto the A938;
- Continue west on the A938 before turning right onto the B9007;

- Continue north on the B9007 to the existing Tom nan Clach Wind Farm site entrance.

3.3.4 A more detailed study would be carried out by the turbine supplier should the proposed development be granted consent. As the turbine delivery vehicles are abnormal indivisible loads then a Special Order is required under The Road Vehicles (Authorisation of Special Types) (General) Order 2003.

3.3.5 The detailed off-site access requirements will be confirmed with Transport Scotland and The Highland Council's (THC) Highway Department once the exact access requirements are established. A Traffic Management Plan will be put in place to ensure safe operation and these will be established with the aforementioned authorities.

3.4 Construction of the wind energy development

Timetable of Events and Indicative Programme

3.4.1 The construction period for the wind energy development will be approximately 14 months in duration and will comprise the following activities:

- Remedial works to the public highway to accommodate turbine deliveries;
- Construction of off-site access track;
- Construction of borrow pits and sourcing of rock;
- Formation of site compound(s) including hard standing and temporary site office facilities;
- Construction of crane hard standing areas;
- Construction of new access tracks and passing places (as required), inter-linking the turbine locations and substation compound;
- Construction and upgrade of culverts under roads to facilitate drainage and maintain existing hydrology;
- Construction of bridges where required;
- Construction of turbine foundations;
- Construction of site control building and associated substation;
- Excavation of trenches and cable laying adjacent to site roads;
- Connection of on-site distribution and signal cables;
- Delivery and erection of wind turbines;
- Commissioning of site equipment; and
- Site restoration.

3.4.2 Where possible, operations will be carried out concurrently (thus minimising the overall length of the construction programme) although they will occur predominantly in the order listed. In addition, development will be phased such that, at different parts of the site, the civil engineering works will be continuing whilst wind turbines are being erected. Site restoration will be programmed and carried out to allow restoration of disturbed areas as early as possible and in a progressive manner.

3.4.3 Floating roads scheduling and construction will be constructed to take account of predicted settlement rates, with monitoring undertaken to ensure their stability.

3.4.4 An indicative programme for construction activities is shown in **Figure 3.7**. The starting date for construction activities is largely dependent upon the date that consent might be granted and grid availability; subsequently the programme will be influenced by constraints on the timing and duration of any mitigation measures confirmed in the individual technical chapters or by the planning decision.

3.4.5 The final length of the programme will be dependent on seasonal working and weather conditions. Summer months are favoured for construction due to longer periods of sunlight allowing longer (and safer) working days. Summer months are generally also drier which aids the construction progress and reduces the impact of site debris reaching the public highway (mud etc.), though wheel wash facilities will be installed at the main site entrance / exit points. Wet weather has the potential to complicate construction activities in peat, although these complications can be minimised through the use of 'stop rules'.

3.4.6 Weather, in particular wind, has a strong influence on the timing of construction activities. Crane activities are generally limited during strong winds (>9 m/s) and erection during these weather conditions may be avoided for safety reasons, the actual conditions will be reviewed as part of the crane lifting plan. During periods of cold weather (<4°C) concrete pouring of the turbine bases must consider cold weather effects, potentially prohibiting concrete pours.

General Considerations

3.4.7 The following sections describe the infrastructure and the outline construction methodologies proposed to be used and serve as a basis for completion of the technical assessments.

3.4.8 The Proposed Development will be constructed in accordance with documented ISO 14001 environmental management procedures which ensure compliance with applicable environmental legislation and best practice. Effective communication underpins the whole system of environmental management, ensuring appropriate information passes between the Applicant's staff and the consultants / contractors engaged. This ensures that environmental considerations are fully integrated into the management of the wind farm throughout construction, the operation and maintenance of the completed project and ultimately to decommissioning.

Construction Method Statement

3.4.9 THC will be required to approve a Construction Method Statement so that construction proceeds in accordance with the approved document. This chapter sets out the basis of the Applicant's approach to construction but it is anticipated that this chapter, other specialist chapters and consultation responses will inform the Construction Method. In turn the Applicant would bind the selected contractor to the terms of the Construction Method Statement.

3.4.10 A contractor's record in dealing with environmental issues will form a part of the criteria in selecting who is awarded the construction contract, and on its provision of evidence that it has incorporated all environmental requirements into its method statements, as well as its staffing and budgetary provisions. The developer will retain the services of specialist advisers, for example on archaeology, ecology and peat restoration, to be called on as required to advise on specific issues, including micro-siting. More detailed information on the role of such specialist advisors during construction is provided in the relevant technical sections, where appropriate.

3.4.11 The contract between the Applicant and the Contractor will specify the measures to be taken to reduce or mitigate the environmental impact of the construction process (as detailed in the technical chapters of this EIA Report). A copy of any conditions associated with the planning permission will be incorporated into the contract with the Contractors constructing the wind farm, and the Contractors will be required to adhere to these.

3.4.12 All of the general mitigation measures would be set out within a Construction Method Statement (CMS), which would be produced prior to the commencement of construction of the development. This CMS would set out how the development would be constructed and the additional mitigation commitments. These additional commitments would include both specific mitigation measures as well as proposals for monitoring and emergency procedures. Such emergency procedures would include a site-specific Pollution Incident Response Plan in order to prevent and mitigate damage to the environment caused by accidents such as spillages and fires.

3.4.13 The CMS would be prepared following the grant of consent and be subject to approval by the local authority in conjunction with relevant consultees for the attendant elements including the Construction and Decommissioning Environmental Management Plan (CDEMP). The CDEMP would incorporate the Pollution Prevention Plan (PPP), Drainage Management Plan (DMP), Traffic Management Plan (TMP), Site Waste Management Plan (SWMP), Stakeholder Management Plan (SMP) and Habitat Management Plan (HMP).

3.4.14 The CDEMP is proposed as the means to capture a diverse range of environmental management controls. Examples of the measures proposed and expected to be incorporated into the CDEMP include the adoption of best practice guidance; the appointment of an Environmental Clerk of Works (ECoW), or equivalent, to oversee correct implementation of agreed commitments; completion of a TMP presenting detailed access routes and delivery timings, car parking arrangements, temporary signage etc.; demarcation of working area following the micro-siting exercise with temporary fencing as required along with location specific method statements if habitat sensitivity is high; completion and implementation of a HMP (an outline HMP is included in **Appendix 11.E**); development of an infrastructure monitoring programme to identify any requirement for remedial work; exclusion of equipment from watercourses and, as far as possible from immediate riparian zone during watercourse crossing construction along with measures to minimise change in in-stream substrates.

3.4.15 The CMS would be submitted for agreement with the appropriate planning authorities and bodies such as SEPA prior to construction and development. In order to ensure that the CMS is being suitably adhered to by the appointed contractors, an independent and suitable qualified Owner's Engineer, who would also liaise with the various environmental, archaeological and other advisers who will have input into the project and would be employed during the construction phase of the project to monitor implementation and provide specialist advice.

Construction Working Practices

3.4.16 Contractors' working areas will be made available, and the location will be clearly delineated on site to ensure that no unnecessary disturbance is caused to any sensitive areas.

3.4.17 Particular attention will be given to the storage and use of fuels for the plant on site. Oil will be stored in accordance with the Water Environment (Controlled Activities) (Scotland) Regulations 2011. Drainage within the temporary site compound, where construction vehicles will park and where any diesel fuel will be stored, will be directed to an oil interceptor to prevent pollution if any spillage occurred. Storage of diesel fuel will be within a bunded area or self-bunded tank in accordance with the SEPA Pollution Prevention Guidelines. Standard construction working practices will be implemented during construction, and any maintenance works, in order to ensure adherence to CIRIA guidance and other current best practice, including the following SEPA pollution prevention guidance notes:

- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR);
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018 (CAR);
- Water Environment (Oil Storage) (Scotland) Regulations 2006; and
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) – A Practical Guide (2015).
- SEPA Engineering in the Water Environment Good Practice Guides available from https://www.sepa.org.uk/regulations/water/engineering/engineering-guidance/. This includes guidance on:
    - Bank Protection; Rivers and Lochs;
    - River Crossings;
    - Riparian Vegetation Management; and
    - Temporary Construction Methods.
- Good Practice During Windfarm Construction (Scottish Renewables, SNH, SEPA, Forestry Commission Scotland, Historic Environment Scotland, 2015);
- Forests and Water: UK Forestry Standard Guidelines (Forestry Commission, 2011);
- Constructed Tracks in the Scottish Uplands (SNH, 2015);
- Floating Roads on Peat (Forestry Commission Scotland and SNH, 2010); and
- Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Government 2017).

Construction Works and Delivery Times

3.4.18 For the purposes of this EIA Report, construction activities have been assumed to take place between 07:00 to 19:00 hours on week days and 07:00 to 13:00 on Saturdays. Quiet on-site working activities such as electrical commissioning have been assumed to extend outside the core working times, noted above, where required. No work on the site will be undertaken on Sundays.

3.4.19 Work outside these hours is not usual, though if it was required to meet specific demands (e.g. during foundation pours, or to undertake work which is highly weather dependent e.g. low wind speeds are needed for turbine tower erection), permission for short term extensions to these hours would be sought from the planning authority as required.

Dust and air quality

3.4.20 In the absence of appropriate mitigation there is the potential for an increase in dust during construction. However, dust control measures form a well-established and effective measure of control during the construction for wind farms. Given the adoption of the mitigation measures that are outlined below, it is not expected that the change in air quality in relation to dust will be significant. The main measures for managing dust that will be used where necessary are:

- Adequate dust suppression facilities will be used on site. This will include the provision of on-site water bowsers with sufficient capacity and range to dampen down all areas that may lead to dust escape;
- Any storage on site of aggregate or fine materials will be properly enclosed and screened so that dust escape from the site is avoided. Adequate sheeting will also be provided for the finer materials that are prone to 'wind whipping';
- Heavy Goods Vehicles (HGVs) entering and exiting the site will be fitted with adequate sheeting to totally cover any load carried that has the potential to be 'wind whipped' from the vehicle;
- Vehicles used on site will be regularly maintained; to minimise vehicle emissions and the risk of leaking of diesel or hydraulic fluids;
- Good housekeeping or 'clean up' arrangements will be employed so that the site is kept as clean as possible. There will be regular inspections of the working areas and immediate surrounding areas to ensure that any dust accumulation, litter or spillages are removed/cleaned up as soon as possible;
- Wheel wash facilities for vehicles entering and exiting the site will ensure that excavated materials do not leave the site. Such facilities will automatically clean the lower parts of HGVs by removing mud, clay, etc from the wheels and chassis in one drive-through operation. A water supply will be provided at the main site entrance/exit points should wheel-washing be necessary for vehicles exiting the site; and
- A site liaison person will investigate and take appropriate action where complaints or queries about construction issues arise.

Construction and operational wastes

3.4.21 Any topsoil material generated by excavation of foundations is expected to be re-used to encourage re-vegetation, re-used on the working areas or allocated for restoration purposes in cutover areas of the development site. Excavated material will (depending on type) be used to backfill excavations, re-used to encourage re-vegetation around the working areas and also for restoration. It is not expected that any material will be unsuitable for re-use in this way, though in the unlikely event that small amounts of such material arise they would be disposed off-site in line with relevant waste disposal regulations, most likely for re-use as an inert fill material.

3.4.22 Steps will be taken to minimise the extraction of peat as per the outline Peat Management Plan (PMP) described in Section 3.4.87 of this Chapter. The PMS will ensure that peat excavated during construction is safely and suitably re-used within the extent of the development site.

3.4.23 Construction waste is expected to be restricted to normal materials such as off cuts of timber, wire, fibreglass, cleaning cloths, paper and similar materials. These will be sorted and recycled if possible, or disposed of to an appropriately licensed landfill by the relevant contractor.

3.4.24 Operational waste will typically be restricted to very small volumes of normal materials associated with machinery repair and maintenance. All such materials will be disposed of by the maintenance contractors in line with normal waste disposal practices

Construction of wind turbine foundations

3.4.25 The wind turbines will be installed on foundations comprising stone and concrete; a typical turbine foundation is illustrated in **Figure 3.6**.

3.4.26 The load bearing strata or bedrock will be levelled off and blinded[1] prior to the in-situ casting of the steel-reinforced concrete slab that will be approximately 18m in diameter. The depth of the excavation will be approximately 3-4m, depending on the depth of the load bearing strata or bedrock, and the sides will be battered back to ensure that they remain stable during construction. Each foundation is made up from approximately 400m^3 of concrete.

3.4.27 On top of the slab, a concrete up-stand will then be cast, to which the turbine tower will later be bolted. The excavated area will be backfilled with compacted layers of graded material from the original excavation, and capped with topsoil. The exact details of each foundation will vary across the Proposed Development in response to the actual ground conditions encountered. A detailed ground investigation will be undertaken prior to construction to establish the requirement at each foundation.

3.4.28 Whilst the foundation excavation is open (typically for 1 to 2 months) it will need to be kept free of water to allow construction of the reinforced concrete base. Water ingress will potentially be from ground (from exposed faces), surface and rain water. The foundation excavation will be designed to be gravity draining, where local topographical conditions allow. If this is not possible, the excavation will be

[1] A process whereby a 50mm layer of low-grade concrete is placed directly onto the bedrock to provide a level and firm working base to support the foundation reinforcing cage.

dewatered by pumping. The discharges from dewatering operations will be subject to a method statement agreed with the on-site ecologist and SEPA. Where necessary, settling ponds, filter treatment facilities and buffer strips will be installed to remove sediment from pumped water. No water from foundation dewatering operations will be discharged directly into a watercourse.

Construction of crane hardstandings

3.4.29 Each wind turbine requires an area of hardstanding to be built adjacent to the turbine foundation. A soft, levelled area is also required adjacent to the hardstanding for assembly of turbine components. This arrangement provides a stable base on which to lay down turbine components ready for assembly and erection, and to site the two to three cranes necessary to lift the tower sections, nacelle and rotor into place.

3.4.30 The crane hardstanding will be left in place following construction in order to allow for the use of similar plant should major components need replacing during the operational lifetime of the Proposed Development. These could also be utilised during decommissioning. The total area of hard standing at each turbine location, including the turbine foundations and the crane pad will be approximately 2000m^2. Approximately a third of this area will be dressed back with peat to a depth of 0.5m and landscaped into the surrounding area upon completion of turbine erection. A typical crane hardstanding is illustrated in **Figure 3.3**.

3.4.31 Based on a fill depth of 800mm, an approximate total of 1210^3 of stone will be required per hardstanding.

3.4.32 The crane hardstanding may also be used for temporary offloading and storage of turbine elements until assembled and lifted into position. The storage of components may also occur at the site compound, dependent on weather conditions and access track construction progress at the time of delivery.

Wind turbine installation

3.4.33 The cranes to be used will be confirmed when the specific turbine type has been selected. However, it is anticipated that two teams will carry out turbine erection, each using either two road-going cranes (one of approximately 160 tonne capacity and one of 800 to 1,200 tonne capacity). The construction contractors would determine the actual cranes used, together with the exact programme and number of teams on site.

3.4.34 The methodology for turbine erection will depend on the crane supplier. Two common methods of blade installation exist: single blade lifts; or, full rotor assembly on the ground prior to lifting. Turbine manufacturers prefer the latter as it is quicker and does not require re-alignment of turbine components. The lay down area will accommodate components ready for assembly and erection and crane hard standings will provide a firm base for cranes used to erect the turbines. If a full rotor assembly is required to be carried out prior to lifting, then additional temporary supports would be required to be positioned under the hub and blades. Because of the uncertainty of support requirements (it varies by turbine manufacturer) exact details cannot be defined but may include creation of small areas of additional support areas built off the sides of the crane hardstanding area.

On-site tracks

3.4.35 Construction timing and design of access tracks can strongly influence the potential for effects on the freshwater environment. In terms of timing, operations during wetter periods of the year pose a significantly greater risk of causing erosion and siltation, which can be particularly severe following major rainfall or snowmelt events. Whilst there is no proposal to restrict construction during such periods, the awareness of the increased potential for effects to arise following precipitation will be captured within the CDEMP. In terms of design, the primary objectives that have informed the access tracks are:

- Requirements to maintain water flows across tracks and minimise disruption to the peat hydrology;
- Minimisation of peat spoil by routing tracks through areas of shallower peat where possible;
- Maintaining and/or improving stability of soft, unstable areas of peat;
- Serviceability requirements for construction and wind turbine delivery vehicles;
- Constructability considerations;
- Track length is kept to a minimum to reduce construction time, the requirement for roadstone and land take;
- Gradients are to be kept to less than 12% where possible to accommodate the requirements of delivery vehicles and also to allow construction plant to move safely around the Proposed Development; and
- Tracks are routed to avoid sensitive ecological and hydrological features.

3.4.36 The design of a particular length of site track will depend on local geological, topographical and drainage conditions. To achieve a track structure that meets the conditions encountered on the site, whilst meeting the primary track design objectives, three different designs have been developed (each with associated construction techniques) as summarised in **Table 3.3**.

Table 3.3 Track Construction Techniques

Design	Construction Method	Typical site conditions	Peat Depth (m)	Figure Number
Excavated Track	Excavated	Shallow areas of peat with steep cross slope - drainage conditions (road thickness estimated 450mm)	<1 m	3.8
Excavated Track	Excavated	Shallow areas of peat with shallow cross slope simple drainage conditions (road thickness estimated 450mm)	<1 m	3.8
Floating Track	Floating	Deep, flat, stable areas of peat (road thickness estimated 600mm)	≥1 m0	3.8

3.4.37 It is anticipated that approximately 4km of new on-site access track will be required for the Proposed Development to access the wind turbines, including turning heads. All new access tracks will be unpaved and constructed from material sourced onsite where possible. In addition, existing access tracks, constructed for the Operational Scheme, will be utilised.

3.4.38 Owing to the size of some of the turbine components, all on-site access tracks will have to be a minimum of 5m wide with some additional localised bend widening to a maximum of 13m. Temporary passing places (15m x 5m) will also be provided as required along with turning heads (10m length, 20m radius) to facilitate traffic movements. The location of the site access tracks is shown in **Figure 3.0** and typical track cross sections are shown in **Figure 3.8**.

3.4.39 As discussed above, the alignment of the onsite tracks has already been subject to initial on-site review and re-routeing to respond to readily identifiable constraints. The final decision on alignment and on the appropriate type of access track design to adopt for a particular length of track will be made by a team of engineers, geologists and the Environmental Clerk of Works (ECoW) in advance of construction, giving enough time to produce method statements and define working areas for discussion with SEPA prior to construction.

Watercourse and service crossings

3.4.40 Watercourse crossings have been avoided in the site layout where possible, but due to the number of watercourses on the site, and limitations regarding access locations, it is not possible for the Proposed Development to take place without watercourse crossings.

3.4.41 Two types of watercourse crossing are proposed for the Proposed Development: bridges and culverts. Further detail can be found in **Chapter 13: Hydrology Hydrogeology, Geology & Peat** (section 13.14.32). However, the use of each of these types of structure will be determined individually to minimise potential effects based on a site-specific assessment, which will account for topographic, hydrological and ecological attributes at each proposed crossing point. All watercourse crossings will be designed in accordance with the SEPA Good Practice Guide for the Construction of River Crossings and, where culverts are required, they will be designed in accordance with the CIRIA Culvert Design and Operation Guide. All river crossings will be designed to convey a 1 in 200 year return period flood event, and individually sized and designed to suit the specific requirements and constraints of its location. The following paragraphs discuss the currently identified water crossings and the anticipated crossing type. As noted above it is probable that additional crossings will be identified on site during construction, or the proposed crossings may change. All crossing points and methodologies will be agreed prior to construction.

Bridges

3.4.42 Bridges are the preferred solution for larger crossings due to their lesser hydrological and ecological effects, and are particularly suited to higher flow watercourses. Bridge construction is unlikely to interfere with the watercourse to the same extent as culvert construction and can be built over the existing alignment of the river without the need for diversion. Foundations will be required on both banks (down to a competent bearing stratum) in order to support the bridge deck. A typical bridge section is shown in **Figure 3.9**.

Culverts

3.4.43 Culverts could be used in locations where there are small but distinct channels with no clear topographic variability. The small size and channel capacity limit the hydrological and ecological benefits that a bridge would bring, while the lack of topographic variation would make bridge design unfeasible.

3.4.44 Where culverts are to be used, their design shall meet minimum requirements as set out in CIRIA Culvert Design and Operation Guide (C689). The size of the culvert will be determined by the design flow of the watercourse and its gradient at the point of crossing. Small circular culverts will be used where a small watercourse or stream needs to be crossed, where the river crossing is deemed to have low environmental sensitivity. A typical section is shown in **Figure 3.10**. The construction technique would be site specific.

3.4.45 When installing culverts in streams, they will be laid at the natural bed level and the same gradient, so as not to cause a barrier to fish movement. The riverbed will be reinstated through the length of the culvert to keep the watercourse flowing as naturally as possible. A mammal tunnel, if judged necessary by ecologists following further pre-construction surveys, will be provided so that no restriction is created to established animal movement routes.

Service crossings

3.4.46 There are no service crossings necessary on site as there is no underground plant equipment present within the site boundary.

Compound and welfare facilities

3.4.47 It is proposed that one temporary construction compound of approximate dimensions 100m x 150m will be constructed. A typical construction compound is shown in **Figure 3.4** and the location of the compound is shown on **Figure 3.0**.

3.4.48 Surface vegetation, peat and soil will be removed from the area of the construction compound and laid on the surrounding undisturbed vegetation or in peat storage areas until required for reinstatement post-construction. The area will then be overlain with geogrid materials covered with compacted stone to approximately 600mm depth depending on ground conditions.

3.4.49 Temporary cabins to be used for site offices and welfare facilities including toilets, drying rooms with provision for sealed waste and storage are proposed. Welfare facilities will be installed as required by the Construction (Design and Management) Regulations 2015. If possible, the site welfare facilities will utilise services already in existence i.e. Low voltage power, potable water and sewerage. If connection to local power is not possible a diesel generator (bunded to 110% diesel capacity) will be used to service the site facilities.

3.4.50 It is also anticipated that a small security area will be established at the junction to the public highway during the construction period as you enter the site. These will be manned to monitor the flow of traffic into and out of the site with a small (3m x 2.4m) security kiosk installed.

3.4.51 Where possible, water extraction for welfare facilities and wheel washing will be provided via mains water supply. Where a mains supply is not available, water will be provided by ground water extraction.

3.4.52 The temporary site compound area will be fully re-instated with peat displaced from elsewhere on site and landscaped to match the local topography.

Stone and concrete requirements and sourcing

3.4.53 Construction of site roads, hardstandings, foundations and compounds will require approximately 59,862 m^3 of rock. The figure provided is, at this stage, an estimate and will require further investigation for ground conditions and subject to a turbine tender procurement exercise after which the final turbine will be known. Table 3.4 provides a breakdown of the required rock volumes for each construction element of the wind farm. It is anticipated that all of the rock will be sourced from rock source areas (borrow pits) within the wind farm site. This has several distinct advantages over importing rock from external sources; it greatly reduces the number of stone wagons on the public highways, reduces haulage distances for stone haulage wagons and hence, reduces vehicle emissions.

Table 3.4 Summary of Rock Volumes Required during Construction

Infrastructure	**Total Rock Volume (m^3)**
Hardstandings and foundations	18,130
Tracks (new and upgraded)	30,432

Temporary construction compound	9,000
Substation/control building compound (inc. BESS)	2,300
Total Rock Volume	**59,862**

On-site rock source areas

3.4.54 The borrow pit used for the Operational Scheme is intended to be reopened for the Proposed Development. The potential borrow pit location is shown in **Figure 3.0**. The estimated volume of material available from the borrow pit is identified in **Table 3.5**.

3.4.55 It is important to note that the actual size of the borrow pit would comprise only a small fraction of the area shown. There is already proven, winnable material available here based on the investigation and extraction completed for the construction of the Operational Scheme, but the volume of this is yet to be fully determined.

Table 3.5 Estimated volumes of on-site rock available

Borrow Pit	Estimated Area Excavated (m^2)	Total Estimated Rock Volume (m^3)*
East	**300m x 150m**	**75,250**
Total Rock Volume		**75,250**

***assuming a borrow pit depth of 5m**

3.4.56 It is recognised that the borrow pits have the potential to give rise to a range of environmental effects, that will therefore need to be controlled. As noted above the extraction requirement at each location and thus potential for environmental effects cannot be confirmed until after detailed intrusive investigations are undertaken. Once these are completed a detailed plan for each borrow pit will be developed and agreed with key consultees (proposed to comprise THC, SEPA and NatureScot). The plan would address establishment, extraction and restoration phases with the management protocols for the borrow pits included in the CMS which is envisaged to be subject to an appropriate planning condition. Any quarrying activities will also follow the Approved Code of Practice, Health and Safety at Quarries Regulations 1999.

3.5.57 Nonetheless the typical effects and expected mitigation that can be anticipated to address effects may include:

- Traffic – The majority of traffic moving stone will use on-site access tracks. Any requirement to cross highways will be addressed through a Traffic Management Plan;

- Blasting – Effects from blasting will be controlled through use of relevant protocols, blast mats and through appropriate communication and publicity about blasting occurrence. Blasts at each borrow pit can be expected to be infrequent, and at substantial distance from residential receptors and are therefore not anticipated to be of any substantive concern, nor likely to give rise to nuisance nor significant effects;
- Noise / vibration – Potential effects arise from blasting itself as well as the use of excavation and stone crushing equipment. Use of appropriately silenced equipment, publicity over blasting, adherence to operational hours and the distance to residential receptors provide the main mitigation for such effects which are anticipated to be well within limits of acceptability established by guidance;
- Dust – Residential receptors are at considerable distance and thus no dust effects on them are expected. Some potential for dust to be deposited on adjacent vegetation exists and will be monitored by ecologists, with damping down of surfaces or use of mist sprays an appropriate and effective mitigation should any potential problems be identified;
- Visual intrusion – Construction effects will be discernible through the presence of construction machinery. Long term an appropriate restoration plan for the borrow pits will be developed in agreement with consultees (SEPA, NatureScot, THC) which is expected to include some regrading of the final profile and measures to encourage re-vegetation and potentially peat habitat restoration;
- Water - The potential for sediment laden water to be released will be controlled through appropriate design and treatment facilities at each borrow pit. Design will be specific to each location and where possible will encourage natural infiltration; and
- Wastes – Any waste arising will be handled as per other construction wastes.

Concrete batching plants

3.4.58 **Table 3.6** provides estimated volumes of concrete required for the installation of 7 wind turbines at the Proposed Development. The majority of the concrete used on site is required for turbine foundations with additional material for the substation and transformer (if required). This will be confirmed subject to a procurement process.

Table 3.6 Volume of Concrete

Infrastructure	Total Volume of Concrete (m^3)
7 Wind Turbine Foundations	4515
Substation/Control Building/BESS Foundations	500

Total Concrete Volume	**5,015**

3.4.59 Concrete may be sourced from local concrete suppliers or produced using materials won and processed on site at an on-site concrete batching plant.

3.4.60 Transportation of concrete from off-site locations would require 2041 loads assuming $6m^3$ wagons are used which could transport approximately 14.4 tonnes of material each. This would result in 5082 vehicle movements in total.

3.4.61 On site concrete batching would result in a significant reduction in the number of vehicle movements on the local road network. A suitable location on-site for the plant would be chosen taking noise nuisance into consideration.

Track drainage

3.4.62 The need for drainage on the access track network will be considered for all parts of the track network separately, since slope and wetness vary considerably across the site. In flat areas, drainage of floating tracks is not required as it can be assumed that rainfall on to the road will infiltrate to the ground beneath the tracks or along the verges. Track-side drainage will be avoided where possible, in order to prevent any local reductions in the water table or influences on the tracks structure and compression (the latter can occur where a lower water table reduces the ability of the peat to bear weight, increasing compression).

3.4.63 Where tracks are to be placed on slopes, lateral drainage will be installed on the upslope side of the track. The length of drains will be minimised, to prevent either pooling on the upslope side or, at the other extreme, creating long flow paths along which rapid runoff could occur. Regular cross-drains will be required to allow flow to pass across the track (as recommended in SEPA's guidance), with a preference for subsequent re-infiltration on the downslope side, rather than direct discharge to the drainage network.

Drainage ditches along excavated tracks

3.4.64 Excavated tracks cut off the natural drainage across it, therefore drainage ditches will be required. It is anticipated that at times the water in the ditches will contain high concentrations of sediment from excavations, track construction and possible other accidental pollutants from construction activities, therefore no water from a drainage ditch will be discharged directly to a watercourse. Instead it will pass through a sand filter, filter strip, silt trap or other best practice pollution control feature. Drains will not be ended directly into natural channels, ephemeral streams or old ditches.

3.4.65 The ditch design will be considered in line with the recommendations of the Forestry Civil Engineering (FCE) and NatureScot guidance, including the use of flat-bottomed ditches to reduce the depth of disturbance.

3.4.66 In instances of drainage close to surface watercourses, discharge from the drainage may be to surface water rather than re-infiltration. In these situations, best practice control measures including sediment settlement will be undertaken before the water is discharged into surface water systems. The discharges will be small and collect from only a limited area, rather than draining a large area to the same location.

3.4.67 Although drainage will be provided in areas of disturbance as required, areas of hardstanding will be minimised so that this need is reduced. This includes careful design of construction compounds, and minimising the size of crane pads at each turbine location.

Cross drainage

3.4.68 Where tracks are to be placed on slopes, lateral drainage will be required on the upslope side of the road. The length of drains should be minimised, to prevent either pooling on the upslope side or, at the other extreme, creating long flow paths along which rapid runoff could occur. Regular cross-drains will be required to allow flow to pass across the road (as recommended in SEPA's guidance), with a preference for subsequent re-infiltration on the downslope side, rather than direct discharge to the drainage network.

3.4.69 Cross-drainage may be achieved using culverts or pipes beneath the track, again in line with the FCE and SNH (2010) guidance. Drainage will be installed before or during track construction, rather than afterwards, to ensure that the track design is not compromised. The cross drainage will flow out in to shallow drainage, which will allow diffuse re-infiltration to the peat on the downslope side. The cross drains will flow out at ground level and not be hanging culverts: the avoidance of steep gradients for the tracks will also reduce the risk of erosion occurring at cross-drain outflows.

Check dams

3.4.70 Check dams (small dams built across channels or ditches) may be required at regular intervals in the drainage ditches alongside an excavated track. They are required for two principal reasons. Firstly, they act as a silt/pollution trap slowing the flow of water so allowing sediment to settle out. Secondly, they help to direct water into the cross drains and so allow natural drainage paths to be maintained as much as possible. The spacing of the check dams will depend on the following factors:

- The gradient of the track;
- The spacing of cross-drains; and
- The depth of excavation.

Interface between different types of road drainage

3.4.71 Where the track construction method changes, the drainage methods will also change. If this results in an end point for a drainage ditch, the ditch will be piped across the road and allowed to discharge to land on the down side of the slope taking into account the precautions against pollution and erosion discussed later in this chapter.

Fuel storage and refuelling activities

3.4.72 Fuel storage and refuelling activities have been identified as having potential effects that can be controlled by the implementation of pollution prevention and control measures and best practice by the site operator.

3.4.73 Fuel and oil may enter the groundwater by migration vertically into the underlying groundwater or runoff into nearby surface waters if accidently released or spilled during storage and refuelling. In order to minimise potential releases into the water environment, fuel will be stored in either a bunded area, self-bunded Above Ground Storage Tank (AGST) on site during the course of the construction phase in accordance with the Prevention of Pollution (Oil) Storage Regulations 2001 and other SEPA Pollution prevention guidelines.

3.4.74 Surface water drainage in areas where there is a potential for hydrocarbon residues from runoff / isolated leakages such as in plant storage areas and the location of the fuel storage tanks and refuelling activities in the proposed temporary site compound will be directed to a hydrocarbon interceptor prior to discharge. The interceptor will filter out hydrocarbon residues from drainage water and retain hydrocarbon product in the event of a spillage to prevent release into surface waters at the discharge point and deterioration of downstream water quality.

Peat management during construction

3.4.75 The Proposed Development site is situated in an area where extensive peat deposits are found. The wind farm layout, design and construction methodology has been refined to minimise peat excavation from tracks and turbine infrastructure, but it has not been possible to avoid it entirely.

3.4.76 Peat will be excavated during the construction of tracks, foundations, hardstandings, substation and temporary compounds. The majority of peat spoil will come from foundations, hardstandings and track construction and, to a lesser extent, temporary compounds.

3.4.77 A PMP will be produced prior to construction and following completion of detailed ground investigations and micro-siting. The PMS will be further refined and detailed methods and specifications agreed with SEPA and NatureScot. This will address methods in respect of peat excavation, haulage, storage, re-use and degraded habitat restoration. The PMS will ensure that peat excavated during construction is safely and suitably re-used within the extent of the Proposed Development site.

3.4.78 Details of the draft PMP (**Appendix 13.C**) and Peat Landslide Hazard and Risk Assessment (**Appendix 13.D**) are provided in **Chapter 13: Hydrology & Hydrogeology**.

3.5 Electrical infrastructure

Control building and substation

3.5.1 Electrical connection will be through suitable switchgear to be installed in a control building on-site. The control building will comprise a single storey building approximately 26m x 6m which will house switchgear and metering, DC battery power supply unit, LV auxiliary supply and distribution consumer unit, protection and control equipment and also welfare facilities. Attached to the control building 0will be a fenced compound, consisting of a hardstanding with dimensions of 66m x 30m for the 33kv substation and associated compliance plant. There will also be allocated areas used for storage and maintenance purposes. **Figure 3.5** shows an illustration of a control building and substation compound. The proposed location of the control building and compound is shown in **Figure 3.0**.

3.5.2 The area for the building will be prepared by removing the peat down to competent bearing strata, which means excavating through the peat and founding on either bedrock or glacial till. Substantial concrete foundations will be required to take the weight of the components. An electrical earth network will be buried around the building.

3.5.3 The underground cables from the wind turbines will be brought through ducts. The ducts will guide the cables to the appropriate switchgear inside the building. Communications cables will enter in a similar manner.

Distribution cabling

3.5.4 Wind turbines produce electricity at 690V, which is typically stepped-up to 33kV via the turbine transformers located adjacent to the tower.

3.5.5 Underground cables will link the turbines to the on-site control building and substation. Detailed construction and trenching specifications will depend on the ground conditions encountered at the time, but typically cables will be laid in a trench 1000mm deep and 400mm to 1,200mm wide. To minimise ground disturbance, cables will be routed alongside the access tracks wherever practicable and, if not, the total footprint of construction activity will be stated within the CMS. Approximately 4km of cable trenches will be required to connect the turbines to the on-site control building. **Figure 3.11** shows a typical cable trench detail.

3.5.6 The method of installation will have to be selected to have minimum disturbance to the peat at the time of installation and afterwards. The 'normal' wind farm method of digging a trench several metres to the side of the access track and laying the cables in a bed of sand may not be suitable, as it would lead to a large area of disturbed peat and possibly form drainage channels.

3.5.7 The following methods will be used where appropriate:

- Burial in ducts across the tracks;
- Fitted in ducts along bridges;
- Burial in trenches; and
- Ploughing.

3.5.8 Any excavations for pits will be cordoned off and marked clearly. Cable hauling operations will be coordinated with traffic movements, especially when hauling is being carried out from the roadway. Cable off-cuts and waste from terminations will be systematically collected, stored and recycled or disposed of properly.

3.6 Battery Energy Storage System

3.6.1 The BESS has been incorporated to further maximise the electricity generated from the proposed wind turbines. The facility would have the approximate maximum electricity storage capacity of 5MW. The battery storage would be contained within the Control Building compound, which can be seen in **Figure 3.5**.

The various options open for the use of the BESS are as follows:

- Ramp control: When the local grid network is not able to absorb the additional wind-power created by a quick wind speed increase the BESS would catch this extra generation and then store it in the batteries and release back onto the grid when possible;
- Predictable power: Provide predictable and consistent power to the local grid network. The BESS would have the ability to smooth out any short-term wind peaks and troughs; and
- Frequency regulation: This allows the wind farm to store energy in the BESS in order to immediately and precisely respond to changes in load, further improving turbine generation flexibility.

3.7 Operation of the wind energy development

Wind turbine characteristics

3.7.1 The power output from a wind farm largely depends on the strength of the wind blowing across the Proposed Development. The Vestas V136 4.5 MW wind turbine (the reference turbine) will start to generate electricity at a wind speed of approximately 3 m/s. Output will increase with wind speed up to the maximum rated power at around 13 m/s wind speed. When the wind speed reaches 32 m/s the wind turbine shuts down automatically in order to protect components from excessive wear.

3.7.2 The proportion of time that the turbines will be generating electricity is therefore dependent on the time that the wind speed is between 3 m/s and 32 m/s. Generation output from a wind farm is also seasonally dependent, such that approximately two thirds of the total annual energy yield from the wind farm is expected to be delivered in the six months between October and March, with the remaining six months delivering the other third.

Turbine monitoring and control

3.7.3 Turbines have a proven track record for safety, although a very small number have been known to fail through accidental damage due to lightning or mechanical problems. However, turbine control and monitoring systems operate with several levels of redundancy to protect the turbines from damage.

3.7.4 All turbines are controlled by a sophisticated Supervisory Control and Data Acquisition (SCADA) system, which will gather data from all the turbines and provide the facility to control them from a central remote location. Communications cables connecting to each turbine will be buried in the electrical cable trenches to facilitate this.

3.7.5 In the case of any fault, including over-speed of the blades, overpower production, or loss of grid connection, the turbines shut down automatically through braking mechanisms. They are also fitted with vibration sensors so that, if, in the unlikely event a blade is damaged, the turbines will automatically shut down.

Meteorological effects

3.7.6 Wind turbines are designed to withstand very high wind speeds, and the Vestas V136 (the candidate turbine) is normally certified against structural failure for wind speeds up to 55 m/s.

3.7.7 Turbines, as with any tall structure, can be susceptible to lightning strike and appropriate measures are included in the turbine design to conduct lightning strike down to earth and minimise the risk of damage to it. In the case of a lightning strike on a turbine or blade the turbine will automatically shut down.

3.7.8 In cold weather, ice can build up on blade surfaces when operating. The turbines can continue to operate with a thin accumulation of snow or ice, but will shut down automatically when there is a sufficient build up to cause aerodynamic or physical imbalance of the rotor assembly.

General servicing

3.7.9 Each turbine manufacturer has specific maintenance requirements but typically routine maintenance or servicing of turbines is carried out twice a year, with a main service at twelve monthly intervals and a minor service at 6 months. In the first year, there is also an initial three-month service after commissioning. The turbine being serviced is switched off for the duration of its service.

3.7.10 Teams of two people with a 4x4 vehicle would carry out the servicing. It takes two people (on average) one day to service each turbine.

3.7.11 At regular periods through the project life, oils and components will require changing, which will increase the service time on-site per machine. Gearbox oil changes are required approximately every 18 months.

3.7.12 Changing the oil and worn components will extend each turbine service by one day. The typical duration of other repair / replacement procedures together with the equipment and personnel that would be required for different tasks is shown in Table 3.7. It should be noted that these figures are only estimates.

3.7.13 Blade inspections will occur as required (somewhere between every two and five years) using a Cherry Picker or similar, but may also be performed with a 50T crane and a man-basket. It could take approximately two weeks to inspect the turbines at the Proposed Development. Repairs to blades would utilise the same equipment.

3.7.14 Blade inspection and repair work is especially weather-dependent. Light winds and warm, dry conditions are required for blade repairs. Hence summer (June, July and August) is the most appropriate period for this work.

3.7.15 The following factors could have significant effects on the duration of repair operations:

- Working with cranes is highly weather-dependent;
- The availability of spares; and
- The stage in the component's life cycle.

Table 3.7 List of potential wind farm operational and maintenance activities

Item	Personnel	Equipment	Duration of Job
Generator	2 x fitters	50T (3 axle) or 100T (6 axle) crane. 10T flat-bed lorry	1 day
Gearbox	4 x fitters	50T or 100T crane 10T flat-bed lorry	6 days
Blade/Rotor	6 x fitters	100T crane and 50T crane Articulated delivery lorry	4 days
Transformer	2 x fitters	50T crane and or 20T flat-bed lorry with own crane	1 day
Track Maintenance	Drivers	40T stone delivery lorries, Grader / roller and Excavator	Very limited, likely to be occasional patching
Snow Clearance	Driver	Excavator	Conditions specific (unlikely to occur)
Dismantling a turbine	8 x fitters	500T crane and support lorries plus 100T crane. Articulated lorries for components	3 days per turbine
HV/comms. Cable faults	6 x fitters	Vans or tracked vehicles for off-site work	Variable

Track maintenance

3.7.16 The frequency of track maintenance depends largely on the volume and nature of the traffic using the track, with weathering of the track surface also having a significant effect. Since the volume of traffic using the access tracks during operation will be low (although heavy plant is particularly wearing) the need for track maintenance is anticipated to be low and infrequent. Any maintenance that is required will generally be undertaken in the summer months when the tracks are dry. However, maintenance can be carried out when required.

Operational waste

3.7.17 Operational waste will generally be restricted to small volumes of waste associated with machinery repair and maintenance disposed of by the maintenance contractors in line with normal waste disposal practices.

Land management

3.7.18 It is anticipated that long term land management practices will continue unaffected by the Proposed Development with normal forestry practices continuing unimpeded.

3.7.19 On-site access tracks could be utilised by transport vehicles and re-planting can commence soon after turbine construction.

3.8 Decommissioning of the wind energy development

3.8.1 The Proposed Development will be designed with an operational life of 40 years. At this time, it will be decommissioned and the turbines dismantled and removed. Any alternative to this action would require consent from The Highland Council and so is not considered in this EIA Report.

3.8.2 During decommissioning the bases would be broken out to below ground level. All cables would be cut off below ground level, de-energised and left in the ground. Access tracks would be left for use by the landowner. No stone would be removed from the Proposed Development. The decommissioning works are estimated to take six months. This approach is considered to be less environmentally damaging than seeking to remove foundations, cables and roads entirely. A Decommissioning Statement for the Proposed Development is included as **Appendix 3.A**.

3.9 Mitigation and enhancement measures summary

3.9.1 The preceding parts of this chapter capture the inherent scheme design that is proposed and that has been the subject of this EIA. In completing the EIA the subsequent technical chapters have identified a number of environmental measures that provide mitigation for predicted effects or are proposed by the developer as enhancement measures. The developer proposes that these will form an integral part of the scheme that is applied for and thus they are summarised in Table 3.8 for completeness.

Table 3.8 Summary of mitigation and enhancement measures

Chapter/Topic	Proposed mitigation/Enhancement measure
Carbon Balance	Implement a Site Waste Management Plan to reduce materials waste
Carbon Balance	Implement a vehicle idling policy to ensure that, where practicable plant and equipment are turned off when not in use, as part of the Construction and Decommissioning Environmental Management Plan
Carbon Balance	Implement a Peat Restoration Plan as part of the Construction Environmental Management Plan, including ditch blocking in order to allow peat habitats to be restored and groundwater levels to be raised to near surface
Traffic & Transport	The following measures will be implemented during the construction phase through the Construction Transport Management Plan: • Where possible the detailed design process would minimise the volume of material to be imported to site to help reduce HGV numbers; • A site worker transport and travel arrangement plan, including transport modes to and from the worksite (including pick up and drop off times); • A Traffic Management Plan; • All materials delivery lorries (dry materials) should be sheeted to reduce dust and stop spillage on public roads; • Specific training and disciplinary measures should be established to ensure the highest standards are maintained to prevent construction vehicles from carrying mud and debris onto the carriageway; • Wheel cleaning facilities may be established at the site entrance, depending the views of THC; • Unless otherwise agreed with THC, normal site working hours would be limited to between 0700 and 1900 (Monday to Friday

Chapter/Topic	Proposed mitigation/Enhancement measure
	and 0700 and 1300 (Saturday) though component delivery and turbine erection may take place outside these hours; • Appropriate traffic management measures would be put in place on the B9007 to avoid conflict with general traffic, subject to the agreement of the roads authority. Typical measures would include HGV turning and crossing signs and banksman where necessary; • Provide construction updates on the project website and or a newsletter to be distributed to residents within an agreed distance of the site. • Adoption of a voluntary speed limit of 15 mph for all construction vehicles through Dulnain Bridge;
Traffic & Transport	All drivers would be required to attend an induction to include: • A tool box talk safety briefing; • The need for appropriate care and speed control; • A briefing on driver speed reduction agreements (to slow site traffic at sensitive locations through the villages); and • Identification of the required access routes and the controls to ensure no departure from these routes.
Traffic & Transport	Video footage of the pre-construction phase condition of the abnormal loads access route and the construction vehicles route would be recorded to provide a baseline of the condition of the road prior to any construction work commencing. This baseline would inform any change in the road condition during the construction phase. Any necessary repairs would be coordinated with The Highland Council's roads team. Any damage caused by traffic associated with the Proposed Development during the construction period that would be hazardous to public traffic would be repaired immediately.
Traffic & Transport	Damage to road infrastructure caused directly by construction traffic would be made good and street furniture that is removed on a temporary basis would be fully reinstated. It is anticipated that a Section 96 Agreement will be developed with THC to ensure that the road network does not deteriorate as a result of the proposed construction traffic.
Traffic & Transport	Abnormal Indivisible Loads Route Survey Report highlighted a number of constraint points, which will need to be mitigated & implemented. An Abnormal Load Management Plan would be developed which would include: • Undertaking abnormal load deliveries at appropriate times; • Advance Warning signs; • Diary of proposed delivery movements; • Protocol for working with local businesses/avoid interference; • Establish Construction liaison committee; and • Providing movement details to local media outlets.
Noise – Construction	Restricted hours of working (07:00 to 19:00 Monday to Friday, 07:00 – 13:00 Saturdays and no audible activities on Sundays and Bank Holidays) are specified for most heavy vehicles movements to avoid sensitive periods. Any requirement to work outside of these periods would only occur through prior agreements with THC (for example turbine erection requires low wind speed conditions and may require longer working hours if conditions are poor at the time).
Noise – Construction	Blasting Noise to be addressed by a condition requiring a pre-blasting noise management programme to be submitted and agreed in writing prior to any blasting operations taking place.
Noise – Construction	All construction activities to be undertaken in accordance with good practice as set out in BS5228-1:2009 and in accordance with: • relevant EU Directives and UK Statutory Instruments that limit noise emissions from a variety of construction plant; • the guidance set out in PAN1/2011 and BS5228: 2009; and

Chapter/Topic	Proposed mitigation/Enhancement measure
	• Section 61 of the Control of Pollution Act 1974 and Section 80 of the Environmental Protection Act.
Noise – Operation	The design of the scheme is such that necessary operational noise limits are met and no mitigation measures are necessary. By way of separation between receptors and turbines resulting from this process, construction noise is also limited, thus only general good-practice noise control measures are required and no specific mitigation is necessary.
Landscape and Visual Impact	These are carried out throughout the iterative design process and are therefore embedded in the final layout.
Cultural Heritage	The risk of potential disturbance to known heritage assets identified within the Inner Study Area will be minimised by demarcation prior to construction works commencing. This would be achieved through appropriate survey, demarcation/fencing and signage.
Cultural Heritage	Any direct construction effects upon previously unknown cultural heritage assets will be mitigated through a programme of archaeological works to include potential impacts upon or beneath peat. The scope and nature of any additional mitigation should it be required would be outlined in a written scheme of investigation and agreed with THC.
Ecology (Embedded)	A PMP will be produced following the completion of detailed ground investigations and infrastructure micro-siting and prior to construction commencing. The PMS will include detailed methods and specifications that will be agreed with SEPA and NatureScot.
Ecology (Embedded)	Use of existing access tracks would be upgraded where possible to minimise habitat loss. The proposed alignment of access tracks, developed through consultation with the ecology team has sought to avoid identified constraints (for example areas supporting more sensitive plant communities such as blanket bog, wet heath, waterbodies and water vole habitat etc.).
Ecology (Embedded)	Electrical cabling will be undergrounded alongside access tracks wherever possible to minimise ground disturbance and land take and the installation of cables will aim to minimise disturbance to peatland habitats. Short trenches will be dug during dry periods, where possible. Silt traps and/or clay bunds will be used in longer trench runs.
Ecology (Construction)	In order to minimise the impacts of construction (e.g., disturbance arising from the works) all activity will be limited to clearly defined working areas, and the storage of surplus materials will be confined to areas of hard-standing. Vegetation clearance would be kept to a minimum and areas of hard-standing will be minimised to reduce the need for additional drainage provision.
Ecology (Construction)	An Ecological Clerk of Works (ECoW) will be appointed to ensure compliance with the Construction Environmental Management Plan (CDEMP) to provide advice in the event of any unforeseen protected species issues that arise during construction and to oversee the implementation of mitigation measures.
Ecology (Construction)	The proposed mitigation and enhancement measures detailed below for habitats, European protected species (e.g., otter and bats) and other legally protected species (e.g., reptiles) would be incorporated into a Habitat Management Plan (HMP), which would be prepared if the development is granted planning permission.
Ecology (Construction)	Surface vegetation, peat and soil excavated when constructing the construction compounds, crane pads, turbine bases, access tracks etc. would be stored appropriately (i.e., separate topsoil, subsoil and peat storage areas) until required for reinstatement, post-construction.
Ecology (Construction)	Watercourses will be protected during the construction phase through the adoption of a range of mitigation measures which include the following: • Avoidance of natural water features with a 50 m stand-off where possible. • Drains, silt traps, check dams and barriers will be used to prevent silt-laden run-off from entering watercourses.

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	• Provision of temporary/permanent drainage routes will be adopted, including cross-drainage at access tracks in line with FCS/SNH guidance. • Sensitive design of drainage ditches to avoid potentially silt-laden run-off flowing directly into natural channels, ephemeral burns or ditches. • Floating roads will be employed where peat soils greater than 1.0 m depth are encountered and cannot be avoided by micro-siting. • Best practice in accordance with SEPA's Guidance for Pollution Prevention (GPP) will be followed. • The existing Operational Scheme borrow pit will be used, which is located away from water environment receptors where rock is exposed or close to the ground surface. • Watercourse crossings will be designed according to SEPA's position statement on the culverting of watercourses (SEPA, 2006), and on SEPA and CIRIA best practice guidelines. Culverts and bridges would be designed to account for the topographic, hydrological and ecological constraints at each proposed crossing point with the exact design agreed with SEPA prior to construction. • Sensitive location and containment of storage areas and stockpiles. • Refuelling will only take place on hard-standing.
Ecology (Construction)	The details of pollution prevention measures will be provided in a Construction Method Statement (CMS) which will include all construction elements, such as access tracks, electric cable laying, wind turbine foundations, crane pads, control building and temporary site construction compound.
Ecology (Construction)	Turbines will be micro-sited (+/- 50m) at the construction stage to avoid environmental or technical constraints including the avoidance of deepest areas of peat.
Ecology (Construction)	A suitable means of escape will be provided for animals from any exposed trenches and other deep excavations (such as a long wooden or metal plank). Deeper excavations (e.g., borrow pits) would be fenced off to prevent wildlife access if they are steep-sided and there is no other means of escape for trapped animals.
Ecology (Construction)	General controls on working hours during construction are detailed in Chapter 3 'Description of the Proposed Development': most works would be undertaken during daylight hours. However, it may be necessary on occasion to undertake work at night or in the hours of darkness. Night working and the need for artificial lighting would be kept to a minimum and would be avoided altogether near watercourses in order to avoid effects on the feeding and commuting behaviour of species such as bats or otter.
Ecology (Operational)	Relevant construction phase control measures will continue to be adopted during the operational phase where potential effects still exist. In particular, the potential for pollution or siltation incidents during routine maintenance activities would be minimised by adoption of best practice based on SEPA pollution prevention guidance. This will include the maintenance of ditches and silt traps to control run-off (further details are included in Chapter 13 'Hydrology, Hydrogeology and Geology').
Ecology (Operational)	Permanent features of the proposed wind farm, which include wind turbines, crane pads and access tracks, are not predicted to have any continuing impacts on important ecological features once they have been constructed. The areas surrounding these permanent features would be reinstated as far as possible.
Ecology (Operation)	Site activities during the operational phase would be limited to monitoring and maintenance activities, with occasional minor excavations possible at the existing borrow pit for track maintenance. During these activities all working areas would be clearly defined and the storage of materials would be restricted to areas of hard-standing. Any maintenance works would take place during the day to minimise the potential for disturbance to protected species on site (e.g., otter and bats).
Ecology (Decommissioning)	During the decommissioning of the Proposed Development, the potential effects on important ecological features are expected to be similar to those identified during the construction phase and thus similar mitigation measures are likely to

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	be required. Any new legislation or guidelines published prior to decommissioning would be adhered to and incorporated into the mitigation design prior to decommissioning taking place. Elements for considerations are likely to include: • Destruction and disturbance of habitats that have developed during the operational life of the wind farm. • Habitat restoration following the completion of decommissioning work. • Protection of watercourses. • Consideration of protected species; taking into account the potential for colonisation by species which were found to be absent during baseline surveys.
Ornithology	As the assessment concluded that there was no requirement for mitigation, no significant residual effects have been identified.
Hydrology, Hydrogeology, Geology & Peat	From the assessment of potential effects, the following key issues which have demonstrated a potential effect significance of moderate will need particular attention for mitigation and management: • The excavation of deep modified peat with the most significant areas being: • T1, T3, T4, T5, T6 and the excavated part of the substation area. • Disturbance of a waterbody: • Turning area for T4.
Hydrology, Hydrogeology, Geology & Peat	Appointing an Ecological Clerk of Works (ECoW) to visually monitor the site as construction commences and to advise on any further micro-siting. The ECoW will have the power to halt all activities if a sensitive/protected habitats/species are identified or activities are identified that are having or have the potential to cause pollution to the water environment. The ecologist would seek advice as appropriate from the statutory agencies and will advise the construction team of best practice measures to follow, through the delivery of monthly 'tool box talks' to ensure that environmental management standards requirements are complied with.
Hydrology, Hydrogeology, Geology & Peat	Prior to the commencement of construction, a site-specific Construction Method Statement shall be submitted to and approved in writing by the Planning Authority in consultation with the Applicant, the fishery boards and SEPA.
Hydrology, Hydrogeology, Geology & Peat	The Construction and Decommissioning Environmental Management Plan (CDEMP) shall include the following and be submitted to SEPA for approval at least two months prior to construction: • A refined, detailed peat management plan (PMP). The outline peat management provided outlines the areas where the focus on peat restoration is recommended however the site is heavily degraded and there are numerous areas that could be improved. A refined plan will further define these areas. • A detailed Habitat Restoration Plan (HMP) • A Drainage Management Plan (DMP) for the management of dewatered groundwater and surface water run-off: including measures to prevent erosion, sedimentation or discolouration of controlled waters should be provided, along with monitoring proposals and contingency plans. • A Pollution Prevention Plan (PPP) to include details of the monitoring and protection of all sensitive water sources. • A Water Quality Monitoring Plan (WQMP) – to monitor the Allt Carn an t-Sean-liathanaich before construction to establish baseline conditions; during construction to ensure any alterations of water quality are identified and sources of the problems are traced and rectified; and after construction to confirm water conditions are similar to prior to the development. • Visual and basic field water quality monitoring (such as pH, turbidity, total dissolved solids and electrical conductivity should be regularly undertaken by the ECoW on site. These records should be able to be supplied to the regulator if required.

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	• Emergency Response Plan (ERP) for any pollution incident (fuel leak or sediment entering a watercourse) should be put in place.
Hydrology, Hydrogeology, Geology & Peat	Track sections crossing potentially diffuse drainage will be treated as drain crossings or use floating road sections with drainage to allow the natural surface water and shallow groundwater to flow downgradient.
Hydrology, Hydrogeology, Geology & Peat	Micro-siting in the construction of turning area of T4 will be used to avoid the bog pool where possible.
Infrastructure	The development is fitted with aviation safety lighting and that sufficient data is submitted to ensure that structures can be accurately charted to allow deconfliction. As a minimum the MoD would require that 25 cd or infra-red (IR) lighting installed on each of the perimeter turbines.