MWP

Chapter 03 Civil Engineering of the Proposed Development

Brittas Wind Farm

Brittas Wind Farm Ltd.

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3. Civil Engineering

3.1 Introduction

This chapter provides additional information to Chapter 1 Introduction and Chapter 2 Project Description on the civil engineering design rationale and works for the various elements of the proposed Brittas Wind energy development (referred to as the proposed project going forward). The following items are described in this chapter:

- Local Access Routes
- Site Entrances
- Internal Wind Farm Site Tracks
- Wind Turbine and Hardstand Infrastructure
- Internal Collector Cables
- External Grid Connection
- Sub-station, IPP and BESS Compound and Buildings
- Meteorological LiDAR Monitor
- Temporary Site Construction Compounds
- Borrow Pit
- Spoil Storage
- Construction Material Volumes
- Watercourse / Drainage Crossing Design
- Site Drainage Systems Design
- Sediment and Erosion Plan

3.2 Local Access Routes

The components for the 10 no. wind turbines will be delivered by cargo ships to the port of Foynes-Limerick. The components for each turbine will be delivered in separate loads, some of which are abnormal in terms of their width and length. The components will be transported from Port to the site along the Motorway, National, Regional and Local road network.

To facilitate the delivery of the turbine components along the proposed route the removal of existing vegetation, signage and street furniture will be required, and the hardening of soft verges will also be required. Localised widenings of bends will be required at N62-L8017 (Rossestown Road) junction, this will require significant tree and vegetation removal on the eastern side of the N62 and southern side of L8017. A temporary stone track will be constructed of UGM A or similar material and compacted. Localised widening is required at the N62-L4039 (Jimmy Doyle Road) junction, in addition to the temporary road and vegetation stripping, the traffic lights to the north and south side of L4039 will need to be temporarily removed and the traffic light on the western side of the N62. Please refer to the Turbine Delivery Route Assessment Report in Appendix 2A of the EIAR for further details.

All works at the sections above will be constructed with imported 150mm UGM A, or similar aggregate on imported 450mm crushed stone Class 6F material and geogrid. Following the completion of the project, the temporary works areas along the turbine delivery route, from the local road at the site entrances to junction 25 on the M7, will be reinstated. Works to harden grassed or soft verges within the curtilage of the public road will be reinstated to the satisfaction of the Local Authority. All material generated from the excavation works at these areas will be reused where possible or will be brought to a licenced waste facility. The construction phase waste is described in the **Construction and Environmental Management Plan (CEMP)** – **Appendix 2B** of the EAIR. The proposed delivery works are shown in **Planning Drawings 23318-MWP-00-00-DR-C-5036 to 5038**.

3.3 Site Entrances

Access to the site will be from four site entrances, 2 existing/upgraded entrances and 2 new entrances. In **Figure 3-1** below three of the site entrances will be for access during the construction phase to the proposed wind farm on the L8017 Rossestown Road (Site Access 1, Site Access 2 and Site Access 3). The fourth site entrance will be for the proposed wind farm sub-station access point and will be off L4120-18 also known as Rossestown Road. This entrance will be for operational use only and will not be used for access during the construction phase. See **Figure 3-2** below.

The proposed site entrances provide appropriate sight distance in both directions on the public road as required by Transport Infrastructure Ireland (TII) standards.

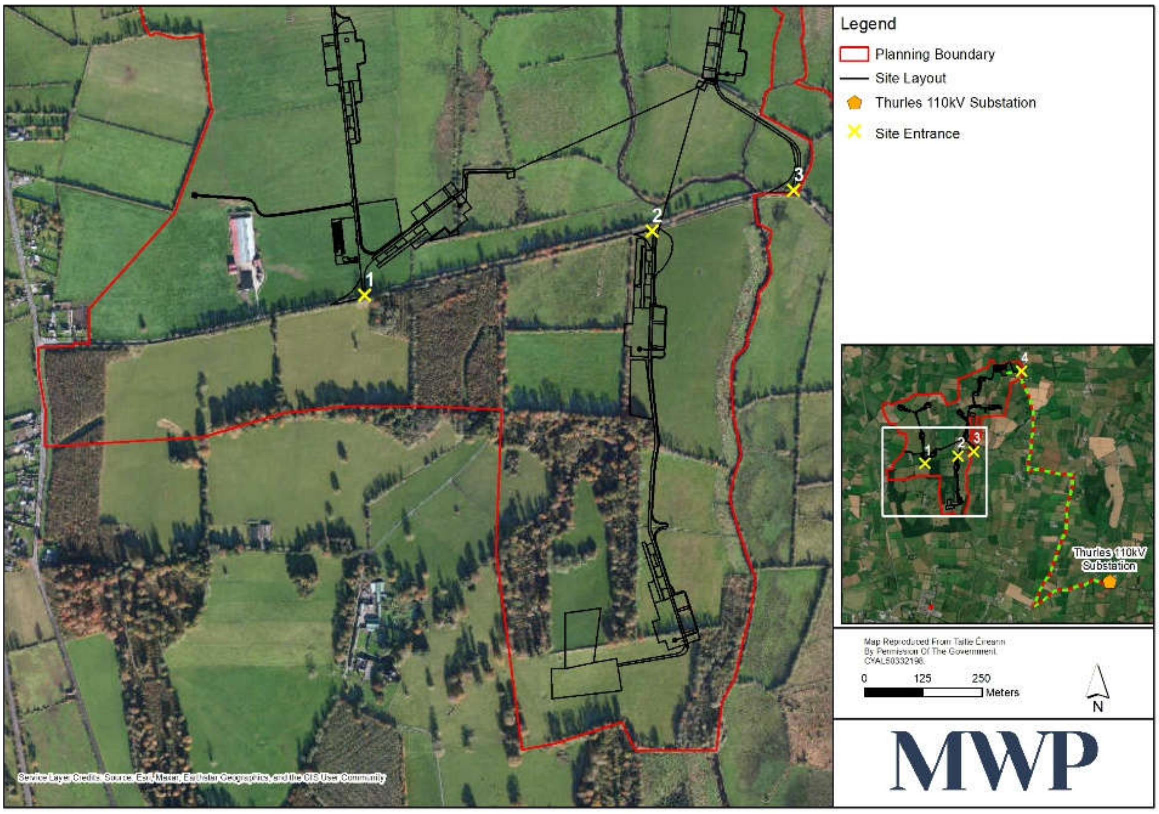

Figure 3-1: Three Site Entrances along Rossestown Road (L-8017)

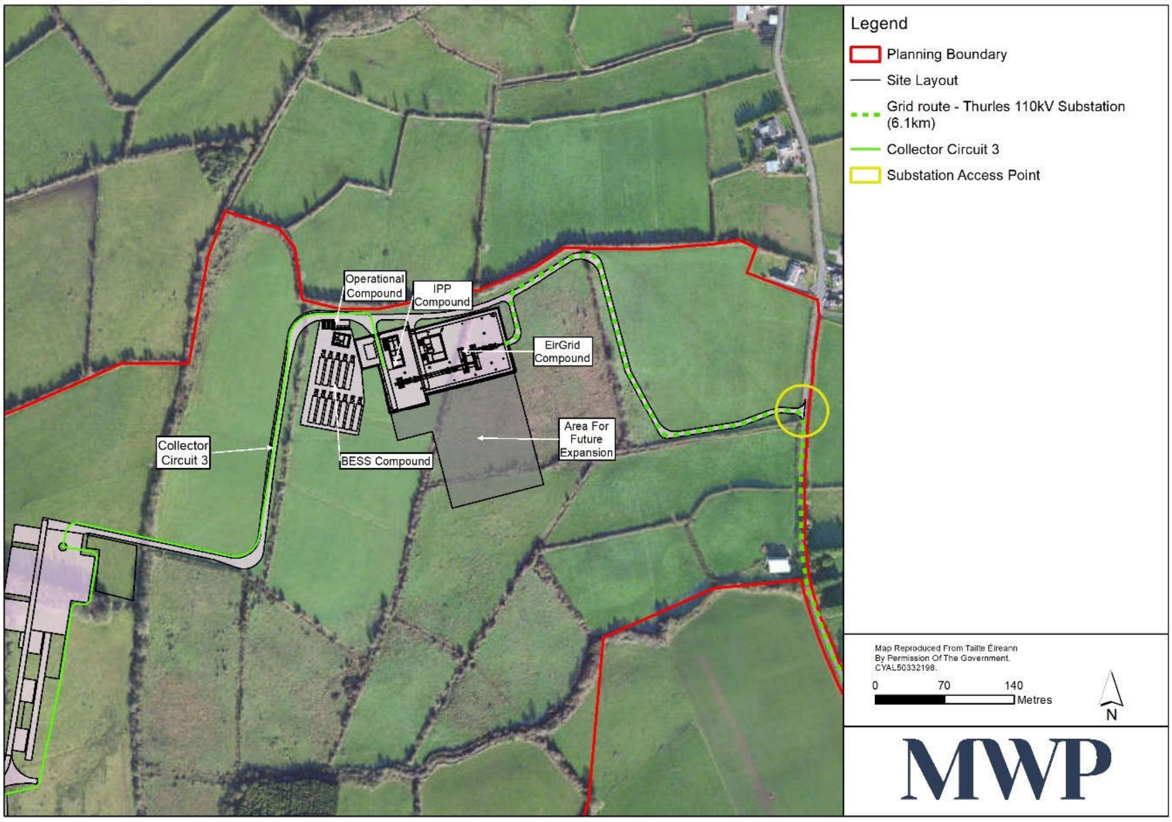

Figure 3-2: Substation Operational Entrance (not to be used during construction) along the L-4120 Road

The requirements for junction sight distances are set out in Transport Infrastructure Ireland (TII) "DN-GEO-03060: Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions)". Sight distance is measured from a point 2.4m from the near edge of the major road along the centre of the minor approach road. This distance is referred to as the 'x-distance'. The visibility distance along the major road is referred to as the 'y-distance' and is measured to the near edge of the major road in both directions. The required sight distance in the vertical plane is based on eye and object heights of 1.05m. The 'y-distance' requirement depends on the design speed of the major road. This is the 85th percentile speed which is the speed below which 85% of vehicles travel.

The statutory speed limit on the local road is 80km/h but the design speed is likely to be somewhat lower. Based on observations on site, a design speed of 60km/h has been taken as being appropriate for entrances 1, 2 and 3 along the L8017 Rossestown Road. At these locations a minimum sight distance of 70m is deemed appropriate due to the restricted horizontal alignment of the local road, presence of an arch bridge which restricts vertical alignment and the tight bends to the east of the proposed entrances onto the local road. A speed survey was carried out along this section of roadway near entrances 1, 2 and 3 and this yielded an 85^{th} percentile speed of 58km/h which provides further justification to the selected design speed. A design speed of 70km/h has been taken as being appropriate along the L4120 at the sub-station entrance. At this location a sight distance of the 120m has been provided.

The sightline distance will be achieved by installing a timber post and rail fence and keeping an area outside the fence free of vegetation or other obstructions. The sight distance splays in both directions are achieved and are shown in Planning Drawings 23318-MWP-00-00-DR-C-5034 to 5035. These improvements will remain in place permanently and will benefit users of the proposed wind farm when exiting the site onto the public road. An example photograph of the proposed wind farm entrance with sightlines improved is given in Plate 3-1.

Stormwater management measures will be implemented to prevent water from the site entrances flowing onto the public road. The entrances will be designed to facilitate access for all vehicles associated with the construction and subsequent operation and maintenance of the proposed wind farm.

Plate 3-1: Wind farm site example of the proposed Entrance

3.4 Internal Wind Farm Site Tracks

The internal site access track design objectives and design rationale for the proposed wind farm are outlined below. The access track drawings are presented in A1 format in the planning application pack. These include:

- Proposed Internal Access Road Layout including identification of existing tracks to be upgraded and widened (refer to Planning Drawings 23318-MWP-00-00-DR-C-5006 to 5013).
- Proposed Internal Access Road Details (refer to Planning Drawings 23318-MWP-00-00-DR-C-5406). and
- Junction Sight Distances (refer to Planning Drawings 23318-MWP-00-00-DR-C-5034 to 5035);

Internal access tracks are required to interconnect elements of the site and allow access to all proposed wind farm turbines and infrastructure. The proposed wind farm will use 7.7km of new tracks to be constructed within the proposed project.

The new access tracks will have a running width of 5.5m along straight sections of road with localised wider areas at bends to accommodate the efficient transport of the wind turbine components. These tracks will be constructed using either founded or floating road techniques. These methods of construction are outlined in the following sections.

The existing routes within the proposed project were identified initially from high resolution aerial photography and thereafter from site visits. The existing tracks were assessed in terms of their width, gradient and associated drainage. The existing tracks that were assessed and deemed appropriate to the proposed site layout will be upgraded. The remaining tracks within the proposed site layout will be a combination of either founded or floating tracks in various parts of the site to suit the ground conditions.

The following outlines the internal access tracks design rationale:

- The access road design was based on the necessity to deliver wind turbines, three turbine models are considered within the EIAR therefore for the Turbine Delivery Assessment a maximum blade length of 81.5m was considered as it will cover all three turbine models. This allows for the delivery of the proposed maximum blade length with some contingency to allow for different types of delivery vehicle to be used.
- Road gradients throughout the site are 12% or less which is sufficient for turbine delivery.
- The maximum camber and crossfall gradient on the access tracks is 2.5%.
- As turbines are normally grouped and linked in electrical circuits, consideration was given to Internal collector cables layout in the internal access tracks route selection process. It is planned to run all internal collector cables along the internal access tracks; it is important to ensure that access routes facilitate efficient cabling.
- The construction of turbines immediately adjacent to the main site tracks was avoided where possible because of the potential conflict with construction traffic and the associated safety issues. Short spur tracks linked to the main access tracks were used where possible within the land-take and environmental constraints and buffers. A relevant construction plan will ensure health and safety issues are minimised when constructing these turbines.
- Avoid stream crossings and water bodies, where possible.
- New sections of access tracks were selected minimising use of steep ground and natural drainage features.
- Road alignments were selected that will have adequate turning radii for delivery of turbines; and
- Aerial photography, Ordnance Survey Ireland (OSI) contour data and LiDAR data were used to inform the internal road design.

The following constraints were taken into account in the final design of the internal access road layout within the site:

1. Site topography (OSI contour data and LiDAR data) to avoid steep slopes for turbine delivery vehicles;
2. A hydrology buffer map where streams were buffered by 50m, except where crossings are required;
3. Avoidance of ecologically sensitive areas;
4. Avoidance of archaeological features.
5. Reduction of visual effects– tracks along contours where possible

The overall site layout is shown on Planning Drawings 23318-MWP-00-00-DR-C-5005.

A network of new founded and new floating tracks will be used to access each of the turbines, the sub-station compound, borrow pit and the meteorological-LiDAR unit. Large splays will be required at the proposed wind farm access points and at spur road junctions for the large turbine component delivery trucks. However, these splayed junctions will be coned off to 12m radii to ensure the safety of the junction for regular construction traffic. See Planning Drawings 23318-MWP-00-00-DR-C-5034 to 5035 for details of the proposed junction layouts.

The design of any length of site access road will depend on local geotechnical, topographical, and hydrological conditions. Both excavated and floating road construction methods will be employed to achieve an access road structure appropriate to the site conditions.

The aggregate required for the construction of the internal access tracks, hardstands and sub-station compound will be sourced from a combination of the proposed on-site borrow pit, suitable excavated aggregate material obtained from associated earthworks and local quarries (for example Campion's Quarry, Kellys of Fantane, Trackstone Killough and Maher Quarries Limited Ltd, currently operational at the time of writing of this chapter). Further information on resources is shown in Chapter 2 Section 2.9 and the CEMP in Appendix 2B. The access tracks will be finished with a top layer of imported limestone from a nearby quarry to give a clean hardwearing running surface for the delivery of turbines.

Overall, the internal site layout design has been optimised in terms of its minimal effect on the existing public road network in the vicinity of the site, the low risk in terms of associated environmental effect, the use of a well-developed existing drainage network and good access and connectivity to the public road network.

3.4.1 Internal Wind Farm Access Tracks Construction Methods

3.4.1.1 Upgrading and Widening of Existing Tracks

For the construction of the proposed wind farm the design utilises existing internal tracks where possible. The existing access track to the location of the proposed permanent LiDAR Monitoring unit will be upgraded. These tracks will be widened by removing organic material and soft subsoil to formation level and constructing a road on a layer of geogrid or geotextile. See Planning Drawings 23318-MWP-00-00-DR-C-5406 for details. This road construction will be similar in build up to the excavated road construction which is outlined in detail in Section 3.4.1.2 below. The new width of track and the existing track surface, if the existing track surface isn't sufficient for construction vehicles, will be capped with a 150mm UGM A or similar aggregate type material.

This road type will have a crossfall of 2.5% from one edge to the other. Where there are no existing drains, new trackside drains on the lower side of the road will be used as part of the dirty water drainage system for the site. The existing or new trackside drains on the higher side of the road will be retained as clean water drains.

An example of an upgraded road can be seen in Plate 3-2. The sequence for upgrading and widening of existing access tracks is anticipated to comprise of the following:

1. The appointed contractor will liaise with the wind turbine supplier prior to the commencement of the works to ensure that the design of the tracks conforms with the wind turbine supplier's specifications and no works beyond that which have received planning permission will be undertaken.
2. The appointed contractor will survey the area for any unforeseen hazards prior to the commencement of works and set up warning signage as appropriate.
3. Drainage measures to ensure the separation of overland clean water flow from construction run-off will be implemented as outlined in Section 3.14.
4. The material required for widening and upgrading the existing site tracks is proposed to be used from either the proposed on-site borrow pit, suitable excavated aggregate material within the proposed wind farm site and imported aggregate from a nearby quarry. All tracks will be finished with imported 150mm UGM A, or similar aggregate type material. Passing bays will be constructed to allow for the safe movement of site traffic along the existing tracks.

5. Where the extraction of aggregate from the proposed borrow pit is used it will be undertaken by excavators and loaded onto articulated dumper trucks that will deliver the aggregate to the required road widening / upgrading locations.
6. Widening works will begin with the use of excavators that will first remove any topsoil / vegetative layer which may be present. This material will be transported to the temporary storage area (within turbine hardstand areas) and maintained for re-use during the restoration phase of the proposed wind farm construction. Topsoil / vegetative removal will be kept to a minimum to prevent any runoff of silt during heavy rainfall.
7. Excavators will continue to strip and excavate the soft subsoil underneath which will be temporarily stored adjacent to the access tracks in accordance with approved methods with the use of an articulated dumper truck. Excavated material will only be temporarily stored on slopes under 5° and to a maximum height of under 1.0m until they are transported to the selected deposition areas where they will be permanently stored.
8. Once a section of the widened access road is exposed to suitable formation; a layer of geogrid or geotextile material may be placed along its formation depending on ground conditions.
9. The aggregate to be used for the widening works will be delivered to the required work area and spread out locally with the use of excavators on top of the geogrid / geotextile material. This will be compacted with the use of a roller which will roll the aggregate in maximum 250mm layers to achieve the required design strength.
10. The road upgrading works will involve the use of a roller compacting the site won aggregate in maximum 250mm layers laid over the existing road pavement. A layer of geogrid or geotextile material may be placed along the existing road pavement prior to the placement of the aggregate to achieve the required design strength.
11. All upgraded / widened access tracks will be constructed to a minimum drivable width of 5.0m with a maximum crossfall of 2.5% in order that water can flow off the tracks and reduce the risk of rutting / potholes occurring.
12. Trackside drains as per Section 3.14 will be constructed to manage clean and dirty water runoff along widened and upgraded access tracks.
13. The final running surface of the new widened / upgraded access tracks will be capped with a minimum 150mm UGM A material or similar using a road grader.
14. Any surplus spoil material generated from the road widening works will be transported back to the borrow pit to aid final reinstatement. Excavated topsoil and subsoil will be kept separate at the excavation and storage areas.
15. All excavations to be carried out will be battered back to a safe angle of repose (a max slope angle of 45°).
16. Where drop offs greater than 1.0m in height occur alongside road edges; physical edge protection will be constructed to reduce the risk of vehicles overturning. Trackside marker posts will also be erected to delineate road edges in poor weather.
17. The appointed contractor will ensure that all on-site personnel are aware of environmental constraints / sensitive areas within the proposed wind farm in which works are to be avoided.

Plate 3-2: Wind farm site example of the proposed upgraded road

3.4.1.2 New Founded Tracks

New founded tracks, of the type shown in Plate 3-3 will be constructed using aggregate obtained from either the proposed on-site borrow pit or imported from the nearby quarry. The aggregate will be placed over a layer of geogrid, where required, after all organic and soft subsoil material is excavated to formation level. Geotextile material, used to separate the road building material from the subsoil, will also be laid at formation level. The road will be finished with imported 150mm UGM A, or similar aggregate type material.

The sequence of constructing new founded access tracks will comprise the following:

1. The appointed contractor will liaise with the wind turbine supplier prior to the commencement of the works to ensure that the design of the new excavated tracks conforms with the wind turbine supplier's specifications and no works beyond that which have received planning permission will be undertaken.
2. The appointed contractor will survey the area for any unforeseen hazards prior to the commencement of works and set up warning signage as appropriate.
3. Drainage measures to ensure the separation of overland clean water flow from construction run-off will be implemented as outlined in Section 3.14.
4. Excavators will first remove any topsoil / vegetative layer which may be present. This material will be transported to the temporary storage area and maintained for re-use during the restoration phase of the proposed wind farm construction. Topsoil / vegetative removal will be kept to a minimum to prevent any runoff of silt during heavy rainfall.
5. Excavators will continue to strip and excavate the soft subsoil underneath which will be temporarily stored adjacent to the access tracks in accordance with approved methods with the use of an articulated dumper truck. Excavated material will only be temporarily stored on slopes under 5° and to a maximum

height of under 1.0m until they are transported to the selected deposition areas where they will be permanently stored.

6. All excavations to be carried out will be battered back to a safe angle of repose (slope angle of 45°) but where excavations are in solid rock the safe angle of repose may be increased to a slope angle of 60°.
7. Once a section of the excavated access road is exposed to suitable formation; a layer of geogrid or geotextile material may be placed along its formation depending on ground conditions which will be covered with site won graded and according to the design specifications as required compacted in maximum 250mm layers.
8. The material required for the excavated access tracks is proposed to be used from either the proposed on-site borrow pit, suitable excavated material within the proposed wind farm and imported aggregate from a nearby quarry. All tracks will be finished with imported 150mm UGM A, or similar aggregate type material. Passing bays will be constructed to allow for the safe movement of site traffic along the new tracks.
9. Where the extraction of aggregate from the proposed borrow pit is used it will be undertaken by excavators and loaded onto articulated dumper trucks that will deliver the aggregate to the required road widening / upgrading locations.
10. The aggregate will be delivered to the required work area and spread out locally with the use of excavators. It will then be placed on top of the geogrid / geotextile material in maximum 250mm thick layers. A roller will then roll and compact the aggregate to achieve the required design strength.
11. All new excavated access tracks will be constructed to a finished carriageway width of 5.5m with a maximum crossfall of 2.5% in order that water can flow off the tracks and reduce the risk of rutting / potholes occurring.
12. Trackside drains as per Section 3.14 will be constructed to manage clean and dirty water runoff along excavated access tracks.
13. The final running surface of the new widened / upgraded access tracks will be capped with a minimum 150mm UGM A material or similar using a road grader.
14. Any surplus spoil material generated from the excavated access road works will be transported back to the borrow pit to aid final reinstatement. Excavated topsoil and subsoil will be kept separate at the excavation and storage areas.
15. Where drop offs greater than 1.0m in height occur alongside road edges; physical edge protection will be constructed to reduce the risk of vehicles overturning. Trackside marker posts will also be erected to delineate road edges in poor weather.
16. The appointed contractor will ensure that on site personnel will be aware of environmental constraints / sensitive areas within the proposed wind farm in which works are to be avoided.

Plate 3-3: Wind farm site example of the proposed new founded track

3.4.1.3 New Floating Tracks

Floating tracks will be utilised where gradient and topographical conditions permit. The use of floating road methods will minimize the excavation of material and reduce interference with the existing drainage regime in these areas of the site. A combination of geogrid and geotextile will be placed over the vegetation on the existing surface to be traversed with the floating road. A minimum thickness of 450mm of site won aggregate, will be placed over the bottom layer of geogrid / geotextile. This will be overlain with a 150mm UGM A or similar material.

Where new access tracks will be constructed through forested areas, the felled trees may be used in the construction of the floating tracks as outlined in the Coford Forest Road Manual (2004, see references at end of document). This construction method involves layering the brash from the felling process on the existing ground surface and placing the felled trees perpendicular to the direction of travel to benefit from the load spread thereby provided. A combination of geogrid and geotextile will be placed on top of the felled trees and the road construction completed using the same construction method as that outlined in Section 3.4.1.2. An image of a floated road in shown in Plate 3-4 for further details refer to Planning Drawings 23318-MWP-00-00-DR-C-5406.

The sequence of constructing floating tracks will comprise the following as per guidance from the Scottish Natural Heritage / Forestry Commission Scotland (Forestry Civil Engineering - FCE) on the construction of floated tracks:

1. The appointed contractor will liaise with the wind turbine supplier prior to the commencement of the works to ensure that the design of the tracks conforms with the wind turbine supplier's specifications and no works beyond that which have received planning permission will be undertaken.
2. The appointed contractor will mark out the line of the proposed floated road using a GPS / total station.
3. Drainage measures to ensure the separation of overland clean water flow from construction run-off will be implemented as outlined in Section 3.14
4. The intended floating road area is cleared of major protrusions such as rocks, trees, bushes etc down to ground level but residual stumps and roots are left in place. The area for floating tracks is the same as the founded track, the vegetation removal is similar for both tracks.

5. The local surface vegetation and soils are left in place where possible as the existing vegetation and root mat may be the strongest layer in the system and care will be taken to preserve this layer however if this layer impacts the road design, the vertical and horizontal alignment, the subbase or the access track drainage this layer will be removed.
6. Any local hollows and depressions are filled in with a suitable local lightweight fill such as tree brash, logs, or geogrid / geotextile material with aggregate.
7. A formation, 7 to 8m, wide is prepared where a layer of geogrid / geotextile is laid out by hand along the line of the proposed floated road.
8. The specification for geotextiles will be finalised by the design engineer at construction stage.
9. Where there is a drainage requirement, suitably sized HDPE drainage pipes shall be laid on top of the installed geogrid / geotextile prior to the placement of aggregate. Cross drains will be laid at appropriate intervals to maintain the existing drainage regime on the site.
10. The material required for the floated access tracks is proposed to be used from either the proposed on-site borrow pit, suitable excavated material within the proposed wind farm and imported aggregate from the nearby quarry. All tracks will be finished with imported 150mm crushed stone of UGM A, or similar aggregate type material.
11. Where the extraction of aggregate from the proposed borrow pit is used it will be undertaken by excavators and loaded onto articulated dumper trucks that will deliver the aggregate to the required road widening / upgrading locations.
12. Wide tracked excavators will be used for constructing the floated tracks by cascading a minimum 450mm thickness of aggregate over the geogrid / geotextile. The aggregate will be suitably sized to achieve a sound interlock with the geogrid / geotextile material. Compaction of the aggregate is done by the wheels and tracks of construction plant alone for floated road construction on wind farms.
13. Where poor bearing capacity under the proposed track is anticipated, an additional layer of geogrid/geotextile reinforcement may be installed on top of the aggregate layer prior to applying the 150mm UGM A wearing course.
14. All floated access tracks will be constructed to a minimum drivable width of 5.0m with a maximum crossfall of 2.5% in order that water can flow off the tracks and reduce the risk of rutting / potholes occurring.
15. Trackside drains as per Section 3.14 will be constructed to manage clean and dirty water runoff along floated tracks.
16. Where drop offs greater than 1.0m in height occur alongside road edges; physical edge protection will be constructed to reduce the risk of vehicles overturning. Trackside marker posts will also be erected to delineate road edges in poor weather.
17. To allow for the safe movement of site traffic during the construction of floated tracks; a site traffic management plan will be prepared by the appointed contractor in accordance with the Traffic Management Plan (TMP) (Volume III, Appendix 16A) submitted with this application. Care will be taken when reversing vehicles on floating tracks to ensure that they do not run along the edge of the road but stay within the delineated safe running zone.
18. The appointed contractor will ensure that on site personnel will be aware of environmental constraints / sensitive areas within the proposed wind farm site in which works are to be avoided.

Plate 3-4: Wind farm site example of the proposed floated track

3.5 Wind Turbines

3.5.1 Wind Turbine Locations

During the design phase, the final step in positioning turbines was to minimise the volume of excavated spoil and to achieve as close as possible to a balance of cut and fill of the underlying strata at each turbine location. This was achieved by orientating the turbine base and crane hardstanding area with its long axis parallel to the ground contours as much as possible while taking account of access criteria for delivery of turbine components. This required adjustment to the position of the access road on the approach to the turbine site. Table 3-1 gives information of the site, ground slope and peat depth at and in the vicinity of each of the proposed turbines.

Table 3-1: Ground Parameters at Turbine Sites

Turbine	Land Use Category	Slope	Peat Depth
T1	Agricultural Area - Pastures	<3°	0.0m
T2	Agricultural Area - Pastures	<3°	0.0m
T3	Agricultural Area - Pastures	<3°	0.3m
T4	Agricultural Area - Pastures	<3°	0.0m
T5	Agricultural Area - Pastures	<3°	0.0m
T6	Agricultural Area - Pastures	<3°	0.0m
T7	Agricultural Area - Pastures	<3°	0.0m
T8	Agricultural Area - Pastures	<3°	0.0m
T9	Agricultural Area - Pastures	<3°	0.0m
T10	Agricultural Area - Pastures	<3°	0.0m

3.5.2 Turbine Crane Hardstands

The layout of the crane hardstand is designed to accommodate the delivery of the turbine components prior to their erection and to support the cranes during erection, as shown in Plate 3-5. Hardstands are also used for maintenance during the operation of the turbine. The hardstands will be rectangular in shape with additional lay down areas to store the turbine blades once delivered and crane pads for construction and maintenance. Refer to Planning Drawing 23318-MWP-00-00-DR-C-5404 for further details. Due to the significant loads that will be imposed by the outriggers of the main lifting crane during the turbine erection process; it is proposed that the hardstands will be constructed using excavation methods over the footprint of the hardstand area / turbine base.

The proposed works will be restricted to the turbine locations and will comprise the following:

1. Each crane hardstand will be formed on competent subgrade of the underlying subsoil / rock which will comprise of aggregate (obtained from either the on-site borrow pit, excavated works, or imported from a nearby quarry) laid on a geotextile filter membrane.
2. Any existing unsuitable soil found within the footprint of the turbine hardstand will be excavated out during formation works. The excavation works will be carried out using hydraulic excavators where surplus subsoil material will be transported to the on-site deposition areas via articulated dumper trucks or tractor and trailer for subsequent reuse in the permanent reinstatement of the borrow pit.
3. The aggregate for the turbine hardstands will be compacted in 250mm layers and will vary from approximately 300mm to 900mm deep depending on the gradient of the underlying subgrade.
4. Temporary set down areas will be formed to facilitate the storage of the turbine components at each crane hardstand (e.g., the turbine blades, the turbine towers, and nacelle). Each temporary set down area will be constructed using compacted aggregate which will be fully removed and reinstated after all turbines have been erected.

5. Plate bearing test results will be undertaken on the finished hardstand surface to check if ground bearing strengths are to the wind turbine supplier's specifications. Once complete the assembly cranes will be set up on the hardstand and erect the wind turbine into place.
6. Where drop offs greater than 1.0m in height occur alongside hardstand edges; physical edge protection will be constructed to reduce the risk of vehicles overturning or persons falling.

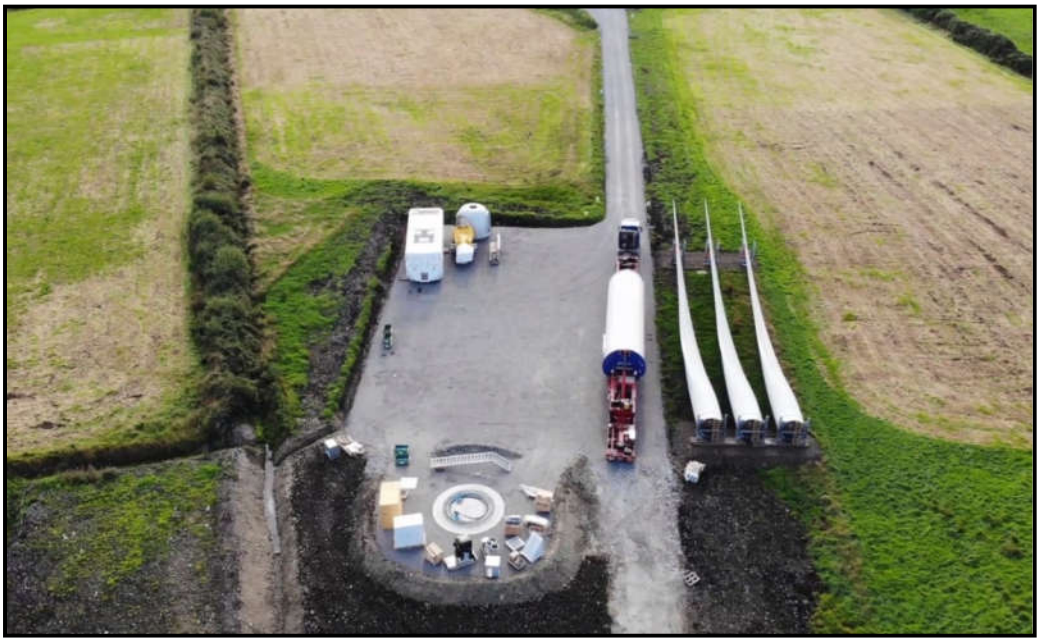

Plate 3-5: Wind farm site example of the proposed finished hardstand

3.5.3 Turbine Bases

It is proposed the 10 no. wind turbines will have a reinforced concrete base pad foundation with a central pedestal above the base, that will in turn support the wind turbine tower. Each turbine base will bear onto rock or other such suitable bearing stratum , that depend on the strength at formation level and will be constructed utilising a spread foundation, which is wide and shallow. A typical foundation will be approximately 32m in diameter and will be installed to a depth of approximately 4.0m below ground level. Approximately 1200m^3 of concrete and 140 tonnes of steel will be used in the construction of each turbine base. Estimated material quantities required for the construction of the turbine bases are shown in Section 3.13. Refer to Planning Drawing 23318-MWP-00-00-DR-C-5403 for further details.

The proposed works will be restricted to the turbine locations and will comprise the following:

I. The extent of the excavation will be marked out and will include an allowance for trimming the sides of the excavation to provide a safe working area and slope batter.
II. Any existing subsoil found within the footprint of the turbine base will be excavated out during formation works at the adjacent crane hardstand area. The excavation works will be carried out using hydraulic excavators where surplus subsoil material will be transported to the on-site deposition areas via articulated dumper trucks or tractor and trailer for subsequent reuse in the permanent reinstatement of the borrow pit.

III. Blasting at turbine locations and hardstands may be necessary to enable excavation of the rock if encountered at less than 3m depth. Any blasting will be carried out by a suitably qualified specialist under licence with a suite of mitigation measures in place. Blasting, and mitigation measures associated with the process, is discussed in further detail in the EIAR in Chapter 8: Land and Soils.

IV. Standing water may build up within the turbine excavations during the works. Dewatering of turbine base excavations will be carried out using pumps or gravity flow where possible. Any water pumped from the turbine bases will be put through settlement ponds to ensure suspended solids are removed from the water prior to entering any water courses; dewatering is discussed in further detail in the EIAR in Chapter 9: Water Sections 9.4.2.8 and 9.4.3.7

V. The excavated surface will be levelled, and adequate drainage measures will be put in place along with suitable set back areas to facilitate placing of aggregate and ultimately the erection of shuttering for the turbine base.

VI. If poor ground conditions are encountered during excavation and a significant depth to sub-formation is required, a piled foundation may be considered. A piled foundation requires the use of a piling machine equipped with an auger drill to rotary bore a number of holes around the area of the turbine base to the sub-formation depth determined at construction stage. Once all the holes have been bored, reinforcement steel is inserted into each with concrete poured afterwards.

VII. Suitable aggregate will be used to form a solid level working foundation surface. The aggregate will be rolled and compacted to a suitable formation level.

VIII. Shutters and steel reinforcement will then be put in place and the foundation of the turbine will be prepared for pouring of concrete.

IX. A layer of concrete blinding approximately 75mm thick will be laid directly on top of the newly exposed formation, tamped and finished with a screed board to leave a flat level surface. The concrete will be protected from rainfall during curing and all surface water runoff from the curing concrete will be prevented from entering surface water drainage directly.

X. High tensile steel reinforcement will be fixed in accordance with the design drawings and schedules. The foundation anchorage system will be installed, levelled and secured to the blinding using steel box section stools.

XI. Ductwork will be installed for services, such as but not limited to power and drainage and formwork erected around the steel cage and propped from the backside as required.

XII. The foundation anchorage system will be checked both for level and line prior to the concrete being installed in the base. These checks will be passed to the turbine supplier for their approval. See Plate 3-6 below showing a turbine base ready for pre-pour inspection.

XIII. Ready-mix concrete will be delivered to each turbine base by a fleet of ready-mix concrete trucks via the internal access tracks. Concrete will be placed into each base by means of a concrete pump where vibrating pokers will be used to ensure that full and proper compaction of the concrete around the reinforcement in the turbine base has been made. Upon completion of the concreting works the foundation base will be covered and allowed to cure.

XIV. Steel shutters will be used to pour the circular chimney section.

XV. Following curing, the shuttering around the turbine base will be struck and removed.

XVI. Earth wires will be placed around the base; and,

XVII. The foundation will be backfilled with a cohesive material, where possible using the material arising during the excavation and landscaped using the vegetated soil set aside during the excavation. A gravel footpath will be formed from the access track to the turbine door and around the turbine for maintenance.

Plate 3-6: Wind farm site example of the proposed turbine base construction

3.6 Internal Collector Cables

A network of underground cabling serving each turbine with electrical power and signal transmission will be installed within the site. The distribution system will electrically connect the wind turbines to the proposed Brittas on-site substation. Cable jointing bays will be required to allow cables to be jointed from the turbines to the proposed Brittas substation.

Cabling on site is proposed to consist of single or twin cable trenches for open ground sections and for trenches within internal access tracks. A cable marker post will be installed on top to protect and identify the cable trench underneath. The build up for the internal site cable trenches will consist of selected excavated backfill on top of bedding material. The minimum cover depth over the ducts will be 750mm which is measured from the top of the cable duct to existing ground level. Where ducting is within internal access tracks; the cable trench will be backfilled with lean-mix concrete to protect ducting from being damaged by heavy axle loads that will pass above. The excavated material generated from the trenches will be reused as backfill where possible or alternatively it will be deposited within the proposed on-site borrow pits as part of their reinstatement.

Where an open drain or watercourse is encountered during the installation of the internal site cable trenches; the cable trenches will cross the open drain or watercourse within the track carriageway via proposed or existing track crossing points to minimise the requirement for in-stream works. Details on the water crossings are include in Chapter 9: Water. Marker tapes of non-corrodible material in bright red and yellow colour will be placed within the trench after backfilling for identification and safety purposes in accordance with ESB Networks guidelines. An earth berm will be placed over the cable trench with a marker post installed on top in a secure and robust manner to prevent the post from being damaged by animals or prevailing ground conditions. Cable marker posts will either be made of concrete, recycled plastic, or timber material. Each marker post will contain appropriately worded warning signage highlighting to persons the presence of high voltage electricity cables underneath. Refer to Planning Drawing 23318-MWP-00-00-DR-C-5408 for further details.

3.7 Grid Connection Route

The grid connection route of the proposed project runs between the proposed Brittas on-site substation within the wind farm site in the townland of Killeenleigh and the existing Thurles 110kV substation in the townland of Ballygammane. The overall 110kV connection cable route will be approximately 7.0km and is outlined below in Figure 3-3.

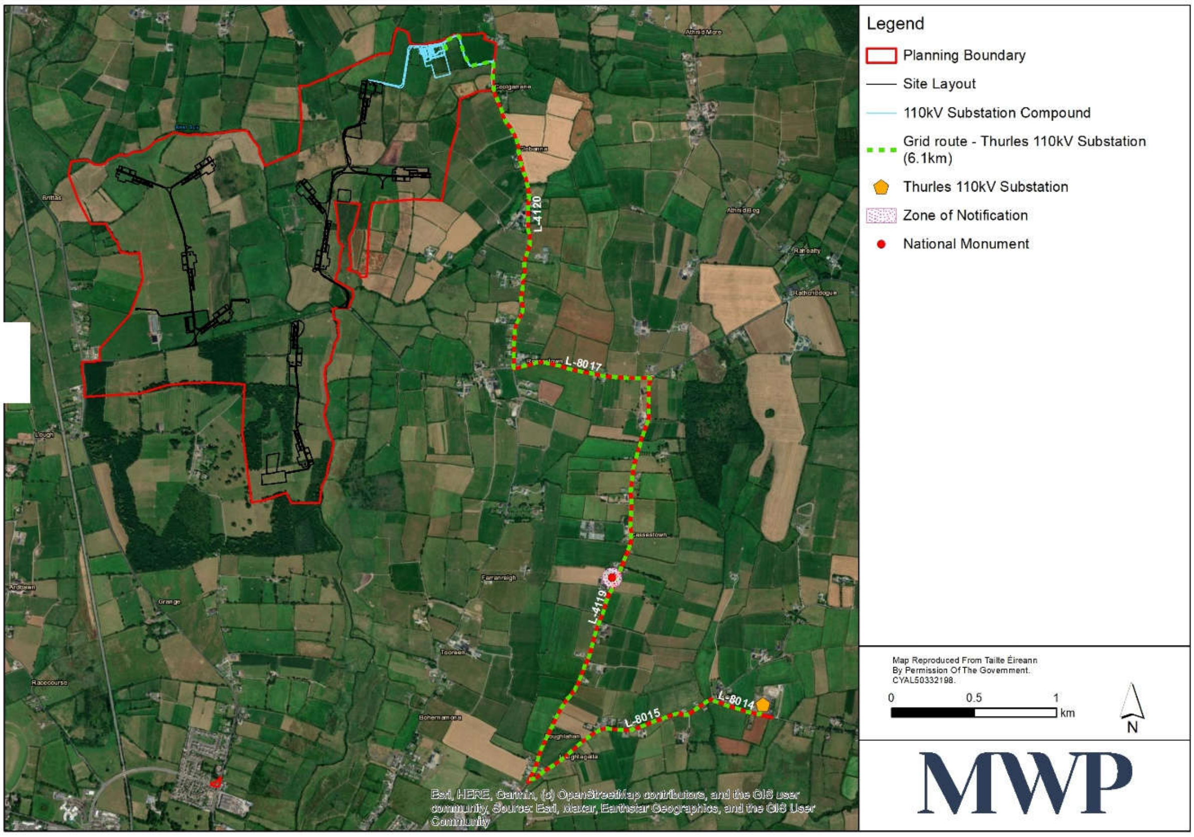

Figure 3-3: Grid Connection Route

3.7.1 Excavation and Duct Installation

The grid connection route will consist of an underground 110kV cable that will be carried within a single cable trench as shown in Planning Drawing 23318-MWP-00-00-DR-C-5427.

The installation of the grid connection involves the following process.

- Prior to works commencing, the area where excavations are planned will be surveyed and all existing services will be confirmed. All relevant bodies i.e., ESB Networks, EirGrid, Gas Networks Ireland, Eir, Tipperary County Council (TCC) etc. will be contacted and drawings for all existing services sought. A road opening licence will be obtained from TCC for the relevant road sections. All plant operators and general operatives will be inducted and informed as to the location of any services.
- Prior to works commencing a dilapidation survey will be carried out photographing and noting any existing damage or defects to structures or road surfaces. A copy of this survey will be submitted to TCC prior to works commencing.
- Prior to works commencing, the route will be inspected and marked out on the ground. Standard good practice preparatory measures are then put in place along the extent of the route. This will include any required warning notices, temporary barriers, etc.
- Prior to works commencing a TMP will be prepared by the appointed contractor and agreed with Tipperary County Council. The proposed TMP is included in Appendix 16A of Volume III of the EIAR.
- During construction works, the trench within the road will be excavated using a wheeled or rubber tracked excavator and hydro vac for crossings services, see Plate 3-7. As stone fill is removed it is temporarily stockpiled adjacent to the trench for re-use in backfilling. In some instances, some soil or unsuitable material may be encountered in the trench, and this is removed from site and brought to an appropriate licensed facility for disposal.
- The trench is then prepared to receive concrete bedding and surround for the ducts. The ducts are surrounded by concrete with adequate cover over the duct.
- Once the concrete is suitability set, appropriate imported aggregate material is placed over the concrete surround and filled back up to the top of the trench. Suitable warning tapes will also be installed in the trench. An example is shown in Plate 3-8.
- Once the trench is filled, the trenching and ducting process will move along the road in planned stages.
- The trench surface receives a temporary dressing of macadam or spray and chip, shown in Plate 3-9 below. Once the overall scheme is completed, the grid connection route and associated road areas will receive a new permanent macadam finish as agreed with Tipperary County Council.
- Joint bays are to be installed at maximum spacings of 750m centres along the grid connection route in the public road or along the grass margin of the public road. Once installed they are temporarily reinstated until they are opened again to allow for pulling cables through the ducts and jointing the cables afterwards. The joint bays will then be permanently backfilled and reinstated to the satisfaction of Tipperary County Council.
- Horizontal Directional drilling will be used where there is insufficient cover on a bridge crossing to allow the grid connection route pass over the crossing in a standard or flatbed trefoil formation. Proposed locations of horizontal directional drilling are described in Table 3-2 below. The launch and reception pits to be made in the public road or grass margin will be permanently backfilled and reinstated to the satisfaction of Tipperary County Council.
- The as-built location of the ducting will be surveyed using a total station / GPS.
- A condition survey will be carried out on the tracks affected by the grid connection route, both pre and post construction. This will include a video survey of the road extent with any significant dilapidations further recorded by photography and local surveying as required.

Plate 3-7: Grid Route example of the proposed excavation works for a cable trench

Plate 3-8: Grid Route example of the proposed ducting installation works for a cable trench

Plate 3-9: Grid Route example of the proposed permanent reinstatement works for a cable trench

3.7.2 Grid Construction - Watercourse Crossings

The grid connection route crosses 2 watercourses (see Figure 3-4 below). Both watercourse crossings are along public roads.

The watercourse crossing on L4120-18 (Rossestown Road) is a single span masonry arch span bridge. The 110kV cable will cross the bridge in a flatbed formation or alternatively a horizontal directional drill (HDD) methodology will be used. Descriptions of the methodologies proposed for crossing this bridge are given in sections.3.7.2.4 and 3.7.2.5. No instream works will be required.

The watercourse crossing on L8015-0 (Furze Road) is a single span masonry arch span bridge. The 110kV cable will cross the bridge in a flatbed formation or alternatively a horizontal directional drill (HDD) methodology will be used. Descriptions of the methodologies proposed crossing this bridge are given in section 3.7.2.5 and 3.7.2.5. No instream works will be required.

Overall, In-stream works are not required along the proposed grid connection route.

Table 3-2: Summary of Watercourse Crossing Methodologies

Crossing Number	Crossing Type	Cover Assessment	Crossing Methodology	In-Stream Works Required	Watercourse Crossing Notes
1	Single span arch stone	Unknown	HDD/Flatbed	No	Heavily vegetated in the vicinity of the bridge
2	Single span arch stone	Low cover	HDD/Flatbed	No	A detailed survey of the existing services crossing the bridge is required to determine if a corridor is available for the proposed cable. If a corridor is available, then separation distances from existing services will need to be maintained

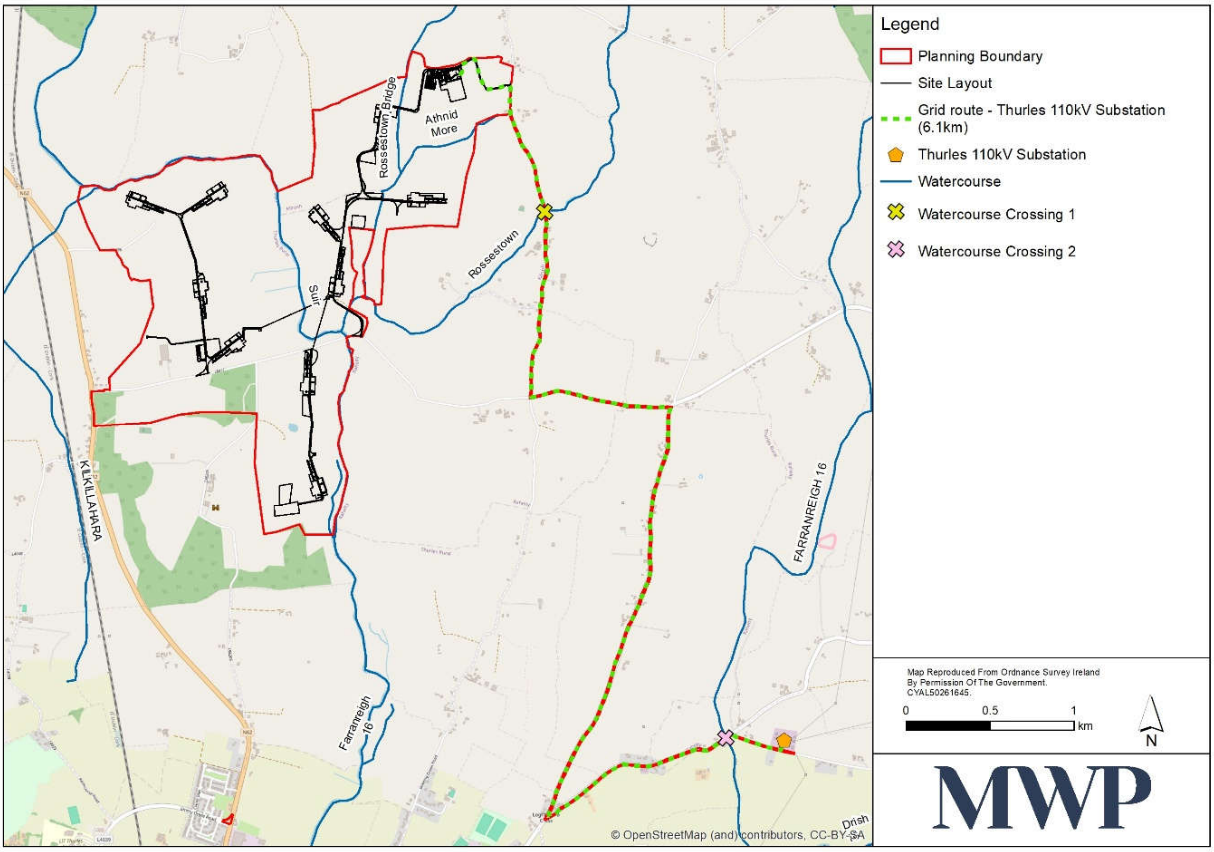

Figure 3-4: Watercourse Crossings Points

3.7.2.4 Option 1 - Flatbed Formation over Water Crossings and Services

Where ducts are to be installed over an existing bridge and sufficient cover cannot be achieved by installing a standard trefoil arrangement (min 600mm cover required for Trefoil), the ducts will be laid in a much shallower trench. The ducts will be laid in a flatbed formation over the existing bridge and encased with galvanized steel plates in a concrete surround.

It may be necessary to locally raise the level of the existing road to achieve the required cover over the ducts. The increased road level will be achieved by overlaying the existing road with a new wearing course where any addition of new pavement will be tied back onto the existing road. Any works to locally raise the level of the existing road and potentially the bridge parapets will be agreed with TCC prior to commencement with all works and reinstatement carried out to their satisfaction. Once the ducts have crossed the bridge the ducts will resume to the standard trefoil arrangement.

3.7.2.5 Option 2 – Horizontal Directional Drilling under Bridges, Watercourses and Services

If putting the ducts in a flatbed arrangement is not feasible or is not preferred by the Local Authority, directional drilling will be utilised, which will require a service trench (launch pit) for the drill within the road corridor, either side of the watercourse. The directional drill process will require that the depth of the service trench will deepen in a defined slope as it approaches the watercourse crossing on either side, as to have sufficient passing depth under the watercourse. This method of duct installation is shown on Planning Drawing 23318-MWP-00-00-DR-C-5429.

Horizontal directional drilling will be carried out as follows:

- The directional drilling machine will set up at a launch and reception pit (an enlarged portion of on-road trench, i.e., a service trench on either side of the crossing point at an appropriate distance back from the watercourse). The drill will then bore in an arc under the watercourse feature.
- The drilling head of the boring tool has a series of nozzles that feed a liquid bentonite mix along the bore direction, which provides both lubrication and seals the cut face of the bore.
- Once the bore reaches the far side, the duct is then attached to the drill head and the duct is pulled back along the route of the bore to the original drilling point.
- Any bentonite mix is deposited within the bore shaft and spillage is collected at either end of the bore with a dedicated sump; all excavated material and excess bentonite will be removed from site and brought to an authorised waste facility.
- Once the duct is in place under the watercourse, the normal process of road trenching can continue from either side of the watercourse structure.
- The launch and reception pits will be backfilled in accordance with normal specification for backfilling excavated trenches and to the satisfaction of Tipperary County Council.

Typical photographs and schematics of the directional drilling process are provided in Plate 3-10 and Figure 3-5.

Plate 3-10: Grid Route example of horizontal directional drilling rig and launch pit

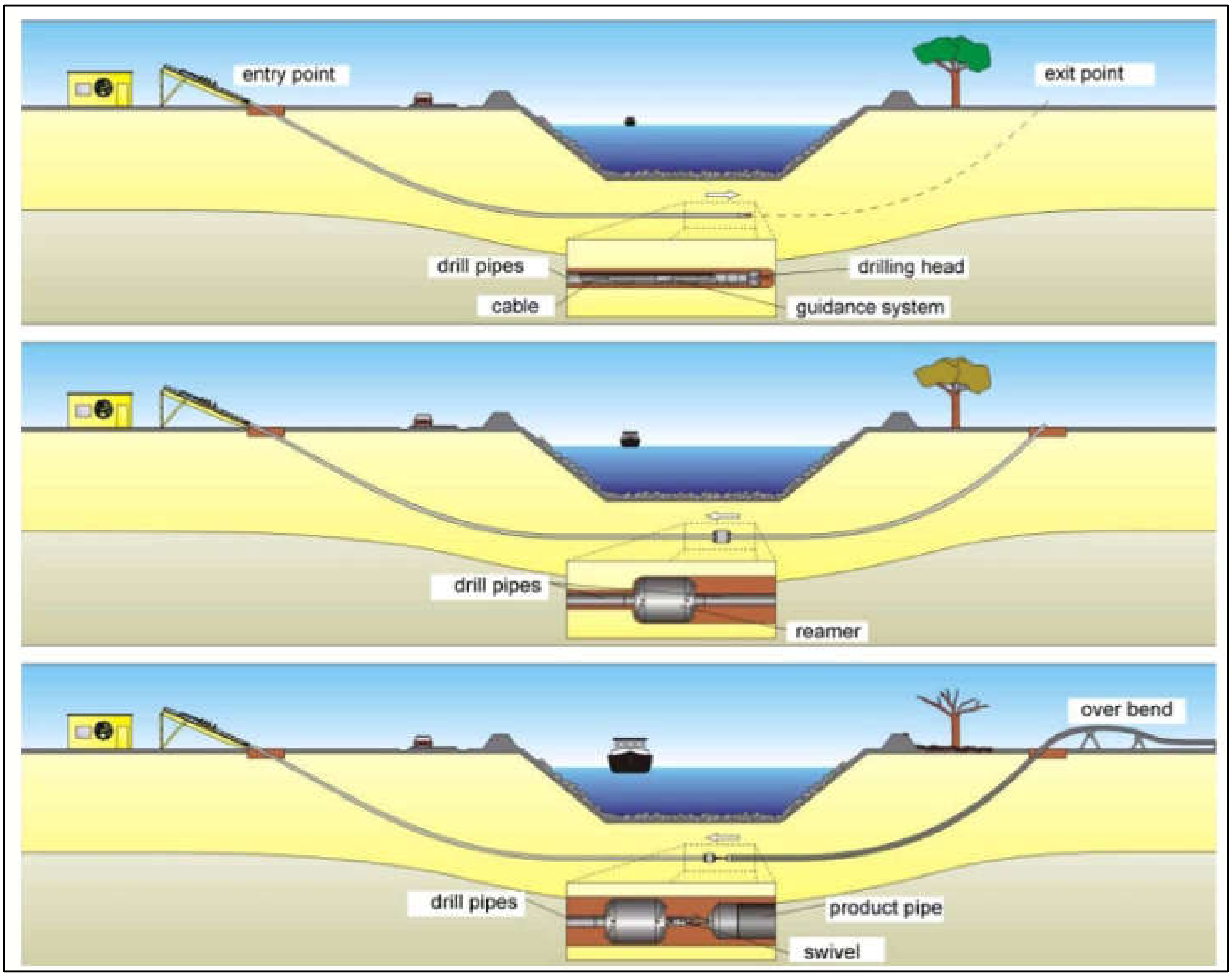

Figure 3-5: Horizontal directional drilling rig and launch pit (From Bayer, H.J. HDD practice handbook (2005), Vulkan-verlag GmbH, Essen Germany)

3.7.3 Grid Connection Construction - Land Drainage Ditches

Where land drains are encountered on the proposed grid connection route, there are two scenarios, as follows:

I. If there is adequate cover over the drain crossing, then the new ducts and trench will pass over the drain without interruption to the drain. No works will be required within the drain at these locations. The trench at these locations will be installed in the existing public / access road.

II. In the event where there is insufficient cover over a drain crossing point, the new grid connection route will have to be installed underneath the existing drain crossing. To do this the following approach is adopted:

- The drain is blocked upslope of the crossing, and a sump is formed using sandbagging and stable clay soil material. This sump will accumulate water flow in the drain and will facilitate the use of an adequately sized submersible pump based on expected flow rates to over pump (fluming) the drain water across the road and back into the drain on the down flow section below the road.

- Two silt fences and filters will be put in place on the downslope of the crossing point to prevent siltation/sedimentation. Once the sump and over-pumping mechanism is in place, then the service trench excavation will progress.
- A section of drain crossing (pipe or culvert) is temporarily removed to allow the trench and duct to continue. The duct will pass under the drain and once in place it will be surrounded with lean mix concrete and then the trench will be backfilled with suitable aggregate from excavations or imported.
- The drain will then be put back in place, surrounded with stone/lean mix concrete and the track restored to its finished level. The over-pumping measure can then be removed and normal drain flow resumes. The duct/trench work can then progress over the remaining length of the public / access road.

3.7.4 Grid Connection Construction – Existing and Proposed Underground Services

Prior to the commencement of construction activities, the contractor carrying out the works is required to contact all relevant bodies i.e., ESB Networks, EirGrid, Gas Networks Ireland, Eir, TCC etc. and drawings for all existing underground services along the grid connection route sought. Any underground services encountered will initially be surveyed for levels to determine if there is adequate cover available for ducting to pass over these services. A minimum clearance of 300mm is required from the bottom of the ducting to the top of any underground service as per ESB Networks requirements. If this clearance cannot be achieved, the ducting will pass below the service with a minimum 300mm clearance maintained from the top of the ducting to the bottom of the service.

If the required separation distances cannot be achieved by either going above or below the underground service, then alternative ducting layouts and construction options are available as outlined section 3.7.2.

The proposed underground grid connection route, refer to Figure 3-3 is approximately 7.0km in length between the existing Thurles 110kV Substation running southwest along L8015 and north along L4119 then west along L8017 and north again along L4120 to site access point D and the proposed project substation location.

The proposed location of the underground HV ducting is subject to during confirmatory investigations and if the proposed location identifies obstructions, such as but not limited to is subject to unidentified services, boundary encroachment, unidentified structures consultation will be carried out with TCC and other relevant stakeholders to confirm the location which will be within the parameters proposed and assessed in this planning application. TCC has regard to all environmental protection measures outlined in the planning application and accompanying technical reports. Any such minor modification will be within the planning boundary.

3.7.5 Grid Connection Construction - Joint Bays and Communication Chambers

Joint bays are pre-cast concrete chambers that will be required along the grid connection route over its entire length. They are required to join cables together to form one continuous cable. They will be located at various points along the grid connection route approximately every 500 - 1,000 metres, the exact location is subject to factors such as but not limited to road gradients, existing services, ground conditions and horizontal alignment of the road. It is proposed to install approximately 12 no. joint bays and communication chambers along the proposed grid connection route, the position and location of the joint bays is shown on This method of duct installation is shown on Planning Drawing 23318-MWP-00-00-DR-C-5428. The final locations of the joint bays are subject to confirmatory investigations and agreement with TCC prior to construction.

Where possible, joint bays will be in areas where there is suitable widening or grass margin on the road to accommodate easier construction and disrupt less traffic. During construction, the joint bay locations will be fenced off and will be incorporated into the grid connection TMP. A TMP is included in Appendix 16A of Volume III of the EIAR., which will be finalised and agreed with TCC prior to the commencement of works in accordance with the parameters set out in this EIAR. Once the joint bays have been constructed, they will be temporarily backfilled until they are re-excavated later to allow for the pulling and jointing of cables at each joint bay. Once complete, the joint bays will be fully backfilled and permanently reinstated to the satisfaction of Tipperary County Council.

The joint bays and communication chambers will be either precast or cast *in situ,* depending on contractor preference. In order to place the boxes, the area of excavation will first be marked out on the ground and any necessary preparatory protection measures put in place to avoid any runoff or loss of soil materials, details on preparatory protection are shown in Section 3.13 and Section 0. These include appropriate siltation measures along trackside drainage (silt fences, check dams etc.).

The material excavated from the joint bay chambers will be removed from site and brought to a suitably licensed facility. Prior to the chamber being installed in a compacted layer of suitable stone or lean mix concrete, appropriate material will be placed in the excavation to a level surface. The boxes are then positioned *in situ* and backfilled around them with imported crushed stone material. The precast concrete joint bay chamber cover is then put in place at a suitable level to allow for a new road surface and chamber cover over. Plate 3-11 shows a typical joint bay installation.

Plate 3-11: Grid Route example of the proposed joint bay construction

3.8 Substation, IPP & BESS Compound and Buildings

This section describes the construction methodologies that will be used for the EirGrid substation building, the Independent Power Producer (IPP) building, Battery Energy Storage System (BESS) as well as the substation and BESS compounds. A visual representation of a finished product is provided below, refer to Plate 3-12 & Plate 3-13

The proposed works will be restricted to the site construction area and will comprise the following:

- Prior to construction, interception ditches will be installed upslope of the proposed substation compound to intercept any existing overland flows (clean water) and convey it downslope to limit the extent of surface water coming into contact with the works. The clean water conveyed will be discharged via a level spreader downslope of the works over existing vegetation.
- The area of the substation compound will be marked out using ranging rods or wooden posts and the soil stripped and removed to a temporary storage area (in development footprint) for later use in landscaping. All remaining excavated material will be brought to the on-site borrow pit / storage areas for final deposition. The area will be surveyed for existing utilities and all existing services will be identified. All plant operators and general operatives will be inducted and informed as to the location of any services.
- Perimeter drains will be installed or upgraded to collect surface water run-off from the substation compound which will include the installation of check dams, silt traps and level spreaders to cater for surface run-off.
- All soils on the substation site will be removed and replaced with site won compacted crushed rock or granular fill.
- Formation of the substation compound will be achieved where the compound will be constructed with compacted layers of suitable hardcore.
- The foundations for both substation buildings will be excavated and appropriately shuttered. Reinforced steel will be placed within the shuttering and concrete will be laid over it.
- The blockwork walls for each substation building will be built up from the footings to DPC level and the floor slab constructed, having first located any ducts or trenches required by the follow on mechanical and electrical contractors.
- The blockwork will then be raised to wall plate level and the gables and internal partition walls formed. Scaffold will be erected around the outside of the two buildings for this operation.
- The concrete roof slabs will be lifted into position using an adequately sized mobile crane.
- The construction and components of the substation buildings will be to EirGrid and ESB Networks specifications.
- The timber roof trusses at each building will then be lifted into position using a telescopic loader or mobile crane depending on site conditions. The roof trusses will then be felted, battened, tiled, and sealed against the weather.
- Installation of a domestic wastewater holding tank to hold effluent from the toilets within the substation buildings.
- Installation of a Class 1 full retention oil separator to collect and treat oil spills within the substation compound.
- Installation of a rainwater harvesting tank to collect rainwater from the roofs of the substation buildings for toilet flushing and hand washing.

- Commencement of civil works associated with the construction of the transformer bund, equipment plinths etc. within the substation compound.
- Commencement of civil works associated with construction of underground cable ducts and trenches within the substation compound.
- Installation of electrical equipment within the substation compound and buildings including transformers, busbars, circuit breakers, cable supports, switchgear, panels etc. and all associated cabling.
- Installation of palisade fencing and associated gates to perimeter of the substation compound.

Plate 3-12: Wind farm example of the proposed substation building and compound

Plate 3-13: Wind farm example of a BESS Compound

3.9 Diversion of 38kV line

In order to facilitate the construction and operation of the proposed wind farm, a diversion of an existing on-site 38kV overhead line will be required. This diversion will be part of a separate planning application; however, the diversion will consist of either an overhead line or an underground cable. The proposed diversion route options are shown in Figure 3-6.

The construction process for the undergrounding of the line will be as per that described in Section 3.6.Internal The construction process for the horizontal directional drill will be as per that described in Section 3.7.2.5. The construction process for the overhead diversion of the line will involve constructing new poles/masts along the route. The new poles will require excavation for the foundation (pile or raft, depending on ground strength at formation level) and the erection of the pole/masts using a crane.

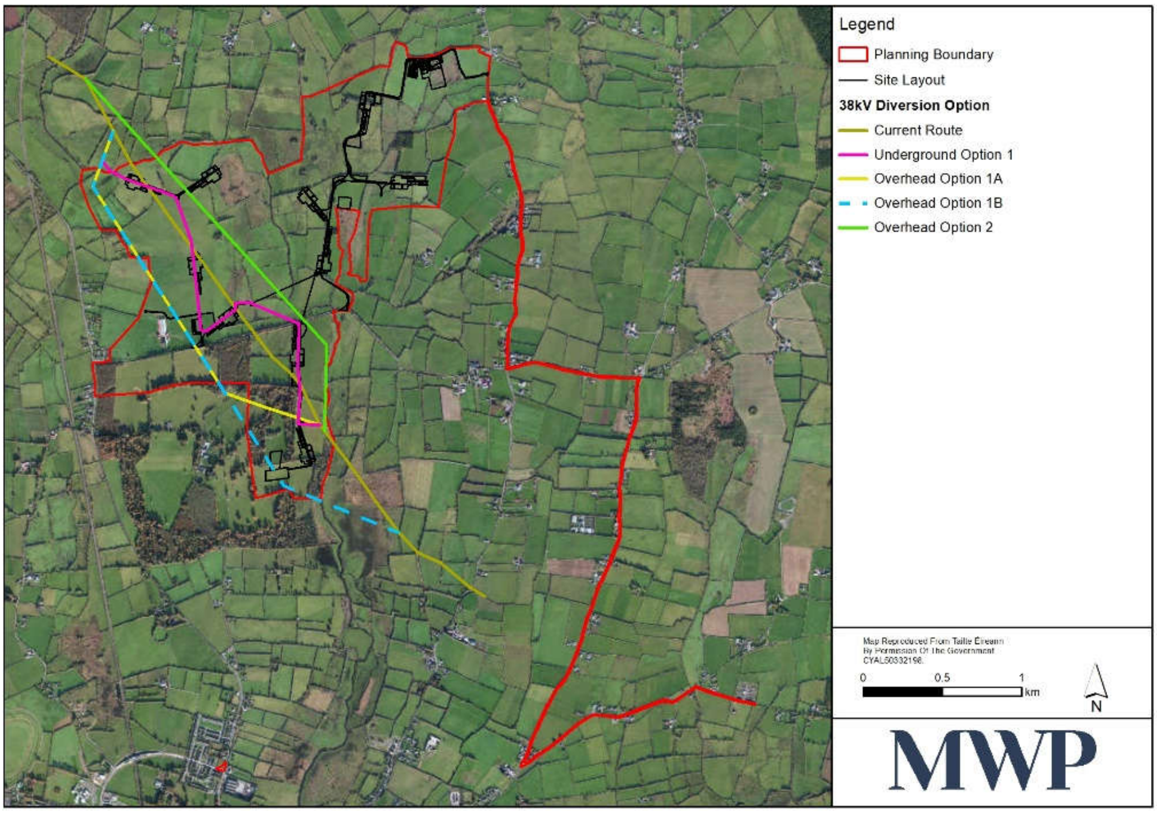

Figure 3-6: ESB 38kV overhead line diversion options through the wind farm site.

3.10 Meteorological LiDAR Monitor

A permanent meteorological Lidar monitor is proposed for the site to monitor the wind regime while the proposed wind farm is in operation. The meteorological Lidar monitor will be located adjacent at the western side of the site (see Figure 3-7). The meteorological Lidar monitor is approximately 1m in height and will l be housed in a steel box. There's an existing farm track that provides access to the location of the proposed permanent meteorological Lidar monitor. Details of the meteorological LiDAR unit are shown in This method of duct installation is shown on Planning Drawing 23318-MWP-00-00-DR-C-5405.

The sequence of constructing upgrading existing track and hardstand will comprise the following:

1. The appointed contractor will liaise with the meteorological Lidar monitor supplier prior to the commencement of the works to ensure that the design of the upgraded track and hardstand conforms with the supplier's specifications and no works beyond that which have received planning permission will be undertaken.
2. The appointed contractor will survey the area for any unforeseen hazards prior to the commencement of works and set up warning signage as appropriate.
3. Drainage measures to ensure the separation of overland clean water flow from construction run-off will be implemented as outlined in Section 3.14.
4. Excavators will first remove any topsoil / vegetative layer which may be present. This material will be transported to the temporary storage area and maintained for re-use during the restoration phase of the

proposed wind farm construction. Topsoil / vegetative removal will be kept to a minimum to prevent any runoff of silt during heavy rainfall.

5. Excavators will continue to strip and excavate the soft subsoil underneath which will be temporarily stored adjacent to the access tracks in accordance with approved methods with the use of an articulated dumper truck. Excavated material will only be temporarily stored on slopes under 5° and to a maximum height of under 1.0m until they are transported to the selected deposition areas where they will be permanently stored.
6. All excavations to be carried out will be battered back to a safe angle of repose (slope angle of 45°) but where excavations are in solid rock the safe angle of repose may be increased to a slope angle of 60°.
7. Once a section of the excavated access track is exposed to suitable formation; a layer of geogrid or geotextile material may be placed along its formation depending on ground conditions which will be covered with site won graded and according to the design specifications as required compacted in maximum 250mm layers.
8. The material required for the access track and hardstand is proposed to be used from either the proposed on-site borrow pit, suitable excavated aggregate material within the proposed wind farm and imported aggregate from a nearby quarry. All tracks will be finished with imported 150mm UGM A, or similar aggregate type material.
9. Installation of 2.4m palisade fencing and associated gates to perimeter of the LiDAR compound.

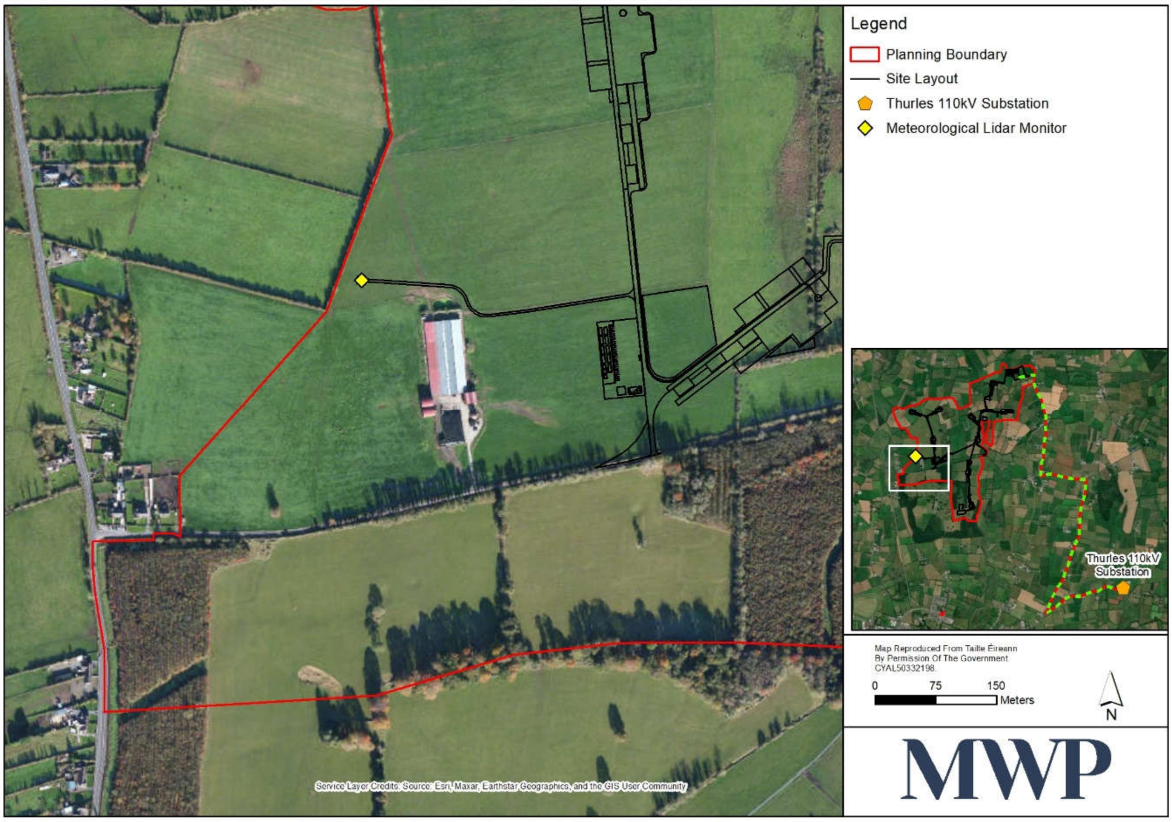

Figure 3-7: Location of permanent meteorological LiDAR monitor

3.11 Temporary Construction Compound

The temporary construction compound will be used for the construction phase of the proposed wind farm. Two temporary compounds will be required. The main temporary construction compound will have dimensions of 95m x 50m and the additional temporary construction compound will have dimensions of 55m x 25m as shown on Planning Drawing 23318-MWP-00-00-DR-C-5411 and 23318-MWP-00-00-DR-C-5412.

The exposed surface will be levelled out by cutting and filling and will be overlain with a layer of crushed stone from the proposed on-site borrow pit. The finished surface will be formed with a layer of UGM A or similar aggregate imported from a local quarry. The site compound will be graded and compacted out before the welfare container facilities are installed.

The compound will be constructed early in the construction phase of the proposed project to provide site offices and accommodation for staff and for the delivery of materials. Temporary compound measures such as but not limited to surface water management, bunding, waste management measures will also be put in place at the outset. Site security will be put in place adjacent to the entrance and will be maintained throughout all phases of the work. The compound will be in place for the duration of the construction phase and will be removed once commissioning is complete. This involves reinstatement of the area to its current use i.e. grassland. A typical example of a compound is shown in Plate 3-14

Areas within the compound will be constructed as access tracks and used as vehicle hardstanding during deliveries and for parking.

1. A bunded containment area will be provided within the compound for the storage of lubricants, oils, and site generators etc.
2. The compound will be fenced and secured with locked gates,
3. During the construction phase, a self-contained port-a-loo with an integrated waste holding tank will be used on site for toilet facilities. This will be maintained by the service contractor on a regular basis and will be removed from the site on completion of the construction phase.
4. Upon completion of the construction phase, the compound will be decommissioned by backfilling the area with the material arising during excavation, landscaping with topsoil as required.

Plate 3-14: Wind farm example of the proposed temporary site construction compound

3.12 Borrow Pit

The borrow pit proposed within the site will be used to obtain site won stone aggregate for use in the construction of the proposed wind farm. The volumes are summarised in Table 3-3. This borrow pit will be located within the southern area of the site where it will be used as a source of hardcore for the construction of access tracks, crane hardstands and construction compound. The details of the proposed borrow pit are shown on 23318-MWP-00-00-DR-C-5415.

Prior to commencement of excavation works, an interceptor drain will first be excavated upslope to intercept existing overland flows and divert them around the borrow pit prior to discharge via a buffer zone on the downslope side. Any subsoil material overlying the rock will be excavated and stockpiled. The stockpile will be sealed, and a perimeter drain installed to intercept any run-off so that it can be discharged through an appropriately designed silt trap.

Standing water, any surface water runoff or water pumped from within the borrow pit is likely to contain an increased concentration of suspended solids. Runoff or pumped water from the borrow pit will be isolated from the clean catchment runoff by means of a series of open drains that will be constructed within the area. These drains will be of check dams that will attenuate the flow and provide storage for the increased runoff from exceptional rainfall events. The settlement ponds have been designed to a modular size where if larger areas of runoff must be catered for at a single discharge point the size of the settlement pond will be increased pro rata.

Inspections of the borrow pit will be made by a geotechnical engineer through regular monitoring of the opening works. Excavators will extract the stone using buckets and a ripper attachment or rock-breaker attachments may be utilised in the borrow pit location. It is expected that excavators will be utilised in tandem in the extraction of rock from the borrow pit. The larger excavators will extract rock from the face and floor of the excavation using digging buckets and rock rippers and will be assisted by smaller excavators, removing rock as it is broken, stockpiling locally within the excavation as well as loading articulated dumper trucks removing rock as required for distribution within the proposed wind farm. The sides of the excavations will be battered back to a suitable angle of repose to be determined by the nature of the rock present. Regular examination of these batters will be carried out by a geotechnical engineer to assess the stability of the rock face and slopes on an ongoing basis. There will be no public access permitted to or within the borrow pit. Secure edge protection and fencing will be erected around the borrow pit with warning signage erected. A berm will be constructed as required, at the leading edge to ensure that articulated dumper trucks are stopped at a safe distance from the edge of the borrow pit during loading of extracted stone aggregate.

Blasting at the borrow pit may be necessary to enable excavation of the rock in the borrow pit and increase production rates to match the construction programme. Any blasting will be carried out by a suitably qualified specialist under licence. Blasting, and mitigation measures associated with the process, is discussed in further detail in the Chapter 8: Land and Soils and Chapter 12: Noise and Vibration of this EIAR.

The appointed contractor will monitor weather conditions regularly and when heavy rain events are forecasted, work will be stopped at the borrow pit area during the heavy rain period, to prevent excessive runoff from being generated.

On completion of extraction activities at the borrow pit; it will be used for the permanent storage of some of the excavated material from the turbine bases, crane hardstands, internal access road construction and other associated infrastructure. The borrow pit will also be suitably landscaped following reinstatement and vegetated.

3.13 Spoil Management and Material Volumes

3.13.1 Excavated Spoil Storage

Excavated spoil will be reused for the backfilling, landscaping, and restoration around the proposed wind farm infrastructure such as turbines and hardstands. The calculated volume of excavated material is summarised in Table 3-3.

Dedicated spoil storage areas and a borrow pit are proposed within the site. These will be used to deposit the generated material from the excavation of access tracks, foundations and hardstands and for spoil storage. The proposed locations for the borrow pit and spoil storage are shown on 23318-MWP-00-00-DR-C-5005.

Spoil will also be stored around the turbines to a maximum height of 1.5m. The felled areas around the turbines have been identified as a potential additional area that, subject to approval, will be used to store material; however, priority will be given to restoration of the borrow pit and the dedicated spoil storage areas.

Berms will be formed along sections of access tracks and hardstands that will act as a physical edge protection measure to prevent vehicles falling off where a drop off greater than 1m exists from the road / hardstand edge. Spoil generated onsite will be used to create these berms.

A summary of the construction material and spoil storage volumes are shown in Table 3-3 below.

Drainage and siltation control measures will be put in place in all spoil storage areas. This will include a dedicated drainage network, temporary silt fences and settlement ponds designed to cater for the size of each storage area. Further details of the drainage philosophy that will be applied as well as siltation control systems and attenuation systems is given in Section 3.14 of this report.

Table 3-3: Spoil Excavation and Construction Material Volumes

Item	Unit	Quantity
Total Excavation Volume	m3	163752
Excavated Material Stored or Reused Onsite	m3	128350
Excavated Material Removed from Site	m3	35402
Total Aggregate Volume	m3	143945
Imported Aggregate	m3	121625
Site Won Aggregate	m3	22319
Total Concrete Volume	m3	20040
Total Reinforcement Volume	Tonnes	1379

3.13.2 Temporary Storage of Excavated Material

No permanent stockpiles will be left on site after the completion of the construction phase works. After completion of the turbine base reinstatement works all remaining stockpiles are to be removed for permanent disposal at the proposed deposition areas within the site.

Any materials excavated during the construction phase which are to be used in the site reinstatement and landscaping process shall, in the first instance, be stored on site in an environmentally safe manner that will not result in the pollution of waters or the smothering of ecologically sensitive habitats. Impacts and mitigation measures are included in Chapter 9: Water Section 9.5.1 and Chapter 8: Land and Soils Section 8.5.1.2.The following principles will be adhered to when considering the temporary storage of excavated materials;

- Spoil disposal will take place within a 30m radius of each structure.
- Preparation of the spoil disposal site will involve the removal of the "top mat" which will be transplanted to suitable area and maintained for re-use during restoration operations.
- Spoil will be deposited, in layers of 0.5m and will not exceed a total thickness of 1.5m.
- Spoil will only be deposited on slopes of less than 5 degrees to the horizontal and greater than 10m from the top of a cutting. The exact location of such areas will be confirmed on consultation with the geotechnical engineer.
- Once reinstatement is complete the disposal sites will be re-vegetated with the "top mat" removed at the commencement of disposal operations.
- Upon commencement of the restoration phase, guidance from a suitably qualified environmental professional will be sought to confirm the methodology and programme. Further details are provided in Chapter 6: Biodiversity

It is proposed that any temporary onsite stockpiles of soil, rock and other excavated material shall be removed and utilised in the site reinstatement programme to infill any excavated areas which will then be mounded and capped with sod prior to the completion of works.

3.13.3 Permanent Deposition Areas

On completion of extraction activities in any cell at the borrow pit; the pit will be used for the permanent storage of the excavated spoil material from the turbine bases, crane hardstands and internal access road construction. The proposed deposition areas will be subdivided into a series of cells. Each cell will be bunded by an embankment of engineered fill material capable of allowing a tracked excavator to move between the cells during deposition activities. The size of each cell will be dictated by the maximum working length of the excavators working the borrow pit. Each cell will be bunded on all downslope sides. The bund will be of adequate strength to retain the spoil stored within each cell.

Water build-up within the disposal area will not be permitted. Water will free drain to the sump of the pit from where it will be discharged utilising a pump discharging to a settlement pond constructed for this purpose. Permanent design features are proposed to allow drainage function correctly over the deposition areas, these are shown on 23318-MWP-00-00-DR-C-5025 to 5033 and described in Chapter 9: Water and Chapter 8: Land and Soils. Upon completion of each cell the surface of the deposited spoil will be profiled to a gradient not exceeding 5% and vegetated with either harvested turves where available or allowed to vegetate naturally as indicated by the project ecologist.

3.14 Site Drainage

3.14.1 Design Principles

The site drainage system was designed integrally with the proposed wind farm infrastructure layout as a measure to ensure that the proposal will not change the existing flow regime across the site, will not deteriorate water quality and will safeguard existing water quality status of the catchments from sediment runoff.

A fundamental principle of the drainage design is that clean water flowing in the upstream catchment, including overland flow and flow in existing drains, is allowed to bypass the works areas without being contaminated by silt from the works. This will be achieved by intercepting the clean water and conveying it to the downstream side of the works areas either by piping it or diverting it by means of new drains or earth mounds.

This process will cause the normally dispersed flow to be concentrated at specific discharge points downstream of the works. To disperse this flow, each clean water drain will be terminated in a discharge channel running parallel to the ground contours that will function as a weir to disperse the flow over a wider area of vegetation. An alternative method is to allow the water to discharge through perforated pipes running parallel to the ground contours. Both methods will prevent erosion of the ground surface and will attenuate the flow rate to the downstream receiving waters. The specific drainage measures to be used at each location are shown on the drainage layout, 23318-MWP-00-00-DR-C-5025 included with the planning application. The clean water interceptor drains, or earth mounds are all positioned upslope to prevent any mixing of the clean and dirty water. The outflow from these drains is then piped under the road at suitable intervals and at low points depending on the site topography.

Separating the clean and dirty water will minimise the volume of water requiring treatment. The dirty water from the works areas will be collected in a separate drainage system and treated by removing the suspended solids before overland dispersal. Dirty water drains will be provided on one or both sides of the access tracks and along the periphery of the turbines, crane hardstands, substation compound, lidar area, borrow pit and the temporary site construction compound.

The treatment system will consist of a series of settlement ponds at designated locations throughout the site (refer to Section 3.14.4.8 below). The outflow from the treatment system will be dispersed over vegetation in the same manner as the clean water dispersion and will become diluted through contact with the clean water runoff in the buffer areas before eventually entering the downstream watercourses.

An extract from the drainage drawings is illustrated in Figure 3-8. The clean water interceptor drains, or earth mounds are all positioned upslope to prevent any mixing of the clean and dirty water. The outflow from these drains is then piped under the road at suitable intervals and at low points depending on the site topography. In the illustration Plate 3-15 'dirty water' drains collect all incident rainwater that falls on the infrastructure. This water then drains to settlement ponds for removal of sediment before it is discharged via overland dispersal to the downstream watercourse.

The site drainage layout is presented in Planning Drawings 23318-MWP-00-00-DR-C-5025 to 5033 with drainage details presented in Planning Drawing 23318-MWP-00-00-DR-C-5407. The drainage layout is overlaid on background OSI mapping in the A1 drawings that accompany the planning application.

MWP

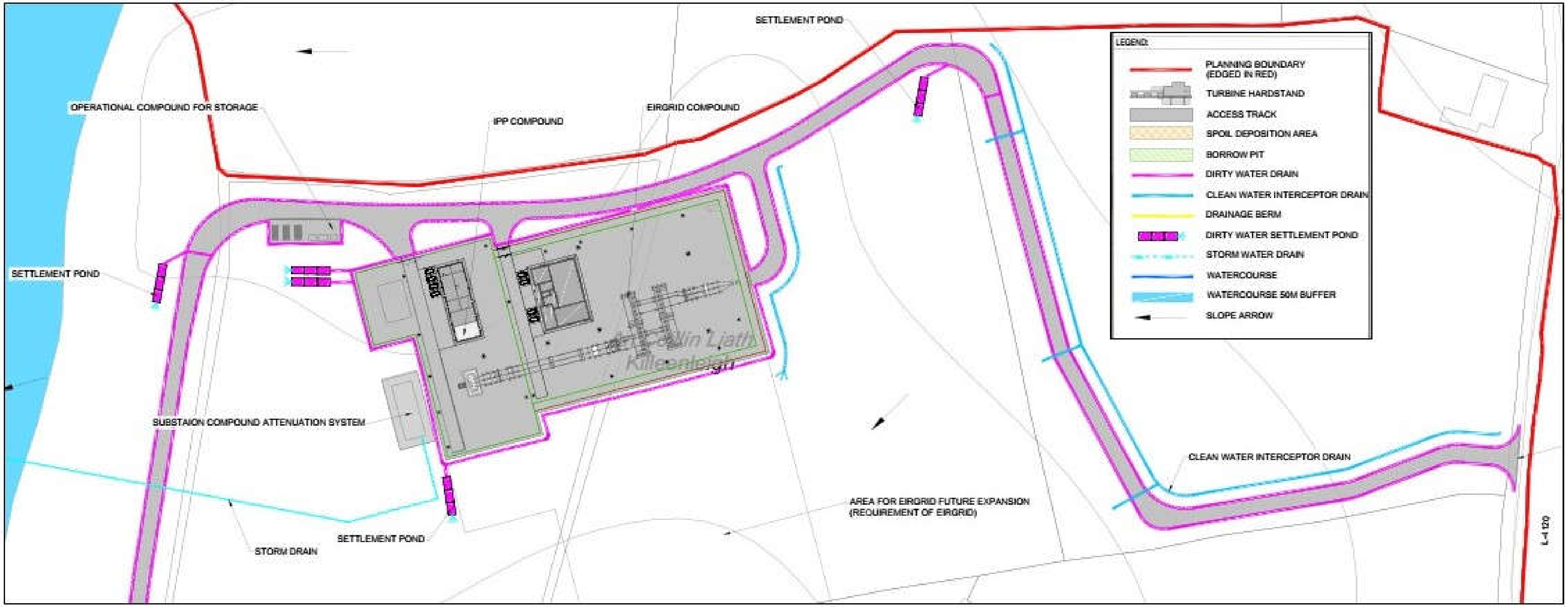

Figure 3-8: Extract from proposed Drainage Drawings

Plate 3-15: Wind farm example of the proposed Separation of Clean and Dirty Water Drainage Flood Attenuation

The creation of impermeable areas within the proposed project site has the effect of increasing rates of runoff into the downstream drainage system and this may increase flood risk and flood severity downstream. This applies particularly to urban areas that drain to closed pipe systems which do not have the capacity to cater for increased hydraulic loads. The proposed wind farm is located within a large rural catchment with an open drainage system. The footprint of the impermeable areas and the associated increase in runoff rate is very small in the context of the catchment size and therefore represents a negligible increase in downstream flood risk. However, it is proposed to provide some attenuation to limit the flow rate into the settlement ponds during high intensity storm events so that they do not become overloaded. This will also attenuate the flow to the downstream watercourses.

The volume of water requiring attenuation relates to direct precipitation on the tracks and other infrastructure footprint only. The developed surfaces have some permeability, and this reduces the attenuation requirement. Conventional attenuation systems use proprietary flow control units, but these can become blocked with debris and vegetation and require regular maintenance. They are, therefore, not appropriate for use within agriculture/forestry environments or where long-term routine maintenance would not be practical.

It is proposed to provide temporary storage within the drainage channels by creating stone dams within them at regular intervals. The spacing of the dams is typically 100 metres but depends on the channel slope, with steeper channels requiring shorter intervals. The dams, which are constructed with small sized aggregate held in place by large aggregate, also reduce the flow rate through the drainage system and are an effective means of providing flow control. Silt fences will also provide storage and flow control.

3.14.2 Drainage / Stream Channel Crossings

No work will take place within 50m buffer zones of watercourses identified in the Water Chapter of the EIAR except for drainage / stream crossings and associated road construction. Working near watercourses during or after intense or prolonged rainfall events will be avoided and work will cease entirely near watercourses when it is evident that there is a risk that pollution could occur. All construction method statements will be developed in consultation with Inland Fisheries Ireland and in accordance with the details in the CEMP accompanying this application.

The selection criteria for crossing natural / artificial drains and streams within the site were:

- Avoid crossing drains or streams at acute angles where possible.
- Avoid meanders at the crossing location.
- Cross where foundations could be constructed without excess excavation.
- Consider vertical alignment requirements.

Where crossings are cut into relatively deep channels these channels would require significant upfill to maintain vertical alignment criteria for turbine deliveries along access tracks. Clear span pre-cast concrete culverts are the preferred installation as this avoids significant instream works, also.as spans increase the height can increase accordingly allowing significant light penetration under the culvert. The increase in height is complimentary to the vertical alignment requirements for access road design. The contractor may opt for a different method, such as a HDPE pipe, if the site conditions restrict the use of clear span pre-cast concrete culverts. The site restricts can be, but are not limit to, boundary encroachment, existing vegetation or proximity to protected structures/areas.

The design of a clear span pre-cast concrete culvert crossings will ensure that:

- The existing channel profile within the watercourse is maintained.
- Gradients within the watercourse are not altered.
- There is unrestricted passage for all size classes of fish by retaining the natural watercourse stream / riverbed.
- There are no blockages within the watercourse. The large size of a clear span culvert allows for the passage of debris in the event of flood flow conditions.
- The watercourse velocity is not changed.
- The clear span of a culvert will ensure that the existing stream / riverbank is maintained during construction which will in turn avoid the occurrence of in-stream works.

Construction of any clear span crossings will be supervised by the Construction Manager, a suitably qualified engineer, the project manager, and the Environmental Manager in accordance with Inland Fisheries Ireland *"Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters, 2016"* and Office of Public Works *"Construction, Replacement or Alteration of Bridges and Culverts, 2013"*.

Typically, the proposed installation works for a clear span pre-cast concrete culvert will comprise the following:

I. Prior to the commencement of works the design of the culvert will be submitted for approval to the Office of Public Works (OPW) under Section 50 of the Arterial Drainage Act, 1945 and to Inland Fisheries Ireland (IFI).
II. Upon design approval the extent of the excavations required for the culvert foundations at either side of the watercourse will be marked out. The foundations are to be set to an agreed minimum distance by IFI from the existing watercourse so as not to effect on the riparian habitat. Health and safety measures

such as lifebuoys on stakes will be installed and where appropriate life jackets will be provided to persons working near the watercourse.

III. Appropriate environmental control measures such as, but not limited to, silt curtains, silt traps, mats will be erected on both sides of the watercourse. These environmental control measures will reduce the potential for sedimentation of the watercourse.

IV. Excavators will begin to excavate the foundations to formation level where all excavations will be battered back to a safe angle of repose (minimum slope angle of 45°) and comply with the final Construction and Environmental Management Plan (CEMP) to be produced by the appointed contractor for the proposed wind farm. All excavation works will stop in the event of heavy rainfall.

V. All excavated material will be transported to the on-site deposition areas located outside of the 50m hydrology buffer zone at the proposed borrow pit. Some of the excavated material will subsequently be reused as backfill around the culvert abutments and structure upon installation. Bare ground will be minimised.

VI. Once formation is reached at suitable ground conditions; steel reinforcement and shuttering will be installed. The culvert abutments will be prepared for the pouring of concrete by dewatering standing water within the excavations, which is likely to contain suspended solids, via a pump to an adequately sized settlement pond located outside of the 50m hydrology buffer zone. The standing water will be treated through the settlement pond and clean filtration stone prior to outfall over vegetation away from the watercourse.

VII. Ready-mix concrete will be delivered to the culvert abutments by ready-mix concrete trucks and placed into each abutment by means of excavators. During the concreting works the watercourse will be temporary covered over with a tarpaulin to protect the watercourse from concrete spills. Upon completion the abutments will be covered and allowed to cure.

VIII. Following curing, the shuttering around the abutments will be struck and removed. A small temporary hardstand will be constructed so that a lifting crane, which will install the pre-cast concrete culvert components onto the abutments, can be set up.

IX. Deliveries of the pre-cast concrete culvert components will arrive to site (see Plate 3-16 and Plate 3-17). These components will be individually fitted and manoeuvred into position by the lifting crane onto the concrete abutments. The components will be inspected to ensure that each unit is level and secure.

X. Backfilling on either side of the culvert will commence using excavated material, in particular larger rock of a uniform size will be placed along the edge.

XI. The access road surface will be laid over the culvert structure using stone aggregate and compacted in maximum 250mm layers with the use of appropriately sized rollers. An internal cable trench will be installed within the carriageway of the culvert so that it can cross over the watercourse.

XII. Vegetated soil bunds will be installed to divert dirty water generated on the section of road over the culvert crossing into the dirty water system outside of the 50m hydrology buffer zone. This will ensure that dirty water will not enter the clean watercourse.

XIII. Steel parapet railings and timber post and rail fencing will be installed at the sides and on the approaches to the culvert. This will prevent persons or vehicles falling into the watercourse while travelling across the culvert.

Plate 3-16: Example of a clear span pre-cast concrete arch units in place over an existing watercourse

Plate 3-17: Example of a clear span pre-cast concrete box culvert over an existing watercourse

The above point describes a crossing with no works within the watercourse however If works within the watercourse are accepted with the local authority and inland fisheries, then the contractor can opt to use precast concrete or HDPE pipes for crossing existing natural or artificial drainage / stream channels. All crossings will be designed for a minimum 1 in 200-year return rainfall event. The invert of the pipe is submerged approximately $^1/_4$ of its diameter below the original drainage bed. Where natural gradients allow, a nominal back fall in the pipe will be incorporated to prevent scour and promote the settling of natural material along the invert of the pipe. An example of a permanent drain crossing is illustrated in Plate 3-18.

New turbine service tracks will be required to cross several minor drains / streams within the site. All such crossings will be in accordance with this application and/or conditions attached to a grant of planning permission and agreed with the OPW and Inland Fisheries Ireland prior to construction.

Plate 3-18: Example of a concrete pipe channel crossing

Plate 3-19 shows a typical measure to be put in place at drainage and watercourse crossings to ensure dirty water does not enter clean watercourses. For the proposed wind farm, the intention is to use vegetated soil bunds to divert dirty water generated on the section of road over the crossings to the dirty water system. Alternatively, where space/area constraints limit placing a bund, silt curtains, as shown in Plate 3-20 are proposed to be placed along the existing tracks within the 50m buffer zone. These silt curtains are proposed to run parallel to watercourses with a layer of stone placed along the bottom to prevent any seepage if there is a risk of silted runoff.

Plate 3-19: Example of a Dirty water containment at watercourse crossings

Plate 3-20: Example of a Silt curtain containment along existing tracks near watercourses

3.14.3 Water Quality Management Systems

3.14.4.1 General

Sediment such as clay or silt can cause pollution during the construction phase of a civil engineering project due to the erosion of exposed soil by surface water runoff. The water quality management system has been prepared in order to control erosion and prevent sediment runoff during the construction phase of the proposed wind farm. The implementation of sediment and erosion control measures is essential in preventing sediment pollution. The system was designed having regard to:

- Knowledge of the site's environmental conditions.
- Previous experience of environmental constraints and issues from construction of wind farms in similar environmental conditions.
- Technical guidance and best management practice manuals (see references).

The following site-specific information was used in the design of the drainage and treatment system:

- High resolution aerial photography.
- LiDAR ground surface information.
- Wind farm infrastructure layout (turbines, service tracks and ancillary development);
- Hydrology maps (watercourses and buffer zones).
- Soil and land use maps.
- Baseline water quality assessments; and
- Met Éireann extreme rainfall data.

The settlement ponds and check dams described in the following subsections provide the essential mechanism for the removal of silt from construction related runoff and the controlled return of the treated runoff to the downstream watercourses.

The drainage and treatment system will ensure that the construction and early post-construction phases of the proposed wind farm will not create adverse effects on the aquatic environment.

3.14.4.2 Construction Works Area

Runoff from the internal roadways, hardstands and other infrastructure will be isolated from the clean catchment runoff by means of a series of open drains that will be constructed within the works areas. These drains will be directed to settlement ponds that will be constructed throughout the site, downhill from the works areas and as shown on the drainage layout, Planning Drawing 23318-MWP-00-00-DR-C-5025 to 5033 submitted with this application. Each drain will incorporate a series of check dams that will attenuate the flow and provide storage for the increased runoff from exceptional rainfall events see below Plate 3-21. The ponds have been designed to a modular size to cater for a single turbine and hardstand area or a 1,200m^2 area of internal access road.

Dewatering of turbine base excavations can result in significant flow rates to the drainage and settlement system if high-capacity pumps are used. To avoid the need for pumping it is proposed to provide drainage channels from the excavations to prevent a build-up of water. Where this is not feasible due to constraints around excavation such as proximity to vegetation or proximity to existing services, temporary storage will be provided within the excavations and dewatering carried out at a flow rate that is within the capacity of the settlement ponds.

Plate 3-21: Example of a stone check dam with large aggregate on downstream side

3.14.4.3 Treatment Process

Contaminated runoff can be generated on the site access tracks, borrow pit, lidar area, construction compound, substation site and turbine hard standing areas and is mainly due to excavation for the infrastructure or movement of delivery vehicles and on-site traffic.

Drains carrying construction site runoff will be diverted into settlement ponds that reduce flow velocities, allowing silt to settle and reducing the sediment loading. A modular approach has been adopted for the design of the settlement ponds which have been sized to cater for a catchment area of 1,200m^2 works area.

The settlement ponds have been designed as a three-stage tiered system and this has been proven to work effectively on wind farm construction sites. The three-stage system also facilitates effective cleaning with minimal contamination of water exiting the pond.

The settlement ponds have been designed with regard to the following:

- Runoff flow rate for the modular catchment area.
- Met Éireann Extreme Rainfall Data (statistical rainfall intensity / duration table).
- Character of the impermeable areas (runoff coefficients); and
- Design particle size and density.

The treatment process consists of primary, secondary and tertiary treatment as follows:

- The *primary treatment* consists of a three-stage settlement pond with an over-topping weir at each stage. The first chamber will remove most of the sediment load, while the remaining two chambers will remove most of the remaining load.

- Before the water is released onto the existing ground surface, it passes through a *secondary treatment* system in the form of a graded gravel filter bed.
- The outflow from each interceptor is dispersed across a wide area of vegetation so that the velocity is minimised, and the vegetation can filter out the residual sediment. This is the final or *tertiary* stage of the treatment process. Existing rills and collector drains within the tertiary treatment area are blocked off to prevent concentration of the flow.

Each sediment treatment unit has been sited using the contour maps and aerial photos to avail of any locally level areas and to ensure that the outflow is spread over as much vegetation as possible before entering an aquatic buffer zone.

Settlement ponds will require inspection and cleaning when necessary. Maintenance will take place regularly throughout the construction phase. This will be carried out under low or zero flow conditions so as not to contaminate the clean effluent from the pond. The water level would first be lowered to a minimum level by pumping without disturbing the settled sediment. The sediment would then be removed by mechanical excavator and disposed of in areas designated for deposition of spoil. Settlement ponds will require perimeter fencing and signage to ensure that there are no health and safety risks.

Plate 3-22 below shows a well-constructed and maintained tiered settlement pond, a similar settlement pond is intended for the proposed project This example is in an upland environment with significant ground surface slope and operates efficiently if it is well maintained. The design has been developed in conjunction with Inland Fisheries Ireland personnel and local authority engineers.

The design of the settlement pond system for the Brittas site is shown in the Planning Drawing 23318-MWP-00-00-DR-C-5407. The hydraulic design of the settlement ponds is outlined in Appendix 3A

The effluent from each settlement pond will discharge to an open channel, 8 to 10 metres in length, running parallel to the ground contours. This will form a weir that will overflow on its downhill side and disperse the flow across the existing vegetation. A minimum buffer width of 20m is specified between the overflow weir and downstream watercourses. Buffer widths are designed in line with *Forests and Water, UK Forestry Standard Guidelines (Forestry Commission, 2011)* on protection of watercourses during forestry operations and management. This method buffers the larger volumes of run-off discharging from the drainage system during periods of high precipitation, further reducing suspended sediment load to surface watercourses. The outflow weirs will not be located on slopes steeper than 3:1. Existing drains within the dispersion zone will be blocked off where necessary to provide additional attenuation, disperse the flow across a larger area of ground and prevent the re-concentration to a single flow.

Plate 3-22: Example of a Multi-tiered settlement pond with stone filter

3.14.4.4 Inspection and Maintenance

The drainage and treatment system for the proposed wind farm will be continuously managed and monitored and particularly after heavy rainfall events during the construction phase. The drainage and treatment system will be regularly inspected and maintained to ensure that any failures are quickly identified and repaired so as to prevent water pollution. A programme of inspection and maintenance will be designed and dedicated construction personnel assigned to manage this programme. A checklist of the inspection and maintenance control measures will be developed and records kept of inspections and maintenance works. These drainage controls will be kept in place during the operational phase of the proposed wind farm until the vegetation is re-established.

3.14.4.5 Weather Monitoring

Weather monitoring is a key input to the successful management of the drainage and treatment system during the construction of the proposed wind farm. This, at a minimum, will involve 24 hour advance meteorological forecasting (Met Éireann download) and on-site rain gauge linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded (e.g., 1 in 5-year storm event), planned responses will be undertaken. Planned responses will be part of the CEMP and contractors' site-specific safety plan (SSSP) and environmental management plan (EMP). These responses will involve control measures including the cessation of construction until the storm event has passed over and flood flows have subsided. Dedicated construction personnel will be assigned to monitor weather.

3.14.4.6 Water Quality Monitoring

A programme for water monitoring will be prepared in consultation with Inland Fisheries Ireland prior to the commencement of the construction of the proposed wind farm. The plan will include monitoring of water during the pre-construction, throughout and post construction phases. This is described further in the EIAR in Chapter 9: Water Section 9.5.5.15.

Further baseline water quality monitoring of streams within or in proximity to the proposed project site will be undertaken prior to construction to confirm existing conditions at the time of construction. This baseline data will include the main components of a full hydrograph for the streams including both high spate flow and base flow where possible.

During the construction phase of the project, water quality in the streams and outflow from the drainage and attenuation system will be monitored, field-tested and laboratory tested on a regular basis during different weather conditions. Testing is carried out for suspended solids, hydrocarbons, E-coli among other potential contaminants. The testing requirements are determined by Inland Fisheries based on the development site in terms of existing watercourses, flora and fauna and relevant construction activities. This monitoring together with the visual monitoring will help to ensure that the mitigation measures that are in place to protect water quality are working effectively.

During the construction phase of the project, the construction activity areas will be monitored regularly for evidence of groundwater seepage, water ponding and wetting of previously dry spots, and visual monitoring of the effectiveness of the constructed drainage and attenuation system to ensure it does not become blocked, eroded, or damaged during the construction process.

3.14.4.7 Surface Water Quality and Cementitious Material

It is important to prevent raw cement from entering waterways within and near the proposed wind farm.

Cement is required as a constituent for concrete. Concrete will be used for construction of the 10 no. turbine bases, Joint Bays, BESS, IPP and substation buildings as well as culvert crossings.

The primary method of reducing the potential effect from cementitious material on the hydrology of the proposed wind farm is the selection of ready-mixed concrete as opposed to site batching of concrete. Site batching requires the delivery and storage on site of significant quantities of raw cement. The chemical reactivity of cement is at its most vigorous in the early stages of its activation by water (hydrolysis, typically in the first 15 minutes). In the batching plant water is added to the cement at the correct water/cement ratio to fully activate the cement hydration process.

By removing cement in its raw state from the site the potential for a significant effect from hydrolysis of cement in the surrounding watercourses is eliminated. When ready-mixed concrete is used the hydrolysis stage of the cement process has already been completed during the batching process and the chemical reaction undergoes a dormancy period during which it enters a plastic state. During this period the concrete is delivered and placed. After approximately 3 hours the cement in the concrete enters a third stage of the chemical process where it hardens, primarily due to the hydration of tricalcium silicate. This process increases in activity for approximately 12 hours and then decreases over the following 20 hours. After approximately 36 hours the concrete is considered to have set. Therefore, on-site batching will be avoided.

As part of the curing process the top exposed surface of poured concrete is covered in a curing blanket which eliminates the effect of rain washing down uncured cement from the top surface. Concrete placement for a truck load is typically complete within 3 hours of batching. It is normal for the truck operator to wash out the drum and chutes of the truck on site. This typically requires approximately 250 litres of water to complete. This concrete washout contains cement that has not fully completed the hydration process and as a result can have an elevated pH level (higher alkalinity).

Concrete truck washouts for the proposed wind farm will be limited to washing down chutes only, reducing water volume to approximately 25 litres. The chute wash down area, which will retain the washout water, will be located within the construction compound and there will be no other chute wash down activity on any other part of the proposed wind farm.

Washout of concrete truck drums will be carried out at the source quarry. There will be no on-site batching of concrete; concrete requirements will be met by ready-mix suppliers.

The environmental manager will monitor the pH of the water in the chute wash out bund and can dose with CO_2 or acidic water from the drains until the wash out water achieves neutrality before discharge. Any overflow of water will be collected in the site compound drainage system which will be connected to a settlement pond for treatment prior to discharge to the external drainage system. The concrete sediment in the construction compound washout area will be removed at regular intervals.

3.14.4.8 Sediment Pond Design

Generally, high-intensity rainfall events have a short duration and lower-intensity rainfall events tend to have a longer duration. The Met Éireann Extreme Rainfall Data for the area Appendix 3B demonstrate that the chance of occurrence of a storm event of a given duration decreases (higher return period) as intensity increases.

For a given return period the total depth of rainfall increases with storm duration but the actual rainfall rate over that period of time decreases. For the operation of the settlement ponds, it is the rate of flow rather than the total rainfall that is relevant. The return period is a measure of the likelihood that a storm of a particular intensity will occur in a given year. However, it is important to note that the chances of occurrence of a storm event with a particular return period are the same in each year but should on average occur once in that time period. This is expressed as an annual exceedance probability (AEP) of 1%; that is, it has a 1% chance of being equalled or exceeded in any year.

The runoff control measures for the proposed wind farm have been designed in the context of storm events of varying duration and intensity. The settlement ponds have been designed to cater for a maximum continuous flow rate associated with a medium-intensity rainfall event. Higher intensity runoff will be attenuated by the open drain collection system which provides temporary storage and limits the rate at which it enters the settlement ponds. This is achieved using check dams within the open drains as described in Section 3.14.4.14. Longer duration storms of 24 hours or more generally have very low intensity and are not critical in terms of the runoff rates that they generate.

The modular settlement ponds are designed to operate effectively for the runoff rate associated with a continuous high rainfall rate of 20 mm/hour. This is approximately equal to a 60-minute duration storm event with a 10-year return period (M10-60). These rates are taken from the Met Éireann Point Rainfall Frequency table for the site location.

Theoretically, the pond depth is not relevant but in practice, a minimum depth is required to ensure laminar flow and to allow temporary storage of settled silt. The modular settlement pond has been designed with a surface area of 24m^2 (12m x 2m) and a depth of 1.25m. This is divided into three chambers of equal length and in practice, it has been found that most of the settlement occurs in the first chamber with very low turbidity levels being achieved in the final effluent. The design is conservative and therefore has sufficient redundancy to cater for occasional higher runoff rates or sediment loads.

3.14.4.9 Sediment Pond Attenuation

For rainfall intensities above the design value of 20mm/hour, the excess runoff needs to be temporarily stored. The storage can be provided in the drainage channels by installing check dams at intervals along the channel as described below.

The storage volumes required for 10-year storm events of various durations are shown in Table 3-4. The volumes are based on a catchment area of 1,200m^2 and a runoff coefficient of 0.70. The maximum storage volume required is 6.61m^3 for 15 minutes storm duration. This is equivalent to 24 minutes of flow through the settlement pond at the design-through flow rate of 5.10 litres/second. The stored water will drain off gradually as runoff from the works area subsides. The storage volume represents an average depth of 0.055m in a 200m long, 0.60m wide open drain and can therefore be easily accommodated in the drainage system.

Table 3-4 Calculated Drainage Storage Volumes

Storm Event	Duration (minutes)	Rainfall rate (mm/hour)	Excess (mm/hour)	Storage Volume (m^3)
M10-60min	60	19.60	00.00	0.00
M10-30min	30	30.8	10.80	4.96
M10-15min	15	48.80	28.80	6.61
M10-10min	10	62.40	42.40	6.49
M10-5min	5	88.80	68.80	5.26

The ability to limit flow rates is fundamental to the control of sediment during extreme storm events. It is not proposed to use any proprietary mechanical devices for this purpose but instead to rely on the check dams to effectively limit flow rates to the required values. The check dams will be constructed with gravel or other suitable material and will be of sufficient length and height to provide the required attenuation rates. The number of dams will vary depending on the gradient of the drainage channel with higher gradients requiring a greater number of dams with larger dimensions. Their ability to retain water and release it slowly can be confirmed visually. Drainage details can be found on Planning Drawing 23318-MWP-00-00-DR-C-5407.

3.14.4.10 Access Track Construction

On-site experience in wind farm construction and forestry development across the country has shown that the most effective method of reducing the volume of sediment created by construction is the finishing of all service tracks with high quality, hard wearing crushed aggregate such as basalt, granite or limestone laid to a transverse grade. When surface water drains transverse across a road constructed from hard wearing aggregate, as opposed to low class aggregate, the level of suspended solids is reduced significantly. The internal tracks will be finished with a hard-wearing aggregate. This can have the added benefit of contributing a balancing pH to help protect water quality from acidic runoff. The proposed project is serviced by local quarries, mentioned in Section 3.4 which can be used as a source of hard-wearing aggregate for road construction.

3.14.4.11 Wheel Washes

Wheel washes will be provided for heavy vehicles exiting the site to ensure that tracks outside of the site boundary are clean. These can take the form of dry or wet wheel wash facilities. In the case of a wet wheel wash a designated bunded and impermeable wheel wash area will be provided, and the resultant wastewater will be diverted to a settlement pond for settling out of suspended solids.

3.14.4.12 Engineered Deposition Areas

Temporary engineered deposition areas will be designated at the turbine and hardstand locations to hold temporary stockpiles. These will be located away from drains and watercourses. Stockpiles that are at risk of erosion will be protected by a silt trapping apparatus such as a geo-textile silt fence to prevent contamination of runoff.

3.14.4.13 Tree Felling

Felling of forestry is required within and around the proposed wind farm infrastructure to accommodate the construction of foundations, hardstands and access tracks as well as to facilitate assembly of turbines and provide ecological buffers. It is proposed to fell to a distance of up to 105m around turbines

All tree felling will be undertaken in accordance with a tree felling licence, using good working practices as outlined by the Department of Agriculture, Food, and the Marine (DAFM) Standards for Felling and Reforestation (2019). These standards deal with sensitive areas, buffer zone guidelines for aquatic zones, ground preparation and drainage, chemicals, fuel, and machine oils. All conditions associated with the felling licence will be complied with.

3.14.4.14 Check Dams

Check dams will be placed at regular intervals, based on gradient, along all drains to provide flow attenuation, slow down runoff to promote settlement and to reduce scour and ditch erosion. Check dams are relatively small and constructed with gravel, straw bales, or other suitable material. They will be placed at appropriate intervals and heights, depending on the drain gradient, to allow small pools to develop behind them. Examples of check dams or swales are shown below in Plate 3-23

3.14.4.15 Silt Fences

Silt fences placed along drains are an alternative method of reducing the volume of suspended sediment. They will be placed at the end of any locally steep section of drain. They have the double benefit of effectively producing a localised swale to reduce scour effects and attenuating and filtering the discharge. An example of a silt fence installation is shown in Plate 3-24

Plate 3-23: Examples of check dams along trackside drainage channels

Plate 3-24: Example of a silt fence used in conjunction with check dams along trackside drainage channels

3.14.4.16 Operational Phase

The measures for control of runoff and sediment relate to the construction phase of the project when there is continuous movement of site vehicles and delivery vehicles moving around the proposed wind farm. Following construction, the amount of on-site traffic will be very low and there will be negligible risk of sediment runoff. It is therefore proposed to partly fill the sediment ponds with stone so that they will not present a long-term safety risk. Runoff from the tracks, hard-standings, and other works areas will continue to be directed to these ponds and from there to the outfall weirs. Check dams within the drainage channels will also remain in place. The retention of this drainage infrastructure will ensure that runoff continues to be attenuated and dispersed across existing vegetation before reaching the downstream receiving waters. This infrastructure will be inspected regularly by the operational maintenance personnel.

The regular inspections during the operational phase will ensure culverts are free from blockages, and there is no damage or erosion of the stream crossing wing walls, particularly after storm events. Silt ponds will also be inspected and maintained before the drains and verges have vegetated.

3.15 Decommissioning and Restoration

3.15.5 Wind Farm

The proposed wind farm has been designed to have an operational life of 35 years and any further proposals for wind farm development at the site after this time will be subject to a new planning permission application. If planning permission is not sought after 35 years, the site will be decommissioned and reinstated with all wind turbines and towers removed. Upon decommissioning, all that will remain will be the tracks. The proposed Brittas sub-station and grid route will be taken in charge by EirGrid and will likely remain in place as part of the permanent electrical infrastructure.

When the site is to be decommissioned, cranes of similar size to those used for construction will disassemble each turbine. The towers, blades and all components will then be removed. The lidar will also be removed from site. It is likely that where possible turbine components will be reused as they have a life well in excess of the wind farm proposal. Wind farm components may also be recycled for other purposes.

Underground cables within the proposed wind farm will likely be cut back and left underground as removal may do more harm than leaving them *in situ*.

Hardstand areas will be remediated to match the existing landscape thus requiring reforestation or return to grassland by placing topsoil and grass seed. Access tracks will be left for use by the landowner. The current view is that the disturbance associated with the removal and disposal of the elements (hard core and sediment) would be more deleterious than leaving them in place.

Any structural materials suitable for recycling will be disposed of in an appropriate manner.

Prior to wind turbine removal, due consideration will be given to any potential effects arising from these operations. Some of the potential issues include:

- Potential disturbance by the presence of a crane, heavy goods vehicles and personnel on-site.
- Potential sedimentation of watercourses

- Noise pollution to local residents
- On-site temporary compound would need to be located appropriately.
- Potential disturbance to local Flora and Fauna
- Time of year and timescale (to be outside sensitive periods); and
- Tracks (site tracks may remain in use for the benefit of the landowner).

Prior to the decommissioning work, a plan will be drawn up to ensure the safety of the public and workforce.

Prior to the decommissioning work, a comprehensive reinstatement proposal, including the implementation of a program that details the removal of all structures and landscaping, will be submitted to the planning authority for approval.

Wastes generated during the decommissioning phase will be taken off site and disposed of appropriately by a licensed waste operator.

3.15.6 Battery Energy Storage System

Similar to the wind farm, upon decommissioning of the BESS, all that will remain will be the tracks. The proposed Brittas sub-station and grid route will be taken in charge by EirGrid and will likely remain in place as part of the permanent electrical infrastructure.

When the site is to be decommissioned, construction vehicles of similar size to those used for the installation of the BESS will be used to disassemble the BESS units. If the BESS units are in good operating condition and within the expected operating life it is possible that the BESS components will be reused. If the BESS units are unsuitable to use elsewhere then they may also be recycled for other purposes.

Underground cables within the proposed BESS compound will likely be cut back and left underground as removal may do more harm than leaving them *in situ*.

Hardstand areas will be remediated to match the existing landscape thus requiring reforestation or return to grassland by placing topsoil and grass seed. Access tracks will be left for use by the landowner. The current view is that the disturbance associated with the removal and disposal of the elements (hard core and sediment) would be more deleterious than leaving them in place.

Any structural materials suitable for recycling will be disposed of in an appropriate manner.

Prior to the removal of the BESS elements, due consideration will be given to any potential effects arising from these operations. Some of the potential issues include:

- Potential disturbance by the presence of a crane, heavy goods vehicles and personnel on-site.
- Potential sedimentation of watercourses
- Noise pollution to local residents
- On-site temporary compound would need to be located appropriately.
- Potential disturbance to local Flora and Fauna
- Time of year and timescale (to be outside sensitive periods); and
- Tracks (site tracks may remain in use for the benefit of the landowner).

Prior to the decommissioning work, a plan will be drawn up to ensure the safety of the public and workforce.

Prior to the decommissioning work, a comprehensive reinstatement proposal, including the implementation of a program that details the removal of all structures and landscaping, will be submitted to the planning authority for approval.

Wastes generated during the decommissioning phase will be taken off site and disposed of appropriately by a licensed waste operator. The BESS is described and assessed in this EIAR, however, is subject to a separate planning application to Tipperary County Council.

3.15.7 Turbine Decommissioning Route

When the site is to be decommissioned, cranes of similar size to those used for construction will disassemble each turbine. The towers, blades and all components will then be removed. Large sections from the decommissioning phase will require heavy haul vehicles due to the abnormal loads. This will require a TMP and enabling works to facilitate the vehicle movements, enabling works include but are not limited to vegetation removal, street signage removal and construction of hardstand areas.

Prior to decommissioning & reinstatement of the Turbine Decommissioning Route enabling works due consideration will be given to any potential effects arising from these operations. Some of the potential issues include:

- Potential disturbance by the presence of a crane, heavy goods vehicles and personnel on-site.
- Potential sedimentation of watercourses
- Noise pollution to local residents
- On-site temporary compound would need to be located appropriately.
- Potential disturbance to local Flora and Fauna
- Time of year and timescale (to be outside sensitive periods); and
- Tracks (site tracks may remain in use for the benefit of the landowner).

Prior to the decommissioning work, a plan will be drawn up to ensure the safety of the public and workforce.

3.15.8 Grid Connection

The grid cable will be taken in charge of by EirGrid and remain a permanent part of the national grid and therefore decommissioning is not foreseen. In the event of decommissioning, it will involve removing the cable from the ducting but leaving the ducting and associated supporting structure in place. The ducting will not be removed if the environmental assessment of the decommissioning operation demonstrates that this would do more harm than leaving them in situ. The assessment will be carried out prior to decommissioning to take into account environmental changes and advancements in technology over the project life. The removal of the ducts would also cause disruption to road users. Leaving the ducts in place would avoid disruption to road users without compromising the structure of the roadway. The proposals will be agreed with TCC prior to decommissioning commencing.

3.16 References

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