

## 4 DESCRIPTION OF THE DEVELOPMENT

### 4.1 THE WIDER CONTEXT

#### *The Over-arching Project*

- 4.1.1 The proposed development of AMEP is directly related to the emerging global project to decarbonise world energy production. The need to decarbonise world energy production, and its overriding benefit to the global environment, is detailed in *Chapter 5*.

#### *The Broad aim of the Development*

- 4.1.2 AMEP will provide a new and substantial manufacturing base for the offshore marine energy sector. Currently, this market is anticipated to be dominated by offshore wind energy with this sector expected to contribute significantly to a new secure, low carbon and balanced energy mix for the UK.
- 4.1.3 As well as having quays to receive and export raw materials and products, the development will also provide facilities that are necessary to assemble the offshore generators, including offshore wind turbines (OWT's), in preparation for loading onto installation vessels for direct transport from their place of manufacture to the offshore development site.

### 4.2 THE DEVELOPMENT

#### *Introduction*

- 4.2.1 The development is located on the south bank of the Humber Estuary as shown in *Figure 1.1*. To obtain a comprehensive understanding of the proposals, this chapter of the ES should be read in association with the drawings included in the application.
- 4.2.2 This site lies between the Humber Sea Terminal (HST) and ABP Immingham Port. The boundary of the site lies partially within the Humber Estuary, which is protected under both national and European law, including the EC Habitats Directive (92/43/EEC). The estuary is part of the Natura 2000 network of nature conservation areas within the European Union that has been established to ensure the survival of Europe's most valuable species and habitats. The network currently comprises 25 000 sites and covers over 800 000 km<sup>2</sup> (or 20 per cent) of the EU's total land area and 100 000 km<sup>2</sup> of marine environment.

4.2.3 As the proposals for AMEP will, if consented, cause the loss of a significant area of estuary and intertidal mudflat which are specific features of the Natura 2000 network, it is necessary, subject to the specific requirements of the Habitats Regulations 2010, to provide compensatory habitat to ensure the continued coherence of the network in the future. Accordingly, a related habitat creation site on the north bank (“the Compensation Site”) has been designed to provide new mudflat and estuarine habitat that offers equivalent functional value to the flora and fauna for which the area has been designated. The EIA for the Compensation Site is reported in *Volume 2* of this ES.

4.2.4 This chapter describes the activities that are proposed to be undertaken during the construction of AMEP and during the subsequent operation and use of the completed facility.

### 4.3 *LOCATION OF THE PROJECT*

4.3.1 As indicated in *Chapter 1*, AMEP is situated in an area known as Killingholme Marshes on the southern bank of the River Humber, approximately 2 km from the village of North Killingholme to the west, and 3.3 km from Immingham to the south.

4.3.2 The site comprises the following development areas:

- Existing terrestrial land - approximately 220 ha to industry and 48 ha to ecological mitigation
- Existing intertidal area - 31.5 ha
- Existing subtidal area - 13.5 ha

4.3.3 The proposed terrestrial areas include 122.4 ha of land that has the benefit of extant planning consents for port related storage and 11.5 ha of land that has temporary consent as a lay-down area during the construction of a biomass fuelled power station; details of these consents are included in *Chapter 3*. Development has commenced in the area for which planning permission has been granted for port related storage; construction of the power station has not commenced. The balance of the terrestrial areas comprises Grade 3 agricultural land that is allocated for industrial development in North Lincolnshire Council’s Local Plan. This land allocation is continued within the Council’s Core Strategy that was adopted in June 2011.

4.3.4 The western boundary of the development is defined by Rosper Road, which provides access to the A160, part of the trunk road network. Beyond Rosper Road lies the Total Oil Refinery and Conoco Philips Humber Refinery and combined Heat and Power Plant. The eastern boundary of the existing territorial area is marked by the existing flood defence wall, beyond which lies the Humber Estuary.

4.3.5 The intertidal and subtidal areas are located within the Humber Estuary and extend from the existing tidal defences towards the deep water channel that serves the HST.

#### 4.4 *DESCRIPTION OF THE WORKS*

##### *Introduction*

4.4.1 A plan showing the core development areas is reproduced in *Figure 4.1*.

4.4.2 An indicative site plan, based on the development serving the offshore wind sector, is reproduced in *Figure 4.2*. The principal elements of the proposal are described below. As discussed in *Chapter 2*, the development proposal necessarily incorporates a degree of flexibility with respect to the actual sizing and siting of buildings.

4.4.3 A project specification is included in *Annex 4.1*, which provides details of the flexibility that is being sought.

##### *The Quay*

4.4.4 Proposals for the quay are detailed on the following drawings included in the application:

- AMEP\_P1D\_D\_001 – Quay General Arrangement
- AMEP\_P1D\_D\_002 – Indicative Piling Layout
- AMEP\_P1D\_D\_003 – Quay Sections 1 of 2
- AMEP\_P1D\_D\_004 – Quay Sections 2 of 2
- AMEP\_P1D\_D\_005 – Front Wall Elevation
- AMEP\_P1D\_D\_006 – Northern Return Wall Elevation
- AMEP\_P1D\_D\_007 – Southern Return Wall Elevation
- AMEP\_P1D\_D\_009 – Concrete Deck General Arrangement

4.4.5 Briefly, the frontage will be 1 279 m in length and will be located close to the western edge of the existing dredged channel that provides access into HST. This existing channel has consent for capital dredging to 7.2 m below Chart Datum (CD).

- 4.4.6 The quay is proposed to be a solid berth structure for 1 200 m of its length with a front wall that comprises a combination of large diameter tubular steel piles alternating with steel sheet piles. This arrangement is commonly referred to as a combi-pile wall. The tubular piles will be tied back with flap anchors that fix the piles in position near their top. These anchors rely on the passive resistance of the quay backfill material. This front wall will return at the southern end of the quay and form part of a specialist berth for emerging offshore wind turbine installation vessels. At the northern end, the quay returns at an angle that is square to the existing flood defence.
- 4.4.7 A piled relieving slab will be constructed behind the front wall and will enable a range of plant including large dock cranes, up to 1 600 t capacity, to operate anywhere on the quay.
- 4.4.8 The berthing pocket in front of the quay will be over-dredged to the top of the natural bedrock and then backfilled to -11 mCD with stone aggregate to enable repeated loading by 'jack-up' barges.
- 4.4.9 The existing intertidal area between the existing flood defence and the new quay will be filled with sea or estuary dredged material. The upper sections of fill, approximately 1 m, will comprise imported stone that will provide a drained heavy duty pavement for operational plant which will include tracked cranes and self propelled mobile transporters. The finished level on the perimeter of the quay will be approximately 6.1 mAOD. This will ensure that waves within the estuary do not significantly overtop the structure in extreme weather events over the lifetime of the development.
- 4.4.10 The structural pavement will enable the storage of heavy components. According to *A Guide to an Offshore Wind Farm*, (Crown Estate, 2010) the storage space taken up by a single set of turbine components is one hectare. Given that sufficient components need to be placed close to the quay to facilitate efficient loading onto the installation vessels, each quay is provided with around 5 ha of lay down area which will provide for storage of around five complete OWTs.
- 4.4.11 The quay will be drained by a network of land drains that discharge into the Humber Estuary. Drainage water will pass through oil interceptors where a high risk of oil spillage exists.

- 4.4.12 To enable the quay to operate twenty-four hours a day, sufficient lighting will be provided to enable personnel to access, egress and carry out their work safely and to identify any hazards or obstacles in the workplace. Accordingly, external lighting over the quay frontage will comprise 50 m towers that will be fitted with directional luminaires to limit spill outside the working areas. Over the operational areas of the quay (notionally taken to be that area within 50 m of the quay edge), the lighting will provide average luminance of 50 lux, with a minimum of 20 lux. Elsewhere, on the storage areas behind the quay, lighting will be designed to provide an average luminance of 20 lux with a minimum of 5 lux.
- 4.4.13 Navigational lighting will be provided on the quay to enable safe berthing and manoeuvring of vessels.
- 4.4.14 Cooling water infrastructure that serves two nearby power stations, operated by E.ON and Centrica, is routed through the intertidal area north of the quay. A new outfall will be constructed in the quay to allow for the diversion of the existing outfalls given the residual uncertainty with respect to potential accretion in this area as a consequence of the development. This uncertainty is further discussed in *Chapter 8*.

### *Dredging*

- 4.4.15 The proposed works will include capital dredging operations.
- 4.4.16 Compressible silt is present over part of the footprint of the proposed new quay and some may need to be removed by a trailing suction hopper dredger (TSHD) before placing any fill material. A TSHD trails a suction pipe (or pipes) when working, and loads the dredge spoil into one or more hoppers in the vessel. When the hoppers are full, the TSHD sails to a disposal area and either dumps the material through doors in the hull or pumps the material out of the hoppers. It is estimated that approximately 250 000 m<sup>3</sup> of silt may be removed from the footprint of the quay in this way. The operation is illustrated in *Figure 4.3* below, and is routinely undertaken on the Humber.

Figure 4.3 Illustration of a Trailing Suction Hopper Dredger



Source: <http://www.dsc.tudelft.nl/Research/Current/skbjzamaar-1144046827-b809-0.jpg>

- 4.4.17 To enable vessel access to the operational quay and allow berthing alongside its length over a commercially viable tidal range, capital dredging will be required from three distinct areas as described below.
- 4.4.18 **Berthing Pocket:** Based on current knowledge of the emerging designs for new generation wind turbine installation vessels, an operational draught of 10 m has been adopted. Accordingly, the quay will have a dredged berthing pocket that will be maintained at -11 mCD with an initial over-dredge to bedrock; this will allow accommodation of 10 m draft vessels with a minimum under keel clearance of one metre. The berthing pocket will be 60 m wide. The side slopes of the berth will have a gradient appropriate to the in-situ properties of the bed material.
- 4.4.19 In the area of the berthing pocket, bed levels currently range from around -2 mCD to -4 mCD. The chalk strata is currently interpreted to be at approximately -8 mCD and -10 mCD at the northern and southern ends of the quay respectively (refer to the planning application drawings). A maximum capital dredge of approximately 9 m is therefore required to create the berthing pocket.
- 4.4.20 **Approach Channel:** Based on a maintained depth of -9 mCD, capital dredging within the approach channel will be around 5.5 m at the northern end of the quay but reduce to about 2.5 m at the southern end. The majority of the approach is already dredged to allow access to

Killingholme Oil Terminal and HST. An initial over-dredge of 0.3m will be undertaken.

4.4.21 **Turning Area:** To enable vessels to arrive and depart at most states of the tide, a turning area will be provided; this will have a maintained depth of -9 mCD. In the turning area, bed levels currently average -9 mCD and a maximum capital dredge of 1.5 m is required.

4.4.22 *Table 4.1* details the approximate quantities of capital dredging works that will be required depending on the final dredge depth.

**Table 4.1** *Approximate Capital Dredge Quantities*

Area	Dredge
Reclamation Area	294 500 m <sup>3</sup>
Berthing Pocket	827 000 m <sup>3</sup>
Approach Channel	682 000 m <sup>3</sup>
Turning Area	132 000 m <sup>3</sup>
<b>TOTAL</b>	<b>1 935 500 m<sup>3</sup></b>

4.4.23 Once the development is complete, maintenance dredging will be required from time to time and an assessment of maintenance dredge requirements at the new development is included in *Chapter 8*. The impact of the development on maintenance dredging of adjacent port sites has also been assessed and is also reported in *Chapter 8*.

### ***Heavy Component Manufacturing Site***

#### *General*

4.4.24 Offshore wind turbines comprise a number of very large and/or heavy components that need direct access to a quayside as they are too large to be transported by road on a frequent basis. The principal components are<sup>1</sup>:

- Nacelles 150-300 t
- Rotors 90-150 t
- Towers 200-400 t
- Blades 5-25 t (60 m long x 5 m max width)
- Steel Foundations 600-800 t

<sup>1</sup> Extracted from, 'A Guide to an Offshore Wind Farm', published by the Crown Estate. Discussions with leading manufacturers however indicate that new generation Nacelle's may increase to 500 t in weight; towers may be up to 450 t and blades up to 30 t.

4.4.25 AMEP will provide a heavy component manufacturing base for the manufacture of the above items. *Figure 4.4* shows these components diagrammatically.

4.4.26 The particular mix of manufacturing facilities that will locate to the site cannot be fixed prior to the application. The heavy component manufacturing site is based on the following indicative development proposal for the offshore wind sector:

- 3No. nacelle factories producing a total of 600 units per year
- 2No. tower factories producing a total of 400 units per year
- 2No. blade factories producing a total of 1 200 units per year
- 1No. foundation factory producing a total of 50 units per year

4.4.27 Based on this indicative mix, the gross weight of goods manufactured on the site would lie within the range 200 000 – 400 000 t.

4.4.28 As the manufactured goods are bulky and, other than blades, cannot be stacked, the factory units require substantial external areas for storage of their finished product. These laydown areas are designed to be sufficient to ensure that manufacturing is never interrupted by the absence of available storage space.



Figure 4.4 Principle Components of an Offshore Wind Turbine



Source: 'A Guide to an Offshore wind Farm', Crown Estate

## Buildings

4.4.29 The schedule below details the maximum size for each building type currently proposed on the heavy component manufacturing site.

**Table 4.2** *Schedule of Buildings*

Reference (see Fig 4.2)	Type	Max Plan Dimensions (exc. Offices)	Max height to eaves	Total Aggregate Area
N1	Nacelle Factory	150 m x 50 m	24 m	
N2	Nacelle Factory	150 m x 50 m	24 m	
N3	Nacelle Factory	150 m x 50 m	24 m	
T1	Tower Factory	200 m x 100 m	24 m	
T2	Tower Factory	200 m x 100 m	24 m	
B1	Blade Factory	300 m x 40 m 100 m x 50 m 100 m x 50 m	24 m	
B2	Blade Factory	300 m x 40 m 100 m x 50 m 100 m x 50 m	24 m	150 000 m <sup>2</sup>
F1	Foundation Factory	300 m x 65 m	45 m	
F1	Foundation factory paintshop	50 m x 50 m	45 m	
	Electric Substation	10 m x 6 m	5 m	
SPMT	SPMT Service Building	72 m x 40 m	6 m	

4.4.30 These factory units will be of steel framed construction with powder coated metal cladding. Buildings will generally be single span portal frame type with a minimum roof pitch of 6°. Rooflights will generally be incorporated into the roof cladding to maximise natural light internally.

Each building will have sectional overhead doors (or their equivalent) to tenant requirements and sufficient fire escape doors to permit safe evacuation of the building. Subject to tenant requirement, a concrete or masonry dado wall will be provided around the perimeter of the building to mitigate the consequences of any low level impact from manoeuvring plant.

- 4.4.31 Lighting levels immediately outside the buildings will be provided by external downlights fixed to the buildings to provide an average luminance of 35 lux.
- 4.4.32 Office space is incorporated into, or annexed to, each building, up to three storeys in height.
- 4.4.33 Each building will have a bituminous car parking area with safe pedestrian access from the car park into the buildings. The car parks will be illuminated with 30 m high columns to achieve an average luminance of 20 lux and a minimum level of 5 lux.
- 4.4.34 A concrete service yard will be provided around the perimeter of the building to permit access by heavy goods vehicles up to 44 t. These areas will be a maximum of 50 m wide.
- 4.4.35 External illuminated unit identification signs may be provided on one side of each building

#### *External Storage Areas*

- 4.4.36 External storage areas within each plot will be provided with a stone pavement suitable for tracking by heavy duty plant. To suppress dust the surface will be finished with a skim of tarmac chippings or similar.
- 4.4.37 As with the quay, the external storage areas around the manufacturing plants will need to operate twenty-four hours a day. Accordingly, external lighting for these areas will comprise 50 m towers that will be fitted with directional luminaires to limit spill outside the working areas. The external lighting will provide an average luminance of 20 lux with a minimum of 5 lux.

#### *Surface Water Drainage*

- 4.4.38 The site lies within the Killingholme Marshes drainage catchment, which is within the North East Lindsey Drainage Board (NELDB) district. The North Killingholme, South Killingholme and Killingholme Marsh's catchment are currently subject to tide locking on each tide cycle, and

during intense rainfall events the flood plains inter-connect to form a complex hydraulic regime. An existing outfall lies within the footprint of the proposed quay. It is proposed to relocate this outfall to the north of the new quay and to construct a new pumping station that will enable surface water run-off from the site to discharge into the Humber Estuary at high tide. At low water the surface water will discharge under gravity. Further details of the proposals are included in *Chapter 13* and in the Flood Risk Assessment.

4.4.39 The site will be provided with an improved ditch system that will carry surface water to the pumping station. The new ditches will be approximately 15 m wide (subject to detailed design) and comprise a main channel and a flood berm that will store water in extreme events and minimise, as far as reasonably practicable, the pumping requirement.

4.4.40 On-plot drainage will comprise high capacity slot drains within the concrete service yards and infiltration drainage within the storage areas. The latter form will comprise stone filled trenches with porous pipes that discharge into the open ditches running through the site.

#### *Foul Water Drainage*

4.4.41 Foul water drainage from buildings will fall by gravity into pumping stations distributed throughout the site. These will pump the foul effluent through rising mains into the adopted foul water drainage system operated and maintained by Anglian Water.

#### *Ground Levelling*

4.4.42 Existing ground levels within the manufacturing site will be graded to provide adequate falls into the new surface water drainage system. There will be a net requirement to import around 2 million m<sup>3</sup> of material to achieve final design levels. Along the eastern edge of the manufacturing area ground levels will be raised by around 3.5 m to tie into the quay.

#### *Fencing*

4.4.43 Each plot will be fenced to provide a secure environment for the storage of raw materials and finished products. Fencing will be approximately 2.5 m high steel palisade or similar.

### *Highway Access*

- 4.4.44 The site is currently provided with two accesses on Rosper Road. One access is currently a private road but will be improved and the junction reconfigured to a standard that is suitable for its increased level of use. Access for existing users will be maintained.
- 4.4.45 One additional access is proposed onto Rosper Road to facilitate access and egress. This new junction is located between Station Road and the existing access into Able Humber Port Facility. Rosper Road will need to be widened at this location to provide a right turn ghost island for traffic approaching the site from the south.

### *Lighting*

- 4.4.46 As noted above lighting will comprise a combination of the following:
- 50 m lighting columns to provide general external lighting;
  - 30 m lighting columns within car parks; and
  - floodlighting fixed to buildings to supplement lighting around the building cartilage.

### *Rail Crossings*

- 4.4.47 The existing rail line that runs through the site is the remnant of the Killingholme Branch Line and has been largely disused since 2005. The existing Network Rail infrastructure terminates just beyond the Humber Sea Terminal, the track beyond having been taken up in the 1960s. The remaining section of line has three level crossings for vehicular traffic (Marsh Lane, Station Road and Haven Road), three level crossings within the Humber Sea Terminal and a number of at-grade farm accommodation crossings. Network Rail undertook a Pre-Feasibility study for re-opening this section of the Killingholme Brach line in 2009 but found that there was no compelling business case to justify the necessary level of investment by them.
- 4.4.48 It is proposed to transfer ownership of the Network Rail land and its associated infrastructure to the applicant. In this case the existing line will become a privately operated siding with Humber Sea Terminal retaining any existing rights. A barrier will be erected to demarcate the siding from the Network Rail line and control access. New level crossings will be constructed to enable access for manufactured goods to the quay.

### *Soft Landscaping*

4.4.49 A soft landscaping scheme is proposed to mitigate for the impacts of the development on the existing ecology and to soften and screen the development insofar as it is possible to do so, given its scale. Landscaping proposals include:

- shrub and tree planting at the entrance to each plot and around car parking areas;
- shrub and tree planting along Rosper Road to supplement existing features; and
- a green corridor running along the side of the main north south ditch running through the site.

4.4.50 Species of generally local provenance will be used that are known to suit the particular microclimate adjacent to the estuary. More details are provided in *Chapter 20*.

### *Supply Chain Park*

#### *General*

4.4.51 The proposed Supply Chain Park (SCP) is wholly located on areas of the site that currently have the benefit of planning consent for port related storage. The main SCP is on land that is currently used for storing imported cars. This part of the site covers around 35 ha.

4.4.52 This area will be developed as a base for supply chain industries serving the offshore energy sector. These industries also need to expand and, ideally, they are located close to their clients' business.

4.4.53 The following supply chain industries are considered most likely to develop new facilities on the site:

- generator manufacturers;
- baseframe manufacturers;
- sub-station control panel manufacturers;
- canopy and spinner manufacturers; and
- project offices

4.4.54 Like the heavy component manufacturing site, the particular mix of facilities that will locate to the site is not known with certainty at this stage. Accordingly, the application will seek to obtain a flexible consent that can respond to market demand. The SCP is based on a total floor area of 25 000 m<sup>2</sup>.

#### *Buildings*

4.4.55 In most respects buildings on the SCP will be similar to those described above on the heavy component manufacturing site.

4.4.56 In summary, these buildings will be in the range 6-15 m high to eaves; car park lighting will be provided by 30 m columns and the concrete service yard will be a maximum of 25 m wide.

#### *External Storage Areas*

4.4.57 The majority of the SCP area currently has a tarmac finish that was designed for use by light vehicles only. It is anticipated that this will be unsuitable for most tenants. Accordingly, the tarmac will be removed as required and the bearing capacity of the pavement layer will be improved to tenant requirements by the addition of imported stone fill and geogrid where necessary.

4.4.58 As with the quay and the heavy component manufacturing site, the external storage areas around the SCP will need to operate twenty four hours a day. The existing external lighting for these areas comprises 30 m towers that are fitted with directional luminaires to limit spill outside the working areas. The lighting is consented for an average luminance of 25 lux with a minimum of 5 lux and will be retained.

#### *Drainage*

4.4.59 Within the main SCP site, the existing drainage system was installed in 2006 and comprises high capacity slot drains that discharge into the open ditches running around its perimeter. These drains will be retained where possible.

#### *Foul Water Drainage*

4.4.60 The existing site has two package treatment plants that discharge into the NELDB drain running through the site; these units will be retained. However, all new buildings will be provided with a connection to the adopted foul water drainage system operated and maintained by Anglian Water.

### *Ground Levelling*

- 4.4.61 Existing ground levels within the SCP will be raised by up to 600 mm to provide a thicker stone pavement. There is expected to be a net requirement to import around 150 000 m<sup>3</sup> of fill material to achieve final design levels.

### *Fencing*

- 4.4.62 The perimeter of the main SCP area has a 2.5 m high electric fence. This will be retained.
- 4.4.63 Each plot will be fenced to provide a secure environment for the storage of raw materials and finished products. Fencing will be 2.5 m high steel palisade or similar.

### *Highway Access*

- 4.4.64 The site is currently provided with two accesses on Haven Road. One access is presently unsuitable for heavy goods vehicles but will be improved under an extant permission to provide a new junction that is suitable for its increased level of use.

### *Lighting*

- 4.4.65 As noted above lighting will comprise a combination of the following:
- 30 m lighting columns to provide general external lighting; and
  - floodlighting fixed to buildings to supplement lighting around the building curtilage.

### *Soft Landscaping*

- 4.4.66 Existing soft landscaping around the perimeter of the SCP will be retained.

### *Overflow Storage Area*

- 4.4.67 The Killingholme Pits SSSI lies adjacent to the northern boundary of the application site. The proposed overflow storage area has the benefit of extant planning consent for port related storage. A condition attached to the consent limits stacking of containers within 200 m of the SSSI boundary. This area will therefore be used as an overflow storage area for items less than 6 m high.



### *Electric Services*

- 4.4.68 The AMEP development requires electrical power in the order of 30 MVA for peak operation of the facility.
- 4.4.69 The power supply necessary for the site will be provided at 33 KV. Within the site there will be three substations from which this medium voltage supply will be stepped down to 11 KV.
- 4.4.70 The supply must be continuous and reliable; therefore the site will be served by two synchronised 33 KV lines.

### *Water Services*

- 4.4.71 AMEP is expected to require a potable water supply in the order of 500 m<sup>3</sup>/day with a peak requirement of 25 litres/second.
- 4.4.72 Anglian Water will reinforce their existing infrastructure to provide the peak demand.

### *Traffic Junction Improvements*

- 4.4.73 A traffic impact assessment has been undertaken and a number of junction improvements are proposed on the approaches to the development site. These are detailed in *Chapter 15*.

## **4.5** *ECOLOGICAL MITIGATION AREA*

- 4.5.1 To the south of the industrial development lies a 48 ha plot that will be landscaped and managed in the future for the benefit of ecological interests that would otherwise be adversely affected by the development. The majority of the plot will be managed as wet grassland to provide feeding and roosting habitat for over-wintering birds.
- 4.5.2 A 0.7 ha plot of land to the south of Chase Hill Wood will also be managed for the benefit of fauna. This will include the creation of new ponds for the translocation of great crested newts from the main development site.

## **4.6** *DIVERSION OF PUBLIC RIGHTS OF WAY*

- 4.6.1 A public right of way exists along the top of the existing flood defence wall within the AMEP site. This right of way will be diverted around the perimeter of the site. The route is shown on the application drawings.

## 4.7 CONSTRUCTION METHODOLOGY – MEP SITE

### *Working Hours*

4.7.1 Construction is proposed to be undertaken at the times detailed in *Table 4.3*:

**Table 4.3** *Schedule of Working Hours*

Location	Day	Working Hours
Marine Works	Monday to Friday	Piling Works: 06:00 – 22:00
	Saturday	
	Sundays and Bank Holidays	All other Works: At all times
MEP Site, existing terrestrial areas	Monday to Friday	07:00 to 19:00
	Saturday	07:00 to 17:00
	Sundays and Bank Holidays	Occasional working as required

### *Task Lighting*

4.7.2 During construction, local mobile task lighting will be used to illuminate areas under construction during the hours of darkness. This lighting will generally be less than 10 m high and will be directed away from sensitive receptors.

### *Marine Development on the AMEP Site*

4.7.3 The proposed construction sequence is illustrated on the following drawings included in the application:

- AMEP\_P1D\_D\_101 – Indicative Sequence Plan View 1/3;
- AMEP\_P1D\_D\_102 – Indicative Sequence Plan View 2/3;
- AMEP\_P1D\_D\_103 – Indicative Sequence Plan View 3/3;
- AMEP\_P1D\_D\_104 – Indicative Sequence Cross Section 1/2;
- AMEP\_P1D\_D\_105 – Indicative Sequence Cross Section 2/2;
- AMEP\_P1D\_D\_106 – Proposed Site Facilities and Access 1/2;
- AMEP\_P1D\_D\_107 – Proposed Site Facilities and Access 2/2.

4.7.4 Marine works, other than piling works, are proposed to be undertaken twenty fours a day. Vessel lighting will be required including localised task lighting after dark. Lighting will be kept to a minimum with light spill controlled by the use of appropriate lighting units.

- 4.7.5 Large diameter tubular piles that will form part of the quay wall, will be installed from barges operating within the estuary; it is anticipated that two jack up barges will operate simultaneously. These piles will be vibrated through any soft superficial deposits that are present and will then be driven to their design depth using hydraulically operated piling hammers.
- 4.7.6 The sheet piles will also be driven by a vibrating ram until refusal. If the pile refuses before reaching its design level, further driving will be completed using a hydraulic hammer.
- 4.7.7 The tubular piles are fixed close to their top by flap anchors. This system avoids the use of anchor piles and thereby avoids further noise generating activity that would arise from their installation. To install the flap anchors a trench will be excavated by backhoe dredger, landward of the combi-pile wall.
- 4.7.8 Parts of the footprint of the new quay will overlies soft alluvial deposits that would settle significantly under loading if left in place. Accordingly, a proportion of this existing bed sediment will be dredged.
- 4.7.9 Once the above operations are complete for a section of quay, land reclamation is expected to commence. The area immediately behind the combi-piles is proposed to be backfilled with marine dredged granular material which would be placed by pumping from a dredger berthed sea side of the quay wall using a technique known as "rainbowing".
- 4.7.10 For the main reclamation area, three cells are proposed to be created using imported granular material. A system of pipelines would then be installed that would transport either imported marine dredged material or material from the dredge, from the supply vessel or dredger respectively, into the cells.
- 4.7.11 Each cell will be surcharged with fill material in order to accelerate settlement of both the placed material and the original ground. Vertical sand drains may also be installed to aid this process.
- 4.7.12 The number of staff required for construction of the quay is expected to vary during the construction phase. However, based on a preliminary programme it is considered likely that employment levels would peak at around 230 staff for this section of the works.

- 4.7.13 A minimum 2 year construction programme is anticipated for the marine works although this is dependent on other constraints established during the consultation process, in particular any restrictions imposed on working during the winter period.

### *Site Infrastructure*

#### *Cut and Fill Earthworks*

- 4.7.14 Existing levels on the site vary from less than 3 mAOD immediately behind the existing flood defence along the eastern edge of the current terrestrial area, to just over 6 mAOD adjacent to Rosper Road along the western edge of the site.
- 4.7.15 As the majority of the site lies within Environment Agency Flood Zone 3, only a relatively small volume of cut/fill operations will be undertaken. The majority of the earthworks are anticipated to be undertaken using imported fill material. Imported fill would comprise a mixture of general fill that complies with the Highways Agency's Specification for Highway Works and capping material or Type 1 sub-base for the pavement layer. The importation would be minimised where possible by using multiple layers of structural geogrids within the pavement layers.
- 4.7.16 Ground levels are anticipated to be raised by around 3.5 m along the landward edge of the existing flood defence.
- 4.7.17 The pavement layer thickness will depend on the bearing capacity of the subsoil which is normally gauged by reference to the measure of its California Bearing Ratio (CBR).
- 4.7.18 It is expected that approximately 2 million m<sup>3</sup> of fill will need to be imported onto the site over a period of around two years. Stone could either be imported into the Port of Immingham and transported to the site on the local road network or could be imported by road from a quarry within the United Kingdom. Once the new quay is partially complete it will also be used for importing fill.

#### *Utility Services*

- 4.7.19 Cooling water pipes for the E.ON and Centrica power stations pass underground through the site. This essential infrastructure will be retained in-situ and will be protected at the start of the works by erecting barriers either side of their centre line to create a protected 6m wide corridor. Heavy duty crossing points will be constructed at discrete locations to enable heavy plant to pass over the pipelines.

4.7.20 At the southern end of the site a number of oil pipelines run underground through the site, within the area to be developed for ecological mitigation.

4.7.21 Following on from the cut/fill operations, drainage and service trenches are proposed to be excavated by a hydraulic excavator to their required depth. Services would be laid in the base of the trenches and imported backfill placed over the pipes or cable. Warning tape will be placed as appropriate to mitigate against accidental damage in the future.

### *Buildings*

4.7.22 Building foundations are expected to be either reinforced concrete pads or pilecaps. Piles are proposed to be either driven steel or precast or alternatively continuous flight auger, which is a low noise, low vibration technique. Excavation for foundations is expected to be undertaken using backhoe excavators. Reinforcement would be delivered by flatbed lorry and concrete is likely to be delivered from an off site batching plant although a temporary on-site batching plant may be installed, subject to its economic viability.

4.7.23 Buildings are proposed generally to have heavy duty reinforced concrete ground bearing slabs that will be cast onto an imported subgrade. Piled slabs may also be used subject to tenant loading requirements for particular buildings and existing ground conditions. Concrete delivery vehicles would discharge into long reach concrete pumps that would transport the concrete close to its final position. Floor slabs are expected to be cast in large sections with saw cut contraction joints made whilst the concrete is still green. Floor finish will be achieved using a laser screed machine to achieve a high quality flat finish.

4.7.24 The steel building frame will be fabricated off site and delivered on lorries. The frame would then be erected by crane and clad using mobile platforms. Once the frame is erected the internal fit out would be undertaken with all deliveries being made by road.

4.7.25 The external concrete service yard is expected to be constructed in a similar manner to the internal floor slabs.

4.7.26 Up to three buildings may be under construction simultaneously.

## *Dredging*

### *Material to be Dredged*

4.7.27 Between 15 June and 15 July 2010 a ground investigation of the foreshore between HST and ABP Immingham was undertaken by Soil Engineering Ltd. on behalf of Yorkshire Forward. The work comprised the following:

- 30 No. vibrocores;
- Bathymetric Survey;
- Magnetometer Survey; and
- Unexploded Ordnance Desk Study.

4.7.28 The results of the investigation are reported in the factual ground investigation report by Soil Engineering and reproduced in Annex 7.3. An interpretative report was prepared by Buro Happold and is reproduced in *Annex 7.4*.

4.7.29 The vibrocore investigation shows that the general subsoil sequence in the area of the investigation comprises the following:

- very soft to soft alluvial clays/clayey silts – occasional thin peat layers;
- silty and gravelly sands; and/or
- soft to firm becoming stiff glacial till with beds of glacial sands and gravels.

4.7.30 The respective volumes of the different materials to be dredged have been estimated from the borehole information and are detailed in *Chapter 7*.

### *Dredging Methodology*

4.7.31 Dredging works will be undertaken using a combination of the following plant:

- TSHD;
- backhoe dredger; and
- bucket ladder dredger.

4.7.32 A detailed dredge methodology is included in *Annex 7.6*.

## 4.8 *MITIGATION OF CONSTRUCTION IMPACTS*

4.7.1 The impact of the construction works on ecology, the local and strategic road network, noise, air quality, water quality, light and navigation will be discussed elsewhere in this report.

4.7.2 Mitigation of any potential effects would be delivered through a Code of Construction Practice (CoCP) to be approved by the local authority. The draft CoCP is included in *Annex 4.2*.

## 4.8 *OPERATIONAL DETAILS*

### *General*

4.8.1 The development will be one of a number of facilities both in the UK and in continental Europe that either manufactures or assembles marine energy components. Manufactured goods will be distributed between these sites in accordance with market demand at any particular point in time.

4.8.2 A schedule of the AMEP development including projected employee numbers and shift patterns is included in *Annex 4.3*.

### *The Quay*

4.8.3 The application includes for the creation of a new harbour authority to manage the operation of the facility. On completion, the quay will be used for the export of goods and for the import of materials and components that are procured from overseas or from other coastal locations within the UK.

4.8.4 A number of berths will be designated along the quay and allocated for use by different tenants. Each berth will be around 200 m long. Whilst the berths will be primarily designated for installation craft this does not exclude their use by other vessels delivering raw materials and other products either related to marine energy or otherwise.

4.8.5 Energy generation components will be moved onto the quay using self propelled mobile transporter (SPMT) units that can be linked together in various permutations to manoeuvre large and heavy items. To take into account the potential for future optimisation of the installation procedure, it is assumed that OWT's that are assembled on the site may be fully erected on the quayside prior to load out.

- 4.8.6 Loading of the installation vessels will be undertaken using a combination of heavy duty mobile dock cranes and the vessels own cranes. Loading of each vessel will be undertaken on a 24/7 basis with a typical total turnaround time for each vessel of between 24 and 48 hours. However loading is a weather critical operation with crane lifts being subject to limiting wind speeds for safety reasons.
- 4.8.7 Vessels alongside will also replenish their consumables and may undertake some routine maintenance.

### *The Manufacturing Park*

#### *General*

- 4.8.8 Given the current focus on offshore wind, the indicative masterplan is based upon a development that serves that sector. Nevertheless, alternative technologies may emerge that will also be served by the facility. There are a number of technologies for wind turbine manufacture; this section outlines the common types and typical features.

#### *Tower Manufacturing Process*

- 4.8.9 **Dimensions and Design:** Towers for offshore wind turbines have, to date, been of the conical steel design with a base diameter of approximately 5 m to 6 m diameter and a top diameter of approximately 3 m. Tower heights range from 60 m to 80 m. Wall thickness is in the range 10 mm to 70 mm thick. Towers are typically manufactured in two or three sections up to 30 m long and will be pre-assembled onshore before being loaded onto an installation vessel to be taken to site. A typical section will have a mass of up to 100 t; the complete tower will weigh between 200-400 t and house electrical and control equipment.
- 4.8.10 **Materials:** Flat steel plate is the prime raw material which is delivered in various thicknesses to the factory. Plate may be supplied in rough cut form or edge prepared and shaped ready for welding and rolling. Steel plate width is a function of the tower design and may be constrained by the width of rollers used in tower fabrication or to comply with transport restrictions. Plates can be up to 14 m long. UK sources of the relevant specification steel are the Tata plate mills in nearby Scunthorpe (200 000 t annual capacity) as well as Motherwell and the Spartan plate mill in County Durham. UK sourced steel would be delivered by rail or road . Vessels supplying steel sourced in Europe are generally up to 7 500 dwt (deadweight tonnage) and typically up to 120 m overall length. Vessels



supplying steel sourced from overseas are generally up to 25 000 dwt and typically up to 180 m overall length.

- 4.8.11 **Components:** Flange rings are supplied to the factory readymade and allow the tower sections to bolt together or to be fixed to its foundation. Flange rings are typically forged or rolled and then machined and have a diameter of up to 6 m and mass of 10 t. Flange sources exist in the UK and overseas and could be located on the SCP.
- 4.8.12 Internal components such as doors, platforms, ladders, dampers and lifts are supplied by sub contractors and delivered by road transport.
- 4.8.13 **Coatings:** Zinc coating and urethane paints are used on the completed tower. Materials are delivered by road transport and supplied in drums up to 50 kg.
- 4.8.14 **Quantities:** The amount of raw materials required varies according to the tower design, but a 1 GW capacity production facility manufacturing 200 towers per year may typically use the following materials:

**Table 4.4** *Typical Raw Material Quantities for a 1 GW Tower Facility*

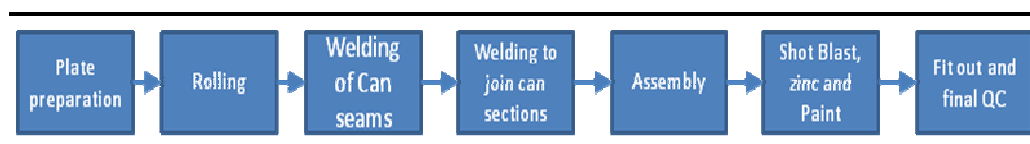
Material	Tonnage p.a.	Approx. number of truck deliveries p.a.*	Truck deliveries/week
Steel Plate	40 000	1 600**	32
Welding materials	500	50	1
Cast components	2 000	200	4
Paint products	54	27	<1
Fittings	50	25	<1

\* Load size per truck varies according to material type

\*\*Can be reduced by direct delivery by ship

- 4.8.15 **Manufacturing Processes:** There are seven distinct stages to the manufacturing process for towers, these are illustrated diagrammatically below in *Figure 4.7* and briefly explained in the following paragraphs.

**Figure 4.7** *Tower Manufacturing Process*



- 4.8.16 Plates can be flame cut to size and weld surfaces prepared either by the supplier or within the tower manufacturing facility. Computer numerical controlled (CNC) cutting will typically be used to ensure

precision of joint lines. Plates are welded together in flat form to feed the rolling process to manufacture 3-4 m long sections of the tower. These individual sections are called “cans”.

- 4.8.17 Multiple cans are welded together to build up tower sections. Submerged arc welding is normally employed to weld the cans together. For circumferential welds the can/tower is rotated. For longitudinal welds the weld arm can be moved. Non destructive testing is completed on all weld joints
- 4.8.18 Flanges are welded in position the ends of each tower section.
- 4.8.19 After welding, the door apertures are cut out and door frames are fitted along with flanges and internal fittings for mounting of platforms, ladders and transformers.
- 4.8.20 Tower sections are cleaned using power washers and detergent to remove ultrasonic gel residue. The sections are then shot blasted inside before being having a zinc rich primer coat applied. The sections are then spray painted and fitted out with internals such as ladders and platforms.
- 4.8.21 A single rolling machine is capable of making cans for up to 200 complete towers per annum on a 24/7 basis.
- 4.8.22 The production processes for a one GW facility produces scrap materials. The quantities vary depending on the manufacturing process but typically may include:

**Table 4.5** *Quantities of Scrap Material Produced from a 1 GW Tower Plant*

<b>Item</b>	<b>Quantity (t)</b>
Landfill	72
Recycling	720
<b>of which</b>	
Steel	470
Paper/cardboard	20
Plastic	15
Wood	30
Shotblast grit	50
Chemicals	35
Other recycling	100

- 4.8.23 **Handling:** Most sections will be moved with SPMT machines.

- 4.8.24 **Hazardous Materials:** In addition to normal industrial disciplines particular precautions will apply in the following areas:
- Handling and storage of flammable materials – paints, solvents; and
  - Dust emissions.

4.8.25 **Employee Health:** Employee health monitoring will include specific checks on lung function and hand-arm vibration (HAV).

4.8.26 The main sources of noise will be extraction fans, power tools and air handling systems. These are consistent with conventional industrial applications. Individual noise sources are unlikely to exceed 80 dBLA<sub>eq</sub> within 5 m.

#### *Blade Manufacturing Process*

4.8.27 **Dimensions:** Blades weigh from 15-25 t with current designs for offshore use in the range 48-73 m long; in future, blade length and mass is likely to increase. The root end (the fixing point of the blade to the wind turbine hub) is in the range 2-4 m in diameter; the chord (the widest point of the blade) is in the range of 4 m to 7 m.

4.8.28 The internal structure is typically a hollow box cross section created either by an internal spar or by a series of shear webs assembled in the moulding process.

4.8.29 **Material Types:** All blades currently used in offshore wind turbines are manufactured from a glass or carbon fibre composite in conjunction with a polymer resin system. Glass or carbon is supplied in woven mats which are laid in moulds. This can be dry or pre-impregnated with resin for the moulding process. Whilst glass fibre is lower cost, carbon fibre has higher stiffness properties.

4.8.30 Mats are supplied in rolls and handled by fork lift. Pre impregnated mats are stored at low temperature at either 5 °C or -18 °C to extend their shelf life. The cost of refrigeration encourages manufacturers to reduce storage and only hold a minimal inventory. Total refrigerated area for those manufacturers would be unlikely to exceed 500 m<sup>2</sup>.

4.8.31 Two types of polymer resin are typically used in offshore blades, thermoset polyester and epoxy. Epoxy resin uses a two-part mix to initiate curing and has superior structural performance but is more expensive. Polyester resin cures in conjunction with a catalyst and has lower strength but is also lower cost

- 4.8.32 Bulk resin is supplied in 20 t liquid containers. On site storage will either be in the supplied container or in purpose built storage vessels within the factory. Bulk resin will be piped to the mixing station alongside each blade mould.
- 4.8.33 Depending on the blade design, components are often joined using structural adhesives. These are commonly epoxy based. Blades may be either painted using two-pack polyurethane paint or have a polyester gelcoat incorporated in the moulding process. Metal inserts are embedded at the root of the blade in order to provide a bolting interface to the rest of the structure. These may be cast iron or steel.
- 4.8.34 Due to the physical scale, shelf life and cash flow implications of blade materials, all blade manufacturers operate with low levels of inventory and will use "just in time" supply systems to support production flow. Glass and resin supplies will be often be delivered daily. High flammability materials are kept to small quantities to both minimise risk and also stay below COMAH levels. The total external storage area for raw materials will not exceed 2000 m<sup>2</sup>.
- 4.8.35 **Quantities:** The amounts of raw materials required varies according to the blade design, but a 1 GW capacity production facility manufacturing 600 blade per year may typically use the following materials:

**Table 4.6** *Typical Raw Material Quantities for a 1 GW Blade Factory*

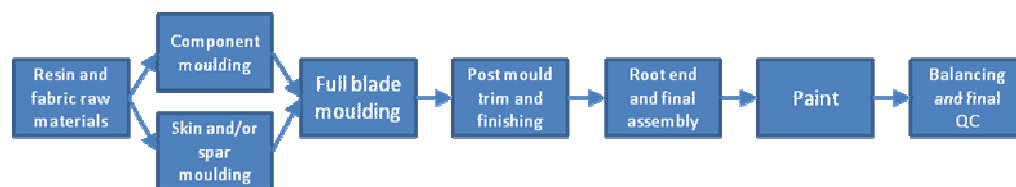
Material	Tonnage p.a.	Approx. number of truck deliveries p.a.*	Truck deliveries/week
Glass / Carbon Fibre	10 000	1 000	10
Resins and adhesives	4 000	300	3 to 5
Iron and steel	250	20	1
Paint products	200	20	1
Cables	20	2	< 0.5
Acetone and thinner*	18	50	1

\* Load size per truck varies according to material type

\*\* Flammable materials handled in low volume containers

- 4.8.36 **Manufacturing Processes:** Whilst there are variations in technology and manufacturing systems, a generic manufacturing process is illustrated below in *Figure 4.8* and described in the paragraphs following.

Figure 4.8 Generic Blade Manufacturing Process



- 4.8.37 Separate components such as root end fittings, shear webs and spars are manufactured prior to the main blade moulding process, either by sub-suppliers or in-house but separate from the blade moulds. The main blade mould is in two halves that close to create the blade shape. Moulds are typically mounted in a steel lattice framework and the closing mechanism is hydraulically operated.
- 4.8.38 Pre-made components are assembled into the main mould along with glass and/or carbon fibre woven fabrics. This “lay-up” is then covered with a polythene bag and the air pumped out. Resin is introduced into the vacuum and is infused through the fabrics and cured. Typical infusion processes are in the temperature range 60 °C to 90 °C and moulds are often temperature regulated (using heating and cooling systems) to maintain strict control of curing.
- 4.8.39 Once the cured blade is lifted out of the mould it is necessary to finish off any rough edges arising at the joints in the mould. Robot automation may be used for edge trimming. Any surface blemishes are repaired at this stage.
- 4.8.40 If paint is to be applied then once the surface is prepared the blade will be placed in a paint booth for spray painting. Paint spraying may be automated or applied manually. Post-curing of the paint will take several hours at 40 °C or more.
- 4.8.41 The production processes will produce scrap from fabric off-cuts, infusion materials, flashing and cured but unused resin. Intelligent handling and segregation of waste will allow recycling in some cases. Almost all waste is inert and safe for landfill or high temperature incineration whilst unused and uncured chemicals are removed from site by specialist licensed operators.
- 4.8.42 The production processes for a one gigawatt facility may typically generate the following scrap:

**Table 4.7** *Quantity of Scrap Material Produced from a 1 GW Blade Plant*

<b>Item</b>	<b>Quantity (t)</b>
Incineration	700
Landfill	100
Recycling	600
	<b>of which</b>
Wood	40
Paper/cardboard	190
Plastic	60
Prepreg	200
Shotblast grit	20
Other	90

- 4.8.43 **Process Equipment:** Fluids used in manufacturing will typically be delivered in containers or drums and moved around site using forklift plant. Bulk infusion resins may be supplied by road tanker with static holding tanks. Mixing equipment is located alongside the moulds and feed mixed resins and adhesives directly to the manufacturing lines. Automated mixing and sampling is used to ensure consistency and quality standards.
- 4.8.44 Various solvents may be used in moderate quantities through the manufacturing process. Any high volatility solvents are held in small quantities and strictly controlled for both health and fire hazard risks. Solvent use is typically well below COMAH limits.
- 4.8.45 Robots are increasingly being used in fabric preparation and lay-up, edge trimming, and paint application.
- 4.8.46 Overhead gantry cranes are used to handle blades, moulds, large equipment and components. Typical cranes have multiple bridges with ratings up to 40 t per bridge.
- 4.8.47 Blades are moved between processes and rotated as required in purpose-build fixtures. Telescopic handlers are typically used in tandem to carry blades to storage or loading onto transport.
- 4.8.48 **Health, Safety and Environment:** In addition to normal industrial disciplines particular precautions apply in the following areas:
- handling and storage of resins – bunded storage and drainage protection;
  - handling and storage of flammable materials – solvents;

- dust emissions;
- vapour emissions from styrene based resins and/or polyurethane paints;
- skin contact with uncured epoxy resins; and
- exothermic risk from epoxy curing.

4.8.49 Employee health monitoring would normally include specific checks on lung function, skin irritation and HAV.

4.8.50 Typical operations are twenty-four hours within the building. With the main sources of noise being extraction fans, power tools and air handling systems. These are consistent with conventional industrial applications.

4.8.51 Certain areas and operations will be designated as requiring ear protection where local noise levels may exceed 80 dBLA<sub>eq</sub>. In particular these may include grinding, polishing and flash trimming within the finishing process. Plant rooms and air extraction equipment are typically equipped with noise insulation to maintain external noise levels below 80 dBLA<sub>eq</sub> within 10 m of the building.

#### *Nacelle Assembly Process*

4.8.52 **Dimensions:** The nacelle is the structure at the top of the wind turbine tower that accommodates the drive train and auxiliary systems and supports the rotor hub assembly onto which the blades are mounted. The nacelle is assembled from its component parts which are manufactured by various specialist suppliers and delivered to the factory by road or sea.

4.8.53 Nacelles for offshore use currently have a maximum (rated) power output in the range of 3 MW to 6 MW. However, designs are being developed for turbines up to 10 MW capacity. They are typically up to 9 m high, 8 m wide and 16 m long, including the hub and any transport frames. There is a large variation in nacelle mass from 70 t for the lightest 3 MW turbines up to 500 t for the heaviest 6 MW turbines. Hub assemblies are in the range 15 to 80 t.

4.8.54 Internal structural components are either cast iron or forged or fabricated steel. Nacelle covers are typically composite fibreglass and polyester, although some are steel or aluminium.

4.8.55 **Material Types and Handling:** The components assembled in the nacelle and hub assembly include large castings and fabrications, large electro-

mechanical sub-assemblies such as generators, control units and gearboxes, wiring looms, hydraulic systems and personnel protection equipment. Whilst castings and large fabrications may be stored externally, most other components are stored inside prior to assembly.

- 4.8.56 Total external storage areas for inbound components for a 1 GW facility including castings, composite covers and fabrications do not exceed 2 000 m<sup>2</sup>.
- 4.8.57 Some nacelle designs incorporate castings as the base structure which supports the drive train. Castings are of spheroidal graphite Iron and may weigh up to 40 t. There are currently no established UK sources for such castings. Units sourced from overseas or some UK locations would typically be delivered by ship but delivery by road from other UK location is also possible.
- 4.8.58 Hub castings can weigh up to 60 t and be up to 4 m in diameter. Larger models require special vehicles for road transport and are preferably delivered by sea. Close proximity of the foundry, machine and paint shops to the assembly facility significantly reduces logistics cost.
- 4.8.59 Castings are typically handled within the assembly facility using overhead gantry cranes. They are delivered pre-machined and painted ready for assembly.
- 4.8.60 Key sub-assemblies may include:
- Generator;
  - Mechanical brake system;
  - Slewing rings and bearings;
  - Pitch and yaw systems;
  - Gearbox;
  - Shafts and couplings;
  - Control system, wiring looms and sensors;
  - Switch gear;
  - Transformer and converter;
  - Auxiliary heating, cooling and health systems;
  - Walkways, guards and railings;
  - Maintenance aids; and
  - Nacelle and hub covers.
- 4.8.61 Components for these sub assemblies can be delivered from sources in the UK and overseas. Heavy or large items such as generators and covers may be supplied directly from adjacent factories established to support the turbine manufacturer.



4.8.62 Many smaller components such as fixings, cables, brackets and electrical components can be supplied by UK stockists and would be delivered by conventional road transport.

4.8.63 The weight of the complete nacelle produces the greatest handling challenge. Self-propelled modular transporters are typically used to move them around site. Large capacity cranes or purpose designed rail mounted trolleys and forklifts may also be used.

4.8.64 **Quantities:** The quantity of components required varies according to the nacelle and hub design but a production facility with the capacity of 1 GW per year and assembling 200 nacelles would typically use the following material:

**Table 4.8** *Components for 1GW Factory assembling 200 Nacelles per year*

Material	Tonnage p.a.	Approx. number of truck deliveries p.a.*	Maximum HGV deliveries/week
Castings	30 000 **	1 500	30
Fabricated assemblies	25 000 **	1 200	24
Major sub-assemblies	2 0000 **	1 300	25
Small components	3 000	2 000	40
Cables	1 500	300	15
Oils and lubricants	400	40	<1
Other	10 500	1 100	22

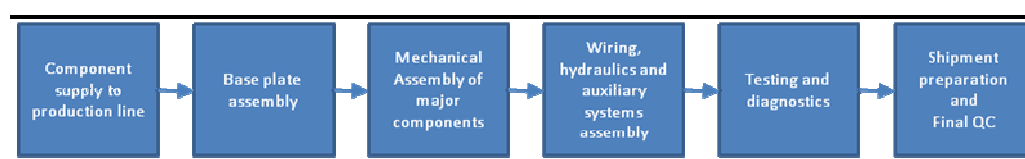
\* Load size per truck varies according to material type

\*\* Direct supply by ship would reduce road movements

4.8.65 The total of 156 truck movements per week would be reduced by direct transfer of product from adjacent manufacturers or by direct delivery by sea.

4.8.66 **Assembly Processes:** A typical assembly process is illustrated diagrammatically below in *Figure 4.9* and explained in the following paragraphs.

**Figure 4.9** *Typical Nacelle and Hub Assembly Process*



- 4.8.67 Larger wind turbine manufacturers are starting to develop a moving production line system with parts delivered directly to line-side locations. Davit or gantry cranes are used to position and then assemble heavy components. Hubs will be assembled in parallel using a similar process and assembled to the nacelle at point of dispatch
- 4.8.68 Major sub-assemblies (such as main bearing to the main shaft) are completed separately from the main production line. These, and major components such as the gearbox, generator frame and generator, are bolted into position prior to electrical and hydraulic connections and the hub assembly being fitted.
- 4.8.69 Power take-off and control system wiring is completed and hydraulic systems are filled.
- 4.8.70 No-load rotation and control system functional tests and diagnostic systems are run to ensure the turbine systems are all working correctly. Finally, hub and nacelle covers are fitted and complete assemblies are mounted onto transport frames.
- 4.8.71 **Waste and Scrap:** As an assembly process, there is little scrap produced. The majority of waste materials will be associated with packaging and transport frames associated with large and heavy items and will be recycled.
- 4.8.72 Steel transport frames are often collected and returned for re-use subject to the costs of return transport and the item value. The production processes for a 1 GW facility may typically generate the following waste:

**Table 4.9** *Quantity of Scrap Material Produced from a 1GW Nacelle Plant*

<b>Item</b>	<b>Quantity (t)</b>
Incineration	40
Recycling	210
	<b>of which</b>
Wood	15
Paper/cardboard	15
Plastic	10
Steel	120
Other	50

- 4.8.73 **Process Equipment:** The most expensive equipment is associated with the moving production line. This incorporates cranes and handling systems to assist in assembling the large components.

- 4.8.74 Although test strategies vary, most facilities incorporate some level of purpose designed systems test equipment to verify correct operation of the assembled nacelle and hub.
- 4.8.75 **Health, Safety and Environment:** In addition to normal industrial disciplines particular precautions apply in the handling and storage of hydraulic fluids and lubricants.
- 4.8.76 Employee health monitoring includes specific checks on HAV.
- 4.8.77 Typical operations are twenty-four hours within the building. External movements are concentrated on daylight hours. Main sources of noise are plant room, power tools and air handling systems. These are consistent with conventional industrial applications. Individual noise sources are unlikely to exceed 80 dB within 5 m.

### *The Supply Chain Park*

#### *General*

- 4.8.78 The Supply Chain Park will provide a base for a range of industries but the precise mix of tenants cannot be known at this stage. This section details a range of potential manufacturing processes that might locate to the site and these examples define the envelope of the environmental impacts.

#### *Substation Control Panel Assembly Process*

- 4.8.79 An offshore wind farm is connected via High Voltage Array Cables to an offshore substation. In a Round 3 wind farm, which is distant from shore, further array cables will carry the power from several substations to a converter station. Here the High Voltage Alternating Current (HVAC) power will be converted to High Voltage Direct Current (HVDC).
- 4.8.80 The substations and converter stations need a very large number of complex control panels to provide protection and control for electrical systems and the substations. The degree of interface and complexity provide advantages to assembling a proportion of the panels close to the industry cluster so that issues are resolved timeously.
- 4.8.81 **Dimensions:** Control panels need not be physically large; many control boards comprise of a suite of many standard rack panels cabled together. Individual panels are circa 1m wide by 1m deep by 2.5 m high. A suite of twenty panels would not be uncommon and there are many advantages to assembling and shipping a fully equipped suite to its final assembly

location. The panels are relatively light compared to other materials, typically up to a maximum of 400 kg per panel.

4.8.82 **Material Types and Handling:** The panels comprise a steel cabinet, to which racks or mounting plates can be fixed. The door of the cabinet might include a PVC panel. The racks and mounting plates will be fitted with components. These will include a wide range of sophisticated protection relays, control relays, PLC's and auxiliary power units. There will also be a considerable low power cabling and connections. It is not expected that the panels will include any hazardous materials.

4.8.83 The steel cabinets represent the largest volume and could be sourced from suppliers such as Rittal or Eldon within Yorkshire, or from more distant suppliers. Materials must be stored internally, and deliveries of components will be by conventional road transport.

4.8.84 **Quantities:** It is anticipated that over 300 substations and 30 converter substations will be required in Round 3, each requiring in excess of 100 control or protection panels. These panels will come from many sources. The limiting factor in the assembly of panels may be the availability of the skilled wiremen needed. It is anticipated that a typical assembly plant will produce 1 000 panels per annum. Such a factory would typically use the following material:

**Table 4.10** *Components for a Factory assembling 1 000 Control and Protection Panels per year*

Material	Tonnage p.a.	Approx. number of truck deliveries p.a.*	Maximum HGV deliveries/week
Cabinets	20	50	1
Protection Relays	50	10	<0.2
Contactors, PLC's	20	10	<0.2
Small components	20	10	<0.2
Cables	20	10	<0.2

\* Load size per truck varies according to material type

4.8.85 The total of two truck movements per week would be in addition to a number of van and courier deliveries.

4.8.86 **Assembly Processes:** Individual panels are required in relatively low volume so represent a highly labour intensive operation. Some robotic preparation of wiring and ferrules has been introduced to the industry but this is still the exception for individual project panels.

- 4.8.87 Preparation of the Cabinet, racks and mounting plates include the drilling and punching of holes and mounting slots, usually by means of a CNC punching machine. Following punching, plates require a painting operation.
- 4.8.88 The racks and mounting plates will be equipped by the necessary hardware such as the PLC modules, protection relays, auxiliary relays and switches, control switches and fuses. The racks and mounting plates will then be prewired with those connecting wires that connect units within the plate.
- 4.8.89 The racks and plates are mounted in the cabinet, and the very large number of connection wires between the different modules and the connection terminals are individually cut to length and crimped. Whilst plug and socket technology is widely used, there are many other connections where individual terminals are used.
- 4.8.90 When the complete cabinet is wired, the wiring is checked for connection and continuity and functional testing of the panel is undertaken. The control or protection suite is then ready for shipment either as a complete unit, or after disconnection as individual panels.
- 4.8.91 **Waste and Scrap:** As an assembly process, there is little scrap produced. The majority of waste materials will be associated with packaging. The cabinet packaging should be suitable for repeated use.
- 4.8.92 The production processes for a 1 000 panel facility may typically generate the following waste:

**Table 4.11** *Quantity of Scrap Material Produced from a 1 000 pa Panel Plant*

<b>Item</b>	<b>Quantity (t)</b>
Recycling	2
	<b>of which</b>
Wood	<0.2
Paper/cardboard	1
Plastic	<0.3
Steel	<0.3
Other	<0.2

- 4.8.93 **Process Equipment:** Equipment for the assembly process is relatively simple. Some panels will include High Voltage inputs and specialist test equipment may be necessary. This will include appropriate shielding

and safeguards such that it poses no risk externally, and is used by trained operators.

4.8.94 **Health, Safety and Environment:** In addition to normal industrial disciplines particular precautions apply to the testing of high voltage electricity.

4.8.95 Employee health monitoring includes specific checks on HAV.

4.8.96 Typical operations are twenty-four hours within the building. External movements are concentrated on daylight hours. Main sources of noise are plant room, power tools and air handling systems. These are consistent with conventional industrial applications. Individual noise sources are unlikely to exceed 80 dBLA<sub>eq</sub> within 5 m.

#### *Base frame (or Yaw Frame) Manufacturing Process*

4.8.97 **Dimensions and Design:** A nacelle is connected to the yaw bearing and drive ring, through its base frame (sometimes called a Yaw Frame). The ability of the nacelle to rotate (yaw) to face the wind greatly increases efficiency. Different designs use entirely fabricated structures, whilst others use a central casting for primary load transfer, with a support frame for the electrical and service structures. The final dimension of a base frame for a typical new generation offshore wind turbine will be 8m wide and 10m long (the width is needed to allow access past the 7m diameter generator). The size of the frame makes its manufacture near to the nacelle assembly facility a significant commercial advantage. A typical base frame will have a mass of up to 15 t. The base frame will not only provide a transfer path for the thrust loads to the tower, but resists the torque created by the generator. It also provides the location frames for the generator stator, converter cubicles, condition monitoring and control cubicle and a range of nacelle facilities.

4.8.98 **Materials:** Flat plate and I beam sections are the prime raw material that is delivered in various sizes to the factory. Plate may be supplied in rough-cut form or edge prepared and shaped ready for welding and rolling. UK sources of the relevant specification steel are the Tata plate mills in Scunthorpe (200 000 t annual capacity) as well as Motherwell and the Spartan plate mill in County Durham. UK sourced steel would be delivered by rail or road. Vessels supplying steel sourced in Europe are generally up to 7 500 dwt and typically up to 120 m overall length. Vessels supplying steel sourced from overseas are generally up to 25 000 dwt and up to 180 m overall length.

4.8.99 **Components:** If the main load transfer is by casting, the casting will be delivered from a foundry, most likely by vessel, but castings could be delivered by lorry as an over width load. Flange rings (into which the Yaw bearings are located) are supplied to the factory readymade. Flange rings are typically forged or rolled and then machined and have a diameter of up to 4 m and mass of 3 t. Flange sources exist in the UK and overseas.

4.8.100 **Coatings:** Urethane paints are used on the completed base frame. Materials are delivered by road transport and supplied in drums up to 50 kg.

4.8.101 **Quantities:** The amount of raw materials required varies according to the base frame design, but a production facility to support 1 GW or nacelle manufacture may typically use the following materials:

**Table 4.12** *Typical Raw Material Quantities for a 1 GW base frame Facility*

Material	Tonnage p.a.	Approx. number of truck deliveries p.a.*	HGV deliveries/ week
Steel Plate	3 000	140**	3
Welding materials	40	10	<2
Cast components***	200	90	2
Paint products	3	10	<2
Fittings	5	10	<2

\* Load size per truck varies according to material type

\*\*Can be reduced by direct delivery by ship

\*\*\* If casting design used (in which case steel plate is reduced)

4.8.102 **Manufacturing Processes:** The stages of the manufacturing process are briefly explained in the following paragraphs.

4.8.103 I sections can be cut to length and profiled, and plates can be flame cut to size and weld surfaces prepared either by the supplier or within the base frame manufacturing facility. Computer numerical controlled (CNC) cutting will typically be used to ensure precision of joint lines. If a fully fabricated design is being manufactured the facility will have a simple plate rolling capability.

4.8.104 A combination of I section and plates are fabricated, incorporating the load bearing casting if appropriate. Submerged arc welding is normally employed to weld the structure. Load bearing elements of the design will have a very high degree of control. Jigs and holding fixtures are extensively used to hold components in place during fabrication.

- 4.8.105 For a fully fabricated design the angle and alignment of the generator stator flange and the yaw bearing flange is critical, and major fixtures will be used.
- 4.8.106 After the load transfer section of the main base frame is welded, the support frames on which a range of electrical cubicles and hydraulic services are mounted are then welded in position.
- 4.8.107 The base frame may be cleaned using power washers and detergent to remove ultrasonic gel residue. The frame is then shot blasted inside before being having a zinc rich primer coat applied. The frame is then spray painted.
- 4.8.108 The production processes for a 1 GW facility produces scrap materials. The quantities vary depending on the manufacturing process but typically may include:

**Table 4.13** *Quantities of Scrap Material Produced from a 1 GW Base Frame Plant*

Item	Quantity (t)
Recycling	76
	<b>of which</b>
Steel	40
Paper/cardboard	1
Plastic	0.5
Wood	1
Shotblast grit	30
Chemicals	2
Other recycling	2

- 4.8.109 **Handling:** Complete base frames will be moved with special trolley frames due to their width and length.
- 4.8.110 **Hazardous Materials:** In addition to normal industrial disciplines particular precautions will apply in the following areas:
- Handling and storage of flammable materials – paints, solvents;
  - Dust emissions.
- 4.8.111 **Employee Health:** Employee health monitoring will include specific checks on lung function, and HAV.
- 4.8.112 Main sources of noise will be extraction fans, power tools and air handling systems. These are consistent with conventional industrial



applications. Individual noise sources are unlikely to exceed 80 dBLA<sub>eq</sub> within 5 m.

#### *Canopy and Spinner Manufacturing Process*

- 4.8.113 **Dimensions:** Canopies are the composite structure that provides the roof and walls of the Nacelle. They weigh from 2 – 4 t with new designs for direct drive turbines for offshore use in the range 8 m diameter and 11 m long; in future, the diameter is likely to increase. Spinners provide weather protection to the blade pitch drives, as well as aerodynamic benefits. Typically 5m in diameter they weigh less than 1 t.
- 4.8.114 Canopies can either be specified as a single piece, complete structure (in which case transport must be by ship), or designed in multiple pieces for road transport. In either case they are relatively thin walled structures with access hatches, and connection points for instruments, ventilation etc. Spinners are usually specified as single piece structures, again with ports for the blades and an access hatch.
- 4.8.115 **Material Types:** Canopies will usually be made from fibreglass. Glass is supplied in woven mats that are laid in moulds. This can be dry or pre-impregnated with resin for the moulding process. Spinners are usually made from a GRP Resin Infusion Moulding process.
- 4.8.116 Mats of fibre and the resins used are similar to those described in the blade manufacturing process above. The total external storage area for raw materials will not exceed 500 m<sup>2</sup>.
- 4.8.117 Depending on the canopy and spinner design, components may be joined using structural adhesives. These are commonly epoxy based. Canopies and spinners may be either painted using two-pack polyurethane paint or have a polyester gelcoat incorporated in the moulding process. Metal inserts are embedded into the structure in order to provide safety rails and interfaces to the rest of the structure. These are usually steel.
- 4.8.118 **Quantities:** The amounts of raw materials required varies according to the canopy and spinner design, but a 1 GW capacity production facility manufacturing 180 canopies/Spinners per year may typically use the following materials:

**Table 4.14 Typical Raw Material Quantities for a 1 GW Canopy/ Spinner Factory**

Material	Tonnage p.a.	Approx. number of truck deliveries p.a.*	HGV deliveries/week
Glass Fibre	500 t	40	<1
Resins and adhesives	250 t	20	<0.5
Iron and steel	20 t	2	<0.1
Paint products	10 t	2	<0.1
Cables	5 t	2	< 0.1
Acetone and thinner*	1 t	2	<0.1

\* Load size per truck varies according to material type

\*\* Flammable materials handled in low volume containers

- 4.8.119 **Manufacturing Processes:** The generic manufacturing process is described in the paragraphs following.
- 4.8.120 Separate components such as fittings for safety rails, anemometers, warning lights, are manufactured prior to the canopy moulding process by sub-suppliers. Where a canopy is designed as a single piece GRP moulding, the mould is in several pieces, which during the laying up process are progressively fitted to create the canopy shape. Spinner moulds are typically rather simpler and may be a two piece arrangement.
- 4.8.121 Pre-made components are assembled into the main mould along with glass fibre woven fabrics. This “lay-up” is then covered with a polythene bag and the air pumped out. Resin is introduced into the vacuum and is infused through the fabrics and cured. Typical infusion processes are in the temperature range 60 °C to 90 °C and moulds are often temperature regulated (using heating and cooling systems) to maintain strict control of curing.
- 4.8.122 Once the cured canopy or spinner is lifted out of the mould it is necessary to finish off any rough edges arising at the joints in the mould. Robot automation may be used for edge trimming. Any surface blemishes are repaired at this stage.
- 4.8.123 If paint is to be applied then once the surface is prepared the blade will be placed in a paint booth for spray painting. Paint spraying may be automated or applied manually. Post-curing of the paint will take several hours at 40 °C or more.
- 4.8.124 The production processes will produce scrap from fabric off-cuts, infusion materials, flashing and cured but unused resin. Intelligent handling and segregation of waste will allow recycling in some cases.

Almost all waste is inert and safe for landfill or high temperature incineration whilst unused and uncured chemicals are removed from site by specialist licensed operators.

4.8.125 The production processes for a 1 GW facility may typically generate the following scrap:

**Table 4.15** *Quantity of Scrap Material Produced from a 1 GW Canopy and Spinner Plant*

Item	Quantity (t)
Incineration	10
Landfill	30
Recycling	20
	<b>of which</b>
Wood	4
Paper/cardboard	5
Plastic	5
Prepreg	3
Other	3

4.8.126 **Process Equipment:** Delivery of materials, the storage and handling of materials and the treatment of flashings are similar to that described above in relation to the blade manufacturing process

4.8.127 **Health, Safety and Environment:** In addition to normal industrial disciplines particular precautions apply in the following areas:

- handling and storage of resins – bunded storage and drainage protection;
- handling and storage of flammable materials – solvents;
- dust emissions;
- vapour emissions from styrene based resins and/or polyurethane paints;
- skin contact with uncured epoxy resins; and
- exothermic risk from epoxy curing.

4.8.128 Employee health monitoring would normally include specific checks on lung function, skin irritation and HAV.

4.8.129 Typical operations are twenty-four hours within the building. With the main sources of noise being extraction fans, power tools and air handling systems. These are consistent with conventional industrial applications.

4.8.130 Certain areas and operations will be designated as requiring ear protection where local noise levels may exceed 80 dBLA<sub>eq</sub>. In particular these may include grinding, polishing and flash trimming within the finishing process. Plant rooms and air extraction equipment are typically equipped with noise insulation to maintain external noise levels below 80 dBLA<sub>eq</sub> within 10 m of the building.

#### 4.9 *THE MAIN DESIGN ALTERNATIVES CONSIDERED*

4.9.1 In accordance with The Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 Schedule 4 Part 1 Section 18, an ES must record;

*“(a)n outline of the main alternatives studied by the applicant and an indication of the main reasons for the applicant’s choice, taking into account the environmental effects.”*

4.9.2 *Annex 4.4* provides an account of the main alternatives to the final proposal that have been studied. *Chapter 6* considers alternative sites to that proposed and also compares the impact of providing the same aggregate capacity as AMEP but on a number of smaller sites.

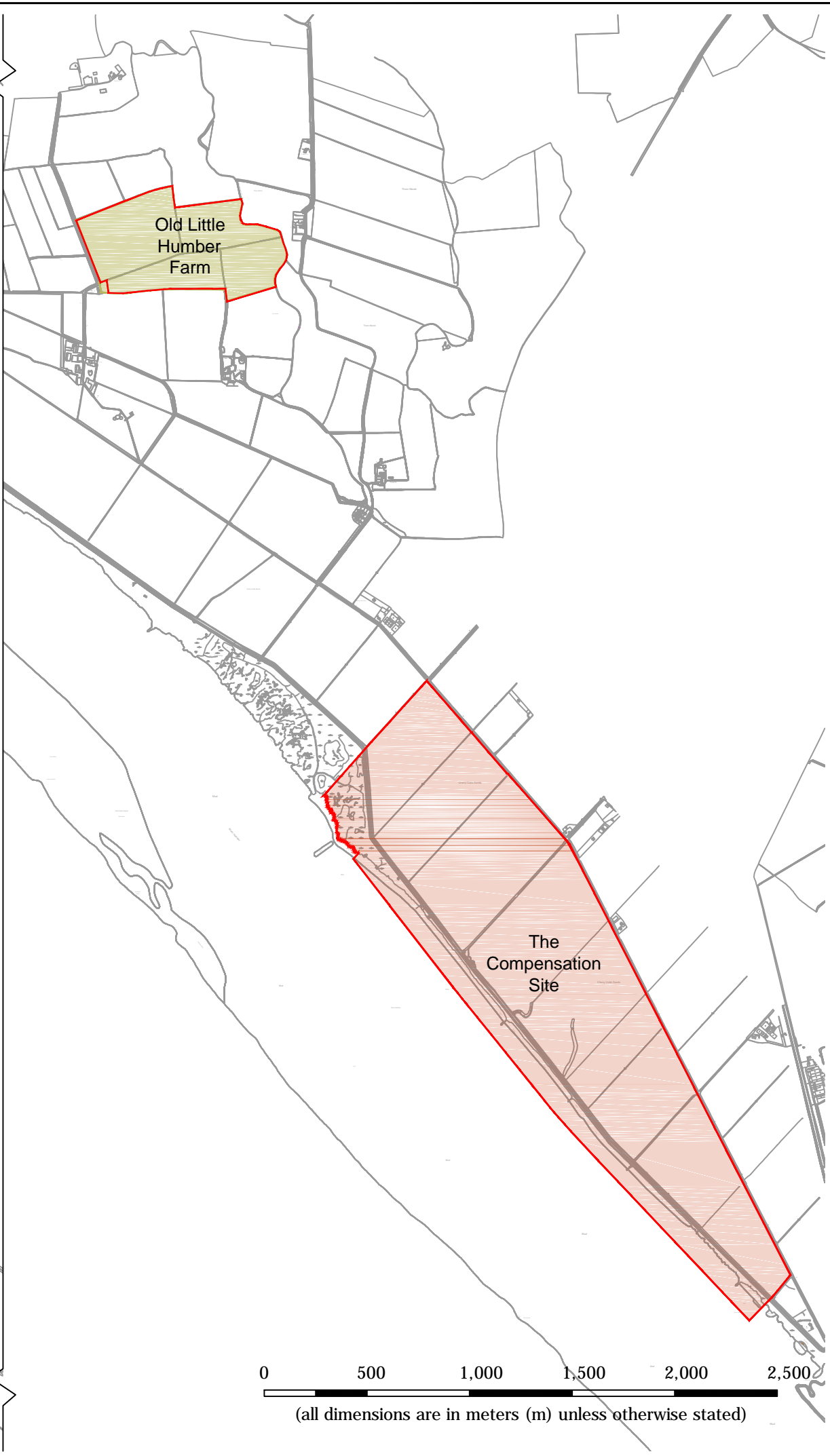
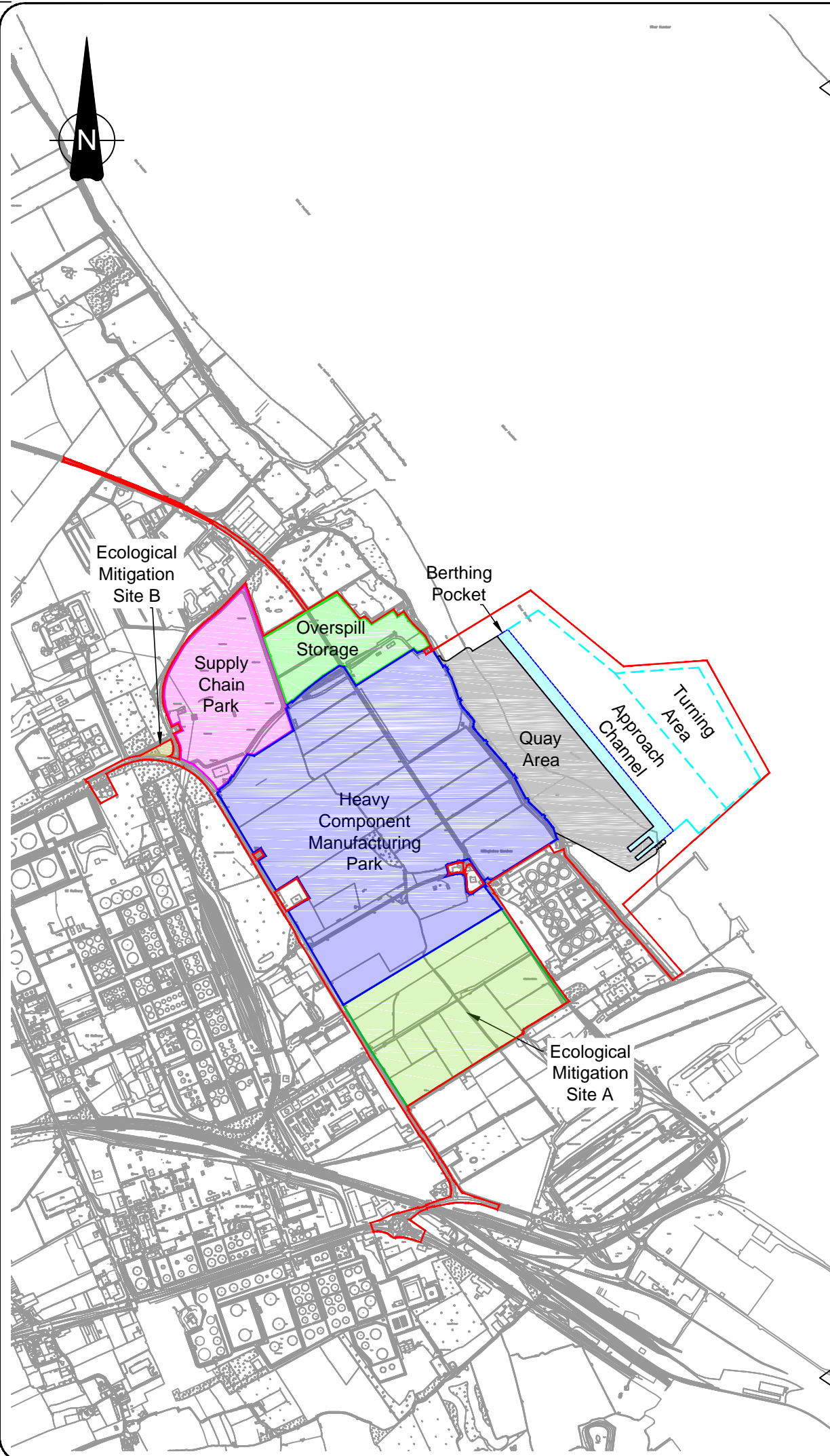
#### 4.10 *DECOMMISSIONING*

##### *The Quay*

4.10.1 The quay, once constructed will form a significant part of the nation’s port infrastructure. In the event that demand for port space by the offshore energy sector reduces in the future, the quay will find other uses related to the import and export of goods. The new quay will also replace an existing flood defence wall and will protect the immediate hinterland and adjacent properties from flooding. The quay will be maintained to ensure that it continues to provide appropriate flood protection, including for the effects of climate change, as currently predicted, over the next one hundred years. Accordingly, there will be an overriding requirement to maintain the quay rather than decommission it.

### *Industrial Buildings and Related Infrastructure*

- 4.10.2 Whilst the industrial buildings will be constructed with a nominal 60year design life, it is possible that in the future they will be dismantled and replaced with other bespoke buildings. A large proportion of the buildings will be recyclable at the end of their commercial life. In particular, the steel frame can either to be taken down and re-erected on another site or sold as scrap to a steel foundry; the concrete can be crushed for use as a sub-base or capping material or as general hardcore.
- 4.10.3 The infrastructure comprising imported fill material and services will be maintained to enable continued use of the facility as a working port in the future.
- 4.10.4 The Health and Safety File, produced in accordance with the Construction (Design and Management) Regulations 2007 will record all materials incorporated into the works to enable safe demolition in the future if it is ever required.



KEY

— Development Consent Order Boundary

A	12/12/11	Preliminary Issue	RK	RC	RC
Rev	Date	Comments	Drw	Chk	App

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Project: **ABLE Marine Energy Park**

Client: **ABLE UK Ltd**

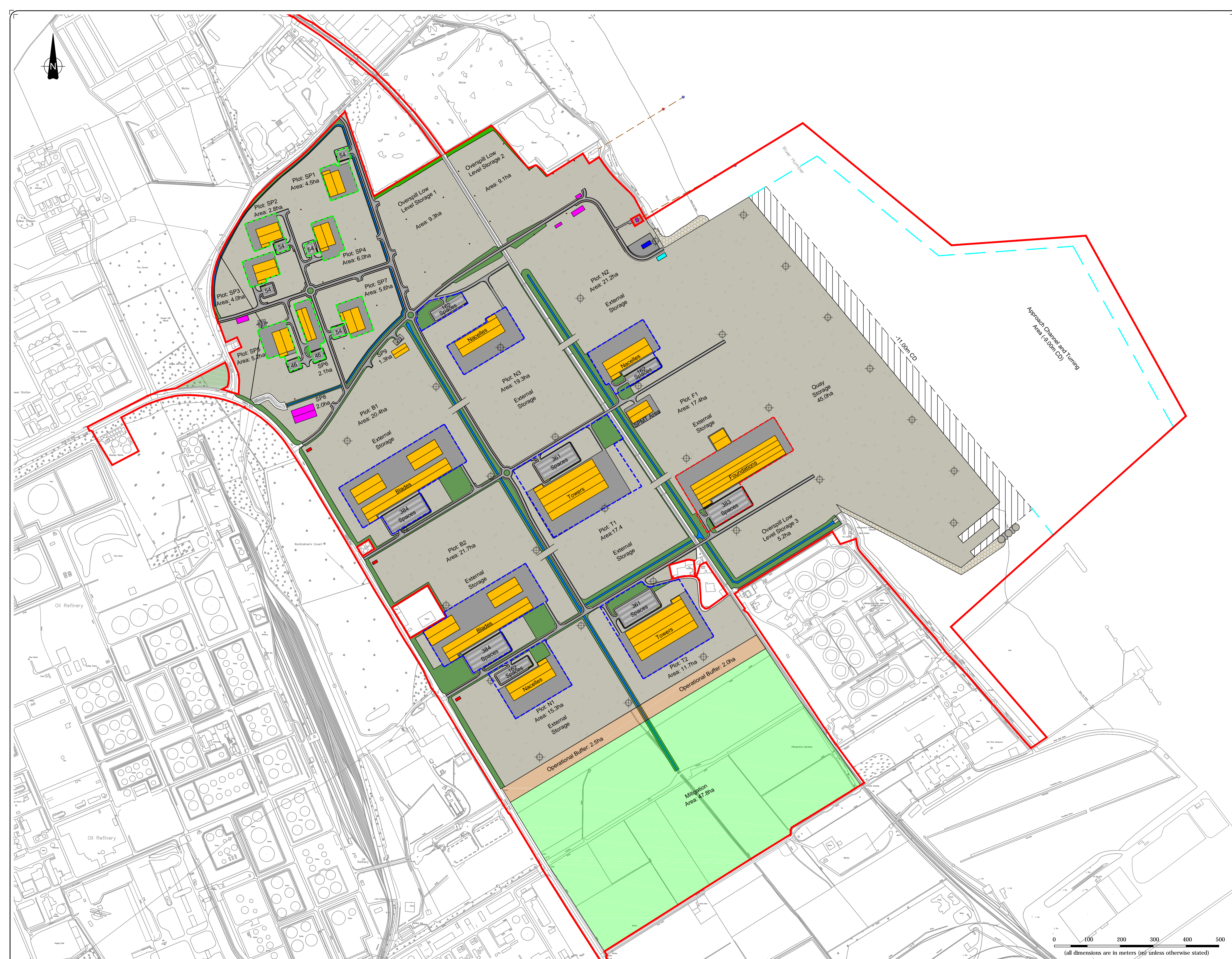
Title: **Figure 4.1 - Core Development Areas**

PRELIMINARY

Scale: 1:25,000@A3	Drawn R Keirl	Checked R Cram	Approved R Cram
Date	12/12/2011	12/12/2011	12/12/2011
Drawing No.	-		Revision: A

0      500      1,000      1,500      2,000      2,500

(all dimensions are in meters (m) unless otherwise stated)



- KEY**
- Limit of deviation for siting of building up to 45m high.
  - Limit of deviation for siting of building up to 25m high.
  - Limit of deviation for siting of building up to 15m high.
  - 48 48 Space Car Park
  - Stone Surfacing
  - Landscaping
  - Rock Revetment
  - Existing Lighting Column (21-30m High)
  - Proposed Lighting Column (50m High)
  - Existing Cooling Water Intake
  - Existing Cooling Water Outfall
  - Existing Building
  - Proposed Building
  - Electric Substation
  - HMRC Office
  - Berthing Pocket
  - Waste Recycling & Transfer Facility
  - Able Approach Channel & Turning Area
  - Proposed Pumping Station

Rev	Date	Comments	Drw	Chk	App
A	12/12/11	Preliminary Issue	RK	RC	RC

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Project:	ABLE Marine Energy Park
Client:	ABLE UK Ltd
Title:	Figure 4.2 - Indicative Masterplan

**PRELIMINARY**

Scale	Drawn	Checked	Approved
1:10,000@A3	R Keir	R Cram	R Cram
1:5,000@A1	R Keir	R Cram	R Cram
Date	12/12/2011	12/12/2011	12/12/2011
Drawing No.	Revision: A		

0 100 200 300 400 500  
 (all dimensions are in meters (m) unless otherwise stated)