free. The sheath bonding equipment, which may be located above or below ground, as shown in Figure 5.13, must be easily accessible as annual inspections will be required.

Installation of Onshore Cable Circuits

5.6.13 Cables are traditionally laid in open trenches which are excavated by using a standard mechanical excavator or specific trenching machine. Once trench preparation has taken place, the cables are laid and the trench is back-filled with the original material. It is likely that alternative material will be required to surround the cables, as detailed in paragraph 5.6.22, if the original material is not deemed to have suitable thermal dissipaton and physical characteristics.

If mechanical excavators are used, they will be similar to those indicated in Figure 5.9 The vehicle will be tracked to spread its weight as evenly as possible.



Figure 5.9 | Tracked mechanical excavator

5.6.14 A recently developed and possibly alternative methodology for laying the cables is to plough the cables into the ground. This is a simultaneous lay-and-bury operation, during which one circuit (three cables) would be reeled off their respective cable drums and buried into the ground to the required depth in one operation, negating the need to construct an open trench. Additional materials, such as thermally resistive material and warning tape, can also be fed in during this single-pass operation. This methodology has recently been employed to lay cable up to 33 kV during the construction of Onshore wind energy projects. Construction plant required to deal with the larger 132 kV cable is currently under development and the possibility of its utilisation during the construction phase will be further considered during the detailed design phase. In keeping with the Rochdale Envelope approach, the open trenching method for cable installation represents the worst case scenario and is detailed further in the following sections.

5.6.15 This recently developed method is presently only available for laying cable of up to 33 kV, and therefore this method is not included within the assessment. 132 kV cable-laying capabilities are anticipated in the near future and will be considered further once available.

5.6.16 It is anticipated, therefore, that the majority of the remaining onshore cable length will be installed within an open trench. The exception will be where the cable crosses further inland (historical) seawalls, walls, large drains and major roads, where HDD will be employed.

5.6.17 Irrespective of the installation method used, the cable route will be surveyed and suitable measures taken to protect any services and drainage channels that might be affected during cable installation. Where necessary, land drains will be reinstated after cable installation.

5.6.18 Figure 5.10 shows a typical trench containing three cables (one circuit). The wooden shuttering in the trench may be required to prevent the trench walls from collapsing. For wider trenches, battered walls (ie sloping walls) could be considered in order to obviate the need for shuttering.



Figure 5.10 | Typical 132 kV cable trench

5.6.19 The layout of the works corridor for an open trench is illustrated in Figure 5.11.

5.6.20 It is assumed for the purposes of this assessment that a corridor width for installation of up to ten circuits (including working areas) will be no greater than 50 m.

5.6.21 Site clearing and preparation (establishing vehicle access) will be required prior to the commencement of cable laying. Once the cables have been laid, the land will be returned to its previous condition, leaving no lasting impact. Where necessary, reinstatement of internal drainage networks will be necessary for each installation method. Appropriate planning will be required in order to ensure that disturbance to hedgerows and other habitat features is avoided or minimised during critical times, eg nesting.

5.6.22 As part of a detailed route survey, the soil will be analysed for its thermal properties. If it is suitable (ie its thermal resistivity is consistent and in line with the design parameters that have been used to calculate the cable ratings), it can be used to back-fill the trenches after installation. If it is not suitable, it will be disposed of at a suitable facility and replaced with a selected sand that does possess the required thermal properties. The soil would be checked to ensure it is free from sharp stones that could cause cable damage. It is expected that some selected sand will be necessary.

5.6.23 The onshore cable would be laid in sections, with the section length dependent on the feasibility of handling the cable drums and cable route design (an average section length would be approximately 500 m). Laying cables in an open trench involves pulling the cables off their drum via a winch positioned at the end of a section.

5.6.24 For cable laying through farmland, the cable must be laid sufficiently deep to prevent any interference from ploughing. A trench depth of 1,250 mm is the UK standard.

5.6.25 The cables for each circuit will be flat spaced, and the cable sheaths will be cross-bonded (ie interconnected) at each joint position.

5.6.26 Removed soil will be stored at the side of each trench. The approximate volumes of soil to be removed are presented in Table 5.2.

Table 5.2 | **Estimated volume of soil to be excavated**

	Lincs	Docking Shoal	Race Bank
Volume of soil to be excavated over 11 km route	41,250 m^3	68,750 m^3	68,750 m^3

5.6.27 While the cable trenches are open, they will be fenced off for health and safety reasons, and security firms will be employed as required.

5.6.28 After the cables have been pulled into the trenches, the trenches will be back-filled.

5.6.29 The sheath bonding equipment, which may be located above underground or below ground, must be easily accessible, as annual inspections will be required. Depending on the location, joint bonding areas may require a small wooden fence for protection from farm machinery.

Seawalls

5.6.30 Moving southwards there are several seawalls, which were constructed during earlier reclamation works, that need to be negotiated. The cables would be installed either by open trenching or by pulling into ducts, which would be pre-installed under the seawalls using an HDD method similar to that described for the landfall.

Drains

5.6.31 For small land drains, defined as less than 1 m wide and 1 m deep, open trenching is the preferred method. Using sheet piling or sandbags to dam the drain tempo-



Figure 5.11 | Onshore cable spacing parameters

rarily, a water pump can be used to divert flow across the sectioned work area. A trench depth of between 1,000–1,500 mm below the bottom of the drain is necessary to allow for any future maintenance requirements of the drain.

5.6.32 Open-cut trenching on medium and large (greater than 1 m × 1 m) may require different methodologies – see below.

5.6.33 There are two options for crossing medium and large drains (greater than 1 m × 1 m):

- Drain culverts – placing culverts into drains (as indicated in Figure 5.12) will allow cables to be installed without the need to bury them at depth. A portion of the drain will be sectioned using sandbags and a diverting water pump if required. An appropriately sized culvert for the drain and necessary support and reinforcement will be installed into the drain if required. The cables will be laid across the top at a minimum depth of approximately 1,500 mm and the remainder backfilled with suitable material. Attention will, at all times, be paid to the ecological value of the drains before culverts are installed. This configuration is shown in Figure 5.12.
- HDD – ducts will be installed under drains to an agreed depth below the bottom of the ditch (to allow for future ditch maintenance). See methodology for crossing larger drainage ditches and major roads below.

5.6.34 The method to be used at each ditch crossing will be determined at the detailed design stage.

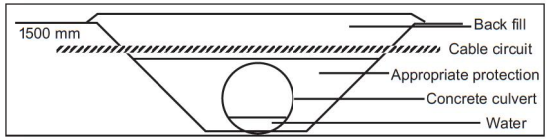


Figure 5.12 | Cross-section of a culverted drain crossing

Roads

5.6.35 Cables passing under roads are not required to be buried to the same depth as those under farmland. A burial depth of 1,100 mm is standard. Due to the high level of surface activity associated with trenching, it is expected that the open trench approach will only be taken with small or lightly used roads, to minimise disturbance.

5.6.36 Drilling under medium to large roads (including the A17) is preferred over trench cable-laying methods, to allow the road to be used as normal by traffic while the work is carried out. A duct would be sunk to an agreed depth below the road, depending on the road construction and location of other services. See methodology for crossing larger drainage ditches and major roads below.

Methodology for Crossing Larger Drainage Ditches and Major Roads

5.6.37 Where it would be impractical to trench through obstacles such as large drains or major roads, it would be necessary to use a trenchless cable-laying technique, such as HDD, using a methodology similar to that described for the landfall.

5.6.38 In order that the target depth under the obstacle be achieved using Horizontal Directional Drilling, the entry and exit pit will be located some distance from either side of the obstacle. The distance at which the pits will be located will be dependent on the target depth at which the conduit must pass under the obstacle.

5.6.39 There are other methods of trenchless cable laying, namely guided augers and micro-tunnelling. These, however, require drilling and reception pits to be sunk either side of the obstacle, and then a duct is drilled between the two. Although there is no need for a separation distance between the drilling site and obstacle boundary, these methods take longer to complete because of the need to excavate and shore up the drill and reception pits.

Onshore Cable Jointing

5.6.40 At the cable section joints, it is possible that the trench would have to be widened to allow more room for the cable joint. The joint bays for all ten circuits can be accommodated within the 50 m corridor by ensuring that the joints are staggered.

5.6.41 Depending on the stability of the ground at the bottom of the trench, it may be necessary to line the trench with a geotextile such as 'Terram'. This material geotextile serves to increase the load-bearing capacity of the ground, increasing the stability of the cable jointing box. It can comprise a plastic grid system or a woven glass fibre mat. The need for and specification of such reinforcements will be determined during the detailed design phase.

5.6.42 On completion of cable jointing, the joint bays would be back-filled with either the original soil, selected sand or, if necessary for thermal reasons, a sand and cement mix. For three cables, a typical joint bay would be 2.5 m wide × 7 m long.

5.6.43 At each joint bay, specialist cable sheath bonding equipment would be necessary. This could be housed in a pit below ground level or in a kiosk above ground, as shown in Figure 5.13.

5.6.44 The excavation that would be necessary to house the underground sheath bonding equipment would be approximately 1.5 m square with a depth of 1 m. An above-ground kiosk is approximately 1.2 m high × 1.5 m wide × 0.4 m deep.

5.6.45 One set of bonding equipment is necessary for every circuit. The equipment must be located within 10 m of each joint location. The equipment requires annual maintenance inspection, so it must be accessible.

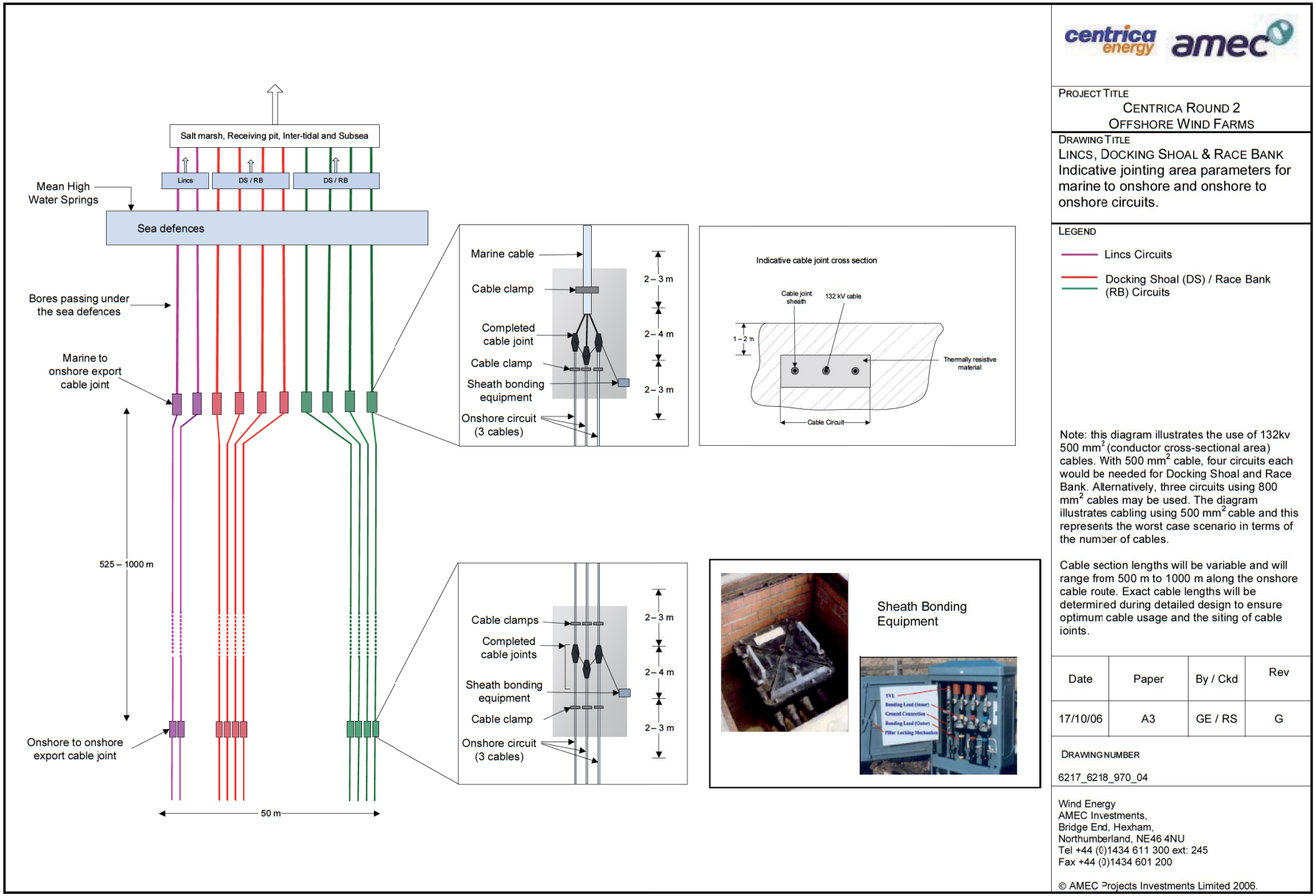


Figure 5.13 | Details of cable jointing

5.6.46 The number of jointing bays required depends on the lengths of the cables used, and this is yet to be decided. Where possible, jointing bays would be located adjacent to field boundaries or roads.

5.6.47 If the sheath bonding equipment is housed in an underground pit, a small area surrounding the pit may be fenced off in order to protect it from agricultural activities.

Transport

5.6.48 The cable drums will be transported via a low-loader articulated truck. Assuming that cables are supplied in 525 m lengths, the number of cables that are required, the combined drum and low loader weights are shown in Table 5.3. A typical low-loader is 18 m long and 2.5 m wide. The typical weight of a low-loader without a payload is 28 tonnes and the ground clearance is about 550 mm. A detailed transportation and access plan will be produced in order to keep local disturbance to a minimum.

Table 5.3 | **Typical cable parameters**

	Lincs	Docking Shoal	Race Bank
Number of cable drums	126	252	252
Weight of each 525 m drum of cable	14 tonne	14 tonne	14 tonne
Weight of low-loader with 525 m drum of cable	42 tonne	42 tonne	42 tonne

Temporary Cable Route Construction Areas

5.6.49 Temporary construction laydown/compound areas will be established at suitable locations along the length of the proposed cable route and substations, as indicated in Figure 5.14.

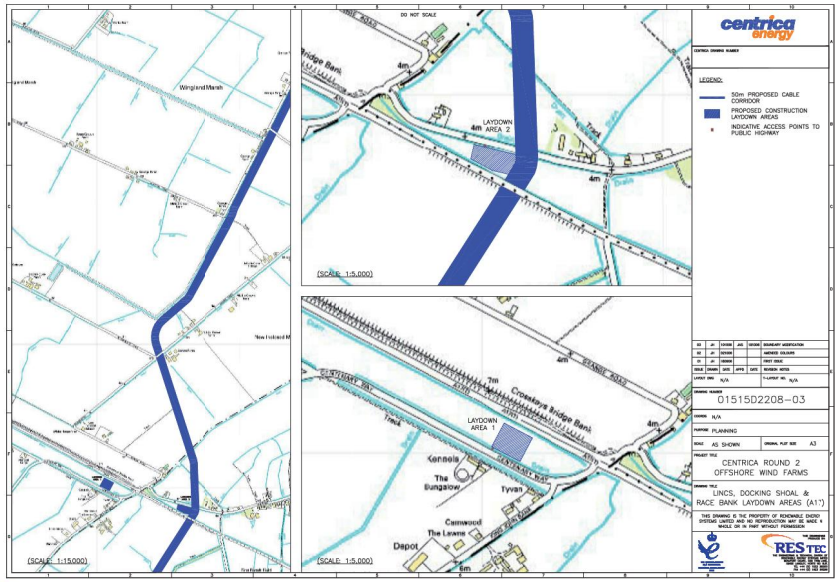


Figure 5.14 | Details of construction laydown areas adjacent to the A17

5.6.50 Cables will be delivered to site as required. Cranes will offload the cables from low-loaders onto specially prepared hard-standings. Hard-standings will be capable of supporting at least three cable drums, one low-loader and a mobile crane. The standing would have a footprint of some 10 m × 30 m and be capable of supporting around 175 tonnes.

5.6.51 During the construction period, temporary construction tracks will be installed across farmland. These construction tracks will be installed within the 50 m cable corridor boundary where possible, negating the requirement for further land take.

5.7 Onshore Substation

5.7.1 The Lincs, Docking Shoal, and Race Bank wind farms will connect to the UK electricity supply network through an extension to the existing National Grid (NG) substation at Walpole.

5.7.2 The equipment installed at the substation will be of a similar type as the existing equipment, with a view to minimising the environmental impact of the development.

5.7.3 The extension of the existing 400 kV bus-bars and for the new 132 kV switchgear at Walpole, required to complete the interface connection between the cabling to