Rampion Offshore Wind Farm

ES Section 3 – Alternatives

RSK Environmental Ltd **Document 6.1.3**

December 2012 **APFP Regulation 5(2)(a)**

Revision A

E.ON Climate & Renewables UK Rampion Offshore Wind Limited

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3 ALTERNATIVES

3.1 Introduction

3.1.1 This section describes the alternatives that have been considered in determining the design of the proposed Rampion Offshore Wind Farm (the Project). Details of the alternatives considered with regards to the offshore array site and the associated export cable to shore, and onshore infrastructure including grid connection, cable landfall, onshore cable route corridor and onshore substation are discussed, as well as alternative construction methodologies.

3.1.2 The section presents how the process of identifying the Project was undertaken, and describes how the Project evolved from the initial very broad definition of the offshore zone, and how this influenced the range of alternative options available for the connection of the wind farm to the grid.

3.2 Offshore Zone Definition

Strategic Environmental Assessment

3.2.1 On 10 December 2007, the Secretary of State for Business Enterprise and Regulatory Reform (BERR) announced the commencement of an Offshore Energy Strategic Environmental Assessment (OESEA) to examine the potential for 25GW of additional UK offshore wind energy generation capacity by 2020, effectively paving the way for a third round for offshore wind licensing in the UK (Round 3). The OESEA was undertaken in 2008/2009 and assessed the potential for siting offshore wind development in the UK Renewable Energy Zone (REZ) and the territorial waters of England and Wales in depths of 60m or less.

E.ON's own Round 3 Offshore Development Area Selection Study

3.2.2 In spring 2008, following the commencement of the OESEA and in anticipation of an announcement by The Crown Estate (TCE) of Round 3, E.ON Climate & Renewables (E.ON) conducted a comprehensive appraisal of potential areas for the further development of offshore wind development in the UK REZ. E.ON set up a steering committee to identify suitable development areas and to undertake site selection studies using internal expertise and knowledge, with the support of external consultants.

3.2.3 The initial assessment was undertaken using a GIS system to produce a 'heat map' of the entire REZ using known constraints to development (water depth, geology, ecology, shipping lanes, aggregates extraction, Ministry of Defence constraints, statutory nature designations and distance from shore). A second iteration was then undertaken using a weighting system in order to identify preferred areas for development in terms of likely environmental acceptance, consentability and constructability.

3.2.4 This assessment process defined a number of potential UK areas that may be suitable for offshore wind farm development, including an area adjacent to the Sussex coastline (see Figure 3.1). This area was not envisaged to necessarily be a very large single project, but was defined as an 'area of search' to enable assessment within this boundary of where development might be most appropriate.

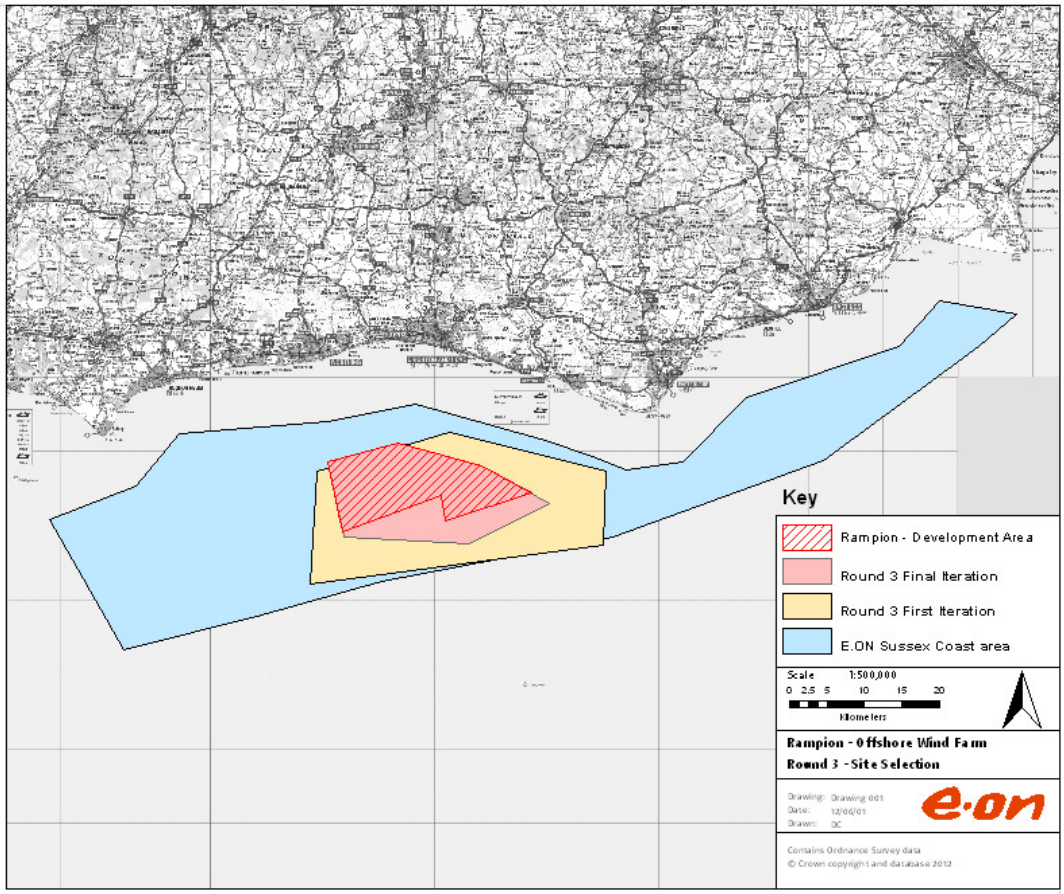

Figure 3.1: The South Coast Area of Search identified by E.ON showing subsequent evolution of the development area (to the point of consulting on the project)

The Crown Estate Round 3 Zones

3.2.5 On 4 June 2008, TCE issued its first iteration for Round 3. This first iteration identified several development 'zones' around the UK which included a zone adjacent to Brighton, falling within the area of search that E.ON had identified along the Sussex coastline. TCE invited potential bidders to feedback any information and or views on the zones. As TCE's process advanced, the final nine Round 3 zones (see Figure 3.2) were selected using TCE's Marine Resource System (MaRS) and the findings of the OESEA. The Round 3 Zone adjacent to Brighton initially identified by TCE was refined to the area known as Zone 6 (also referred by TCE as the 'Hastings' zone). In January 2010, following a competitive tendering process, TCE announced the successful bidders for each of the nine Round 3 offshore wind zones. E.ON was successful in securing the development rights for Zone 6 ('the Zone'), located off the Sussex coast.

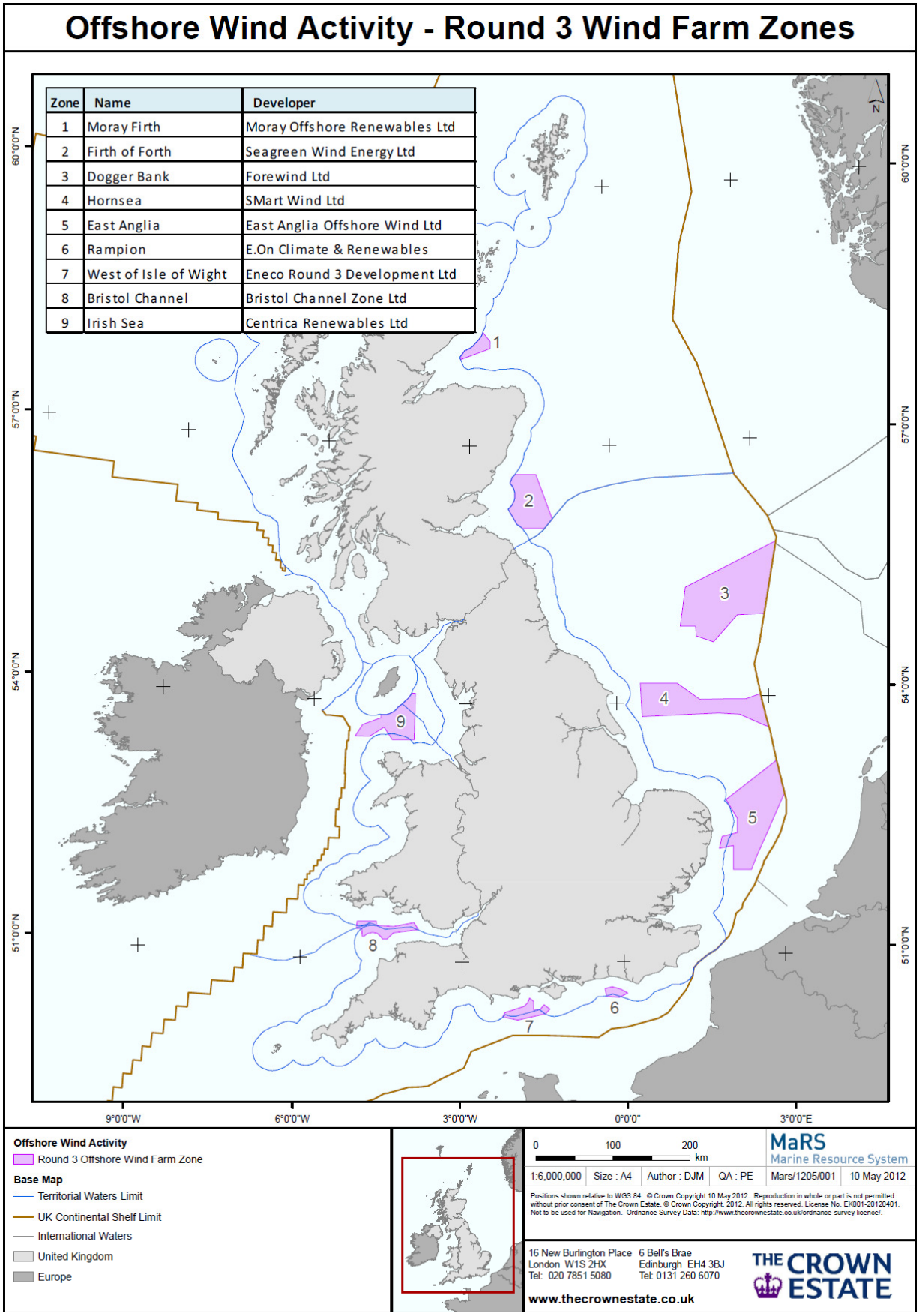

Figure 3.2: Round 3 Offshore Wind Farm Zones

Project Definition

3.2.6 Following the award of the Zone, E.ON revisited their initial assessment and undertook a refinement exercise to consider the feasible area for the development of a project within the Zone. The key constraint to the development of the entire Zone is water depth. Since the southernmost portion of the Zone lies in water of greater than 50m depth, E.ON determined that, at present, construction within this area would not be viable due to current technological limitations. The Project boundary was accordingly refined for the purposes of consultation, to an area of 167km^2 as shown in Figure 3.3. Following consultation, the Project boundary has been further reduced to the Rampion Offshore Wind Farm Site which has been assessed in the Environmental Impact Assessment (EIA). This comprises an area of 139km^2, as shown in Figure 1.1 in Section 1 (Introduction).

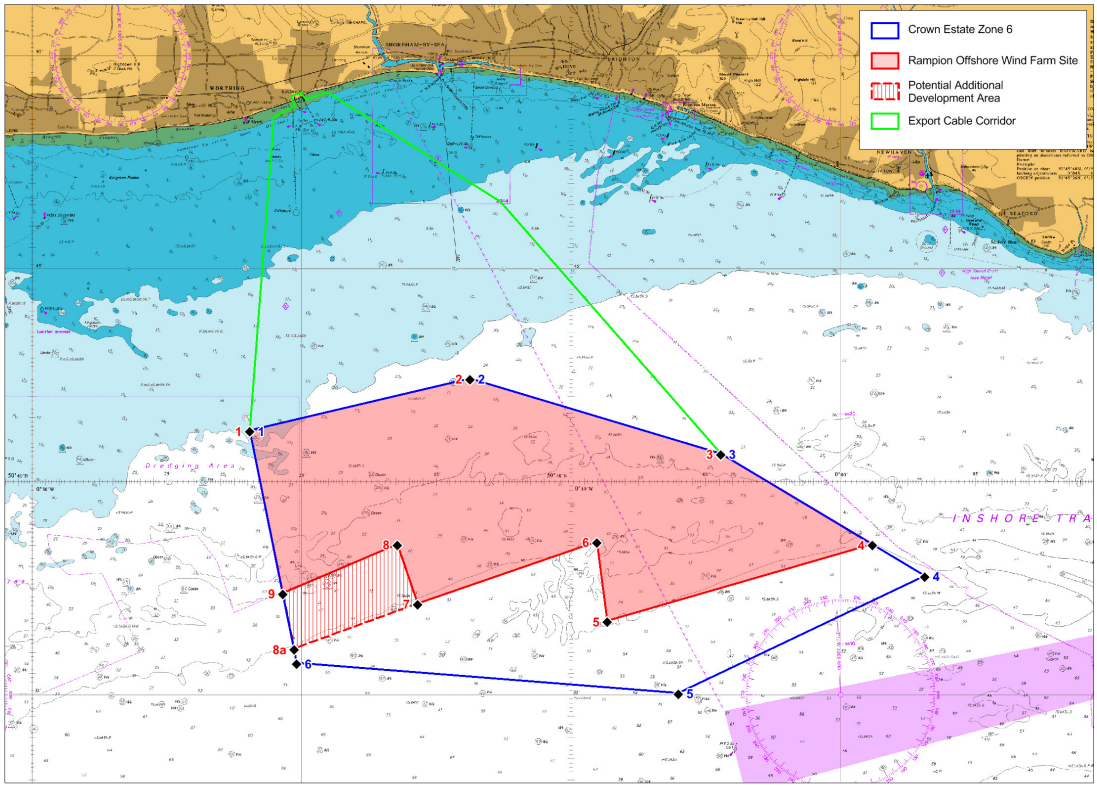

Figure 3.3: Site Boundary used for Consultation

3.3 Grid Connection

3.3.1 In parallel with assessing the offshore site, identification of a feasible grid connection was undertaken in order to determine the 'route to market' for the electrical output from the offshore wind farm.

3.3.2 Key considerations in choosing a suitable connection point include the capability of the existing network to accommodate the scale of generation to be delivered and the identification of a suitable landfall location and connection route from the wind farm to landfall and on to the connection point.

3.3.3 The UK electricity system is divided into two main areas – Transmission and Distribution. This is illustrated in Figure 3.4. The Transmission system operates at voltages of 275kV and 400kV and is used for the bulk transfer of power from large generation stations to 'demand centres', such as cities and towns. The Distribution system operates at voltages of 132kV and below and distributes the power across these demand centres to the consumer. At the Transmission level, electricity is transmitted at higher voltages to reduce power losses over large distances. At Distribution level, because the power flows are smaller and the distances shorter, it is possible to distribute the power at lower voltages.

3.3.4 Occasionally, smaller generating stations known as 'embedded generators' connect to the Distribution system and act effectively as a 'negative load', reducing the amount of power that needs to be taken from the Transmission system and, in cases of low demand, 'spilling' power back up to the Transmission system. Shoreham Power Station, rated at 400MW, is an embedded generator whose output is used as a negative load, offsetting local demand on the coastal Distribution system.

3.3.5 The electricity industry regulator Ofgem places obligations on the Distribution and Transmission network operators to maintain supplies to the consumer at all times, and therefore the system needs to be designed to operate under all scenarios of generation and demand throughout the year.

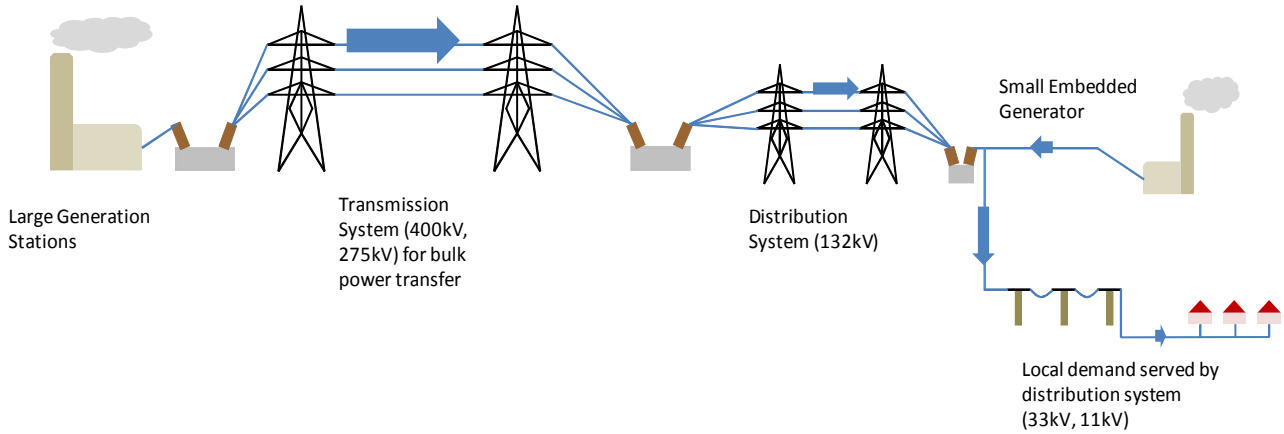

Figure 3.4: Illustration of how Transmission and Distribution Systems are linked

3.3.6 In the South East of England, a 400kV high voltage Transmission system runs from Lovedean 400kV substation in the west (north of Portsmouth) to Dungeness 400kV substation in the east. Intermediate grid supply points are located at Bolney 400kV substation (north of Brighton) and Ninfield 400kV substation (near Bexhill). Various 132kV Distribution circuits are fed from the 400kV Transmission system, and in turn a number of 33kV local substations.

3.3.7 Figure 3.5 shows the Distribution system in green and the Transmission system in red.

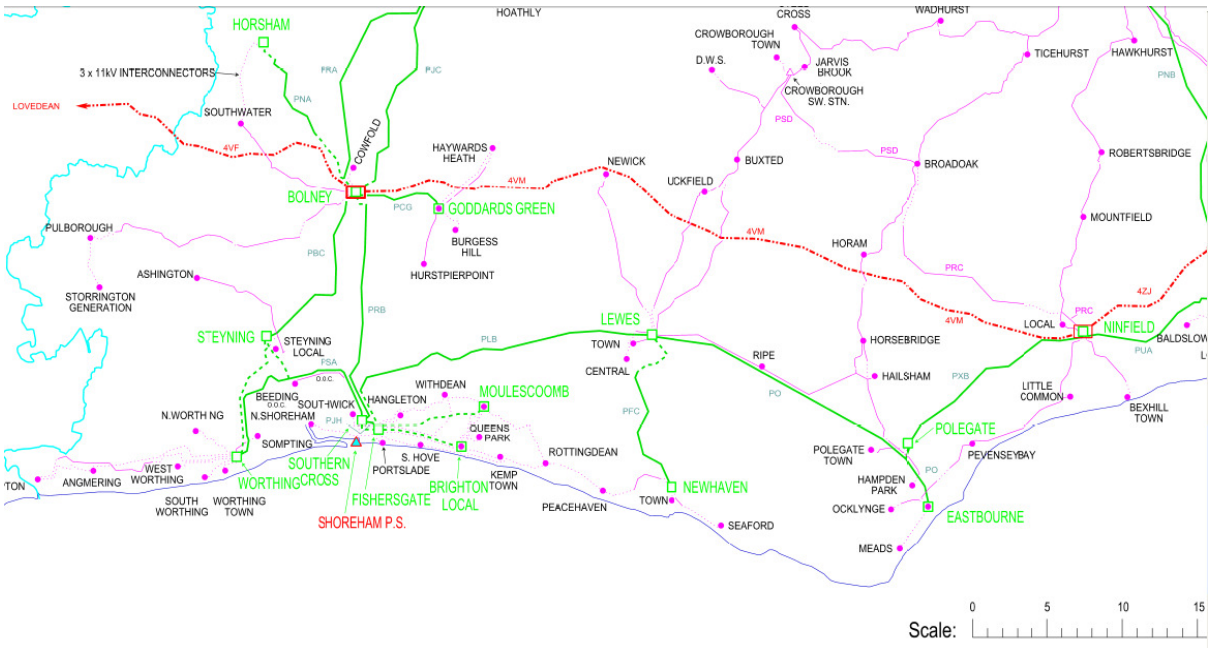

Figure 3.5: Electricity Distribution and Transmission system along South Coast, scale in km (Source: UK Power Networks)

3.3.8 During the initial appraisal of potential areas for the development of offshore wind farms by E.ON in 2008, a grid connection feasibility study was undertaken by Babcock & Brown Ltd (with input from PMSS and RPS) to determine the optimal grid connection locations for a potential wind farm off the South Coast. PMSS carried out a desktop analysis of potential landfall sites while RPS provided environmental feasibility assessment for the various potential connection options identified.

3.3.9 Potential Distribution and Transmission connections were reviewed, with relevant issues affecting grid connection feasibility considered, including:

- Electrical capacity of existing substations and power lines;
- System power flows;
- Physical space requirements;
- Constructability of new assets;
- Length of offshore and onshore cables required;
- Environmental implications; and
- Consentability of new assets.

3.3.10 E.ON's goal was to minimise the extent of the onshore infrastructure required to connect the project, since this would limit the environmental impacts that would arise from this element of the project, it would also likely be more cost effective and more straightforward to construct. In particular a key preference was to avoid the

need to undertake unnecessary development within the South Downs National Park (SDNP), which lies north of the developed coastline. Therefore the feasibility of connecting into the existing coastal Distribution system, thus avoiding the need to develop any new connections through the SDNP, was a prime focus of initial assessment.

Distribution (132kV or less) Connection Options

3.3.11 The Babcock & Brown study identified a potential 132kV connection point at Southern Cross and a 33kV option at Fishersgate (both located within Adur District), along with 33kV options at Worthing and Newhaven. However, based on the electrical capacity limits of these substations and the interconnecting 132kV network, the study concluded that a connection at any single point on the Distribution network would not be feasible. See Appendix 3.1 for further technical information.

3.3.12 Consideration was also given to the feasibility of splitting the Project into several smaller connections across a combination of these substations. In order to accommodate this, each connection point would require a new Rampion substation adjacent to the existing substation sites, as well as the identification of suitable multiple landfall locations.

3.3.13 In addition, when generation on the Distribution system exceeds demand, the excess power needs to flow back onto the Transmission system, i.e. from Southern Cross (which is a common 'node' on the system between the other local Distribution substations and therefore a bottleneck) back up to Bolney. The existing overhead lines from Southern Cross to Bolney could only potentially accommodate a further 250-300MW of generation.

3.3.14 For anything in excess of 250-300MW, major new electrical infrastructure work (underground cable or overhead line) would be required to be constructed through the National Park between Southern Cross 132kV and Bolney, as well as significant reinforcements at the various connection points.

3.3.15 Therefore, in order to connect an offshore wind farm of up to 700MW into the Distribution system, new infrastructure would be required adjacent to existing infrastructure. Assuming physical space constraints could be overcome, this would result in significant environmental impact over a wider area and additional disturbance to local communities than would occur with a connection directly into the 400kV Transmission system (see below). This is because as well as the new Distribution infrastructure referred to above, there would still be a need to traverse the SDNP up to Bolney which feeds this part of the Distribution system. This approach is also much less cost effective than a single point of connection proposal.

3.3.16 The above findings were verified through discussions with EdF Energy Networks (the then operator of the Distribution system prior to UK Power Networks (UKPN)) who advised that connecting into the 132kV network closer to the coast than Bolney would require significant reinforcement of the circuits from the connection point to

Bolney, due to the resulting excess generation present on their system flowing back up towards the Transmission system.

3.3.17 It was concluded on the above basis that a Distribution connection would not be feasible for the Project. Further information on this is contained in Appendix 3.1 which provides further technical information in relation to the grid connection constraints considered.

Transmission (275/400kV) Connection Options

3.3.18 There are no 275kV circuits on the Transmission network in and around Sussex, therefore a transmission connection would need to be onto the 400kV network.

3.3.19 The Babcock & Brown study identified that the output of the proposed wind farm scheme could be comfortably accommodated at either of the existing 400kV Transmission substations at Bolney in West Sussex or Ninfield in East Sussex. Neither option would require reinforcements to the wider 400kV Transmission system (e.g. upgrades to overhead lines running east to west, with additional environmental and consent implications). Lovedean in Hampshire was discounted as an option as it is significantly further from the Rampion site (30-40km further depending on route) and would involve more extensive offshore and onshore cable sections (see Appendix 3.1).

3.3.20 Given the geographical location of Bolney substation, it was clear that a direct Transmission connection at this point would require the wind farm export circuits to run through the South Downs National Park. For a potential connection at Ninfield, while it could potentially facilitate a route avoiding the SDNP, it would require a significantly longer (approximately three times as far) offshore connection.

3.3.21 The Bolney and Ninfield connection options were therefore taken forward into the next stage of assessment to consider the broader implications of connecting into each substation.

3.3.22 In particular, it was necessary to further understand the likely landfall options for bringing the cables to shore, the cable distance from wind farm to landfall and the potential onshore route corridors from landfall to connection point. In the early development phase of the proposal, the connection and landfall options were assessed in parallel for this reason.

3.4 Landfall Selection Process

3.4.1 A desk based analysis was undertaken by PMSS in 2008, supported by site visits (also attended by Babcock & Brown and RPS staff), to assess potential landfall options for a connection into either Bolney or Ninfield. Following award of the zone development rights to E.ON, further site visits were conducted in 2010.

3.4.2 In selecting a suitable landfall location for the wind farm, several factors were taken into consideration, including:

- Engineering feasibility including space and overall length for major Horizontal Directional Drilling (HDD) rig and offshore cable barge access (if this type of installation method is required);
- Onwards cable route feasibility towards the grid connection point;
- Degree of permanent and temporary environmental impacts that the landfall and resulting onward cable route would have;
- Degree of permanent impact and temporary disruption to local residents and businesses that the landfall and resulting onward cable route would have; and
- The overall cable route lengths (offshore and onshore) and economic viability.

3.4.3 The degree of urbanisation along the Sussex coastline meant that potential landfall locations were extremely limited in terms of meeting criteria to avoid significant impacts on areas of residential or commercial properties, major disruption to busy roads and overall impact on communities. The assessment of suitable landfall locations not only had to consider the immediate vicinity of the landfall but also the onwards routing of the cable from this point.

3.4.4 For the Bolney connection option, steep cliffs and complex topography ruled out a route directly to the east of Brighton, and taking a route west of Worthing would have resulted in unnecessarily long offshore and onshore cable routes with associated environmental and economic impacts. In practice, the only realistic landfall options for a Bolney connection lay in a limited number of gaps in the built environment between Worthing and Shoreham.

3.4.5 For a connection into Ninfield, routes via the west, or east, of Bexhill, were considered.

3.4.6 Appendix 3.1 shows the ‘long list’ of landfall options considered which includes three options originally considered at the screening stage that were discounted.

3.4.7 Based on the initial desktop and field based assessments undertaken, the following combinations of grid connection points and cable landfall windows were considered to be potentially feasible options:

- Option 1: Bolney / Worthing East (Brooklands Pleasure Park);

- Option 2: Bolney / Shoreham (Widewater Lagoon);
- Option 3: Bolney / Shoreham (Norfolk Bridge);
- Option 4: Ninfield / Bexhill West (Cooden); and
- Option 5: Ninfield / Bexhill East (Glyne Gap).

3.4.8 Brief descriptions of these landfall options are given below.

Option 1: Bolney / Worthing East (Brooklands Pleasure Park)

3.4.9 A potential landfall location was identified at Brooklands Pleasure Park, situated between Worthing and Lancing. This location represents the single largest gap in the heavily built up coastline stretching from Worthing to Brighton. The site features local authority owned golf courses (Par 3 and pitch and putt), parkland, a lake and other leisure amenities, which would need to be temporarily disturbed in order to lay cables from the wind farm. Constraints to the onshore route include the SDNP.

3.4.10 This is the landfall option ultimately selected and forms the basis of the proposal set out within this Environmental Statement (ES). See Figure 2b.1 in Section 2 Project Description (Onshore).

Option 2: Bolney / Shoreham (Widewater Lagoon)

3.4.11 This potential landfall option lies at the easternmost end of Widewater Lagoon, Shoreham-by-Sea. There is a public car park immediately north of the beach, with a lagoon oriented in an east to west direction. However, this landfall is restricted by a number of residential properties between the lagoon and the A259. Restrictions on the laying of cables underneath properties would mean the compulsory acquisition and demolition of 6-7 homes. It was a view shared by E.ON, as a socially responsible developer, and Adur & Worthing Councils, that this would not be an acceptable proposition. Further information on the difficulties associated with this landfall option is presented in Appendix 3.1. Constraints to the onshore route include the SDNP.

Option 3: Bolney / Shoreham (Norfolk Bridge)

3.4.12 A third potential landfall area for Bolney was identified close to Norfolk Bridge at a small gap in the built environment north of Beach Green where a children's play area is currently situated. A sizeable community of residential houseboats line the south bank of this stretch of the River Adur, with similar difficulties as Widewater Lagoon in terms of not being able to lay cables under dwellings and the need to remove 8-10 of the houseboats from this community. Again, this was not considered to be an acceptable proposition in the view of E.ON or Adur & Worthing Councils. This landfall option would also require the laying of cables through the Adur Estuary (the minimum route being to the Adur Recreation ground) which is designated as a Site of Special Scientific Interest (SSSI) and Royal Society for the Protection of Birds (RSPB)

Nature Reserve (see Appendix 3.1). Constraints to the onshore route include the SDNP.

Option 4: Ninfield / Bexhill West (Cooden)

3.4.13 A landfall to the west of Bexhill at Cooden was evaluated. This would require a considerably longer offshore cable than any of the Bolney landfall options, but with shorter onshore cable distances. This option is complicated by the Pevensey Levels SSSI and Ramsar site, comprising an area of low lying grazing marshes intersected by a complex system of ditches supporting a variety of wetland communities, which would form part of the route. Any proposal to lay cables across this area was considered to have likely unacceptable onshore environmental impacts.

Option 5: Ninfield / Bexhill East (Glyne Gap)

3.4.14 To the east of Bexhill an alternative landfall for a Ninfield connection was identified at Glyne Gap which would require significantly longer offshore and onshore cable distances than a connection to the west via Cooden. The beach at Glyne Gap is locally designated for nature conservation importance. The onshore route between the landfall around the edge of Bexhill is very constrained for the first 2-3km. Constraints to the onshore route include a sewage works, landfill and ancient woodland.

Conclusion on Preferred Connection and Landfall Combination

3.4.15 Aside from constraints to the onshore routing of the cable, a major concern in determining the feasibility of the Ninfield option was whether such a long offshore export connection from the wind farm site would be economically viable. Appendix 3.1 - Table 1, shows the offshore cable length associated with a connection into Ninfield (approximately three times as long as the Bolney option) and estimated costs compared with the Bolney option. During the broad evaluation of the options against environmental, technical and economic criteria, it became evident that the significantly higher cost of such a connection via landfall Options 4 or 5 would be cost prohibitive and would almost certainly make the overall project uneconomic.

3.4.16 In addition, a connection into Ninfield, via a route to the west of Bexhill, was considered to have likely unacceptable onshore environmental impacts on the Pevensey Levels SSSI and Ramsar site. Routing the cable to the east of Bexhill would take an even longer and less economic route.

3.4.17 Therefore both routes via Bexhill were discounted which meant that a connection into the transmission system at Ninfield was not pursued any further.

Potential Impact on the South Downs National Park

3.4.18 It was recognised that pursuing a Bolney based connection would necessarily require a route through the SDNP. In considering potential grid connection solutions and their likely associated environmental impact, a strong weighting was placed on the importance of the SDNP. The decision to designate the South Downs as a National

Park was made in 2009, further to its existing status as an Area of Outstanding Natural Beauty (AONB). In April 2011 the South Downs National Park Authority (SDNPA) was established and became the statutory Planning Authority for the National Park area. Early discussions in 2010 with the SDNP and other statutory bodies including Natural England and other local authorities, underlined the need for any development within the SDNP to be sensitive to the character of the National Park and minimise environmental impact.

3.4.19 The approach taken was to seek to select a means of connection to minimise permanent impacts to the SDNP, identify an environmentally acceptable and technically feasible route, and develop appropriate construction methodologies and mitigation to limit the temporary impacts as far as possible.

3.4.20 It was also clear that for a connection to Bolney, only the Brooklands landfall option provided a means of bringing the cables ashore without having a major adverse and permanent impact on communities in the area, with Norfolk Bridge also having environmental issues associated with the Adur Estuary SSSI and RSPB Nature Reserve. Therefore the Widewater Lagoon and Norfolk Bridge landfall options were not pursued further.

3.4.21 In conclusion, it was decided that the combination of grid connection into Bolney, via a landfall at Brooklands Pleasure Park in East Worthing, would form the basis of the onshore elements of the Rampion Project.

Verification by Other Studies

3.4.22 An independent grid feasibility study commissioned by TCE for their entire Round 3 portfolio in 2008, reached the same conclusion with regards to Bolney being the only feasible and economically viable connection option. The study, carried out by electrical engineering specialists Senergy Econnect, considered alternative connection points for Zone 6 into the existing Bolney and Ninfield National Grid 400kV substations. The study discounted Ninfield as a potential connection point as a result of the significantly longer cable route and likely prohibitive cost.

3.4.23 A second independent study by National Grid, known as the Connection Infrastructure Options Note (CION) (August 2011), reached the same conclusion. The CION forms part of National Grid's obligations as a regulated transmission operator to the electricity industry regulator Ofgem. National Grid is required to demonstrate that the most 'economic and efficient' connection solution is being progressed (in terms of limiting unnecessary costs to the end consumer).

3.4.24 National Grid subsequently made a connection offer for the Project to connect at Bolney substation.

3.5 Connection Type and Methodology

Overhead Line versus Underground Cable

3.5.1 The decision to underground the entire cable route was made very early in the development process, following initial discussions with the SDNPA and Natural England, in order to minimise permanent impacts associated with the installation of additional large pylons across the South Downs.

3.5.2 While the approach of undergrounding the cables is significantly more expensive than the equivalent overhead line option, it was considered necessary to avoid any permanent visual impact across these environmentally sensitive areas. It was clear from early engagement with stakeholders that temporary impacts arising from an underground cable route would be likely to be more acceptable than any permanent impacts associated with overhead structures and cables.

3.5.3 Further to the decision to underground the cables, work was carried out to develop a construction methodology using ducted cable circuits, rather than direct burial, which has significant benefits in terms of allowing quicker reinstatement of the cable working area. This is detailed further in Section 3.9 – Alternative Construction Techniques. Specific mitigations for the most sensitive section of the cable route, crossing a section of chalk grassland at Tottington Mount on steep slopes, were also developed as described in Section 2b – Project Description (Onshore).

3.6 Onshore Cable Route Selection Process

3.6.1 In common with other types of linear development, the effect that a cable may have on the environment largely depends on the route selected.

3.6.2 Careful selection of a route is of primary importance in avoiding, wherever possible, and thereafter minimising, potential adverse impacts on the environment, socio-economic features and public amenity in the vicinity of the route. In recognition of the above, a systematic route selection process was adopted, consisting of the following stages:

- Identification of an area of search;
- Identification of a broad potential route corridor within the area of search based on an assessment of desk-based information;
- Selection of a preferred route corridor;
- Identification of a preliminary cable route within the preferred route corridor; and
- Identification of the preferred cable route during the conceptual and detailed design stages of the Project, based on the results of increasingly detailed surveys,

studies and consultations with statutory bodies, environmental advisory organisations and landowners.

Cable Area of Search

3.6.3 Initial consultation on the Project was carried out via the Rampion Offshore Wind Farm Scoping Report (E.ON/RSK, September 2010). Responses received are presented in the Infrastructure Planning Commission (IPC) Scoping Opinion (IPC, October 2010). A copy of the Scoping Report and Scoping Opinion including consultee comments are included in Appendices 5.1 and 5.2 respectively. The Scoping Report identified an indicative 'Area of Search' (see Figure 3.6) for an onshore cable corridor based on a grid connection at Bolney substation via one of the landfall Options 1-3 (all three being still under consideration at that stage). The start and finish points for the onshore cable corridor are the high water mark on the coast between Worthing and Shoreham, and Bolney substation respectively.

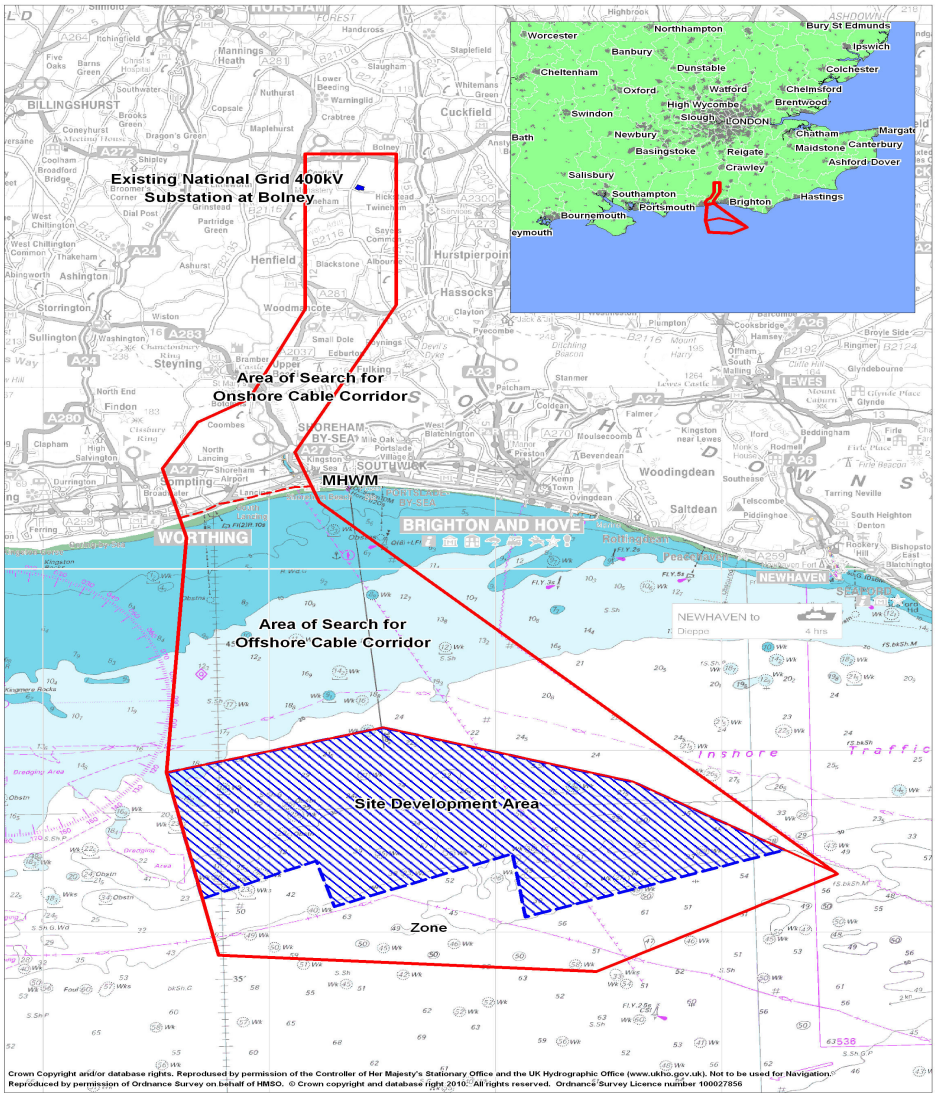

Figure 3.6 Indicative Areas of Search

Cable Corridors Identified within Area of Search

3.6.4 Within the onshore area of search, a constraints mapping exercise was conducted to identify potential cable route corridors. The following environmental, engineering and construction considerations were taken into account in identifying and selecting route corridors:

- The start and end points of the cable;
- The width of corridor to accommodate the required number of cable circuits;
- Avoidance of centres of populations as far as possible;
- Avoidance of significant environmental features as far as possible (including Ramsar sites, SSSI, Special Protection Areas (SPAs), Special Areas of Conservation (SACs), National Parks, RSPB Reserves, Ancient Woodland, and Local Nature Reserves);
- Where a route potentially crosses major roads, ensure sufficient space to allow for a methodology to minimise disruption (i.e HDD);
- Avoidance of potentially difficult construction areas, such as sustained steep slopes, tight bend radii, side gradients and so on, as far as possible;
- Land ownership; and
- The shortest distance, where possible (noting however that a balance needs to be struck between a shorter more sensitive route versus a longer less sensitive route).

3.6.5 Environmental constraints maps were prepared (see Figure 3.7) and aerial photography was referenced in order to select a broad cable corridor. Note that it was only after receipt of the Scoping Opinion that the final decision to drop landfall Options 2 and 3 was made, following meetings with consultees including Adur & Worthing Councils.

3.6.6 Appendix 3.1 explores alternative corridors which were discounted, including routing northwards via a lowland route through the Adur Valley. Constraints formed by the adjoining settlements of Steyning, Bramber and Upper Beeding, together with the steep and complex topography of the valley slopes within which they are situated, meant that there was no exit route from the valley to the north, towards the Weald. These constraints informed the decision that the cable route would need to ascend the uplands part of the route via Tottington Mount.

3.6.7 Also presented in Appendix 3.1 is information relating to rationale for the particular crossing point chosen to drill under the A283 and the River Adur, again highly constrained by topographical considerations.

3.6.8 The conclusion that exiting the valley in the vicinity of Steyning/Bramber/Beeding would not be feasible, together with the identification of a preferred crossing point under the A283 and River Adur, heavily influenced the route selection between the Brooklands landfall and the river crossing point. Following a northwards route from Brooklands, the cable was then routed east to Steep Down, heading across agricultural land with gentle gradients towards the river crossing point.

Onshore Cable Route Refinement

3.6.9 In August 2010, land agents were appointed to commence land referencing for the wider cable corridor.

3.6.10 A meeting was held with the project design engineers, land agents and environmental experts to feed the results of the land referencing exercise into the cable route selection process. A preliminary cable route was selected based upon the same engineering, environmental and social constraints that had been earlier identified, and on initial discussions with landowners.

3.6.11 Walk-over surveys of the preliminary cable route were then carried out by the project design engineers, land agents and ecologists. A landscape and visual vantage point assessment of the preliminary cable route was also carried out to review landscape and visual issues relating to it. Additional local environmental designations (including chalk grassland, Sites of Nature Conservation Importance (SNCIs) and updated Ancient Woodland records) were also considered at this stage.

3.6.12 The results of the walk-over surveys, vantage point survey, desk-based assessments and comments received from landowners were used to refine the preliminary cable route over the period October 2010 to February 2011 within the route corridor, so that more detailed surveys and further assessment work could commence in February 2011. The following refinements were made to the preliminary cable route in early 2011:

- Route amended to avoid a Scheduled Monument (cross dyke, a linear earthwork structure) on the west slope of Steep Down;
- Route amended in various locations to maximise distance to landowner properties and minimise disruption during construction;
- Route amended to avoid trees east of New Erringham Farm; and
- Route amended to avoid a number of badger setts identified during winter walk-over.

3.6.13 A range of further surveys, studies and consultations were carried out, as part of the EIA process, culminating in the publication of the draft ES. These included a comprehensive suite of ecological surveys, archaeological field reconnaissance, a landscape and visual appraisal and engineering land surveys. A number of further refinements were made to the cable route during this period including:

- Route amended to avoid SNCI at Steep Down;
- Route amended to minimise impact on SNCI at Applesham Farm Bank;
- Route amended to minimise landscape and visual impact and impact on chalk grassland at Tottington Mount;
- Route amended in various locations to account for landowner preferences;
- Working width minimised at ecologically sensitive hedgerow and water course crossings; and
- Working width minimised at Old Erringham Farm SNCI to avoid the slope to the north which supports unimproved chalk grassland.

3.6.14 Following community and statutory consultation in 2012, specific cable laying techniques to minimise disruption at the most sensitive section of Tottington Mount, where the cable route passes through chalk grassland on steep slopes, were developed and discussed with the SDNPA.

3.6.15 The proposed route for the onshore cable is shown in Figure 2b.1. This is the route that is the subject of this ES.

Summary

3.6.16 Due to the requirement to connect at Bolney and the geographical extent of the SDNP, the cable route necessarily has to pass through it. The proposed route has been selected in order to minimise potentially permanent or significant impacts from what are effectively fixed points at Bolney and at the landfall at East Worthing, and along the route, to designated sites, ecologically important sites and sites of cultural heritage.

3.6.17 The length of cable in the current proposal which passes through the SDNP, circa 14km, is longer than the theoretical shortest route 'as the crow flies' which is approximately 4km (though in practice any route via this shortest route along the Adur Valley, if such a route had been feasible, would in practice be more like 6-7km on the ground due to the winding nature of the Adur Valley). The principal factors here are:

- The selection of landfall at Brooklands Park, compared with a landfall in the vicinity of Shoreham combined with taking a route through the Adur valley. Such a route would represent a shorter cable route length, but presents overriding environmental and technical constraints as are presented in 3.6.6-3.6.8 and Appendix 3.1;
- The fact that there is no practicable feasible way to exit the Adur valley in the north, due to the built up areas of Steyning, Bramber and Beeding and complex topography either side of these settlements, as described in Appendix 3.1; and

- The majority of the route within the SDNP is routed through relatively low ecologically sensitive agricultural land, with the notable exception of high ground and a small area of chalk grassland near to Tottington Mount, and any impacts will be largely temporary in nature.

3.6.18 Figure 3.8 summarises the overall decision making process which was undertaken in selecting the grid connection point, landfall and cable route within the current proposal.

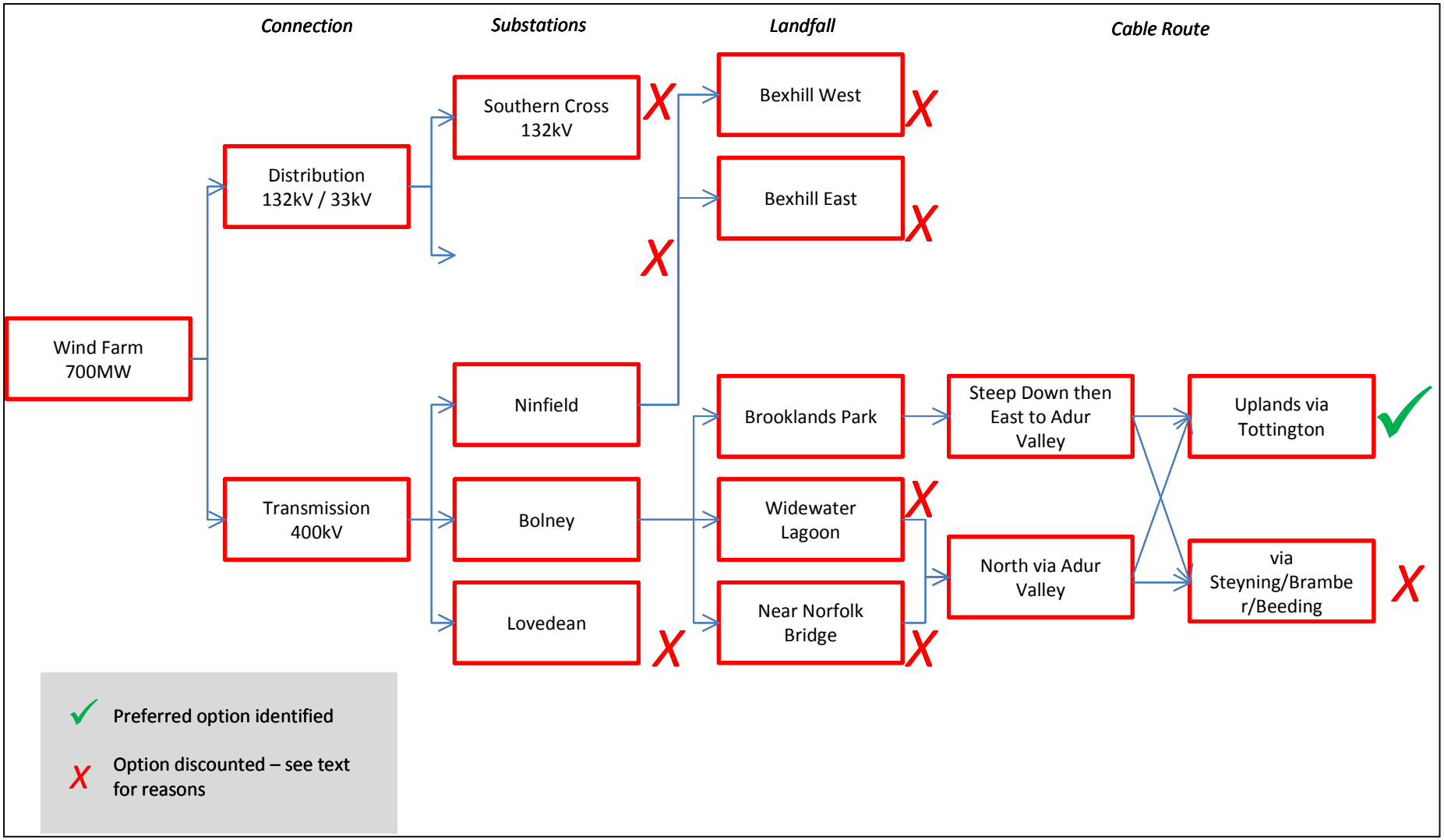

Figure 3.8 Decision Making Process

3.7 Offshore Cable Route Selection Process

Area of Search

3.7.1 In order to define an offshore cable corridor, it was first necessary to explore the grid connection and landfall options as described in earlier sections.

3.7.2 The Rampion Scoping Report (September 2010) identified an indicative area of search (see Figure 3.6) for the offshore cable corridor based on a grid connection to Bolney. The start and finish points for the offshore cable corridor are the Project's offshore wind farm site substation(s) and the high water mark on the coast between Worthing and Shoreham where the offshore cable will join the onshore section of the cable. Between these locations lay the three landfall options which were considered in detail. The indicative offshore cable corridor area of search was centred on an approximately direct corridor between these connection points.

3.7.3 Baseline data on potential environmental constraints were collated for the indicative area of search from publicly available sources.

Offshore Cable Route Corridor Identification

3.7.4 Following consultation, the offshore cable corridor was narrowed as shown in Figure 1.1 (Section 1 – Introduction). This corridor still provides flexibility for the detailed routing of the cables, which will be further refined on the basis of future seabed investigations and engineering design work.

Identification of Preliminary Offshore Cable Route

3.7.5 The corridor currently defined is still relatively broad, reflecting the need to maintain flexibility on exact alignments at this stage in the development. The corridor width will be refined pending outcome of currently ongoing work and consultation feedback, although it will still need to provide a flexible corridor to allow micrositing of cables if required during construction if, for example, local ground conditions require. A detailed geophysical and geotechnical survey of the refined cable corridor will assist in confirming the feasibility of the refined corridor.

Offshore Cable Route Refinement

3.7.6 The following factors will also be considered when determining the final cable route (n.b. there will be up to 4 cables installed, 2 from each substation):

- The start and end points of the export cable;
- Avoidance of BAP/Annex I habitats;
- Avoidance of identified wrecks;
- Avoidance of the anchoring area for Shoreham harbour;

- Avoidance of areas of rock outcrop;
- Avoidance of outfall pipe crossings;
- The minimum cable separation will be 50m, except at the beach crossing and on approach to the offshore substations;
- Route deviations will not exceed 20° with a separation of at least 1.5 times the water depth;
- Where possible the route will follow the palaeochannels;
- Where possible the route will avoid areas of high concentrations of boulders and magnetometer contacts; and
- The four cables will be kept in the same route corridor as far as possible.

3.8 Onshore Substation Site Selection Process

Generic Description of the Substation Site Selection Process

3.8.1 Initial requirements for substation sites are established based on the connection capacity and system operational requirements of the project. Potential transmission connection points adjacent to existing overhead lines, ideally with an existing substation to connect into, are highly preferable in order to minimise the wider transmission system reinforcement required to facilitate the connection. Potential locations and site layouts are then subject to identification, review and refinement in order to identity a preferred connection solution.

3.8.2 To ensure that the substation site selection process takes account of the environmental considerations from the earliest stage, E.ON has adopted the guidelines set out in National Grid's 'Horlock Rules' for the siting of new substations. These rules set out seven key criteria to inform the substation siting and design process to ensure the environmental impacts are minimised. These criteria are summarised below;

- Consider environmental issues from the earliest stage during site selection in order to balance technical and cost implications against the consequential environmental impacts;
- Seek to avoid altogether internationally and nationally designated areas of amenity, cultural or scientific value;
- Protection as far as reasonably practicable of areas of local amenity value;
- Take advantage of screening provided by landform and existing features;
- Keep visual, noise and other environmental effects to a reasonably practicable minimum;

- Consider the land use effects when selecting the site of new substations; and
- Consider at an early design stage how the effect of circuit entries, equipment, buildings and ancillary equipment at an early stage can be minimised as far as reasonably practicable.

3.8.3 In addition to the guidelines set out in the Horlock Rules, the substation site selection criteria included the following considerations:

- Proximity to existing transmission infrastructure in order to minimise the level of transmission system development required;
- Distance from residential properties;
- Engineering and constructability considerations such as topography and flood risk;
- Access for construction and inspection and maintenance staff and equipment; and
- Land ownership.

Site Selection Process for the Project's Onshore Substation

3.8.4 In order to connect the onshore cable to the electricity network, the need for a new substation on land near to the existing National Grid 400 kV substation at Bolney (location of National Grid connection offer) was identified. This new substation would house the necessary plant and equipment to facilitate the connection of the Rampion offshore wind farm into the transmission system.

3.8.5 A desk based assessment and early discussions with landowners identified potential substation sites within an area surrounding the northern, eastern and southern boundaries of the existing Bolney substation.

3.8.6 Through 2011, further assessment of environmental and technical factors led to the potential area for a substation site being narrowed down to an area of search extending from the east of the existing substation site round to the north of the site. The area to the south of the existing substation was discounted due to the presence of several UK Power Networks 132kV underground cable circuits running along the southern boundary of the existing substation. The area adjacent to the northern boundary of the existing substation was also discounted due to the requirement for National Grid to retain this area for operational reasons.

3.8.7 Two potential substation locations were identified within this area of search (see Figure 3.9). Option A was an area of land located to the north-east of the existing substation bounded by existing 400kV and 132kV overhead lines. Option B was located north of the existing substation adjacent to Wineham Lane. Both of these sites were presented during consultation on the Project as potential options for the substation location.

Figure 3.9: Potential Substation Locations

3.8.8 An assessment of these siting options was carried out against the criteria set out in the 'Horlock Rules', along with the additional assessment criteria set out by E.ON, in order to establish a preferred substation location based on a combination of environmental, technical and landowner considerations.

3.8.9 From an ecological and environmental perspective, arboricultural surveys undertaken at both substation options note that trees located in Option B are generally in better condition than Option A. Option B has a high number of long-lived, healthy, mature trees around its perimeter and part of its northern boundary abuts an Ancient Semi Natural Woodland. The eastern of the two fields in Option B consists of species-rich unimproved grassland which represents the best example of the UKBAP Priority Habitat - Lowland Meadows in the onshore Project survey area, compared with semi-improved grassland in Option A which are species poor.

3.8.10 From a noise perspective, Option A would be preferable to Option B due to the distance from the nearest receptors.

3.8.11 From a technical perspective, both substation sites offer sufficient space to accommodate all the required plant and equipment. Option A would result in a shorter underground cable route from the new substation to the existing substation at Bolney, as well as a marginal reduction in onshore export cable route length. Both substation options would require diversion or crossing of existing UKPN distribution

assets, with Option A requiring the diversion and potential undergrounding of an existing 11kV overhead line than runs across the substation site.

3.8.12 Following this assessment, Option A was identified as the preferred option for the substation site.

Access for Construction

3.8.13 Alternative construction accesses were considered based on the selection of Option A for the substation. There are three potential access routes:

- Access from Bob Lane from the west (via A272 and Wineham Lane);
- Access from Bob Lane from the east (via Twineham); or
- Access directly from Wineham Lane via a new junction and access track to be developed for temporary use during construction following which reinstatement would take place.

3.8.14 Due to limited width and tight bends an access from Bob Lane from the east was discounted as not feasible for the nature and number of loads requiring delivery during construction of the new substation equipment.

3.8.15 Responses from the consultation process and face-to-face meetings with residents living near to the Bolney substation indicated a strong preference for construction traffic not to use Bob Lane and instead access the site directly from Wineham Lane.

3.8.16 This has been incorporated into the final proposals assessed within this ES. The existing access route from Bob Lane will only be utilised for a brief period during site establishment to provide initial access for a limited number of vehicles. Otherwise the vast majority of construction vehicles will use the Wineham Lane access route to access the substation site via a temporary construction access track.

3.8.17 During the operation of the substation, access for vehicles engaged in operation and maintenance will gain access via the existing track from Bob Lane.

3.9 Alternative Construction Techniques

Offshore Construction Methodology

3.9.1 Detailed design work later in the engineering process will determine the construction methods which will be used offshore to install the foundations, turbines and cables that constitute the wind farm. At the current stage in design, many options still exist for installation of the different components. Section 2a – Project Description (Offshore) includes descriptions of the methods being proposed with some which could be used across the wind farm, while others may have restrictions on their usage by factors such as water depth or seabed conditions. The impacts sections in this ES consider the 'worst-case' scenario in environmental terms for each of the installation options that are being considered.

Onshore Cable Construction Methodology

3.9.2 Once the decision was made to underground the onshore circuits to eliminate any permanent visual impact along the route, various options were considered on the cable installation methodology to minimise the temporary disturbance during the installation period. In order to minimise the time that any section of cable trench would have to be open, the project chose to employ a ducted cable installation methodology in preference to a direct burial approach. A ducted approach involves the installation of PVC ducts during the trenching process, which allows the trench to be backfilled in advance of the cable installation process. At a later date, the cable can then be pulled through the installed ducts via small joint bays located at intervals of approximately 600m-1,000m.

3.9.3 While this approach is marginally more expensive than a standard direct burial approach, by removing the requirement to leave the trench open until the cable has been installed, the backfill and resultant reinstatement operations can commence at a significantly earlier stage. This allows the temporary disruption associated with the trenching activities along the cable route to be minimised.

3.9.4 Appendix 3.1 compares the pros and cons of direct and ducted cable burial (including a comparison with an overhead line).

3.10 References

Round 3 Offshore Wind Farm Connection Study Version 1.0, Senergy Econnect, December 2008.

Connection Infrastructure Options Note (CION), National Grid, August 2011 (not public domain due to National Grid commercial and security sensitivities).

Rampion Offshore Wind Farm

ES Section 3 – Alternatives

Figures

RSK Environmental Ltd **Document 6.2.3**

December 2012 **APFP Regulation 5(2)(a)**

Revision A

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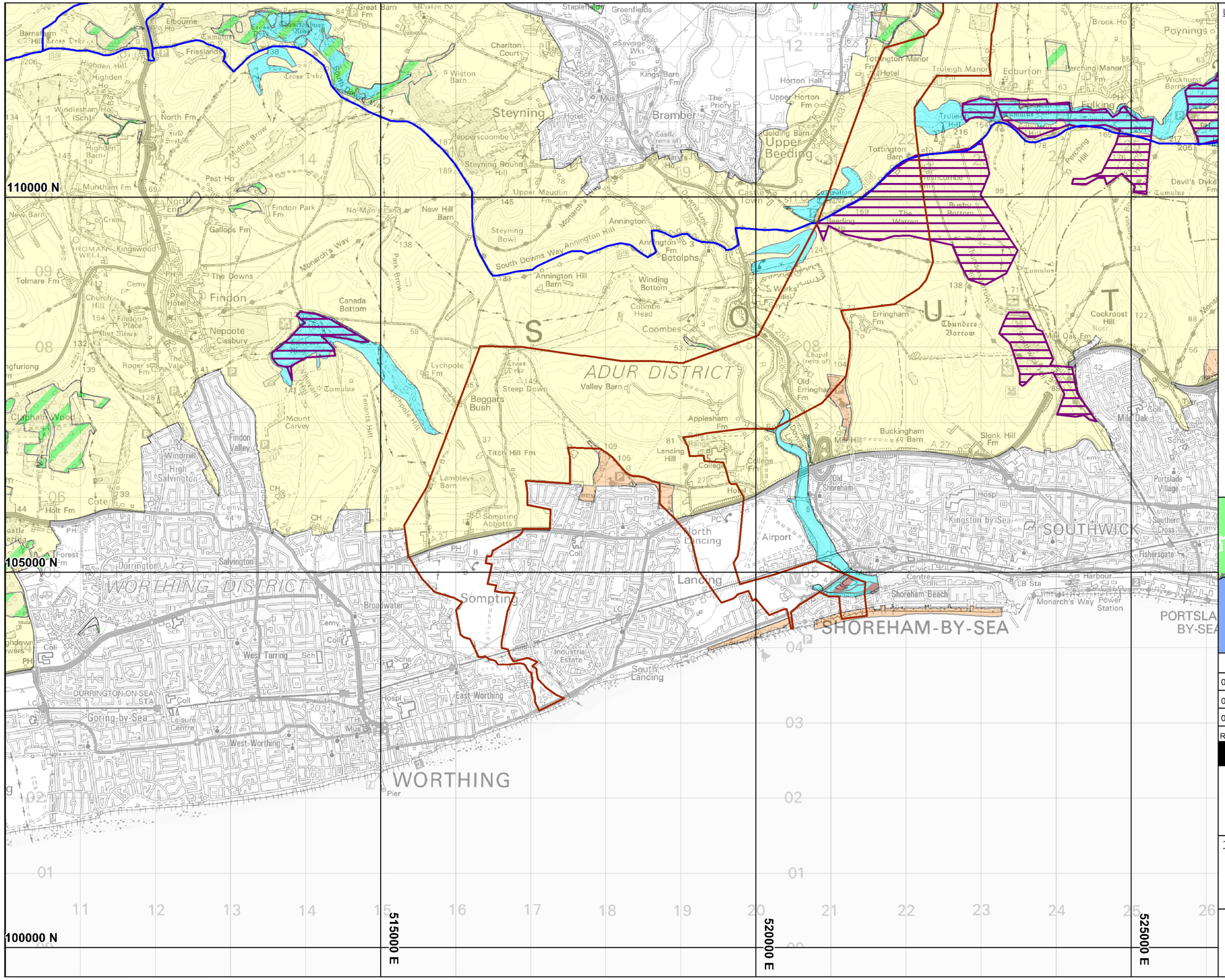

Rev	Date	Description	Drn	Chk	App
02	23.10.12	New Layout	DL	KB	DW
01	06.03.12	New Layout	LG	KB	DW
00	25.01.11	First Draft	LH	KB	DW

Rampion Offshore Wind Farm

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Title :

Figure 3.7 - Cable Route Corridor - Environmental and Landscape Constraints (Map 1 of 2)

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120000 N

115000 N

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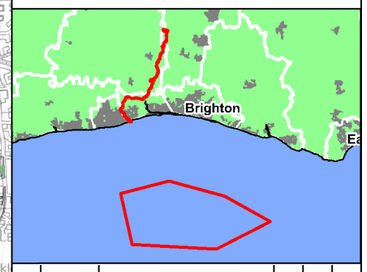
525000 E

530000 E

Legend :

- Cable Route Corridor
- Special Protection Area
- National Nature Reserve
- National Trust Land
- Special Area of Conservation
- Ramsar
- RSPB Reserve
- Ancient Woodland
- Site of Special Scientific Interest
- Local Nature Reserve
- National Park
- National Trail



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00	25.01.11	First Draft	LH	KB	DW

Rampion Offshore Wind Farm

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Figure 3.7 - Cable Route Corridor - Environmental and Landscape Constraints (Map 2 of 2)

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Rampion Offshore Wind Farm

ES Section 3 – Alternatives

Appendix 3.1

Moore Marine Services Ltd **Document 6.3.13i**

December 2012 **APFP Regulation 5(2)(a)**

Revision A

E.ON Climate & Renewables UK Rampion Offshore Wind Limited

APPENDIX 3.1 Alternatives Supporting Information

1. Grid Connection Options

Distribution System

The distribution system around the landfall options identified is primarily served by the Bolney 400kV substation, which feeds the local distribution network from a 132kV ring running via Steyning, Worthing and Southern Cross substations. From this ring, radial 132kV links run to Fishersgate, Moulsecoomb and Brighton Local substations from Southern Cross. Only Southern Cross is a 132kV substation, with all other substations 33kV. The 400MW embedded generation provided by Shoreham Power Station connects to Southern Cross substation at 132kV.

The Bolney 132kV ring is linked to the 132kV ring served by Ninfield 400kV substation by a single 132kV overhead line route running via Lewes and Polegate substations, with a 132kV radial link to Eastbourne (see Figure 1).

When considering the potential for a distribution connection for the wind farm, Southern Cross 132kV substation was identified as the optimum potential connection point due to it being a substation proximate to the coast and near the likely wind farm landfall. Also, being the only 132kV substation in the area, a connection at Southern Cross would not require significant substation replanting to upgrade from 33kV to 132kV in order to accommodate the wind farm 132kV export cables.

A summer demand of approximately 257MW is served from Southern Cross substation, therefore, when Shoreham Power Station is at full output (400MW), approximately 143MW of generation will spill from Southern Cross substation. This excess power will be shared across the three 132kV circuits running from Southern Cross – two running to Bolney substation and the 132kV circuit running from Southern Cross to Lewes. The combined summer transfer capability of the Southern Cross - Bolney (434MW) and Southern Cross – Lewes (111MW) circuits is 544MW, which is adequate capacity to accommodate these flows.

If an additional 700MW of generation from the Rampion Project was connected in at Southern Cross, the potential excess generation at Southern Cross would increase to 843MW in low demand conditions. This level of excess generation cannot be accommodated on the existing 132kV links to Bolney and Lewes, triggering the need for additional capacity on the 132kV circuits running from Southern Cross.

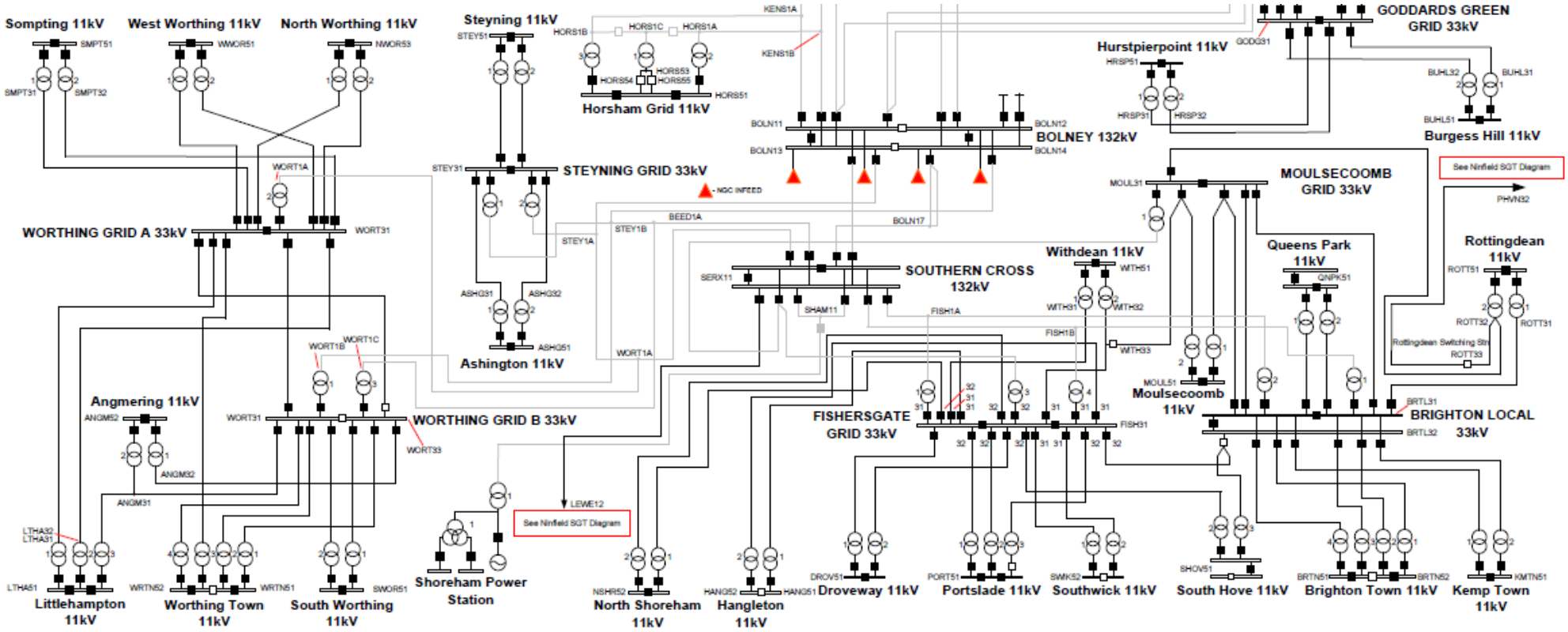

Figure 1: Electricity Distribution and Transmission system along South Coast

Given that the circuit to Lewes would be feeding a finite demand that is also served by Ninfield, the vast majority, if not all of this additional generation will flow back towards Bolney 400kV substation. Additionally, the export limit on the circuits running from Lewes would also make Newhaven an unsuitable connection point as, in addition to the upgrades to on the circuits up to Bolney, the Lewes – Southern Cross circuits would require extensive reinforcement.

The connection point at Southern Cross would therefore require the transfer capacity on the Bolney - Southern Cross 132kV circuit to be almost doubled from the current summer rating of 434MW to close to 843MW. It is therefore clear that a distribution connection at a single point would not be possible without very significant reinforcement of the 132kV network between Southern Cross and Bolney, or by reducing the wind farm size to around 250-300MW, which would make the scheme uneconomic.

Multiple Distribution Connections

Once the option of a single distribution system connection point was deemed infeasible, the possibility of multiple distribution connection points was considered in an attempt to distribute the power from the wind farm across a wider network area.

A search of the substations near the potential landfall locations identified Worthing Grid and Fishersgate substations as potential additional connection points.

Both Worthing Grid and Fishersgate substations are 33kV substations, meaning that any connection would require extensive expansion and reinforcement in order to accommodate a 132kV connection from the wind farm. More significantly, both substations are served by Southern Cross 132kV substation. This would mean that, even if the connection challenges could be overcome and multiple distribution connections achieved, it would not remove the requirement for a significant increase in transfer capacity between Southern Cross and Bolney. In fact, the likely additional requirement to upgrade the Worthing – Southern Cross and the Fishersgate - Southern Cross circuits, would make the overall impact of this solution less favourable than a single connection option at Southern Cross.

On this basis, the option of a distribution connection for the wind farm was not considered further.

Transmission System

There is no 275kV transmission network in and around the Sussex area, therefore a transmission connection would need to be onto the southern 400kV network running from Sellindge to Lovedean.

The output of the proposed wind farm can be comfortably accommodated on the existing 400kV transmission substations at Bolney or Ninfield without any significant reinforcement to the wider 400kV transmission system. Lovedean was discounted as an option as it is significantly further from the Rampion site and would involve more extensive offshore and onshore cable sections. Of the remaining options of Bolney and Ninfield, National Grid

concluded that the Bolney connection with a landfall east of Worthing was the most economically efficient connection option. The Ninfield connection would require a significantly longer offshore cable route and corresponding major increase in the connection cost, which would make the project uneconomic, as shown in Table 1 below.

Table 1: Comparison of 400kV connection points

Connection Point	Offshore distance	Onshore Cable length estimate	Budget Cost of Connection	Conclusion
Lovedean	15-19km	50-60km	Not considered – cost prohibitive	Not economically viable due to onshore and offshore cable route length
Bolney	15-19km	19-20km	Baseline	Identified by NGET to be most economic and efficient connection option
Ninfield	54km	6km	+ £132m to £138m	Not economically viable 60km on the limits of AC technology, HVDC could add further £17m overall

Connection Types

The decision to underground the entire cable route was made very early in the development process, following initial discussions with the South Downs National Park Authority (SDNPA) and Natural England, in order to minimise permanent impacts from the installation of additional large pylons across the South Downs.

While the approach of undergrounding the cables is significantly more expensive than the equivalent overhead line option, it was considered necessary to avoid any permanent visual impact across these environmentally sensitive areas.

Further to the decision to underground the cables, further work was done to develop a construction methodology using ducted cable circuits, as opposed to direct burial, which has significant benefits in terms of allowing quicker reinstatement of the cable working area. A comparison of connection types is presented in Table 2.

Table 2: Comparison of connection types

Methodology	Advantages	Disadvantages
Overhead Line	Most Cost Effective Easier to install over difficult terrain (hills, etc.) Potential to re-string to increase capacity if necessary to upgrade/increase rating	Visual impact More at risk from adverse weather (ice load, wind)
Underground: Direct burial	No permanent visual impact Marginally cheaper than ducted burial solution	Trench reinstatement linked to cable delivery/installation programme Fault repair would require excavation to recover/repair the cable
Underground: Ducted	No permanent visual impact Quicker trench reinstatement than direct burial approach	More expensive than direct buried cables Requirement for small joint bays to be excavated at cable installation stage

2. Landfall Options

Prior to selecting Brooklands Park in East Worthing as the preferred landfall location, other landfall options in the vicinity of Shoreham were originally considered. The original long list of options for a connection at Bolney is as presented in Table 3.

Table 3: Long list of potential landfall options for a connection at Bolney

Option	Location	Description	Initial screening
1	Brooklands, East of Worthing	Brooklands Pleasure Park - golf course, park, lake and other leisure amenities	Considered feasible landfall option.
2	Airport West	Landfall east of Widewater Lagoon	Initially identified as good beach landing site, but no break in the built environment. Would require demolition of substantial number of homes and issues with immediate onward cable route. **Not pursued further.**
3	Widewater Lagoon East	Landfall east of Widewater Lagoon	No clear gap in built up area but relatively narrow part of urban coastline. Assessed further as below.
4	Norfolk Bridge	Landfall at Beach Road play area	Break in the urban environment but includes established house boat community in the Adur as well as beach huts and childrens' play area. Assessed further as below.
5	Shoreham Port and up the River Adur	Cable installed through port entrance and up the River Adur	Would result in significant disruption to port operations and environmental impact due to ploughing/jetting 4 marine cables in the riverbed of the Adur Estuary SSSI. **Not pursued further.**
6	Portslade/Shoreham Port	HDD drill under the harbour wall and tunnel across to harbour	Would result in significant disruption to port operations and no clear technical solution to cross harbour and onward cable route. **Not pursued further.**

The two options other than Brooklands Park with most potential from the initial screening exercise, namely the Widewater Lagoon and Norfolk Bridge options, are described below in more detail.

Widewater Lagoon

Figure 2 shows the Widewater Lagoon landfall option, which would come ashore west of Shoreham Beach, although this option in practice is heavily constrained due to the presence of residential properties between the lagoon and the A259. A long horizontal directional drill (HDD) would be required underneath the lagoon and the A259. The indicative corridor shown in red in Figure 2 is approximately 40m in width (requiring greater separation of circuits than the standard trenching method of cable installation due to the nature of the HDD methodology). Even this alignment of the corridor, which manages to avoid direct conflict with properties on the north side of the road by taking an angled route, would be in conflict with a number of existing properties on the south side.

Industry practice does not permit the laying of major electricity transmission cables underneath permanent dwellings for a number of reasons including the risk of causing structural problems to the properties, the inaccessibility of cables in the event of fault and the perception of potential health issues associated with electromagnetic fields (EMFs).

This option was discounted due to the requirement to compulsory acquire and demolish an estimated 6-7 homes on the south side of the A259 as well as land to the north of the road.

As a socially responsible developer, E.ON did not believe such an impact to be acceptable. An initial meeting in November 2010 with senior officers from Adur & Worthing Councils, where the three shortlisted landfalls (Brooklands Park, Widewater Lagoon and Norfolk Bridge) were discussed, supported the conclusion that Widewater Lagoon would not be an acceptable landfall location.

Figure 2: Potential landfall location at eastern end of Widewater Lagoon, showing indicative HDD corridor requirement (red)

Norfolk Bridge

Figure 3 shows the Norfolk Bridge landfall option, which would come ashore at Beach Green in Shoreham. A relatively straightforward HDD would be required for the shore landing into an area currently used as a childrens' play area, but would then require an additional HDD of approximately 700-800m across the Adur Estuary, emerging in the Adur Recreational Ground.

As can be seen in Figure 3, situated along the south bank of the Adur is an established riverside settlement of houseboats. The indicative HDD corridor shown in red is approximately 40m in width (requiring greater separation of circuits than the standard trenching method of cable installation).

Since major electricity transmission cables cannot be laid underneath permanent dwellings, as with the Widewater Lagoon option, this would require a significant number of compulsory acquisitions and the removal of an estimated 8-10 houseboats from this established river-based community. E.ON did not consider this to be an acceptable solution and this was the consensus in the meeting to discuss landfall options with Adur & Worthing Councils in November 2010.

In addition to the challenges of a long drill under the tidal Adur Estuary, the estuary is designated as a SSSI, which would require significant disruption during the drilling period.

Figure 3: Potential landfall location south of Norfolk Bridge, showing indicative HDD corridor requirement (red)

3. Cable Route Options

Route from Brooklands to the River Adur

Heading north from the selected landfall at Brooklands Park the cable route enters the South Downs National Park (SDNP) north of the A27. The cable is then routed eastwards around difficult topography and a Site of Nature Conservation Importance (SNCI) at Steep Down, whilst also avoiding complex topography further north at Winding Bottom (see Figure 4). Existing overhead lines pass further north, but running in parallel with this route would not be feasible for trenched underground cables.

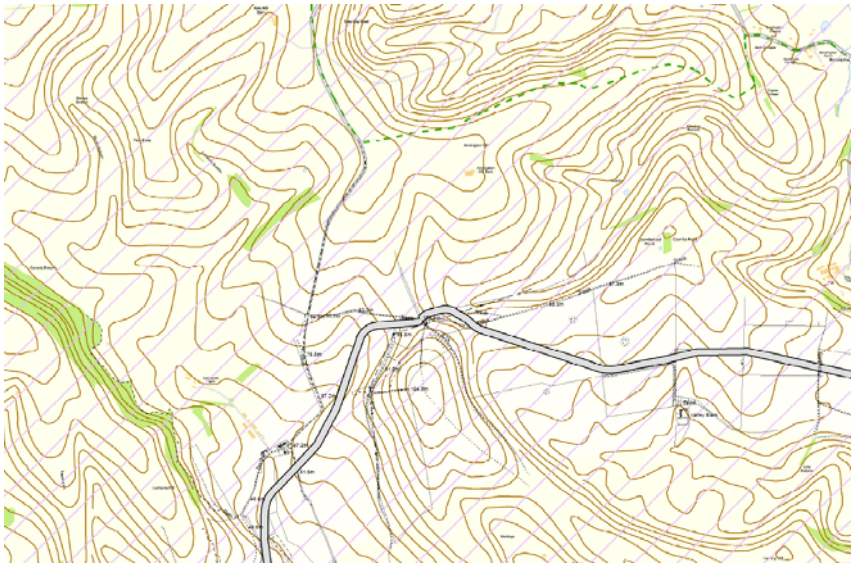

Figure 4: Cable routing eastwards between challenging terrain of Steep Down SNCI to the south and Winding Bottom to the north

River Crossing Point

The preferred crossing point of the River Adur (see Figure 5) has been selected for a number of reasons. Firstly, it is at a point where the river and the A283 run relatively close to one another, reducing the overall length of the drill. Secondly, with most of the terrain to the east of the A283 being extremely steep and not possible to cable up, the chosen route has a flat section of sufficient area to allow a HDD site to be established, with a relatively shallow gradient for the ongoing cable route.

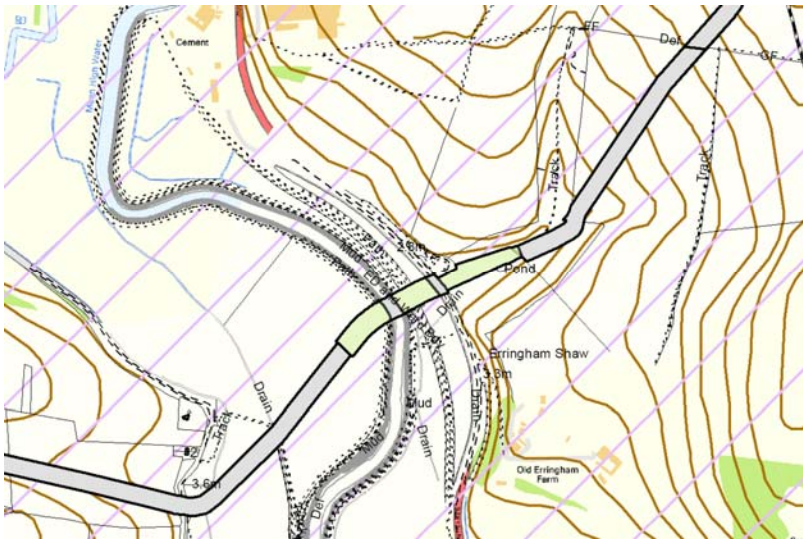

Figure 5: Selected crossing point under River Adur

Other points along the A283 either have no room for a HDD area to be established or, where there is room, the surrounding terrain is so steep as to make an onwards cable route not feasible, as shown in Figure 6.

Figure 6: Typical steep escarpment on east side of the River Adur constraining locations for crossing the river

Adur Valley

Although a cable corridor running along the Adur Valley (along the disused railway and/or the riverbed) for part of the cable route was also considered, a number of constraints were identified with this option including:

- The tidal part of the Adur Estuary is a SSSI of favourable condition noted for its littoral sediments. Disturbance to these and the river embankments would cause environmental impact to the SSSI (note that the ruling out of Norfolk Bridge landfall made a route running along this southern part of the Adur could not be pursued in any case);
- The route would run along a disused railway line for some distance; this is significantly narrower (approximately 6-8m, see Figure 7) than the corridor width required for the construction area and permanent cable easement, and in fact is insufficiently wide for the cable easement and haul road required to install the cables, even if some means of temporarily storing topsoil and subsoil offsite were practical;
- The disused railway is lined on both sides with mature trees, vegetation and valuable habitats, approximately 3km of which would need to be removed to accommodate the construction corridor;
- Embankments along the disused railway line would be unsuitable for extensive trenching to accommodate the four cable circuits, therefore extensive major re-sculpting of the landform would be required to bring the railway line elevation

back down to the level of the valley and losing evidence of the former railway which may not be acceptable in heritage terms;

- The disused railway is also in use as a public right of way, the 'Downslink'. The cabling works would require the closure of this route for a significant period of time;
- There are a number of issues preventing the cables being installed under the riverbed itself. The installation would be similar to an offshore installation requiring specialist vessels and large cable laying equipment, which would cause major disruption to other users of the river. Also, the installation would be highly constrained by the width and depth of the river, as well as the clearance to bridges. Installation of cables alongside the river presents its own problems due to it being within the floodplain. In addition to the installation difficulties caused by the ground conditions, the risk associated with a cable or joint failure due to ingress of moisture is elevated in these floodplain areas; and
- A lack of suitable crossing locations and very steep gradients/residences on the eastern side of the Adur would prevent a crossing point further north than the selected route proposed.

Further north the route is highly constrained by the adjoining settlements Bramber and Upper Beeding, therefore a crossing of the Adur south of this built up area would be required in order for the route to continue north towards Bolney (see, 'Route exiting Adur Valley to the north' below).

Figure 7: Typical section of the Downslink path with mature trees approx 3km from southernmost extent to point at which the former railway crossed the River Adur

Route exiting Adur Valley to the north

Instead of the route heading across higher ground to the east of the Adur and ascending Tottington Mount, options were explored to establish a route either between the settlements of Steyning, Bramber and Beeding, or circumnavigating to the west or east of the built up area.

The previous comments about issues of laying underground cables in the flood plain (see 'Adur Valley' above) should be noted.

Such a route could potentially deliver a shorter cable length through the SNDP as well as avoiding the most challenging section (in both environmental and engineering terms) of the route at Tottington Mount.

Figure 8 highlights the built up areas in blue, with Steyning in the west, Bramber in the centre (including Bramber Castle on an elevated mound highlighted in green) and Upper Beeding to the east. These settlements nestle in the valley between steep and complex topography of the South Downs. Arrows show the three indicative routes for passing through this area:

- To the west of Steyning through complex and steep topography would have no benefit in reducing the length of cable route within the SDNP and would elongate the River Adur flood plain crossing and the overall cable length, this was therefore discounted;
- To the east of Upper Beeding presents challenging topography in terms of being able to safely trench and effectively reinstated steep slopes (with slopes perpendicular to the direction of cable route being especially difficult to traverse), potential small reduction in distance of cable through the SDNP; and
- Routing by/under Bramber Castle (which would be the route which minimises cable length through the SDNP).

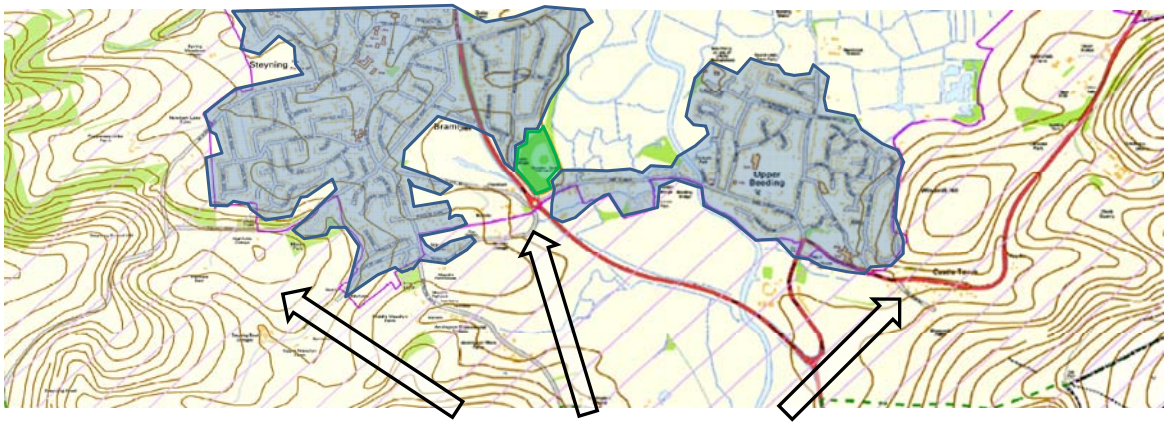

Figure 8: Settlements of Steyning, Bramber and Upper Beeding at the head of the Adur Valley

East of Upper Beeding

There are effectively two sub-options if routing to the east of Beeding.

Sub-option 1
Keeping east of the A2037 presents prolonged steep side slopes and complex topography which would be very difficult to safely lay trenches using typical cable laying techniques. This can only be done using 'zig-zag' techniques that would mean route length saving in SDNP would not be as great as if it was 'as the crow flies'. Cable trenches would require significant 'benching' into the hillside which are more likely to create prominent scars, as well as making effective reinstatement more difficult (and prone to wash out during long periods of rain).

Sub-option 2
Taking a route via Windmill Hill would require a HDD through the hill, as the topography would make trenching over the top or around this hill challenging, or routing on side slopes would have the same practical and safety issues as noted above. In addition to these challenges, the onward route either side of Windmill Hill is highly constrained due to presence of residential properties, roads and other steep gradients. This means that, even if a methodology for traversing of Windmill Hill was identified, the onward the overall route would still not be viable.

Four HDD drills of approximately 600m each would be required to cross under Windmill Hill. The main challenge would be the effective drill depth of at least 30m and resultant thermal de-rating of the cable. Essentially, the ground has a thermal insulating effect around the cable which, along with the depth that cable is buried to, limits how much current each cable can carry without overheating. Certain soils including chalk, have a particularly high thermal resistance. This would require additional drills, cables and likely require cooling systems to achieve the ratings required for the circuits. For cable circuits laid at this depth, typically a tunnel with forced air cooling is used to ensure the cable ratings are maintained (e.g. Elstree – St Johns Wood National Grid 400kV circuit). This would be cost prohibitive for such a short section.

Due to the technical constraints identified above, these options were discounted.

Via Bramber Castle

Bramber Castle is a Scheduled Monument and Grade 1 listed building. The castle is owned by the National Trust and managed by English Heritage. Due to the presence of adjacent St Nicholas Church and graveyard (the oldest Norman church in Sussex) and nearby residential properties, the only way to pass through this area would be a very long and deep HDD route. A route starting south of the A283 roundabout (see Figure 9) under the castle mound would be the only potential means way of continuing the cable route north of Bramber and Upper Beeding.

Figure 9: A283/A2037 roundabout looking towards Bramber Castle and St Nicholas Church

Subsidence on a large scale led to the ruin of the castle during the 16th century, this could be a risk factor of drilling several large cable circuits under what now remains of the castle. The same issues apply as noted above for Windmill Hill in relation to thermal rating problems of cables buried at significant depths.

If a HDD were feasible and acceptable, the cable route would need to then progress through a large flood plain area which is also designated as a SNCI and also features a Scheduled Monument (group of salterns low grassy mounds which are the remains of salt-making in the Middle Ages and earlier).

On the basis of significant technical uncertainties and environmental issues, this option was discounted.