Document 5.2.2.1

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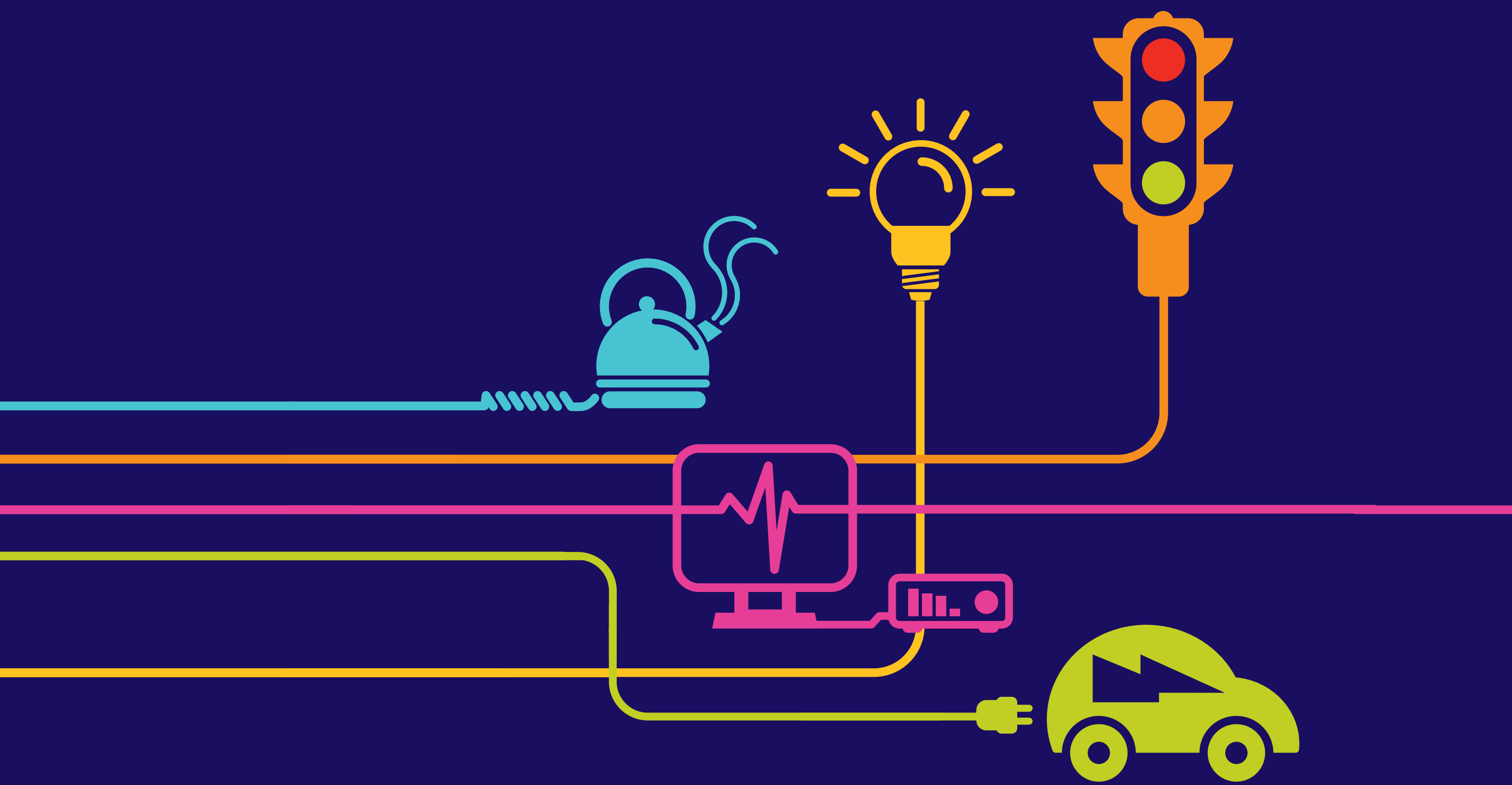
Environmental Statement
Project Need and Alternatives
Appendices 2A to 2C

Hinkley Point C Connection Project

Regulation 5(2)(a) of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009



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May 2014

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Environmental Statement

Hinkley Point C Connection Project

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Appendix 2A – Hinkley Point C Connection Project
Strategic Optioneering Report (2009)

Hinkley Point C Connection

Strategic Optioneering Report

National Grid
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Gallows Hill
Warwick
CV34 6DA

December 2009

CONTENTS **PAGE No.**

Issue date: 04/12/09

1 PURPOSE OF REPORT

1.1 This report, produced by National Grid Electricity Transmission plc (referred to in this report as "National Grid"), has been prepared to inform statutory consultees and other stakeholders of the process of developing and assessing options, which led to a proposal to construct a new 400kV overhead line electricity transmission connection between the proposed Hinkley Point C nuclear power station and Seabank substation near Avonmouth. The connection is being promoted by National Grid and is the subject of a Route Corridor Study.

1.2 The report first provides some background to the statutory role and responsibilities of National Grid, and specifically with regard to the development of new electricity transmission infrastructure to facilitate the connection of new generators. The process by which National Grid develops and assesses infrastructure development options is described and finally the options considered to facilitate the connection of Hinkley Point C are described and evaluated.

2 BACKGROUND

2.1 National Grid owns the high voltage electricity transmission system in England and Wales and is responsible for operating the transmission system across Great Britain.

2.2 The network of transmission lines was primarily constructed in the 1960s and 1970s, and connects historic generation locations with urban areas where demand for electricity is high.

2.3 National Grid has a statutory duty to develop and maintain an efficient, coordinated and economical system of electricity transmission under the Electricity Act 1989. This includes a duty to connect new generating stations to the transmission system. The form which these connections might take depends on a number of factors including, but not limited to, the location and capacity of the new generating stations. For example, wind farms are often remote from the existing transmission network, while new nuclear power stations generally have a higher generating capability which may require additional transmission capacity in order to facilitate their output.

2.4 As a consequence and in compliance with its statutory and licence obligations National Grid must develop the system in accordance with a number of technical standards including those embodied within the Grid Code and the National Electricity Transmission System Security and Quality of Supply Standard (NETSQSS)[1].

2.5 The Grid Code[2] provides the technical requirements for electrical equipment connected to the transmission system, and specifies clear levels of expected performance from the transmission system on which the design of other parties' equipment may be based or reviewed. By application of these standards, material damage to other parties' equipment, resulting from credible events in the development, maintenance and operation of the transmission system, may be avoided.

2.6 Under the terms of its transmission licence, National Grid is required to plan, develop and operate its transmission system in accordance with the NETSQSS. It is required to offer and honour terms for connection of new generation which do not conflict with this obligation[3]. Accordingly such offers are assessed on the basis of :

- overall capital cost;
- the technical viability of the connection;
- the connection not unduly adversely impacting the timing of the connection dates and other commitments made to connectees.

2.7 As well as the technical standards described above, Section 38 and Schedule 9 of the Electricity Act 1989[4] requires National Grid, when formulating proposals for new lines and other works, to:

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[1] National Electricity Transmission System Security and Quality of Supply Standard Version 2.0 : 24/06/09
[2] NGET : The Grid Code Issue 4 : 24/06/09
[3] Based upon the Ofgem consultation of 8th May 2009, National Grid may also apply to Ofgem, in restricted circumstances, to be derogated in its connection to new users, provided it can demonstrate a manageable solution not giving rise to excessive operating costs and not compromising other obligations including Nuclear Site Licences. Such “connect and manage” positions will only be deemed acceptable by the regulator if the works ultimately restore compliance with the NETSQSS.
[4] Electricity Act 1989 c29

- "…have regard to the desirability of preserving natural beauty, of conserving flora, fauna, and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest; and shall do what [it] reasonably can to mitigate any effect which the proposals would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects".

2.8 National Grid's Schedule 9 Statement[5] sets out how the company will meet the duty placed upon it by the aforementioned legislation. This includes :

- only seeking to build new lines and substations where the existing transmission infrastructure cannot be upgraded to meet transmission security standards;

- seeking to avoid nationally and internationally designated areas where new infrastructure is required; and

- minimising the effects of new infrastructure on other sites valued for their amenity.

2.9 The Statement also refers to the application of best practice methods to assess the environmental impacts of proposals and identify appropriate mitigation measures. Effective consultation with stakeholders is also promoted by the Statement.

2.10 The next section describes the particular issues arising following the connection application of Hinkley Point C.

3 NEED

3.1 This section describes the current configuration and capacity of the transmission system in the area affected by the connection application by Hinkley Point C. It also describes the extent of transmission investment which is currently planned or underway in the region and which is aimed to increase transmission capacity. Other generation connection applications affecting the area are also described and finally the implications of these on the transmission system is explained.

[5] National Grid Electricity Transmission plc : Electricity Act 1989 - Schedule 9 Statement : November 2006

The Existing Transmission System in the Region

3.2 Hinkley Point is located at a part of the transmission system which connects the South West peninsula and South Wales with the rest of the system. This means that there are significant interactions between the transmission system in South Wales and the South West and neither can be considered in isolation of the other.

The Existing South West transmission system & Connected Generation

3.3 The transmission system in South West England consists mainly of 400kV transmission equipment and has four transmission circuits connecting it into the rest of the main interconnected transmission system (MITS). These circuits join the MITS at Melksham (Wiltshire), and Lovedean (near Chichester). Appendix C includes a diagram of the existing transmission network in the region.

3.4 Hinkley Point B nuclear power station is connected to the transmission system via a 400kV substation and two 400kV overhead lines. One overhead line route runs between Hinkley Point and Melksham, passing to the north of Bridgwater and west of Frome in Somerset (known as the ZG route). The other route runs from Hinkley Point to Taunton in Somerset, passing to the west of Bridgwater (known as the ZZ route). Melksham is a major transmission connection point connecting multiple transmission lines serving London, the Midlands and South Wales. From Taunton the transmission system extends onto the South West Peninsula and towards Exeter and the south coast.

3.5 The existing 400kv substation at Hinkley Point has two transformer circuits which provide supplies to Hinkley Point 275kV substation. Local supplies to the regional Distribution Network Operator (DNO), in this case Western Power Distribution, are provided from Bridgwater 275kV substation which is connected by a 19km 275kV double circuit overhead line from Hinkley Point 275kv sub station.

Future Transmission Works in the South West

3.6 Replacement of overhead line conductors is planned to be carried out between 2013 and 2018 in the area of South West England, stretching from Reading to the Sedgemoor area. In all some 220km of existing overhead line conductors are to be replaced or enhanced to increase existing transmission capacity to its maximum extent. It should be noted that these works will not involve the construction of new towers or overhead line routes but seek to optimise the use and capacity of existing routes.

Connected Generation in the South West

3.7 Generating stations currently connected to the transmission system in the South West consist of: -

• Indian Queens	140MW
• Langage	905MW
• Hinkley Point B	1261MW
• Fawley	1036MW
• ESSO Fawley (Embedded)	158MW
• Marchwood	900MW
• Didcot A	2109MW
• Didcot B	1550MW
• Seabank	1234MW

South Wales transmission system & Connected Generation

3.8 The transmission system in South Wales consists of both 400kV and 275kV transmission equipment. The 275kV system in South Wales forms connections to power stations typically on the estuary coastline. Appendix C includes a diagram of the current transmission network in the region.

3.9 The South Wales transmission system is connected to the rest of the MITS via six circuits:

- the northern 400kV circuits from South Wales to Walham, near Gloucester cross the Wye valley in Monmouthshire via underground cable circuits;
- the southern 400kV circuits to Seabank at Avonmouth, Bristol and Melksham cross the River Severn via a subsea cable tunnel;

- the southern 275kV circuits to Iron Acton in South Gloucestershire cross the River Severn by means of a high level overhead line river crossing.

In each case, the cable and high level overhead line sections have a lower power transfer capacity or rating than an equivalent overhead line and therefore limit the maximum power transfer capability of these circuits.

Future Transmission Works in South Wales

3.10 The Wye valley 400kV cables and the 275kV Severn River crossing are proposed to be upgraded to increase their capacity. National Grid will need to undertake these major works before 2018 to facilitate the connection of additional generation in South Wales. This will enable both of these double circuit routes to operate to the equivalent ratings of the overhead line (2200MVA and 1000MVA respectively) and therefore improve the power transfer capability from South Wales.

3.11 The Severn River crossing 400kV cable tunnel circuits are close to requiring upgrading and new generator connections in South Wales above 50-100MW will trigger the need for this work to be done. Options for uprating these cable circuits are limited as the existing tunnel is not big enough to accommodate bigger or additional cable circuits. Increasing the capacity of these routes would either require establishing an overhead line crossing, which is unlikely due to suitable crossing points being unavailable, or establishing an additional tunnel. Any option to resolve this issue will incur significant cost and is to be avoided if more economic solutions can be identified.

3.12 In South Wales, a new Swansea North 400kV Grid Supply Point is being constructed to meet the ongoing demand supply needs for National Grid and the local Network Distribution Operator, Western Power Distribution (South Wales), and is due to be completed in 2011.

Connected Generation in South Wales

3.13 Generating stations currently connected to the transmission system in South Wales consists of: -

- Aberthaw 1455MW
- Barry (Embedded in WPD network) 245MW

• Uskmouth	363MW
• Severn Power	850MW
• Baglan Bay	552MW

Connection Applications in the South West and South Wales

3.14 National Grid has an obligation to make firm date connection offers to both demand and generation customers wishing to connect to the transmission system. National Grid has ninety days from the submission of an application to make an offer for connection. Once an offer has been accepted it forms the basis of National Grid's contracted background and is therefore included within the generation and demand assumptions used to assess the future requirements of the transmission system.

3.15 At the time of preparing this optioneering report, National Grid has contracted positions with demand and generation customers for the period up to 2023. Therefore between 2009 and 2023 a number of projects (outlined below in 3.19) are due to make connections to the transmission network which may require new infrastructure and changes to existing infrastructure. National Grid has a contractual obligation to meet the agreed connection date of these customers.

3.16 With regard to Hinkley Point C, British Energy proposed that the new power station should be built alongside the existing power station (Hinkley Point B) sited at Hinkley Point near Bridgwater in Somerset. On 6th July 2007 British Energy submitted an application to National Grid requesting connection of the new 3600MW nuclear power station. British Energy required an initial connection by 31st October 2014 (to provide an electricity supply to the new Hinkley Point C power station), with the commercial capacity of 3600MW available by 31st October 2016. The connection application stated that Hinkley Point C would be of the European Pressurized (water) Reactor (EPR) design. In accordance with National Grid's licence obligations, a connection offer was made in October 2007.

3.17 Subsequently a Modification Application to National Grid was made in March 2009, to revise the date of connection for the two EPR units. This Modification Application also sought to split the commercial availability of the power generation into two stages each connecting 1800MW by September 2017 and September 2018 respectively. The initial connection date for electricity supply to the new Hinkley Point C station was also deferred to 2015.

3.18 The existing power station, Hinkley Point B, was first connected to the transmission system in 1976 and is currently proposed to be decommissioned in 2016 at the earliest, with the possibility for further licence extension. For the purpose of the optioneering process, the possibility that parallel operation of the new station and Hinkley Point B has been considered and the local connection design at Hinkley Point accommodates this requirement. However, it should be noted, that the requirement for wider transmission system reinforcement is not based upon the parallel running of Hinkley Point B and C. Rather, the requirement for new transmission system reinforcement stems from the generation connection applications in the wider South West and South Wales regions, as set out below, and the limited capacity available in the current transmission network.

3.19 In addition to proposals for the Hinkley Point C power station, Connection Agreements are in place to connect the following new generation to the transmission system in the South West and South Wales:

- Pembroke Power Station gas fired power station 2000MW (connection 2011/12)
- Rhigos wind farm 299MW (2012)
- Prenergy Power at Margam bio-mass power station 350MW (2013)
- Abernedd gas fired power station at Baglan Bay 870MW (2013-16)
- Atlantic Array wind farm at Alverdiscott 1512MW (2014)
- Eon Oldbury-on-Severn EPR nuclear power station 1600MW (2020)
- NDA Oldbury-on-Severn EPR nuclear power station 1600MW (2023)
- Seabank 3 gas fired power station 824MW (2023)

3.20 As well as changes to the generation background, electricity demand forecasts are updated on an annual basis by every Distribution Network Operator (DNO) to National Grid. These forecasts indicate anticipated demand to allow forward planning for a 7 year period in accordance with the Grid Code. In assessing the future requirements of the transmission system due consideration must be given to both the contractual generation and the identified demand forecasts.

Technical Issues Arising

(Please see **Appendix D** for a more detailed explanation of these items)

Transmission Capacity

3.21 As described above, there are a number of initiatives underway to increase the capacity of the transmission system in the South West and South Wales. However, even when the circuits in the South West and South Wales have been reinforced to their maximum capability the connection of generating stations at Hinkley Point C, Alverdiscott, Seabank and Oldbury–on–Severn means that this capacity is insufficient.

3.22 As a result and under the requirements of the NETSQSS, under the Electricity at Work Regulations[6] and Electricity Safety, Quality and Continuity Regulations[7] National Grid requires additional transmission capacity to meet its obligations.

3.23 These standards and regulations ensure that National Grid does not operate its assets outside of their proven capability and risk injury to personnel or the general public, or risk an uncontrolled electrical failure of the transmission system that could lead to widespread loss of supply, not least to the South West or South Wales areas.

Quality of supply – Negative Phase Sequence (NPS)

3.24 The existing connections to the north of Seabank, near Avonmouth are such that under maintenance conditions, power can flow in opposite directions in the two circuits on the same towers (known as the 4YX route); e.g. from Seabank to Cilfynydd and back from Cilfynydd to Melksham, hence creating unbalanced voltages. As described in Appendix D, this can lead to the presence of negative phase sequence voltage which must be monitored in order that the transmission system may be operated reliably within the technical limits specified in the Grid Code. In the case of the Hinkley Point C connection the proposed new substation at Aust mitigates this NPS effect.

[6] Electricity at Work Regulations 1989 : SI 1989/635
[7] Electricity Safety Quality and Continuity Regulations 2002 : SI 2002/2665

Transient stability

3.25 As described in Appendix D, transient stability is an important technical factor which National Grid must give detailed consideration to in its assessment of any generation connection.

3.26 The loss of circuits connecting Hinkley Point to the Main Interconnected Transmission System (MITS) at Melksham or via the south coast to Lovedean leads to a situation in which power normally flowing via both these routes has only one export route. This has the effect increasing the impedance between Hinkley Point and the rest of the system and the amount of power flowing in the un-faulted route. Under certain circumstances, this leads to instability following the connection of Hinkley Point C. By design, the existing system does not exhibit instability for these faults due to the lower levels of generation currently connected in this area.

3.27 Further, for generation planned to connect to the west and north of Bristol (at Oldbury-on-Severn, and Seabank) similar stability effects are seen for the loss of circuits connecting Seabank and Oldbury-on-Severn to Melksham. To maintain stability there is the need for a solution which provides sufficient capacity to feed back to Melksham via Hinkley Point; or an additional 400kV route to Melksham would be required from the north Bristol area - again to avoid the risk of damage to these generators following a fault.

Government 2020 renewable energy targets

3.28 In March 2009, the Electricity Networks Strategy Group (ENSG) identified a strategic need for new electricity infrastructure in the South West area to support the achievement of the Government's 2020 renewable energy targets. The background to this group and its report are explained below.

3.29 During the Transmission Access Review (TAR), Government and Ofgem considered the changes that are required to facilitate the timely connection of new electricity generation. The Review was conducted because access to the electricity network is seen as a barrier to entry for new generators, particularly renewable ones. In June 2008, the TAR Final Report[8] made a number of recommendations on how to

[8] Department for Business Enterprise and Regulatory Reform/Ofgem : Transmission Access Review : Final Report : June 2008

improve transmission access. At the same time, Government published its Renewable Energy Strategy consultation[9]. In both documents, Ofgem and Government asked the transmission companies to initiate work to identify the transmission reinforcements needed to support the 2020 targets.

3.30 Following on from this, the Electricity Networks Strategy Group (ENSG), a cross industry group jointly chaired by the Department of Energy and Climate Change and Ofgem, asked the three Great Britain Transmission Licensees, National Grid Electricity Transmission (NGET), Scottish Hydro Electric Transmission Ltd (SHETL) and Scottish Power Transmission (SPT) with the support of an Industry Working Group to take forward a study to:

- Develop electricity generation and demand scenarios consistent with the EU target for 15% of the UK's total energy to be produced from renewable sources by 2020; and

- Identify and evaluate a range of potential electricity transmission network solutions that would be required to accommodate these scenarios.

3.31 The report of the study[10] presents a number of network reinforcements based on a range of scenarios that take into account the significant changes anticipated in the generation mix between now and 2020. In particular, the scenarios examine the potential transmission investments associated with the connection of large volumes of onshore and offshore wind generation required to meet the 2020 renewables target, whilst, at the same time, facilitating the connection of other essential new generation, such as new nuclear power that will be needed to reduce carbon emissions and maintain continued security of supply.

3.32 To ensure that the justifications for the identified reinforcements are sufficiently robust, they have been tested against a range of background scenarios, which take account of likely developments up to the year 2020. In identifying the potential transmission reinforcements, the opportunity was taken first to maximise the utilisation of the existing assets. Thereafter the options identified are based on new or replacement assets. In both circumstances consideration has been given to

[9] Department for Business Enterprise and Regulatory Reform : UK Renewable Energy Strategy Consultation : June 2008

[10] Electricity Networks Strategy Group : Our Electricity transmission Network : A Vision for 2020 : March 2009

employing the latest technology, especially where additional economic and/or additional environmental benefits can be expected. In such cases, due account has been taken of the lead time required to develop robust engineering solutions and the need to obtain the necessary planning consents for each reinforcement.

3.33 The current National Electricity Transmission System Security and Quality of Supply Standard (NETSQSS) was used in determining the reinforcements necessary under the scenarios.

3.34 In relation to the South West, the report concludes :

5.10.1 This area of the network, around the Severn Estuary, is characterised by large volumes of localised generation, high demand levels and a limited export capacity. Future changes in the generation connected in this region, including the potential for large amounts of gas-fired generation and possible nuclear replanting at Hinkley Point and/or Oldbury-on-Severn, drive the need for additional transmission capacity. Planned offshore wind generation through future rounds of wind leasing in this area further add to this requirement.

5.10.2 Proposed reinforcements to accommodate the agreed 2020 scenarios and sensitivities investigated include a new 400 kV circuit between Hinkley Point and Seabank approximately 50 km in length. Reconductoring of existing circuits between Hinkley Point, Melksham and Bramley is also needed to provide the power generated in this area with a stronger electrical connection to the demand centre of London.

4 PROCESS

4.1 The trigger for the strategic optioneering process was the connection offer made by National Grid to British Energy in October 2007 for a new nuclear power station of 3600MW at Hinkley Point. The making of the offer was mandatory as it was the result of a customer application and the works were consistent with the NETSQSS. In making the original connection offer in 2007, consideration was given to a number of alternatives which are identified in **Appendix A**. The proformas in Appendix A are based on the information available at the time of the consideration of the connection offer. Under the terms of its licence, National Grid has only 90 days following receipt of a technically competent application, and appropriate payment, to provide an offer to a customer committing it to a date by which it can provide a licence compliant connection. The assessments undertaken during that period are necessarily time constrained and focused towards identification of the optimal works necessary to effect that connection within the bounds of confidence and information available at that time.

4.2 The connection offer made to British Energy took account of the technical specification and development programme for the proposed power station and the need to provide the most economic and efficient solution to meet the request for a connection. Consideration was also given to potential impacts on amenity and a range of commercial issues.

4.3 The identified infrastructure works, forming part of the connection offer, included :

- Installation of a new 18-bay 400kV GIS double bus bar substation at Hinkley Point;

- Construction of two new 400kV overhead line interconnectors between the new GIS substation at Hinkley Point and the existing 400kV AIS substation at Hinkley Point substation (1km);

- Uprating the 275kV Hinkley Point-Bridgwater route to 400kV operation and uprating Bridgwater Substation to 400kV;

- Breaking into the existing Hinkley Point – Melksham (ZG) overhead line route near the M5 motorway, and teeing the Melksham leg of this route into the Hinkley Point – Bridgwater circuit (VQ) by a short (4km) section of new overhead line, creating Hinkley Point – Bridgwater – Melksham Overhead line route. This route also requires complete re-conductoring;

- Building a new double circuit overhead line between the Hinkley Point leg of the Hinkley Point – Melksham OHL (ZG) route and Seabank 400kV substation (50km);

- Extending the existing 400kV GIS substation at Seabank.

4.4 In addition, the offer included various modifications to substations at Hinkley Point and Bridgwater as well as wider system reinforcement works, including uprating and reconductoring of some 220km of existing overhead lines in the surrounding area and the construction of a new 400kV 4-switch mesh substation near Aust, north of Bristol. Initially the option of building a new substation near Tockington in proximity to the existing T point of the 2VL and 4YX routes was proposed. However, initial substation siting assessment work has revealed the Tockington location to be an area of high flood risk. Therefore a site next to the existing Severn tunnel cable tunnel head house and sealing end compound at Aust was a preferred location.

4.5 The option to modify the offered position is enshrined within the Connection and Use of System Code[11]. The opportunity to re-appraise the original design may occur where time and/or improved information allows a fuller appraisal of options and the further exploration of risks and opportunities. Sometimes this leads to altered delivery approaches or revisions to the works involved in a project.

4.6 Due to the nature of the changing system and market conditions, National Grid keeps its requirements and the scope and timing of works under constant review, always noting its requirement to provide a timely and deliverable solution to meet the agreements in place with its customers. Changes may need to be made, for example, if another connection has to be incorporated into the same area of the system or due to another generator terminating its agreement, or some other change to the generation or demand background. It is also possible to vary an agreement where a review following the initial 3 month offer period identifies a more efficient option being available. This is in line with National Grid's duty to manage the system in the most economic and efficient way.

4.7 In August 2008, an optioneering workshop was held to consider and review the connection offer. Those attending included representatives of the System Development group, Land and Development group and communications team within National Grid, the Electricity Alliance and Western Overhead Lines Alliance, and 3G Communications. The purpose of the meeting was to capture, consider and assess a wide range of options to facilitate the connection offer and meet the commitments of National Grid as a licence holder. All the options previously considered (whether discounted or not) were reviewed by the workshop to determine the robustness of the connection offer decision. In the event that another option appeared to be more beneficial in terms of the key criteria of

[11] National Grid Electricity Transmission plc : Connection and Use of System Code : June 2001 with amendments

economy, efficiency and amenity, further detailed work would need to be undertaken to determine whether a revised connection offer should be made.

4.8 This optioneering exercise assumed:

- the design of the generators were as per the connection applications received - this could not be changed, as it is for the generator to determine and is outside the remit of National Grid;

- that Hinkley Point B will continue to operate at current capacity during and post-commissioning/connection of Hinkley Point C, but due regard should be given to its future closure and ongoing need for infrastructure;

- the impact of other generation connections where a formal offer had been made by National Grid and Connection Agreements were in place

- the demand forecasts provided by the DNO in the area – Western Power Distribution - as provided under the Grid Code against a formal annual process of bilateral dialogue and assessment between National Grid and the DNO.

4.9 The strategic options are described in Chapter 5 and **Appendix B**, and the associated diagrams are shown in **Appendix C**. This includes three options which were initiated after the optioneering workshop, as potential variants of options considered at the workshop.

4.10 When discussing each option, a consensus was reached on whether to take it forward for further investigation or whether the option should be "parked". Parking an option meant that further assessment would not be undertaken unless those options which had been selected for assessment proved not to be deliverable and/or that baseline assumptions changed. The main reasons for parking options were that they could not provide a practicable solution to securing the necessary connections within the required timeframe or that they would be likely to result in high costs and significant environmental impacts where other shorter and less expensive routes are available.

4.11 Of the twenty options considered by the August 2008 workshop, it was decided to park twelve because it was considered that they could not provide a practicable solution to securing the connection of Hinkley Point C within the required timeframe.

4.12 Options H5, H5a, H6, H10, H11, H14, H15, H19 and H20 were to be taken forward for further more detailed research and consideration to establish which provided the most suitable option to facilitate connection of Hinkley Point C within the required timeframe. These options were :

- H5 and H5a Hinkley Point to Aberthaw Subsea Cable AC and DC
- H6 Hinkley Point to Seabank Subsea Cable DC
- H10 Hinkley Point to Seabank overhead line
- H11 Hinkley Point to Melksham overhead line
- H14 Hinkley Point to Mannington or Chickerell overhead line
- H15 Hinkley Point to Nursling overhead line
- H19 Uprate VQ overhead line route to 400kV and extend to Axminster
- H20 Hinkley Point to Seabank Subsea Cable AC

4.13 As Option H10 was a variant of the original sanctioned offer and was supported by the results of the ENSG study, efforts were concentrated on this option and initial consultation with the key stakeholders was carried out on this basis.

4.14 A further workshop was held in August 2009. This reviewed the outputs of the first workshop in the light of more recent information. In some cases this resulted in options being discounted where they would not be system compliant, would involve very high costs or would be clearly unacceptable on amenity grounds. For the reasons set out in Section 5, it was confirmed that, of the options proposed, by the August 2008 workshop, to be taken forward, Options H5, H5a, H6 and H20 should be discounted on technical and cost grounds and H14 and H19 on the grounds that they would not be system compliant. The August 2009 workshop also concluded that H11 and H15 should be parked as they would be more difficult and costly to deliver than Option H10. A variant of the latter (Option H10a) had been introduced following the August 2008 workshop. This proposed the use of the route of a 132kV DNO overhead line between Bridgwater and Seabank and it was recommended that this also be taken forward for further investigation.

4.15 The inclusion of Options H10 and H10a in a Route Corridor Study, carried out by an independent environmental consultancy, is separately reported.

5 OPTIONS EVALUATION

5.1 In evaluating the options which were considered following the connection offer, due regard was given to the key criteria (as set out in National Grid's statutory and licence obligations) of economy, coordination, efficiency (including system compliance and deliverability) and amenity.

5.2 For the purposes of strategic optioneering, the cost estimates for individual post-sanction options were based on generalised unit costs for the key elements of the option, reflecting recent contract values or manufacturers / consultant budget estimates. This is sufficient to allow a broad order of relative costs to be established for the options, as necessary at the strategic level, and is not intended to provide an accurate cost for each option which can only be obtained at the detailed design stage. The cost of DNO works have been included where an initial estimate has been identified, along with the cost of the provision of grid supply points. Some options which were discounted for not meeting system requirements or other reasons were not costed in detail.

5.3 Issues of system compliance and deliverability were addressed by National Grid's System Development team and the South West Substation Alliance and West Overhead Lines Alliance.

5.4 Amenity impacts were advised by the results of a desk study of key environmental constraints such as high level nature conservation, heritage and landscape designations and the definition of major urban areas. The Route Corridor Studies then take into account a wider range of environmental constraints.

5.5 Additional information on individual options is provided in **Appendix B**.

Do Nothing Option

5.6 The Do Nothing option (**Option H1**) was discounted because it would be a clear breach of National Grid's transmission licence obligations to provide a connection. The current infrastructure is unable to accommodate any more generation without breaching thermal, quality of supply and stability constraints. Failure to provide a connection would have wider consequences for the electricity supply and government targets for renewable and low carbon generation would not be met.

System enhancement options

5.7 The existing transmission network in the South West is limited in its extent and connections to South Wales are constrained. Further enhancements of the existing system (**Option H8**) could not, on their own, ensure adequate system capacity and system stability requirements. Most of the options taken forward for consideration also encompass enhancements of the existing transmission network, such as reconductoring overhead lines or other asset replacement work. The DNO network was reviewed (**Option H9**) and it was determined that there are no assets and equipment capable of carrying transmission voltages.

5.8 The decision was therefore taken to discount this option because it would not comply with National Grid's transmission licence obligations.

Generator action options

5.9 Consideration was then given to a number of measures which may be open to the generators to modify the performance of their equipment which could have implications for the design of the transmission system. Examples include the use of fast valving (**Option H2**), to reduce the energy input to the steam turbines during fault conditions, the use of various AC/DC control systems (**Option H3**), and the use of static VAR compensation (**Option H4**).

5.10 National Grid is obliged to offer a connection based upon the generator's equipment specification. Modifications to generator control systems alone would not allow the transmission system to accommodate any more generation without breaching thermal, quality of supply and stability constraints.

5.11 The decision was therefore taken to discount these options.

Subsea cable options

5.12 Achieving connections using subsea cables could potentially reduce the amount of overhead line construction. Various options were considered for providing a cable connection between Hinkley Point and Seabank (**Options H6 and H20**), Hinkley Point and Aberthaw (**Options H5 and H5a**), and Hinkley Point and alternative destinations in South Wales (**Options H7 and H7a**). The options covered both HVDC and AC forms of connection.

5.13 There are no known worldwide 400kV AC submarine cable installations that would be as long as or of the required rating for the circuits. Very significant technical challenges would have to be overcome in terms of switching transients; circuit breaker duty; voltage step change; compensation configuration / location; and possible resonance issues. For a submarine cable above 30km in length, where midpoint compensation is not possible, charging currents become so significant as to severely limit the power carrying capability. The shortest of the submarine cable options would be at least 30km in length to South Wales.

5.14 For the South Wales connections referenced above, the additional works once a subsea cable is landed, would include several new substations and overhead line reinforcements from 275kV operation to 400kV within South Wales, as well as reinforcement of the existing River Severn crossing circuits at significant cost. This option would also require the rebuilding of an overhead line north of Bristol between Iron Acton and Melksham offline at 400kV, as the line is currently constructed of the L3 design of towers not capable of 400kV operation. Also other short sections of new line to meet the contracted connection requirements in the Bristol Area at Seabank and Oldbury-on-Severn would be required. These options would be prohibitively expensive and would require significantly more reinforcement of existing transmission assets in addition to the new, which would be unlikely to be delivered in the timescales required to meet contracted connection dates.

5.15 The type of HVDC technology required for a subsea cable solution in this particular situation has never been utilised at the required capacity or integrated in such a manner within an AC transmission system. An HVDC link involves rectification (AC to DC) at the sending end and inversion (DC to AC) at the receiving end via high power Thyristor or IGBT (Insulated Gate Bipolar Transistor) valves. Power can flow in both directions on an HVDC link, but there are physical limits on the rate at which it can change output (ramp) and more importantly the speed at which the power flow can be reversed. An AC connection in comparison can change direction of flow instantaneously. In the case of an HVDC connection between Hinkley Point and Seabank, the HVDC link would be required to react to multiple faults scenarios, some of which would require power reversals in tens of milliseconds to ensure that the integrity and compliance of the power system is maintained. There are many complex technical issues with the implementation of HVDC technology in this particular application, some of which are beyond the capability of present day or emerging HVDC technology. Could these issues not be resolved, the connection of the contracted generation would then not be possible in the timescales available. Whilst in this case, all HVDC options are uneconomic compared to the overhead line options, National Grid continues to carry out technical investigations into the application of HVDC technology for use in appropriate circumstances.

5.16 All subsea cable options would be extremely expensive and it was uncertain whether such connections could be made to work in the timescales available. A Hinkley Point to Seabank route could also conflict with emerging proposals for a Severn Barrage and with the need to maintain a deep water channel for shipping to enter Avonmouth Docks. All works in the estuary would affect the European and internationally designated nature conservation sites.

5.17 It was concluded that, in none of these cases could an economic, technically feasible and system compliant solution be delivered in the available timescale. The options were therefore discounted.

Overhead line options

5.18 Given the above, various options for constructing new overhead lines were considered. It was assumed that an overhead line for an appropriate connection would be a double circuit 400kV overhead line with triple Araucaria conductors per phase, supported by lattice steel towers.

<u>Hinkley Point to Seabank</u>

5.19 The next step was to consider options for a connection between Hinkley Point and Seabank. The two options were considered for a new route, one of which required a new 400kV build Overhead Line route (**Option H10**). The other option involved utilising the existing 132kV DNO overhead line route between Bridgwater and Seabank and replacing it with new 400kV towers and rationalising/improving the route where possible (**Option H10a**). This is consistent with the conclusions of the ENSG report (see paragraph 3.34 above).

5.20 Option H10 would involve uprating the existing Hinkley Point to Bridgwater circuit to operate at 400kV and connecting this to the existing Hinkley Point to Melksham overhead line, via a new 5km section of line, to form a Hinkley Point - Bridgwater - Melksham circuit. A 400kV overhead line would be constructed from this point to Seabank, a distance of about 50km, and connected to the existing 400kV line to Hinkley Point to form a Hinkley Point - Bridgwater - Seabank circuit. Additional substations would be required at Oldbury-on-Severn, Bridgwater, Hinkley Point and Aust, with an extension to the substation at Seabank. A 5km overhead line connection would also be required in the Oldbury-on-Severn area for the connection of power stations at Oldbury-on-Severn, together with the reconductoring of various sections of overhead line in the area.

5.21 Option 10a would involve similar works, but instead of creating a new route, the existing DNO 132kV overhead line between Bridgwater and Seabank would be dismantled and replaced with a 400kV overhead line. In order to support Western Power Distribution's requirements, a new Grid Supply Point substation would be required at Churchill, to connect into the existing WPD 132kV substation at Churchill, with a short (6km) overhead line connection to the new 400kV overhead line.

5.22 Both routes would run through the Mendip Hills AONB and would pass close to settlements on the coastal plain, including Weston, Clevedon, Nailsea and Portishead, before passing through residential and industrial areas in the Bristol conurbation.

5.23 Both options are considered to comply with system requirements and would be deliverable, though Option 10a would be more complex and costly in view of third party (DNO) involvement. Discussions between National Grid and the DNO (Western Power Distribution) are continuing in order to determine more precisely the extent of their requirements, although initial cost estimates of the DNO works have been included, in the context of their development plan.

5.24 The decision was taken to take both these options forward for further consideration because they offer deliverable, satisfy multiple transmission needs in a coordinated manner are scalable and cost effective solutions.

Hinkley Point to Melksham

5.25 **Option H11** would involve uprating the Hinkley Point to Bridgwater circuit to operate at 400kV and constructing a 400kV overhead line between Bridgwater and Melksham, running parallel to the Hinkley Point to Melksham ZG route for much of its 80km length. The option would pass through SPA and Ramsar sites in the Somerset Levels and would pass close to the edge of the Cranborne Chase AONB - the increased wirescape would be visible from this area and from the settlements along the route such as Frome and Shepton Mallet.

5.26 Additional substations would be required at Oldbury-on-Severn, Bridgwater, Hinkley Point, Aust and Iron Acton. This option would also require the rebuilding of an overhead line north of Bristol between Iron Acton and Melksham offline at 400kV, as the line is currently constructed of the L3 design of towers not capable of 400kV operation. Also other short sections of new line to meet the contracted connection requirements in the Bristol Area at Seabank and Oldbury-on-Severn. The option with the additional works is considered to be system compliant and could potentially be delivered, though, as the works are more extensive than Options 10 or 10a, this would involve greater difficulty and cost.

5.27 As more cost effective options are available, which also better satisfy the coordinated requirements of the transmission system, it was decided that this option should be parked.

Hinkley Point to Nursling

5.28 **Option H15** would involve uprating the Hinkley Point to Bridgwater circuit to operate at 400kV and constructing a 400kV overhead line between Bridgwater and Nursling on the northern edge of Southampton, a distance of about 125km. The route would run to the south of the existing ZG route as far as Frome before running south east to Nursling. The eastern section of the route would pass close to Cranborne Chase AONB and to World Heritage sites and nature conservation designations on Salisbury Plain. The section of parallel running near Frome could have an adverse visual impact

5.29 Additional substations would be required at Oldbury-on-Severn, Bridgwater, Hinkley Point, Aust and Iron Acton, significant rebuilding of Nursling substation and the Chilling cable tunnel under Southampton Water would also need to be replaced. This option would also require the rebuilding of an overhead line north of Bristol between Iron Acton and Melksham offline at 400kV, as the line is currently constructed of the L3 design of towers not capable of 400kV operation. Also other short sections of new line to meet the contracted connection requirements in the Bristol Area at Seabank and Oldbury-on-Severn would be required. The option is considered to be system compliant and could be delivered, though the length of route and scheme complexity pose a risk to delivery and result in costs considerably higher than those for Options 10/10a.

5.30 As more cost effective options are available, which also better satisfy the coordinated requirements of the transmission system, it was decided that this option should be parked.

Discounted overhead line options

5.31 Several options were discounted because they would not address either system stability or system thermal capacity issues and must therefore be considered non-compliant against the NETSSQSS. Because of not satisfying transmission need these options were discounted and not considered in further detail. The options were as follows:

Option H12 : Hinkley Point to Taunton - constructing a second 400kV overhead line between Hinkley Point/Bridgwater and Taunton, a distance of about 25km.

Option H13 : Hinkley Point to Exeter - constructing a second 400kV overhead line between Hinkley Point /Bridgwater and Exeter, a distance of about 60km (via Taunton) or 90km (via Axminster).

Option H14 : Hinkley Point to any point between Mannington and Chickerell - constructing a 400kV overhead line between Hinkley Point /Bridgwater and a point (as yet undetermined) on the 4VN overhead line between Chickerell, near Weymouth, and Mannington, north west of Poole) - a distance of about 90km.

Option H19 : Uprate VQ to 400kV and extend to Axminster - uprating the Hinkley Point to Bridgwater overhead line from 275kV to 400kV and extending it south to join the 4YA route at Axminster - a distance of about 40km.

Option H16 would have involved extending the Hinkley Point to Seabank option as far as Whitson, north of the Severn Estuary. This option would involve an overhead line from Hinkley Point following the route proposed by (option H10), running past Seabank via Overhead Line, crossing the river Severn into South Wales, construction of a new 400kV substation at Whitson, and reinforcement of the existing 400kV river Severn tunnel crossing with no obvious advantage in operational terms. Given that the solution would be clearly uneconomic it was discounted.

Application of new technology

5.32 Outside the UK, some electricity transmission systems now employ four circuit towers or ultra high voltage (UHV) connections.

5.33 **Option H18** considered whether the existing 400kV overhead line between Hinkley Point and Melksham could be replaced with 80m high towers carrying four circuits. This option would not resolve system issues, as just providing the thermal capacity required on the route does not exclude the possibility of common mode failure due to the loss of a tower/s on the route which National Grid is required to consider against the NETSQSS and nuclear safety case. Such a tower failure would almost certainly result in transmission power system failure in the South West of England, for these reasons the option was discounted.

5.34 Changing to Ultra High Voltage (**Option H17**) would involve upgrading overhead lines in the area to operate at 800kV and would require wholesale replacement of the routes with taller towers (probably 70-80m in height) and new substations at multiple locations, including Hinkley Point, Melksham, Taunton, Exeter, Axminster, Chickerell, Mannington and Nursling. This would be extremely expensive and there would be significant difficulties in integrating the 800kV network with the rest of the system. The decision was taken to discount this option because the technology is currently untested and unavailable in the UK.

Undergrounding

5.35 Undergrounding of 400kV transmission lines was not considered at the strategic optioneering stage, although it is accepted that the possibility of undergrounding some short sections of route should be considered when detailed route alignments are being developed. National Grid has a policy related to the use of underground cables which, in summary, reserves consideration of their use to areas of high technical constraint and to areas of the highest recognised amenity value.

Conclusions

5.36 A summary of the options evaluation is provided in Table 5.1. The evaluation has confirmed that Options H10 and H10a are the appropriate transmission network reinforcements that should be considered in the context of its proposed application for development consent. The Route Corridor Studies are undertaken on this basis.

Table 5.1 Summary of option evaluation

Reference	Option	Decision
Pre-Sanction options		
Pre-Sanction 1	Tee Seabank route into Hinkley Point -Bridgwater circuit	Take forward
Pre-Sanction 2	Hinkley Point to Seabank direct	Discount
Pre-Sanction 3	Off shore cable Hinkley Point to Seabank	Discount
Post-Sanction options		
H1	Do Nothing	Discount
H2	Generator action - fast valving	Discount
H3	Generator action - AC/DC/AC controls	Discount
H4	Static VAR compensation	Discount
H5	HVDC subsea cable Hinkley Point to Aberthaw	Discount
H5a	AC subsea cable Hinkley Point to Aberthaw	Discount
H6	HVDC subsea cable Hinkley Point to Seabank	Discount
H7	HVDC subsea cable Hinkley Point to elsewhere	Discount
H7a	AC subsea cable Hinkley Point to elsewhere	Discount
H8	Upgrade existing National Grid assets	Discount
H9	Upgrade existing DNO assets	Discount
H10	Hinkley Point to Seabank	Take forward
H10a	Hinkley Point to Seabank using DNO route	Take forward
H11	Hinkley Point to Melksham	Park
H12	Hinkley Point to Taunton	Discount
H13	Hinkley Point to Exeter	Discount
H14	Hinkley Point to Mannington/Chickerell	Discount
H15	Hinkley Point to Nursling	Park
H16	Hinkley Point to Whitson	Discount
H17	Ultra High Voltage	Discount
H18	Four circuit towers	Discount
H19	Upgrade VQ and extend to Axminster	Discount
H20	AC subsea cable Hinkley Point to Seabank	Discount

6 ABBREVIATIONS

AC	Alternating current
AIS	Air insulated switchgear
AONB	Area of Outstanding Natural Beauty
bn	Billion
DC	Direct Current
DNO	Distribution Network Operator
ENSG	Electricity Networks Strategy Group
EPR	European Pressurised Reactor
EU	European Union
GIS	Gas Insulated Switchgear
GW	Gigawatt (1000 million Watts)
HV	High Voltage
Hz	Hertz
kA	Kiloampere (1000 Amperes)
km	Kilometre
kV	Kilovolt(1000 Volts)
MITS	Main interconnected transmission system
MVA	Megavolt Ampere
MW	Megawatt (1 Million Watts)
NETSQSS	National Electricity Transmission System Security and Quality of Supply Standard
NGET	National Grid Electricity Transmission
Ofgem	Office of the Gas and Electricity Markets
OHL	Overhead line
rpm	Revolutions per Minute
RSPB	Royal Society for the Protection of Birds

SAC	Special Area of Conservation
SGT	Super Grid Transformer
SHETL	Scottish Hydro Electric Transmission Ltd
SPA	Special Protection Area
SPT	Scottish Power Transmission
SSSI	Site of Special Scientific Interest
TAR	Transmission Access Review
UHV	Ultra High Voltage
UK	United Kingdom
VAr	Volt amperes reactive

Appendix A

Options considered in making the connection offer October 2007

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Pre Sanction Option 1 : Sanctioned scheme Hinkley Point to Seabank**
Option Description :	• 18 bay 400kV GIS double busbar substation Hinkley Point • Cable interconnectors between new GIS substation and existing AIS substation Hinkley Point (1 km) • Uprate Hinkley Point - Bridgwater overhead line and Bridgwater substationto 400kV • Tee in Hinkley Point - Melksham 400kV overhead line to Hinkley Point -Bridgwater circuit (3.5 km) to form Hinkley Point -Bridgwater - Melksham circuit • Double circuit 400kV overhead line from Hinkley Point -Melksham tee point to Seabank (50 km) to form Hinkley Point -Bridgwater - Seabank circuit • Extend 400kV substation Seabank • Replace Bridgwater 275kV with 400kV assets • 4 switch mesh 400kV substation Tockington • Install Quadrature Boosters at Fawley 400kV • Various uprating and reconductoring

Evaluation criteria	**Issues**
Economy Cross if reason to park/discount	• Estimated cost £562 m
Efficiency - system compliance Cross if reason to park/discount	• System compliant • Potential impact on DNO network
Efficiency - deliverability Cross if reason to park/discount	• Deliverable - no new technology required • Involves wider system reinforcement •
Amenity Cross if reason to park/discount	• Runs through Mendip Hills AONB • Environmentally sensitive Somerset Levels • Affects numerous small settlements and National Trust property • Passes through residential and industrial areas in Bristol conurbation • Tockington substation on Greenfield site

Recommendation :	Sanctioned scheme - option to be investigated further		
Revision :	0	Revision date :	10/09/07

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Pre Sanction Option 2 : Hinkley Point to Seabank direct**
Option Description :	• Construct 54 km 400kV overhead line Hinkley Point - Seabank • 18 bay 400kV GIS double busbar substation Hinkley Point • Cable interconnectors between new GIS substation and existing AIS substation Hinkley Point (1 km) • Extend 400kV substation Seabank • 4 switch mesh 400kV substation Aust • Uprate the Hinkley Point – Melksham 400kV circuit • Various uprating and reconductoring

Evaluation criteria		**Issues**
Economy		• Not costed at pre-sanction stage as discounted for other reasons
Cross if reason to park/discount		
Efficiency - system compliance		• System compliant
Cross if reason to park/discount		
Efficiency - deliverability		• Deliverable
Cross if reason to park/discount		
Amenity		• Would involve four double circuit OHLs converging on Hinkley Point • Runs through Mendip Hills AONB • Environmentally sensitive Somerset Levels • Affects numerous small settlements and National Trust property • Passes through residential and industrial areas in Bristol conurbation
Cross if reason to park/discount	X	

Recommendation :	Option discounted because of potential impacts on amenity especially at Hinkley Point		
Revision :	0	Revision date :	10/09/07

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Pre Sanction Option 3 : Offshore cable Hinkley Point to Seabank**
Option Description :	• Construct offshore cable (AC or HVDC) between Hinkley Point and Seabank • Associated works not specified at pre-sanction stage

Evaluation criteria		**Issues**
Economy		• Estimated to cost over £500m more than the sanctioned option, to provide just the capacity required for the Hinkley Point connection.
Cross if reason to park/discount	X	
Efficiency - system compliance		• Further consideration required as part of the assessment process
Cross if reason to park/discount		
Efficiency - deliverability		• Further consideration required as part of the assessment process
Cross if reason to park/discount		
Amenity		• Would affect designated Special Area of Conservation, SPA and Ramsar sites in Severn Estuary
Cross if reason to park/discount		

Recommendation :	Option discounted on cost grounds		
Revision :	0	Revision date :	10/09/07

Appendix B

Options considered in the assessment process

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H1: Do nothing**
Option Description :	• No change to transmission system

Evaluation criteria		**Issues**
Economy		• No additional capital cost
Cross if reason to park/discount		
Efficiency - system compliance		• Not compliant • Current infrastructure unable to accommodate more generation without breaching thermal, quality of supply and stability constraints • Will not fulfil connection obligations
Cross if reason to park/discount	X	
Efficiency - deliverability		• No deliverability issue
Cross if reason to park/discount		
Amenity		• No impact on amenity
Cross if reason to park/discount		

Recommendation :	Option should now be discounted given that it would be a clear breach of National Grid's licence obligation to provide connections		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H2 :- Generator action - fast valving**
Option Description :	• Generator adopts fast valving system to protect turbines in the event of system faults

Evaluation criteria		Issues
Economy		• No cost implications for National Grid
Cross if reason to park/discount		
Efficiency - system compliance		• Not compliant • Use of unproven technology could cause system to become unstable in the event of a double circuit fault • System thermal compliance is not resolved • Will not fulfil connection obligations
Cross if reason to park/discount	X	
Efficiency - deliverability		• Outside National Grid control, so no guarantee of delivery
Cross if reason to park/discount	X	
Amenity		• Impact on amenity not determined • No additional overhead lines required
Cross if reason to park/discount		

Recommendation :	Option should now be discounted given that it would be non-compliant and outside National Grid's control		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H3 : Generator action AC/DC/AC control systems**
Option Description :	• Generator adopts AC/DC/AC control systems

Evaluation criteria		Issues
Economy		• No cost implication for National Grid
Cross if reason to park/discount		
Efficiency - system compliance		• Not compliant • Will not fulfil connection obligations • System thermal compliance is not resolved
Cross if reason to park/discount	X	
Efficiency - deliverability		• Outside National Grid control, so no guarantee of delivery • Use of non-proven technology
Cross if reason to park/discount	X	
Amenity		• Impact on amenity not determined • No additional overhead lines required
Cross if reason to park/discount		

Recommendation :	Option should now be discounted given that it would be non-compliant and outside National Grid's control		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H4 : Static var compensation**
Option Description :	• Use of static VAR compensators to regulate voltages and stabilise the system • Would require extension to Hinkley Point substation

Evaluation criteria		Issues
Economy		• No cost implication for National Grid
Cross if reason to park/discount		
Efficiency - system compliance		• Would not solve system stability problems • System thermal compliance is not resolved
Cross if reason to park/discount	X	
Efficiency - deliverability		• Outside National Grid control, so no guarantee of delivery
Cross if reason to park/discount	x	
Amenity		• Impact on amenity not determined • No additional overhead lines required
Cross if reason to park/discount		

Recommendation :	Option should now be discounted given that it would be non-compliant and outside National Grid's control		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H5 : High voltage DC subsea cable Hinkley Point to Aberthaw**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 4 x 1000MW Converter Stations at Hinkley Point • 14 bay 400kV GIS Substation at Iron Acton • 9 bay 400kV GIS Substation at Aberthaw • 4 x 1000MW Converter Stations at Aberthaw • 9 bay 400kV AIS substation at Upperboat • Install 2 x 400kV Quadrature Boosters at Cilfynydd • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Re-conductor and uprate to 400kV Aberthaw-Upperboat-Cilfynydd Overhead Line • Re-conductor Cilfynydd - Rassau Overhead Line • Hotwire Seabank to Aust Overhead Line • Install DC cables Between Hinkley Point and Aberthaw • Construct a new 400kV Severn cable tunnel to increase circuit rating • Western Power Distribution 132kV required and estimate included in cost

Evaluation criteria		**Issues**
Economy		• Estimated option cost >£2 bn
Cross if reason to park/discount	X	
Efficiency - system compliance		• The two ends of the route are at different voltages, resulting in significant reinforcement works to connect to the South Wales 400kV network. • Would need upgrade of Severn cable tunnel and network in South Wales. • Requires power reversal in tens of mS to meet transient stability requirements.
Cross if reason to park/discount		
Efficiency - deliverability		• Use of unproven technology • Time constraints linked to licence requirements • Potential bottlenecks at Hinkley Point • Engineering in tidal environment • Technology issues unlikely to be resolved in available timescale • Potential implications of Severn Barrage
Cross if reason to park/discount		
Amenity		• Crosses designated Special Area of Conservation, SPA and Ramsar sites • Tidal environment • Shipping issues • Significant land requirements for converter stations at both Hinkley Point and Aberthaw.
Cross if reason to park/discount		

Recommendation :	Option to be discounted on cost grounds		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H5a : High voltage AC subsea cable Hinkley Point to Aberthaw**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 800Mvar 400kV reactive compensation at Hinkley Point • 14 bay 400kV GIS Substation at Iron Acton • 9 bay 400kV GIS Substation with 800MVAr reactive compensation at Aberthaw • 9 bay 400kV AIS substation at Upperboat • Install 2 x 400kV Quadrature Boosters at Cilfynydd • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Re-conductor and uprate to 400kV Aberthaw-Upperboat-Cilfynydd Overhead Line • Re-conductor Cilfynydd - Rassau Overhead Line • Hotwire Seabank to Aust Overhead Line • Install AC cables Between Hinkley Point and Aberthaw • Construct a new 400kV Severn cable tunnel to increase circuit rating • Western Power Distribution 132kV required and estimate included in cost

Evaluation criteria	Cross if reason to park/discount	Issues
Economy		• Estimated option cost £1.8bn
Efficiency - system compliance	X	• The two ends of the route are at different voltages, resulting in significant reinforcement works to connect to the South Wales 400kV network. • Would need upgrade of Severn cable tunnel and network in South Wales.
Efficiency - deliverability	X	• Technically very difficult to implement due to switching transients; circuit breaker duty; voltage step change; compensation configuration / location; and possible resonance issues • Use of unproven technology – currently no designs of 400kV AC submarine cables exist. • Time constraints linked to licence requirements • Potential bottlenecks at Hinkley Point • Engineering in tidal environment
Amenity		• Crosses designated Special Area of Conservation, SPA and Ramsar sites • Tidal environment • Shipping issues

Recommendation :	Option to be discounted on cost grounds and technically difficulties which are potentially not resolvable		
Revision :	0	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H6: High voltage DC subsea cable Hinkley Point to Seabank**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 4 x 1000MW DC converter stations at Hinkley Point • 2 SGT bay 400kV teed substation at Bridgwater • 4 x 1000MW DC converter stations at Seabank • Re-conductor Seabank - Aust Overhead Line • Install DC cables between Hinkley Point and Seabank

Evaluation criteria		**Issues**
Economy		• Estimated option cost £1.9 bn
Cross if reason to park/discount	X	
Efficiency - system compliance		• Requires power reversal in tens of mS to meet transient stability requirements.
Cross if reason to park/discount	X	
Efficiency - deliverability		• Use of unproven technology • Technology issues unlikely to be resolved in available timescale • Engineering in tidal environment • Potential implications of Severn Barrage
Cross if reason to park/discount	X	
Amenity		• Runs entirely within designated Special Area of Conservation and crosses SPA and Ramsar sites • Tidal environment • Shipping issues - crosses entrance to deep water port • Significant land requirements for converter stations at both Hinkley Point and Seabank.
Cross if reason to park/discount		

Recommendation :	Option to be discounted due to high cost, uncertainty of delivery, uncertain resolution of technical issues and compliance issues		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H7 : High voltage DC subsea cable Hinkley Point to elsewhere (not Aberthaw or Seabank)**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 14 bay 400kV GIS Substation at Iron Acton • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line • Additional works in excess of those proposed by option H5 in South Wales

Evaluation criteria		Issues
Economy		• Longer crossings than Hinkley-Aberthaw (H5) would involve higher costs > £2bn
Cross if reason to park/discount	X	
Efficiency - system compliance		• May require power reversal in tens of milliseconds to meet transient stability requirements.
Cross if reason to park/discount	X	
Efficiency - deliverability		• Use of unproven technology • Technology issues unlikely to be resolved in available timescale • Engineering in tidal environment • Potential implications of Severn Barrage
Cross if reason to park/discount	X	
Amenity		• Crosses designated Special Area of Conservation/SPA and Ramsar sites • Tidal environment • Shipping issues • Significant land requirements for converter stations at both Hinkley Point and elsewhere.
Cross if reason to park/discount		

Recommendation :	Option to be discounted due to high cost, uncertainty of delivery and compliance issues		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H7a : High voltage AC subsea cable Hinkley Point to elsewhere (not Aberthaw or Seabank)**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 14 bay 400kV GIS Substation at Iron Acton • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line • Additional works in excess of those proposed by option H5a in South Wales

Evaluation criteria	Cross if reason to park/discount	**Issues**
Economy		• Longer crossings than Hinkley-Aberthaw (H5a) would involve higher costs > £1.8 bn
Efficiency - system compliance	X	• The two ends of the route are at different voltages, resulting in operational complexity
Efficiency - deliverability	X	• Technically very difficult to implement due to switching transients; circuit breaker duty; voltage step change; compensation configuration / location; and possible resonance issues • Use of unproven technologies • Time constraints linked to licence requirements • Potential bottlenecks at Hinckley Point • Engineering in tidal environment
Amenity		• Crosses designated Special Area of Conservation/SPA and Ramsar sites • Tidal environment • Shipping issues

Recommendation :	Option to be discounted on cost grounds and technically difficulties which are potentially not resolvable		
Revision :	0	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H8 : upgrade existing network - National Grid assets**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • Up-rate required sections of the system by Stringing larger conductors from existing towers

Evaluation criteria		**Issues**
Economy		• Option not costed, as other reasons for parking
Cross if reason to park/discount		
Efficiency - system compliance		• Would not meet system needs as far as stability is concerned. • Also not sufficient capability to meet thermal requirements • Any further rating increases would exceed substation continuous current ratings • Non-compliant
Cross if reason to park/discount	X	
Efficiency - deliverability		• Not considered, as other reason for parking
Cross if reason to park/discount		
Amenity		• Not considered, as other reason for parking
Cross if reason to park/discount		

Recommendation :	Option to be discounted because it is non-compliant		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H9 : upgrade existing network - DNO assets**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • Then use DNO assets to carry transmission equipment

Evaluation criteria		Issues
Economy		• Option not costed, as other reasons for parking
Cross if reason to park/discount		
Efficiency - system compliance		• Would not meet system requirements • Non-compliant
Cross if reason to park/discount	X	
Efficiency - deliverability		• No suitable DNO assets identified • Involvement of third party (DNO) poses risk to delivery
Cross if reason to park/discount		
Amenity		• Not considered, as other reason for parking
Cross if reason to park/discount		

Recommendation :	Option to be discounted because it is non-compliant		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H 10 : Hinkley Point to Seabank**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 2 SGT bay 400kV teed substation at Bridgwater • Construct Hinkley Point to Seabank Overhead line • Re-conductor Seabank - Aust Overhead Line

Evaluation criteria		**Issues**
Economy		• Estimated option cost £656m
Cross if reason to park/discount		
Efficiency - system compliance		• System compliant • Potential impact on DNO network
Cross if reason to park/discount		
Efficiency - deliverability		• Deliverable - no novel technology • Involves wider system reinforcement
Cross if reason to park/discount		
Amenity		• Runs through Mendip Hills AONB • Environmentally sensitive Somerset Levels • Affects numerous small settlements and National Trust property • Passes through residential and industrial areas in Bristol conurbation • Aust substation on greenfield site
Cross if reason to park/discount		

Recommendation :	Option to be investigated further		
Revision :	0	Revision date :	19/08/08

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H 10a : Hinkley Point to Seabank (using DNO route)**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 2 SGT bay 400kV teed substation at Bridgwater • 2 SGT bay 400kV line breaker Mesh at Churchill • Construct Hinkley Point to Seabank Overhead line • Construct Overhead Line Spur to Churchill • Re-conductor Seabank - Aust Overhead Line • Western Power Distribution 132kV required and estimate included in cost

Evaluation criteria		**Issues**
Economy		• Estimated option cost £698m
Cross if reason to park/discount		
Efficiency - system compliance		• System compliant • Potential impact on DNO network cost included
Cross if reason to park/discount		
Efficiency - deliverability		• Deliverable - no novel technology • Involves wider system reinforcement
Cross if reason to park/discount		
Amenity		• Use of DNO route reduces landscape impact • Runs through Mendip Hills AONB • Environmentally sensitive Somerset Levels • Affects numerous small settlements and National Trust property • Passes through residential and industrial areas in Bristol conurbation • Aust substation on greenfield site
Cross if reason to park/discount		

Recommendation :	Option to be investigated further		
Revision :	0	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H11: Hinkley Point to Melksham**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 2 SGT bay 400kV teed substation at Bridgwater • 14 bay 400kV GIS Substation at Iron Acton • Extend by 4 bays 400kV AIS substation at Melksham • offline Re-build Iron Acton - MelKsham line at 400kV • Construct new Sections and re-conductor existing Overhead Line Hinkley Point - Bridgwater - Melksham Overhead Line • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line

Evaluation criteria		**Issues**
Economy		• Estimated option cost £916 m
Cross if reason to park/discount	X	
Efficiency - system compliance		• System compliant
Cross if reason to park/discount		
Efficiency - deliverability		• Deliverable but high risk attached to Iron Acton-Melksham works on northern fringe of Bristol
Cross if reason to park/discount	X	
Amenity		• Passes through SPA/Ramsar sites in Somerset Levels • Extensive paralleling would increase wirescape, visible from Cranborne Chase • Close to Frome and Shepton Mallet • Close to Lacock Abbey - National Trust • Results in c. 130km new OHL line.
Cross if reason to park/discount		

Recommendation :	Option to be parked as lower cost solution available and schemes providing better coordination of transmission works available.		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H12 : Hinkley Point to Taunton**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 14 bay 400kV GIS Substation at Iron Acton • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line • Construct 400 kv overhead line between Hinkley and Taunton - c 25km

Evaluation criteria		**Issues**
Economy		• Option not costed, as other reasons for parking
Cross if reason to park/discount		
Efficiency - system compliance		• Non compliant • Would not address system stability issues
Cross if reason to park/discount	X	
Efficiency - deliverability		• Deliverable short route
Cross if reason to park/discount		
Amenity		• Crosses or passes close to Quantocks AONB • Would lead to increase in wirescape in sensitive area
Cross if reason to park/discount		

Recommendation :	Option to be discounted as non-compliant		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H13 : Hinkley Point to Exeter**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 14 bay 400kV GIS Substation at Iron Acton • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line • Construct 400 kv overhead line between Hinkley Pt and Exeter - c 60km

Evaluation criteria		Issues
Economy		• Option not costed, as other reasons for parking
Cross if reason to park/discount		
Efficiency - system compliance		• Non compliant • Would not address system stability issues
Cross if reason to park/discount	X	
Efficiency - deliverability		• Deliverable
Cross if reason to park/discount		
Amenity		• Crosses or passes over Quantocks and Blackdown Hills AONB • Close to 2 SSSI
Cross if reason to park/discount		

Recommendation :	Option to be discounted as non-compliant		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H14 : Hinkley Point to a point between Mannington and Chickerell**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 14 bay 400kV GIS Substation at Iron Acton • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line • Construct 400 kv overhead line from Hinkley Point/Bridgwater to the 4VN route between Mannington (north west of Poole) and Chickerell - approx 90km

Evaluation criteria	Cross if reason to park/discount	**Issues**
Economy		• Option not costed, as other reasons for parking
Efficiency - system compliance	X	• Non compliant • Would not address system stability issues
Efficiency - deliverability		• Deliverable, though long route
Amenity		• Nature conservation designations east of Bridgwater • Would cross Cranborne Chase and Dorset Downs • Lengthy new overhead line in the landscape • Passes close to small town and MOD airspace

Recommendation :	Option to be discounted as non-compliant		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H15 : Hinkley Point to Nursling**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 2 SGT bay 400kV teed substation at Bridgwater • 14 bay 400kV GIS Substation at Iron Acton • Re-build 15bay 400kV AIS substation at nursling with 300MVAr of compensation • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Construct Bridgwater to Nursling Overhead Line • Hotwire Seabank to Aust Overhead Line • Construct a new 400kV Chilling cable tunnel to increase circuit rating

Evaluation criteria		**Issues**
Economy		• Estimated option cost £1.18bn
Cross if reason to park/discount	X	
Efficiency - system compliance		• System compliant
Cross if reason to park/discount		
Efficiency - deliverability		• Deliverable but long route • High risk attached to Iron Acton-Melksham works on northern fringe of Bristol
Cross if reason to park/discount	X	
Amenity		• Passes close to Cranborne Chase AONB • Passes close to World Heritage sites on Salisbury Plain • Passes close to SPA/SAC • Lengthy new overhead line in the landscape
Cross if reason to park/discount		

Recommendation :	Option to be parked as lower cost solution available and schemes providing better coordination of transmission works available.		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H16 : Hinkley Point to Whitson**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • Construct 400 kv overhead line between Hinkley Point and Whitson, near Uskmouth following the same route as proposed in (H10) • Cross the river Severn west of the M48 river crossing • Build an new 400kV substation at Whitson • Replace the existing 400kV river Severn crossing

Evaluation criteria		**Issues**
Economy		• Substantially more expensive than Hinkley - Seabank (H10a) • > £698m with no obvious advantage in operational terms
Cross if reason to park/discount	X	
Efficiency - system compliance		• Considered to be system compliant
Cross if reason to park/discount		
Efficiency - deliverability		• Would involve longer route running past Seabank with no obvious advantage in operational terms, and require a substantial river Severn Crossing
Cross if reason to park/discount	X	
Amenity		• In addition to the impacts associated with Hinkley - Seabank (H10) would include parallel sections north of Severn Estuary • Requires a major 400kV river Severn Crossing
Cross if reason to park/discount		

Recommendation :	Option to be discounted on cost as shorter option to Seabank available and no operational advantage in passing Seabank		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H17 : Ultra High Voltage**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 800kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 14 bay 400kV GIS Substation at Iron Acton • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line • Use of 800kV equipment on routes in the area • Upgrade circa 230 km existing overhead lines to operate at UHV (800kV) would require new towers and substations. • 800kV substations at Melksham, Taunton, Exeter, Axmister, Chickerell, Mannington, Nursling and Lovedean

Evaluation criteria		**Issues**
Economy		• Very high costs well in excess of other high cost options >>£2bn , not possible to estimate as specification of bespoke equipment not available
Cross if reason to park/discount		
Efficiency - system compliance		• System compliance would need to be established
Cross if reason to park/discount	X	
Efficiency - deliverability		• Technology untested in UK . Would require the development of a complete set of specifications for bespoke UHV equipment which could take 5-6 years
Cross if reason to park/discount	X	
Amenity		• The technology would use very high towers and affect very long sections of the existing network • Potential increases in current levels of EMF and operational noise
Cross if reason to park/discount		

Recommendation :	Option should now be discounted due to excessive cost and given that the technology is not currently available in the UK and could not be delivered in the required timescale		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H18 : Four circuit towers**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 14 bay 400kV GIS Substation at Iron Acton • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line • replace existing overhead line between Hinkley Point and Melksham with 80m towers carrying four circuits

Evaluation criteria	Cross if reason to park/discount	**Issues**
Economy		• Estimated option cost similar to option (H11) circa £916m . the scheme does not meet compliance requirement, and therefore parked
Efficiency - system compliance	X	• Would not solve further system stability issues • Carries increased power loss risk if four circuits lost • Not considered compliant for single mode failure of a tower • Will not meet Nuclear safety case
Efficiency - deliverability	X	• Unproven technology in UK • Maintenance issues
Amenity		• Would have a very significant visual impact, particularly on views from Cranborne Chase AONB and nearby settlements

Recommendation :	Option should now be discounted given compliance and deliverability issues.		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

Scheme :	Hinkley
Option Reference and Title :	**Option H19 : Uprate VQ to 400 kV and extend to Axminster**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 14 bay 400kV GIS Substation at Iron Acton • offline Re-build Iron Acton - Melksham line at 400kV • Construct a second circuit between Seabank and Tockington Tee • Hotwire Seabank to Aust Overhead Line • Uprate 275 kV Hinkley Point to Bridgwater overhead line to 400 kV and extend to Axminster - c 40km new line

Evaluation criteria		**Issues**
Economy		• Not costed, as other reasons for discounting
Cross if reason to park/discount		
Efficiency - system compliance		• Would not resolve system stability issues
Cross if reason to park/discount	X	
Efficiency - deliverability		• Deliverable
Cross if reason to park/discount		
Amenity		• Passes close to Quantocks and Blackdown Hills AONB
Cross if reason to park/discount		

Recommendation :	Option to be discounted as non-compliant		
Revision :	A	Revision date :	03/09/09

OPTIONS EVALUATION PROFORMA

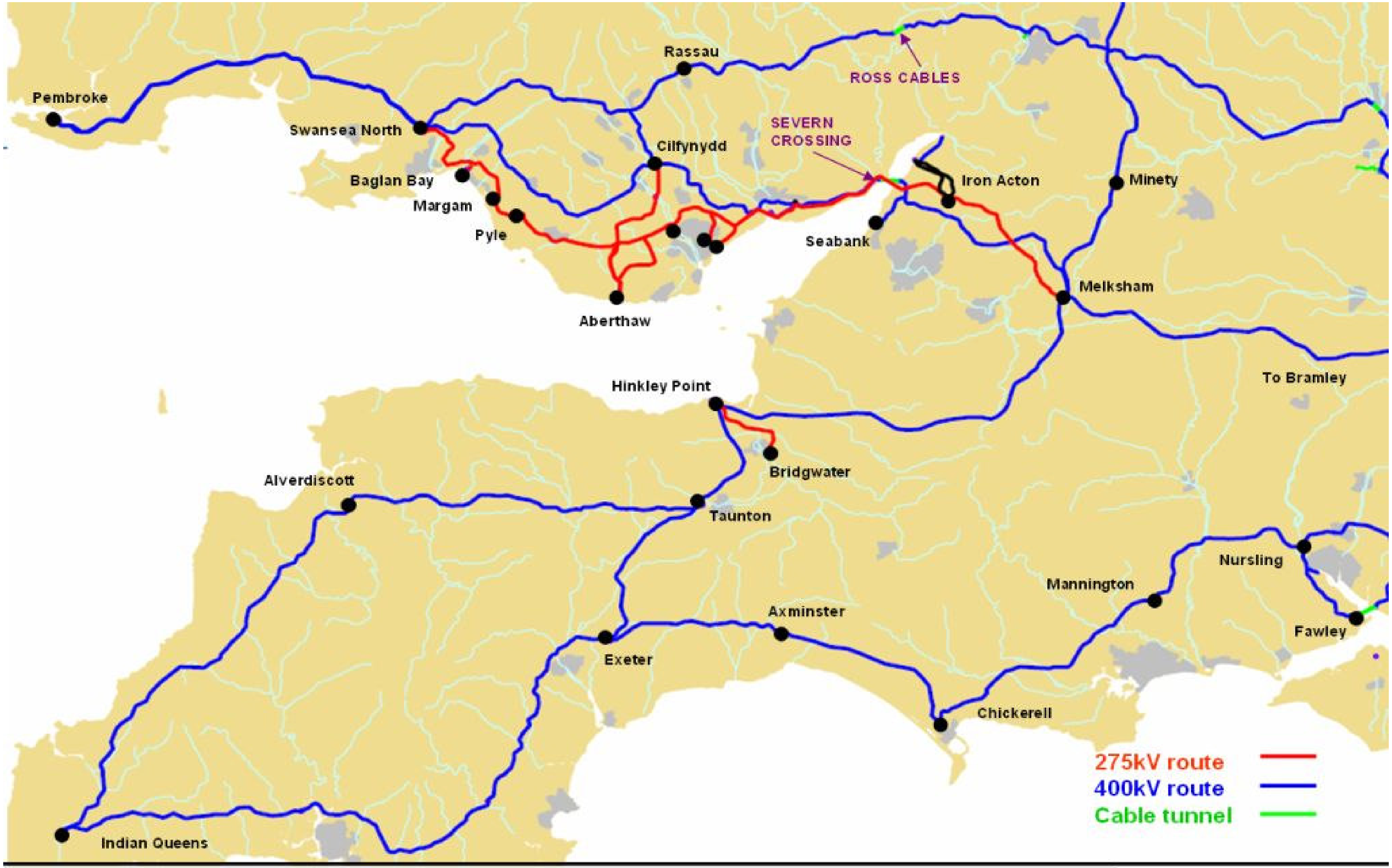
Scheme :	Hinkley
Option Reference and Title :	**Option H20: 400kV AC sub-sea cable Hinkley Point to Seabank**
Option Description :	• 14 bay 400kV GIS Substation at Oldbury-on-Severn • 4 switch mesh 400kV GIS Substation at Aust • 18 bay 400kV Substation at Hinkley Point • Extend Seabank 400kV GIS by 5 bays • Install 2 x 400kV Quadrature Boosters at Fawley • Re-arrange line entries at Melksham 400kV • Construct new Sections and re-conductor existing Overhead Line Connections to Oldbury-on-Severn • Re-conductor the Melksham to Bramley Overhead Line • Hotwire sections of Aust/Seabank - Oldbury on Severn - Melksham • Double Cowley - Walham Cables • 1600Mvar 400kV reactive compensation at Hinkley Point • 2 SGT bay 400kV teed substation at Bridgwater • 1600Mvar 400kV reactive compensation at Seabank • Re-conductor Seabank - Aust Overhead Line • Install AC cables between Hinkley Point and Seabank

Evaluation criteria	Cross if reason to park/discount	Issues
Economy		• Estimated option cost £1.93 bn
Efficiency - system compliance	X	• To resolve switching issues landfall may need to be made at the midpoint of the cable to add an additional switching station. This cost is not included and would make this scheme even further un-economic
Efficiency - deliverability	x	• Technically very difficult to implement due to switching transients; circuit breaker duty; voltage step change; compensation configuration / location; and possible resonance issues • Use of unproven technology – no current designs of 400kV submarine cable exist. • Time constraints linked to licence requirements • Potential bottlenecks at Hinkley Point • Engineering in tidal environment
Amenity		• Crosses designated Special Area of Conservation, SPA and Ramsar sites • Tidal environment • Shipping issues

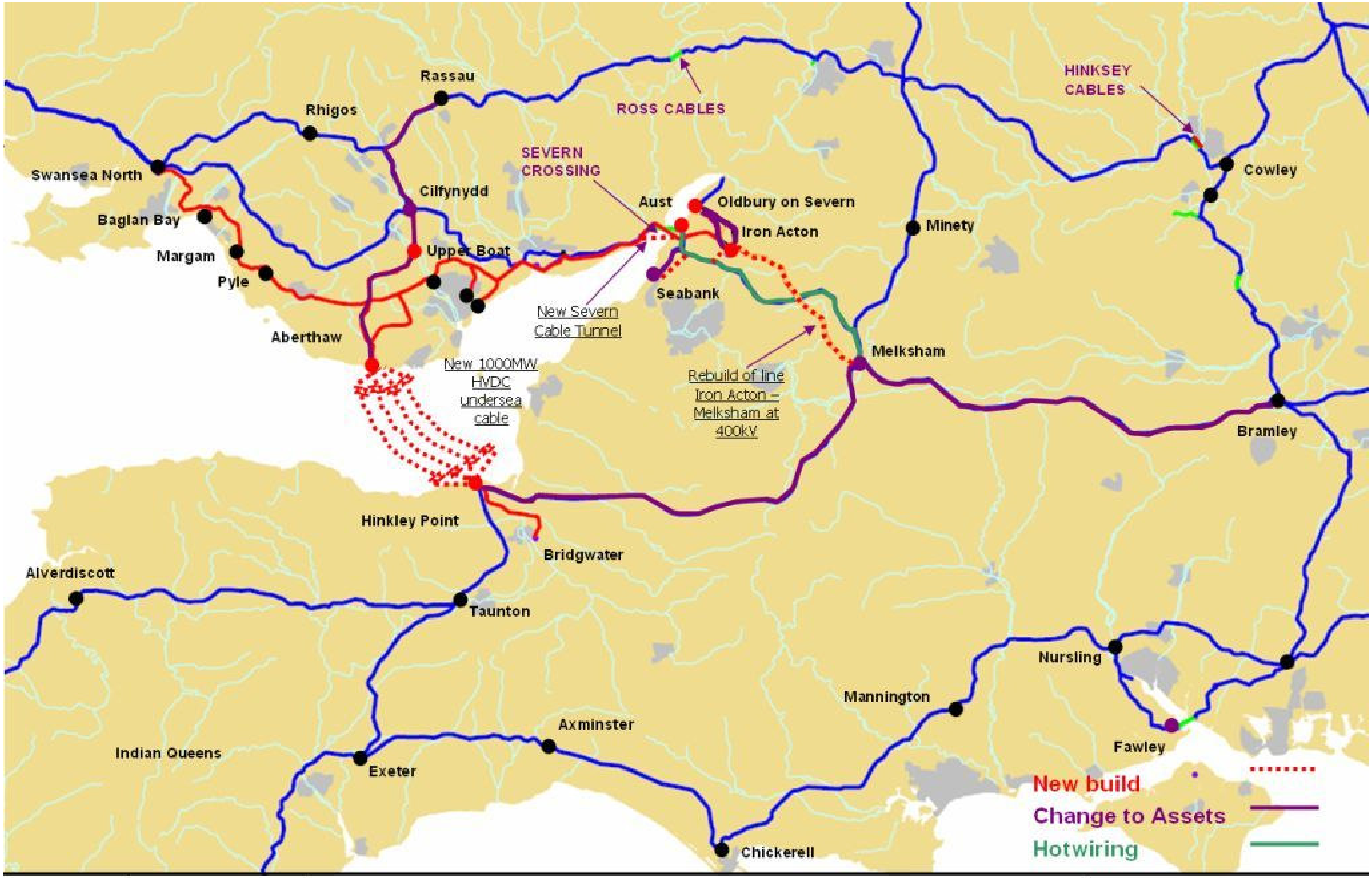
Recommendation :	Option to be discounted on cost grounds and technically difficulties which are potentially not resolvable		
Revision :	A	Revision date :	03/09/09

Appendix C

Existing transmission network and option diagrams

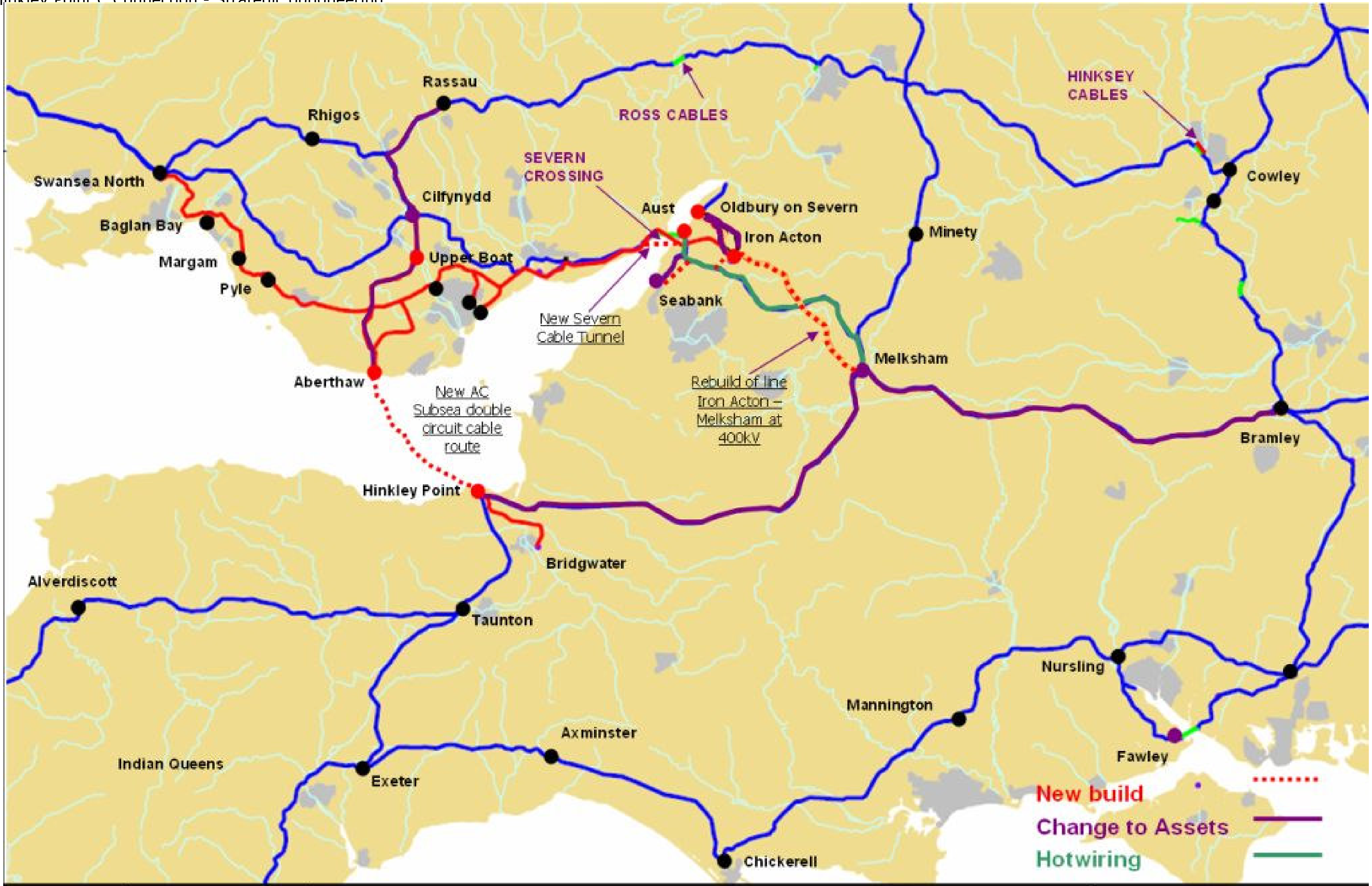


Purpose	Information	Hinkley Point C - Strategic Optioneering	nationalgrid The power of action.
Date	November 2009	Existing Transmission Network	



Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Option H5 (variants H7) HVDC Subsea cable Hinkley Point to Aberthaw (or elsewhere in South Wales)

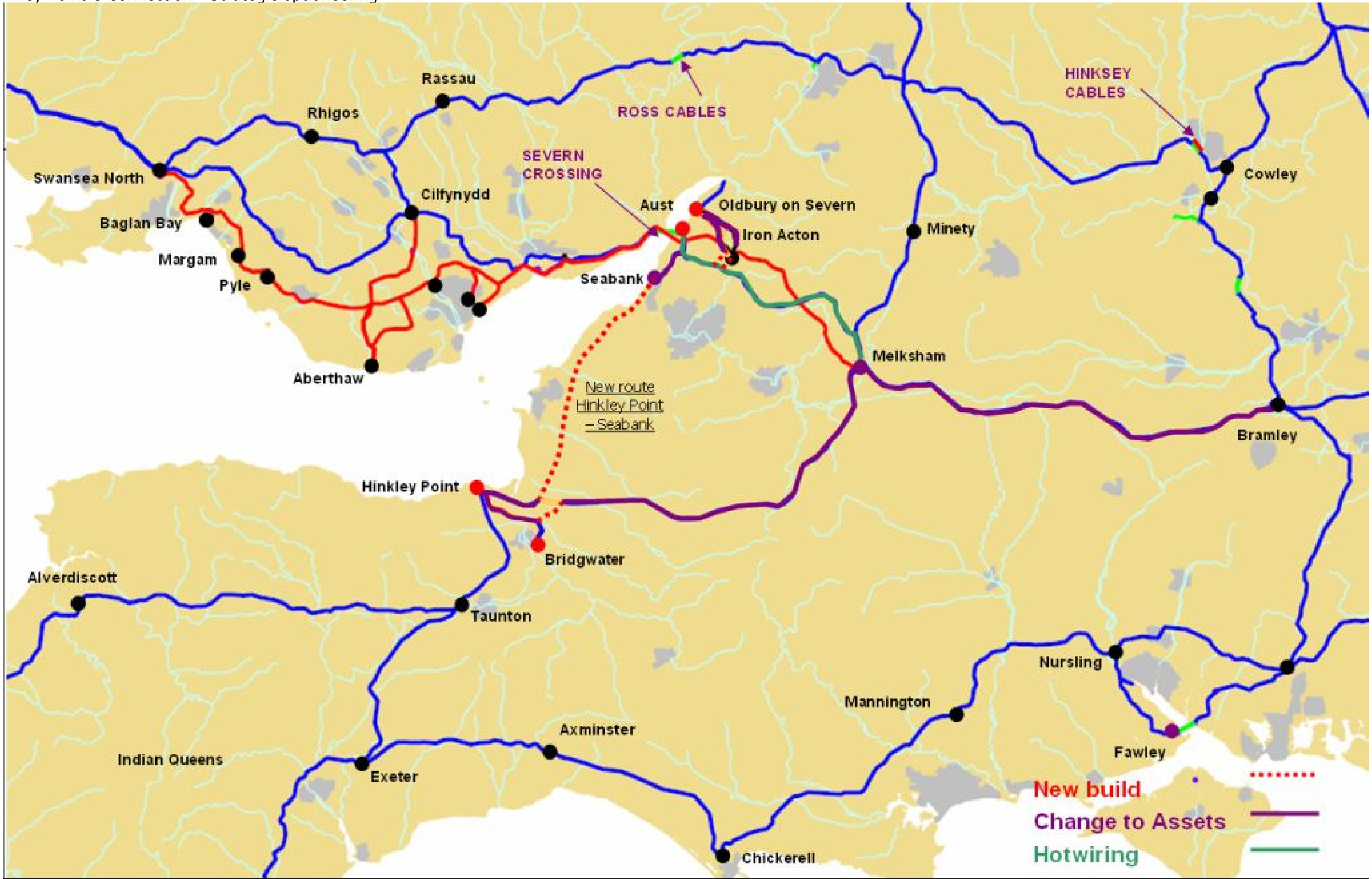
nationalgrid
The power of action.



Purpose	Information	Hinkley Point C - Strategic Optioneering	nationalgrid The power of action.
Date	November 2009	Option H5a (variants H7a) HVAC Subsea cable Hinkley Point to Aberthaw (or elsewhere in South Wales)	

Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Option H6 HVDC Subsea cable Hinkley Point to Seabank

nationalgrid
The power of action.

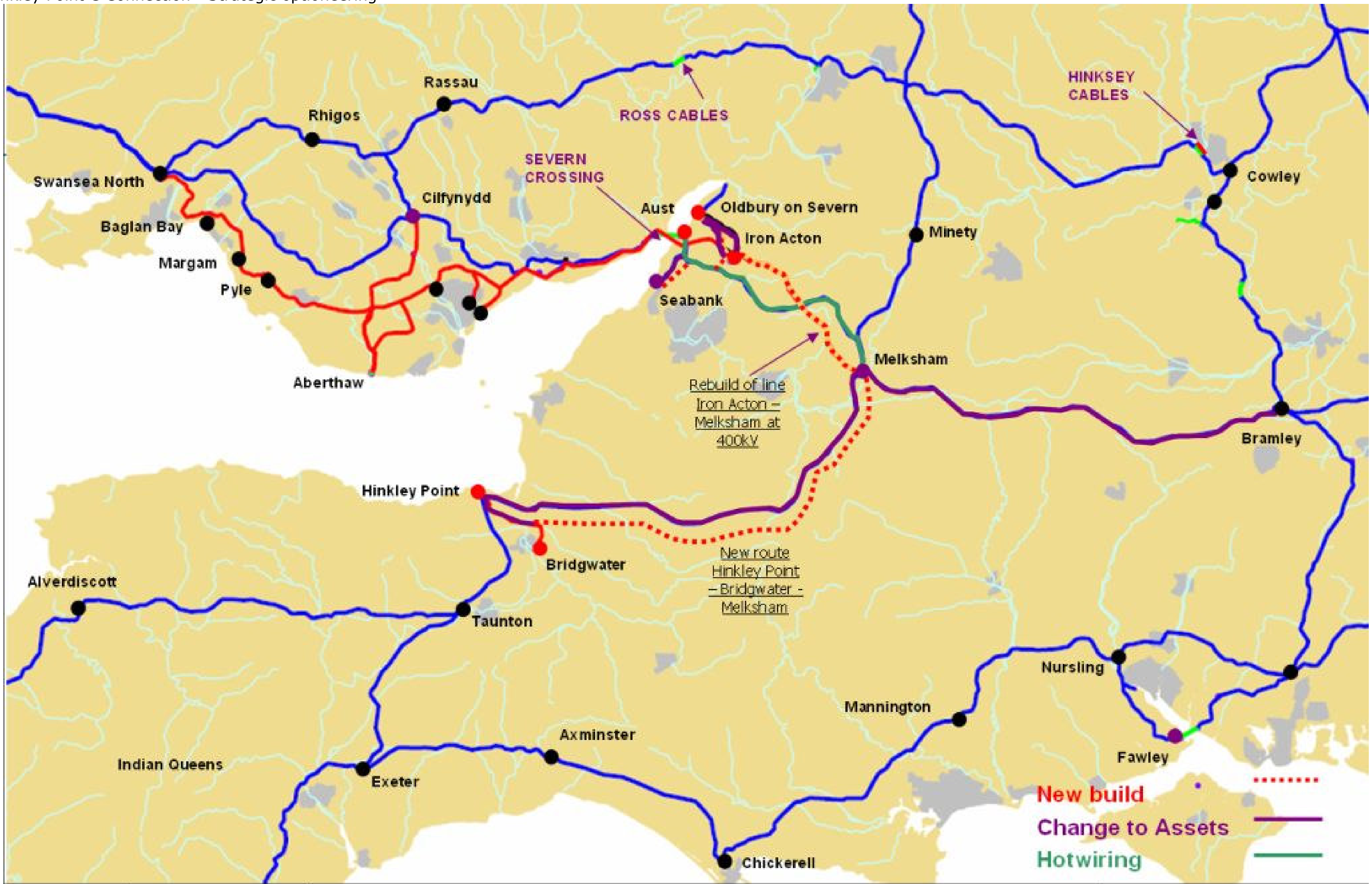


Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Option H10 Hinkley Point to Seabank overhead line

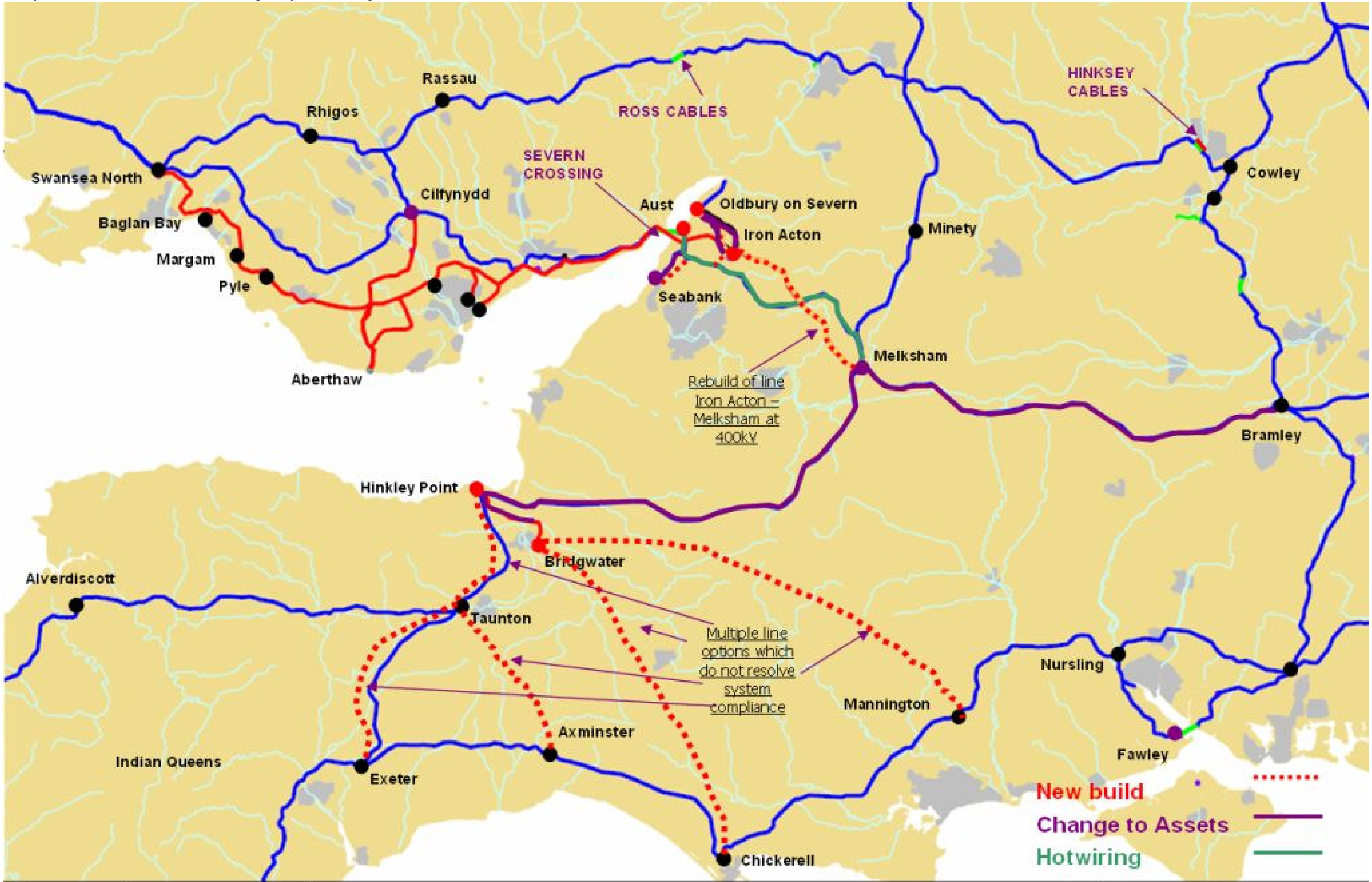
nationalgrid
The power of action.

Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Option H10a Hinkley Point to Seabank overhead line using DNO route

nationalgrid
The power of action.



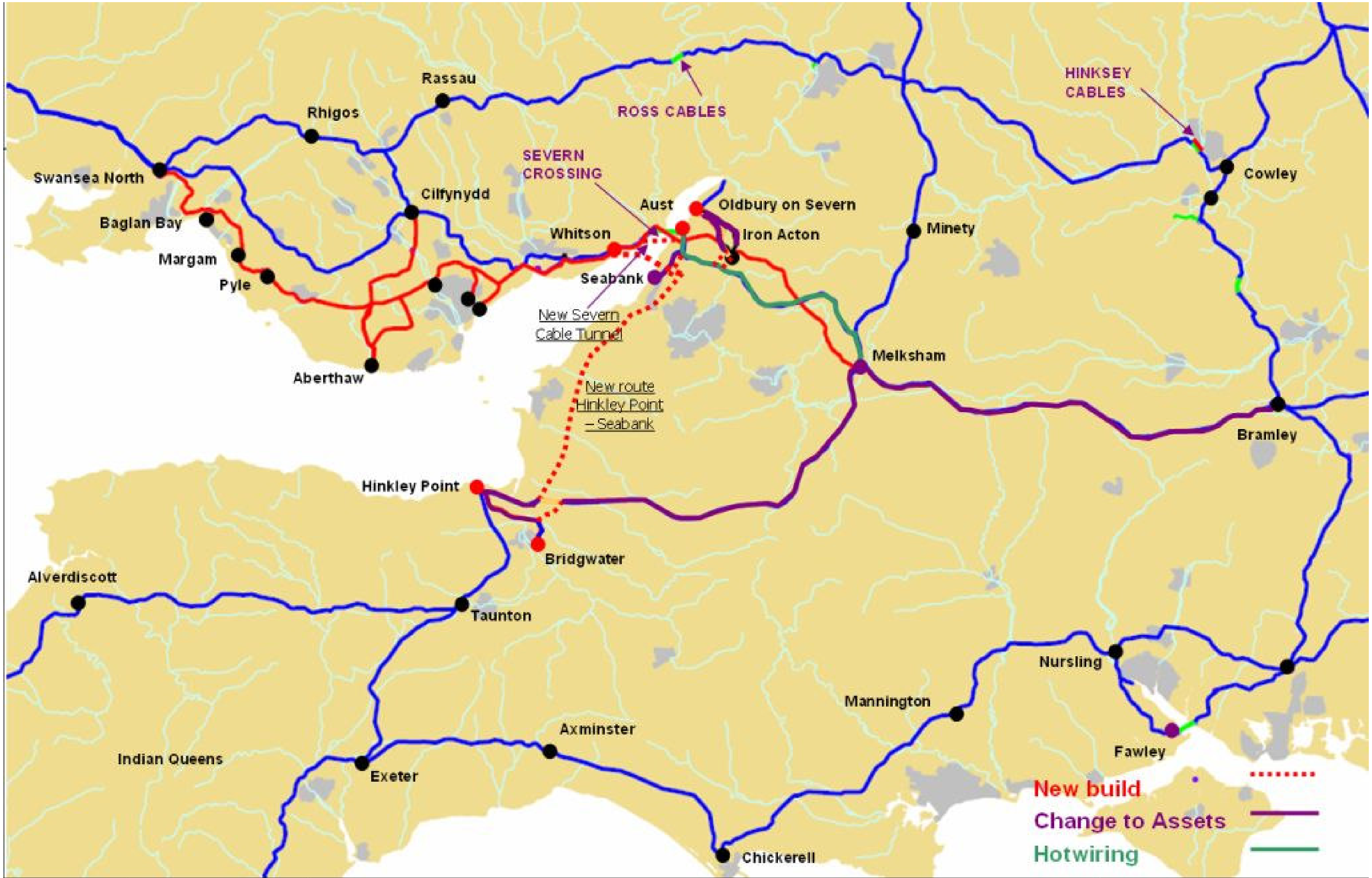
Purpose	Information	Hinkley Point C - Strategic Optioneering	nationalgrid The power of action:
Date	November 2009	Option H11 Hinkley Point to Melksham overhead line route	



Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Options H12, H13, H14 and H19 Hinkley Point to west of Nursling overhead line options (does not resolve Stability or Thermal issues anywhere west of Nursling)

nationalgrid
The power of action.

Purpose	Information	Hinkley Point C - Strategic Optioneering	nationalgrid The power of action.
Date	November 2009	Option H15 Hinkley Point to Nursling overhead line route	

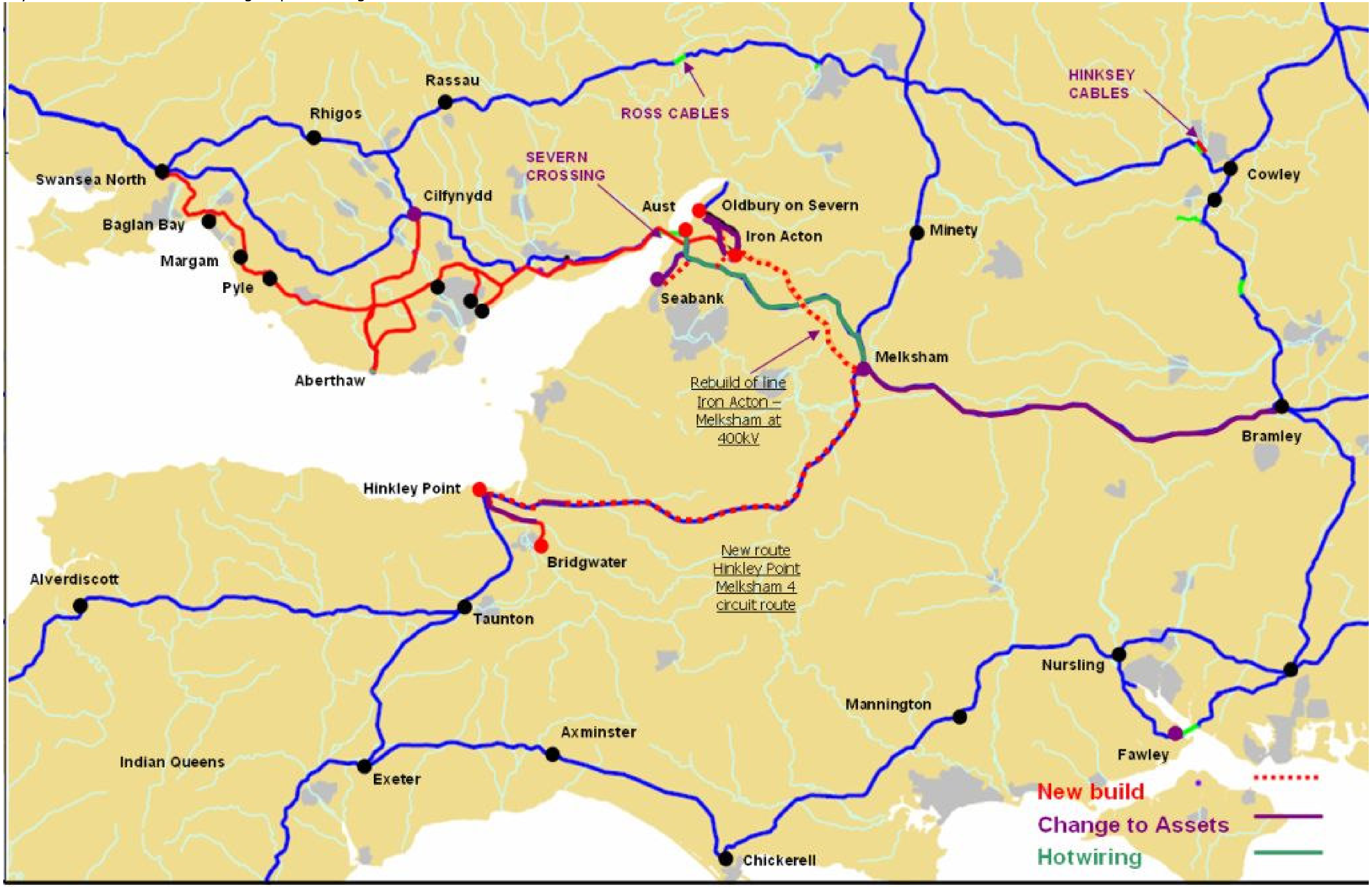


Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Option H16 Hinkley Point to Whitson overhead line

nationalgrid
The power of action.

Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Option H17 Ultra High Voltage Routes

nationalgrid
The power of action.



Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Option H18 Hinkley Point to Melksham 4 circuit overhead line route

nationalgrid
The power of action.

Purpose	Information	Hinkley Point C - Strategic Optioneering
Date	November 2009	Option H20 HVAC Subsea cable Hinkley Point to Seabank

nationalgrid
The power of action

Appendix D

Technical Appendices

Thermal Limits

1.1 Conductors are designed for a certain operating temperature and safe clearances between the conductors and the ground/structures are based on this assumption. Overloading causes conductors to overheat which will increase the sag of the conductors and reduce clearances. Operating at a temperature greater than their design temperature could also lead to a reduction in conductor strength.

1.2 The transfer capacity or operating rating of an overhead line is therefore determined by this thermal limit.

Quality of supply – Negative Phase Sequence (NPS)

1.3 Overhead lines, whether single or double circuit, have some degree of unbalance due to the lack of physical symmetry between the position of the phase conductors with respect both to each other and to any earth wire(s). These differences will, as a result of power transfer through the circuit, give rise to unbalance both in the conductor phase currents and the phase voltages. An individual double circuit is generally phased with the same phase colour (or designation) on the middle cross arms and a top to bottom change for the other phase colours e.g. RYB to BYR assuming that the power flow on both circuits is in the same direction. The result of this phasing configuration is that the imbalance is partially self-compensated. However any partial self-compensation on a double circuit is lost when one circuit is out of service, or the phasing intended to provide some unbalance compensation may introduce an adverse effect if the system configuration is such that the current flows are in the opposite direction.

1.4 The NPS component of voltage causes NPS currents to flow in the transmission system, and consequently in three phase generators and motors connected to the system. This in turn produces heating effects, which can damage the machine or cause its protection to operate. It may also effect the operation of three-phase equipment; in particular rectification and inverter equipment may produce more harmonic currents. It is therefore necessary to assess levels of NPS voltage on the transmission system in order that the transmission system may be operated reliably within the technical limits specified in the Grid Code.

Transient stability

1.5 All large generators connected to the National Grid transmission system are synchronous machines. Synchronous generators throughout the GB transmission system operate at the exact same electrical frequency of 50 hertz (or 3000rpm) and are furthermore electrically coupled together by the system so that they remain in step with each other. It is, therefore, important that synchronism is maintained. In the event of instantaneous faults occurring on the transmission system (a transient situation), circumstances can arise in which generators close to the fault begin to accelerate relative to others further away. If the fault is not removed sufficiently quickly or post event they remain weakly connected to the transmission system, then the generator or generators affected may accelerate so much that they become out of step with the remainder of the system (loss of synchronism / pole slipping). Generators themselves can be severely damaged possibly leading to failure of major components. Pole slipping can also have a very severe impact on local consumers and in particular nuclear power station auxiliary loads. The precise behaviour of generators prior to, during and following a fault is unique to; their individual locations on the transmission system; the control systems used to manage that generator; and its physical design. They therefore have to be considered in particular detail when planning any new connection to the transmission system.

Appendix 2B – Hinkley Point C Connection Strategic Optioneering Report Additional Information (2010)

Hinkley Point C Connection

Strategic Optioneering Report

Additional Information June 2010

National Grid Electricity Transmission plc
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

CONTENTS **PAGE No.**

Issue date: JUNE 2010

1 Introduction

1.1 Over the past few months National Grid has been consulting on potential route corridors associated with a proposed electricity transmission line between its existing substations at Bridgwater and Seabank (Avonmouth).

1.2 Many statutory consultees, local communities and interest groups have requested additional information that will explain why National Grid has ruled out alternatives to the proposed overhead line, particularly on the use of subsea High Voltage Direct Current (HVDC) cables.

1.3 This paper, produced by National Grid Electricity Transmission plc (referred to in this report as "National Grid"), has been prepared to provide additional information to interested parties on:

- National Grid's policy with regard to underground cables;
- the range of subsea options that National Grid considered during its technical assessment, including a cost breakdown of each option;
- a discussion of transmission losses associated with HVDC technology, and
- a discussion of the transmission network's carbon footprint.

1.4 National Grid owns the high voltage electricity transmission system in England and Wales and is responsible for operating the transmission system across Great Britain. It has a statutory duty to develop and maintain an efficient, coordinated and economical system of electricity transmission under Section 9 (2) of the Electricity Act 1989. This includes a duty to connect new generating stations to the transmission system. The form which these connections take depends on a number of factors including the location and capacity of the new generating stations.

1.5 Although National Grid can discuss with generators potential connection locations and options available, the final location decision is that of the Generator. When a Generator applies to connect at a specific point on the transmission system National Grid is obliged to make a connection offer.

1.6 As well as these duties, National Grid is bound by the requirements of a series of technical standards which govern the design and operation of the transmission system. These standards include the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS)[1] and the Grid Code. Connection offers are made in strict compliance with the technical standards.

1.7 It should be noted that the form, content and any modifications to the NETS SQSS must be approved by the energy regulator OFGEM.

1.8 National Grid is required to offer and honour terms for connection of new generation which do not conflict with these obligations[2]. Accordingly such offers are assessed on the basis of:

- the technical viability of the connection;
- the connection not unduly adversely impacting the timing of the connection dates and other commitments made to connectees, and
- the need to be efficient, coordinated and economic.

1.9 The last of these requirements is reflected in National Grid's regulatory obligations. It is designed to protect electricity consumers from the potential for National Grid to over-invest in its system and thus burden the electricity industry and society in general with unnecessary cost.

1.10 To ensure this is the case the energy regulator, OFGEM, at regular intervals scrutinises the investment plans of National Grid. OFGEM employs independent technical consultants to formally review a selection of detailed projects, and the overarching business processes and policies adopted by National Grid. Detailed reports are made to OFGEM and these are publicly available at:

http://www.ofgem.gov.uk/Networks/Trans/PriceControls/TPCR4/ConsultantsReports/Pages/ConsultantsReports.aspx

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[1] National Electricity Transmission System Security and Quality of Supply Standard Version 2.0 : 24/06/09

[2] Based upon the Ofgem consultation of 8th May 2009, National Grid may also apply to Ofgem, in restricted circumstances, to be derogated in its connection to new users, provided it can demonstrate a manageable solution not giving rise to excessive operating costs and not compromising other obligations including Nuclear Site Licences. Such "connect and manage" positions will only be deemed acceptable by the regulator if the works ultimately restore compliance with the NETSQSS.

1.11 Ofgem uses these assessments as part of the process it employs to set the level of revenue that National Grid is entitled to earn.

1.12 Within this regulatory framework, National Grid promotes infrastructure developments which are fit for purpose, provide value for money and continue to deliver the required standards of security and reliability.

1.13 The form of transmission investment is therefore a balance between the technical compliance, economic costs, amenity impact and deliverability. In this context National Grid is required to make judgements and assessments between the alternative options.

2 UNDERGROUND CABLES

2.1 Underground cables are amongst the suite of technical solutions National Grid can use when seeking to add capacity to the transmission system. However, a number of significant issues with the use of underground cables affect its deployment and therefore there is limited use on the high voltage transmission system (e.g. 675km out of a total transmission network of 7,900km).

2.2 These issues include operability issues, such as the management of charging currents, potential cable cooling systems, impact on system voltage and the need for supplementary reactive compensation equipment. As well as these operability issues there are significant construction issues which together account for 400kV underground cables costing significantly more, between 12 and 17 times as much, than the equivalent overhead line.

2.3 Given its duties as set out above, to develop the transmission system in an efficient, coordinated and economical manner, National Grid must therefore, in the first instance, considers adding transmission capacity and connecting new generation by overhead line connections, rather than by underground cables. As a result, the use of underground cables as a total connection solution is not considered at the Strategic Optioneering Stage.

2.4 However, undergrounding some sections of route may well be considered when detailed route alignments are being developed and following public consultation. These will include of nationally or internationally designated areas of amenity value, exceptionally constrained estuaries or major river crossings and exceptionally constrained urban areas.

2.5 National Grid's policy related to the use of underground cables, which reserves consideration of their use to areas of technical constraint and to areas of the highest recognised amenity value, can be found at:

http://www.nationalgrid.com/uk/LandandDevelopment/SC/Undergrounding/.

3 Subsea Cables

3.1 With regard to the Hinkley C Project and the options considered, National Grid has been requested on a number of occasions to provide further explanation of its decision to rule out the use of subsea cables.

3.2 As set out in the Hinkley Point C Strategic Optioneering Report published in December 2009, AC and DC subsea cables were considered (Options H5, 5a, H6, H7, H7a and H20). Intuitively these options look viable as they provide direct undersea routes and avoid the need for new overhead lines in the region. Indeed, that is why they were considered and evaluated by the design team.

3.3 Following detailed analysis it became clear that application of such technology in this part of the network could not be credibly promoted by National Grid given its obligations for efficient, coordinated and economical development of the transmission system. In this paper we seek to explain the analysis underpinning that conclusion and why the subsea options were discounted.

3.4 The following sections include cost estimates for each of the options presented. The base unit cost estimates are derived from National Grid's internal asset management system. National Grid's base unit costs are determined by using a number of sources of data and then aggregated dependent on the most recent application. The data sources include:

- Historic actual contracts from the last 5 years
- Recent and live contracts
- Informed estimates and quotations

3.5 As discussed above, the asset management system and individual project proposals are subject to regular scrutiny and review by the energy regulator OFGEM who employs independent technical consultants to robustly and formally review the detailed projects, the overarching business processes and policies adopted by National Grid. Detailed reports are made to OFGEM and these are publicly available at http://www.ofgem.gov.uk/Networks/Trans/PriceControls/TPCR4/ConsultantsReports/Pages/ConsultantsReports.aspx

3.6 Subsea Cables between Hinkley – Aberthaw

3.7 Option H5 and H5a were options connecting Hinkley Point with Aberthaw in South Wales via AC and DC subsea cables, over a distance of 30km.

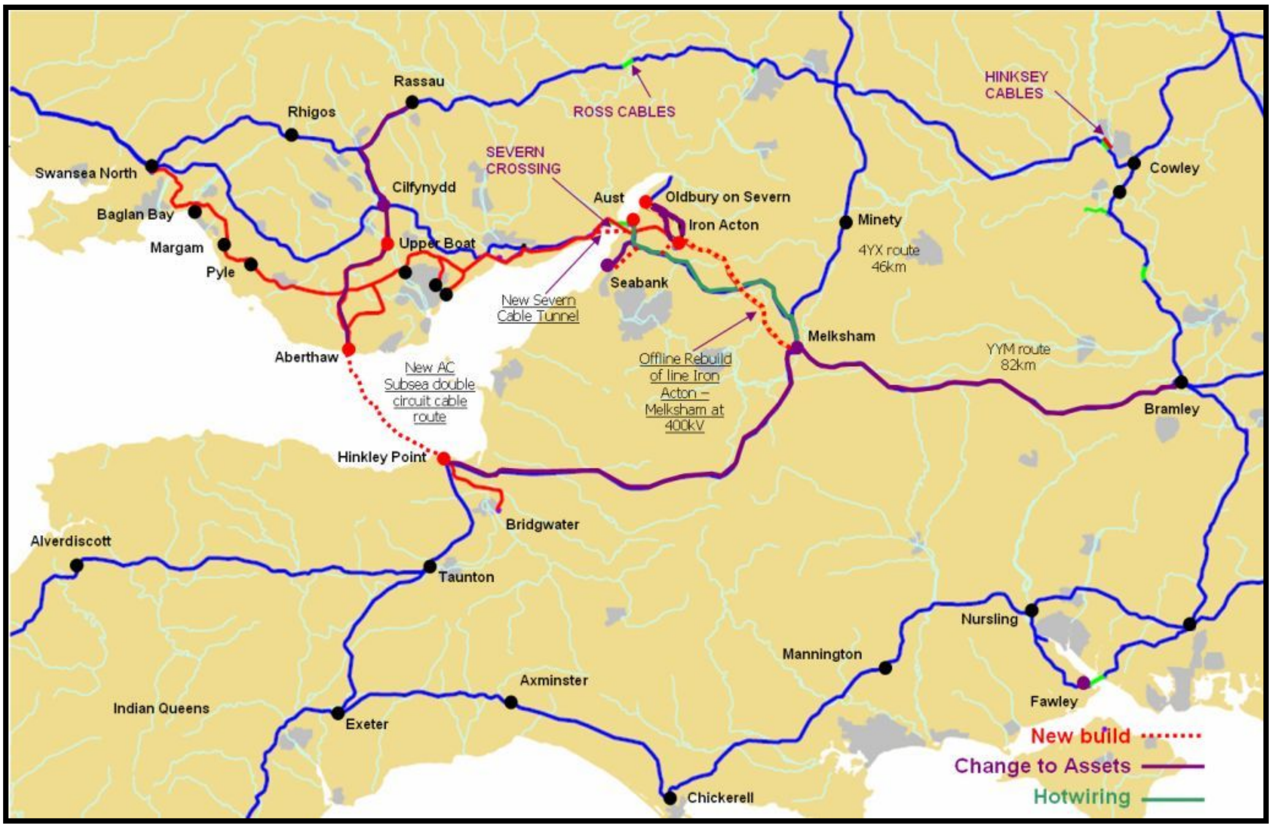


Figure 1: Option H5 / H5a – Hinkley Point – Aberthaw (AC or DC Subsea cables)

3.8 Option H5 considered the subsea connection via an HVDC link.

3.9 National Grid has to design the system so that power continues to flow even if parts of the system break down or are taken out of service for maintenance. We have to make sure power continues to flow safely and reliably, and that no damage is cause to equipment connected to the system.

3.10 This is done by conducting a comprehensive suite of power system studies and scenario analysis that ensures the design of the transmission system is technically compliant with engineering standards.

3.11 In this case our studies concluded that given the generation background as set out in Section 3 of the Strategic Optioneering Report, the required capacity of the subsea cables needs to be 4000MW in order to resolve both transient instability and circuit overloads. A further explanation of these issues is provided in the short film "Connecting Hinkley Point C – The Technical Challenges".

3.12 This 4000MW of capacity is the minimum required to ensure that the transmission system continues to operate within operational standards following transmission faults in the Oldbury part of the network (Oldbury-Melksham double circuit). In other words, following a fault on transmission circuits in the region, the subsea cables must be capable of carrying up to 4000MW of power, otherwise electricity supplies in the region will not meet reliability or quality standards. In comparison, the overhead line solution (H10/H10a), described later, provides 6000MW of capacity which is 2000MW more.

3.13 As well as the HVDC link, substantial works would be required in and around South Wales in order to facilitate the potential power flows. The scope of works is shown in the table below and was estimated to cost in the region of £2.19bn.

Item	**Description**	**Estimated Cost**
New Substation Build	Hinkley Point, Oldbury, Aust, Iron Acton, Aberthaw, Upper Boat	£490m
Substation Modifications	Seabank, Fawley, Cilfynydd, Melksham	£100m

New Overhead lines	Seabank – Aust, Connections to Oldbury, Iron Acton – Melksham 400kV	£105m
Modifications to Overhead Lines	Melksham – Bramley, Connections to Oldbury, Hinkley Point – Melksham	£255m
New Cable Cost	New Severn crossing 400kV cable tunnel, Hinskey Cables	£279m
HVDC Converters	8 x 1GW VSC Converters (4 at Hinkley Point and 4 at Aberthaw)	£800m
HVDC Cable Sealing Ends	8 units (4 at Hinkley Point and 4 at Aberthaw)	£1m
HVDC cables	4 x 1GW cables x 30km	£156m
Total Estimated Cost – Option H5		**£2.186bn**

Table 1: Option H5 - HVDC Cost Breakdown

3.14 Option H5a considered the subsea connection via AC cables. As well as AC cables, substantial works would be required in and around Aberthaw in order to facilitate the potential power flows in the region. The scope of works is shown in the table below and was estimated to cost in the region of £1.8bn.

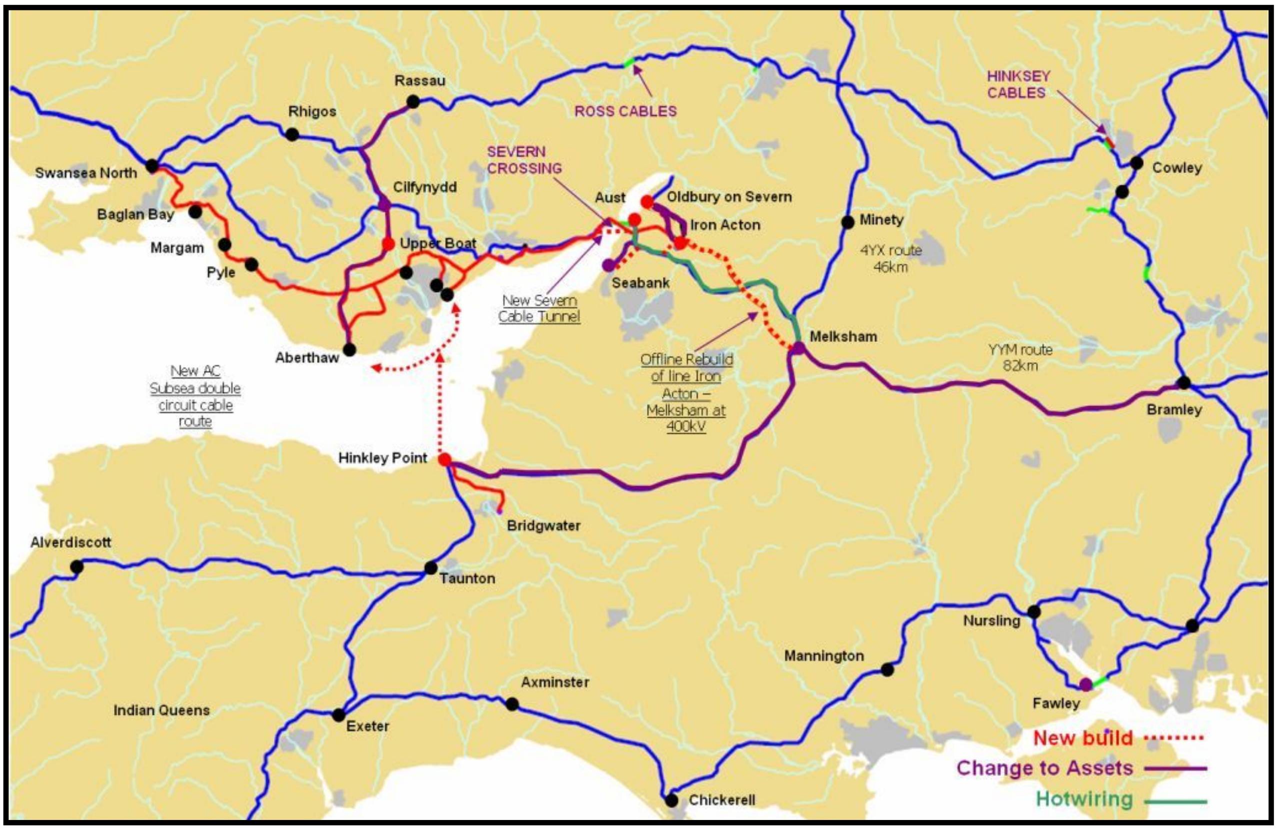
Item	Description	Estimated Cost
New Substation Build	Hinkley Point, Oldbury, Aust, Iron Acton, Aberthaw, Upper Boat	£490m
Substation Modifications	Seabank, Fawley, Cilfynydd, Melksham	£100m
New Overhead lines	Seabank – Aust, Connections to Oldbury, Iron Acton – Melksham	£105m

	400kV	
Modifications to Overhead Lines	Melksham – Bramley, Connections to Oldbury, Hinkley Point – Melksham	£255m
New Cable Cost	Hinkley Point – Aberthaw, New Severn crossing 400kV cable tunnel, Hinskey Cables.	£864m
Total Estimated Cost – Option H5a		**£1.814bn**

Table 2: Option H5a AC Cables Cost Breakdown

3.15 Subsea Cables from Hinkley Point to elsewhere in South Wales

3.16 Options H7 and H7a considered AC and HVDC subsea cables from Hinkley Point to an



alternative location in South Wales, not Aberthaw.

Figure 2: H7 / 7a – Hinkley Point to South Wales (not Aberthaw)

3.17 Although the connection would be longer than Aberthaw the scope of works required in the wider network to facilitate potential power flows would be very similar to those, but in excess, required for Option 5 and 5a with additional reinforcements required at the connection point in South Wales network. Due to the sizeable power flows any connection on the South Wales side shall require a connection at 400kV and the relevant reinforcements to reach the South Wales 400kV network.

3.18 A cost breakdown for Option H7 is provided in the table below:

Item	**Description**	**Estimated Cost**
New Substation Build	Hinkley Point, Oldbury, Aust, Iron Acton, Aberthaw, Upper Boat	£490m
Substation Modifications	Seabank, Fawley, Cilfynydd, Melksham	£100m
New Overhead lines	Seabank – Aust, Connections to Oldbury, Iron Acton – Melksham 400kV	£105m
Modifications to Overhead Lines	Melksham – Bramley, Connections to Oldbury, Hinkley Point – Melksham	£255m
New Cable Cost	New Severn crossing 400kV cable tunnel, Hinskey Cables	£279m
HVDC Converters	8 x 1GW VSC Converters (4 at Hinkley Point and 4 in South Wales)	£800m
HVDC Cable Sealing Ends	8 units (4 at Hinkley Point and 4 in South Wales)	£1m
HVDC cables	4 x 1GW cables x greater than 30km	Over £156m
Total Estimated Cost – Option H7		**Over**

	£2.186bn

Table 3: Option H7 HVDC Cables Option H7 Cost Breakdown

3.19 Option H7a considered the subsea connection via AC cables. As well as AC cables, substantial works would be required in and around the region in order to facilitate the potential power flows. The scope of works is shown in the table below and was estimated to cost in the region of £1.8bn.

Item	**Description**	**Estimated Cost**
New Substation Build	Hinkley Point, Oldbury, Aust, Iron Acton, Aberthaw, Upper Boat	£490m
Substation Modifications	Seabank, Fawley, Cilfynydd, Melksham	£100m
New Overhead lines	Seabank – Aust, Connections to Oldbury, Iron Acton – Melksham 400kV	£105m
Modifications to Overhead Lines	Melksham – Bramley, Connections to Oldbury, Hinkley Point – Melksham	£255m
New Cable Cost	Hinkley Point – South Wales, New Severn crossing 400kV cable tunnel, Hinskey Cables.	Over £864m
Total Estimated Cost – Option H7a		**Over £1.814bn**

Table 4: Option H7a AC Cables Cost Breakdown

3.20 Subsea Cables from Hinkley Point to Seabank

3.21 Option H6 and H20 were options connecting Hinkley Point with Aberthaw in South Wales via AC and DC subsea cables, over a distance of approximately 60km.

Figure 3: H6 – Hinkley Point to Seabank HVDC Subsea Link

3.22 Option H6 considered the subsea connection via an HVDC link. National Grid's analysis, based on the NETSQSS, concluded that given the generation background as set out in Section 3 of the Strategic Optioneering Report, the required capacity of the subsea cables would be 4000MW.

3.23 This 4000MW of capacity is the minimum required to ensure that the transmission system continues to operate within operational standards (thermal & stability) following transmission faults in the Oldbury part of the network (Oldbury-Melksham double circuit). In comparison, the overhead line solution (H10/H10a) described later provides 6000MW of capacity which is 2000MW more.

3.24 As well as the HVDC link, substantial works would be required in and around the region in order to facilitate the potential power flows. The scope of works is shown in the table below and was estimated to cost in the region of £1.6bn.

Item	**Description**	**Cost**
New Substation Build	Hinkley Point, Oldbury, Aust	£206m
Substation Modifications	Seabank, Fawley, Melksham	£67m
New Overhead lines	Connections to Oldbury	£6m
Modifications to Overhead Lines	Melksham – Bramley, Connections to Oldbury, Hinkley Point – Melksham, Seabank – Aust	£213m
New Cable Cost	Hinskey Cables	£22m
HVDC Converters	8 x 1GW VSC Converters (4 at Hinkley Point and 4 at Seabank)	£800m
HVDC Cable Sealing Ends	8 units (4 at Hinkley Point and 4 at Seabank)	£1m
HVDC cables	4 x 1GW cables x 63km	£327m
Total Estimated Cost – Option H6		**£1.642bn**

Table 5: Option H6 HVDC Cables Cost Breakdown

3.25 Option H20 considered the subsea connection via AC cables. As well as AC cables, substantial works would be required in and around the region in order to facilitate the potential power flows. The scope of works is shown in the table below and was estimated to cost in the region of £1.9bn.

Item	**Description**	**Cost**
New Substation Build	Hinkley Point, Oldbury, Aust, Including	£304m

	Reactive Compensation requirements	
Substation Modifications	Seabank, Fawley, Melksham, Including Reactive Costs	£153m
New Overhead lines	Connections to Oldbury	£6m
Modifications to Overhead Lines	Melksham – Bramley, Connections to Oldbury, Hinkley Point – Melksham, Seabank – Aust	£213m
New Cable Cost	Hinskey Cables, Hinkley Point – Seabank Cables	£1.25bn
Total		**£1.926bn**

Table 6: Option H20 AC Cables Cost Breakdown

3.26 The costs of each of the subsea cables options are summarised in the table below:

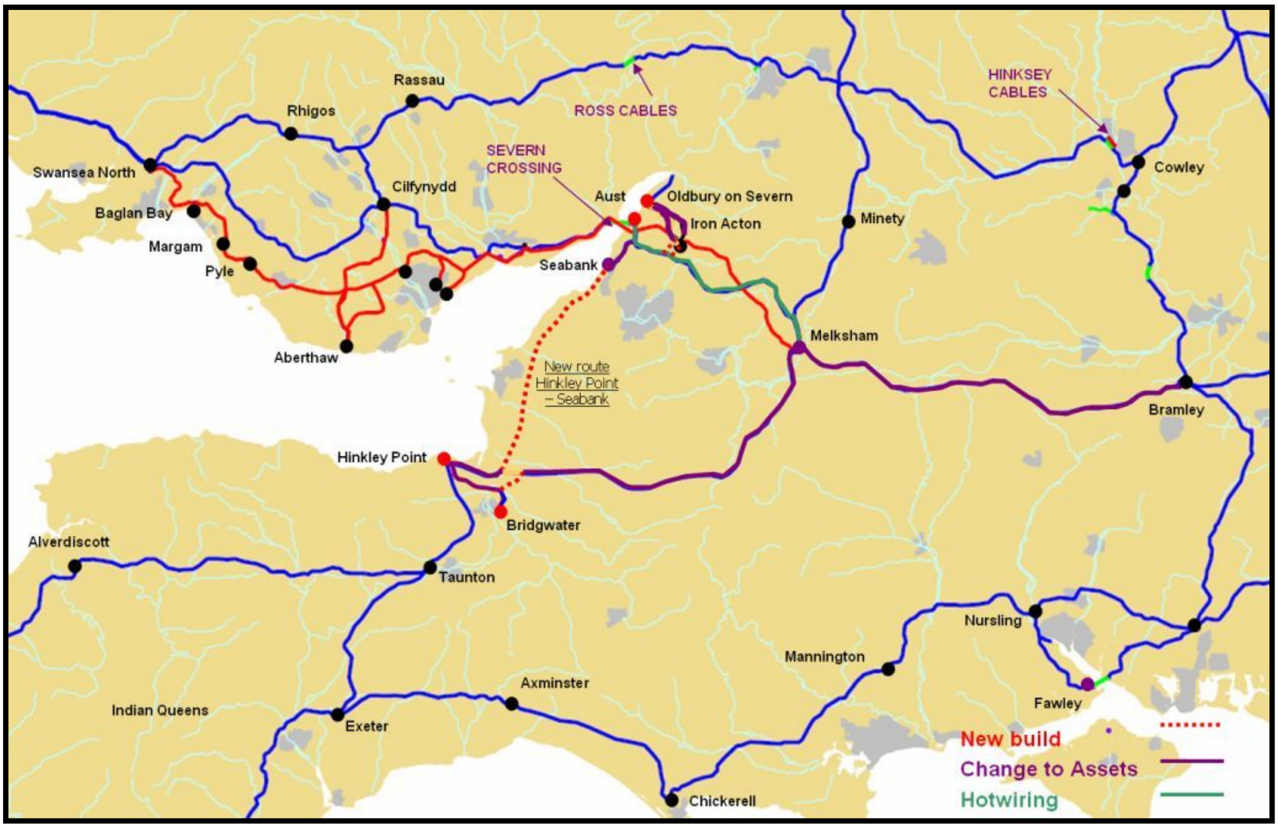
Option	Description	Cost Estimate
H5	HVDC Subsea Cables from Hinkley Point to Aberthaw	£2.186bn
H5a	AC Subsea Cables from Hinkley Point to Aberthaw	£1.814bn
H6	HVDC Subsea Cables from Hinkley Point to Seabank	£1.642bn
H7	HVDC Subsea Cables from Hinkley Point to South Wales	Over £2.186bn
H7a	AC Subsea Cables from Hinkley Point to South Wales	Over £1.814bn
H20	AC Subsea Cables from Hinkley Point to Seabank	£1.926bn

Table 7: Cost Summary of the Subsea Options

3.27 The next section considers the proposed overhead line options.

3.28 New Overhead Line routes between Hinkley Point and Seabank

3.29 Options H10 and H10a propose new overhead line routes between Hinkley Point and Seabank. Option H10 is a proposal for a new route while Option H10a considers taking over the existing overhead line route owned by WPD and operated at 132kV. Option H10a would replace the existing 132kV overhead line with a new 400kV line and also involve the construction of a new substation at Churchill. The overhead line solutions



provide 6000MW of capacity which will potentially facilitate up to a further 2000MW of generation in the region.

Figure 4: Option H10: Hinkley Point to Seabank New Overhead Line

3.30 H10 – Hinkley Point to Seabank New Overhead Line

Item	Description	Cost

New Substation Build	Hinkley Point, Oldbury, Aust, Bridgwater	£218m
Substation Modifications	Seabank, Fawley, Melksham	£67m
New Overhead lines	Connections to Oldbury, Hinkley Point to Seabank	£135m
Modifications to Overhead Lines	Melksham – Bramley, Connections to Oldbury, Hinkley Point – Melksham, Seabank – Aust	£213m
New Cable Cost	Hinskey Cables	£22m
Total		**£655m**

Table 8:

Option H10: New Overhead Line Cost Breakdown

3.31 Figure 5: H10a – Hinkley-Seabank OHL utilising existing WPD 132kV overhead line route

Item	Description	Cost
New Substation Build	Hinkley Point, Oldbury, Aust, Bridgwater, Churchill	£251m
Substation Modifications	Seabank, Fawley, Melksham	£67m
New Overhead lines	Connections to Oldbury, Hinkley Point to Seabank	£144m
Modifications to Overhead Lines	Melksham – Bramley, Connections to Oldbury, Hinkley Point – Melksham, Seabank – Aust	£213m
New Cable Cost	Hinskey Cables	£22m
Total		**£697m**

Table 9: Option H10a New Overhead Line utilising existing WPD route cost breakdown

4 Summary

4.1 The following table summarises the costs of the subsea cables options and the two overhead line options.

Option	Description	Cost Estimate
H5	HVDC Subsea Cables from Hinkley Point to Aberthaw	£2.186bn
H5a	AC Subsea Cables from Hinkley Point to Aberthaw	£1.814bn
H6	HVDC Subsea Cables from Hinkley Point to Seabank	£1.642bn
H7	HVDC Subsea Cables from Hinkley Point to South	Over £2.186bn

	Wales	
H7a	AC Subsea Cables from Hinkley Point to South Wales	Over £1.814bn
H10	Hinkley Point to Seabank Overhead Line	£655m
H10a	Hinkley Point to Seabank Overhead Line utilising the existing WPD 132kV route	£697m
H20	AC Subsea Cables from Hinkley Point to Seabank	£1.926bn

Table 10: Cost Summary

4.2 The overhead line options H10 & H10a are substantially lower cost than the subsea options, with the proposed new overhead line element making up less than a ¼ of the of the overall project cost of these options.

4.3 All the options highlighted in this document require additional infrastructure to facilitate the generation connections, at Hinkley Point, Oldbury-on-Severn and Seabank. The majority of these works and associated costs are required whichever option is chosen, for new substations (especially at the point where new generators connect) and other overhead line works also required. These additional costs are highlighted in the option cost breakdowns in this document.

4.4 As well as these substantial differences in cost, overhead lines also provide up to 6000MW (versus 4000MW) of transmission capacity which means that they will be able to accommodate additional generation, beyond what we know about today, without the need for more development. In contrast an HVDC solution would require further incremental capacity, at extra cost, to facilitate extra generation in the region.

4.5 Further, the use of HVDC technology in this part of the transmission system would also be very challenging. HVDC systems are normally set up to behave a bit like “oil tankers”. They are set up for the bulk transfer of power in one direction, normally between two countries. In this case we need the HVDC system to carry 4000MW of power but at the same time be dynamic enough to change direction of the power flow very quickly, in less than 200ms. The fastest response time by an installed VSC HVDC system is currently in the region of 350ms. This would pose a significant technical risk to design and operational risk to the reliability and quality of power supplies in the region.

4.6 National Grid must promote the most economic technically compliant solutions. Hence the route corridor study and consultation have been progressed on the basis of the overhead line routes described in options H10 and H10a.

4.7 The capital costs, which are the most significant cost element, associated with both HVDC and AC subsea solutions of this capacity were all in excess of £1.6bn which was over twice the total project cost of the overhead line options H10 and H10a.

4.8 National Grid has also been requested to provide information on the cost of transmission losses and the carbon footprint associated with overhead lines and HVDC solutions.

5 Transmission Losses

5.1 Transmission losses occur in all electrical equipment and are related to the operation and design of the equipment.

5.2 Overhead lines are generally constructed from aluminium conductor bundles. The estimated level of transmission loss is dependent on the load carried by the line. The assumed average load for an overhead line is 50%. Transmission losses typically range from 0.7-1% per 100km per circuit based on the circuit rating.

5.3 In the case of the Hinkley Point to Seabank overhead lines, 60km, the average transmission losses are estimated to be 0.5-1.0%[3].

5.4 Transmission losses in HVDC systems stem from each of the components within the system. Losses from DC cables are much lower than those of an overhead line, however, losses in the converters (of which there are two per 1000MW, one at each end of the link) are significant.

5.5 The HVDC technology required in the case of Hinkley Point is the VSC type. The transmission losses in a VSC converter range from 1-2% per converter. Meaning they

[3] Note that the Bridgwater to Seabank overhead lines comprise of two circuits.

range from 2-4% per link, taking account there is a converter at each end of the link. These are substantially more than that of an equivalent overhead line.

5.6 Transmission loss considerations therefore make the case for HVDC technology less economic.

6 Carbon Footprint

6.1 National Grid is committed to managing its emissions of greenhouse gases. As such it is working with other stakeholders to develop industry wide policies and agree the use of suitable tools to capture the costs of carbon within in its asset investment methodologies and processes.

6.2 To date, independent studies[4] have estimated the lifecycle carbon emissions from the transmission network based on current research and available information on raw materials & manufacturing, construction, operation & maintenance and decommissioning & disposal phases.

6.3 The carbon footprint of the major elements of the transmission system is dominated by the transmission losses whilst in service. Generic estimates indicate that this could account for >95% of emissions on a life cycle basis. As mentioned above, the HVDC systems have higher losses than the overhead lines and therefore they would not be justified on the basis of carbon assessment alone, regardless of any differences in the carbon footprint associated with the manufacture and construction phases.

7 Conclusion

7.1 National Grid has a statutory duty to develop the transmission system in an efficient, coordinated and economical manner. In this paper we have analysed the subsea and overhead line options, and provided a cost breakdown of each option. In addition we have described the technical issues associated with each option.

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[4] Lifecycle Assessment of the Transmission Network in Great Britain, Gareth P.Harrison, Edward (Ned).J.McLean, Serafeim Karamanlis, Luis F. Ochoa.

7.2 With regard to HVDC technology we have discussed both transmission losses and carbon emissions.

7.3 Given our statutory duties, which in effect seek to ensure that National Grid makes the most economic technically compliant infrastructure investments, the comparison of costs associated with each option led to National Grid's decision to discount these options prior to the consultation on the potential route corridors.

8 ABBREVIATIONS

AC	Alternating current
bn	Billion
DC	Direct Current
DNO	Distribution Network Operator
GW	Gigawatt (1000 million Watts)
HV	High Voltage
Hz	Hertz
km	Kilometre
kV	Kilovolt (1000 Volts)
MW	Megawatt (1 Million Watts)
NETSQSS	National Electricity Transmission System Security and Quality of Supply Standard
Ofgem	Office of the Gas and Electricity Markets
OHL	Overhead line

Appendix 2C – Hinkley Point C Connection Project Strategic Optioneering Report (2011)

AUGUST 2011

Hinkley Point C Connection Project

Strategic Optioneering Report (August 2011)

1 Introduction

1.1 This review of the Strategic Optioneering Report (the "Report"), previously published in December 2009, is part of the pre-application procedures adopted by National Grid taking account of the consultation feedback received from stakeholders and the general public since National Grid began its consultation on the Hinkley - Seabank Route Corridor Study in Autumn 2009.

1.2 This Report outlines the analysis which has been conducted in support of the need to extend National Grid's electricity transmission system in the South West and, at the same time, continue to ensure that National Grid complies with its licence standards.

1.3 As part of its regular review of options National Grid has taken account of relevant environmental and socio-economic information and additional information regarding High Voltage Direct Current (HVDC), undergrounding and gas insulated line (GIL) technology, and the most recent cost data.

1.4 This Report provides:

(a) A description of National Grid's licence and legal obligations;

(b) A summary of the project need case;

(c) An analysis of the technical options;

(d) An overview of the options appraisal approach;

(e) An overall assessment of each option taking into account technical, economic and amenity issues, which is taken to mean environmental and socio-economic effects, and

(f) Summary and identification of our preferred option

1.5 National Grid will continue to regularly review its Strategic Optioneering Report in light of changes of circumstances that could materially affect the analysis. This includes, but is not limited to, technology developments, cost updates and changes to the connection dates of new generators in the region.

1.6 Comments on the content and analysis included in this Report are welcome and will be taken into account in the on-going development of the project.

2 National Grid Role & Obligations

2.1 Transmission of electricity in Great Britain requires permission by licence granted under Section 6(1)(b) of the Electricity Act 1989 (as amended) ("the Electricity Act").

2.2 National Grid has been granted a transmission licence and is therefore bound by the legal obligations primarily set out in the Electricity Act and transmission licence.

2.3 National Grid owns and operates the transmission system in England and Wales[1] and is also responsible for operation of parts of the transmission system that are owned by other transmission licensees (SP Transmission Limited and Scottish Hydro Electricity Transmission Limited).

2.4 National Grid has a statutory duty to develop and maintain an efficient, coordinated and economical system of electricity transmission under Section 9 of the Electricity Act. These duties, which are documented in Standard Licence Conditions[2], are summarised in the following paragraphs.

2.5 Standard Condition C8 (Requirement to offer terms) of the transmission licence sets out obligations on National Grid regarding provision of offers to provide connections to the transmission system. In summary, where a party applies for a connection National Grid shall offer to enter into an agreement(s)[3] to connect, or to modify an existing connection, to the transmission system and the offer shall make detailed provision regarding:

- the carrying out of works required to connect to the transmission system;
- the carrying out of works (if any) in connection with the extension or reinforcement of the transmission system; and

[1] National Grid also operates, but does not own, the transmission systems in Great Britain's offshore waters and in Scotland.

[2] http://epr.ofgem.gov.uk/document_fetch.php?documentid=15184

[3] Paragraph 6 of Licence Condition C8 sets out exceptions where National Grid is not obliged to make an offer e.g. where to do so would put it in breach of certain other contracts or regulations.

- the date by when any works required to permit access to the transmission system (including any works to reinforce or extend the transmission system) shall be completed.

2.6 Standard Condition C10 (Connection and Use of System Code) requires National Grid to prepare a connection and use of system code ("CUSC") which sets out, among other things, the terms of the arrangements for connection to and use of the transmission system.

2.7 Standard Condition C14 (Grid Code) requires National Grid to "prepare and at all times have in force and shall implement and comply with the Grid Code". This document (among other things), sets out the technical performance and data provision requirements that need to be met by users connected to or seeking to connect to the transmission system. The document also sets out the process by which demand data from Network Operators and other users of the transmission system should be presented on an annual basis to allow National Grid to plan and operate the transmission system.

2.8 Standard Condition C17 (Transmission system security standard and quality of service) requires National Grid to at all times plan, develop and operate the transmission system in accordance with the National Electricity Transmission System Security and Quality of Supply Standard (SQSS).

2.9 The SQSS is a document that defines criteria which specify the robustness of the transmission system, in terms of the faults (or breakdowns) and combinations of faults that it must be able to withstand without any interruption of supplies, and the maximum interruption to supplies which is permitted under certain more onerous combination of faults.

2.10 The SQSS is open to industry and public scrutiny, is subject to periodic review and consultation and any changes are implemented by a change to the licence Standard Conditions and approved by the industry regulator, Ofgem.

2.11 The SQSS requires that National Grid must plan for all demand and generation conditions (or "backgrounds") "*which ought reasonably to be foreseen to arise in the course of a year of operation …* [and] *shall include forecast demand cycles, typical power station operating regimes and typical planned outage patterns.*"

2.12 Application of the SQSS achieves minimum performance requirements for the transmission system. These minimum performance requirements underpin the performance of the transmission system in terms of reliability of service delivered and availability of the system for use by generators, demand customers and other users of the transmission system.

2.13 As well as the technical standards described above, Section 38 and Schedule 9 of the Electricity Act 1989[4] require National Grid, when formulating proposals for new lines and other works, to:

"*…have regard to the desirability of preserving natural beauty, of conserving flora, fauna, and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest; and shall do what [it] reasonably can to mitigate any effect which the proposals would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects*".

2.14 National Grid's Stakeholder, Community and Amenity Policy[5] sets out how the company will meet the duty to the environment placed upon it. These commitments include:

- only seeking to build new lines and substations where the existing transmission infrastructure cannot be upgraded technically or economically to meet transmission security standards;

- where new infrastructure is required seek to avoid areas nationally or internationally designated for their landscape, wildlife or cultural significance; and

- minimising the effects of new infrastructure on other sites valued for their amenity.

2.15 The statement also refers to the application of best practice methods to assess the environmental impacts of proposals and identify appropriate mitigation

[4] Electricity Act 1989 c29 (**http://www.legislation.gov.uk/ukpga/1989/29/contents**).

[5] http://www.nationalgrid.com/uk/LandandDevelopment/SC/Responsibilities/sched9/schedule+9.htm

and/or offsetting measures. Effective consultation with stakeholders and the public is also promoted by the statement.

2.16 In compliance with these legal duties and obligations, National Grid has conducted a technical, economic, environmental and socio-economic appraisal of a range of strategic options to resolve the transmission system needs in the South West, South Wales and Gloucestershire.

3 Summary of the Need Case

3.1 The planned connection of Hinkley Point C nuclear power station triggers the need for new transmission capacity in the South West.

3.2 Under Section 9 (2) of the Electricity Act National Grid has a duty to "develop and maintain an efficient, coordinated and economical system of electricity transmission". These duties mean that when considering how best to provide transmission capacity the organisation should do so in a coordinated manner by considering all potential developments that may interact with the current requirement.

3.3 In this case the connection of Hinkley Point C triggers, in 2018 (or 2017 if Hinkley Point B nuclear power station is granted a life extension), the need for additional transmission capacity. The Need Case[6] document identified that additional capacity will also be required to facilitate the connection of both Oldbury-upon-Severn nuclear power station in 2020 and Seabank Stage 3 combined cycle gas turbine (CCGT) in 2023.

3.4 The Need Case explained that two technical limits exist within the current system. These two limits, or "boundaries", restrict the amount of electricity that can be safely exported on the transmission system from both the South West and South Wales & Gloucestershire.

3.5 Figure 1 below shows the boundaries. The yellow line shows the South West boundary and the green line shows the South Wales & Gloucestershire boundary.

[6] Hinkley Point C Connection: Need Case for the South West and the South Wales and Gloucester Region August 2011.

Figure 1: Transmission Boundaries in the South West and South Wales & Gloucestershire

3.6 The Need Case also explained that the technical limits of the existing transmission infrastructure will be breached over the next few years as new power stations connect to the transmission system and that to maintain compliance with the SQSS, additional transmission capacity in the region is required. Specifically, by 2018 the South West region requires new transmission capacity in excess of 2700MW, while South Wales & Gloucestershire requires new capacity in excess of 3300MW by 2023.

3.7 As well as these "boundary" conditions the Need Case also explained that additional transmission circuits will be required at Seabank 400kV substation in Bristol. These new circuits are required in order to facilitate the new generation connecting at Seabank and at the same time to maintain compliance with the SQSS.

3.8 This Strategic Optioneering Report not only considers the options for providing the transmission capacity for connecting Hinkley Point C but also considers the interaction of those options with the transmission requirements of connecting both Oldbury-upon-Severn and Seabank Stage 3. The Strategic Optioneering

Report identifies the option which best meets the future requirements of the transmission system and not just the immediate need of connecting Hinkley Point C.

3.9 The following sections of this document assess a number of options, or Potential Connections, that could provide this additional transmission capacity.

4 Potential Connections Considered

4.1 Before proposing new transmission infrastructure, National Grid will seek to provide transmission capacity by upgrading the existing transmission system.

4.2 A number of upgrades and associated works, which are common across all of the options (Potential Connections), have been identified and these are:

Transmission System Upgrades	Total Estimated Capital Cost
Reconductoring Melksham-Bramley circuits	£289.8m
Reconductoring Hinkley Point –Melksham circuits	
Reconductoring Aust – Melksham circuits	
Melksham 400kV substation line entries	
New Quadrature Boosters at Nursling 400kV substation	
New Aust 400kV substation	
Upgrade the Cowley-Minety / Cowley-Walham Cables	

4.3 Although these works would increase the capacity of the existing system they would not adequately meet the requirements set out above and additional capacity across the South West and South Wales & Gloucestershire boundaries is still required.

4.4 The Hinkley Point C Connection: Strategic Optioneering Report (December 2009) considered 20 different options for the provision of the required transmission capacity. Of these 13 were discounted as being non-compliant with the requirements of the SQSS. These 13 have been reviewed and remain non-compliant and are therefore not discussed further.

4.5 Of the remaining 7 options, 2 covered connections from Hinkley Point to Aberthaw, in South Wales, and 2 covered connections from Hinkley Point to another undefined point in South Wales. There is insufficient information to differentiate between these two locations in South Wales and as such National Grid does not believe that connections to the undefined point in South Wales are options that should be considered further.

4.6 Each of the remaining connection options is reviewed in this document in light of the most recent cost and technical information available. The Potential Connections (PCs) taken forward for consideration are:

(a) PC1: Hinkley – Aberthaw (subsea)

(b) PC2: Bridgwater – Melksham

(c) PC3: Bridgwater – Nursling

(d) PC4: Bridgwater – Seabank (onshore)

(e) PC5: Hinkley Point – Seabank (subsea)

4.7 These Potential Connections resolve the issues associated with the South West boundary. However, the other boundary and system issues described in the Section 3 also need to be resolved.

South West Boundary

4.8 Adding transmission capacity to the South West boundary by a transmission connection between Bridgwater and Melksham, or between Bridgwater and Nursling, or Bridgwater and Seabank as illustrated in Figure 2 below.

Figure 2: Onshore Connection Options for the South West Transmission Boundary

4.9 Transmission capacity could also be added to the South West boundary by adding a transmission connection between Hinkley Point and Aberthaw, or between Hinkley Point and Seabank as illustrated in Figure 3 below.

Figure 3: Offshore Connection Options for the South West Transmission Boundary

South Wales & Gloucestershire Boundary

4.10 Additional transmission capacity is also required for the South Wales & Gloucestershire boundary. For the purposes of this Report it is assumed this is achieved by upgrading the 275kV transmission connection between Iron Acton and Melksham to 400kV, or by a new 400kV connection between Seabank and Bridgwater, or between Seabank and Hinkley Point, as illustrated in Figure 4.

Figure 4: Connection Options for the South Wales & Gloucestershire Transmission Boundary

4.11 Upgrading the connection between Iron Acton and Melksham to 400kV, would not be possible by solely increasing the capacity of the existing circuits as they are a "L3" pylon design which is not capable of 400kV operation. The connection would therefore have to be rebuilt, potentially in parallel to the existing route. Were this connection option to be taken forward it would be subject to its own detailed optioneering and consultation exercise.

4.12 The connection could be delivered by underground cable which would increase the capital cost of the solution, however for the purposes of this Report it is assumed that for Potential Connections that do not also resolve the South West and Gloucestershire boundary issues (PC1, PC2 & PC3) that an overhead line rebuild would be required.

Additional Transmission Capacity at Seabank

4.13 In order to facilitate the connection of Seabank Stage 3 power station additional transmission capacity is also required at Seabank 400kV substation. These circuits could be, for example, new circuits between Seabank and

Hinkley Point, Bridgwater or Melksham. However, another option would be to build a 6km section of double circuit overhead line from Seabank to Tockington so as to connect to the existing circuit that connects Aust and Melksham, see Figure 5.

Figure 5: Circuit between Seabank and Tockington

4.14 Were this connection option to be taken forward it would be subject to its own detailed optioneering and consultation exercise. However, for the purposes of this Report it is assumed that for Potential Connections which do not also resolve the issues at Seabank 400kV (PC1, PC2, PC3 and PC5b) that new circuits between Seabank and Tockington would be required.

Summary of Connection Options

4.15 This section describes the Potential Connections considered for resolving the transmission capacity issues in the South West. It also describes the solutions to be assumed for resolving the South Wales & Gloucestershire boundary and system issues arising at Seabank 400kV, when the Potential Connection does not also resolve these issues.

4.16 The following Potential Connections (PC) are assessed in this document as they provide the necessary transmission capacity whilst meeting the requirements of the SQSS:

(a) PC1: Hinkley – Aberthaw (including Iron Acton – Melksham & Seabank – Tockington)

The 30km Hinkley – Aberthaw subsea connection provides the required capacity across the South West boundary but would also require the

30km rebuild of the Iron Acton – Melksham connection to provide the required capacity across the South Wales & Gloucestershire boundary. This option also requires 6km of new double circuit overhead line between Seabank and Tockington to facilitate the connection of new generation at Seabank. In addition, as explained in Section 9, further works are required to upgrade the transmission system in South Wales.

(b) PC2: Bridgwater – Melksham (including Iron Acton – Melksham & Seabank – Tockington)

The 80km Bridgwater – Melksham connection provides the required capacity across the South West boundary but would also require the 30km rebuild of the Iron Acton – Melksham connection to provide the required capacity across the South Wales & Gloucestershire boundary. This option also requires two new 6km transmission circuits between Seabank and Tockington to facilitate the connection of new generation at Seabank.

(c) PC3: Bridgwater – Nursling (including Iron Acton – Melksham & Seabank – Tockington)

The 110km Bridgwater – Nursling connection provides the required capacity across the South West boundary but would also require the rebuild of the 30km Iron Acton – Melksham connection to provide the required capacity across the South Wales & Gloucestershire boundary. This option also requires two new 6km transmission circuits between Seabank and Tockington to facilitate the connection of new generation at Seabank.

(d) PC4: Bridgwater – Seabank (onshore)

The 57km Bridgwater – Seabank on-shore connection simultaneously provides the required capacity across both the South West and South Wales & Gloucestershire boundaries. It also provides the necessary circuits to facilitate the connection of new generation at Seabank.

(e) PC5: Hinkley Point – Seabank (subsea) (including Seabank – Tockington for HVDC)

The 50km Hinkley Point – Seabank subsea connection simultaneously provides the required capacity across both the South West and South Wales & Gloucestershire boundaries. However, for an HVDC solution this option also requires two new 6km of new double circuit overhead line between Seabank and Tockington to facilitate the connection of new generation at Seabank.

4.17 The Potential Connections for the transmission circuits have been identified and are shown in Figure 6.

Figure 6: A diagram showing each of the connection options

4.18 Section 5 describes the transmission technologies by which the required transmission connection can be made.

5 Overview of Technology Options

5.1 This section provides an overview of the technology options used in the evaluation of Potential Connection options described later in this Report. This section provides a high level description of each technology, its relevant features, capabilities and costs.

5.2 The electricity transmission system in Great Britain operates at both 275kV and 400kV. 275kV was the original transmission voltage whereas the majority of National Grid's transmission system is now constructed and operates at 400kV which facilitates higher power transfers and lower transmission losses.

5.3 There are a number of different technologies by which the required transmission connections can be made. These technologies have different features which affect when and where they are used. The main technology options for electricity transmission include:-

- Overhead transmission lines;
- Underground cable circuits;
- Gas insulated lines (GIL), and
- High Voltage Direct Current (HVDC) technology.

5.4 In this section each of these technologies is discussed in high level generic terms. Further information, including more detailed technical information is available in a series of factsheets that can be found at:

www.nationalgrid.com/uk/electricity/majorprojects/HinkleyConnection/Documents/

5.5 Alternating Current (AC) Overhead transmission line solutions

5.5.1 Construction Overview

5.5.2 Overhead lines form the majority of the existing transmission system in Great Britain (GB) and in transmission systems across the world and there is established understanding of their construction and use.

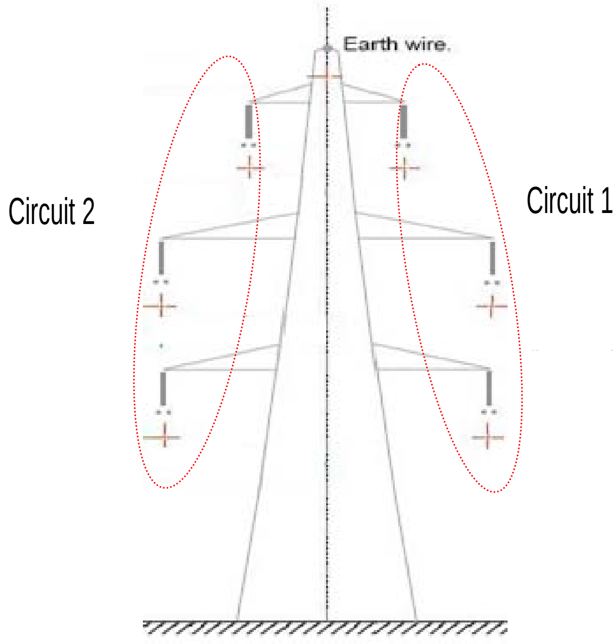

Figure 7: Example of a 400kV Double Circuit Tower

5.5.3 Figure 7 shows the typical configuration of a 275kV or 400kV transmission towers (normally referred to as pylons) each carrying two electrical circuits in three sets of conductors (wires). A standard pylon therefore has six arms, three either side, each carrying a set (bundle) of conductors. The number of conductors required in each set on an arm, depends on the amount of power to be transmitted and is normally between 2, 3 and 4 sets. Newer installations tend to only have 2 or 3 sets of conductors as technology developments mean these now carry sufficient capacity.

5.5.4 The height of 400kV and 275kV pylons is driven by safety considerations associated with providing the clearance needed to prevent the electricity arcing between the lines or to the ground, buildings or structures (known as 'flashover'). The minimum clearance of conductors to ground is set by the lowest point of the conductor which is normally at the mid point between the pylons. The "sag" of the conductor must allow sufficient clearance[7] for vehicles and obstacles as shown in Figure 8.

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[7] More information can be found in the brochure "Development near overhead lines" at http://www.nationalgrid.com/uk/LandandDevelopment/DDC/devnearohl_final/.

5.5.5 Lower voltage circuits need less clearance and are therefore smaller in size, but are limited in their power transfer capability.

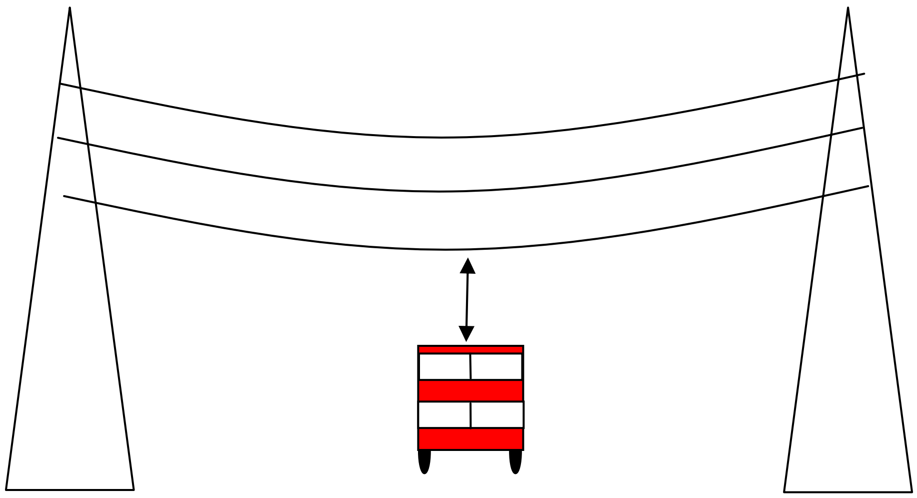


Figure 8: Safe height between sag of conductor and vehicle or other obstacle

5.5.6 On the transmission system, pylons are usually 300-400m apart which ensures the lowest point of the conductor does not infringe clearance distances as described above.

5.5.7 **Technical Overview of Overhead Lines**

5.5.8 Overhead lines are the most common technology used by National Grid and other transmission companies around the world and there is vast operational experience of there their use. Transmission companies have established operational processes and requirements for overhead lines forming part of their transmission system.

5.5.9 At times, circuits must be taken out of service for repair and maintenance. However, rapid restoration times are achievable on overhead line circuits where they are needed to maintain a secure supply of electricity.

5.5.10 In addition, emergency pylons can be erected in relatively short timescales to bypass damage and restore supplies. Overhead line maintenance and repair therefore provides a good degree of operational flexibility which helps reduce security of supply risks to end consumers.

5.5.11 Overhead lines circuits are made up of three main component types which are conductors (used to transport power), pylons (used to support the conductors) and insulators (used to safely connect the conductors to pylons). Each of these component types has a different design life which are:

- Between 40 and 50 years for overhead line conductors;
- 80 years for pylons, and
- Between 20 and 40 years for insulators.

5.5.12 Based on the design life of component parts, National Grid assumes an initial design life of around 40 years for overhead line circuits. After the initial 40 year life of an overhead line circuit, substantial pylon replacement works would not normally be required and this is reflected in the indicative capital costs. As pylons have an 80 year life and can be re-used to carry new replacement conductors. The replacement costs for overhead line circuits at the end of their initial design life are assessed by National Grid as being around 50% of the initial capital cost, through the re-use of pylons.

5.5.13 Asset replacement is generally expected at the end of design life and indicative costs for overhead line circuits are assessed on this basis. However, National Grid’s asset replacement decisions (that are made at the end of design life) will also take account of actual asset condition and may lead to actual life being longer than the design life.

5.5.14 Table 1 below shows the capital installation costs for overhead lines in financial year 2011/12 prices.

No of Conductors Sets (bundles) on each arm of a pylon	275kV Conductors Rating per circuit	400kV Conductors Rating per circuit	Capital Cost For a two circuit pylon route (equivalent cost per circuit)
2 conductor sets per arm	1500MVA (3150 Amp limit of National Grid 275kV systems)	3000MVA (circa 4300 Amps)	£1.6m/km (£0.8m/km)
3 conductor sets per arm	N/A	3450MVA (5000 Amp limit of National Grid 400kV systems)	£1.8m/km (£0.9m/km)

Table 1: Overhead Line Rating and Costs[8]

5.6 Alternating Current (AC) Underground Cable solutions

5.6.1 Construction Overview

5.6.2 Underground cables at 275kV and 400kV make up approximately 10% of the GB transmission system which is typical of transmission systems world wide. Most of the underground cable installed in the GB transmission system is in urban built up areas where achieving an overhead route is not practical. Examples of other situations where underground cables have been used in the past, in preference to overhead lines, include crossing rivers, passing close to or through parts of nationally designated landscape areas and protecting important views.

5.6.3 Cables consist of the electrical conductor in the middle, which is usually copper or aluminium, surrounded by insulating material and sheaths of protecting metal and plastic. The insulating material acts to prevent flashover, in this case electricity jumping to the ground in which the cable is buried. The properties of the insulating material ensure that although the conductor is operating at 400kV, the outside of the cable is at zero volts and therefore safe.

[8] Costs included in the table are for overhead lines in rural installations with no obstacles.

5.6.4 In order to connect underground cables to above ground equipment such as substations and/or overhead lines, cables require a termination compound or 'cable sealing end', where the cable emerges from the ground and is connected to the substation or line.

Figure 9: Key Components of underground cables

5.6.5 Technical Overview of Underground Cables

5.6.6 Due to the nature of the insulating material, cables introduce a significant capacitive effect (causing an increase in voltage) to the operation of the transmission system. This capacitive effect increases as the operating voltage increases and as the length of cable increases. As a result, the effects seen on the transmission system include:

- High charging currents;
- Resonance within cable circuits;
- High Voltages (Over-Voltages).

5.6.7 These issues can be managed, but often require additional equipment and specific operational arrangements to do so. Additional equipment requirements include the installation of shunt reactors to counteract the capacitive effect of the cable on voltage. This may at times also require mid circuit switching stations for management of charging currents and the strategic placement of shunt reactors but is subject to detailed cable design.

5.6.8 Identifying faults in underground cable circuits will often require multiple excavations to locate the fault and some repairs will require extraction and installation of new cables which can take a number of weeks to complete.

5.6.9 For regular maintenance and inspection high voltage underground cables must be taken out of service and, depending on whether cable excavation has been required, emergency restoration for security of supply reasons, typically takes a lot longer than for overhead lines (days rather than hours).

5.6.10 Underground cable circuits require significant civil works associated with installation. These make the construction times for cable circuits longer than for overhead lines. The construction swathe required for two AC circuits comprised of 2-3 cables per phase is between 35-50m.

5.6.11 The costs of underground cables are dependent on the voltage and rating of cables (i.e. how much power they are required to carry) and the topography of the land and specifically whether the cables are to be buried or placed in a tunnel. In general, cable installation is more difficult and therefore expensive in steep and varied terrain than along level areas of easily worked land.

5.6.12 The number of cables which are needed in parallel for each phase depends on the power transfer requirement of the circuit. Table 2 below shows the cable requirements for different power transfer requirements. For example, for a 400kV underground circuit carrying up to 1500MVA then 1 cable per phase is required. On each transmission circuit on the network there are 3 different phases (just like one side of an overhead line pylon) resulting in 3 cables in total for a 1500MVA circuit. However, for power transfers between 1500MVA and 3000MVA, 2 cables per phase are required, 6 in total.

No of Cables	275kV Cable 2500mm^2 (maximum cable capacity per circuit)	400kV Cable 2500mm^2 (maximum cable capacity per circuit)	Capital Cost For a two circuit cable route (equivalent cost per circuit)
1 Cable per Phase (i.e. 3 cables per circuit)	1000MVA (circa 2000 Amp)	1500MVA (circa 2000 Amp)	£8.8m/km (£4.4m/km)
2 Cables per Phase (i.e. 6 cables per circuit)	1500MVA (3150 Amp limit of National Grid 275kV systems)	3000MVA (circa 4300 Amp)	£18m/km (£9m/km)
3 Cables per Phase (i.e. 9 cables per circuit)	N/A	3450MVA (5000 Amp limit of National Grid 400kV systems)	£22m/km (£11m/km)

Table 2: Cable Ratings and Costs[9]

5.6.13 Underground cables have a life of up to 40 years. Components such as the joints and cable sealing ends also perform well and are normally replaced after 40 years.

5.6.14 The costs of underground cables therefore vary significantly depending on the specific capacity required. Therefore for the purposes of this Report, cost estimates are based on the specified rating required for this transmission circuit and assumed topology.

5.6.15 Underground cable circuits are made up of two main component types which are underground cable and connectors (cable joints which connect a cable to another cable, am overhead line or equipment in a substation). Each of these component types has a design life of between 40 and 50 years.

[9] Costs included in the table are for cable elements only direct buried rural installations, with no obstacles. The costs exclude shunt reactors and any intermediate switching stations which are distance dependant. Cable tunnel installations would have a higher capital installation cost than direct buried rural installations, although the cost of cables replacement would be less than the cost of the initial installation because the tunnel would remain in situ.

5.6.16 Asset replacement is generally expected at the end of design life and indicative costs for underground cable circuits are assessed on this basis. However, National Grid's asset replacement decisions (that are made at the end of design life) will also take account of actual asset condition and may lead to actual life being longer than the design life.

5.6.17 Table 2 above shows the capital installation costs for underground AC cables in financial year 2011/12 prices. It should be noted that at the end of their initial design life, replacement costs for underground cables are estimated to be equal or potentially slightly greater than the initial capital cost. This is because of works being required to excavate and remove old cables prior to installing new cables in their place in some instances.

5.7 Gas Insulated Lines (GIL)

5.7.1 Gas-insulated transmission lines (GIL) are a developing alternative to conventional underground cables for high voltage transmission. GIL has been derived from the well-established technology of gas-insulated switchgear (GIS), which has been applied on the GB transmission system since the 1970s.

5.7.2 GIL uses a mixture of Nitrogen and SF_6 gas to provide the electrical insulation, whereas in underground cables the special polymer material provides insulation. Air is the insulator for overhead lines. The GIL is constructed from welded or flanged tube structures with a copper or aluminium conductor running through the centre. Three tubes are required per circuit, one tube for each phase. Six tubes are therefore required for two circuits, as illustrated in Figure 10 below.

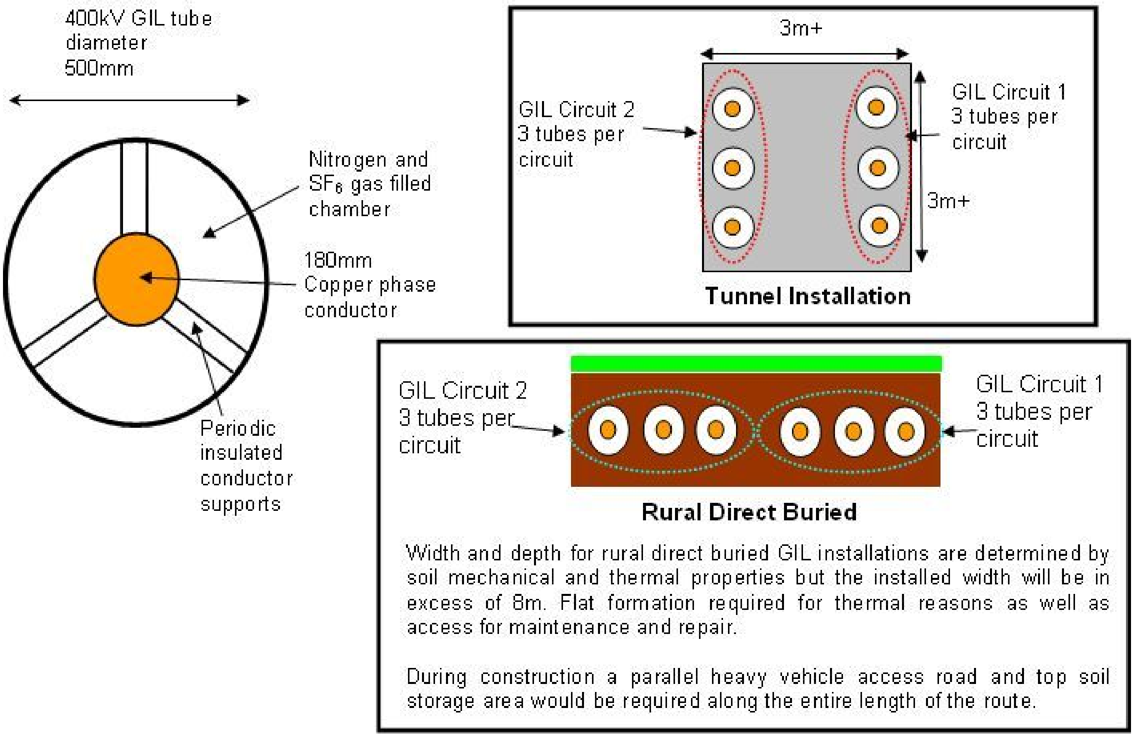


Figure 10: Key Components of GIL[10]

5.7.3 National Grid has two GIL installations on the transmission system which are 545m and 150m long. These are both located within electricity substations, one of which is above ground and the other is in a tunnel.

5.7.4 The longest section of directly buried transmission voltage GIL in the world, which is approximately 1km, was recently installed on the German transmission system around Frankfurt Airport.

5.7.5 The major advantage of GIL compared to traditional underground cable is that it does not require reactors or intermediate above ground installations that long underground cables require. The installation widths of land can also be smaller than cable installations, especially where more than 1 cable per phase is required. GIL also has a reliability benefit in that like overhead lines these

[10] The distances are based on initial manufacturer estimates of tunnel and buried GIL dimensions which would be subject to full technical appraisal by National Grid and manufacturers to achieve required ratings which may increase the separation required. It should be noted that the diagram does not show the swathe of land required during construction. Any GIL tunnel installations would have to meet the detailed design requirements of National Grid for such installations.

circuits can immediately be reused after a fault. If the fault is permanent the circuit will automatically come out of service again, but if not the circuit can be reused. This cannot be done with underground cables due to the safety risk of a small explosion and resulting permanent cable damage.

5.7.6 A significant issue with GIL, from an environmental perspective, is the use of SF_6[11] gas in the insulating gas mixture. A solution in which SF_6 gas is eliminated completely from the gas mixture is not possible with current technology. However, since GIL uses welded enclosure joints instead of bolted flanges, gas leakage is expected to be insignificant and since the enclosure will withstand arcing due to an internal fault, the probability of release of the insulating gas is remote. At the end of life, SF_6 can be separated from the gas mixture and recycled or disposed of by incineration.

5.7.7 The GIL installations will also be broken into gas zones, sections of pipes where the gas on either side is contained in separate compartments and can be isolated. This is done to ensure that if a failure does occur then only a limited amount of gas is lost. These zones will be every few kilometres and will need access so that the GIL when installed can be filled with the gas mixture.

5.7.8 GIL needs to be brought to site in 10-20m sections of pipe tubing. It is important in GIL that no impurities enter the tubing during construction and welding on site, as this would potentially cause the insulation to fail. Therefore the installation methods have additional special requirements over and above that required in natural gas pipeline installations.

[11] SF6 is a greenhouse gas with a global warming potential, according to the Intergovernmental Panel on Climate Change, Working Group 1 (Climate Change 2007, Chapter 2.10.2), of 22,800 times that of CO2. **www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html**

GIL Type based on current Amp rating	275kV GIL	400kV GIL	Capital Cost For a two circuit GIL route (equivalent cost per circuit)
2000A Rated GIL	1000MVA (circa 2000 Amp)	1500MVA (circa 2000 Amp)	£13.5m/km (£6.75m/km)
4000A Rated GIL	1500MVA (3150 Amp limit of National Grid 275kV systems)	3000MVA (circa 4300 Amp)	£15.2m/km (£7.6m/km)
5000A Rated GIL	N/A	3450MVA (5000 Amp limit of National Grid 400kV systems)	£22.8m/km (£11.4m/km)

Table 3: GIL Ratings and Costs[12]

5.7.9 The cost of GIL technology is in the region of £6.75m - £11.4m per circuit km. These costs are favourable to XLPE underground cables when the circuit capacity requirements are in the region of 3000MVA, which is the case here.

5.7.10 GIL is a new technology and its operational life is not proven. In the absence of proven design life information and to promote consistency with assessment of other technology options, GIL has been assessed over a design life of 40 years.

5.7.11 Table 3 above shows the capital installation costs for underground GIL using financial year 2011/12 prices. It should be noted at the end of the initial design life estimated replacement costs for underground GIL would be equal to or potentially greater than the initial capital cost. This is because of works

[12] Costs included in table are for GIL direct buried rural installations with no obstacles. GIL tunnel installations would have a higher capital cost than direct buried rural installations.

being required to excavate and remove GIL prior to installing new GIL in their place in some instances.

5.7.12 GIL is therefore considered in the appraisal process below.

5.8 High Voltage Direct Current ("HVDC") solutions

5.8.1 The electricity that supplies most of the world's homes and businesses is called Alternating Current (AC) electricity. Direct Current (DC) electricity did not develop as the means of transmitting bulk power supplies from power stations because bulk transmission by low voltage DC could only supply homes over short distances. In contrast, AC electricity could supply over longer distance by use of transformers to change the voltage level (which only works with AC electricity). This meant that the electrification of whole countries was therefore delivered quickly and efficiently by adopting AC technology rather than DC. This largely remains the case today, with AC solutions normally being the most efficient way of adding transmission capacity.

5.8.2 However, HVDC transmission is used in some special cases and works by converting AC electricity at sending-end converter stations, into DC electricity for onward transmission, and then back to AC electricity at receiving-end converter stations.

Where is HVDC used?

5.8.3 HVDC solutions require converter stations, which have a very significant cost. Although HVDC conductors can cost much less than the AC alternative the overall cost of a HVDC solution limits its application.

5.8.4 There are circumstances where HVDC has advantages over AC, generally where transmission takes place over long distances or between different, electrically-separate systems, such as between Great Britain and France or Great Britain and Ireland.

5.8.5 HVDC links may also be used to connect generating stations that are located a long distance from the rest of the electricity grid, for example very remote hydro electric schemes in China utilise HVDC technology with very long overhead lines.

5.8.6 The capital costs of HVDC installations can be much higher than for equivalent AC overhead line transmission routes, although HVDC may be more economic than equivalent AC overhead lines where the route length is many hundreds of kilometres.

5.8.7 In the UK, off-shore windfarms generally over 60km from shore will be likely to use HVDC technology as an alternative to an AC subsea cable. AC subsea cables suffer from a number of technical limitations for lengths over 60km, such as high charging currents and the need for mid-point compensation equipment. Cost estimates, in financial year 2011/12 prices, are given in Table 4 below:

HVDC Converter Type	**2GW Converter Cost**	**2GW DC Cable Pair Cost**
Current Source Technology or “Classic” HVDC	£160m (at each end)	£1.4m / km
Voltage Source Technology	£130m (at each end)	£1.4m / km

Table 4: HVDC Costs

5.8.8 Long HVDC systems incur a high capital cost associated with the converter stations above. However, the HVDC cables normally make up a lower proportion of the overall cost because when compared to AC equivalent cables they:

- require a minimum of two cables per circuit rather than a minimum of three;
- do not require reactive compensation mid-route, and
- require a cable of smaller cross-sectional area than equivalent AC cables for the same capacity.

5.8.9 DC cable circuits are therefore generally lower in cost than equivalent AC installations due to their construction. For the complete comparison it is also necessary to add in the cost of the 2 converter stations (one at each end) to the cable costs.

5.8.10 Evaluation of transmission projects needs to consider the cost of operating and maintaining equipment. Maintenance costs for DC systems are generally higher than AC because of the complex converter stations that require regular, specialist maintenance. Maintenance costs for all technologies are described in Appendix 1 "Lifetime Costs".

5.8.11 HVDC systems have an estimated design life of 40 years, and large parts of the converter stations (valves and control systems) are normally replaced after 20 years.

5.8.12 Table 4 above shows the capital installation costs for HVDC in financial year 2011/12 prices. It should be noted at the end of the initial design life replacement costs for HVDC are significant. This due to the large capital costs for the replacement of converter stations and the cost of replacing underground or subsea HVDC cables when required.

5.9 Electrical Losses Considerations for Technologies

5.9.1 Transmission losses occur in all electrical equipment and are related to the operation and design of the equipment.

5.9.2 The process of converting AC power to DC is not 100% efficient. Power losses occur in all elements of the converter station: the valves, transformers, reactive compensation/filtering and auxiliary plant. Depending on the specific type of converter, losses can be in the region of 1-2% per converter (2-4% per link).

5.9.3 As there is a cost associated with lost power, these losses can significantly increase the cost of a converter station over its lifetime. When compared to AC transmission, the converter station losses render HVDC transmission considerably less efficient than AC transmission over short distances.

5.9.4 Over short distances, the losses in both AC cables and AC overhead lines are very small. Losses in AC transmission are in the region of 0.7%-1% per 100km for an overhead line route and 0.3%-0.6% for a GIL / cable system. Consequently, very long lengths of AC cable or AC overhead line are required before the losses in the converter stations are offset and HVDC becomes more efficient than AC.

6 Options being taken forward for Appraisal

6.1 The following Potential Connections (PC) have been identified earlier in this document as credible options that would provide the necessary transmission capacity whilst meeting the requirements of the SQSS:

PC1: Hinkley – Aberthaw

PC2: Bridgwater – Melksham

PC3: Bridgwater – Nursling

PC4: Bridgwater – Seabank

PC5: Hinkley - Seabank

6.2 Section 5 has described a number of technologies which can be used to deliver the connection options, namely:

(a) AC underground cables;

(b) Gas insulated lines (GIL);

(c) Voltage source HVDC systems; and

(d) AC overhead lines.

6.3 As explained below, the most relevant technology alternatives have been assessed taking account of the specific parameters of each Potential Connection option and consultation feedback.

6.4 For example, PC1 (Hinkley to Aberthaw), which is a subsea route, consideration has been given to AC and HVDC subsea cables only as neither overhead lines nor GIL technology would be feasible.

6.5 PC2 (Bridgwater to Melksham) and PC3 (Bridgwater to Nursling) are not assessed using AC underground cables or GIL technology. These routes are significantly longer than the PC4 (Bridgwater – Seabank) and as such would have a greater amenity impact and incur a greater cost whilst offering no benefit over PC4. As such National Grid does not believe that consideration of options PC2 and PC3 by either AC underground cable or GIL technology are options that should be pursued.

6.6 The full list of options and each applicable technology is set out in Table 5 below.

Technology	PC1 Hinkley – Aberthaw	PC2 Bridgwater – Melksham	PC3 Bridgwater – Nursling	PC4 Bridgwater - Seabank	PC5 Hinkley - Seabank
AC Underground Cables	Yes (subsea)	No	No	Yes	Yes (subsea)
Gas Insulated Line (GIL)	No	No	No	Yes	No
HVDC	Yes (subsea)	No	No	No	Yes (subsea)
AC Overhead Line	No	Yes	Yes	Yes	No

Table 5: Overview of Technology Options

6.7 The next section provides an overview of the options appraisal methodology.

7 Overview of Options Appraisal Methodology

7.1 The option appraisal is a multi-criteria analysis which considers relevant technical, environmental and socio-economic issues and the costs associated with each potential connection option. Analysis of these factors allows National Grid to assess which option best meets its various statutory and licence obligations as explained in Section 2 and are explained below.

Technical Appraisal

7.2 Section 6 explains that each potential connection option has been assessed initially to ensure that it meets the Need Case and that the resultant transmission system would comply with the standards set out in the NETS SQSS. This means that the implications of each option on both the local and wider transmission system are fully assessed before it is appraised further. Strategic options which do not meet the Need Case or otherwise would not meet the standards set out in the NETS SQSS have not been identified for further analysis.

7.3 In some cases wider transmission works are required in order to resolve overload or other technical issues arising from a connection option. This is because the nature of each identified connection option has a different effect on resolving the need for additional system capacity. The infrastructure works, including wider works, for each option also take into account any construction, deliverability and operational issues associated with that option.

Economic Appraisal

7.4 Once the full scope of works associated with each option is identified an estimate of their capital cost of that scope of works is made. For the specific overhead line, underground AC cable, GIL and HVDC components of each option, operational lifetime costs are then estimated.

7.5 Capital cost is an estimate of the cost of equipment and installation costs. For the purposes of strategic optioneering, the cost estimates are based on generalised unit costs for the key elements of the option, reflecting recent contract values or manufacturers / consultant budget estimates. This is sufficient to allow a broad order of relative costs to be established for the options, as necessary at the strategic level, and is not intended to provide a detailed cost for each option which can only be obtained at the detailed design stage.

7.6 The lifetime cost is an estimate of the transmission losses and maintenance costs for the specific overhead line, underground AC cable (including shunt reactors), GIL or HVDC converter and cable elements of the connection options over a 40 year lifetime. The lifetime cost estimate methodology is explained in Appendix 1.

Environmental Appraisal

7.7 The environmental appraisal for each of the Potential Connections, see Appendix 2, has considered environmental constraints of international and national importance. Features considered as constraints to the Potential Connection are presented in Table 6 below. The table also summarises the legislation under which protection is conferred and the data sources from which information (where applicable) was taken.

Feature	Legislation	Routeing Response (and Reference)	Data Sources
National Parks	National Parks and Access to the Countryside Act 1949	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1)	magic.gov.uk
Areas of Outstanding Natural Beauty	National Parks and Access to the Countryside Act 1949/ Countryside and Rights of Way Act 2000	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1	magic.gov.uk
Heritage Coasts	n/a	Seek to avoid(NG Commitments/ Holford Rule 1)	magic.gov.uk
World Heritage Sites	1972 World Heritage Convention	Seek to avoid(NG Commitments/ Holford Rule 1)	English-heritage.org.uk
Sites of Special Scientific Interest	Wildlife and Countryside Act 1981 Countryside and Rights of Way Act 2000	Seek to avoid/verify potential effects(NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk

Feature	Legislation	Routeing Response (and Reference)	Data Sources
Special Protection Areas	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Special Areas of Conservation	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Ramsar sites	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
National Nature Reserves	National Parks and Access to the Countryside Act 1949	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Scheduled Monuments	Ancient Monuments and Archaeological Areas Act 1979	Seek to avoid/consider effect on setting (NG Commitments/ Holford Rule 2)	English-heritage.org.uk
Settlements	n/a	Seek to avoid (Supplementary Note)	Digitised from Ordnance Survey
Historic buildings (Listed I, II and II*)	Planning (Listed Buildings and Conservation Areas) Act 1990	Seek to avoid/consider effect on setting (Note to Holford Rule 2)	English-heritage.org.uk
Conservation Areas	Planning (Listed Buildings and Conservation Areas) Act 1990	Seek to avoid/consider effect on setting (Note to Holford Rule 2)	Development plans
Registered Parks and Gardens	n/a	Seek to avoid (NG Commitments)	magic.gov.uk
Registered Battlefields	n/a	Minimise effects (NG Commitments)	English-heritage.org.uk
Woodlands	n/a	Seek to avoid (Note to Holford Rules 4 and 5)	National Inventory of Woodlands
Landform	n/a	Holford Rules 4 and 5	OS Open Data

Table 6 - Environmental constraints and data sources

7.8 In accordance with the National Policy Statement for Electricity Networks Infrastructure EN-5[13], when siting new overhead lines, the principles of the Holford Rules should be taken into account.

Environmental issues scoped out of the appraisal at this stage

7.9 It is not feasible to undertake a meaningful assessment of the effects of the Potential Connection on certain environmental factors both because of the high level nature of this environmental appraisal and because a detailed connection design would have to be identified. As a result the effects of these factors have not influenced the selection of a preferred connection. The factors scoped out of the appraisal at this stage are outlined at paragraphs 7.11 to 7.14 below.

7.10 Although scoped out of the options appraisal process at this stage these factors will require consideration as part of routeing studies, detailed connection design and environmental assessment whichever connection is taken forward.

Flood Risk

7.11 National Grid considers its siting of installations such as substations very carefully in relation to flood risk. However, it is relatively straightforward to build flood resilience into overhead lines by addressing safety clearances from anticipated flood levels in the overhead line design. The presence of overhead line pylons in areas of flood risk has negligible effect on the risk or displacement of water as the lattice steel construction poses no material changes to surface water flow.

7.12 The presence of an underground connection in areas of flood risk would not affect the connection's operation and has a negligible effect on the risk or displacement of water as underground connections pose no material changes to water flow.

7.13 As outlined at paragraph 5.8.2 converter stations are required for HVDC connections and mid point switching stations may be required for long AC

[13] Paragraphs 2.8.4 -2.8.7, Pages 13-14, National Policy Statement for Electricity Networks Infrastructure (EN-5) July 2011.

cables. The location of the converter stations or mid-point switching stations would require further consideration and assessment in accordance with Planning Policy Statement (PPS) 25 if these connection options were taken forward. However, due to the high level nature of this assessment, flood risk has been scoped out of the appraisal at this stage.

Noise, air quality and transport

7.14 Due to the high level nature of the assessment at this stage it is not possible to undertake a meaningful assessment of the effects on noise, air quality and transport as this would require specific overhead line or underground cable routes to be identified. These factors have, therefore, been scoped out of the appraisal at this stage, although further detailed study would be required to assess the effects on these environmental factors whichever connection option was taken forward.

Planning Policy & Socio-Economic Appraisal

7.15 Analysis has been carried out to examine the locations of key relevant features in relation to the Potential Connections. The analysis at this Strategic Optioneering stage has included:

Planning Policy Constraints and Opportunities

7.16 A high level planning policy analysis has been undertaken to identify the main areas of economic importance in policy terms. The status of particular areas in employment terms is largely reflected in Development Plans and any supporting Economic Development Strategies, prepared by local authorities or regional bodies. In considering the planning policy context[14] we have looked at:

- LDF Core Strategies;
- Saved policies in Local Plans/Unitary Plans;
- Saved policies in Minerals Local Plans (prepared at County level), and

[14] A list of documents reviewed is given in Appendix 1.

- Minerals Core Strategies (prepared at County level, where available).

7.17 The following planning policy areas relevant to socio-economic issues have been considered where development implications might affect/be affected by potential connection Options:

- Spatial settlement policies;
- Employment policies, including tourism;
- Recreation/leisure policies including green infrastructure;
- Areas of current/potential mineral workings, and
- other significant development proposals with impacts relevant to strategic options.

7.18 Socio-economic effects have been assessed to determine the extent to which they assist in meeting policy objectives:

- Where there are some tensions between the policy approach and elements of the Option arising either from visual impacts or from the option's land take considerations, it should generally receive a negative assessment;
- Where there are no policy tensions e.g. where visual impact would be minimal or where the assumed land take is not considered likely to be significant (for agricultural or industrial interests), the option has been considered neutral;
- Where elements of the potential connection option could contribute to overall policy objectives or where other planning objectives could be achieved, a positive assessment may be appropriate.

<u>Tourism and Recreation Sector Assessment</u>

7.19 The potential impacts of electricity transmission infrastructure on recreation, leisure and tourism are not well understood and there is no evidence or studies that demonstrate a measurable economic effect from overhead transmission lines. National Grid acknowledges that tourism is important to some parts of the economy in the part of South West where the need for new infrastructure has been identified. For the purposes of assessing strategic options, National Grid has assumed that there may be potential effects on tourism from the proposed transmission reinforcement options. However, it is not considered that potential effects on tourism comprise a significant factor in choosing between different options at this strategic level

7.20 When assessing strategic options for tourism (including recreation) amenity, there is no accredited designation comparable for example with habitat or biodiversity designations. In its absence, assessment of the importance of tourism (including recreation) activity and the potential for it to be affected by a Potential Connection Option examines:

- The number and proportion of visitor-related businesses in the economy;
- Concentrations of such businesses and their scale;
- Examination of tourism expenditure data, and
- Identification of amenities, businesses or attractions which attract large numbers of visitors to the area.

Agricultural Land Quality Assessment

7.21 An analysis of the Agricultural Land Classification survey data was undertaken. This identifies the significance of high quality agricultural land in each Potential Connection Option area, where it is located, and as a proportion of all agricultural land in the area.

Socio Economic issues scoped out of the appraisal at this stage

Wider Economic Benefits

7.22 Until a preferred option is identified it is not possible to provide meaningful analysis of the wider economic benefits to the local community. Such analysis would be linked to the nature and scale of construction activity (and related supply chain benefits) or proximity to facilities which would not otherwise be provided. As a meaningful analysis of potential impacts cannot be done until the detailed connection design is known, it is scoped out of the analysis at this stage.

Deprivation

7.23 The Index of Multiple Deprivation is generally acknowledged to be the main tool for examining impacts on deprived areas. The Index is a combined index derived from 37 different indicators, which cover specific aspects or dimensions of deprivation: income, access to employment, housing, education, skills and training, health and disability, living environment, and crime. These are weighted and combined to create the overall Index of Multiple Deprivation. It is considered that none of these factors are likely to be affected by connection options.

- Income - Access to opportunity is what influences income – or the lack of it in such areas – whether through lack of jobs in the area, poor public transport, or lack of skills and education, none of which are likely to be affected by different modes of transmission connection.

- Employment - Providing the settlements affected / disadvantaged areas are located in close proximity to employment centres these will offer 'access level' job opportunities suitable largely for the likely skills profile of residents. Despite this, deprived areas may still have intractable problems of unemployment. However, different connection options are unlikely to have any impact upon this issue nor will they discourage investment in such areas.

- Health - High levels of poor health are frequently a legacy of deprived areas' industrial past and this has often not been satisfactorily addressed. Longer term health issues tend not therefore to be related to different transmission options.

- Education - Lack of education and skills can also contribute to deprivation.

- Housing – This domain measures the physical and financial accessibility of housing and key local services. The indicators fall into two sub-domains: 'geographical barriers', which relate to the physical proximity of local services, and 'wider barriers' which includes issues relating to access to housing such as affordability.

- Crime - This domain measures the rate of recorded crime for four major crime types – violence, burglary, theft and criminal damage – representing the risk of personal and material victimisation at a small area level.

7.24 It is considered that none of these are likely to be affected by connection options.

Property Values

7.25 In investigating potential connection options, National Grid seeks to avoid or minimise impacts upon settlements (or as route alignments become more certain in the later stages of detailed design, maximise the distance from individual homes) for reasons of general amenity. Analysis of the potential effects of different connection options on factors such as agricultural land, residential property and commercial property values is not included in this socio-economic appraisal. Those whose property will have National Grid equipment sited on or across it (e.g. if the conductors/ wires – oversail a landholding) are entitled to compensation under property law and these factors may be the subject of compensation assessment once the final route alignment is decided[15].

7.26 Potential effects on property prices are, therefore, scoped out of the appraisal at this stage.

[15] The degree to which impact in terms of injurious affection of property and entitlement to compensation is something which can only really be assessed and agreed once a transmission connection is in place and the actual impact evaluated.

8 Options Appraisal – Common Works

8.1 Sections 9 - 14 appraise PC1-PC5 but as explained in paragraph 4.2 there are a number of Transmission System Upgrades, which are common across each of the Potential Connections, and that are required to upgrade the existing system. These are shown in the table below:

Transmission System Upgrades	Total Estimated Capital Cost
Reconductoring Melksham-Bramley circuits	£289.8m
Reconductoring Hinkley Point –Melksham circuits	
Reconductoring Aust – Melksham circuits	
Melksham 400kV substation line entries	
New Quadrature Boosters at Nursling 400kV substation	
New Aust 400kV substation	
Upgrade the Cowley-Minety / Cowley-Walham Cables	

8.2 As well as these transmission system upgrades there are costs associated with the connection of the new generators at Hinkley Point C, Oldbury-upon-Severn and Seabank Stage 3 which will require the construction of new substations or the substantial extension of existing substations. For the purposes of comparing options it is assumed these are:

Generator Connection Assets		Total Estimated Capital Cost
Hinkley Point C	New Hinkley Point C 400kV substation	£201.6m
Oldbury-upon-Severn	New Oldbury-on-Severn 400kV substation	
	New Aust-Oldbury and Oldbury-Melksham 400kV transmission circuits	
Seabank Stage 3	Seabank 400kV substation extension	

8.3 These works, which total **£491.4m** are incorporated within the cost estimates for each Potential Connection but have not been included within the environmental or socio-economic appraisal as they would not help to distinguish between options.

9 PC1: Hinkley - Aberthaw (subsea)

9.1 PC1 involves the construction of subsea cables between Hinkley Point and Aberthaw in South Wales, a distance of approximately 30km. Two subsea technologies are considered, AC (PC1a) and HVDC (PC1b). This Potential Connection would resolve the transmission issues associated with the South West which are explained in the Need Case.

9.2 However, as explained in paragraph 4.11, additional works would be required in order to resolve the issues associated with South Wales and Gloucestershire. For the purpose of this analysis it is assumed that this would require a rebuild of the existing 275kV connection between Iron Acton and Melksham (30km) to operate at 400kV and the construction of a 400kV substation at Iron Acton.

9.3 In addition, as explained in paragraph 4.14 two new transmission circuits are required to facilitate the connection of new generation at Seabank. For the purpose of this analysis it is assumed that two additional transmission circuits between Seabank and Tockington are required.

9.4 As explained in Section 8 there are Transmission System Upgrades and Generator Connection Assets, which are common across each of the Potential Connections, and that are required to upgrade the existing system.

9.5 These works are incorporated within the cost estimates but have not been included within the environmental or socio-economic appraisal as they would not help to distinguish between options.

9.6 In addition to the works listed above, a connection to Aberthaw would trigger the requirement to upgrade a number of 275kV transmission circuits and substations in South Wales to 400kV operation.

9.7 The 275kV system in South Wales is an older part of the transmission system that runs along the coast and was constructed before 400kV transmission was used in the UK. 275kV transmission has a lower power carrying capacity and incurs higher transmission losses than 400kV transmission. The list of works required are shown below:

Contingent Transmission Works	Total Estimated Capital Cost
New Upper Boat 400kV substation	£284.7m
New Quadrature Boosters at Cilfynydd 400kV substation	
Reconductor Aberthaw – Upperboat – Cilfynydd circuits	
Reconductor Cilfynydd - Rassau 400kV double circuit	
Reconductor Seabank – Aust 400kV circuit	
New Severn Tunnel and uprate cables	

Technology options considered for PC1

9.8 PC1 involves the construction of subsea cables between Hinkley Point and Aberthaw in South Wales. Two subsea technologies are considered, AC (PC1a) and HVDC (PC1b).

9.9 An AC connection (PC1a), reactive compensation equipment is likely to be required and for a HVDC connection (PC1b) two 2000MW converter stations would be required at each end of the route.

9.10 The cost estimates associated with PC1a and PC1b are summarised in Table 7 & 8 below.

Generator Connection Assets		
As described in Chapter 8		£201.6m
System Upgrades		
As described in Chapter 8		£289.8m
Transmission Reinforcement Assets		
To resolve the South West Boundary	Hinkley Point C 400kV Substation extension	£7.8m
	Hinkley Point – Aberthaw AC Cables (2 cables per phase)	£540m
	Aberthaw 400kV Substation	£68.4m
	Shunt Reactors at Aberthaw 400kV and Hinkley Point C 400kV	£6m
To resolve the South Wales & Gloucestershire Boundary	New Iron Acton 400kV substation	£152.6m
	Iron Acton – Melksham offline rebuild	
To resolve loss of power infeed at Seabank	New Seabank – Tockington Tee 400kV double circuit	£9.6m
Contingent Transmission Works		
New Upper Boat 400kV substation		£284.7m
New Quadrature Boosters at Cilfynydd 400kV substation		
Reconductor Aberthaw – Upperboat – Cilfynydd circuits		
Reconductor Cilfynydd - Rassau 400kV double circuit		
Reconductor Seabank – Aust 400kV circuit		
New Severn Tunnel and uprate cables		
	TOTAL	£1,560.5m

Table 7 - PC1a (AC Cables) Capital Cost Summary

Generator Connection Assets		
As described in Chapter 8		£201.6m
System Upgrades		
As described in Chapter 8		£289.8m
Transmission Reinforcement Assets		
To resolve the South West Boundary	Hinkley Point C 2 x 2000MW Converters	£260m
	Hinkley Point – Aberthaw HVDC Cables	£84m
	Aberthaw 2 x 2000 MW Converters	£260m
	Aberthaw 400kV Substation	£60.6m
To resolve the South Wales & Gloucestershire Boundary	New Iron Acton 400kV substation	£152.6m
	Iron Acton - Melksham offline rebuild	
To resolve loss of power infeed at Seabank	New Seabank – Tockington Tee 400kV double circuit	£9.6m
Contingent Transmission Works		
New Upper Boat 400kV substation		£284.7m
New Quadrature Boosters at Cilfynydd 400kV substation		
Reconductor Aberthaw – Upperboat – Cilfynydd circuits		
Reconductor Cilfynydd - Rassau 400kV double circuit		
Reconductor Seabank – Aust 400kV circuit		
New Severn Tunnel and uprate cables		
	TOTAL	£1,602.9m

Table 8 - PC1b (HVDC) Capital Cost Summary

Lifetime Cost

9.11 PC1 can be delivered by either AC subsea cable or by a HVDC connection which requires converter stations to convert electricity to DC and back to AC electricity. The options as detailed above have the same scope of works except for the different type of cable and HVDC converters.

9.12 The lifetime cost methodology is explained in Appendix 1 but for the specific AC cable & Shunt Reactors of PC1a and HVDC converters & cables of PC1b, the lifetime costs are shown in Table 9 below:

	PC1a **Cable and Shunt Reactors**	**PC1b** **HVDC** **Converters & Cables**
Capital Cost	£546m	£604m
Transmission Loss Cost	£17.6m	£251.3m
Maintenance Cost	£4.6m	£85.2m
Lifetime Cost	**£568.2m**	**£940.5m**

Table 9: PC1 Lifetime Cost

9.13 The analysis shows that by including the lifetime costs of transmission losses and maintenance that for PC1 an AC cable solution is more economical than an HVDC solution. This is because of the higher transmission losses incurred in the converter stations and the higher annual maintenance costs also associated with the converter stations.

PC1a and PC1b Environmental Appraisal

9.14 The study area for the Hinkley – Aberthaw connection is illustrated at Figure 11 and extends for approximately 30km between Hinkley Point Power Station, West Somerset and Aberthaw Power Station, Vale of Glamorgan. The study area is focussed on the Severn Estuary/Bristol Channel and the land associated with the connection points at Hinkley Point and Aberthaw. The additional works associated with this connection (outlined at 9.7) extend across much of South Wales.

9.15 The most significant environmental constraints to the Potential Connection would be the Severn Estuary which is designated as a SPA, SAC, SSSI and Ramsar site. The subsea cables would need to travel through the SPA, SAC and Ramsar designations and would come on-shore in proximity to/or through either Blue Anchor to Lilstock Coast SSSI or Bridgwater Bay SSSI to make a connection to the Hinkley Point power station.

9.16 The installation of either AC or HVDC subsea cables through the Severn Estuary could result in the following effects on the SPA, SSSI, SAC and Ramsar designations:

- Disturbance of the mudflats/bed of the estuary from cables installation across a construction swathe of approximately 440m for AC cables or 150m - 350m for HVDC cables (depending on the number of cables required) which may alter the species composition of the flora and fauna;

- Suspended Sediments – resulting from the release of sediment from the cabling activities could affect the benthic communities associated with the SAC designation;

- Mobilisation of contaminants in sediments could impact on the flora and fauna of the Estuary; and

- Disturbance from the cable laying activities could impact on species using the SPA, SAC, SSSI and Ramsar sites.

9.17 The nature and scale of these effects would require further assessment in accordance with the Conservation of Habitats and Species Regulations 2010 to ensure that there would be no adverse effects on the integrity of the designation or its qualifying features. If the likelihood of significant adverse effect could not be ruled out, or if there was uncertainty, then an 'appropriate assessment' would need to be undertaken by the competent authority.

9.18 Where there are likely to be significant effects, consent for development can only be granted where it would not adversely affect the integrity of the site taking into account the manner in which the development will be carried out and any conditions that might be imposed on the consent or, where there are no alternative solutions and the development must be carried out for imperative reasons of overriding public interest relating to human health, public safety or benefits of primary importance to the environment.

9.19 The construction of converter stations (for a HVDC connection) or reactive compensation equipment (for an AC connection) would require a large land take in the vicinity of the cables landing point. This infrastructure has the potential to result in effects on local amenity and depending on the siting, visual impacts to settlements and effects on the setting of Scheduled Monuments such as Wick Barrow at Hinkley Point and Listed Buildings to the north of Aberthaw Power Station. The location of the converter stations or reactive compensation equipment would require further consideration and assessment as part of detailed siting studies if this connection option was taken forward.

9.20 Of the subsea connection methods available to make the Potential Connection, HVDC subsea cables would offer environmental benefits over AC subsea cables as they require the installation of fewer cables over a narrower installation corridor, resulting in less sea-bed disturbance and a shorter installation programme. However, the large converter stations required at either end of the HVDC connection would introduce effects on landscape and views and would require further consideration and assessment as part of detailed siting studies.

New 400kV substations at Aberthaw and Upper Boat

9.21 As outlined at paragraph 9.7, if this connection was selected as the Preferred Connection and taken forward, new 400kV substations would be required at Aberthaw and Upper Boat in South Wales. The siting and design of these substations would be subject to detailed study in accordance with the guidelines presented in the Horlock Rules[16].

Aberthaw

9.22 To make a landing connection at Aberthaw, the Potential Connection would need to travel through a narrow area of land between the East Aberthaw Coast SSSI and the Glamorgan Coast (Heritage Coast) designations. At this stage, the precise location of a substation at Aberthaw has not yet been determined but in order to avoid adverse effects it would need to be outside these designations. No other environmental designations of international or national importance have been identified within or in close proximity to the existing substation which would constrain potential substation sites.

9.23 However, the construction of a new 400kV substation at Aberthaw would introduce effects on landscape and views which would require further consideration and assessment as part of detailed siting studies.

[16] National Grid plc: NGC Substation and the environment – guidelines on siting and design: March 2003

Upper Boat

9.24 At this stage, the precise location of a substation at Upper Boat has not yet been determined. However, a new substation in the vicinity of the existing Upper Boat substation would need to avoid blocks of woodland and the settlements of Church Village, Upper Boat and Hawthorn. No other environmental designations of international or national importance have been identified within or in close proximity to the existing substation that would constrain potential substation sites.

9.25 However, the construction of a new 400kV substation at Upper Boat would introduce effects on landscape and views which would require further consideration and assessment as part of detailed siting studies.

<u>Reinforcements of overhead lines from 275kV to 400kV within South Wales</u>

9.26 As outlined at paragraph 9.7, if this connection was selected as the Preferred Connection and taken forward the existing 275kV Aberthaw – Upper Boat - Cilfynydd overhead line would need to be reinforced to 400kV operation and reconductoring works undertaken on the existing 400kV Cilfynydd - Rassau overhead line.

9.27 The existing 275kV Aberthaw to Cilfynydd overhead line passes through, or close to, the following areas of constraint:

- Scheduled Monuments including East Orchard Wood Pillbox and East Orchard Manor House;
- Historic Parks and Gardens including: Old Beaupre, Hensol Castle and Talygarn;
- Listed Buildings;
- Settlements, and
- Woodland.

9.28 The 275kV pylons around Aberthaw as well as those on routes towards Swansea North and Cilfynydd are predominantly of "L2" pylon design. These pylons can typically be utilised for 400kV overhead lines, although some pylon raising and/or strengthening may be required. There are some sections of line in South Wales which utilise pylons of "L3" design which are normally not suitable for 400kV operation. As such, these sections are likely to require either significant upgrades or replacement with pylons suitable for 400kV operation. The upgrades required would be subject to future detailed feasibility assessments (including consideration of the effects on landscape and views) and routeing studies if this connection option was taken forward.

9.29 The existing Cilfynydd to Rassau 400kV overhead line passes through, or close to, the following areas of constraint and also passes within 500m of the boundary of the Brecon Beacons National Park:

- SSSIs: Cwn glo a glyndyrys and Mynydd Llangatwg;
- Usk Bats SAC;
- Scheduled Monuments;
- Listed Buildings;
- Settlements, and
- Woodland.

Rebuild of Iron Acton to Melksham Overhead Line

9.30 As outlined at paragraph 9.2, if the Potential Connection was taken forward the existing Iron Acton to Melksham 275kV overhead line would need to be re-built to 400kV construction. This would involve the construction of a new overhead line and pylons suitable for 400kV operation in close proximity to the existing overhead line. Following completion of construction and the transfer of electrical circuits the existing 275kV overhead line would be removed.

9.31 The existing Iron Acton to Melksham 275kV overhead line is approximately 30km long and crosses approximately 16.7km of the Cotswolds AONB. The AONB extends for large distances to the north and south. A route that avoids the designated landscape would be approximately 60km longer than the existing connection and would take a new overhead line close to other constraints including Bath World Heritage Site. If the route of the existing overhead line was adopted the new overhead line would cross in excess of 16km of the AONB. This is likely to give rise to adverse effects on the landscape of the AONB which could affect the objective to conserve and enhance natural beauty.

9.32 The existing overhead line also passes across Honeybrook Farm SSSI and close to Coleme Park and Monk's Wood SSSIs. Detailed environmental surveys would be required to ensure that the integrity of these sites or their qualifying features was not adversely affected by the construction of a new overhead line.

<u>Seabank to Tockington new overhead line</u>

9.33 If the Potential Connection was taken forward a new 400kV double circuit overhead line of approximately 6km would be required between Seabank, Bristol and Tockington, South Gloucestershire.

9.34 Between Seabank and Tockington there are no areas protected at the highest level by national or international nature conservation or landscape designations. However, the following constraints would require detailed consideration as part of routeing studies if this Potential Connection was taken forward:

- The existing 400kV Seabank to Tockington overhead line (2VL route);
- Settlements including Marsh Common, Piling, Almondsbury and Awkley;
- Listed buildings and the Conservation Areas of Almondsbury and Olveston;
- Individual residential properties, and
- Blocks of woodland.

9.35 The construction of a new overhead line parallel to the existing 400kV Seabank to Tockington overhead line would result in cumulative visual effects but would limit effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists.

PC1a and PC1b Planning Policy Assessment

9.36 The adopted West Somerset Local Plan does not allocate specific employment sites in villages near to Hinkley. Core Strategy options relating to Stogursey note the employment likely to be generated by the expansion at Hinkley Point power station (in construction and operation of the two nuclear reactors and the power plant), and the commercial opportunities likely to present themselves (while also noting the need for physical mitigation to protect settlement characteristics). While sub-sea cabling would not affect this, the scale of construction activity associated with converter station construction (were an HVDC connection implemented) would be greater than for an AC connection.

9.37 The impact of the sub-sea cable is expected to be neutral particularly if the end-point infrastructure is located at or close to the existing Hinkley Point nuclear power station.

9.38 Core Strategies relevant to this Potential Connection include the Vale of Glamorgan's preferred Local Development Plan (not yet adopted). This indicates that development at East Aberthaw should focus on rural diversification. The implication of this may be that some of the rural businesses may wish to diversify into food processing/production, tourism related activities, and other areas. Sub-sea cabling is unlikely to have a significant impact on achieving these policies.

9.39 The location of onshore infrastructure for the sub-sea cable should avoid limestone reserves in East Aberthaw. The impact of the sub-sea cable is expected to be neutral particularly if the end-point infrastructure is located at or close to the existing Aberthaw coal-fired power station.

PC1a and PC1b Tourism Sector Assessment

9.40 Potential effects on tourism and leisure would be restricted to the connection points of the subsea cables at both Hinkley Point and Aberthaw. Were an HVDC option pursued, this would include 2 converter stations close to the power stations at both sides of the connection. Whilst these would have visual impacts from either coast, they would be viewed as part of the concentration of power station and connection infrastructure in each area.

9.41 As an AC connection would not require converter stations, visual impact would be correspondingly lower.

9.42 The tourism and leisure sectors are relatively small in both areas and there are few if any major attractors. The impact on tourism businesses is considered to be neutral and is not considered significant at a strategic level.

PC1a and PC1b Agricultural Land Quality Assessment

9.43 The potential quantity of land affected will depend upon: where a subsea cable could be laid; where it would surface; and whether HVDC or AC technology was employed. The converter stations associated with an HVDC option would generate a significant land take on both banks of the Severn. However, analysis of Agricultural Land Classification data indicates that this would not affect significant concentrations of high quality agricultural land. As an AC connection would not require converter stations, agricultural land take would be considerably lower.

9.44 The impact on agricultural land is not considered significant at a strategic level, although it would clearly be significant for any landowner affected by an HVDC option.

South Wales System Enhancements

9.45 While the wider system works to upgrade the network in South Wales would largely follow the existing alignment some pylons would need to be replaced. While the area potentially affected is extensive, impacts are likely to be limited to those areas where replacement pylons would be required. As the existing line passes close to the Brecon Beacons National Park, care should be taken when locating any new pylons which may be needed in this area. Subject to this qualification, it is considered that this element would not generate significant additional tourism or other effects.

Rebuild of Iron Acton to Melksham overhead line

9.46 The existing overhead line passes close to the historic market town of Chipping Sodbury and across the Cotswolds AONB which is a visitor attraction in its own right. Chipping Sodbury/Yate are close to the Avon cycleway, Monarchs Way Long Distance Footpath and Frome Valley Walkway. The towns are surrounded by green belt to the south and the Cotswold AONB is to the east.

9.47 Bath World Heritage Site lies to the south of the study area. The existing overhead line passes close to Corsham, a historic market town in Wiltshire, with attractions such as Corsham Court and potential strategic development options towards the west side of the town. Further east is Chippenham one of the largest towns in Wiltshire and a strategic location for growth, principally towards the north and east.

9.48 Any upgrading of the route will have to consider the potential for effects on agricultural land and tourism activity in relation to the Cotswolds AONB in particular, and for long distance walking and cycling routes.

9.49 It is noted that a proposed urban extension to the north of Yate is identified in the Draft South Gloucestershire Core Strategy. As the proposed extension has been promoted with the existing line in situ close by the proposals would be unlikely to be significantly affected by a rebuilt line.

9.50 The existing Iron Acton to Melksham 275kV overhead line crosses approximately 16.7km of the Cotswolds AONB, which extends large distances to the north and south. While rebuilding the existing line is likely to require a similar connection length, it is unlikely to have a significant additional visual impact on the businesses and residents in the area, particularly where it follows a route similar to the current alignment.

9.51 Avoiding the AONB would require a connection some 60km longer than that which exists, and consideration would have to be given to potential affects on Bath World Heritage Site.

9.52 Outside the AONB, the majority of tourism and leisure businesses in the area are located in and around the existing urban areas and as such would be unlikely to witness significant effects.

Seabank -Tockington overhead line

9.53 It is assumed that the overhead line would pass to the east of the existing overhead line. Such an alignment avoids sizeable settlements, employment areas and areas of established tourism activity. The impacts on such receptors in this area would be considered to be neutral. While agricultural landholdings may be affected, land take would be expected to be minimal. Potential impacts should be capable of mitigation through route alignment.

10 PC2: Bridgwater – Melksham

10.1 PC2 would involve uprating the existing 275kV Hinkley Point to Bridgwater circuit to operate at 400kV and constructing a new transmission connection between Bridgwater and Melksham (80km). This resolves the transmission issues associated with the South West which are explained in the Need Case.

10.2 However, as explained in paragraph 4.11, additional works would be required in order to resolve the issues associated with South Wales and Gloucestershire. For the purpose of this analysis it is assumed that this would require a rebuild of the existing 275kV connection between Iron Acton and Melksham (30km) to operate at 400kV and the construction of a 400kV substation at Iron Acton.

10.3 In addition, as explained in paragraph 4.14 two new transmission circuits are required to facilitate the connection of new generation at Seabank. For the purpose of this analysis it is assumed that two additional transmission circuits between Seabank and Tockington are required.

10.4 As explained in Section 8 there are Transmission System Upgrades and Generator Connection Assets, which are common across each of the Potential Connections, and that are required to upgrade the existing system.

10.5 These works are incorporated within the cost estimates but have not been included within the environmental or socio-economic appraisal as they would not help to distinguish between options.

Technology Options Considered for PC2

10.6 With a total new connection length of 116km, comprised of 80km between Bridgwater and Melksham, 30km between Iron Acton and Melksham and 6km between Seabank and Tockington, this Potential Connection is significantly longer than the shortest new on-shore connection length of PC4 which is 57km. As such neither undergrounding nor GIL technology options have been considered for PC2 as they would incur significantly higher costs whilst providing no amenity benefit over the use of these technologies on the shorter PC4.

10.7 PC2 is therefore assessed for the use of AC overhead line technology.

10.8 The cost estimates associated with PC2 are summarised in Table 10 below.

Generator Connection Assets		
As described in Chapter 8		£201.6m
System Upgrades		
As described in Chapter 8		£289.8m
Transmission Reinforcement Assets		
To resolve the South West Boundary	Hinkley Point – Bridgwater 275kV – 400kV upgrade	£9.7m
	New Bridgwater 400kV Substation	£12.2m
	New Bridgwater – Melksham 400kV circuit	£128m
	Line entries at Melksham 400kV substation	£11.7m
To resolve the South Wales & Gloucestershire Boundary	New Iron Acton 400kV substation	£152.6m
	Iron Acton - Melksham offline rebuild	
To resolve loss of power infeed at Seabank	New Seabank – Tockington Tee 400kV double circuit	£9.6m
Contingent Transmission Works		
None Required.		
	TOTAL	£815m

Table 10 – PC2 Capital Cost Summary

Lifetime Cost

10.9 The lifetime cost of the AC overhead line component of PC2 is shown in Table 11 below:

	PC2 (Bridg-Melk OHL)
Capital Cost	£128m
Transmission Loss Cost	£62.9m
Maintenance Cost	£2.5m
Lifetime Cost	**£193.4m**

Table 11: PC2 Lifetime Cost

PC2 Environmental Appraisal

10.10 The study area for the Bridgwater – Melksham connection is illustrated at Figure 12 and extends for approximately 80km from the eastern edge of Bridgwater, Somerset to the existing National Grid Melksham substation, Wiltshire. An existing overhead line owned and operated by National Grid travels through the study area in a west-east alignment between Hinkley Point and Melksham substations (ZG Route). The study area includes the main settlements of Glastonbury, Shepton Mallet and Frome in Somerset and Westbury and Trowbridge in Wiltshire.

10.11 The most significant constraints to achieving a direct overhead line route between Bridgwater and Melksham are the Mendip Hills AONB and the Cotswolds AONB. An overhead line through these sites would have an effect on the landscape which will affect the objective to conserve and enhance their natural beauty. These sites and the numerous Scheduled Monuments (SMs) contained within them constrain a direct overhead line route and limit the study area for the Potential Connection to a swathe of land to the south of these designations and the north of the Cranbourne Chase to West Wiltshire Downs AONB. As part of detailed routeing studies for a connection between Bridgwater and Melksham further assessment would be required to determine the potential for adverse effects on the setting of the AONBs as a result of the Potential Connection.

10.12 The construction of a new Bridgwater to Melksham overhead line parallel to the existing 400kV Hinkley Point to Melksham overhead line would result in cumulative visual effects but would limit adverse effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists. However, a new overhead line parallel to the existing line would pass through the Somerset Levels and Moors SPA, SSSI and Ramsar sites and parts of the Somerset Levels containing a high concentration of SMs. The effects of an additional overhead line on the SPA, SSSI and Ramsar designations would require further assessment in accordance with the Conservation of Habitats and Species Regulations 2010 to ensure that there would be no adverse effects on the integrity of the designation or its qualifying features.

10.13 To avoid the SPA, SSSI and Ramsar designations an overhead line would need to route to either the north or south of this area. To the south a route is constrained by a number of small hamlets and villages and the larger settlements of Street and Glastonbury. To the north, a route could be achieved but would be constrained by the settlements of Blackford, Wedmore and Wookey and numerous SMs.

10.14 To the east of the Somerset Levels and Moors a variety of constraints would influence the route of a potential overhead line. The northern part of the Study area is constrained by a cluster of constraints between Shepton Mallet and Frome. Whilst an overhead line could be established through this area the constraints would have an influence on the directness of a potential route. The existing 400kV Hinkley to Melksham overhead line travels through the southern part of the study area. In this area an overhead line route could be achieved between constraints. However, it would need to pass close to the edge of Cranbourne Chase and West Wiltshire Downs AONB and numerous blocks of woodland.

<u>Rebuild of Iron Acton to Melksham Overhead Line</u>

10.15 As for Option PC1.

<u>Seabank to Tockington new overhead line</u>

10.16 As for Option PC1.

PC2 Planning Policy Assessment

10.17 The Core Strategies relevant to this option are those of Sedgemoor and Mendip District Councils and Wiltshire Unitary Council. Sedgemoor's proposed Core Strategy focuses on Bridgwater as the principal area for growth and identifies key rural settlements for local growth to improve self containment and strengthen local communities with Woolavington, Puriton, Mark, East Huntspill, Wedmore, Ashcott and Westonzoyland included in this definition. Shepton Mallet, Glastonbury, Frome and Street are five market towns identified as the focus for locally significant development, to increase their self containment and role as service centres. Trowbridge is one of the three strategically significant towns identified in Wiltshire's preferred spatial strategy with a focus on economic and housing growth. The West Wiltshire Local Plan promotes regeneration of towns in the A350 corridor (Trowbridge, Melksham and Westbury) and seeks a balance of development and environmental protection in Bradford on Avon, Warminster and other villages and rural areas.

10.18 The Potential Connection would need to consider spatial growth aspirations and connection routeing studies will need to avoid the key settlements.

10.19 The development of an 80 km overhead line between Bridgwater and Melksham would not be a significant factor in either successfully meeting or underperforming against the planning objectives as expressed in paragraph 10.17. Important recreation and leisure features such as the Kennet and Avon Canal or urban fringe country parks, will need consideration as part of routeing studies but any potential negative impacts are likely to be mitigated through detailed routeing.

PC2 Tourism Sector Assessment

10.20 The tourism economy of Sedgemoor, Mendip, and Wiltshire attracts approximately £520 million visitor expenditure with day and stay visitor numbers being broadly similar (6.7 million day visits and 5.5 million staying nights). Relative to other options, the area has a relatively large tourism and leisure sector. The visitor attraction relates to the historic environments of the main towns (e.g. Glastonbury Abbey, attracting over 100,000 visits annually) environment (e.g. the Mendip Hills AONB and linked concentrations of tourism businesses to the west of Shepton Mallett, Glastonbury Tor) and a small number of attractions / tourist parks including Centreparcs, Longleat Estate and Safari, Glastonbury Lake Village Museum etc. Some such as Longleat Estate are of regional significance attracting some 250,000 visitors per annum. The predominant tourism and leisure related businesses are accommodation providers.

10.21 Despite the presence of some regionally significant attractions, most potential tourism and recreation impacts are capable of being mitigated by careful routeing. Potential tourism impacts at the strategic level are therefore not considered significant.

PC2 Agricultural Land Quality Assessment

10.22 Some 7,592 ha. (9.7%) of the option area's agricultural land is Grade 1 'Excellent' or Grade 2 'Very good' . The potential impact on these areas can be mitigated through careful routeing, the landtake once operational is anticipated to be minimal. As such, at this strategic level there are considered to be no significant agricultural land constraints associated with this Potential Connection.

Iron Acton - Melksham OHL Upgrade Impact

10.23 As for Option PC1

Seabank –Tockington new overhead line

10.24 As for Option PC1

11 PC3: Bridgwater – Nursling

11.1 PC3 would involve uprating the existing 275kV Hinkley Point to Bridgwater overhead line to operate at 400kV and constructing a new transmission connection between Bridgwater and Nursling (110km), near Southampton. This resolves the transmission issues associated with the South West which are explained in the Need Case.

11.2 However, as explained in paragraph 4.11, additional works would be required in order to resolve the issues associated with South Wales and Gloucestershire. For the purpose of this analysis it is assumed that this would require a rebuild of the existing 275kV connection between Iron Acton and Melksham (30km) to operate at 400kV and the construction of a 400kV substation at Iron Acton.

11.3 In addition, as explained in paragraph 4.14 two new transmission circuits are required to facilitate the connection of new generation at Seabank. For the purpose of this analysis it is assumed that two additional transmission circuits between Seabank and Tockington are required.

11.4 As explained in Section 8 there are Transmission System Upgrades and Generator Connection Assets, which are common across each of the Potential Connections, and that are required to upgrade the existing system.

11.5 These works are incorporated within the cost estimates but have not been included within the environmental or socio-economic appraisal as they would not help to distinguish between options.

Technology Options Considered for PC3

11.6 With a total new connection length of 146km, comprised of 110km between Bridgwater and Nursling, 30km between Iron Acton and Melksham, and 6km between Seabank and Tockington, this Potential Connection is significantly longer than the shortest new on-shore connection length of PC4 which is 57km. As such undergrounding and GIL technology options have not been considered for PC3 as they would incur significantly higher costs whilst providing no amenity benefit over the use of these technologies on the shorter PC4.

11.7 PC3 is therefore assessed for the use of AC overhead line technology.

11.8 The cost estimates associated with PC3 are summarised in Table 12 below.

Generator Connection Assets		
As described in Chapter 8		£201.6m
System Upgrades		
As described in Chapter 8		£289.8m
Transmission Reinforcement Assets		
To resolve the South West Boundary	Hinkley Point – Bridgwater 275kV – 400kV upgrade	£9.7m
	New Bridgwater 400kV Substation	£12.2m
	New Bridgwater – Nursling 400kV circuit	£176m
	Extension of Nursling 400kV substation	£96.1m
To resolve the South Wales & Gloucestershire Boundary	New Iron Acton 400kV substation	£152.6m
	Iron Acton - Melksham offline rebuild	
To resolve loss of power infeed at Seabank	New Seabank – Tockington Tee 400kV double circuit	£9.6m
Contingent Transmission Works		
New Chilling tunnel and uprate cables on Fawley – Lovedean circuits		£146.5m
	TOTAL	£1094m

Table 12 – PC3 Cost Summary

Lifetime Cost

The lifetime cost of the AC overhead line component of PC3 is shown in the table below:

	PC3 (Bridg-Nurs OHL)
Capital Cost	£176m
Transmission Loss Cost	£86.5m
Maintenance Cost	£3.5m
Lifetime Cost	**£266.0m**

Table 13: PC3 Lifetime Cost

PC3 Environmental Appraisal

11.9 The study area for the Bridgwater – Nursling connection is illustrated at Figure 13 and extends for approximately 110km from the eastern edge of Bridgwater, Somerset to Nursling substation in Hampshire. An existing overhead line owned and operated by National Grid travels through the western part of the study area between the Hinkley Point and Melksham substations (ZG Route). Two further high voltage overhead lines connect into the existing National Grid Nursling substation; these comprise the Mannington to Nursling overhead line (YB Route) and the Nursling to Lovedean overhead line (YC Route).

11.10 The study area includes the main settlements of Glastonbury, Shepton Mallet and Frome in Somerset, Warminster and Salisbury in Wiltshire and Romsey and Nursling in Hampshire.

11.11 The most significant constraints to achieving a direct overhead line route between Bridgwater and Nursling are Cranbourne Chase and West Wiltshire Downs AONB and the New Forest National Park. An overhead line through these sites would have an effect on the landscape which will affect the objective to conserve and enhance their natural beauty. These sites and the numerous SMs contained within them constrain a direct overhead line route and limit the study area to a swathe of land to the north of the designations. Whilst these sites could be avoided by a Potential Connection between Bridgwater and Nursling as part of detailed routeing studies further assessment would be required to determine the potential for adverse effects on the setting of the AONB and National Park as a result of the Potential Connection.

11.12 The construction of a new Bridgwater to Nursling overhead line parallel to the existing 400kV Hinkley Point to Melksham overhead line for approximately half of the Potential Connection would result in cumulative visual effects but would limit adverse effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists. However, a new overhead line parallel to the existing line would pass through the Somerset Levels and Moors SPA, SSSI, Ramsar sites and parts of the Somerset Levels containing a high concentration of SMs. The effects of an additional overhead line on the SPA, SSSI and Ramsar designations would require further assessment in accordance with the Conservation of Habitats and Species Regulations 2010 to ensure that there would be no adverse effects on the integrity of the designation or its qualifying features if this connection was identified as the most suitable Potential Connection and taken forward.

11.13 Between Warminster and Nursling a variety of constraints would influence the route and directness of an overhead line connection. These include the settlements of Warminster and Salisbury, Salisbury Plain SSSI, SPA and SAC, Stonehenge World Heritage Site and numerous blocks of woodland to the north of Nursling. Through this area an overhead line route would be on generally lower ground within a valley. This would provide opportunities for backgrounding to limit effects on landscape and views. However, any overhead line route would need to pass close to the edge of Cranbourne Chase and West Wiltshire Downs AONB, Stonehenge World Heritage Site and the New Forest National Park and would oversail the River Avon SSSI and SAC. If this Potential Connection was taken forward further detailed study would be required to determine the potential for direct and indirect effects on these sites.

<u>Rebuild of Iron Acton to Melksham Overhead Line</u>

11.14 As for option PC1.

<u>Seabank to Tockington new overhead line</u>

11.15 As for Option PC1.

PC3 Planning Policy Assessment

11.16 Sedgemoor's proposed Core Strategy focuses on Bridgwater as the main area for growth and identifies key rural settlements for local growth including Woolavington, Puriton, Mark, East Huntspill, Wedmore, Ashcott and Westonzoyland.

11.17 Similarly the Mendip Local Plan identifies Shepton Mallet, Glastonbury, Frome and Street as the focus for locally significant development, to increase their role as service centres.

11.18 Wiltshire's preferred Core Strategy focuses economic and housing growth in three strategically significant towns of which Salisbury is relevant to this strategic option. Warminster is designated as a market town where the preferred Core Strategy allows sufficient growth to enable it to grow its service centre role. The West Wiltshire Local Plan focuses on regeneration of the towns in the A350 corridor (Trowbridge, Melksham and Westbury) and seeks a balance of development and environmental protection in Warminster and other villages and rural areas. South Wiltshire's Core Strategy identifies Salisbury as the primary strategic service centre with a focus for growth; whereas local services centres - includes Wilton within the study area – are designated for limited growth only.

11.19 Test Valley "preferred options" consultations (the last available Core Strategy related document) identify Romsey as one of two main centres for growth, with key service centres defined (including Nursling) for limited growth. In the Southern Test Valley existing capacity in settlements was expected to accommodate housing requirements, in particular sites in Romsey and North Baddesley with a housing reserve site allocated near Romsey. The Test Valley Core Strategy preferred options report proposed 9 strategic employment site allocations including Romsey, Nursling, North Baddersley, Valley Park and Chilworth.

11.20 These strategic employment allocations are not incompatible with an overhead line as it could be accommodated within any potential development.

11.21 Overhead line routeing would normally seek to avoid settlements, however there may be negative visual impacts for settlements within the option area, particularly for the rural Service Centres and villages identified in spatial strategies, and for Warminster, Glastonbury and Salisbury where the setting of the towns is significant and is part of the attraction to visitors. Impacts may be less negative or neutral for some larger towns and neutral for Bridgwater itself.

PC3 Tourism Sector Assessment

11.22 The area examined for Option PC3 Bridgwater-Nursling overhead line contains nearly 320 tourism and leisure businesses. The key concentrations are in and close to the main towns i.e. Street, Glastonbury, and Salisbury, with accommodation businesses prevalent.

11.23 In addition to the natural attractions common to options PC1 and PC2 (i.e. the Cotswold AONB, and in the case of PC2 the Mendip Hills AONB), this option area also includes two visitor destinations of national and international significance, namely the Stonehenge World Heritage site (with some 890,000 visitors annually, 50% of whom come from overseas), and the New Forest, which now has National Park status and attracts some 13 million day visits each year (40% staying tourists, 25% day-trippers travelling more than 5 miles, and 35% living within 5 miles.). Overhead line routeing would have to consider the tourism and recreation value of both sites. Any connection should avoid the World Heritage site and would need to consider Salisbury Plain SSSI and other conservation designations, as well as Cranbourne Chase and West Wiltshire Downs AONB.

11.24 Other important tourist attractions include: Glastonbury Lake Village Museum, Longleat Estate and Safari Park, Glastonbury (Tor, Abbey and festival) and Salisbury Cathedral (the latter attracting some 233,000 visitors annually).

11.25 The tourism economy of Mendip, West Wiltshire, Sailsbury, and Test Valley attracts approximately £648 million in visitor expenditure annually with much higher number of day visitors compared to stay visitor numbers (10.5 million day visits and 4.3 million staying nights). While it should be possible to mitigate potential impacts on these areas through careful routeing, given the concentration of designations and the value of the visual tourism and visitor asset in the east of the option area, the potential for effects should be considered as part of routeing studies.

PC3 Agricultural Land Quality Assessment

11.26 The option area extends to some 19,337 ha, over 12% of which is the highest grade agricultural land (Grade 1 'Excellent' and Grade 2 'Very good'). As with Option PC2, most of this is located north-west of Glastonbury and north-east of Bridgwater, although large areas are also found surrounding Warminster (particularly to the south). Again, while the potential impact on high quality agricultural land may be mitigated through careful routeing, the landtake once operational is anticipated to be minimal in any case. At this strategic level, and on the basis of the information available, there are considered to be no significant agricultural land constraints associated with this option.

Rebuild of Iron Acton to Melksham Overhead Line

11.27 As for Option PC1.

Seabank –Tockington new overhead line

11.28 As for Option PC1

12 PC4: Bridgwater – Seabank (on-shore)

12.1 PC4 would involve uprating the existing Hinkley Point to Bridgwater circuit to operate at 400kV and constructing a new transmission connection between Bridgwater and Seabank (57km), in Avonmouth. This connection resolves the transmission issues associated with the South West, South Wales & Gloucestershire and the system issues around Seabank 400kV which were explained in Section 4.

12.2 However, as explained in Section 8 there are Transmission System Upgrades and Generator Connection Assets, which are common across each of the Potential Connections, and that are required to upgrade the existing system.

12.3 These works are incorporated within the cost estimates but have not been included within the environmental or socio-economic appraisal as they would not help to distinguish between options.

Technology Options Considered for PC4

12.4 PC4 is the shortest of the on-shore connection options at approximately 57km. As such overhead line, undergrounding and GIL technology options have each been considered for PC4 as set out below:

- PC4a: Bridgwater – Seabank 400kV Overhead Line
- PC4b: Bridgwater – Seabank 400kV AC underground cable
- PC4c: Bridgwater – Seabank 400kV AC Gas Insulated Line (GIL)

12.5 The cost estimates associated with PC4a, PC4b and PC4c are summarised in Table 14-16 below.

Generator Connection Assets		
As described in Chapter 8		£201.6m
System Upgrades		
As described in Chapter 8		£289.8m
Transmission Reinforcement Assets		
Resolves the South West Boundary, South Wales & Gloucestershire and loss of power infeed at Seabank.	Hinkley Point – Bridgwater 275kV – 400kV upgrade	£9.7m
	New Bridgwater 400kV Substation	£12.2m
	New Bridgwater – Seabank 400kV circuit	£91.2m
	Sub-total	£113.1m
Contingent Transmission Works		
Reconductor Seabank – Aust 400kV circuit		£8.4m
	Sub-total	£8.4m
	TOTAL	£612.9m

Table 14 – PC4a Capital Cost Summary

<table>
<tr><td colspan="3">Generator Connection Assets</td></tr>
<tr><td colspan="2">As described in Chapter 8</td><td>£201.6m</td></tr>
<tr><td colspan="3">System Upgrades</td></tr>
<tr><td colspan="2">As described in Chapter 8</td><td>£289.8m</td></tr>
<tr><td colspan="3">Transmission Reinforcement Assets</td></tr>
<tr><td rowspan="6">Resolves the South West Boundary, South Wales & Gloucestershire and loss of power infeed at Seabank.</td><td>Hinkley Point – Bridgwater 275kV – 400kV upgrade</td><td>£9.7m</td></tr>
<tr><td>New Bridgwater 400kV Substation</td><td>£12.2m</td></tr>
<tr><td>Bridgwater 400kV substation extension</td><td>£27.8m</td></tr>
<tr><td>New Bridgwater – Seabank 400kV AC cables (2 cables per phase)</td><td>£1026m</td></tr>
<tr><td>Extension of Seabank 400kV substation</td><td>£15.6m</td></tr>
<tr><td>Shunt Reactors at Bridgwater and Seabank</td><td>£12m</td></tr>
<tr><td colspan="3">Contingent Transmission Works</td></tr>
<tr><td colspan="2">Reconductor Seabank – Aust 400kV circuit</td><td>£8.4m</td></tr>
<tr><td colspan="2">Sub-total</td><td>£8.4m</td></tr>
<tr><td colspan="2">TOTAL</td><td>£1603.1m</td></tr>
</table>

Table 15 – PC4b Capital Cost Summary

Generator Connection Assets		
As described in Chapter 8		£201.6m
System Upgrades		
As described in Chapter 8		£289.8m
Transmission Reinforcement Assets		
Resolves the South West Boundary, South Wales & Gloucestershire and loss of power infeed at Seabank.	Hinkley Point – Bridgwater 275kV – 400kV upgrade	£9.7m
	New Bridgwater 400kV Substation	£12.2m
	New Bridgwater – Seabank 400kV GIL circuits	£866.4m
Contingent Transmission Works		
Reconductor Seabank – Aust 400kV circuit		£8.4m
	Sub-total	£8.4m
	TOTAL	£1388m

Table 16 – PC4c Capital Cost Summary

Lifetime Cost

12.6 PC4 can be delivered by either AC overhead line, underground cable or by a GIL connection. The options as detailed in Tables 14-16 above have the same scope of works except for the different type of connection and in the case of AC cables the requirement for shunt reactors.

12.7 The lifetime cost methodology is explained in Appendix 1 but for the overhead line component of PC4a, the cable and shunt reactor components of PC4b and the GIL component of PC4c are shown in Table 17 below:

	PC4a OHL	PC4b Cable and Shunt Reactors	PC4c GIL
Capital Cost	£91.2m	£1,038m	£866.4m
Transmission Loss Cost	£44.8m	£34.3m	£20.9m
Maintenance Cost	£1.8m	£8.8m	£2.5m
Lifetime Cost	**£137.8m**	**£1081.1m**	**£889.8m**

Table 17: PC4 Lifetime Cost

12.8 The analysis shows that by including the lifetime costs of transmission losses and maintenance that for PC4 an AC overhead line solution is more economical than a GIL solution which is in turn more economical than an AC underground cable solution.

PC4a (overhead line) - Environmental Appraisal

12.9 The study area for the Bridgwater – Seabank connection is illustrated at Figure 14 and extends for approximately 57km from the eastern edge of Bridgwater, Somerset to the existing National Grid 400kV substation at Seabank, Bristol. An existing 132kV overhead line owned and operated by Western Power Distribution (WPD) travels through the study area in a north-south alignment between WPD's existing substations at Bridgwater and Seabank.

12.10 The study area includes the main settlements of Bridgwater and Burnham-on-Sea in Somerset, Weston-super-Mare, Clevedon and Portishead in North Somerset and Avonmouth in Bristol.

12.11 An overhead line connection between Bridgwater and Seabank would need to travel through the Somerset Levels and Moors which was a candidate site for World Heritage Site (WHS) status (although this is no longer being promoted by Somerset County Council). The WHS bid was based on the area's unique palaeo-environmental records that include a 10,000 year record of climate, sea level and landscape change. Features include prehistoric trackways, lake villages, relic roman wetland landscapes, medieval reclamations and river canalisations. Whilst it would be possible to avoid the SMs within the Levels with an overhead line route, effects on their setting would require detailed assessment and further consideration of the effects on other known and unknown non-designated assets would be required as part of detailed routeing studies.

12.12 It would not be feasible to avoid the Mendip Hills AONB in a reasonably direct connection route between Bridgwater and Seabank. To the west of the AONB, a route would be constrained by the settlement of Weston-super-Mare, blocks of ancient woodland and the topography of the landscape. To the east, the AONB extends for approximately 22km and a Potential Connection would be constrained by woodland, settlements and SMs. To minimise visual effects and avoid constraints such as SSSIs, SACs and woodland the connection would need to travel through the AONB for approximately 6km utilising lower ground within the Lox Yeo Valley. An overhead line through this area would have an effect on the landscape which will affect the objective to conserve and enhance natural beauty. As part of detailed routeing studies further assessment would be required to determine the significance of any adverse effects on the AONB and its setting.

12.13 The study area contains large areas of land (including ditches and rhynes) designated as SSSIs (e.g. Puxton Moor SSSI and Nailsea, Tickenham and Kenn Moors SSSI). Due to the presence of other constraints such as settlements, woodland and SMs, a potential route would be constrained to areas of land to the east of the M5. Whilst an overhead line would be able to oversail the ditches and rhynes to which the SSSI designation applies further detailed study would be required to determine the potential for direct and indirect effects on these sites and their features of special interest if this Potential Connection was identified as the most suitable and taken forward.

12.14 Due to the presence of built development which extends from the coast at Avonmouth to the City of Bristol, any Potential Connection to Seabank substation would need to cross the River Avon, a component part of the Severn Estuary SSSI, SAC, SPA and Ramsar site. Further detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects which may arise on the integrity of the designation through the construction or operation of this connection option.

PC4a (overhead line) - Planning Policy Assessment

12.15 Sedgemoor's proposed Core Strategy focuses on Bridgwater as the principal area for growth and identifies key rural settlements for local growth with Woolavington, Mark, East Huntspill and Puriton included in this definition.

12.16 In North Somerset the proposed Core Strategy approach identifies Weston-super-Mare as the main development focus (with urban extension areas combining employment and housing proposals on land to the east of the town and up to the M5). It defines Nailsea, Clevedon and Portishead as 'market and coastal towns' and Banwell, Congresbury, Yatton, Churchill, Locking and Winscombe as "Service Villages" where development should support their role as local hubs with new development within village development boundaries. The North Somerset Replacement Local Plan (2007) set out housing land allocations (those at Portishead and Yatton are relevant). It also included a proposal for a Banwell by pass (north of the village). This proposal has been carried forward into the North Somerset Core Strategy Policy CS10.

12.17 In Bristol, the proposed Core Strategy identifies the Avonmouth area as a regionally important industrial and warehousing business location. The Local Plan had previously identified Avonmouth as a priority area for economic regeneration. A Bristol City Council 'Site Allocations and Development Management Policies' options consultation paper proposes an 'Avonmouth and Kingsweston Urban Edge' designation, for undeveloped land in Avonmouth, to maintain it predominantly as open space. This designation would cover part of the area in the north of Avonmouth and west of the M5. Royal Portbury Dock in North Somerset has some land safeguarded for further development for port uses.

12.18 In South Gloucestershire the Severnside area is identified in the proposed Core Strategy as strategically important for employment uses, safeguarding and developing its uses for distribution and other extensive employment land uses.

12.19 The potential for negative impacts in relation to the settlement strategy in the three rural Districts near to towns and villages identified for some growth will have to be considered further as part of the connection routeing study.

12.20 At Avonmouth and Severnside, impacts are more likely to be neutral as these are areas in economic use within existing overhead line corridors. The potential impact on the achievement or otherwise of planning objectives is considered to be neutral in advance of more detailed route definition as potential effects due to visual impact or land take can be mitigated through careful route design. At this stage, the option does not generate significant impacts on the achievement of planning policy objectives.

PC4a (overhead line) - Tourism Sector Assessment

12.21 The option area has some 207 tourism and leisure businesses, with the areas around Weston-super-Mare and to the north of Burnham-on-Sea having the highest concentration. Many are accommodation providers. This is linked to the areas' coastal location, in particular: Burnham-on-Sea, Berrow, and Brean seven-mile sand beach (one of the longest stretches of sand beach in Europe). Weston Super Mare (a traditional seaside resort with a range of attractions and activities, e.g. Winter Gardens, Seaquarium) and Sand Bay to the north offer holiday park accommodation with coastal and beach access. Coastal areas appear particularly sensitive due to the number of tourism businesses and therefore an overhead line route should avoid them. In the north of this area, and nearby, attractions such as Noah's Ark Zoo Farm (109,000 visitors) and Ashton Court Estate (1.6 million visitors), as well as the National Trust Properties at Clevedon Court and Tyntesfield, are important visitor facilities.

12.22 The Mendip Hills AONB is a particularly significant tourism and recreation resource. Covering an area of approximately 200km^2, the hills run east to west between Weston-super-Mare and Frome, overlooking the Somerset Levels to the south and Avon Valley to the north. The area includes significant features such as Cheddar Caves and Gorge (estimated to attract some 500,000 visitors annually), Wookey Hole Caves, Bristol Water's Chew Valley and Blagdon Lake. As the landscape features are the main attraction, more detailed routeing should take care to avoid these areas wherever possible.

12.23 Despite the presence of regionally significant tourism facilities, tourism impact is not considered significant at a strategic level, as it would be possible to avoid main areas of tourism and visitor activity.

PC4a (overhead line) - Agricultural Land Quality Assessment

12.24 Some 13% of the option area - 7,104 ha – is in the two highest grades of agricultural land (Grade 1 'Excellent' and Grade 2 'Very good'). Concentrations of Grade 1 and Grade 2 high quality agricultural land are located mostly in the northern part of the area of search, in particular around Nailsea, East End, and Horsecastle with a lot of Grade 1 land to the north-east of Horsecastle and east of East End. Land north-east of Bridgwater is also of high quality agricultural grade (mainly between Bridgwater and Bawdrip). Relative to options PC2 and PC3, a greater proportion of land is urban (8%), most of which is in Avonmouth/Bristol. It may be expected that a higher proportion of Grade 3a land will be found in the study area, which may need to be confirmed/investigated at later stages if this option is taken forward.

12.25 The potential impact on these areas should be able to be mitigated through careful routeing, and the landtake once operational is anticipated to be minimal. At this strategic level, and on the basis of the information available, there are considered to be no significant agricultural land constraints associated with this option.

PC4b/4c (Underground cable / GIL) - Environmental Appraisal

12.26 The study area for the Bridgwater – Seabank underground and GIL connection is illustrated at Figure 15 and extends from the eastern edge of Bridgwater, Somerset to the existing National Grid 400kV electricity substation at Seabank, Bristol. The study area includes the main settlements of Bridgwater and Burnham-on-Sea in Somerset, Weston-super-Mare, Clevedon, Portishead in North Somerset and Avonmouth, Bristol.

12.27 Many of these settlements constrain a direct underground/GIL connection route due to their proximity to the western edge of the M5 motorway. As a result this study has focussed on a Potential Connection to east of the M5.

12.28 A new GIL connection between Bridgwater and Seabank could be achieved and would offer benefits in terms of landscape and views over an equivalent length of overhead line. However, the construction of gas filling stations (GIL) may have localised visual effects.

12.29 The construction of underground/GIL connections is more invasive than for an overhead line and would have a greater scale of effect on sites important for their ecology or archaeology. Construction results in disturbance to ground vegetation which could affect the integrity of a designation or its qualifying features and detailed study would be required to determine appropriate working methods and mitigation.

12.30 An underground connection between Bridgwater and Seabank would need to travel through the Somerset Levels and Moors which was a candidate site for World Heritage Site (WHS) status (although this is no longer being promoted by Somerset County Council). The WHS bid was based on the area's unique palaeo-environmental records that include a 10,000 year record of climate, sea level and landscape change. Features include prehistoric trackways, lake villages, relic roman wetland landscapes, medieval reclamations and river canalisations. Whilst it would be possible to avoid the SMs within the Levels there are other known non-designated assets and unknown assets which would be affected.

12.31 An underground/GIL connection would have visual benefits on the setting of designated historic sites but this would need to be balanced with the negative effects on buried archaeology which may be lost through the construction of an underground/GIL connection. Further detailed study along any underground/GIL connection route would be required to identify the potential for archaeological remains and any direct and indirect effects resulting from construction and installation. Planning Policy Statement 5 (PPS5) highlights the importance of the heritage resource stating *'The historic environment and its heritage assets should be conserved'*. To achieve this Government objectives for planning in the historic environment are *'to deliver sustainable development by ensuring policies and decisions concerning the historic environment recognise that heritage assets are a non-renewable resource'*. Underground/GIL connections routed through heritage assets may cause permanent loss due to the wide construction swathe required and the intrusive nature of the construction.

12.32 It would not be feasible to avoid the Mendip Hills AONB in a reasonably direct route between Bridgwater and Seabank. To the west of the AONB, a route would be constrained by the settlement of Weston-super-Mare, blocks of ancient woodland and the topography of the landscape. To the east, the AONB extends for approximately 22km and a Potential Connection would be constrained by woodland, settlements and SMs. The connection would need to be routed through the AONB for approximately 6km on lower ground within the Lox Yeo Valley to avoid constraints such as SSSIs, SACs and woodland. The Potential Connection would give rise to temporary effects on landscape and views within the AONB during construction. However, once the land has re-established, effects would be lower than an equivalent length of overhead line.

12.33 The study area contains large areas of land (including ditches and rhynes) designated as SSSIs (e.g. Puxton Moor and Nailsea, Tickenham and Kenn Moors SSSI). In combination with settlements, woodland and SMs, a potential route would be constrained to narrow areas of land to the east of the M5. Whilst an underground/GIL connection could be achieved which largely avoided these SSSIs they would have an influence on the directness of any route and further detailed assessment would be required to determine the potential for direct and indirect effects on these sites and their features of special interest if this Potential Connection was identified as the most suitable and taken forward.

12.34 The Potential Connection would need to cross the River Avon, a component part of the Severn Estuary SSSI, SAC, SPA and Ramsar site. The use of a tunnel under the River would be less invasive than direct bury techniques but may require the construction of tunnel headhouses on either side of the channel. Further detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects which may arise on the integrity of the designation if this connection was identified as the most suitable Potential Connection and taken forward.

12.35 An underground/GIL connection between Bridgwater and Seabank would offer environmental benefits on landscape and views particularly relating to the Mendip Hills AONB and settlements compared with an overhead line connection. However the potential for effects to arise on designated and non-designated heritage assets and sites designated for their biodiversity value as a result of this Potential Connection would require further assessment as part of detailed routeing studies if this connection was identified as the most suitable Potential Connection and taken forward.

PC4b/4c (Underground cable / GIL) - Planning Policy Assessment

12.36 The option area for the underground/GIL Bridgwater to Seabank Potential Connection is the same as Option PC4a and the Core Strategies relevant to this strategic option are also the same i.e. Sedgemoor, North Somerset, Bristol City and South Gloucestershire.

12.37 Ultimately the visual impacts of GIL will be minimal compared with overhead line options. However, the construction of gas filling stations (GIL) may have localised visual effects.

12.38 While an underground/GIL connection would have temporary construction effects on the landscape of the AONB once the land is re-established effects would be minimal compared to an overhead line. However, consideration would need to be given to any proposals for industrial development in Avonmouth and Severnside.

12.39 The potential impact on the achievement or otherwise of planning objectives is viewed as neutral in advance of more detailed route definition as potential effects due to land take can be mitigated through careful route design. At this stage, the option does not generate significant impacts on the achievement of planning policy objectives.

PC4b/4c (Underground cable / GIL) - Tourism Sector Assessment

12.40 The analysis of the value of the visitor economy for Option PC4a suggests that North Somerset's larger day visitor economy may witness temporary impacts. These however, would be minimal if the potential underground cable/GIL route avoids more popular tourist locations. Despite regionally significant tourism facilities, tourism impact is considered neutral at this stage of the analysis. As visual impacts would be minimised though undergrounding and it should be possible to route away from the main areas of tourism and visitor activity, the impact on tourism is not considered significant at a strategic level.

PC4b/4c (Underground cable / GIL) - Agricultural Land Quality Assessment

12.41 Underground cable/GIL Potential Connection options may have a more negative impact on agricultural land than other PC4 options, due to the land take required across Sedgemoor and North Somerset to bury the cable and subsequently restrict agricultural use within a defined corridor as described in paragraphs 5.6.10 and 5.7.8. North Somerset may have a higher negative impact as the majority of Grade 1 agricultural land in the option area is located around Nailsea, East End, and Horsecastle with a lot of Grade 1 land to the north-east of Horsecastle and east of East End.

12.42 The potential impact on these areas should be able to be mitigated through careful routeing. At this strategic level, and on the basis of the information available, there are considered to be no significant agricultural land constraints associated with this option.

13 PC5: Hinkley – Seabank (subsea)

13.1 PC5a (AC cable) and PC5b (HVDC) would involve establishing a new subsea transmission connection between Hinkley Point and Seabank (50km), in Avonmouth.

13.2 PC5a resolves the transmission issues associated with the South West, South Wales & Gloucestershire and the system issues around Seabank 400kV which were explained in Section 4.

13.3 PC5b resolves the transmission issues associated with the South West and South Wales & Gloucestershire. However, it may not resolve the system issues around Seabank 400kV due to the on-going risk that the HVDC technology would not reverse flow quickly enough to prevent transient instability at Seabank. Although HVDC technology continues to develop quickly there is no operational experience of the technology reversing in the timescales required in this case. Therefore for PC5b the connection between Seabank and Tockington is included.

13.4 As explained in Section 8 there are Transmission System Upgrades and Generator Connection Assets, which are common across each of the Potential Connections, and that are required to upgrade the existing system.

13.5 These works are incorporated within the cost estimates but have not been included within the environmental or socio-economic appraisal as they would not help to distinguish between options.

Technology Options Considered for PC5

13.6 PC5 is approximately 50km in length. As a subsea connection both AC cable and HVDC options have each been considered as set out below:

- PC5a: Hinkley Point – Seabank 400kV Subsea AC Cable
- PC5b: Hinkley Point – Seabank 400kV HVDC Subsea Cable

13.7 For an AC connection, reactive compensation equipment is likely to be required and, for a HVDC connection, 2 converter stations would be required at both ends of the route.

13.8 The cost estimates associated with PC5a and PC5b are summarised in Table 18 and 19 below.

Generator Connection Assets		
As described in Chapter 8		£201.6m
System Upgrades		
As described in Chapter 8		£289.8m
Transmission Reinforcement Assets		
Resolves the South West Boundary, South Wales & Gloucestershire and loss of power infeed at Seabank.	Hinkley 400kV substation extension and shunt reactors	£15.6m
	New Hinkley Point – Seabank 400kV AC cables	£900m
	Extension of Seabank 400kV substation and shunt reactors	£15.6m
	Shunt Reactors at Hinkley Point and Seabank	£12m
Contingent Transmission Works		
Reconductor Seabank – Aust 400kV circuit		£8.4m
	Sub-total	£8.4m
	TOTAL	£1443m

Table 18 – PC5a Capital Cost Summary

Generator Connection Assets		
As described in Chapter 8		£201.6m
System Upgrades		
As described in Chapter 8		£289.8m
Transmission Reinforcement Assets		
To resolve the South West Boundary and South Wales & Gloucestershire Boundary.	2 x 2000MW converters at Hinkley Point	£260m
	New Hinkley Point – Seabank HVDC circuits	£140m
	2 x 2000MW converters at Seabank	£260m
To resolve the loss of power infeed at Seabank.	New Seabank – Tockington 400kV double circuit	£9.6m
Contingent Transmission Works		
Reconductor Seabank – Aust 400kV circuit		£8.4m
	Sub-total	£8.4m
	TOTAL	£1169.4m

Table 19 – PC5b Capital Cost Summary

Lifetime Cost

13.9 PC5 can be delivered by either AC subsea cable or by a HVDC connection which requires converter stations to convert electricity to DC and back to AC electricity.

13.10 The lifetime cost methodology is explained in Appendix 1 but for the specific AC cable & Shunt Reactors of PC5a and HVDC converters & cables of PC5b, the lifetime costs are shown in Table 20 below:

	PC5a **AC** **Cable & Shunt Reactors**	**PC5b** **HVDC** **Converters & Cables**
Capital Cost	£912m	£660m
Transmission Loss Cost	£32.4m	£251.3m
Maintenance Cost	£8m	£85.2m
Lifetime Cost	**£952.4m**	**£996.5m**

Table 20: PC5 Lifetime Cost

13.11 The analysis shows that by including the lifetime costs of transmission losses and maintenance that for PC5 an AC cable solution is more economical than an HVDC solution. This is because of the higher transmission losses incurred in the converter stations and the higher annual maintenance costs also associated with the converter stations.

PC5a and PC5b - Environmental Summary

13.12 The study area for the Hinkley – Seabank connection is illustrated at Figure 16 and extends for approximately 50km between the Hinkley Power Station, West Somerset and the existing National Grid 400kV substation at Seabank, Bristol. The study area for the Potential Connection is focussed on the Severn Estuary, its coastline and land associated with the connection points at Hinkley Point and Seabank.

13.13 The most significant environmental constraints to achieving the Potential Connection would be the Severn Estuary which is designated as a SPA, SAC, SSSI and Ramsar site. Although it may be possible to route the subsea cable largely outside of the SPA and Ramsar designations, the cable would need travel through the SAC designated area and would come on-shore through the SPA/Ramsar designations in proximity to/or through the Bridgwater Bay or Blue Anchor to Lilstock Coast SSSIs to make a connection to the Hinkley Point Power Station and through the Severn Estuary SSSI to make a connection to Seabank.

13.14 The installation of either AC or HVDC subsea cables through the Severn Estuary could result in the following effects on the SPA, SSSI, SAC and Ramsar designations.

- Disturbance of the mudflats / bed of the Estuary from cables installation across a construction swathe of approximately 440m for AC cables or 150m - 350m for HVDC cables (depending on the number of cables required) may alter the species composition of the flora and fauna found within the mudflats;

- Suspended Sediments – resulting from the release of sediment from the cabling activities could affect the benthic communities associated with the SAC designation;

- Mobilisation of contaminants in sediments could impact on the flora and fauna of the Estuary; and

- Disturbance from the cable laying activities could impact on species using the SPA, SAC, SSSI and Ramsar sites.

13.15 The nature and scale of these effects would require further assessment in accordance with the Conservation of Habitats and Species Regulations 2010 to ensure that there would be no adverse effects on the integrity of the designation or its qualifying features. If the likelihood of significant adverse effect could not be ruled out, or if there was uncertainty, then an 'appropriate assessment' would need to be undertaken by the competent authority.

13.16 Where there are likely to be significant effects, consent for development can only be granted where it would not adversely affect the integrity of the site taking into account the manner in which the development will be carried out and any conditions that might be imposed on the consent or there are no alternative solutions and the development must be carried out for imperative reasons of overriding public interest relating to human health, public safety or benefits of primary importance to the environment.

13.17 The construction of converter stations (for a HVDC connection) or reactive compensation equipment (for an AC connection) would require a large land take in the vicinity of the cables landing point. This infrastructure has the potential to result in effects on local amenity and depending on the siting, visual impacts to settlements and effects on the setting of SMs such as Wick Barrow SM at Hinkley Point. The location of the converter stations or reactive compensation equipment would require further consideration and assessment as part of detailed siting studies if this option was taken forward.

13.18 Of the subsea connection methods available to make the Potential Connection, HVDC subsea cables would offer environmental benefits over AC subsea cables as they require the installation of fewer cables over a narrower installation corridor, resulting in less sea-bed disturbance and a shorter installation programme. However, the large converter stations required at either end of the HVDC connection would introduce effects on landscape and views and would require further consideration and assessment as part of detailed siting studies.

Seabank to Tockington new overhead line (PC5b only)

13.19 As for Option PC1.

PC5a and PC5b - Planning Policy Assessment

13.20 At Avonmouth and Severnside impacts are likely to be neutral as these are areas in economic use and land-take issues should be localised to Seabank. Land take could be potentially negative if it extends into allocated employment areas, which the onshore part of the cable would need to avoid.

13.21 The requirement to maintain commercial shipping lanes may be affected by the location of the sub sea cable, particularly were it to cross the entrance to the deep water port at Avonmouth. However, careful routeing should mitigate against this. Should this not be possible, this would become a significant material issue for this option.

13.22 Otherwise, the potential impact on the achievement or otherwise of planning objectives is considered as neutral ahead of detailed route definition. The option does not generate significant impacts on the achievement of planning policy objectives at this stage.

PC5a and PC5b - Tourism Sector Assessment

13.23 Tourism and leisure impact would be restricted to the connection of the sub sea cable at both Seabank and Hinkley. Were an HVDC option pursued, this would include 2 converter stations close to the power stations at both ends of the connection. While their scale would generate visual impacts, it is likely that this would be viewed as part of the concentration of power station and connection infrastructure in each area. While the scope to vary their location is necessarily limited, their presence would be unlikely to significantly affect visitor and tourism activity.

13.24 As an AC connection would not require converter stations, visual impact would be correspondingly less.

13.25 The tourism and leisure sectors are relatively small in both areas and there a few if any major attractors. The impact on tourism businesses is considered to be neutral at this stage of the analysis. Impacts are likely to be minimal due to the relative importance of sector activity in the area. The impact on tourism is not considered significant at a strategic level.

PC5a and PC5b - Agricultural Land Quality Assessment

13.26 Half of the land in the area of search for this option is classified as Grade 3, which may include some of the Grade 3a 'Good quality' land, however the Severnside area is allocated for employment uses and therefore the percentage of Grade 3a land within this area is limited. Around half of the land (Avonmouth) is classified as Urban. The impact on high quality agricultural land may be neutral. Further assessment with respect to Grade 3a and Grade 3b land may be required when defining the onshore part of the cable route and location of additional infrastructure associated with it.

13.27 The potential quantity of land affected will depend upon: where a subsea cable could be laid; where it would surface; and whether HVDC or AC technology was employed. The converter stations associated with an HVDC option would generate a significant land take on the banks of the Severn. However, analysis of Agricultural Land Classification data indicates that this would not affect significant concentrations of high quality agricultural land. As an AC connection would not require converter stations, agricultural land take would be considerably lower.

13.28 The impact on agricultural land is not considered significant at a strategic level, although it would clearly be significant for any landowner affected by an HVDC option.

Seabank -Tockington new overhead line (for PC5b only)

13.29 As for Option PC1

14 Summary of Options Analysis

14.1 This Report describes the review that National Grid has conducted of options to extend the electricity transmission system in the South West and, at the same time, continue to ensure that National Grid complies with its statutory obligations and its licence standards. This analysis is summarised in Table 21.

14.2 The review tested whether, on the basis of the most up to date information, the selection of a connection option based upon the provision of a new overhead transmission line between Bridgwater and Seabank was robust (Strategic Optioneering Report December 2009).

14.3 This Report:

- Reviews the technology options available to meet the identified need for system reinforcement, including the use of AC underground cables and overhead lines, gas insulated lines and HVDC technology;
- Assesses the lifetime costs of each technology option as well as the initial capital cost, and
- Assesses the environmental and socio-economic effects of each option.

14.4 There were five options which after assessment of the transmission capacity issues in the South West, South Wales and Gloucestershire regions, could provide the necessary capacity whilst meeting the requirements of the SQSS:

- PC1 Hinkley – Aberthaw (subsea)
- PC2 Bridgwater - Melksham
- PC3 Bridgwater – Nursling
- PC4 Bridgwater – Seabank (onshore)
- PC5 Hinkley – Seabank (subsea)

14.5 There are a number of different technologies by which the required transmission connection can be made:

- Alternating Current (AC) Overhead transmission lines;
- AC Underground cable circuits;
- AC Gas Insulated lines (GIL), and
- High Voltage Direct Current (HVDC) technology.

Table 21: Options Summary

	Route Length	Environmental	Socio-economic	Technical	Economic	
					Capital Cost[17]	Lifetime Cost[18]
PC1a Hinkley -Aberthaw & Iron Acton – Melksham / Seabank – Tockington (AC subsea / AC OHL)	30km (new) plus 30km (rebuild) and 6km (Seabank-Tockington)	Constrained by a number of international and national designations (e.g. Severn Estuary SAC / SPA / Ramsar / SSSI). As avoidance of the designated sites can't be achieved, an assessment under the Conservation of Habitats and Species Regulation 2010 would be required to determine the potential for significant adverse affects. Requires new 6km overhead line between Seabank and Tockington. Requires 30km rebuild of Iron Acton – Melksham overhead line 16.7km of which would be through the Cotswolds AONB. Requires new substations and reconductoring works across the South Wales network.	There are no significant socio-economic constraints that cannot be addressed by detailed alignment.	Long AC cables will require operational restrictions for management of both voltage and charging current issues. Subsea cable fault repair times are more complex and take longer. Scope of contingent works are significant and would introduce a major construction challenge.	£1,560m	£568.2m
PC1b Hinkley -Aberthaw & Iron Acton – Melksham / Seabank – Tockington (HVDC subsea cable / AC OHL)	30km (new) plus 30km (rebuild) and 6km (new Seabank-Tockington)	Constrained by a number of international and national designations (e.g. Severn Estuary SAC / SPA / Ramsar / SSSI). As avoidance of the designated sites can't be achieved, an assessment under the Conservation of Habitat and Species Regulations (2010) would be required to determine the potential for significant adverse affects. Land take, visual and environmental effects associated with converter station sites at each end of	There are no significant socio-economic constraints that cannot be addressed by detailed siting and alignment.	Multiple converter and cables need to accommodate power flows (maximum currently installed is 350MW although suppliers indicate they could achieve 2000MW). Subsea cable fault repair times are more complex and take longer. Refurbishment required after 20-25 years due to environmental factors. Scope of contingent works are	£1,602m	£940.5m

17 Capital Cost includes the capital cost of system upgrades, generator connection assets and contingent transmission works.

18 Lifetime Cost of the proposed transmission connection assets (overhead lines, underground cables and shunt reactors, GIL and HVDC converters and cables).

	Route Length	Environmental	Socio-economic	Technical	Economic	
					Capital Cost[17]	Lifetime Cost[18]
		the connection. Visual benefit as no overhead line.		significant and would introduce a major construction challenge.		
PC2 Bridgwater - Melksham & Iron Acton – Melksham / Seabank – Tockington (AC OHL)	80km (new) plus 30km (rebuild) and 6km (Seabank-Tockington)	Increased visual impact due to length of route and number of pylons (circa 3 per km equals 258 new pylons plus 90 slightly larger replacement pylons). Conflicts with Rule 6 of the Holford Rules (wirescape) as paralleling of an existing 400kV overhead line would be unavoidable in some places. Constrained by a number of international and national designations (e.g. Somerset Levels and Moors, Mendip Hills and numerous scheduled monuments). Constrained by settlements in the Somerset Levels, Shepton Mallet and Frome. Requires new 6km overhead line between Seabank and Tockington. Requires 30km rebuild of Iron Acton – Melksham overhead line 16.7km of which would be through the Cotswolds AONB.	The option area includes some sensitive historical and environmental areas that attract a lot of tourism e.g. Glastonbury, Street, Bradford-on-Avon and Frome. There are no significant socio-economic constraints that cannot be addressed by detailed routeing.	Well established and proven technology Provides additional spare capacity Ease of maintenance and repair that can extend life to 80 years End of life replacement not onerous Flexible technology able to accommodate further connections along the route	£815m	£193.4m

	Route Length	Environmental	Socio-economic	Technical	Economic	
					Capital Cost[17]	Lifetime Cost[18]
PC3 Bridgwater – Nursling & Iron Acton – Melksham / Seabank – Tockington (AC OHL)	110km (new) plus 30km (rebuild) and 6km (Seabank-Tockington)	Increased visual impact due to length of route and number of pylons (circa 3 per km equals 348 new pylons plus 90 slightly larger replacement pylons). Conflicts with Rule 6 of the Holford Rules (wirescape) as paralleling of an existing 400kV overhead line would be unavoidable in some places. Constrained by a number of international and national ecological designations (e.g. Somerset Levels and Moors, New Forest and Salisbury Plain). Constrained by a number of international and national archaeological designations (e.g. Stonehenge, Salisbury Plain and numerous scheduled monuments). Constrained by a number of national landscape designations (e.g. New Forest National Park, Cranbourne Chase and West Wiltshire Downs AONB). Constrained by settlements in the Somerset Levels, Warminster and Salisbury. Requires new 6km overhead line between Seabank and Tockington. Requires 30km rebuild of Iron Acton – Melksham overhead line 16.7km of which would be through the Cotswolds AONB.	Impact assessed as negative. The tourism economy is particularly important in this option area with significant tourism and recreation assets including Stonehenge and the New Forest. However, there are no significant socio-economic constraints that cannot be addressed by detailed routeing.	Well established and proven technology. Provides additional spare capacity. Ease of maintenance and repair that can extend life to 80 years. End of life replacement not onerous. Flexible technology able to accommodate further connections along the route.	£1,094m	£266m

	Route Length	Environmental	Socio-economic	Technical	Economic	
					Capital Cost[17]	Lifetime Cost[18]
PC4a Hinkley – Seabank (OHL)	57km	Least visual impact of overhead line options due to shorter length of route and fewer pylons (circa 3 per km equals 171 new pylons). Conflicts with Rule 6 of the Holford Rules (wirescape) as paralleling of existing lower voltage overhead lines would be unavoidable in some places. Constrained by a number of international and national designations (e.g. Somerset Levels and Moors, River Avon and numerous scheduled monuments). Would need to travel through approximately 6km of Mendip Hills AONB. Constrained by settlements in the Somerset Levels, Burnham-on-Sea, Weston-super-Mare, Clevedon, Portishead and Avonmouth. No rebuild of 30km Iron Acton –Melksham circuit required. No requirement for new Seabank – Tockington double circuit overhead line.	There are no significant socio-economic constraints that cannot be addressed by detailed alignment and consideration of undergrounding in specific locations or other mitigation.	Well established and proven technology. Provides additional spare capacity. Ease of maintenance and repair that can extend life to 80 years. End of life replacement not onerous. Flexible technology able to accommodate further connections along the route.	£612.9m	£137.8m

	Route Length	Environmental	Socio-economic	Technical	Economic	
					Capital Cost[17]	Lifetime Cost[18]
PC4b Hinkley – Seabank (AC under-ground cable)	57km	Least visual impact of all Potential Connections. Visual benefits as no new overhead lines required. Constrained by a number of international and national designations (e.g. Somerset Levels and Moors, River Avon and numerous scheduled monuments). Would need to travel through approximately 6km of Mendip Hills AONB. Constrained by settlements in the Somerset Levels, Burnham-on-Sea, Weston-super-Mare, Clevedon, Portishead and Avonmouth. Greater potential for effect on buried archaeology and biodiversity resources during construction. No rebuild of 30km Iron Acton –Melksham circuit. No requirement for new Seabank – Tockington overhead line.	There are no significant socio-economic constraints that cannot be addressed by detailed routeing or other mitigation.	Proven technology. Long length will require voltage compensation and operational procedures. Cable failure will require identification, excavation, extraction, delivery of cable and installation which may be significant in duration.	£1,603m	£1081.1m

	Route Length	Environmental	Socio-economic	Technical	Economic	
					Capital Cost[17]	Lifetime Cost[18]
PC4c Hinkley – Seabank (GIL)	57km	Visual benefits as no new overhead lines required. Constrained by a number of international and national designations (e.g. Somerset Levels and Moors, River Avon and numerous scheduled monuments). Would need to travel through approximately 6km of Mendip Hills AONB. Constrained by settlements in the Somerset Levels, Burnham-on-Sea, Weston-super-Mare, Clevedon, Portishead and Avonmouth. Greater potential for effect on buried archaeology and biodiversity resources during construction. Gas filling stations would have localised visual effects. No rebuild of 30km Iron Acton – Melksham circuit required. No requirement for new Seabank – Tockington overhead line.	There are no significant socio-economic constraints that cannot be addressed by detailed routeing or other mitigation.	Developing technology. Very limited experience at 400kV. Currently longest direct buried 400kV length in service is circa 1km. Gas Zone separation is required every few km with access to gas and de-gas system required. Failure will require, excavation, de-gassing access, extraction, equipment delivery and installation.	£1,388m	£889.8m

	Route Length	Environmental	Socio-economic	Technical	Economic	
					Capital Cost[17]	Lifetime Cost[18]
PC5a Hinkley – Seabank (AC subsea)	50km	Visual benefits as no new overhead lines required. Constrained by a number of international and national designations (e.g. Severn Estuary SAC / SPA / Ramsar / SSSI.) As avoidance of the designated sites can't be achieved, an assessment under the Conservation of Habitats and Species Regulations (2010) would be required to determine the potential for significant adverse affects. No rebuild of 30km Iron Acton – Melksham circuit required. No requirement for new Seabank – Tockington overhead line.	There are no significant socio-economic constraints that cannot be addressed by detailed siting and routeing.	Long AC cables will require operational restrictions for management of both voltage and charging current issues. Subsea cable fault repair times are more complex and take longer.	£1,443m	£952.4m
PC5b Hinkley – Seabank and Seabank – Tockington (HVDC subsea / OHL)	50km and plus 6km (Seabank-Tockington)	Constrained by a number of international and national designations (e.g. Severn Estuary SAC / SPA / Ramsar / SSSI.) As avoidance of the designated sites can't be achieved, an assessment under the Conservation of Habitats and Species Regulations (2010) would be required to determine the potential for significant adverse affects. Land take, visual and environmental effects associated with converter station sites at each end of the connection Visual benefit as less overhead line	There are no significant socio-economic constraints that cannot be addressed by detailed siting and routeing.	Multiple converter and cables need to accommodate power flows (maximum currently installed is 350MW although suppliers indicate they could achieve 2000MW). Subsea cable fault repair times are more complex and take longer. Refurbishment required after 20-25 years due to environmental factors.	£1,169m	£996.5m

14.6 The economic review showed that AC overhead line technology would be the most economic of the options. AC underground cables and GIL are less economic but could be used in combination which AC overhead lines if there is a need to mitigate the potential impacts of overhead lines on sensitive locations. HVDC generally becomes more economic where transmission takes place over long distances; which does not apply in this case and is therefore the most expensive of the options considered in this review. Differences in lifetime costs which have also been calculated are not sufficiently significant to influence a decision.

14.7 An evaluation of socio-economic factors considered the potential impacts of each connection option on the main areas of economic importance in planning policy terms and on the tourism and agricultural business sectors. It concluded that it was not possible to discriminate between options on the basis of the socio-economic evaluation.

14.8 The significant cost of the Hinkley-Aberthaw (PC1) and Hinkley-Seabank (PC5) sub-sea options, together with connection routes through the Severn Estuary, which would require further assessment to establish the potential for any significant adverse effects on the Ramsar site, Special Protection Area, Special Area of Conservation and Site of Special Scientific interest, lead to the conclusion that these options should only be pursued if there were no other practicable options.

14.9 The additional works (e.g. Iron Action - Melksham rebuild and Seabank - Tockington new overhead line), greater length and amenity impact, capital and lifetime costs of potential connections between Bridgwater and Melksham or Nursling compared with those of Bridgwater to Seabank means that, of the overhead line options, Bridgwater to Seabank would be preferred for further development. The two other technology options considered for a Bridgwater to Seabank connection would both be more than an overhead line connection, GIL would be £775m more expensive and an AC underground cable £990m more expensive. While both would offer benefits in terms of landscape and views over an equivalent length of overhead line, the construction of underground/GIL connections would be more invasive than for an overhead line and would have a greater scale of effect on sites important for their ecology or archaeology.

14.10 The conclusion of this Report is that the option of constructing an overhead transmission line between Bridgwater and Seabank would best meet National Grid's technical, economic and environmental obligations and should remain the preferred option to take forward for further investigation, taking National Grid's statutory obligations and its licence standards into account. However, National Grid recognises that due to amenity issues in some areas, sections of the proposed connection may be placed underground. These and other mitigation measures will be investigated in the next stage of the project.

Glossary

AC	Alternating current
Amps	The unit of electrical current, symbol A.
AONB	Area of Outstanding Natural Beauty
bn	Billion
Boundary	Boundaries reflect the main weaknesses on the interconnected system. Such weaknesses can lead to the need to restrict power flows across the system.
CCGT	Combined Cycle Gas Turbine
CSC	Current Source Converter
DNO	Distribution Network Operator
GIL	Gas Insulated Line
GW	Gigawatt (one thousand Megawatts)
ha	Hectare
HV	High Voltage
HVDC	High Voltage Direct Current
Hz	Hertz
km	Kilometre
kV	Kilovolt (one thousand volts)
MVA	Mega Volt Amp (one million volt amps) – This is a Standard Unit and is used to describe physical capabilities of electrical equipment.
MW	Megawatt (one million watts)
Need Case	Hinkley Point C Connection: Need Case for the South West and the South Wales and Gloucestershire Region August 2011
NGET	National Grid Electricity Transmission
Ofgem	Office of the Gas and Electricity Markets
OHL	Overhead line
SAC	Special Area of Conservation
SF6	Sulphur Hexafluoride Gas

SGT	Supergrid transformer
SPA	Special Protection Area
SQSS	National Electricity Transmission system Security and Quality of Supply Standard
SSSI	Site of Special Scientific Interest
SM	Scheduled Monument
VSC	Voltage Source Converter
WPD	Western Power Distribution
XLPE	Cross-linked polyethylene cable

Appendix 1

LIFETIME COSTS

A1.1 National Grid has prepared a lifetime valuation for each of the connection options and applicable technology. The valuation includes the lifetime cost of energy losses and lifetime operation and maintenance costs.

A1.2 The following formula was used to assess the lifetime cost of each type of connection.

Total Cost, CTot = CDC + CL + COM

Where

CDC = The capital cost of the equipment, delivered, installed and commissioned

CL = The net present value of the cost of losses over the lifetime (40years) of the assets

COM = "The net present value of the typical cost of operation and maintenance over the lifetime (40 years) of the assets

A1.3 The discount rate used in the net present value calculations, 3.5%, being the figure recommended in Her Majesty's Treasury's Green Book for discounting future benefits and costs in project appraisal.

A1.4 The average load of a transmission circuit which is integrated into the transmission system is estimated to be 34%. This is based on the analysis of the load on each circuit in the National Grid transmission system over the course of a year, which includes varying generation and demand conditions. This analysis shows that the average loading is 34% of the circuit's capability and this figure has been used to determine the average losses for each new circuit connection option. The average loading is lower than expected because peak loads are seen typically for only limited periods during the year although all circuits must have sufficient capacity to accommodate the peak power flows in order to meet the requirements of the NETS SQSS.

Costs

A1.5 The cost used to assess losses on the system is the price of £60 per MWh as assumed by Ofgem in the Project Discovery documents.

A1.6 The available transmission technologies, as explained in Section 5 are:

a. Overhead Lines;

b. AC Underground Cables;

c. Gas Insulated Lines, and

d. High Voltage DC Underground Cables.

A1.7 For each technology, costs comprise:

a. the capital cost of procuring, installing and commissioning the transmission lines;

b. the on-going costs of the electrical energy lost in overcoming the electrical resistance in the conductors; and

c. the on-going other costs of operations and maintenance.

A1.8 It is unusual for a part of the transmission system to be decommissioned and the site reinstated. Typically, transmission assets will be decommissioned and removed only as part of an upgrade or replacement by different assets. Hence, decommissioning and reinstatement costs are not included in the lifetime costs.

Overhead Lines

A1.9 There are three principal designs in current use by National Grid. These designs vary by the number and cross-sectional area of the conductors used for each phase of each circuit:

a. double-circuit 2 x 570mm^2 (resistance = 0.025Ω/km);

b. double-circuit 2 x 850mm^2 (resistance = 0.0184Ω/km), required for Bridgwater – Seabank connection, and

c. double-circuit 3 x 700mm^2 (resistance = 0.014Ω/km).

A1.10 Operations and maintenance costs consist principally of the cost of repainting the transmission pylons, which is scheduled to happen every 18 years, and the costs of regular inspection both from the ground and by helicopter. The annual costs are estimated to £0.80k/km.

AC Underground Cables

A1.11 AC underground cables installations vary principally by how the cables are laid. The principal methods employed by National Grid are direct burial and deep bore tunnels.

a. The Cable requirement for a Bridgwater – Seabank connection is for two cores per phase 2500mm2 cables, 12 cables in total for two circuits (resistance = 0.0065Ω/km).

b. However with each circuit generating 20MVAr per km of capacitive gain, each circuit would require 2 x 200MVAr reactors (4 in total for two circuits). Each Reactor has 0.4MW of losses associated with it (1.6MW for 4 reactors).

A1.12 O&M costs have an approximate annual cost of £2.80 k/km.

Gas Insulated Lines

A1.13 Like underground cables, gas insulated lines may be direct-buried or installed in tunnels. As with cables, tunnel installation is used where direct burial is impracticable.

a. The GIL requirement for the Bridgwater - Seabank connection is for 4000A, 2400MVA rated equipment (resistance = 0.0086Ω/km).

A1.14 The annual maintenance costs for gas insulated lines are estimated to be £1k per km.

HVDC Technology

A1.15 There are two broad categories of HVDC systems: voltage source converter (VSC) and current source converter (CSC).

A1.16 Converter stations dominate electrical losses with approximately 0.5-1% of the power transmitted being lost at each end for a CSC and 1-2% at each end for a VSC. Cable losses in HVDC systems are negligible.

A1.17 Annual operation and maintenance costs are significant and estimated to be approximately £1m per converter station.

Calculation of the Cost of Transmission Losses

A1.18 The cost of transmission losses are calculated as follows:

Step 1: Calculate the Average Circuit Loading

- Peak Circuit Power Flow * Average Circuit Utilisation (34%)

Generic Example: 3100MW x 0.34% peak load would be 1054MW Average Loading

Step 2: Calculate the Average Loading per Circuit in KW:

- Average Loading per Circuit kW =

(Average Loading (MW) / number of circuits) * 1000 (to convert to kW)

There are 2 circuits in most cases.

Example: (1054MW / 2) x 1000 = 527,000 kW

Step 3: Calculate the Average Current per Circuit in Amps:

- I = Average Loading Per Circuit kW / (√3 X Operating Voltage in kV)

Operating Voltage 400kV or 275kV

Example: 527,000/ (√3 x 400) = 760.7 Amps

Step 4: Calculate the Resistance per Circuit:

- R = resistance/km * circuit length kms

Example: 2 x 850mm Overhead Line = 0.0184Ω/km x 60km = 1.104 Ω

Step 5: Calculate the Three Phase Lost Power per Circuit in MW:

- Three Phase Lost Power per circuit = $3 \times I^2 \times R$

  Example: $3 \times 760.7^2 \times 1.104$ = 1.9MW

Step 6: Calculate the Lost Power in a 2 Circuit Route:

- This is multiplied by 2 to get the losses in a two circuit route

  Example: 1.9 x 2 = 3.8MW

Step 7: Calculate the Annual Cost of Losses:

- Annual Loss Cost = Lost Power x Cost per MWh x 24hrs x 365 days a year

  Example: 3.8 x £60 per MWh x 24hrs x 365 days a year = £2m per annum

Step 8: Calculate the Average Loading per Circuit in KW:

- The net present value of transmission losses is then derived by applying a discount rate of 3.5% to the annual cost over 40 years.

Appendix 2

ENVIRONMENTAL APPRAISALS

Appendix 2 - Environmental Appraisals

PC1 Hinkley - Aberthaw

HINKLEY TO ABERTHAW ENVIRONMENTAL APPRAISAL

1.0 INTRODUCTION

1.1 This planning and environmental appraisal (the Study) has been produced by Mott MacDonald (MML) for National Grid Electricity Transmission plc (National Grid). The appraisal considers the planning and environmental constraints associated with the installation of a subsea cable connection between the proposed Hinkley Point C Power Station (Power Station) and Aberthaw Power Station (the Potential Connection).

1.2 The Potential Connection is one of a number of alternative options considered by National Grid to facilitate the connection of the Power Station to the high voltage electricity transmission system. Detailed technical information relating to the Potential Connection is set out under option PC1 in the Hinkley Point C Connection Strategic Optioneering Report (August 2011).

Assumptions

1.3 For the purpose of this Study it has been assumed that the new 400kV Potential Connection would be made via either high voltage alternating current (AC) sub-sea cables or high voltage direct current (HVDC) sub-sea cables. Detailed technical information relating to each of these connection methods is set out in Section 5.0 of the Strategic Optioneering Report; a brief summary of the points relevant to this Study is summarised below.

<u>HVDC Subsea Cables</u>

1.4 For an HVDC sub-sea cable connection up to 8 cables would be required.

1.5 The HVDC cables are likely to be laid in bundled pairs, to reduce the risk of interference with the ship navigation systems. Each bundled pair would be installed in its own trench on the sea-bed. Due to the shipping movements, sediment mobility and dredging activities in the Severn Estuary, an average depth of cover of 1–3m is likely to be required. Additional protection for the cables (e.g. concrete or sand filled mattresses, rock armour, etc.) may also be required in addition to, or as an alternative to, deeper burial in areas where special constraints (e.g. dredging, areas of high sediment mobility, etc.) are encountered.

1.6 Initial studies, undertaken by Mott MacDonald indicate that the overall installation corridor for HVDC subsea cables in the Severn Estuary would be in the range of 150m if 4 cables are required and 350m if 8 cables are required. This includes consideration of factors such as threats from anchor drag and operational maintenance, which dictate the separation distance between bundled pairs of cables.

1.7 Methods of laying and burying subsea cables include continuous lay and bury techniques (such as ploughing and water jetting) and pre-trenching methods where excavation and laying operations are carried out separately. These techniques have varying levels of impact with respect to disturbance of the estuary bed. Further detailed study would be required to determine the actual methods to be used.

<u>DC Converter Stations</u>

1.8 For a HVDC subsea cable connection, between 2 and 4 AC/DC converter stations would be required at each end of the connection (i.e. at Hinkley Point and Aberthaw), to convert the 400kV AC transmission voltage/current to HVDC voltage/current and vice-versa. The number of converter stations required for the Potential Connection would depend upon the selected transmission voltage for the Potential Connection and the power rating of each converter module. The options considered for the purpose of this Study are 2 x 2000MW at

+/- 500kV DC and 4 x 1000MW at +/- 320kV DC, however, a further detailed options assessment would be required to determine the actual transmission voltage and power rating to be used.

1.9 A 1000MW converter station is anticipated to cover an area of at least 6,000m^2, and a 2000MW converter station at least 20,000m^2. The Potential Connection between Hinkley and Aberthaw is thus anticipated to have a total land occupation of between 24,000m^2 to 40,000m^2 at either end (for 4 x 1GW or 2 x 2GW converter stations), subject to further detailed study. The approximate height of the converter station buildings would be in the range of 20 – 25m. Additional infrastructure to facilitate connections to National Grid's AC substations and transmission network would also be required if the Potential Connection is identified as the most suitable Potential Connection and taken forward.

AC Subsea Cables

1.10 For an AC subsea cable connection up to 12 cables would be required. Each AC cable would typically be laid in a single trench on the sea-bed. The average depth of cover and cable protection considerations are generally as set out for HVDC subsea cables at paragraphs 1.5 to 1.7 above.

1.11 Initial studies, undertaken by Mott MacDonald indicate that the overall installation corridor would be approximately 440m wide, which is wider than estimated for the HVDC options due to the greater number of cables required for an AC connection. This includes consideration of factors such as threats from anchor drag and operational maintenance, which dictate the separations between individual cables.

1.12 AC subsea cable installation, laying vessel, and shore landing considerations are generally as set out for HVDC subsea cables at paragraphs 1.5 to 1.7 above. The construction and installation requirements for land cables would be the same as discussed for HVDC underground cable systems (see Section 5 of the Strategic Optioneering Report).

Associated AC Equipment

1.13 There are no known 400kV AC subsea cable installations of a similar length or electrical circuit rating to the Potential Connection being considered as part of this Study. Further information on the technical feasibility and challenges of long distance AC underground connections is presented in the MML technical report no. 284136/03/A. However, the distances involved in this Potential Connection may require the application of special circuit switching arrangements and additional AC equipment, such as reactive compensation equipment (i.e. shunt reactors) and special duty circuit breakers. Further detailed study would be required to determine the requirement and optimum location of this equipment should this Potential Connection be identified as the most suitable Potential Connection and be taken forward.

Additional Works

1.14 The following additional works would be required to ensure the security and stability of the electricity transmission system should the Potential Connection be taken forward:

- New 400kV substation at Aust, South Gloucestershire;
- New 400kV substation at Hinkley Point, Somerset;
- Installation of 2 Quadrature Boosters at Nursling, Hampshire;
- New underground cable circuit between Cowley, Gloucestershire and Minety, Wiltshire; and
- Extension of Melksham substation.
- New 400kV substations at Aberthaw and Upperboat, South Wales;
- Re-build of the Iron Acton - Melksham 275kV overhead line to 400kV capacity;
- New 400kV double circuit overhead line between Seabank and Tockington;

- New underground cable circuit between Cowley, Gloucestershire and Minety, Wiltshire; and
- Reinforcement of overhead lines from 275kV to 400kV within South Wales.

1.15 The construction of new 400kV substations and the reinforcement of existing overhead lines from 275kV to 400kV operation in South Wales are only required for a connection to Aberthaw. The re-build of the Iron Acton to Melksham 275kV overhead line to 400kV construction and the new 400kV double circuit overhead line between Seabank and Tockington are only required for certain connection options. These works have, therefore, been considered as part of this Study (see Section 3.0).

Environmental Constraints

1.16 This Study has considered environmental constraints of international and national importance. Features considered as constraints to the Potential Connection are presented in Table 1.1 below. The table also summarises the legislation under which protection is inferred and the data sources from which information (where applicable) was taken.

Table 1.1: Environmental constraints and data sources

Feature	Legislation	Routeing Response (and Reference)	Data Sources
National Parks	National Parks and Access to the Countryside Act 1949	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1)	magic.gov.uk
Areas of Outstanding Natural Beauty	National Parks and Access to the Countryside Act 1949/ Countryside and Rights of Way Act 2000	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1	magic.gov.uk
Heritage Coasts	n/a	Seek to avoid (NG Commitments/ Holford Rule 1)	magic.gov.uk
World Heritage Sites	1972 World Heritage Convention	Seek to avoid (NG Commitments/ Holford Rule 1)	english-heritage.org.uk
Sites of Special Scientific Interest	Wildlife and Countryside Act 1981	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Special Protection Areas	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Special Areas of Conservation	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Ramsar sites	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
National Nature Reserves	National Parks and Access to the Countryside Act 1949	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Scheduled Monuments	Ancient Monuments and Archaeological Areas Act 1979	Seek to avoid/consider effect on setting (NG Commitments/ Holford Rule 2)	english-heritage.org.uk
Settlements	n/a	Seek to avoid (Supplementary Note)	Digitised from Ordnance Survey

Feature	Legislation	Routeing Response (and Reference)	Data Sources
Historic buildings (Listed I, II and II*)	Planning (Listed Buildings and Conservation Areas) Act 1990	Seek to avoid/consider effect on setting (Note to Holford Rule 2)	english-heritage.org.uk
Conservation Areas	Planning (Listed Buildings and Conservation Areas) Act 1990	Minimise effects/consider effect on setting (Note to Holford Rule 2)	Development plans
Registered Parks and Gardens	n/a	Seek to avoid (NG Commitments)	magic.gov.uk
Registered Battlefields	n/a	Minimise effects (NG Commitments)	english-heritage.org.uk
Woodlands	n/a	Seek to avoid (Note to Holford Rules 4 and 5)	National Inventory of Woodlands
Landform	n/a	(Holford Rules 4 and 5)	OS Open Data

Environmental Aspects 'Scoped Out' of Assessment at this Stage

1.17 It is not feasible to undertake a meaningful assessment of the effects of the Potential Connection on certain environmental factors both because of the high level nature of this environmental appraisal and because a detailed connection design would have to be identified. As a result the effects of these factors have not influenced the selection of a preferred connection. The factors scoped out of the appraisal at this stage are outlined at paragraphs 1.19 to 1.22 below.

1.18 Although scoped out of the options appraisal process at this stage these factors will require consideration as part of routeing studies, detailed connection design and environmental assessment whichever connection is taken forward.

Flood Risk

1.19 National Grid considers its siting of installations such as substations or converter stations very carefully in relation to flood risk.

1.20 As outlined at paragraph 1.8 above, converter stations would be required for a HVDC subsea connection at both Hinkley Point and Aberthaw and substations would be required at Aberthaw and Upperboat.

1.21 The exact locations of the converter stations and substations would require further detailed consideration and assessment in accordance with Planning Policy Statement (PPS) 25 and Technical Advice Note (TAN) 15 if the Potential Connection was taken forward. However, due to the high level nature of this assessment, flood risk has not been considered an influence on the identification of the most suitable Potential Connection to be taken forward at this stage.

Noise

1.22 Noise during construction will be temporary and managed by procedures and controls to ensure that it is not unacceptable. Noise during operation will be controlled primarily by separation of sources of noise from noise-sensitive receptors and also by noise-suppression measures as appropriate. The review of options considers whether there is likely to be appropriate distances from settlements and dwellings for amenity reasons which would also allow separation to mitigate effects of noise. The noise sources and measures taken will be applied as required for any option and noise is not a material factor in distinguishing between options.

Air Quality

1.23 New transmission infrastructure will not give rise to any material effects on air quality. Temporary construction works can give rise to dust affecting air quality locally. This will be managed by procedures and controls to ensure that it is not unacceptable. These measures will be applied as required for any option and air quality is not a material factor in distinguishing between options.

Transport

1.24 Construction works will involve transport of materials and workforce to sites. The effects will be temporary and will be subject to management to ensure that effects are not unacceptable. This will be the case for any option and transport is not a material factor in distinguishing between options.

Study Area

1.25 The Study area extends for approximately 30km between Power Station, West Somerset and Aberthaw Power Station, Vale of Glamorgan. The Study area for the Potential Connection is focussed on the Severn Estuary/Bristol Channel and land associated with the connection points at Hinkley Point and Aberthaw. However, the additional works associated with this connection (outlined at paragraph 1.14); extend across much of South Wales and parts of South West England.

2.0 ENVIRONMENTAL CONSTRAINTS

2.1 A description of the Study area in relation to the environmental constraints outlined in Table 1.1 above is presented below and illustrated at Map 2 (drawing number 1979.224).

World Heritage Sites, National Parks and Areas of Outstanding Natural Beauty (AONBs)

2.2 There are no World Heritage Sites, National Parks or AONBs within the Study area.

Heritage Coasts

2.3 There is one heritage coast designation within the Study area: the Glamorgan Coast. The Glamorgan Heritage Coast lies immediately west of Aberthaw Power Station and was designated in 1973. The Heritage Coast lies predominantly within the Vale of Glamorgan and comprises approximately 20km of the western part of the Vale coastline extending from Ogmore to Aberthaw. The designation extends from the mean low water mark (MLWM) inland for a distance of approximately 1-1.5km, covering a land area in the region of 30km^2 in total. The Glamorgan Heritage Coast includes some of the Vale of Glamorgan's most important habitats and is managed for its nature conservation interest.

Implications for subsea routeing

2.4 The Heritage Coast is a non-statutory designation applied by local planning authorities in liaison with Natural England and the Countryside Council for Wales (CCW), to protect and preserve the best remaining stretches of undeveloped coastline in Britain. The Vale of Glamorgan's Unitary Development Plan (2005) seeks to conserve and enhance the Heritage Coast.

2.5 This designation could be avoided by locating the subsea cables landing point to the east of this designation.

Sites of Special Scientific Interest (SSSI)

2.6 Within the Study area there are a number of sites designated as SSSIs. The most significant of these sites and the reasons for their designation are summarised in Table 2.1.

Table 2.1 – Summary of SSSIs

Site	Location / Grid Ref	Designation	Reason for Designation
East Aberthaw Coast	ST04066586	SSSI	This coast supports a range of habitats including rocky and sandy shore, shingle spits, saltmarsh, relict sand dunes and Liassic limestone cliffs.
Bridgwater Bay	ST 290480	SSSI and National Nature Reserve	Bridgwater Bay comprises a range of habitats including extensive intertidal mudflats, saltmarsh, shingle beach and grazing marsh intersected by a complex network of ditches. It supports internationally and nationally important over-wintering and passage migrant waders and waterfowl. The ditches and ponds contain a diverse invertebrate fauna including six nationally rare species and eighteen nationally scarce species. The site is an integral part of the Severn Estuary system and is ecologically linked to the Somerset Levels which provide alternative winter feeding grounds for waders and wildfowl.
Blue Anchor to Lilstock Coast	ST 033435	SSSI	Blue Anchor to Lilstock Coast is a geological SSSI in North Somerset which contains important geological exposures and formations from various periods of geological history.
Severn Estuary	ST 480830	SSSI, SPA, SAC, Ramsar	The Severn Estuary SSSI forms part of a larger area which includes the Upper Severn Estuary SSSI, the Taf/Ely Estuary SSSI and Bridgwater Bay SSSI and National Nature Reserve. The Severn Estuary lies on the south west coast of Britain at the mouth of four major rivers (the Severn, Wye, Usk and Avon) and many lesser rivers. The immense tidal range (the second highest in the world) and classic funnel shape make the Severn Estuary unique in Britain and very rare worldwide. The intertidal zone of mudflats, sand banks, rocky platforms and saltmarsh is one of the largest and most important in Britain. The estuarine fauna includes: internationally important populations of waterfowl; invertebrate populations of considerable interest; and large populations of migratory fish, including the nationally rare and endangered *Allis Shad Alosa alosa.*

<u>Implications for subsea routing</u>

2.7 The potential effect of the Potential Connection on a SSSI will depend on the nature of the effect caused and the special interest of the site. Consultation with Natural England and/or the Countryside Council for Wales (CCW) would be required before consent could be granted for any development or operations likely to damage the SSSIs features of qualifying interest.

2.8 There are a number of SSSIs which would influence cable routeing and landing sites due to their size or proximity to one another along the coastline. The Potential Connection would need to cross parts of the Severn Estuary SSSI to achieve the connection between Hinkley

Point and Aberthaw. However, avoidance of large parts of the SSSI could be achieved by careful routeing of the cables through the deepest sections in the middle of the estuary (although this area forms part of the SAC designation).

2.9 Where the subsea cables come ashore at Hinkley Point they could not avoid either the Bridgwater Bay SSSI or Blue Anchor to Lilstock Coast SSSI due to their coverage along the coastline in proximity to the Power Station site. The installation of HVDC subsea cables requires a narrower installation corridor than AC subsea cables (due to a reduced number of cables) and would therefore have environmental benefits. Detailed studies into the effects the installation of HVDC subsea cables as compared to AC subsea cables on the designated sites would be required. Further consideration of the feasibility of different cable installation techniques (such as horizontal directional drilling (HDD)) would be required to minimise effects on these sites. Where steep gradients exist (e.g. shore cliffs) either HDD or tunnelling techniques would need to be considered to minimise effects on the designated sites and their features of special interest. As described in paragraph 2.8, detailed studies into the effects of construction methods on the integrity of the designated site or its qualifying features would be required if this Potential Connection is identified as the most suitable Potential Connection and taken forward.

2.10 To make a landing connection at Aberthaw, the Potential Connection would need to travel through a narrow area of land between the East Aberthaw Coast SSSI and the Glamorgan Coast (Heritage Coast) designations. Further detailed study would be required to determine the potential for direct and indirect effects on these sites if the Potential Connection is identified as the most suitable Potential Connection and taken forward.

Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar sites

Severn Estuary SPA, SAC and Ramsar site

2.11 The Severn Estuary is an internationally important site for bird and wildlife habitats and is one of the most important sites in the UK for wintering wildfowl and waders. The Estuary is protected by a number of important nature conservation designations including: Special Protection Area (SPA), Special Area of Conservation (SAC), and Ramsar Site. These designations and the reasons for designation are outlined below.

2.12 The Severn Estuary SPA lies along the eastern boundary of the Study area and the full extent of the designation covers an area of approximately 24,000ha. The site qualifies as an SPA under Article 4.1 of the Birds Directive (79/409/EEC) by supporting bird populations of European importance that are listed on Annex 1 of the Directive and under Article 4.2 by regularly supporting at least 20,000 waterfowl.

2.13 The Severn Estuary SAC is designated due to the important populations of fish and natural habitats present within the estuary. Important species of fish protected by the site’s SAC designation include Allis Shad, Twaite Shad, River Lamprey and Sea Lamprey. Important habitats present within the Estuary protected by the SAC designation include Atlantic Salt Meadows, Mudflats and Sandflats not covered by seawater at low tide, Reefs and Sandbanks.

2.14 The Severn Estuary SPA and Ramsar designations cover the same geographical area as each other and overlap extensively in their reasons for designation. The internationally important bird populations and the habitats on which they depend are reasons for designation for both the SPA and Ramsar sites. The Ramsar designation extends to cover fish populations of the estuarine and river system which is one of the most diverse in Britain with over 110 species recorded.

Implications for sub-sea routeing

2.15 SPAs, SACs and Ramsar sites are afforded protection under the Conservation of Habitats and Species Regulations 2010. The Regulations only permit development in the first instance on such sites where it is directly connected with or necessary to site management for nature conservation; or where the proposal would not be likely to have a significant effect on the conservation objectives of the site, alone or in combination with other plans and projects.

2.16 The process for the consideration of development proposals likely to affect a European designated site is set out in the ODPM Circular 6/2005 as illustrated on the flow chart at Diagram 1[1]. As the Potential Connection is not necessary for management of the designated sites, the first test that would apply is whether the project *'is likely to have a significant effect on the sites'*. This is a 'filtering test' intended to avoid the need for detailed assessment of projects which are unlikely to have significant effect. Case law has clarified that mitigation and design measures can be considered. For example, if a project might affect breeding birds in a SPA (if carried out in the breeding season), then it would be possible to avoid the likelihood of an effect by imposing a condition restricting the timing of works and the filtering test can consider this mitigation measure and conclude that the works are unlikely to have a significant effect.

2.17 If the likelihood of significant adverse effect cannot be ruled out, or if there is uncertainty, then the competent authority must carry out an 'appropriate assessment' to test the effect of the project on the integrity of the designated sites. Subject to a defined exception being established, an authority may only grant consent for a project where 'appropriate assessment' shows that it will not adversely affect the integrity of the designated European site.

2.18 An authority may exceptionally grant consent for a project which will adversely affect the integrity of a designated site where there is an absence of alternative solutions and the project must be carried out for imperative reasons of overriding public interest, including those of a social or economic nature.

2.19 The development of the Potential Connection through the Severn Estuary could result in the following effects:

- Disturbance of the mudflats / bed of the Estuary from the installation of cables which could alter the species composition of the flora and fauna found within the mudflats which are important for wintering bird populations. Mobile species, in the vicinity of the cable route and impact area, may move to avoid harm. Sessile species, however, maybe damaged or destroyed during excavation through direct contact with the installation device, burial and dislodgement. Nevertheless, studies have shown that in shallow water and estuarine environments where disturbance is more frequent and opportunistic species are more likely to dominate the community structure, recovery occurs rapidly[2]. Further assessment would be required to assess the degree of impact on this habitat including the potential impacts to wintering bird species.
- Suspended Sediments – resulting from the release of sediment from the cabling activities - can have a number of impacts on the benthic communities, including affecting filtering mechanisms (e.g. clogging gills) and prolonged sediment disturbance can affect the penetration of light through the water affecting photosynthetic activity for aquatic flora. Prolong impacts are considered unlikely as the installation of the cables is likely to be a short term impact and studies have shown that species adapted to survive in estuaries are more likely to survive sediment disturbances[3].
- Mobilisation of contaminants in sediments could impact on the flora and fauna of the Estuary.

[1] Extract from ODPM Circular 6/2005.

[2] BERR Department for Business Enterprise and Regulatory Reform, Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry, Technical Report January 2008. In association with DEFRA.

[3] BERR Department for Business Enterprise and Regulatory Reform, Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry, Technical Report January 2008. In association with DEFRA.

- Disturbance from the cable laying activities could impact on the SSSI and behaviour of species. Disturbance from cable laying barges could disturb feeding birds. However, works could be timed to avoid sensitive seasons.

2.20 Detailed studies would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects on the integrity of these designations if this Potential Connection was taken forward. Furthermore, if there was found to be an adverse effect on the integrity of a designated site, National Grid would have to demonstrate that there was no alternative solution.

National Nature Reserve (NNR)

2.21 The only wildlife site within the Study area designated as a NNR which could be affected by the Potential Connection is the Bridgwater Bay NNR. The Bridgwater Bay NNR covers the same geographical area as the Bridgwater Bay SSSI and the reasons for designation are provided in Table 2.1 above.

Implications for subsea routeing

2.22 A subsea connection route parallel to the coast would cross the Bridgwater Bay NNR and SSSI). To avoid this area of designation, the subsea cables would need to be routed in the middle and deepest sections of the Severn Estuary, away from the land side coastal designations.

2.23 In order to make the necessary connection to land, the cables would need to cross the NNR and SSSI in the vicinity of Hinkley Point. Further detailed study would be required to determine the effects on the integrity of the NNR and SSSI arising from the Potential Connection if this option was taken forward.

Scheduled Monuments

There are no SMs within the Severn Estuary or close to the landing point at Aberthaw. However, Wick Barrow (also known as ‘Pixies Mound’) SM which is a round barrow dating from the Neolithic and Bronze Age periods lies in the vicinity of the Power Station.

Implications for subsea routeing

2.24 SMs are nationally important monuments and archaeological remains which are protected under the provisions of the Ancient Monuments and Archaeological Areas Act 1979. Consent is required from English Heritage, the statutory advisor on the historic environment, under the 1979 Act before works directly affecting an SM may be carried out.

2.25 The proximity of Wick Barrow SM to the Power Station site would require consideration as part of converter station siting studies (for a HVDC connection) or reactive compensation equipment siting studies (for an AC connection) if this Potential Connection was identified as the most suitable Potential Connection and taken forward.

Listed Buildings, Conservation Areas and Registered Parks and Gardens

2.26 There are no Conservation Areas or Registered Parks and Gardens close to Hinkley Point or Aberthaw that would influence the routeing of the Potential Connection or the location of the converter stations (for a HVDC connection) or reactive compensation equipment (for an AC connection).

2.27 There are no Listed Buildings close to Hinkley Point however there are two Listed Buildings to the north of Aberthaw at East Aberthaw and Gilston. The effects of converter stations or reactive compensation equipment on the setting of these Listed Buildings would require further consideration as part of detailed siting studies if the Potential Connection was taken forward.

Woodlands

2.28 There is little woodland along the coastline of the Severn Estuary. However, there are blocks of woodland to the west of the Power Station site that would require consideration as part of converter station siting studies if a HVDC connection was taken forward.

Settlements

2.29 There are numerous villages dispersed across the Study area including East and West Aberthaw, Gileston to the north of Aberthaw and Wick, Shurton and Stolford to the south and east of Hinkley Point.

Implications for subsea routeing

2.30 The Potential Connection could avoid towns and villages.

2.31 The siting of new converter stations for a HVDC connection or reactive compensation equipment for an AC connection could avoid settlements. However, there would be effects on views in from public and private receptors in the vicinity of this equipment. Further detailed study and the consideration of the effects on views would be required as part of detailed siting studies if the Potential Connection was identified as the most suitable Potential Connection and taken forward.

3.0 ADDITIONAL WORKS

3.1 As outlined at paragraph 1.14 above, additional works to the high voltage electricity transmission system would be required to support a subsea connection between Hinkley Point and Aberthaw. The environmental constraints relevant to these additional works are summarised below.

New 400kV substations at Aberthaw and Upper Boat, South Wales

3.2 As outlined at paragraph 1.14, if this connection was selected as the Preferred Connection and taken forward, new 400kV substations would be required at Aberthaw and Upper Boat in South Wales.

3.3 The siting and design of these substations would be subject to detailed study in accordance with the guidelines presented by the Horlock Rules.

Aberthaw

3.4 To make a landing connection at Aberthaw, the Potential Connection would need to travel through a narrow area of land between the East Aberthaw Coast SSSI and the Glamorgan Coast (Heritage Coast) designations. At this stage, the precise location of a substation at Aberthaw has not yet been determined but in order to avoid adverse effects it would need to be outside these designations. No other environmental designations have been identified within or in close proximity to the Power Station which would constrain potential substation sites.

3.5 The construction of a new 400kV substation at Aberthaw would introduce effects on landscape and views which would require further consideration and assessment as part of detailed siting studies.

Upper Boat

3.6 At this stage, the precise location of a substation at Upper Boat has not yet been determined. However, a new substation in the vicinity of the existing Upper Boat substation would need to avoid blocks of woodland and the settlements of Church Village, Upper Boat and Hawthorn. No other environmental designations of international or national importance have been identified within or in close proximity to the existing substation that would constrain potential substation sites.

3.7 The construction of a new 400kV substation at Upper Boat would introduce effects on landscape and views which would require further consideration and assessment as part of detailed siting studies.

Iron Acton to Melksham Overhead Line

3.8 If the Potential Connection was taken forward the existing Iron Acton to Melksham 275kV overhead line would need to be re-built to 400kV construction. This would involve the construction of a new overhead line and towers suitable for 400kV operation in close proximity to the existing overhead line. Following completion of construction and the transfer of electrical circuits the existing 275kV overhead line would be removed.

3.9 The existing Iron Acton to Melksham 275kV overhead line is approximately 33km long and crosses approximately 16.7km of the Cotswolds AONB. The AONB extends for large distances to the north and south. A route that avoids the designated landscape would be approximately 60km longer than the existing connection and would take a new overhead line close to other constraints including the Bath World Heritage Site. If the route of the existing overhead line was adopted the new overhead line would cross in excess of 16km of the AONB. This is likely to give rise to adverse effects on the landscape of the AONB which could affect the objective to conserve and enhance natural beauty.

3.10 The existing overhead line also passes through Honeybrook Farm SSSI and close to Coleme Park and Monk's Wood SSSIs. Detailed environmental surveys would be required to ensure that the integrity of these sites or their qualifying features are not adversely affected by the construction of a new overhead line.

Reinforcements of overhead lines from 275kV to 400kV within South Wales

3.11 If the Potential Connection was taken forward the existing Aberthaw – Upper Boat - Cilfynydd 275kV overhead line would need to be reinforced to 400kV operation and reconductoring works undertaken on the Cilfynydd - Rassau overhead line.

3.12 The existing Aberthaw to Upper Boat 275kV overhead line passes through, or close to, the following areas of constraint:

- Scheduled Monuments including East Orchard Wood Pillbox and East Orchard Manor House;
- Historic Parks and Gardens including: Old Beaupre, Hensol Castle and Talygarn;
- Listed Buildings;
- Settlements; and
- Woodland.

3.13 The existing Upper Boat to Cilfynydd 275kV overhead line passes through, or close to, the following areas of constraint:

- Settlements; and
- Woodland.

3.14 The existing Cilfynydd to Rassau 400kV overhead line passes through, or close to, the following areas of constraint:

- SSSIs: Cwn glo a glyndyrys and Mynydd Llangatwg;
- Usk Bats SAC;
- Scheduled Monuments;
- Listed Buildings;
- Settlements; and
- Woodland.

3.15 The Cilfyndd to Rassau overhead line also passes within 500m of the boundary of the Brecon Beacons National Park which is designated for its outstanding landscape qualities. Further detailed study would be required to establish the effects of the reconductor works on the constraints identified above.

3.16 The 275kV pylons around Aberthaw as well as those on routes towards Swansea North and Cilfynydd are predominantly of L2 pylon design. These pylons can typically be utilised for 400kV overhead lines, although some pylon raising and/or strengthening may be required. There are some sections of line in South Wales which utilise pylons of L3 design which are normally not suitable for 400kV operation. As such, these sections are likely to require either significant upgrades or replacement with pylons suitable for 400kV operation. The upgrades required would be subject to future detailed feasibility assessments (including consideration of the effects on landscape and views) and routeing studies if this connection option was taken forward.

Seabank to Tockington Overhead Line

3.17 If the Potential Connection was taken forward a new 400kV double circuit overhead line of between 6km and 7km would be required between Seabank and Tockington.

3.18 Between Seabank and Tockington there are no areas protected at the highest level by national or international nature conservation or landscape designations. However, the following constraints would require detailed consideration as part of routeing studies if this Potential Connection was taken forward:

- The existing 400kV Seabank to Tockington overhead line (2VL route);
- Settlements including Marsh Common, Piling, Almondsbury and Awkley;
- Listed buildings and the Conservation Areas of Almondsbury and Olveston;
- Individual residential properties; and
- Blocks of woodland.

3.19 The construction of a new overhead line parallel to the existing 400kV Seabank to Tockington overhead line would result in cumulative visual effects but would limit effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists.

4.0 ASSESSMENT

4.1 The Potential Connection involves the construction of subsea cables between the Power Station, West Somerset and Aberthaw Power Station, Vale of Glamorgan. For an AC connection reactive compensation equipment is likely to be required and for a HVDC connection between 2 and 4 converter stations would be required at both ends of the route. The Potential Connection would also require a significant amount of additional work to ensure the security and stability of the transmission system, including new substations at Aberthaw and Upper Boat, upgrade works to the Iron Acton to Melksham and the Aberthaw – Upper Boat - Cilfynydd – Rassau overhead lines and a new 400kV overhead line between Seabank and Tockington.

4.2 The most significant constraints to the Potential Connection would be the Severn Estuary, SPA, SAC, SSSI and Ramsar site. The subsea cables would need to travel through the SPA, SAC and Ramsar designations and would come on-shore in proximity to/or through either Blue Anchor to Lilstock Coast SSSI or Bridgwater Bay SSSI to make a connection to the Power Station.

4.3 The development of the Potential Connection through the Severn Estuary could result in the following effects on the SPA, SSSI, SAC and Ramsar designations. These effects would require further assessment in accordance with the Conservation of Habitats and Species Regulations 2010 to ensure that there would be no adverse effects on the integrity of the designation or its qualifying features.

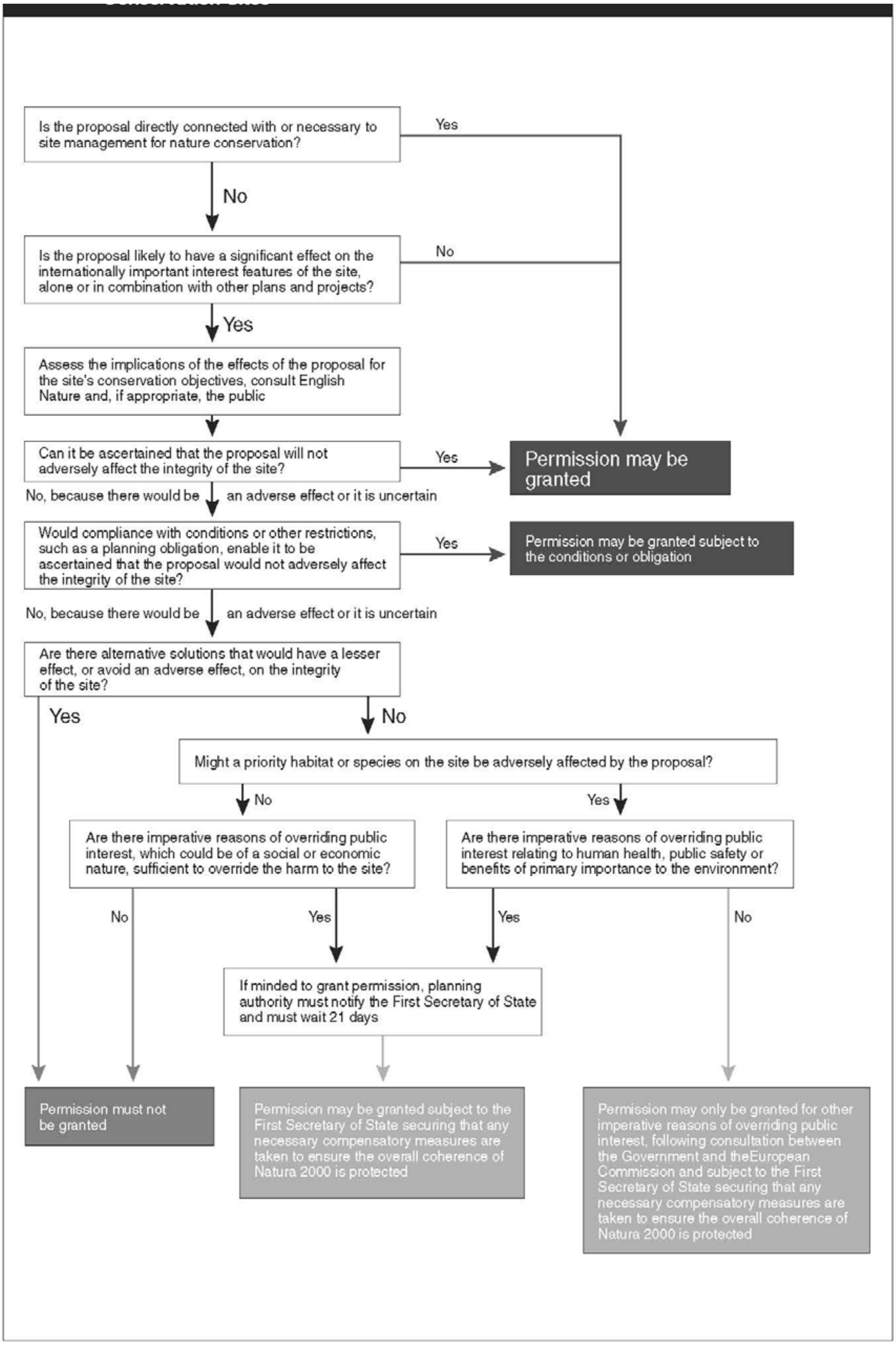
- Disturbance of the mudflats / bed of the Estuary from cables installation which may alter the species composition of the flora and fauna found within the mudflats;
- Suspended Sediments – resulting from the release of sediment from the cabling activities could affect the benthic communities ;
- Mobilisation of contaminants in sediments could impact on the flora and fauna of the Estuary; and
- Disturbance from the cable laying activities could impact on species using the SPA, SAC, SSSI and Ramsar sites.

4.4 The construction of converter stations (for a HVDC connection) or reactive compensation equipment (for an AC connection), could result in effects on local amenity and depending on the siting, visual impacts to settlements and effects on the setting of SMs such as Wick Barrow SM at Hinkley Point and Listed Buildings to the north of Aberthaw Power Station. The location of this equipment would require further consideration and assessment as part of detailed siting studies if this connection was taken forward.

4.5 Known historic assets, such as SMs, have been identified in the vicinity of the landing sites at Hinkley Point and Aberthaw. However, there may be unknown archaeological assets that could be affected by the cables installation or construction of converter stations or reactive compensation equipment. Further detailed study would be required to determine the potential for archaeological remains and any direct and indirect effects on archaeology resulting from construction. PPS5 highlights the importance of the heritage resource stating *‘The historic environment and its heritage assets should be conserved’*. To achieve this Government objectives for planning in the historic environment are *‘to deliver sustainable development by ensuring policies and decisions concerning the historic environment recognise that heritage assets are a non-renewable resource’*. Any landing site connection routed through heritage assets may cause permanent loss due to the intrusive nature of the construction.

4.6 Of the subsea connection methods available to make the Potential Connection, HVDC subsea cables would offer environmental benefits over AC subsea cables as they require the installation of fewer cables over a narrower installation corridor, resulting in less sea-bed disturbance and a shorter installation programme. However, HVDC subsea cables require the construction of large converter stations at either end of the route. These converter station sties would introduce effects on landscape and views and would require further consideration and assessment as part of detailed siting studies.

Diagram 1 - Consideration of development proposals affecting Internationally Designated Nature Conservation Sites (extract from ODPM Circular 6/2005)



Appendix 2 - Environmental Appraisals

PC2 Bridgwater- Melksham

BRIDGWATER TO MELKSHAM ENVIRONMENTAL APPRAISAL

1.0 INTRODUCTION

1.1 This planning and environmental appraisal (the Study) has been produced by TEP for National Grid Electricity Transmission plc (National Grid). The appraisal considers the planning and environmental constraints associated with a 400kV double circuit overhead line between Bridgwater, Somerset and Melksham substation, Wiltshire (the Potential Connection).

1.2 The Potential Connection is one of a number of alternative options considered by National Grid to facilitate the connection of the proposed Hinkley Point C Power Station to the high voltage electricity transmission system. Detailed technical information relating to this connection option is set out under Option PC2 in the Strategic Optioneering Report (August 2011).

Assumptions

1.3 The Potential Connection would require the existing overhead line which connects Hinkley Point to Bridgwater (VQ Route) to be uprated from 275kV to 400kV. Using this existing infrastructure would require overhead line reconfiguration close to the Power Station's site and north of Bridgwater but removes the need to install a new line east from Hinkley Point within the Steart Peninsula area of proposed managed retreat. As a result of these reconfiguration works a new overhead line connection would begin in the area to the north of Bridgwater substation.

1.4 For the purpose of this study it has been assumed that the Potential Connection would be supported on steel lattice towers approximately 47m high as these are the appropriate size to safely support a 400kV double circuit overhead line. Each tower would have three cross arms on both sides, with up to three sets of conductors (wires) suspended from each of the cross arms.

1.5 The following additional works would be required to the electricity transmission system should the Potential Connection be taken forward:

- New 400kV substation at Aust, South Gloucestershire;
- New 400kV substation at Hinkley Point, Somerset;
- New 400kV substation at Bridgwater, Somerset;
- New 400kV substation at Iron Acton, Gloucestershire;
- Installation of 2 Quadrature Boosters at Nursling, Hampshire;
- Re-build of the Iron Acton to Melksham 275kV overhead line to 400kV construction;
- New 400kV double circuit overhead line between Seabank and Tockington;
- New underground cable circuit between Cowley, Gloucestershire and Minety, Wiltshire; and
- Extension of Melksham substation.

1.6 The majority of the above works are required to ensure the security and stability of the electricity transmission system for whichever connection option is taken forward. However, the re-build of the Iron Acton to Melksham 275kV overhead line to 400kV construction and the new 400kV double circuit overhead line between Seabank and Tockington are only required for certain connection options. These works have, therefore, been considered as part of this study (see Section 3.0).

1.7 The Study has considered environmental constraints of international and national importance. Features considered as constraints to the Potential Connection route are presented in Table 1.1 below. The table also summarises the legislation under which protection is inferred and the data sources from which information (where applicable) was taken.

Table 1.1: Environmental constraints and data sources

Feature	Legislation	Routeing Response (and Reference)	Data Sources
National Parks	National Parks and Access to the Countryside Act 1949	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1)	magic.gov.uk
Areas of Outstanding Natural Beauty	National Parks and Access to the Countryside Act 1949/ Countryside and Rights of Way Act 2000	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1	magic.gov.uk
Heritage Coasts	n/a	Seek to avoid (NG Commitments/ Holford Rule 1)	magic.gov.uk
World Heritage Sites	1972 World Heritage Convention	Seek to avoid (NG Commitments/ Holford Rule 1)	english-heritage.org.uk
Sites of Special Scientific Interest	Wildlife and Countryside Act 1981	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Special Protection Areas	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Special Areas of Conservation	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Ramsar sites	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
National Nature Reserves	National Parks and Access to the Countryside Act 1949	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Scheduled Monuments	Ancient Monuments and Archaeological Areas Act 1979	Seek to avoid/consider effect on setting (NG Commitments/ Holford Rule 2)	english-heritage.org.uk
Settlements	n/a	Seek to avoid (Supplementary Note)	Digitised from Ordnance Survey
Historic buildings (Listed I, II and II*)	Planning (Listed Buildings and Conservation Areas) Act 1990	Seek to avoid/consider effect on setting (Note to Holford Rule 2)	english-heritage.org.uk
Conservation Areas	Planning (Listed Buildings and Conservation Areas) Act 1990	Minimise effects/consider effect on setting (Note to Holford Rule 2)	Development plans
Registered Parks and Gardens	n/a	Seek to avoid (NG Commitments)	magic.gov.uk
Registered Battlefields	n/a	Minimise effects (NG Commitments)	english-heritage.org.uk
Woodlands	n/a	Seek to avoid (Note to Holford Rules 4 and 5)	National Inventory of Woodlands
Landform	n/a	(Holford Rules 4 and 5)	OS Open Data

1.8 In accordance with the National Policy Statement EN5, when siting new overhead lines, the principles of the Holford Rules[1] should be taken into account. These are considered throughout this Study.

1.9 Due to the presence of existing overhead lines, particular consideration has been given to Rule 6 of the Holford Rules throughout. This rule advises that high voltage lines should be kept as far as possible independent of other masts wires and cables to avoid a concentration of lines or a 'wirescape'.

Environmental Aspects 'Scoped Out' of Appraisal at this Stage

1.10 It is not feasible to undertake a meaningful assessment of the effects of the Potential Connection on certain environmental factors both because of the high level nature of this environmental appraisal and because a detailed connection design would have to be identified. As a result the effects of these factors have not influenced the selection of a preferred connection. The factors scoped out of the appraisal at this stage are outlined at paragraphs 1.12 to 1.15 below.

1.11 Although scoped out of the options appraisal process at this stage these factors will require consideration as part of routeing studies, detailed connection design and environmental assessment whichever connection is taken forward.

Flood Risk

1.12 National Grid considers its siting of installations such as substations very carefully in relation to flood risk. However, it is relatively straightforward to build flood resilience into overhead lines by addressing safety clearances from anticipated flood levels in line design. The presence of overhead line towers in areas of flood risk has negligible effect on the risk or displacement of water as the lattice steel construction poses no material changes to water flow. Flood risk has therefore not been considered an influence on the Potential Connection.

Noise

1.13 Noise during construction will be temporary and managed by procedures and controls to ensure that it is not unacceptable. Noise during operation will be controlled primarily by separation of sources of noise from noise-sensitive receptors and also by noise-suppression measures as appropriate. The review of options considers whether there is likely to be appropriate distances from settlements and dwellings for amenity reasons which would also allow separation to mitigate effects of noise. The noise sources and measures taken will be applied as required for any option and noise is not a material factor in distinguishing between options.

Air Quality

1.14 New transmission infrastructure will not give rise to any material effects on air quality. Temporary construction works can give rise to dust affecting air quality locally. This will be managed by procedures and controls to ensure that it is not unacceptable. These measures will be applied as required for any option and air quality is not a material factor in distinguishing between options.

Transport

1.15 Construction works will involve transport of materials and workforce to sites. The effects will be temporary and will be subject to management to ensure that effects are not unacceptable. This will be the case for any option and transport is not a material factor in distinguishing between options.

[1] Paragraph 2.8.7, National Policy Statement for Electricity Networks Infrastructure (EN-5), July 2011

Study Area

1.16 The Study area extends for approximately 80km from the eastern edge of Bridgwater to the Melksham substation. An existing overhead line owned and operated by National Grid travels through the study area in a west-east alignment between Hinkley Point and Melksham substations (ZG Route). The Study area includes the main settlements of Glastonbury, Shepton Mallet and Frome in Somerset and Westbury and Trowbridge in Wiltshire.

2.0 ENVIRONMENTAL CONSTRAINTS

2.1 A description of the study area in relation to the environmental constraints outlined in Table 1.1 is presented below and illustrated on Maps 3 and 4 (drawing numbers 1979.228 and 1979.229).

National Parks, Heritage Coasts and World Heritage Sites

2.2 There are no National Parks, Heritage Coasts or World Heritage Sites within the Study area.

Areas of Outstanding Natural Beauty (AONB)

Mendip Hills

2.3 The Mendip Hills AONB covers an area of approximately 200km^2 and is an extensive range of limestone hills to the south of Bristol. The hills run in an east to west direction between the coast at Weston-super-Mare and Frome in Somerset and border the northern edge of the Somerset Levels.

2.4 The hills of the AONB form prominent landmarks. The designation relates to landscape and scenic importance although the Mendip Hills are also valued for the many industrial archaeological sites reflecting the lead, coal and cloth industries. The AONB is also characterized by an open, largely treeless, limestone plateau surrounded by gorges, cliffs and escarpment slopes.

Cranbourne Chase and West Wiltshire Downs

2.5 This AONB covers an area of approximately 983km^2 and is an extensive belt of chalk land. It is divided into two areas by the fertile wooded Vale of Wardour. Cranbourne Chase is characterised by its rounded downs, steeply cut combes and dry valleys. The Wiltshire Downs is more varied with knolls and whaleback ridges.

2.6 The AONB is designated primarily for its landscape and scenic importance although it is of ecological importance and is also rich in archaeological sites including ancient monuments and historic field patterns. The Vale of Wardour is important for its large 18th and 19th century estates, parklands and associated villages.

Cotswolds

2.7 The Cotswolds AONB, at 2,038km^2, is the largest in England and Wales and is the third largest designated landscape in the UK after the Lake District and Snowdonia. It extends from Bath and Wiltshire in the south through Gloucestershire and Oxfordshire to Warwickshire and Worcestershire in the north. Jurassic limestone gives the AONB its distinctive character. The limestone lies in a sloping plateau with a steep scarp slope in the west drained by short streams in deep cut wooded valleys, and a gentle dip slope which forms the headwaters of the River Thames.

2.8 The AONB is nationally important for rare limestone grassland and ancient beech woodlands. The land also includes a number of ecologically and archaeologically important sites which are protected through a range of designations.

Implications for Overhead Line Routeing

2.9 AONBs are designated under the National Parks and Access to the Countryside Act 1949 (as amended) for the purpose of conserving and enhancing the natural beauty of the area. The importance of these sites and the protection afforded to them is further highlighted in Planning Policy Statement (PPS) 7 and Rule 1 of the Holford Rules which place strict restrictions on developments within these sites. Paragraph 22 of PPS7 states that major developments should not taken place in these designated areas except in exceptional circumstances and that such applications will be subject to rigorous examination and should include an assessment of the national need, cost and scope of developing outside the designated area and effects on the environment, landscape and recreational opportunities. A new overhead line through an AONB would have an effect on the landscape which will affect the objective to conserve and enhance natural beauty.

2.10 A direct overhead line route between Bridgwater and Melksham would pass through the Mendip Hills and Cotswolds AONBs. To avoid these designations an overhead line would need to travel to the south of Wells, Somerset (to the immediate south of the Mendip Hills AONB) in an area of land occupied by the existing 400kV Hinkley to Melksham overhead line between the Cotswolds AONB and Cranbourne Chase and West Wiltshire Downs AONB. The proximity and effects of an additional overhead line on the setting of the AONBs would require further consideration if a new overhead line between Bridgwater and Melksham was taken forward.

Sites of Scientific Interest (SSSI)

2.11 SSSIs are sites designated for their biodiversity or geological interest and are protected from development and operations which are likely to damage their special interest. There are SSSIs dispersed throughout the study area. The most significant of these sites and the reasons for their designation are summarised in Table 2.1.

Table 2.1 – Summary of SSSIs

SSSI	Location / Grid Ref	Reason for Designation
Moorlinch	Only partly in study area (ST 390360)	Moorlinch is part of an extensive grazing marsh grasslands and ditch system in the Somerset Levels and Moors. It forms part of the Somerset Levels and Moors SSSI, SPA, Ramsar site to the north east of Bridgwater. The moor contains botanically rich ditch systems and is important for wintering wading birds and waterfowl.
The Catcott, Edington and Chilton Moors, Tealham and Tadham Moors and Westhay Moors	North east of Bridgwater (ST 390420)	The Catcott, Edington and Chilton Moors, Tealham and Tadham Moors and Westhay Moors SSSIs are a collection of adjoining moors which form part of the Somerset Levels and Moors SSSI, SPA, Ramsar site to the north east of Bridgwater. These sites comprise diverse habitats which provide feeding and nesting sites for a wide range of birds such as Golden Plover and Lapwing. The existing 400kV Hinkley to Melksham overhead line passes through this area close to development at Burtle and Westhay.
St Dunstan's Well Catchment	North of Stoke St Michael (ST 668475 ST 655475)	St Dunstan's Well Catchment is an important cave system, containing a range of cave formations which are of national importance dating back to the Pleistocene Ice Age. The formations are important in relation to geological evolution in southern England. The sites also support species-rich unimproved calcareous grassland. Part of the area is also designated as a SAC. The caves are important for a range of bats including Greater and Lesser Horseshoe and Natterer's Bats which hibernate in the cave system.

SSSI	Location / Grid Ref	Reason for Designation
Edford Woods and Meadows	South of Helcombe (ST 665485 ST 675488 ST678480)	This site is important for the range of semi-natural ancient woodland, unimproved pasture and meadows which are now uncommon in Britain. The SSSI is within the valley of Mells stream. The designation covers a number of sites between Stoke St Michael and Helcombe and Coleford. The site supports a range of important herb species including the nationally rare Monk's Hood.
Asham Wood	South west of Frome (ST 705460)	Asham Wood is the largest and most diverse semi-natural woodland in the Mendips (it lies outside the Mendip Hills AONB designation). It occupies two deep valleys and interconnecting plateaux and offers optimal conditions for a range of lower plants. The site is also designated SAC. The site has recently suffered through quarrying locally although this has now ceased. The site is also important for buzzard, sparrowhawk, garden warbler, spotted flycatcher and greater spotted woodpecker.
Cloford Quarry	West of Nunney (ST 718444)	The quarry is important for exposures of sediments of Triassic and Jurrassic age.
Holwell Quarries	(ST 726450)	Holwell Quarries is internationally important for its geology. It shows a comprehensive assemblage of Triassic, Lower Jurassic and Middle Jurassic fissures.
Postlebury Wood	South west of From (ST 740430)	Postlebury Wood is a large relatively undisturbed ancient wood established on poorly drained Oxford Clays. The site has a well developed ground flora including important ancient woodland herb species Herb Paris and Woodruff. The site supports large populations of the homostyle primrose which is of international importance as it is only found on one site outside south east Somerset. The woodland is also an important location for breeding for a range of birds and mammals.
Longleat Woods	West of Warminster (ST 795435)	This is a large semi-natural ancient woodland with a predominantly high forest structure which is unusual in south west Britain. The site supports a range of woodland types more characteristic of central England and rare in the west. There are a large number of plant species normally only found in ancient woodland including: Broadleaved Helleborine and Wood Small-reed. The fauna has not been studied in detail but a range of mammals, breeding birds and invertebrates have been recorded.
Vallis Vale	(ST 755490)	Vallis Vale is an ancient woodland supporting ash-wych elm stand which has a restricted distribution in Britain. Hells Stream and Egford Brook flow through deeply dissected wooded valleys. The site is one of only a few sites in Somerset supporting Crayfish. It is also important for Banded Agrion and Demoiselle Agrion. The site also supports breeding birds: kingfisher, dipper and kestrel. Greater Horseshoe Bats have been recorded. The site is also of geological importance with nationally important rock displaying 'Britain's most classic outcrops'.

SSSI	Location / Grid Ref	Reason for Designation
Picket and Clanger Wood	South east of Trowbridge (ST 875543)	This is floristically rich ancient woodland which supports a range of butterfly species including several scarce species including two which are rare and vulnerable. The site is also important for the range of birds typical of southern and western England. Almost two thirds of the site has undergone coniferisation although much of the semi-natural vegetation has remained between planting. It is important for a range of breeding birds (including 15-20 breeding pairs of nightingales) and for more than 300 moths including the rare narrow-bordered bee hawk-moth and lesser spotted pinion. The site also supports common lizard, stoat, weasel, bank vole, common and pygmy shrew.

Implications for Overhead Line Routeing

2.12 The potential effect of an overhead line on a SSSI would vary depending on the nature of the effect caused and the special interest of the site. Consultation with Natural England would be required before consent could be granted for any development or operations likely to damage the SSSI interest.

2.13 Whilst many SSSIs within the study area could be avoided by the Potential Connection there are a number which would influence routeing and detailed alignment due to their size or proximity to each other.

2.14 The existing 400kV Hinkley to Melksham overhead line travels through Tealham and Tadham Moors and Catcott, Edington and Chilton Moors SSSIs. If an overhead line was constructed parallel to the existing line it would also pass through these areas of designation. The effects of an additional overhead line on the integrity of these sites or their qualifying features would require further detailed consideration if this route option was taken forward.

2.15 To avoid these SSSIs an overhead line would need to travel either north or south of the Moors. However, the presence of other constraints such as SMs (see paragraphs 2.29 – 2.36 below) and settlements would further constrain a route through this area.

2.16 Between Shepton Mallet and Frome an overhead line route is constrained by a cluster of SSSIs. These include: St Dunstan's Well Catchment; Edford Meadows and Woods; Asham Wood; Cloford Quarry; Holwell Quarries and Postlebury Wood. To avoid these SSSIs an overhead line would need to travel through the area between St Dunstan's Well and Asham Wood although settlements would pose a further constraint to routeing through this area.

Special Protection Areas (SPA) and Ramsar sites

Somerset Levels and Moors SPA and Ramsar

2.17 The Somerset Levels and Moors are one of the largest areas of traditionally managed wet grassland and fen habitats in lowland UK. The SPA and Ramsar sites cover the same geographical area as each other (approximately 35,000ha) and include the floodplains of the Rivers Axe, Brue, Parrett, Tone and their tributaries. The internationally important bird populations and the habitats on which they depend are reasons for both the SPA and Ramsar designations; the Ramsar designation also extends to cover rare invertebrate populations.

Implications for Overhead Line Routeing

2.18 SPAs and Ramsar sites are afforded protection under the Conservation of Habitats and Species Regulations 2010. The Regulations only permit development in the first instance on such sites where it is directly connected with or necessary to site management for nature conservation; or where the proposal would not be likely to have a significant effect on the conservation objectives of the site, alone or in combination with other plans and projects.

2.19 Where there are likely to be significant effects, consent for development can only be granted where it would not adversely affect the integrity of the site taking into account the manner in which the development will be carried out and any conditions that might be imposed on the consent or there are no alternative solutions and the development must be carried out for imperative reasons of overriding public interest relating to human health, public safety or benefits of primary importance to the environment.

2.20 The existing 400kV Hinkley to Melksham overhead line passes through the SPA and Ramsar site close to development at Burtle and Westhay, Somerset. To avoid this designation, an overhead line would need to be routed to the north, between the SPA/Ramsar site and the settlements of Blackford and Wedmore, Somerset, or to the south where a route is constrained by a number of small hamlets and villages and the larger settlements of Street and Glastonbury, Somerset.

Special Areas of Conservation (SAC)

<u>Mells Valley SAC</u>

2.21 The Mells Valley SAC comprises a collection of sites which are semi-natural dry grasslands and scrubland facies on calcareous substrate. The cave system is considered to be one of the best areas in Britain for Greater Horseshoe bats. The component sites of the SAC are also designated as SSSIs.

<u>Mendip Woodlands SAC</u>

2.22 The Mendip Woodlands SAC is a *Tilio-Acerion* forest of slopes, screes and ravines. It covers a number of sites which are within the Mendip Hills AONB; this site covers Asham Wood which is the most easterly of the sites outside the AONB designation. The wood has been affected by quarrying in the past although this activity has now ceased. The wood is also designated as a SSSI.

<u>Implications for Overhead Line Routeing</u>

2.23 Like SPAs and Ramsar sites, SACs are afforded protection under the Conservation of Habitats and Species Regulations 2010 and development is strictly controlled.

2.24 An overhead line route between the Mells Valley SAC and the Mendip Woodlands SAC would be constrained by the presence of settlements and woodland.

2.25 The existing 400kV Hinkley to Melksham line travels to the south of the SACs. An overhead line route parallel to the existing line would avoid these designated sites. However, in accordance with Natural England's Bat Mitigation Guidelines (2004) the effects of a new overhead line within 4km of the Mells Valley SAC would require further assessment to ensure there would be no adverse effects on the integrity of the designation or its qualifying features.

National Nature Reserves (NNRs)

2.26 There are several wildlife sites within the study area designated as NNRs. The majority of these lie to the north east of Bridgwater and form part of larger sites afforded protection under other ecological designations such as SSSI, SPA and Ramsar. The NNRs in the study area are listed in Table 2.2:

Table 2.2 - Summary of NNRs

NNR	Grid Ref/Location	Reason for Designation
Huntspill River	ST 320443	This is an artificial river within the Somerset Levels and is managed by the Environment Agency. The area is of interest to various birds and otters. The area is also of archaeological interest. The river stretches for 5 miles from Bridgwater Bay to the western boundary of the Catcott Edington and Chilton Moors SSSI.
Somerset Levels	ST 387360	This NNR is important for its open water and lowland grasslands. It is currently closed to the public.
Westhay Moor	ST 453440	This NNR is owned and managed by Somerset Wildlife Trust. It comprises restored peat fields and water-filled compartments with islands of reeds and bulrushes. The land also includes poor fen and a fragment of acid moor which is currently being restored.
Shapwick Heath	ST 430400	This is a wetland reserve managed by Natural England covering over 500ha. It is important for its reed beds, fens, meadows and wet woodland. The NNR also includes the oldest Neolithic ‘Sweet Track’, the oldest routeway in Britain.
Ham Wall	ST 458402	This NNR is owned and managed by the RSPB. It is an area of former commercial peat extraction and is currently being restored to wetland habitats.

Implications for Overhead Line Routeing

2.27 The existing 400kV Hinkley to Melksham overhead line crosses the Huntspill River NNR, which is also crossed in two places by existing lower voltage overhead line owned and operated by Western Power Distribution. The 400kV overhead line then continues east passing between a number of other NNRs within the Somerset Levels and Moors SSSI, SPA and Ramsar.

2.28 An overhead line parallel to the existing line would cross the Huntspill River NNR and other NNRs within the Somerset Levels and Moors SSSI, SPA and Ramsar sites. To avoid these areas of designation, an overhead line would need to be routed to the south of the Somerset Levels and Moors where a route would be constrained by a number of small hamlets and villages and the larger settlements of Street and Glastonbury.

Scheduled Monuments (SMs)

2.29 The south west of England is a region of high archaeological and historical importance and contains over a third of all SMs in England. There are approximately 93 SMs distributed across the study area.

2.30 There are clusters of SMs within the Mendip Hills AONB, Cotswolds AONB and Cranbourne Chase and West Wiltshire Downs AONB. The presence of these SMs would pose a further constraint to routeing through these designated landscapes and achieving a direct overhead line route for the Potential Connection.

Implications for Overhead Line Routeing

2.31 SMs are nationally important monuments and archaeological remains which are protected under the provisions of the Ancient Monuments and Archaeological Areas Act 1979. Consent is required from English Heritage, the statutory advisor on the historic environment, under the 1979 Act for works for works directly affecting an SM may be carried out.

2.32 Within the Somerset Levels there is a cluster of timber trackways dating from the Bronze and Iron Ages plus other scheduled monuments around Glastonbury such as Glastonbury Tor, a number of duck decoys, lake villages and a medieval road.

2.33 The existing 400kV overhead line between Hinkley and Melksham travels through this cluster of SMs, in places oversailing some of the timber trackways. An overhead line route parallel to the existing line would be constrained by the SMs and detailed assessment would be required to identify the direct and indirect effects on the monuments and their setting.

2.34 An overhead line route to the south of these SMs would be constrained by the settlements of Edington, Catcott, Shapwick, Street and Glastonbury and a route to the north by Blackford, Wedmore and Wookey.

2.35 The existing 400kV overhead line travels to the south of Frome passing between Witham Priory and Marston Moat. An overhead line route parallel to the existing line could be achieved through this area but detailed studies on the direct and indirect effects on the integrity and setting of the monuments would need to be undertaken.

2.36 There is sufficient separation between other SMs to avoid them with the Potential Connection route. However, clusters of SMs would act as a constraint to overhead line routeing to the north of Bruton, north and south of Shepton Mallet and north and west of Frome.

Historic Buildings

2.37 There are approximately 76 Grade I and 203 Grade II* listed buildings within the Study area. These are distributed across the study area but are often clustered within larger settlements. Particular clusters of historic buildings are found within the settlements of Wells; Glastonbury; Shepton Mallet; Frome; Westbury and Trowbridge.

Implications for Overhead Line Routeing

2.38 Buildings of special architectural or historic interest are added to a list of buildings protected under the Planning (Listed Buildings and Conservation Areas) Act 1990. Planning authorities are required to consult with English Heritage on planning applications which may affect a Grade I and Grade II* listed building outside Greater London and listed building consent is required for any works likely affect a listed building.

2.39 Routes could be achieved for the Potential Connection which avoid listed buildings. However, further detailed study would be required to identify any adverse effects on the setting of any isolated buildings.

Conservation Areas

2.40 Within the Study area there are 21 Conservation Areas. These are generally focused within town and village centres and include Glastonbury; Mells; Street; East Pennard; Littleton; Norton; Rode; Shepton Mallet; Shapwick; Wedmore; Evercreech; Batcombe; Frome; Buckland Dinham; Beckington/Lullington; Tellisford; three at Hilperton; Bradford on Avon; and Broughton Gifford.

Implications for Overhead Line Routeing

2.41 Conservation Areas are areas designated by local authorities because of special architectural or historic interest and are protected under the Planning (Listed Buildings and Conservation Areas) Act 1990. Conservation Area consent is required from the local planning authority for any development within the area.

2.42 Routes could be achieved for the Potential Connection which avoid Conservation Areas. However, further detailed study would be required to identify any adverse effects on their setting.

Registered Parks and Gardens

2.43 There are 11 Registered Parks and Gardens within the Study area. These are summarised in Table 2.3 below.

Table 2.3 – Summary of Registered Parks and Gardens

Registered Park and Garden	Grid Ref/Location	Reason for Designation
Mells Park (193 ha)	ST 713487	Grade II listed parkland and lakes dating back to the 18th century. Considered one of the finest examples of an English Country House.
Babington House (57 ha)	ST 704510	Babington House includes grade II listed 18th - and 19th - century gardens and pleasure grounds of around five hectares, set in 52 hectares of parkland. The house is a private hotel.
The Chantry (12 ha)	ST 719470	The Grade II listed grounds include the remains of a landscape with lakes and grottoes dating to around 1825.
Ammerdown House (188 ha)	ST 710527	The Grade II* listed park includes an early 20th -century Italianate formal garden designed by Sir Edwin Lutyens, set within a late 18th to early 19th century park.
Mells Manor House (1.5 ha)	ST 727493	This Grade I listed park and garden includes a walled garden dating from around 1520 with changes and additions made following advice by Sir Edwin Lutyens and Gertrude Jekyll around 1902-1910.
Marston House (222 ha)	ST 756452	The garden is Grade II listed and includes pleasure grounds laid out by Stephen Switzer between 1724 and 1745 and a late 18th century landscape park.
Longleat Park (505 ha)	ST 810430	Grade I listed 19th and 20th century formal gardens extending to 2.5 hectares. The site is now primarily known as a safari park introduced by the Marquess of Bath in 1964.
Hapsford House (Also known as Vallis Villa) (5 ha)	ST 759497	The Grade II park includes pleasure grounds associated with the early 19th century Hapsford House. There are also 20th century additions to the gardens, including a laburnum arch over a box-edged formal walk. The house is at the northern end of a steep-sided rocky valley known as Vallis Vale.
Orchardleigh (329 ha)	ST 777513	The Grade II* listed grounds include 19th century formal gardens and pleasure grounds (4 ha). The pleasure grounds are set within a landscaped deer park dating from medieval times (325ha).
Trowbridge General Cemetery (3.8 ha)	ST 862590	A Grade II listed mid 19th century burial cemetery designed by C E Davis of Bath. The site was laid out with a broad central avenue dividing the consecrated and unconsecrated land. The cemetery includes two chapels, a lodge and serpentine outer walks.
The Courts, Holt (2.8 ha)	ST 861618	Grade II listed early 20th century garden including an arboretum. The site is owned by the National Trust.
Great Chalfield Manor (8 ha)	ST 860631	Grade II listed early 20th century garden in the grounds of a moated manor house. Site is owned by the National Trust.

<u>Implications for Overhead Line Routeing</u>

2.44 The English Heritage 'Register of Historic Parks and Gardens of special historic interest in England' (compiled under powers contained in Historic Buildings and Ancient Monuments

Act 1953) identifies sites assessed to be of national importance. Registration is a 'material consideration' in the planning process, meaning that planning authorities must consider the impact of any proposed development on the landscapes' special character.

2.45 An overhead line very close to a Registered Park or Garden is likely to cause adverse effects.

2.46 The majority of Registered Parks and Gardens within the study area are clustered between Coleford and Frome and present a constraint to routeing to the north of Frome. The area between Colford, Mells and Radstock with Mells Park is particularly constrained by the presence of Babington House, Ammerdown House and Mells Manor House together with other constraints such as woodland and settlements.

2.47 The existing 400kV overhead line passes between Marston House and Longleat Park. A new overhead line route could be achieved through this area however, the cumulative effects of an additional line would require further consideration in accordance with the Holford Rules if the Potential Connection was taken forward.

Registered Battlefields

2.48 There is one registered battlefield which is the site of the battle of Sedgemoor in 1685. The site lies north of Westonzoyland, Somerset approximately 1km east of Bridgwater substation and does not pose a constraint to routeing between Bridgwater and Melksham.

Woodland

2.49 There are numerous blocks of woodland, many of which are ancient woodland, interspersed throughout the study area. Several woodlands are also designated as SSSIs.

2.50 The majority of woodlands within the study area are relatively small, although many are long and linear. The largest woodland is Longleat Woodland on the edge of Cranbourne Chase and West Wiltshire Downs AONB. Other large woodland within the study area includes Asham Wood and Blackdog Woods.

<u>Implications for Overhead Line Routeing</u>

2.51 Installing an overhead line through woodland would result in the permanent loss of woodland along the length of the connection. Holford Rules 4 and 5 refer to woodlands and their value in providing background to views and advise to avoid cutting extensive swathes through woodland blocks wherever possible.

2.52 The main concentrations of woodland which would influence the route of the Potential Connection are around Stoke St Michael, Coleford, Mells and Frome in Somerset.

2.53 To the south of the Study area, woodland is concentrated between Asham Wood south of Chantry and Longleat Wood on the edge of Cranbourne Chase and West Wiltshire Downs AONB. An overhead line route through this area would be achievable but would need to change direction in a number of areas to avoid the woodland blocks and other scattered constraints.

2.54 Woodland also acts as a constraint to achieving an overhead line route to the west of Westbury and east and west of Trowbridge.

Settlements

2.55 There are a number of settlements within the Study area. The largest include Bridgwater, Wells, Street, Glastonbury, Shepton Mallet, Frome, Westbury, Trowbridge and Melksham.

2.56 There are numerous other villages of varying size dispersed throughout the Study area, the larger of which are along classified roads. Smaller villages and hamlets are linked by minor road systems.

Implications for Overhead Line Routeing

2.57 The existing 400kV Hinkley to Melksham overhead line passes to the north of Glastonbury then to the south of Shepton Mallet and south of Frome where settlement is less clustered than the northern part of the study area. The existing overhead line passes close to the eastern edge of Frome.

2.58 Settlement also provides a constraint between Westbury and Trowbridge. The existing 400kV overhead line passes between these settlements and is close to the southern edge of Trowbridge oversailing North Radley.

2.59 There is a concentration of built form between Bridgwater and Street and Glastonbury which would act as a constraint to routeing the Potential Connection. To the north of the Somerset Levels and Moors built form is less concentrated although settlement at Blackford, Wedmore and Wookey would constrain potential overhead line routes.

2.60 Clustered settlements also present a constraint to routeing to the north of Shepton Mallet, south of Midsomer Norton and Norton Radstock and west of Frome. This area includes numerous small villages and interconnected scattered linear hamlets which would be difficult to avoid without significant changes in direction or bringing an overhead line close to properties.

Landform

2.61 Landform of the Study area shows some variations and is illustrated at Map 1 (drawing number 1979.261).

Implications for Overhead Line Routeing

2.62 The Holford Rules refer to aspects of topography and physiography such as hills, ridges, dips, open valleys and flat land in considering overhead line routeing. For example, the Rules advise on exploiting the 'backgrounding' effect of high land and seeking to avoid ridges.

2.63 In the south of the study area the landscape generally comprises low lying moorland (approximately 6mAOD) forming part of a wider area known as the Somerset Levels and Moors.

2.64 The Mendip Hills AONB to the north of the study area rises sharply from the Somerset Levels and Moors. The AONB comprises a series of limestone hills which pose a significant constraint to overhead line routeing.

2.65 The main part of the study area is generally low flat to undulating ground within a primarily wide valley between the Mendip Hills AONB, the Cotswolds AONB and Cranbourne Chase and West Wiltshire Downs AONB. The land rises slightly between Shepton Mallet and Frome before falling again north of Frome towards Melksham.

2.66 The southern part of the study area is on slightly lower ground where there would be greater opportunities for utilising landform to background an overhead line.

3.0 ADDITIONAL WORKS

Iron Acton to Melksham Overhead Line

3.1 As outlined at paragraph 1.5, if the Potential Connection was taken forward the existing Iron Acton to Melksham 275kV overhead line would need to be re-built to 400kV construction. This would involve the construction of a new overhead line and towers suitable for 400kV operation in close proximity to the existing overhead line. Following completion of construction and the transfer of electrical circuits the existing 275kV overhead line would be removed.

3.2 The existing Iron Acton to Melksham 275kV overhead line is approximately 33km long and crosses approximately 16.7km of the Cotswolds AONB. The AONB extends for large distances to the north and south. A route that avoids the designated landscape would be approximately 60km longer than the existing connection and would take a new overhead line close to other constraints including Bath World Heritage Site. If the route of the existing overhead line was adopted the new overhead line would cross in excess of 16km of the AONB. This is likely to give rise to adverse effects on the landscape of the AONB which could affect the objective to conserve and enhance natural beauty.

3.3 The existing overhead line also passes through Honeybrook Farm SSSI and close to Coleme Park and Monk's Wood SSSIs. Detailed environmental surveys would be required to ensure that the integrity of these sites or their qualifying features was not adversely affected by the construction of a new overhead line.

Seabank to Tockington Overhead Line

3.4 As outlined at paragraph 1.5, if the Potential Connection was taken forward a new 400kV double circuit overhead line of between 6km and 7km would be required between Seabank and Tockington.

3.5 Between Seabank and Tockington there are no areas protected at the highest level by national or international nature conservation or landscape designations. However, the following constraints would require detailed consideration as part of routeing studies if this Potential Connection was taken forward:

- The existing 400kV Seabank to Tockington overhead line (2VL route);
- Settlements including Marsh Common, Piling, Almondsbury and Awkley;
- Listed buildings and the Conservation Areas of Almondsbury and Olveston;
- Individual residential properties; and
- Blocks of woodland.

3.6 The construction of a new overhead line parallel to the existing 400kV Seabank to Tockington overhead line would result in cumulative visual effects but would limit effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists.

4.0 ASSESSMENT

4.1 A new overhead line connection between Bridgwater and Melksham substation could be achieved but would pass close to, and be constrained by a number of environmental constraints.

4.2 The most significant constraints to achieving a direct overhead line route between Bridgwater and Melksham are the Mendip Hills and Cotswolds AONBs. These sites and the numerous SMs contained within them constrain a direct overhead line route and limit the study area to a swathe of land to the south of these designations and the north of the Cranbourne Chase to West Wiltshire Downs AONB. As part of detailed routeing studies for an additional overhead line between these designated areas further assessment would be required to determine the potential for adverse effects on the setting of the AONBs.

4.3 The construction of a new Bridgwater to Melksham overhead line parallel to the existing 400kV Hinkley to Melksham overhead line would limit effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists. However, a new overhead line parallel to the existing line would pass through the Somerset Levels and Moors SPA, SSSI, Ramsar sites and parts of the Somerset Levels containing a high concentration of SMs. The effects of an additional overhead line on the SPA, SSSI and Ramsar designations would require further assessment in accordance with the Conservation of Habitats and Species Regulations 2010 to ensure that there would be no adverse effects on the integrity of the designation or its qualifying features.

4.4 To avoid the SPA, SSSI and Ramsar designations an overhead line would need to route to either the north or south of this area. To the south a route is constrained by a number of small hamlets and villages and the larger settlements of Street and Glastonbury. To the north, a route could be achieved but would be constrained by the settlements of Blackford, Wedmore and Wookey and numerous SMs.

4.5 To the east of the Somerset Levels and Moors a variety of constraints would influence the route of a potential overhead line. The northern part of the study area is constrained by a cluster of constraints between Shepton Mallet and Frome. Whilst an overhead line could be established through this area the constraints would have an influence on the directness of a potential route. The existing 400kV Hinkley to Melksham overhead line travels through the southern part of the study area. In this area an overhead line route could be achieved between constraints. However, it would pass close to the edge of Cranbourne Chase and West Wiltshire Downs AONB and numerous blocks of woodland.

4.6 A Bridgwater to Melksham overhead line route would be constrained by numerous international and national environmental designations and would be approximately 20km longer than a connection to Seabank. This connection would also require the re-build of the Iron Acton to Melksham overhead line, which travels through approximately 16.7km of the Cotswolds AONB and passes close to a number of other environmental constraints, and a new overhead line of between 6km and 7km long between Seabank and Tockington.

Appendix 2 - Environmental Appraisals

PC3 Bridgwater - Nursling

BRIDGWATER TO NURSLING ENVIRONMENTAL APPRAISAL

1.0 INTRODUCTION

1.1 This planning and environmental appraisal (the Study) has been produced by TEP for National Grid Electricity Transmission plc (National Grid). The appraisal considers the planning and environmental constraints associated with a 400kV double circuit overhead line between Bridgwater, Somerset and Nursling substation, Hampshire (the Potential Connection).

1.2 The Potential Connection is one of a number of alternative options considered by National Grid to facilitate the connection of the proposed Hinkley Point C Power Station (Power Station) to the high voltage electricity transmission system. Detailed technical information relating to this connection option is set out under Option PC3 in the Strategic Optioneering Report (August 2011).

Assumptions

1.3 The Potential Connection would require the existing overhead line which connects Hinkley Point to Bridgwater (VQ Route) to be uprated from 275kV to 400kV. Using this existing infrastructure would require overhead line reconfiguration close to the Power Station's site and north of Bridgwater but removes the need to install a new line east from Hinkley Point within the Steart Peninsula area of proposed managed retreat. As a result of these reconfiguration works a new overhead line connection would begin in the area to the north of Bridgwater substation.

1.4 For the purpose of this Study it has been assumed that the Potential Connection would be supported on steel lattice pylons approximately 47m high as these are the appropriate size to safely support a 400kV double circuit overhead line. Each pylon would have three cross arms on both sides, with up to three sets of conductors (wires) suspended from each of the cross arms.

1.5 The following additional works would be required to the electricity transmission system should the Potential Connection be taken forward:

- New 400kV substation at Aust, South Gloucestershire;
- New 400kV substation at Hinkley Point, Somerset;
- New 400kV substation at Bridgwater, Somerset;
- New 400kV substation at Iron Acton, Gloucestershire;
- Installation of 2 Quadrature Boosters at Fawley, Hampshire;
- Re-build of the Iron Acton to Melksham 275kV overhead line to 400kV construction;
- New 400kV double circuit overhead line between Seabank and Tockington;
- New underground cable circuit between Cowley, Gloucestershire and Minety, Wiltshire;
- New Chilling cable tunnel replacement; and
- Extension of Nursling substation to double bus bar.

1.6 The majority of the above works are required to ensure the security and stability of the electricity transmission system for whichever connection option is taken forward. However, the re-build of the Iron Acton to Melksham 275kV overhead line to 400kV construction and the new 400kV double circuit overhead line between Seabank and Tockington are only required for certain connection options. These works have, therefore, been considered as part of this study (see Section 3.0).

1.7 The Study has considered environmental constraints of international and national importance within the Study area. Features considered as constraints to the Potential Connection are presented in Table 1.1. The table also summarises the legislation under which protection is inferred and the data sources from which information (where applicable) was taken.

Table 1.1: Environmental constraints and data sources

Feature	Legislation	Routeing Response (and Reference)	Data Sources
National Parks	National Parks and Access to the Countryside Act 1949	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1)	magic.gov.uk
Areas of Outstanding Natural Beauty	National Parks and Access to the Countryside Act 1949/ Countryside and Rights of Way Act 2000	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1	magic.gov.uk
Heritage Coasts	n/a	Seek to avoid (NG Commitments/ Holford Rule 1)	magic.gov.uk
World Heritage Sites	1972 World Heritage Convention	Seek to avoid (NG Commitments/ Holford Rule 1)	english-heritage.org.uk
Sites of Special Scientific Interest	Wildlife and Countryside Act 1981	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Special Protection Areas	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Special Areas of Conservation	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Ramsar sites	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
National Nature Reserves	National Parks and Access to the Countryside Act 1949	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Scheduled Monuments	Ancient Monuments and Archaeological Areas Act 1979	Seek to avoid/consider effect on setting (NG Commitments/ Holford Rule 2)	english-heritage.org.uk
Settlements	n/a	Seek to avoid (Supplementary Note)	Digitised from Ordnance Survey
Historic buildings (Listed I, II and II*)	Planning (Listed Buildings and Conservation Areas) Act 1990	Seek to avoid/consider effect on setting (Note to Holford Rule 2)	english-heritage.org.uk
Conservation Areas	Planning (Listed Buildings and Conservation Areas) Act 1990	Minimise effects/consider effect on setting (Note to Holford Rule 2)	Development plans
Registered Parks and Gardens	n/a	Seek to avoid (NG Commitments)	magic.gov.uk
Registered Battlefields	n/a	Minimise effects (NG Commitments)	english-heritage.org.uk
Woodlands	n/a	Seek to avoid (Note to Holford Rules 4 and 5)	National Inventory of Woodlands
Landform	n/a	(Holford Rules 4 and 5)	OS Open Data

1.8 In accordance with the National Policy Statement EN5, when siting new overhead lines, the principles of the Holford Rules[1] should be taken into account. These are considered throughout this Study.

1.9 Due to the presence of existing overhead lines, particular consideration has been given to Rule 6 of the Holford Rules throughout this Study. This rule advises that high voltage lines should be kept as far as possible independent of other masts wires and cables to avoid a concentration of lines or a 'wirescape'.

Environmental Aspects 'Scoped Out' of Appraisal at this Stage

1.10 It is not feasible to undertake a meaningful assessment of the effects of the Potential Connection on certain environmental factors both because of the high level nature of this environmental appraisal and because a detailed connection design would have to be identified. As a result the effects of these factors have not influenced the selection of a preferred connection. The factors scoped out of the appraisal at this stage are outlined at paragraphs 1.12 to 1.15 below.

1.11 Although scoped out of the options appraisal process at this stage these factors will require consideration as part of routeing studies, detailed connection design and environmental assessment whichever connection is taken forward.

<u>Flood Risk</u>

1.12 National Grid considers its siting of installations such as substations very carefully in relation to flood risk. However, it is relatively straightforward to build flood resilience into overhead lines by addressing safety clearances from anticipated flood levels in the overhead line design. The presence of overhead line pylons in areas of flood risk has negligible effect on the risk or displacement of water as the lattice steel construction poses no material changes to water flow. Flood risk has therefore not been considered an influence on the Potential Connection at this stage.

<u>Noise</u>

1.13 Noise during construction will be temporary and managed by procedures and controls to ensure that it is not unacceptable. Noise during operation will be controlled primarily by separation of sources of noise from noise-sensitive receptors and also by noise-suppression measures as appropriate. The review of options considers whether there is likely to be appropriate distances from settlements and dwellings for amenity reasons which would also allow separation to mitigate effects of noise. The noise sources and measures taken will be applied as required for any option and noise is not a material factor in distinguishing between options.

<u>Air Quality</u>

1.14 New transmission infrastructure will not give rise to any material effects on air quality. Temporary construction works can give rise to dust affecting air quality locally. This will be managed by procedures and controls to ensure that it is not unacceptable. These measures will be applied as required for any option and air quality is not a material factor in distinguishing between options.

<u>Transport</u>

1.15 Construction works will involve transport of materials and workforce to sites. The effects will be temporary and will be subject to management to ensure that effects are not unacceptable. This will be the case for any option and transport is not a material factor in distinguishing between options.

[1] Paragraph 2.8.7, National Policy Statement for Electricity Networks Infrastructure (EN-5), July 2011

Study Area

1.16 The Study area extends for approximately 110km from the eastern edge of Bridgwater, Somerset to Nursling substation in Hampshire. An existing overhead line owned and operated by National Grid travels through the western part of the Study area between the Hinkley Point and Melksham substations (ZG Route). Two further high voltage overhead lines connect into the Nursling substation, these comprise the Mannington to Nursling overhead line (YB Route) and the Nursling to Lovedean overhead line (YC Route).

1.17 The Study area includes the main settlements of Glastonbury, Shepton Mallet and Frome in Somerset, Warminster and Salisbury in Wiltshire and Romsey and Nursling in Hampshire.

2.0 ENVIRONMENTAL CONSTRAINTS

2.1 A description of the Study area in relation to the environmental constraints outlined in Table 1.1 above is presented below and illustrated at Maps 5 and 6 (drawing numbers 1979.225 and 1979.226).

Heritage Coasts

2.2 There are no Heritage Coasts within the Study area.

World Heritage Sites

<u>Stonehenge</u>

2.3 Stonehenge World Heritage Site covers an area of approximately 51km^2. Stonehenge and Avebury, in Wiltshire, are among the most famous groups of megaliths in the world and comprise two areas of chalk land with complexes of Neolithic and Bronze Age ceremonial and funerary monuments.

2.4 The World Heritage Site is designated for its outstanding universal value due to the monuments of Stonehenge, Avebury and associated sites which demonstrate outstanding creative and technological achievements in prehistoric times. The site provides an outstanding illustration of the evolution of monument construction and the continual use and shaping of the landscape over more than 2,000 years from the early Neolithic to the Bronze Age. The complexes of monuments also provide an exceptional insight into funerary and ceremonial practices in Britain in the Neolithic and Bronze Age. Together with their settings and associated sites they form landscapes without parallel.

<u>Implications for overhead line routeing</u>

2.5 World Heritage Sites are natural and cultural sites designated under the 1972 World Heritage Convention which aims to identify, protect and preserve cultural and natural heritage around the world considered to be of outstanding value to humanity. World Heritage Sites vary considerably and include sites of high natural value and also highly modified sites such as cities. It would be appropriate to refer to the detailed nomination information for any World Heritage Site to identify the characteristics of that site and the harm that could be posed by a new overhead line. Greater harm would be posed where a new overhead line would introduce a high level of change discordant with the characteristics of a Site.

2.6 The importance of World Heritage Sites and the protection afforded to them is further highlighted in Planning Policy Statement (PPS) 5 and Rule 1 of the Holford Rules which place strict restrictions on developments within these sites. Any Potential Connection would need to avoid the World Heritage Site designation routeing either to the north, where Salisbury Plain Site of Special Scientific Interest (SSSI), Special Protection Area (SPA), Special Area of Conservation (SAC) provides a constraint, or to the south where land is constrained between the World Heritage Site and Cranbourne Chase and West Wiltshire Downs Area of Outstanding Natural Beauty (AONB). A new overhead line in close proximity to the World Heritage Site would have an adverse effect and further detailed Study would be required to determine the effects on the setting of this designation.

National Parks

The New Forest

2.7 In 2005 the New Forest became England's eighth National Park and was the first to be designated in the 21st century. The New Forest National Park covers an area of approximately 570km^2 and is the most intact surviving example in England of a medieval hunting forest and pastoral system.

2.8 The diversity of its landscape is unique and includes woodland, open heathland, riverine and coastal land. Much of its landscape is also of importance to nature conservation and archaeology and is protected by designations such as SSSI, SAC and Scheduled Monuments (SMs).

2.9 The New Forest National Park Authority (NPA) works across the whole of the forest area, encouraging and co-ordinating joint actions from local and national groups with an interest in protecting its unique qualities. The NPA took up its full range of statutory powers and functions on the 1st of April 2006.

Implications for Overhead Line Routeing

2.10 National Parks are designated under the National Parks and Access to the Countryside Act 1949 (as amended) for the purpose of conserving and enhancing the natural beauty of the area. The importance of National Parks and the protection afforded to them is further highlighted in Planning Policy Statement (PPS) 7 and Rule 1 of the Holford Rules which place strict restrictions on developments within these sites. Paragraph 22 of PPS7 states that major developments should not take place in these designated areas except in exceptional circumstances and that such applications will be subject to rigorous examination and should include an assessment of the national need, cost and scope of developing outside the designated area and effects on the environment, landscape and recreational opportunities. A new overhead line through a National Park would have an effect on the landscape which will affect the objective to conserve and enhance natural beauty.

2.11 A direct overhead line route between Bridgwater and Nursling would pass through the New Forest National Park. To avoid this designation an overhead line would need to travel to the north of the village of Whiteparish, Somerset and north of the A27 which runs in an east-west direction north of the New Forest National Park. The proximity and effects of an overhead line on the setting of the National Park would require further consideration if this Potential Connection was taken forward.

Areas of Outstanding Natural Beauty (AONB)

Mendip Hills

2.12 The Mendip Hills AONB covers an area of approximately 200km^2 and is an extensive range of limestone hills to the south of Bristol. The hills run in an east to west direction between the coast at Weston-super-Mare and Frome in Somerset and border the northern edge of the Somerset Levels.

2.13 The hills of the AONB form prominent landmarks. The designation relates to landscape and scenic importance although the Mendip Hills are also valued for the many industrial archaeological sites reflecting the lead, coal and cloth industries. The AONB is also characterized by an open, largely treeless, limestone plateau surrounded by gorges, cliffs and escarpment slopes

Cranbourne Chase and West Wiltshire Downs

2.14 This AONB covers an area of approximately 983km^2 and is an extensive belt of chalk land. It is divided into two areas by the fertile wooded Vale of Wardour. Cranbourne Chase is characterised by its rounded downs, steeply cut combes and dry valleys. The Wiltshire Downs is more varied with knolls and whaleback ridges

2.15 The AONB is designated primarily for its landscape and scenic importance although it is of ecological importance and is also rich in archaeological sites including SMs and historic field patterns. The Vale of Wardour is important for its large 18th and 19th century estates, parklands and associated villages.

Cotswolds

2.16 The Cotswolds AONB, at 2,038km^2, is the largest in England and Wales and is the third largest designated landscape in the UK after the Lake District and Snowdonia. It extends from Bath and Wiltshire in the south through Gloucestershire and Oxfordshire to Warwickshire and Worcestershire in the north. Jurassic limestone gives the AONB its distinctive character. The limestone lies in a sloping plateau with a steep scarp slope in the west drained by short streams in deep cut wooded valleys, and a gentle dip slope which forms the headwaters of the River Thames.

2.17 The AONB is nationally important for rare limestone grassland and ancient beech woodlands. The land also includes a number of ecologically and archaeologically important sites which are protected through a range of designations.

Implications for Overhead Line Routeing

2.18 AONBs are designated under the National Parks and Access to the Countryside Act 1949 (as amended) for the purpose of conserving and enhancing the natural beauty of the area. The importance of these sites and the protection afforded to them is further highlighted in Planning Policy Statement (PPS) 7 and Rule 1 of the Holford Rules which place strict restrictions on development within these sites. Paragraph 22 of PPS7 states that major developments should not take place in these designated areas except in exceptional circumstances and that such applications will be subject to rigorous examination and should include an assessment of the national need, cost and scope of developing outside the designated area and effects on the environment, landscape and recreational opportunities. A new overhead line through an AONB would have an effect on the landscape which will affect the objective to conserve and enhance natural beauty.

2.19 A direct overhead line route between Bridgwater and Nursling would pass through Cranbourne Chase and West Wiltshire Downs AONB. To avoid this designation an overhead line would need to travel to the north of the AONB and south of Wells, Somerset (immediately south of the Mendip Hills AONB) in an area of land occupied by the existing 400kV Hinkley to Melksham overhead line. It would then need to continue to the north of Cranbourne Chase and West Wiltshire Downs AONB. A route would be further constrained by Salisbury Plain SSSI, SPA and SAC which would restrict the Potential Connection to a narrow area of land close to the boundary of the AONB. The proximity and effects of an additional overhead line on the setting of the AONBs would require further consideration if a new overhead line between Bridgwater and Nursling was taken forward.

Sites of Special Scientific Interest (SSSI)

2.20 SSSIs are sites designated for their biodiversity or geological interest and are protected from development and operations which are likely to damage their special interest. There are SSSIs dispersed throughout the Study area. The most significant of these sites and the reasons for their designation are summarised in Table 2.1.

Table 2.1 – Summary of SSSIs

SSSI	Location / Grid Ref	Reason for Designation
Moorlinch	Only partly in Study area (ST 390360)	Moorlinch is part of an extensive grazing marsh grasslands and ditch system in the Somerset Levels and Moors. It forms part of the Somerset Levels and Moors SSSI, SPA, Ramsar site to the north east of Bridgwater. The moor contains botanically rich ditch systems and is important for wintering wading birds and waterfowl.
The Catcott, Edington and Chilton Moors, Tealham and Tadham Moors and Westhay Moors	North east of Bridgwater (ST 390420)	The Catcott, Edington and Chilton Moors, Tealham and Tadham Moors and Westhay Moors SSSIs are a collection of adjoining moors which form part of the Somerset Levels and Moors SSSI, SPA, Ramsar site to the north east of Bridgwater. These sites comprise diverse habitats which provide feeding and nesting sites for a wide range of birds such as Golden Plover and Lapwing. The existing 400kV Hinkley to Melksham overhead line passes through this area close to development at Burtle and Westhay.
St Dunstan's Well Catchment	North of Stoke St Michael (ST 668475 ST 655475)	St Dunstan's Well Catchment is an important cave system, containing a range of cave formations which are of national importance dating back to the Pleistocene Ice Age. The formations are important in relation to geological evolution in southern England. The sites also support species-rich unimproved calcareous grassland. Part of the area is also designated as a SAC. The caves are important for a range of bats including Greater and Lesser Horseshoe and Natterer's Bats which hibernate in the cave system.
Edford Woods and Meadows	South of Helcombe (ST 665485 ST 675488 ST678480)	This site is important for the range of semi-natural ancient woodland, unimproved pasture and meadows which are now uncommon in Britain. The SSSI is within the valley of Mells stream. The designation covers a number of sites between Stoke St Michael, Helcombe and Coleford. The site supports a range of important herb species including the nationally rare Monk's Hood.
Asham Wood	Southwest of Frome (ST 705460)	Asham Wood is the largest and most diverse semi-natural woodland in the Mendips (it lies outside the Mendip Hills AONB designation). It occupies two deep valleys and an interconnecting plateaux and offers optimal conditions for a range of lower plants. The site is also designated SAC. The site has recently suffered through quarrying locally although this has now ceased. The site is also important for buzzard, sparrowhawk, garden warbler, spotted flycatcher and greater spotted woodpecker.
Cloford Quarry	West of Nunney (ST 718444)	The quarry is important for exposures of sediments of Triassic and Jurrassic age.
Holwell Quarries	(ST 726450)	Holwell Quarries is internationally important for its geology. It shows a comprehensive assemblage of Triassic, Lower Jurassic and Middle Jurassic fissures.

SSSI	Location / Grid Ref	Reason for Designation
Postlebury Wood	Southwest of Frome (ST 740430)	Postlebury Wood is a large relatively undisturbed ancient wood established on poorly drained Oxford Clays. The site has a well developed ground flora including important ancient woodland herb species Herb Paris and Woodruff. The site supports large populations of the homostyle primrose which is of international importance as it is only found on one site outside south east Somerset. The woodland is also an important location for breeding for a range of birds and mammals.
Longleat Woods	West of Warminster (ST 795435)	This is a large semi-natural ancient woodland with a predominantly high forest structure which is unusual in south west Britain. The site supports a range of woodland types more characteristic of central England and rare in the west. There are a large number of plant species normally only found in ancient woodland including: Broadleaved Helleborine and Wood Small-reed. The fauna has not been studied in detail but a range of mammals, breeding birds and invertebrates have been recorded.
Vallis Vale	(ST 755490)	Vallis Vale is an ancient woodland supporting ash-wych elm stand which has a restricted distribution in Britain. Hells Stream and Egford Brook flow through deeply dissected wooded valleys. The site is one of only a few sites in Somerset supporting Crayfish. It is also important for Banded Agrion and Demoiselle Agrion. The site also supports breeding birds: kingfisher, dipper and kestrel. Greater Horseshoe Bats have been recorded. The site is also of geological importance with nationally important rock displaying ‘Britain’s most classic outcrops’.
Picket and Clanger Wood	Southeast of Trowbridge (ST 875543)	This is floristically rich ancient woodland which supports a range of butterfly species including two species which are rare and vulnerable. The site is also important for the range of birds typical of southern and western England. Almost two thirds of the site has undergone coniferisation although much of the semi-natural vegetation has remained between planting. It is important for a range of breeding birds (including 15-20 breeding pairs of nightingales) and for more than 300 moths including the rare narrow-bordered bee hawk-moth and lesser spotted pinion. The site also supports common lizard, stoat, weasel, bank vole, common and pygmy shrew.
Salisbury Plain	Northwest of Warminster (ST 950480 SU 070500 SU 200490)	Also designated as a SPA and SAC, this is the largest known expanse of unimproved chalk downland in North western Europe representing 41% of Britain’s remaining area of this habitat type. Salisbury Plain supports 13 species of nationally rare/scarce plants, 67 species of rare and scarce invertebrates and is internationally important for birds. Habitats also include scrub, woodland, pools and Nine Mile River.

SSSI	Location / Grid Ref	Reason for Designation
Cley Hill	West of Warminster (ST 838449)	Cley Hill is an area of botanically rich chalk grassland, supporting many of the plants characteristic of the downs of south and south-west England. The value of the site is enhanced by the occurrence of plant and animal species with a nationally restricted distribution. Many important archaeological features are also present within the site.
River Avon System	Throughout the eastern extents of the Study area. (SZ 163923 SU 073583 ST 867413 ST 63297 SU 170344 SZ 41147)	The River Avon and its tributaries are of national and international importance for their wildlife communities. The Avon is richer and more varied than most chalk streams as it has one of the most diverse fish faunas in Britain, a wide range of aquatic invertebrates and over 180 species of aquatic plant. Wiltshire tributaries and different geologies are included on account of their importance for internationally rare or threatened species.
Scratchbury and Cotley Hills	East of Warminster (ST 915437)	This is a chalk grassland site south-east of Warminster, supporting a rich flora and an outstanding associated butterfly fauna. The site includes species listed on the Red Data Book.
Stearvall & Stony Down	East of Codford St Mary (ST 991400)	Stearvall and Stony Down is a large block of botanically rich chalk grassland. A wide variety of herbs typical of the South and Southwest Chalk are represented in the vegetation, among them species with nationally restricted designations. The site supports a characteristic downland fauna including a nationally scarce butterfly and robber fly.
Yarnbury Castle	North of Steeple Langford (SU 037403)	Yarnbury Castle is an Iron Age Hillfort on the Upper Chalk north of the Wylve Valley. The steep ramparts and earthworks support a rich chalk grassland flora which includes several plants of nationally restricted distribution. The botanical interest is confined to the double bank and ditch which surrounds agriculturally improved grassland in the centre of the hillfort.
Parsonage Down	South of Shrewton (SU 050412)	Parsonage Down is one of the most outstanding chalk downland sites in Britain. Situated on the Upper Chalk of the southern edge of Salisbury Plain. There is an extensive area of flat and gently sloping land, much of which has escaped ploughing and other agricultural improvement during the last 100 years. A variety of vascular plants occur within the sward; it is common to record over 30 species in a square metre. Orchids are well represented and the land supports rare spiders
River Till	Running in a north-south direction to the west of Stapleford (SU 051452 SU068368)	The River Till is a tributary of the River Wylve, itself part of the River Avon SSSI. The site is notified as an example of a winterbourne chalk stream containing the internationally important habitat “floating vegetation” of water crowfoot and supports internationally important fish species. The site is also important for water vole and otter.
Steeple Langford Down	North of Steeple Langford (SU 036387 SU 042383)	An area of exceptionally herb-rich chalk grassland supporting several plant species that have a restricted distribution in Britain. The site occupies part of a valley formed in the Upper and Middle Chalk at the southern edge of Salisbury Plain. The regularly grazed turf is extremely rich with up to 43 species having been recorded per square metre. The site is also important for numerous species of butterfly.

SSSI	Location / Grid Ref	Reason for Designation
Camp Down	Northwest of Salisbury (SU 120338)	Botanically rich chalk grassland overlooking the Avon Valley near Salisbury. The downland is rich in plants characteristic of South Wiltshire chalk grasslands, including several species of nationally restricted distribution. The site is also important for a variety of butterflies, bugs and beetles.
Lower Woodford Water Meadows	North of Salisbury (SU 124347 SU 126355 SU 124356)	Lying alongside the River Avon, this site includes one of the last two actively managed water-meadow systems in Wiltshire. It is one of the few sites which retain the grassland community characteristic of this long established and once widespread form of management. Supports 18 species of grass.
Cockey Down	Northeast of Salisbury (SU 170317)	An area of botanically rich chalk grassland. The considerable variety of calcareous plants growing at this site includes two nationally restricted species, eight species of orchid and a wide range of grasses. In addition the downland supports a range of butterfly and snail species and the rare robber fly.
Figsbury Ring	Northeast of Salisbury (SU 188338)	National Trust owned iron-age hill fort with botanically diverse chalk grassland, representative of that found on the south and south-west chalk. It supports nationally restricted plant and animal species as well as large populations of orchids.
Bracknell Croft	Northeast of Salisbury (SU 180330)	Bracknell Croft comprises a mosaic of botanically-rich chalk grassland and developing juniper scrub. Juniper colonies in southern England are almost entirely restricted to calcareous soils and within this region.
Blackmoor Copse	North of East Grimstead (SU 234292)	An area of botanically and entomologically rich broadleaved woodland east of Salisbury. The site includes strands of wet ash-maple, pedunculate oak-hazel-ash and hazel-pedunculate oak wood. Blackmoor Copse has one of the richest floras recorded from a Wiltshire wood on Tertiary strata. Glades and rides contribute to the sites diversity.
Bentley Wood	North of West Dean (SU 250295)	The site was former ancient woodland but was replanted to conifers and native hardwoods post-war. This has eliminated much of the former scientific interest however the site supports a wide range of butterflies and moths.
Brickworth Down & Dean Hill	South of West Dean (SU 246259 SU 213251 SU 213248 SU 206249)	Chalk grassland with nationally restricted plant and invertebrate species. The site is recognised as important for insect populations and butterflies.
Whiteparish Common	South of Whiteparish (SU 255223)	The site is within the New Forest National Park and comprises an extensive area of ancient semi-natural woodland. It is predominantly beechwood with pedunculate oak and ash but also exhibits a large number of other woodland types. It supports an exceptionally diverse woodland flora and some uncommon butterfly species including one of nationally restricted distribution. Streams with meanders, pools and riffles support wetland species and mature trees are important for invertebrates. Wood also supports range of woodland birds.

SSSI	Location / Grid Ref	Reason for Designation
Mottisfont Bats	South of Broughton (SU 314281)	The woodland habitat around Mottisfont supports a nationally important population of the rare barbastelle bat. It is the only known maternity roost in Hampshire and one of only six known sites in the UK (2002 Data). The known breeding colonies in Britain are either in old trees or old buildings. A total of nine species of bat have been recorded at Mottisfont.
River Test	Running in a north-south direction to the west of Romsey (SU 533498 SU 367150 SU 361145)	The River Test is a classic chalk stream. It is one of the most species-rich lowland rivers in England. The entire river system exhibits a flora characteristic of chalk streams. In the lower reaches, additional species more commonly found in other river types, add diversity to the assemblage. The Test supports a high diversity of invertebrate species and is especially rich in aquatic molluscs. Over 100 species of flowering plant, moss and liverwort have been recorded along its channel and bank. Over 232 invertebrate taxa have been recorded in the Test and it is a valuable habitat for wetland birds and water voles.

Implications for Overhead Line Routeing

2.21 The potential effect of an overhead line on a SSSI would vary depending on the nature of the effect caused and the special interest of the site. Consultation with Natural England would be required before consent could be granted for any development or operations likely to damage the SSSI interest.

2.22 Whilst many SSSIs within the Study area could be avoided by the Potential Connection there are a number which would influence routeing and detailed alignments due to their size or proximity to each other.

2.23 The existing 400kV Hinkley to Melksham overhead line travels through Tealham and Tadham Moors and Catcott, Edington and Chilton Moors SSSIs. If an overhead line was constructed parallel to the existing line it would also pass through these areas of designation. The effects of an additional overhead line on the integrity of these sites or their qualifying features would require further detailed consideration if this route option was taken forward.

2.24 To avoid these SSSIs an overhead line would need to travel either north or south of the Moors. However, the presence of other constraints such as SMs (see paragraph 2.48 – 2.56 below) and settlements would further constrain a route through this area.

2.25 Between Shepton Mallet and Frome an overhead line route is constrained by a cluster of SSSIs. These include: St Dunstan’s Well Catchment; Edford Meadows and Woods; Asham Wood; Cloford Quarry; Holwell Quarries and Postlebury Wood. To avoid these SSSIs an overhead line would need to travel through the area between St Dunstan’s Well and Asham Wood although settlements would pose a further constraint to routeing through this area.

2.26 Between Frome and Salisbury an overhead line route is constrained by several SSSIs the largest of which is Salisbury Plain. Due to the presence of numerous SMs to the north of this site an overhead line which avoids Salisbury Plain would need to pass through a narrow area of land north of Cranbourne Chase and West Wiltshire Downs AONB. Other SSSIs which pose a constraint to routeing through this narrow area include: the River Avon; Cley Hill; Scratchbury and Cotley Hills; Stearvall and Stony Down, Parsonage Down, Yarnbury Castle, River Till, Steeple Langford Down and the Lower Woodford Water Meadows.

2.27 An overhead line route could be achieved which avoids the majority of these designations but their proximity to each other would influence the directness of a route. Stonehenge World Heritage Site and settlement at Warminster provide further constraints to routeing.

2.28 Between Salisbury and Nursling substation an overhead line route is constrained by several large SSSIs. These include: Blackmoor Copse; Bentley Wood; Brickworth Down and Dean Hill; Whiteparish Common; Mottisfont Bats; and the River Test. To avoid these SSSIs an overhead line would need to travel through the area south of Bentley Wood and Mottisfont Bats however concentrations of woodland and numerous settlements would further constrain a route through this area.

2.29 To achieve a connection to Nursling an overhead line route would oversail the River Till and the River Avon. Further study would be required to establish effects on the integrity of these SSSIs if this Potential Connection was taken forward.

Special Protection Areas (SPA) and Ramsar sites

Somerset Levels and Moors SPA and Ramsar

2.30 The Somerset Levels and Moors are one of the largest areas of traditionally managed wet grassland and fen habitats in lowland UK. The SPA and Ramsar sites cover the same geographical area as each other (approximately 35,000 hectares) and include the floodplains of the Rivers Axe, Brue, Parrett, Tone and their tributaries. The internationally important bird populations and the habitats on which they depend are reasons for both the SPA and Ramsar designations; the Ramsar designation also extends to cover rare invertebrate populations.

The New Forest SPA and Ramsar

2.31 The New Forest covers an area of over 28,000 hectares. Valley mires and wet heaths are found throughout the site and are of outstanding scientific interest. The site contains the largest concentration of intact valley mires of their type in Britain. The site supports a diverse assemblage of plants and animals including: seven species of nationally rare plant and at least 65 British Red Data Book species of invertebrate. The mire habitats are of high ecological quality and diversity they also have undisturbed transition zones. The invertebrate fauna of the site is important due to the concentration of rare and scarce wetland species. The wetland habitats support a number of species such as: honey buzzard; Montagu’s harrier; Hen harrier; redshank; lapwing; curlew; snipe; kingfisher; woodlark; nightjar; and Dartford warbler with the New Forest holding 75% of the UK’s population of Dartford warblers.

Salisbury Plain SPA

2.32 Salisbury Plain SPA covers 19,689 hectares and is the largest area of open chalk grassland in north western Europe. It is owned by the Ministry of Defence and used intensively for military training. The SPA also covers areas of heath and semi-natural dry grasslands. The site is the best remaining example in the UK of lowland juniper scrub on chalk and is considered to be one of the best areas in the UK for common juniper formations on heaths or calcareous grasslands and semi-natural dry grasslands. The grasslands support important orchid populations and the important marsh fritillary butterflies are present on site.

Porton Down SPA

2.33 Porton Down SPA covers an area of 1,562 hectares and supports the largest uninterrupted tract of calcareous grassland in Britain. The site supports a rare species of spider – Typhocrestus simoni – which is recorded at only one other site in the UK. During the breeding season the site supports 10% of the British population of Stone-Curlew. The site is considered to support an outstanding breeding bird community including hobby, buzzard and long-eared owl.

Implications for Overhead Line Routeing

2.34 SPAs and Ramsar sites are afforded protection under the Conservation of Habitats and Species Regulations 2010. The Regulations only permit development in the first instance on such sites where it is directly connected with or necessary to site management for nature conservation; or where the proposal would not be likely to have a significant effect on the conservation objectives of the site, alone or in combination with other plans and projects.

2.35 Where there are likely to be significant effects, consent for development can only be granted where it would not adversely affect the integrity of the site taking into account the manner in which the development will be carried out and any conditions that might be imposed on the consent or there are no alternative solutions and the development must be carried out for imperative reasons of overriding public interest relating to human health, public safety or benefits of primary importance to the environment.

2.36 The existing 400kV Hinkley to Melksham overhead line passes through the Somerset Levels and Moors SPA and Ramsar site close to development at Burtle and Westhay, Somerset. To avoid this designation, an overhead line would need to be routed to the north, between the SPA/Ramsar site and the settlements of Blackford and Wedmore or to the south where a route is constrained by a number of small hamlets and villages and the larger settlements of Street and Glastonbury.

2.37 To avoid Salisbury Plain SPA a new overhead line would need to be routed to the south; however the settlement of Warminster and the Cranborne Chase and West Wiltshire Downs AONB further constrain possible routes. To avoid other SPAs within the Study area an overhead line would need to be routed to the south of Porton Down SPA and north of the New Forest SPA where other constraints such as SSSIs, SACs, settlements and woodland are present.

Special Areas of Conservation (SAC)

2.38 There are SACs dispersed throughout the Study area. The most significant of these sites and the reason for their designation are summarised below.

Mells Valley SAC

2.39 The Mells Valley SAC comprises a collection of sites which are semi-natural dry grasslands and scrubland facies on calcareous substrate. The cave system is considered to be one of the best areas in Britain for Greater Horseshoe bats. The component sites of the SAC are also designated as SSSIs.

Mendip Woodlands SAC

2.40 The Mendip Woodlands SAC is a *Tilio-Acerion* forest of slopes, screes and ravines. It covers a number of sites which are within the Mendip Hills AONB; this site covers Asham Wood which is the most easterly of the sites and lies outside the AONB designation. The wood has been affected by past quarrying although this activity has now ceased. The wood is also designated as a SSSI.

River Avon SAC

2.41 The River Avon SAC is a large, lowland river system that includes sections running through chalk and clay, with transitions between the two. It rises in Pewsey Vale as a network of clay streams fed by chalk springs which converge as a chalk river running through Salisbury Plain. The River Avon and its tributaries are of national and international importance for their wildlife communities and are designated as a SSSI.

Salisbury Plain SAC

2.42 Salisbury Plain SAC is a large area of open chalk grassland which is the best remaining example in the UK of lowland juniper scrub on chalk. The juniper is juxtaposed with extensive semi-natural dry grassland and chalk heath and the site supports a wide range of flora and fauna. The site is also designated as a SPA, SSSI and has numerous SMs within the SAC boundary.

Mottisfont Bats SAC

2.43 The Mottisfont Bats SAC is a mixture of woodland types including hazel coppice with standards, broadleaved and coniferous plantation. It is one of the best sites in the UK for bats and supports an important population of the rare barbastelle bats. The wood is also designated as a SSSI.

The New Forest SAC

2.44 The New Forest SAC is important for its wide variety of habitats including oligotrophic waters and old acidophilous oak woods. It is considered to have some of the best areas in the UK for North Atlantic wet heaths; dry heaths; molinea meadows on calcareous, peaty and clayey-silt-laden soils; transition mires; quaking bogs; depressions on peat substrates; alkaline fens; Atlantic beech forests; bog woodland and alluvial forests. It is considered to be one of the best areas in the UK for the southern damselfly, supports a significant population of great-crested newt and is one of only four outstanding localities for the stag beetle. The site is also designated as part of the New Forest National Park and is covered by Ramsar, SSSI and SPA designations.

Implications for Overhead Line Routeing

2.45 Like SPAs and Ramsar sites, SACs are afforded protection under the Conservation of Habitats and Species Regulations 2010 and development is strictly controlled.

2.46 An overhead line route between the Mells Valley SAC and the Mendip Woodlands SAC would be constrained by the presence of settlements and woodland.

2.47 The existing 400kV Hinkley to Melksham line travels to the south of the SACs. An overhead line route parallel to the existing line would avoid these designated sites. However, in accordance with Natural England's Bat Mitigation Guidelines (2004) the effects of a new overhead line within 4km of these SACs would require further assessment to ensure there would be no adverse effects on the integrity of the designation or its qualifying features.

2.48 To avoid other SACs within the Study area the Potential Connection would need to travel to the south of Salisbury Plain SAC and to the north of the New Forest SAC. The River Avon SAC extends between these sites and an overhead line route would need to cross the SAC, potentially oversailing the river. The effects of an overhead line on the integrity of this site or its qualifying features would require further detailed consideration if this Potential Connection was taken forward.

National Nature Reserves (NNRs)

2.49 There are several wildlife sites within the Study area designated as NNRs. The majority of these lie to the north east of Bridgwater and form part of larger sites afforded protection under other ecological designations such as SSSI, SPA and Ramsar. The NNRs in the Study area are summarised in Table 2.2.

Table 2.2 - Summary of NNRs

NNR	Grid Ref/Location	Reason for Designation
Huntspill River	ST 320443	This is an artificial river within the Somerset Levels and is managed by the Environment Agency. The area is of interest to various birds and otters. The area is also of archaeological interest. The river stretches for 5 miles from Bridgwater Bay to the

NNR	Grid Ref/Location	Reason for Designation
		western boundary of the Catcott Edington and Chilton Moors SSSI.
Somerset Levels	ST 387360	This NNR is important for its open water and lowland grasslands. It is currently closed to the public.
Westhay Moor	ST 453440	This NNR is owned and managed by Somerset Wildlife Trust. It comprises restored peat fields and water-filled compartments with islands of reeds and bulrushes. The land also includes poor fen and a fragment of acid moor which is currently being restored.
Shapwick Heath	ST 430400	This is a wetland reserve managed by Natural England covering over 500ha. It is important for its reed beds, fens, meadows and wet woodland. The NNR also includes the oldest Neolithic 'Sweet Track', the oldest routeway in Britain.
Ham Wall	ST 458402	This NNR is owned and managed by the RSPB. It is an area of former commercial peat extraction and is currently being restored to wetland habitats.
Parsonage Down	SU 056416	This NNR is a working farm owned and managed by Natural England. It is lowland grassland notable for its abundant wildflowers, in particular orchids. The site also contains areas of scrub which support breeding birds. As well as the wildlife features the site includes two SMs and several archaeological features.
Langley Wood	SU 231207	This NNR is an extensive tract of ancient, mainly oak, forest. The varied soils and drainage have produced diverse woodland. The site supports 'old forest' lichens, deer, dormouse and breeding birds including wood warbler, woodcock and lesser-spotted woodpecker.

Implications for Overhead Line Routeing

2.50 The existing 400kV Hinkley to Melksham overhead line crosses the Huntspill River NNR, which is also crossed in two places by existing lower voltage overhead lines owned and operated by WPD. The 400kV overhead line then continues east passing between a number of other NNRs within the Somerset Levels and Moors SSSI, SPA and Ramsar.

2.51 An overhead line parallel to the existing line would cross the Huntspill River NNR and other NNRs within the Somerset Levels and Moors SSSI, SPA and Ramsar sites. To avoid these areas of designation, an overhead line would need to be routed to the south of the Somerset Levels and Moors where a route would be constrained by a number of small hamlets and villages and the larger settlements of Street and Glastonbury.

2.52 Due to the presence of other constraints such as SMs and settlements an overhead line would need to travel to the south of Salisbury Plain and Parsonage Down NNR. However, the directness of a route through this area would be constrained by the presence of a number of SACs, SSSIs and blocks of woodland.

2.53 Langley Wood NNR is within the New Forest National Park boundary. Routeing which avoided the National Park would avoid this NNR.

Scheduled Monuments (SMs)

2.54 The south west of England is a region of high archaeological and historical importance and contains over a third of all SMs in England. There are approximately 162 SMs distributed across the Study area.

2.55 There are clusters of SMs within the Mendip Hills AONB, Cranbourne Chase and West Wiltshire Downs AONB, the New Forest National Park and Salisbury Plain World Heritage Site. The presence of these SMs would pose a further constraint to routeing through these designated landscapes and achieving a direct route for the Potential Connection.

Implications for Overhead Line Routeing

2.56 SMs are nationally important monuments and archaeological remains which are protected under the provisions of the Ancient Monuments and Archaeological Areas Act 1979. Consent is required from English Heritage, the statutory advisor on the historic environment, under the 1979 Act for works for works directly affecting an SM may be carried out.

2.57 Within the Somerset Levels there is a cluster of timber trackways dating from the Bronze and Iron Ages plus other SMs around Glastonbury such as Glastonbury Tor, a number of duck decoys, lake villages and a medieval road.

2.58 The existing 400kV overhead line between Hinkley and Melksham travels through this cluster of SMs, in places oversailing some of the timber trackways. An overhead line route parallel to the existing line would be constrained by the SMs and detailed assessment would be required to identify the direct and indirect effects on the monuments and their setting.

2.59 The existing 400kV overhead line travels to the south of Frome passing between Witham Priory and Marston Moat. An overhead line route parallel to the existing line could be achieved through this area; however the cumulative effects of an additional line would require further consideration in accordance with the Holford Rules.

2.60 Within Salisbury Plain there is a large concentration of SMs. To avoid direct effects on the SMs and the World Heritage Site designation an overhead line would need to be routed to the south of Salisbury Plain.

2.61 To the west of Warminster there are a number of SMs including a cluster of bowl barrows and the large Scratchbury Hill monuments. The proximity of these SMs to each other would constrain routeing and affect the directness of a potential overhead line route. If this Potential Connection was taken forward, further detailed study on the direct and indirect effects of an overhead line on the setting of the monuments would be required.

2.62 Other clusters of SMs that would influence the directness of any overhead line route include camps and barrows to the north west and south east of Berwick St James and a cluster of SMs around Salisbury.

Historic Buildings

2.63 There are approximately 126 Grade I and 334 Grade II* listed buildings within the Study area. These are distributed across the Study area but are often clustered within larger settlements. Particular clusters of historic buildings are found within the settlements of Wells; Glastonbury; Shepton Mallet; Frome; Warminster; Salisbury and Romsey.

Implications for Overhead Line Routeing

2.64 Buildings of special architectural or historic interest are added to a list of buildings protected under the Planning (Listed Buildings and Conservation Areas) Act 1990. Planning authorities are required to consult with English Heritage on planning applications which may affect a Grade I and Grade II* listed building outside Greater London and listed building consent is required for any works likely affect a listed building.

2.65 Routes could be achieved for the Potential Connection which avoid listed buildings. However, further detailed study would be required to identify any adverse effects on the setting of any isolated buildings.

Conservation Areas

2.66 Within the Study area there are 29 Conservation Areas. These are generally focused within town and village centres and include: Glastonbury; Mells; Street; East Pennard; Littleton; Norton; Shepton Mallet; Shapwick; Wedmore; Evercreech; Batcombe; Frome; Buckland Dinham; Beckington/Lullington; Tellisford; two at Warminster; Bishopstrow; Heytesbury; Berwick St James; Stareford; Lower Woodford; Netton; Salisbury; Winterbourne Earls; Winterbourne Dauntsey; Pitton; Farley and West Dean.

Implications for Overhead Line Routeing

2.67 Conservation Areas are areas designated by local authorities because of special architectural or historic interest and are protected under the Planning (Listed Buildings and Conservation Areas) Act 1990. Conservation Area consent is required from the local planning authority for any development within the area.

2.68 Routes could be achieved for the Potential Connection which avoid Conservation Areas. However, further detailed study would be required to identify any adverse effects on their setting.

Registered Parks and Gardens

2.69 There are 18 Registered Parks and Gardens within the Study area. These are summarised in Table 2.3 below.

Table 2.3 – Summary of Registered Parks and Gardens

Registered Park and Garden	Grid Ref/Location	Reason for Designation
Mells Park (193 ha)	ST 713487	Grade II listed parkland and lakes dating back to the 18th century. Considered one of the finest examples of an English Country House.
Babington House (57 ha)	ST 704510	Babington House includes grade II listed 18th and 19th century gardens and pleasure grounds of around five hectares, set in 52 hectares of parkland. The house is a private hotel.
The Chantry (12 ha)	ST 719470	The Grade II listed grounds include the remains of a landscape with lakes and grottos dating to around 1825.
Ammerdown House (188 ha)	ST 710527	The Grade II* listed park includes an early 20th century Italianate formal garden designed by Sir Edwin Lutyens, set within a late 18th to early 19th century park.
Mells Manor House (1.5 ha)	ST 727493	This Grade I listed park and garden includes a walled garden dating from around 1520 with changes and additions made following advice by Sir Edwin Lutyens and Gertrude Jekyll around 1902-1910.
Marston House (222 ha)	ST 756452	The garden is Grade II listed and includes pleasure grounds laid out by Stephen Switzer between 1724 and 1745 and a late 18th century landscape park.
Longleat Park (505 ha)	ST 810430	Grade I listed 19th and 20th century formal gardens extending to 2.5 hectares. The site is now primarily known as a safari park introduced by the Marquess of Bath in 1964.
Hapsford House (Also known as Vallis Villa) (5 ha)	ST 759497	The Grade II park includes pleasure grounds associated with the early 19th century Hapsford House. There are also 20th century additions to the gardens, including a laburnum arch over a box-edged formal walk. The house is at the northern end of a steep-sided rocky valley known as Vallis Vale.

Registered Park and Garden	Grid Ref/Location	Reason for Designation
Orchardleigh (329 ha)	ST 777513	The Grade II* listed grounds include 19th century formal gardens and pleasure grounds (4 hectares). The pleasure grounds are set within a landscaped deer park dating from medieval times (325 hectares).
Heale House (11 ha)	SU 128364	The Grade II* listed grounds include 20th century gardens of 3 hectares set within a larger agricultural estate.
Wilton House (363 ha)	SU 100310	The Grade I listed complex includes a private home, an 18th century landscape garden and a 19th century Italian garden. A mid-18th-century park wall (listed Grade II) encloses the site to the north-west and west.
Bourne Hill House and Gardens (2 ha)	SU 147303	The Grade II listed 18th century gardens at Bourne Hill House were originally associated with the 13th century St Edmund's College and incorporate part of the medieval rampart of Salisbury.
The North Canonry, Cathedral Close (0.69 ha)	SU 141295	Grade II 18th century formal garden restored in the late 19th century by Sir George Gilbert Scott.
Longford Castle (159ha)	SU 171266	Grade II* listed 16th century park which was landscaped in the 18th century. The park covers 125 hectares, with 19th century formal gardens of two hectares.
Mottisfont Abbey (18.7 ha)	SU 327270	Grade II listed mid to late 20th century garden with 18th century origins and 19th century additions has: modern formal gardens; pleasure grounds; a landscape park; and walled gardens of approximately 18.5 hectares. The gardens hold a National Collection of old-fashioned shrub roses.
Awbridge Danes (48 ha)	SU 320230	The Grade II listed site includes pleasure grounds, follies and a park laid out in the 1820s on a new site along with the building of a gothic mansion by the architect William Garbett.
Embley Park (150 ha)	SU 322208	Grade II listed 18th century formal house and gardens, 19th and 20th century informal woodland gardens which surrounds the previous home of Florence Nightingale and pleasure grounds of approximately 126 hectares. Much of the site is now a golf course and some areas of school grounds.
Broadlands (186 ha)	SU 354203	Grade II* listed site developed in the 18th century covering 186 hectares, of which 16 hectares are formal and walled gardens and pleasure grounds and around 170 hectares are parkland and farmland. A house and garden of 16th and 17th century origin with work possibly by William Kent was remodelled in the 19th century by William Eden Nesfield.

Implications for Overhead Line Routeing

2.70 The English Heritage 'Register of Historic Parks and Gardens of special historic interest in England' (compiled under powers contained in Historic Buildings and Ancient Monuments Act 1953) identifies sites assessed to be of national importance. Registration is a ‘material consideration’ in the planning process, meaning that planning authorities must consider the impact of any proposed development on the landscapes’ special character.

2.71 An overhead line very close to a Registered Park or Garden is likely to cause adverse effects.

2.72 The majority of Registered Parks and Gardens within the Study area lie in three clusters: between Coleford and Frome; to the south and west of Salisbury; and to the north of Nursling.

2.73 To the north of Frome the area between Coleford, Mells and Radstock is particularly constrained by the presence of Babington House, Ammerdown House and Mells Manor House together with other constraints such as woodland and settlements.

2.74 The existing 400kV overhead line between Hinkley and Melksham passes between Marston House and Longleat Park. A new overhead line route could be achieved through this area. However, the cumulative effects of an additional line would require further consideration in accordance with the Holford Rules if the Potential Connection was taken forward. Beyond these sites a potential route would divert south east towards Nursling.

2.75 To the south and west of Salisbury a cluster of Registered Parks and Gardens present a constraint to routeing. To avoid these sites an overhead line would need to travel to the north of Salisbury. An overhead line route could be achieved through this area but would be constrained by a number of Conservation Areas, SMs and blocks of woodland.

2.76 Clusters of large Registered Parks and Gardens to the north of Nursling present a constraint to routeing into the substation. The presence of these sites together with other constraints such as woodland would affect the directness of a potential route into the substation.

Registered Battlefields

2.77 There is one registered battlefield within the Study area which is the site of the battle of Sedgemoor in 1685. The site lies north of Westonzoyland, Somerset approximately 1km east of Bridgwater substation and does not pose a constraint to routeing between Bridgwater and Nursling.

Woodland

2.78 There are numerous blocks of woodland, many of which are ancient woodland, interspersed throughout the Study area. Several woodlands are also designated as SSSIs.

2.79 Woodlands within the Study area vary in size from large blocks to smaller more linear blocks. The largest woodland is Longleat Woodland on the edge of Cranbourne Chase and West Wiltshire Downs AONB. Other large woodland within the Study area includes Asham Wood, Blackdog Woods, Norridge Wood, Clarendon Park Copses and Tytherington Common.

<u>Implications for Overhead Line Routeing</u>

2.80 Installing an overhead line through woodland would result in the permanent loss of woodland along the length of the connection. Holford Rules 4 and 5 refer to woodlands and their value in providing background to views and advise to avoid cutting extensive swathes through woodland blocks wherever possible.

2.81 The main concentrations of woodland which would influence the route of the Potential Connection are around Stoke St Michael, Coleford, Mells, Frome, Warminster, Salisbury and to the north west of Nursling substation.

2.82 To the west of the Study area, woodland is concentrated between Asham Wood south of Chantry and Longleat Wood on the edge of Cranbourne Chase and West Wiltshire Downs AONB. An overhead line route through this area would be achievable but would need to change direction in a number of areas to avoid the woodland blocks and other scattered constraints. Norridge Wood, which covers the narrow corridor between Salisbury Plain and

Cranbourne Chase and West Wiltshire Downs AONB acts as a constraint to achieving an overhead line route to the west of Warminster.

2.83 The area to the east of Warminster is scattered with a number of small woodland blocks. An overhead line route through this area could be achieved but would need to change direction in a number of areas to avoid the woodland blocks and other scattered constraints.

2.84 To the north west of Nursling there is several large woodland blocks including Clarendon Park Copses and Tytherington Common along with a concentration of smaller woodland blocks, many of which are ancient woodland. An overhead line route through this area would be difficult to achieve without direct effects on the woodland.

Settlements

2.85 There are a number of settlements within the Study area. The largest include Bridgwater, Street, Glastonbury, Shepton Mallet, Frome, Warminster, Salisbury and Romsey.

2.86 There are numerous other villages of varying size dispersed throughout the Study area, the larger of which are along classified roads. Smaller villages and hamlets are linked by minor road systems.

Implications for Overhead Line Routeing

2.87 The existing 400kV Hinkley to Melksham overhead line passes to the north of Glastonbury then to the south of Shepton Mallet and south of Frome where settlement is less clustered. The existing overhead line passes close to the eastern edge of Frome.

2.88 There is a concentration of built form between Bridgwater, Street and Glastonbury which would act as a constraint to routeing the Potential Connection. To the north of the Somerset Levels and Moors built form is less concentrated although settlement at Blackford, Wedmore and Wookey would constrain potential overhead line routes.

2.89 Clustered settlements also present a constraint to routeing to the north of Shepton Mallet, south of Midsomer Norton and Norton Radstock and west of Frome. This area includes numerous small villages and interconnected scattered linear hamlets which would be difficult to avoid without significant changes in direction or bringing an overhead line close to properties.

2.90 Settlement at Warminster presents a key constraint to routeing due to its position between the Cranbourne Chase and West Wiltshire Downs AONB and Salisbury Plain SSSI, SPA and SAC. A potential overhead line route through this area would be constrained to a narrow corridor of land to the north or south of the settlement.

2.91 Scattered settlement also presents a constraint to routeing to the east and south of Salisbury and includes numerous interconnected small villages and hamlets linked by minor roads and interspersed with large amounts of woodland and other constraints. These settlements would be difficult to avoid without significant changes in direction or bringing an overhead line close to properties.

Landform

2.92 Landform of the Study area shows some variations and is illustrated at Map 1 (drawing number 1979.261).

Implications for Overhead Line Routeing

2.93 The Holford Rules refer to aspects of topography and physiography such as hills, ridges, dips, open valleys and flat land in considering overhead line routeing. For example, the

Rules advise on exploiting the 'backgrounding' effect of high land and seeking to avoid ridges.

2.94 In the west of the Study area the landscape generally comprises low lying moorland (approximately 6mAOD) which forms part of a wider area known as the Somerset Levels and Moors.

2.95 To the north of Salisbury the landscape comprises generally low lying moorland which rises sharply over Salisbury Plain to a height of approximately 200mAOD. Cranbourne Chase and West Wiltshire Downs to the southeast of Warminster rises to approximately 250m at peak heights and these two AONBs provide a topographical constraint to routeing. The rise and fall of the landform across these two areas is typified by the valleys draining into the River Avon system reaching low points at Salisbury.

2.96 Between Warminster and Salisbury the land is characterised by the steep valley sides of Salisbury Plain and Cranbourne Chase and West Wiltshire Downs, constraining routeing to the north and south. The valley bottom is lower ground where there would be greater opportunities for utilising landform to background an overhead line.

2.97 The land falls to less than 50mAOD at Romsey and Nursling and typifies an area of the river valley draining towards the Solent Estuary at Southampton.

3.0 ADDITIONAL WORKS

Iron Acton to Melksham Overhead Line

3.1 As outlined at paragraph 1.5, if the Potential Connection was taken forward the existing Iron Acton to Melksham 275kV overhead line would need to be re-built to 400kV construction. This would involve the construction of a new overhead line and pylons suitable for 400kV operation in close proximity to the existing overhead line. Following completion of construction and the transfer of electrical circuits the existing 275kV overhead line would be removed.

3.2 The existing Iron Acton to Melksham 275kV overhead line is approximately 33km long and crosses approximately 16.7km of the Cotswolds AONB. The AONB extends for large distances to the north and south. A route that avoided the designated landscape would be approximately 60km longer than the existing connection and would take a new overhead line close to other constraints including Bath World Heritage Site. If the route of the existing overhead line was adopted the new overhead line would cross in excess of 16km of the AONB. This is likely to give rise to adverse effects on the landscape of the AONB which could affect the objective to conserve and enhance natural beauty.

3.3 The existing overhead line also passes through Honeybrook Farm SSSI and close to Coleme Park and Monk's Wood SSSIs. Detailed environmental surveys would be required to ensure that the integrity of these sites or their qualifying features was not adversely affected by the construction of a new overhead line.

Seabank to Tockington Overhead Line

3.4 As outlined at paragraph 1.5, if the Potential Connection was taken forward a new 400kV double circuit overhead line of between 6km and 7km would be required between Seabank and Tockington.

3.5 Between Seabank and Tockington there are no areas protected at the highest level by national or international nature conservation or landscape designations. However, the following constraints would require detailed consideration as part of routeing studies if this Potential Connection was taken forward:

- The existing 400kV Seabank to Tockington overhead line (2VL route);
- Settlements including Marsh Common, Piling, Almondsbury and Awkley;
- Listed buildings and the Conservation Areas of Almondsbury and Olveston;
- Individual residential properties; and
- Blocks of woodland.

3.6 The construction of a new overhead line parallel to the existing 400kV Seabank to Tockington overhead line would result in cumulative visual effects but would limit effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists.

4.0 ASSESSMENT

4.1 A new overhead line connection between Bridgwater and Nursling substation could be achieved but would pass close to, and be constrained by, a number of significant environmental constraints. This Potential Connection offers no environmental benefits over any other option considered for the connection of Hinkley Point C.

4.2 The most significant constraints to achieving a direct overhead line route between Bridgwater and Nursling are Cranbourne Chase and West Wiltshire Downs AONB and the New Forest National Park. These sites and the numerous SMs contained within them constrain a direct overhead line route and limit the Study area to a swathe of land to the north of the designations. As part of detailed routeing studies further assessment would be required to determine the potential for adverse effects on the setting of the AONB and National Park.

4.3 The construction of a new Bridgwater to Nursling overhead line parallel to the existing 400kV Hinkley to Melksham overhead line for approximately half of the Potential Connection would limit adverse effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists. However, a new overhead line parallel to the existing line would pass through the Somerset Levels and Moors SPA, SSSI, Ramsar sites and parts of the Somerset Levels containing a high concentration of SMs. The effects of an additional overhead line on the SPA, SSSI and Ramsar designations would require further assessment in accordance with the Conservation of Habitats and Species Regulations 2010 to ensure that there would be no adverse effects on the integrity of the designation or its qualifying features if this connection was identified as the most suitable Potential Connection and taken forward.

4.4 Between Warminster and Nursling a variety of constraints would influence the route and directness of an overhead line connection. These include the settlements of Warminster and Salisbury, Salisbury Plain SSSI, SPA, SAC, Stonehenge World Heritage Site and numerous blocks to woodland to the north of Nursling. Through this area an overhead line route would be on generally lower ground within a valley. This would provide opportunities for backgrounding to limit effects on landscape and views. However, any overhead line route would need to pass close to the edge of Cranbourne Chase and West Wiltshire Downs AONB, Stonehenge World Heritage Site and the New Forest National Park and would oversail the River Avon SSSI, SAC. If this Potential Connection was taken forward further detailed study would be required to determine the potential for direct and indirect effects on these sites.

4.5 A Bridgwater to Nursling overhead line route would be constrained by numerous international and national environmental designations and would be approximately 70km longer than the closest alternative. This connection would also require the re-build of the Iron Acton to Melksham overhead line, which travels through approximately 16.7km of the Cotswolds AONB and passes close to a number of other environmental constraints, and a new overhead line of between 6km and 7km long between Seabank and Tockington.

Appendix 2 - Environmental Appraisals

PC4 (a) Bridgwater – Seabank Overhead Line

BRIDGWATER TO SEABANK ENVIRONMENTAL APPRAISAL

1.0 INTRODUCTION

1.1 This planning and environmental appraisal (the Study) has been produced by TEP for National Grid Electricity Transmission plc (National Grid). The appraisal considers the planning and environmental constraints associated with a 400kV double circuit overhead line connection between Bridgwater, Somerset and Seabank substation, Bristol (the Potential Connection).

1.2 The Potential Connection is one of a number of alternative options considered by National Grid to facilitate the connection of the proposed Hinkley Point C Power Station (Power Station) to the high voltage electricity transmission system. Detailed technical information relating to the connection is set out under option PC4 in the Strategic Optioneering Report (August 2011).

Assumptions

1.3 The Potential Connection would require the existing overhead line which connects Hinkley Point to Bridgwater (VQ Route) to be uprated from 275kV to 400kV. Using this existing infrastructure would require overhead line reconfiguration close to the Power Station's site and north of Bridgwater but removes the need to install a new line east from Hinkley Point within the Steart Peninsula area of proposed managed retreat. As a result of these reconfiguration works a new overhead line connection would begin in the area to the north of Bridgwater substation.

1.4 For the purpose of this Study it has been assumed that the Potential Connection would be supported on steel lattice pylons approximately 47m high as these are the appropriate size to safely support a 400kV double circuit overhead line. Each pylon would have three cross arms on both sides, with up to three sets of conductors (wires) suspended from each of the cross arms.

1.5 The following additional works would be required to the electricity transmission system should the Potential Connection be taken forward:

- New 400kV substation at Aust, South Gloucestershire;
- New 400kV substation at Hinkley Point, Somerset;
- New 400kV substation at Bridgwater, Somerset;
- Installation of 2 Quadrature Boosters at Nursling, Hampshire;
- New underground cable circuit between Cowley, Gloucestershire and Minety, Wiltshire; and
- Extension of Melksham substation.

1.6 The above works would be required to ensure the security and stability of the electricity transmission system for any of the connection options to be taken forward.

1.7 The Study has considered environmental constraints of international and national importance within the Study area. Features considered as constraints to the Potential Connection are presented in Table 1.1. The table also summarises the legislation under which protection is inferred and the data sources from which information (where applicable) was taken.

Table 1.1: Environmental constraints and data sources

Feature	Legislation	Routeing Response (and Reference)	Data Sources
National Parks	National Parks and Access to the Countryside Act 1949	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1)	magic.gov.uk
Areas of Outstanding Natural Beauty	National Parks and Access to the Countryside Act 1949/ Countryside and Rights of Way Act 2000	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1	magic.gov.uk
Heritage Coasts	n/a	Seek to avoid (NG Commitments/ Holford Rule 1)	magic.gov.uk
World Heritage Sites	1972 World Heritage Convention	Seek to avoid (NG Commitments/ Holford Rule 1)	english-heritage.org.uk
Sites of Special Scientific Interest	Wildlife and Countryside Act 1981	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Special Protection Areas	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Special Areas of Conservation	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Ramsar sites	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
National Nature Reserves	National Parks and Access to the Countryside Act 1949	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Scheduled Monuments	Ancient Monuments and Archaeological Areas Act 1979	Seek to avoid/consider effect on setting (NG Commitments/ Holford Rule 2)	english-heritage.org.uk
Settlements	n/a	Seek to avoid (Supplementary Note)	Digitised from Ordnance Survey
Historic buildings (Listed I, II and II*)	Planning (Listed Buildings and Conservation Areas) Act 1990	Seek to avoid/consider effect on setting (Note to Holford Rule 2)	english-heritage.org.uk
Conservation Areas	Planning (Listed Buildings and Conservation Areas) Act 1990	Minimise effects/consider effect on setting (Note to Holford Rule 2)	Development plans
Registered Parks and Gardens	n/a	Seek to avoid (NG Commitments)	magic.gov.uk
Registered Battlefields	n/a	Minimise effects (NG Commitments)	english-heritage.org.uk
Woodlands	n/a	Seek to avoid (Note to Holford Rules 4 and 5)	National Inventory of Woodlands
Landform	n/a	(Holford Rules 4 and 5)	OS Open Data

1.8 In accordance with the National Policy Statement EN5[1], when siting new overhead lines, the principles of the Holford Rules should be taken into account. These are considered throughout this Study.

[1] Paragraph 2.8.7, National Policy Statement for Electricity Networks Infrastructure (EN-5), July 2011

1.9 Due to the presence of existing overhead lines, particular consideration has been given to Rule 6 of the Holford Rules throughout this Study. This rule advises that high voltage lines should be kept as far as possible independent of other masts wires and cables to avoid a concentration of lines or a 'wirescape'.

Environmental Aspects 'Scoped Out' of Appraisal

1.10 It is not feasible to undertake a meaningful assessment of the effects of the Potential Connection on certain environmental factors both because of the high level nature of this environmental appraisal and because a detailed connection design would have to be identified. As a result the effects of these factors have not influenced the selection of a preferred connection. The factors scoped out of the appraisal at this stage are outlined at paragraphs 1.12 to 1.15 below.

1.11 Although scoped out of the options appraisal process at this stage these factors will require consideration as part of routeing studies, detailed connection design and environmental assessment whichever connection is taken forward.

Flood Risk

1.12 National Grid considers its siting of installations such as substations very carefully in relation to flood risk. However, it is relatively straightforward to build flood resilience into overhead lines by addressing safety clearances from anticipated flood levels in the overhead line design. The presence of overhead line pylons in areas of flood risk has negligible effect on the risk or displacement of water as the lattice steel construction poses no material changes to water flow. Flood risk has therefore not been considered an influence on the Potential Connection at this stage. `

Noise

1.13 Noise during construction will be temporary and managed by procedures and controls to ensure that it is not unacceptable. Noise during operation will be controlled primarily by separation of sources of noise from noise-sensitive receptors and also by noise-suppression measures as appropriate. The review of options considers whether there is likely to be appropriate distances from settlements and dwellings for amenity reasons which would also allow separation to mitigate effects of noise. The noise sources and measures taken will be applied as required for any option and noise is not a material factor in distinguishing between options.

Air Quality

1.14 New transmission infrastructure will not give rise to any material effects on air quality. Temporary construction works can give rise to dust affecting air quality locally. This will be managed by procedures and controls to ensure that it is not unacceptable. These measures will be applied as required for any option and air quality is not a material factor in distinguishing between options.

Transport

1.15 Construction works will involve transport of materials and workforce to sites. The effects will be temporary and will be subject to management to ensure that effects are not unacceptable. This will be the case for any option and transport is not a material factor in distinguishing between options.

Study Area

1.16 The Study area for the Potential Connection extends for approximately 56km from the eastern edge of Bridgwater, Somerset to the existing National Grid 400kV electricity substation at Seabank, Bristol. An existing 132kV overhead line owned and operated by Western Power Distribution (WPD) travels through the Study area in a north-south alignment between WPD's existing substations at Bridgwater and Seabank.

1.17 The Study area includes the main settlements of Bridgwater and Burnham-on-Sea in Somerset, Weston-super-Mare, Clevedon and Portishead in North Somerset and Avonmouth in Bristol.

2.0 ENVIRONMENTAL CONSTRAINTS

2.1 A description of the Study area in relation to the environmental constraints outlined in Table 1.1 is presented below and illustrated at Map 7 (drawing number 1979.255).

National Parks, Heritage Coasts and World Heritage Sites

2.2 There are no National Parks, Heritage Coasts or World Heritage Sites within the Study area.

Areas of Outstanding Natural Beauty (AONB)

Mendip Hills AONB

2.3 The Mendip Hills AONB covers an area of approximately 200km^2 and is an extensive range of limestone hills to the south of Bristol. The hills run in an east to west direction between the coast at Weston-super-Mare and Frome and overlook the Somerset Levels to the south and Avon Valley to the north.

2.4 The hills of the AONB form prominent landmarks. The designation relates to landscape and scenic importance although the Mendip Hills are also valued for the many industrial archaeological sites reflecting the lead, coal and cloth industries. The AONB is also characterized by an open largely treeless limestone plateau surrounded by gorges, cliffs and escarpment slopes.

2.5 The existing WPD 132kV Bridgwater to Seabank overhead line passes through the AONB for approximately 6km. The line enters the AONB to the east of Loxton, travels through the Lox Yeo Valley and exits between the settlements of Sandford and Banwell.

Implications for Overhead Line Routeing

2.6 AONBs are designated under the National Parks and Access to the Countryside Act 1949 (as amended) for the purpose of conserving and enhancing the natural beauty of the area. The importance of these sites and the protection afforded to them is further highlighted in Planning Policy Statement (PPS) 7. Paragraph 22 of PPS7 states that major developments should not take place in these designated areas except in exceptional circumstances and that such applications will be subject to rigorous examination and should include an assessment of the national need, cost and scope of developing outside the designated area and effects on the environment, landscape and recreational opportunities. A new overhead line through an AONB would have an effect on the landscape which will affect the objective to conserve and enhance natural beauty.

2.7 Map 7 illustrates that it would not be feasible to avoid the Mendip Hills AONB in a reasonably direct connection route between Bridgwater and Seabank. To the west of the AONB, a route would be constrained by the settlement of Weston-super-Mare, blocks of ancient woodland and the topography of the landscape. To the east, the AONB extends for approximately 22km and a Potential Connection would be constrained by woodland, settlements and Scheduled Monuments. Further detailed study would be required to assess the effects of an overhead line on the conservation objectives of the AONB if this connection option was identified as the most suitable Potential Connection and taken forward.

Sites of Special Scientific Interest (SSSI)

2.8 SSSIs are designated for their biodiversity or geological interest and are protected from development and operations likely to damage their special interest. There are SSSIs dispersed throughout the Study area. The most significant of these sites and the reasons for their designation are summarised in Table 2.1.

Table 2.1 – Summary of SSSIs

SSSI	Location / Grid Ref	Reason for Designation
The Catcott, Edington and Chilton Moors, Tealham and Tadham Moors and Westhay Moors	North east of Bridgwater (ST 390420)	The Catcott, Edington and Chilton Moors, Tealham and Tadham Moors and Westhay Moors SSSIs are a collection of adjoining moors which form part of the Somerset Levels and Moors SSSI, SPA and Ramsar site to the north east of Bridgwater. These sites comprise diverse habitats which provide feeding and nesting sites for a wide range of birds such as Golden Plover and Lapwing.
Shiplate Slait	(ST 364567)	This site lies towards the western end of the Mendip Hills AONB on the south and west facing slopes. It is important for its unimproved calcicolous grassland, some is mixed with dwarf shrub, mosaics of calcicolous grassland, scrub and woodland.
Crook Peak and Shute Shelve	East of Loxton (ST 385555)	This site is in the Mendip Hills AONB and covers the high ground of Crook Peak and Shute Shelve Hill. The designation covers a range of habitats including ancient and semi-natural broadleaved woodland and unimproved calcareous grassland.
Banwell Ochre Caves SSSI	East of Banwell (ST 407593)	This SSSI lies within the Mendip Hills AONB and forms part of the North Somerset and Mendip Bats SAC. The SSSI comprises five caves which contain the most extensive and accessible yellow ochre workings in the Mendip Hills.
Banwell Caves	South of Banwell (ST 383588)	This SSSI lies within the Mendip Hills AONB and forms part of the North Somerset and Mendips Bats SAC. It is a Geological Review Site (a site identified as of national and international importance during the Geological Conservation Review) and is used as a hibernation site by Greater Horseshoe Bats.
Puxton Moor, Biddle Street, Tickenham, Nailsea and Kenn Moors	North of the Mendip Hills AONB (ST 440700)	These wildlife sites form part of the Avon Levels and Moors, an extensive area of low lying agricultural land north of the Mendip Hills. The Avon Levels and Moors is drained by a network of rhynes and ditches which act as ‘wet fences’ providing water for livestock. The combination of management practices and the variation in the soils has resulted in watercourses which support a wide range of aquatic plant communities, many of which are of considerable nature conservation interest.
Severn Estuary	South west coast, covers Mouth of the Avon in study area	The Severn Estuary, also a SPA, SAC and Ramsar site, lies on the south west coast of Britain at the mouth of four major rivers (the Severn, Wye, Usk and Avon). It is an internationally important site for birds and wildlife habitats and is one of the most important sites in the UK for wintering wildfowl and waders.
Gordano Valley	North east of Clevedon (ST 435730)	The Gordano Valley covers an area of approximately 161ha and is an extensive low-lying and poorly drained peat moor situated between Carboniferous Limestone ridges. The area is designated for its national ornithological, entomological and stratigraphic interest.
Weston Big Wood	South east of Portishead (ST 455750)	Weston Big Wood is an area of mixed deciduous woodland covering approximately 37ha. The wood lies on the plateau of a narrow ridge of Carboniferous Limestone and various factors suggest the site is the remnant of an ancient forest.

Implications for Overhead Line Routeing

2.9 The potential effect of an overhead line on a SSSI would vary depending on the nature of the effect caused and the special interest of the site. Consultation with Natural England would be required before consent could be granted for any development or operations likely to damage the SSSI interest.

2.10 Whilst many SSSIs within the Study area could be avoided by the Potential Connection there are a number which would influence routeing due to their size or proximity to each other.

2.11 Within the Mendip Hills AONB, Crooke Peak and Shute Shelve SSSI and Shiplaite Slait SSSI are both on higher ground. To avoid these sites an overhead line connection would need to utilise lower ground along the Lox Yeo Valley to the east of Loxton. Through the Mendip Hills a connection adjacent to the east of the M5 could be achieved but would be constrained by the topography of the landscape, Banwell Caves SSSI (also a SAC) and blocks of woodland.

2.12 The SSSI designation for Puxton Moor, Biddle Street, Tickenham, Nailsea and Kenn Moors covers ditches and rhynes in low lying farmland. To avoid these sites the Potential Connection would need to travel to the east or west of the SSSIs. To the west a Potential Connection would be constrained by the M5 motorway, the settlements of Kenn and Tickenham and woodland blocks on Tickenham Ridge. To the east, a connection would be constrained by areas of built development including Nailsea, Backwell, Yatton and Congresbury. An overhead line would be able to oversail the ditches and rhynes to which the SSSI designation applies however, further detailed study would be required to determine the potential for direct and indirect effects on these sites if this connection option was taken forward

2.13 Due to the presence of a continuous band of built development between Avonmouth and the City of Bristol any overhead line connection to Seabank substation would need to cross the River Avon which is a component site of the Severn Estuary SSSI (also a SAC, SPA and Ramsar site). Further detailed study would be required to assess the effects of an overhead line connection on the integrity of the site and its qualifying features if this connection option was identified as the most suitable Potential Connection and taken forward.

Special Protection Areas (SPA) and Ramsar sites

Severn Estuary SPA and Ramsar

2.14 The Severn Estuary SPA lies along the western boundary of the Study area and the full extent of the designation covers an area of approximately 24,000ha. The Estuary is the largest coastal plain estuary in the UK with extensive mudflats and sandflats, rocky shore platforms, shingle and islands. The Estuary's unique funnel shape means it has a high tidal range which results in a variety of plant and animal communities typical of liquid mud and tide-swept sand and rock.

2.15 The site qualifies as an SPA under Article 4.1 of the Birds Directive (79/409/EEC) by supporting bird populations of European importance that are listed on Annex I of the Directive and under Article 4.2 by regularly supporting at least 20,000 waterfowl.

2.16 The Ramsar designation also extends to cover fish populations of the estuarine and river system which is one of the most diverse in Britain with over 110 species recorded.

Somerset Levels and Moors SPA and Ramsar

2.17 The Somerset Levels and Moors are one of the largest areas of traditionally managed wet grassland and fen habitats in lowland UK. The SPA and Ramsar sites cover the same geographical area as each other (approximately 35,000ha) and include the floodplains of the Rivers Axe, Brue, Parrett, Tone and their tributaries. The internationally important bird populations and the habitats on which they depend are reasons for both the SPA and Ramsar designations; the Ramsar designation also extends to cover rare invertebrate populations.

Implications for Overhead Line Routeing

2.18 SPAs and Ramsar sites are afforded protection under the Conservation of Habitats and Species Regulations 2010. The Regulations only permit development in the first instance on such sites where it is directly connected with or necessary to site management for nature conservation; or where the proposal would not be likely to have a significant effect on the conservation objectives of the site, alone or in combination with other plans and projects.

2.19 Where there are likely to be significant effects, consent for development can only be granted where it would not adversely affect the integrity of the site taking into account the manner in which the development will be carried out and any conditions that might be imposed on the consent or there are no alternative solutions and the development must be carried out for imperative reasons of overriding public interest relating to human health, public safety or benefits of primary importance to the environment.

2.20 To avoid the Severn Estuary and Somerset Levels and Moors the Potential Connection would need to be established in land between the SPA and Ramsar sites. A Potential Connection close to either designated site would give rise to the potential for greater effects and detailed study would be required to consider the potential for disturbance to bird movements or foraging habitat.

2.21 The Severn Estuary SPA includes the mouth of the River Avon. An overhead line connection across this part of the SPA would be unavoidable as alternative routes across land are constrained by a continuous band of built development which extends from Avonmouth to Bristol as shown in drawing 1979.255. Detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects which may arise on the integrity of the designation as a result of the development of the Potential Connection.

Special Areas of Conservation (SAC)

Severn Estuary SAC

2.22 The Severn Estuary SAC lies along the western boundary of the Study area and covers an area of approximately 73,000ha. The SAC was confirmed in 1995 and further amended in 2000. The site is designated for important populations of fish and the natural habitats present within the Estuary.

Mendip Limestone Grasslands SAC

2.23 The Mendip Limestone Grasslands SAC comprises three separate SSSIs totalling approximately 417ha. Brean Down SSSI and Uphill Cliff SSSI are south of Weston-super-Mare, contiguous with the Severn Estuary SAC. The Crook Peak to Shute Shelve SSSI is approximately 10km inland from the Estuary within the Mendip Hills.

North Somerset and Mendip Bats SAC

2.24 North Somerset and Mendip Bats SAC is centred on the Mendip Hills. The SAC comprises caves, grassland and woodland and is a composite site spread across a wide area. The component sites include the Banwell Caves SSSI and Banwell Ochre Caves SSSI on the northern side of the Mendip Hills with Brockley Hall Stables SSSI and King's Wood and Urchin Wood SSSI to the north east of Congresbury.

2.25 These sites are considered of international importance for their semi-natural dry grasslands, significant blocks of *Tilio-Acerion* forest and the limestone caves of the Mendips which provide a range of important hibernation sites for greater and lesser horseshoe bats. Policy ECH/12 of the North Somerset Replacement Local Plan (2007) provides a 5km ‘consultation zone’ which covers important feeding grounds surrounding the SAC and in which development proposals are subject to particular scrutiny for potential effects on the designated sites.

Implications for Overhead Line Routeing

2.26 Like SPAs and Ramsar sites, SACs are afforded protection under the Conservation of Habitats and Species Regulations 2010 and development is strictly controlled.

2.27 An overhead line route could be established which avoids the SACs in the Study area but would pass through the 5km consultation zone of the North Somerset and Mendip Bats SAC. The potential effects on SAC bat species arising from an overhead line are associated with loss of habitat resulting in fragmentation and degradation of foraging grounds. If this Potential Connection was identified as the most suitable Potential Connection and taken forward further assessment of the effects on the integrity of the SAC and its qualifying features would be required.

2.28 In the northern part of the Study area an overhead line route would need to cross the River Avon, a component site of the Severn Estuary SAC. Detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects which may arise on the integrity of the designation as a result of the development of the Potential Connection.

National Nature Reserves (NNRs)

2.29 There are several wildlife sites in the study area designated as NNRs. The majority of these form part of larger sites afforded protection under other ecological designations. The NNRs in the Study area are listed in Table 2.2.

Table 2.2 - Summary of NNRs

NNR	Grid Ref/Location	Reason for Designation
Huntspill River	ST 320443	This is an artificial river within the Somerset Levels managed by the Environment Agency. The area is of interest to various birds and otters. The river stretches for 5 miles from Bridgwater Bay to the western boundary of the Catcott, Edington and Chilton Moors SSSI. The area is also of archaeological interest.
Somerset Levels	ST 387360	This NNR is important for its open water and lowland grasslands. It is currently closed to the public.
Westhay Moor	ST 453440	This NNR is owned and managed by Somerset Wildlife Trust. It comprises restored peat fields and water-filled compartments with islands of reeds and bulrushes. The land also includes poor fen and a fragment of acid moor which is currently being restored.
Shapwick Heath	ST 430400	This is a wetland reserve managed by Natural England covering over 500ha. It is important for its reed beds, fens, meadows and wet woodland. The NNR also includes a Neolithic ‘Sweet Track’, the oldest routeway in Britain.
Ham Wall	ST 458402	This NNR is owned and managed by the RSPB. It is an area of former commercial peat extraction and is currently being restored to wetland habitats.
Gordano Valley	ST 435731	This NNR is important for its peatland habitats. The site is currently closed to the public.

Implications for Overhead Line Routeing

2.30 A number of sites to the north east of Bridgwater form part of larger sites within the Somerset Levels and Moors afforded protection under other ecological designations such as SSSI, SPA and Ramsar. Drawing 1979.255 illustrates that these sites could be avoided by the Potential Connection.

2.31 To avoid the designated part of the Huntspill River an overhead line would need to travel to the east of Gold Corner between the Huntspill River NNR and sites within the Somerset Levels SPA and Ramsar site. The Potential Connection would still need to cross the Huntspill River. Further detailed study would be required to determine the effects on the NNR arising from the Potential Connection if this option was identified as the most suitable Potential Connection and taken forward.

Scheduled Monuments (SMs)

2.32 The south west of England is a region of high archaeological and historical importance containing over a third of all SMs in England. There are SMs interspersed throughout the Study area. The majority of these sites are on higher ground within the Mendip Hills AONB and close to or within settlements.

Implications for Overhead Line Routeing

2.33 SMs are nationally important monuments and archaeological remains which are protected under the provisions of the Ancient Monuments and Archaeological Areas Act 1979. Consent is required from English Heritage, the statutory advisor on the historic environment, under the 1979 Act before works directly affecting an SM may be carried out.

2.34 North of Bridgwater, a medieval settlement and hill fort would constrain routeing adjacent to the M5. To avoid this designation and the settlement of Puriton, which abuts the motorway, an overhead line would need to be routed away from the motorway to the east of the settlement.

2.35 Brent Knoll SM is an Iron Age Hill Fort within the Somerset Levels and Moors to the south of the Mendip Hills AONB. The SM is a prominent feature within the landscape and has panoramic views across the surrounding Somerset Levels and Moors. Whilst this SM could be avoided with the Potential Connection the effects on its setting and views from it would require further consideration and assessment as part of detailed routeing studies.

2.36 Within the Mendip Hills AONB there is a cluster of SMs comprising hill forts, camps and roman settlements. These SMs are typically on high ground where woodland and SSSIs would further constrain a Potential Connection. To avoid these designations a route would need to be established on lower ground in the Lox Yeo Valley.

2.37 To the north of Avonmouth, Mere Bank SM would be difficult to avoid with the Potential Connection due to its linear nature and the proximity of settlements and built form. This SM is oversailed by two existing low voltage overhead lines operated by WPD. Detailed assessment would be required to determine the effects of routeing an overhead line over this SM if this connection option was identified as the most suitable Potential Connection and taken forward.

Historic Buildings

2.38 There are approximately 18 Grade I and 62 Grade II* listed buildings within the Study area. Whilst these are distributed across the Study area they are often clustered within the larger settlements. Some isolated buildings are in more rural areas; these are generally farmsteads and country houses. Particular clusters of historic buildings are found within the settlements of Bridgwater, Banwell and Clevedon.

Implications for Overhead Line Routeing

2.39 Buildings of special architectural or historic interest are added to a list of buildings protected under the Planning (Listed Buildings and Conservation Areas) Act 1990. Planning authorities are required to consult with English Heritage on planning applications which may affect a Grade I and Grade II* listed building outside Greater London and listed building consent is required for any works likely affect a listed building.

2.40 Routes could be achieved for the Potential Connection which avoid listed buildings however the effects on setting would require consideration as part of detailed routeing studies.

Conservation Areas

2.41 Within the study area there are 48 Conservation Areas. They are generally focused in towns and village centres and include Loxton, Christon, Banwell, Congresbury, Yatton, Nailsea, Chelvey and Avonmouth.

Implications for Overhead Line Routeing

2.42 Conservation Areas are areas designated by local authorities because of special architectural or historic interest and are protected under the Planning (Listed Buildings and Conservation Areas) Act 1990. Conservation Area consent is required from the local planning authority for any development within the area.

2.43 Routes could be achieved for the Potential Connection which avoid Conservation Areas however the effects on setting would require consideration as part of detailed routeing studies.

Registered Parks and Gardens

2.44 There are several sites within the Study area designated as Registered Parks and Gardens. The most significant of these sites likely to influence overhead line routeing are summarised in Table 2.3.

Table 2.3 – Summary of Registered Parks and Gardens

Registered Park and Garden	Grid Ref/Location	Reason for Designation
Clevedon Court (80 ha)	ST 423715	Grade II* listed 18th century terraced gardens which are set within parkland. The site includes a 13th century crenulated wall, medieval barn, octagonal summerhouse, and 19th century ornamental woodlands. The site is owned by the National Trust.
Tyntesfield (57 ha)	ST 505715	This site lies to the south of Bristol and is an extensive 19th century estate owned by the National Trust. The house and grounds are currently being restored.

Implications for Overhead Line Routeing

2.45 The English Heritage 'Register of Historic Parks and Gardens of special historic interest in England' (compiled under powers contained in Historic Buildings and Ancient Monuments Act 1953) identifies sites assessed to be of national importance. Registration is a ‘material consideration’ in the planning process, meaning that planning authorities must consider the impact of any proposed development on the landscapes’ special character.

2.46 An overhead line very close to a Registered Park or Garden is likely to cause adverse effects. To avoid these sites a Potential Connection would need to be routed through land to the east of Clevedon, south of Tickenham and west of Tyntesfield. Other constraints such as woodland, SMs, SSSIs and settlements further constrain routing although a route could be achieved which avoided these constraints.

Registered Battlefields

2.47 There is one registered battlefield within the Study area which is the site of the battle of Sedgemoor in 1685. The site lies north of Westonzoyland approximately 1km east of Bridgwater substation and does not pose a constraint to the Potential Connection.

Woodland

2.48 There are numerous blocks of woodland, some of which are ancient woodland, interspersed throughout the study area. Several woodlands are also designated as SSSIs.

<u>Implications for Overhead Line Routeing</u>

2.49 Installing an overhead line through woodland would result in the permanent loss of woodland along the length of the connection. Holford Rules 4 and 5 refer to woodlands and their value in providing background to views and advise to avoid cutting extensive swathes through woodland blocks wherever possible.

2.50 There is a cluster of woodland to the south of Puriton. The presence of this woodland and built development at Puriton would constrain routeing next to the M5 in this area. To avoid these constraints a Potential Connection would need to be routed on the raised ground between woodland blocks to the east of Puriton and west of Knowle.

2.51 There are numerous blocks of woodland within the Mendip Hills AONB. This woodland is primarily on higher ground and could be avoided with a Potential Connection using lower ground within the Lox Yeo Valley.

2.52 A further cluster of woodland is present on Tickenham Ridge, some of which is ancient woodland. To avoid the woodland, a Potential Connection would need to pass through a gap in settlements at Stone Edge Batch before traversing Tickenham Ridge in a north easterly direction along a similar route to existing WPD 132kV overhead lines.

2.53 On the northern side of Tickenham Ridge a route to the east of the M5 would be constrained by Priors Wood and settlement at Portbury and Gordano and to the west by built development at Sheepway. To avoid these constraints an overhead line route would need to travel towards the existing Portishead 132kV substation before changing direction and travelling through land associated with the Royal Portbury Docks.

Settlements

2.54 The key settlements within the Study area are sited along or in close proximity to the banks of the Severn Estuary and include Bridgwater, Burnham-on-Sea, Weston-super-Mare, Clevedon, Portishead and Avonmouth.

2.55 There are numerous other towns and villages dispersed throughout the study area, the larger of which are along classified roads. Smaller villages and hamlets are linked by the minor road system.

<u>Implications for Overhead Line Routeing</u>

2.56 Settlements within the Study area could be largely avoided through careful routeing. However, in the northern part of the Study area Avonmouth and the City of Bristol form a continuous band of development that extends to the mouth of the River Avon at the Severn Estuary. The Potential Connection would need to negotiate this area to achieve the connection into Seabank and further detailed study would be required to identify appropriate routes through this area.

Landform

2.57 Landform in the Study area shows some variations and is illustrated at Map 1 (drawing number 1979.261).

Implications for Overhead Line Routeing

2.58 The Holford Rules refer to aspects of topography and physiography such as hills, ridges, dips, open valleys and flat land in considering overhead line routeing. For example, the Rules advise on exploiting the 'backgrounding' effect of high land and seeking to avoid ridges.

2.59 In the south of the Study area the landscape generally comprises low lying moorland (approximately 6mAOD) which forms part of a wider area known as the Somerset Levels and Moors. Within this predominantly flat landscape are areas of higher ground including Brent Knoll, to the north east of Burnham-on-Sea and the Mid Somerset Hills to the east of Bridgwater.

2.60 The Mendip Hills AONB lies in the centre of the Study area and rises sharply from the Somerset Levels. The AONB comprises a series of limestone hills which pose a significant constraint to overhead line routeing. The only break in the hills is the valley of the Lox Yeo River through which the M5 motorway and the existing WPD 132kV overhead line currently travels.

2.61 To the north of the Mendip Hills the topography is more varied and comprises large areas of flat open moorland, a prominent ridge at Tickenham (Tickenham Ridge) and a series of hills to the east of development at Yatton, Congresbury and Nailsea.

3.0 ASSESSMENT

3.1 An overhead line connection between Bridgwater and Seabank would need to travel through the Somerset Levels and Moors which was a candidate site for World Heritage Site (WHS) status (although this is no longer being promoted by Somerset County Council). The WHS bid was based on the area's unique palaeo-environmental records that include a 10,000 year record of climate, sea level and landscape change. Features include prehistoric trackways, lake villages, relic roman wetland landscapes, medieval reclamations and river canalisations. Whilst it would be possible to avoid the SMs within the Levels with an overhead line route, effects on their setting would require detailed assessment and there are other known non-designated assets and unknown assets which could potentially be affected.

3.2 A direct connection between Bridgwater and Seabank would need to travel through the Mendip Hills AONB. To minimise visual effects and avoid constraints such as SSSIs, SACs and woodland the connection would need to utilise lower ground within the Lox Yeo Valley. An overhead line through this area would have an effect on the landscape which will affect the objective to conserve and enhance natural beauty. As part of detailed routeing studies further assessment would be required to determine the significance of any adverse effects on the AONB and its setting.

3.3 The Study area contains large areas of land (including ditches and rhynes) designated as SSSIs. Due to the presence of other constraints such as settlements, woodland and SMs, a potential route would be constrained to areas of land to the east of the M5. Whilst an overhead line would be able to oversail the ditches and rhynes to which the SSSI designation applies further detailed study would be required to determine the potential for direct and indirect effects on these sites if this Potential Connection was identified as the most suitable Potential Connection and taken forward.

3.4 Due to the presence of built development which extends from the coast at Avonmouth to the City of Bristol any Potential Connection to Seabank substation would need to cross the

River Avon, a component part of the Severn Estuary SSSI, SAC, SPA and Ramsar site. Further detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects which may arise on the integrity of the designation through the construction or operation of this connection option.

3.5 A Bridgwater to Seabank overhead line route would pass through and be constrained by a number of international and national environmental designations. However, the connection would be approximately 20km shorter than the closest alternative and would not require the construction or re-build of any additional overhead lines.

Appendix 2 - Environmental Appraisals

PC4 Bridgwater – Seabank

(b) AC Underground Cable
(c) Gas Insulated Line

BRIDGWATER TO SEABANK UNDERGROUND ENVIRONMENTAL APPRIASAL

1.0 INTRODUCTION

1.1 This planning and environmental appraisal (the Study) has been produced by TEP for National Grid Electricity Transmission plc (National Grid). The appraisal considers the planning and environmental constraints associated with a 400kV underground connection between Bridgwater, Somerset and Seabank substation, Bristol (the Potential Connection).

1.2 The Potential Connection is one of a number of alternative options considered by National Grid to facilitate the connection of the proposed Hinkley Point C Power Station (Power Station) to the high voltage electricity transmission system. Detailed technical information relating to the connection is set out under option PC4 in the Strategic Optioneering Report (August 2011).

Assumptions

1.3 The Potential Connection would require the existing overhead line which connects Hinkley Point to Bridgwater (VQ Route) to be uprated from 275kV to 400kV. Using this existing infrastructure would require overhead line reconfiguration close to the Power Station's site and north of Bridgwater but removes the need to install a new overhead line or underground connection east from Hinkley Point within the Steart Peninsula area of proposed managed retreat. As a result of these reconfiguration works a new underground connection would begin in the area to the north of Bridgwater substation.

1.4 For the purpose of this Study it has been assumed that the new 400kV connection would be made via either alternating current (AC) underground cables or AC gas insulated line (GIL) underground cables. Detailed technical information relating to each of these connection methods is set out in Section 5.0 of the Strategic Optioneering Report (August 2011); a brief summary of the points relevant to this study is summarised below.

AC Underground Cables

1.5 For a 400kV AC underground connection up to 12 cables would be required. Each cable would be installed in a trench approximately 1m wide and spaced approximately 3m apart (at 4m centres), with a typical depth of cover to the top of cables of 1.2m. The combined construction area incorporating the cable trenches and associated haul road, would be approximately 35m wide.

1.6 Cables would be installed in lengths according to the quantity of cable on each drum (up to 800m). A joint bay approximately 30m to 40m long and 5m wide would be constructed where each section of cable connects with another.

1.7 Typical cable installation methods involve excavating cable trenches and storing removed topsoil at the side of trenches for later reinstatement. The profile of soil would be carefully maintained during the storage process, with topsoil separated from subsoil so that reinstatement closely matches the profile of excavated soil.

1.8 Granular fill to protect the cables and assist in heat dissipation will be laid in the bottom of the trench. The cables would be surrounded by cement-bound sand or similar material to an approximate depth of 100mm. Above this, the stored soil would be used to reinstate the trench, with subsoil and topsoil replaced to ensure the restored profile has the same depth of topsoil as excavated.

1.9 To construct the trench all surface vegetation would be removed including trees, shrubs and hedgerows. Ditches would need to be temporarily blocked to allow construction but would be reinstated. Crossing streams and rivers would be via directional drilling.

1.10 Maintenance access along the route is required for the lifetime of the cables to allow monitoring and any rectification of faults that may arise. There are also restrictions placed on land use operations. National Grid places restrictions on the types of shrubs that can be planted within 3m of an underground cable. No trees can be planted within 3m where their roots could affect the thermal conductivity of land through penetration into backfill and cables which could lead to failure of the system.

AC Gas Insulated Line (GIL)

1.11 GIL is a developing technology which uses a mixture of Nitrogen and SF_6 gas for electrical insulation. For a 400kV AC GIL underground connection up to 6 cables/phases would be required (this equates to 3 cables/phases per circuit). For the Potential Connection two different construction methods could be used: direct burial or 'cut and cover' tunnel.

1.12 For direct burial, cables would be laid in two trenches approximately 4m wide, at a depth of 1.8m with a typical depth of cover to the top of cables of 0.9m. The combined construction area incorporating the cable trenches and associated haul road, would be approximately 35m wide.

1.13 For 'cut and cover' construction a precast concrete tunnel is laid in a trench typically 3m deep (with an ultimate cover depth of 300mm) and dependant on the method to construct the trench, between 6m and 20m in width. The total construction area would be between 30m and 55m wide.

1.14 The construction method for the GIL would be similar to that described in paragraphs 1.7 to 1.9 above.

Additional Works

1.15 The following additional works would be required to the electricity transmission system should the Potential Connection be taken forward:

- New 400kV substation at Aust, South Gloucestershire;
- New 400kV substation at Hinkley Point, Somerset;
- New 400kV substation at Bridgwater, Somerset;
- Installation of 2 Quadrature Boosters at Nursling, Hampshire;
- New underground cable circuit between Cowley, Gloucestershire and Minety, Wiltshire; and
- Extension of Melksham substation.

1.16 The above works would be required to ensure the security and stability of the electricity transmission system for any of the connection options to be taken forward.

Environmental Constraints

1.17 The study has considered environmental constraints of international and national importance within the Study area (see Section 2.0 onwards). Features considered as constraints to the Potential Connection are presented in Table 1.1 below. The table also summarises the legislation under which protection is inferred and the data sources from which information (where applicable) was taken.

Table 1.1: Environmental Constraints and Data Sources

Feature	Legislation	Routeing Response (and Reference)	Data Sources
National Parks	National Parks and Access to the Countryside Act 1949	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1)	magic.gov.uk

Feature	Legislation	Routeing Response (and Reference)	Data Sources
Areas of Outstanding Natural Beauty	National Parks and Access to the Countryside Act 1949/ Countryside and Rights of Way Act 2000	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1	magic.gov.uk
Heritage Coasts	n/a	Seek to avoid (NG Commitments/ Holford Rule 1)	magic.gov.uk
World Heritage Sites	1972 World Heritage Convention	Seek to avoid (NG Commitments/ Holford Rule 1)	english-heritage.org.uk
Sites of Special Scientific Interest	Wildlife and Countryside Act 1981	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Special Protection Areas	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Special Areas of Conservation	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Ramsar sites	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
National Nature Reserves	National Parks and Access to the Countryside Act 1949	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Scheduled Monuments	Ancient Monuments and Archaeological Areas Act 1979	Seek to avoid/consider effect on setting (NG Commitments/ Holford Rule 2)	english-heritage.org.uk
Settlements	n/a	Seek to avoid (Supplementary Note)	Digitised from Ordnance Survey
Historic buildings (Listed I, II and II*)	Planning (Listed Buildings and Conservation Areas) Act 1990	Seek to avoid/consider effect on setting (Note to Holford Rule 2)	english-heritage.org.uk
Conservation Areas	Planning (Listed Buildings and Conservation Areas) Act 1990	Minimise effects/consider effect on setting (Note to Holford Rule 2)	Development plans
Registered Parks and Gardens	n/a	Seek to avoid (NG Commitments)	magic.gov.uk
Registered Battlefields	n/a	Minimise effects (NG Commitments)	english-heritage.org.uk
Woodlands	n/a	Seek to avoid (Note to Holford Rules 4 and 5)	National Inventory of Woodlands
Landform	n/a	(Holford Rules 4 and 5)	OS Open Data

Environmental Aspects 'Scoped Out' of Appraisal at this Stage

1.18 It is not feasible to undertake a meaningful assessment of the effects of the Potential Connection on certain environmental factors both because of the high level nature of this environmental appraisal and because a detailed connection design would have to be identified. As a result the effects of these factors have not influenced the selection of a preferred connection. The factors scoped out of the appraisal at this stage are outlined at paragraphs 1.20 to 1.25 below.

1.19 Although scoped out of the options appraisal process at this stage these factors will require consideration as part of routeing studies, detailed connection design and environmental assessment whichever connection is taken forward.

Flood Risk

1.20 National Grid considers its siting of installations such as substations very carefully in relation to flood risk. However, the presence of an underground connection in areas of flood risk would not affect the connection's operation and has a negligible effect on the risk or displacement of water as underground connections pose no material changes to water flow. Due to the high level nature of this assessment, flood risk has not been considered an influence on the Potential Connection at this stage.

Noise

1.21 Noise during construction will be temporary and managed by procedures and controls to ensure that it is not unacceptable. Noise during operation will be controlled primarily by separation of sources of noise from noise-sensitive receptors and also by noise-suppression measures as appropriate. The review of options considers whether there is likely to be appropriate distances from settlements and dwellings for amenity reasons which would also allow separation to mitigate effects of noise. The noise sources and measures taken will be applied as required for any option and noise is not a material factor in distinguishing between options.

Air Quality

1.22 New transmission infrastructure will not give rise to any material effects on air quality. Temporary construction works can give rise to dust affecting air quality locally. This will be managed by procedures and controls to ensure that it is not unacceptable. These measures will be applied as required for any option and air quality is not a material factor in distinguishing between options.

Transport

1.23 Construction works will involve transport of materials and workforce to sites. The effects will be temporary and will be subject to management to ensure that effects are not unacceptable. This will be the case for any option and transport is not a material factor in distinguishing between options.

Climate Change

1.24 The Potential Connection could be made with any of the underground connection options outlined at paragraph 1.4 and the decision on which of the technologies would be used will be taken at a later stage if the Potential Connection is taken forward.

1.25 As outlined at paragraph 1.11 above, a GIL underground connection would utilise Sulphur Hexafluoride (SF_6) gas for insulation. SF_6 gas is a non-toxic greenhouse gas which is in common use in the electricity industry due to its superior insulating properties. For a GIL the SF_6 gas would be housed within pipes using a double sealing method to prevent leakage. All SF_6 insulated equipment would be fully tested in the factory by a gas leak detector to ensure that as far as practicably possible, there is no leakage from any of the components. Due to the high level nature of this assessment climate change has not been considered an influence on the Potential Connection, however further detailed study would be required to assess the effects of a GIL underground connection on climate change if this connection option was taken forward.

Study Area

1.26 The Study area extends from the eastern edge of Bridgwater, Somerset to the existing National Grid 400kV electricity substation at Seabank, Bristol. An existing 132kV overhead line owned and operated by Western Power Distribution (WPD) travels through the study area in a north-south alignment between WPD's existing substations at Bridgwater and Seabank. The Study area includes the main settlements of Bridgwater and Burnham-on-

Sea in Somerset, Weston-super-Mare, Clevedon, Portishead in North Somerset and Avonmouth, Bristol.

1.27 Many of these settlements constrain a direct underground connection route due to their proximity to the western edge of the M5 motorway. As a result this study has focussed on a Potential Connection to east of the M5.

2.0 ENVIRONMENTAL CONSTRAINTS

2.1 A description of the study area in relation to the environmental constraints outlined in Table 1.1 is presented below and illustrated at Map 7 (drawing number 1979.255).

National Parks, Heritage Coasts and World Heritage Sites

2.2 There are no National Parks, Heritage Coasts or World Heritage Sites within the study area.

Areas of Outstanding Natural Beauty (AONB)

Mendip Hills AONB

2.3 The Mendip Hills AONB covers an area of approximately 200km^2 and is an extensive range of limestone hills to the south of Bristol. The hills run in an east to west direction between the coast at Weston-super-Mare and Frome and overlook the Somerset Levels to the south and Avon Valley to the north.

2.4 The hills of the AONB form prominent landmarks. The designation relates to landscape and scenic importance although the Mendip Hills are also valued for the many industrial archaeological sites reflecting the lead, coal and cloth industries. The AONB is also characterized by an open largely treeless limestone plateau surrounded by gorges, cliffs and escarpment slopes.

Implications for underground routeing

2.5 AONBs are designated under the National Parks and Access to the Countryside Act 1949 (as amended) for the purpose of conserving and enhancing the natural beauty of the area. The importance of these sites and the protection afforded to them is further highlighted in Planning Policy Statement (PPS) 7. Paragraph 22 of PPS7 states that major developments should not take place in these designated areas except in exceptional circumstances and that such applications will be subject to rigorous examination and should include an assessment of the national need, cost and scope of developing outside the designated area and effects on the environment, landscape and recreational opportunities. An underground connection would have temporary effects associated with construction on the landscape of the AONB affecting the objective to conserve and enhance natural beauty. However, once the land has re-established effects would be reduced.

2.6 To avoid the Mendips Hills AONB the Potential Connection would have to extend to the west where the settlement of Weston-super-Mare, blocks of ancient woodland and the topography of the landscape would constrain routeing. To the east, the AONB extends for approximately 22km and a Potential Connection would be constrained by woodland, settlements and Scheduled Monuments. To achieve a direct connection between Bridgwater and Seabank the Potential Connection would need to be established through the AONB.

2.7 Any underground connection would need to avoid areas of woodland and other features which are important to the scenic character of the AONB. The Mendip Hills AONB is also noted for its ecological and archaeological importance. This would need to be considered further if an underground connection option was taken forward.

Sites of Special Scientific Interest (SSSI)

2.8 SSSIs are designated for their biodiversity or geological interest and are protected from development and operations likely to damage their special interest. There are SSSIs dispersed throughout the Study area. The most significant of these sites and the reasons for their designation are summarised in Table 2.1.

Table 2.1 – Summary of SSSIs

SSSI	Location / Grid Ref	Reason for Designation
The Catcott, Edington and Chilton Moors, Tealham and Tadham Moors and Westhay Moors	North east of Bridgwater (ST 390420)	The Catcott, Edington and Chilton Moors, Tealham and Tadham Moors and Westhay Moors SSSIs are a collection of adjoining moors which form part of the Somerset Levels and Moors SSSI, SPA, Ramsar site to the north east of Bridgwater. These sites comprise diverse habitats which provide feeding and nesting sites for a wide range of birds such as Golden Plover and Lapwing.
Shiplate Slait	(ST 364567)	This site lies towards the western end of the Mendip Hills AONB on the south and west facing slopes. It is important for its unimproved calcicolous grassland, some is mixed with dwarf shrub, mosaics of calcicolous grassland, scrub and woodland.
Crook Peak and Shute Shelve	East of Loxton (ST 385555)	This site is in the Mendip Hills AONB covering high ground of Crook Peak and Shute Shelve Hill. The designation covers a range of habitats including ancient and semi-natural broadleaved woodland and unimproved calcareous grassland.
Banwell Ochre Caves SSSI	East of Banwell (ST 407593)	This SSSI lies within the Mendip Hills AONB and forms part of the North Somerset and Mendip Bats SAC. The SSSI comprises five caves which contain the most extensive and accessible yellow ochre workings in the Mendip Hills.
Banwell Caves	South of Banwell (ST 383588)	This SSSI lies within the Mendip Hills AONB and forms part of the North Somerset and Mendips Bats SAC. It is a Geological Review Site and is used as a hibernation site by Greater Horseshoe Bats.
Puxton Moor, Biddle Street, Tickenham, Nailsea and Kenn Moors	North of the Mendip Hills AONB (ST 440700)	These wildlife sites form part of the Avon Levels and Moors, an extensive area of low lying agricultural land north of the Mendip Hills. The Avon Levels and Moors is drained by a network of rhynes and ditches which act as 'wet fences' providing water for livestock. The combination of management practices and the variation in the soils has resulted in watercourses which support a wide range of aquatic plant communities, many of which are of considerable nature conservation interest.
Severn Estuary	South west coast, covers Mouth of the Avon in study area	The Severn Estuary, also a SPA, SAC and Ramsar site, lies on the south west coast of Britain at the mouth of four major rivers (the Severn, Wye, Usk and Avon). It is an internationally important site for birds and wildlife habitats and is one of the most important sites in the UK for wintering wildfowl and waders.
Gordano Valley	North east of Clevedon (ST 435730)	The Gordano Valley covers an area of approximately 161ha and is an extensive low-lying and poorly drained peat moor situated between Carboniferous Limestone ridges. The area is designated for its national ornithological, entomological and stratigraphic interest.
Weston Big Wood	South east of Portishead (ST 455750)	Weston Big Wood is an area of mixed deciduous woodland covering approximately 37ha. The wood lies on the plateau of a narrow ridge of Carboniferous Limestone and various factors suggest the site is the remnant of an ancient forest.

Implications for underground routeing

2.9 The potential effect of an underground connection on a SSSI will depend on the nature of the effect caused and the special interest of the site. Underground connections are more invasive than an equivalent length of overhead line as the land disturbance is greater during construction and there are permanent restrictions on tree planting and land use during operation. Consultation with Natural England would be required before consent could be granted for any development or operations likely to damage the SSSI interest.

2.10 Whilst many SSSIs within the Study area could be avoided by the Potential Connection there are a number which would influence routeing due to their size or proximity to each other.

2.11 Within the Mendip Hills AONB Crooke Peak and Shute Shelve SSSI and Shiplaite Slait SSSI are both on higher ground. To avoid these sites an underground connection would need utilise lower ground along the Lox Yeo Valley to the east of Loxton. Through the Mendip Hills a connection adjacent to the east of the M5 could be achieved but would be constrained by the topography of the landscape, Banwell Caves SSSI and SAC and woodland.

2.12 The SSSI designation for Puxton Moor, Biddle Street, Tickenham, Nailsea and Kenn Moors covers ditches and rhynes in low lying farmland. The construction of an underground connection through these sites would cause disturbance during construction and may have effects on their special interest. To avoid these sites the Potential Connection would need to travel to the east or west of the SSSIs. To the west of the SSSIs a Potential Connection could be achieved but would be constrained by settlement at Kenn and Tickenham, woodland on Tickenham Ridge and a Scheduled Monument. To the east, a direct connection would be limited by the settlements of Yatton, Congresbury and Nailsea.

2.13 Any underground connection to Seabank substation would need to cross the River Avon which is a component site of the Severn Estuary SSSI (also a SAC, SPA and Ramsar). The use of a tunnel under the River would be less invasive than direct bury techniques but would require the construction of tunnel headhouses on either side of the channel. Further detailed study would be required to assess the effects of an underground connection on the integrity of the site and its qualifying features if this connection option was taken forward.

Special Protection Areas (SPA) and Ramsar sites

Severn Estuary SPA and Ramsar

2.14 The Severn Estuary SPA lies along the western boundary of the study area and the full extent of the designation covers an area of approximately 24,000ha. The Estuary is the largest coastal plain estuary in the UK with extensive mudflats and sandflats, rocky shore platforms, shingle and islands. The Estuary's unique funnel shape means it has a high tidal range which results in a variety of plant and animal communities typical of liquid mud and tide-swept sand and rock.

2.15 The site qualifies as an SPA under Articles 4.1 of the Birds Directive (79/409/EEC) by supporting bird populations of European importance that are listed on Annex I of the Directive and under Article 4.2 by regularly supporting at least 20,000 waterfowl.

2.16 The Ramsar designation also extends to cover fish populations of the estuarine and river system which is one of the most diverse in Britain with over 110 species recorded.

Somerset Levels and Moors SPA and Ramsar

2.17 The Somerset Levels and Moors are one of the largest areas of traditionally managed wet grassland and fen habitats in lowland UK. The SPA and Ramsar sites cover the same geographical area as each other (approximately 35,000ha) and include the floodplains of the Rivers Axe, Brue, Parrett, Tone and their tributaries. The internationally important bird populations and the habitats on which they depend are reasons for both the SPA and

Ramsar designations; the Ramsar designation also extends to cover rare invertebrate populations.

Implications for underground routeing

2.18 SPAs and Ramsar sites are afforded protection under the Conservation of Habitats and Species Regulations 2010. The Regulations only permit development in the first instance on such sites where it is directly connected with or necessary to site management for nature conservation; or where the proposal would not be likely to have a significant effect on the conservation objectives of the site, alone or in combination with other plans and projects.

2.19 Where there are likely to be significant effects, consent for development can only be granted where it would not adversely affect the integrity of the site taking into account the manner in which the development will be carried out and any conditions that might be imposed on the consent or there are no alternative solutions and the development must be carried out for imperative reasons of overriding public interest relating to human health, public safety or benefits of primary importance to the environment.

2.20 To avoid the Severn Estuary and Somerset Levels and Moors the Potential Connection would need to be established in land between the two SPA and Ramsar sites. An underground connection close to either designated site would give rise to greater effects and detailed study would be required to consider the potential for disturbance to bird movements or foraging habitat as a result of the Potential Connection.

2.21 The Severn Estuary SPA includes the mouth of the River Avon. An underground connection across this part of the SPA would be unavoidable as land is constrained by built development at Bristol and Avonmouth. The use of a tunnel under the River would be less invasive than direct bury techniques but would require the construction of tunnel headhouses on either side of the channel. A detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects which may arise on the integrity of the designation through the Potential Connection.

Special Areas of Conservation (SAC)

Severn Estuary SAC

2.22 The Severn Estuary SAC lies along the western boundary of the study area and covers an area of approximately 73,000ha. The SAC was confirmed in 1995 and further amended in 2000. The site is designated for the important populations of fish and natural habitats present within the estuary.

Mendip Limestone Grasslands SAC

2.23 The Mendip Limestone Grasslands SAC comprises three separate SSSIs totalling approximately 417ha. Brean Down SSSI and Uphill Cliff SSSI are south of Weston-super-Mare, contiguous with the Severn Estuary SAC. Crook Peak to Shute Shelve SSSI is approximately 10km inland from the estuary, in the Mendip Hills.

North Somerset and Mendip Bats SAC

2.24 North Somerset and Mendip Bats SAC is centred on the Mendip Hills. The SAC comprises caves, grassland and woodland and is a composite site spread across a wide area. The component sites include the Banwell Caves SSSI and Banwell Ochre Caves SSSI on the north side of the Mendip Hills with Brockley Hall Stables SSSI and King's Wood and Urchin Wood SSSI to the north east of Congresbury.

2.25 These sites are considered of international importance for their semi-natural dry grasslands, significant blocks of *Tilio-Acerion* forest and the limestone caves of the Mendips which provide a range of important hibernation sites for greater and lesser horseshoe bats. Policy ECH/12 of the North Somerset Replacement Local Plan (2007) provides a 5km ‘consultation zone’ which covers important feeding grounds surrounding the SAC and in which development proposals are subject to particular scrutiny for potential effects on the designated sites.

Implications for underground routeing

2.26 Like SPAs and Ramsar sites, SACs are afforded protection under the Conservation of Habitats and Species Regulations 2010 and development is strictly controlled.

2.27 An underground connection could be established which avoids the SACs in the Study area but would pass through the North Somerset and Mendip Bats SAC 5km consultation zone. The potential effects on SAC bat species arising from an underground connection are associated with loss of habitat resulting in fragmentation and degradation of foraging grounds. If this Potential Connection was taken forward further assessment of the effects on the integrity of the SAC and its qualifying features would be required.

2.28 In the northern part of the Study area an underground connection would need to cross the River Avon a component site of the Severn Estuary SAC. The use of a tunnel under the River would be less invasive than direct bury techniques but would require the construction of tunnel headhouses on either side of the channel. A detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects which may arise on the integrity of the designation through the Potential Connection.

National Nature Reserves (NNRs)

2.29 There are several wildlife sites in the study area designated as NNRs. The majority of these form part of larger sites afforded protection under other ecological designations. The NNRs in the Study area are listed in Table 2.2.

Table 2.2 - Summary of NNRs

NNR	Grid Ref/Location	Reason for Designation
Huntspill River	ST 320443	This is an artificial river within the Somerset Levels managed by the Environment Agency. The area is of interest to various birds and otters. The river stretches for 5 miles from Bridgwater Bay to the western boundary of the Catcott Edington and Chilton Moors SSSI. The area is also of archaeological interest.
Somerset Levels	ST 387360	This NNR is important for its open water and lowland grasslands. It is currently closed to the public.
Westhay Moor	ST 453440	This NNR is owned and managed by Somerset Wildlife Trust. It comprises restored peat fields and water-filled compartments with islands of reeds and bulrushes. The land also includes poor fen and a fragment of acid moor which is currently being restored.
Shapwick Heath	ST 430400	This is a wetland reserve managed by Natural England covering over 500ha. It is important for its reed beds, fens, meadows and wet woodland. The NNR also includes a Neolithic ‘Sweet Track’, the oldest routeway in Britain.
Ham Wall	ST 458402	This NNR is owned and managed by the RSPB. It is an area of former commercial peat extraction and is currently being restored to wetland habitats.
Gordano Valley	ST 435731	This NNR is important for its peatland habitats. The site is currently closed to the public.

Implications for underground routeing

2.30 A number of sites to the north east of Bridgwater form part of larger sites afforded protection under other ecological designations such as SSSI, SPA and Ramsar site known as the Somerset Levels and Moors. These sites could be avoided by the Potential Connection.

2.31 To avoid the designated part of the Huntspill River an underground connection would need to travel to the east of Gold Corner between the Huntspill River NNR and sites within the Somerset Levels SPA and Ramsar. The Potential Connection would still need to cross the Huntspill River. Further detailed study would be required to determine the effects on the integrity of the NNR arising from the Potential Connection if this option was taken forward.

Scheduled Monuments (SMs)

2.32 The south west of England is a region of high archaeological and historical importance containing over a third of all SMs in England. There are SMs interspersed throughout the Study area. The majority of these sites are on higher ground within the Mendip Hills AONB and close to or within settlements.

Implications for underground routeing

2.33 SMs are nationally important monuments and archaeological remains which are protected under the provisions of the Ancient Monuments and Archaeological Areas Act 1979. Consent is required from English Heritage, the statutory advisor on the historic environment, under the 1979 Act for works for works directly affecting an SM may be carried out.

2.34 SMs could be largely avoided by the Potential Connection. An underground connection would have less adverse effects on the setting of SMs than an overhead line as impacts are largely temporary during construction. However, if an underground connection could not avoid a SM it may be permanently damaged or destroyed.

2.35 North of Bridgwater, a medieval settlement and hill fort would constrain routeing adjacent to the M5. To avoid this designation and the settlement of Puriton, which abuts the motorway, an underground connection would need to be routed to the east of the settlement.

2.36 There is a cluster of SMs in the Mendip Hills AONB comprising hill forts, camps and roman settlements. These SMs are typically on high ground where woodland and SSSIs would further constrain a Potential Connection. To avoid these designations a route would need to be established on lower ground in the Lox Yeo Valley.

2.37 To the north of Avonmouth, Mere Bank SM would be difficult to avoid with the Potential Connection due to its linear nature and the proximity of settlements and built form. If routed through this site the Potential Connection would cause adverse effects to the integrity of the monument resulting in the permanent loss of part of the feature. Detailed assessment would be required of the effects of routeing through this SM; mitigation and recording of the feature are likely to be required if the SM could not be avoided.

Historic Buildings

2.38 There are approximately 18 Grade I and 62 Grade II* listed buildings within the Study area. Whilst these are distributed across the Study area they are often clustered within the larger settlements. Some isolated buildings are in more rural areas; these are generally farmsteads and country houses. Particular clusters of historic buildings are found within the settlements of Bridgwater, Banwell and Clevedon.

Implications for underground routeing

2.39 Buildings of special architectural or historic interest are added to a list of buildings protected under the Planning (Listed Buildings and Conservation Areas) Act 1990. Planning authorities are required to consult with English Heritage on planning applications which may affect a Grade I and Grade II* listed building outside Greater London and listed building consent is required for any works likely affect a listed building.

2.40 Routes could be achieved for the Potential Connection which avoided listed buildings.

Conservation Areas

2.41 Within the study area there are 48 Conservation Areas. They are generally focused in towns and village centres and include Loxton, Christon, Banwell, Congresbury, Yatton, Nailsea, Chelvey and Avonmouth.

Implications for underground routeing

2.42 Conservation Areas are areas designated by local authorities because of special architectural or historic interest and are protected under the Planning (Listed Buildings and Conservation Areas) Act 1990. Conservation Area consent is required from the local planning authority for any development within the area.

2.43 Routes could be achieved for the Potential Connection which avoid Conservation Areas.

Registered Parks and Gardens

2.44 There are several sites within the Study area designated as Registered Parks and Gardens. The most significant of these sites likely to influence routeing are summarised in Table 2.3.

Table 2.3 – Summary of Registered Parks and Gardens

Registered Park and Garden	Grid Ref/Location	Reason for Designation
Clevedon Court (80 ha)	ST 423715	Grade II* listed 18th century terraced gardens which are set within parkland. The site includes a 13th century crenulated wall, medieval barn, octagonal summerhouse, and 19th century ornamental woodlands. The site is owned by the National Trust.
Tyntesfield (57 ha)	ST 505715	This site lies to the south of Bristol and is an extensive 19th century estate owned by the National Trust. The house and grounds are currently being restored.

Implications for underground routeing

2.45 The English Heritage 'Register of Historic Parks and Gardens of special historic interest in England' (compiled under powers contained in Historic Buildings and Ancient Monuments Act 1953) identifies sites assessed to be of national importance. Registration is a ‘material consideration’ in the planning process, meaning that planning authorities must consider the impact of any proposed development on the landscapes’ special character.

2.46 To avoid these sites a Potential Connection would need to be routed through land to the east of Clevedon, south of Tickenham and west of Tyntesfield. Other constraints such as woodland, SMs, SSSIs and settlements further constrain routing although a route could be achieved which avoided these constraints.

Registered Battlefields

2.47 There is one registered battlefield within the study area which is the site of the battle of Sedgemoor in 1685. The site lies north of Westonzoyland approximately 1km east of Bridgwater substation and does not pose a constraint to the Potential Connection.

Woodland

2.48 There are numerous blocks of woodland, some of which are ancient woodland, interspersed throughout the study area. Several woodlands are also designated as SSSIs.

Implications for underground routeing

2.49 Installing an underground connection through woodland would result in the permanent loss of woodland along the length of the connection. Permanent restrictions on what may be planted above and adjacent to the Potential Connection would prevent the re-establishment of land following the completion of construction work.

2.50 There is a cluster of woodland to the south of Puriton. The presence of woodland and built form at Puriton would constrain routeing next to the M5 in this area. To avoid these constraints a Potential Connection would need to be routed on the raised ground between woodland blocks to the east of Puriton and west of Knowle.

2.51 There are numerous blocks of woodland within the Mendip Hills AONB. However, this woodland is primarily on higher ground and could be avoided with an underground connection using lower ground within the Lox Yeo valley.

2.52 A further cluster of woodland is present on Tickenham Ridge, some of which is ancient woodland. To avoid the woodland, an underground connection would need to pass through a gap in settlements at Stone Edge Batch before traversing Tickenham Ridge in a north easterly direction along a similar route to existing WPD 132kV overhead lines.

2.53 On the northern side of Tickenham Ridge a route to the east of the M5 would be constrained by Priors Wood and settlement at Portbury and Gordano. To avoid these constraints an underground connection would need to utilise land on the other side of the motorway.

Settlements

2.54 The key settlements within the study area are sited along or in close proximity to the banks of the Severn Estuary and include Bridgwater, Burnham-on-Sea, Weston-super-Mare, Clevedon and Portishead.

2.55 There are numerous other towns and villages dispersed throughout the study area, the larger of which are along classified roads. Smaller villages and hamlets are linked by the minor road system.

Implications for underground routeing

2.56 Settlements within the Study area could be largely avoided through careful routeing. However, in the northern part of the Study area Avonmouth and the City of Bristol form a continuous band of development that extends to the mouth of the River Avon at the Severn Estuary. The Potential Connection would need to negotiate this area to achieve the connection into Seabank and further detailed study would be required to identify appropriate routes through this area.

Landform

2.57 Landform in the Study area shows some variations and is illustrated at Map 1 (drawing number 1979.261).

Implications for underground routeing

2.58 In the south of the Study area the landscape generally comprises low lying moorland (approximately 6mAOD) which forms part of a wider area known as the Somerset Levels and Moors. The Mendip Hills AONB lies in the centre of the study area and rises sharply from the Somerset Levels. In the north the topography is more varied and comprises large areas of flat open moorland and a prominent ridge at Tickenham.

2.59 Landform does not pose a constraint to a Potential Connection although lower ground may be preferable for underground routes due to ease of construction.

3.0 ASSESSMENT

3.1 A new underground connection between Bridgwater and Seabank could be achieved and would offer benefits in terms of landscape and views over an equivalent length of overhead line. However, the construction of underground connections is more invasive than for an overhead line and would have a greater scale of effect on sites important for their ecology or archaeology. Construction results in disturbance to ground vegetation which could affect the integrity of a designation or its qualifying features and detailed study would be required to determine appropriate working methods and mitigation. With buried archaeology an underground connection through a designation would result in the permanent loss of that feature.

3.2 A direct connection between Bridgwater and Seabank would need to travel through the Mendip Hills AONB. The connection would need to be routed on lower ground within the Lox Yeo Valley to avoid constraints such as SSSIs, SACs and woodland. The Potential Connection would give rise to temporary effects on landscape and views within the AONB during construction. However, once the land has re-established, effects would be lower than an equivalent length of overhead line.

3.3 The Study area contains large areas of land (including ditches and rhynes) designated as SSSIs. In combination with settlements, woodland and SMs, a potential route would be constrained to narrow areas of land to the east of the M5. Whilst an underground connection could be achieved environmental constraints would have an influence on the directness of any route.

3.4 The Potential Connection would need to cross the River Avon, a component part of the Severn Estuary SSSI, SAC, SPA and Ramsar site. The use of a tunnel under the River would be less invasive than direct bury techniques but would require the construction of tunnel headhouses on either side of the channel. Further detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects which may arise on the integrity of the designation if this connection was identified as the most suitable Potential Connection and taken forward.

3.5 An underground connection would need to travel through the Somerset Levels and Moors which was a candidate site for World Heritage Site (WHS) status (although this is no longer being promoted by Somerset County Council). The WHS bid was based on the area's unique palaeo-environmental records that include a 10,000 year record of climate, sea level and landscape change. Features include prehistoric trackways, lake villages, relic roman wetland landscapes, medieval reclamations and river canalisations. Whilst it would be possible to avoid the SMs within the Levels there are other known non-designated assets and unknown assets which would be affected.

3.6 An underground connection would have visual benefits on the setting of designated historic sites but would need to be balanced with the negative effects on buried archaeology which may be lost through the construction of an underground connection. Further detailed study along any underground connection route would be required to identify the potential for archaeological remains and any direct and indirect effects resulting from construction and installation. PPS5 highlights the importance of the heritage resource stating *'The historic environment and its heritage assets should be conserved'*. To achieve this Government objectives for planning in the historic environment are *'to deliver sustainable development by ensuring policies and decisions concerning the historic environment recognise that* *heritage assets are a non-renewable resource'*. Underground connections routed through heritage assets may cause permanent loss due to the intrusive nature of the construction.

3.7 An underground connection between Bridgwater and Seabank would, therefore, offer environmental benefits on landscape and views particularly relating to the AONB and settlements compared with an overhead line connection.

Appendix 2 - Environmental Appraisals

PC5 Hinkley - Seabank

HINKLEY TO SEABANK ENVIRONMENTAL APPRAISAL

1.0 INTRODUCTION

1.1 This planning and environmental appraisal (the Study) has been produced by Mott MacDonald Limited (MML) for National Grid Electricity Transmission plc (National Grid). The appraisal considers the planning and environmental constraints associated with the installation of subsea cables between the proposed Hinkley Point C Power Station (Power Station) and Seabank substation (the Potential Connection).

1.2 The Potential Connection is one of a number of alternative options considered by National Grid to facilitate the connection of the Power Station to the high voltage electricity transmission system. Detailed technical information relating to this connection option is set out under option PC5 of the Hinkley Point C Connection Strategic Optioneering Report (August 2011).

Assumptions

1.3 For the purpose of this Study, it has been assumed that the new 400kV Potential Connection would be made via either high voltage alternating current (AC) subsea cables or high voltage direct current (HVDC) subsea cables. Detailed technical information relating to each of these connection methods is set out in Section 5.0 of the Strategic Optioneering Report; a brief summary of the points relevant to this Study is summarised below.

HVDC Subsea Cables

1.4 For a HVDC subsea cable connection up to 8 cables would be required.

1.5 The HVDC cables are likely to be laid in bundled pairs, to reduce the risk of interference with the ship navigation systems. Each bundled pair would be installed in its own trench on the sea-bed. Due to the shipping movements, sediment mobility, and dredging activities in the Severn Estuary, an average depth of cover of 1–3m is likely to be required. Additional protection for the cables (e.g. concrete or sand filled mattresses, rock armour, etc.) may also be required in addition or as an alternative to, deeper burial in areas where special constraints (e.g. dredging, areas of high sediment mobility, etc.) are encountered.

1.6 Initial studies, undertaken by Mott MacDonald indicate that the overall installation corridor for HVDC subsea cables in the Severn Estuary would be in the range of 150m if 4 cables are required and 350m if 8 cables are required. This includes consideration of factors such as threats from anchor drag and operational maintenance, which dictate the separation distance between bundled pairs of cables.

1.7 Methods of laying and burying subsea cables include continuous lay and bury techniques (such as ploughing and water jetting) and pre-trenching methods where excavation and laying operations are carried out separately. These techniques have varying levels of impact with respect to disturbance of the estuary bed. Further detailed study would be required to determine the actual methods to be used.

DC Converter Stations

1.8 For a HVDC subsea cable connection, between 2 and 4 AC/DC converter stations would be required at each end of the connection (i.e. at Hinkley Point and Seabank), to convert the 400kV AC transmission voltage/current to HVDC voltage/current and vice-versa. The number of converter stations required for the Potential Connection would depend upon the selected transmission voltage for the Potential Connection and the power rating of each converter module. The options considered for the purpose of this study are 2 x 2000MW at

+/- 500kV DC and 4 x 1000MW at +/- 320kV DC; however; a further detailed options assessment would be required to determine the actual transmission voltage and power rating to be used.

1.9 A 1000MW converter station is anticipated to cover an area of at least 6,000m^2, and a 2000MW converter station at least 20,000m^2. The Potential Connection between Hinkley and Seabank is thus anticipated to have a total land occupation of at least 24,000m2 for a 4 x 1000MW connection or 40,000m^2 for a 2 x 2000MW connection, subject to further detailed study. The approximate height of the converter station buildings would be in the range of 20 – 25m. Additional infrastructure to facilitate connections to National Grid's AC substations and transmission network would also be required if the Potential Connection is identified as the most suitable Potential Connection and taken forward

AC Subsea Cables

1.10 For an AC subsea cables connection up to 12 cables would be required. Each AC cable would typically be laid in a single trench on the sea-bed. The average depth of cover and cable protection considerations are generally as set out for HVDC subsea cables at paragraphs 1.5 to 1.7 above.

1.11 Initial studies, undertaken by Mott MacDonald indicate that the overall installation corridor would be approximately 440m wide, which is wider than estimated for the HVDC options due to the greater number of cables required for an AC connection. This includes consideration of factors such as threats from anchor drag and operational maintenance, which dictate the separations between individual cables.

1.12 AC subsea cable installation, laying vessel, and shore landing considerations are generally as set out for HVDC subsea cables at paragraphs 1.5 to 1.7 above. The construction and installation requirements for land cables would be the same as discussed for AC underground cable systems (See Chapter 5.0 of the further Strategic Optioneering Report).

Associated AC Equipment

1.13 There are no known 400kV AC subsea cable installations of a similar length or electrical circuit rating to the Potential Connection being considered as part of this study. The distances involved in this Potential Connection may require the application of special circuit switching arrangements and additional AC equipment, such as reactive compensation equipment (i.e. shunt reactors) and special duty circuit breakers. Further detailed study would be required to determine the requirement and optimum location of this equipment should this Potential Connection be identified as the most suitable Potential Connection and be taken forward.

1.14 The following additional works would be required to the electricity transmission system should the Potential Connection be taken forward:

- New 400kV substation at Aust, South Gloucestershire;
- New 400kV substation at Hinkley Point, Somerset;
- New 400kV substation at Bridgwater, Somerset;
- Installation of 2 Quadrature Boosters at Nursling, Hampshire;
- New 400kV double circuit overhead line between Seabank and Tockington;
- New underground cable circuit between Cowley, Gloucestershire and Minety, Wiltshire; and
- Extension of Melksham substation.

1.15 The majority of the above works are required to ensure the security and stability of the electricity transmission system for whichever connection option is taken forward. However, the new 400kV double circuit overhead line between Seabank and Tockington is only required for certain connection options. These works have, therefore, been considered as part of this study (see Section 3.0).

Environmental Constraints

1.16 The Study has considered environmental constraints of international and national importance. Features considered as constraints to the Potential Connection are presented in Table 1.1 below. The table also summarises the legislation under which protection is inferred and the data sources from which information (where applicable) was taken.

Table 1.1: Environmental constraints and data sources

Feature	Legislation	Routeing Response (and Reference)	Data Sources
National Parks	National Parks and Access to the Countryside Act 1949	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1)	magic.gov.uk
Areas of Outstanding Natural Beauty	National Parks and Access to the Countryside Act 1949/ Countryside and Rights of Way Act 2000	Seek to avoid/consider undergrounding (NG Commitments/Holford Rule 1	magic.gov.uk
Heritage Coasts	n/a	Seek to avoid (NG Commitments/ Holford Rule 1)	magic.gov.uk
World Heritage Sites	1972 World Heritage Convention	Seek to avoid (NG Commitments/ Holford Rule 1)	english-heritage.org.uk
Sites of Special Scientific Interest	Wildlife and Countryside Act 1981	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Special Protection Areas	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Special Areas of Conservation	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
Ramsar sites	The Conservation of Habitats and Species Regulations 2010	Seek to avoid (birds interest) (NG Commitments/Holford Rule 2)	gis.naturalengland.org.uk
National Nature Reserves	National Parks and Access to the Countryside Act 1949	Seek to avoid/verify potential effects (NG Commitments/ Holford Rule 2)	gis.naturalengland.org.uk
Scheduled Monuments	Ancient Monuments and Archaeological Areas Act 1979	Seek to avoid/consider effect on setting (NG Commitments/ Holford Rule 2)	english-heritage.org.uk
Settlements	n/a	Seek to avoid (Supplementary Note)	Digitised from Ordnance Survey
Historic buildings (Listed I, II and II*)	Planning (Listed Buildings and Conservation Areas) Act 1990	Seek to avoid/consider effect on setting (Note to Holford Rule 2)	english-heritage.org.uk
Conservation Areas	Planning (Listed Buildings and Conservation Areas) Act 1990	Minimise effects/consider effect on setting (Note to Holford Rule 2)	Development plans
Registered Parks and Gardens	n/a	Seek to avoid (NG Commitments)	magic.gov.uk

Feature	Legislation	Routeing Response (and Reference)	Data Sources
Registered Battlefields	n/a	Minimise effects (NG Commitments)	english-heritage.org.uk
Woodlands	n/a	Seek to avoid (Note to Holford Rules 4 and 5)	National Inventory of Woodlands
Landform	n/a	(Holford Rules 4 and 5)	OS Open Data

Environmental Aspects 'Scoped Out' of Appraisal at this Stage

1.17 It is not feasible to undertake a meaningful assessment of the effects of the Potential Connection on certain environmental factors both because of the high level nature of this environmental appraisal and because a detailed connection design would have to be identified. As a result the effects of these factors have not influenced the selection of a preferred connection. The factors scoped out of the appraisal at this stage are outlined at paragraphs 1.19 to 1.23 below.

1.18 Although scoped out of the options appraisal process at this stage these factors will require consideration as part of routeing studies, detailed connection design and environmental assessment whichever connection is taken forward.

Flood Risk

1.19 National Grid considers its siting of installations such as substations or converter stations very carefully in relation to flood risk.

1.20 As outlined at paragraph 1.8 above, converter stations would be required for a HVDC subsea connection at both Hinkley Point and Seabank. The exact location of the converter stations would require further consideration and assessment in accordance with Planning Policy Statement 25 if the Potential Connection was taken forward. However, due to the high level nature of this assessment, flood risk has not been considered an influence on the identification of the most suitable Potential Connection to be taken forward at this stage.

Noise

1.21 Noise during construction will be temporary and managed by procedures and controls to ensure that it is not unacceptable. Noise during operation will be controlled primarily by separation of sources of noise from noise-sensitive receptors and also by noise-suppression measures as appropriate. The review of options considers whether there is likely to be appropriate distances from settlements and dwellings for amenity reasons which would also allow separation to mitigate effects of noise. The noise sources and measures taken will be applied as required for any option and noise is not a material factor in distinguishing between options.

Air Quality

1.22 New transmission infrastructure will not give rise to any material effects on air quality. Temporary construction works can give rise to dust affecting air quality locally. This will be managed by procedures and controls to ensure that it is not unacceptable. These measures will be applied as required for any option and air quality is not a material factor in distinguishing between options.

Transport

1.23 Construction works will involve transport of materials and workforce to sites. The effects will be temporary and will be subject to management to ensure that effects are not unacceptable. This will be the case for any option and transport is not a material factor in distinguishing between options.

Study Area

1.24 The Study area extends for approximately 50km between the Power Station, West Somerset and the existing National Grid 400kV substation at Seabank, Bristol. The Study area for the Potential Connection is focussed on the Severn Estuary, its coastline and land associated with the connection points at Hinkley Point and Seabank.

2.0 ENVIRONMENTAL CONSTRAINTS

2.1 A description of the Study area in relation to the environmental constraints outlined in Table 2.1 below is presented below and illustrated at Map 8 (drawing number 1979.254).

National Parks, Areas of Outstanding Natural Beauty (AONB), Heritage Coasts and World Heritage Sites

2.2 There are no National Parks, AONBs, Heritage Coasts or World Heritage Sites within the Study area.

Sites of Special Scientific Interest (SSSI)

2.3 Within the Study area, there are a number of designated sites. The most significant of these sites and the reasons for their designation are summarised in Table 2.1.

Table 2.1 – Summary of SSSIs

Site	Location / Grid Ref	Designation	Reason for Designation
Blue Anchor to Lilstock Coast	ST 033435	SSSI	Blue Anchor to Lilstock Coast is a geological SSSI in North Somerset which contains important geological exposures and formations from various periods of geological history.
Bridgwater Bay	ST 290480	SSSI and National Nature Reserve (NNR)	Bridgwater Bay comprises a succession of habitats ranging through extensive intertidal mudflats, saltmarsh, shingle beach and grazing marsh intersected by a complex network of freshwater and brackish ditches. It supports internationally and nationally important numbers of over-wintering and passage migrant waders and waterfowl. The ditches and ponds contain a diverse invertebrate fauna including six nationally rare species and eighteen nationally scarce species. The site is an integral part of the Severn Estuary system and is ecologically linked to the Somerset Levels which provide alternative winter feeding grounds for waders and wildfowl.
Walton Common	ST 428738	SSSI	The site supports a complex mosaic of grassland, scrub and woodland. It is of high botanical and entomological interest. The site is one of only two known locations in Britain for the nationally rare moss *Cheilothela chloropus.*

Site	Location / Grid Ref	Designation	Reason for Designation
Portishead to Black Nore	ST 474778 ST 464776 ST 450767	SSSI	Portishead to Black Nore is 71ha geological SSSI near Portishead in North Somerset. The SSSI is made up of 3 sections (Portishead Pier, Portishead Point and Portishead) which contain important geological exposures and formations from various periods of geological history.
Severn Estuary	ST 480830	SSSI, SPA, SAC, Ramsar	The Severn Estuary SSSI forms part of a larger area which includes the Upper Severn Estuary SSSI, the Taf/Ely Estuary SSSI and Bridgwater Bay SSSI and National Nature Reserve. The Severn Estuary lies on the south west coast of Britain at the mouth of four major rivers (the Severn, Wye, Usk and Avon) and many lesser rivers. The immense tidal range (the second highest in the world) and classic funnel shape make the Severn Estuary unique in Britain and very rare worldwide. The intertidal zone of mudflats, sand banks, rocky platforms and saltmarsh is one of the largest and most important in Britain. The estuarine fauna includes: internationally important populations of waterfowl; invertebrate populations of considerable interest; and large populations of migratory fish, including the nationally rare and endangered *Allis Shad Alosa alosa*.

Implications for subsea routeing

2.4 The potential effect of the Potential Connection on a SSSI will depend on the nature of the effect caused and the special interest of the site. Consultation with Natural England and the Countryside Council for Wales (CCW) would be required before consent could be granted for any development or operations likely to damage the SSSI's features of qualifying interest.

2.5 There are a number of SSSIs which would influence cables routeing and landing sites due to their size or proximity to one another along the coastline. The Potential Connection would need to cross parts of the Severn Estuary SSSI to achieve a connection to Hinkley Point and Seabank. However, avoidance of large parts of the SSSI could be achieved by careful routeing of the cables through the deepest sections in the middle of the estuary (although this area forms part of the SAC designation). Consideration should be given to the effects of the Potential Connection on locally inland protected sites arising from disturbance to the Severn Estuary and other coastline protected areas which may include disturbance to avian habitats.

2.6 Where the subsea cables come ashore at Hinkley Point and Seabank they could not avoid the Bridgwater Bay and Severn Estuary SSSIs. Consideration of the subsea connection methods available to make the Potential Connection will be required. The installation of HVDC subsea cables requires a narrower installation corridor than AC subsea cables due to a reduced number of cables and would therefore have environmental benefits. Detailed studies into the effects the installation of HVDC subsea cables as compared to AC subsea cables on the designated sites would be required. Further detailed consideration of feasibility of different cable installation techniques (such as horizontal directional drilling (HDD)) would be required to minimise effects on these sites. Where steep gradients exist (e.g. shore cliffs) either HDD or tunnelling techniques would need to be considered to minimise effects on the designated sites and their features of special interest. Detailed studies into the effects of construction methods on the integrity of the designated site or its qualifying features would be required if the Potential Connection is identified as the most suitable Potential Connection and was taken forward.

2.7 There may also be indirect effects, associated with disturbance and displacement, on land based SSSIs close to the Severn Estuary from the installation of the subsea cables depending on the construction methods proposed. Detailed study would be required to determine the potential for indirect effects to arise on these sites or their features of special interest if this Potential Connection is identified as the most suitable Potential Connection and is taken forward.

Special Protection Area (SPA), Special Area of Conservation (SAC) AND Ramsar sites

Severn Estuary SPA, SAC and Ramsar site

2.8 The Severn Estuary is an internationally important site for birds and wildlife habitats and is one of the most important sites in the UK for wintering wildfowl and waders. The Estuary is protected by a number of important nature conservation designations including: Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar Site. The designations and the reasons for the designation are outlined below.

2.9 The Severn Estuary SPA lies along the eastern boundary of the study area and the full extent of the designation covers an area of approximately 24,000ha. The site qualifies as an SPA under Article 4.1 of the Birds Directive (79/409/EEC) by supporting bird populations of European importance that are listed on Annex I of the Directive and under Article 4.2 by regularly supporting at least 20,000 waterfowl.

2.10 The Severn Estuary SAC is designated due to the important populations of fish and natural habitats present within the estuary. Important species of fish protected by the site's SAC designation include Allis Shad, Twaite Shad, River Lamprey and Sea Lamprey. Important habitats present within the estuary protected by the SAC designation include Atlantic Salt Meadows, Mudflats and Sandflats not covered by seawater at low tide, Reefs and Sandbanks.

2.11 The Severn Estuary SPA and Ramsar designations cover the same geographical area as each other and overlap extensively in their reasons for designation. The internationally important bird populations and the habitats on which they depend are reasons for designation for both the SPA and Ramsar sites. The Ramsar designation extends to cover fish populations of the estuarine and river system which is one of the most diverse in Britain with over 110 species recorded.

Implications for subsea routeing

2.12 SPAs, SACs and Ramsar sites are afforded protection under the Conservation of Habitats and Species Regulations 2010. The regulations only permit development in the first instance on such sites where it is directly connected with or necessary to site management for nature conservation; or where the proposal would not be likely to have a significant effect on the conservation objectives of the site, alone or in combination with other plans and projects.

2.13 The process for the consideration of development proposals likely to affect an European designated site is set out in the ODPM Circular 6/2005 as illustrated on the flow chart at Diagram 1[1]. As the Potential Connection is not necessary for management of the designated sites, the first test that would apply is whether the project *'is likely to have a significant effect on the sites*'. This is a 'filtering test', intended to avoid the need for detailed assessment of projects which are unlikely to have significant effect. Case law has clarified that mitigation and design measures can be considered. For example, if a project

[1] Extract from ODPM Circular 6/2005.

might affect breeding birds in a SPA (if carried out in the breeding season), then it would be possible to avoid the likelihood of effect by imposing a condition restricting the timing of works and the filtering test can consider this mitigation measure and conclude that the works are unlikely to have a significant effect.

2.14 If the likelihood of significant adverse effect cannot be ruled out, or if there is uncertainty, then the competent authority must carry out an 'appropriate assessment' to test the effect of the project on the integrity of the designated sites. Subject to a defined exception being established, an authority may only grant consent for a project where 'appropriate assessment' shows that it will not adversely affect the integrity of the designated European site.

2.15 An authority may exceptionally grant consent for a project which will adversely affect the integrity of a designated site where there is an absence of alternative solutions and the project must be carried out for imperative reasons of overriding public interest, including those of a social or economic nature.

2.16 The development of the Potential Connection through the Severn Estuary could result in the following effects:

- Disturbance of the mudflats / bed of the Estuary from the installation of cables which could alter the species composition of the flora and fauna found within the mudflats which are important for wintering bird populations. Mobile species, in the vicinity of the cable route and impact area, may move to avoid harm. Sessile species, however, maybe damaged or destroyed during excavation through direct contact with the installation device, burial and dislodgement. Nevertheless, studies have shown that in shallow water and estuarine environments where disturbance is more frequent and opportunistic species are more likely to dominate the community structure, recovery occurs rapidly[2]. Further assessment would be required to assess the degree of impact on this habitat including the potential impacts to wintering bird species.
- Suspended Sediments – resulting from the release of sediment from the cabling activities - can have a number of impacts on the benthic communities, including affecting filtering mechanisms e.g. clogging gills and prolonged sediment disturbance can affect the penetration of light through the water affecting photosynthetic activity for aquatic flora. Prolonged impacts are considered unlikely as the installation of the cables is likely to be a short term impact and studies have shown that species adapted to survive in estuaries are more likely to survive sediment disturbances[3].
- Mobilisation of contaminants in sediments could impact on the flora and fauna of the Estuary.
- Disturbance from the cable laying activities could impact on the SSSI and behaviour of species. Disturbance from cable laying barges could disturb feeding birds. However, works could be timed to avoid sensitive seasons.

2.17 Detailed study would be required in accordance with the Conservation of Habitats and Species Regulations 2010 to identify any direct or indirect effects on the integrity of the designation if this Potential Connection was taken forward. Furthermore, if there was found to be an adverse effect on the integrity of a designated site, National Grid would have to demonstrate that there was no alternative solution.

National Nature Reserve (NNR)

2.18 The only wildlife site within the Study area designated as a NNR which could be affected by the Potential Connection is Bridgwater Bay NNR. The Bridgwater Bay NNR covers the

[2] BERR Department for Business Enterprise and Regulatory Reform, Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry, Technical Report January 2008. In association with DEFRA.
[3] BERR Department for Business Enterprise and Regulatory Reform, Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry, Technical Report January 2008. In association with DEFRA.

same geographical area as the Bridgwater Bay SSSI and the reasons for designation are provided in Table 2.1 above.

Implications for subsea routeing

2.19 A subsea connection route parallel to the coast would cross the Bridgwater Bay NNR and SSSI). To avoid this area of designation, the subsea cables would need to be routed in the middle and deepest sections of the Severn Estuary, away from the land side coastal designations.

2.20 In order to make the necessary connection to land the cables would need to cross the NNR and SSSI in the vicinity of Hinkley Point. Further detailed study would be required to determine the effects on the integrity of the NNR and SSSI arising from the Potential Connection if this option was taken forward.

Scheduled Monuments (SMs)

2.21 There are no SMs located within the Severn Estuary. However, SMs in the vicinity of Hinkley Point and Seabank would pose a constraint to the siting of the converter stations required for a HVDC connection or the siting of reactive compensation equipment for an AC connection. These sites and the reasons for their designation are summarised in Table 2.2.

Table 2.2 – Summary of Scheduled Monuments

Site	Location / Grid Ref	Reason for Designation
Wick Barrow Pixie's Mound	ST 20900 45570	St. George Gray in 1907. Found to be a round mound of 84ft in diameter and 5ft high, built mainly of large stones of up to 2.5ft in length. It contains a roughly circular walled enclosure built of dry stone, with a maximum diameter of 31.5ft, height 3.5ft and thickness of 18ins at the top. No central burial was found but there had been an earlier excavation which showed as a central depression.
Heavy Anti-aircraft battery 520 m east of Holes Mouth	ST52428083	The monument includes a Heavy Anti-aircraft Battery at Rockingham Farm, approximately 3km north of Avonmouth. The site lies a short distance from the coast and is bordered by a railway line on its western side and the A403 road on its eastern side. To the south of the site are modern industrial units and to the north an area of marsh.

Implications for subsea routeing

2.22 SMs are nationally important monuments and archaeological remains which are protected under the provisions of the Ancient Monuments and Archaeological Areas Act 1979. Consent is required from English Heritage, the statutory advisor on the historic environment, under the 1979 Act before works directly affecting an SM may be carried out.

2.23 The SMs identified in the Study area can be avoided by the Potential Connection. However, the proximity of Wick Barrow (also known as 'Pixie's Mound') SM to the Power Station would require consideration as part of converter station siting studies (for a HVDC connection) or reactive compensation equipment siting studies (for an AC connection) if this Potential Connection was identified as the most suitable Potential Connection and taken forward.

Listed Buildings, Conservation Areas and Registered Parks and Gardens

2.24 There are no listed buildings, Conservation Areas or Registered Parks and Gardens close to Hinkley Point or Seabank that would influence the routeing of the Potential Connection or be affected by converter stations required for a HVDC connection.

Woodlands

2.25 There is little woodland along the coastline of the Severn Estuary. However, there are blocks of woodland to the west of the Power Station site that would require consideration as part of converter station siting studies if a HVDC connection was taken forward.

Settlements

2.26 There are numerous large towns within the Study area. These are focussed along or in close proximity to the coast of the Severn Estuary and include Burnham-on-Sea, Weston-super-Mare, Clevedon, Portishead and Avonmouth.

Implications for subsea routeing

2.27 The Potential Connection could avoid towns and villages.

2.28 The siting of new converter stations for a HVDC connection or reactive compensation equipment for an AC connection could avoid settlements. However, there would be effects on views in the vicinity of this equipment. Further detailed study and the consideration of the effects on views would be required as part of detailed siting studies if the Potential Connection was identified as the most suitable Potential Connection and taken forward.

3.0 ADDITIONAL WORKS

Seabank to Tockington Overhead Line

3.1 As outlined at paragraph 1.14, if the Potential Connection was taken forward a new 400kV double circuit overhead line of between 6km and 7km would be required between Seabank and Tockington.

3.2 Between Seabank and Tockington there are no areas protected at the highest level by national or international nature conservation or landscape designations. However, the following constraints would require detailed consideration as part of routeing studies if this Potential Connection was taken forward:

- The existing 400kV Seabank to Tockington overhead line (2VL route);
- Settlements including Marsh Common, Piling, Almondsbury and Awkley;
- Listed buildings and the Conservation Areas of Almondsbury and Olveston;
- Individual residential properties; and
- Blocks of woodland.

3.3 The construction of a new overhead line parallel to the existing 400kV Seabank to Tockington overhead line would result in cumulative visual effects but would limit effects on landscape and views to a localised area. Siting the lines further apart would introduce effects over a greater area and introduce a new line where no overhead line currently exists.

4.0 ASSESSMENT

4.1 The Potential Connection involves the construction of subsea cables between the Power Station and Seabank substation. For an AC connection, reactive compensation equipment is likely to be required and, for a HVDC connection, between 2 and 4 converter stations would be required at both ends of the route.

4.2 Further works required to reinforce the transmission system such as new substations and overhead lines have not been assessed as part of this Study because the nature and scope of works to be undertaken has not been defined; however, would require further consideration and assessment of as part of detailed routeing and siting studies if the

Potential Connection was identified as the most suitable Potential Connection and taken forward.

4.3 The most significant constraints on the Potential Connection would be the Severn Estuary SPA, SAC, SSSI and Ramsar site. Although it maybe possible to route the subsea cable largely outside of the SPA and Ramsar designations, the cable would need travel through the SAC designated area and would come on-shore through the SPA/Ramsar site in proximity to/or through the Bridgwater Bay or Blue Anchor to Lilstock Coast SSSIs to make a connection to the Power Station and through the Severn Estuary SSSI to make a connection to Seabank.

4.4 The development of the Potential Connection through the Severn Estuary could result in the following effects on the SPA, SSSI, SAC and Ramsar designations. These effects would require further assessment in accordance with the Conservation of Habitats and Species Regulations 2010 to ensure that there would be no adverse effects on the integrity of the designation or its qualifying features.

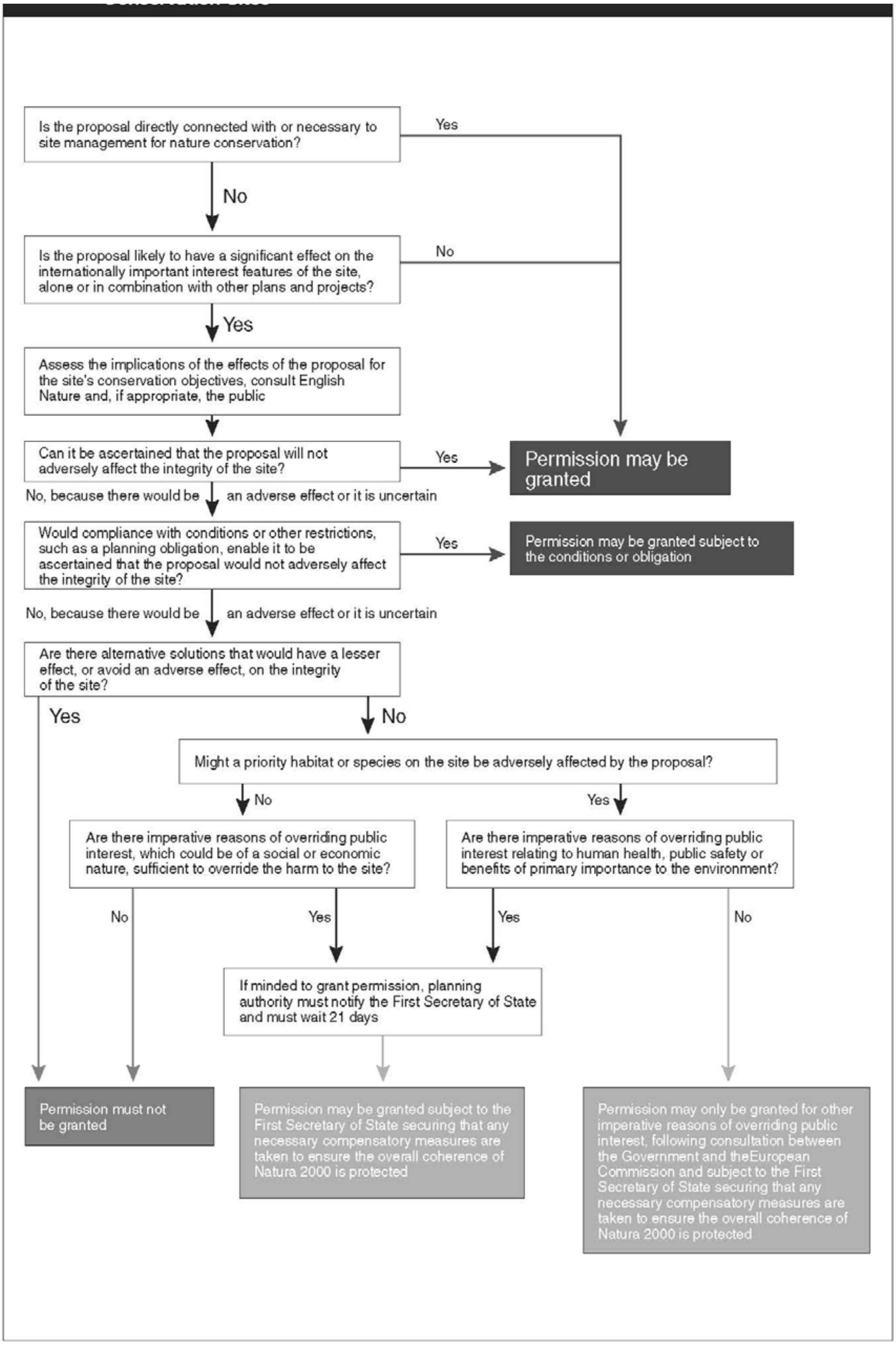
- Disturbance of the mudflats / bed of the Estuary from cables installation which may alter the species composition of the flora and fauna found within the mudflats;
- Suspended Sediments – resulting from the release of sediment from the cabling activities could affect the benthic communities ;
- Mobilisation of contaminants in sediments could impact on the flora and fauna of the Estuary; and
- Disturbance from the cable laying activities could impact on species using the SPA, SAC, SSSI and Ramsar sites.

4.5 The construction of converter stations (for a HVDC connection) or reactive compensation equipment (for an AC connection) could result in effects on local amenity and depending on the siting, visual impacts to settlements and effects on the setting of areas of SMs such as Wick Barrow SM at Hinkley Point. The location of this equipment would require further consideration and assessment of as part of detailed siting studies if this connection was taken forward.

4.6 Known archaeological sites such as SMs have been identified in the vicinity of the landing sites at Hinkley Point and Seabank. However, there may be unknown archaeological assets that could be affected by the cables installation or construction of converter stations or reactive compensation equipment. Further detailed study would be required to determine the potential for archaeological remains and any direct and indirect effects on archaeology resulting from construction. PPS5 highlights the importance of the heritage resource stating *'The historic environment and its heritage assets should be conserved'*. To achieve this Government objectives for planning in the historic environment are *'to deliver sustainable development by ensuring policies and decisions concerning the historic environment recognise that heritage assets are a non-renewable resource'*. Any landing site connection routed through heritage assets may cause permanent loss due to the intrusive nature of the construction.

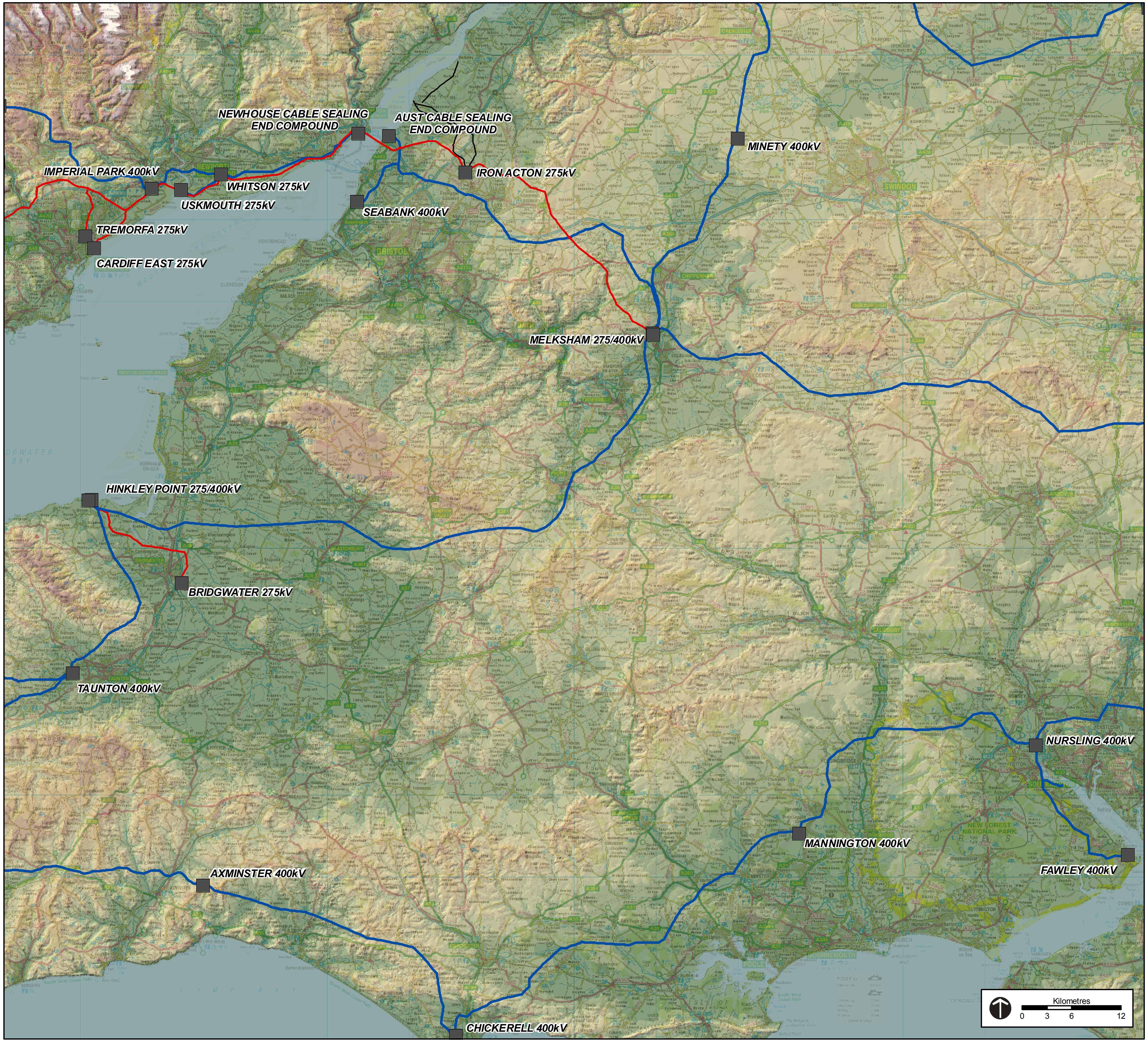
4.7 Of the subsea connection methods available to make the Potential Connection, HVDC subsea cables would offer environmental benefits over AC subsea cables as they require the installation of fewer cables over a narrower installation corridor, resulting in less sea-bed disturbance and a shorter installation programme. However, HVDC subsea cables would require the construction of large converter stations at either end of the route. These converter station sites would introduce effects on landscape and views and would require further consideration and assessment as part of detailed siting studies.

Diagram 1 - Consideration of development proposals affecting Internationally Designated Nature Conservation Sites (extract from ODPM Circular 6/2005)



Appendix 2 Environmental Appraisals – Drawings

Map Number	Title	Drawing Reference
1	Landform	1979.261
2	Hinkley to Aberthaw	1979.224
3	Bridgwater to Melksham (Part 1) Environmental Constraints	1979.228
4	Bridgwater to Melksham (Part 2) Environmental Constraints	1979.229
5	Bridgwater to Nursling (Part 1) Environmental Constraints	1979.225
6	Bridgwater to Nursling (Part 2) Environmental Constraints	1979.226
7	Bridgwater to Seabank	1979.255
8	Hinkley to Seabank	1979.254



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Key

Existing Infrastructure

- Existing Substation
- Existing 400kV Overhead Line
- Existing 275kV Overhead Line
- Existing 132kV Overhead Line

Elevation in metres

- 440 - 479
- 400 - 439
- 360 - 399
- 320 - 359
- 280 - 319
- 240 - 279
- 200 - 239
- 160 - 199
- 120 - 159
- 80 - 119
- 40 - 79
- 0 - 39

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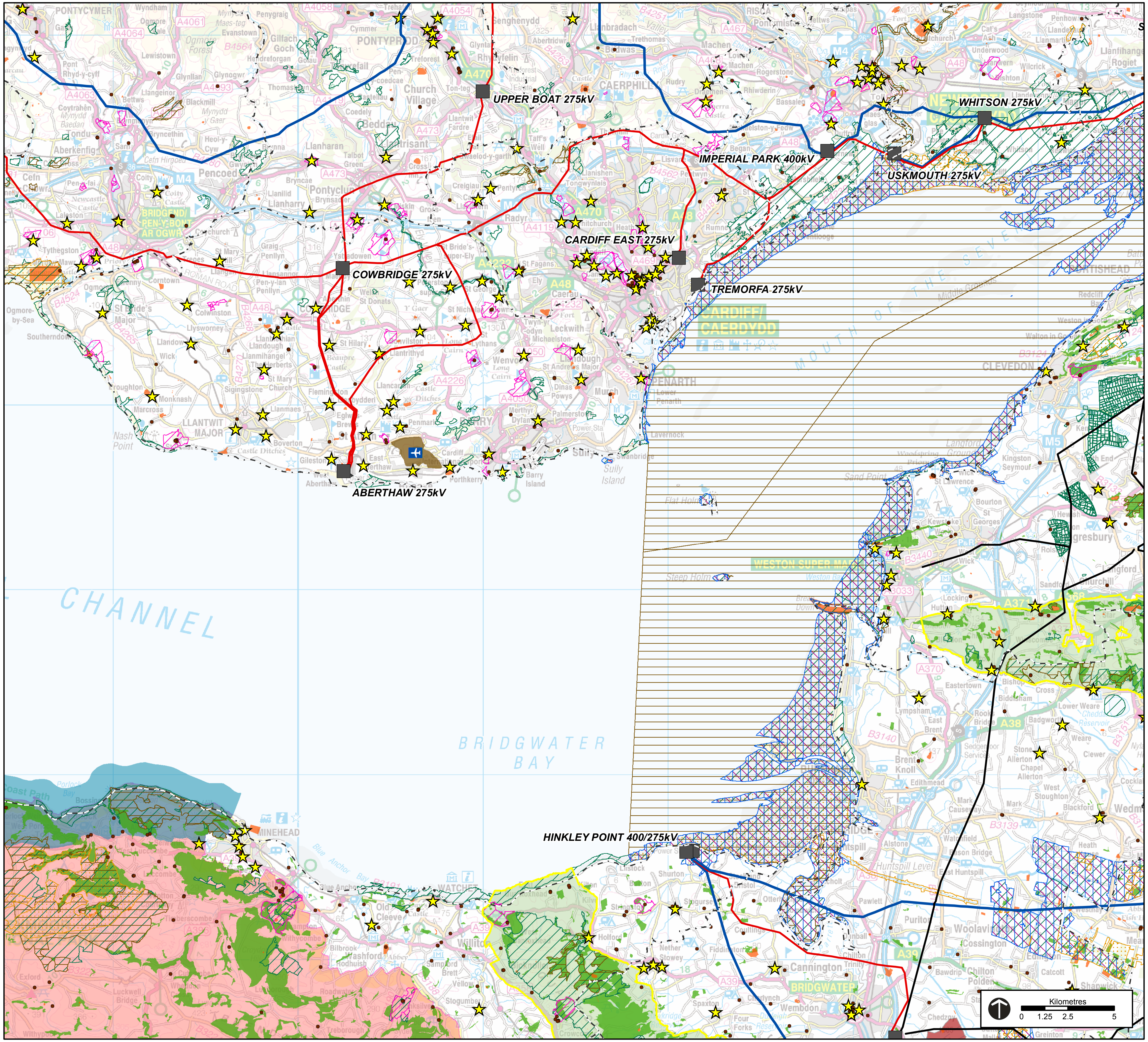
Project: Hinkley C Connection		
Title: Landform		
Drawing No: G1979.261		
Date: 30-03-11	TEP Ref No: G1979.261	
Drawn: CB	Checked: CC	Approved: CC



Key

Existing Infrastructure

- Existing Substation
- Existing 400kV Overhead Line
- Existing 275kV Overhead Line
- Existing 132kV Overhead Line
- Administrative Boundary

Environmental Constraints

- National Park
- Area of Outstanding Natural Beauty
- Ramsar Site
- Special Protection Area
- Special Area of Conservation
- Site of Special Scientific Interest
- Site of Special Scientific Interest (Ditches & Rhynes)
- National Nature Reserve
- Scheduled Monument
- Registered/Historic Parks and Garden
- Registered Battlefield
- Heritage Coast
- Historic Building (Listed I, II*)
- Conservation Area
- Woodland
- Airport/Airfield

NOTE 1:
Grade II listed buildings are not illustrated but have been considered in the appraisal

NOTE 2:
The following environmental constraints do not occur:
- World Heritage Sites
- Protected Wrecks

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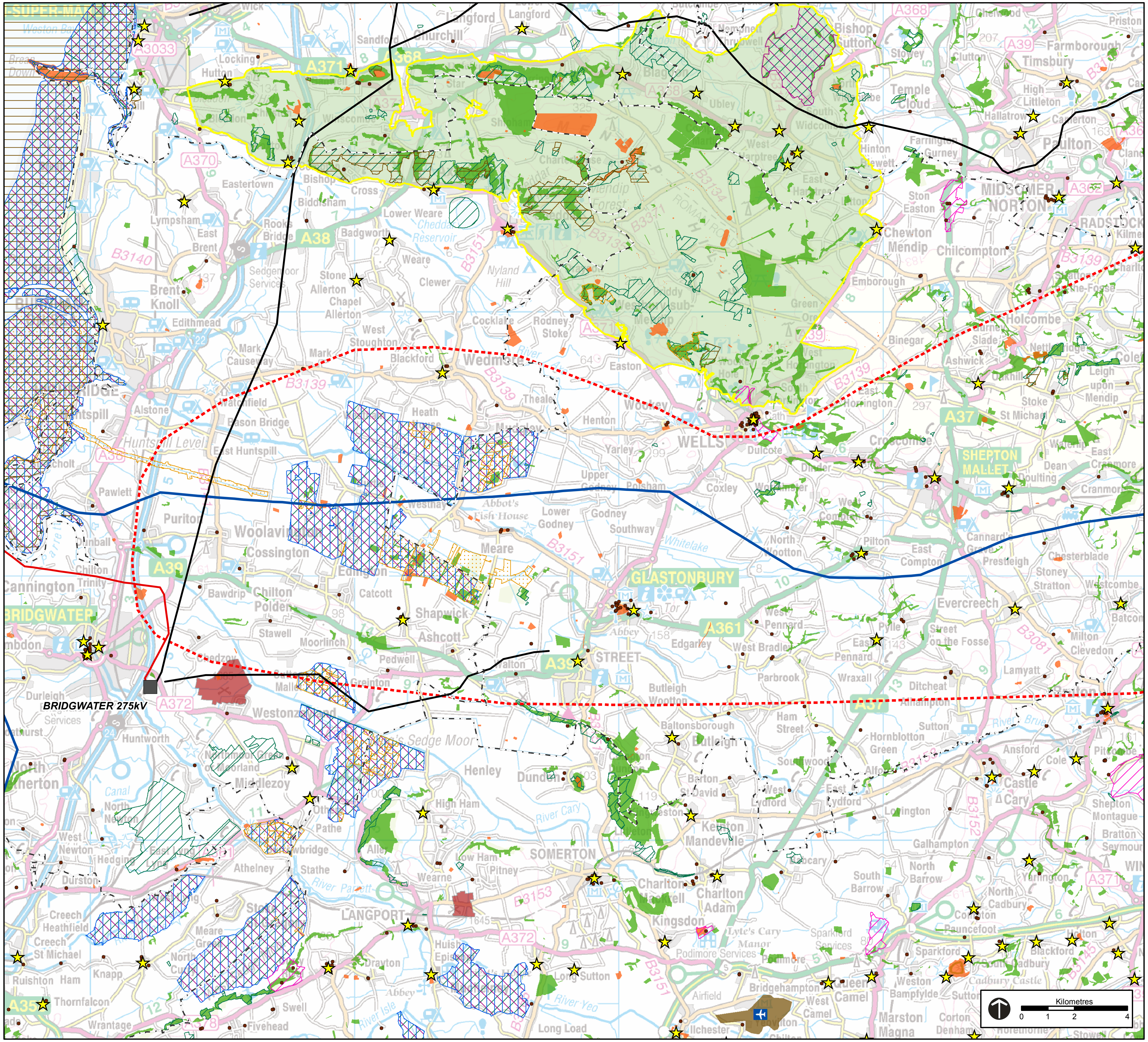
Project:	Hinkley C Connection
Title:	Hinkley to Aberthaw - Environment Constraints
Drawing No:	G1979.224
Date: 23-03-11	TEP Ref No: G1979.224

Drawn:	Checked:	Approved:
CB	TS	CC



Key

Existing Infrastructure
- Existing Substation
- Existing 400kV Overhead Line
- Existing 275kV Overhead Line
- Existing 132kV Overhead Line
- Administrative Boundary
- Study Area

Environmental Constraints
- Area of Outstanding Natural Beauty
- Ramsar Site
- Special Protection Area
- Special Area of Conservation
- Site of Special Scientific Interest
- National Nature Reserve
- Scheduled Monument
- Registered/Historic Parks and Garden
- Registered Battlefield
- Historic Building (Listed I, II*)
- Conservation Area
- Woodland
- Airport/Airfield

NOTE 1:
Grade II listed buildings are not illustrated but have been considered in the appraisal

NOTE 2:
The following environmental constraints do not occur:
- World Heritage Site
- National Park
- Heritage Coasts
- Protected Wrecks

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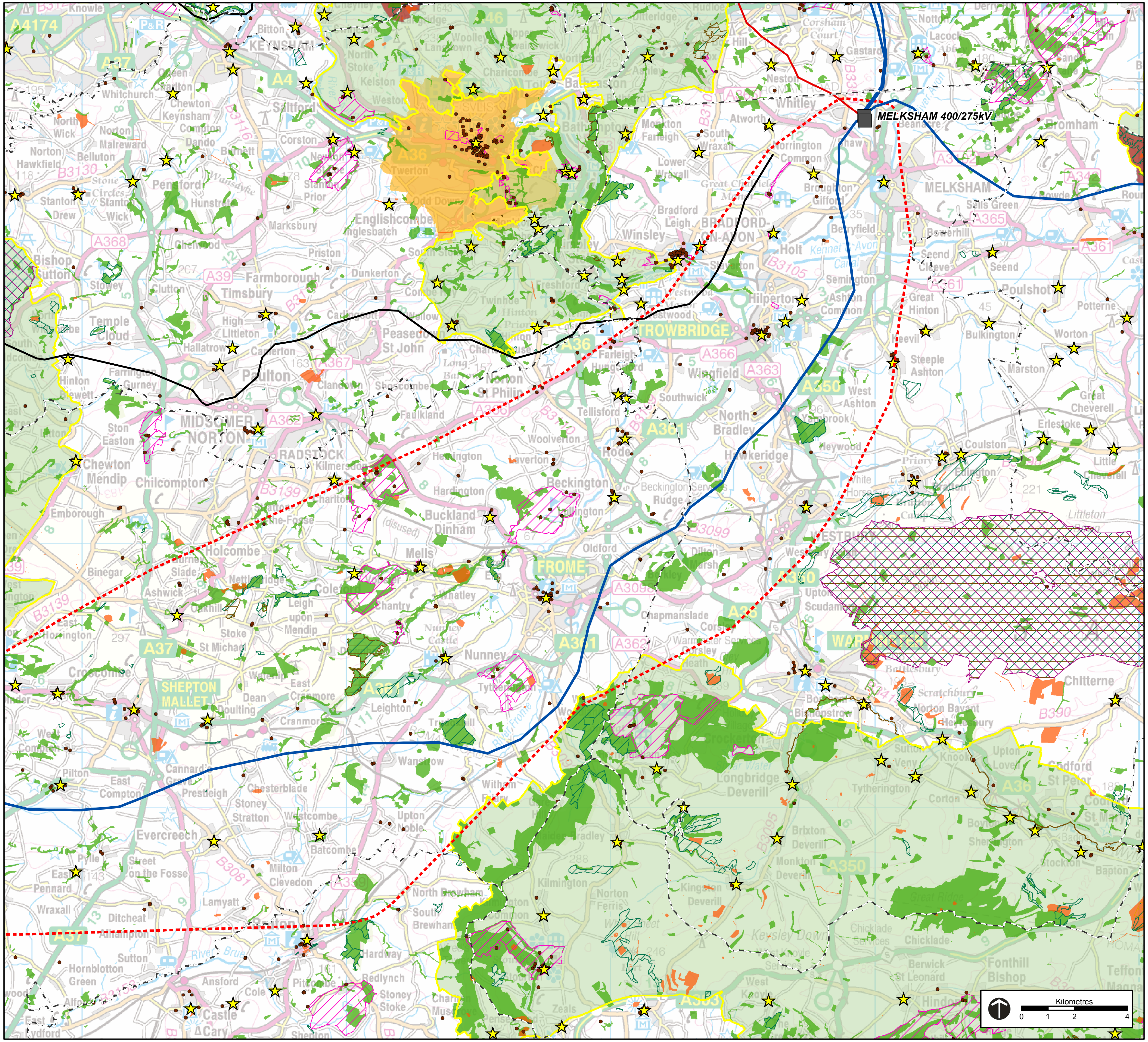
Project:	Hinkley C Connection
Title:	Bridgwater to Melksham (Part 1)- Environment Constraints
Drawing No:	G1979.228
Date: 23-03-11	TEP Ref No: G1979.228

Drawn:	Checked:	Approved:
CB	TS	CC



Key

Existing Infrastructure

- Existing Substation
- Existing 400kV Overhead Line
- Existing 132kV Overhead Line
- Administrative Boundary
- Study Area

Environmental Constraints

- World Heritage Site
- Area of Outstanding Natural Beauty
- Ramsar Site
- Special Protection Area
- Special Area of Conservation
- Site of Special Scientific Interest
- National Nature Reserve
- Scheduled Monument
- Registered/Historic Parks and Garden
- Registered Battlefield
- Historic Building (Listed I, II*)
- Conservation Area
- Woodland

NOTE 1:
Grade II listed buildings are not illustrated but have been considered in the appraisal

NOTE 2:
The following environmental constraints do not occur:
- National Park
- Heritage Coasts
- Protected Wrecks
- Airport/Airfield

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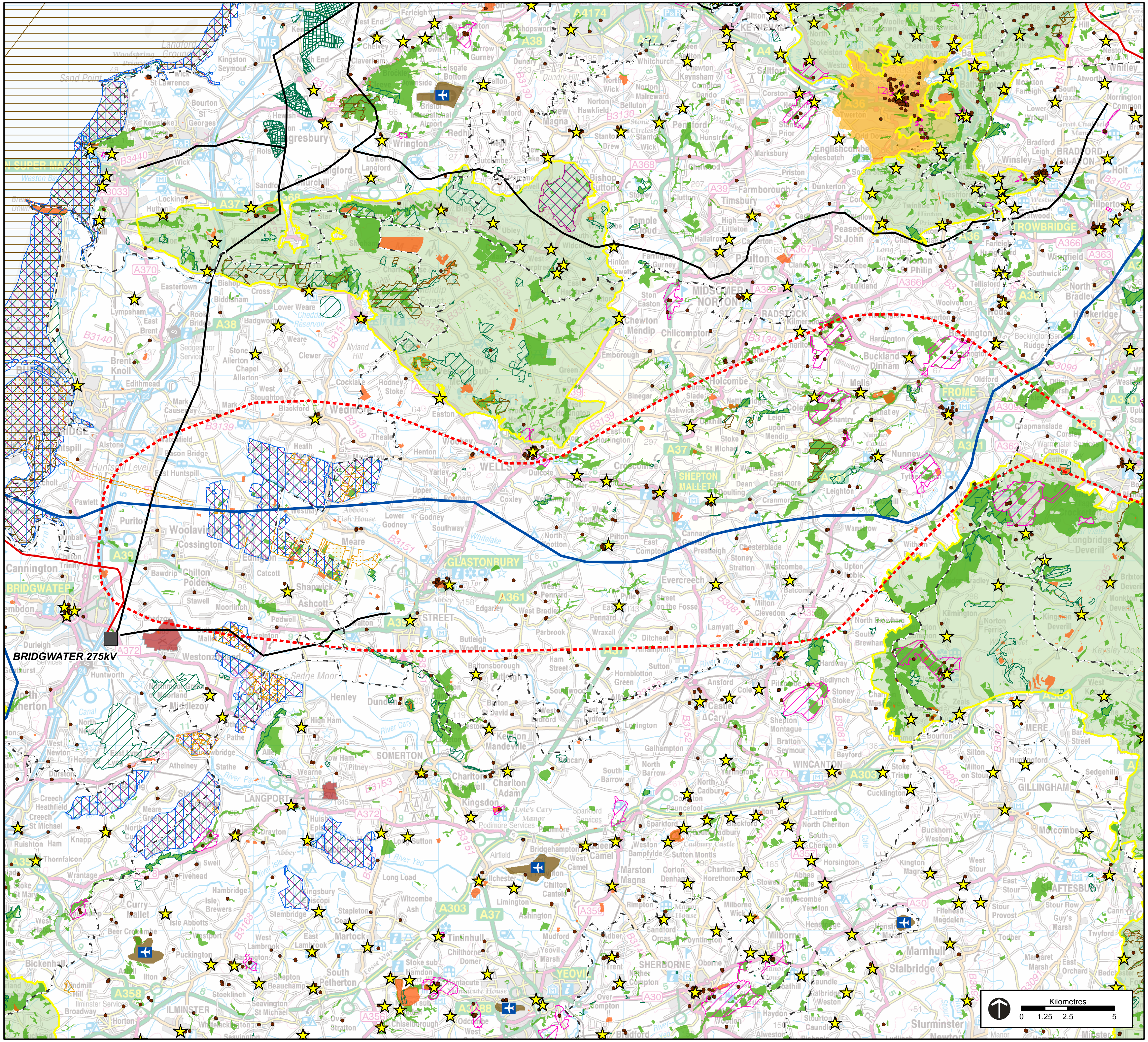
Project:	Hinkley C Connection
Title:	Bridgwater to Melksham (Part 2) - Environment Constraints
Drawing No:	G1979.229
Date: 23-03-11	TEP Ref No: G1979.229

Drawn:	Checked:	Approved:
CB	TS	CC



Key

Existing Infrastructure

- Existing Substation
- Existing 400kV Overhead Line
- Existing 275kV Overhead Line
- Existing 132kV Overhead Line
- Administrative Boundary
- Study Area

Environmental Constraints

- World Heritage Site
- Area of Outstanding Natural Beauty
- Ramsar Site
- Special Protection Area
- Special Area of Conservation
- Site of Special Scientific Interest
- Site of Special Scientific Interest (Ditches & Rhynes)
- National Nature Reserve
- Scheduled Monument
- Registered/Historic Parks and Garden
- Registered Battlefield
- Historic Building (Listed I, II*)
- Conservation Area
- Woodland
- Airport/Airfield

NOTE 1:

Grade II listed buildings are not illustrated but have been considered in the appraisal

NOTE 2:

The following environmental constraints do not occur:
- National Park
- Heritage Coasts
- Protected Wrecks

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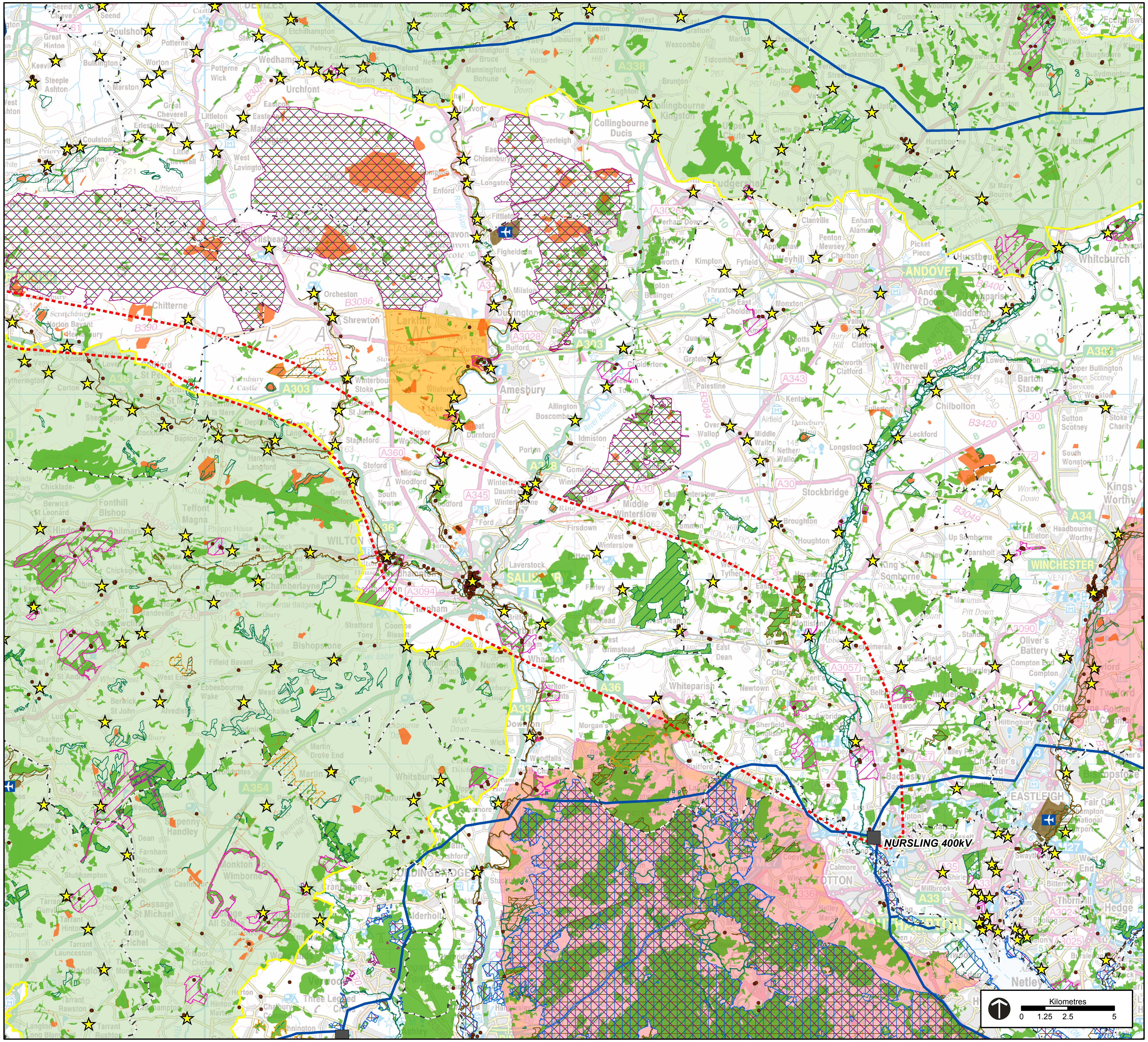
Project:	Hinkley C Connection
Title:	Bridgwater to Nursling (Part 1) - Environment Constraints
Drawing No:	G1979.225
Date: 23-03-11	TEP Ref No: G1979.225

Drawn:	Checked:	Approved:
CB	TS	CC



Key

Existing Infrastructure

- Existing Substation
- Existing 400kV Overhead Line
- Existing 132kV Overhead Line
- Administrative Boundary
- Study Area

Environmental Constraints

- World Heritage Site
- National Park
- Area of Outstanding Natural Beauty
- Ramsar Site
- Special Protection Area
- Special Area of Conservation
- Site of Special Scientific Interest
- National Nature Reserve
- Scheduled Monument
- Registered/Historic Parks and Garden
- Registered Battlefield
- Historic Building (Listed I, II*)
- Conservation Area
- Woodland
- Airport/Airfield

NOTE 1:
Grade II listed buildings are not illustrated but have been considered in the appraisal

NOTE 2:
The following environmental constraints do not occur:
- Heritage Coasts
- Protected Wrecks

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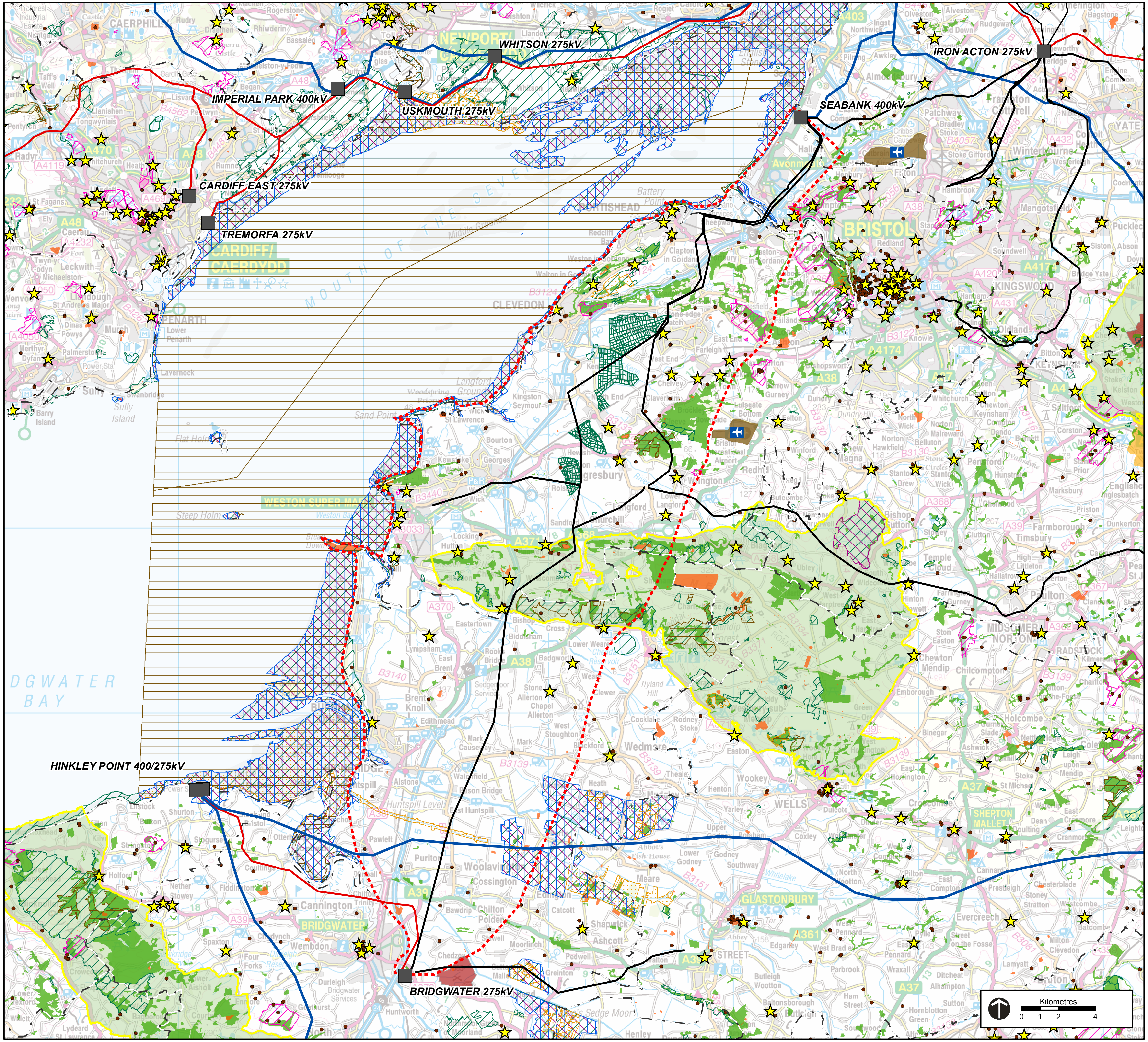
Project:	Hinkley C Connection
Title:	Bridgwater to Nursling (Part 2)- Environment Constraints
Drawing No:	G1979.226
Date: 23-03-11	TEP Ref No: G1979.226

Drawn:	Checked:	Approved:
CB	TS	CC



Key

Existing Infrastructure

- Existing Substation
- Existing 400kV Overhead Line
- Existing 275kV Overhead Line
- Existing 132kV Overhead Line
- Administrative Boundary
- Study Area

Environmental Constraints

- World Heritage Site
- Area of Outstanding Natural Beauty
- Ramsar Site
- Special Protection Areas
- Special Area of Conservation
- Site of Special Scientific Interest
- Site of Special Scientific Interest (Ditches & Rhynes)
- National Nature Reserves
- Scheduled Monument
- Registered Parks and Gardens
- Registered Battlefields
- Historic Buildings (Listed I, II*)
- Conservation Areas
- Woodland
- Airport/Airfield

NOTE 1:
Grade II listed buildings are not illustrated but have been considered in the appraisal

NOTE 2:
The following environmental constraints do not occur:
- National Parks
- Heritage Coasts
- Protected Wrecks

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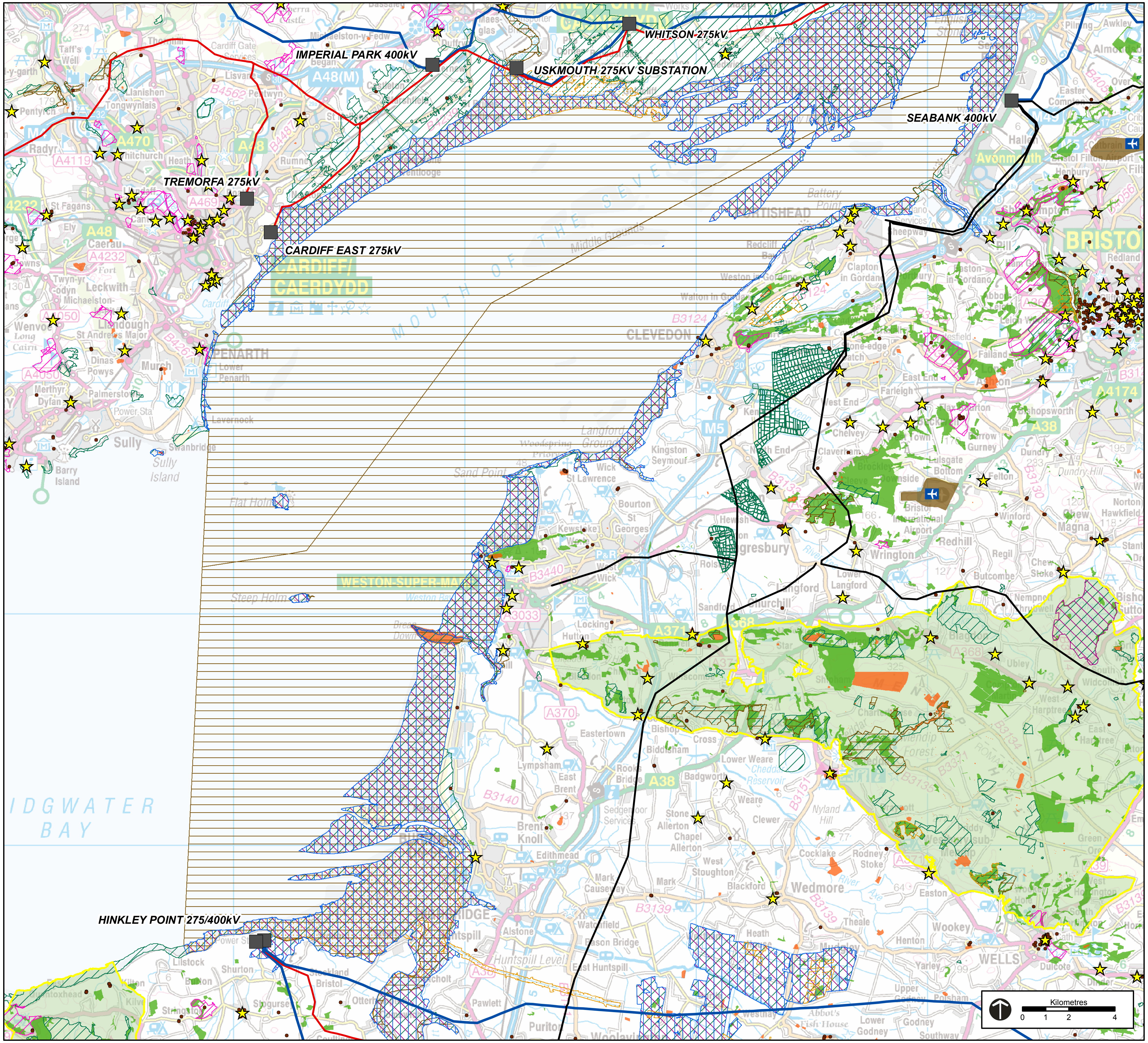
Project:	Hinkley C Connection
Title:	Bridgwater to Seabank - Environmental Constraints
Drawing No:	G1979.255
Date: 23-03-11	TEP Ref No: G1979.255

Drawn:	Checked:	Approved:
CB	CC	CC



Key

Existing Infrastructure

- Existing Substation
- Existing 400kV Overhead Line
- Existing 275kV Overhead Line
- Existing 132kV Overhead Line
- Administrative Boundary

Environmental Constraints

- Area of Outstanding Natural Beauty
- Ramsar Site
- Special Protection Areas
- Special Area of Conservation
- Site of Special Scientific Interest
- Site of Special Scientific Interest (Ditches & Rhynes)
- National Nature Reserves
- Scheduled Monument
- Registered Parks and Gardens
- Registered Battlefields
- Historic Buildings (Listed I, II*)
- Conservation Areas
- Woodland
- Airport/Airfield

NOTE 1:
Grade II listed buildings are not illustrated but have been considered in the appraisal

NOTE 2:
The following environmental constraints do not occur:
- World Heritage Sites
- National Parks
- Heritage Coasts
- Protected Wrecks

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Project:	Hinkley C Connection
Title:	Hinkley to Seabank - Environmental Constraints
Drawing No:	G1979.254
Date: 23-03-11	TEP Ref No: G1979.254

Drawn:	Checked:	Approved:
CB	CC	CC

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