Onshore Converter Station

Detailed Design Report

DCO Requirement 12 (1), (2), (3), (4), (6) and (7)

(Applicable to Work No. 67)

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Description of Revisions			
Rev	**Page**	**Section**	**Description**
1	All	All	New Document
2	All	All	Amended following stakeholder comments (MSDC, 13/05/21 and SCC,18/05/21) and input of design information from Converter Station Principal Contractor
3	5 9 10 12 13	1.1 4 5.2.1 5.2.4 5.3	No comments received from stakeholders – document finalised on basis of Final Draft

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1. INTRODUCTION AND SCOPE

1.1. Project Overview

1. East Anglia Three Limited (EATL) was awarded a Development Consent Order (DCO) by the Secretary of State, Department of Business, Energy & Industrial Strategy (DBEIS) on 7 August 2017 for the East Anglia THREE Offshore Windfarm (EA THREE). The DCO granted consent for the development of a 1200MW offshore windfarm and associated infrastructure and is live until 28 August 2022. The DCO has now been subject to three non-material variations:

- In March 2019 EATL submitted a non-material change application to DBEIS to amend the consent to increase the maximum generating capacity from 1,200MW to 1,400MW and to limit the maximum number of gravity base foundations to 100. In June 2019 DBEIS authorised the proposed change application and issued an Amendments Order.
- In July 2020 EATL submitted a second non-material change application to DBEIS to amend the parameters of its offshore substations (reducing the number of these to one) and wind turbines (a decrease in the number of turbines and an increase in their hub height and rotor radius). On 15 April 2021 DBEIS authorised this proposed change application and issued an Amendments Order.
- In August 2021 EATL submitted a third non-material change application to DBEIS to amend the consent to remove the maximum generating capacity of 1,400MW and to amend the parameters of its wind turbines (a decrease in the number of turbines and an increase in their hub height and rotor radius). The application is currently in the consultation phase.

2. The onshore construction works associated with EA THREE will have a capacity of 1400MW and transmission connection of 1320MW. The construction works will be spread across a 37km corridor between the Suffolk coast at Bawdsey and the East Anglia THREE converter station at Bramford, passing the northern side of Ipswich. As a result of the strategic approach taken, the cables will be pulled through pre-installed ducts laid during the onshore works for East Anglia ONE Offshore Windfarm (EA ONE), thereby substantially reducing the impacts of connecting to the National Grid (NG) at the same location. The infrastructure to be installed for EA THREE, therefore, comprises:

- The landfall site with one associated transition bay location with two transition bays containing the connection between the offshore and onshore cables;
- Two onshore electrical cables (single core);
- Up to 62 jointing bay locations each with up to two jointing bays;
- One onshore converter station, adjacent to the EA ONE Substation;
- Three cables to link the converter station to the National Grid Bramford Substation;
- Up to three onshore fibre optic cables; and
- Landscaping and tree planting around the onshore converter station location.

3. Since the granting of the DCO, the decision has been made that the electrical connection for EA THREE will comprise a high voltage direct current (HVDC) cable rather than a high voltage alternating current cable and, therefore, the type of substation that will be required is a HVDC converter station. The substation will be referred to here as a 'converter station' and this amended terminology has been agreed with the relevant authorities on 15 October 2020. It has also been determined that only one converter station will be constructed rather than two and that the converter station will be installed in a single construction phase.

1.2. Purpose and Scope

4. This document sets out the details for the design of the EA THREE Converter Station (Converter Station) (Work No 67) located to the north of the existing NG substation and adjacent to the EA ONE Substation (Figure 1 Site Context Plan). This document explains how the design for the Converter Station has been developed so that it is sensitive to its location and minimises its potential visual impact as far as practical. This document has been produced to discharge DCO Requirement 12 part (2) which states:

> ***12***.- *(1) The total number of buildings housing the principal electrical equipment for an onshore substation comprised in Work No.67 must not exceed two.*
>
> *(2) Construction works for the buildings referred to in paragraph (1) above must not commence until details of the layout, scale and external appearance of the same have been submitted to and approved by the relevant planning authority. The onshore substations must be carried out in accordance with the approved details.*

5. In addition, Parts (3) to (7) are of note as follows:

> *(3) Any details provided by the undertaker pursuant to paragraph (2) must accord with the design and access statement and be within the Order limits.*
>
> *(4) Buildings comprised in Work No. 67 must not exceed a height of 25 metres above existing ground level and external electrical equipment comprised in Work No. 67 must not exceed a height of 15 metres above existing ground level.*
>
> *(5) For the purposes of this requirement 'existing ground level' means 54 metres above ordnance datum.*
>
> *(6) The total footprint of the buildings housing the principal electrical equipment for an onshore substation comprised in Work No. 67 must not exceed 116 metres in length and 85 metres in width.*
>
> *(7) The fenced compound area (excluding its accesses) for the onshore substations comprised in Work No. 67 must not exceed 3.04ha.*

6. In the case of Requirement 12, it is Mid Suffolk District Council (MSDC) who is the relevant planning authority. However, EATL has acknowledged from an early stage that Suffolk Council (SCC) and Babergh District Council (BDC) are important consultees in the process.

7. The purpose of this document is to detail the process that has been followed and demonstrate that consideration has been given to the design of the Converter Station in accordance with the Design and Access Statement (Document 8.3 of the DCO submission) as required by DCO Requirement 12.

8. There are other elements of the onshore construction works of EA THREE that are linked very closely to the Converter Station design, which are the subject of DCO requirements in their own right. These are considered in detail in the following independent documents:

- Converter Station Landscaping Management Scheme (EA3-OND-CNS-REP-IBR-000002));
- Converter Station Fencing and Enclosures Plan (EA3-GRD-CON-PLN-IBR-000106);
- Converter Station Ecological Management Plan (EA3-OND-CNS-REP-IBR-000004)
- Converter Station Operational Lighting Scheme (EA3-OND-CNS-REP-IBR-000007)
- Converter Station Operational Noise Insulation Scheme (EA3-OND-CNS-REP-IBR-000008); and
- Converter Station Surface Water and Drainage Management Plan (EA3-GRD-CON-PLN-IBR-000107).

9. The measures contained herein will form part of the contractual agreement between EATL and its Principal Contractor and the implementation and compliance will be monitored by the Construction Management Team. These measures will only be revised with the agreement of MSDC and SCC.

1.3. Site location and Context

10. The existing landscape context around the Converter Station site is illustrated in Figure 1. The newly built EA ONE Substation and the existing NG substation are key features in the immediate landscape. In general terms, the wider landscape around the Converter Station site is predominantly farmed agricultural land with the land use pattern relating to the topography. Large open fields feature extensively around the site, which are mainly used for arable crops.

11. The Converter Station will be situated within the Ancient Plateau Claylands Landscape Character Type[1]. This is described in the Suffolk Landscape Character Assessment as:

- Flat or gently rolling arable landscape of clay soils dissected by small river valleys.
- Field pattern of ancient enclosure – random patterns in the south but often co-axial in the north. Small patches of straight-edged fields associated with the late enclosure of woods and greens.
- Dispersed settlement pattern of loosely clustered villages, hamlets and isolated farmsteads of medieval origin.
- Villages often associated with medieval greens or tyes.
- Farmstead buildings are predominantly timber-framed, the houses colour-washed and the barns blackened with tar.

[1] https://suffolklandscape.org.uk/

- Roofs are frequently tiled, though thatched houses can be locally significant.
- Scattered ancient woodland parcels containing a mix of oak, lime, cherry, hazel, hornbeam, ash and holly.
- Hedges of hawthorn and elm with oak, ash and field maple as hedgerow trees.
- Substantial open areas created for WWII airfields and by 20th century agricultural changes.
- Network of winding lanes and paths often associated with hedges create visual intimacy.

12. Many of the field boundaries are a mixture of intact areas of hedgerow with mature trees, areas with some gaps or occasional trees, and large sections with no hedgerow. There are large areas of mature vegetation surrounding the site – blocks of ancient and semi-natural woodland, tree belts and hedgerows, which provide good natural screening of the site. Communication links include the busy A14 to the east, the rail line through the Gipping valley and a network of minor roads, tracks and footpaths in the west of the area. Pylon lines form linear man-made features in the landscape and cross through the surrounding countryside, converging on the existing NG substation at Bramford, which, along with the EA ONE Substation are features in the local landscape. The presence of these substations will provide some screening to the south and west of the EA THREE Converter Station and, in association with the pylons, establish energy infrastructure as a key feature in the landscape character.

13. Mitigation planting as part of East Anglia ONE landscaping scheme has been placed to the south-west, immediate north and east, with further mitigation planting proposed as part of the project. The potential impact of ash die back to the screening effect of existing woodland for the East Anglia THREE project, and the management strategies that aim to mitigate these effects, are set out in the Ecological Management Plan (EA3-OND-CNS-REP-IBR-000004). The Landscape management Plan details impacts from ash die back and thus the species mix to be used to create resilience.

14. The main settlement pattern in the area is of isolated farmsteads and small villages which are scattered throughout the landscape and often situated within the valleys. The local area is interspersed with farm buildings, barns and residential houses. To the east, lies the western edge of Ipswich which is visible in long views from elevated positions across the area. The settlements of Sproughton and Bramford extend the urban influence into the area. Views are extensive, particularly on higher ground and frequently open. Small woodland blocks and sections of hedgerow are seen in many views and can limit views in lower lying areas. Overhead transmission lines and pylons are seen on the skyline in most views within the area. Views into the site from immediate surrounding areas are generally restricted by existing vegetation. The plateau landform does provide a number of open distant views, but the network of winding lanes and tall hedges means that other areas can be much more intimate.

2. ABBREVIATIONS

BDC	Babergh District Council
CCS	Consolidated Construction Site
DBEIS	Department of Business, Energy and Industrial Strategy
DC	Direct Current
DCO	Development Consent Order
EA ONE	East Anglia ONE Offshore Windfarm
EA THREE	East Anglia THREE Offshore Windfarm
EATL	East Anglia THREE Limited
ECoW	Ecological Clerk of Works
ES	Environmental Statement
HVDC	High Voltage Direct Current
MSDC	Mid Suffolk District Council
MW	Megawatt
NG	National Grid
SCC	Suffolk County Council

3. EAST ANGLIA ONE OFFSHORE WINDFARM DESIGN AND DELIVERY PROCESS

15. The design process for the East Anglia ONE substation provides the context and framework for the design of the Convertor Station. The following text sets out the design process for East Anglia ONE to set the context of the East Anglia THREE design. It was always expected that the framework which was established as part of East Anglia ONE would continue to influence the detailed design process for East Anglia THREE.

3.1. Design Principles Adopted – East Anglia ONE

16. The design and delivery process adopted for the adjacent East Anglia ONE onshore substation comprised:

- Engagement with local communities and stakeholders during the pre-application stage of its DCO application regarding the onshore substation design and landscape mitigation;
- Submission of an Outline Substation Design Principles Statement with the DCO application, which set out the considerations and process for finalising the detailed design and which achieved design improvements and reductions in the environmental impact of the onshore substation;
- Engagement with stakeholders post consent, as part of the detailed design process; and
- Commissioning of the Design Council to undertake an independent design review of the onshore substation.

17. As part of the pre-construction phase for East Anglia ONE, a Landscape Masterplan (Ref EA1-GRD-DG-OPEN-MPLAN-01)) was developed to illustrate the general principles and coordinated phased nature of the development of the East Anglia Bramford Connection Developments. This process was used to establish a successful long-term approach for the area and for this type of infrastructure development. At the time it was envisaged that there would be three East Anglia substations in the local area. The Landscape Masterplan was developed to complement the East Anglia ONE Outline Substation Design Principles Statement which provided greater detail on the design of the substation compound itself.

18. The East Anglia ONE Outline Substation Design Principles Statement allowed the East Anglia ONE design teams to further develop and refine the design of the onshore substation based on stakeholder's feedback; the Design Council independent design review; and the design team's challenge and refinement of the design envelope through the procurement and detailed design stage to reduce the environmental impact of the project.

3.2. Design Council Feedback

19. The Design Council's response to the EA ONE initial design brief submission recognised: "*the project team's commitment to good design, the extensive research and analysis undertaken of the existing environment and careful consideration given to the site's natural assets are an excellent starting point for this project*".

20. The Design Council's feedback comprised of three core themes:

- Principles: for instance, a key recommendation was to develop a strategic masterplan to guide the evolution of the landscape in a holistic way and inform the development of an appropriate architectural response. The Applicants have adopted this approach for the Projects, through the Outline Landscape Management Plan presented in the Outline Landscape and Ecological Management Strategy (REP3-030), which considers the landscape mitigation necessary for the East Anglia ONE, East Anglia THREE and also the East Anglia 'Future Projects'.
- Landscape: for instance, use of a varied woodland mix; use of mesh fencing; reuse of excavated material to form berms; establish early planting.
- Substation building and surrounding equipment: for instance, development of functional, simple, crisply detailed substation building but which responds successfully to the surrounding context.

21. These are all considered to be relevant to the development of the Convertor Station design.

3.3. Design Iteration

22. The engagement process and Design Council independent review resulted in improvements to the EA ONE onshore substation design, which were incorporated into the procurement and detailed design stages of the project which delivered:

- A maximum 'as built' building height of 68m AOD (12m), reduced from 75m AOD (19m) as specified in the DCO; and
- A maximum 'as built' external equipment height of 68m AOD (12m), reduced from 69m AOD (13m) as specified in the DCO.

4. DESIGN PRINCIPLES AND PARAMETERS – EAST ANGLIA THREE

23. DCO Requirement 12 part (2) identifies that details of the layout, scale and external appearance of Work No 67 should be submitted to the relevant planning authority for written approval. Parts (2) and (3) of the requirement provide that such details must accord with the approved details, the Design and Access Statement (EATL, 2015) and be within the Order limits. Parts (4) to (7) of DCO Requirement 12 set the parameters for the key elements of the Converter Station.

24. The EA THREE Design and Access Statement notes that the key design principles in relation to the EA ONE Substation were agreed with Suffolk County Council and Mid Suffolk District Council and that these principles are equally applicable to the Converter Station as follows (*inter alia*):

(1) Engagement: with Parish Councils, local residents and relevant authorities (Mid Suffolk District Council (MSDC), Babergh District Council (BDC) and Suffolk County Council (SCC));

(2) Design: sensitive to place, with visual impacts minimised as far as possible by the use of appropriate design, building materials, shape, layout, coloration and finishes;

(3) Height: building and ancillary equipment will be kept to a minimum and the slab level will be set at the lowest practical level;

(4) Landscaping: to minimise the visual intrusion, and respond to local landscape character and biodiversity; considered in the building design and layout of ancillary structures;

(5) Embedded ecological mitigation and enhancement: with particular attention to lighting, large areas of glass and baffling of noise sources;

(6) Sustainable Drainage (SuDS) strategy: to be developed in accordance with DCO Requirement 18 relating to a Surface Water and Drainage Management Plan;

(7) Engagement: Through development of the final design and landscaping proposals provide opportunity to engage with local communities who will be directly affected by the Converter Station; and

(8) Design Review: The design should be subject to design review, in consultation with the relevant local authorities.

25. The key parameters set by Requirement 12 are as follows:

- The total number of buildings housing the principal electrical equipment must not exceed two;
- No building shall exceed 25m above existing ground level;
- External electrical equipment shall not exceed 15m above existing ground level;
- The ‘existing ground level’ means 54m above ordnance datum;
- The total footprint of the buildings housing the Converter Station must not exceed 116m in length and 85m in width; and
- The fenced compound (excluding its accesses) must not exceed 3.04ha.

26. This document considers each of the principles in turn and describes how each principle has been addressed.

5. MATTERS FOR APPROVAL

27. The following section presents the details of the design of the onshore Converter Station and how each of the principles and parameters identified in Section 4 have been addressed.

5.1. Engagement

28. EATL has undertaken consultation with officers from BDC, MSDC and SCC in respect of the Converter Station since the DCO was published. A number of working group meetings have been held with officers of MSDC, BDC and SCC specifically to discuss the onshore Converter Station. Converter Station Working Group meetings have been held on 15 October 2020, 10 March 2021, 12 April 2021, 10 September 2021, 25 November 2021 and there was also a meeting on the 9 December 2021. During the course of these meetings the approach to the design of the Converter Station was discussed and SCC and MSDC updated in respect of the design progression and the development of the overall master plan. The involvement of the Design Council was discussed and it was agreed

that such consultation was not necessary for the EA THREE Converter Station, as the EA ONE Substation design as well as the design concept for the EA THREE Converter Station has already been considered and approved by them.

5.2. Design

29. EATL is committed to good design and appointed Optimised Environments (OPEN), a landscape design and architectural practice, to consider the existing environment and develop a design approach for the Converter Station that builds on the principles set out in Design and Access Statement (see Section 4). The design approach ensures that the Converter Station is sensitive to place, with visual impacts minimised as far as practical by the use of appropriate design, building materials, shape, layout, coloration and finishes, whilst considering the functional operation of a substation and its Health and Safety obligations, Electrical Safety Regulations and electrical design specifications. The design approach for the Converter Station buildings is described in this section, together with details of the layout, scale and external appearance of the Converter Station.

5.2.1. Layout and Scale

30. There are a number of important technical constraints which are inherent to the design of the Converter Station, particularly in respect to the location, form and appearance of the key electrical equipment. The layout is determined by the functional demands of the Converter Station, practical restrictions and considerations, which results in a specific electrical layout model (presented in Figures 4 and 5 and Appendix 2). The design criteria for the Converter Station layout are relatively rigid, in order to comply with Health and Safety obligations, Electrical Safety Regulations and electrical design specifications. However, around these constraints other elements including landscape design, have been used to ensure the Converter Station responds as far as practical to a sense of place and visual impact.

31. Installations and equipment must be capable of withstanding electrical, mechanical, climatic and environmental influences anticipated on site. The design, therefore, takes into account:

- The purpose of the installation;
- The user's requirements such as power quality, reliability, availability, and ability of the electrical network to withstand the effects of transient conditions such as short power outages and re-energisation of the installation;
- The safety of the operators and the public;
- The environmental influence; and
- The maintenance.

32. Plant and equipment must satisfy their specified functional and performance requirements and must also operate safely and without any degradation in performance for the appropriate range of primary voltages. The plant and equipment has been designed so that system and its components will be operated and maintained in accordance with the relevant statutory requirements, including:

- Converter Station electrical clearances - minimum clearances from Phase to Earth and Phase to Phase;
- Converter Station safety clearances - safety distance, design clearance for safety (vertical and horizontal) and insulation height for pedestrian access (oversailing conductors shall be eliminated from the design as far as is reasonably practicable);
- Clearance to roadways;
- Maximum equipment heights;
- Insulation levels;
- Earthing system; and
- Electromagnetic compatibility.

33. Further details on the electrical and safety clearance are presented in Appendix 1. The electrical layout for the Converter Station is presented in Figures 4 and 5 and Appendix 2, which shows the layout of the main electrical elements of Converter Station and identifies the dimensions of the compound. In accordance with the DCO Requirement 12 (1), (6) and (7), there will be two buildings that house the main electrical equipment, the Converter Building and the Control Building, which are joined together over a shared section of elevation and have the following dimensions respectively: 74.65m long x 46.70m wide x 20.77m high and 41.10m long x 22.80m wide x 6.64m high. In addition, there is a further Storage Building which is 30.30m long x 16.80m wide x 8.3m high. The buildings each have a finished floor level of 54.75m Above Ordnance Datum (AOD). The Converter Station compound is 150m by 190m (ie 2.85ha) and the finished ground level is 54.55m AOD.

5.2.2. Fencing

34. A perimeter security fence shall be installed around the Converter Station compound, as described in the Fencing and Enclosures Plan (EA3-GRD-CON-PLN-IBR-000106). The fencing must comply with "The Electricity safety, Quality and Continuity Regulations 2002" as a minimum standard and relevant British Standards (e.g. BS 1722). The function of the perimeter security fence is to provide a deterrent, physical barrier and potential alarm against intruders, and must be robust enough to delay entry into the compound for persons who are unauthorised.

35. The perimeter fence around the Converter Station compound will consist of a 2.4m high fence, which is the minimum fence height required for safety and security purposes, which are paramount. The perimeter fencing system will be a mesh fence configuration Hi SEC Super 6 or similar solution. This solution provides a close mesh that is almost impossible to climb and very difficult to cut through with anything but power tools. The Hi Sec security system uses welded mesh to repel would-be intruders. There will be four rows of barbed wire on top of the 2.4m mesh fence (approximately 450mm height). The perimeter fence will be screened by earthworks to the north of the Converter Station as well as extensive woodland and hedgerow planting (Figures 14 and 15).

5.2.3. Converter Station Building Form

36. The detailed design process for the EA ONE Substation involved extensive engagement with the local planning authority (Mid Suffolk District Council (MSDC)), the Design Council and local communities (see Sections 5.1, 5.5 and 5.6 for details). Detailed work was undertaken to develop buildings that respond successfully to the surrounding context, speak a confident architectural language and respond to views of the local community. This is as set out in the East Anglia ONE Substation Detailed Design and the East Anglia Bramford Connection Developments Architectural Report (EA1-CON-F-IBR-010113), hereafter described as the Architectural Report. The principles of these documents are continued into the detailed design for East Anglia THREE.

37. The existing context for the EA THREE Converter Station includes the Bramford National Grid substation. It is a functional substation building with dark-grey steel vertical cladding. The local agricultural vernacular in the surrounding landscape has distinct style of wall treatments for barns, observed to be dark weatherboard cladding as stand-alone, or in combination with rendered or brick walls, together with contemporary barn buildings generally clad in metal. The EA ONE substation has now been built immediately to the west of the EA THREE Converter Station site and accords with the principles set out in the Architectural Report. Its dark base (and electrical infrastructure) and lighter upper facades are considered to sit comfortably against the backdrop of mature woodland, grassland and sky.

38. The Architectural Report illustrated the twin, large-scale converter halls that were anticipated for EA THREE on page 33 of the document (see Figure 2). However, the required built form for EA THREE has evolved from this to buildings of a smaller scale as set out in Section 5.2.1 (see Figure 6). Two of the buildings are also linked making their combined appearance more akin to the conceptual appearance of EA ONE shown on page 36 of the Architectural Report (see Figure 3).

39. During the detailed design stages, which have involved important technical input from Siemens, it became apparent that the apparently flat roof, shown in the Architectural Report as one of the design principles for the electrical infrastructure buildings at Bramford, is not a practical solution for housing the necessary electrical equipment for EA THREE. The reasons for this are that with a flat roof the gutter would be integrated in the roof construction and the downcomers would therefore at least have been partly inside the building which is not recommended for a building housing HV equipment.

40. As a result of this the large Converter Building is now proposed with a pitched roof. The pitch is shallow and is at an angle of 4.5 degrees, rising by 1.65m from the edge to the ridge of the roof. This change to the approach for the Converter Building was agreed with the MSDC (13/10/21).

41. The Control Building appears to have a flat roof. In-fact the roof is not flat but is at a slight angle, concealed behind low parapets in a similar manner to the Control Building of EA ONE. It shares an elevation with a short section of the Converter Building facade. This is in-keeping with the principles of the Architectural Report.

42. The Architectural Report did not set out the approach to the form for the smaller buildings. The Storage Building at EA THREE is akin in height and form to the Statcom Building of EA ONE, which has a slightly pitched roof. Therefore, a similar approach to form and roof line has been followed for the EA THREE Storage Building.

43. The following text sets out the proposed treatment for the Converter Station.

5.2.4. Building Materials and Colour

44. Consideration of a range of Converter Station cladding proposals and fundamental material options for the electrical infrastructure buildings was undertaken to inform the Architectural Report. Key factors assessed included cost effectiveness, functionality, sustainability and aesthetics. The relative advantages and disadvantages of material options for the Converter Station buildings are explored in full in the Architectural Report (EA1-CON-F-IBR-010113).

45. Kingspan Trapezoidal steel cladding has been selected as the cladding material for the Converter Station buildings, based on the form and articulation described above while having a series of significant technical advantages in terms of being a large, lightweight and composite panel, which provides safety benefits, short erection and installation programmes, reduced structural support requirements and minimises delivery vehicle movements.

46. In developing the architectural principles set out in the Architectural Report a colour comparison exercise was undertaken to inform the choice of colour for the Converter Station buildings. The optimum Kingspan colour solution for the Converter Station/ control building is considered to be a dark grey base element (e.g. Anthracite, RAL 7016) which will tend to recede visually rather than stand out, and a visually lighter/mid grey upper building element (e.g. Merlin Grey, RAL 180 40 05), which will tend to be less visible against sky or land (Figure 6). The form of the Converter Station/control building will be visually split into two distinct elements, with the articulation of these colours on different parts of the connected building parts. A darker grey (e.g. Anthracite) lower element will run the full length of the Converter Station/control building, with a mid-grey (e.g. Merlin Grey) upper element housing the taller Converter Building (Figure 6). This breaks the overall mass of the building down and creates a 'lower' horizontal emphasis to the built form.

47. Elevations, illustrative section drawings and photomontage visualisations showing the appearance of the Converter Station are shown in Figures 4, Figure 5, Figure 6, Figure 10 and Figure 11.

48. The colour proposed for the lower Storage Building is the darker grey (Anthracite) across its full height.

49. The shallow, pitched roofs of the Converter Station and the Storage Building will continue the colours of the walls they connect with so that there is no colour change apparent. The roof of the Storage Building will be the dark grey (Anthracite) colour. The roof of the Converter Station will be the lighter/mid grey (Merlin Grey) and this will lessen the degree to which the pitch on the roof of the Converter Station is noticeable, particularly at any distance.

5.3. Height and Key Parameters

50. The DCO Requirement 12 (4) to (7) sets the maximum dimensions with respect to the height and size of buildings, compound and other infrastructure within the Converter Station. A plan showing the height and dimensions and the different elements of the Converter Station is presented as Figure 3. Table 5-1 provides a summary of the height and dimensions of the Converter Station and how they are in accordance with the key parameters stated within the DCO.

Table 5-1 Converter Station Dimensions

DCO Requirement	Key Parameters	Converter Station Dimensions	
12 (4)	Buildings comprised in Work No. 67 must not exceed a height of 25m above existing ground level External electrical equipment comprised in Work No. 67 must not exceed a height of 15m above existing ground level	Maximum Height of Converter Building Maximum Height of Control Building Maximum height of outdoor electrical equipment	75.32m AOD 61.39m AOD 69.55m AOD
12 (6)	The total footprint of the buildings housing the principal electrical equipment for an onshore	Converter Building	74.65m length x 46.70m width

DCO Requirement	Key Parameters	Converter Station Dimensions	
	Converter Station comprised in Work No. 67 must not exceed 116m in length and 85m in width	Control Building	41.10m length and 22.80m width
12 (7)	The fenced compound (excluding its accesses) comprised in Work No 67 must not exceed 3.04ha	Converter Station Compound	157m by 186m ie 2.92ha
Note 12 (5) states that for the purposes of this requirement 'existing ground level' means 54m AOD.			

51. The Converter Station buildings have the following main features:

- Converter Building –74.65m x 46.70m, with the linked Control Building – 41.10m x 22.80m.
- The Converter Building has a maximum height of 20.77m to the apex of the roof, with the control building being lower with a maximum height of 6.64m (Figure 6 and Appendix 2).
- One Storage Building with a maximum height of 8.3m.

52. The finished ground level for the Converter Station compound has been set at 54.55m AOD. This is slightly higher than the 'existing ground level' within the Converter Station Compound site due to the balancing of cut and fill as part of earthworks calculation exercise. The key level in terms of the potential landscape and visual impact of the Converter Station is, however, not the ground level but the upper height of the buildings and other components. The tallest height AOD of the Converter Building is 75.32m whilst the maximum permitted height of buildings was 79m AOD. This equates to the proposed maximum building height being 3.68m than was permitted by DCO Requirement 12(4).

5.4. Areas of Glass

53. To minimise potential ecological impacts, the Converter Station buildings have been designed to avoid areas of glass as far as is practicable. The Control Building and Storage Building) will be structural steelwork, with concrete floors and roof and walls with profiled steel panels, all of them without exterior windows. The Converter Building will be of similar construction but will have four windows on the western façade (ie facing the EA ONE Substation building).

5.5. Engagement with Local Communities

54. The EA THREE Converter Station design has been based on the successful design principles and feedback from the Design Council and local community with regards to the EA ONE Substation, which resulted in a co-ordinated design which reflects local stakeholder's views where possible. The involvement of the local community is not, therefore, considered necessary with respect to the design of the EA THREE Converter Station, as their views on the EA ONE substation design approach have already been received and taken into consideration with respect to EA THREE Converter Station design.

5.6. Design Review

55. The eighth principle of the Design Principles (see Section 4) derived for EA ONE and taken forward for EA THREE relates to a review of the design of the Converter Station, in consultation with the relevant local authorities. If appropriate the outcome of this review process should form part of the procurement process.

56. As set out in Section 5.1, a number of meetings, attended by representatives of MSDC, BDC and SCC, have been held regarding the design of the converter station as it evolved. The design details were then formally presented to the EA THREE Steering Group, attended by MSDC, BDC and SCC on 16 March 2022. The local planning authorities have also been able to review the design of the converter station through their review of this document as interim draft and final draft versions.

6. REFERENCES

Bat Conservation Trust (BCT), ILP (2018), Guidance Note 08/18 Bats and artificial lighting in the UK, Bats and the Built Environment series, (BCT, ILP, 2018); and

BCT Interim Guidance: artificial lighting and wildlife (BCT, 2014)

East Anglia THREE Limited , November 2015, East Anglia THREE Design and Access Statement, Document Reference – 8.3, Revision History – A

APPENDIX 1 ELECTRICAL AND SAFETY CLEARANCE DETAILS

Plant and equipment shall satisfy their specified functional and performance requirements and shall also operate safely and without any degradation in performance for the appropriate range of primary voltages given in tables below.

System Voltages

Nominal System Voltage	400kV	320KV (DC)	34.5kV
Rated Voltage of Primary Equipment	420kV	245kV	36kV

Converter Station Electrical Clearances

Nominal System Voltage (kV)	BIL, SIL kVp	Basic Electrical Clearance (Phase to Earth) (m)	Phase to Phase Clearance (m)
34.5	170	0.5	0.5
320kV DC	1050	2.1	2.4
400	1425/1050-1575	2.8	3.6

Converter Station Safety Clearances

Nominal System Voltage (kV)	Safety Distance (m)	Design Clearance for Safety (vertical) Ds (m)	Design Clearance for Safety (horizontal) Ds (m)	Insulation Height (pedestrian access) (m)
34.5	0.8	3.2	2.3	2.4
320kV DC	2.4	4.8	3.9	2.4
400	3.1	5.5	4.6	2.4

Clearance to Roadways

Nominal System Voltage (kV)	Minimum Clearance to Roadways
34.5	6
320kV DC	10
400	5.0

APPENDIX 2 ELECTRICAL LAYOUT AND ELEVATIONS

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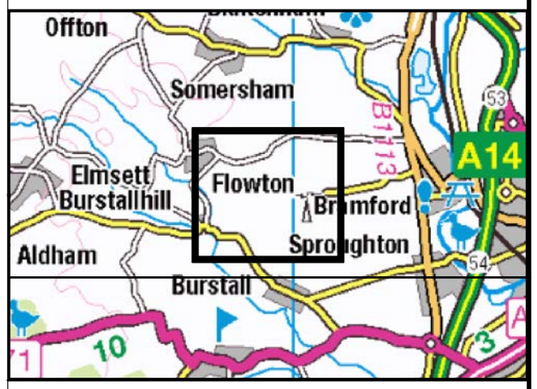
SCOTTISHPOWER RENEWABLES

LEGEND

- EA THREE DCO Boundary
- Substation Compound

Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

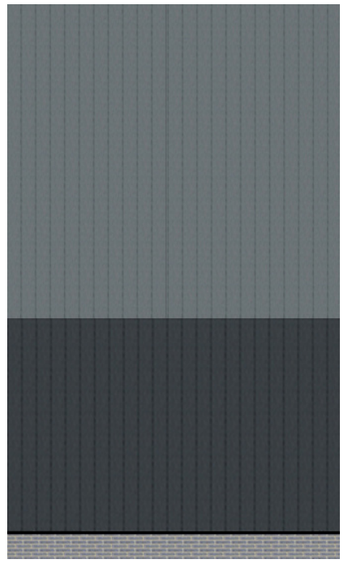


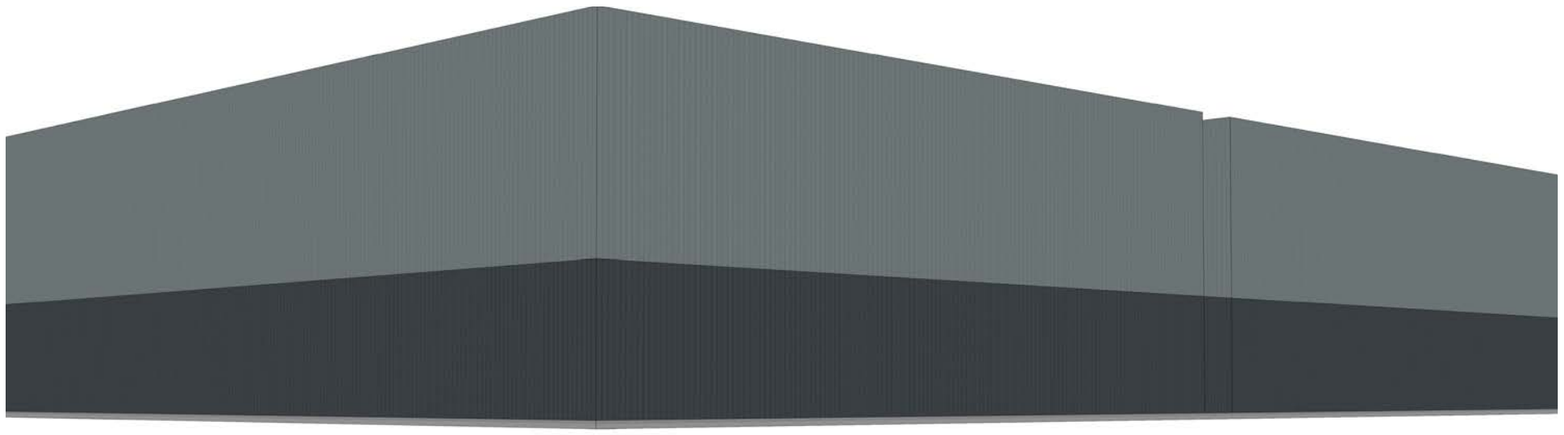
DRAWING NUMBER	*1*
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936
PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	*FINAL FOR DISCHARGE*
SCALE	1:8,000 (0 50 100 m)
ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA THREE)*
DRAWING TITLE	*SITE CONTEXT*
DRAWING ID	**1**
DRAWING PREPARED BY:	TW

EA THREE

Kingspan Trapezoidal Wall Panels, Anthracite Base, Merlin Grey Upper

Illustrative cross section of proposed EA THREE convertor hall facade with Kingspan cladding, anthracite base and merlin grey upper





Illustrative oblique view of proposed EA THREE convertor hall facade with Kingspan cladding, anthracite base and merlin grey upper

Source: EA1-CON-F-IBR-010113 ‘EA1 Architectural Report’ (p33)

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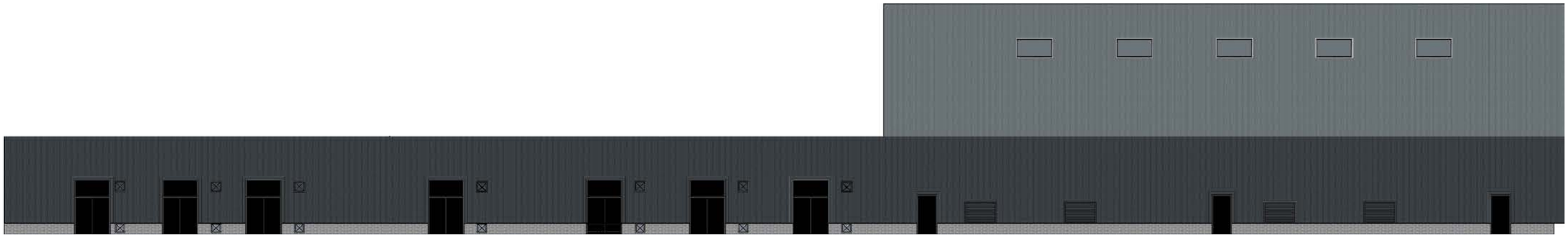
Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

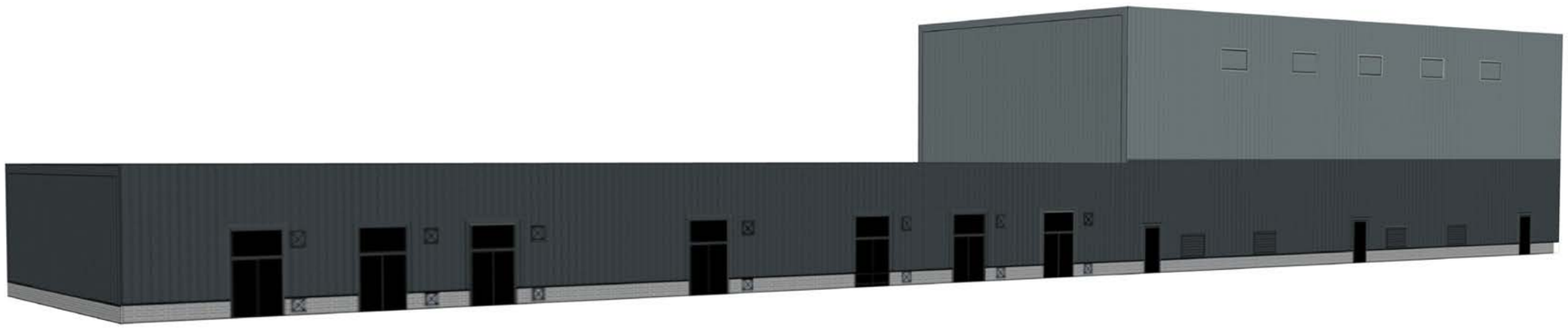
DRAWING NUMBER	2		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*EA3 CONVERTER STATION MATERIALS*		
DRAWING ID	**2**	DRAWING PREPARED BY:	LA

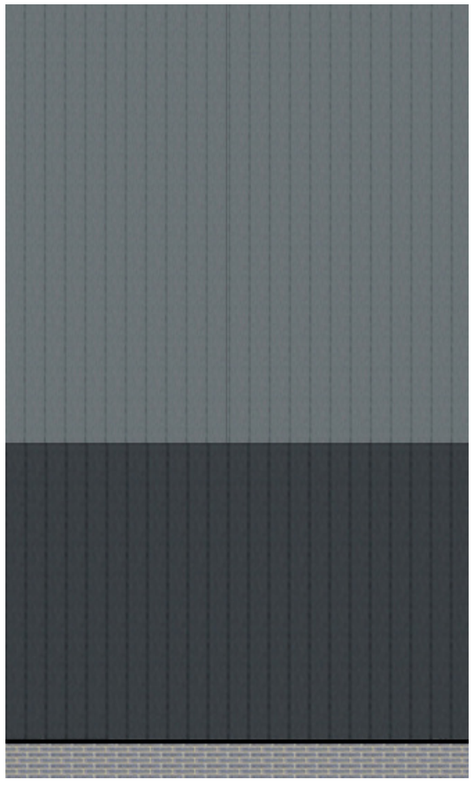
EA ONE

Kingspan Trapezoidal Wall Panels Anthracite Base, Merlin Grey Upper



Illustrative cross section of proposed EA ONE substation facade with Kingspan cladding, anthracite base and merlin grey upper





Illustrative oblique view of proposed EA ONE substation facade with Kingspan cladding, anthracite base and merlin grey upper

Source: EA1-CON-F-IBR-010113 ‘EA1 Architectural Report’ (p31)

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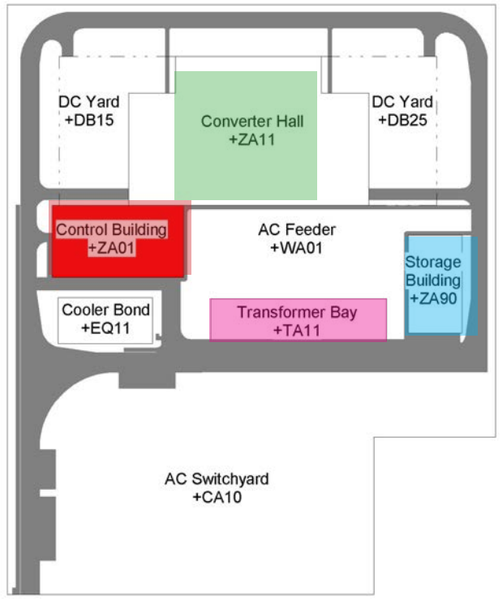
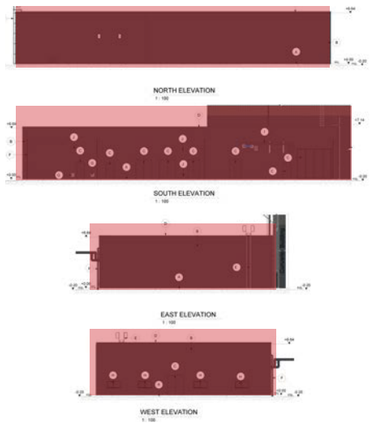
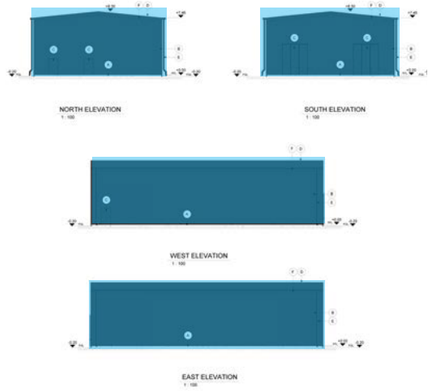
Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	3		
COORDINATE SYSTEM / DATUM	BNG OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*EA1 SUBSTATION BUILDING MATERIALS*		
DRAWING ID	**3**	DRAWING PREPARED BY:	LA

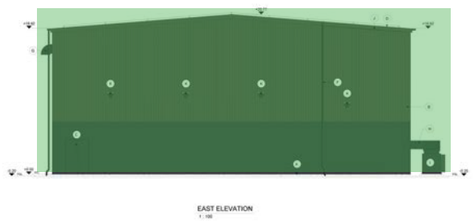


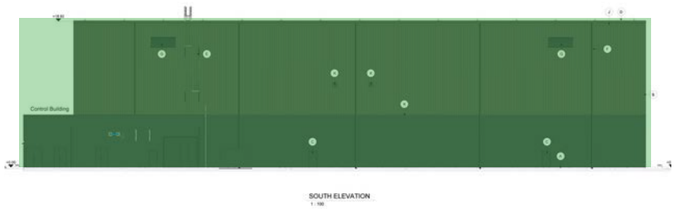


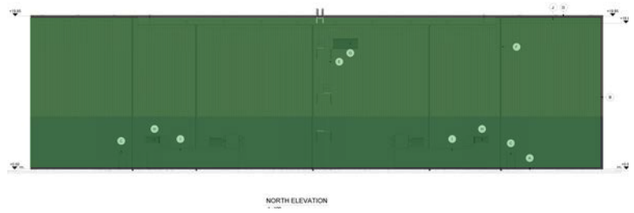
CONTROL BUILDING



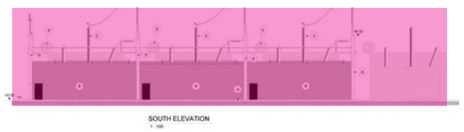
STORAGE BUILDING

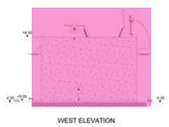






CONVERTER HALL





TRANSFORMER BAY

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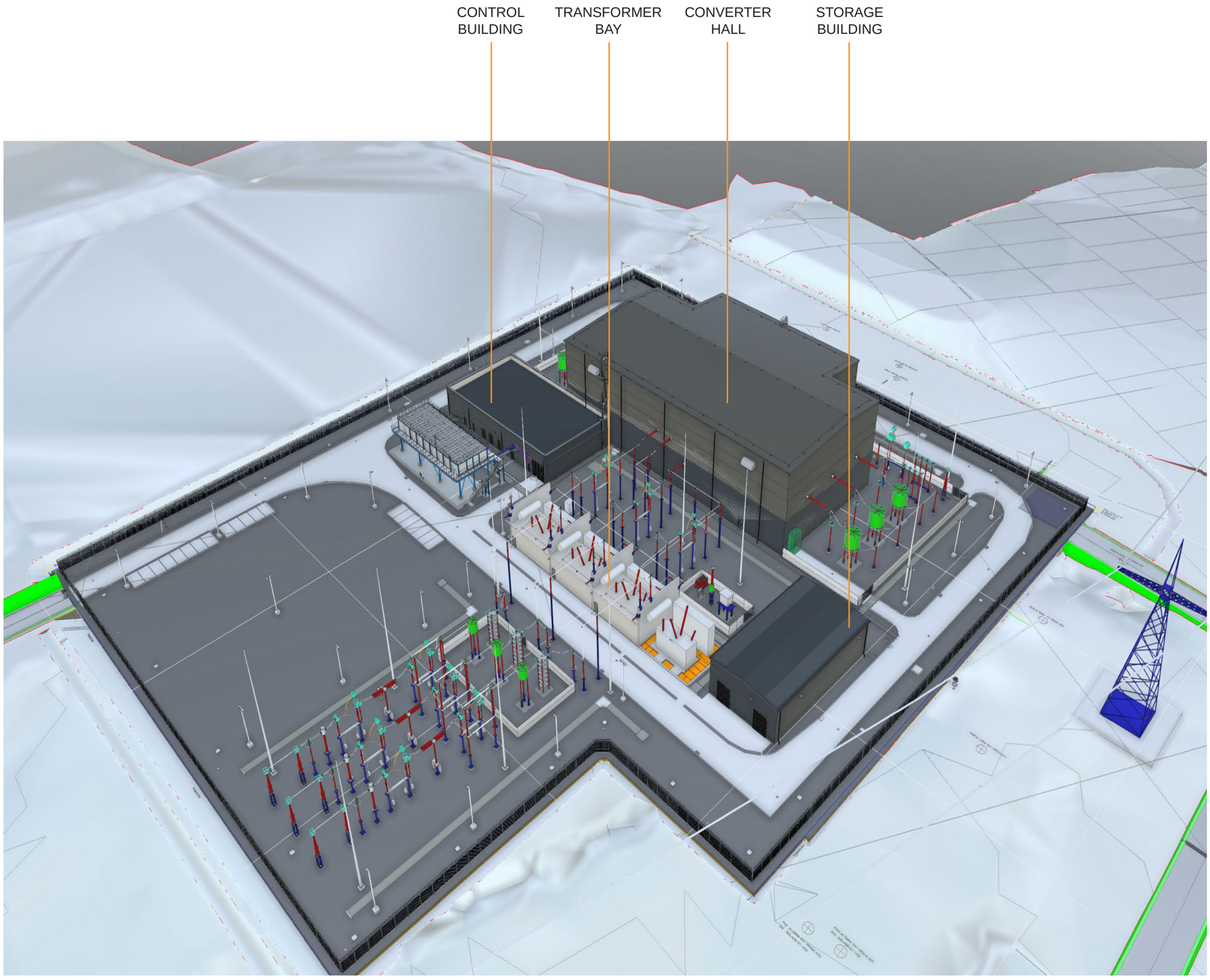
SCOTTISHPOWER RENEWABLES

Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	4		
COORDINATE SYSTEM DATUM	BNG OSGB 1936	PROJECTION UNITS	TRANSVERSE MERCATOR METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*KEY CONVERTER STATION COMPONENTS*		
DRAWING ID	**4**	DRAWING PREPARED BY:	LA



SCOTTISHPOWER RENEWABLES

Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	5		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*CONVERTER STATION 3D MODEL*		
DRAWING ID	**5**	DRAWING PREPARED BY:	LA

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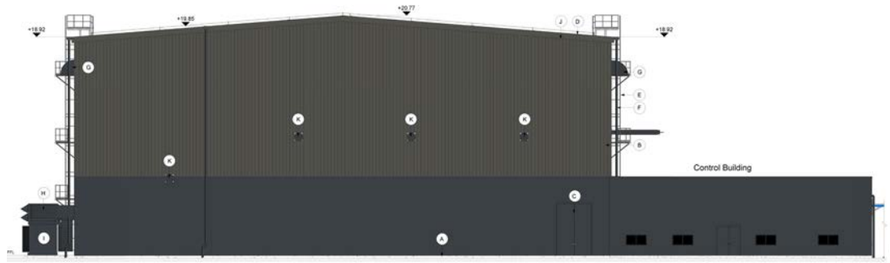
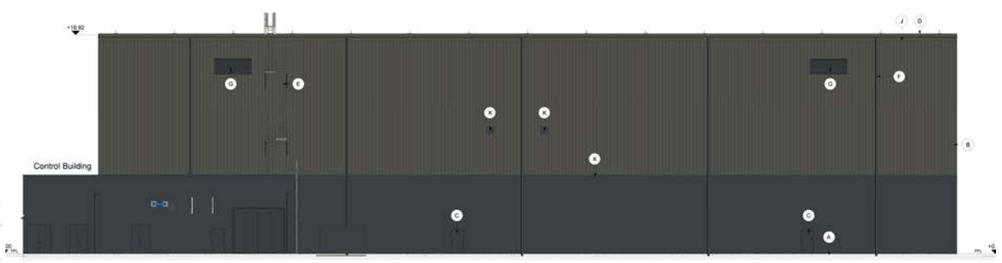
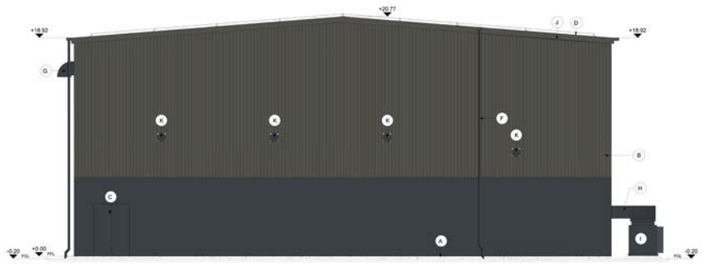


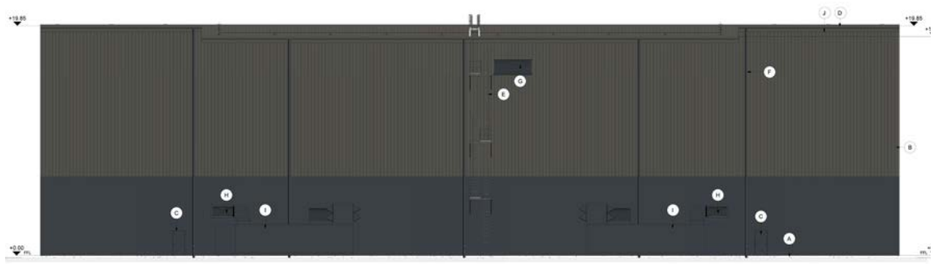
Western Elevation



Southern Elevation



Eastern Elevation



Northern Elevation

Kingspan Trapezoidal Wall Panels
Anthracite Base, Merlin Grey Upper

Goosewing Grey
RAL 080 70 05 BS 10A05

Merlin Grey
RAL 180 40 05 BS 18B25

Anthracite
RAL 7016

Colour palette and gradation
(dark to light with building height)

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SCOTTISHPOWER RENEWABLES

Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	6		
COORDINATE SYSTEM DATUM	BNG OSGB 1936	PROJECTION UNITS	TRANSVERSE MERCATOR METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*CONVERTER STATION BUILDING APPEARANCE*		
DRAWING ID	**6**	DRAWING PREPARED BY:	LA

SOFT LANDSCAPE general arrangement drawing showing key elements of structural woodland planting, containing belts of faster growing species for visual screening.

SCOTTISHPOWER RENEWABLES

LEGEND

- EA THREE DCO Boundary
- Existing Contours
- Proposed Contours (+54.00)
- Existing Vegetation to be retained
- Indicative areas of existing mature woodland
- Pylon
- Overhead powerlines (HV)
- Approximate underground cable alignment

Proposed Planting

- **Txx** Tree replanting location. See plant schedules for details.
- **H1** Mixed native species hedge. See plant schedules for details.
- **WM1** Core Woodland comprising generally slower growing mixed broadleaf species such as oak (See plant schedules for details)
- **WM2** Edge woodland comprising generally lower growing mixed broadleaf species such as Rowan (See plant schedules for details)
- **WM4** Wet woodland planting mix appropriate for SUDs detention basin area. (See plant schedules for details)
- **R1** Supplementary / infill planting for gaps in existing hedgerows using WM2 tree/shrub mix or H1 hedgerow mix as specified
- **G1** Amenity grass seed mix for embankments, verges and swale sides
- **G2** Wetland areas grassland seed mix areas.
- **G3** Species rich grassland seed mix areas.
- **G6** Marginal aquatic planting for the margins around the permanent pond.
- **G7** Marginal aquatics for the SUDs basin forebay and swale base areas
- Filter drain with grass cover and manhole access (Refer to engineers specification)
- Filter drain with exposed aggregate and manhole access (Refer to engineers specification)
- Filter drain within substation compound (Refer to engineers specification)
- **P4: Reinforced grass road surface** Description: Golpla pre-grown reinforced grass road from Geosynthetics Ltd.

FOR INFORMATION ONLY:

- EA1 Woodland. Woodland planting carried out as part of EA1 landscape works. For information only.
- Existing land use to be retained and managed as agricultural use in accordance with local landowners recommendations and guidance

Proposed Fencing to New Woodland

- **F2: Fence** Description: Rabbit / deer protection fencing for new woodland.
- **F3: Maintenance access gate** Description: 2m wide maintenance gate / height dependent upon adjacent fencing.

Note:
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DRAWING NUMBER	7		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*SOFT LANDSCAPE: GENERAL ARRANGEMENT*		
DRAWING ID	7	DRAWING PREPARED BY:	LA

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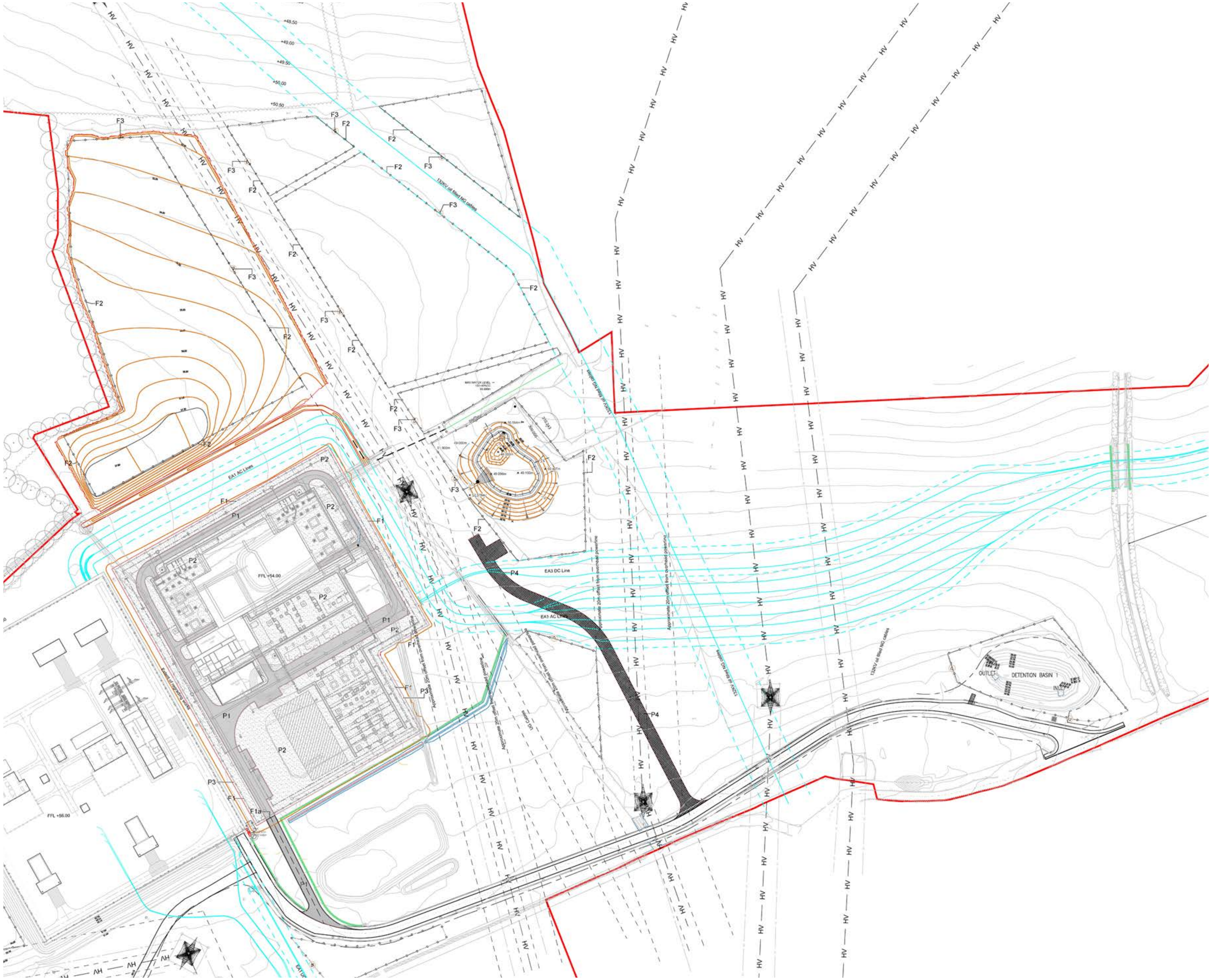
HARD LANDSCAPE



SCOTTISHPOWER RENEWABLES

LEGEND

HARD LANDSCAPE LEGEND

- EA THREE DCO Boundary
- Existing Contours
- Proposed Contours
- Pylon
- Overhead powerlines
- Approximate underground cable alignment

Proposed Hardworks

- **P1: Asphalt road**
  Description: Rural road with concrete kerb edging to Engineers specification.
- **P2: Permeable gravel groundcover within substation**
  Description: Local flint aggregate subject to conduction testing
- **P3: Self binding gravel footpath**
  Description: Natural gravel self-binding footpath.
- **P4: Reinforced grass road surface**
  Description: Golpla pre-grown reinforced grass road from Geosynthetics Ltd.
- **F1: Fence**
  Description: 2.4m high galvanised steel mesh fencing.
- **F1a: Gate**
  Description: 2.4m high galvanised steel entrance gate.
- **F2: Fence**
  Description: Rabbit / deer protection fencing for new woodland.
- **F3: Maintenance access gate**
  Description: 2m wide maintenance gate / height dependent upon adjacent fencing.
- Filter drain with grass cover and manhole access (Refer to engineers specification)
- Filter drain with exposed aggregate and manhole access (Refer to engineers specification)
- Filter drain within substation compound (Refer to engineers specification)
- Field drain and manhole access (Refer to engineers specification)

NOTE: Final alignments of existing tracks within site boundary to be confirmed

Note:
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DRAWING NUMBER	8		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*HARD LANDSCAPE: GENERAL ARRANGEMENT*		
DRAWING ID	8	DRAWING PREPARED BY:	LA

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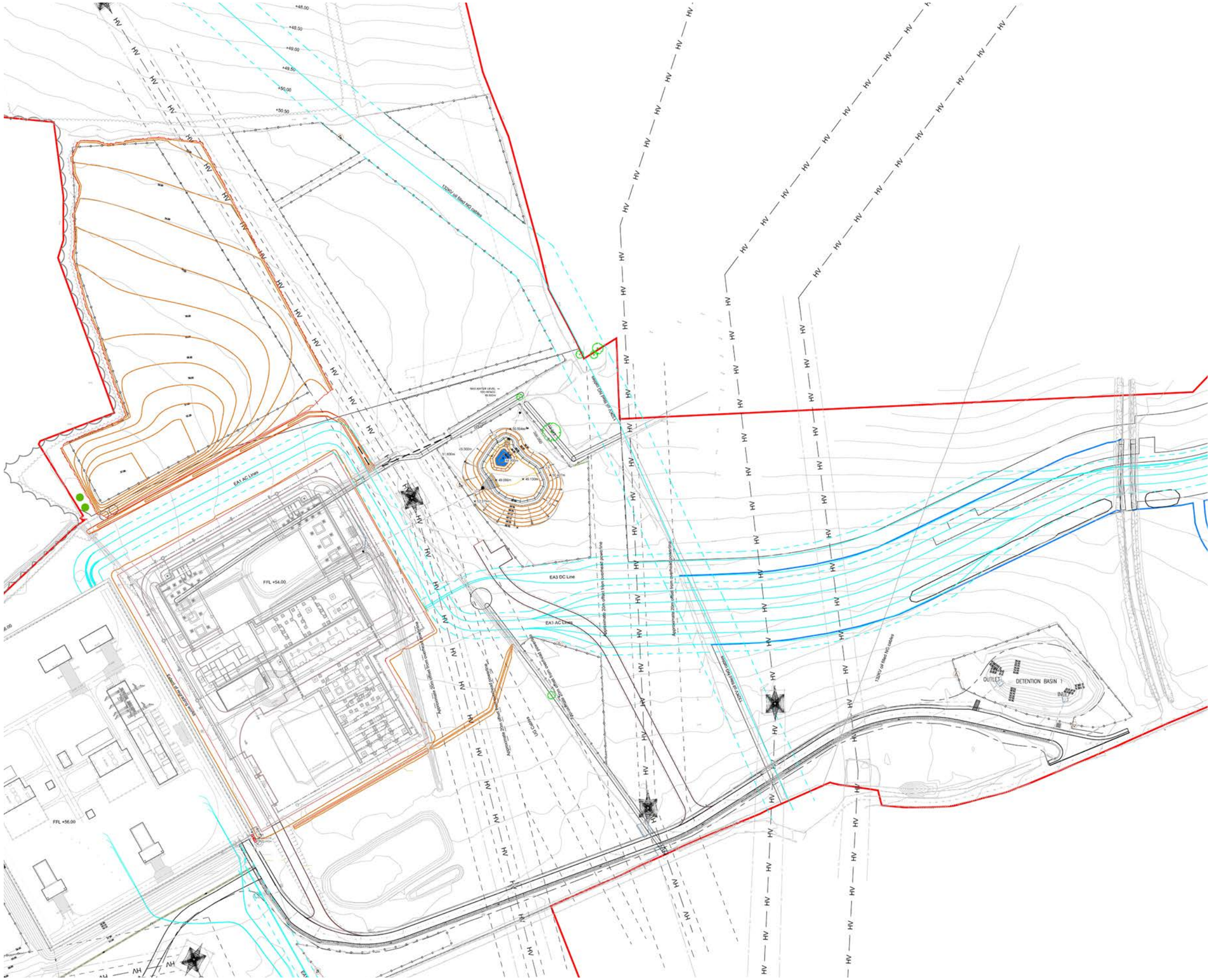
EARTHWORKS



SCOTTISHPOWER RENEWABLES

LEGEND

- EA THREE DCO Boundary
- Existing Contours
- Proposed Contours (+54.00)
- Pylon
- Overhead powerlines
- Approximate underground cable alignment
- Filter drain with grass cover and manhole access (Refer to engineers specification)
- Filter drain with exposed aggregate and manhole access (Refer to engineers specification)
- Filter drain within substation compound (Refer to engineers specification)
- Field drain and manhole access (Refer to engineers specification)

Note:
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DRAWING NUMBER	9		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*EARTHWORKS: GENERAL ARRANGEMENT*		
DRAWING ID	**9**	DRAWING PREPARED BY:	LA

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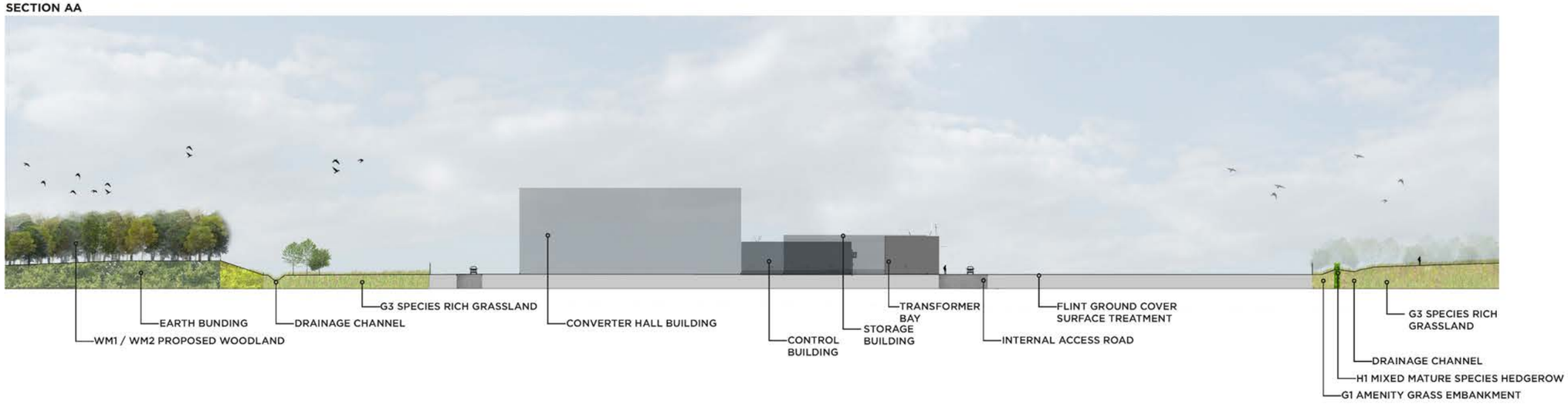
KEY SECTION through the site with details showing relationship between fence, perimeter boundary and hedging.

SCOTTISHPOWER RENEWABLES

SECTION AA



Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	10		
COORDINATE SYSTEM / DATUM	BNG OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*ILLUSTRATIVE CROSS SECTION A-A*		
DRAWING ID	**10**	DRAWING PREPARED BY:	LA

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KEY SECTION through the site with details showing relationship between fence, perimeter boundary and hedging.

SCOTTISHPOWER RENEWABLES

Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	11		
COORDINATE SYSTEM / DATUM	BNG OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*ILLUSTRATIVE CROSS SECTION B-B*		
DRAWING ID	**11**	DRAWING PREPARED BY:	LA

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Photomontage visual representation of the substation.

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Note:
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DRAWING NUMBER	12		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*VISUAL REPRESENTATION: VIEWPOINT 5*		
DRAWING ID	**12**	DRAWING PREPARED BY:	LA

SCOTTISHPOWER RENEWABLES

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Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	13		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*VISUAL REPRESENTATION: VIEWPOINT 6*		
DRAWING ID	**13**	DRAWING PREPARED BY:	LA

Photomontage visual representation of the substation. *Please note that the woodland block WM2-H has been omitted from the visualisation to create this view.*

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Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	14		
COORDINATE SYSTEM / DATUM	BNG OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*VISUAL REPRESENTATION: VIEWPOINT 11*		
DRAWING ID	**14**	DRAWING PREPARED BY:	LA

Photomontage visual representation of the substation. *Please note that the woodland block WM2-H has been omitted from the visualisation to create this view.*

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Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	15		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*VISUAL REPRESENTATION: VIEWPOINT 12*		
DRAWING ID	**15**	DRAWING PREPARED BY:	LA

Photomontage visual representation of the substation. *Please note that the woodland block WM2-H has been omitted from the visualisation to create this view.*

Note:
This map has been produced to the latest known information at the time of issue. Please consult with the GIS team to ensure the content is still current before using the information contained on this map.

DRAWING NUMBER	16		
COORDINATE SYSTEM / DATUM	BNG / OSGB 1936	PROJECTION / UNITS	TRANSVERSE MERCATOR / METRE
PURPOSE	FINAL FOR DISCHARGE		
SCALE	NOT TO SCALE	ORIGINAL PLOT SIZE	A3
PROJECT TITLE	*East Anglia THREE Wind Farm (EA3)*		
DRAWING TITLE	*VISUAL REPRESENTATION: VIEWPOINT A*		
DRAWING ID	**16**	DRAWING PREPARED BY:	LA

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