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SELECTION REPORT FOR OHL, UGC AND CSEC TERMINATIONS

ZF Route: Cotswolds VIP

REFERENCE: **PDD-101300-REP-004 - R02 SELECTION REPORT FOR OHL, UGC AND CSEC TERMINATIONS**

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Reference Standard and Specifications

Table 1 – References Standard, Specification and Technical Papers

Document No.	Rev.	Title
BS EN 50341:1	2012	Overhead Electrical Lines exceeding AC 45kV-General requirements.
BS EN 50341:2-9	2017 +A1 2018	Overhead Electrical Lines exceeding AC 45kV-National Normative Aspects, Great Britain.
NGTS 2.04	Issue 6 2021	National Grid - Generic Design Principles for Overhead Lines
NGTS 3.04.37	Issue 8 Jan 2022	Conductors and Conductor Systems for Overhead Lines
ENA TS 43-8	Issue 5 2019	Overhead line clearances

Reference Model, Document and Drawings

Table 2 – References Model, Document and Drawings

Document No.	Rev.	Title
30003359-BHK-XX-XX-M3-HV-0001	Preliminary	OHL PLS Model for ZF Route Cotswolds VIP
30003359-BHK-XX-XX-DR-HV-0001	02	Layout for North Cable Sealing End Location and Overhead Line Termination - A
30003359-BHK-XX-XX-DR-HV-0002	02	Layout for North Cable Sealing End Location and Overhead Line Termination - B
30003359-BHK-XX-XX-DR-HV-0003	02	Layout for South Cable Sealing End Location and Overhead Line Termination - A
30003359-BHK-XX-XX-DR-HV-0004	02	Layout for South Cable Sealing End Location and Overhead Line Termination - B
30003359-BHK-XX-XX-DR-HV-0005	02	Layout for South Cable Sealing End Location and Overhead Line Termination - C
30003359-BHK-XX-XX-DR-HV-0006	02	Layout for North Cable Sealing End Location and Overhead Line Termination – C
30003359-BHK-XX-XX-DR-HV-0007	01	Layout for North Cable Sealing End Location and Overhead Line Termination – D.01
30003359-BHK-XX-XX-DR-HV-0008	01	Layout for North Cable Sealing End Location and Overhead Line Termination – D.02
30003359-BHK-XX-XX-DR-HV-0009	01	Layout for North Cable Sealing End Location and Overhead Line Termination – D.03
30003359-BHK-XX-XX-DR-HV-0010	01	Layout for North Cable Sealing End Location and Overhead Line Termination – D.04
30003359-BHK-XX-XX-DR-HV-0011	01	Layout for North Cable Sealing End Location and Overhead Line Termination - E
30003359-BHK-XX-XX-DR-HV-0012	01	Layout for North Cable Sealing End Location and Overhead Line Termination – F
30003359-BHK-XX-XX-DR-HV-0013	01	Layout for South Cable Sealing End Location and Overhead Line Termination – D
30003359-BHK-XX-XX-DR-HV-0014	01	Layout for South Cable Sealing End Location and Overhead Line Termination - E
30003359-BHK-XX-XX-DR-HV-0015	03	Layout for South Cable Sealing End Location and Overhead Line Termination – F

Glossary of Terms

Table 3 - Glossary

Abbreviation	Description
ACSR	Aluminium Conductor Steel Reinforced
BS	British Standard
BS EN	British Standard Euronorm
CSEC	Cable Sealing End Compound
ENA TS	Energy Networks Association Technical Specification
GZTACSR	“Gap” type ZT Aluminium Conductor Steel Reinforced
NGTS	National Grid Technical Specification
NNA	National Normative Aspect
OHL	Overhead Line
PLS	Power Line Systems
UGC	Underground Cable

Contents

Tables

Figures

EXECUTIVE SUMMARY

The National Grid Cotswolds VIP scheme consists of the undergrounding of a section of two 400kV OHL circuits on ZF Route (Feckenham-Minety and Feckenham Walham). The undergrounding of the OHL circuits will be done by constructing two cable sealing end compounds (CSEC): one on the North end and other on the South end.

The northern CSEC will be constructed in span between towers ZF307 and ZF308 by replacing tower ZF308 by a terminal tower ZF308(NEW) with downleads to the gantry of the Northern CSEC. The southern CSEC will be in span ZF324-ZF325, where a full tension gantry will be constructed and the ZF325 (suspension tower) will have suspended tension sets installed.

This brief memo summarises the discussions regarding the OHL, UGC and CSEC termination selection that took place in the design review meetings and registers the conclusions that led to decisions of proceeding with alternative ‘North C’ and ‘South F’.

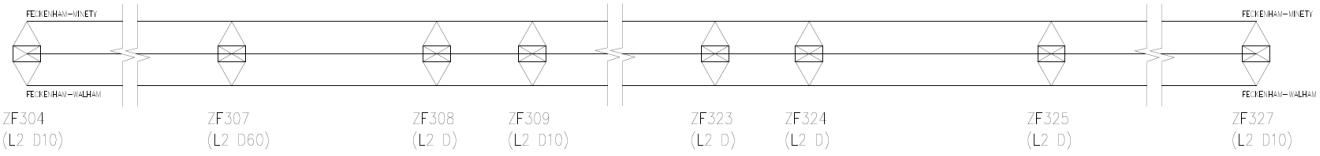
1. INTRODUCTION

The ZF Route sections between towers ZF307 and ZF327 consist of two 400kV OHL circuits strung with twin AAAC Rubus:

- 400kV Feckenham – Seven Springs – Minety Overhead Line Circuit (Eastern)
- 400kV Feckenham – Seven Springs – Walham Overhead Line Circuit (Western)

Figure 1 illustrates the existing OHL configuration with tower types.

Figure 1 – System configuration of 400kV circuits between Elstree and Sundon



Cotswold's VIP project consists of the undergrounding of a section between from tower ZF308 to ZF324 and dismantling the towers and foundations of that section. Conductors landing on the gantries for new cable sealing end compounds will be twin Matthew GAP.

This report details the selection studies carried out for each end termination alternative considered.

2. PURPOSE OF THIS DOCUMENT

This document is intended to register discussions between National Grid (Client) and BakerHicks (Principal Designer) regarding the termination selection for Cotswold VIP scheme. It captures topics discussed during design review meetings such as: CDM; Health and Safety; Environmental and Visual Impact; and Engineering Difficulties for each termination alternative. In the end of each section a table is presented where specific of those aspects are compared for all assessed possibilities.

3. NORTH CSEC, UGC AND OHL TERMINATIONS

On the northern side of the diversion, all the termination alternatives consider installing a new terminal tower L8c DT and a Cable Sealing End Compound on the eastern side of the existing line, between towers ZF307 and ZF308. All alternatives consider the positions of terminal tower and CSEC to be in the same field.

The differences between them are the Cable Sealing End Compound Location and the terminal tower position. These factors have effect on the visual impact of the arrangement; terminal tower height; vegetation trimming, cut and fill, access, and land use.

3.1. North End - A

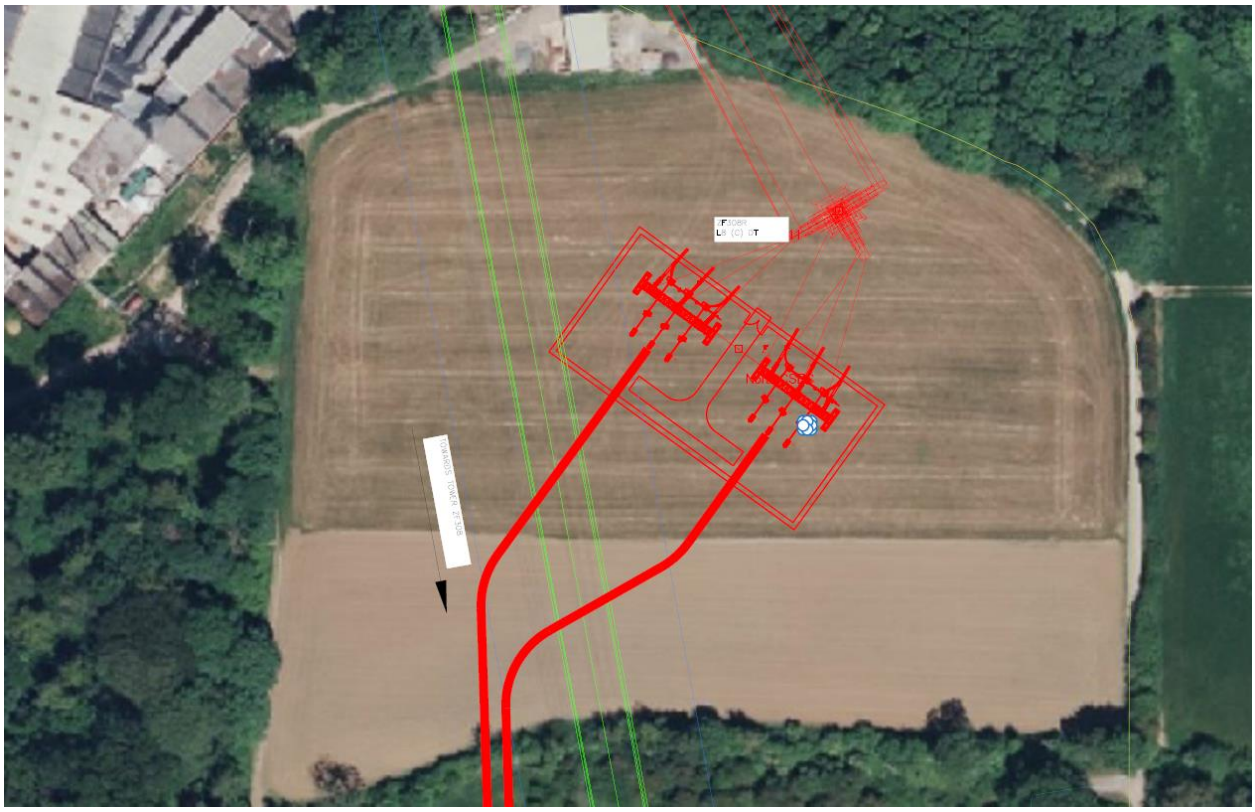
Layout for North Cable Sealing End Location and Overhead Line Termination - A.

References:

- PDD-101300-LAY-001 / 30003359-BHK-XX-XX-DR-HV-0001

This alternative consists of the terminal tower being positioned on the Northeast portion of the field and the CSEC in the middle of the field. Terminal tower requires auxiliary crossarm for the Feckenham Minety circuit. Cables enter relatively straight into the compound in the middle of the field. Terminal Tower and CSEC can be both constructed with both circuits live.

Figure 2 – Layout for North CSEC Location and OHL Termination - A



3.2. North End – B

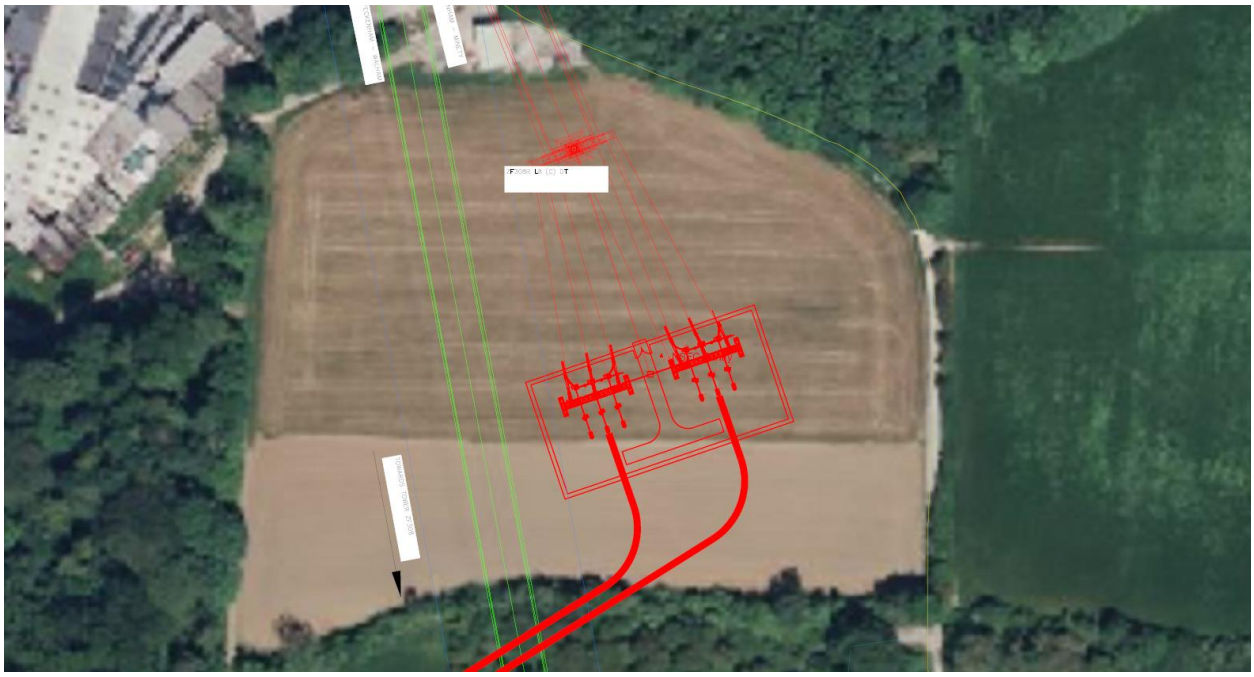
Layout for North Cable Sealing End Location and Overhead Line Termination - B.

References:

- PDD-101300-LAY-002 / 30003359-BHK-XX-XX-DR-HV-0002

Alternative B consists of the terminal tower being positioned on the North side of the field, which has a lower Z altitude. The CSEC is positioned on the southern bit of the field, on the same alignment from the span between ZF307-ZF308(NEW), therefore terminal tower does not need the auxiliary crossarm. CSEC and terminal tower can be erected with both circuits live.

Figure 3 – Layout for North CSEC and OHL Termination - B



3.3. North End – C

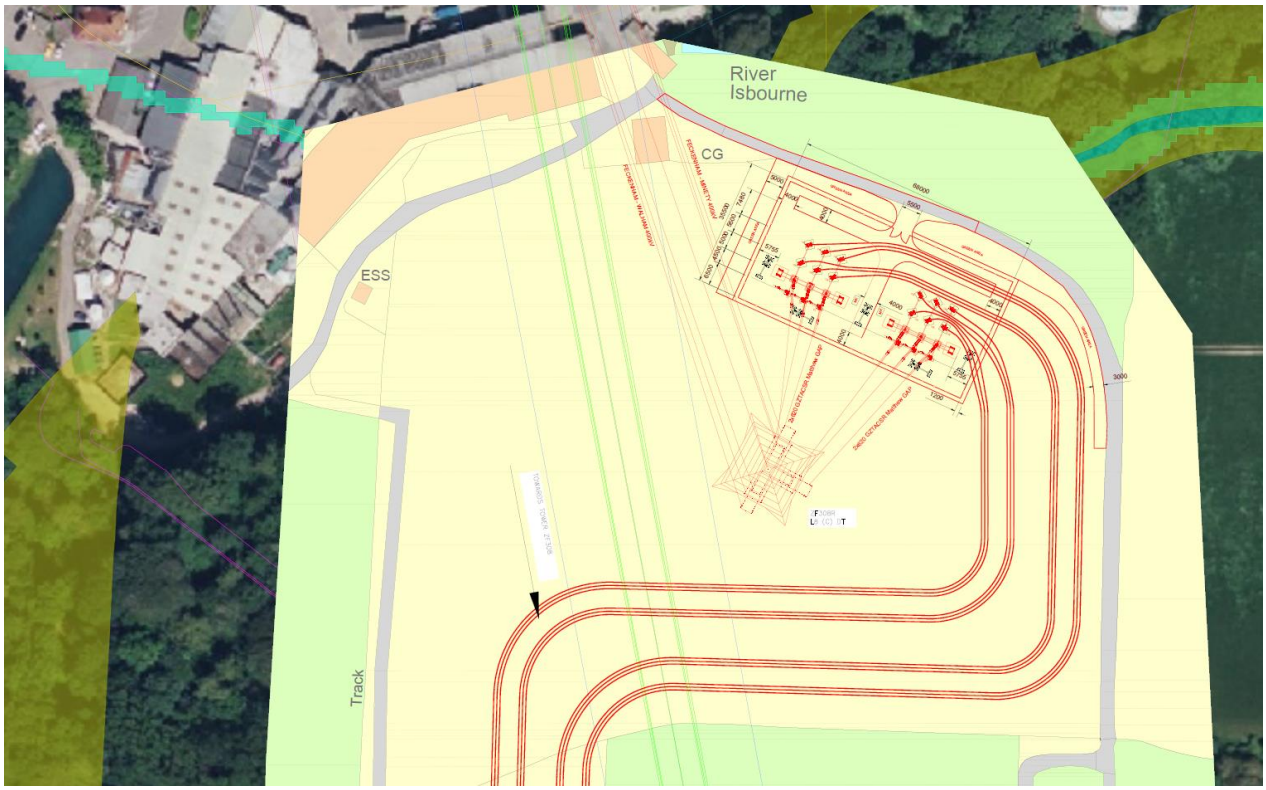
Layout for North Cable Sealing End Location and Overhead Line Termination – C.

References:

- PDD-101300-LAY-006 / 30003359-BHK-XX-XX-DR-HV-0006

This alternative consists of the terminal tower being positioned at a central position and the CSEC on the Northeast of the field. The sharp bend in the alignment requires that the terminal tower uses an auxiliary crossarm. The CSEC location is closer to the woods and in the lower part of the area. Terminal tower and CSEC can be constructed with both circuits live.

Figure 4 – Layout for North CSEC and OHL Termination C



3.4. North End - D.01

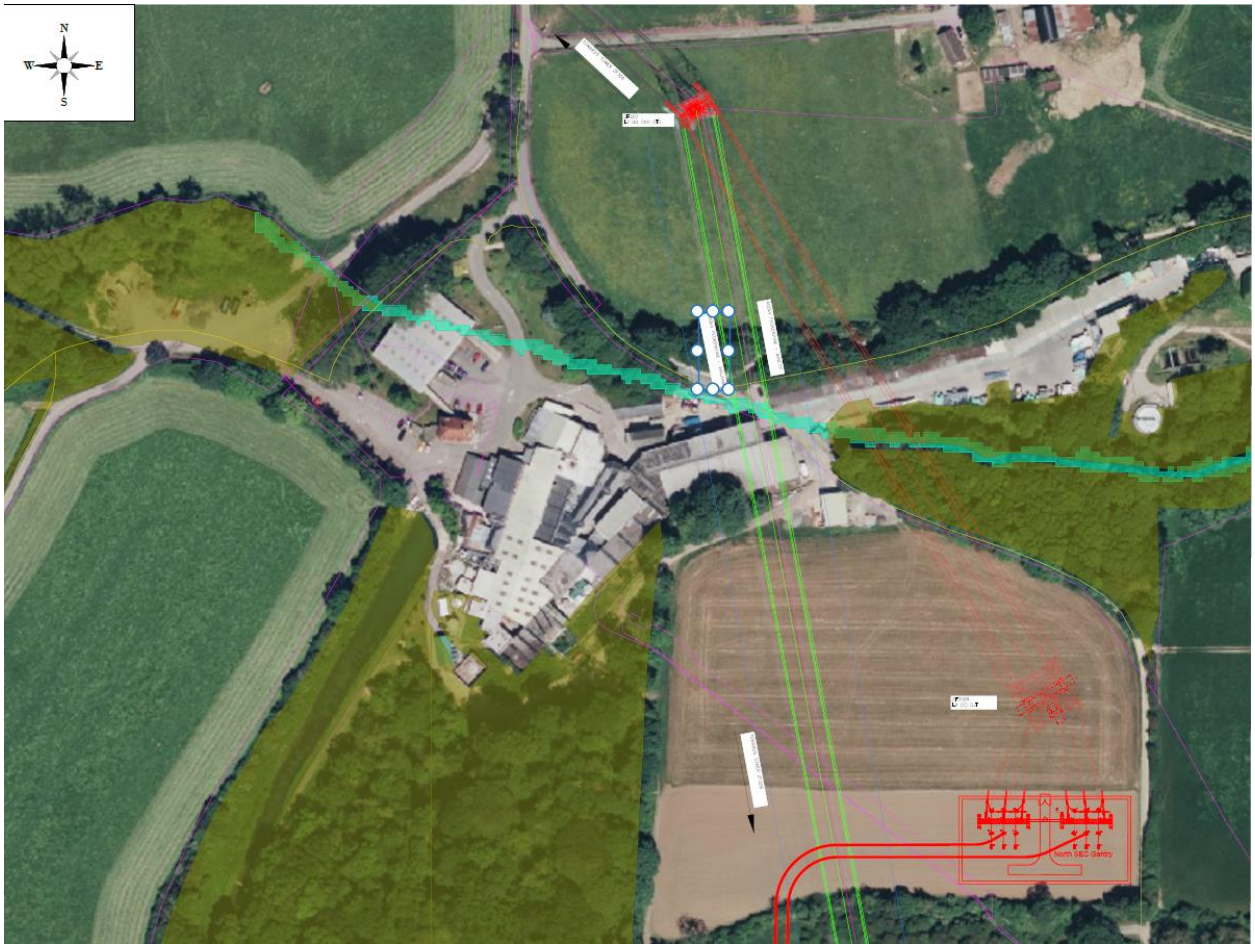
Layout for North Cable Sealing End Location and Overhead Line Termination – D.01.

References:

- PDD-101300-LAY-007 / 30003359-BHK-XX-XX-DR-HV-0007

D.01 consists of the CSEC being positioned on the Southeast part of the field, which has a higher Z altitude. Terminal tower is positioned at the east and do not require auxiliary crossarms for the downleads to land on the gantries. Terminal tower and CSEC can be constructed with both circuits live.

Figure 5 – Layout for North CSEC and Overhead Line Termination - D.01



3.5. North End - D.02

Layout for North Cable Sealing End Location and Overhead Line Termination - D.02.

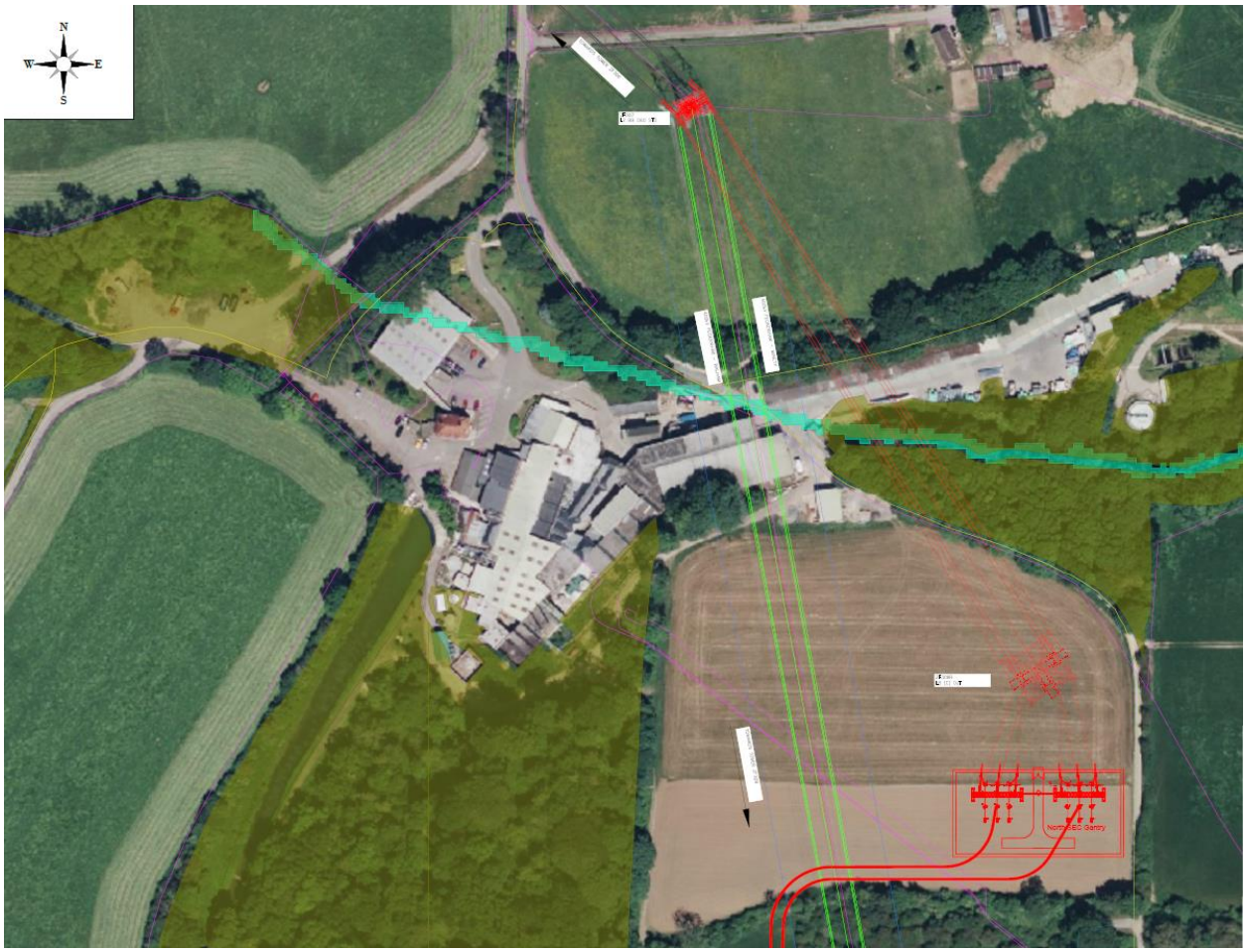
References:

- PDD-101300-LAY-008 / 30003359-BHK-XX-XX-DR-HV-0008

D.02 consists of the CSEC being positioned on the Southeast part of the field, which has a higher Z altitude. Terminal tower is positioned at the east and do not require auxiliary crossarms for the downleads to land on the gantries. Terminal tower and CSEC can be constructed with both circuits live.

The key difference between D.01 and D.02 is that D.02 sets the CSEC slightly to the North so that the cables can enter the CSEC in a more favourable route.

Figure 6 – Layout for North CSEC and OHL Termination – D.02



3.6. North End – D.03

Layout for North Cable Sealing End Location and Overhead Line Termination – D.03.

References:

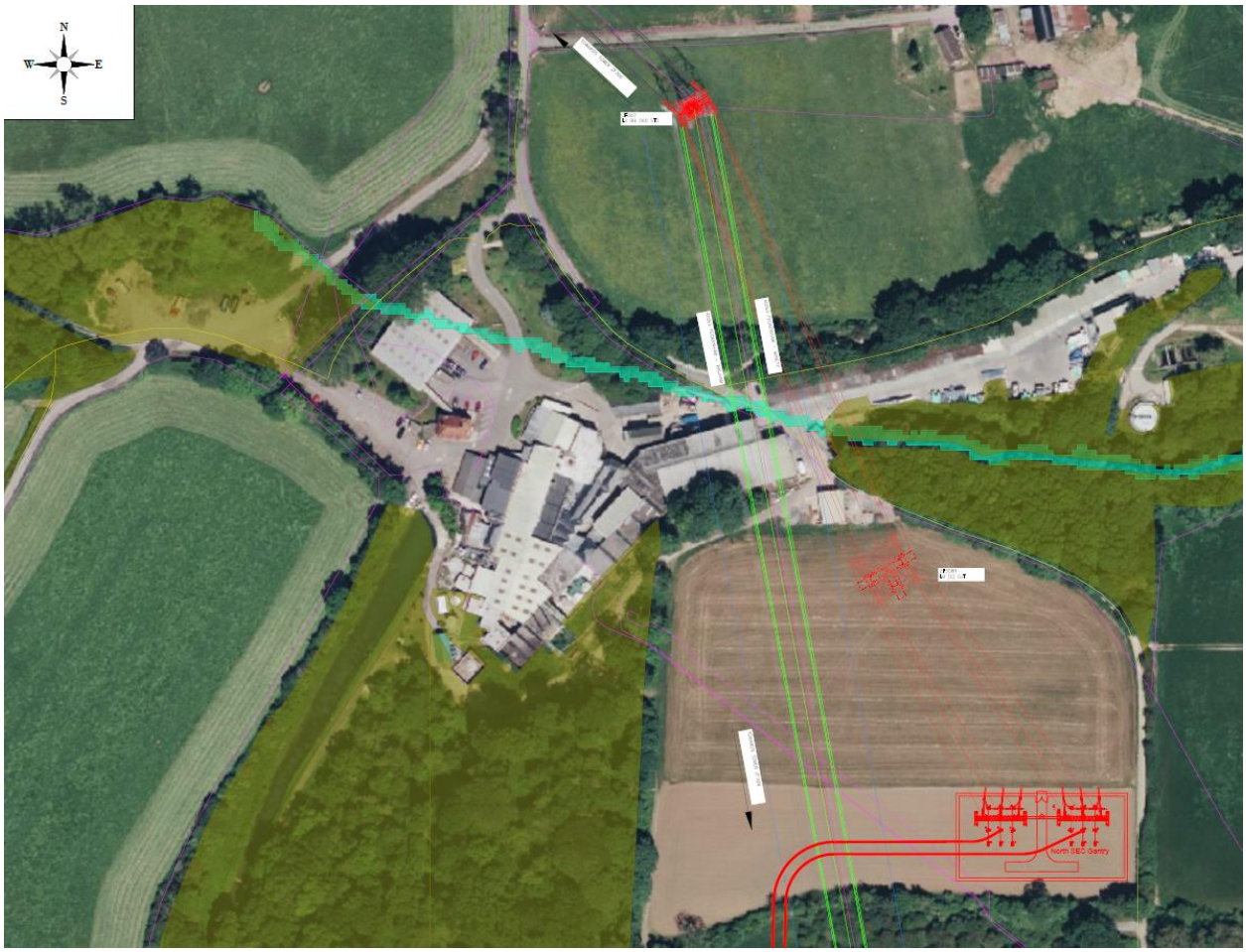
- PDD-101300-LAY-009 / 30003359-BHK-XX-XX-DR-HV-0009

Similar to D.01 and D.02, alternative D.03 consists of the CSEC being positioned on the Southeast part of the field, which has a higher Z altitude.

However, terminal tower is positioned on the northern side of the field. The small angle at ZF308 does not require auxiliary crossarms for the downleads to land on the gantries.

Terminal tower and CSEC can be constructed with both circuits live.

Figure 7 – Layout for North CSEC and OHL Termination – D.03



3.7. North End – D.04

Layout for North Cable Sealing End Location and Overhead Line Termination – D.04.

References:

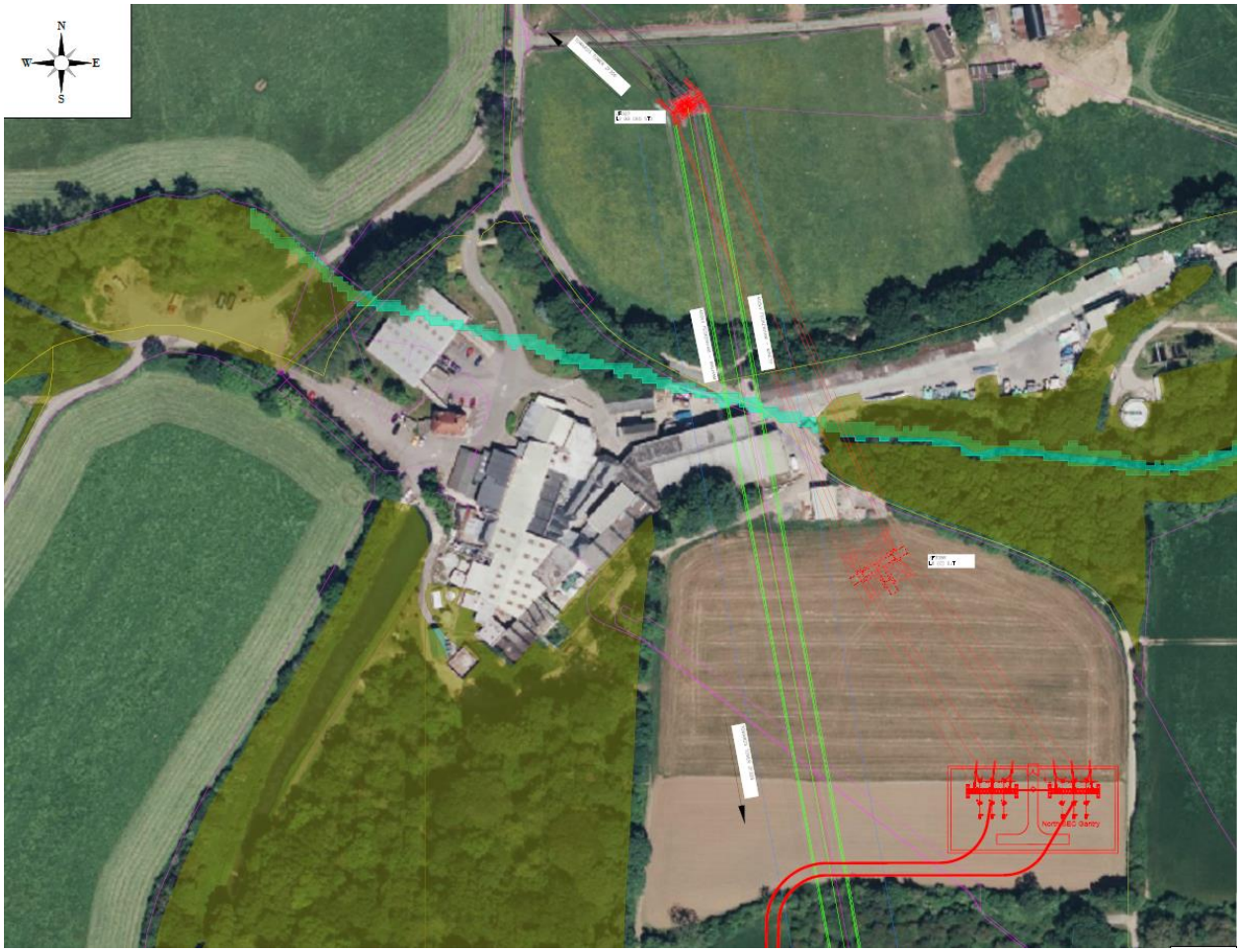
- PDD-101300-LAY-010 / 30003359-BHK-XX-XX-DR-HV-0010

Similar to D.03, configuration D.04 consists of the CSEC being positioned on the Southeast part of the field, which has a higher Z altitude and terminal tower is positioned on the northern side of the field. The small angle at ZF308 does not require auxiliary crossarms for the downleads to land on the gantries.

Terminal tower and CSEC can be constructed with both circuits live.

The difference between tower D.03 and D.04 is that in D.04 the CSEC location is slightly to the North so that cables to make easier for the cables to enter the CSEC.

Figure 8 – Layout for North CSEC and OHL Termination – D.04



3.8. North End – E

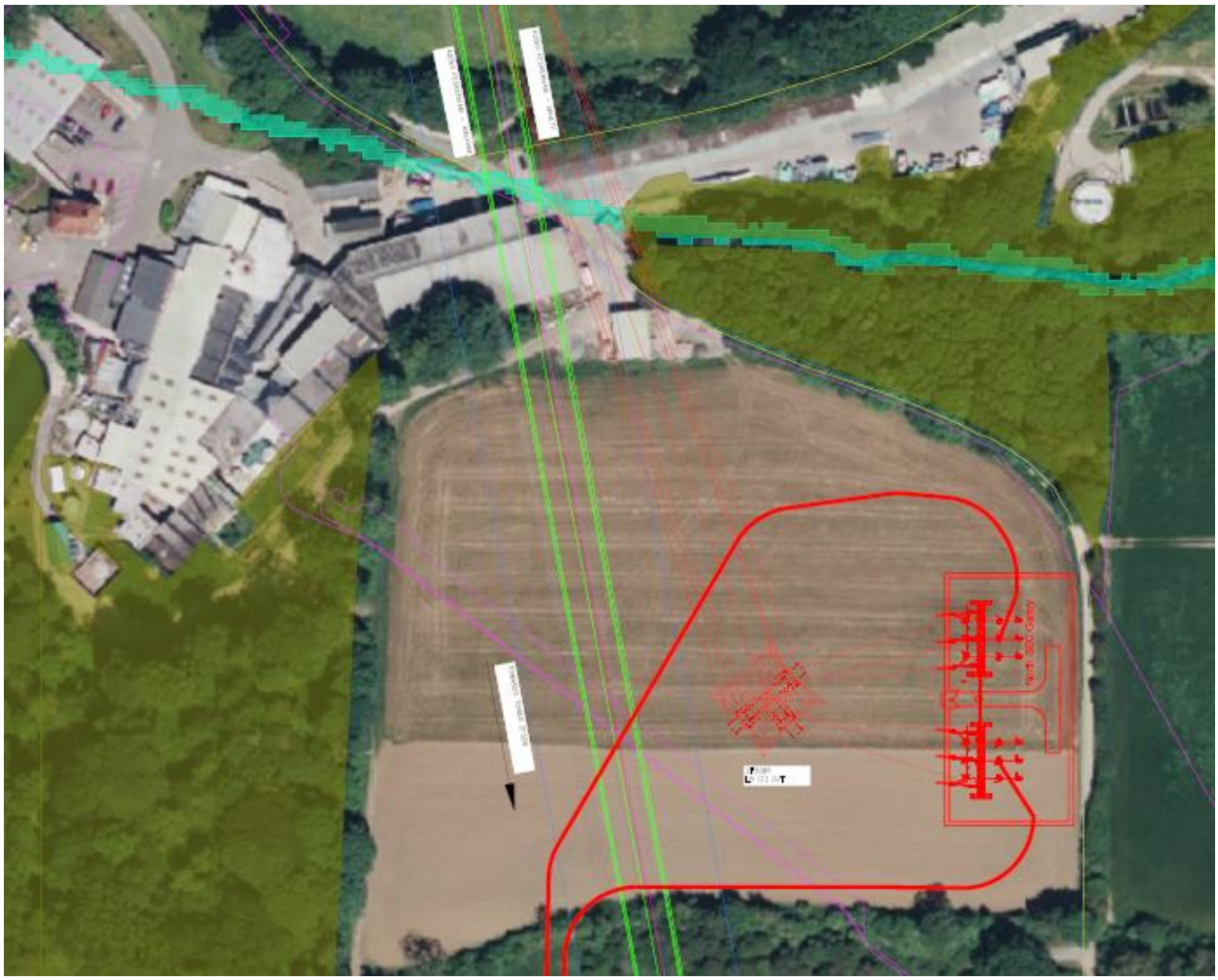
Layout for North Cable Sealing End Location and Overhead Line Termination – E.

References:

- PDD-101300-LAY-011 / 30003359-BHK-XX-XX-DR-HV-0011

Alternative E consists of the CSEC being set at the east end and the terminal tower in the centre of the field (both at higher Z altitudes). Sharp line angle requires auxiliary crossarms. The cable route requires large sweeping bends on the middle of the field. Both terminal tower and CSEC can be build with both circuits live.

Figure 9 – Layout for North CSEC and OHL Termination - E



3.9. North End - F

Layout for North Cable Sealing End Location and Overhead Line Termination – F.

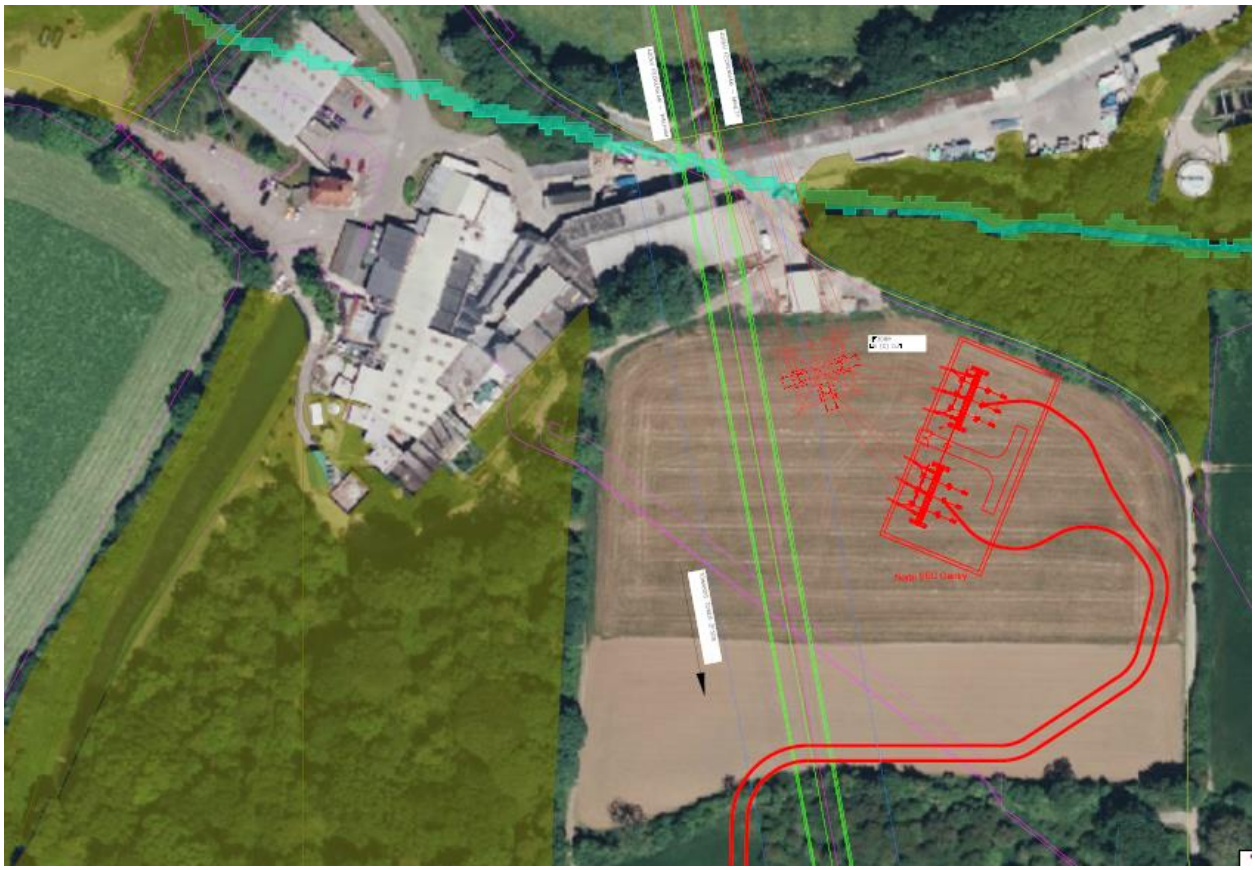
References:

- PDD-101300-LAY-012 / 30003359-BHK-XX-XX-DR-HV-0012

F alternative for North CSEC sets the tower on the North end (lower Z altitude) of the field as close as possible from the original alignment. The cable sealing end is located at Northeast. This alignment requires that the terminal tower has auxiliary crossarm.

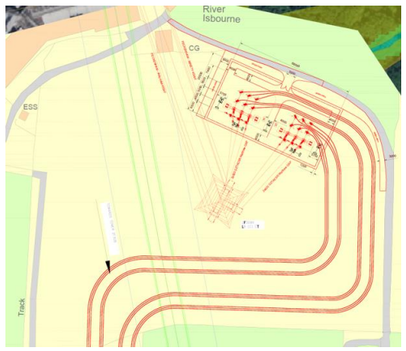
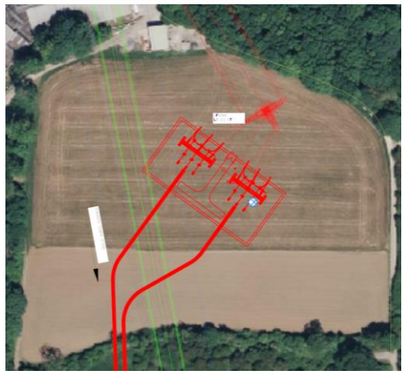
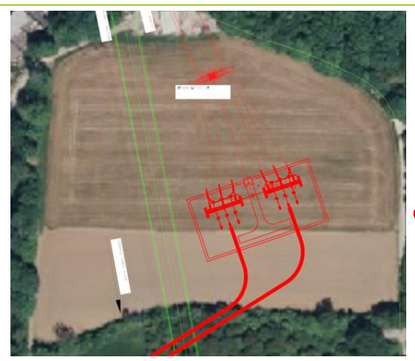
Terminal tower can NOT be erected offline as it is very close to existing alignment, and it can be difficult to set crane position with one or two circuits live. CSEC, however, can be constructed fully with both circuits live.

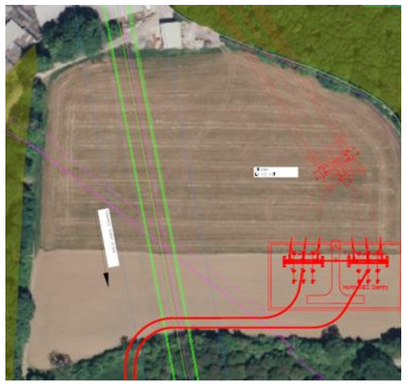
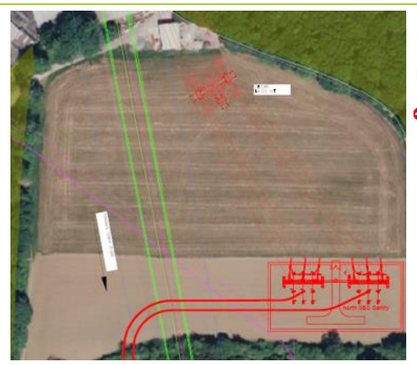
Figure 10 – Layout for North CSEC and OHL Termination – F.

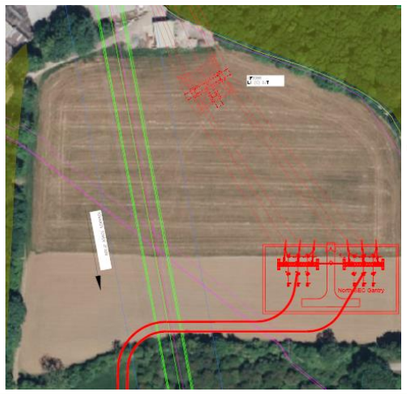
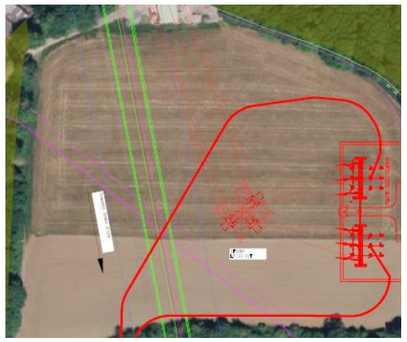
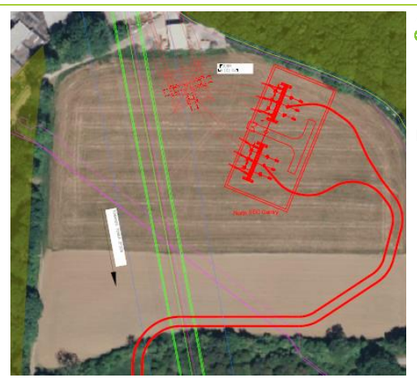


3.10. Comparison between North End configurations

Table 4 –Northern end terminations comparison

NG Ref: PDD-101300-LAY-XXX BH Ref: 30003359-BHK-XX-XX-DR-HV-0XXX		Picture	Visual Impact	CDM Health and Safety Management	Environmental and Land Use Impact	Engineering and Construction	Decision
006	North end – C		Advantages ⊕ CSEC is not in the middle of the field but on the corner (lower height coordinate), which reduces the visual impact ⊕ Minimum alignment changes of the existing route so less change in the overall visual impact of the OHL section Disadvantages ⊖ Tower in the middle of the field with auxiliary crossarms and jumpers, which may increase the visual impact caused by the new tower itself.	Advantages ⊕ Tower and gantries can be built offline complying with the HSE guidelines. ⊕ Easier permanent access to the CSEC ⊕ Less oversailing conductors on the field. Disadvantages ⊖ Potentially challenging installation of cable routes within compound ⊖ UGC route cross underneath the existing line	Advantages ⊕ CSEC is not in the middle of the field but on the corner (lower height coordinate), which mitigates the land use limitation ⊕ Less change in the original alignment reducing the likelihood of significant vegetation trimming in the wood ⊕ Cable routes following the field boundary as close as possible and all going into the CSEC from the same side ⊕ Shorter permanent access to the CSEC.	Advantages ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of tower or foundation strengthening. ⊕ Tower ZF308R and gantries can be built with both circuits live. Disadvantages ⊖ Potentially challenging installation of cable routes within compound	• Proceed with this configuration. • This alternative is to be further developed and visual impact assessment will be carried out.
001	North end – A		Advantages ⊕ ZF308(new) on the lower side of the field, which is good because is protected by the woods. Disadvantages ⊖ Terminal tower with auxiliary arm increase the visual impact of the termination ⊖ CSEC in the middle of the field.	Advantages ⊕ Tower and gantries can be built offline complying with the HSE guidelines. ⊕ Straight alignment for UGC entering the CSEC makes construction easier. Disadvantages ⊖ UGC route cross underneath the existing line.	Disadvantages ⊖ CSEC in the middle of the field will limit the use of the land ⊖ New section oversailing the woods is likely to require significant vegetation trimming. ⊖ Cable routes in the middle of the field of the land potentially sterilising it for future use.	Advantages ⊕ Relatively straight alignment for cables entering CSEC ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of tower steelwork or foundation strengthening ⊕ Tower ZF308R and gantries can be built with both circuits live	• Ruled out due to the use of land limitation
002	North end – B		Advantages ⊕ Tower on the North side of the field (lower altitude), protected by the woods. ⊕ No auxiliary crossarm for tower ZF308(new), reducing visual impact for the tower Disadvantages ⊖ CSEC on the higher portion of the field increasing the visual impact.	Advantages ⊕ Tower and gantries can be built offline complying with the HSE guidelines. Disadvantages ⊖ UGC route cross underneath the existing line ⊖ ZF308(new) on the lower level of the field thus requiring higher extensions ⊖ Large portion of the field with oversailing conductors.	Advantages ⊕ Less change in the original alignment reducing the likelihood of significant vegetation trimming in the woods Disadvantages ⊖ CSEC in the middle of the field will limit the use of the land ⊖ Downleads oversailing the middle of the field increasing visual impact and limiting the land use ⊖ Cable route interferes with the existing woods on the south side of the field.	Advantages ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of tower steelwork or foundation strengthening. ⊕ Tower ZF308(new) and gantries can be built with both circuits live Disadvantages ⊖ ZF308R on the lower level of the field thus requiring higher extensions ⊖ Tight bending along short length to bring cables onto the termination structures	• Ruled out due to the use of land limitation

NG Ref: PDD-101300-LAY-XXX BH Ref: 30003359-BHK-XX-XX-DR-HV-0XXX		Picture	Visual Impact	CDM Health and Safety Management	Environmental and Land Use Impact	Engineering and Construction	Decision
007	North end-D.01		Advantages ⊕ Tower with no auxiliary arm needed Disadvantages ⊖ Terminal tower and CSEC are on the higher side of the field, thus have higher visual impact	Advantages ⊕ Tower and gantries can be built offline complying with the HSE guidelines. ⊕ Easier permanent access to the CSEC ⊕ Less oversailing conductor on the land Disadvantages ⊖ Potentially challenging installation of cable routes within compound ⊖ UGC cross underneath the existing line	Advantages ⊕ Terminal tower and CSEC are closer to the edge of the land therefore minimising any land use limitations ⊕ Less oversailing conductor on the land ⊕ Cables follow the field boundary as close as possible Disadvantages ⊖ Significant change of alignment that probably will require significant tree cutting or trimming ⊖ Change in the alignment brings conductor in span ZF307-308(new) to properties east form ZF307.	Advantages ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of steelwork or foundation strengthening. ⊕ Tower ZF308R and gantries can be built with both circuits live Disadvantages ⊖ Potentially challenging installation of cable routes within compound	• This is shortlisted but is put on hold as , in comparison with North C, it has more oversailing conductor and potentially higher visual impact..
008	North end-D.02		Advantages ⊕ Tower with no auxiliary arm needed Disadvantages ⊖ Terminal tower and CSEC are on the higher side of the field, thus have higher visual impact	Advantages ⊕ Tower and gantries can be built offline complying with the HSE guidelines. ⊕ Easier permanent access to the CSEC ⊕ Less oversailing conductor on the land Disadvantages ⊖ UGC cross underneath the existing line	Advantages ⊕ Terminal tower and CSEC are closer to the edge of the land therefore minimising any land use limitations ⊕ Less oversailing conductor on the land ⊕ Cables follow the field boundary as close as possible Disadvantages ⊖ Significant change of alignment that probably will require significant tree cutting or trimming ⊖ Change in the alignment brings conductor in span ZF307-308(new) to properties east form ZF307.	Advantages ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of steelwork or foundation strengthening. ⊕ Tower ZF308R and gantries can be built with both circuits live	• Ruled out due to the fact that in terms of land use is worse than D.01 and the UGC routes are feasible for both • This is virtually the same as D.01, with the only difference being a slight change in the position of the CSEC. In termination D.02 the CSEC is slightly more to the north when compared to D.01. This is done to make easier the UGC route.
009	North end-D.03		Advantages ⊕ Tower without auxiliary arm needed Disadvantages ⊖ CSEC is on the higher side of the field, thus has higher visual impact	Advantages ⊕ Easier permanent access to the CSEC by the landborder Disadvantages ⊖ Overhead conductor oversailing a large area of the field. ⊖ Potentially challenging installation of cable routes within the compound ⊖ UGC cross underneath the existing line	Advantages ⊕ Terminal tower and CSEC are closer to the edge of the land therefore minimising any land use limitations. ⊕ Cables follow the field boundary as closes as possible Disadvantages ⊖ Overhead conductor oversailing a large area of the field.	Advantages ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of steelwork or foundation strengthening. ⊕ Tower ZF308(NEW) and gantries can be built with both circuits live. Disadvantages ⊖ Potentially challenging installation of cable routes within the compound ⊖ Terminal tower on the lower side of the field, thus require higher extensions to meet clearances.	• Ruled out..

NG Ref: PDD-101300-LAY-XXX BH Ref: 30003359-BHK-XX-XX-DR-HV-0XXX		Picture	Visual Impact	CDM Health and Safety Management	Environmental and Land Use Impact	Engineering and Construction	Decision
010	North end D.04		Advantages ⊕ Tower with no auxiliary arm needed Disadvantages ⊖ CSEC is on the higher side of the field, thus has higher visual impact.	Advantages ⊕ Easier permanent access to the CSEC Disadvantages ⊖ Overhead conductor oversailing a large area of the field ⊖ UGC cross underneath the existing line.	Advantages ⊕ Terminal tower and CSEC are closer to the edge of the land therefore minimising any land use limitations ⊕ Cables follow the field boundary as close as possible Disadvantages ⊖ Overhead conductor oversailing a large area of the field	Advantages ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of steelwork or foundation strengthening ⊕ Tower ZF308R and gantries can be built with both circuits live ⊕ Tower with no auxiliary arm needed Disadvantages ⊖ Terminal tower on the lower side of the field, thus require higher extensions to meet clearances	• Ruled out due to the fact that in terms of land use is worse than 009 and the UGC routes are feasible for both. • This alternative is virtually the same as termination D.03, with the only difference being a slight change in the position of the CSEC. In termination D.04 the CSEC is slightly more to the north when compared to D.03. This is done to make easier the UGC route.
011	North end - E		Disadvantages ⊖ CSEC and terminal tower are on the higher side of the field, thus has higher visual impact. In addition, tower needs auxiliary crossarm.	Advantages ⊕ Tower and gantries can be built offline complying with the HSE guidelines. ⊕ Easier permanent access to the CSEC Disadvantages ⊖ Overhead conductor oversailing a large area of the field ⊖ Possibly significant excavations for CSEC. ⊖ UGC cross underneath the existing and the proposed line.	Advantages ⊕ CSEC is closer to the edge of the land therefore minimising any land use limitations ⊕ Minimum diversion in the span ZF307-308(new) when compared to the existing. Disadvantages ⊖ Overhead conductor oversailing a large area of the field ⊖ Cable route affects a large portion of the field. ⊖ Possibly significant cut & fill required for CSEC	Advantages ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of steelwork or foundation strengthening. ⊕ Tower ZF308R and gantries can be built with both circuits live Disadvantages ⊖ Large sweeping bends for cables into compound on the northern side	• Ruled out due to the disadvantages.
012	North end - F		Advantages ⊕ Tower ZF308(NEW) and CSEC on the lower side of the field minimising the visual impact. Disadvantages ⊖ Proposed terminal tower needs auxiliary crossarm	Advantages ⊕ Easier permanent access to the CSEC ⊕ Oversailing conductor above the field is kept to the minimum Disadvantages ⊖ Works in the proximity of conductors. Regardless of existing line being live or dead, the proximity with the conductors is a significant hazard. ⊖ Hazardous position for cranes. ⊖ UGC cross underneath the existing line.	Advantages ⊕ CSEC is closer to the edge of the land therefore minimising any land use limitations ⊕ Minimum diversion in the span ZF307-308(new) when compared to the existing. ⊕ Cables follow the field boundary as close as possible. Disadvantages ⊖ Possibly significant cut and fill works required for CSEC.	Advantages ⊕ Favourable angle at tower ZF307. The position alleviates the mechanical loads at ZF307 thus reduces the likelihood of need of steelwork or foundation strengthening. ⊕ Gantries and CSEC can be built with both circuits live Disadvantages ⊖ Difficult to set crane position for tower ZF308 (new) and CSEC gantries ⊖ Feckenham-Minety circuit outage is required to erect tower ZF308R because of the clearance to the live wires.	• Ruled out due to the disadvantages.

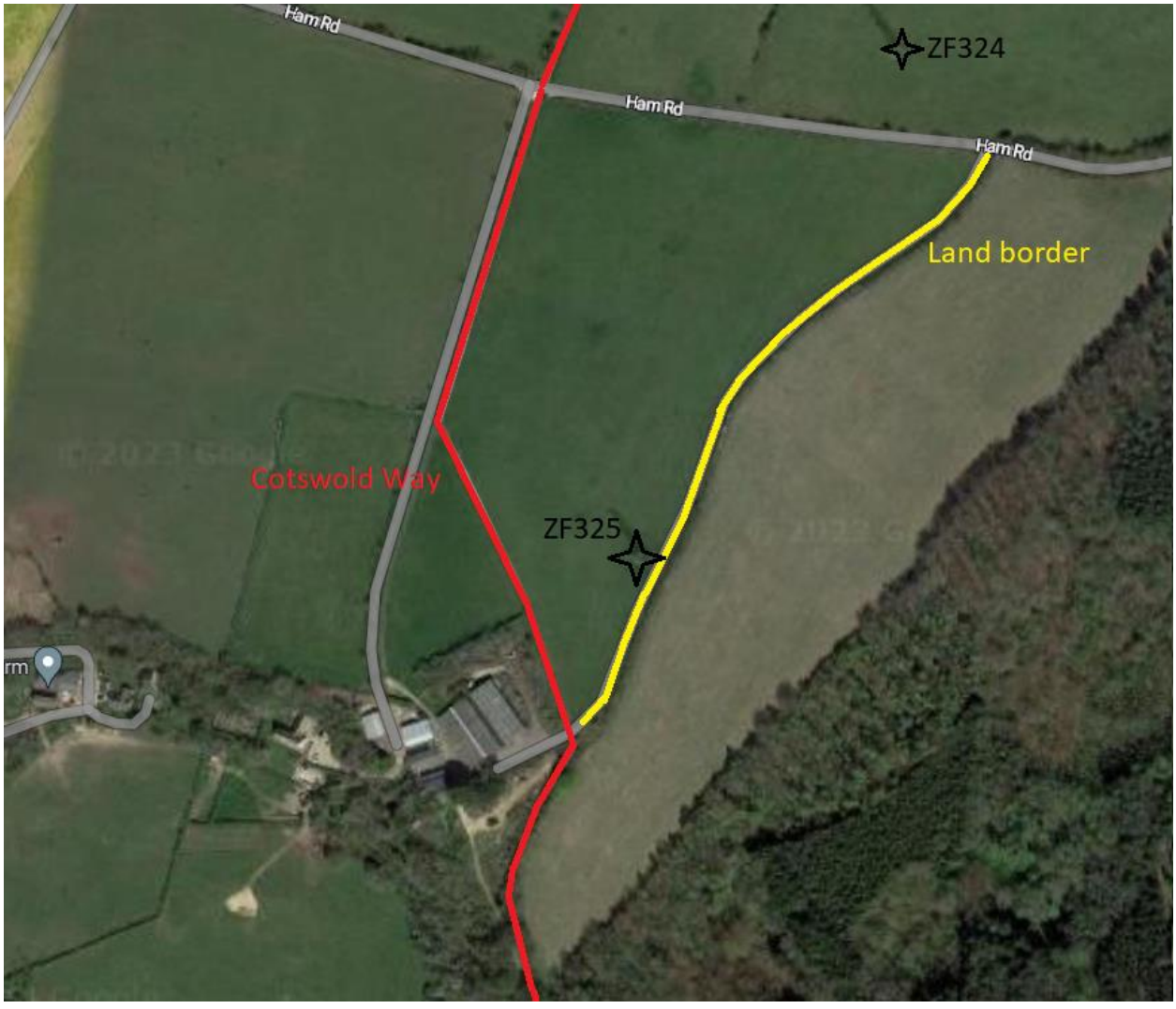
4. SOUTH CSEC, UGC, AND OHL TERMINATIONS

Solutions for OHL, UGC and CSEC for the South end of the diversion involve finding positions for the CSEC between existing towers ZF324 and ZF325. The stringing section of the OHL starts at ZF321 (L2 D10) and ends at ZF327 (L2 D10). All towers in between are suspension towers.

So, the modification on the OHL to accommodate a CSEC in that area requires either installing a new terminal (or angle tower) on the existing alignment or reuse the suspension towers with suspended tension sets to full tension CSEC Gantries.

East of the existing OHL route there is a local access road that separates two lands. Southwest from tower ZF325 there is Cotswold Way National Trail.

Figure 11 – Areas for South CSEC Location



4.1. South End - A

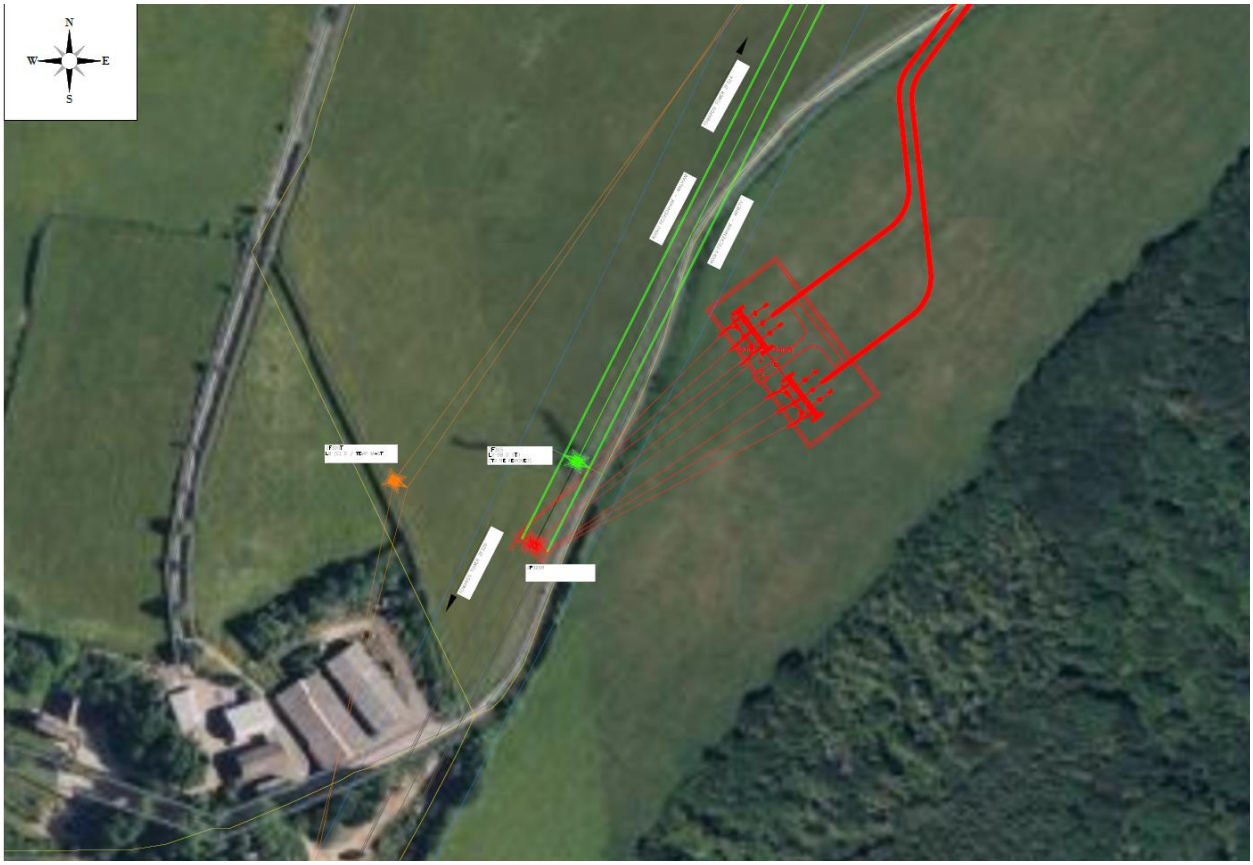
Layout for South Cable Sealing End Location and Overhead Line Termination - A.

References:

- PDD-101300-LAY-003 / 30003359-BHK-XX-XX-DR-HV-0003

Termination configuration A for South CSEC consists of a terminal tower ahead of ZF325 and a standard gantry for the CSEC. This alternative needs a temporary diversion for the Feckenham – Walham circuit with a temporary tower set west from ZF325. Tower ZF325 to ZF308 would be dismantled.

Figure 12 – Layout for South CSEC and OHL Termination - A



4.2. South End - B

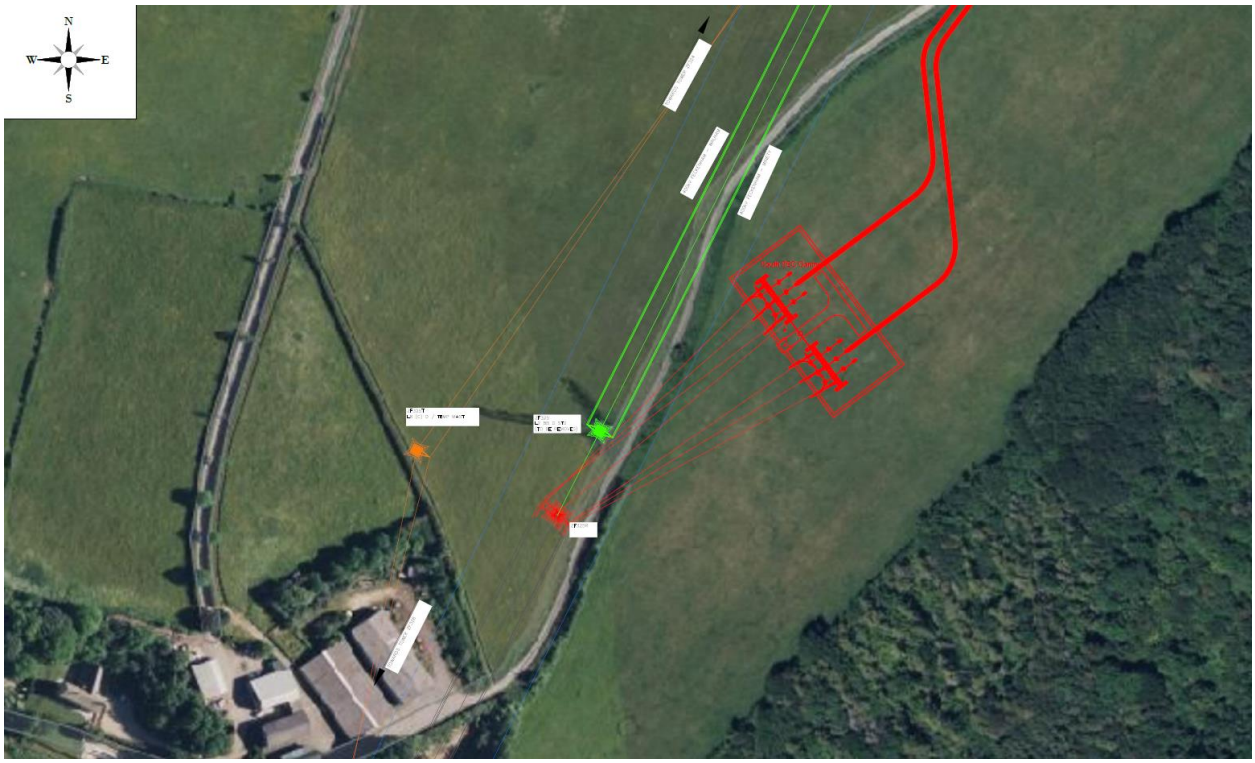
Layout for South Cable Sealing End Location and Overhead Line Termination - B.

References:

- PDD-101300-LAY-004 / 30003359-BHK-XX-XX-DR-HV-0004

Termination configuration B for South CSEC is similar to A. However, B uses an angle tower and full tension gantry at the CSEC. The temporary diversion requirements are the same.

Figure 13 – Layout for South CSEC and OHL Termination - B



4.3. South End - C

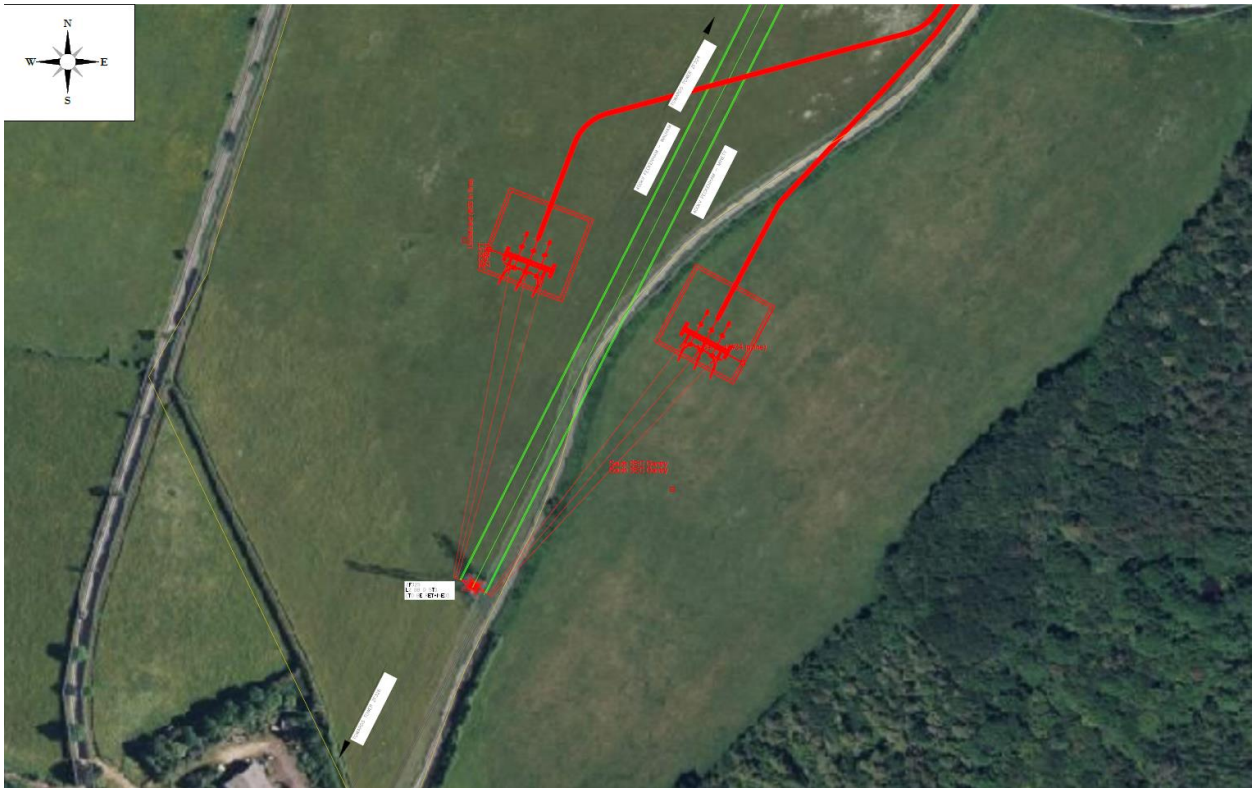
Layout for South Cable Sealing End Location and Overhead Line Termination - C.

References:

- PDD-101300-LAY-005 / 30003359-BHK-XX-XX-DR-HV-0005

Termination configuration C for South CSEC consists of reusing the suspension tower ZF325. Two separate CSEC one at each side of the existing alignment. Tower ZF325 would need to have its existing suspension sets replaced by suspended tension sets and the section from South CSECs to ZF327 will have its existing twin AAAC Rubus conductor system replaced by twin Matthew GAP. Both CSECs' Gantries are full tension gantries. This alternative requires the earth peak from the tower ZF325 to be modified as well to accommodate two earthwires.

Figure 14 – Layout for South CSEC and OHL Termination - C



4.4. South End - D

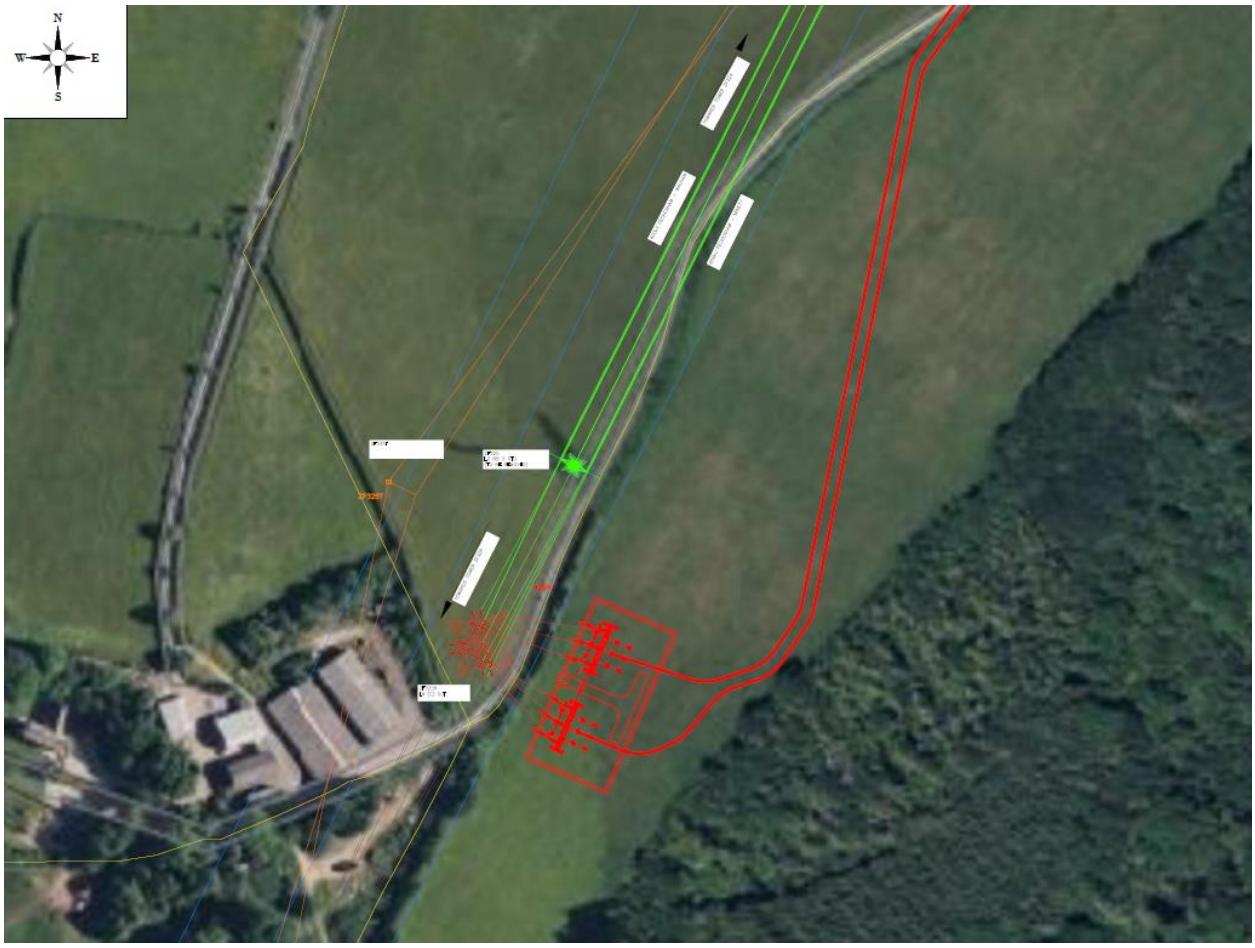
Layout for South Cable Sealing End Compound Location and Overhead Line Termination – D.

References:

- PDD-101300-LAY-013 / 30003359-BHK-XX-XX-DR-HV-0013

Configuration D for South CSEC location consists of a terminal tower ahead (southwest) to ZF325 close to the existing barn and the Cotswold Way. The cable sealing end compound is set near to the terminal tower on the opposite side of the access road. Due to sharp angle of the alignment the terminal tower has an auxiliary crossarm. Temporary diversion is required and construction works in both lands.

Figure 15 – Layout for South CSEC and OHL Termination – D



4.5. South End – E

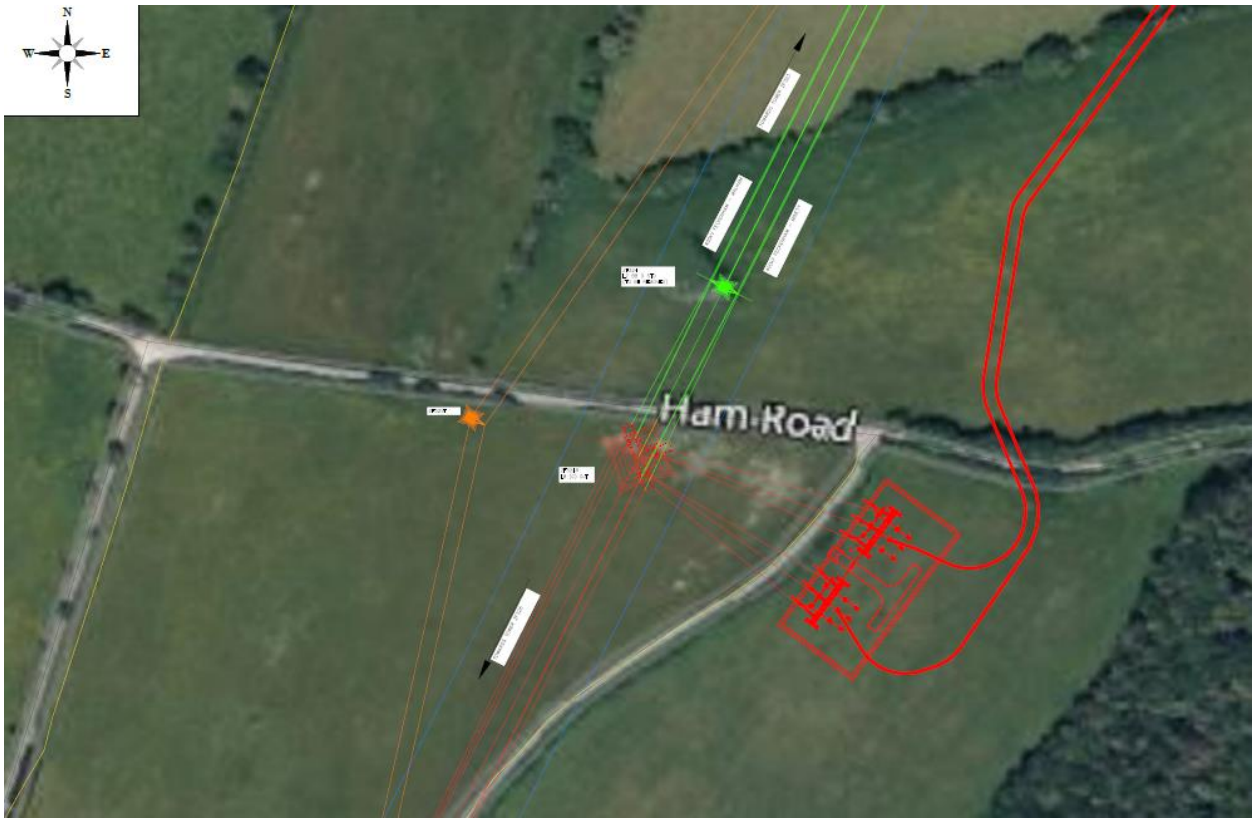
Layout for South Cable Sealing End Compound Location and Overhead Line Termination - E.

References:

- PDD-101300-LAY-014 / 30003359-BHK-XX-XX-DR-HV-0014

Configuration E for South CSEC consists of a terminal tower ahead of ZF324 close to the local Ham Road on the existing alignment. The CSEC position is set on the opposite side of the local access road. Due to the sharp bend of the alignment terminal tower has auxiliary crossarm. Temporary diversion of the Feckenham Walham circuit is required to erect tower while Feckenham Minety circuit is dead. Construction of CSEC can be done with both circuits live.

Figure 16 – Layout for South CSEC and OHL Termination – E



4.6. South End – F

Layout for South Cable Sealing End Compound Location and Overhead Line Termination – F.

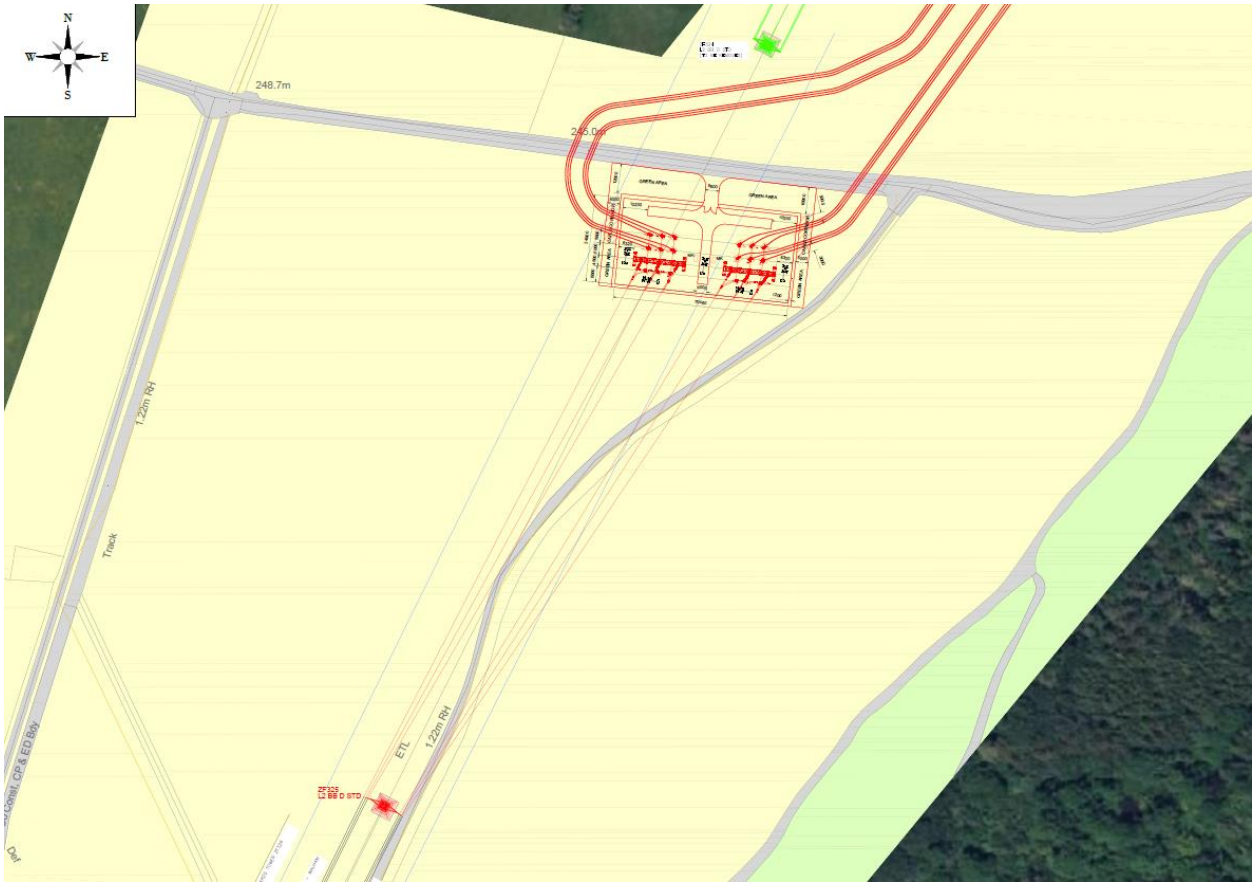
References:

- PDD-101300-LAY-015 / 30003359-BHK-XX-XX-DR-HV-0015

Configuration alternative F consists of a CSEC constructed slightly offset from the original alignment. The suspension tower ZF325 is reutilised with the use of suspended tension set. Gantries at South CSEC are full tension gantries. The section between South CSEC Gantries up to ZF327 is restrung with twin Matthew GAP.

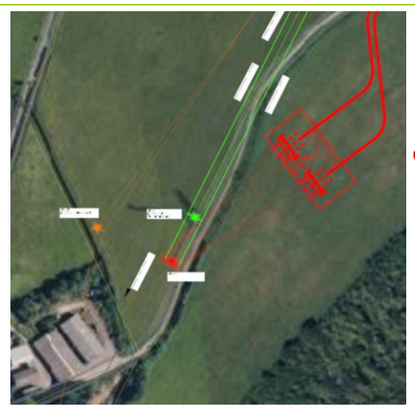
The bay for the Feckenham - Minety (eastern circuit) can be built with both circuits live. The Feckenham – Walham bay require outage of the Feckenham – Walham circuit. Temporary diversion of western circuit may help with outage requirements and works schedule.

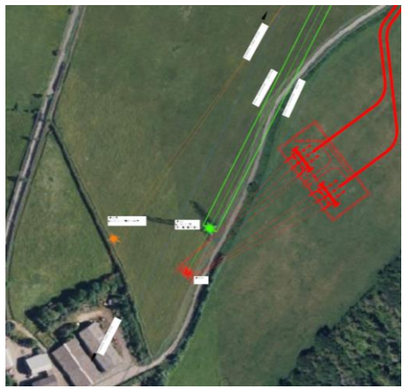
Figure 17 – Layout for South CSEC and OHL Termination – F



4.7. Comparison between South End configurations

Table 5 –Southern end termination comparison

NG Ref: PDD-101300-LAY-XXX BH Ref: 30003359-BHK-XX-XX-DR-HV-0XXX		Picture	Visual Impact	CDM Health and Safety Management	Environmental and Land Use Impact	Engineering and Construction	Decision
015	South end – F		Advantages ⊕ No visual impact change around tower ZF325. ⊕ Less change in the original alignment. ⊕ No need for a new big terminal tower. Disadvantages ⊖ Most of OHL section between span ZF324-325 remain overhead.	Advantages ⊕ Minimum change on the current alignment ⊕ CSEC stays far from Cotswold National Trail → less interference Disadvantages ⊖ Oversailing conductors above the local access.	Advantages ⊕ CSEC stay on the same land from the existing alignment.	Advantages ⊕ There is no need for a new terminal tower as ZF325 is to be retained and the CSEC would have full tension gantries. ⊕ Western Cable Sealing End Compound (Feckenham – Minety circuit) can be built with both circuits live. Eastern CSEC require a single circuit outage ⊕ Relatively direct approach for cables into the compound Disadvantages ⊖ Using ZF325 as first tower after the gantry is likely to require structure strengthening. Structural analysis to confirm. ⊖ Although this alternative can be carried out without temporary diversion, it may be needed as contingency to ensure early return to service (or be more flexible in the programme). ⊖ Need to restring the section from the South CSEC to ZF327.	• Proceed with this termination alternative. • This is to be further developed
003	South end - A		Advantages ⊕ Longer section undergrounded → Tower ZF325 replaced. less visual impact for Ham Road users Disadvantages ⊖ Proposed temporary tower and new terminal tower (angle tower) and CSEC are very close to Cotswold Way (National trail). This represents a significant concern regarding visual impact and public acceptance of the project.	Disadvantages ⊖ Downleads cross the existing road/access	Disadvantages ⊖ The new terminal tower cross (as well as temporary tower for diversion) and CSEC are in different lands. Therefore, is more difficult in regard to landowners and permissions. ⊖ CSEC in the middle of the field, limiting the use of the land.	Disadvantages ⊖ Temporary diversion is required, unless long double circuit outage is permitted.	• Ruled out due to the use of the visual impact on Cotswolds National Trail and due to land limitation

NG Ref: PDD-101300-LAY-XXX BH Ref: 30003359-BHK-XX-XX-DR-HV-0XXX		Picture	Visual Impact	CDM Health and Safety Management	Environmental and Land Use Impact	Engineering and Construction	Decision
004	South end – B		Advantages ⊕ Longer section undergrounded → Tower ZF325 replaced. less visual impact for Ham Road users. Disadvantages ⊖ Proposed temporary tower, new terminal tower (angle tower) and CSEC are very close to Cotswold Way (National trail). This represents a significant concern regarding visual impact and public acceptance of the project.	Disadvantages ⊖ Downleads cross the existing road/access	Disadvantages ⊖ The new terminal tower cross (as well as temporary tower for diversion) and CSEC are in different lands. Therefore, is more difficult in regard to landowners and permissions ⊖ CSEC in the middle of the field, limiting the use of the land	Disadvantages ⊖ Need for temporary diversion, unless long double circuit outage is permitted.	• Ruled out due to the use of the visual impact on Cotswolds National Trail and due to land limitation. • This alternative is virtually the same as A, with the only difference being the type of tower for ZF325R and CSEC gantry. For A ZF325(New) is terminal, while for B is an angle. For South A the gantry is a standard gantry, while for South B is a full tension.
005	South end – C		Advantages ⊕ Less visual impact for Ham Road users ⊕ Reuses the existing tower ZF325. Minimum changes in the ahead span. Disadvantages ⊖ Western South CSEC has significant impact on Cotswolds Way National Trail as it is brought closer to the footpath.	Disadvantages ⊖ Two accesses to manage ⊖ Full tension downleads oversails the access track.	Advantages ⊕ Re-use of tower ZF325. Therefore, no need for a new tower construction. Disadvantages ⊖ Two CSECs, each in a different land → Access arrangements and construction in different lands ⊖ Higher land use limitation for the western CSEC as it lays in the middle of the field. ⊖	Advantages ⊕ No need for temporary diversion Disadvantages ⊖ Mechanical loads at ZF325 change and is likely to need steelwork or foundation strengthening ⊖ Need to restring the section from the South CSEC to ZF327.	• The idea of reusing the existing suspension tower ZF325 is interesting and welcome. So, further development of this concept is shown in South F. • Layout C is ruled out because South F is a better alternative
013	South end - D		Advantages ⊕ As the OHL to UGC transition is done closer ahead of ZF325, a longer section of OHL is undergrounded which mitigates visual impact in existing area of span ZF324-ZF325. Disadvantages ⊖ Tower ZF325R will have an auxiliary crossarm. ⊖ Terminal tower and CSEC are very close to the existing Cotswolds Way. This will face resistance from the public and is a huge disadvantage from the visual impact point of view ⊖ Strong visual impact during construction	Advantages ⊕ Oversailing conductor on the field is kept to a minimum ⊕ Longer section of OHL is removed so the remainder OHL section on the field in span Zf324-325 is 100% removed.	Advantages ⊕ New terminal tower and CSEC are close to each other Disadvantages ⊖ Tower ZF325R and CSEC are in different lands → access and arrangements issues ⊖ Limited land use on the field for CSEC.	Disadvantages ⊖ Temporary diversion is required ⊖ Longer cable routes.	• Ruled out because of the CSEC proximity with Cotswold National Trail.

NG Ref: PDD-101300-LAY-XXX BH Ref: 30003359-BHK-XX-XX-DR-HV-0XXX		Picture	Visual Impact	CDM Health and Safety Management	Environmental and Land Use Impact	Engineering and Construction	Decision
014	South end – E		Advantages ⊕ CSEC and ZF324R are not as close to the Cotswolds Way as other South CSEC alternatives Disadvantages ⊖ Although the tower is farther from the trail compared to the other terminations, the terminal tower and CSEC still would be visible from the Cotswolds Trail. ⊖ Auxiliary crossarm needed so terminal tower is bigger.	Disadvantages ⊖ Increase the oversailing area of the OHL conductors.	Disadvantages ⊖ Tower ZF325R and CSEC are in different lands → access and arrangements issues ⊖ Downleads oversail the existing access road.	Disadvantages ⊖ Temporary diversion is required ⊖ Tight cable bending into compound (feasible however).	• Ruled out as disadvantages outweigh advantages.

5. DISCUSSION ON SELECTED CONFIGURATIONS

Table 6 summarises the shortlisted layouts to be further developed and assessed.

Table 6 –Shortlisted terminations for OHL, UGC and CSEC

Document No.	Title
30003359-BHK-XX-XX-DR-HV-0006 PDD-101300-LAY-006	LAYOUT FOR NORTH CABLE SEALING END LOCATION AND OVERHEAD LINE TERMINATION - C
30003359-BHK-XX-XX-DR-HV-0015 PDD-101300-LAY-015	LAYOUT FOR SOUTH CABLE SEALING END LOCATION AND OVERHEAD LINE TERMINATION - F

The aerial images presented in the following subsections are not intended to be a visual impact assessment. They are merely Google Earth® representations of the OHL PLS Models that facilitate the understanding of the proposed configurations.

5.1. Discussion on Selected layout North C

North C (reproduced again in the picture below) is selected as this stage for the development stage as this configuration is considered as having the best balance between engineering, visual impact and health and safety aspects.

Figure 18 – Selected configuration (C) for North end CSEC

From the visual impact perspective, Layout C sets the CSEC on the lower (north) side of the field, where its visual impact is deemed to be less when compared to any other alternative where the CSEC is on the middle or south side of the field.

From engineering design and construction perspective, all alternatives have considered required bending radius for UGCs so any apparent sharp bend is not considered a problem. Minimum bend radii of both cables and ducts shall need to be respected.

The need of an auxiliary line for the terminal tower requires maintenance as more steelwork and pilots sets need to be used. This is however the drawback of setting the CSEC on the lower side of the field, which benefits the visual impact and Health & Safety by minimising the oversail of the conductor on the existing field.

Figure 19 –Layout C for North CSEC KMZ views (a)

Figure 20 –Layout C for North CSEC KMZ views (b)

Figure 21 –Layout C for North CSEC KMZ views (c)

5.2. Discussion on Selected layout South F

Layout South F has been selected to proceed on the South End of the undergrounding diversion.

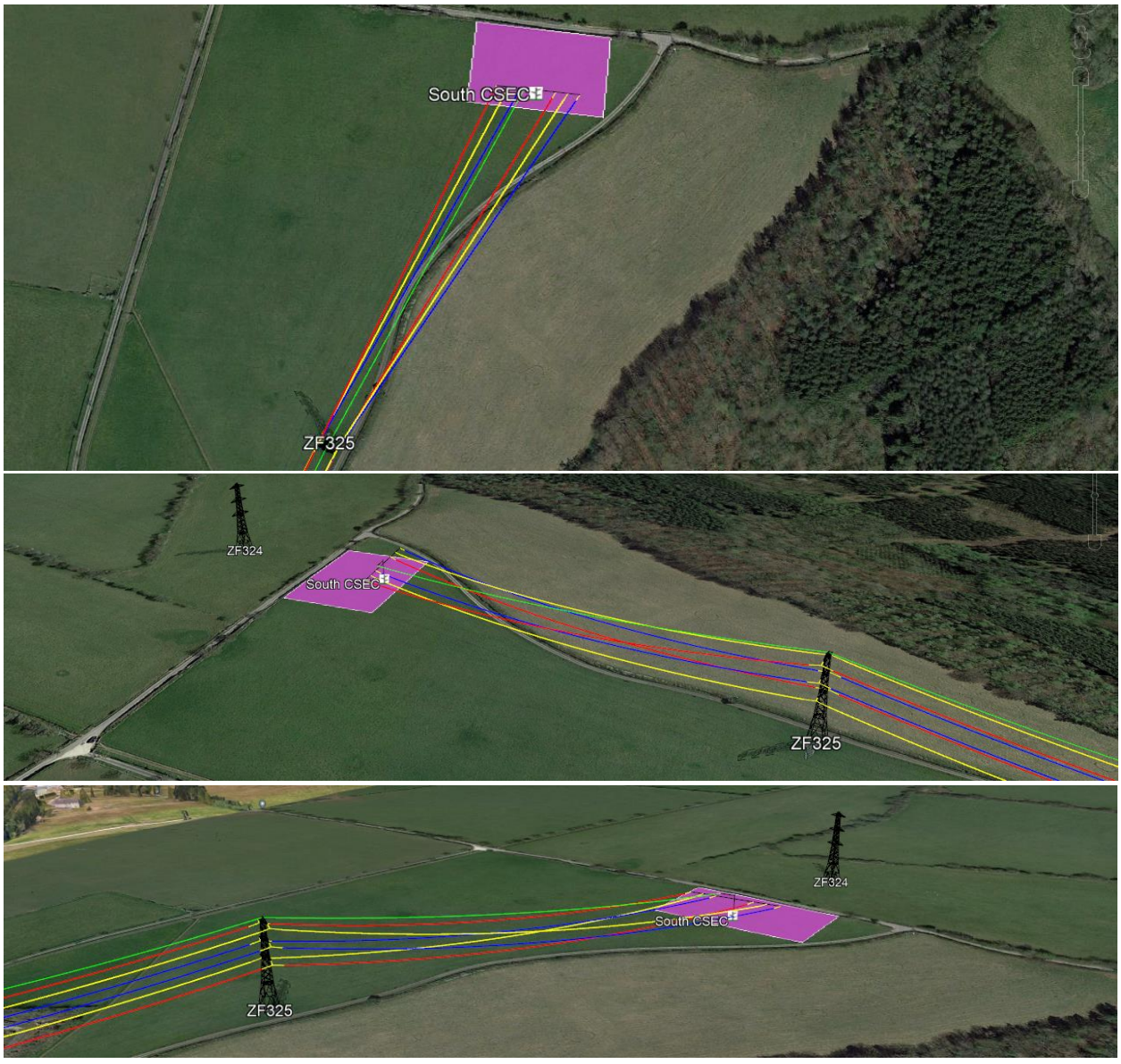
Figure 22 –Selected Layout F for South

From visual impact perspective, South F has the advantage of being the alternative that has less change from the original alignment and does not set any new CSEC or tower closer to the Cotswolds National trail, which is a key driver for the decision.

From the construction point of view, the selected South F may require reinforcement of steelwork and foundation of ZF325, as the alignment has a slight change. It also requires that the full stringing section from South CSEC to ZF327 is restrung with new conductors. The use of suspended tension sets is required at ZF325.

The location of access gate along with permanent access to CSEC is currently being revised to be set at the Northeast corner of the CSEC, which is not represented in the layout's screenshots of this document.

Figure 23 – South F CSEC KMZ views (a)



6. CONCLUSIONS

The following points summarise the discussion:

i. Layout North C is chosen at this stage for North CSEC due to the best position for CSEC and minimisation of impact on the field.

   Main factor affecting the selection for the North CSEC

   a. Topographic slope from the field, which is higher on the south and lower on the northern side.
   b. Oversailing conductors on the field to be minimised wherever is possible.
   c. It is the safest alternative by design as it minimises the oversailing conductors on the field and sets a good position for the CSEC in terms of visual impact.

ii. Layout South F is chosen at this stage for the South CSEC due to avoid the construction of a new terminal structure and to set a CSEC position that can minimise the visual impact to Cotswolds Trail as well to avoid constructing on two different lands.

   The location of access gate along with permanent access to CSEC is currently being revised to be set at the Northeast corner of the CSEC, which is not represented in this document.

   Main factors affecting the selection for the South CSEC:

   a. Proximity to the Cotswolds National Trail. Look for an termination that sets a position for CSEC further away from the trail. If not possible that allow effective screening.
      South F meet this requirement and because of that also improve safety by design.
   b. Constructing in two lands. Termination alternative should avoid constructing on two different land to minimise issues with access (construction and arrangements with landowners).

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