

03.

Evolution of Design and Alternatives

3 Evolution of Design and Alternatives

3.1 Introduction

- 3.1.1 In accordance with Regulation 5(2)(d) and Schedule 4, paragraph 2 of EIA Regulations, this chapter describes the reasonable alternatives studied by the Applicant which are relevant to the Project.
- 3.1.2 Schedule 4, Paragraph 2 of the EIA Regulations requires the EIA Report to include: “A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the Project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects”.
- 3.1.3 This chapter sets out the main reasons for the option selected and describes how the likely environmental effects of the alternatives have been considered. The design of the Project has evolved over a number of years since the need for reinforcement of the network in the central belt of Scotland was first identified. This has included consideration of alternatives for the New Build Overhead Line as well as consideration of modifications to the existing network, including substation extensions.
- 3.1.4 The chapter first considers the ‘Do Nothing’ option, before considering alternatives to the Project.

3.2 ‘Do Nothing’ Option

- 3.2.1 The ‘Do Nothing’ option was discounted at the outset. This option would be inconsistent with the Applicant’s statutory duties and licence obligations as a transmission licence holder. Under Section 9 (1) (a) of the Electricity Act 1989, the Applicant is “*responsible for maintaining an efficient, co-ordinate and economical system of electric distribution*”. The Applicant is also bound by Ofgem’s Electricity Licence Standard Conditions D2, D3 and D4A, which obliges them to provide transmission services, provide a security and quality service, and provide connections when requested. The Project is required to help enable growth in renewable electricity and support the transition to net zero also alleviating constraints on the electricity transmission system, ensuring the obligation set with the Electricity Act 1989 and by Ofgem are met. As a result, a ‘Do Nothing’ option for the whole Project was discounted.

Table 3.1 explains why each component of the Project is necessary to meet the Applicant’s statutory duties and licence obligations and why a ‘Do Nothing’ option was discounted.

Project Component	Need
New Build Overhead Line	Network reinforcement: this Project will assist in increasing the transfer capacity of the SPT network.
Upgraded Overhead Lines	As above

CB Route Removal	To be replaced with the new build WB 400 kV Overhead Line.
AA Route Undergrounding	The proposed new build Overhead Line shall oversail elements of existing AA 132kV Overhead Line. To ensure necessary ground clearance, these sections shall be undergrounded.
Denny North Substation Extension	Required to accommodate the uprating of existing ZG route from 275kV to 400kV and to allow the turn in of the Clydesmill 400kV circuit, which will maintain connection on this vital corridor carrying power to the south, maintaining and enhancing the capacity of this corridor.
Bonnybridge Substation Extension	To establish a 400/132kV Substation required for new build WB 400kV Overhead Line, including two new transformers. The extension is needed to assist in getting the power corridor connected quicker and will therefore reduce / alleviate the heavily constrained B5 boundary, which this project reinforces. It will allow larger transformers to be installed, increasing the potential demand and generation capacity of the 132kV group.
Wishaw Substation Extension	Works are required to connect the uprated 400kV circuit to the Wishaw 400kV GIS substation. Five bays of 400kV Gas Insulated Switchgear (GIS) includes a Bus Section Circuit Breaker required to facilitate the turn in of the existing 400kV Strathaven – Torness Overhead Line circuit and two bays for future projects.

3.3 Project Options

3.3.1 The Network Options Assessment (NOA) is carried out every year by NESO (previously known as NGESO) to determine what enhancements to the electricity system are required to ensure the economic and efficient operation of the transmission system. The NOA is an economic assessment of projects proposed by Transmission Operators (TO) including SPT to provide network capacity and meet the future needs to the electricity network. A number of different options to the Project were considered to achieve this goal. All of these aimed to make the best use of the existing transmission network and had been tested as alternatives or in combination with the Project:

- Windyhill-Lambhill-Denny North 400kV Reinforcement – Uprating of the existing Windyhill-Lambhill-Denny 275kV overheadline circuit, construct a new 400kV substation at Windyhill and install new 400/275kV transformers at the existing substation Grid Supply Points (GSPs) at Windyhill and Lambhill. The aim of this proposal was to allow greater flow of generation output from the SHE transmission network into the SPT

network and onto the wider GB Transmission System. This was submitted as part of the NOA 2020/21, with a recommendation from NGESO (now NESO) to delay the delivery of this project.

- Eastern Scotland B55 400kV Reinforcement. Formation of a new 400kV overhead line circuit by uprating and reconfiguring existing 275kV overhead line circuits between Longannet in Fife and Cockenzie to the south of Edinburgh area, via existing substation GSPs at Kincardine, Currie, Smeaton and Kaimes. Again, the aim of this proposal was to allow a greater flow of generation output from the SHE Transmission network into the SPT network and onto the wider GB Transmission System. This was submitted as part of the NOA 2020/21. NGESO recommended that it did not proceed at this time as it would conflict with other works to be brought forward on the SPT network during the RIIO-T2 price control period of April 2021 to March 2026. This option will continue to be reviewed via the ongoing NOA process.
- Establish Denny North-Clydesmill-Wishaw 400kV circuit from existing 275kV circuits. Construct a new 400kV overhead line circuit between the existing substation GSPs at Denny North, Clydesmill and Wishaw by reconfiguring the existing 275kV circuits between Longannet, Easterhouse and Clydesmill and Wishaw and uprating of the overhead line to operate at 400kV. This was proposed as part of the NOA 2020/2021 and was recommended to proceed by the NGESO.

3.3.2 The Project was given a 'proceed' signal meaning that it was considered appropriate to be taken forward in successive NOA publications in 2019/20¹, 2020/21² and 2021/22³ as well as the NOA Refresh published in 2022 in parallel with the publication of the Holistic Network Design (HND) which also recommended the development of the Project. The latter which set out a blueprint for the electricity network upgrades required to enable the connection of offshore wind needed to meet the Government's 2030 targets (also referred to as the 'Pathway to 2030').

3.4 Undergrounding

3.4.1 As set out in SP Energy Network's 'Approach to Routeing and Environmental Impact Assessment'⁴, SP Energy Networks' starting point for new electricity transmission infrastructure is typically an overhead line. This is because having regard to their statutory duties and licence obligations, the requirement to balance environmental, technical and economic factors supports the development of an overhead line in most circumstances. SP Energy Networks' approach to routeing identifies the main effect of new overhead lines is visual and seeks to reduce the degree of impact through careful route selection.

3.4.2 While underground cables would have a lesser permanent visual impact compared to an overhead line solution, the extent of temporary and permanent land-take has the potential for greater impacts on other environmental aspects including impacts on habitats and protected species, archaeology, surface and groundwater, soils and land use. This includes impacts

¹ NESO (2020) *Network Options Assessment* Available at: <https://www.neso.energy/document/162356/download>

² NESO (2021) *Network Options Assessment*. Available at: <https://www.neso.energy/document/185881/download>

³ NESO (2022) *Network Options Assessment*. Available at: <https://www.neso.energy/document/233081/download>

⁴ SP Energy Networks (2020) *Approach to Routeing and Environmental Impact Assessment*. Available at: https://www.spenergynetworks.co.uk/userfiles/file/Denny_to_Wishaw_Network_Upgrade_Routeing_and_Consultation.pdf

resulting from more extensive vegetation removal, topsoil and subsoil stripping, excavation of multiple trenches (typically 1-2m deep) and installing cable crossings of watercourses as well as the installation of other temporary features to enable underground cable installation such as temporary roads alongside cable trenches. This can also result in greater impacts on land use during the construction stage, particularly agricultural land use compared to typical overhead line construction activities.

- 3.4.3 Indicative engineering assessments showed that an alternative underground solution would require a minimum of 18 single core 400kV underground cables in order to deliver an equivalent capacity to the proposed 400kV double circuit overhead line. These cables would be laid within six trenches (i.e. three cables per trench) and, for technical reasons, these cables would be required to be suitably spaced out, increasing both the temporary and permanent land-take. To achieve the necessary separation and enable construction, a temporary working corridor of around 70-80m width would be required.
- 3.4.4 Technical requirements for underground cable solutions also require that ground surface infrastructure is installed. Cables are manufactured in sections and require to be connected. Adjacent sections of cable are connected at joint bays which are positioned at regular intervals along the route at which ground level infrastructure access would be required for operations and maintenance. Cable link boxes contained within access chambers would need to be located at these joint locations, and can be within small, fenced compounds depending on the surrounding land use which would protect the infrastructure from accidental damage and limit access to ensure safety. A cable solution, particularly over such lengths, would likely lead to the requirement for reactive compensation apparatus to be installed to offset the reactive power generated by these cables. This additional equipment would lead to an increase in project cost and the overall size of the substation footprint at each end of cable circuits and would likely increase the environmental impacts of the connected substations. It should be noted that the technical requirements and environmental impacts that an underground cable solution has, such as the increased space required to construct and install an underground cable as well as potential to impact features such as ecological habitats and archaeological remains, mean that an underground solution would not necessarily be feasible or preferable within the corridor identified for the WB Overhead Line solution, potentially requiring an alternative route altogether for an underground solution.
- 3.4.5 In addition to the technical constraints and environmental impacts outlined above, in line with its statutory duties, SP Energy Networks must also have regard to cost. The costs of undergrounding are significantly higher than those of an overhead line. The most recent research into electricity transmission technologies and their comparative costs was undertaken by the Institute of Engineering and Technology (IET) and published in 2025⁵. This report estimated that the initial construction of an underground cable solution is generally between five to ten times more expensive than an equivalent overhead line. The IET research also estimates that the whole life cost for an underground cable solution is generally around 4.5 times more than an equivalent overhead line solution. Given that projects of this nature

⁵ IET (April 2025) A Comparison of Electricity Transmission Technologies: Costs and Characteristics. Available at: https://www.theiet.org/media/axwkktkb/100110238_001-rev-j-electricity-transmission-costs-and-characteristics_final-full.pdf

are ultimately funded by the consumer, SP Energy Networks must ensure that an economic, coordinated and efficient solution is developed and implemented.

- 3.4.6 Overall, having regard to its statutory duties and licence obligations, SP Energy Networks do not consider an underground cable route to be a feasible alternative to an overhead line route for the project.

3.5 Proposed Works

Overview

- 3.5.1 The following section provides an overview of the approach to the identification and assessment of alternatives with a focus on the New Build Overhead Line (known as the 'WB Route') between Bonnybridge Substation and the existing overhead line (known as the 'XX Route') north of Glenmavis. The New Build Overhead Line joins the existing XX Route.
- 3.5.2 The approach to identification and assessment of alternative routes for the New Build Overhead Line has followed SPEN's approach as set out in 'Approach to Routeing and Environmental Impact Assessment'⁶. This describes SPEN's general approach to the routeing and siting of new electricity transmission infrastructure taking account of its statutory duties under the Electricity Act 1989 as well as established practice for routeing of overhead lines as set out in the Holford Rules (including subsequent reviews to reflect contemporary considerations). SPEN's approach is in two stages, Stage 1: The Routeing Process and Stage 2: Environmental Impact Assessment of Projects. In Stage 1, SPEN assesses the likely environmental effects of an overhead line and evaluates whether undergrounding should be pursued in full or for specific sections of the route. SPEN develops multiple route options and selects a preferred route to take forward, which may be refined as the design progresses and further environmental information becomes available. Stage 2 comprises the Environmental Impact Assessment (EIA) of the proposed route, the findings of which are presented in this EIA Report.
- 3.5.3 SPEN's starting point for new electricity transmission infrastructure is typically an overhead line. This is because having regard to their statutory duties and licence obligations, the requirement to balance environmental, technical and economic factors supports the development of an overhead line in most circumstances. SPEN's approach to routing identified the main effect of new overhead lines is visual and seeks to reduce the degree of impact through careful route selection. The routing study was undertaken on the basis of route options comprised entirely of overhead line routes unless such options were not considered feasible. As a preferred option and subsequently modified preferred option were identified, which would comprise entirely of new overhead line, undergrounding the route between Bonnybridge and Glenmavis was not considered necessary. In the course of developing the design of the Project as a whole consideration has been given to undergrounding existing transmission or distribution assets where they interact with the New Build Overhead Line, for example where they are physically crossed by it or where there is increased potential for significant cumulative effects as a result of the formation of wirescapes.

⁶ SPEN (2020). *Approach to Routeing and Environmental Impact Assessment*. Available at: https://www.spenergynetworks.co.uk/userfiles/file/SPEN_Approach_to_Routeing_Document_2nd_version.pdf

- 3.5.4 The approach also considered the aforementioned Holford Rules, which are the guidelines for routeing overhead lines which are generally accepted across the electric industry. The Holford Rules are as follows:
1. Avoid altogether, if possible, the major areas of highest amenity value, by so planning the general route of the line in the first place, even if the total mileage is somewhat increased in consequence.
 2. Avoid smaller areas of high amenity value or scientific interest, by deviation; provided that this can be done without using too many angle towers (i.e. the more massive structures which are used when lines change direction).
 3. Other things being equal, choose the most direct line, with no sharp changes of direction and thus fewer angle towers.
 4. Choose tree and hill backgrounds in preference to sky background wherever possible and when the line has to cross a ridge, secure this opaque background as long as possible and cross obliquely when a dip in the ridge provides an opportunity. Where it does not, cross directly, preferably between belts of trees.
 5. Prefer moderately open valleys with woods, where the apparent height of the towers will be reduced and views of the line will be broken by trees.
 6. In country which is flat and sparsely planted, keep the higher voltage lines as far as possible independent of smaller lines, converging routes, distribution lines and other masts, wires and cables so as to avoid a concatenation or 'wirescape'.
 7. Approach urban areas through industrial zones where they exist and where pleasant residential and recreational land intervenes between the approach line and substation, go carefully into the costs of undergrounding, for lines other than those of the highest voltage.
- 3.5.5 Phase 1 of the approach comprised a routeing study, the objective of which was “to identify a technically feasible and economically viable 400 kV overhead line route between Bonnybridge Substation and an appropriate tie-in point on the existing overhead line route from Easterhouse to Newarthill which causes, on balance, least disturbance to the environment of the study area and the people who live, work and enjoy recreation within it.” The routeing study identified a preferred route option, referred to as the ‘2021 Preferred Route Option’ (shown on Figure 3.2). The routeing study was reported in a Routeing and Consultation Document (RCD)⁷ and was published as part of Phase 1 Consultation which took place in 2021.
- 3.5.6 As part of Phase 1, a review of Phase 1 Consultation feedback as well as wider technical studies resulted in some modifications to the 2021 Preferred Route Option, referred to as the ‘Modified Preferred Route Option’. This was reported in a Preferred Route Option Update Report (PROUR)⁸ and was published as part of Additional Phase 1 Consultation in 2025.
- 3.5.7 Thereafter, Phase 2 commenced, comprising detailed engineering studies undertaken in parallel with EIA studies. This has resulted in the identification of a proposed route alignment

⁷ AECOM (2021). Denny to Wishaw Network Upgrade. Bonnybridge to Glenmavis 400kV Overhead Line: Routeing and Consultation Document. May 2021.

⁸ AECOM (2024). Denny-Wishaw Network Upgrade. Bonnybridge to Glenmavis 400 kV Overhead Line. Preferred Route Option Update Report. December 2024.

as well as associated works. The proposed route alignment has been designed and the corridor informed by the modified preferred route option. Phase 2 Consultation on the proposed route alignment was undertaken in autumn 2025 and modifications made in response to stakeholder and landowner/occupier feedback.

3.5.8 Feedback received during the consultation process resulted in a number of changes to the Project. These included:

- micro-siting new towers to reduce visual impact;
- moving tower WB021B by approximately 60 metres south-east to avoid Japanese knotweed, which will be treated on-site;
- altering the red line boundary of Cumbernauld Substation to include two small areas of trees that would be affected by soil excavation works to create the new substation platform (these trees will be felled and the area will be allowed to regenerate naturally); and
- updating site drainage plans in consultation with North Lanarkshire Council.

3.5.9 Further requests were also considered during consultation. These included requests for the new line (WB route) to enter Bonnybridge Substation from the east; however, this is not possible, as the new line must connect to existing infrastructure on the opposite side of the substation. Requests for the new line to follow the existing CB overhead line route were also examined, but this is not feasible as it would affect the Slamannan Plateau Special Protection Area (SPA), potentially resulting in habitat loss. In addition, we confirmed our commitment to work with the organisers of Palacerigg Country parkrun to minimise any impact on the event during construction works.

3.5.10 Consultation also included engagement with individual landowners. At Glenmavis, a landowner expressed concern that the proposed overhead line connection would have a significant negative impact on the future development potential of land owned by Pinwhinnie Property Company Ltd. While acknowledging the need for the proposed upgrades, the landowner put forward an alternative route that they considered preferable. SP Energy Networks responded to the landowner's representative, advising the landowner's suggested alternative route was not feasible for health and safety reasons, given it crossed the same corridor as a gas pipeline. Also, ground investigations undertaken in the vicinity show areas of made ground, and areas of historic mining activity, including mine shafts and mining voids, exist in the locale. Existing dwellings are located to the south.

PHASE 1: Routeing Study including route review and modification	01	Establish Project Routeing Objective
	02	Establish Study Area
	03	Identify Routeing Constraints and Considerations
	04	Identify and assess Route Corridors
	05	Identify Preferred Route Corridor
	06	Identify and assess Route Options
	07	Identify Preferred Route Option
	08	Phase 1 Consultation on Preferred Route Option
	09	Review of Consultation Feedback
	10	Modification of Preferred Route Option
	11	Additional Phase 1 consultation on Modified Preferred Route Option
	12	Confirmation of Proposed Route (for Scoping and EIA)
PHASE 2: EIA, design and consenting	13	Engineering and EIA (scoping, baseline and EIA studies)
	14	Identify Proposed Route Alignment
	15	Phase 2 Consultation on Proposed Route Alignment
	15	Modification of Proposed Route Alignment
	16	Confirmation of Proposed Route Alignment (for EIA and Consenting)

Plate 3-1: Approach to routeing and consenting for preferred route alignment

2021 Preferred Route Option

- 3.5.11 The Routeing and Consultation Document (RCD) set out the routeing study which identified the 2021 Preferred Route Option⁷. The identification of alternative route options for the New Build Overhead Line focused on a study area extending from Bonnybridge Substation to a section of the existing XX Route which is routed west to east (north of Coatbridge and Airdrie) where potential route options would end.
- 3.5.12 Strategic routeing considerations which informed the identification of larger strategic route corridors comprised large, designated sites of international or national importance as well as larger settlements. These were considered to be areas of the highest or high environmental value within the study area and included:

- The Antonine Wall, part of the Frontiers of the Roman Empire World Heritage Site (WHS) and Scheduled Monument which extends east to west across the north of the Study Area,
- The Battle of Falkirk Battlefield Inventory site to the north of the Study Area immediately south of Falkirk and Camelon;
- The Slamannan Plateau Special Protection Area (SPA) and Site of Special Scientific Interest (SSSI) which occupies a significant area in the centre of the Study Area; and
- The larger settlements of Bonnybridge, Camelon, Cumbernauld and Glenmavis which are located to the north, west and south of the Study Area.

3.5.13 In addition to the above, there were a number of other designated sites as well as scattered residential properties which were considered to be of highest or high environmental value within the study area, however, these tend to be smaller in size and more widely dispersed. Such constraints were not considered in developing route corridors given their scale and distribution but were a key consideration in the identification of route options within the route corridors. This included:

- West Fannyside Moss, Blacklaw Moss and Blawhorn Moss all designated as Special Area of Conservations (SACs) and SSSIs;
- Howierig Muir, Darnrig Moss, Longriggend Moss and North Bellstane Plantation all designated SSSIs;
- Smaller settlements and scattered rural properties or cluster of properties present within the countryside.
- A number of scheduled monuments including Roughcastle Fort, Thieves Hill and Avonhead Colliery and Drumbowie Farm; and
- A number of listed buildings including Lochgreen Farmhouse, Fannyside Mill, Luggiebank Bridge, Cleddans House and Glenboig Farm.

3.5.14 For the purposes of identifying and assessing route options the study area was split into three sections: Bonnybridge Substation to Slamannan Plateau North, Slamannan Plateau North to Slamannan Plateau South and Slamannan Plateau South to the XX route. The appraisal of alternative route options is summarised in Table 3-1 and route options are illustrated in Volume 2 Figures, Figure 3-1.

Table 3-1: Appraisal of alternative route options

Section	Route Options	Summary of Routeing Appraisal	Preferred Route Option
1. Bonnybridge Substation to Slamannan Plateau North	- Option 1a - Option 1b - Option 1c - Option 1d	All of the Route Options within this section share similar, unavoidable environmental and technical constraints. The linear nature of constraints which extend east to west including the Antonine Wall WHS and Rough Castle Fort Scheduled Monument, the Forth and Clyde canal (also a Scheduled Monument) and two railway corridors all require to be crossed by any route extending north to south. All options cross parts of the Rough Castle Fort Scheduled Monument, although Route Options 1b and 1c cross parts of the Fort that are likely to be visited most often as a place of interest by members of the public. They are also likely to have most impact on the setting of this heritage asset due to the relatively open nature of the landscape. Route Option 1a is separated from the main part of the Fort by woodland and crosses at a location where the landscape is primarily characterised by regenerating woodland and restored ground with a shallow valley landform. On balance whilst Route Option 1a crosses the largest extent of native and Ancient Woodland, it can use these features to provide separation and partial screening of the Route Option from Rough Castle Fort and from the recreational resource of the Falkirk Wheel. Route Option 1b parallels the existing 132 kV overhead lines and so contributes substantially to cumulative wirescape issues which would not be considered acceptable in heritage or landscape and visual impact terms unless the existing overhead lines are undergrounded. There is a range of infrastructure present within this section including roads, railway lines and existing transmission and distribution overhead lines. The housing allocation site to the east of Bonnybridge would be crossed by Option 1b and is comparatively less preferable to other options, however	Route Option 1a

Section	Route Options	Summary of Routeing Appraisal	Preferred Route Option
		neither existing land use or infrastructure are considered to be significant constraints. On balance Route Option 1a is considered the preferred option in this section of the route corridor.	
2. Slamannan Plateau North to Slamannan Plateau South	• Option 2a • Option 2b • Option 2c • Option 2d • Option 2e • Option 2f • Option 2g	The Route Options in this section extend across the Slamannan Plateau either east or west of the SPA. Due to the constrained nature of the route corridor to the east of the SPA there is only one Route Option (2b) which threads its way across the plateau in between the SPA and Bean Goose fields, avoiding the residential properties scattered across the landscape. Where possible the Route Option uses plantation woodland to partially screen and provide a backcloth to views of the Route Option as it crosses the moorland landscape. Route Option 2b also uses small deviations in alignment to avoid minor ridgelines within the landscape, the high points of which are often occupied by residential properties. To the west of the SPA, Route Options 2d and 2e cross an open agricultural transitioning to moorland landscape which is sparsely settled with pockets of woodland cover and plantation woodland around its edges which provides varying containment to views experienced from locations around its periphery. The land rises to the south and consequently Route Options 2d and 2e are less elevated than 2c. Route Option 2c parallels the existing 132kV overhead line crossing a landscape defined by agriculture and plantation woodland at its eastern extent to moorland and plantation woodland to the west. Aside from a section which passes close to a loose collection of properties at Tippet Craig, it is less settled than the landscape context of 2d and 2e and therefore preferable. However, Route Option 2c crosses the north western corner of the SPA and so consequently is least preferred of the three	• Route Option 2d • Route Option 2g

Section	Route Options	Summary of Routeing Appraisal	Preferred Route Option
		options. There is little difference in terms of landscape fit between Route Options 2d and 2e, although 2d provides a slightly more direct route. The subsequent Route Options 2f and 2g continue in a south westerly direction with 2g following the alignment of the existing overhead lines through the moorland plateau landscape, thereby concentrating the potential wirescape. Route Option 2f takes an alignment that disperses wirescape and follows lower topography to the north of a minor ridgeline through plantation woodland. The woodland backcloth would assist in assimilating parts of this Route Option into the landscape, however, this Route Option also passes in close proximity to the urban edge of Cumbernauld and would increase perception of overhead line from the settlement. On balance Route Option 2g is considered to be preferable to 2f. Taking into account the potential for functionally linked habitats to be present as well as known flight lines or movements of the SPA's qualifying species (Bean Goose) across the Slamannan Plateau, Route Option 2b is considered to be least preferred compared with the options which route to the west of the SPA. There is a range of existing transmission and distribution overhead lines within this section. Neither existing land use or infrastructure are considered to be significant constraints. Of these options, Route Options 2d and 2g are on balance considered to be the preferred Route Options for traversing the Slamannan Plateau.	
3. Slamannan Plateau South to the XX overhead line route	• Option 3a • Option 3b • Option 3c • Option 3d	All of the Route Options within this section thread routes which are as direct as possible to potential connection points along the Easterhouse to Newarthill overhead line. Depending on whether the Route Option provides a	• Route Option 3e • Route Option 3i

Section	Route Options	Summary of Routeing Appraisal	Preferred Route Option
	- Option 3e - Option 3g - Option 3g - Option 3h - Option 3i - Option 3j	continuation from the east or west of the Slamannan Plateau will determine which of the Route Options are followed in this section of the Route Corridor. For the continuation of Route Options to the east of the Slamannan Plateau, two principal Route Options have emerged (3a and 3b). Both of these Route Options pass through the extensive restored landscape to the west of Longriggend. Route Option 3b is aligned to the north of this area and 3a takes a less direct route to the south. A series of minor ridgelines run broadly east-west across this substantially modified landscape. Both Route Options avoid high points but Route Option 3a follows a slightly more elevated landform. Route Option 3a is also located to the north of a minor ridge that would provide some visual separation to the settlements of Caldercruix and Plains to the south. Route Option 3b passes to the north of a ridgeline that rises from Greengairs and Wattston and would not benefit to the same degree from topographic screening and separation to these settlements. Options 3a and 3b both encroach on the rotor offset of existing wind turbines as well as various planning applications for industrial/commercial development which together makes these options less desirable. There are two further options to achieve termination points on the Easterhouse to Newarthill overhead line, north of Airdrie (Route Options 3c and 3d). Route Option 3d is slightly more preferable with regard to limiting effects on potential visual receptors. A continuation of Route Options to the west of the Slamannan Plateau will result in the unavoidable crossing through Palacerigg Country Park due to the presence of the Community Growth Area to the immediate east of Cumbernauld and the SPA. There are two alternative Route Options. Route Option 3f skirts the northern edge of the Country Park whilst 3e crosses the Park following a north south alignment. While potential effects on the amenity of users of the Country Park would be reduced by Route Option 3f (as it passes through the woodland), effects on landscape features would be	

Section	Route Options	Summary of Routeing Appraisal	Preferred Route Option
		increased. Route Option 3f would also be more prominent in views from Cumbernauld as it follows a minor ridgeline before diverting south across the eastern edge of another Community Growth Area which is comparatively less preferred than other options. To the south of the Country Park, both options (3e, and 3f (continue south as option 3g)) cross minor ridgelines at oblique angles and then follow shallow valley landform, avoiding the increasingly dense pattern of scattered properties before reaching a terminating point along the existing XX route to the north of Glenmavis (Route Option 3i). To the west, additional Route Options were considered providing a termination point further west along the Easterhouse to Newarthill overhead line. These options do not provide further benefit over the Route Options described above as they encroach on various environmental constraints including Ancient Woodland, a SSSI and trigger for consideration zones associated with the increased density of residential properties present across the more settled lowland landscape. There is a range of infrastructure present in this section including roads, existing transmission and distribution overhead lines as well as Community Growth Areas and windfarms. From a land use and infrastructure perspective, Route Options 3e, 3g, 3h, 3i and 3j provide fewer constraints. Of these options, Route Options 3e and 3i are on balance considered to be the preferred Route Options for crossing the area from south of the Slamannan Plateau to XX route.	

Modified Preferred Route Option (2021)

- 3.5.15 Following Phase 1 Consultation a small number of modifications were made to the 2021 preferred route option. In summary these comprised:
- A change to the 2021 preferred route option taking account of where it starts within Bonnybridge Substation and the uprating of ZG route.
 - Changes to and rationalisation of other existing overhead lines in the vicinity of the 2021 preferred route option.
 - A change to the 2021 preferred route option to connect it to an extension at the existing Cumbernauld Substation including an extension of the substation.
 - A change to where and how the 2021 preferred route option connects to the XX route in the Glenmavis area as well as modifications of XX route.

- 3.5.16 These modifications are presented in Volume 2 Figures, Figure 3-1 to 3-3.

Bonnybridge Substation

- 3.5.17 At Bonnybridge Substation the 2021 preferred route option was routed southeast from the eastern side of the substation, however, the 'start' point for the new overhead line requires to be moved to the western side of the substation where ZG route connects to it. Connecting this new 'start' point to the 2021 preferred route option would require a longer route around the perimeter of the substation so consideration was given to a more direct route, similar to Route Option 1b previously considered, continuing south from the new 'start' point.
- 3.5.18 The key consideration within this area is the potential impact on the Antonine Wall WHS and its Outstanding Universal Value (OUV), as well as the potential impact on up to four scheduled monuments including the Antonine Wall and Rough Castle Fort as well as their settings. The 2021 preferred route option was selected because it was considered less impacting than a more direct route crossing. A direct route option crossing the WHS to the west was considered more likely to impact the setting of heritage assets due to the comparatively more open nature of the landscape in this section as well as the existing 132kV overhead lines which are also present.
- 3.5.19 The modified preferred route option utilises the same crossing of the WHS as the 2021 preferred route option by routeing within a more enclosed area where woodland provides some separation. Historic Environment Scotland (HES) were consulted extensively on route options within this area and in their feedback agreed with the 2021 preferred route option on balance, while highlighting some impacts would remain and should be considered in the development of the detailed design, in particular the location of overhead line towers in proximity to the Antonine Wall. While the modified preferred route option increases the length of new overhead line route within the WHS buffer zone and is closer to Wester Carmuir's scheduled monument to the south of the substation, this is not considered to alter the preference to cross the WHS to the east. Overall, this was still considered to be the least impacting location in which to cross the WHS particularly when taking account of additional opportunities to reduce the amount of existing electricity transmission infrastructure within the WHS setting through the rationalisation of lower voltage overhead lines including in the vicinity of Bonnybridge Substation.

Existing Overhead Line Rationalisation

- 3.5.20 There are two existing 132kV overhead lines routed south from Bonnybridge Substation. These routes head south to Drum Wood where they diverge southwest to Cumbernauld (known as 'CB Route') and southeast to Bathgate (known as 'AA Route'). The 2021 preferred route option crossed both of the existing 132kV overhead lines to the north of Drum Wood. The modified preferred route option would also cross them to the immediate south of Bonnybridge Substation where it parallels the southern boundary of the substation.
- 3.5.21 As part of the modified preferred route option it is proposed to remove CB Route in its entirety (approximately 11km of overhead line route) between Bonnybridge and Cumbernauld Substations while AA Route would be undergrounded for two short sections, south of Bonnybridge Substation and north of Drumwood, where it would be crossed by the modified preferred route option.
- 3.5.22 The AA Route, which carries both Bonnybridge-Bathgate-Drumcross 132kV feeder circuits, will be undergrounded in two sections at the locations where the new 400kV WB Route crosses this route. It is necessary to underground the 132kV Overhead Line at these points to minimise both network and safety risks resulting from the extremely unlikely event where a higher voltage conductor could fall onto the 132kV route. This also removes the requirement for additional circuit outages on both WB route circuits when carrying out maintenance on AA Route.
- 3.5.23 As noted above this rationalisation of existing infrastructure helps to reduce impacts on the WHS and scheduled monuments. In addition to removing CB Route, the modified preferred route option can largely follow the existing wayleave. There is a small section of the existing CB Route which crosses a small part of the Slamannan Plateau SPA north at Tippet Craigs. Additionally, there is a section of the existing CB Route which is routed through an area identified in the Falkirk Local Development Plan (LDP) 2 as a Wildlife Site and an area with potential to create new bog and wetland habitat (referred to as GN15). While the towers required for the New Build Overhead Line are larger (typically 46m compared to around 33m), following the existing CB Route wayleave, with the exception of the area which coincides with the Slamannan Plateau SPA, would reduce impacts including reducing the amount of woodland removal required.

Cumbernauld Substation Extension

- 3.5.24 As part of the removal of CB Route outlined above, the modified preferred route option includes an approximate 750m long spur of new 400kV overhead line which connects it to Cumbernauld Substation (see 3.5) which shall be extended. This additional section of overhead line is required to enable the removal of the existing CB Route and maintain supply of electricity to Cumbernauld Substation. Approximately 300m of the spur connecting to Cumbernauld Substation would cross Palacerigg Country Park and part of a housing allocation (reference NLCN0490B1 and NLCN0490B2) which is part of the Cumbernauld Mid Forest Community Growth Area identified in the North Lanarkshire LDP.

XX Route Tee-in

- 3.5.25 The New Build overhead line is required to connect to the existing XX Route which will also be upgraded to 400kV. The 2021 preferred route option connected to XX Route via a tee-in to the

north of Glenmavis, north of a housing development that has been constructed since the 2021 consultation. In this area a combination of the more recently constructed properties and existing housing which is spanned by the XX Route has resulted in a change of the proposed tee-in arrangement.

- 3.5.26 The XX Route is currently routed in a southeastern direction to the north of Glenmavis and spans existing housing at Grantown Gardens before turning in a slightly more southern direction as it crosses the B803 at Raebog Road to the west of the Albert Bartlett factory. As part of the modification of the Project it is proposed to divert the XX Route in an eastern/northeastern direction slightly away from Glenmavis and form a t-shape with the modified preferred route option. This will prevent the uprated XX Route oversailing the existing housing development with it being modified and continuing southwards to the east of Glenmavis within Laverock Knowe Quarry Site of Importance for Nature Conservation (SINC). The New Build Overhead Line would be moved approximately 500m east from where the 2021 preferred route option finished and instead finish at the new tee-arrangement. A small section of the existing XX Route would require to be removed including part which is routed through Laverock Knowe Quarry SINC. The modified XX Route would cross Raebog Road re-joining the existing XX Route to the west of the Albert Bartlett factory.

Detailed Route alignment 2025

- 3.5.27 This section presents a summary of the design evolution which occurred during the EIA process, and after the Stage 1 Routeing studies described in Section 3.3.1 above. During the EIA stage, the alignment of permanent and temporary infrastructure was developed within the preferred route option. The layout and alignment of the Project was amended where appropriate in response to design interventions by EIA topic leads during the EIA stage.
- 3.5.28 A summary of all design interventions and their outcomes is provided below in Table 3-2.

Table 3-2 Summary of design interventions during EIA stage

Details	Topic	Outcome
Alteration of access strategy off Brackenhirst Road Following surveys, evidence of water vole habitation was identified along Shank Burn (approximately 270m upstream of where it crosses Brackenhirst Road). To avoid impacts on Water Vole, the following changes were requested to the temporary access strategy: – proposed watercourse crossing over Shank Burn to be removed. – The use of an alternate construction access route off Brackenhirst Road to the west to be used. To better control the spread of Invasive Non-Native Species (INNS), it was requested that no construction vehicles would move	Biodiversity Water Environment	The access route has been revised for WB001 to WB003 with regards to Water Vole and a water crossing.

Details	Topic	Outcome
directly between the fields occupied by proposed new towers 002 and 003. Vehicles should instead use the alternate access from Brackenhirst Road described above.		
Alteration of access strategy, temporary works and permanent infrastructure to avoid area of peat and carbon rich soils, in particular of deep peat (>50cm). A peat depth survey was undertaken in the vicinity of proposed towers WB36, WB37 and WB38. This survey identified an area of particularly deep peat (up to 4.96m deep) beneath a proposed access track.	Ground Conditions	Access route for WB31 - WB34 have been realigned taking account of peat depth greater than 500mm
The construction traffic route for Wishaw Substation was rerouted to ensure that there was no overlap with proposed road improvements works around Motherwell and avoid impacts to traffic.	Traffic and Movement	Construction traffic route for Wishaw was rerouted to follow the overhead line proposed construction traffic route.
A section of WB was rerouted to minimise impact on agricultural working area of Pollocks Farm.	Planning	WB Towers WB043 - WB047 were realigned to the south, resulting in the overhead line oversailing a small section of Ancient Woodland.
An existing planning permission (reference: P/09/0409/FUL) (Falkirk Council) for a caravan park and chalets has been part implemented. This would be directly oversailed by the New Build Overhead Line.	Planning	The decision was taken to alter the WB route to avoid conflict with the approved planning permission and to pull the alignment further to the west and away from the land with planning permission by altering tower positions (WB50 to 48).
Previously a small extension was required at Easterhouse Substation to facilitate the installation of a new line Circuit Breaker. This requirement was removed during the detailed design process.	Design refinement	These works are now required independently of DWNO and in turn are scoped out of the EIA Report.

Details	Topic	Outcome
Newarthill substation has been considered as part of the design since scoping. This requires only internal works.	Design refinement	These works are now required independently of DWNO and in turn are scoped out of the EIA Report.
Internal substation works at Denny North Substation were formerly in scope.	Design refinement	The internal works proposed at Denny North substation are removed from scope as these works were approved under extant Planning Permission Ref: 05/0913/FUL (Falkirk Council).

3.6 Uprated Overhead Lines

- 3.6.1 Upgrading of existing infrastructure where possible was determined to be the most economical solution to contributing to increased capacity of the transmission network, while also minimising impacts on the environment. Alternatives which would achieve the same goal include installation of entirely new overhead and underground transmission infrastructure. However, this would likely result in unacceptable cost, and higher environmental impacts in comparison to upgrading existing infrastructure.
- 3.6.2 The upgrading of existing overhead lines alone cannot establish a fourth north to south 400kV double circuit Overhead Line across the B5 boundary, due to the required additional transmission capacity, hence the need for the new 400kV double circuit between Bonnybridge 275/132kV substation to XX route at Glenmavis.
- 3.6.3 The route options for WB are guided by the points of connection, Bonnybridge substation to XX route tee-in at Glenmavis via Cumbernauld Substation. This is the primary driver as opposed to the ability to upgrade existing lines.
- 3.6.4 Upgrading constitutes a smaller scale of works in comparison to creating new transmission infrastructure. Upgrading involves the replacement of existing conductors between existing transmission towers and tower strengthening and foundation upgraded may be required, to facilitate conductor upgrades.
- 3.6.5 As part of the Project, it was decided to upgrade the following existing overhead line routes from 275kV to 400kV:
- XR route;
 - XX route; and
 - ZG route.

3.7 Substations

- 3.7.1 The decision to extend substations is primarily driven by the decision to uprate existing infrastructure. The substation extensions are required to accommodate new electrical equipment required in response to the increased operating voltage.
- 3.7.2 It was not considered appropriate to create new substations at a separate location from the existing substation outlined above. This would likely require additional underground cabling or new overhead line infrastructure, which would result in likely higher costs and environmental impacts.

Denny North Substation Extension

- 3.7.3 The requirement to extend Denny North Substation is driven by uprating existing overhead lines as described in Section 3.6 above. Specifically, the extension at Denny North Substation is required due to the uprating of the existing ZG route to 400kV and to accommodate new electrical equipment required in response to the increased operating voltage. The extension at Denny North Substation is designed to extend out in an western and southern direction, this is to facilitate a direct connection to both the ZG Route to the south and ZD towers to the west.

Bonnybridge Substation Extension

- 3.7.4 The requirement to extend Bonnybridge substation is driven by uprating existing overhead lines as described in Section 3.6. Specifically, the extension at Bonnybridge Substation is required due to the uprating of the existing ZG route as well as the construction of the New Build Overhead Line and to accommodate new electrical equipment required in response to the increased operating voltage. A western side extension was selected as there is sufficient land available on the western side and it facilitates the most direct connection to the ZG Route and the New Build Overhead Line.

Cumbernauld Substation Extension

- 3.7.5 The requirement to extend Cumbernauld substation is driven by the decision to rationalise existing grid infrastructure in this region and minimise potential for increased setting impacts on the Antonine Wall WHS (World Heritage Site). The existing CB route presently crosses the Antonine Wall WHS. This rationalisation includes removal of the existing CB route in its entirety. CB route currently connects to Cumbernauld Substation. The removal of CB route would otherwise disconnect it from the network . The New Build Overhead Line route is proposed to be connected to Cumbernauld substation therefore requiring an extension to Cumbernauld substation due to an increase in operating voltage. An alternative substation site would not be a reasonable alternative given CB route connects the GSP to the transmission system.
- 3.7.6 By removing CB route, this also permits the New Build Overhead Line to largely follow the existing CB route wayleave. A small section of the existing CB route presently crosses a small part of the Slamannan Plateau SPA north at Tippet Craigs, and this would be removed.

275kV/33kV substation extension location and siting

- 3.7.7 The Project would extend the existing Cumbernauld substation generally to the south-east of the existing substation.

- 3.7.8 The layout and footprint of the Project have been determined by existing technical constraints, including Forest Road to the north-west, and a residential housing development to the north-east. Design refinement at Cumbernauld Substation Extension has minimised extending the existing substation footprint significantly to the south-west. This minimises as far as possible the impacts on an area of woodland situated to the south-west of the existing substation. This area of woodland forms part of Palacerigg Country park. This woodland is also designated both as a Site of Interest for Nature Conservation, and a Scottish Wildlife Trust Reserve, each of which shall remain.

Substation technology

- 3.7.9 All new switchgear and busbar connections associated with Cumbernauld Substation Extension will be air-insulated. Air-insulated technology is an alternative to gas-insulation technology. Gas insulation utilises Sulphur Hexafluoride (SF₆), which is a powerful greenhouse gas.

Although gas insulation technology requires less space (and would minimise the overall substation extension footprint), air-insulation avoids construction and operational fugitive (accidental or unwanted) SF₆ emissions. While the circuit breakers in the air-insulated substation would contain gas (to be determined as SF₆ or non-SF₆) this is within the contained circuit breakers as opposed to insulation of the whole substation.

Drainage design

- 3.7.10 As an alternative to raising ground levels, elevating equipment or barriers around individual items, SPEN's Substation Flood Resilience Policy stipulates that a flood wall or embankment around the Site perimeter can be considered. As with barriers around individual items, there is the residual risk of the flood wall or embankment failing which is not present when the level of plant items and equipment are raised.
- 3.7.11 The feasibility of this method was investigated in the pluvial flood model by representing a raised wall around the perimeter of the entire proposed substation platform. The outputs indicate that this would result in overland flows from the south of the Site being intercepted by the flood wall. The majority of the flows would be redirected along the western extent of the Site and onto Forest Road. This would result in an increase in flood depths on Forest Road in the 1-in-200-year-plus climate change return period. This increase in flood risk outside of the Site is considered unacceptable under National Planning Framework 4, therefore, this mitigation option is not considered suitable for the Site.

Earthworks

- 3.7.12 Two earthworks' options were considered, a 1:3 slope and 1:1 slope. A 1:3 slope was taken forward as the 1:1 slope was unverifiable due to a lack of ground investigation works. Once ground investigation works have been complete, the 1:1 slope may be reconsidered to reduce the amount of cut and fill and impact of the works.

Wishaw Substation Extension

- 3.7.13 The requirement to extend Wishaw substation is driven by the decision to rationalise existing grid infrastructure in this region by uprating existing overhead lines as described in Section 3.6. Specifically, the extension at Wishaw Substation is required due to the uprating of the

existing XR Route and to accommodate new electrical equipment required in response to the increased operating voltage.

- 3.7.14 The layout and footprint for Wishaw Substation Extension has been determined by the space required to install air-insulated busbars and gas-insulated busbars around the site. Underground cables were considered to achieve the 400kV connection into the substation, however this was discounted due to space constraints.

Easterhouse Substation Internal Works

- 3.7.15 Previously a small extension of the site was required to facilitate the installation of the new line Circuit Breaker within the existing footprint. This requirement was removed during the detailed design process and will not be progressed. Consequently, this design confines the substation works to the existing platform, avoiding any new land take. As such Easterhouse Substation has been scoped out of the EIA.

Newarthill Substation Internal Works

- 3.7.16 In order to maintain the connection between the west and east following the repurposing of the Newarthill-Wishaw No.1 275kV circuit, it is necessary to replace some additional Current Transformers, Disconnectors and Earth Switches and to connect the existing Newarthill-Wishaw No.2 275kV circuit to the reconfigured 275kV Busbars. This design confines the substation works to the existing platform, avoiding any new land take. As such Newarthill Substation internal works has been scoped out of the EIA.

3.8 CB Route Removal

- 3.8.1 As detailed in Section 3.5 during the selection of the Modified Preferred Option the decision was made to remove the existing 132kV overhead line CB Route. The removal of the CB Route is required to rationalise the existing infrastructure to help reduce the impact on the Antonine Wall part of the WHS and Scheduled Monument, and to also enable the New Build Overhead Line to follow the existing wayleave corridor. The removal of a small section of the existing CB Route which crosses a small part of the Slamannan Plateau SPA north at Tippet Craigs would also ensure that no overhead lines are present within the designation reducing any impacts. Additionally, there is a section of the existing CB Route which is routed through an area identified in the Falkirk LDP 2 as a Wildlife Site and an area with potential to create new bog and wetland habitat (referred to as GN15).

3.9 AA Route Undergrounding

- 3.9.1 The AA route will be undergrounded at two sections where the existing overhead line crosses the New Build Overhead Line will be undergrounded to provide the required safety clearances. In addition, in consultation with Historic Environment Scotland (HES) it has been proposed to assist with the reduction of potential impacts on the WHS and scheduled monuments within the wider area, and a decision was taken along with the inputs of Falkirk Council and SPEN for the design to underground two sections of the AA route and between Bonnybridge Substation and existing AA towers of AA001 and in between existing towers AA006 and AA009. Towers AA001A, AA001B, AA006, AA007, AA008 and AA009 will be dismantled and the undergrounding will require 3 new CSE towers to be constructed

(AA001CSE, AA006CSE and AA009CSE). Please refer to Section 3.4 for further information on the design evolution.

3.10 Distribution Line Diversions

Need for Works

- 3.10.1 In order to facilitate the construction of the WB route and uprating of ZG, XX, XR routes and to establish the necessary safety clearances, the existing distribution assets (11 & 33kV overhead line) are required to be temporarily dipped (taken down and undergrounded) and in some locations permanently diverted.
- 3.10.2 The undergrounding of distribution infrastructure is predominantly temporary due to the nature of these being Overhead Lines. SPD prefer these are returned to Overhead Line due to difficulties identifying faults under emergency situations. Notwithstanding this, there are instances where underground cables are required to remain permanent, for example where towers or transmission lines replace existing SPD assets or where substation extensions are constructed where distribution Overhead Lines are currently situated.

Alternatives Considered

- 3.10.3 There are no currently known alternatives to the approach for the SPD works as it is a safety requirement to have the correct clearances in place when working in proximity to other overhead line(s).

3.11 Summary

As detailed above the Project has been designed to fulfil the Applicant's statutory duties and licence obligations as a transmission licence holder. This requires that the Project is designed to provide the right balance of economic, technical and environmental considerations. Existing assets have been utilised as much as possible by uprating the XR, XX and ZG overhead lines and extending existing substations. The New Build Overhead Line has been routed and designed to avoid or minimise any environmental effects including by selecting the route with the least impact to the Antonine Wall WHS, and routing west of the Slamannan Plateau to avoid sensitive habitats. The design has been further refined during the EIA process to avoid existing planning applications and to minimise effects on peat, protected species, woodland.