Scottish Hydro Electric

ScottishPower

Proposed Beauly to Denny 400 kV Overhead Transmission Line

The use of underground cable as an alternative to overhead line:

STIRLING

Final Report
October 2007

PB In association with

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

1) SHETL and SPT have applied for Section 37 Consent under the Electricity Act 1989 to construct a new 400 kV overhead line (OHL) between Beauly and Denny. Underground cable (UGC) alternatives to various parts of the OHL have been proposed in response to this application, and the applicants wish to assess the implications of these alternatives in terms of technical feasibility, environmental impact, and cost considerations.

2) A number of parties proposed OHL and UGC search areas between the existing substation at Braco and the existing substation at Denny. These proposals, when considered together, comprised two search areas: (i) Braco to Denny (33km) referred to as the West of Stirling Route, and (ii) a search area east of Stirling from Cocksburn Wood to Manor Powis (3.9km) referred to as the Ochils Escarpment Route. The areas of search included, as required, routeing of OHLs, UGCs and location of Sealing End Compounds (SECs). This report sets out at a strategic level the technical and cost appraisals, and environmental commentaries of such alternative routes and technologies within these search areas.

3) Graphical overview of these proposals may be found in this document on the following pages:-

- In diagrammatic format in Figure 1-1 to Figure 1-3
- In aerial photograph format in Appendix 5, and
- In map format in Appendix 6.

4) This appraisal relies upon and makes extensive use of the following previous reports to the Public Inquiry on the subject of undergrounding:

- The Use of Underground Cable as an Alternative to Overhead Line in Specific Locations (APL 5/16a – referred to in this report as APL 5/16).
- Report: The Effect of Heat Dissipation and Soil Disturbance due to Construction on Vegetation Re-establishment (APL 5/16b).
- The Use of Underground Cable as an Alternative to Overhead Line: Beauly – Eskadale (APL/INV-4).
- The Use of Underground Cable as an Alternative to Overhead Line: Cairngorms National Park (APL/CNP-41).
- The Use of Underground Cable as an Alternative to Overhead Line: Perth & Kinross (APL/PTH-41).

1.2 OBJECTIVE OF APPRAISAL

5) This document reports, at a strategic level, upon the technical, environmental, and cost implications of routeing and construction alternatives in two search areas (to the west of Stirling, and to the east of Stirling at the Ochils Escarpment) that have been put forward in response to the proposed OHL. The work has comprised a comparison of the alternative UGC/OHL routes and construction options with those of the Proposed OHL, based on site and desk work, concentrating upon:

- Strategic technical and routeing considerations for UGC and OHL technologies along with sealing end compound (SEC) requirements,
- Strategic environmental commentary on the likely significant adverse residual environmental effects of the proposals associated with underground and overhead line routes, and comparing the significant adverse environmental effects of UGC/OHL routes with those reported for the proposed OHL, and
- Strategy level cost differences between UGC/OHL routes and the proposed OHL.

6) The environmental appraisal is based upon the Environmental Statement (ES) and the work already completed and reported to the Strategic and Local Sessions of the Public Inquiry in the documents listed in paragraph 4.

7) The objective of the appraisal is to provide a comparison between the proposed OHL and routeing and construction alternatives proposed by other parties. This comparison is carried out at a strategic level having regard to technical, environmental and cost considerations.

1.3 APPRAISAL BRIEF

1.3.1 Appraisal Process

8) The area from Braco to Denny was visited by Simon Lloyd, Mark Turnbull and Mark Winfield on 30 January 2007 during the preparation of Case Study 3: Lower Taylorton to Logie, Case Study 4: Lower Taylorton to Cocksburn Wood and Case Study 5: Glenburn to Touch Road contained in APL 5/16. Simon Lloyd and Mark Winfield then visited the area on a number of occasions during September/October 2007 for the purposes of this present report. Mark Turnbull and other members of the EIA Team had visited the areas on previous occasions.

9) Mark Turnbull prepared and circulated a draft briefing note "Identification of Cambushinnie to Denny (West of Stirling Route) and Bridge of Allan Route" on 23 August 2007 (Appendix 1). At the time the draft briefing note was prepared SHETL/SPT were still in the process of clarifying Stirling Council's position regarding its support for the SNH proposals, and its intention, therefore, not to submit any separate proposals of its own. Consequently no proposal was indicated for the Council in the draft brief.

1.3.2 Terminology

10) To avoid confusion between the various undergrounding proposals and appraisals covered by the undergrounding documents listed in paragraph 4 above, care has been taken to use different terminology, nomenclature and numbering for each.

TERMINOLOGY	**NOMENCLATURE & NUMBERING**	**COMMENT**
Search Area	UGC1 to UGC4	UGC1 – Beauly to Eskadale UGC2 – Garva Bridge to south of Dalwhinnie UGC3 – Tummel Bridge to south of Muthill UGC4 – Braco to Denny
Search Area Sections	A, B, B1, B2 etc., C etc.	

1.3.3 Proposals Received

11) Three undergrounding proposals from four objectors have been assessed. The four objectors are as follows:

- Scottish Natural Heritage (SNH)
- Stirling Council (SC)
- Stirling Before Pylons (SBP)
- University of Stirling (UoS)

12) The reason that only three undergrounding proposals have been assessed is that Stirling Council has declared to SHETL that it will support the SNH proposals, and has not, therefore submitted any separate proposals of its own even though it has stated separate objectives.

1.3.4 Interpretation and Identification of Search Areas

13) The route proposal information received was interpreted as follows.

14) SNH provided, on 18 June 2007, three route drawings. These were titled "Beauly – Denny Transmission Line West Stirling Alternative Route Map 1 (North) and Map 2 (South) SNH Revised Alternative 18 June 2007" (Figure 1-5 and Figure 1-6), and Map 3 SNH Other Alternative Routes South of A811 (Figure 1-7). This last drawing was originally issued on 30 January 2007, but was reiterated in their 18 June 2007 letter.

15) SNH Maps 1 and 2 (referred to here as the "SNH 18June07" option) propose undergrounding between Strathallan and Cambusbarron, and OHL between Cambusbarron and Denny, whilst the earlier Map 3 (referred to here as the "SNH 30Jan07" option) proposes undergrounding all the way from Strathallan to Denny.

16) SC supports SNH's route proposal information.

17) SBP, in a letter of 22 January 2007, do not identify a route to the west of Stirling, but suggested following the existing oil and gas pipeline corridor shown in the proposed Beauly - Denny 400kV Overhead Transmission Line - Consultation Document January 2004 Vol 1: Text, subsection 4.8.2 "Safeguarded Areas", and Vol 2: Figures, figure 4.22 "Pipeline Consultation Area". They also suggest investigating a route following the M9. An email of 8 October 2007 from SBP to SHETL confirmed that they were seeking undergrounding through the whole of the Stirling Area on a route to the west of Stirling. This was interpreted as undergrounding from Braco to Denny by connecting at an appropriate point an UGC route from Braco to SNH's UGC route from Cambushinnie to Denny.

18) UoS propose undergrounding the Proposed OHL route at Bridge of Allan (see Figure 1-8).

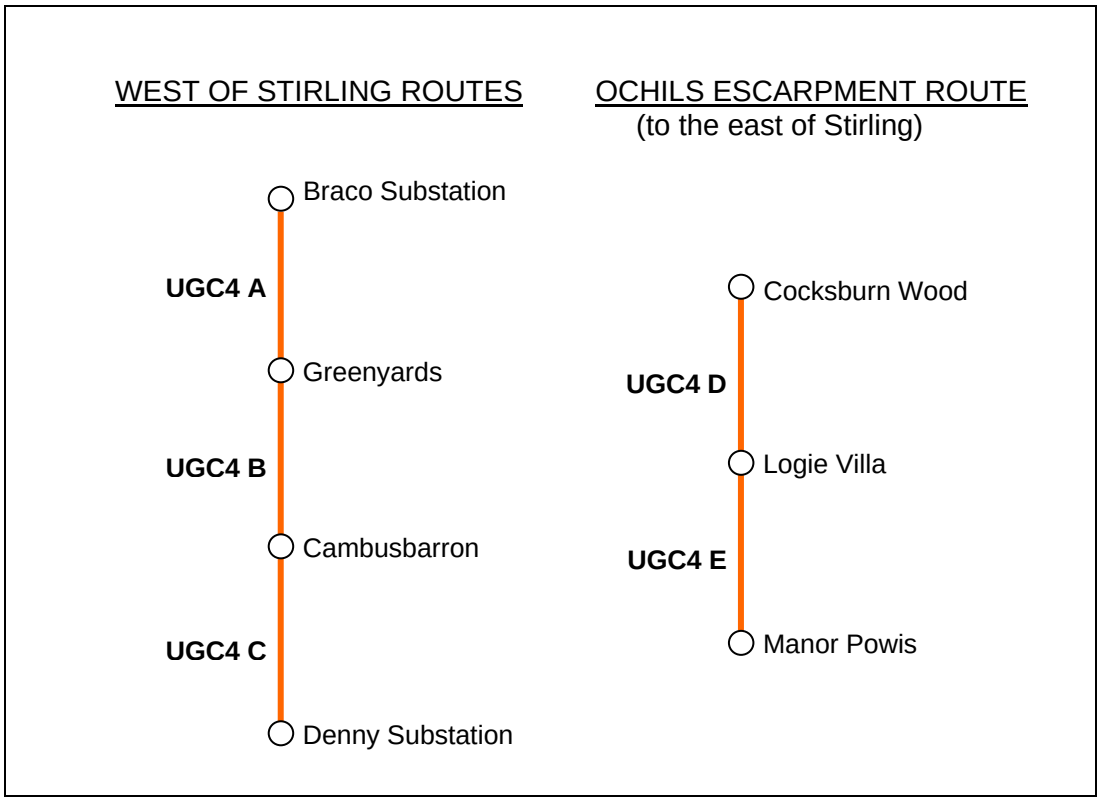
19) These three undergrounding proposals are all designated UGC4 (to distinguish them from the more northerly proposals made at the earlier Local Sessions of the Public Inquiry) and may be considered to consist of the following sections:

- West of Stirling -
    - UGC4 A – Braco Substation to Greenyards (just south of A820)
    - UGC4 B – Greenyards to Cambusbarron
    - UGC4 C – Cambusbarron to Denny Substation

- East of Stirling -
  - o UGC4 D – Cocksburn Wood to Logie Villa
  - o UGC4 E – Logie Villa to Manor Powis

20) These sections may be depicted at a high level as shown in Figure 1-1.

Figure 1-1: Undergrounding Route Sections



21) In practice, sections UGC4 A and UGC4 C have more than one assessed route, and parts of these routes comprise OHL rather than UGC. The following diagrams, Figure 1-2 and Figure 1-3, show these details, and also indicate the northern and southern extents of each objector's proposals.

Figure 1-2: Undergrounding Routes West of Stirling

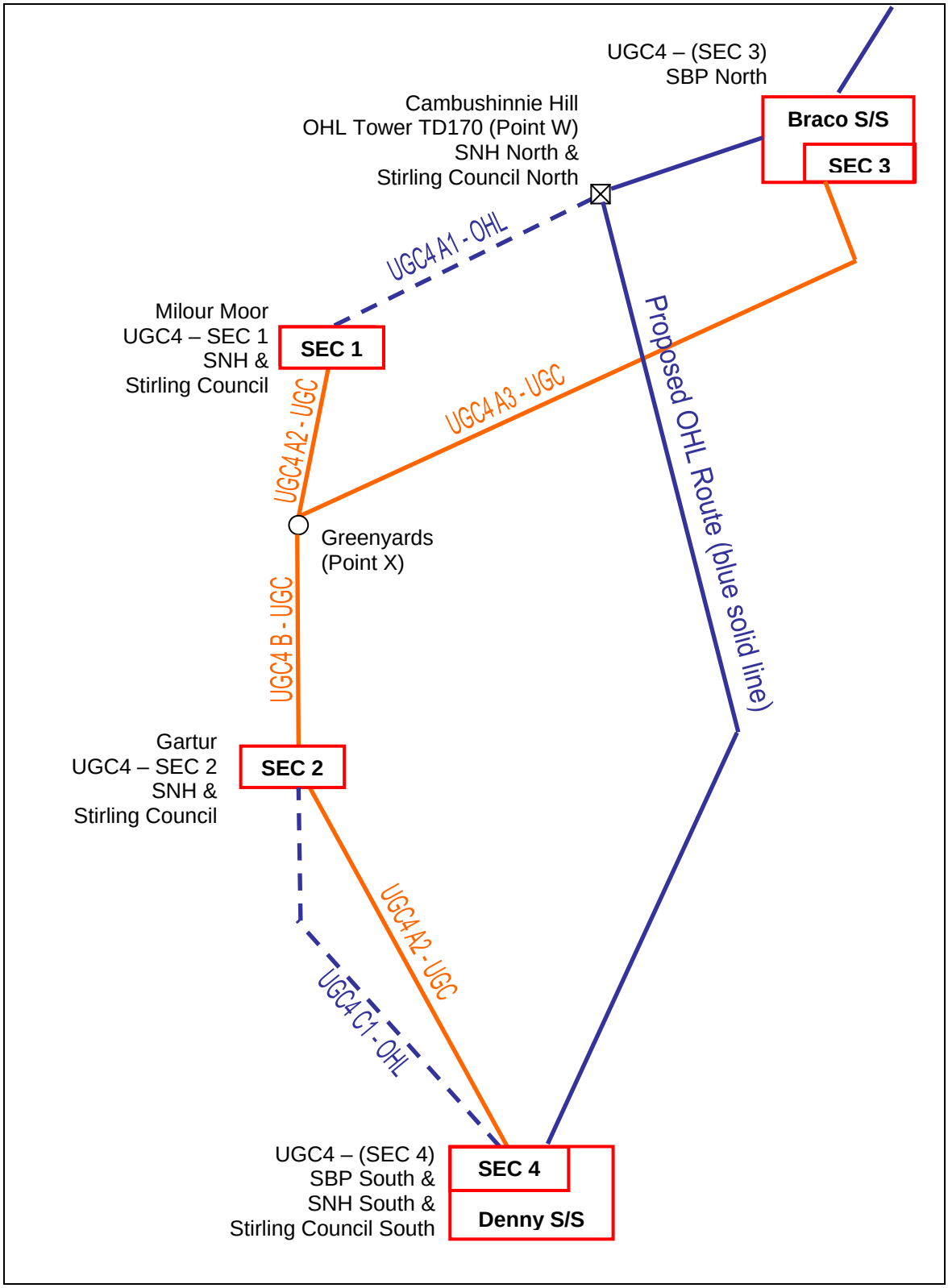
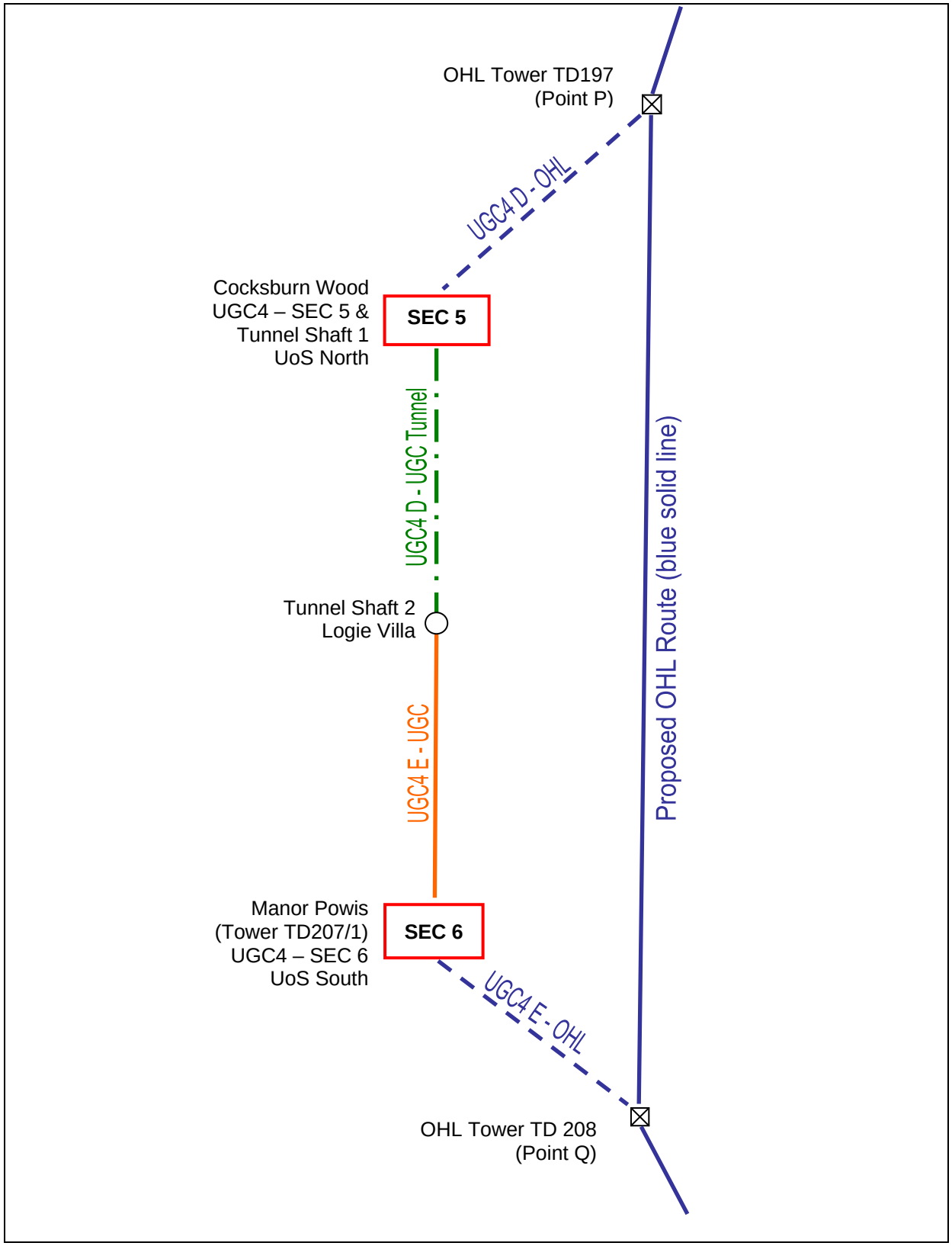


Figure 1-3: Ochils Escarpment Route East of Stirling



1.3.5 Data Used

22) The appraisal was at a strategic level, mainly desk based using existing data, combined with information from site visits and knowledge of the areas. Guidance

and information has been obtained from the sources below. Unlike the proposed OHL, no detailed survey or other information was available to the EIA Team with regards to the west of Stirling Route other than that contained in the Consultation Document.

- Report: The Use of Underground Cable as an Alternative to Overhead Line in Specific Locations" (APL 5/16, January 2007) in particular Case Studies 4 and 5,
- Report: The Effect of Heat Dissipation and Soil Disturbance due to Construction on Vegetation Re-establishment (APL 5/16b),
- Knowledge already gained, in particular from the earlier reports in this series, Beauly – Eskadale (APL/INV-4, April 2007), Cairngorms National Park (APL/CNP-41, August 2007), and Perth and Kinross (APL/PTH-41, September 2007),
- Any data available from the preparation of the SHETL/SPT Consultation Document, Environmental Statement (ES) and other EIA work (all parts of the ES including the Addenda and work on access tracks etc) and Significant Effects maps, and
- Information readily available from site visits and a desk based review including maps, aerial photographs, or relevant websites.

1.3.6 Working Strategy

- Identify, in line with the content of alternative proposals, practical undergrounding routes and most favourable route access points.
- break route into sections that on a technical, environmental and cost basis may be analysed in the same way as route-types that occurred in previous undergrounding appraisals for the Public Inquiry, and
- identify route sections whose types have not previously occurred in previous appraisals, and seek specialist strategic advice for their analysis, as necessary.

1.3.7 Working Method

- Identify search areas,
- Obtain undergrounding objectives from Proposers,
- Obtain relevant OS maps (Appendix 6) and where possible aerial photographs (Appendix 5), and indicate search areas,
- Undertake site visits as necessary,
- Identify UGC and OHL routes and locations for SECs
- Identify applicability of previous technical, environmental and cost work to the various environmental conditions within the search areas,
- Team working by telephone and email discussion.
- Prepare a First Draft Report for comment by SHETL and SPT,
- Discussion meetings (if necessary)
- Prepare Final Report for submission to SHETL and SPT.

1.3.8 Stated Objectives of Objectors

23) **SNH** in an email to SHETL of 1 October 2007 stated their alternative routeing objective for their West of Stirling OHL and UGC routes as follows:

> The objective of SNH is to ascertain if there is an alternative route option, including but not limited to the search areas identified on the maps that accompanied the letter of 18 June 2007, which:
>
> (i) Avoids the adverse visual and landscape impacts associated with the proposed OHL route over the Ochils scarp and the associated woodland clearance, and
>
> (ii) Avoids both equivalent levels of adverse impact on any other valued aspect of the natural heritage and effects of major significance on the visual amenity of residents in the Stirling area.

24) In a letter of 2 October 2007 SHETL sought clarification from SNH on what they meant by "including but not limited to the search areas identified on the maps that accompanied the letter of 18 June 2007". SNH responded in a letter of 3 October 2007 confirming that it was a matter for SHETL/SPT to determine the basis upon which it would prepare an undergrounding report for the Stirling local session and that SHETL's letter of 2 October stated that the basis would be SNH's proposals of 18 June 2007 (Figure 1-5 to Figure 1-7).

25) In response to SHETL's request for SC to confirm their verbal support the SNH proposals of 18 June 2007 (Figure 1-5 to Figure 1-7) and to state the Council's undergrounding objectives for these proposals, SC responded by emailing the document below.

Figure 1-4: Email from SC

Other Planning Issues

ISSUE: **Beauly to Denny 400kv overhead line upgrade proposal**

Public Inquiry information statement in relation to preparation of Council documentation for the Inquiry

Officer: Mick Stewart, Telephone: 442958, Email: stewartmj@stirling.gov.uk

Considerations:

Members will recall the decision taken at Planning Panel on 4th May 2006 to notify Scottish Ministers that the Council objected to the proposed development in the form submitted.
The objections were on four grounds, noting concern over: -

a) The effect of the proposal on high amenity and historic areas.
b) Prematurity pending the release of the SAGE report on emissions.
c) Public concern on health issues.
d) Insufficient justification having been provided on route selection.

Subsequent to that decision, work has been undertaken on identifying a strategy for the Council to present at the Inquiry. This work has focused on the selection of the route of the line around Stirling, and has led to the identification of a route corridor to the west of Stirling, where it is considered, in consultation with Scottish Natural Heritage, that it is environmentally possible to locate the power line. If the inquiry were to accept the suggested western route, it is considered that a substantial part, if not all, of the line would have to be laid underground to minimise any visual environmental effects. The Reporters asked that objectors consider potential alternative routes.

If a western route were to be adopted, it is considered that it would relate to the terms of the Council's objections in the following ways: -

a) There would be no effect on the site of the Battle of Sheriffmuir and the Wallace Monument
b) The issue of emissions from overhead lines on populated areas and people would be removed as a major factor, although detailed western routing would require to be carefully considered.
c) Public concern over health issues relating to overhead lines would be satisfactorily addressed
d) The route selection process could be seen to have been comprehensive in considering all options.

It is therefore considered that the Strategy, set out above would, if successful, provide a satisfactory resolution of the Council's well-founded objections to the original proposal.

The documents setting out the Council's Statement of Case for the local session of the Inquiry, which commences on 20th November, and the Joint (Highland, Perth & Kinross and Stirling) Councils Statement of Case for the Strategy session which commences on 8th February are available within Planning Services in Viewforth, and at the Central Library.

StatementtoCouncil.doc

26) Further confirmation was sought by SHETL on the matter of support for SNH's proposals however an email received from the Council on 7 October 2007 in response to this request was not specific and arrived after the final selection of the UGC and OHL routes on 5-10-07.

Figure 1-5: SNH Alternative Route Map 1 (18June07)

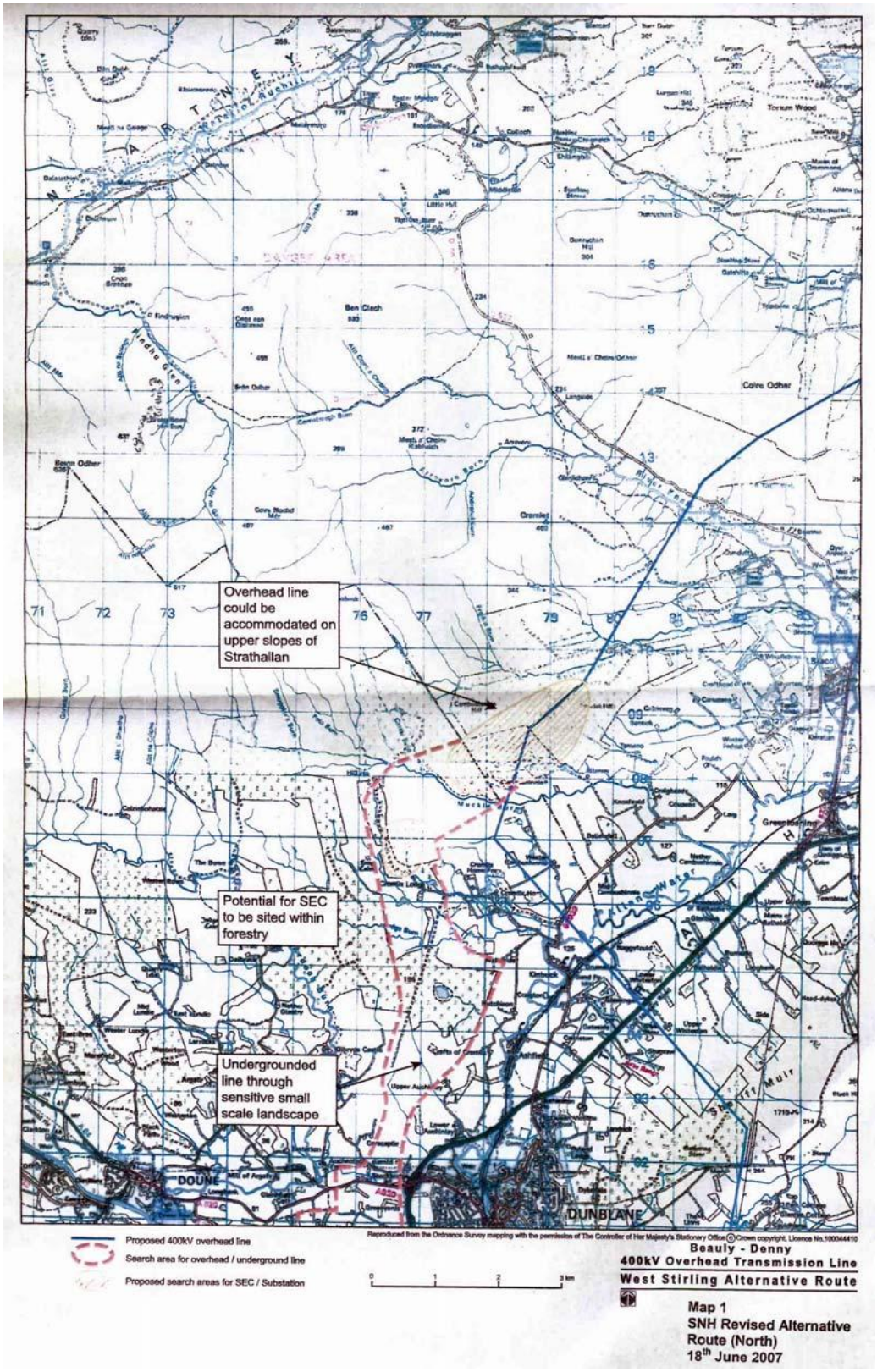


Figure 1-6: SNH Alternative Route Map 2 (18June07)

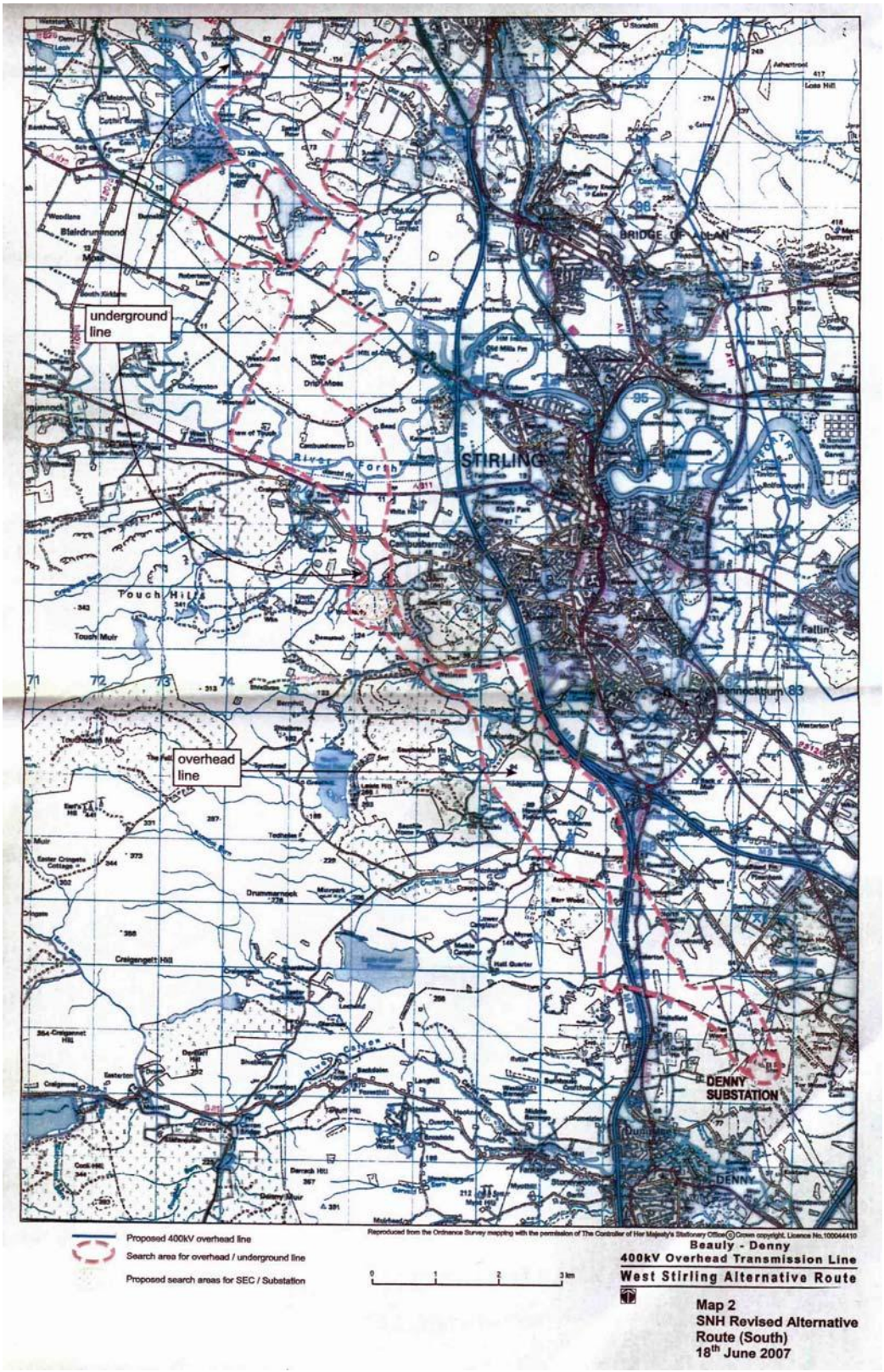
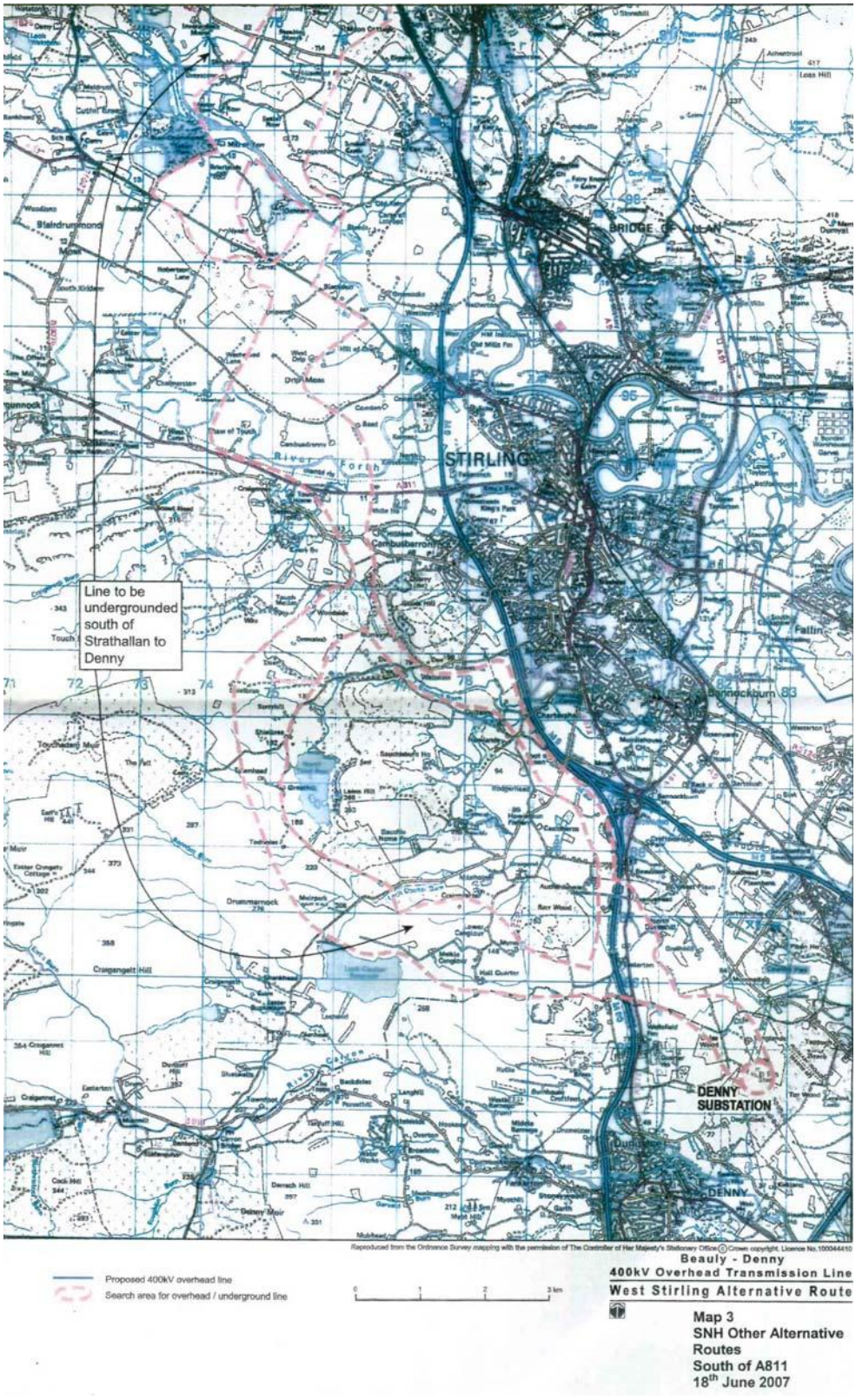


Figure 1-7: SNH Alternative Route Map 3 (30Jan07)



27) With reference to **SBP's** letter of 22 January 2007, SHETL emailed SBP on 1 October 2007 requesting confirmation that SBP was seeking the totality of the route from Braco to Denny to be undergrounded or specific areas within the length of that route, in this context specific reference was made to SNH's all UGC proposal of 18 June 2007, SBP confirmed that their position remained unchanged from their letter.

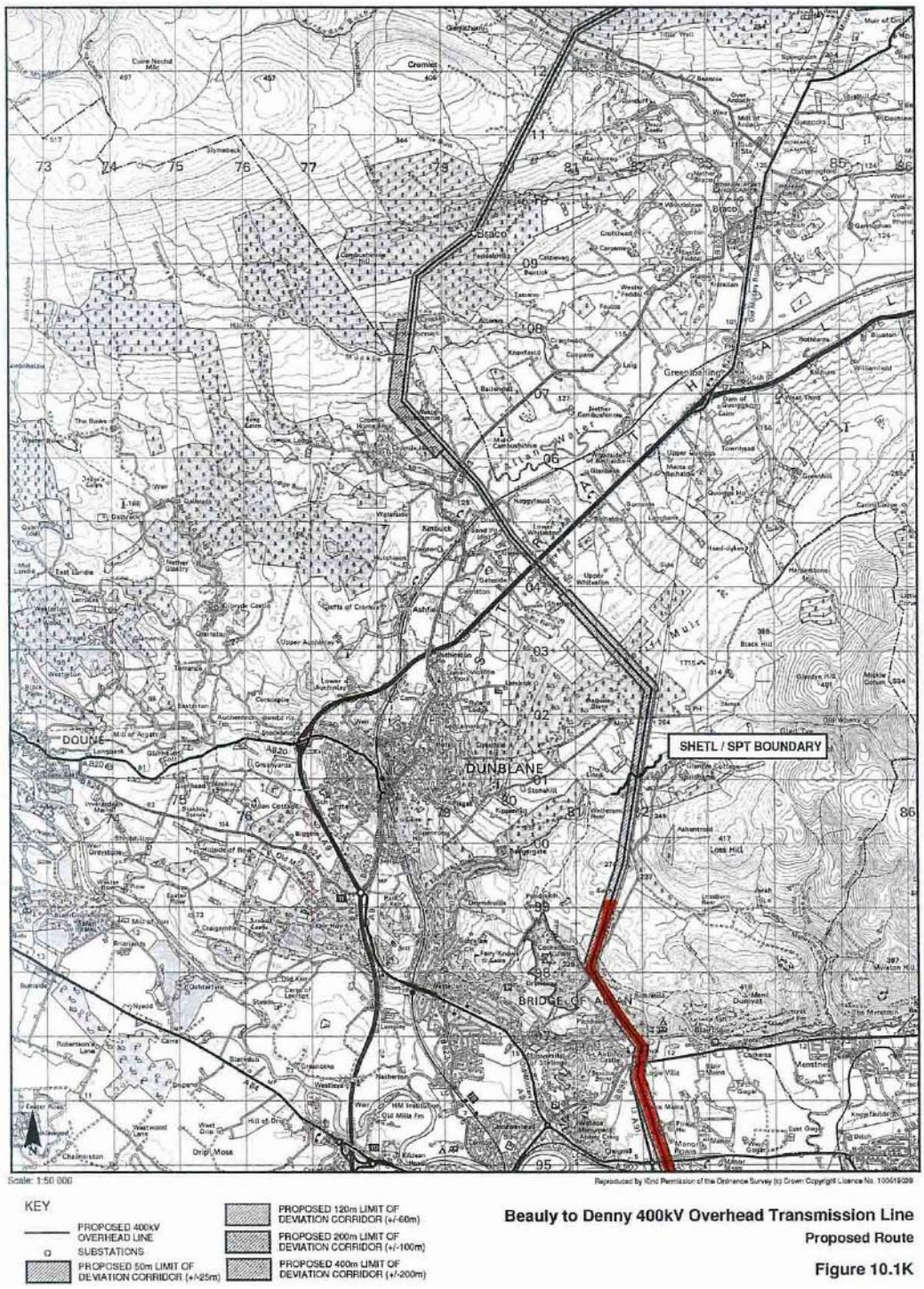
28) The **UoS** attached a map (Figure 1-8) to an email of 14 December 2006 to SHETL showing the section of the proposed OHL at the Ochils Escarpment (to the east of Stirling) they considered should be undergrounded or re-routed. The objectives of the University are set out in their letter of objection of 7 December 2005 and their Amplified Grounds of Objection dated 25 November 2006. The Amplified Grounds of Objection precede the email and map of 14 December 2006 and therefore the objectives are based on the following statements which formed part of the conclusion to the Grounds of Objection.

29) The Proposal will have high adverse impacts on the setting of the GDL, Airthrey Castle and important views there from and thereto. The built and cultural heritage that comprises the campus is of national importance and its protection must take priority over the Proposal, particularly, when there are clear opportunities for avoiding these impacts through re-routing or undergrounding.

30) The adverse landscape and visual Impacts for the section of the Proposal lying between Braco and: Denny, crossing the Ochil Hills are of particularly high significance, and in this section we consider that a fuller appraisal of alternative routes is necessary. The University's objection on landscape and visual grounds is intrinsically linked to its concerns regarding the marketability of the University to prospective students and business users of the University's conference facilities.

31) These points are explained in more detail in Section 1 of the Amplified Grounds of Objection.

Figure 1-8: UoS – Ochils Escarpment Route (to the East of Stirling) Cocksburn Wood to Manor Powis



1.4 TECHNICAL BRIEF

1.4.1 Technical – OHL

32) Diversions from the Proposed OHL route that would connect to sections of UGC should match the Proposed OHL type in all respects – tower family, conductor system, and capacity.

1.4.2 Technical – SEC

33) The SEC designs considered by this report are to match those discussed in the undergrounding report APL 5/16.

1.4.3 Technical - UGC System Design Considerations

34) UGC cable systems are to be developed to manage the required capacity and to run within the search areas provided by the other parties.

35) Table 1-1 gives the pre- and post-fault ratings requirement for the cable as advised by SHETL. This requirement is to meet the performance of the overhead line and thus both the 275 kV and the 400 kV cables would need to be designed to carry the same current.

Table 1-1: Seasonal Circuit Ratings and Maximum Ambient Temperatures

400 kV and 275 kV	Winter (Dec to Feb)	Normal Cold (Mar, Apr, Nov)	Normal Hot (Sep, Oct)	Summer (May to Aug)
Pre-Fault Rating of the OHL	3400A	3270A	3270A	3040A
Post-Fault Rating of OHL (24 hour duration)	4050A	3890A	3890A	3620A
Pre-fault Rating per Cable (2 cables per phase)	1700A	1635A	1635A	1520A
Post-fault Rating per Cable (24 hour duration) (2 cables per phase)	2025A	1945A	1945A	1610A
Direct buried	10°C	10°C	15°C	15°C
Filled surface trough	10°C	15°C	25°C	35°C

36) The power cable conductor size and design would be affected by the cable current rating requirement. For the power transmission requirement between Beauly and Denny it would be necessary to install two underground cables per phase to meet the overhead line rating.

37) The cable construction required would most likely have either a 2000mm² or 2500mm² conductor size depending on the cable construction offered by the manufacturer and his optimised installation arrangement. A photograph of the power cable is shown in Figure 1-9 and further details may be found in APL 5/16.

Figure 1-9: EHV XLPE Cable Sample

1.4.4 Environmental Commentary

38) Given that the OHL EIA Team only have general data from the Consultation Document and the ES for the search areas, an environmental commentary at a strategic level is supplied in this report. The commentary concentrates upon the possible significant residual adverse environmental effects of the UGC/OHL routes and construction techniques that are reported by this document.

1.4.5 Costing

39) The costings are to be based upon those developed in the undergrounding report APL 5/16, and are to be modified as necessary to accommodate any extraordinary costs imposed by adhering to the Objectors' routeing proposals.

1.5 APPROACH

1.5.1 Basis of Appraisal

40) The basis of the Appraisal is as follows:

- Double circuit swathe of 27-31m with 4 cable trenches each being 1 -1.4m wide, 1.3m deep, with a 5m wide haul road with passing places (see APL 5/16[1] Figure 2-8).
- Groups of four cable joint bays each being 10m long, 3m wide and 2m deep.
- A cable sealing end compound (82m by 55m - Figure 2-6 of APL 5/16) with terminal tower, and with shunt reactors if required). Shunt reactors to provide reactive compensation have been allowed for where necessary.
- Access track assumptions- full overlay of 400mm of type 1 on geotextile brought up the sides to be installed for the majority of the route.

[1] APL 5/16: Proposed Beauly to Denny 400kV Overhead Transmission Line - The Use of Underground Cable as an alternative to Overhead Line in Specific Locations: Final Report, Jan 2007

- Proposed OHL based upon information provided in the ES.
- A permanent roadway would be required from cable sealing end compounds containing reactors.

41) This appraisal is based upon direct-buried underground cables rather than ducted, since:

- this represents the lowest cost option. Note however, that direct-buried construction carries higher risks to successful reinstatement of the route due to the length of trench exposed and the length of time topsoil would be stored (APL 5/16 Addendum Sections 6 and 8).
- placing the power cables in air filled ducts has a de-rating effect due to the increased thermal resistance of the air within the ducts, and
- there are technical risks associated with placing cables in ducts. These risks are associated with the control of gravitational, thermomechanical, short circuit and vibrational forces and movements of the cables when in service. These forces increase with duct gradient, conductor size, change in conductor temperature, magnitude of fault current and vibration (e.g. road traffic). A technical paper[2] was published by Cigre in 2006 which describes these issues. It is recommended that any cables installed between Beauly and Denny of an appreciable length should be directly buried to avoid the risks associated with ducted installations. However, if large conductor 400kV and 275kV cables are to be installed in air filled ducts then these risks would need to be recognised and development work and trials undertaken to improve the likely in-service reliability.
- Where direct burial is not possible or the costs may exceed the cost of tunnelling, an underground cable tunnel may be considered.

42) Where areas of the UGC route traverse areas of poor drainage the importation of compactable fill materials (such as Type 1 road stone) would be required to expand and elevate the existing tracks.

43) In principle a minimum bending radius of 20 times the cable diameter may be used, though in practice more generous cable installation bending radii in the order of 50 times the cable diameter (typically 5m to 10m) are normally adopted.

44) Cable surround backfill material under the cover tile would be a cement bound sand mixture.

45) Excess excavated material would either be used for landscaping or removed to a landfill site. Sharp stone for temporary access track construction would, if required, be from local borrow pits, and would be returned to these.

46) Directional drilling under the water courses would need to be a minimum of 3m below the existing river bed. On sensitive water courses the drilling positions would be no closer than 50m from the bank of the water course.

47) It is assumed that, once constructed, an underground cable route would require to be patrolled regularly. Link pillars would require to be accessed on foot once every 3 to 5 years. Repairs to the cable itself would require access for a cable drum carrying lorry, excavator, cranes and jointers' vehicles to get to site. Track-

[2] "Thermomechanical design of XLPE insulated HV and EHV cables installed in duct and pipe systems." Zenger W, Gregory B, Cigré, Paris August 2006.

way would need to be laid over any soft ground to avoid damage to the soils. A repair time in the order of six weeks would probably be needed to find the fault, lay the track-way, excavate the fault, prepare the joint bays, lay the repair cable, wait for jointers to become available from overseas manufacturers, install the cable, assemble the repair joints, arrange for suitable HV test apparatus, wait for good enough weather for testing, backfill open excavations and reinstate top soil.

48) The greater the length of the installed UGC, the more likely it is that some reactive compensation would be required. Reactive compensation would most probably be located at the sealing end compounds. No definitive cable and reactive compensation design has been produced, therefore no reactor locations have been firmly established at this stage. This level of detail design would only be performed in the event that the need for undergrounding is confirmed. For the purposes of this study allowance has been made for reactive compensation at SECs at both ends of the cable sections. Dependant upon the network performance it may be necessary on long lengths of cable to include intermediate reactive compensation. This would require the construction of reactor compounds part way along the cable route.

49) In this report the use of ventilated cable tunnels is considered. The reader is directed to the report issued as document APL/PTH-41 for further information on tunnelling and its consideration for UGC cable installations in the Perth and Kinross area.

1.5.2 Methodology

50) The proposals received, and the interpretation of the search areas, are set out in Sections 1.3.3 and 1.3.4 of this report.

51) The appraisal process, the data used, the working strategy and method and stated objectives are set out in Section 1.3.1, and 1.3.5 to 1.3.8 of this report.

52) OS maps with and without the search areas superimposed, were supplied to the Appraisal Team (see Appendix 6).

1.5.3 Approach to Routeing

1.5.3.1 Cables

53) Based on desk study and the site visits, feasible cable route options were developed using OS maps and the preferred route options were then selected by Simon Lloyd after checking a number of matters with Mark Turnbull and Mark Winfield. The Appraisal Team reviewed the draft report and their comments have been taken into account in this Final Report.

1.5.3.2 Overhead Lines

54) Overhead lines form part of the northern and southern section ends of the undergrounding proposal.

1.5.3.3 Sealing End Compound Location

55) The locations for sealing end compounds were selected to lie within the corridors indicated by the objectors (see maps in Appendix 5), and with due consideration given to Holford Rule 3, Note (a), by selecting locations at low levels and where possible in areas where advantage could be taken of existing tree and scrub cover.

1.5.4 Scope of Appraisals

1.5.4.1 Technical Appraisal

56) The scope of the work reported here is

- The identification of technically feasible UGC routes within the areas indicated by Objectors.
- The technical appraisal of an identified route to develop an outline design in a manner similar to that used for the case studies contained within APL 5/16.
- Identification of appropriate SEC locations and OHL routes are identified in parallel with this process.

57) The cable system operating voltage and current rating are determined by the overall power transmission design requirements. A detailed technical appraisal is given in APL 5/16, and is summarised below.

58) The power cable conductor size and design would be affected by the cable current rating requirement. For the specified power transmission requirement between Beauly and Denny it would be necessary to install two underground cables per phase to meet the overhead line rating, resulting in a total of 12 cables. Six of these power cables would operate at 400kV and a further six at 275kV. Additional fibre optic cables would be installed with the power cables for the monitoring of the cable temperature surface temperature and the signalling operations. It may also be necessary, depending upon the bonding and earthing system, to install separate insulated earth continuity conductors in the same trench as the power cables. This is further discussed in APL 5/16.

59) Consideration is also given to a cable tunnel arrangement where the topography is unsuitable for the installation for a direct buried EHV power cable system.

1.5.4.2 Environmental Commentary

60) Based on Team discussion, environmental commentary was sought from the Appraisal Team on the following ES topics:

- Geology and Soils
- Hydrology
- Forestry
- Ecology and Nature Conservation
- Landscape Effects
- Visual Effects
- Cultural Heritage and Archaeology

61) Comments were not sought on the following ES topics:

- Land Use
- Agriculture and Sporting Interests
- Tourism and Recreation

- Cumulative Visual Effects
- Disruption due to Construction
- Construction Noise
- Construction Air Quality
- Operational Noise
- Electric and Magnetic Fields
- Radio and TV Interference

1.5.4.3 Cost Appraisal

62) The unit costs for the proposed alternative underground cable and overhead line routes considered by this report are based mainly upon PB Power's APL 5/16 report to the Strategy Session of the Public Inquiry. As such, allowances are included for directional drilling, thrust boring, and measures needed to avoid damaging the quality of the water flowing off the area. No separate costs for ducted UGC have been provided as an alternative to the direct-buried option since the ducted cost estimates lie within 1% of the direct-buried figures. The environmental appraisals have assumed direct-buried throughout.

63) UGC end costs are separately identified (see Cost Appraisal, Section 3.5.7.1), and estimates include appropriate tree and hedge replacement, landscaping of sealing end compounds, special work to habitats, and communications with the public.

64) A tunnel ahs been proposed to achieve the requirements of one of the objectors. Since APL 5/16 did not develop unit costs associated with tunnels, this present report refers to the Undergrounding Report of Perth and Kinross (APL/PTH-41) where such unit costs were estimated.

1.6 LIMITATIONS

65) There are a number of areas which present technical challenges to the design, supply, installation and operation of an EHV cable system on the routes selected. The cable routes shown have been selected on the basis of a series of criteria detailed further in Section 1.5. No sub-surface or on-site profile surveys have been performed to confirm the suitability of each route. If constructed, adjustments to the cable route selected may be required as the exact position and depth of buried hydrocarbon fuel lines is not known. The conclusions of this report would need to be considered with these limitations in mind.

CHAPTER 2: DESCRIPTION OF SEARCH AREAS

66) The areas corresponding to the three undergrounding proposals that have been appraised by this report have been described in the Appraisal Brief (Section 1.3). SNH and SBP all undergrounding proposals UGC4 B and C2) only differ in the area of Section UGC4 A. These two objectors share the search areas for Sections UGC4 B and UGC4 C2. That said, one of the objectors, SNH, is content that Section UGC4 C comprises OHL, whilst the other, SBP proposes UGC (UGC4 C) through this terrain (see Figure 1-2).

67) The following paragraphs provide a broad description of the areas through which the existing overhead line, the proposed overhead line and proposed alternative underground and OHL routes are located. Each section of the proposed underground and OHL routes are considered in turn.

2.1 UGC4 A1 AND A2: CAMBUSHINNIE – GREENYARDS

68) This section covers the proposed SNH and Stirling Council OHL and UGC route south from Cambushinnie to Greenyards (just south of the A820 where SBP UGC proposal joins the SNH and Stirling Council UGC proposal) (See Figure 1-2).

2.1.1 Characteristics of the area

69) The following paragraphs provide a brief description of the area between Cambushinnie and Greenyards to the west of Dunblane. The area to the south of Cambushinnie comprises the lower foothills of the Forest of Glenartney, which run into the carselands of the Rivers Teith and Forth.

2.1.1.1 Geology and Landform

70) The geology of this area is part of the Midland Valley, which has a wide variety of relief, with some hills and plateaux of relatively hard igneous rock. The lowland areas are underlain by softer bedrock with thicker deposits of glacial till and sands and gravels. This area consists of predominantly lowland areas characterised by wide floodplains comprising glacial meltwater deposits (sands and gravels) with glacial till (boulder clay) on surrounding land. In the southern section along the River Forth there are deposits of alluvium associated with marine influences. More upland areas are characterised by limited drift deposits. The depth of drift deposits varies depending on topography and geographic location, with deeper deposits in river valleys and lowland areas (ES Chapter 20, paras. 20.4.2.2-4).

71) The landform of the area is heavily influenced by this geology and comprises areas of higher ground to the north and the south, interrupted by a wide valley floor or carse area. Gradients can be as steep as 1 in 2 but more typically are 1 in 8 to 1 in 10 within areas of higher ground. The carse lowland areas are generally very flat and there is generally little, if any, transition between these areas. The low-lying carselands are typically around 10-20m AOD, whereas the higher areas of ground extend up from 20m AOD to 500-600m AOD in the higher hills to the north, and 300-450m AOD in the Touch Hills, to the south. In the Cambushinnie area the landform is at around 300m AOD.

2.1.1.2 Drainage Pattern

72) The drainage pattern of the area reflects the varied landform. Within the areas of higher ground to the north there are numerous small streams flowing down from the higher ground, towards the larger watercourses on the floor of the carse. The main watercourse is the Ardoch Burn, which flows generally east and south through the Cambushinnie area into the River Teith at Doune. To the east is the River Allan, which flows from south-west to north-east in the area to the north of Dunblane.

2.1.1.3 Cultural and Natural Heritage

73) The cultural heritage of the area reflects the more settled nature of the carse floors and the adjacent areas of higher ground. There are a number of Scheduled Ancient Monuments, listed buildings and Historic Gardens and Designed Landscapes in this area. Farmland in the area contains numerous crop marks and enclosures and there is extensive evidence of Roman occupation within this area. ES Figure 26.1K indicates the locations of archaeological and cultural heritage features within the areas around Dunblane; ES Figure 26.2K indicates areas of sensitivity in terms of unknown remains.

74) The statutorily designated nature conservation importance of the area is indicated on ES Figures 22.1n and 22.1o. There is a Special Area of Conservation (River Teith SAC) associated with the Ardoch Burn. A small area designated as a Special Protection Area (SPA) is located at Loch Mahaick, to the north of the Braes of Doune.

75) There are many areas listed on the Ancient Woodland Inventory located in the surrounding area but the pattern of these may mean that they can be avoided by this alternative.

2.1.1.4 Land Use

76) The land use of this area includes agriculture (grazing) on the lower foothills, forestry and sporting activity on areas of higher moorland, and formal and informal recreation.

2.1.1.5 Road, River Bridging, and Settlement Patterns

77) There are a number of main roads running through this area, including the A9, A820 and various other A and B roads connecting the many settlements. The topography provides a partial constraint to the routeing of roads in this area and these generally seek to make use of the lower lying ground below the upper slopes. Roads are more limited in extent in the areas of higher ground and comprise more minor roads and tracks, following the easier gradients within these areas where possible. The mainline railway runs within this area, linking Stirling and Dunblane to points further north and south. Rivers are bridged at convenient points using narrower widths of watercourses where a choice is available.

78) The settlement pattern of the area avoids development on areas of higher or more steeply sloping ground and settlements tend to be located on lower ground at the edges of the carse (as at Dunblane). There are numerous smaller settlements (such as Doune) and scattered groups of properties and farmsteads located throughout this area. This is a relatively well populated area.

2.1.1.6 Landscape Character

79) The area lies within the SNH Landscape Character Areas covering the Central Area (as shown on ES Figure 23.2B). There are a number of different landscape character types within the area between the hills to the west of Cambushinnie and the area to the west of Dunblane:

80) Lowland Hill Fringes

81) Lowland River Valleys

82) Lowland Valley Fringes

83) The main characteristics of these landscape character types are described in ES Technical Annex 23.1.

84) The *Lowland Hill Fringes* are characterised by distinctive hummocky terrain providing a transition between the higher *Lowland Hills* and the lower carselands. There is a diverse mosaic of landcover with numerous woodlands of varying sizes and characteristics, scattered farmsteads and small watercourses.

85) The *Lowland River Valleys* in the Teith area comprises a landscape that is more enclosed and undulating, agricultural land. The area is also under pressure from development.

86) The *Lowland Valley Fringes* provide a further area of transition with small scale field patterns and a dense network of hedges, trees and small woodland areas. Located close to centres of population, places these areas under pressure from development.

87) Important features within this landscape are the policy woodlands enclosing large estates.

2.1.1.7 Landscape Designations

88) There are several Historic Gardens and Designed Landscapes in this area: at Doune, Blair Drummond and Keir. These are described in the ES, Chapter 23 at section 23.6.

2.1.1.8 Visual Characteristics

89) The visual characteristics of the area reflect the enclosure created by areas of tree cover, on the whole. The areas of higher ground to the north tend to frame views in this direction. Within these areas of higher ground, there is greater potential for long-distance views from areas where woodland and forestry blocks do not obstruct views. Within lower-lying areas, the extensive woodland cover tends to restrict views.

90) Properties in more elevated areas are more likely to be oriented to take advantage of more distant views. Within lower areas of ground there is generally no particular preferred orientation of properties.

2.1.1.9 Existing 132kV OHL route

91) The existing 132kV overhead line runs within the area to the east of Dunblane, running from the existing Braco substation southwards and crossing the A9 at

Greenloaning. From here the line runs south across Sheriff Muir to descend the southern slope of the Ochil Hills in the area immediately to the east of the Bridge of Allan.

2.1.1.10 Proposed 400kV OHL route

92) The proposed 400kV overhead line would need to run from the proposed substation at Braco, which is further to the west of the existing 132kV overhead line, southwards to Denny. In so doing, the proposed line would exit the area of woodland on Cambushinnie Hill in a south-westerly direction, turning to the south-east in the area of Wester Cambushinnie in order to cross the A9 in the Glassingall area. The proposed overhead line would continue south-east onto Sheriff Muir before joining the route of the existing 132kV line to the west of the Sheriffmuir Inn. The proposed 400kV overhead line would then follow the route of the existing 132kV line southwards, descending the Ochil Hills in the same area to the east of the Bridge of Allan.

93) The significant residual effects of the proposed OHL and the significant effects of the proposed overhead line including designations and pinch points are shown in Figure 2-1 and Figure 2-2.

2.1.2 Proposed Alternative Search Areas

94) The SNH proposed alternative search area to the west of Stirling, between Cambushinnie and Greenyards, consist of an area for either an overhead line or an underground cable route running from north-east to south-west across the sloping ground on the lower slopes of the hillside, south-east of the Braes of Doune windfarm site. This would pass above and to the north of the Cromlix Home Farm and to the west of the western Cromlix Lodge, where the alternative search area would turn to run to the south. The alternative search area would run on the eastern edge of conifer woodland at Upper Grainston before running within this woodland south to the Greenyards area. The SNH maps indicate search areas for SECs at or to the south-west of the proposed Braco substation or on the edge of forestry north of the western Cromlix Lodge. However, due to the difficulty of routeing an underground cable through the area north of Milour Moor, an alternative SEC is proposed at Milour Moor, UGC4-SEC 1.

95) From this SEC an underground cable route would run generally to the south-south-west, following field boundaries where possible, to cross the minor road north and west of Corscaplie. The underground cable route would then turn to run south, passing to the east of Auchenteck Farm, as far as Greenyards (south of the A820, OS reference NN758011, also referred to in this document as “Point X”).

Figure 2-1: Significant Residual Effects of Proposed OHL - Braco to Bridge of Allan

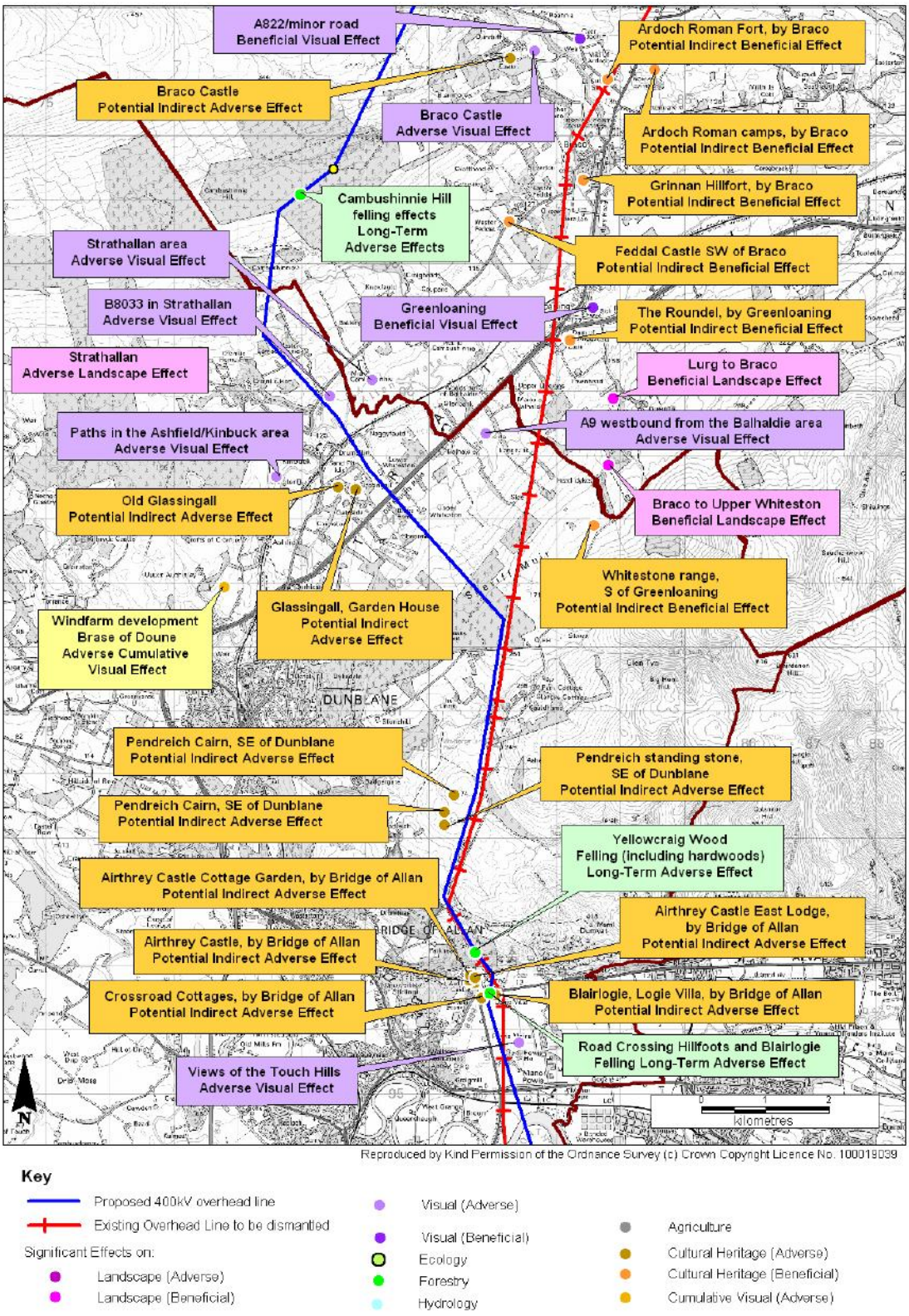
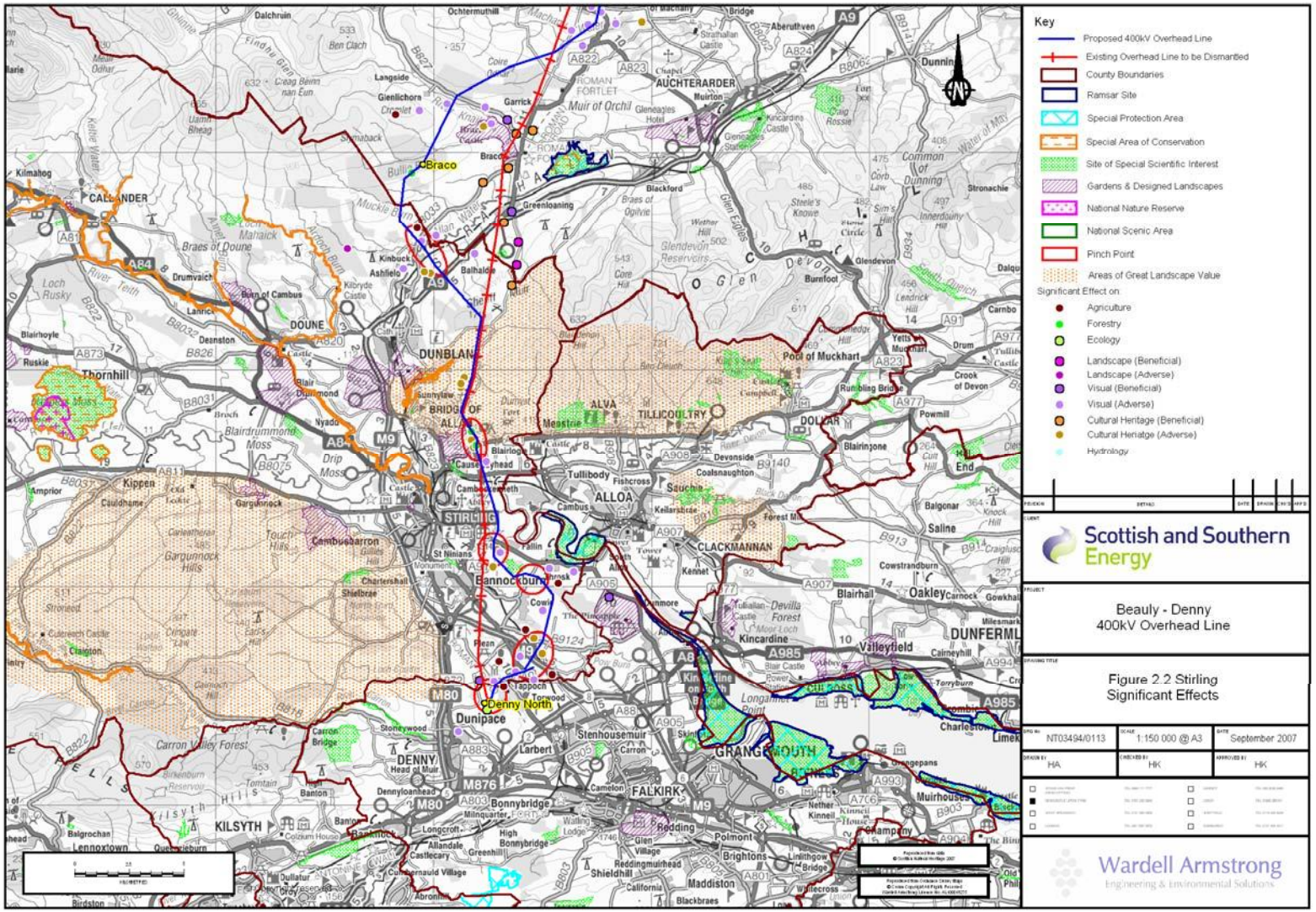


Figure 2-2: Significant Residual Effects of Proposed OHL including Designations and Pinch Points Braco to Denny



2.2 UGC4 A3: BRACO – GREENYARDS

96) This section covers the SBP proposal from Braco to Greenyards, just south of the A820 (see Figure 1-2).

2.2.1 Characteristics of the area

97) The following paragraphs provide a brief description of the area between Braco and Greenyards to the west of Dunblane. This area comprises the lower foothills to the north-west of Strathallan, Strathallan and the south-eastern valley side and undulating ground at the south-western end of the strath, which forms a watershed between the Allan Water (which flows northwards) and the Teith and Forth watercourses (which flow to the east).

2.2.1.1 Geology and Landform

98) The geology of this area is part of the Midland Valley, which has a wide variety of relief, with some hills and plateaux of relatively hard igneous rock. The lowland areas are underlain by softer bedrock with thicker deposits of glacial till and sands and gravels. This area consists of predominantly lowland areas characterised by wide floodplains comprising glacial meltwater deposits (sands and gravels) with glacial till (boulder clay) on surrounding land. In the southern section along the River Forth there are deposits of alluvium associated with marine influences. More upland areas are characterised by limited drift deposits. The depth of drift deposits varies depending on topography and geographic location, with deeper deposits in river valleys and lowland areas (ES Chapter 20, paras. 20.4.2.2-20.4.2.4).

99) The landform of the area is heavily influenced by this geology and comprises areas of higher ground to the north-west and the south-east, interrupted by the floor of the strath. Gradients can be as steep as 1 in 2 but more typically are 1 in 8 to 1 in 10 within areas of higher ground. The floor of the strath includes hummocky areas of glacial deposits (sands and gravels). The floor of the strath around 100-120m AOD, whereas the higher areas of ground extend up to 500-600m AOD in the higher hills to the north-west, and 300-500m AOD in the Ochil Hills, to the south-east.

2.2.1.2 Drainage Pattern

100) The Allan Water is the main watercourse within this area, flowing from south-west to north-east through the relatively narrow floor of the strath. Numerous smaller watercourses flow down from the higher ground to the north-west and south-east to join this river.

2.2.1.3 Cultural and Natural Heritage

101) The cultural heritage of the area reflects the more settled nature of the strath floor and the adjacent areas of higher ground. There are a number of Scheduled Ancient Monuments, listed buildings and a Historic Garden and Designed Landscape in this area. Farmland in the area contains numerous crop marks and enclosures and there is extensive evidence of Roman occupation within part of this area. ES Figure 26.1K indicates the locations of archaeological and cultural heritage features within the area between Braco and Dunblane; ES Figure 26.2K indicates areas of sensitivity in terms of potential unknown remains.

102) The statutorily designated nature conservation importance of the area is indicated on ES Figures 22.1n and 22.1o. This indicates the location of the goose roost sites associated with the South Tayside Goose Roosts SPA, in the Carsebreck area east of Braco. ES Figure 22.5g notes the locations of protected mammal species in this area (in particular otter), however, this has only been surveyed for the corridor of the proposed 400 kV line and the existing 132 kV, no field surveying has been undertaken specifically for any of these alternatives. In addition, there are areas listed on the Ancient Woodland Inventory located across the area which will be difficult to avoid.

2.2.1.4 Land Use

103) The land use of this area reflects the improved potential for agriculture on the floor of the strath and the production of Christmas trees is a feature of the Cambushinnie area of Strathallan. Elsewhere the land is used for grazing and some crops, with forestry on areas of higher ground. A small landfill site exists in the Kinbuck area. The area is used for informal recreation, with a number of paths, including alongside the river.

2.2.1.5 Road, River Bridging, and Settlement Patterns

104) The A9 runs through this area from south-west to north-east and is connected to a number of more minor roads including the B8033 and the A822. These in turn link with a network of smaller roads and tracks leading into the wider area. The mainline railway also runs within the floor of the strath, on the north side of the A9. There are few, if any constraints to the crossing of rivers in this area.

105) In the south, Dunblane is the main town, located on the western edge of the Ochil Hills and extending onto the lower slopes as well as across the flatter floor of the strath. The A9 forms the western edge of the town. Further north are the smaller villages of Greenloaning and Braco. Within the wider area are numerous scattered properties and farmsteads. The main outlook of these properties tends to be across the floor of the strath.

2.2.1.6 Landscape Character

106) The area lies within the SNH Landscape Character Area covering the Tayside area and the Central Region (as shown on ES Figure 23.2B). There are a number of different landscape character types within the area between Braco and the west of Dunblane:

- (Tayside LCA)
- Lowland Hills
- Broad Valley Lowland
- Igneous Hills
- (Central Region LCA)
- Lowland River Valley
- Lowland Hill Fringes
- Lowland Valley Fringes

107) The main characteristics of these landscape character types are described in ES Technical Annex 23.1.

108) The main characteristics of the *Lowland Hills* landscape character type are the smooth and rounded nature of these hills, which form a transition between the highlands to the north and west and the lowlands to the east and south. The transitional character includes the land use, which ranges from pasture on lower slopes to rough grazing and open moorland higher up. Extensive woodland and forestry is also a feature of this landscape.

109) The *Broad Valley Lowland* landscape character type consists of a broad valley floor formed by glacial erosion, often occupied by a much smaller river. Glacial deposition has resulted in a complex local topography, with red soils and local stone. Large estates frequently influence the landscape through their policy woodlands.

110) The *Igneous Hills* landscape character type is formed of hard volcanic rock and this results in distinctive scarp and dip slopes, with short, steep glens and burns flowing from these. These are open landscapes dominated by grass moorland, with some forestry in places.

111) The *Lowland River Valley* in the area to the south of Strathallan, is a transitional area merging the diverse visual qualities of Strathallan to the north, the Ochil Hills to the east and the narrowing valley to the south. The numerous glacial hummocks create visual interest in addition to numerous small areas of woodland. There is pressure for development from the adjacent urban areas and for sand and gravel extraction.

112) The *Lowland Hill Fringes* are characterised by distinctive hummocky terrain providing a transition between the higher *Lowland Hills* and the lower carselands. There is a diverse mosaic of landcover with numerous woodlands of varying sizes and characteristics, scattered farmsteads and small watercourses.

113) The *Lowland Valley Fringes* provide a further area of transition with small scale field patterns and a dense network of hedges, trees and small woodland areas. Located close to centres of population places these areas under pressure from development.

114) The main landscape features of this area are the forestry blocks on the higher ground to the north-west and south-east, and the smaller areas of woodland within the lower parts of the strath.

2.2.1.7 Landscape Designations

115) Landscape designations in this area are restricted to the Historic Gardens and Designed Landscapes at Braco Castle and Keir. These are described in the ES, Chapter 23 at section 23.6.

2.2.1.8 Visual Characteristics

116) The visual characteristics of the area reflect the landform and tree cover and are influenced at a local level by the hummocky nature of the terrain within the floor of Strathallan. In an area where longer distance views might be expected, these are restricted by the undulating landform and also by the extensive use of the area for growing Christmas trees. Longer views are possible from more elevated areas, where these are not also restricted by woodland or forestry.

117) Properties within more elevated areas, on the sides of the strath are more likely to be oriented to take advantage of these longer distance views.

2.2.1.9 Existing 132kV OHL route

118) The existing 132kV overhead line runs within the area to the east of Dunblane and Stirling, running from the existing Braco substation southwards and crossing the A9 at Greenloaning. From here the line runs south across Sheriff Muir to descend the southern slope of the Ochil Hills in the area immediately to the east of the Bridge of Allan.

2.2.1.10 Proposed 400kV OHL route

119) The proposed 400kV overhead line would need to run from the proposed substation at Braco, which is further to the west of the existing 132kV overhead line, southwards to Denny. In so doing, the proposed line would exit the area of woodland on Cambushinnie Hill in a south-westerly direction, turning to the south-east in the area of Wester Cambushinnie in order to cross the A9 in the Glassingall area. The proposed overhead line would continue south-east onto Sheriff Muir before joining the route of the existing 132kV line to the west of the Sheriffmuir Inn. The proposed 400kV overhead line would then follow the route of the existing 132kV line southwards, descending the Ochil Hills in the same area to the east of the Bridge of Allan.

120) The significant residual effects of the proposed OHL and the significant effects of the proposed overhead line including designations and pinch points are shown on Figure 2-1 and Figure 2-2.

2.2.2 Proposed Alternative Search Areas

121) The SBP alternative underground cable route proposed between the proposed Braco substation and the Greenyards area would involve the development of a sealing end compound (UGC4-SEC3) within the proposed substation. The underground cable route would follow a forestry ride to exit the forestry on the hillside to the east of the substation, before running to the south-east and south. The cable route would pass within a narrow strip of trees at Faulds Wood and between the properties at Craighead and Coupans, to cross the B8033 east of Craighead Cottages. The cable route would then run to the south-west, crossing the Muckle Burn and the Allan Water. To the south of the Allan Water the cable route would turn to the south-east and pass beneath the railway line before approaching the A9.

122) The cable route would run on the northern side of the A9, south-west through the woodland adjacent to Lower Whiteston and skirting other small areas of roadside woodland. At Glassingall the route would turn to the west towards the River Allan, crossing the railway line and the river immediately to the north of Ashfield. After crossing the minor road to the west, the underground cable route would run south and south-west towards Lower Auchinlay.

123) From this point the underground cable route would run to the west of the A9, south of the Stockbridge area and would cross the A820 in order to run south and south-west to Greenyards (Point X).

2.3 UGC4 B: GREENYARDS – GARTUR (SOUTH OF CAMBUSBARRON)

124) This section covers the SNH, Stirling Council and SBP UGC proposals from Greenyards just south of A820 to Gartur, south of Cambusbarron (See Figure 2-1).

2.3.1 Characteristics of the area

125) The following paragraphs provide a brief description of the area between Greenyards, to the west of Dunblane and Gartur (south of Cambusbarron). This is a generally lowland area covering the carse of Teith and Forth, with the developed areas of Dunblane, Bridge of Allan and Stirling to the east and more open countryside to the west.

2.3.1.1 Geology and Landform

126) The geology of this area is part of the Midland Valley, which has a wide variety of relief. The lowland areas are underlain by softer bedrock with thicker deposits of glacial till and sands and gravels. This area consists of predominantly lowland areas characterised by wide floodplains comprising glacial meltwater deposits (sands and gravels) with glacial till (boulder clay) on surrounding land. In the southern section along the River Forth there are deposits of alluvium associated with marine influences. The depth of drift deposits varies depending on topography and geographic location, with deeper deposits in river valleys and lowland areas (ES Chapter 20, paras. 20.4.2.2-4).

127) The landform of this area is dominated by the flatter carse land associated with the Rivers Teith and Forth, with some localised areas of higher ground in Stirling and to the south of the carse, south of Cambusbarron. The low-lying carselands are typically around 10-20m AOD.

2.3.1.2 Drainage Pattern

128) The main watercourses in this area are the River Teith, which flows from north-west to south-east through the northern part of the flat valley floor, passing to the south of Doune and through Stirling; and the River Forth, which flows from west to east through the southern part of the floor of the carse to be joined by the River Teith just to the west of Stirling. Smaller watercourses flow down from the Touch Hills, into the River Forth.

2.3.1.3 Cultural and Natural Heritage

129) The cultural heritage of the area reflects the more settled nature of the carse floors and the adjacent areas of higher ground. There are a number of Scheduled Ancient Monuments, listed buildings and Historic Gardens and Designed Landscapes in this area. Farmland in the area contains numerous crop marks and enclosures and there is extensive evidence of Roman occupation within this area. ES Figures 26.1K and 26.1L indicate the locations of archaeological and cultural heritage features within the areas around Dunblane and Stirling; ES Figures 26.2K and 26.2L indicate areas of sensitivity in terms of unknown remains.

130) The statutorily designated nature conservation importance of the area is indicated on ES Figures 22.1o and 22.1p. The River Teith SAC is associated with the Rivers Teith, Forth and the Ardoch Burn. Small areas designated as SSSIs are located to the south of Blair Drummond, at Robertson's Lane, and Sauchie Craig, further south of this section on the Bannock Burn, west of Stirling.

131) There are numerous woodland areas listed on the Ancient Woodland Inventory located within this overall area.

2.3.1.4 Land Use

132) The land use of this area reflects the agricultural land use on the floor of the carse and the more urban areas associated with Dunblane and Stirling. There are some small areas of forestry within this area. The Blair Drummond Safari Park is one of many tourist sites in the area which includes Stirling Castle and the Wallace Monument. There are industrial areas associated with Stirling and other towns in the eastern part of the Forth carse.

2.3.1.5 Road, River Bridging, and Settlement Patterns

133) The M9 and the A9 are the main roads in this area, running from north to south; these connect with the wider road network including the A811 on the southern side of the floor of the carse and the A84, to the north, both of which run from west to east. There are numerous other 'A' and 'B' roads in this area. The mainline railway runs to the east of the M9 and A9. There are no constraints to the bridging of rivers in this area.

134) The settlement pattern in this area is dominated by the City of Stirling and the town of Dunblane, on the eastern edge of this search area. There are a number of smaller, outlying settlements such as Cambusbarron, to the west of the M9 and Doune, to the west of Dunblane. Within the floor of the carse are numerous individual properties and farmsteads.

2.3.1.6 Landscape Character

135) The area lies within the SNH Landscape Character Areas covering the Central Area and the Stirling and Grangemouth area (as shown on ES Figure 23.2B). There are a number of different landscape character types within the area between the hills to the west of Cambushinnie and the south of Stirling:

136) Lowland Valley Fringes

137) Lowland River Valleys

138) Lowland Hill Fringes

139) The main characteristics of these landscape character types are described in ES Technical Annex 23.1.

140) The *Lowland Valley Fringes* provide a further area of transition with small scale field patterns and a dense network of hedges, trees and small woodland areas. Located close to centres of population places these areas under pressure from development.

141) The *Lowland River Valleys* in the Forth area are characterised by the flat nature of the landform with predominantly open agricultural land and a distinctive geometric pattern of roads and field boundaries. The agricultural land is important for overwintering flocks of geese. In the Teith area the landscape is more enclosed and undulating. These areas are also under pressure from development.

142) The *Lowland Hill Fringes* are characterised by distinctive hummocky terrain providing a transition between the higher *Lowland Hills* and the lower carselands.

There is a diverse mosaic of landcover with numerous woodlands of varying sizes and characteristics, scattered farmsteads and small watercourses

2.3.1.7 Landscape Designations

143) Landscape designations in this area relate to the Touch Hills Area of Great Landscape Value on the southern side of the carselands; the Historic Gardens and Designed Landscapes of the Keir, Ochtertyre and Blair Drummond estates, on the northern side of the carse, and the Touch House HGDL on the southern side, immediately west of Cambusbarron. These are described in the ES, Chapter 23 at section 23.6.

2.3.1.8 Visual Characteristics

144) The visual characteristics of this area are influenced by the topography and the tree cover. Within more open parts of the flat floor of the carse there are longer distance views, though in the eastern part of this area these are blocked by the urban development of Stirling. More elevated areas, such as on the lower slopes around Cambusbarron, will also have long distance views across the floor of the carse.

2.3.1.9 Existing 132kV OHL route

145) The route of the existing 132kV overhead line does not run within this search area; it runs to the east of Dunblane and Stirling.

2.3.1.10 Proposed 400kV OHL route

146) The proposed 400kV overhead line does not run within this search area, but would be located to the east of Dunblane and Stirling.

147) The significant residual effects of the proposed OHL and the significant effects of the proposed overhead line including designations and pinch points are shown on Figure 2-1 to Figure 2-3.

2.3.2 Proposed alternative search areas

148) The proposed alternative underground cable route in the area between Greenyards and Gartur would need to find a route through this small scale landscape. The underground cable route would run southwards from Greenyards just south of the A820, skirting around property and woodland and crossing the B824 to the west of the junction with a minor road near Hillside of Row. The underground cable route would follow the western side of this minor road southwards before crossing the road east of Easter Row and turning to run to the south-east.

149) The underground cable route would pass to the south of Arnhall Castle, where it would turn to run south towards the junction of two minor roads west of Old Keir. The underground cable route would turn to run south-west in order to cross the River Teith west of the bend in the river near Steeds Farm. The underground cable route would continue south-west and south, passing to the west of Blackdub, to the east of Dripend and close to the western side of West Drip. The underground cable route would cross a track to the south of West Drip before turning to the south-east and crossing the Chalmerston Road.

150) The underground cable route would pass to the east of East Cambusdrenny to cross the River Forth and the A811 in the area west of Hillhead. The underground cable route would run south across two minor roads west of Cambusbarron to the sealing end compound, UGC4-SEC2 at Gartur, on the northern edge of an area of woodland.

2.4 UGC4 C1 AND C2: GARTUR – DENNY SUBSTATION

151) This section covers the SNH, Stirling Council and SBP proposals from Gartur to Denny and SNH and Stirling Council OHL proposal from Gartur to Denny (SEE Figure 1-2).

2.4.1 Characteristics of the area

152) The following paragraphs provide a brief description of the area between Gartur and Denny substation. The area between Gartur, to the west of Stirling and Denny, to the north-west of Falkirk, covers the area of the Touch Hills, west of the M9 and the areas west and east of the M80.

2.4.1.1 Geology and Landform

153) The geology of this area is part of the Midland Valley, which has a wide variety of relief, with some hills and plateaux of relatively hard igneous rock. The lowland areas are underlain by softer bedrock with thicker deposits of glacial till and sands and gravels. More upland areas are characterised by limited drift deposits. The depth of drift deposits varies depending on topography and geographic location, with deeper deposits in river valleys and lowland areas (ES Chapter 20, paras. 20.4.2.2-4).

154) The landform of the area is heavily influenced by this geology and comprises areas of higher ground where gradients can be as steep as 1 in 2 but more typically are 1 in 8 to 1 in 10. The higher areas of ground extend up from 20m AOD to 300-450m AOD in the Touch Hills. In the Denny area the landform is at around 100m AOD.

2.4.1.2 Drainage Pattern

155) The drainage pattern reflects the landform, with small watercourses flowing down through areas of higher ground to ultimately drain into the River Forth. The Loch Coulter Reservoir and the North Third Reservoir provide water for the adjacent urban areas, as well as offering opportunities for recreation.

2.4.1.3 Cultural and Natural Heritage

156) The cultural heritage of the area reflects the more settled nature of the carse floors and the adjacent areas of higher ground. There are a number of Scheduled Ancient Monuments, listed buildings and Historic Gardens and Designed Landscapes in this area. Farmland in the area contains numerous crop marks and enclosures and there is extensive evidence of Roman occupation within this area.

157) The only statutorily designated nature conservation importance in this area includes a small SSSI at Sauchie Craig, close to the Bannock Burn (there are further designated sites to the west but these are outwith this area of influence). In addition, there are numerous areas designated as Ancient and Semi-Natural

Woodland (Inventory Woodland) located to the west and south-west of Stirling and to the west of Denny.

2.4.1.4 Land Use

158) Land use within this area is mainly agricultural (grazing) and forestry, with formal and informal areas of recreation associated with the reservoirs as well as sporting uses of the area. There are existing and abandoned stone quarries within the hillsides. Within the southern part of the Touch Hills, existing electricity transmission lines run from the Denny area, in a generally south-west direction.

2.4.1.5 Road, River Bridging, and Settlement Patterns

159) Main roads in this area are generally confined to the eastern edges of the higher ground and include the M80, M9 and A9, as well as other 'A' and 'B' roads. The M80 and M9 run generally from north to south through this area, with the M9 continuing eastwards, north of Denny. Within the Touch Hills, roads generally follow the shallower gradients into the higher ground. There are generally few constraints to roads bridging rivers in this area, in terms of the topography of this area.

160) The settlement pattern reflects the topography, with the main settlement areas located on the lower ground to the east of the Touch Hills. Within the areas of higher ground there are smaller groups of properties and settlements such as Fankerton, as well numerous scattered individual properties and farmsteads.

2.4.1.6 Landscape Character

161) The area lies within the SNH Landscape Character Areas covering the Central Area (as shown on ES Figure 23.2B). The different landscape character types within the area between Gartur and Denny are:

162) Lowland Hill Fringes

163) Lowland Hills

164) The main characteristics of these landscape character types are described in ES Technical Annex 23.1.

165) The *Lowland Hill Fringes* are characterised by distinctive hummocky terrain providing a transition between the higher *Lowland Hills* and the lower carselands. There is a diverse mosaic of landcover with numerous woodlands of varying sizes and characteristics, scattered farmsteads and small watercourses.

166) The *Lowland Hills* are characterised by a simplicity and unity of landform and the precise definition of the northern edge, and its contrast with the smooth slopes of the main plateau. The area is characterised by stone dykes, reservoir water bodies and forestry plantations; these provide important visual diversity and scale reference points. The area is threatened by further loss and fragmentation of existing heather moorlands.

2.4.1.7 Landscape Designations

167) Landscape designations in this area include the Touch Hills AGLV and an HGDL at Touch House. These areas are described in ES Chapter 23, at section 23.6.

2.4.1.8 Visual Characteristics

168) The areas of higher ground within the Touch Hills have the potential for long distance views, mainly to the north and north-east, where these are not obstructed by woodland. Within lower-lying areas, the undulating landform restricts outward views.

2.4.1.9 Existing 132kV OHL route

169) The route of the existing 132kV overhead line does not run within this search area; it runs to the east of Dunblane and Stirling.

2.4.1.10 Proposed 400kV OHL route

170) The proposed 400kV overhead line does not run within this search area, but would be located to the east of Dunblane and Stirling.

171) The significant residual effects of the proposed OHL and the significant effects of the proposed overhead line including designations and pinch points are shown on Figure 2-2 to Figure 2-3.

2.4.2 Proposed alternative search areas

172) The proposed alternative route between Gartur and Denny consists of alternative proposals for an overhead line (SNH and Stirling Council) and an underground cable route (SNH, Stirling Council and SBP). These generally follow a similar corridor within the area to the west of the M9. The following paragraphs describe these routes, identifying the differences between these routes where applicable.

173) The overhead line and underground cable would follow the same alignment south and south-east through the woodland and along the north-east facing sloping ground on the edge of the Touch Hills, to cross the Bannock Burn west of Wallstale. The alternative overhead line would remain on the northern side of the Bannock Burn whereas the underground cable route would cross to the southern side of the burn and run to the south-east, towards Cultenhove. The alternative overhead line would cross the Bannock Burn further to the east before rejoining the route of the underground cable north of Cultenhove.

174) Both routes would continue south-east towards the M9, crossing the minor roads east of Cultenhove before turning to run more to the south, passing to the west of Foot o' Green. The routes would diverge in this area with the alternative overhead line running more to the south, in a south-east direction towards the junction of the M9 and M80. The underground cable route would follow a route further to the north, following field boundaries towards the M80, before running to the south, on the western side of the M80.

175) The alternative overhead line would cross the M80 close to the southern end of the slip roads with the M9, whereas the underground cable route would continue southwards through woodland to cross to the eastern side of the M80 further to the south, north of Mains of Auchenhowie.

176) After crossing to the east of the M80, both routes would run southwards on the eastern side of the A872, the alternative overhead line taking a direct route as far south as Easterton; the underground cable route taking a more varied route south-south-east towards Dales Wood.

177) Both routes would follow the same alignment from the north-west of Dales Wood, south-east to the south of a farm and passing close to the north-eastern corner of this wood, to the proposed Denny North substation. The substation would be the site for the location of the sealing end compound, UGC4-SEC4.

2.5 UGC4 D: COCKSBURN WOOD – LOGIE VILLA

178) This section covers the University of Stirling OHL and UGC proposal from Cocksburn Wood to Logie Villa (See Figure 1-3).

2.5.1 Characteristics of the area

179) The following paragraphs provide a brief description of the area between Cocksburn Wood and Logie Villa. This is a small area in the south-western part of the Ochil Hills.

2.5.1.1 Geology and Landform

180) The geology of this area is part of the Midland Valley, which has a wide variety of relief, with some hills and plateaux of relatively hard igneous rock. This igneous rock comprises the Ochil Hills, where there are limited drift deposits. The depths of drift deposit vary depending on topography and geographic location, with deeper deposits in river valleys (ES Chapter 20, paras. 20.4.2.2-4).

181) The landform in this area comprises the higher and undulating ground associated with this part of the Ochil Hills, including the steep, south-facing slope on the northern edge of the Forth Carse and the flatter ground in this part of the carse. Gradients in places can be steeper than 1 in 2, though more generally gradients are in the order of 1 in 5 to 1 in 10, with some locally shallower ground.

2.5.1.2 Drainage Pattern

182) The Cocksburn Reservoir receives water from part of the higher ground in this area. There are other small watercourses draining down from the higher ground to the east and north.

2.5.1.3 Cultural and Natural Heritage

183) The area includes Scheduled Ancient Monuments, listed buildings and other cultural heritage or archaeological sites, as indicated on ES Figure 26.1L. The areas to the east of Cocksburn Wood and to the south of the A91 at Logie Villa are considered to be sensitive to the presence of potential unknown archaeological remains (ES Figures 26.2J and 26.2K).

184) The statutorily designated nature conservation interest of this area relates to the Kippenrait Wood SAC, to the north-west. There are also a number of areas of woodland listed in the Ancient Woodland Inventory within this area.

2.5.1.4 Land Use

185) The area is used for forestry, in the main, with some grazing; in addition the area is important as an area of informal recreation, with paths to the summit at Dumyat commencing in this area. The University of Stirling is located to the south-west of this area.

2.5.1.5 Road, River Bridging, and Settlement Patterns

186) One minor road runs within this area, connecting the upper parts of Sheriff Muir with the Bridge of Allan area, to the south. This separates into two narrow roads in the area to the east of Cocksburn Wood, with one road continuing south-west to Bridge of Allan and the other running to the south-east, through to the B998 and the A91 at Logie Villa, on the southern edge of this area. There are no rivers to bridge within this area.

187) The settlement pattern of the majority of this area is restricted to occasional individual houses, such as Pendreich and Parkhead. In the flatter, lower areas to the south there are a greater number of houses in the Logie Kirk and adjacent areas.

2.5.1.6 Landscape Character

188) This area lies within the Central Region LCA, as shown on ES Figure 23.2B. The landscape character types within this area are the *Lowland Hills* and *Lowland River Valleys*.

189) The *Lowland Hills* are characterised by the dramatic contrasts between the steep slopes and the very flat, adjoining carselands (described as an experience unique in Scotland), while the proximity of this area to settlements encourages recreational use of the area.

190) The *Lowland River Valleys* in this area are characterised by the flatness of the land, contrasting with the steep slopes to the north. These are generally open, agricultural and industrial landscapes, described as important for the setting of Stirling and Stirling Castle and for wintering flocks of geese.

2.5.1.7 Landscape Designations

191) Landscape designations in this area include the Ochil Hills AGLV and an HGDL at Airthrey Castle. These areas are described in ES Chapter 23, at section 23.6.

2.5.1.8 Visual Characteristics

192) There are extensive outward views from parts of the higher ground in this area, and across the lower-lying ground. Woodland cover restricts views in places. Both the Wallace Monument and Stirling Castle are prominent visual features in views from parts of this area, including from the area around Logie Villa.

2.5.1.9 Existing 132kV OHL route

193) The existing 132kV line follows the line of the minor road, running to the south and south-south-west, before turning to descend the Ochil Hills onto the floor of the carse. In this area the line runs within a notch on the hillside in a generally south-east direction, to beyond Logie Villa, where the existing line turns to run to the south.

2.5.1.10 Proposed 400kV OHL route

194) The proposed 400kV line would generally follow the existing 132kV line within this area, other than for a minor deviation at the foot of the Ochils, in order to run to the west of Logie Villa.

195) The significant residual effects of the proposed OHL and the significant effects of the proposed overhead line including designations and pinch points are shown on Figure 2-1 to Figure 2-3.

2.5.2 Proposed Alternative Search Areas

196) The proposed alternative tunnel route between Cocksburn Wood and Logie Villa would take a direct route running almost due south from the proposed sealing end compound UGC4-SEC5 and tunnel shaft 1 on the north-eastern edge of the woodland. A minor deviation to the Proposed OHL would be required to connect with this SEC / tunnel shaft. The southern end of the tunnel shaft (2) would be close to the eastern side of the A91, south of the Crossroad Cottages area.

2.6 UGC4 E: LOGIE VILLA – MANOR POWIS

197) This section covers the UoS UGC and OHL proposal from Logie Villa to Manor Powis (See Figure 1-3).

2.6.1 Characteristics of the area

198) The following paragraphs provide a brief description of the area between Logie Villa and Manor Powis. This is a small area to the south of the Ochil Hills and the north of the River Forth.

2.6.1.1 Geology and Landform

199) The geology of this area is part of the Midland Valley, which has a wide variety of relief. The lowland areas are underlain by softer bedrock with thicker deposits of glacial till and sands and gravels. This area consists of predominantly lowland areas characterised by wide floodplains comprising glacial meltwater deposits (sands and gravels) with glacial till (boulder clay) on surrounding land. In the southern section along the River Forth there are deposits of alluvium associated with marine influences. The depth of drift deposits varies depending on topography and geographic location, with deeper deposits in river valleys and lowland areas (ES Chapter 20, paras. 20.4.2.2-4).

2.6.1.2 Drainage Pattern

200) The River Forth is the principal river in this area, winding through the floor of the carse from west to east. Smaller watercourses drain across the floor of the carse into this river.

2.6.1.3 Cultural and Natural Heritage

201) The area includes listed buildings and other cultural heritage and archaeological features, as indicated on ES Figure 26.1L. The Wallace Monument, further to the west, is a Scheduled Ancient Monument. The area between the A91 and the River Forth is an area identified as sensitive to the presence of potential unknown archaeological remains (ES Figure 26.2K).

202) The statutorily designated areas of importance for nature conservation are shown in ES Figure 22.1O. In this area the alternatives are fairly close to the River Forth SPA, SSSI and Ramsar, and there is a woodland SSSI in the Abbey Craig area. Areas of Ancient and Semi-Natural Woodland include this Abbey Craig area,

woodland on the Ochils scarp slope (including Yellowcraig Wood) and Cocksburn Wood.

2.6.1.4 Land Use

203) The land use in this area is predominantly agriculture (mainly grazing) with industrial land further to the east. The existing 132kV line runs within this area.

2.6.1.5 Road, River Bridging, and Settlement Patterns

204) The A91, A907 and B998 are the main roads in this area, with minor access tracks leading to the various local properties. The A91 crosses the River Forth further to the south. A mineral railway line runs from east to west through this area; this is being refurbished at present.

205) Within this area settlement is confined to individual properties; the larger settlements are Stirling and Bridge of Allan to the west, Menstrie to the east and Fallin to the south. Blairlogie, to the east, is a small village on the southern edge of the Ochils, with properties in elevated positions on the hillside.

2.6.1.6 Landscape Character

206) This area lies within the Central Region LCA, as shown on ES Figure 23.2B. The landscape character type within this area is the *Lowland River Valleys*.

207) The *Lowland River Valleys* in this area are characterised by the flatness of the land, contrasting with the steep slopes to the north. These are generally open, agricultural and industrial landscapes, described as important for the setting of Stirling and Stirling Castle and for feeding flocks of wintering geese.

2.6.1.7 Landscape Designations

208) The Ochil Hills AGLV lies to the north of this area, as does the Airthrey Castle HGDL.

2.6.1.8 Visual Characteristics

209) The visual characteristics of this area reflect the open and flat nature of the topography, with long distance views towards Stirling and the Ochils, as well as towards the Touch Hills, further to the south. Both the Wallace Monument and Stirling Castle are prominent visual features in views from this area, as are the Ochil Hills.

2.6.1.9 Existing 132kV OHL route

210) The 132kV overhead line crosses the A91 at Logie Villa and runs on the eastern side of this road, southwards to cross the River Forth in the Taylorton area.

2.6.1.10 Proposed 400kV OHL route

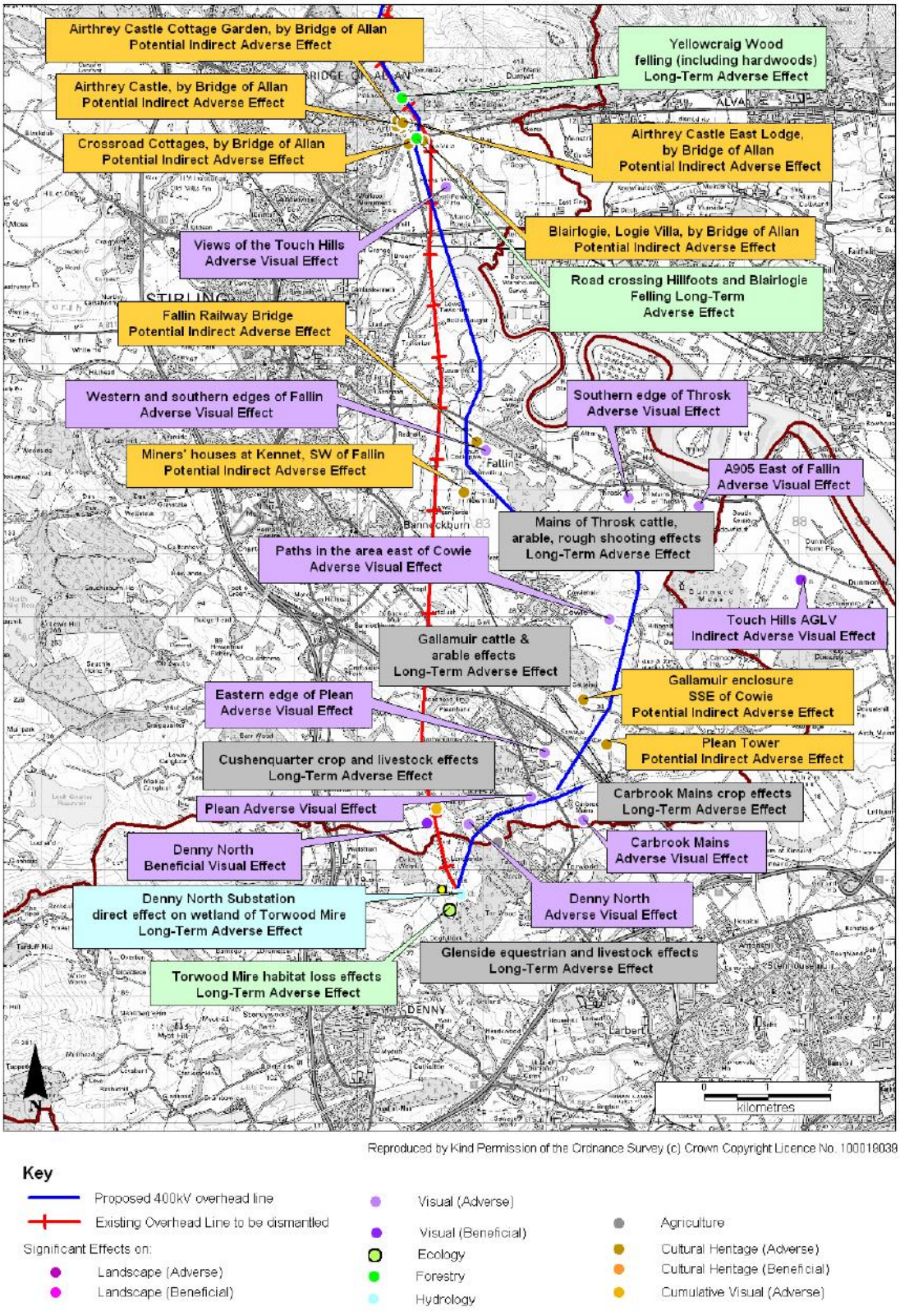
211) The proposed line would make a minor deviation in the Logie Villa area before running more to the east of south in order to cross the River Forth slightly further to the east, in the Lower Taylorton area. The proposed 400kV overhead line would then continue to the south-east, increasing in distance from the existing 132kV overhead line.

212) The significant residual effects of the proposed OHL and the significant effects of the proposed overhead line including designations and pinch points are shown on Figure 2-2 and Figure 2-3.

2.6.2 Proposed Alternative Search Areas

213) The underground cable route southwards from the tunnel shaft 2 near Logie Villa would run on the eastern edge of the A91 to the southern sealing end compound, UGC4-SEC6, located to the south-east of the roundabout junction of the A91 and A907 and on the north side of the mineral railway (in the process of being restored). A short section of new overhead line would be required in order to connect back to the Proposed OHL, south of the railway line and north of the River Forth; this would require an angle tower on the northern edge of the river.

Figure 2-3: Significant Residual Effects of Proposed OHL - Bridge of Allan to Denny



2.7 ABNORMAL LOADS

214) Abnormal loads for undergrounding proposals in all search areas consist of:

- Reactors for SECs.
- Cable drums transported by low-loader if gross vehicle weights (GVW) exceed 44 tonnes.

215) The GVW for reactor transport is estimated to be 120 tonnes. Gross vehicle weights for cable drums vary with the length of cable on the drum. The range of GVWs is as follows:

Cable length	900 m	675 m	540 m	450 m	245 m
Cable wt + 4t drum	52t	40t	33t	28t	17t
Approx GVW with 27t low loader	79t	67t	60t	55t	44t

2.7.1 Delivery of Cable Drums

216) Other than on trunk roads, each situation would require detailed individual assessment so that, ideally, 60-70t GVW transporters can be used universally, with the less practically satisfactory 44t transporters each carrying 245 m of cable as a minimum requirement, for cable drum transportation.

217) Abnormal loads of approx 120t for the shunt reactors would require particular investigation with transport Scotland, for trunk roads, and with Perth and Kinross Council and Stirling Council for all local A roads. There is particular concern over the load carrying capability of minor roads and road structures on these roads, though in the cases of Deny Substation and the proposed new substation at Braco, routes have already been established, or at least identified, for the delivery of transformers of similar weight.

218) For the other SEC sites, in particular SEC 1 and SEC2 which are associated with long UGC sections, any undergrounding project would need to assess the considerable additional costs of road strengthening on access routes to the SECs.

CHAPTER 3: WEST OF STIRLING APPRAISAL

3.1 INTRODUCTION

219) Two underground cable routes have been considered to the west of Stirling. These routes have been appraised in response to documentation and communications received from Scottish Natural Heritage (SNH), Stirling Council (SC) and Stirling Before Pylons (SBP).

220) Undergrounding route studies to the west of Stirling have a number of common sections. This report thus considers each discrete area in turn and does not repeat information on a route for one objector that has been previously discussed elsewhere within the report.

221) From Figure 1-2, the meeting point of sections UGC4 A2 and UGC4 B is about 300m west of Greenyards (sometimes referred to in this document as Point X). This is the point where the SNH and SBP routeing alternatives converge. North of this point routeing for the SNH proposal is guided by the SNH search area, whilst routeing for the SBP proposal is guided by their preference for the UGC to stay near the motorway and pipeline corridor. South of this point however, both the SNH and SBP proposals would be addressed by a single UGC route. These options are illustrated in Figure 1-2 and on the OS maps of Appendix 6.

3.2 TECHNICAL APPRAISAL - SNH ROUTES

222) There are two undergrounding options considered for SNH. The first would run from Tower TD170 in the north to Denny Substation and would incorporate sections of both overhead line and underground cable. From Figure 1-2, the routeing would comprise sections UGC4 A1(OHL), UGC4 A2(UGC), UGC4 B(UGC) and UGC4 C1(OHL). This route would require UGC between the SECs of Milour Moor (SEC 1) and Gartur (SEC 2).

223) The second SNH option is to install underground cable from Tower TD170 in the north, utilising a SEC at Milour Moor, all the way to Denny Substation. From Figure 1-2, the routeing would comprise sections UGC4 A1(OHL), UGC4 A2(UGC), UGC4 B(UGC) and UGC4 C2(UGC). This route would require UGC between Milour Moor SEC and Denny Substation.

224) The exact analysis by SNH which led to the boundaries selected for the SNH cable route corridor is not known by the authors of this report. There is however some similarity between the routes of the existing pressurised hydrocarbon pipelines and the corridor provided here for the electricity transmission circuits.

225) SNH have advised at previous sessions of the public inquiry that the route corridors shown on their drawings are indicative only. The selection of a cable route by the authors has not, therefore, rigidly adhered to the SNH corridor boundaries. However, as a general principal the limits of the SNH corridor boundary have been observed. At two locations (Corscaplie Farm and the River Teith crossing) the route selected crosses the corridor boundaries due to the topography. In each case the selected route returns to the SNH corridor, whilst minimising any route length increase.

226) A route profile of the selected SNH route is given in Figure 3-1. This profile has been drawn from Ordnance Survey data. The profile provides the elevation of the cable route against the distance of the route from Milour Moor SEC. Notable locations have been annotated onto the profile along with regions where ground gradients exceed 12.5%. This profile will be referred to by later sections of the report covering the two SNH route options.

227) The locations of cable crossing points for rivers and roads etc. and other nearby locations mentioned in this report may be found in Appendix 3.

3.2.1 UGC4 A1: OHL from Point W (Tower TD170) to SEC 1

228) This 5.5 km section of OHL is proposed by both the SNH 18June07 and the SNH 30Jan07 undergrounding options.

229) From the new Braco Substation, the Proposed OHL would run SW across the top slopes of Cambushinnie Hill, and then at tower TD170 it would turn south. At this point the SNH route would deviate from the Proposed route, holding the same straight line SW across the rough south-facing slopes of the hill, some of which is forested. On this section it would cross Crocket Burn and Muckle Burn, and about one km of wet boggy land as it rises towards the western edge of the SNH search area.

230) At the search area boundary the OHL would turn south, crossing Bracklin Burn and Lodge Burn, and running parallel to the edge of the search area until it reached a track near the SW extremity of the forest noted by SNH as suitable for siting a SEC.

231) The terrain covered by this section of the OHL route is considered impractical for the installation of UGC.

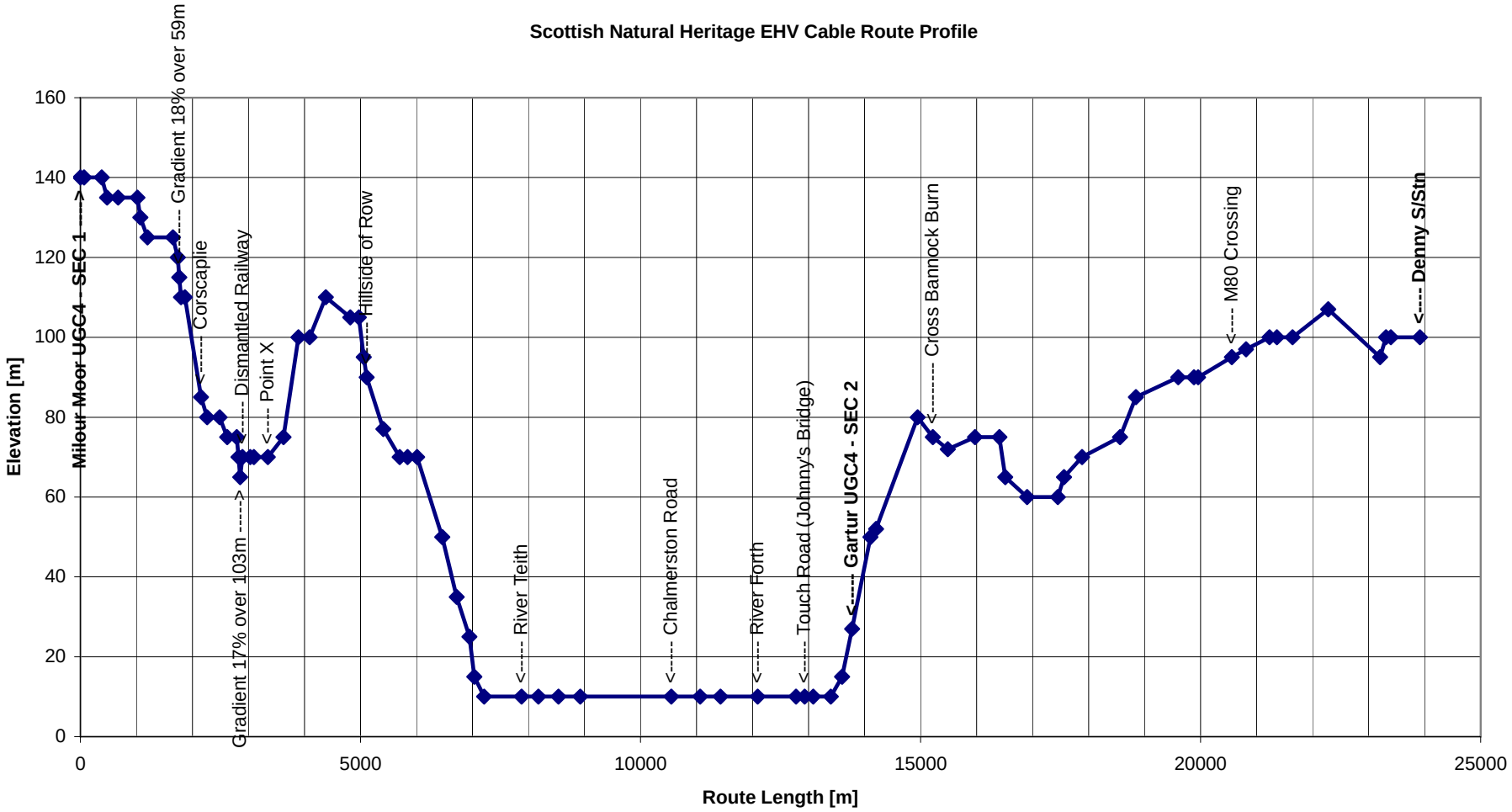
3.2.2 UGC4 SEC 1: Milour Moor

232) SEC 1 represents the northernmost point of SNH's undergrounding proposals, the OHL north from this point simply acting to connect the SEC back to the remainder of the Proposed OHL route. This SEC is proposed by both the SNH 18June07 and the SNH 30Jan07 undergrounding options.

233) SEC 1 would be sited towards the SW corner of the area designated by SNH for this purpose. The intention of this site is to minimise the length (and therefore cost) of the UGC going south from this forest, whilst at the same time using the commercial woodland to provide some visual screening of the SEC structures. Since the OHL would arrive at the SEC site from the NW, and the UGC would leave the site towards the SW, there should be no need to create any new straight-line swathe through the woodland, which should minimise the visual impact on the skyline from any distant viewpoint.

234) This SEC 1 would be the northern termination of a section of cable of at least 13.7 km in length (if its southern end terminated at Gartur) or 24 km in length (if it ran south as far as Denny Substation). Either of these lengths of UGC would almost certainly require reactive compensation at the SEC itself, and permanent abnormal load access would therefore be required. It is quite possible that the 24km section would also require a compound part way along its route to accommodate intermediate reactive compensation.

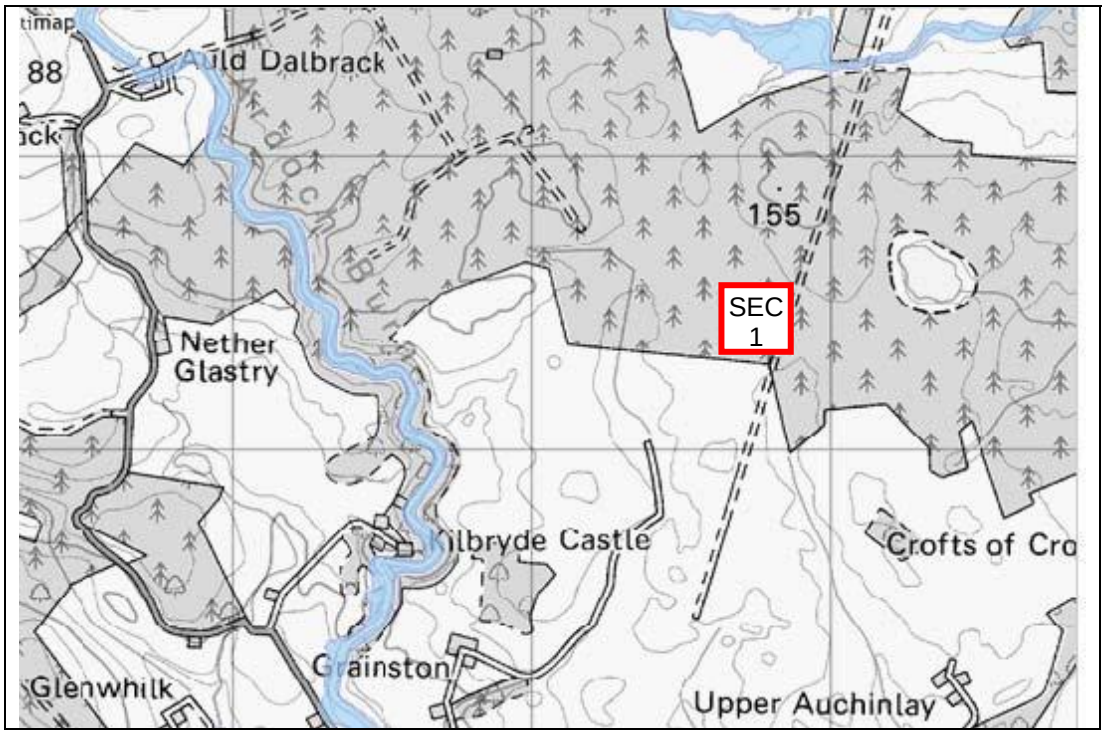
Figure 3-1: SNH Route Profile (both alternatives)



235) Existing road access to this area would not accommodate loads of abnormal length and weight, so substantial new permanent road works would be required. Whilst early, temporary, vehicular access may be available via the track-way running through the woods to the NE of the site, permanent access would possibly best be achieved by adopting the first 2.4 km of the UGC route haul road south to the minor road to the north of the A820 highway at Anfield (NN759023). If this minor road itself proves to be inadequate then the access road could be extended a further 0.8 km to the A820 itself, at NN758015, just over 1 km to the west of the A9 / A820 junction.

236) As can be seen from Figure 3-2, SEPA identifies no flood risk associated with SEC 1.

Figure 3-2: – SEC 1 Flood Risk Map



3.2.3 UGC4 A2: UGC from SEC 1 to Point X (Greenyards)

237) UGC SEC 1 is located at NN768044.

238) The cable exits SEC 1 to the east as the ground is wetter directly to the south of the SEC. There is an existing track running SW from the SEC for approximately 1km which the cable route follows on its eastern edge.

239) At the end of the track (NN765034) the cable route continues southwest towards Corscaplie farm (NN761023). The cable route thus leaves the SNH designated corridor to avoid less favourable terrain, indicated by the ordnance survey map data, both in terms of the ground contours and the wetter ground (NN765025) to the northeast of Corscaplie Farm.

240) Figure 3-3 is a photograph of land to the west of Corscaplie Farm (the farm is visible on the right hand side of the photograph). As can be seen in the

photograph, taken from the minor road, the land is locally undulating which could require either some levelling work or rerouteing of the haul road.

241) Despite rerouteing the cables outside of the SNH area there would still be an 18% ground gradient which extends over a length of 60m. This is located north of Corscaplie Farm at NN762027 and it will be necessary to "work" this gradient. Access to the cable route between Corscaplie and SEC 1 could require access from both north and south of the steep gradient for cable drum carrying vehicles or a modification of the haul road to avoid or lessen the gradient (possibly by going further west).

Figure 3-3: – Corscaplie Farm and Land to the West

242) The cable route would run to the west of Corscaplie Farm crossing over a small water course (NN760024) and the minor road (NN758023). The minor water course would either have cable ducts installed by directionally drilling beneath or the water course itself ducted and the cables installed beneath. The haul road would run over the top of the water course. The minor road would have the cables installed beneath within a ducted concrete encasement. Installation of this encasement would require a short road closure or, if this is not acceptable then a directionally drilled duct installation.

243) Passing southwards the cable route would run down a steep embankment and cross a disused railway (Figure 3-4). This forms an obstruction to the haul road and access would be required from the minor roads to work the swathe. Both the gradient (17%) and the disused railway line may be open cut by tracked excavators.

Figure 3-4: – Disused Railway

244) Further south the cable route re-enters the SNH route corridor and passes to the east of a disused pit (NN757017).

245) The cable route crosses a small water course at NN758017; this watercourse appears to be a tributary of the Ardoch Burn which is part of an SAC. The ground between the dismantled railway and the small water course crossing may be accessed from the minor road to the west with an access point at NN755018.

246) The cable route crosses the A820 (NN757015); this crossing would also be a site access point for the works traffic. The cable crossing of this road would either be by directional drilling or by a ducted concrete encasement.

247) South of the A820 the cable route avoids the hill immediately to the north of Greenyards Farm and crosses a small water course (NN757014); this watercourse appears to be a tributary of the Ardoch Burn which is part of an SAC. The route would then continue southwards towards Greenyards (NN757011).

3.2.4 UGC4 B: UGC from Greenyards (Point X) to UGC4-SEC 2 (Gartur)

248) Greenyards (NN757011) is located to the southeast of this crossing near a disused pit and to the northwest of Greenyards Farm (NN761011).

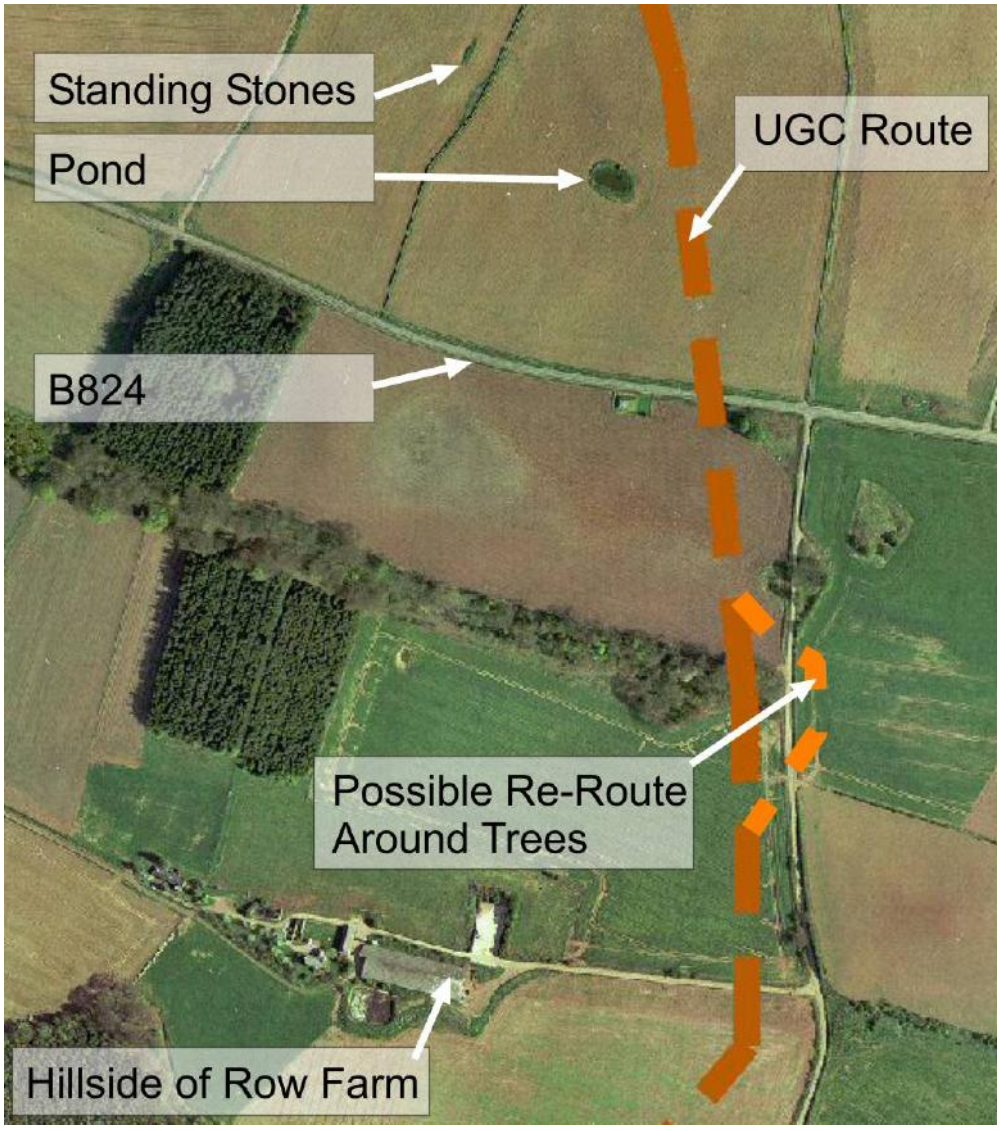
249) From here the cable route would run south to an unclassified road servicing a number of farms. The road crossing method would be a ducted encasement installed during a road closure or partial road restriction. The crossing point of this road is approximately at grid reference NN757011.

250) The cable route would run south past a standing stone site to the east across fields, and would then run parallel before running through a short strip of ancient woodland. The map shows Moon Strip farm buildings at NN755007.

251) From Moon Strip Farm the cable route would proceed southeast towards the B824. The cable route passes a Standing Stone Site and a pond to the north of

the B824 before crossing the road at approximate grid reference NN757002. There would be a site access point at this location.

Figure 3-5: – Possible Rerouteing Near Hillside of Row Farm



252) South of the B824 the cable route passes through the roadside edge of a wood (NN756000); it should be noted that it may be possible to avoid damaging this ancient woodland by crossing the minor road north of the wood. Having passed through the wood, the route would run alongside a minor road between the B820 and Easter Row Farm (NS751992). The cable route would cross this road at grid reference NS754994.

253) Between the road crossing and Craigarn Hall (NS753985) the cable route would be positioned to take best advantage of the contours and to avoid any unfavourable wet areas where possible.

254) Consideration has been given to the position of the crossing of the River Teith which impacts on the cable route between a position near Easter Row Farm (NS751992) and Dripend Farm (NS753962).

255) The hillside immediately to the north of the River Teith is steep and does not lend itself either to cable installation or the approach to a suitable location to cross the River Teith. This problem extends along the practical width of the SNH corridor where it is traversed by the River Teith. In order to overcome this problem it would be necessary for the cable route to leave the SNH corridor. A route has therefore been selected which would run from Easter Row Farm south-eastwards through fields towards a narrow strip of woodland (NS763983). Then towards Glen Burn, crossing the minor road (NS762978) near Old Kier Farm and re-entering the SNH corridor at its eastern edge before crossing the River Teith at grid location NS759975. The crossing of the small water courses and burns would be as previously described at other similar locations. The crossing of the River Teith SAC could be performed either by directional drilling (using bentonite filled ducts) or using a cable bridge structure. A haul road bridge over the River Teith would not be required as there is access for construction traffic to either side of the river.

256) Immediately south of the River Teith the landscape flattens out into the Carse of Stirling (also known as the Carse of Forth) and the ground conditions are favourable to excavation. There are a number of possible cable route alternatives. Where multiple route options exist, the route selected for this report has been based upon least cost whilst staying within the SNH corridor and avoiding buildings and obstructions where these may be circumvented without a significant increase in route length (cost).

257) From the River Teith running southwards the cable route and haul road would cross a farm track (NS757973), a small water course at NS756969 followed by a crossing of the A84 at approximately NS755966. The cable road crossing could be performed using a concrete encased duct block utilising lane closures and traffic controls to make the road available.

258) The selected route would run to the east of Drip End Farm, the access to Drip End Farm would be crossed at NS755964. The route would cross a small water course or field drain at NS755961 and pass to the west of Drip Moss Farm. The method of crossing these water courses would need to consider whether or not the method would impact on the River Teith SAC.

259) The cable route would then cross Nailer's Lane at NS754952 on the extreme eastern edge of the route corridor. If it is not permissible to close Nailer's Lane for the duration of the open cut trenches and cable laying, it could be an open cut and ducted.

260) A direct (straight line) route may be selected from Nailer's Lane to the SEC at Gartur. However, this would require additional crossings of water courses than a compared to a slightly longer route that avoids Johnny's Burn. A route avoiding multiple crossings of Johnny's Burn (discussed later) has therefore been selected.

261) From Nailer's Lane the cable route would run down to cross Charlmerston Road (a minor road) at NS757945 close to the entrance to East Cambusdrennie Farm. The route crosses the access road to the farm (at NS758944) and would then continue southeast towards the River Forth.

262) The crossing of the River Forth would be at NS761937 slightly to the west of where Johnny's Burn (which flows under Polrogan Bridge in Figure 3-6) flows into the River Forth. The crossings of pressurised hydrocarbon fuel pipes are reasonably close to this location so it may be necessary to relocate any cable crossing at least 50m away from the pipeline crossing point (to avoid damage

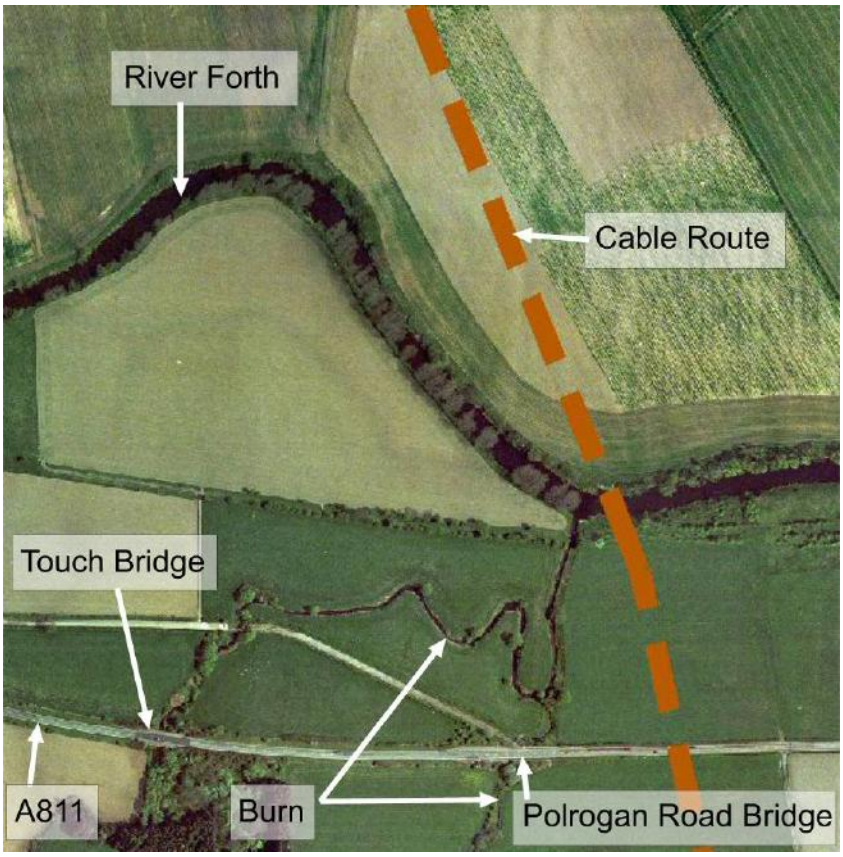
during the construction of the river crossing, particularly if directional drilling is used where there is an increased risk of a misdirected drill hitting and damaging a pipe). Figure 3-6 is an annotated aerial photograph of the position for the crossing of the River Forth.

263) The position for the proposed cable crossing is shown as being east of the position where Johnny's Burn flows into the Forth. This position avoids any crossing of the burns south of the River Forth shown in Figure 3-6. However, this is likely to have been a consideration of the pressurised fuel pipe installers and thus the two positions may conflict. The cable crossing position shown is therefore only a preferred position.

264) The section of the River Forth which lies within the SNH corridor is shown in Figure 3-6, beneath which, in all probability, a cable crossing could be performed at a number of alternative locations. Cable crossing positions of the Forth to the west of Johnny's Burn would require each of the burns to the south of the River Forth to be crossed, and in the case of Johnny's Burn, two such crossings would be required for the cable route to reach the SEC at Gartur.

265) It would be preferable to install the cables in directionally drilled ducts installed beneath the River Forth. These ducts would be filled with bentonite to secure the cable against thermomechanical movement and to improve the thermal heat transfer properties of the ducted crossing.

Figure 3-6: – River Forth Crossing



266) Immediately to the south of the River Forth is the A811. The cable route would pass under this road (at NS762934) in concrete encased ducts installed using open cut methods and road traffic control. If the latter is not acceptable to the road

maintainers then the ducts for the cable may be installed using a directional drilling method. Care would need to be taken to locate the cable crossing away from the gas mains. Alternative positions for crossing this road are available if the cable crossing of the River Forth is relocated.

267) Where crossings by the cable either under or over the hydrocarbon fuel lines would be required discussions with the pipeline owners should be undertaken to agree both a crossing method and location. Such crossing methods would usually require excavation beneath the gas main and the installation of a direct buried cable or ducted concrete encasement at a depth below the gas lines agreeable to the gas operator (normally >0.3m). If the cables are to pass over a buried gas main then this may be achieved within a ducted concrete encasement. If the gas mains are well below cable trench excavation requirements and the minimum depth of cable burial in farm land can be achieved (1m to cover tile) then a normal direct burial method may be used. Discussions would also be required regarding the passing of the haul road over any hydrocarbon fuel lines due to the heavy loads to be moved.

268) The cable route passes to the east of the gas compound (National Grid fenced compound 'Stirling 6135' at NS762928) crossing Touch Road at NS963928 and a minor road further south at NS763924. The cable route then passes into the ancient woodland of Murray's Wood resulting in total vegetation destruction for the swathe wide clearing all tree roots and top soil. Replanting of trees or vegetation with roots that may damage the power cables would not be permissible. At the north extent of Murray's Wood is a small water course which would need to be crossed (NS763921).

Figure 3-7: – Gas Main Compound near Johnny's Bridge on Touch Road

269) For the first SNH route option a SEC (UGC4-SEC2) would be located at Gartur, NS763919.

270) The cable route option for the SNH UGC route between Milour Moor and Gartur SEC is approximately 13.8km in length.

271) A cable route which has been selected in order to try and meet the requirements of SNH's second option, which would also meet the requirements of SBP through the same area, would pass through this position at Gartur and continue southwards

towards Denny Substation. This UGC route continuation is discussed in Section 280) below.

3.2.5 UGC4 SEC 2: Gartur

272) SEC 2 at Gartur represents the southern end of the SNH 18June07 undergrounding proposal. South from this point SNH propose that a new section of OHL route connects the UGC back to the Denny Substation.

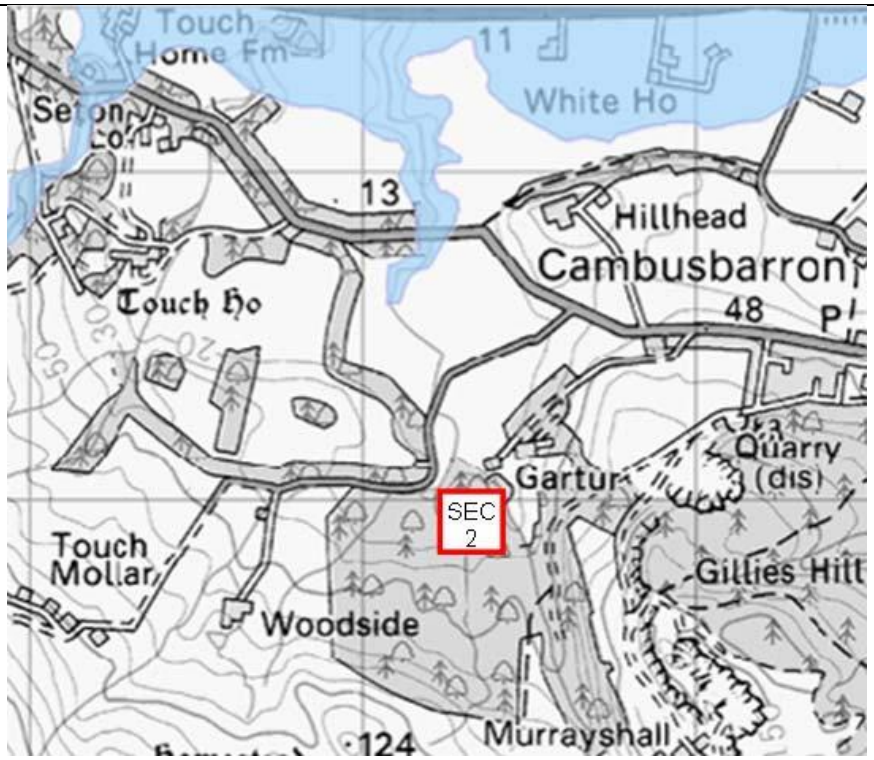
273) SEC 2 would be sited within the north end of Murray's Wood at Gartur, the intention of this site being to minimise the length (and therefore cost) of the UGC going south from this forest, and to use the woodland to provide some visual screening of the SEC structures.

274) This SEC would be the southern termination of a section of cable of around 13.7 km in length. This length of UGC reactive compensation may require reactive compensation to be sited at the SEC. If so, permanent abnormal load access would also be required.

275) The existing minor road to Gartur would not accommodate loads of abnormal length and weight, so substantial permanent road strengthening works would be required as a minimum. It is possible, even with this provision, that gradients on this minor road would preclude the delivery of the shunt reactors needed for reactive compensation, in which case it may be necessary to construct a new section of roadway north from Gartur to Touch Road, in the vicinity of Johnny's Bridge, and then to strengthen / widen Touch Road between that point and its junction to the northwest with the A811.

276) As may be seen from Figure 3-8, SEPA identifies no flood risk associated with SEC 2.

Figure 3-8: – SEC 2 Flood Risk Map



3.2.6 UGC4 C1: OHL from-SEC 2 (Gartur) to SEC 4 (Denny S/Stn)

277) This 10.2 km section of OHL is proposed by the SNH 18June07 undergrounding option. The OHL route would proceed almost due south through and along the edge of Murray's Wood, and would remain within the eastern leg of the SNH search area, and generally in the bottom of the valley as it makes its way towards the M9 motorway.

278) The proposed OHL route aims to avoid close proximity to buildings, but this becomes impracticable at a pinch-point in the search area at Auchenbowie Wood and Auchenbowie House just to the SSW of the M9 / M80 motorway junction. For this reason it is proposed that the OHL crosses the motorway a little north of the SNH search area, re-entering the search area approximately 1 km to the south.

279) The final section of this proposed OHL route follows the lane along the side of Craw Hill before turning to the SE for its final run into Denny Substation.

3.2.7 UGC4 C2: UGC from-SEC 2 (Gartur) to SEC 4 (Denny Substation)

280) This section of UGC is proposed by the SNH 30Jan07 undergrounding option, and is an SNH alternative to the UGC4 C1 OHL route just described in Section 3.2.6.

281) Murray's Wood rises above the flat farmland of the carse containing the Rivers Teith and Forth.

282) Whilst it is not a SBP requirement for the cable route to remain within the SNH corridors it is recognised that should undergrounding be a requirement in this area

then SNH would have an input into an acceptable routeing. The authors have thus utilised the SNH corridors where possible.

283) South of Murray's Wood SNH provided two corridors for possible undergrounding. A westerly route would run through Castlehill Wood (NS753908), an area belonging to the MOD and marked as a "DANGER AREA" (NS753906), Berryhill (NS752900), Townhead (NS748890), Todholes (NS752880), Meikle Canglour (NS775864) to Easterton (NS804863). This westerly route would add approximately 2.5km to the overall route length. A technical advantage to this route would be the removal of concerns regarding service crowding at the crossing of the Bannock Burn (see below). However, the westerly route contains Castlehill Wood which is ancient woodland and also located on upland habitats. Some consideration must also be given to the additional cable length (cost) required and the uncertainties, dangers and clearance costs of crossing any areas which may contain unexploded ordnance. For these reasons a route through the SNH easterly route corridor has been selected and described below.

284) The cable route would run parallel and to the east of a small water course flowing from south to north through Murray's Wood. The cable route would cross the water course at NS766912 if the cable route is located southeast between Castlehill and Touchadam Craig. An alternative would be to position the cable route just outside of the swathe close to Murray's Hall Farm (NS964910).

285) The cable route would follow the foot of Touchadam Craig until the route crosses a minor road and the Bannock Burn at NS771907. High pressure hydrocarbon fuel lines run through this area.

Figure 3-9: – Fuel Line Marker Posts at Bannock Burn Crossing

286) The SNH corridor at this location is very narrow and space is constricted between vertical rock faces of Sauchie Craig and the rock outcrop near Wallstale farm. This is a route pinch point and the location of the hydrocarbon fuel lines would be critical when undertaking final route selection. Some negotiation with the pipeline owners regarding the most appropriate cable route in this area would be prudent.

287) Figure 3-9 is a photograph of the minor road alongside Bannock Burn (the burn is not visible in the photograph). Oil line marker posts are visible and prolific at this location. A rocky outcrop can be seen in the centre distance. There is a cutting through this outcrop to the rear of Wallstale Farm (Figure 3-10). An option would

be to widen the cutting through this rock outcrop such that it may accept a cable route.

Figure 3-10: – Alternative Cable Route Through Existing Cutting (Requires widening)

288) The cable route would run to the west of Bannock Burn taking a line between Cultenhove and Chartershall Farms and crossing a local water course at NS788899.

289) The cable route would cross minor roads to the north (NS788899) and east (NS789897) of Gateside Farm. The route would then locate around the southwest of Foot o' Green Farm (NS792893).

290) South of Foot o' Green Farm the cable route would maintain a position in the centre of the SNH corridor. There are a number of possible route options and apart from the existing buildings, most of the corridor appears suitable for use. The cable route would also run parallel and 250-350m to the south/west of the M80. The cable route would pass under a farm track at NS799885 and a small water course or land drain at NS800882.

Figure 3-11: – Moss Side Farm view from minor road

291) The cable route would pass under a C road (>4m wide) at NS794891, a farm track at NS799885 and a small water course or land drain at NS800882.

292) The route would pass to the east of Moss-Side Farm between the wood and the farm buildings and cross a minor road at NS801878. The cable would then run through Auchenbowie Wood. The route has been positioned to avoid the disused shaft at NS802875.

293) The cable route would run to the east of Auchenbowie House (NS800875) and cross the estate access road at NS802873. It will be necessary to install a cable crossing at NS803872 beneath the M80 near the Mains of Auchenbowie. This would be a directionally drilled ducted installation similar to that discussed in APL 5/16 for the crossing of the A9 at Dalwhinnie. The cable route then crosses the A872 at NS805871.

294) South of the crossing of the A872 the cable rises onto Craw Hill running alongside a minor road giving access to North Durieshill Farm. The cable route crosses this road at NS808867.

295) The cable route would keep to the easterly extremity of the SNH corridor (albeit that there is slightly preferable ground 100m or so to the east which may be used). The cable route crosses farm tracks at NS809864 and NS813858.

Figure 3-12: – View from Minor Road near Dales Wood Looking Towards Denny S/S

296) The cable route crosses a water course at NS816855 and passes to the south of Woodcockfauld farm (NS818855) crossing a minor road and water course at (NS819852) the northeast corner of Dales Wood (Figure 3-12). From this crossing the cable route would run to the SEC alongside the existing Denny Substation (NS823847).

297) The SNH route option for a complete undergrounding between Milour Moor SEC and Denny Substation would be approximately 24km in length.

3.3 SBP ROUTE

298) This section of the report considers the underground cable route around Stirling based upon the Stirling Before Pylons (SBP) letter to the Scottish Executive dated 22nd January 2007. A cable route has been selected in order to try and meet the requirements of SBP and for brevity is referred to as the "SBP Route".

299) In their communication of the 22nd January 2007 SBP provided the following technical requirements for an underground cable route in the Stirling area which may be summarised as follows: a) That any cable route should pass to the west of Stirling, b) That the cable route should pass through the whole Stirling area (no use of OHL), and c) Consideration should be given to the existing oil pipeline routes, installing cables along the M9 and any other alternatives. SBP also wished to rely on the expertise of others to determine a suitable UGC cable route or routes. A cable routeing was thus selected by the authors based upon the general requirements identified by SBP.

300) In accordance with the methods used in APL 5/16 site visits were made and inspections of alternative route options performed. In order that other team members, particularly those assessing environmental impacts, could start their appraisal of the impact of any cable route as soon as possible, a preliminary route map was prepared early in the process.

301) The 'SBP route' would run as underground cable from Braco Substation in the north to Denny Substation in the south with no OHL (a SBP requirement). In the schematic drawing shown in Figure 1-2, the underground cable route would run along the schematic line UGC4 A3 —— UGC4 B —— UGC4 C2.

302) The entire route would run from north to south with a routeing to the west of Stirling (a SBP requirement) and would consist entirely of UGC. The cable terminations would be located within the 400/275kV compounds at Denny and the new Braco substation.

303) It should be noted that on this SBP route the positions Greenyards and 'Gartur' are locations which are significant only as aids to the route description. Greenyards is where this route option diverges from that of the SNH route option. Gartur would be the location of a SEC (UGC4-SEC2) only under one of the SNH route options.

304) Some of the proposed alternative routes for the transmission line pass close to, or over, hydrocarbon fuel pipelines. The following paragraphs regarding cable routeing apply to both the SNH and SBP routes.

3.3.1 Hydrocarbon Pipe Lines

305) The owners of hydrocarbon pipe lines are understandably protective of their assets and the damage that can be caused by third parties excavating in the vicinity of their services. This hazard extends to the safety of personnel excavating alongside the pipeline. The hazards would include contact with the substance being transported, fire hazard and risk of explosion. Damage to a hydrocarbon fuel line can also result in a significant pollution event, particularly with an oil line near a water course. Damage does not need to be great to cause a serious hazard. Pressurised pipelines have protective anticorrosive coatings to protect the

pressure retaining membrane (generally a steel tube) from the surrounding environment. If these coatings are damaged and not repaired then there is a risk that localised corrosion may occur which can ultimately lead to a puncture of the pressure retaining membrane.

306) There is a risk that any gas leakage from a gas transport system could give rise to a build up of gas in a cable system joint bay. If joint bays were located near to a gas line then gas detection equipment would need to be employed to warn of this hazard. This is only a hazard during construction when excavations are open. A direct buried joint bay, as opposed to an air filled chamber containing joints, would be backfilled on completion and thus would not be prone to gas accumulation. Apart from any tunnel application, direct buried joint bays would be used throughout the various studies published by the undergrounding team.

307) The gas transport system would not be expected to have a significantly adverse impact on the power cable system construction. For the majority of the route the cables would be sufficiently remote from the gas pipelines that installation of the cables would not be impeded by any concern over damaging the gas pipes during cable trench excavation. Consideration would however need to be given to haul road construction and position for the movement of heavy loads over the pipe lines at haul road crossing points.

308) Metallic pipelines can suffer electrolytic corrosion due to voltages induced on the pipeline as a result of magnetic induction and earth return currents from electric power lines. The pipeline must be adequately protected against such corrosion as this phenomenon increases with both proximity between the power line and the pipeline and the length over which they run together. For the cable system routes selected the cable and pipeline routes do come into close proximity and discussion with the pipeline owners regarding the cable routeing and pipeline protection systems would be required.

3.3.2 Coincident Highway and UGC Routes

309) It is also understood that SBP required that consideration be given for the cables to run along the M9[3]. This suggestion could be broadened to consider all the dual carriageway trunk roads between Braco and Denny. At first, this would seem to be a sensible solution with the following perceived advantages:

3.3.2.1 Perceived Advantages:

310) a) The M9, M80 and A9 are all wide trunk roads generally having sufficient width within which the EHV cables and joints may be contained.

311) b) Access for the heaviest construction traffic is very good and the heaviest cable drums and longest cable lengths may be delivered.

312) c) The cables will give off heat which may be useful during cold weather to keep the motorway somewhat free of snow and ice.

313) d) There is little or no additional impact on the ecology of the route along which the cables run.

[3] SBP letter to the Scottish Executive dated 22nd January 2007.

3.3.2.2 Disadvantages of Coincident Highways and UGC Routes

314) There are however a number of disadvantages to such an installation method which would discourage both the transmission operator and Transport Scotland from adopting such a solution:

315) a) In order to place the power cables under a trunk road it would be necessary to open the road surface and install the power cable. This would require closure of traffic multiple lanes or carriageways both to contain the cables, to accommodate the construction traffic and to provide workers with a degree of road safety. Each kilometre of double circuit, two cables per phase, power cable installation would take in the order of four months to complete. If it were possible to use the major trunk roads then the absolute maximum length of cable route for each road under consideration would be the A9 (10.58km), the M9 (9.32km) and the M80 (2.80km). Thus up to 22.7km of trunk road could be utilised for a cable route from Braco to Denny. By utilising multiple teams of contractors and suppliers this work would need to be completed in four years (to match the OHL installation). On a 48 month timescale the cable route (both circuits) would need to be installed at a rate of one kilometre every 2 months. There would thus need to be at least two teams working with 2km of road lane closure from Townhead (A9) in the north along the M9 to J9 and on to Avenue Head (M80) for the entire four year period. This would cause considerable traffic congestion for the vehicles using the roads (in the order of 20 to 40 thousand per day[4]). Whilst the work duration may be shortened by the use of multiple teams, closing longer stretches of road and round the clock working there would be a significant cost impact to the transmission company in doing so.

316) b) Some sections of trunk road may not be able to accommodate power cables. Examples of this are road bridges and elevated road sections. At these locations there is unlikely to be sufficient depth on the deck of the bridge to accommodate the cables to a depth of 0.9m. Some bridges contain cavities which can accept cables, for others it may be possible to agree with Transport Scotland that a shallower depth of burial may be employed; with additional protective measures both against accidental damage to cables and the possible damage to the road surface as a result of a cable system failure. Such precautions may not always be possible or indeed acceptable to Transport Scotland.

317) c) Elevated or bridging road spans also include two or more expansion joints. Road users will be familiar with the “clunk-clunk” sound that vehicle front and rear tyres make when entering or leaving a motorway bridge span as they pass over an expansion joint. These joints are required to allow the bridge to dilate, primarily as a result of thermal expansion. Special arrangements would need to be made to avoid cables being damaged by bridge dilation at their expansion joints. If allowance for the relative movement across an expansion joint is not made, unacceptable localised cable strain is likely to occur resulting in damage to the power cable system. One example of a transition structure for multi-circuit 132kV cables to overcome bridge dilation was recently given in a JICABLE[5] paper. This paper describes the tests on a bow spring transition structure carrying 132kV XLPE cables. A photograph of a similar design, but for a single circuit, is shown in Figure 3-13 (Single core gas filled cables over the River Lee in East London). The arrangement for six 400kV and six 275kV cables would be considerably larger if this type of design were employed and would require significant space in a bridge

[4] Information obtained from Transport Scotland’s website http://www.transportscotland.gov.uk/defaultpage1221cde0.aspx?pageID=295

[5] “Verification of Mechanical Support for Cables Used on Bridge Structures at Dilation Points”, Foulard et al, Victoria University, paper B8.5, JICABLE 2007

cavity. Trunk road bridge designs do not, unless specifically designed to do so, naturally lend themselves to carry EHV power cables in cavities. At road bridge locations which contain expansion joints it is most probable that the cable systems would need to leave the trunk road and find their own way across the obstruction, be it river, road or railway etc. This may require considerable cable diversions to find a suitable cable route and cable bridging point to pass over an obstruction (such as the crossing of Allan Water).

318) d) If a failure occurs on an EHV cable system, this represents a major disruption to the transmission operator's system and they thus seek to repair the system and place it back into service as soon as possible. If the cables are installed in fields then the excavation becomes a matter of gaining access to the land. For cables installed under a motorway matters would be somewhat more complex and would involve several agencies including the police and Transport Scotland. Under most circumstances this would require the closure of traffic lanes and the excavation of the road surface to gain access to the buried cable system. The repairs may also inconveniently coincide with other motorway maintenance works which could conceivably increase traffic flow problems. For routine maintenance (such as a serving repair) Transport Scotland are likely to be very resistant to any maintenance work on the cable system which requires any road lane closure unless it is either an emergency repair or conveniently coincides with lane closures planned for highway maintenance.

319) e) The placing of cable joints under the road surface would also be problematic. The joints are the most likely components to fail in service. In some countries (such as in Austria[6] and the USA) cable joints have been placed in air filled chambers. This has the advantage of easier inspection of both the joints and the link equipment contained within. The placement of air filled chambers under the surface of a trunk road or motorway may require forced cooling to remove heat from the EHV cable joints. An air filled manhole with water pipe cooling has been installed in Vienna with the entire cable system being water cooled. A water cooling system requires more maintenance than a naturally cooled system and the repair process is complicated by the hydraulic requirements of the water cooling system. Where air filled joint chambers have been used there has been some experience of manhole covers being blown-off when a joint fails or a flammable gas build-up explosion occurs. This has led some utilities to reassess their design philosophy and to subsequently fill the joint bay chamber with sand. This negates the main benefits of installing an air filled joint chamber. Where there is no option but to install EHV cables beneath a trunk road (e.g. in towns) it is preferable, although not always possible, to directly bury the power cable joints in a joint bay located to the side of the trunk road such that the joints and link equipment may be accessed without the need for road lane closures.

320) f) In cold weather, above heavily loaded large conductor circuits, snow or ice may melt above the power cables as a result of ground warming. This phenomenon is due to heat loss produced by a power cable. The primary heat loss is a result of conductor resistive heating (which is proportional to the square of the current). EHV cables have a low conductor resistance, are capable of carrying thousands of amps, at thousands of volts and are buried at least 0.9m deep. An EHV cable circuit would only be expected to produce a noticeable effect for a limited ambient temperature drop and only then when carrying significant load. By

[6] 400kV Vienna The Vienna 400kV North Input, Vavra J et al, Cigre 2006, Paper B1-101, Paris.
[6] The Construction (Design and Management) Regulations 2007, The Stationary Office Limited, ISBN 9780110757896

comparison, trace heating cables, which are commercially available for heating beneath road surfaces, have a small conductor with a high conductor resistance, operate at low current flows and are installed at a shallow depth (generally less than 300mm). As a design concept a trace heating cable is the diametric opposite to a transmission class cable. Trace heating cables are designed to produce heat at low current flows whereas transmission class cables are designed to produce as little heat as possible such that they can carry very high current flows. Transmission class cables are thus not suitable for the reliable heating of a road surface to prevent the formation of a snow or ice covering and may not be modified to do so without compromising their prime function.

321) g) Safety issues must also be considered when designing such projects and there are duties upon designers which may be enforced under the CDM 2007 regulations. These duties (CDM 207 Clause 11) must be performed so far as is reasonably practicable, taking due account of other relevant design considerations. One such duty is that "*Every designer shall in preparing or modifying a design which may be used in construction work in Great Britain avoid foreseeable risks to the health and safety of any person*". In paragraph (4) of the same clause, "*In discharging the duty in paragraph (3), the designer shall - (a) eliminate hazards which may give rise to risks; and (b) reduce risks from any remaining hazards…*". In order to fully comply with these requirements a design risk assessment must be performed. It is self evident that the hazards of workers installing cables along busy trunk roads (A9, M9, M80) and the hazards to road users (restrictions, road narrowing etc) could be eliminated if the cables were instead installed in the adjacent fields and land that can be seen in the Stirling area. The authors are not aware of any recent installation of EHV cables in a major UK trunk road where such an option was available.

322) h) Aside from the inconvenience to road users and the indirect costs which may arise, the capital cost of installing the EHV cables below trunk roads would be expected to be greater due to the cost of road reinstatement, and the precautions necessary to provide a safe working environment for both operatives and road users. These costs would be expected to far outweigh any cost savings such as fewer joints, less haul road and fencing if the cables were installed in fields.

Figure 3-13: Expansion Joint and a Flexible Cable Crossing Design

323) The outer limit of the trunk roads is bounded by a construction fence. These areas are, in most locations, too narrow to accommodate the power cable circuits and would still require some lane closures for safety reasons in areas where any works were being carried out.

324) From the above it may be concluded that the installation of cables under the major trunk roads should only be considered where other alternatives are not available.

325) In order that an UGC route may be provided that meets SBP requirements for a connection between Braco and Denny a route has been selected which a) passes to the west of Stirling, b) follows alongside the major road and rail links and follows the routeing strategy in APL 5/16. This route comprises of sections UGC4 A3, UGC4 B and UGC4 C2 in Figure 1-2.

326) Figure 3-14 is a profile plot of the cable route which is approximately 33km in length. Where ground gradients exceed 12.5% these have been identified. It can be seen that where these gradients exist they are all less than 110m in length and it should be possible to work the ground by use of tracked vehicles and haul road turn around positions (see APL/CNP-41 Strathmashie route).

327) Intermediate compensation would require a fenced compound containing reactors, switchgear and cable sealing ends. These compounds would be slightly smaller than the SECs discussed to date since they would not require any terminal tower.

3.3.3 UGC4 SEC 3: Braco Substation

328) SEC 3 represents the northernmost point of SBP's undergrounding proposals, and would be co-located with the proposed new transmission substation for Braco, in the woodland on Cambushinnie Hill, and above Feddal Hill at NN795095. The location of the substation and SEC is quite high compared to the surrounding countryside, so from a distance there would be no additional visual impact on account of the presence of the SEC. Indeed the absence of the second terminal tower and OHL running south from the site would, in all probability reduce the visual impact.

329) This SEC 3 would be the northern termination of a section of cable of around 33 km in length. This UGC would thus almost certainly require reactive compensation at the SEC itself, and permanent abnormal load access would therefore be required. It should be noted that it is quite possible that a full system study would indicate that the 33km UGC section would also require a compound part way along the route to accommodate intermediate reactive compensation. Intermediate compensation would require a fenced compound containing reactors, switchgear and cable sealing ends. These compounds would be slightly smaller than the SECs discussed to date since they would not require any terminal tower.

330) There are no highways into the site at present so a new road would be required. There is an existing track-way that finds its way down the eastern ridge of Cambushinnie Hill before turning SE across Mill Burn, past Whistlebrae, and finally Easter Feddal before linking to the B8033 – around 5.6 km in all. This may be the least steep route, and would avoid crossing major waterways, but would need very significant development in terms of strength, corner radius and gradient before cable drums and shunt reactors cold be delivered.

331) In addition to this new road on to Cambushinnie Hill, access for abnormal loads would also need to be available for the 1.5 km along the B8033 to the A822 at

Braco. It is understood that this is the preferred access route for constriction of Braco substation and the associated 120tonne transformers.

332) The area is hilly, but the gradients on the roadway access from the A9 would need to be restricted to about 8% to allow for the heavy loads. (Gradients up to 12% could be accommodated for short distances if absolutely necessary.) The status of this B-road has been assessed by others who have separately confirmed that it would be the route of choice when delivering transformers to the proposed new Braco Substation.

333) In this case the cable sealing ends, reactive compensation, and other equipment associated with the cable terminations, would be enclosed within the substation compound fence rather than having a separate SEC although, of course, similar amounts of land would be required in order to accommodate the equipment.

334) As may be seen from Figure 3-15, SEPA identifies no flood risk associated with SEC 3.

Figure 3-14: Cable Route Profile for the SBP Route Option

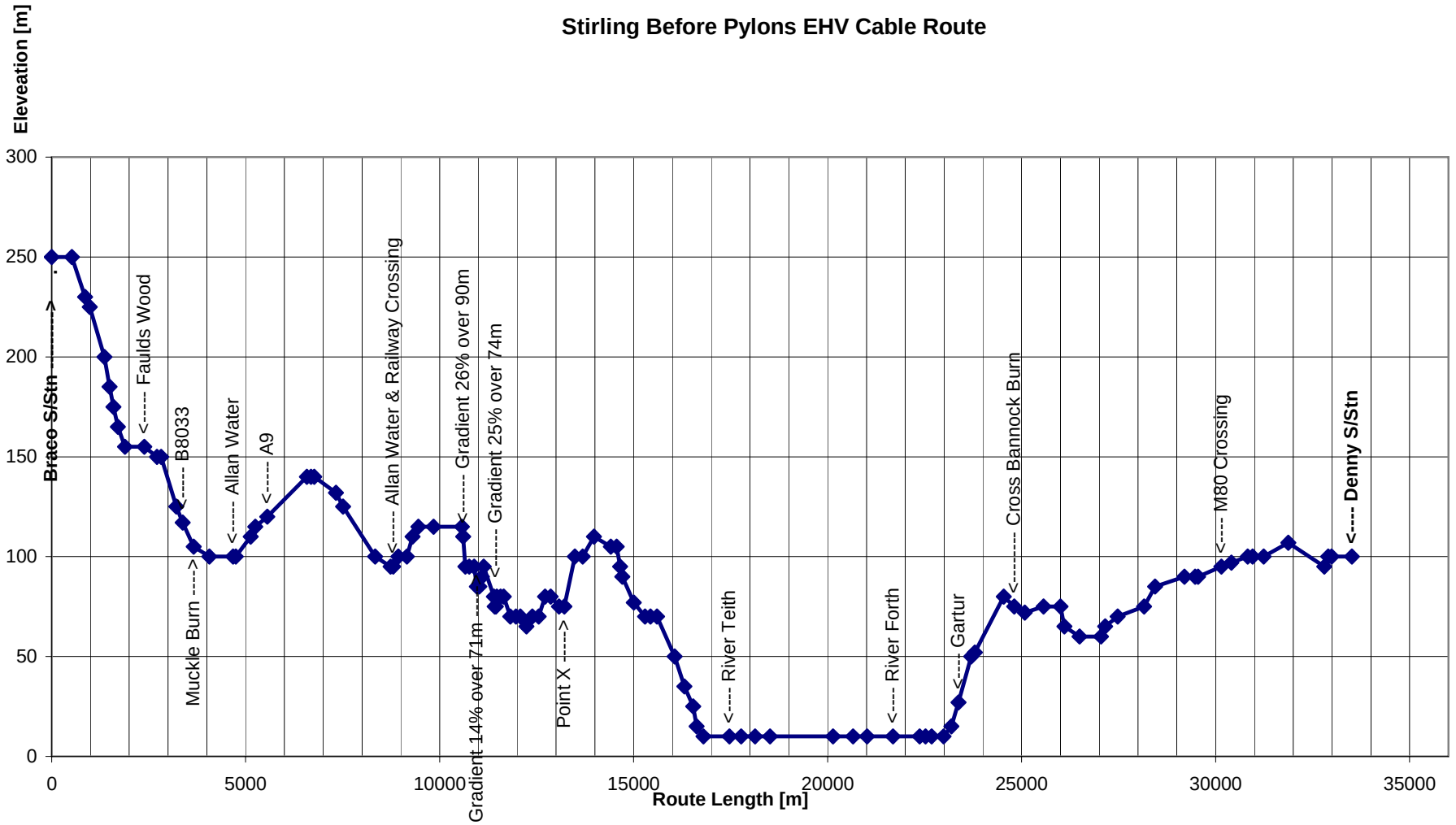
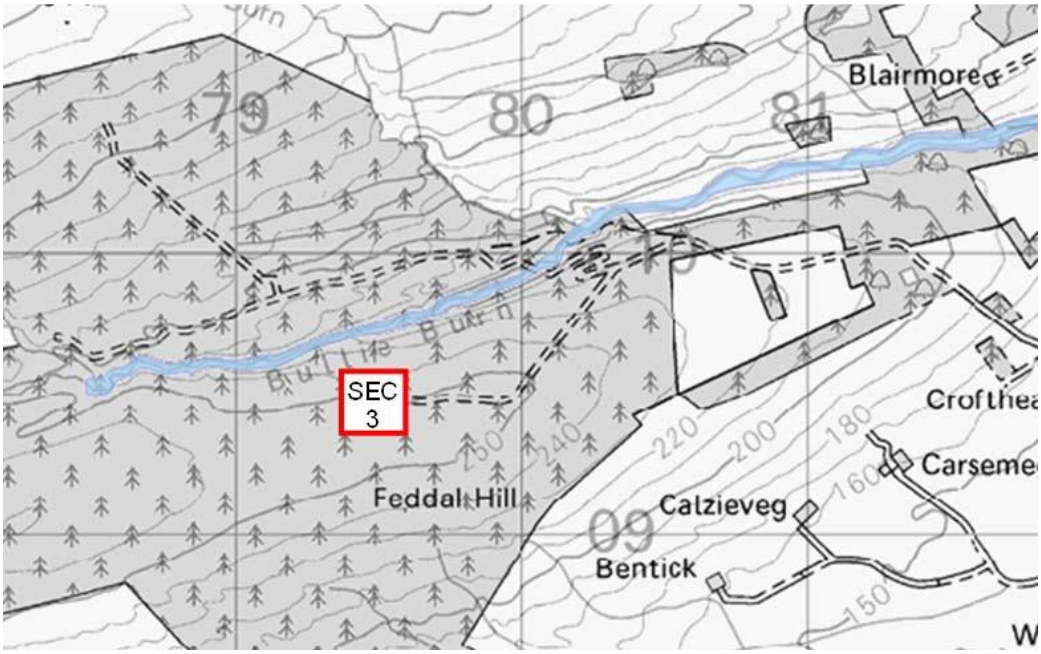


Figure 3-15 – SEC 3 Flood Risk Map



3.3.4 UGC4 A3: UGC - New Braco Substation to Greenyards (Point X)

Figure 3-16: View looking North from the A9 over Strath Allan

335) The northern end of the proposed cable route would be at a new Braco Substation location at NN794094 (this should not be confused with the existing 132kV Braco Substation at NN838108).

336) The substation is to be located within wooded land on Cambushinnie Hill (which is in the far distance in Figure 3-16). The hill has a gently sloping eastern side, a steep northern side (which has been incised by tributaries of the Kier Burn), a moderately steep southern side and a difficult, incised, wooded and wetter western approach.

SNH Search Area for the SBP Routeing Alternative from Braco?

Consideration was given to undergrounding directly between the new Braco Substation and the position at Milour Moor (SEC 1), thereafter following the SNH route proposal discussed in Section 246).

However this route would require traversing the western approach to Cambushinnie Hill and there are a number of difficulties with such a route. The route would extend for several kilometres through forest and it is not possible without a more detailed on the ground survey to establish the type of terrain that would need to be traversed or the topography of the ground upon which the forest lies.

The OS map indicates that the terrain is wet across the entire SNH corridor near the Muckle Burn (NN772079), Bracklin Burn (NN767054) and Lodge Burn (NN767054).

The Muckle Burn is incised into the terrain. Whilst this presents a problem to the cable route (which would require a special construction, probably a cable bridge) it would also present difficulties for the haul road and the method by which it would cross the burn or approach the cable route on either bank. The presence of wet ground across the entire SNH corridor, the lack of nearby roads and the difficulty of road building on both boggy and/or forested cross slopes for the cable drum carrying vehicles makes this route impracticable and there would be a reasonably high probability that it would prove to be unusable.

337) In order that a cable route with a better degree of practicability may be indicated and costed for the Inquiry, a route down the south side of Cambushinnie Hill and along the A9 is described below. This route meets the SBP requirements of a UGC for the complete route from Braco S/Stn to Denny S/Stn.

338) The gradient on the south side of Cambushinnie Hill is not suitable (below 10%) for construction at every location. In order to try and avoid cross slopes and zig-zag road cuts into the hill side a route has been selected with a descent to the east of Bentick Farm (NN807088); this route requires that the cable route leaves the substation in an easterly direction and makes a gradual south easterly descent of Cambushinnie Hill between a 250m elevation at NN799094 to a 165m elevation at NN807089. Where possible the route shall follow the edge of the fields.

339) The descent of the hill requires the crossing of two small water courses at NN806090 and NN807088. The route would pass to the east of Bentick Farm and cuts the farm access road at NN807087. Following crossing the farm access road two small water courses would need to be crossed at their confluence (NN807085).

340) The route is then positioned through a narrow strip of Faulds Wood (NN807082), if necessary this woodland could be spared by diverting the cable westwards, following an existing track alongside the wood. The cable route would then run to the east of Craighead Cottage and cross the B8033 at NN812073.

341) South of the B8033 the cable route enters the floor of Strathallan. The cable route is unable to traverse westwards very far along the floor of the Strath due to the topography near the B8033 bridge over Allan Water (NN791053 see Figure 3-17).

This is due to the proximity of steep gradients either side of the river and the risks of flooding on the floor of the strath. A route has therefore been selected which would ascend the south side of the strath at a suitable point and follow alongside the A9 before re-crossing Allan Water (a salmon river, but not designated), the railway and the B8033 further west.

Figure 3-17: - Allan Water Near Kinbuck (B8033)

342) The cable route selected would thus cross the floor of Strathallan and cross the Muckle Burn (a tributary of Allan Water) at NN811070. The haul road may cross the burn by use of a temporary bridge to give access to the swathe west of Muckle Burn. Alternatively, an access road can be installed from the B8033 to recommence the haul road on the west side of Muckle Burn (Figure 3-17).

Figure 3-18: - The Muckle Burn

343) The route would then pass to the south of Nether Cambushinnie Farm and cross a small water course at NN810065. Then passing between an oxbow lake and Allan Water at NN809062 and crossing Allan Water itself at NN809060.

344) The cable route would then rise from the floor of the Strath crossing the railway at NN809059 parallel and to the east of Todhill Burn to meet the A9 at NN812053. Access to the strip of land between the south bank of Allan Water and the railway may be problematic. There is however a railway crossing point at NN813061 which may be used to carry light equipment suitable for the limited excavations required. Alternatively, a single directionally drilled cable crossing could be installed beneath both Allan Water and the railway where they are in close proximity at NN810060.

345) A cable route mainly in the fields alongside the A9 would have the benefit of good heavy load access. These loads could be transported and delivered more easily to the cable route provided the road operator permits reasonable access to and from the A9 for construction traffic.

346) Todhill burn would be crossed at NN812052. The route would then pass through woodland (the ancient woodland of the Firs of Kinbuck) from NN809049 to NN806046 which would require clearance and root removal over a length of 530m for the width of the swathe. Alternatively the cable route could be diverted around the north side of the wood at some additional expense.

347) A small water course and the access road to Lower Whiteston Farm would need to be crossed at NN804045 with further small water course crossings at NN803043 and NN801041.

348) The access road to Gateside Farm will require to be crossed at NN800040 as will a track from Cairnston Farm at NN795035. The cable route would pass through a strip of ancient woodland north of Cairnston Farm alongside the track.

349) The cable route position has been selected to re-cross the combination of Allan Water and the railway alongside. This would be a difficult undertaking close to the A9 at N783029 and would require an engineering survey beyond the scope of this report. The survey would consider structures such as one or more naturally ventilated cable tunnels. These tunnels would be less than 500m in length and rely upon ventilation by natural thermal convection. These would be costly structures however they could reduce the circuit length by approximately 1km. A cable bridge is unlikely to be suitable as it would need to be constructed over the railway which would present construction and maintenance difficulties. There are no available options south of the A9 principally due to the built up areas of Dunblane. To avoid the considerations of a detailed engineering survey to cross Allan Water and to provide a feasible route for this report, a route to the north, around Ashfield, has been selected.

Figure 3-19: - Allan Water and Rail Cutting at A9 Crossing

350) From Gateside Farm the cable route crosses a farm road at NN794040 and crosses the B8033 at NN790039.

351) The proposed cable route lies north of Ashfield; where the river (Allan Water) is not so heavily incised into the land, and where the railway and river could be crossed (at NN787041) either in one combined directional drilling operation or as two separate operations. (Figure 3-20; the river is just visible to the left hand side).

352) Access to the cable route to the west of Allan Water between the river and rail crossing at Ashfield to Lower Auchinlay is poor. The minor road is in poor condition and has a number of sharp bends. This road would be required for access all the way from the housing estate in Dunblane to the bridge over Allan Water near Kinbuck. It would be likely to prove necessary to increase the width of this road to allow construction vehicles to access the site. The B8033 bridge over Allan Water at Kinbuck has a weight limit of only 10 tonnes and would not be useable for construction traffic. This restriction would require the construction traffic to access the route via Braco.

Figure 3-20: – Rail and Allan Water Crossing at Ashfield

353) West of Allan Water the cable route crosses a small water course which flows into the river at NN783039 and a minor road at NN781038. The cable route is positioned alongside this road as far as NN779034. From this point the cable route heads towards the A9 via a position north of Rhu House (NN776025).

354) At Lower Auchinlay there is a steep gradient (up to 31% at NN775027 see Figure 3-21) which would need to be negotiated over approximately 150m. Access to the top and bottom of this slope is available for the haul road (provided the minor road running parallel to the route is made fit for the purpose). Construction using tracked vehicles on the gradient over this short distance would be possible. In which case the gradient should not present an insurmountable obstacle to construction.

Figure 3-21: Steep Gradients near Rhu House Farm at Lower Auchinlay

355) At NN775026 the access road to Upper Auchinlay Farm would need to be crossed. The cable route is then positioned to the north of Rhu House at NN774025. The cable route then heads towards the junction of the A9 with the A820 crossing a water course (a tributary of the Ardoch Burn - part of the SAC) at NN771020 as it does so.

356) At the junction between the A9 and the A820 the cable route is in close proximity to the SNH cable route corridor and the SBP route crosses this corridor to meet up with the SNH UGC cable route at Greenyards to proceed South towards Denny Substation.

357) The cable route crosses a track at NN769018, and passes south (NN768017) of the Stockbridge Farm buildings. A water course is located north of the A820 alongside which the cable route is located. The cable route is positioned south of a Nursery (NN765016) and crosses through part of the nursery land. Access to

the Nursery would need to be maintained. A minor road would be crossed at NN764016.

Figure 3-22: Water course alongside the A820 (as crossed by Nursery Access Road)

358) The cable route then follows the easiest gradients and crosses the A820 and the water course alongside the road at NN763016. On the south side of the A820 the cable route passes north of Greenyards farm to 'Point X'.

3.3.5 UGC4 B: UGC from Greenyards (Point X) to Gartur

359) This part of the UGC route is identical to the same portion in the SNH route. The reader is thus directed to Section 3.2.4 above.

3.3.6 UGC4 C1: OHL from Gartur to Denny Substation

360) This part of the UGC route is identical to the same portion of the SNH route. The reader is directed to Section 3.2.7 above.

3.3.7 UGC4 SEC 4: Denny Substation

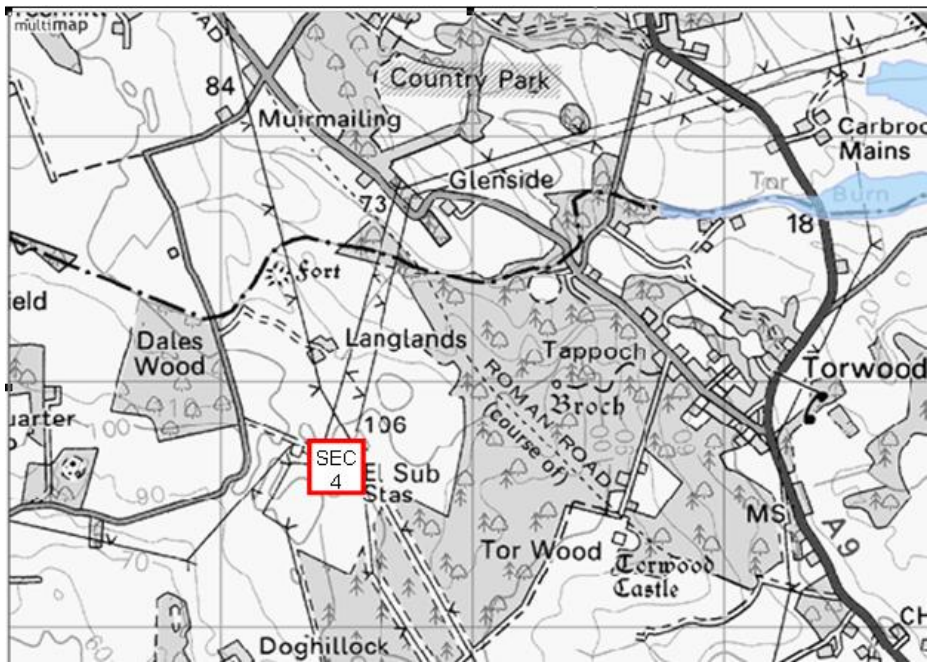
361) SEC 4 represents the southernmost point of SBP's undergrounding proposals, and would be co-located with the existing transmission substation at Denny. No terminal tower would be required at this site since the UGC would run right into the substation compound and terminate at the equipment there.

362) In this case, as for SEC 3 at Braco, the cable sealing ends, reactive compensation, and other equipment associated with the cable terminations, would be enclosed within an enlarged substation compound fence rather than having a separate SEC. Similar amounts of land to that of an SEC would, however, be required in order to accommodate the equipment.

363) This SEC 4 would be the southern termination of a section of cable of around 33 km in length, and would thus almost certainly require reactive compensation at the SEC itself. Delivery of cable drums and shunt reactors should be practical since abnormal load access already appears to be available.

364) As would be expected, Figure 3-23 indicates that SEPA identifies no flood risk associated with this site.

Figure 3-23: – SEC 4 Flood Risk Map



3.4 GENERAL NOTES ON CABLING FOR THESE ROUTE ALTERNATIVES

365) The SNH routes have approximate lengths of 14km and 24km and the SBP route has an approximate length of 33km.

Table 3-1 – UGC4 Single Circuit and Manufacturing Cable Lengths

Route	Route Length	Equivalent Single Circuit Length 400kV and 275kV each	Manufacturing Cable Length 400kV and 275kV each
UGC4 SNH Route v1	14km	28km	84km
UGC4 SNH Route v2	24km	48km	144km
UGC4 SBP Route	33km	66km	198km

366) The equivalent single circuit length given in Table 3-1 for each route option may be compared with the world wide experience of large projects given in Table 7-1 of APL 5/16. The longest 400kV direct buried installation recorded, with an equivalent single circuit length of 27km, was installed in Denmark. It can be seen from Table 3-1 that the shortest route required by SNH exceeds the current world maximum for a direct buried installation. The Denmark cable also has a considerably lower rating and smaller conductor size than that which would be

required by the Beauly-Denny connection which will give rise to lower thermomechanical forces on the cable and joints.

367) It should be noted that the above analysis does not include the additional requirements of the 275kV cable system. The main impact of these cables would be that they would be manufactured on the same plant as the 400kV cable and thus extend project delivery durations.

368) Manufacturing capabilities vary from one manufacturer to the next but typically manufacturing of 100km to 150km of EHV cable per year should be achievable. When considering 275kV and 400kV cables the manufacturing lengths in Table 3-1 must be doubled to take account of the required 275kV cable supply.

Table 3-2 – Cable Manufacturing Duration

Route	Route Length	Manufacturing Cable Length 400kV and 275kV total	Manufacturing Duration Based on 125km/annum
UGC4 SNH v1	14km	168km	70 weeks
UGC4 SNH v2	24km	288km	120 weeks
UGC4 SBP	33km	396km	165 weeks

369) It can be seen from Table 3-2 that the manufacturing durations will absorb a substantial part of a manufacturer's capacity, and cable manufacturing would be expected to last beyond a year.

370) Where the route lengths extend beyond 7km it is likely to be necessary to engage more than one manufacturer and civil contractor. This brings its own problems, the most notable being the introduction of a new set of cable and accessory designs onto the operators network; this however may be unavoidable if there is a requirement to install UGC systems on more than one section of the Beauly-Denny line. In the case of a single power cable connection containing the cable of two or more manufacturers it will be necessary to design and test a transition joint to connect each combination of cable design. This would include any transition joint kept as a maintenance spare. Each joint type will need to undergo the rigours of testing to IEC 62067[7] which includes a year long prequalification test. There would be a requirement to hold additional spare joints for each transition arrangement.

371) For the longest route length of 33km, three or more manufacturers may be required to meet a four year schedule. Such a demand for cable is likely to produce an upward pressure on cable system prices as there are only a limited number of European manufacturers of this type of cable, with varying degrees of experience, and only two EHV cable installers in Scotland with relevant experience.

372) It is considered that it should be possible to install an EHV cable system. along the routes indicated. However, the ground has not been opened so ground conditions at each location have been assessed on likely suitability based on a combination of visual inspection on site, aerial photography and ordnance survey map information.

[7] IEC 62067 (2001-10) - Power cables with extruded insulation and their accessories for rated voltages above 150 kV (Um = 170 kV) up to 500 kV (Um = 550 kV) - Test methods and requirements, International Electrotechnical Commission, Geneva, 2001 (amendment 1, 2006)

3.5 ENVIRONMENTAL COMMENTARY

373) In the following text there are many references to UGC4 A, B, & C. These route sections are depicted in Figure 1-1 to Figure 1-3, and in the maps of Appendix 6.

3.5.1 Geology and Soils

3.5.1.1 UGC4 A

374) The UGC4 A options (Figure 1-2) are located over bedrock of clastic deposits laid down during Lower Old Red Sandstone times and comprising inter-bedded sequences of sandstones, siltstones and shales that in total persist over many hundreds of metres in thickness and hundreds of square kilometres in outcrop. During the Pleistocene this bedrock was entirely overlain by an ice-sheet that left a combination of boulder clay and fluvio-glacial sands and gravels over gently undulating terrain that is today valuable farmland. As a result the soils in the area form a well drained, firm and competent media for construction of cable swathes, sealing end compounds and river crossings.

375) There will be no significant adverse residual impact on geology and soils from construction of the OHL section UGC4 A1. Construction will require excavation of tower foundations only, and in terms of the soil volumes involved these are trivial, and can be re-used for landscaping the completed tower foundations.

376) There will be a significant adverse residual impact on soils arising from the undergrounding options UGC4 A2 and UGC4 A3 on account of the surplus soil arisings that will need to be disposed of due to the displacement of soils by the UGC infrastructure.

3.5.1.2 UGC4 B

377) UGCB is located predominantly over bedrock of clastic deposits laid down during Lower Old Red Sandstone times and comprising inter-bedded sequences of sandstones, siltstones and shales that in total persist over many hundreds of metres in thickness and hundreds of square kilometres in outcrop. Much of the UGCB route crosses over land which, since the last ice-age, has formed a part of the River Teith and River Forth's historic flood plain. Late-glacial and post-glacial deposits of marine and estuarine alluvium have accumulated here and, within the Stirling area, these extend from Bannockburn in the south, northwards past Stirling, up to Bridge of Allan, where the extent of the Forth's historic flood plain has been constrained by the presence of the much older Ochil Hills. The soils in the UGC4 B route area therefore form a well drained, firm and competent media for construction of cable swathes, sealing end compounds and river crossings.

378) There will be a significant adverse residual impact on soils arising from the undergrounding option UGC4 B on account of the surplus soil arisings that will need to be disposed of due to the displacement of soils by the UGC infrastructure.

3.5.1.3 UGC4 C

379) UGC4 C weaves its way through the igneous outcrops of the Touch Hills to the west that are comprised of former basaltic lava flows, and Gillies Hill to the east that is capped by a quartz dolerite intrusive sill. The proposed route follows the low lying land in between these two features and will therefore be located on the boulder clay and fluvio-glacial deposits that has been retained within this valley -

following retreat of an ice-sheet that formerly covered the entire area. The soils in the UGC4 C route area therefore form a well drained, firm and competent media for construction of cable swathes, sealing end compounds and river crossings.

380) There will be no significant adverse residual impact on geology and soils from construction of the overhead line at UGC4 C1. Construction will require excavation of tower foundations only and in terms of the soil volumes involved these are trivial, and can be re-used for landscaping the completed tower foundations.

381) There will be a significant adverse residual impact on soils arising from the undergrounding option UGC4 C2 on account of the surplus soil arisings that will need to be disposed of due to the displacement of soils by the UGC infrastructure.

3.5.2 Hydrology

3.5.2.1 UGC4 A

382) UGC4 A passes through the catchments of two major rivers: the Ardoch Burn (Option UGC4 A2) and Allan Water (Option UGC4 A3). The Ardoch Burn flows south and then west towards Doune, as shown in Appendix 4 Figure A4- 1, whilst Allan Water flows from northeast to southwest towards Dunblane, as shown in Appendix 4 Figure A4- 2.

383) The Ardoch Burn is part of the River Teith SAC which is designated on account of qualifying interests such as salmon and lamprey. The confluence of the Ardoch Burn and the River Teith is immediately south of Doune where the River Teith flows from northwest to southeast, towards Stirling – as shown in Appendix 4 Figure A4- 1. The River Forth, southeast of Stirling is also part of the River Teith SAC.

384) The number of watercourse crossings associated with each undergrounding option within UGC4 A can be used to provide a qualitative indication and basis for comparison of the hydrological risks that accrue from the overall scale and duration of each option. Analysis of watercourse crossing points along UGC4 A2, as shown in Appendix 4 Table A4- 1 and Figure A4- 1, reveals three crossing points (A1-A3). The same analysis along UGC4 A3, shown in Appendix 4 Table A4- 1 and Figure A4- 2, reveals seventeen crossing points (A4-A20). There is therefore a marked increase in the nature and extent of hydrological risks associated with UGC4 A3 compared to UGC4 A2. This difference arises on account of the UGC4 A3 route being aligned parallel to Strathallan, thereby intercepting many of the burns and brooks that drain into Allan Water from the surrounding land, whereas UGC4 A2 follows the interfluve between Ardoch Burn to the west and Allan Water to the east.

385) There is a risk of significant adverse residual impact on hydrology arising from undergrounding on account of the inherent uncertainty associated with drilling (or tunnelling) under watercourses, as well as the number of watercourse crossings at which a directional drilling is likely to be required.

3.5.2.2 UGC4B

386) UGCB passes across the ancient flood plain of the River Teith where the soils comprise well drained marine and estuarine alluvium. As a result, groundwater plays an important role in draining the local area and, with the exception of the

River Teith itself, there are a limited number of minor field drains and surface watercourses in the area. Rainfall infiltrates the ground, recharging groundwater which subsequently discharges as baseflow into the River Teith. Water quality in the River Teith will therefore be closely linked to local groundwater conditions and this in turn will be an important factor in sustaining the qualifying interests of the River Teith SAC, including salmon and lamprey.

387) The number of watercourse crossing points associated with undergrounding UGC4 B can be used to provide a qualitative indication of the hydrological risks that accrue from the overall scale and duration of the proposed works. An analysis of watercourse crossing points along UGC4 B, as shown in Appendix 4 Table A4- 1 and Figure A4- 3 reveals five crossing points (B1-B5), including crossing of the River Teith itself (B1). As the scale and extent of the UGC4 B works is therefore relatively minor, the hydrological risks associated with undergrounding in this area are, with the exception of the River Teith itself, relatively minor. The River Teith is an SAC and although directional drilling is the most likely means of crossing this watercourse (see below) the ecological sensitivity of this area will increase the risks associated with such a process, risks that do not arise by comparison to the proposed 400 kV overhead line.

388) There is a risk of significant adverse residual impact on hydrology arising from undergrounding on account of the inherent uncertainty associated with drilling (or tunnelling) under watercourses, as well as the number of watercourse crossings at which a directional drilling is likely to be required.

3.5.2.3 UGC4 C

389) UGC4 C2 passes through the catchment of the Bannock Burn, to the southwest of Stirling. The burn is maintained by discharge from North Third Reservoir and surface runoff from the low permeability igneous rocks that form the Lewis Hill to the west of the UGC4 C2 route. The natural drainage pattern in the area will have been modified by construction of the M9 and M90 motorways. Runoff to the west of the motorways, in the vicinity of the UGC4 C2 route, will be diverted towards to Bannock Burn where it passes underneath the M9 and then follows the natural gradient towards the northeast and the River Forth.

390) The number of watercourse crossing points associated with undergrounding UGC4 C2 can be used to provide a qualitative indication of the hydrological risks that accrue from the overall scale and duration of the proposed works. An analysis of watercourse crossing points along UGC4 C2, as shown in Appendix 4 Table A4- 1 and Figure A4- 4, reveals seven crossing points (C1-C7). The most significant of these is the Bannock Burn crossing at C3, as this is the principal watercourse in the area and it provides a pathway for local drainage to pass beneath the M9 and head northeast towards the River Forth. With the exception of the Bannock Burn, all the other crossing points along the UGC4 C2 route are relatively minor and the degree of hydrological risk arising from the associated works is therefore also considered to be relatively minor.

391) There is a risk of significant adverse residual impact on hydrology arising from undergrounding on account of the inherent uncertainty associated with drilling (or tunnelling) under watercourses, as well as the number of watercourse crossings at which a directional drilling is likely to be required.

3.5.3 Forestry

3.5.3.1 SNH/Stirling Council route - UGC4 - A1/A2/B/C1

392) From tower TD165A, the site of the proposed Braco sub-station, the proposed OHL route passes through some 3858m of forest and woodland, requiring the clearance of some 33.24ha, of which 0.14ha is designated ASNW 1a, 0.03ha as 2a, and 2.44ha as 2b.

393) The alternative SNH & Stirling Council route UGC4 - A1/A2/B/C1, which deviates from the proposed route south of TD171A, has the following net impact on forests and woodlands, after including woodland areas impacted by the proposed OHL, where the alternative routes do not differ from the proposed OHL:

Table 3-3 – Woodland - Comparison of Route UGC4 - A1/A2/B/C1 West of Stirling

Route	Length of route through woodland	Area to be cleared	SNH designated areas		
			Designation	Length through woodland	Area to be cleared
Proposed OHL	3858	33.24	1A/2A/2B	785	2.61
UGC4 - A1/A2/B/C1 (SNH & Stirling Council)	4049	48.56	1B/2B	1090	11.80

394) From Table 3-3 it can be seen that the alternative route passes through a slightly longer distance of woodland, but that areas that require to be cleared increase to a much greater area. Whilst the West of Stirling UGC4 - A1/A2/B/C1 route avoid routeing through the Sherrifmuir conifer blocks, the nature of the conifer areas that are affected by the western route alternatives result in an increased felling requirement for stability and landscaping reasons.

395) The SNH & Stirling Council route impacts on Ancient Woodland designated sites, with over a 4-fold increase compared to the proposed OHL route.

396) The SNH/Stirling Council route avoids the Ochils escarpment to the East of Stirling, thereby removing the major significant effect that the proposed OHL has on Yellowcraig.

3.5.3.2 SBP route - UGC4 - A3/B/C2

397) From TD165A, the proposed Braco sub-station site and the point where route UGC4 - A3/B/C2 digresses from the proposed route, the proposed OHL route passes through some 3858m of forest and woodland, requiring the clearance of some 33.24ha, of which 0.14ha is designated ASNW 1a, 0.03ha as 2a, and 2.44ha as 2b.

398) The alternative SBP route UGC4 - A3/B/C2, routed directly west from the proposed sub station site has the following net impact on forests and woodlands,

after including woodland areas impacted by the proposed OHL, where the alternative routes do not differ from the proposed OHL:

Table 3-2 – Woodland - Comparison of Route UGC4 - A3/B/C2 (SBP) West of Stirling

Route	Length of route through woodland	Area to be cleared	SNH designated areas		
			Designation	Length through woodland	Area to be cleared
Proposed OHL	3858	33.24	1A/2A/2B	785	2.61
UGC4 - A3/B/C2 (SBP)	2861	25.75	2A/2B	1507	18.23

399) From table 3-2, the SBP route impacts most on Ancient Woodland designated sites with a 7-fold increase, compared to the proposed OHL route.

400) The SBP route has the effect of reducing the area of conifer felling at Cambushinnie (-12.7ha), but with additional felling required adjacent to the more sensitive A9, the net reduction in clearance is some 7.4ha.

401) The SBP route has the effect of removing the moderately significant effect that the proposed OHL route has on Cambushinnie Forest, and also removes the major significant effect that the proposed OHL route has on the Ochils escarpment (Yellowcraig).

3.5.3.3 UGC4 A1 OHL

402) The alternative OHL deviates from proposed OHL south of TD171C, Cambushinnie Hill and is routed through two conifer plantations either side of the Stirling District Council boundary.

403) North of the boundary, the alternative OHL route passes through some 260m of mature conifer and requires the felling of the whole woodland block, some 8ha.

404) Immediately to the south of the district boundary, the alternative OHL route passes through 225m of semi mature conifer plantation, requiring the felling of some 2.3ha.

405) After some 1600m, the alternative OHL route passes through young conifer plantation for some 220m, immediately to the north of, but outwith the older conifer woodland, designated as ASNW 2b (long established - of plantation origin) and c. 1.2ha of plantation would require to be felled.

406) The alternative OHL route finally passes through some 700m of conifer plantation at Milour Moor before terminating at SEC 1, requiring the clearance of 9.9ha.

3.5.3.4 UGC4 A2 UGC

407) The alternative UGC route (alternative Cable route) exits Milour Moor plantation from SEC 1, over some 200m, requiring the clearance of c. 1.7ha of conifer plantation.

408) At GR NN7629, 0276 the alternative Cable route passes through a mature broadleaved hedgerow of trees, requiring the felling of approximately 25m of hedgerow trees (0.1ha) to the north of Corscaplie Farm, before passing through agricultural land to Point X/Greenyards.

3.5.3.5 UGC4 A3 UGC

409) The alternative Cable route deviates from the eastwards from the proposed OHL route at TD165A, through Shindour production conifer plantation, within Feddal Forest, for some 880m, and requiring the clearing of some 4.7ha of forest.

410) After exiting the wood, the alternative Cable route turns south for approximately 1200m, before passing through 95m of conifer plantation south-east of Tamano. Some 0.76ha of woodland area will need to be clear.

411) Thereafter, the alternative cable route heads south, over the Allan Water to the A9.

412) The alternative Cable route is then routed southwards alongside and to the north of the A9 and affects a number of small and larger conifer shelterbelts and plantations, and broadleaved woodland areas, resulting in a moderately significant 'roadside widening' effect as it effects each woodland block, the main woodland being Firs of Kinbuck. In this area, the alternative Cable route passes through 665m of woodland, requiring the clearance of some 9.6ha, of which 580m, or 9.1ha is designated ASNW 2b.

413) After routing westwards from the A9 towards the north of Ashfield, the alternative Cable route passes through a conifer strip above Cairnston for some 57m, and requiring the felling of some 0.4ha, designated ASNW 2b.

414) To the east of Upper Auchinlay, the alternative Cable route passes through the remnants of a mature mixed broadleaved shelterbelt (40m, 0.3ha), before heading southwards to Greenyards, and the vicinity of Point X.

3.5.3.6 UGC4 B UGC

415) From Point X, the alternative Cable route passes southwards over the A820 and through a strip of semi-mature hardwoods together with younger conifers at Moon Strip for some 38m and requires the clearance of 0.25ha of woodland (Grid ref: NN 7571 0068).

416) North of Hillside of Row, the alternative Cable route passes through the eastern edge of designated ASNW 2b for some 42m, requiring the clearance of some 0.15ha of scrub broadleaves (GR NS 7568 9999) and then a further 40m (0.36ha) of broadleaves at Well Lodge, before crossing the riparian woodlands either side of the River Teith (20m, 0.1ha).

417) Moon Strip, Well Lodge and the Teith woodlands are designated ASNW 2b.

418) The alternative Cable route then passes through three hedgerows before passing through riparian hardwoods at GR NN7620 9370 River Forth crossing; 30m (0.07ha) to Point Z.

419) At SEC2 (Gartur Wood) the alternative Cable route passes through some 136m of mixed woodland requiring the felling of some 1.6ha, SNH designated as ASNW 2b (Murray's Wood).

3.5.3.7 UGC4 C1 OHL

420) From SEC2, the alternative OHL route passes south through Murray's Wood (designated as ASNW 2b) comprising mixed open woodland, and skirts Brommiebrae woodland before exiting into farmland. Here the route passes through some 430m of woodland and requires the felling of some 5.35ha of lightly stocked trees.

421) At Wester Craigend (GR NS 7710 9073) the alternative OHL route leaves the route of the alternative Cable route and passes through 55m of mature mixed broadleaves to the East of the house, requiring the felling of 0.26ha of woodland.

422) The route then passes north of the Bannock Burn, and before crossing the burn, runs through small broadleaved woodland for some 240m requiring the felling of some 0.88ha, inclusive of the burn crossing.

423) The alternative OHL route then passes south eastwards largely through farmland, and passes through a small area of woodland south of Chartershall (GR NS 7854 9014) for some 84m, which will require the felling of some 0.44ha.

424) It then heads south through farmland, and through a number of small hedgerows, over the M80, to Auchenbowie (NS 8072 8760) where it passes through a further section of 84m, this time designated as ASNW 1b, and named as (Avenue Wood) and 2b (Auchenbowie Wood) This woodland comprises mature open mixed hardwoods and will require the felling of some 0.88ha (1b: 44m, 0.52ha, 2b: 40m, 0.36ha).

425) The alternative OHL route then passes through the north-eastern corner of Dales Wood (GR NS 8195 8521), for some 100m. Here, this will require the clearance of some 2.0ha of semi-mature mixed woodland, designated as ASNW 2b, before passing down to SEC4.

426) As it enters the SEC4 site at the proposed Denny substation, it passes through some 50m of scrub woodland to the north of SEC 4, which will require the clearance of some 0.16ha.

3.5.3.8 UGC4 C2 UGC

427) From SEC2, the alternative UGC route passes south through Murray's Wood (designated as ASNW 2b) comprising mixed open woodland, and skirts Brommiebrae woodland before exiting into farmland. Here the route passes through some 430m of woodland and requires the felling of some 5.35ha of lightly stocked trees.

428) At Wester Craigend (GR NS 7713 9077) the alternative Cable route leaves the route of the alternative OHL route and passes through 69m of mature mixed

broadleaves some 120m to the to the East of the house, requiring the felling of 0.37ha of woodland.

429) The alternative Cable route then passes south eastwards largely through farmland, and passes through a small area of woodland south of Chartershall (GR NS 7854 9014) for some 53m, which will require the felling of some 0.18ha.

430) It then heads south through farmland, and through a number of small hedgerows, largely following the alternative OHL route, but routed to the east of Auchenbowie (NS 8018 8767) where, before crossing the M80, it passes through some 184m designated as ASNW 1b (Avenue Wood) and 2b (Auchenbowie Wood) woodland comprising mature open mixed hardwoods and requiring the felling of some 0.97ha (1b: 82m, 0.43ha; 2b: 102m, 0.54ha).

431) The alternative Cable route broadly follows the alternative OHL route, crossing through a roundel of mature broadleaves at Rundle Wood (32m, 0.18ha Grid Ref: NS8105, 8615), and then skirts the north-eastern corner of Dales Wood.

432) Thereafter the alternative OHL route crosses farmland until it enters SEC 4 at the proposed Denny substation, where it passes through some 50m of scrub woodland to the north of SEC 4 requiring the clearance of some 0.16ha.

3.5.4 Ecology and Nature Conservation

433) At a strategic level of detail, the following statutory designated nature conservation constraints are present in the alternative proposals put forward in this area (covering the relevant search areas and the specific routes within it).

3.5.4.1 UGC4 A1 OHL

434) No statutory designations.

435) In relation to birds, the OHL section of the proposed alternative is closer to an important area for red kite than the Applicant's proposal. It is also further from the regular goose flight corridor along the Allen Water. However, it is not possible to assess in any detail the potential comparative magnitude of impact of this route, in comparison to the Applicant's proposed overhead route, on the local red kite population or on any other bird receptors with the data available at present.

3.5.4.2 UGC4 – SEC 1

436) Uphill in very wet ground from Grainston Burn a tributary of Ardoch Burn (part of the River Teith SAC).

3.5.4.3 UGC4 A2 UGC

437) Uphill in very wet ground from Grainston Burn and close to several other tributaries of the Ardoch Burn further south (part of the River Teith SAC).

3.5.4.4 UGC4 – SEC 3 Braco Substation

438) No statutory designations.

3.5.4.5 UGC4 A3 Underground Cable

439) Very close to and crosses several tributaries of the Ardoch Burn further south (part of the River Teith SAC).

3.5.4.6 UGC4 B Underground Cable

440) Crosses the River Teith SAC, then crosses field drains and several tributaries of the River Teith close to the main river within a wide floodplain. Also crosses the River Forth and several small tributaries (not part of the SAC but upstream from the confluence with the River Teith SAC).

3.5.4.7 UGC4 – SEC 2

441) No statutory designations but in inventory woodland and close to several minor tributaries of the River Forth, itself a major tributary of the River Teith SAC.

3.5.4.8 UGC4 C1 OHL

442) Close to Sauchie Craig Wood SSSI but may be able to avoid it.

3.5.4.9 UGC4 C2 UGC

443) Close to Sauchie Craig Wood SSSI but may be able to avoid it.

3.5.4.10 UGC4 – SEC 4 (Denny Substation)

444) No statutory designations.

445) The key statutory sensitivities highlighted above relate to watercourses. In addition to the statutory designated national and European level sites listed above there are also further constraints within these alternative routes. Those we can be aware of at present from desk study only are related to additional salmonid watercourse crossings and ancient woodland inventory areas, for example two crossings of the Allan Water, and Murray's Wood (location for UGC4 - SEC 2 + both overhead and underground alternatives), Auchenbowie Wood/Avenue Wood and Dales Wood.

446) It is important to note that areas to the west of Stirling are important for geese, those feeding in particular, and related mainly to populations associated with the South Tayside Goose Roosts SPA, the Forth SPA and Ramsar site and other areas which are important for geese within the Forth Valley but are not designated such as River Forth at Gargunnock and the Lake of Menteith. However, at present it is not possible to be more specific than this related to these alternatives. What can be said is that further work would be required to determine the importance of these routes related to geese.

447) The alternative corridor to the far south west of Stirling which was not utilised in this study would have ecological impacts associated with ancient woodland. It is also likely to have a greater level of additional habitat impacts due to its more upland character. However, no further information is currently available on this area.

448) At this strategic stage of the under-grounding study, it is not possible to be more specific about the ecological impacts likely and their relative significance. However, it is clear from the constraints noted above that there is the potential for

significant impacts on ecological resources designated at a European level, as well as undesignated but important and sensitive additional ecological resources from such alternatives.

3.5.5 Landscape Character

449) The assessment of effects on landscape character for the Proposed OHL identified moderate adverse residual effects on the landscape character of the areas between the proposed Braco substation and the forestry area on Sheriffmuir (the point at which the proposed OHL rejoins the route of the existing OHL), and on paths in the Ashfield and Kinbuck and Hermitage Wood/Airthrey Gardens area. In other areas, effects on landscape character were identified as minor adverse.

3.5.5.1 UGC4 A1 Overhead Line

450) The alternative SNH and Stirling Council overhead line from TD170 would cross the sloping ground above Cromlix House, crossing the end of a minor ridge line but with towers backdropped against the higher ground to the north-west. An angle tower would be required at the change of direction and the OHL would run on the edge of, and then within forestry to the proposed SEC at Milour Moor (UGC4 SEC 1). Notwithstanding some non-compliance with some Holford Rules, effects on the landscape character of the northern and southern parts of this area, as a result of the proposed OHL, would be on a landscape of low sensitivity and of medium magnitude and would result in minor adverse effects. Within the central section, in the area of the angle tower and the Cromlix Estate, the sensitivity of the landscape may be increased as a result of the features associated with the Estate. In this area the potential effect of the alternative OHL on the landscape character would be moderate adverse.

3.5.5.2 UGC4 SEC 1 at Milour Moor

451) UGC4 SEC 1 would be located in woodland and this would screen the site from within the wider landscape; the effects on the landscape character of this area would be on a landscape of low sensitivity and of medium magnitude and would result in minor adverse effects.

3.5.5.3 UGC4 A2 Underground Cable from SEC 1 to Greenyards

452) The underground cable route from the Milour Moor SEC would run through moorland across a localised ridge line, before descending across undulating topography towards Greenyards Farm and Point X, Greenyards. The route would cut through a line of trees on the hillside above Corscaplie; there are few such trees in this landscape and it would be preferable to avoid any such loss, if possible.

453) The landscape to the south of the A820 has greater tree cover, is more undulating, and is of a smaller scale than the landscape to the north. This area could be expected to be more sensitive to the routeing of an underground cable than the area to the north, particularly from the loss of any trees.

454) The effect on the landscape character as a result of the proposed underground cable route would be on a landscape of low sensitivity, to the north of the A820, and of medium magnitude in the short term (up to five years), until the ground cover vegetation is successfully reinstated: minor adverse effects. In the longer term effects on the landscape character would be expected to be minor / negligible. In the area to the south of the A820, effects would be on a landscape

of moderate sensitivity and of medium magnitude and would result in moderate adverse effects, in the short term, reducing to minor / negligible in the longer term with the reinstatement of vegetation.

3.5.5.4 UGC4 SEC3 Braco substation

455) UGC4 SEC3 is located at the proposed Braco substation and would be sited within the forestry. This would mitigate any potential adverse effects on the landscape character of the area; effects would be no greater than minor adverse.

3.5.5.5 UGC4 A3 Underground cable from Braco substation to Greenyards (Point X)

456) The underground cable from the proposed Braco substation to Point X, near Greenyards, would run within agricultural land and some woodland in descending the sloping ground towards the Allan Water. The majority of this area is a small scale landscape and would be sensitive to underground cable routeing, at least until such time as the ground is successfully reinstated. The cables would require to cross two watercourses and the railway line. Effects on the landscape character in this area would be on a landscape of moderate sensitivity and of medium magnitude (at least in the short term) and would result in short term, moderate adverse effects. Effects would reduce to minor adverse / negligible following the successful reinstatement of the groundcover vegetation.

457) The underground cable route would ascend the sloping ground to the A9 before running parallel to this road as far as Glassingall. In this area there would be some loss of woodland on, or close to the edge of the road, though this is unlikely to result in significant adverse effects on the landscape character. Effects on the landscape character of this area would be on a landscape of moderate sensitivity and of medium magnitude (at least in the short term) and would result in short term, moderate adverse effects. Effects would reduce to minor adverse / negligible following the successful reinstatement of the groundcover vegetation.

458) The underground cable route would cross through the small scale landscape east and west of Kinbuck, again with some loss of trees and disturbance to the undulating ground. The route continues south and south-west, through undulating and hilly agricultural land, to the Greenyards area. Effects on the landscape character of this area would be on a landscape of moderate sensitivity and of medium magnitude (at least in the short term) and would result in short term, moderate adverse effects. Effects would reduce to minor adverse / negligible following the successful reinstatement of the groundcover vegetation.

3.5.5.6 UGC4 B Underground cable from Greenyards to Gartur

459) The underground cable from Greenyards to Gartur would run generally southwards and south-east through the low, undulating hills to the west of Dunblane. This is also a small scale landscape with some extensive areas of woodland that the route of the cable would generally seek to avoid, wherever possible. It would appear from the aerial photographs that some field boundaries are hedgerows and these would be removed, at least temporarily, during construction. Effects on the landscape character of this area would be on a landscape of moderate sensitivity and of medium magnitude (at least in the short term) and would result in short term, moderate adverse effects. Effects would reduce to minor adverse / negligible following the successful reinstatement of the groundcover vegetation.

460) The eastwards diversion in order to route the cables through shallower topography would follow the southern edge of the Keir HGDL and it would be important that this route does not result in any adverse effect on the setting of the Keir HGDL, for instance from the removal of trees providing the setting to the southern Lodge. Effects on the landscape character of this area would be on a landscape of moderate sensitivity and of medium magnitude (at least in the short term) and would result in short term, moderate adverse effects. Effects would reduce to minor adverse / negligible following the successful reinstatement of the groundcover vegetation.

461) The underground cable route would then run within a flatter landscape on the western edge of the Carse of Lecropt, east of the Ochtertyre HGDL, north and south of the River Teith, extending south to the River Forth. This is a larger scale landscape, with larger and more open fields and fewer trees, though the area adjacent to the River Forth has more tree and hedgerow cover, including alongside the river. Effects on the landscape character of these areas would be on landscapes of low sensitivity and of medium magnitude (at least in the short term) and would result in short term, minor adverse effects, reducing to negligible in the longer term.

462) In the approach to Gartur the landscape has greater tree cover, and reflects the area immediately to the south, at the northern end of the Touch Hills. This is a medium scale landscape. Effects on the landscape character of this area would be on a landscape of moderate sensitivity and of medium magnitude (at least in the short term) and would result in short term, moderate adverse effects. Effects would reduce to minor adverse / negligible following the successful reinstatement of the groundcover vegetation.

3.5.5.7 UGC4 SEC2 at Gartur

463) The sealing end compound at Gartur, SEC 2, lies within the Touch Hills AGLV. The SEC would be located in the northern part of Murray's Wood and is likely to require some levelling of the ground within this wood. The loss of woodland to the SEC would result in a moderate adverse effect on the local landscape character of this area, as a result of the moderate sensitivity of the landscape and the medium magnitude of effect. The location of the SEC may impinge on the setting of the Touch House HGDL and there may be the potential for significant adverse effects on this designated landscape. There would be some scope for mitigation in the form of additional planting at this site and this would reduce effects in the longer term to minor adverse.

3.5.5.8 UGC4 C1 Overhead line from Gartur to Denny North substation

464) The overhead line from the Gartur SEC southwards lies within the Touch Hills AGLV. The OHL would require a clearance corridor within Murray's Wood (much of which is open in nature) and (depending on the precise route) may require some further clearance of the western edge of the woodland to the south-east (though much of this also appears to be open in nature). The overhead line would run on the northern side of the Bannock Burn, largely following the contours towards Cultenhove. Various light angle towers would be required to accommodate slight changes in direction, as far as the M9. Effects on the landscape character of this area are considered to be on a landscape of moderate sensitivity and of medium magnitude (there are no other OHLs in this area) and would result in moderate adverse effects.

465) At the M9 the proposed OHL would turn south to generally follow the direction of the M9 and M80, set back from these roads by some 150-500m and with a deviation to avoid the property at Foot o' Green. To the west of the motorways, the proposed OHL would be located within, or on the edge of the Touch Hills AGLV. The proposed OHL would be set at a higher level than the motorways and would be prominent within the landscape as experienced from these roads. There would appear to be little tree cover to provide screening. The proposed OHL would cross the M80 to the south of the junction with the M9 and run to the east of the A872. Effects on the landscape character of the area to the west of the motorways would be on a landscape of moderate sensitivity and of medium magnitude and would be moderate adverse. The effect on the landscape character in the area of the motorway crossing would be on a landscape of low sensitivity and of medium magnitude and would result in a minor adverse effect, in this local area. Effects on the landscape character of the area to the east of the motorways would be on a small scale landscape of moderate sensitivity and of medium magnitude and would result in moderate adverse effects.

466) The proposed OHL continues to run within a landscape of undulating topography and of a relatively small scale, though the sense of enclosure relates more to the topography than to the tree cover. It is only in the Dales Wood area that the presence of another high voltage transmission line is evident. Effects on the landscape character of this area would be on a landscape that is largely of moderate sensitivity and of medium magnitude of effect, and would result in moderate adverse effects.

3.5.5.9 UGC4 C2 Underground cable from Gartur to Denny SEC 4

467) The proposed underground cable from Gartur to Denny North would follow a similar alignment to the proposed OHL, though with some differences in places, as previously described.

468) As noted above, the route south of Gartur and west of the M80 lies within the Touch Hills AGLV. The proposed UGC would run through Murray's Wood, requiring any trees on the route to be removed, before crossing to the south side of the Bannock Burn. The UGC route would descend the valley side to avoid the property at Cultenhove before turning to run south, on the western side of the M9. The UGC would run over lower ground to the west of the two motorways before ascending the hillside west of the interchange and cutting through Auchenbowie Wood. Effects on the landscape character of this area would be on a landscape of moderate sensitivity and medium magnitude, at least in the short term, and would result in moderate adverse effects, over this time. In the longer term and with the successful reinstatement of the groundcover vegetation, effects would reduce to minor adverse / negligible.

469) The UGC would cross the M80 in an area where the road is on embankment, crossing the A872 and ascending the side of a small hill east of Easterton. A relatively direct route is proposed across the undulating landscape, towards Denny. Effects on the landscape character in the area of the motorway would be on a landscape of low sensitivity and medium magnitude and would result in minor adverse effects. Further east, effects would be on a landscape of moderate sensitivity and of medium magnitude and would result in moderate adverse effects, at least in the short term, reducing to minor adverse / negligible in the longer term.

3.5.5.10 UGC4 SEC4 Denny substation

470) The SEC at the Denny substation would be located within the existing substation and would not require a terminal tower. The landscape character of this area relates to the undulating nature of the topography and is influenced by the number of existing overhead lines that approach this substation from the north, north-east, west and south / south-east.

471) Effects on the landscape character as a result of the proposed SEC would be on a landscape of low sensitivity and of medium effect and would result in minor adverse effects. Mitigation in the form of appropriate tree or scrub planting and mounding could be provided in this area.

3.5.6 Visual Amenity

472) The assessment of effects on visual amenity for the Proposed OHL identified both major and moderate residual adverse effects on the various receptors located between the proposed substations at Braco and Denny North. Major adverse effects on visual amenity would be limited to individual properties. Moderate adverse effects would occur as residual effects on the settlements of Fallin, Cowie, Throsk and Plean, on individual properties and on roads and paths in the vicinity of the proposed overhead line. These would include the B8033 in the Wester Cambushinnie area, minor roads in Strathallan, the A9 westbound in the Balhaldie area, A905 east of Fallin, minor roads in the area south of the River Forth, including west of Fallin and from Throsk to Cowie and in the Whitehall / Plean Tower area, the A9 in the Carbrook Mains area, paths in the area east of Cowie, and on views of the Touch Hills AGLV from areas to the east of the proposed OHL. Moderate adverse visual effects would remain from the increased wirescaping in the area of the proposed Denny North substation. There would be moderate adverse visual effects on users of paths in the Ashfield / Kinbuck and the Hermitage Wood areas.

3.5.6.1 UGC4 A1 Overhead Line

473) The proposed OHL between TD170 and the SEC at Milour Moor would run across the sloping ground above Cromlix House, crossing the end of a minor ridge line but with towers backdropped against the higher ground to the north-west. An angle tower would be required at the change of direction and the OHL would run on the edge of, and within forestry to the proposed SEC at Milour Moor (UGC4 SEC 1). The proposed OHL would run to the north of, and above the majority of the properties on the Cromlix Estate, but would be sufficiently far away not to dominate the majority of these. The exception would be the western Lodge, from where there may be views of the proposed OHL as it descends towards the conifer plantation. Some small blocks of trees may limit the extent to which the proposed OHL would be visible but effects would be on a receptor of high sensitivity and medium magnitude and would result in moderate adverse visual effects.

474) The proposed OHL would be seen from the A9, for both northbound and southbound road users, with towers backdropped against the rising ground to the north-west. Effects on the visual amenity of road users on the A9 would not be expected to be greater than minor adverse. Other roads in the area are unlikely to incur significant adverse visual effects.

475) No recreation users have been identified in this area, though there may be some sporting use of the land in the vicinity of the proposed OHL. Effects could be expected to be moderate adverse, in such an instance.

3.5.6.2 UGC4 SEC 1 at Milour Moor

476) UGC4 SEC 1 would be located in woodland and this would screen the site from view from within the wider area. No significant adverse effects on visual amenity would be anticipated in this area.

3.5.6.3 UGC4 A2 Underground Cable from SEC 1 to Greenyards

477) The underground cable route from the Milour Moor SEC would run through moorland across a localised ridge line, before descending across undulating topography towards Greenyards and Point X. There are some individual properties within the area to the west of the proposed cable route, over the northern section of this route, and to the east, further south, though effects on the visual amenity of these would largely be related to construction activities and would be short term effects, therefore. Such effects would be on receptors of high sensitivity and potentially of medium magnitude, resulting in short term, moderate adverse effects, until such time as the ground cover vegetation is satisfactorily reinstated, reducing to minor adverse / negligible effects in the longer term.

478) Similarly, this route would require to cross the A820 and other minor roads and there would be short term, adverse effects on road users during the construction period. The moderate sensitivity of receptors and medium magnitude of effects would result in moderate adverse effects on visual amenity in the short term, reducing to minor adverse / negligible effects in the longer term.

479) The UGC route would cross a dismantled railway line and if this is used for informal recreation, there would be adverse effects on the visual amenity of users of this route, as well as any other such paths in this area. Effects would be on receptors of moderate sensitivity and of medium magnitude, in the short term (during construction and reinstatement), reducing to minor adverse / negligible in the longer term.

3.5.6.4 UGC4 SEC3 Braco substation

480) UGC4 SEC3 is located at the proposed Braco substation and would be sited within the forestry. This would mitigate any potential adverse effects on the visual amenity of receptors in this area; effects would be no greater than minor adverse.

3.5.6.5 UGC4 A3 Underground cable from Braco substation to Greenyards

481) The underground cable from the proposed Braco substation to Point X, near Greenyards, would run within agricultural land and some woodland in descending the sloping ground towards the Allan Water. The UGC would then ascend the sloping ground to the A9 and run on the northern edge of this road, from north-east to south-west.

482) There are a number of individual properties on the rising ground to either side of the Allan Water and in the area further to the south-west and there would be views from these properties towards the route of the proposed UGC. Effects on visual amenity would be greatest during construction, when effects would be on receptors of high sensitivity and potentially of medium magnitude, resulting in short term, moderate adverse effects. Following the successful reinstatement of the groundcover vegetation, effects would reduce to minor adverse / negligible.

483) The route of the proposed UGC would run adjacent to the A9 and would cross other roads in this area. There would be views from these roads of the route of the

cables as it descends the hillside below the proposed Braco substation. Similarly from the B8033, there would be views towards the section of the UGC that ascend towards the A9. Effects on users of these roads would be on receptors of moderate sensitivity and potentially of medium magnitude, resulting in moderate adverse effects during the short term, reducing to minor adverse / negligible in the longer term.

484) There are paths and walks in the area between Ashfield and Kinbuck and the construction of this UGC would adversely affect the visual amenity of users of these. Effects would be on receptors of moderate sensitivity and of medium magnitude, during construction and the reinstatement of the ground cover vegetation, and would result in moderate adverse effects on visual amenity, during this period. In the longer term effects would reduce to minor adverse / negligible.

3.5.6.6 UGC4 B Underground cable from Greenyards to Gartur

485) The underground cable from Point X at Greenyards to Gartur would run generally southwards and south-east through the low, undulating hills to the west of Dunblane. This is a more settled area, with more properties, roads and rights of way than the areas further to the north.

486) A small number of individual properties are located close to the route of the proposed UGC and there would be views from these properties towards the route of the proposed UGC. Effects on visual amenity would be greatest during construction, when effects would be on receptors of high sensitivity and potentially of medium and high magnitude, resulting in short term, moderate and major adverse effects. Following the successful reinstatement of the groundcover vegetation, effects would reduce to minor adverse.

487) In areas where the route of the proposed UGC would cross over, or run close to roads in this area (which include the A84 and A811) there would be near distance views of the construction and disturbance. Effects would be on receptors of moderate sensitivity and potentially of medium magnitude, resulting in moderate adverse effects, during the short term. Following the successful reinstatement of the groundcover vegetation, effects would reduce to minor adverse.

488) Some of the minor roads in this area may be used for informal recreation and there are a limited number of footpaths present in this area. Any such routes in close proximity to the proposed UGC would be adversely affected, particularly during construction, when effects would be on receptors of moderate sensitivity and potentially of medium magnitude, resulting in moderate adverse effects, during the short term. Following the successful reinstatement of the groundcover vegetation, effects would reduce to minor adverse. The Blair Drummond Safari Park is located to the west of the UG route; however, the distance between the safari park and the UGC is likely to be sufficient for the proposed UGC not to significantly adversely affect the visual amenity of this facility. The southernmost end of this section of the UGC, south of the A811 would be located within the Touch Hills AGLV.

3.5.6.7 UGC4 SEC2 at Gartur

489) The sealing end compound at Gartur, SEC 2, lies within the Touch Hills AGLV. The SEC would be located in the northern part of Murray's Wood and is likely to require some levelling of the ground within this wood. The loss of woodland may open this area up to views from within the wider area. The elevated position of this

substation relative to the surrounding area, particularly to the north, and the presence of land at an equivalent height, to the north-west, may result in the SEC being visible from within the wider area. In views from the north, the distances over which the SEC may be visible are likely to result in any adverse effects being no greater than minor. Views from the north-west may include views from the HGDL at Touch House.

490) Effects on the visual amenity of residential properties, where these occur, would be on receptors of high sensitivity. The magnitude of effect would depend on the extent to which there would be views of the SEC, though it is accepted that these are likely to be limited. Effects may therefore be minor adverse, in the main.

491) Effects on users of roads and rights of way are likely to be limited to those routes in close proximity to the SEC. Effects on visual amenity would be on receptors of moderate sensitivity and potentially of medium magnitude, resulting in moderate adverse effects, though within limited areas only.

492) There would appear to be no formal recreation areas in the vicinity of the proposed SEC at Gartur.

493) There would be scope for mitigation in the form of additional or replacement planting at this site, in order to reduce potential adverse effects on visual amenity to minor adverse.

3.5.6.8 UGC4 C1 Overhead line from Gartur to Denny substation

494) The overhead line from the Gartur SEC southwards lies within the Touch Hills AGLV. The OHL would require a clearance corridor within Murray's Wood (much of which is open in nature) and (depending on the precise route) may require some further clearance of the western edge of the woodland to the south-east (though much of this also appears to be open in nature). The overhead line would run on the northern side of the Bannock Burn, largely following the contours towards Cultenhove. Various light angle towers would be required to accommodate slight changes in direction, as far as the M9, where a more substantial tower would be required. The proposed OHL would cross the M80 towards the south of the interchange / junction to the east of the A872 before running to the south-east, to the substation at Denny.

495) Effects on the visual amenity of residential properties in the area of the proposed OHL would depend on the proximity to the overhead line, which would be a new feature in this landscape, and whether towers were seen against the skyline or backdropped. In this area the scope for towers to be backdropped relates more to views from the north-east, from which direction towers would be seen against the higher ground of the Touch Hills. This would include areas on the south-western edge of Stirling. Towers are more likely to be seen against the skyline in views from the west (including the north-west and south-west). There are a number of individual properties in the immediate area of the proposed OHL and effects on the visual amenity of these can be expected to be moderate, or major effects in some instances, as a result of the high sensitivity of these properties and the medium or high magnitude of effects.

496) Effects on the visual amenity of road users would include effects on users of the M80 and M9, in the area where the proposed OHL would run alongside these roads. Effects would be on receptors of moderate sensitivity and of low or medium magnitude, depending on the duration and nature of the view, and would result in

minor or moderate adverse effects. Users of other minor roads in the area between Gartur and Denny can also be expected to incur adverse effects on visual amenity, where the proposed OHL runs over or adjacent to these roads. As above, effects would range from minor to moderate adverse. Any users of rights of way in the immediate vicinity of the proposed OHL would similarly be expected to incur both minor and moderate adverse effects.

497) There are some formal recreation areas in the wider area including the golf course on the southern edge of Stirling, from where there would be views of the proposed OHL, though seen beyond the motorway and junction. A Heritage Centre is noted on the OS plan, on the south-western edge of Stirling and a caravan / camp site is located to the west, in the Cauldbarns area. Effects on the visual amenity of receptors in these areas would range from high (within the AGLV) to moderate sensitivity and of low to medium magnitude and could result in moderate adverse effects.

3.5.6.9 UGC4 C2 Underground cable from Gartur to Denny SEC 4

498) The proposed UGC from Gartur to Denny North would follow a similar alignment to the proposed OHL, though with some differences in places, as previously described.

499) Effects on the visual amenity of receptors in the vicinity of this UGC route would relate largely to construction effects and during reinstatement of the ground cover vegetation and would therefore be short term effects. Effects could expect to be at least moderate adverse, during this period, on individual properties, and on users of roads and rights of way. No significant adverse effects are anticipated on formal recreation areas.

3.5.6.10 UGC4 SEC4 Denny substation

500) The SEC at the Denny substation would be located within the existing substation and would not require a terminal tower. This would reduce the potential for adverse visual effects in this area. There are limited areas from which the SEC would be visible, within the local area, and this would limit the potential for adverse effects on visual amenity in this area. It is considered that there would be scope for mitigation through planting and mounding, in this area.

3.5.7 Cultural Heritage

3.5.7.1 Results of the Assessment of the Effects of the Proposals – UGC4 A

501) The ES established that the proposals would result in one significant adverse potential direct effect, two minor adverse direct effects and one direct effect of unknown significance. However, the nature of the development proposal is such that direct effects on most of the known sites potentially affected can be avoided through demarcation or, where the sites are linear features, mitigation can be achieved through re-instatement of the feature. With this mitigation programme of demarcation/avoidance and re-instatement, the number of residual direct effects reduces to two – a minor adverse direct effect on site 688: Sheriffmuir Battlefield and an unknown potential adverse direct effect on site 390: Drumallan Roman Road. At Sheriffmuir the impact was reported to be capable of mitigation my means of a metal-detecting survey and monitoring, while the potential impact at Drumallan Roman Road would be mitigated through archaeological monitoring of ground disturbances in the vicinity of the possible site. The direct impact of the

proposals on known sites in this area would thus be low. Two areas of archaeological sensitivity were also identified in the ES in this section of the route – at Drumallan to White Stone (No. 21) and at Sheriffmuir (No. 22). The significance of effect on any as-yet-unidentified archaeology cannot, at present, be established.

502) Following Historic Scotland's response to the ES, a programme of archaeological investigation was conducted on Sheriffmuir in order to attempt to locate the core of the Battle of Sheriffmuir. The results of this work were published in the second addendum to the ES, and in their response to that document Historic Scotland stated that "The proposed route will not have a significant adverse impact on the site" (para 3.2) and that the low remaining potential for impact from individual towers could be appropriately mitigated through a combination of measures (HS Annex para 1.7).

503) In addition, the ES identified 5 significant (moderate) adverse potential setting effects of the 400kV (i.e. those parts of the route that would be replaced by UGC4 A). With mitigation the ES states that this would reduce to 2 significant (moderate) effects, though this should be revised upwards to 3.

3.5.7.2 Outline Assessment of the Effects of the UGC Proposals – UGC4 A

504) Most of both of the UGC4 A routes fall outwith both the DBA and field survey corridors established for the EIA, with a few exceptions: a short stretch of UGC4 A1 at Cambushinnie Hill (TD170) and a very small section where UGC4 A3 crosses the proposed 400kV OHL near Lower Whiteston. A rapid assessment was undertaken of known sites in the areas of the UGC4 A routes which fall outside the DBA corridor, though this is likely to underestimate the archaeology present, in the absence of a formal field survey.

505) It appears that UGC4 A1 & 2 will pass through or close to 3 known sites, 2 of which are shieling huts/mounds to the north west of Cambushinnie and one is a possible Prehistoric Long Barrow cropmark to the north of Greenyards. There are thus 3 potential direct impacts on known sites. It will be possible to mitigate at least some and perhaps all of these potential direct impacts through demarcation/avoidance particularly those which fall within UGC4 A1 which is a proposed OHL though avoidance of the crop mark site by an undergrounded cable will be harder to achieve without moving the route.

506) It appears that UGC4 A3 and SEC 3 will pass through or close to 1 known site (No 392 in ES) which is the possible site of a Roman Road at Lower Whiteston. There is thus 1 potential direct impact on known sites. It may be possible to mitigate this potential direct impact through demarcation/avoidance, though the potential for direct impacts is much higher for an undergrounded line than for an overhead line. It may also prove harder to avoid known sites in constructing the UGC. The UGC will require the excavation of a continuous linear trench, while the impact of the OHL will be limited to ground disturbance at specific points: tower bases, access tracks, etc. The greater flexibility afforded by the applicants OHL proposal means that the extent of direct impacts should be less.

507) UGC4 A3 does, however, cross a sensitive area identified in the ES (No. 21: Drumallan to White Stone). It is also likely that areas to the north and south of the A820 at Greenyards, as well as a further section along the north side of the A9, roughly between Nether Cambushinnie Farm and LB 3995: Gateside Octagon, should all be deemed sensitive to unknown remains. While the significance of

impacts on as-yet-unidentified remains is yet to be established, it is probable that the UGC will have a much greater effect on such remains than the proposed OHL. The risk of direct impacts on as-yet-unidentified remains is far higher for the UGC.

508) A precise assessment of the setting effects of the UGC4 A proposals would require further work, but in general terms, one would anticipate the setting impacts of an underground line, overall, to be significantly less than those associated with an OHL. The most significant setting effects are likely to occur on UGC4 A1 where 2 SAMs lie very close to a proposed OHL section (SAM 6557, Cromlix Lodge, Hut Circle & SAM 6556, Cromlix Lodge, Long Cairn). Significant setting effects are likely to accrue from the UGC route, though these effects would be greatest in the construction phase and immediately thereafter, reducing with time as vegetation re-establishes itself, etc. The UGC4 A2 route passes close to two B Listed buildings (at Kilbride Castle) but these appear to be shielded by trees and the route is unlikely to have any potential impact on their setting. There is therefore a good chance that the UGC will not have long term significant setting effects. UGC4 A3 passes close to 2 category B listed buildings and 1 category C(s) listed building. There is therefore a good chance that the UGC will have significant setting effects, at least during construction, on at least some of these features though most, if not all, are unlikely to be long term effects.

3.5.7.3 Results of the Assessment of the Effects of the Proposals – UGC4 B

509) The ES established that the OHL proposals roughly equivalent to UGC4 B would result in no significant adverse potential direct effects, three potential minor adverse effects and one of unknown significance. However, the nature of the development proposal is such that direct effects on most of the known sites potentially affected can be avoided through demarcation or, where the sites are linear features, mitigation can be achieved through re-instatement of the feature. With this mitigation programme of demarcation/avoidance and re-instatement, the number of residual direct effects reduces to one – an unknown potential adverse effect on site 410: Blackhill, Cropmark Enclosure. This potential impact will be mitigated through, where possible, demarcation and where not possible archaeological evaluation with subsequent mitigation being put in place as appropriate. The direct impact of the OHL proposals on known sites in this area is thus minimal. Six areas of archaeological sensitivity were also identified in the ES in this section of the route – at Pendreich (No. 23), Cocksburn Reservoir (No. 24), Forth to Logie Villa (No. 25), Steuarthall to Forth (No. 26), Steuarthall (No. 27) and Dykes (No. 28). The significance of effect on any as-yet-unidentified archaeology cannot, at present, be established. In addition, the ES identified 13 significant (moderate) adverse potential setting effects of the Proposed OHL (i.e. those parts of the route roughly equivalent to UGC4 B). With mitigation the ES states that this would reduce to 9 significant (moderate) effects, though this should be revised to 11.

3.5.7.4 Outline Assessment of the Effects of the UGC Proposals – UGC4 B

510) All of the UGC4 B route falls outwith both the DBA and field survey corridors established for the EIA. A rapid assessment was undertaken of known sites in the areas of the UGC4 B, though this is likely to underestimate the archaeology present, in the absence of a formal field survey.

511) It appears that UGC4 B will pass through or close to 2 known sites, of which both relate to possible crop mark enclosures. There are thus 2 potential direct impacts on known sites. It will be possible to mitigate some of these potential direct

impacts through demarcation/avoidance. However, the incidence of potential direct impacts is much higher for the UGC than for the OHL proposals. In addition, it may prove harder to avoid known sites in constructing the UGC. The UGC would require the excavation of a continuous linear trench, while the impact of the Proposed OHL will be limited to ground disturbance at specific points: tower bases, access tracks, etc. The greater flexibility afforded by the latter proposal means that the extent of direct impacts should be less.

512) UGC4 B does not cross any of the sensitive areas identified in the ES. It is likely, however, that all of the route will be deemed sensitive to unknown remains due to its location on the flood plain of the River Forth and the concentration of known sites, particularly crop marks and scheduled prehistoric remains, in the surrounding area. This is particularly apparent in the area to the north of the River Forth as far as Greenyards. While the significance of impacts on as-yet-unidentified remains is yet to be established, it is probable that the UGC will have a much greater effect on such remains than the Proposed OHL. The risk of direct impacts on as-yet-unidentified remains is far higher for the UGC.

513) A precise assessment of the setting effects of the UGC4 B proposals would require further work, but in general terms, one would anticipate the setting impacts of an underground line, overall, to be significantly less than those associated with an OHL. Nevertheless, significant setting effects are likely to accrue from the UGC route, though these effects would be greatest in the construction phase and immediately thereafter, reducing with time as vegetation re-establishes itself etc. The UGC4 B route passes close to four SAMs, one Listed B category building, four Listed C(s) category buildings and two HGDLs (with associated Listed Buildings). There is therefore a good chance that the UGC will have significant setting effects, at least during construction, on at least some of these features though most, if not all, are unlikely to be long term effects.

3.5.7.5 Results of the Assessment of the Effects of the Proposals – UGC4 C

514) The ES established that the OHL proposals would result in one potential moderate adverse direct effect and one minor adverse. However, the nature of the development proposal is such that direct effects on most of the known sites potentially affected can be avoided through demarcation or, where the sites are linear features, mitigation can be achieved through re-instatement of the feature. With this mitigation programme of demarcation/avoidance and re-instatement, the number of residual direct effects reduces to none. The direct impact of the OHL proposals on known sites in this area is thus minimal. Five areas of archaeological sensitivity were also identified in the ES in this section of the route – at Dykes (No. 28), Throsk (No. 29), Gallamuir to Easter Moss(No. 30), Tor Wood (No. 31), Denny North Substation (No. 34). The significance of effect on any as-yet-unidentified archaeology cannot, at present, be established. In addition, the ES identified 9 significant (1 major & 8 moderate) adverse potential setting effects of the OHL (i.e. those parts of the route that would be replaced by UGC4 C). With mitigation the ES states that this would reduce to four significant (moderate) effects, though this should be revised upwards to 5.

3.5.7.6 Outline Assessment of the Effects of the UGC Proposals – UGC4 C

515) Most of the UGC4 C route falls outwith both the DBA and field survey corridors established for the EIA, with the exception of the southern end at Denny North Sub Station. A rapid assessment was undertaken of known sites in the areas of the

UGC4 C routes which fall outside the DBA corridor, though this is likely to underestimate the archaeology present, in the absence of a formal field survey.

516) It appears that UGC4 C1 will pass through or close to 2 known sites, of which 1 is a find of an artefact rather than a structure or site on the ground today. There is therefore only 1 potential direct impact on a known site. It will be possible to mitigate this potential direct impact through demarcation/avoidance as it falls within UGC4 C1 which is a proposed OHL.

517) It appears that UGC4 C2 will pass through or close to some 3 known sites, of which 1 is a find of an artefact rather than a structure or site on the ground today. There are therefore only 2 potential direct impacts on known sites. It may be possible to mitigate some of these potential direct impacts through demarcation/avoidance. The incidence of potential direct impacts is thus higher for the UGC than for the OHL proposals. In addition, it may prove harder to avoid known sites in constructing the UGC. The UGC would require the excavation of a continuous linear trench, while the impact of the Proposed OHL would be limited to ground disturbance at specific points: tower bases, access tracks, etc. The greater flexibility afforded by the latter proposal means that the extent of direct impacts should be less.

518) Neither UGC4 C1 nor C2 crosses any of the sensitive areas identified in the ES. It is likely, however, that there will be pockets of land deemed sensitive to unknown remains. While the significance of impacts on as-yet-unidentified remains is yet to be established, it is probable that the UGC4 C2 would have a much greater effect on such remains than UGC4 C1 or the Proposed OHL line. The risk of direct impacts on as-yet-unidentified remains is far higher for the UGC.

519) A precise assessment of the setting effects of the UGC4 C proposals would require further work, but in general terms, one would anticipate the setting impacts of an underground line, overall, to be significantly less than those associated with an OHL. The most significant setting effects are likely to occur on UGC4 C1 where 10 SAMs, 3 Listed A buildings, 8 Listed B buildings and 1 HGDL (with associated Listed Buildings) lie close to the proposed OHL section. Significant setting effects are also likely to accrue from the UGC4 C2 route, though these effects would be greatest in the construction phase and immediately thereafter, reducing with time as vegetation re-establishes itself etc. There is therefore a good chance that both the UGC and OHL proposals will have significant setting effects but the UGC proposal setting effects will be limited to the construction period and a short time thereafter.

3.6 COST APPRAISAL

520) Three undergrounding options are costed here:

- Option 1: SNH 30Jan07 option - OHL north, UGC south,
- Option 2: SNH 18June07 option - OHL north and south, UGC past Stirling
- Option 3: SBP - UGC Braco to Denny

521) The same approach is taken as in the earlier reports, that is, appropriate unit costs are identified from the case study work reported in APL 5/16, and these unit costs are then applied to the circuit lengths appraised in this present study. The estimated costs of undergrounding are then compared with the estimated costs of the original Proposed OHL over the equivalent part of the route.

3.6.1 Unit Costs

522) It should be noted that the APL 5/16 Case Study costings assumed that access roads from the highway to an SEC site would not be greater than 100m. This assumption does not apply to SEC 1, on Milour Moor, although the other SECs are reasonably close to existing roads or, in the case of Braco, will be near a road when the rest of the substation is built.

523) As with earlier reports to the Public Inquiry, over-ground works are generally accorded a 10% contingency. Cables and trench work are accorded a 15% contingency at this stage of the investigation, to cover the additional risks / unknowns associated with the geology and the transmission cable market.

524) The cable routes that have been identified between Braco and Denny pass through landscape of the same general character as that encountered during APL 5/16 Case Study 5, and the unit costs derived from that study are thus used here. They are presented in the following Table 3-4.

3.6.2 Cost Appraisal – SNH Option 1: Milour Moor to Denny

525) This proposal by SNH effectively would replace the 30.3 km section of the Proposed OHL route between the proposed new substation at Braco and Denny Substation. A 6.5 km section of OHL (including 959 m of the Proposed OHL between the new Braco substation and Tower TD170 - Point W) would connect Braco to SEC 1 at Milour Moor. Then 24 km of trenched UGC would connect Milour Moor to Denny. This option may be seen in outline in Figure 1-2, and in detail on both the aerial photographs of Appendix 5 and on the OS maps of Appendix 6.

526) It can be seen from Table 3-5 that whilst the Proposed OHL route would be expected to cost £28.5m, this alternative is estimated to cost £327.3m, or an additional £298.8m. The Proposed and alternative route lengths are virtually the same, at just over 30 km.

3.6.3 Cost Appraisal – SNH Option 2: Milour Moor to Gartur

527) This proposal by SNH again would replace the 30.3 km section of the Proposed OHL route between the proposed new substation at Braco and Denny Substation. This time, however, 6.5 km section of OHL (including 959 m of the Proposed OHL between the new Braco substation and Tower TD170 - Point W) would connect Braco to SEC 1 at Milour Moor, whilst a further 10.2 km section of OHL would connect SEC 2 at Gartur to Denny Substation. This leaves only 13.8 km of trenched UGC needed to connect SEC 1 at Milour Moor to SEC 2 at Gartur. This option may be seen in outline in Figure 1-2, and in detail on both the aerial photographs of Appendix 5 and on the OS maps of Appendix 6.

528) It can be seen from Table 3-6 that whilst the Proposed OHL route would be expected to cost £28.5m, this alternative is estimated to cost £202.5m, or an additional £174m. As before, the Proposed and alternative route lengths are virtually the same, at just over 30 km.

3.6.4 Cost Appraisal – SBP: Braco to Denny

529) This proposal by SBP would replace in its entirety the 30.3 km section of Proposed OHL route between the proposed new transmission substation at Braco and Denny Substation. A 33.4 km section of trenched UGC would connect the two

substations. This option may be seen in outline in Figure 1-2, and in detail on both the aerial photographs of Appendix 5 and on the OS maps of Appendix 6.

530) It can be seen from Table 3-7 that whilst the Proposed OHL route would be expected to cost £28.5m, this alternative is estimated to cost £444.7m, or an additional £416.2m. The Proposed OHL route length is about 30.3 km, whilst the alternative route length is 33.4 km.

Table 3-4 – Unit Costs – Case Study 5

Stirling Area Undergrounding Costing Study - Unit Costs

Item	Unit Cost	Source
a. Case Study 5 - West of Stirling (mainly agricultural land) - Applied here to all Stirling trenched UGC options:-		
1. OHL unit cost per km:-		
Total OHL cost per km (£k/km): all study average = £1051k / km)	943	APL 5/16 Case Study 5, p111, Table 5-26
less 10% contingency (of £86k / km)	86	
OHL unit cost per km before contingency (£k/km) =	858	= Stirling Source Ref 1
Contingency Rate =	10%	
2. SEC cost (end costs), per pair:-		
Total cable-end for section (£k)	5,072	APL 5/16 Case Study 5, p112 Table 5-27(A)
plus Maintenance (£k)	259	APL 5/16 Case Study 5, p112 Table 5-27(B)
SEC Unit cost per pair (£k) =	5,331	= Stirling Source Ref 2
Contingency Rate =	10%	
3. UGC unit cost per km:-		
Total cable route for section (£k)	52,736	APL 5/16 Case Study 5, p112 Table 5-27(A)
plus Wayleaves (£k)	122	APL 5/16 Case Study 5, p112 Table 5-27(B)
plus 40-year replacement (£k)	4,734	APL 5/16 Case Study 5, p112 Table 5-27(B)
all divided by Length (km):	5.039	APL 5/16 Case Study 5, p112 Table 5-27
UGC unit cost per km before contingency (£k/km) =	11,429	= Stirling Source Ref 3
Contingency Rate =	15%	

Table 3-5 – UGC4 Option 1 – SNH: Milour Moor to Denny

UGC4 Option 1 - SNH: UGC Strathallan to Denny: SEC 1 (Milour Moor) to SEC 4 (Denny)

Proposed OHL being displaced	**Item**	**Units**	**Quantities**	**Lifetime Unit cost (£k)**	**Source Ref**	**Contingency Rate (%)**	**Cost incl. Contingency (£k)**
Milour Moor (tower n/a) - Denny (tower n/a)	OHL	km	30.255	858	=StSR1	10%	28,540
UGC Option - UGC costs are for direct-buried / tunnelled cable							
Unit cost source:	Case study No. 5						
Additional OHL required to connect to north and south SECs	OHL	km	6.456	858	=StSR1	10%	6,090
UGC4 Option 1 - SNH: UGC Strathallan to Denny: cable between SEC 1 and SEC 4	UGC	km	23.995	11,429	=StSR3	15%	315,381
North and South SECs	SEC	pair	1	5,331	=StSR2	10%	5,864

NB:

1. SEC costs include lifetime maintenance cost estimates
2. Cable costs include wayleaves and 40 year replacement cost estimates. Tunnel costs also included, where appropriate.
3. Costs for ducted cable are estimated to lie within 1% of that for direct-buried, and so are not shown separately.

Summary - UGC4 Option 1 - SNH: UGC Strathallan to Denny	**Item**	**km**	**£k**
Totals for the proposed OHL	OHL	30.3	28,540
OHL totals for the UGC option	OHL	6.5	6,090
UGC totals for the UGC option	UGC +SEC	24.0	321,245
Whole route totals for the UGC option	All	30.5	327,335

Comparisons between the undergrounding and OHL options:	**km**	**£k**
Differences: UGC Option less proposed OHL	0.2	298,796
Route length increase of UGC over proposed OHL (%)	0.6%	
Cost Factor: UGC over OHL (times)		11.5 times

Table 3-6 – UGC4 Option 2 – SNH: Milour Moor to Gartur

UGC4 Option 2 - SNH: UGC Strathallan to Cambusbarron: SEC 1 (Milour Moor) to SEC 2 (Gartur)

Proposed OHL being displaced	**Item**	**Units**	**Quantities**	**Lifetime Unit cost (£k)**	**Source Ref**	**Contingency Rate (%)**	**Cost incl. Contingency (£k)**
Milour Moor (tower n/a) - Gartur (tower n/a)	OHL	km	30.255	858	=StSR1	10%	28,540
UGC Option - UGC costs are for direct-buried / tunnelled cable							
Unit cost source:	Case study No. 5						
Additional OHL required to connect to north and south SECs	OHL	km	16.704	858	=StSR1	10%	15,757
UGC4 Option 2 - SNH: UGC Strathallan to Cambusbarron: cable between SEC 1 and SI	UGC	km	13.764	11,429	=StSR3	15%	180,909
North and South SECs	SEC	pair	1	5,331	=StSR2	10%	5,864

NB:

1. SEC costs include lifetime maintenance cost estimates
2. Cable costs include wayleaves and 40 year replacement cost estimates. Tunnel costs also included, where appropriate.
3. Costs for ducted cable are estimated to lie within 1% of that for direct-buried, and so are not shown separately.

Summary - UGC4 Option 2 - SNH: UGC Strathallan to Cambusbarron	**Item**	**km**	**£k**
Totals for the proposed OHL	OHL	30.3	28,540

OHL totals for the UGC option	OHL	16.7	15,757
UGC totals for the UGC option	UGC +SEC	13.8	186,773
Whole route totals for the UGC option	All	30.5	202,530

Comparisons between the undergrounding and OHL options:	**km**	**£k**
Differences: UGC Option less proposed OHL	0.2	173,990
Route length increase of UGC over proposed OHL (%)	0.7%	
Cost Factor: UGC over OHL (times)		7.1 times

Table 3-7 – UGC4 Option 3 – SBP: Braco to Denny

UGC4 Option 3 - SBP: UGC Braco to Denny: SEC 3 (Braco) to SEC4 (Denny)

Proposed OHL being displaced	**Item**	**Units**	**Quantities**	**Lifetime Unit cost (£k)**	**Source Ref**	**Contingency Rate (%)**	**Cost incl. Contingency (£k)**
Braco (tower TD165) - Denny (tower n/a)	OHL	km	30.255	858	=StSR1	10%	28,540
UGC Option - UGC costs are for direct-buried / tunnelled cable							
Unit cost source:	Case study No. 5						
Additional OHL required to connect to north and south SECs	OHL	km	0	858	=StSR1	10%	-
UGC4 Option 3 - SBP: UGC Braco to Denny: cable between SEC 3 and SEC4	UGC	km	33.391	11,429	=StSR3	15%	438,879
North and South SECs	SEC	pair	1	5,331	=StSR2	10%	5,864

NB:

1. SEC costs include lifetime maintenance cost estimates
2. Cable costs include wayleaves and 40 year replacement cost estimates. Tunnel costs also included, where appropriate.
3. Costs for ducted cable are estimated to lie within 1% of that for direct-buried, and so are not shown separately.

Summary - UGC4 Option 3 - SBP: UGC Braco to Denny	**Item**	**km**	**£k**
Totals for the proposed OHL	OHL	30.3	28,540
OHL totals for the UGC option	OHL	0.0	-
UGC totals for the UGC option	UGC +SEC	33.4	444,743
Whole route totals for the UGC option	All	33.4	444,743

Comparisons between the undergrounding and OHL options:	**km**	**£k**
Differences: UGC Option less proposed OHL	3.1	416,203
Route length increase of UGC over proposed OHL (%)	10.4%	
Cost Factor: UGC over OHL (times)		15.6 times

3.7 CONCLUSIONS ON WEST OF STIRLING APPRAISAL

3.7.1 Technical

531) Feasible undergrounding routes have been identified for each of the objectors' proposals.

532) Although it was not practical to utilise the SNH search area for the northern end of the SBP undergrounding option, separate routes have been found north of the A820 that satisfy the individual requirements of each objector organisation.

533) South of the A820 a common UGC route has been identified.

534) For the longest route length of 33km, three or more manufacturers may be required to meet a four year schedule. Such a demand for cable is likely to produce an upward pressure on cable system prices as there are only a limited number of European manufacturers of this type of cable, with varying degrees of experience, and only two EHV cable installers in Scotland with relevant experience.

535) It is considered that it should be possible to construct cable routes along the routes indicated. However, the ground has not been opened so ground conditions at each location have been assessed on likely suitability based on a combination of visual inspection on site, aerial photography and Ordnance Survey map information.

536) The exact location and depth of all the hydrocarbon fuel pipelines has not been fully established and thus it has been necessary to assume some positions. The cable routes shown must therefore be considered as purely indicative. There are a number of locations where there are pinch points to the route due to the topography or the corridor provided (one example being the crossing of the Bannock Burn another is the position for the crossing of the River Teith). More generally however there are a multitude of options for the location of a cable route and in particular in the carse. It would be appropriate at these locations to route the cables away from the hydrocarbon fuel lines wherever reasonably practicable to minimise the hazards of proximity working and to minimise any adverse impacts of the cable system (corrosion) on the fuel lines.

537) Access to the route to the west of Allan Water between Ashfield and the A9 would be of concern as power cable drums would need to be transported via Braco to the construction site. If the B8033 is unable to support the weight of the drum carrying transport to the haul road then this route is at risk of being unusable. It will also be necessary to upgrade the minor road connecting the B8033 from the bridge over Allan Water to the point where the cable route crosses the minor road and the haul road starts.

538) Three of the four SECs appraised here would require substantial road-works.

3.7.2 Environmental

3.7.2.1 Geology and Soils

539) There will be a significant adverse residual impact on soils arising from the undergrounding options UGC4 A2, UGC4 A3, UGC4 B AND UGC4 C2, which

does not exist for the current 400kV OHL proposal. This is on account of the surplus soil arisings that will need to be disposed of due to the displacement of soils by the UGC infrastructure, whereas OHL works do not carry with them this requirement. The removal of such soils from the UGC works area also impacts on soil function, principally in terms of drainage but also in terms of soil resources in the UGC corridor. It has been estimated in Cable Consulting's note on construction plant and traffic (March 2007) that 2.3 m^3 of in situ soil material per linear metre of cable route will need to be exported from the site. Using a typical bulking factor of 1.5 this is equivalent to an ex situ volume of approximately 3.5 m^3 per linear metre of cable route, currently assumed to be destined for landfill disposal.

3.7.2.2 Hydrology

540) There is a clear difference in the degree of hydrological risk that undergrounding presents compared to the proposed 400kV OHL works. The undergrounding works are by their nature much greater in spatial extent and duration compared to OHL works. Whilst such risks are in general manageable, the potential for accidental pollution events to arise from sediment entrainment in water flows or for accidental fuel spillage to migrate towards water features is much greater on account of the scale and duration of the works.

541) Unless specifically stated, it has been assumed here that all water features (including but not limited to water bodies and watercourses as defined in the Environmental Statement) will be crossed by a combination of directional drilling beneath the water features to facilitate permanent placement of the cables and a temporary crossing above the water feature (comprising a bridging culvert or similar) to facilitate vehicle movements. Other cable options include tunnelling, laying the cables in pipes or directly on the bed of each water feature. From an environmental perspective, however, directional drilling is the preferred option since it avoids direct disturbance to the water feature itself (or minimises it where vehicle crossings are still required) whilst also avoiding the much higher costs associated with tunnel construction. Directional drilling is, however, not without significant risks, as explained below.

542) There is a much greater risk of significant adverse residual impact on hydrology arising from undergrounding, compared to the proposed OHL, on account of the inherent uncertainty associated with drilling (or tunnelling) under watercourses, as well as the number of watercourse crossings at which a directional drilling is likely to be required (see Appendix 4 Table A4- 1 and Figure A4- 1 to Figure A4- 4). Construction risks during directional drilling under watercourses include breakout of drilling fluids or grout (the latter being used to seal fractures in tunnel excavations). Whilst such occurrences are likely to locally impact on watercourses in the short term, longer term risks will accrue where the balance of flow between surface water bodies and groundwater is altered, for example, where low river flows during dry weather are further reduced by enhanced leakage from the bed of a river (or rivers) into the underlying strata.

3.7.2.3 Forestry

543) The **proposed OHL** route passes through some 3858m of forest and woodland, requiring the clearance of some 33.24ha, of which 0.14ha is designated ASNW 1a, 0.03ha as 2a, and 2.44ha as 2b.

544) The **Stirling Council/SNH** alternative route passes through a slightly longer distance of woodland, but that area that requires to be cleared increase to a much greater extent. Whilst the West of Stirling UGC4 - A1/A2/B/C1 route avoids routeing through the Sherrifmuir conifer blocks, the nature of the conifer areas that are affected by the western route alternatives result in an increased felling requirement of between 25-75% for stability and landscaping reasons.

545) The **SNH/Stirling Council** route avoids the Ochils escarpment to the East of Stirling, thereby removing the major significant effect that the proposed OHL has on Yellowcraig.

546) The **SNH & Stirling Council** route impacts on Ancient Woodland designated sites, with over a 4-fold increase compared to the proposed OHL route.

547) The **SBP** route has the effect of removing the moderately significant effect that the proposed OHL route has on Cambushinnie Forest, and also removes the major significant effect that the proposed OHL route has on the Ochils escarpment (Yellowcraig).

548) The **SBP** alternative route passes through a shorter distance of woodland, and has the effect of reducing the area of conifer felling at Cambushinnie (-12.7ha), with additional felling elsewhere, (principally along the A9), the net reduction in clearance is some 7.4ha.

549) Whilst the **SBP** route avoids felling immediately south of the proposed sub-station in the more remote Cambushinnie Forest and also the Sherrifmuir conifer blocks, much of the conifer areas that are affected with the alternative route are located along the more sensitive A9.

550) The **SBP** route impacts most on ASNW designated sites, with a 7-fold increase of ASNW designated felling areas from 2.6 to 18.2 hectares.

3.7.2.4 Ecology and Nature Conservation

551) At a strategic level, there are several European and nationally designated sites that could potentially be affected by the alternatives to the west of Stirling, as well as other undesignated but significant ecological resources. There is the potential for impacts on ecological receptors (direct and indirect) overall, to be greater than the assessed level of impact associated with the proposed overhead line to the east of Stirling. At this stage we are particularly aware of the following issues: sensitive watercourses, ancient woodland and the potential for significant bird issues (although potential bird collision impact may be comparatively lower than the proposed OHL route). However, it is not possible to be more specific at this strategic stage, due to a current lack of specific and targeted ecological surveys to the west of Stirling.

3.7.2.5 Landscape

552) Effects on landscape character would be greatest for the combined underground and overhead route to the west of Stirling and this relates mainly to the overhead line sections of this route. The OHL would significantly adversely affect the landscape in the area close to the Cromlix Estate and in the area south of Gartur. The proposed all underground route from Cambushinnie to Denny would generally only result in short term, moderate adverse effects on landscape character, that would reduce to minor adverse effects following the successful reinstatement of

the groundcover vegetation. The proposed UGC4 SEC2 at Gartur would result in moderate adverse effects on landscape character on the local area within the Touch Hills AGLV and in potential adverse effects on the Touch House HGDL, though these could be reduced to minor with the implementation of mitigation measures.

3.7.2.6 Visual Amenity

553) Effects on visual amenity would similarly be greatest for the combination of overhead line and underground cable, with potentially moderate and major adverse effects on residential properties, and moderate adverse effects on roads and rights of way, as well as potentially on recreation areas on the edge of, and to the west of Stirling. Adverse effects on visual amenity as a result of the various sections of alternative route involving underground cable, would generally be short term, relating to construction effects, and would reduce to minor adverse effects following the successful reinstatement of the groundcover vegetation. Potentially moderate adverse effects on visual amenity would result from the proposed sealing end compound at Gartur, for roads and rights of way in the vicinity of this site.

3.7.2.7 Cultural Heritage

554) It is difficult to distinguish between the relative levels of effect of UGC4 A1 & 2 and the Proposed OHL. The former appears to have slightly less potential for direct impacts on known archaeology, which are worse than indirect effects, though most of these on both route options will be avoidable where OHLs are employed meaning that the former route is likely to end up with one residual direct impact compared with two on the Proposed OHL. However, the UGC4 A1 and A2 routes have not been field surveyed, thus scope exists for further archaeology to be discovered. The Proposed OHL also appears to have a higher level of indirect impact as well as running through two, rather than one, areas sensitive to the discovery of unknown remains, one of which includes Sheriffmuir. Overall, as direct effects are irreversible, much depends on the levels of archaeology present in the areas of sensitivity, though an underground route is almost certain to create more direct impacts than an overhead line on both known and as-yet-undiscovered cultural heritage sites. On balance, currently there appears to be little to choose between them, save for the issue of undergrounding of UGC4 A2, though a full assessment of UGC 4 A1 & A2 would be required before a final judgement could be made. Should evaluation prove that significant sub surface archaeology survives on the line of the undergrounded section, this would render the Proposed OHL the better option on cultural heritage grounds.

555) Again, it is difficult to distinguish between the relative levels of effect of UGC4 A3 and the Proposed OHL. Both have roughly similar potential for direct effects on known sites and both run through similar numbers of areas potentially sensitive to unknown remains. The UGC option appears to have a higher potential for direct impacts on unknown archaeology particularly in the SW area near Greenyards and at Glenbank, which would be worse than indirect effects, but the OHL route will have a higher level of indirect impact. Overall, as direct effects are irreversible, much depends on the levels of archaeology present in the areas of sensitivity, though an underground route is almost certain to create more direct impacts than an overhead line on both known and as-yet-undiscovered cultural heritage sites. However, it is equally almost certain that there would be a reduction in the level of indirect adverse effects on cultural heritage sites, at least following the construction period. On balance, currently there appears to be little to choose

between them, save for the issue of undergrounding of UGC4 A3, though a full assessment of UGC4 A3 would be required before a final judgement could be made. Should evaluation prove that significant sub surface archaeology survives on the line of the undergrounded section, this would render the Proposed OHL the better option on cultural heritage grounds.

556) It is very difficult to compare the different levels of effect created by UGC4 B and the equivalent stretch of the Proposed OHL. Both have roughly similar potential direct effects on known sites. The whole course of UGC4 B runs through an area sensitive to the discovery of unknown remains, while the Proposed OHL will affect six discrete areas of similar sensitivity. In this respect, the undergrounded option is worse from a cultural heritage perspective. However, the Proposed OHL was reported to have 13 potential significant setting effects, while the undergrounded option has the potential to affect fewer sites and the setting effects arising in this case would be unlikely to be long term. Overall, as direct effects are irreversible, much depends on the levels of archaeology present in the areas of sensitivity, though an underground route is almost certain to create more direct impacts than an overhead line on both known and as-yet-undiscovered cultural heritage sites, particularly in areas of archaeological sensitivity such as UGC4 B. However, it is equally almost certain that there would be a reduction in the level of indirect adverse effects on cultural heritage sites, at least following the construction period. At present, on balance, the Proposed OHL seems preferable, on the grounds that it is likely to have fewer irreversible direct effects though a full assessment of UGC4 B would be required before a final judgement could be made.

557) It is very difficult to compare the different levels of effect created by UGC4 C1 and C2 and the equivalent stretch of the Proposed OHL. All have fairly similar levels of potential direct impact, though it is likely that the undergrounded UGC4 C2 route will have a higher level of direct impact than the two overhead options. The Proposed OHL appears to run through an area generally more sensitive to the discovery of unknown remains, though pockets of potentially sensitive areas also exist on the western route. It is likely that the undergrounded UGC4 C2 route will have far less indirect impact than either of the overhead options. UGC4 C1 with 22 potential significant impacts on the setting of designated monuments seems likely to have a greater impact than the Proposed OHL which was reported to have 9 potential significant impacts, though a detailed assessment of the setting impacts of the former line would be required before a final judgement could be reached. With the caveat that further assessment work would be necessary on both UGC4 C1 and C2, at present the Proposed OHL appears to have fewer significant potential indirect adverse impacts overall than UGC4 C1. Both OHL options would generally be preferable to UGC4 C2 on cultural heritage grounds because they are likely to generate fewer direct (i.e. irreversible) effects, though much depends on the levels of archaeology present in the areas of sensitivity. Of the two OHLs the Proposed OHL seems preferable as it appears to have fewer indirect effects on cultural heritage sites than UGC4 C1 though a full assessment of the latter would be required before a final judgement could be made.

3.7.3 Costs

558) The West of Stirling undergrounding alternatives comprise 3 options:

- UGC4 – SNH Option 1: The Proposed OHL route length being assessed is 30.3 km, whilst the undergrounding alternative would be 30.5 km, of which 24 km would be UGC and 6.5 km OHL. The cost of the Proposed OHL is estimated to be £28.5m. The cost of the alternative undergrounding

proposal is estimated to be £327.3m, an additional £298.8m over and above the OHL solution.

- UGC4 – SNH Option 2: The Proposed OHL route length being assessed is 30.3 km, whilst the undergrounding alternative would be 30.5 km, of which 13.8 km would be UGC and 16.7 km OHL. The cost of the Proposed OHL is estimated to be £28.5m. The cost of the alternative undergrounding proposal is estimated to be £202.5m, an additional £174m over and above the OHL solution.
- UGC4 – SBP: The Proposed OHL route length being assessed is 30.3 km, whilst the undergrounding alternative would be 33.4 km, all of which would be UGC. The cost of the Proposed OHL is estimated to be £28.5m. The cost of the alternative undergrounding proposal is estimated to be £444.7m, an additional £416.2m over and above the OHL solution.

CHAPTER 4: OCHILS ESCARPMENT ROUTE EAST OF STIRLING APPRAISAL

4.1 TECHNICAL APPRAISAL

559) The University of Stirling (UoS) submitted a requirement for the proposed 400kV OHL to be replaced by underground cable over the region shown in Figure 1-8.

560) Within the report submitted to the inquiry as document APL 5/16 a case study (number 4) was prepared that considered a similar undergrounding of the overhead line between Cocksburn Wood and Lower Taylorton.

561) In that case study, a route up the Ochil Hills escarpment between Yellow Craig and Carlie Craig was considered but rejected due to construction difficulties in favour of an alternative route through the UoS and the Bridge of Allan. The case study route may also be considered for this proposal as it would not require the installation of OHL over that portion of the proposed route which the UoS wishes to be placed underground.

562) It is not proposed to repeat the findings of the APL 5/16 case study within this report. The reader is directed to that report and Case Study 4 for an undergrounding study which is believed to meet the UoS's stated requirements.

563) The UoS requirements may also be met by the routeings to the West of Stirling suggested by SNH and SBP as neither of these routes require OHL in the areas marked for undergrounding by the UoS.

564) If, however, the Inquiry considers the alternative routes to the west of Stirling to be unacceptable, an eastern route still needs to be pursued. During the work on the Perth and Kinross undergrounding studies (APL/PTH-41) consideration was given to the use of ventilated tunnels beneath difficult terrain. This was not considered in APL 5/16 as an above ground route was identified (Case Study 4).

565) However, tunnels are a last rather than a first choice. This is primarily due to the capital cost of installation and the long term maintenance and upkeep requirements of the structure, buildings and its mechanical, LV electrical supplies and intruder security commitments. In addition, the forced ventilation requirement also represents a considerable increase to the energy losses incurred whenever the circuit is in operation: these losses represent both financial burden to the consumer and long-term impact on the carbon footprint of the project. Apart from these technical issues, tunnels pose an increased risk to operator safety due to the confined space and working conditions, deep shafts, proximity to electrical equipment, the need for self-rescue, and other safety issues related to working in tunnels.

566) The combination of the positioning of the Ochil escarpment and the town suggest that a tunnel solution is worth consideration. This section of the report thus considers placing a tunnel under the Ochil Hills in order that the Inquiry may at least compare this option with that described in APL 5/16 Case Study 4.

567) The locations of cable crossing points for rivers and roads etc. and other nearby locations mentioned in this report may be found in Appendix 3.

4.1.1 UGC4 SEC 5: Cocksburn Wood (including UGC4 D - OHL connection)

568) SEC 5 represents the northernmost point of UoS's undergrounding proposal, and would be located immediately to the north of Cocksburn Wood (NS816990), between the locations presently proposed for towers TD 196 and TD197 (this is the location appraised by this report, since a slight depression in the ground at that point would minimise the height of the SEC. That said, a more detailed visual amenity study may suggest that less impact would result from a location away from the road behind Cocksburn Wood. For the purposes of this appraisal, the technical and cost differences between these two locations would be negligible).

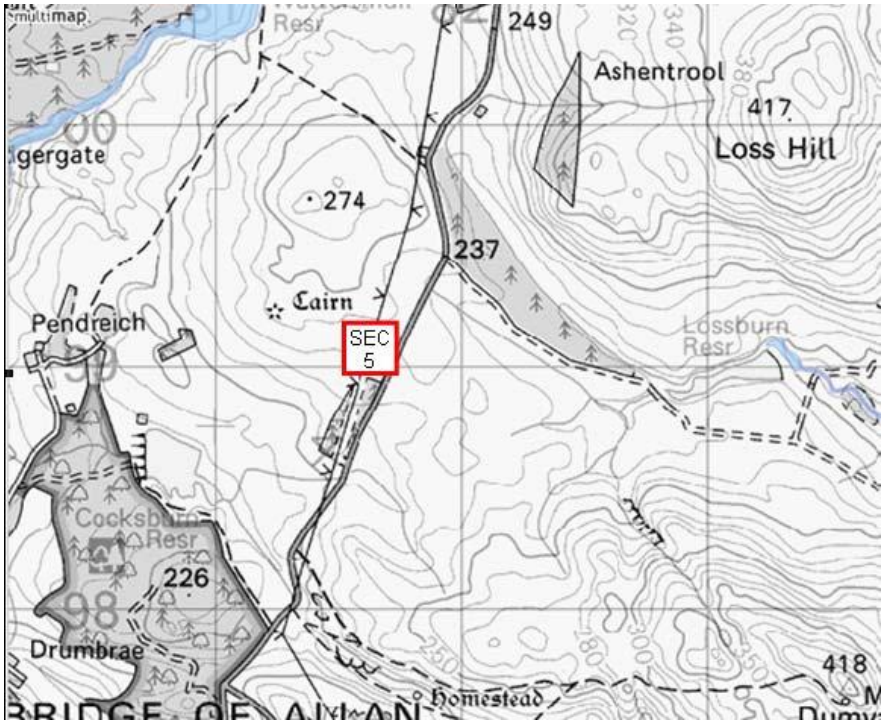
569) This SEC would terminate the northern end of around 4.3 km of UGC. It is unlikely that reactive compensation would be required here, so the need for access by abnormal loads would be limited to the delivery, during construction, of the cable drums and boring equipment for the shaft and tunnel. Only a minor road to the site exists at present, and access along that road from the south is quite restricted by very steep gradients, winding route, and narrow roadway (flanked by walls and rock). The alternative approach, from the north, is less constrained, though there is at least one weak bridge signed as such. Undoubtedly considerable road strengthening would be required, and consideration would also need to be given to the gradients and road radii between this site and Dunblane.

570) The area is hilly, but the gradients on the roadway access from the A9 would need to be restricted to about 8% to allow for the heavy loads (gradients up to 12% could be accommodated for short distances if absolutely necessary).

571) The SEC would be sited adjacent to the tunnel shaft head-works that would accommodate tunnel maintenance equipment and the forced cooling fans for the tunnel. The overall compound would therefore be somewhat larger than the SECs described in APL 5/16. A substantial low voltage supply would need to be run to the site to supply the fans.

572) As may be seen from Figure 4-1, SEPA identifies no flood risk associated with SEC 5.

Figure 4-1: – SEC 5 Flood Risk Map



573) SEC 5 would be connected to the Proposed OHL route by slightly diverting one or two spans immediately north of the SEC on to the SEC terminal tower. This diversion would probably comprise around 640m of OHL.

4.1.2 UGC4 D: Tunnelled UGC from Cocksburn Wood to Logie Villa

574) The shaft head house at Cocksburn Wood would be located at NS816919. This is a difficult location to reach for heavy equipment and, as has been mentioned above, the strengthening of road bridges would be required in order for tunnelling equipment and power cable drums to reach this location.

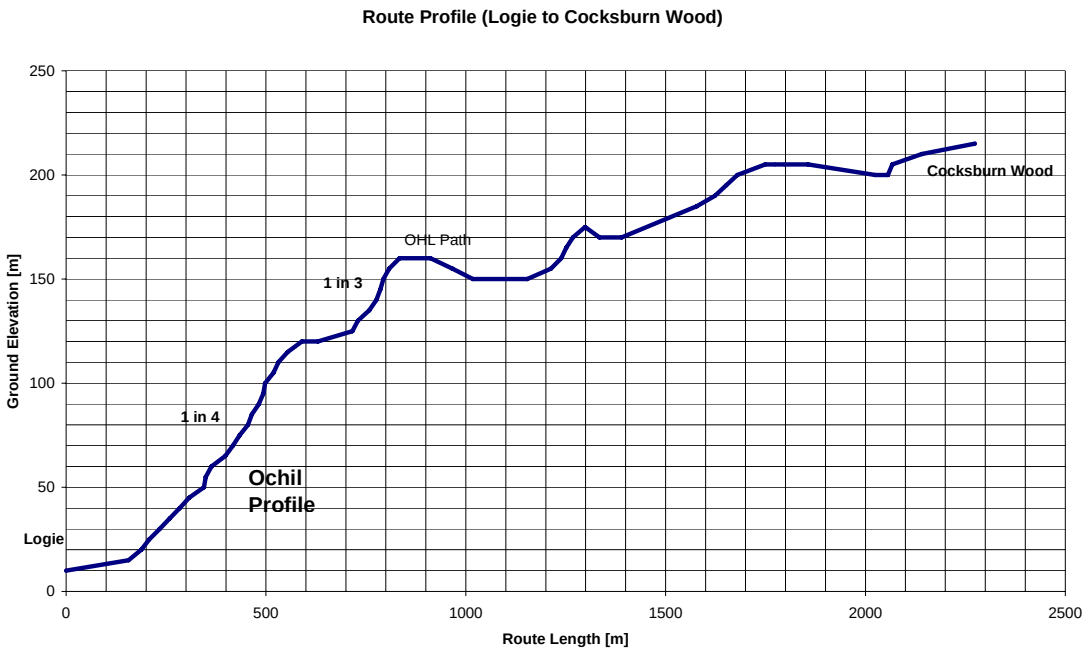
575) A tunnel has the advantages of protecting the EHV cable circuits from damage by third party excavations. It is also available to the transmission company if there is a requirement to install additional services at marginal additional installation cost. A tunnel also travels beneath other services, this is useful in dense urban areas where there is little or no room in existing highway and road openings and routine maintenance is difficult to perform. A tunnel has the advantage of being a stable structure within which cables may be installed and to which they may be attached.

576) Figure 4-2 is a copy of the profile drawing shown in APL5/16 Figure 5-13. It can be seen from this drawing that the fall in elevation from Cocksburn Wood at elevation 215m to the foot of the Ochil Hills at Logie, elevation 10m, is a descent of 205m.

577) If a tunnel were installed 20m below ground at Logie then the total descent would be 225m for a tunnel with a level invert. This would require a shaft at Cocksburn Wood to be 225m deep. In order that the reader may visualise such a shaft, its depth would be over three times the height of the nearby Wallace Monument (67m high) or two thirds the height of the Eiffel Tower in Paris (324m). This structure

would require careful design to be capable of receiving and installing EHV power cables. In this case consideration may be given to installing the tunnel invert with a slight gradient. The magnitude of this gradient would be determined by the abilities of the selected tunnelling machinery and any service vehicles and the practicalities of safety inside the tunnel, particularly with regard to evacuation times in case of a fire if the evacuation route requires individuals to travel up an incline to safety.

Figure 4-2: - Steep Ground Profile of the Ochil Hills



578) For the purposes of this report, it has been considered that a shallower 20m deep shaft would be sunk at Logie and a horizontal tunnel drilled between the two shafts. The horizontal section of the tunnel would be provided with a very slight fall to allow any ground water seepage to be collected at a pumping point for licensed discharge into a local water course. Investigation of the ecology might determine that an alternative tunnel configuration is preferable.

579) At the top of each shaft a head house building would be a required. This would contain the equipment necessary for the forced air ventilation of the tunnel, shaft entry equipment, hoists etc. A tunnel control room would also be required where data from the tunnel, including air temperature, sump water pump, fan control, lighting and security alarms is collected. This control room would be connected to the transmission operators main control centre where operational alarms would register.

580) During the installation of the cable system, and during its operation it would be necessary for any operatives within the tunnel to talk to one another and to personnel in the tunnel control room. A tunnel is a confined space and special safe working arrangements are required to work in such areas. This may include such precautions as the provision and training in the use of emergency breathing apparatus. A tally control would need to be employed to ensure that the personnel count in the tunnel is known. As a result of the hazards involved with a cable tunnel the fire service and rescue teams would not enter a tunnel to fight a fire. It is therefore necessary that personnel entering a cable tunnel are aware and

trained for self rescue and emergency evacuation procedures. This is an ongoing commitment not only for the transmission operator's personnel but also any contractors or third parties entering the tunnel.

581) There are a significant number of hazards in a cable tunnel system, some of which are self evident such as the deep shafts, live power cables etc. There are also less obvious dangers such as the build-up of noxious gases and heat exhaustion.

582) At Cocksburn Wood this shaft head building would be contained within the SEC for the overhead line connection. At Logie the cables would leave the building in cable trenches. The design of these buildings would need to be carefully considered to ensure that where the cables approach the building, consideration is given to the mutual heating between cables. This may require the cables to be placed in surface troughs or that the width of the building is sufficient to allow cables to enter the building at their normal depth.

583) Installation of the cables into the shafts may be achieved by attaching the cables to a steel bond wire which would be pre-tensioned and run for the length of the cable. It would be necessary for the steel hawser and the temporary attaching binds to carry the weight of the cable as it descended the shaft. Once in position the cable would be manoeuvred into cleats which would have been pre-secured to shaft and tunnel steelwork. Installation of the cables in to the vertical shafts could be achieved using cable cleats (clamps) which use frictional forces to hold the cable in position. These cleats and the support steelwork would need to be capable of withstanding both the weight of the cable and the thermomechanical forces developed in service (Figure 4-3).

Figure 4-3: - 400kV Cables Cleated in a Tunnel Shaft

584) The power cable and all of the tunnel services may only enter through the shafts. It is therefore necessary to lower all equipment down the shafts and to transport the cable and equipment along the tunnel to its installation position. On long tunnels (typically over 3km), this requires that the installers devise a tunnel transport system. One such system is an overhead monorail suspend from the top of the tunnel another is a guided vehicle or locomotive. The materials being transported may be lowered vertically down the shaft before being attached to the monorail and carried horizontally along the tunnel.

585) Jointing of discrete cable lengths from drums would need to take place within the tunnel. The joints connecting these lengths are assembled and secured to the tunnel on purpose designed steelwork. If cable phase positional transpositions are required these are also performed using purpose built steelwork (Figure 4-4). The physical area and the cleanliness required to perform jointing quarantines the jointing area which restricts the passage for other tunnel to all but emergency use. This can interfere with the progress of other construction activities in the tunnel.

Figure 4-4: - 400kV Cable Joints and Phase Transposition

586) It can be seen in Figure 4-4 that in the particular tunnel photographed there is a concrete channel cast into the floor. This is designed as a limit guide for an electric vehicle to avoid the vehicle hitting the cable or joints. It also acts as a collection point for tunnel seepage water which flows along a gentle decline to a tunnel water discharge pump. A power cable joint can be seen on the upper left hand side cable. This has a red label alongside which provides the description of the joint including the phase it is connected to and the circuit it is part of. Beyond this joint, in the picture middle distance, a physical cable phase positional rotation can be seen and, particularly clearly, the lower cable can be seen to rise up to take the upper position of the three cables on the tunnel wall beyond the rotation point.

587) A second circuit of three cables can be seen on the right hand side of Figure 4-4. It should be noted that these cables have been installed as a single cable per phase installation with the cables arranged in a vertically spaced formation. Other formations are available such as a trefoil formation and this is shown for EHV cables installed in Japan in Figure 4-5. This arrangement allows more cables to installed in a tunnel than the arrangement in Figure 4-4 but it does not provide the same level of thermal heat transfer to the air due to the close mutual proximity of the cables.

Figure 4-5: - EHV Cables Installed in Trefoil

588) In addition to the EHV cables running through the tunnel, additional cables are also required if lighting, power supplies, leaky coaxial cables for radio communication, fire sensing cables, intruder alarm cables and sensors etc. These can be seen carried in the tray suspended from the ceiling of the tunnel in Figure 4-4. In this particular tunnel permanent lighting has been installed which requires maintenance.

589) In case of a fire in the tunnel it would need to be possible for those in the tunnel to have a reasonable prospect of escaping using portable breathing apparatus. One of the major delays to leaving the tunnel to safety is the ascent of the shaft. In order to provide a safe haven for personnel at the foot of the shaft a separate fire door may be installed between the tunnel or shaft containing cables and a separate stair well contained within a partition of the shaft which is fire resistant and has its own air supply.

590) In order to maintain the tunnel power supplies in case of an LV supply failure local backup generators with auto-start may be required. These generators require a fuel supply within a bunded compound and this would need to be large enough to maintain the air cooling of the tunnel such that the EHV circuits may continue to operate. The emergency support supplies within the tunnel system would also need to be supplied in case personnel are within the tunnel when the incoming supply power fails. This fuel supply would need to be sufficient to last the generator through an emergency period and any bad weather period (snow) which could restrict access to the site by fuel delivery vehicles. These generators would need regular maintenance and test operation.

591) Security of the shaft head compound and building requires particular attention. It has been the experience of both transmission and distribution companies that unmanned buildings and compounds can attract vagrant, criminal and foolhardy activity from third parties. Apart from the dangers of the SEC with its open

terminal equipment the shaft head building contains a number of additional hazards including exposed EHV cables, very large shaft drops and electrical equipment. There is also the consideration of the transmission operator's staff having to respond to an intruder alarm at a remote shaft head location. An intrusion alarm in the small hours of the morning at a remote location with the prospect of intruders inside the tunnel itself is a matter of concern for personal safety which can only be addressed by sophisticated monitoring systems (CCTV) and a 24 hour availability response by an adequate number of trained staff.

592) Inside a cable tunnel, operatives come into close proximity to the power cables. The design of a tunnel cable layout would require the arrangement of the cables to be designed such that the EMF levels were not above acceptable norms. Due to the depth of the tunnels the exposure to the general public would be well below that found for direct buried cables.

593) Whilst it is considered that the placing of cables in an air filled tunnel does significantly reduce the risk of third party damage, the cables are dependant on the tunnel for this level of protection. Should a fire occur in the tunnel then there is a very high probability that both the 275kV and 400kV systems would be affected. The damage from a fire could result in a lengthy repair period to the cable systems, tunnel services, and possibly the tunnel and shaft structures. The introduction of XLPE cables has reduced, but not eliminated, the threat of serous fire spread, in conjunction with other fire precaution measures (inhibited auto-reclose, optical fibre fire detection, fire extinguishing systems, tunnel fire barriers and in specialised cases by installation in CBS etc,). Some work has been performed by manufacturers to improve the fire performance of XLPE cables themselves which includes the extrusion of a fire resistant coating over the cable sheath. However, once aflame XLPE can burn continuously and freely in air. Polyethylene is the base material for XLPE and has a calorific value[8] of 46,000kJ/kg which is similar to petrol which has a range[9] of between 44,800 to 46,900kJ/kg.

594) Risk assessments of the design will be required to determine if personnel should enter the tunnel when either circuit is in service. This is an important consideration as both circuits are in the same tunnel and whilst one is shut down for maintenance the other circuit may be switched out to avoid a risk of injury to personnel inside the tunnel should an electrical cable fault occur. The nature of the work being performed may also present a physical risk to a live circuit requiring both circuits to be switched out simultaneously. This situation may be avoided if the cables are directly buried.

595) Apart from any visual effects due to the shaft head house buildings and compound, when the cables are energised they give off heat which is removed from the tunnel by the tunnel ventilation fans. These fans would draw air from the tunnel and exhaust to the atmosphere. The maximum temperature of a cable tunnel is likely to be limited to be 50°C (to permit personnel entry). The humidity in the tunnel, under most conditions, would be expected to be above that of the atmosphere outside. After a period of heavy circuit loading during the winter months, hot warm air from the tunnel would meet cold air outside, which could give rise to a condensation plume at the tunnel-air exhaust.

[8] from Dow website, http://www.dow.com/perffoam/info/ehs/reduce.htm
[9] Kempes Year Book, 1983

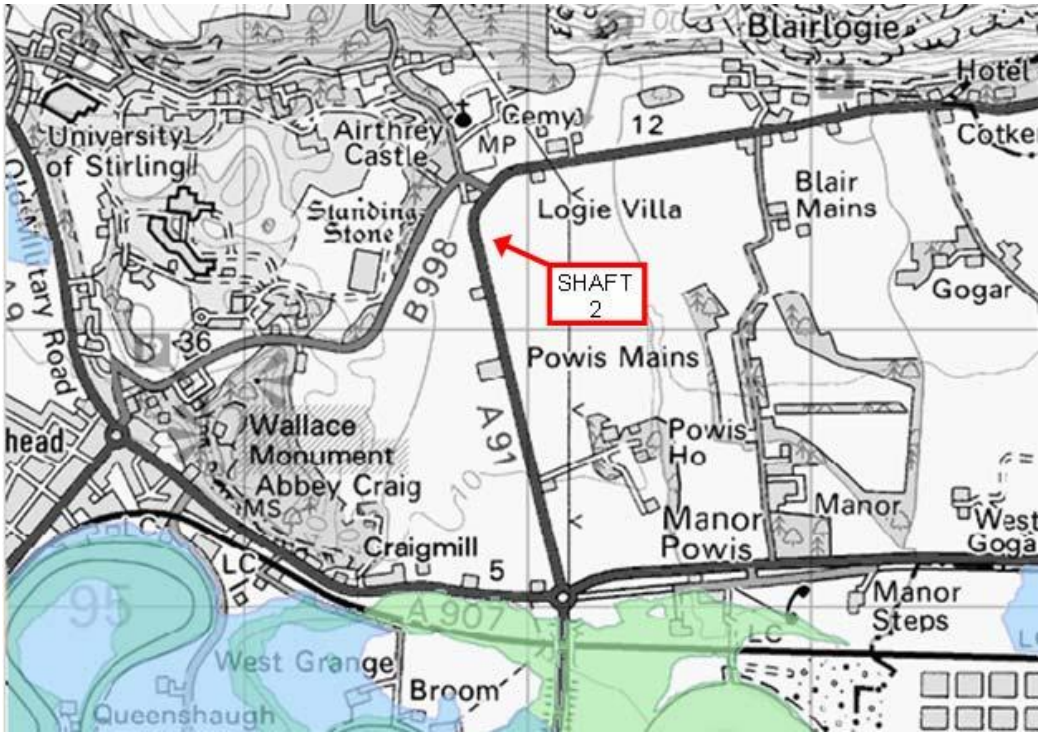
596) The construction of the tunnel should be completed prior to any cable installation works commencing. This is necessary as the cable installation activity requires access from the shaft to the point of work with men and materials moving along the tunnel. This will inhibit any other work in this area of the tunnel. From a cable manufacturing view point this has advantages as there is likely to be a delay in the delivery of materials as cable manufacturing plant becomes available. This perceived programming advantage would need to be offset against the critical programming path which would include the substantially complete installation of the tunnel and infrastructure followed by the installation of the power cable system.

4.1.3 UGC4 Tunnel Shaft 2: Logie Villa

597) This site would accommodate the shaft head-works of the lower shaft. No sealing ends would need to be accommodated at this point – the UGCs would arrive at the end of the tunnel, rise up the shaft, and continue their way in trenches towards Manor Powis.

598) As may be seen from Figure 4-6, SEPA identifies no flood risk in the vicinity of tunnel shaft 2. Nevertheless, this is flat land on the geological flood plain of the River Forth, and appropriate investigations regarding the controls of the river level should be made before designs of the head-works are finalised.

Figure 4-6: – Tunnel Shaft 2 Flood Risk Map



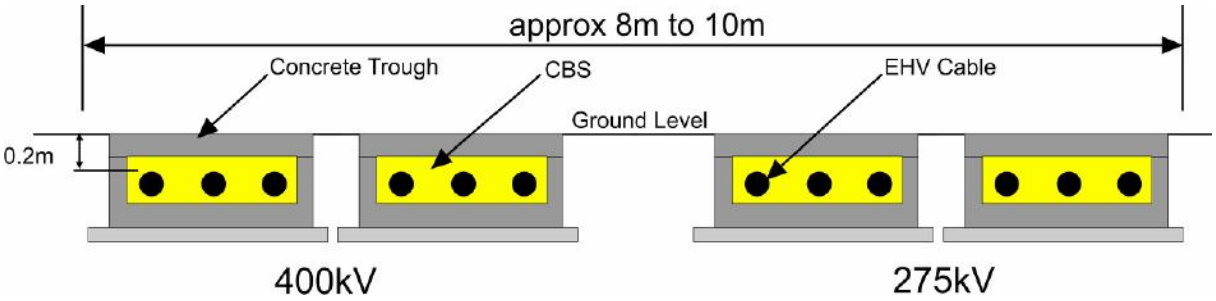
4.1.4 UGC4 E: UGC from Logie Villa to Manor Powis

599) When the cable leaves the shaft head house building at Logie it will probably be laid within surface troughs (Figure 4-7) in order to maintain the heat dissipation when the cable circuit groups are close together. It would be preferable that the

head house compound boundary fence is extended to the limit of all surface troughs and positions where the cables are at less than 1.0m deep to the buried protective cover tile to prevent damage by third parties. These troughs would also carry any fibre optic cables for communication and temperature sensing along with any earth continuity cables (a description and use of ECCs is given in APL 5/16).

600) It should be noted that this type of trough arrangement is not suitable for use on farm land and current practice is not to employ these troughs to contain EHV XLPE cable systems in areas with public access due to a risk of injury during a local fault.

Figure 4-7: – Cables Within Lidded Concrete Surface Troughs



601) The cable would be positioned to the east and alongside the A91. There is an access road to Powis House to be crossed at NN820954, the A907 and an abandoned road at the same location of NS821950. Access to the cable route and Manor Powis Shaft may be obtained from the A91. Access to the cable route south of the A907 may be obtained from the A907 and the disused road to its south.

602) Manor Powis SEC compound is located at NS822949 in the parcel of land bounded by the A907, A91, a railway line and Manorneuk Farm. An alternative position for the SEC would be on the south side of the River Forth at Lower Taylorton, this location is described in Case Study No.3 of APL 5/16.

4.1.5 UGC4 SEC 6: Manor Powis (including UGC4 E - OHL connection)

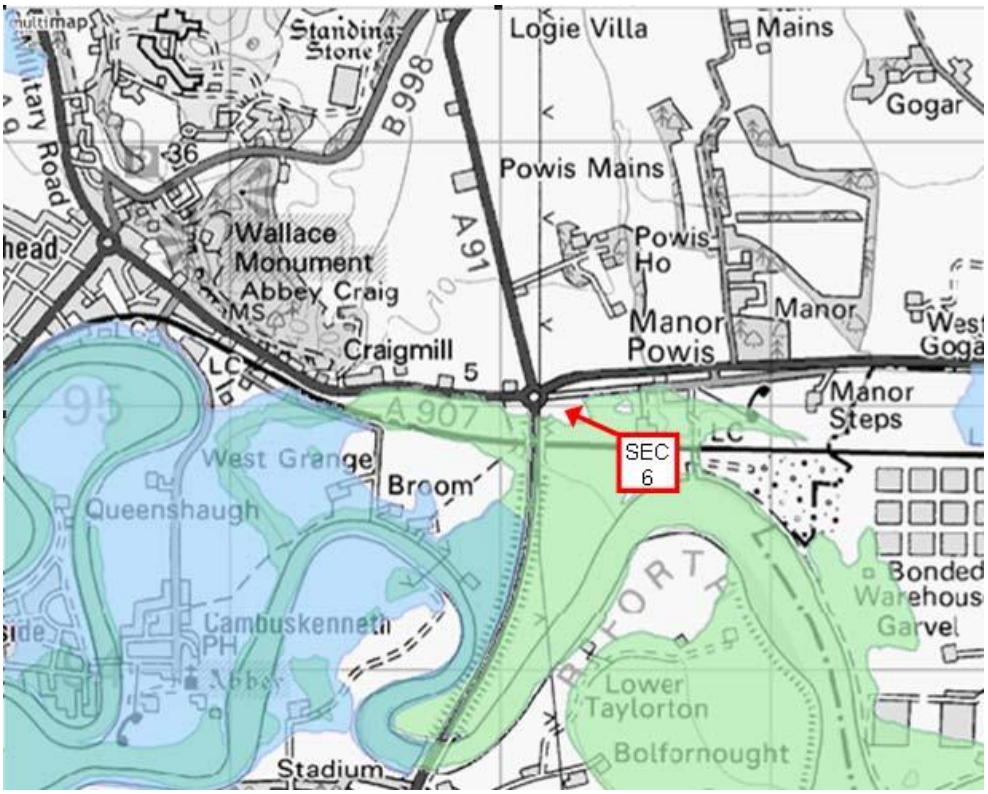
603) SEC 6 is at the southern end of UoS's undergrounding proposal, and would be located immediately to the SE of the A91 / A907 roundabout junction (NS822950).

604) This SEC would terminate around 4.3 km of UGC. Reactive compensation may well be required at this site but access for abnormal loads is readily available here.

605) As may be seen from Figure 4-8, SEPA identifies flood risk from both the river and the sea in the vicinity of SEC 6, although not precisely at the point selected for this equipment. Nevertheless, it is considered prudent that the floor of the site be raised as appropriate with rock and gravel to further reduce the risk of inundation.

606) SEC 6 would be connected to the Proposed OHL route by replacing tower TD207/1 with the SEC terminal tower some 150m to the west. This diversion of one span of the Proposed route would probably comprise around 310m of OHL.

Figure 4-8: – SEC 6 flood risk map



4.2 ENVIRONMENTAL COMMENTARY

4.2.1 Geology and Soils

4.2.1.1 UGC4 D

607) UGC4 D principally comprises a tunnel construction through the Ochil Hills. These hills are formed by ancient volcanic lavas laid down during Lower Old Red Sandstone times. These are mainly basic andesite and basaltic lavas that are harder, older and more weather resistant than the surrounding sedimentary deposits, and therefore stand today above the weaker and more highly eroded sedimentary deposits of the surrounding plains. There is little or no drift cover overlying the Ochil Hills as this has been eroded by the exposed nature of their hilly outcrop.

608) Although feasible, tunnelling through the hard crystalline basement that forms the Ochil Hills will pose a greater challenge than tunnelling through many other strata due to the hardness of the bedrock. The construction will also generate a significant volume of rock waste that will require disposal to an off-site landfill (although it may possible to re-use the rock spoil as a secondary aggregate this cannot be guaranteed at this stage). Overall, the construction of a tunnel under UGC4 D is not considered likely to have any significant adverse residual impact on the geology and soils of the area. From a geological perspective, the amount of bedrock removed will be a very small proportion of the total mass of similar bedrock that already exists in the area.

4.2.1.2 UGC4 E

609) UGC4 E principally comprises an underground cable swathe connected to the proposed tunnel construction UGC4 D to the north and sealing end compound (SEC) 6 at Manor Powis to the south. UGC4 E is located on late-glacial and post-glacial drift deposits of marine and estuarine alluvium that have accumulated within the ancient flood plain of the Forth Valley. The route underlies bedrock comprising interbedded cyclical sequences of sandstones, mudstones, limestones, coal deposits and seatrocks that form the northern limit of the Central Coalfield Syncline which was laid down within a basinal environment and deformed during Carboniferous times. The soils in the UGC4 E route area therefore form a well drained, firm and competent media for construction of cable swathes, sealing end compounds and river crossings.

610) There will be a significant adverse residual impact on soils arising from the undergrounding options UGC4 A2 and UGC4 A3 on account of the surplus soil arisings that will need to be disposed of due to the displacement of soils by the UGC infrastructure.

4.2.2 Hydrology

4.2.2.1 UGC4 D

611) The tunnel route developed within UGC4 D passes through the Ochil Hills. These hills are cut by a northwest to southeast trending fault system that is reflected in the network of burns that has exploited these lines of weakness in an otherwise hard and competent body of volcanic rock. These faults are post depositional and therefore cut through the mass of rock that forms the Ochil Hills.

612) An analysis of watercourse crossing points along the UGC4 D route, as shown in Appendix 4 Table 1 and Appendix 4 Figure 5, reveals two crossing points (D1-D2). The relevance of these in view of the proposed tunnelling solution within the UGC4 D corridor will depend on the hydrogeological connections that may exist between the streams at surface and the proposed tunnel position at depth.

613) If a tunnelling solution were to be progressed in this area it should be noted that a shallow groundwater table is likely to be present in the cable corridor due to the relatively high density of surface watercourses in the area. Whilst this groundwater system may not be particularly active in terms of groundwater flows, the levels are likely to be such that any tunnel would be excavated below the groundwater table. This in turn would necessitate sealing of the tunnel walls to impede the ingress of water into the tunnel itself and to maintain the structural integrity of the tunnel. Even once sealed, tunnel construction is likely to enhance rock permeability around the tunnel corridor, and therefore an increase in groundwater flow in this area is also likely. Increases in groundwater flow are also likely on account of the natural fault system that exists within the Ochil Hills as these would serve to transmit groundwater towards the tunnel, which must cross-cut this fault system. As no tunnel can be totally waterproof, active dewatering systems should therefore be considered to remove the groundwater likely to accumulate in the tunnel. The depth of the tunnel will need to be set so as to minimise the risk of leakage through the base of the overlying watercourses (and thereby minimise any loss of flow in these bodies).

614) The Cocksburn Reservoir, due west of SEC5 is located on a geological fault that extends to the southeast, towards the proposed tunnel route. Consideration will

need to be given to the potential impact on the reservoir due to an increase in the rock permeability beneath it that may be created by the tunnel construction.

615) Overall, the availability of water from rainfall in the area is considered sufficient to make up for any general loss of surface water that might result from tunnelling. The exception to this is the Cocksburn Reservoir which is a special case on account of its position on a geological fault and therefore should be subject to further investigation. At this stage it is therefore appropriate to consider there to be a significant residual hydrological impact arising from UGC4 D pending further hydrogeological investigation of the fault system beneath Cocksburn Reservoir.

4.2.2.2 UGC4 E

616) UGC4 E passes across the ancient flood plain of the River Forth between Tunnel Shaft No. 2 near Logie Villa in the north and SEC 6 near Manor Powis in the south. Here the soils comprise well drained marine and estuarine alluvium. As a result, groundwater plays an important role in draining the local area and, with the exception of the River Forth itself, there are no major watercourses and only a few small burns that are also oriented north-south. Rainfall infiltrates the ground, recharging groundwater which subsequently discharges as baseflow into the River Forth. Water quality in the River Forth in this area will therefore be closely linked to local groundwater conditions.

617) An analysis of watercourse crossing points along UGC4 E, as shown in Appendix 4 Table 1 and Appendix 4 Figure 5, reveals no crossing points. This is because the route is located on the interfluve between the Logie Burn to the west and the Powis Burn to the east. Both streams flow from north to south, parallel to UGCE4E. The A90 is oriented west-east near the southerly limit of UGC4 E. This will limit surface runoff in a southerly direction towards the River Forth, thereby providing a degree of protection from any washout of soils and/or accidental spillage of fuels within the UGC4 E works. As a result of these considerations there will be no significant adverse residual impact on hydrology arising from undergrounding of UGC4 E.

4.2.3 Forestry

4.2.3.1 Proposed Route

618) From the proposed Braco sub-station site, the proposed OHL route passes through some 3858m of forest and woodland, requiring the clearance of some 33.24ha, of which 0.14ha is designated ASNW 1a, 0.03ha as 2a, and 2.44ha as 2b.

619) The eastern alternative route has the following impact on forests and woodlands, after including woodland areas impacted by the proposed OHL, where the alternative routes do not differ from the proposed OHL:

Table 4-1 – Woodland - Comparison of Routes East of Stirling

Route	Length of route through woodland	Area to be cleared	SNH designated areas		
			Designation	Length through woodland	Area to be cleared
Proposed OHL	3858	33.24	1A/2A/2B	785	2.61
UGC4 - D/E (UoS)	3281	32.14	2A/2B	255	1.76

620) From Table 4-1 it can be seen that the UoS route reduces the impact on ASNW designated sites, by avoiding impact on the Yellowcraig Wood, whilst accepting the majority of the Proposed OHL route to the north and south of the Yellowcraig area.

621) Whilst potentially requiring the felling of designated ASNW woodland at Cocksburn Wood, the UoS route removes the major significant effect that the proposed OHL route has on the Ochils escarpment (Yellowcraig).

4.2.3.2 UGC4 D/E

622) From the proposed OHL route tower TD195, the UGC4 D-UGC Tunnel route passes southwards as OHL, to SEC5, at Cocksburn Wood.

623) Here, the proposed tunnel shaft affects some 105m, and 0.59ha designated as ASNW 2b, that will require to be felled.

624) The tunnel then passes under open hill ground, and the woodland complex at Yellowcraig to Logie Villa (the Proposed OHL affected woodlands 094, 095 and 096, 795m and 2.48ha, 2.43ha of which are designated ASNW 1a, (0.56ha), and 2b (1.87ha)).

625) From Tunnel shaft 2 at Logie Villa, the alternative Cable route follows to the east of the A91 parallel and to the west of the proposed OHL, passing through the trees on the Powis House drive, where 0.05ha of mature broadleaves will need to be felled.

4.2.4 Ecology and Nature Conservation

626) At a strategic level of detail, there are no statutory designated nature conservation constraints directly affected by the route of the alternative proposals put forward in this area (covering the relevant search areas and the specific route within it).

627) There are local wildlife sites, ancient woodland sites and areas which were assigned additional value (important habitat, bird and mammal areas) as part of the evaluation for the proposed overhead line project present (see ES for further details). In terms of local wildlife sites, Cocksburn Reservoir and Manor Powis Bing Scottish Wildlife Trust sites are within the search area but can probably be avoided. Cocksburn Wood would be the likely location for a shaft and this area is

listed in the ancient woodland inventory. In addition, investigation would require to be undertaken into the effect such construction and operation may have on birds using the nearby River Forth and designated areas (Forth SPA and Ramsar) as well as surrounding land for foraging, particularly related to geese. It is unknown at present whether such effects on birds could be significant. However, as the majority of flight activity by species associated with the Firth of Forth SPA and Ramsar Site are concentrated at the River Forth and, in relation to geese, in the carse areas to the south of the river, it is considered unlikely that potential collision and displacement impacts on birds would differ markedly from the proposed OHL route.

628) At this strategic stage of the undergrounding study, it is not possible to be more specific about the ecological impacts likely and their relative significance. However, the results of this desk study do indicate that ecological impacts for the east of Stirling alternative (particularly on ancient woodland) would be likely to be less overall than those to the west of Stirling.

4.2.5 Landscape Character

629) The ES has not identified any adverse effects on landscape character as a result of the proposed 400kV overhead line in the area of the proposed alternative between Cocksburn Wood and Manor Powis.

4.2.5.1 UGC4 - SEC 5 + Tunnel Shaft (Cocksburn Wood)

630) The presence of a sealing end compound and tunnel shaft in the Cocksburn Wood area would lie within the Ochil Hills AGLV and can be expected to result in significant (at least moderate) adverse effects on the landscape character of this area. The minor diversion of a section of OHL would not result in any significant adverse effects on landscape character.

631) Effects on the landscape character of this area as a result of the presence of this SEC would be on a landscape of moderate sensitivity and of medium magnitude and would give rise to moderate adverse effects.

4.2.5.2 UGC4 D Underground Cable Tunnel

632) The presence of the tunnel is not of itself expected to give rise to any adverse effects on landscape character.

4.2.5.3 UGC4 E Underground Cable

633) The underground cable located on the eastern side of the A91, within generally open agricultural land, would not give rise to significant adverse effects on the landscape character of this area, other than short term effects during construction. Effects would be on a landscape of low sensitivity and of medium magnitude and would result in minor adverse effects.

4.2.5.4 UGC4 - SEC 6 Manor Powis

634) The proposed sealing end compound, UGC4 SEC6, would be located in generally flat agricultural land close to the junction of the A91 and A907. It is noted that there would be a requirement to build up the levels beneath this SEC in order to reduce the risk of flooding and this would potentially result in an increased adverse effect on the landscape character of this area. The presence of the SEC would not

be uncharacteristic within this general landscape, though screen planting would be required in order to mitigate adverse effects.

635) Effects on the landscape character of this area as a result of the presence of this SEC would be on a landscape of low sensitivity and of medium magnitude and would result in minor adverse effects.

636) An additional section of OHL would be required to connect back to the proposed 400kV OHL and this would include a moderately light angle tower, close to the northern bank of the River Forth.

4.2.6 Visual Amenity

637) The ES has identified some major and moderate adverse effects on visual amenity in the area between Cocksburn Wood and Manor Powis, mainly relating to effects on properties in this area, from the presence of the proposed 400kV overhead line.

4.2.6.1 UGC4 - SEC 5 + Tunnel Shaft (Cocksburn Wood)

638) The presence of the proposed sealing end compound UGC4 SEC5 and tunnel shaft in the Cocksburn Wood area, would give rise to adverse effects on the visual amenity of road users on the minor road through the Sheriffmuir area. Effects would be on receptors of high sensitivity and of medium magnitude and would result in moderate adverse effects on visual amenity. Some mitigation would be possible in the form of screen planting and this would, once established, reduce effects to minor adverse.

639) There are some paths in this area and effects on the visual amenity of users of these paths, in areas where there would be views of the SEC and tunnel shaft, would be on receptors of high sensitivity and of medium magnitude, in areas where there are unobstructed views of the SEC. Effects would be moderate adverse, in these instances.

4.2.6.2 UGC4 D Underground Cable Tunnel

640) The presence of the tunnel is not expected to give rise to adverse visual impacts on receptors in this area.

4.2.6.3 UGC4 E Underground Cable

641) The underground cable, located on the eastern side of the A91, would give rise to adverse effects on visual amenity, during construction. Effects on residential properties such as Powis Mains and those in the Powis House area would be on receptors of high sensitivity and of medium magnitude and would result in short term, moderate adverse effects. Effects on users of the A91 would be on receptors of moderate sensitivity and of medium magnitude and would result in short term, moderate adverse effects. Effects would reduce to minor adverse / negligible on the successful reinstatement of the groundcover vegetation.

4.2.6.4 UGC4 - SEC 6 Manor Powis

642) The proposed sealing end compound, UGC4 SEC6, would be located in generally flat agricultural land close to the junction of the A91 and A907. It is noted that there would be a requirement to build up the levels beneath this SEC in order to reduce the risk of flooding and this would potentially increase the visibility of this

site within the wider area. In addition, a new section of OHL and angle tower would be required in the area to the west and southwest of Manorneuk.

643) Effects on the visual amenity of the properties in the immediate vicinity of the SEC site would be on receptors of high sensitivity and of medium magnitude and would result in moderate adverse effects. These could be reduced to minor with the establishment of screen planting. The new terminal tower and angle tower would be visible from the property at Manorneuk and this would maintain the major adverse effect on visual amenity identified for this property within ES Chapter 24, at para. 24.5.5.16.

644) Effects on the visual amenity of road users and paths in the area of this SEC would be on receptors of moderate sensitivity and of medium magnitude and would result in moderate adverse effects. These could be reduced to minor with the establishment of screen planting. Similar adverse effects would be anticipated for users of the mineral railway line, which is undergoing reconstruction at the present time.

4.2.7 Cultural Heritage

4.2.7.1 Results of the Assessment of the Effects of the Proposals – UGC4 D & E

645) The ES established that the OHL proposals would result in no significant adverse potential direct effects, one potential minor adverse effect and one of unknown significance. However, the nature of the development proposal is such that direct effects on most of the known sites potentially affected can be avoided through demarcation or, where the sites are linear features, mitigation can be achieved through re-instatement of the feature. With this mitigation programme of demarcation/avoidance and re-instatement, the number of residual direct effects reduces to none. The direct impact of the OHL proposals on known sites in this area is thus minimal. Three areas of archaeological sensitivity were also identified in the ES in this section of the route – at Pendreich (No. 23), Cocksburn Reservoir (No. 24) and Forth to Logie Villa (No. 25). The significance of effect on any as-yet-unidentified archaeology cannot, at present, be established. In addition, the ES identified 13 significant (moderate) adverse potential setting effects of the OHL (i.e. those parts of the route that would be replaced by UGC4 B). With mitigation the ES states that this would reduce to 9 significant (moderate) effects though this should be revised upwards to 11.

4.2.7.2 Outline Assessment of the Effects of the UGC Proposals – UGC4 D

646) The UGC4 D route falls outwith both the DBA and field survey corridors established for the EIA in the central section.

647) Working on the assumption that the tunnel will be constructed at considerable depth beneath the surface, there will be no direct impacts on known cultural heritage sites or potential direct impacts on unknown remains, with the possible exception of the locations where the tunnel starts and finishes.

648) A tunnel will similarly have no impacts on the setting of cultural heritage sites, with the possible exception of the locations where the tunnel starts and finishes and SEC 5, which may impact on the setting of the three SAMs at Pendreich.

4.2.7.3 Outline Assessment of the Effects of the UGC Proposals – UGC4 E

649) All of the UGC4 E route falls within the DBA corridor established for the EIA and partly within the field survey corridor. A rapid assessment was undertaken of known sites in the areas of the UGC4 E.

650) Neither UGC4 E nor SEC 6 will impact directly on any known sites.

651) UGC4 E and SEC 6 are within the sensitive area Forth to Logie Villa (No. 25) identified in the ES. While the significance of impacts on as-yet-unidentified remains is yet to be established, it is probable that the UGC will have a much greater effect on such remains than the Proposed OHL. The risk of direct impacts on as-yet-unidentified remains is far higher for the UGC.

652) A precise assessment of the setting effects of the UGC4 E proposals would require further work, but in general terms, one would anticipate the setting impacts of an underground line, overall, to be far less than those associated with an OHL. Nevertheless, significant setting effects are likely to accrue from the UGC route, though these effects would be greatest in the construction phase and immediately thereafter, reducing with time as vegetation re-establishes itself etc. The UGC4 E route passes close to 8 Listed B category buildings and one HGDL, while SEC 6 may be visible from 3 Listed B category buildings and the HGDL. There is, therefore, a chance that SEC 6 will have significant setting effects and that the UGC could have significant setting effects, at least during construction, on some of these features.

4.3 COST APPRAISAL

653) One undergrounding option is costed here:

- Option 4: UoS - UGC Cocksburn Wood to Manor Powis

654) The same approach is taken as in the earlier reports, that is, appropriate unit costs are identified from the case study work reported in APL 5/16, and these unit costs are then applied to the circuit lengths appraised in this present study. The estimated costs of undergrounding are then compared with the estimated costs of the original Proposed OHL over the equivalent part of the route.

4.3.1 Unit Costs

655) It should be noted that the APL 5/16 Case Study costings assumed that access roads from the highway to an SEC site would not be greater than 100m. This assumption does not really apply to **SEC 5** (Cocksburn Wood) since, although it is near to a road, this route is so steep and narrow (at least to the south) that the only practical access for heavy loads is likely to be via a long and circuitous route from the north via Dunblane. This northern route would be likely to require considerable work to improve camber and gradients, and to strengthen the roadway. A full cost assessment of this work is beyond the scope of this present report.

656) Since this appraisal considers a tunnelled solution, the unit costs for the SECs are taken from the tunnelling assessment in the previous undergrounding report, APL/PTH-41, which were, in fact sourced by APL 5/16 Case Study 2.

657) As with earlier reports to the Public Inquiry, over-ground works, including SECs, are generally accorded a 10% contingency. **Cables and trench work** are accorded a 15% contingency at this stage of the investigation, to cover the

additional risks / unknowns associated with the geology and the transmission cable market.

658) For the **tunnelling** unit costs, no APL 5/16 Case Study is relevant, so estimates have been made using other recent tunnelling experiences of PB Power. In particular, the 400kV double circuit tunnel to supply the Olympic Village in London, provides useful and current cost guides.

659) Cost rates on this Cocksburn Wood to Logie Villa route would, however, vary significantly from the London project due to the differences in geology of the areas in question. PB Power tunnelling specialists consider that, given the uncertainties prior to any ground condition survey or feasibility study bore-holing, and given also what is already known in general about the geology of the two areas (particularly regarding the hardness of rock) they would expect a premium with a range of between 200% and 300% would apply to the contractor's price for this work.

660) Less well documented, but worthy of note nonetheless to all those seeking to benefit from a tunnel, is that tunnelling projects often seem to outturn in the region of 30% over budget, reflecting the enormous levels of uncertainty about subterranean conditions even with the benefit of geological surveys. This appraisal adopts the 200% premium for geological conditions, and applies a 30% contingency to the tunnelling part of the costs. A 15% contingency is applied to the cable work as before, and 10% contingency is applied to the mechanical and electrical works for the tunnel. Worked in together this amounts to a 24% overall contingency for the tunnelled part of the route, as indicated in Table 4-2 below. See Appendix 2 for further details of this.

661) To provide an upper estimate for the costs of tunnelling, however, the same calculations have been repeated with the 300% premium for geological conditions. Though not shown in a separate table here, this premium would raise the total tunnelled cost for UGC from £21.9m per km (see Table 4-2) to £28.7m per km.

662) The section of the Proposed **OHL** route that would be replaced by this UoS proposal is 0.75 km shorter than that examined in APL 5/16 Case Study 4. The cost estimates for the short sections of OHL that would connect SEC 5 and SEC 6 to the rest of the Proposed OHL route would be more appropriately represented by unit costs from Case Study 5.

4.3.2 Cost Appraisal – UoS: Cocksburn Wood to Manor Powis

663) This proposal by SNH effectively would replace a 5.3 km section of the Proposed OHL route between the proposed new substation at Braco and Denny Substation. A 0.6 km OHL diversion from the Proposed OHL route tower TD 197 would connect SEC 5 at Cocksburn Wood, and a further 0.3 km of diverted OHL would connect SEC 6 back to the Proposed OHL route at TD 208. SEC 5 and SEC 6 would then be connected together with a 3.9 km section of UGC, of which about 2.6km would be tunnelled and a further 1.4 km would be trenched. This option may be seen in outline in Figure 1-3, and in detail on both the aerial photographs of Appendix 5 and on the OS maps of Appendix 6.

664) It can be seen from Table 4-3 that whilst the Proposed OHL route would be expected to cost £6.6m, this alternative is estimated to cost £94m, or an additional £87.4m. The Proposed and alternative route lengths are both in the region of 5 km.

665) During this early stage of consideration of a tunnelling project, the cost uncertainties are very high, so costs may be considerably higher than estimated above. If the costs of the tunnelling were to correspond to the upper unit cost estimate described in the Perth & Kinross Report (APL/PTH-41) - which is quite likely in this case given the depth of the shaft at Cocksburn Wood and the relatively short length of tunnel compared to that considered in the Perth & Kinross undergrounding report - then this alternative cost estimate rises to £116.7m, or an additional £110.1m.

666) To put this estimate in the context of the APL 5/16 Case Study 4 cost estimates, if the route of this present study were to be extended south to the Case Study 4 SEC at Lower Taylorton (an extra 0.75km), then the normal and upper cost estimates for the tunnelled option become £103.7m & £126.6m respectively. The Case Study 4 route length between Cocksburn Wood and Lower Taylorton was 7.3 km and replaced 4.8 km of OHL. The cost estimate for Case Study 4 was £98.8m.

Table 4-2 – Unit Costs – Tunnelling Option

Stirling Area Undergrounding Costing Study - Unit Costs

Item	Unit Cost	Source
b. Tunnelling Estimate - Applied to Cocksburn Wood - Logie Villa tunnel section:-		
1. OHL unit cost per km:-		
Total OHL cost per km (£k/km):	1,246	APL 5/16 Case Study 4, p103, Table 5-21
less 10% contingency (of £113k / km)	113	
OHL unit cost per km before contingency (£k/km) =	1,133	= Stirling Source Ref 4
Contingency Rate =	10%	
2. End costs for tunnelled cable (not inc. tunnel shaft headworks):-		(Sources as for Tummel - Appin of Dull estimate:)
Total cable-end for section (£k)	5,173	APL 5/16 Case Study 2, p85 Table 5-12(A)
plus Maintenance (£k)	227	APL 5/16 Case Study 2, p85 Table 5-12(B)
SEC Unit cost per pair (£k) =	5,399	= Stirling Source Ref 5
Contingency Rate =	10%	
3. UGC unit cost per km (trenched section):-		(Source as for Case Study 5 - West of Stirling, previous table)
UGC unit cost per km before contingency (£k/km) =	11,429	= Stirling Source Ref 6
Contingency Rate =	15%	
4. Tunnelled UGC unit cost per km:-		(Sources as for Tummel - Appin of Dull estimate:)
Cables supply and install - no civils (£k per km)	5,202	APL 5/16 Case Study 2, p85, Table 5-12(Aii), lines 1-4
Tunnel, 4m dia., -inc. vent & end shafts & headworks (£k per km)	13,720	PB Power budget estimates
Mechanical and Electical Installations (M&E)	2,940	
Total tunnelled UGC unit cost per km before contingency (£k/km) =	21,862	= Source Ref 7
Overall Contingency Rate =	24%	No geological investigations to date

Table 4-3 – UGC4 Option 4 – UoS: Cocksburn Wood to Manor Powis

UGC4 Option 4 - UoS: UGC Cocksburn Wood to Manor Powis: SEC 5 (Cocksburn Wood) to SEC 6 (Manor Powis)

Proposed OHL being displaced	**Item**	**Units**	**Quantities**	**Lifetime Unit cost (£k)**	**Source Ref**	**Contingency Rate (%)**	**Cost incl. Contingency (£k)**
Cocksburn Wood (tower TD197) - Manor Powis (tower TD208)	OHL	km	5.32	1,133	=StSR4	10%	6,629
UGC Option - UGC costs are for direct-buried / tunnelled cable							
Unit cost source:	Estimate for Tunnel						
Additional OHL required to connect to north and south SECs	OHL	km	0.941	858	=StSR1	10%	888
UGC4 Option 4 - UoS: UGC Cocksburn Wood to Manor Powis: cable between SEC 5 an	UGC	km	1.354	11,429	=StSR6	15%	17,796
North and South SECs	SEC	pair	1	5,399	=StSR5	10%	5,939
Cost of tunnelled UGC section	Tunnel	km	2.56	21,862	=StSR7	24%	69,399

NB:
1. SEC costs include lifetime maintenance cost estimates
2. Cable costs include wayleaves and 40 year replacement cost estimates. Tunnel costs also included, where appropriate.
3. Costs for ducted cable are estimated to lie within 1% of that for direct-buried, and so are not shown separately.

Summary - UGC4 Option 4 - UoS: UGC Cocksburn Wood to Manor Powis	**Item**	**km**	**£k**
Totals for the proposed OHL	OHL	5.3	6,629

OHL totals for the UGC option	OHL	0.9	888
UGC totals for the UGC option, including extra cost of tunnel	UGC +SEC	3.9	93,135
Whole route totals for the UGC option	All	4.9	94,022

Comparisons between the undergrounding and OHL options:	**km**	**£k**
Differences: UGC Option less proposed OHL	-0.5	87,393
Route length increase of UGC over proposed OHL (%)	-8.7%	
Cost Factor: UGC over OHL (times)		14.2 times

4.4 CONCLUSIONS ON EAST OF STIRLING APPRAISAL

4.4.1 Technical

667) This report considered only one underground cable routeing to the East of Stirling. This was submitted by the University of Stirling. The University had marked on their drawing the section of line to be placed underground.

668) Whilst this undergrounding requirement could be met by either the SNH or SBP proposals to the west of Stirling, or by the Forth case study in APL 5/16 it was decided to perform a separate exercise which would underground only the section of line as marked by the UoS. To overcome the physical barrier of the Ochil Hills a forced ventilated cable tunnel has been considered.

669) The use of a tunnel has been shown to have a number of benefits including a means of overcoming the obstacle presented by the Ochil Hills and as protection from third party damage. However this protection would only extend to that part of the route which is in the tunnel which is only a small part of the Beauly to Denny line as a whole. With regard to the other advantages described, these are only beneficial in dense urban environments where space below ground is difficult to obtain and third party excavations are more numerous.

670) Following any decision to install a cable tunnel a tunnel design study would be required in order to ascertain the exact ground conditions, type of tunnel design and construction method that could be employed. In addition a cable heat transfer study and a tunnel air flow model would be required in order to confirm that the cable ratings may be met and to identify the air flow and ventilation requirements. A study would also be required to consider the safety of personnel working within and around the tunnel both during and after construction.

671) The technical conclusion is not to recommend a cable tunnel for the route and application shown. It has already been demonstrated (case study 4 in APL 5/16) that an alternative direct buried cable route would be possible. This latter route would be expected to provide the benefit of requiring substantially less maintenance than a tunnel.

672) The cable manufacturing lengths for the route (approximately 4km) are not exceptional and longer length installations in tunnels are in service around the world.

4.4.2 Environmental

4.4.2.1 Geology and Soils

673) Overall, the construction of a tunnel under UGC4 D is not considered likely to have any significant adverse residual impact on the geology and soils of the area. From a geological perspective, the amount of bedrock removed will be a very small proportion of the total mass of similar bedrock that already exists in the area.

674) There is, however, a significant adverse residual impact on soils arising from the undergrounding UGC4 E, which does not exist for the current 400kV OHL proposal. This is on account of the surplus soil arisings that will need to be disposed of due to the displacement of soils by the UGC infrastructure, whereas OHL works do not carry with them this requirement. The removal of such soils

from the UGC works area also impacts soil function, principally in terms of drainage but also in terms of soil resources in the UGC corridor.

4.4.2.2 Hydrology

675) Overall, the availability of water from rainfall in the area is considered sufficient to make up for any general loss of surface water that might result from tunnelling. The exception to this is the Cocksburn Reservoir which is a special case on account of its position on a geological fault and therefore should be subject to further investigation. At this stage it is therefore appropriate to consider there to be a significant residual hydrological impact arising from UGC4 D pending further hydrogeological investigation of the fault system beneath Cockburn Reservoir.

676) An analysis of watercourse crossing points along UGC4 E, as shown in Appendix 4 Table 1 and Appendix 4 Figure 5, reveals no crossing points. As a result of these considerations there will be no significant adverse residual impact on hydrology arising from undergrounding of UGC4 E.

4.4.2.3 Forestry

677) The proposed OHL route passes through some 3858m of forest and woodland, requiring the clearance of some 33.24ha, of which 0.14ha is designated ASNW 1a, 0.03ha as 2a, and 2.44ha as 2b.

678) Whilst potentially requiring the felling of designated ASNW woodland at Cocksburn Wood, the UoS route removes the major significant effect that the proposed OHL route has on the Ochils escarpment (Yellowcraig).

679) In comparison to the proposed OHL route, the UoS route reduces the impact on ASNW designated sites, by avoiding impact on the Yellowcraig Wood, whilst accepting the majority of the Proposed OHL route to the north and south of the Yellowcraig area.

680) The eastern alternative route would reduce the clearance of ASNW designated woodland, from 2.6 hectares to 1.7 hectares.

4.4.2.4 Ecology and Nature Conservation

681) At a strategic level there are no international, European or nationally important ecological sites within the search area that are likely to be directly affected by this alternative, although indirectly effects on designated bird sites cannot be ruled out at this stage. There are additional local to national level ecological resources present within the search area which could be impacted. However, although the precise detail of these effects is unknown at present, it can also be stated that any such ecological impacts from the east of Stirling alternative are unlikely to be significantly greater overall than the level of impact associated with the proposed overhead line to the east of Stirling; they may be less, given the smaller areas of ancient woodland impacted. Further, any such impacts from the alternative to the east of Stirling are likely to be less than those alternatives proposed to the west of Stirling.

4.4.2.5 Landscape

682) Effects on landscape character from the presence of the sealing end compound and tunnel shaft, in the Cocksburn Wood area, would result in moderate adverse

effects. There would be adverse effects on the Ochil Hills AGLV in this area. These would be greater effects than those identified within the ES, for the proposed 400kV overhead line. Other effects would be short term and temporary effects, mitigated through successful reinstatement or the provision of screen planting.

4.4.2.6 Visual Amenity

683) Effects on visual amenity as a result of this alternative route would be an improvement over those of the proposed 400kV overhead line. Moderate adverse visual effects would result from the presence of the southern SEC and the angle tower, for properties and users of roads and paths in this area. As above, mitigation would in due course reduce these effects to minor adverse.

4.4.2.7 Cultural Heritage

684) The tunnelled route UGC4 D would virtually remove the potential for both indirect and direct impacts, on known or as-yet-undiscovered remains, working on the assumption that the tunnel will be constructed at considerable depth beneath the surface. It is therefore preferable to the Proposed OHL in cultural heritage terms.

685) The underground route UGC4 E would create a higher potential for direct impacts than an overhead line on as-yet-undiscovered cultural heritage sites, particularly as UGC4 E is deemed sensitive to unknown remains. However it is likely that there would be a significant reduction in the level of indirect adverse effects on cultural heritage sites, at least following the construction period. The OHL option would generally be preferable to UGC4 E on cultural heritage grounds because it is likely to generate fewer direct (i.e. irreversible) effects, though much depends on the levels of archaeology present in the area of sensitivity. A full assessment of the latter would be required before a final judgement could be made.

4.4.3 Costs

686) The East of Stirling undergrounding alternatives comprise 1 option. The cost estimates for this option are as follows:

- UGC4 – UoS: The Proposed OHL route length being assessed is 5.3 km, whilst the undergrounding alternative would be 4.9 km, of which 3.9 km would be UGC and 0.9 km OHL. The cost of the Proposed OHL is estimated to be £6.6m. The cost of the alternative undergrounding proposal is estimated to be £94m, an additional £87.4m over and above the OHL solution.
- If the upper unit cost for tunnelling is used (in order to have a greater confidence at this early stage of covering the costs of tunnelling in unknown rock) this alternative cost estimate rises to £116.7m, or an additional £110.1m. The band of reasonable cost estimates for the tunnelling is thus wide.

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CHAPTER 5: ABBREVIATIONS AND ACRONYMS

AC	Alternating current
AGLV	Area of Great Landscape Value
AOD	Above Ordnance Datum
bgl	Below ground level
CBS	Cement bound sand (14:1 sand to cement mix by volume)
Circuit	A circuit connects two parts of the power transmission network. A very high voltage AC power circuit almost always comprises three AC phases – either above ground (in the case of an overhead line) or below ground (in the case of an underground cable). The UK transmission system normally incorporates two circuits on each route, to provide continuity of supply should one circuit become faulty.
CNPA	Cairngorms National Park Authority
DTI	Department of Trade and Industry
DTS	Distributed temperature sensing system. This is used to measure temperatures along a length of fibre optic cable attached to a power cable
EIA	Environmental Impact Assessment
ES	Environmental Statement for the Proposed OHL
HGDL	Historic Garden and Designed Landscape
kV	Kilovolt – 1000 Volts
LoD	'Limits of Deviation' – the limits of deviation of tower positions from a proposed centre-line
MVA	mega volt ampere
MVAr	mega volt ampere reactive
NGET	National Grid Electricity Transmission Company
OHL	overhead line
OS	Ordnance Survey (maps)
PI	Public Inquiry

pu	per unit (alternative to expressing percentage)
SAC	Special Area of Conservation
SAM	Scheduled Ancient Monument
SBP	Stirling Before Pylons
SC	Stirling Council
SEC	Sealing End Compound
SHETL	Scottish Hydro Electric Transmission Ltd
SNH	Scottish National Heritage
SPA	Special Protection Area
SPT	SP Transmission Ltd
SSSI	Site of Special Scientific Interest
THC	The Highland Council
TOV	Temporary overvoltage
UGC	Underground cable
UoS	University of Stirling
XLPE	Cross-linked polyethylene

APPENDIX 1 SUMMARY BRIEFING NOTE

1 PROPOSALS RECEIVED

Route proposal information for the area Cambushinnie to Denny (West of Stirling Route) and Bridge of Allan were received from the following:

- Scottish Natural Heritage (West of Stirling Route)
- Stirling Before Pylons (West of Stirling Route)
- University of Stirling (Bridge of Allan)

2 INTERPRETATION

The information received was interpreted as follows:

Scottish Natural Heritage provided three route drawings titled “Beauly – Denny Transmission Line West Stirling Alternative Route Map 1 (North) and Map2 (South) SNH Revised Alternative 18 June 2007” (Figures 1 and 2) and Map 3 SNH Other Alternative Routes South of A811 (Figure 3) also of 18 June 2007.

Stirling Before Pylons in a letter of 22 January 2007 do not identify a route to the west of Stirling but suggested following the existing oil and gas pipeline corridor shown in the Consultation Document. They also suggest investigating a route following the M9.

Stirling University propose undergrounding the proposed route at Bridge of Allan. These proposals were broken down into three search areas in two sections (Figure 4) as: follows

UGC4 – A1 : West of Stirling Route Overhead line from Cambushinnie to south of Crofts of Cromlix, underground cable to south of Cambusbarron and then overhead line to Denny as proposed by Scottish Natural Heritage

UGC4 A2 – West of Stirling Route alternative South of A811, underground cable from south off Cambusbarron to Denny as proposed by Scottish Natural Heritage.

UGC4 – B : Bridge of Allan Route as proposed by the University of Stirling.

3 CASE STUDIES

The document “The Use of Underground Cable as an Alternative to Overhead Line in Specific Locations”, Case Study 4: Lower Taylorton to Cocksburn Wood examined alternatives in the University of Stirling area and that Case Study 5: Glenburn to Touch Road examined part of the route proposed by SNH.

It should be noted that Stirling Before Pylons do not support an underground cable route down the Ochils escarpment as proposed by the University of Stirling.

4 Terminology

To avoid confusion with the terminology used in the overhead line routeing documents, care has been taken to use different terminology, nomenclature and numbering.

TERMINOLOGY	NOMENCLATURE AND NUMBERING	COMMENT
Search Area	UGC1 to UGC4	UGC1 – Beauly to Eskadale UGC2 – Garva Bridge to south of Dalwhinnie UGC3 – Tummel Bridge to South of Muthill UGC4 – Braco to Denny
Search Area Sections	A1, A2, and B etc	

5 UNDERGROUNDING TEAM

Simon Lloyd (CCI) – Technical – Underground cables, including their capital costs
Mark Turnbull (MTLA) – Environmental
Mark Winfield (PB Power) – Technical – OHL and SECs, overall costing and editorial

6 UNDERGROUNDING TEAM SUPPORT (AS REQUIRED)

Beverly Walker (Enviros) - Construction and Heat Effects
Ian Dickson (SAC) - Construction and Heat Effects

7 EIA TEAM

Gillian Beauchamp (Wardell Armstrong) – Landscape and Visual
Andy Mackenzie (MBEC) - Ecology
Alan Leslie (GUARD) - Archaeology
Norman O'Neill (RTS) - Forestry
Duncan Russell (WSP) - Hydrology, Soils, Geology and Traffic
Annie Say (Natural Capital) - Access Track Methodology and general EIA consistency check
Bill Jack (SHETL) - Access Track Methodology
Ian Ross (Fairhurst) - Construction Traffic
David Keddie (RTP) - Tourism and Recreation

APPENDIX 2 ISSUES RAISED BY STUDY

There were no fundamentally new issues raised by this study.

APPENDIX 3 CABLE ROUTE CROSSINGS AND LOCATIONS

This appendix contains tables detailing the various crossings, their location and the methods that may be employed to cross each obstacle.

Table A3- 1 contains the various options for the cable system to cross an obstruction to the route where open cut direct burial is not available.

Table A3- 2 contains the options available for haul road planning at locations where a haul road may not be laid directly onto the existing ground.

Table A3- 1 – Cable System Crossings

Label	Method of Cable System Crossing
B1	Bridge 1. An existing bridge is used to carry the cables across the obstruction. The cables will be installed in the deck of the bridge within a cavity of the bridge.
B2	Bridge 2. The power cables are installed on a purpose built bridge to carry cable only. Following construction there will be no public access to the bridge and security measures will be taken to prevent this.
B3	Bridge 3. A bridge is constructed over the obstruction upon which the cable is placed. This bridge is required to carry the haul road traffic.
C	Cooled crossing. This is a water cooled pipe system where water cooling or heat sharing is used to remove heat from cables installed too deep, close or in poor heat transfer environments such that they need alternative cooling methods.
D	Drill. Directional drilling in bentonite filled ducts. A thick wall self supporting duct is installed beneath the obstruction using a guided drill. The cables are then installed within the duct and subsequently filled with a bentonite mixture. The bentonite fill is used to provide improved thermal heat transfer properties and thermomechanical rigidity for the cables.
E	Encasement. A ducted encasement installed beneath a road, track, footpath or small water course. For a road crossing, the road would either be temporarily closed (with traffic diversions) whilst the ducts are installed or lane(s) closed with traffic control whilst the ducts are installed..
I	Infill and/or earthworks on obstruction to allow cable to cross using direct buried methods.
P	Pumped crossing: Used on small water courses, typically drains where the water channel is blocked and water is pumped across while ducts are installed beneath the bed of the water course by open cut methods.
S	Surface trough. A surface trough is used to cross an obstruction or width restriction where the cables cannot be buried at normal depth. This is normally employed within substations or protected compounds when installing EHV XLPE cables.
T1	Forces ventilated tunnel. Generally a long deep tunnel with forced cooling installed. Normally air cooled by the use of fans.
T2	Naturally ventilated tunnel. Natural ventilation and air drafts are created through the tunnel by the construction of chimney(s) at shaft positions. These are generally

	used over short distances and the cables are installed within the tunnel, in air.
W	Water in duct. In this method a duct or multiple ducts are installed along the water course in order that the ground may be excavated beneath and/or once backfilled, a haul road may pass above.
X	Closure. The obstruction (normally a road, track or footpath is closed for the necessary duration of the works in the area. No provision would be made for crossing of the cable swathe and the trenches are open cut as a normal installation.

Table A3- 2 – Haul Road Construction Options

Type	Haul Road Construction Options
A	Haul road access point. Wheel washing for any cars leaving. Traffic control lights installed if necessary.
B	Haul road elevated bridge (temporary) would be built over obstruction.
G	Haul Road crosses. Haul road would have priority right of way. Gated access to swathe if necessary.
I	Infill / earthworks to remove the obstruction to allow the haul road to pass over
N	Haul road junction with existing road. Road has priority right of way.
P	Haul road would be installed over the top of pipe carrying water course.
R	Haul road crosses existing road. Road has priority right of way
T	Haul road stops with turn around point.

UGC4 A2 – UGC : Milour Moor to Greenyards - SNH Route Only

No.	UGC4 A2 : from SEC1 to Point X - Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing Methods	Haul Road Crossing Methods	Grid Reference
1	Milour Moor			-	-	NN768044
2	Track	West		-	-	NN768043 - NN765034
3	Grainston Burn	West		-	-	NN764038
4	Water course	East		-	-	NN766033 - NN765030
5			Water Course	D, P or W	B or P	NN760024
6			C road (<4m wide)	E or D	A & R	NN758023
7	Corscaplie Farm	East		-	-	NN761023
8	Anfield	East		-	-	NN759023
9	Auchenteck Farm	West		-	-	NN756019
10			Dismantled Railway	I	T	NN757018
11	C road	West	Access point	-	A	NN755018
12	Pit (dis)	West		-	-	NN757017
13			Water Course	D, P or W	B or P	NN758017
14			A820	E or D	A & R	NN757015
15	Pit (dis)	West		-	-	NN756013
16			Water course	D, P or W	-	NN757014
17	Greenyards Farm	West		-	-	NN761011
18	Point X			-	-	NN757011

Further tables are on following pages.

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UGC4 A3 – UGC : Braco S/S to Greenyards - SBP Route Only

No.	UGC4 A3 : Braco S/S to Point X Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing method	Haul Road Crossing Method	Grid Reference
1			New Braco Substation	-	-	NN794094
2	Woodland ends	on line		-	-	NN803093
3	Calzieveg Farm	East		-	-	NN810090
4			Water course	P, W or D	P or B	NN806090
5			Water course	P, W or D	P or B	NN807088
6	Bentick Farm	West		-	-	NN807088
7			Bentick Farm access road	E or D	R	NN807087
8			Two water courses	P, W or D	P or B	NN807085
9	Faulds Wood	on line		-	-	NN807082
10	Craighead Farm	West		-	-	NN807077
11	Coupans Farm	East		-	-	NN812077
12	Craighead Cottage	West		-	-	NN811073
13			B8033	E or D	A & R	NN812073
14			Muckle Burn	D or B2	B or T	NN811070
15	Nether Cambushinnie Farm	West		-	-	NN809067
16			Water course	P, W or D	P or B	NN810065
17			Allan Water	B2 or D	T	NN809060
18			Railway line	D or T2	T	NN809059
19	Glenbank Farm	East		-	-	NN811057
20	Glenbank Cottage	East		-	-	NN813055
21	A9	East		-	-	NN812053
22			Todhill Burn	P, W or D	T	NN812052
23	Toll Wood	East		-	-	NN811052
24	Firs of Kinbuck woodland	on line		-	-	NN809049 - NN806046
25	Balhaldie	East		-	-	NN812050
26	Lower Whiteston Farm	West		-	-	NN802047
27			Lower Whiteston Farm access road	E or D	A & R	NN804045
28			Water course	P, W or D	P or B	NN804045
29			Water course	P, W or D	P or B	NN803043
30			Water course	P, W or D	P or B	NN801041

UGC4 A3 – UGC : Braco S/S to Greenyards - SBP Route Only Continued …

No.	UGC4 A3 : Braco S/S to Point X Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing method	Haul Road Crossing Method	Grid Reference
31	The White Stone standing stone	East		-	-	NN806041
32	Gateside Farm	West		-	-	NN799042
33			Gateside Farm access	E or D	A & R	NN800040
34	Woodland	South		-	-	NN798040
35	Woodland	on line		-	-	NN794040
36	Cairnston Farm	South		-	-	NN793037
37			Cairnston Farm track	none or E	G	NN795035
38	Lodge	North		-	-	NN792040
39			B8033	E or D	A & R	NN790039
40	The Clachan	South		-	-	NN787039
41	Ashfield	South		-	-	NN785038
42			Railway Line & Allen Water	D or T2	T	NN787041
43			Water course	P, W or D	T	NN783039
44			C road (<4m)	E or D	A & R	NN781038
45	C road	East		-	-	NN780037
46	Crofts of Cromix	East		-	-	NN781036
47	Upper Auchinlay	West		-	-	NN774032
48	Woodend Cottage	East		-	-	NN780030
49	Lower Auchinlay	East		-	-	NN778026
50	Rhu House	East		-	-	NN775025
51			Upper Auchinlay Farm access	D	A & R	NN775026
52			Water course	P, W, B2 or D	T	NN771020
53	A9	East		-	-	NN771019
54	Stockbridge Farm	North		-	-	NN768017
55			Stockbridge Farm track	None or D	None or G	NN769018
56	Water Course	South		-	-	NN766016
57	Nursery	North		-	-	NN765016
58			C road (<4m)	D or E	A & R	NN764016
59			Water course	P,W or D	T	NN763016
60			A820	E or D	A (south) & R	NN763016

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UGC4 A3 – UGC : Braco S/S to Greenyards - SBP Route Only Continued

No.	UGC4 A3 : Braco S/S to Point X Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing method	Haul Road Crossing Method	Grid Reference
61	Woodland	West		-	-	NN762014
62	Greenyards Farm	South		-	-	NN760011
63	Point X			-	-	NN757014

UGC4 B – UGC : Greenyards to SEC 2 : SNH and SBP Routes

No.	UGC4 B : Point X to SEC2 Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing method	Haul Road Crossing Method	Grid Reference
1	Point X			-	-	NN757011
2			Farm access road	E	R	NN757011
3	Non-Roman Standing Stone	East		-	-	NN756010
4	Moonstrip Farm	West		-	-	NN755007
5	Moon Cottage	East		-	-	NN759006
6	Non-Roman Standing Stone	East		-	-	NN755003
7			B824	E or D	A & R	NN757002
8	C road	East		-	-	NN757001 - NS754994
9	Hillside of Row	West		-	-	NN754997
10	Hillside of Row	West	Farm access road	E	R	NN756997
11			C road (<4m wide)	E or D	A & R	NS754994
12			Farm access track	none or E	G	NS756988
13	C road	West		-	-	NS753993
14	Easter Row Farm	West		-	-	NS751992
15	Bank Cottages	West		-	-	NS753988
16	Craigarn Hall	West		-	-	NS753985
17	Woodland strip	West		-	-	NS763983
18	Craigarn Plantation	West		-	-	NS757982
19	Remains of Arnhall Castleto	East		-	-	NS762986
20	Lodge	East		-	-	NS763983
21	Glen Burn	East		-	-	NS763981
22	Old Keir	East		-	-	NS765978
23			C road (<4m wide)	E or D	A & R	NS762978
24	Water course	West		-	-	NS761977
25			River Teith	B2 or D	T	NS759975
26	Steeds Farm	East		-	-	NS764974
27			Farm Track	none or E	G	NS757973
28			Water course	D, P or W	B or P	NS756969
29	The Saughs Farm	West		-	-	NS755968
30	Blackdub Farm	East		-	-	NS758966

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UGC4 B – UGC : Greenyards to SEC 2 : SNH and SBP Routes Continued..

No.	UGC4 B : Point X to SEC2 Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing method	Haul Road Crossing Method	Grid Reference
31			A84	D or E	A & R	NS755966
32	Dripend Farm	West		-	-	NS753962
33			Dripend Farm access track	E	R	NS755964
34			Water course	D, P or W	B or P	NS755961
35	Drip Moss Farm	East		-	-	NS754956
36	West Drip Farm	East		-	-	NS754955
37			West Drip Farm access track	none or E	G	NS754952
38			Nailers Lane track	none or E	G	NS754952
39	Water course	West		-	-	NS754952
40			Chalmerston Road (<4m wide)	E or D	A & R	NS757945
41	Baad	East		-	-	NS761944
42			East Cambusdrennie Farm access track	E	R	NS758944
43	East Cambusdrennie Farm	West		-	-	NS758941
44			River Forth	B2 or D	T	NS761937
45	Touch Bridge	West		-	-	NS758935
46			A811	D or E	A & R	NS762935
47	Polrogan Bridge	West		-	-	NS762934
48	Bankend Farm	East		-	-	NS764933
49	Johnnys Burn	West		-	-	NS761929
50			Touch Road (generally >4m)	D or E	A & R	NS763928
51			C road	D or E	A & R	NS763924
52	Murray's Wood	West		-	-	NS762916
53			Water course	D, P or W	B or P	NS763921
54	Gartur (SEC2)			-	-	NS763919

UGC4 C – UGC : Gartur to Denny S/S SNH and SBP Routes

No.	UGC4 C2 : Gartur to Denny S/S Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing method	Haul Road Crossing Method	Grid Reference
1			Gartur	-	-	NS763919
2	Murray's Wood	West		-	-	NS762916
3	Touchadam Craig	East		-	-	NS767915
4	Castlehill Wood	West		-	-	NS753908
5	Water course	East		-	-	NS764918
6			Water course	P,W or D	P or B	NS766912
7	Touchadam Craig	North		-	-	NS757915
8	Castlehill	South		-	-	NS760912
9	Murrayshall Farm	South		-	-	NS764910
10	Murrayshall Quarry	East		-	-	NS771912
11	Castlehill Wood	West		-	-	NS753908
12	DUN (rems of)	West		-	-	NS767908
13			C road (<4m)	E or T2	A & R	NS771907
14			Bannock Burn	D, B2, B3 or T2	B	NS771907
15	Wallstale	East		-	-	NS773907
16	Graystale			-	-	NS776908
17	Bannock Burn	East		-	-	NS773905
18	M9	East		-	-	NS789898 - NS793895
19	Cultenhove Dam	West		-	-	NS779899
20	Chartershall House	East		-	-	NS786902
21	Chartershall Farm	East		-	-	NS789901
22	Cultenhove	East		-	-	NS785899
23			Water course	P, W, or D	B	NS788899
24			C road (<4m)	D or E	A & R	NS788899
25			C road (<4m)	D or E	R	NS789897
26	Gateside Farm			-	-	NS790898
27	Howlands	West		-	-	NS784896
28	Foot o' Green Farm	East		-	-	NS792893
29	Rogerhead	West		-	-	NS791889
30			C road (>4m)	D or E	A & R	NS794891

UGC4 C – UGC : Gartur to Denny S/S SNH and SBP Routes Continued

No.	UGC4 C2 : Gartur to Denny S/S Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing method	Haul Road Crossing Method	Grid Reference
31	M80	East		-	-	NS799890 - NS803872
32	M80 services	East		-	-	NS802886
33			Farm track	none or E	G	NS799885
34			Water course	P, W, or D	T or P	NS800882
35	Corse Hill	East		-	-	NS801882
36	Auchenbowie	West		-	-	NS796879
37	Moss Side Farm	West		-	-	NS800879
38			C road (<4m)	E or D	A & R	NS801878
39	Auchenbowie Wood					NS802876
40			Track in Auchenbowie Wood	none or E	none or G	NS801877
41			Track in Auchenbowie Wood	none or E	none or G	NS801876
42	Shaft (dis)	West		-	-	NS802875
43	Auchenbowie House	West		-	-	NS800875
44			Auchenbowie House access road	D	R	NS802873
45	Mains of Auchenbowie	West		-	-	NS801871
46			M80	D	T	NS803872
47			A872	D or E	A & R	NS805871
48	Avenuehead Farm	East		-	-	NS805873
49	Muir Wood	East		-	-	NS810870
50			North Durieshill Farm access	E	R	NS808867
51	North Durieshill Farm	East		-	-	NS810867
52	Craw Hill	West		-	-	NS809866
53	Easterton Farm	West		-	-	NS804863
54			Farm track	None or E	G	NS809864
55			Farm track	None or E	G	NS813858
56			Water course	P, W, or D	B or P	NS816855
57	Woodcockfauld Farm	East		-	-	NS818855
58			C road (<4m)	E or D	A & R	NS819852
59			Water course	P, W, or D	B or P	NS819852
60	Dales Wood	West		-	-	NS818850

UGC4 C – UGC : Gartur to Denny S/S SNH and SBP Routes Continued …

No.	UGC4 C2 : Gartur to Denny S/S Nearby Locations to Route	Heading from Route	Feature/Obstacle Crossing	Cable Crossing method	Haul Road Crossing Method	Grid Reference
61	Langlands Farm	East		-	-	NS824851
62			Denny Substation	-	-	NS823847

APPENDIX 4 WATERCOURSES

Table A4- 1 Water Crossings Likely to be Required for Stirling Undergrounding

Alternative U / G Proposals	Crossing Ref. (1,2,3)	Approx OS Grid Ref	Crossing Name
UGC4 A2			
	A1	276000 702464	Field drain to west of Corscaple
	A2	275796 701742	Unnamed burn southeast of Auchenteck Farm
	A3	275759 701477	Unnamed burn northwest of Greenyards
Total No. Crossings for UGC4 A2	**3**		
Alternative U / G Proposals	**Crossing Ref. (1,2,3)**	**Approx OS Grid Ref**	**Crossing Name**
UGC4 A3			
	A4	280695, 708927	Unnamed burn northwest of Bentick
	A5	280728, 708689	Unnamed burn southwest of Bentick
	A6	280736, 708581	Unnamed burn northeast of Tamano
	A7	281139, 707095	Muckle Burn
	A8	281027, 706576	Unnamed tributary of Allan Water
	A9	280885, 706109	Allan Water
	A10	281217, 705317	Todhill Burn
	A11	280881, 704899	Unnamed burn southwest of Balhaldie
	A12	280441, 704582	Unnamed burn southeast of Lower Whiteston
	A13	280317, 704350	Unnamed burn south of Lower Whiteston
	A14	280153, 704193	Unnamed tributary of Allan Water
	A15	279081, 703988	Field / road drain
	A16	278667, 704022	Allan Water
	A17	278290, 703992	Unnamed tributary of Allan Water
	A18	277110, 702099	Unnamed burn northwest of Dunblane
	A19	276329, 701624	Unnamed burn southwest of Stockbridge
	A20	275851, 701124	Unnamed burn west of Greenyards
Total No. Crossings for UGC4 A3	**17**		
Alternative U / G Proposals	**Crossing Ref. (1,2,3)**	**Approx OS Grid Ref**	**Crossing Name**
UGC4 B			
	B1	275924, 697514	River Teith SAC
	B2	275625, 696976	Unnamed tributary of River Teith SAC
	B3	275532, 696095	Unnamed tributary of River Teith SAC
	B4	276215, 693706	River Forth (Non SAC)
	B5	276359, 692105	Unnamed burn southwest of Gartur
Total No. Crossings for UGC4 B	**5**		

Alternative U / G Proposals	Crossing Ref. (1,2,3)	Approx OS Grid Ref	Crossing Name
UGC4 C2			
	C1	276498, 691522	Unnamed burn northeast of Murrayshall Farm
	C2	276701, 691272	Unnamed burn north of Murrayshall Farm
	C3	277891, 690391	Bannock Burn
	C4	278840, 689962	Tributary of Bannock Burn
	C5	280000, 688290	Firld drain west of Corse Hill
	C6	281576, 685516	Unnamed burn to west of Woodcockfauld
	C7	281855, 685277	Unnamed burn north of Dales Wood
Total No. Crossings for UGC4 C2	**7**		

Alternative U / G Proposals	Crossing Ref. (1,2,3)	Approx OS Grid Ref	Crossing Name
UGC4 D			
	D1	281664, 698508	Unnamed burn to east of Sherrifmuir Road
	D2	281747, 697600	Unnamed burn north of Yellowcraig Wood
Total No. Crossings for UGC4 D	**2**		

Alternative U / G Proposals	Crossing Ref. (1,2,3)	Approx OS Grid Ref	Crossing Name
UGC4 E			
	None		
Total No. Crossings for UGC4 E	**0**		

Notes

(1) Principal crossing points double checked against APL/STG-41 with further details added during the course of this assessment based on generic approach explained in APL 5/16

(2) Additional water crossings may be required for access roads for all alternatives (including OHL proposals)

(3) Crossing points identified from 1:25K scale mapping, Figures 1-5 of Duncan Russell's Undergrounding Precognition refer

(4) Vulnerability and type of crossing assessed using qualitative assessment of catchment characteristics

Figure A4- 1: Water Crossings Likely to be Required for UGC4 A

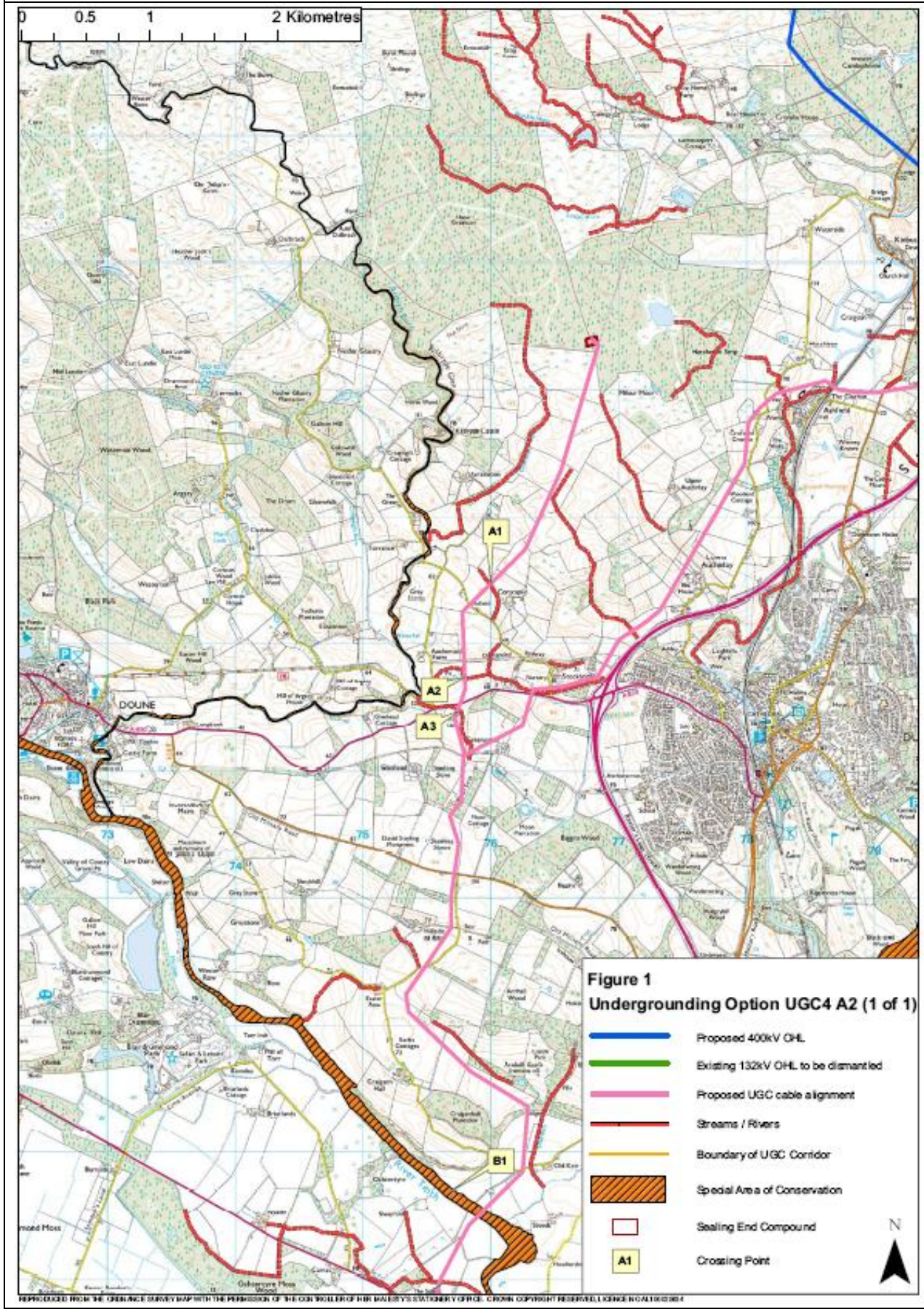


Figure A4- 2 - UGC4 A3

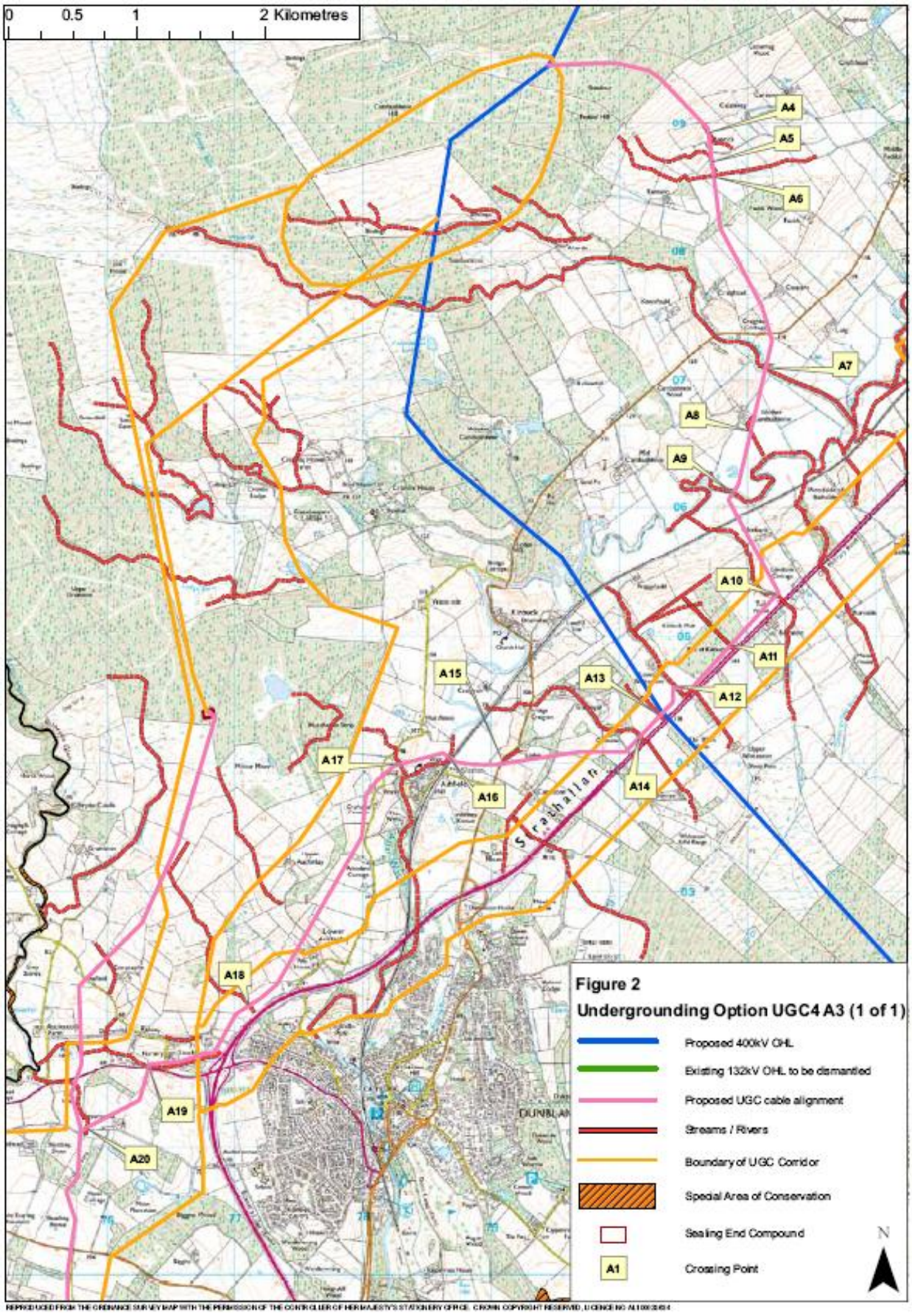


Figure A4- 3 - UGC4 B

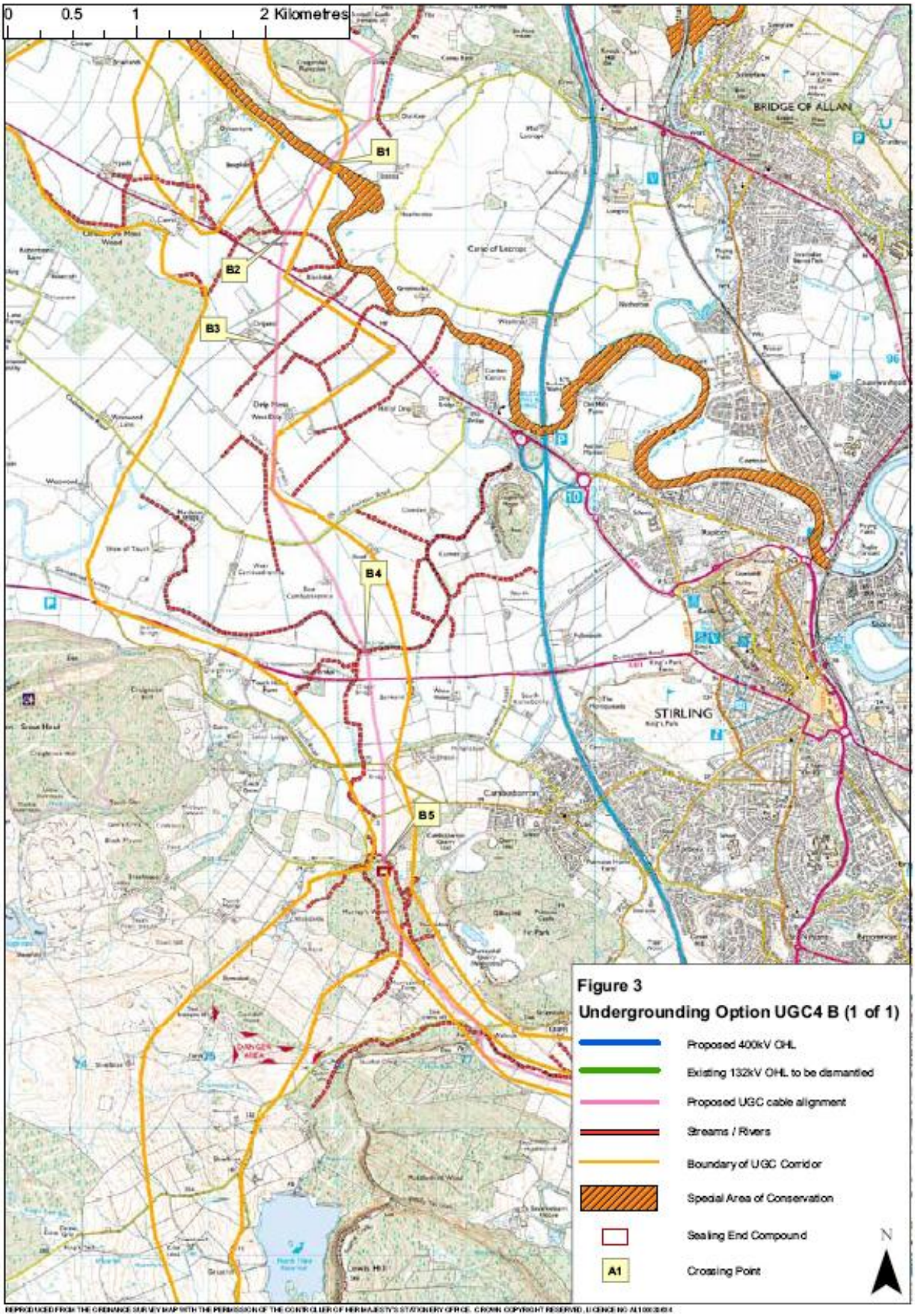


Figure A4- 4 - UGC4 C2

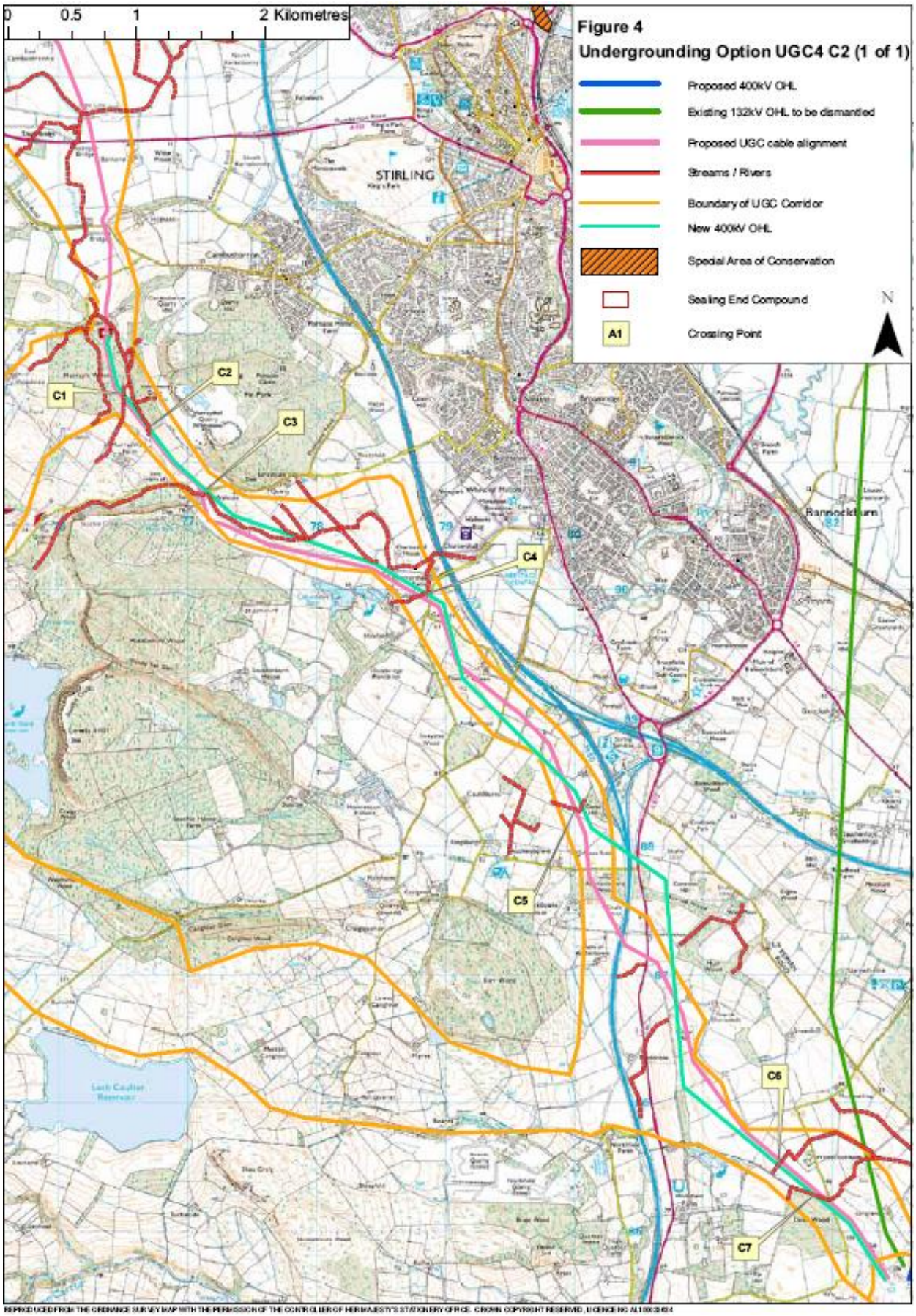
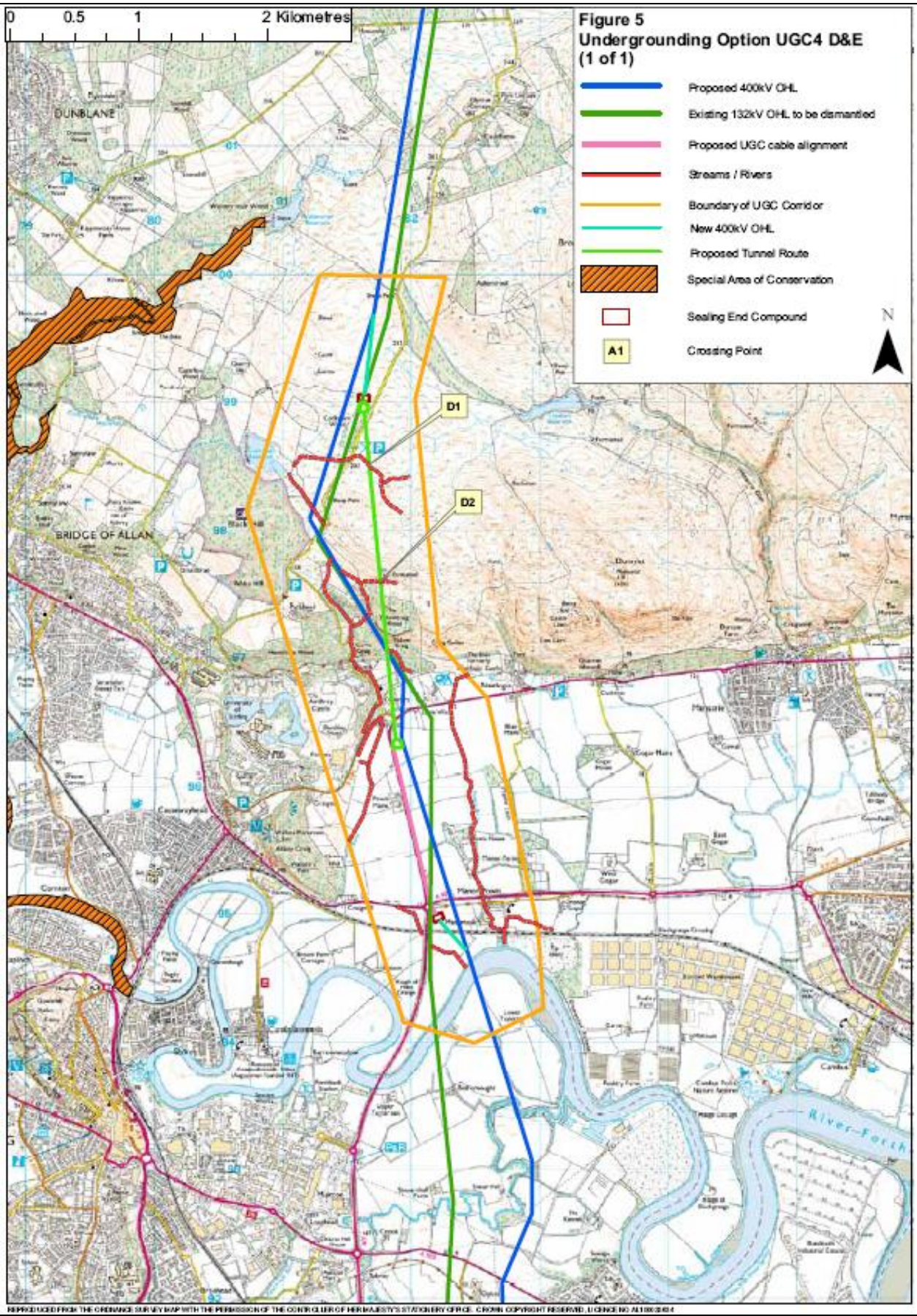
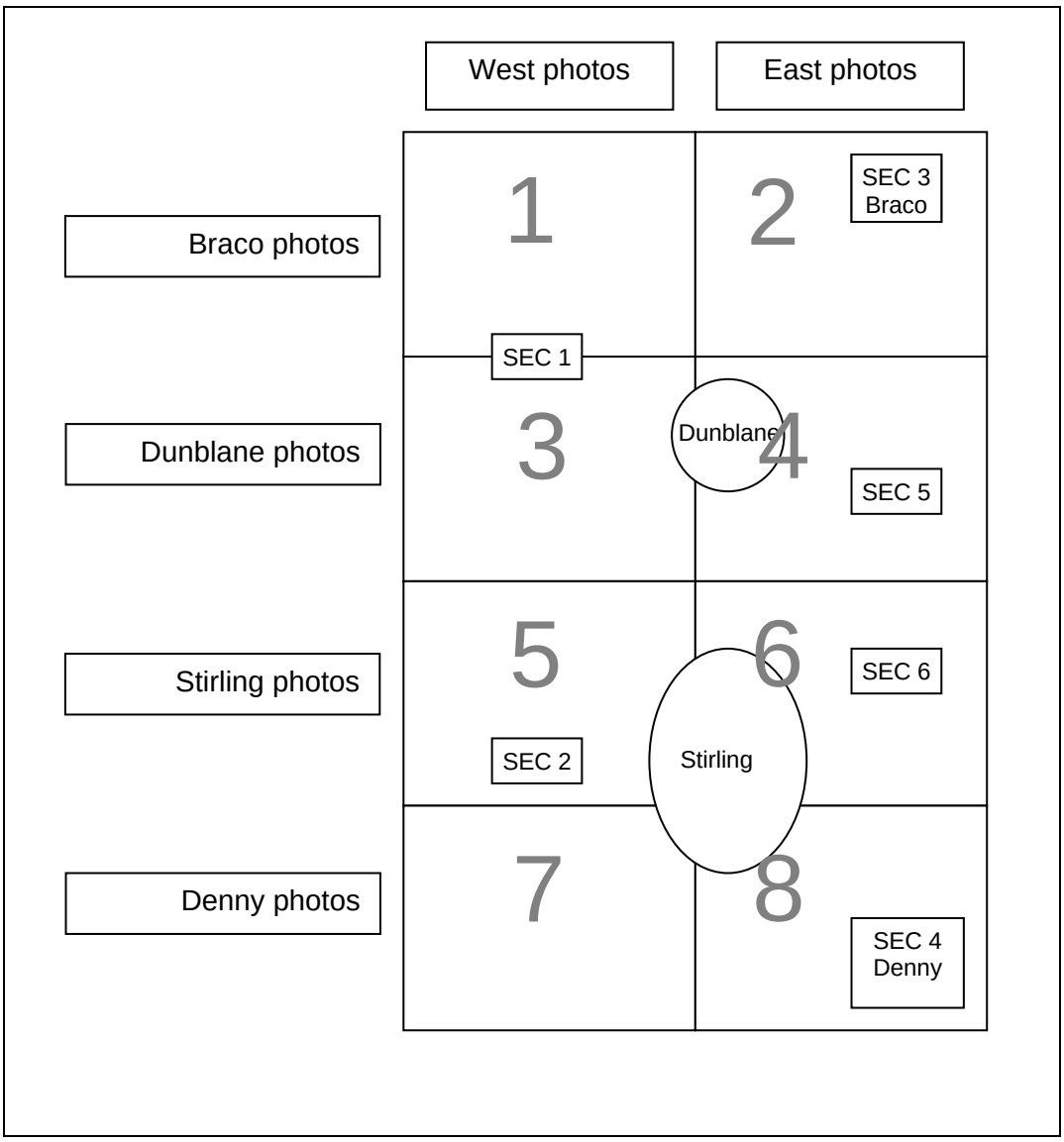


Figure A4- 5- UGC4 D & E



APPENDIX 5 SEARCH AREA AERIAL PHOTOGRAPHS

The following eight annotated aerial photographs cover the area for all of the undergrounding proposals appraised by this report. Whilst each may be considered separately, they relate to each other spatially in the following way:



The key relating to the annotations on the aerial photographs follows:

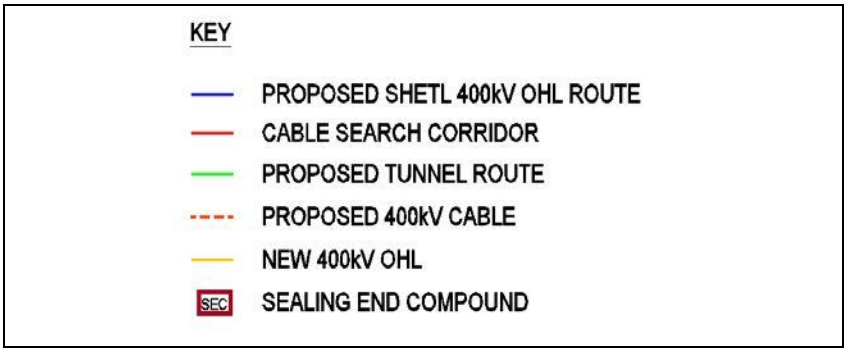


Figure A5- 1 Aerial Photograph - Braco West

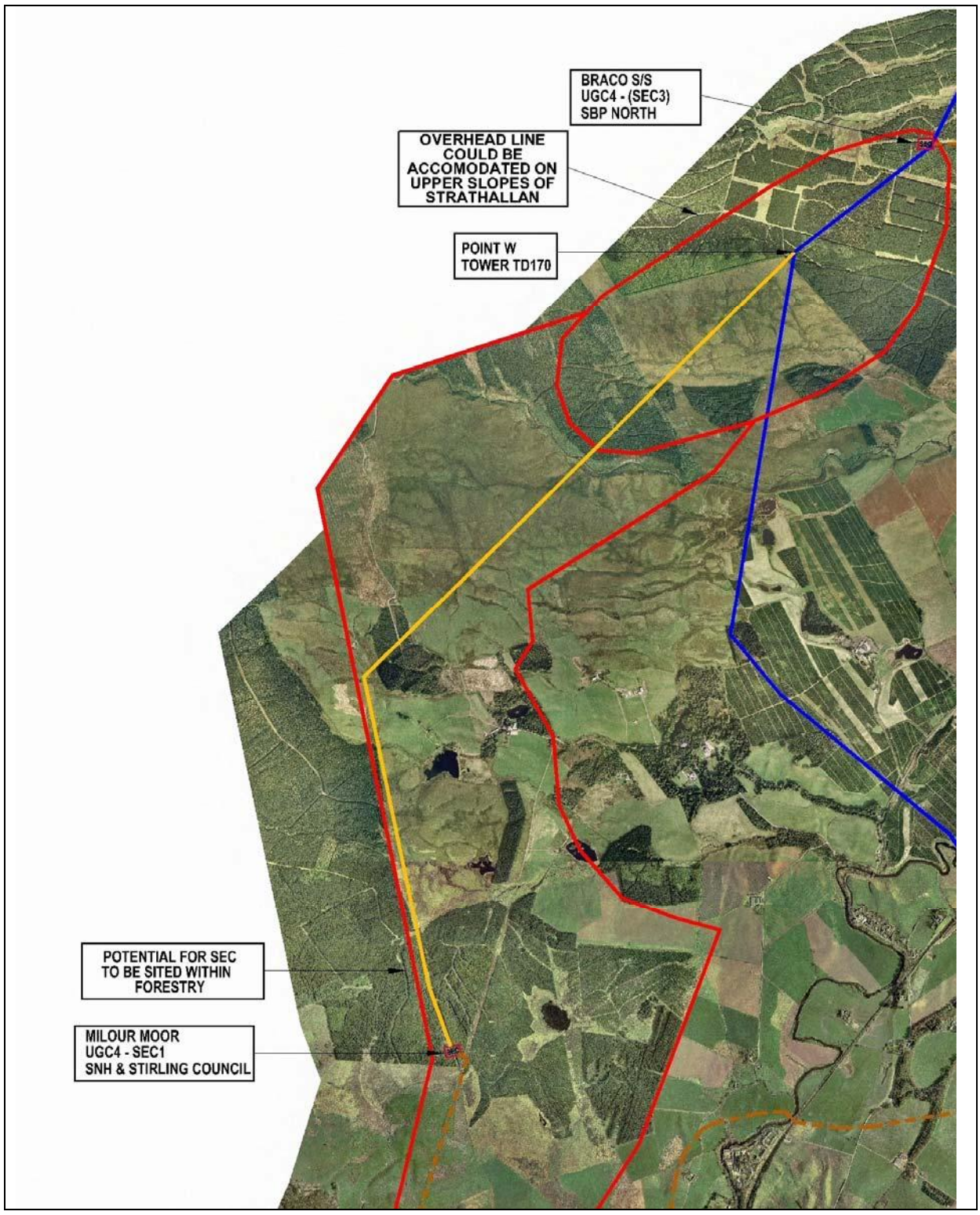


Figure A5- 2 Aerial Photograph - Braco East

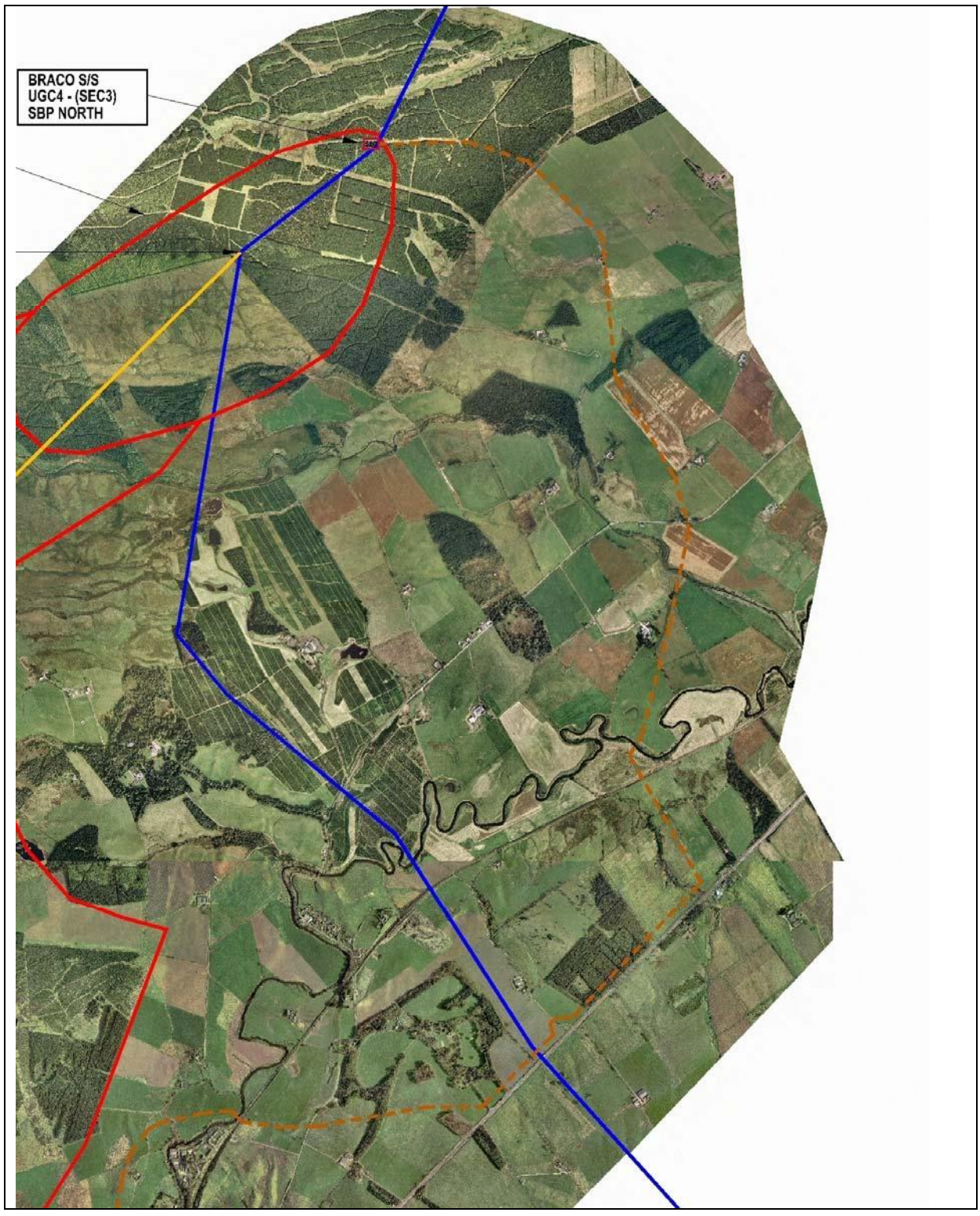


Figure A5- 3 Aerial photograph - Dunblane West

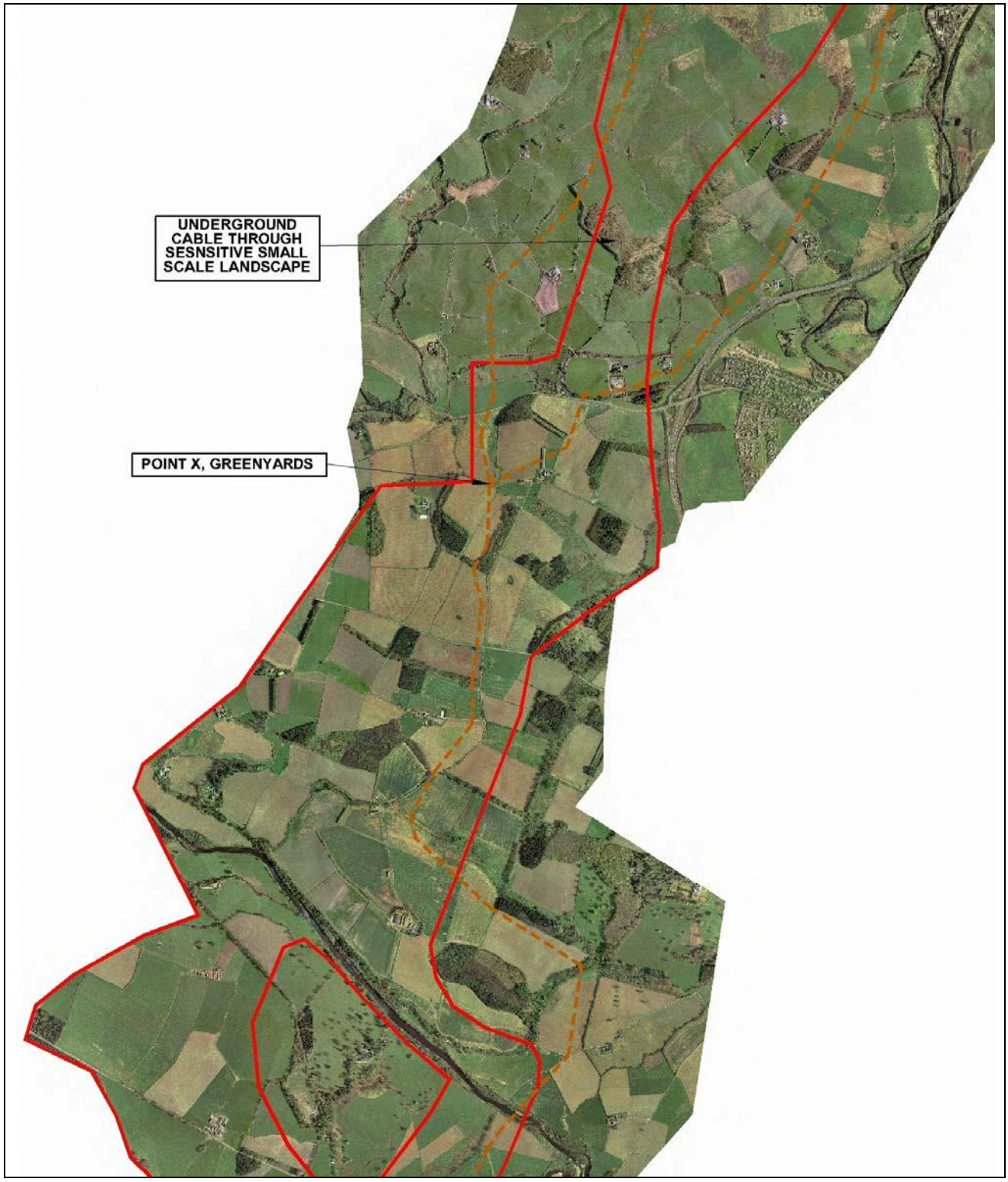


Figure A5- 4 Aerial Photograph - Dunblane East

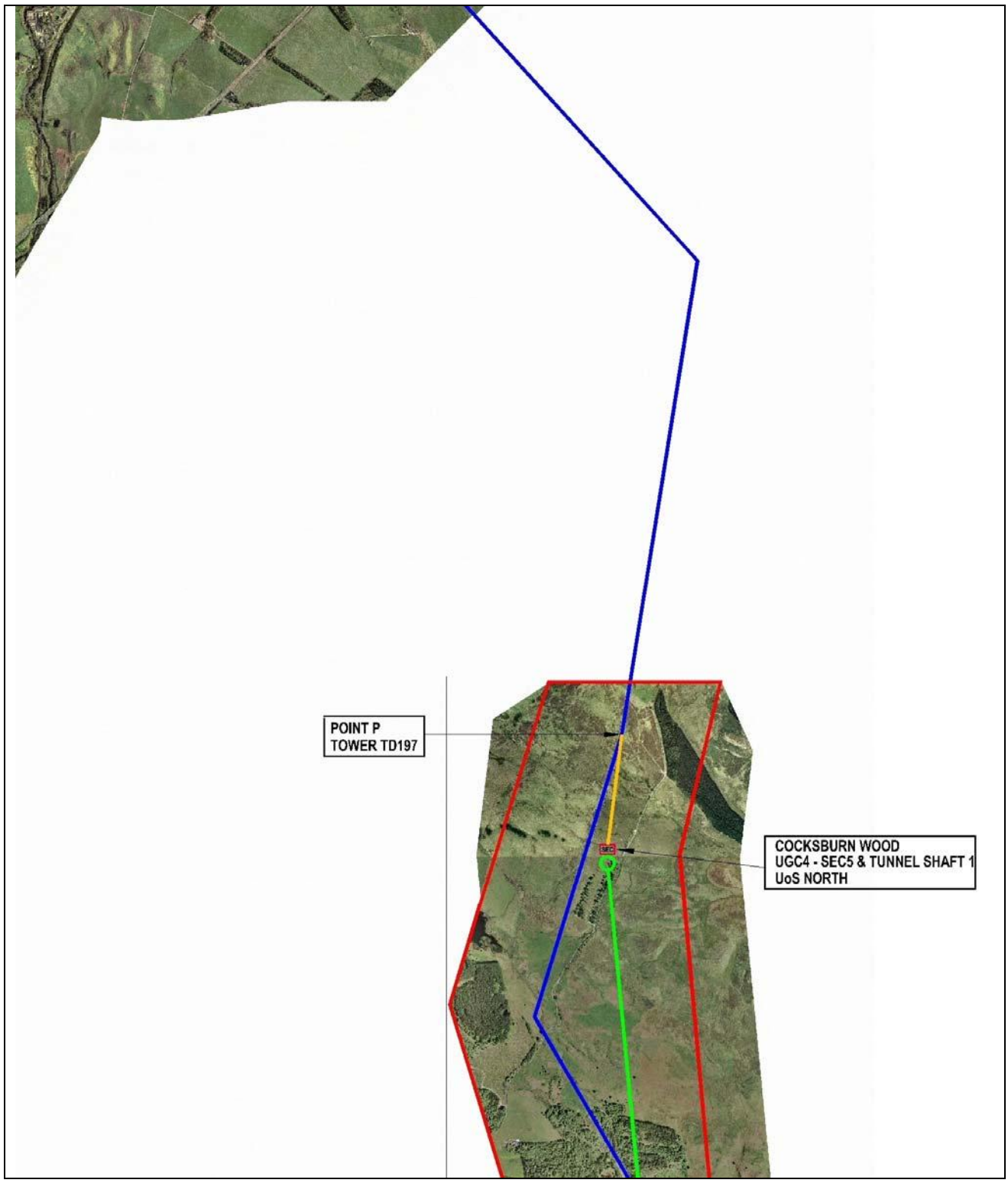


Figure A5- 5 Aerial Photograph - Stirling West

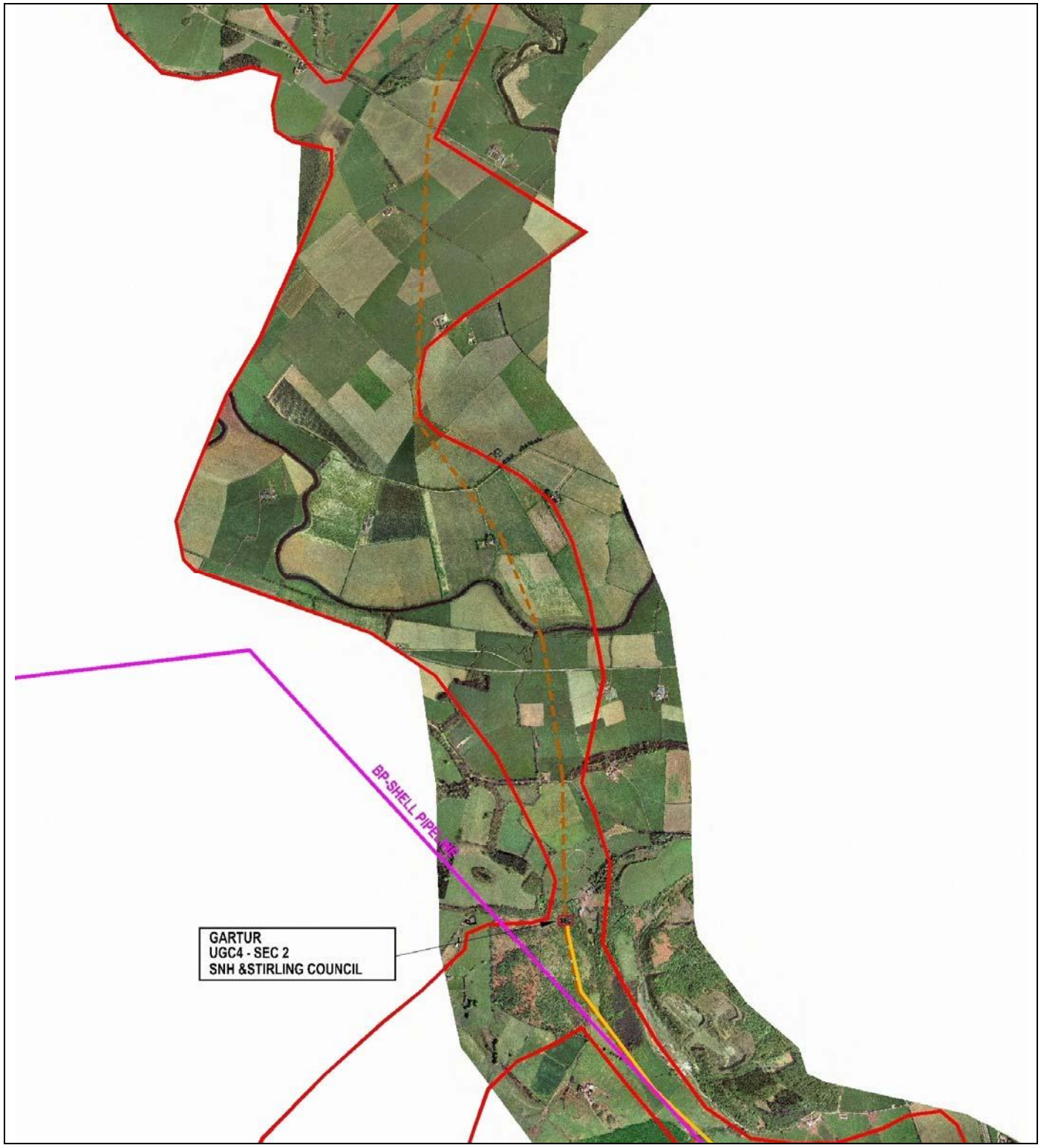


Figure A5- 6 Aerial Photograph - Stirling East

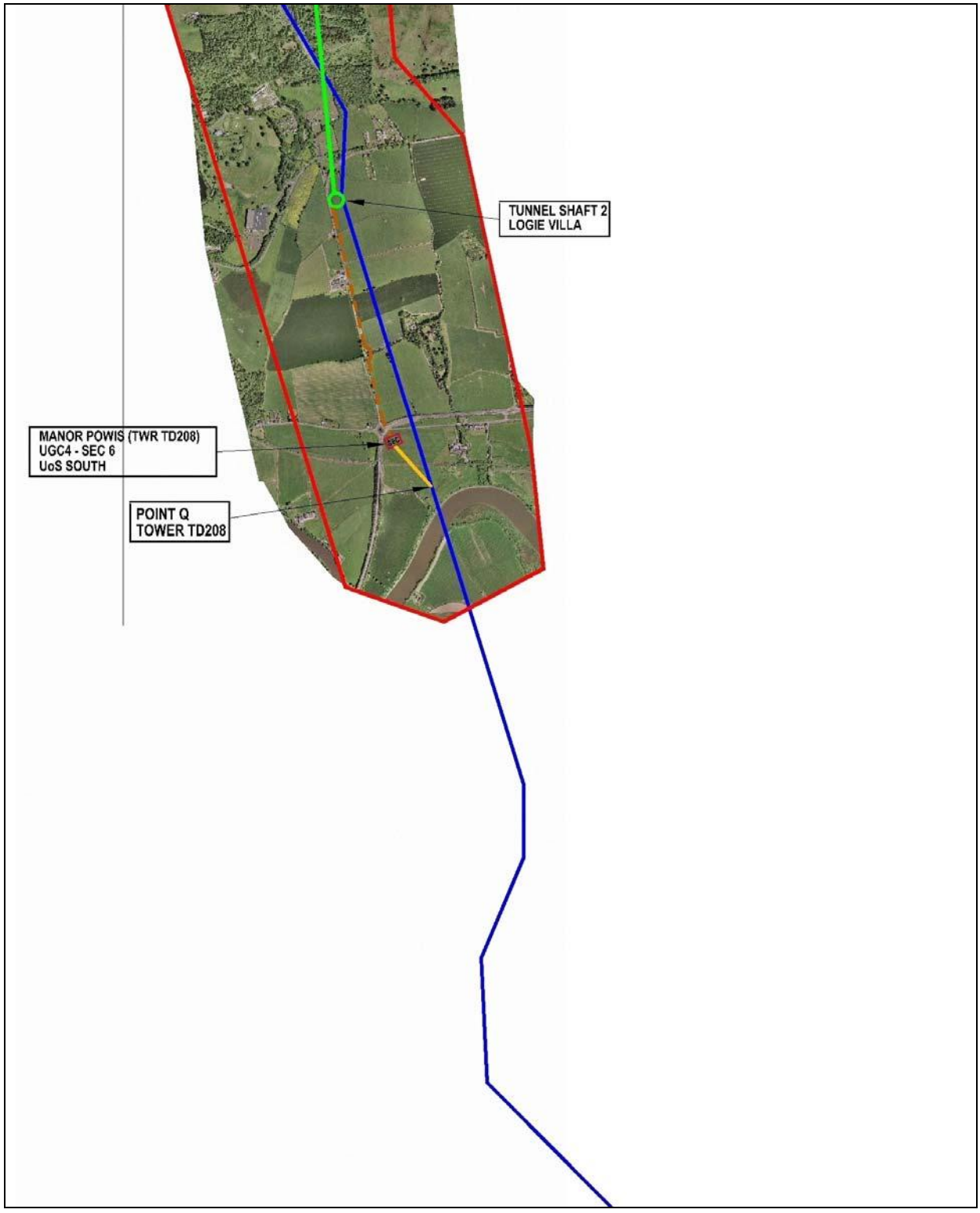
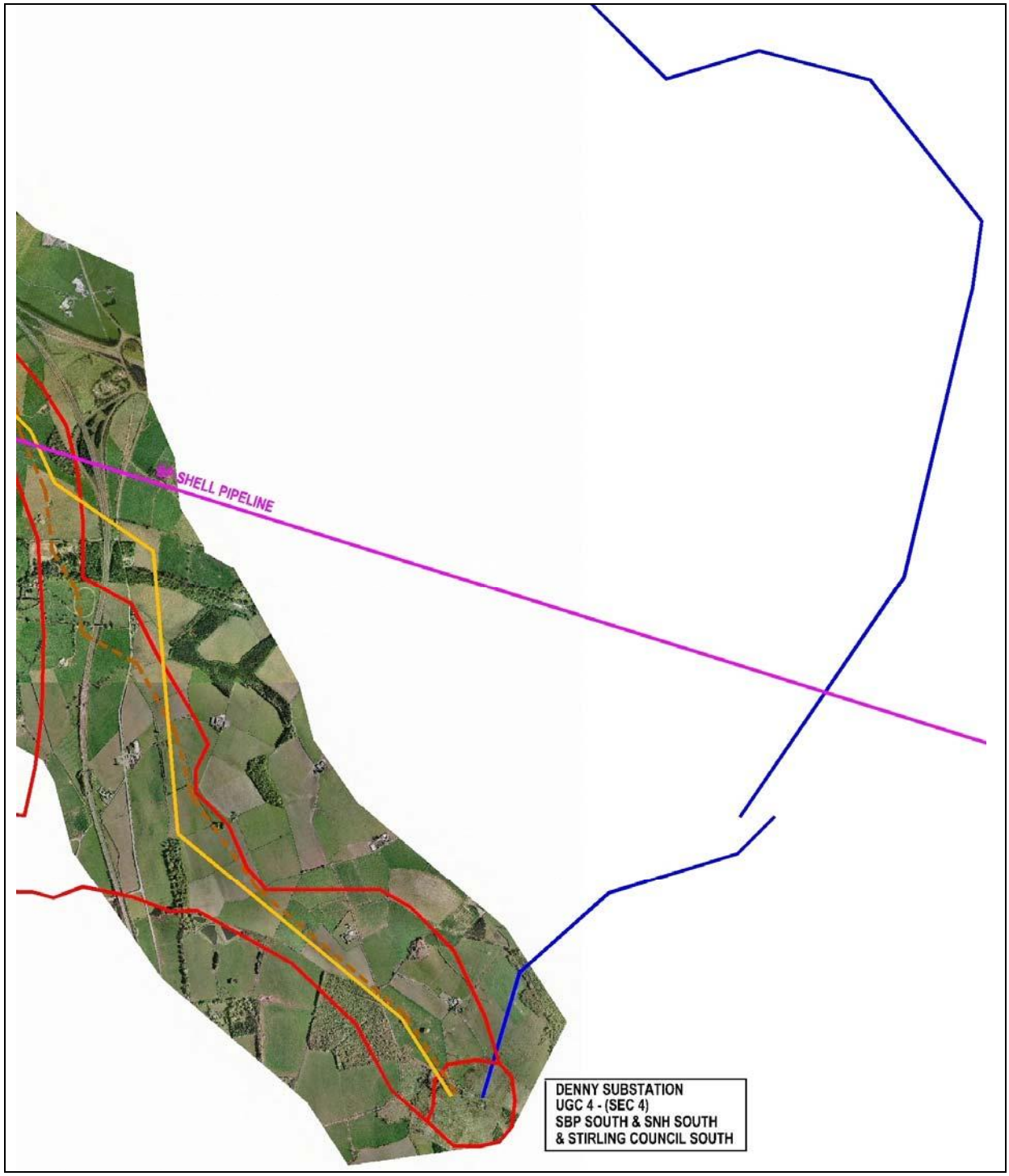


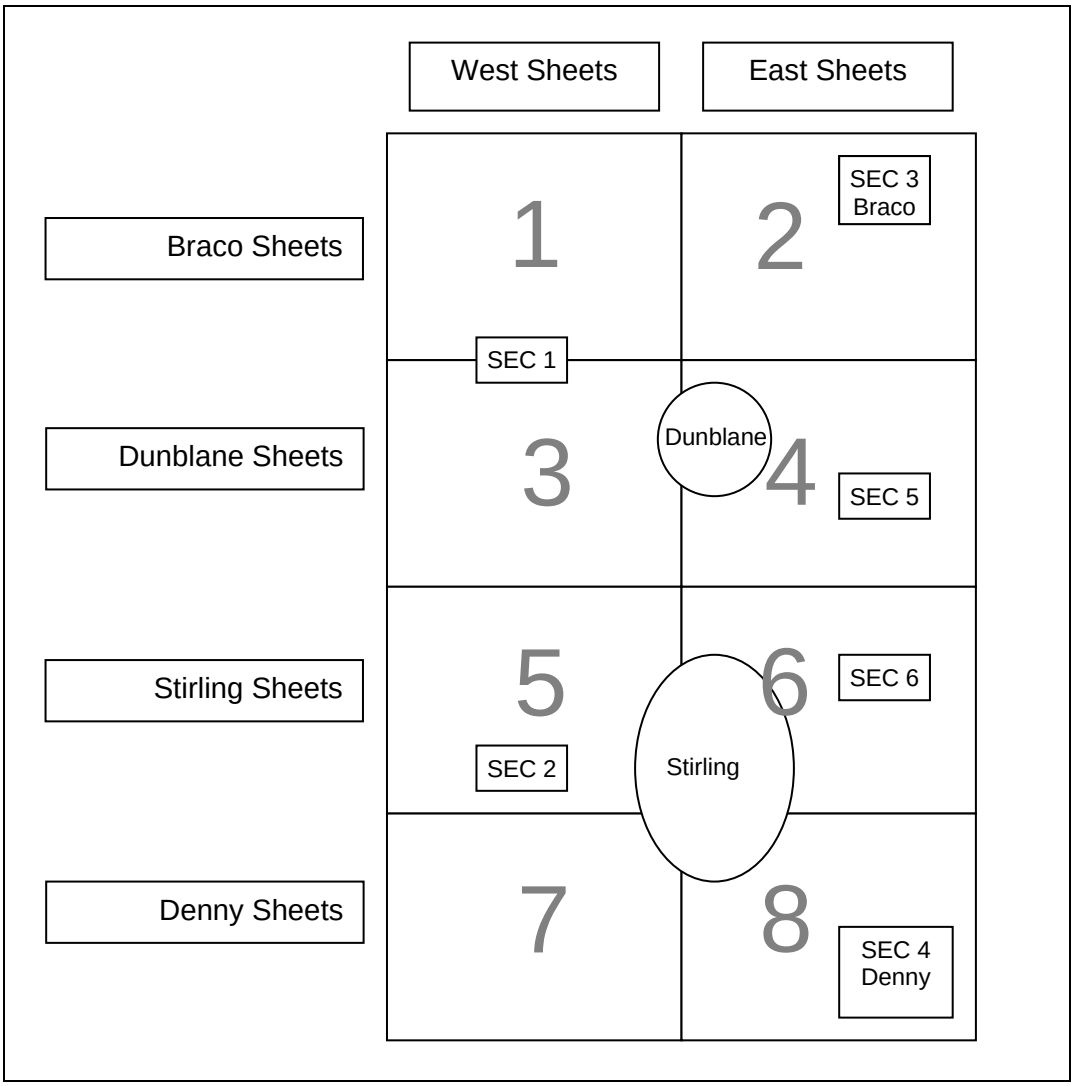
Figure A5- 7 Aerial photograph - Denny West

Figure A5- 8 Aerial photograph - Denny East



APPENDIX 6 ORDNANCE SURVEY MAPS

The following eight annotated Ordnance Survey (OS) maps cover the area for all of the undergrounding proposals appraised by this report. Whilst each may be considered separately, they relate to each other spatially in the following way:



The key relating to the annotations on the OS maps follows:

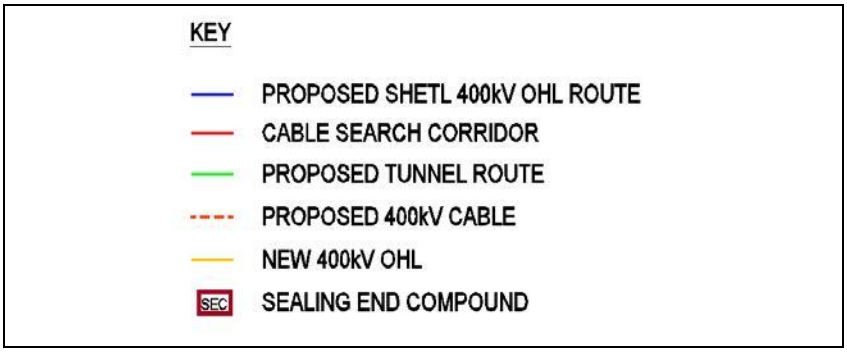


Figure A6- 1 Braco – West Sheet

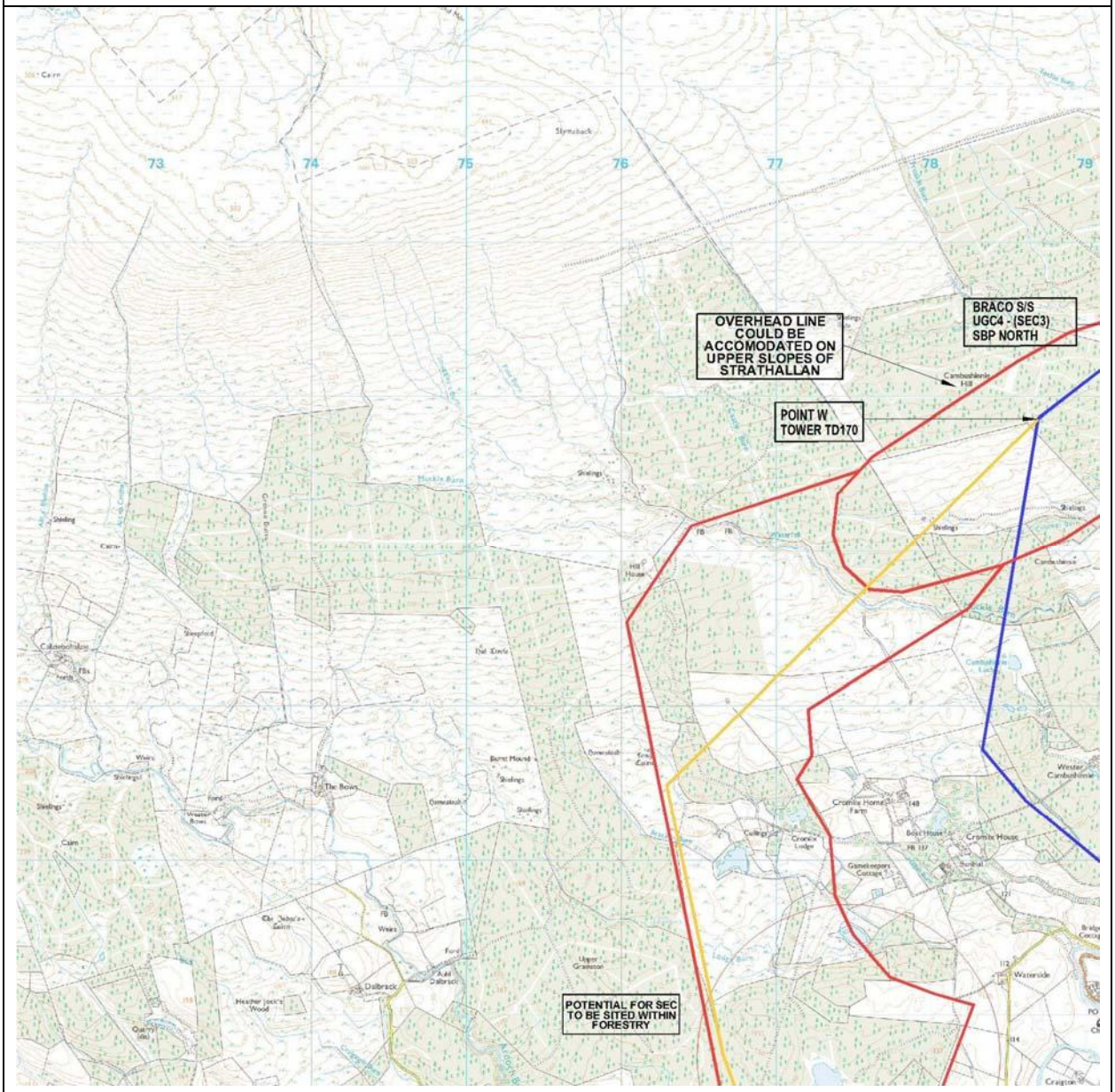


Figure A6- 2 Braco – East Sheet

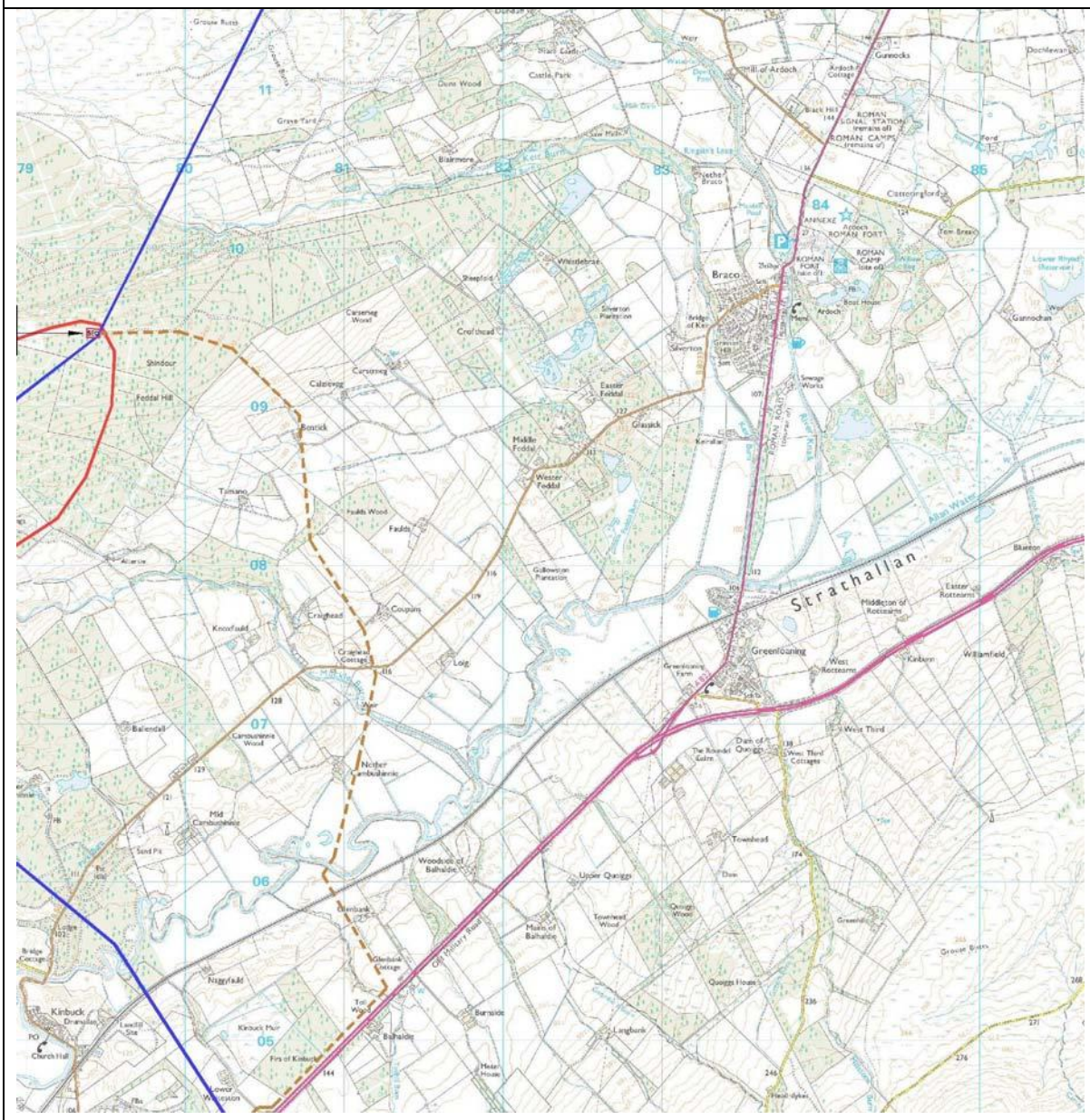


Figure A6- 3 Dunblane – West Sheet

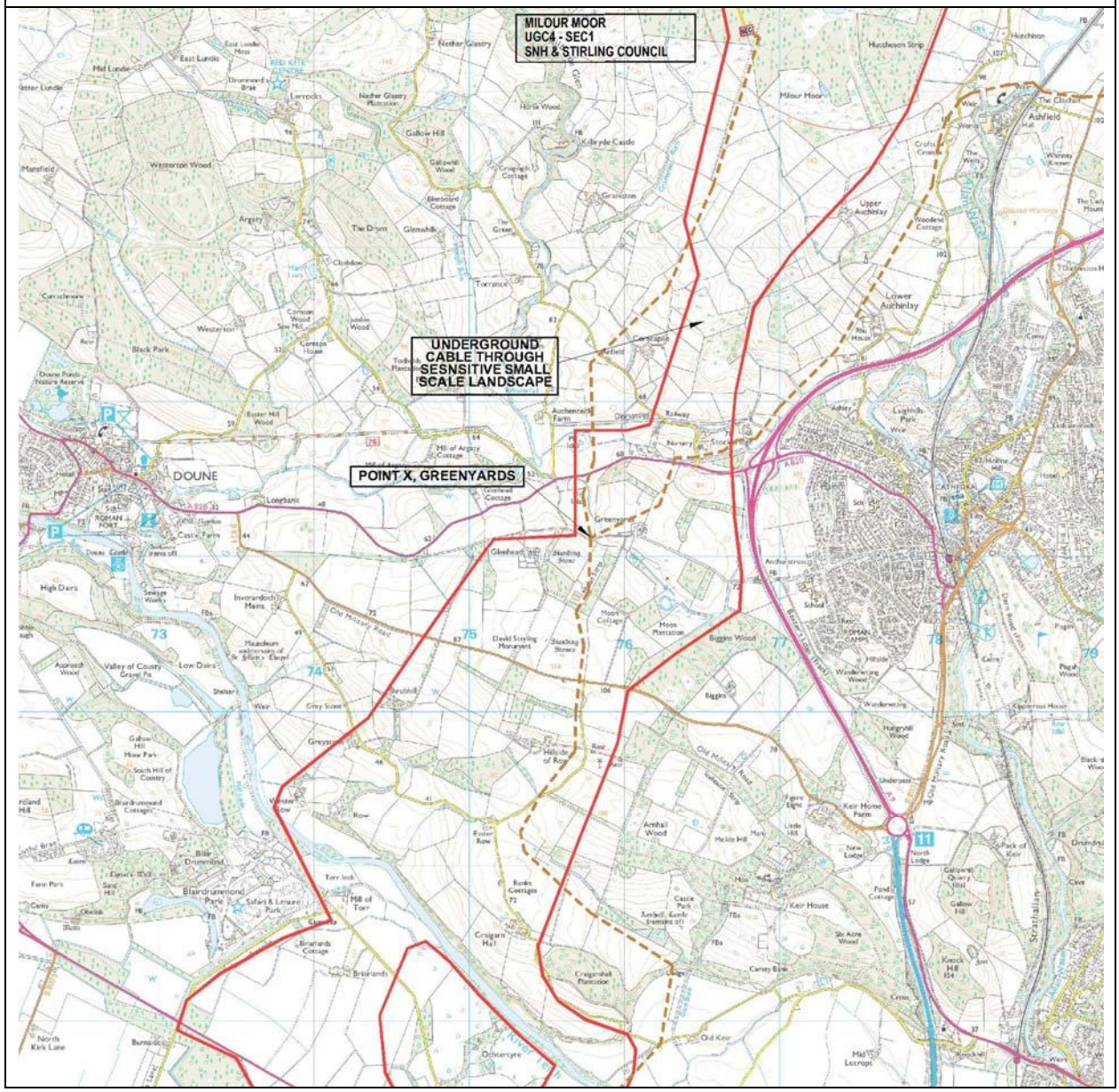


Figure A6- 4 Dunblane – East Sheet

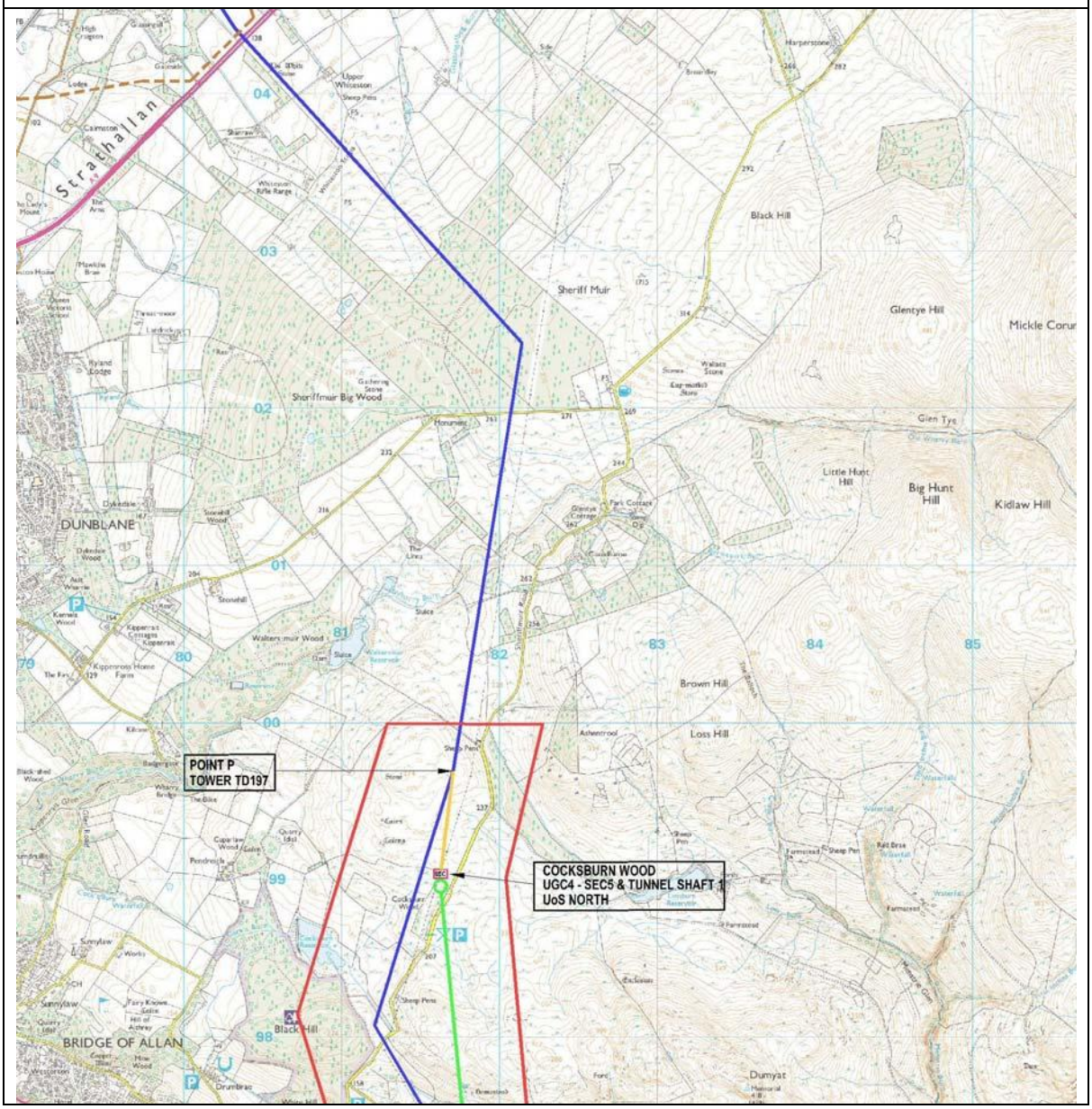


Figure A6- 5 Stirling – West Sheet

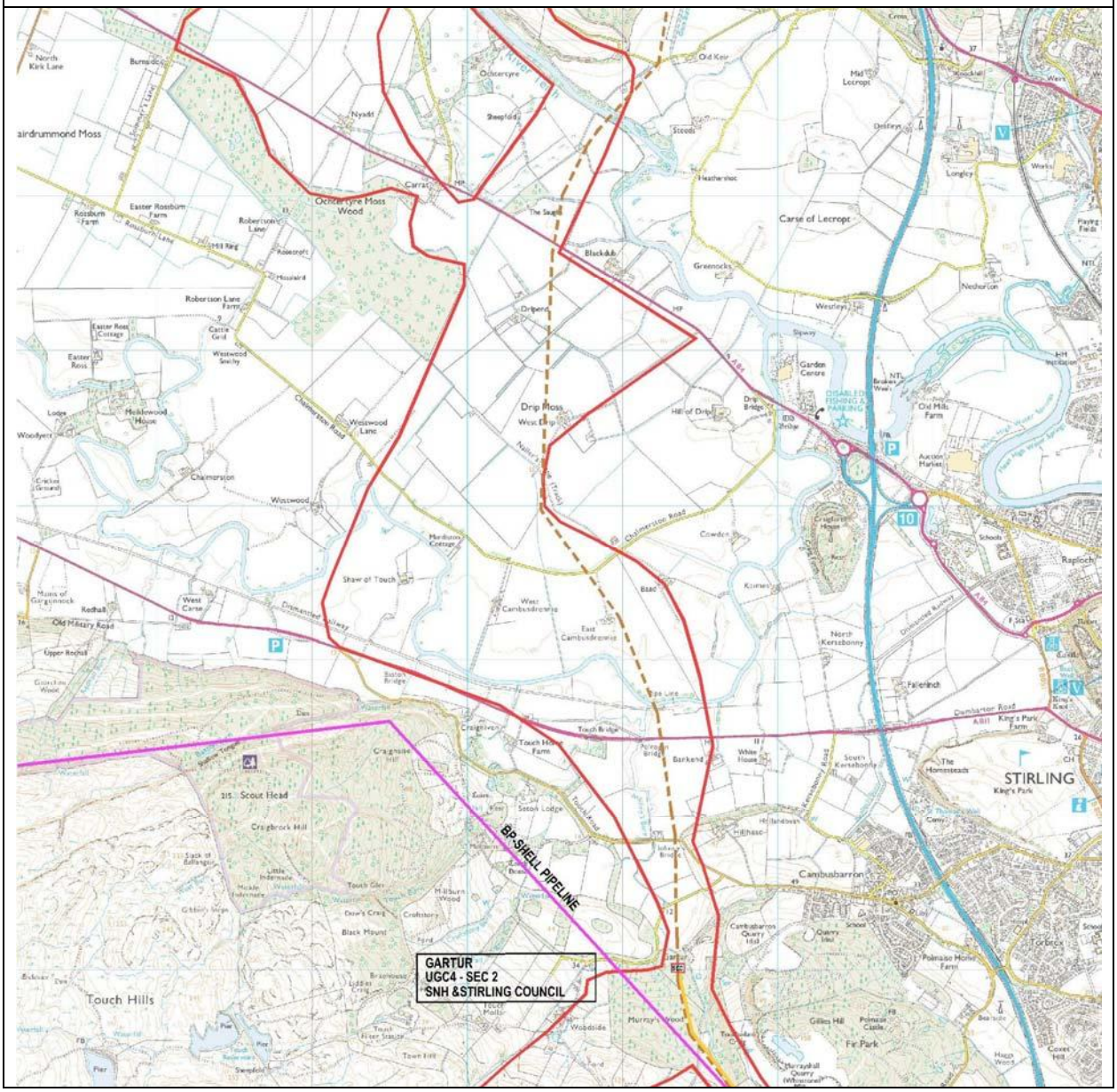


Figure A6- 6 Stirling – East Sheet

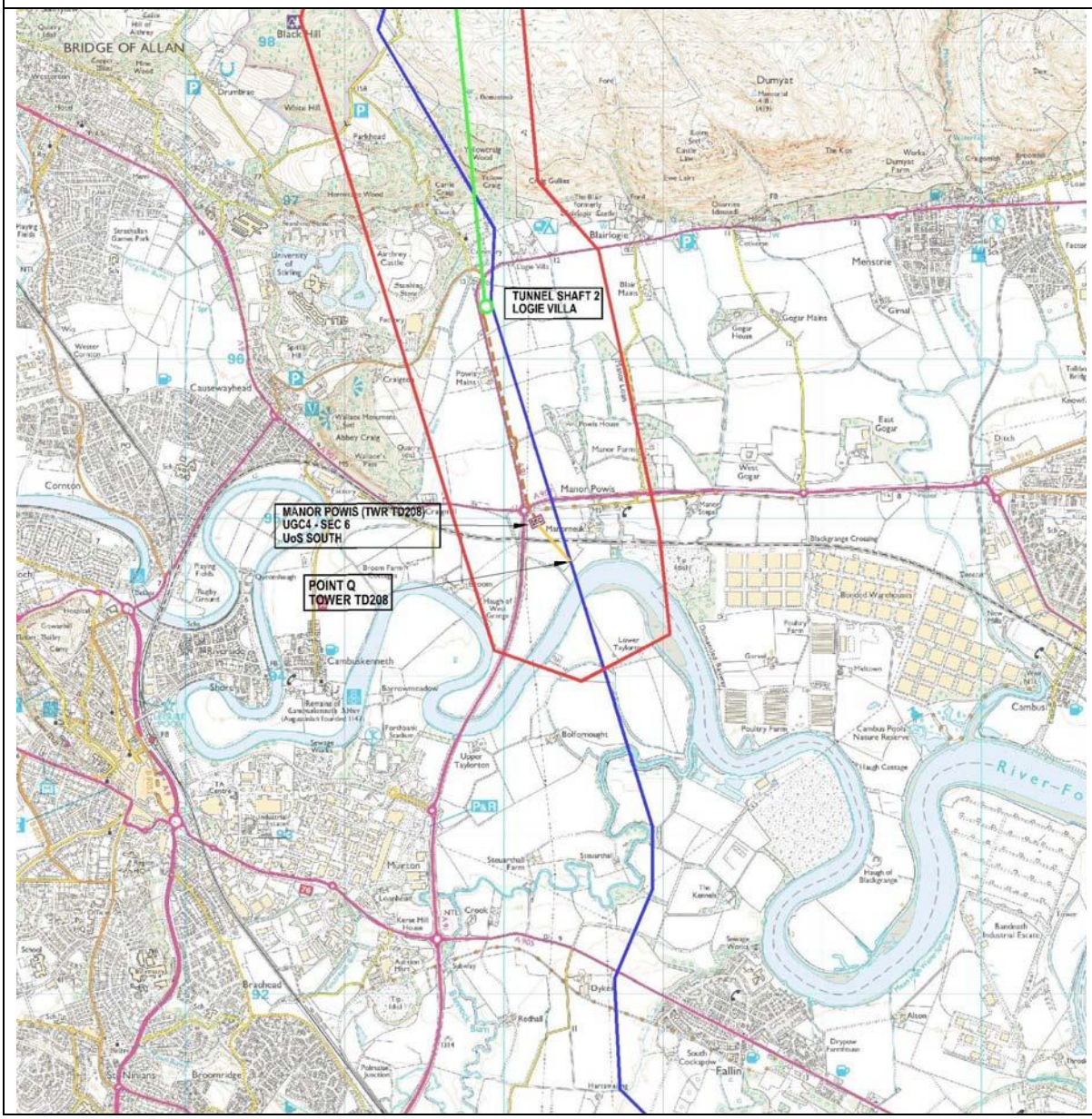


Figure A6- 7 Denny – West Sheet

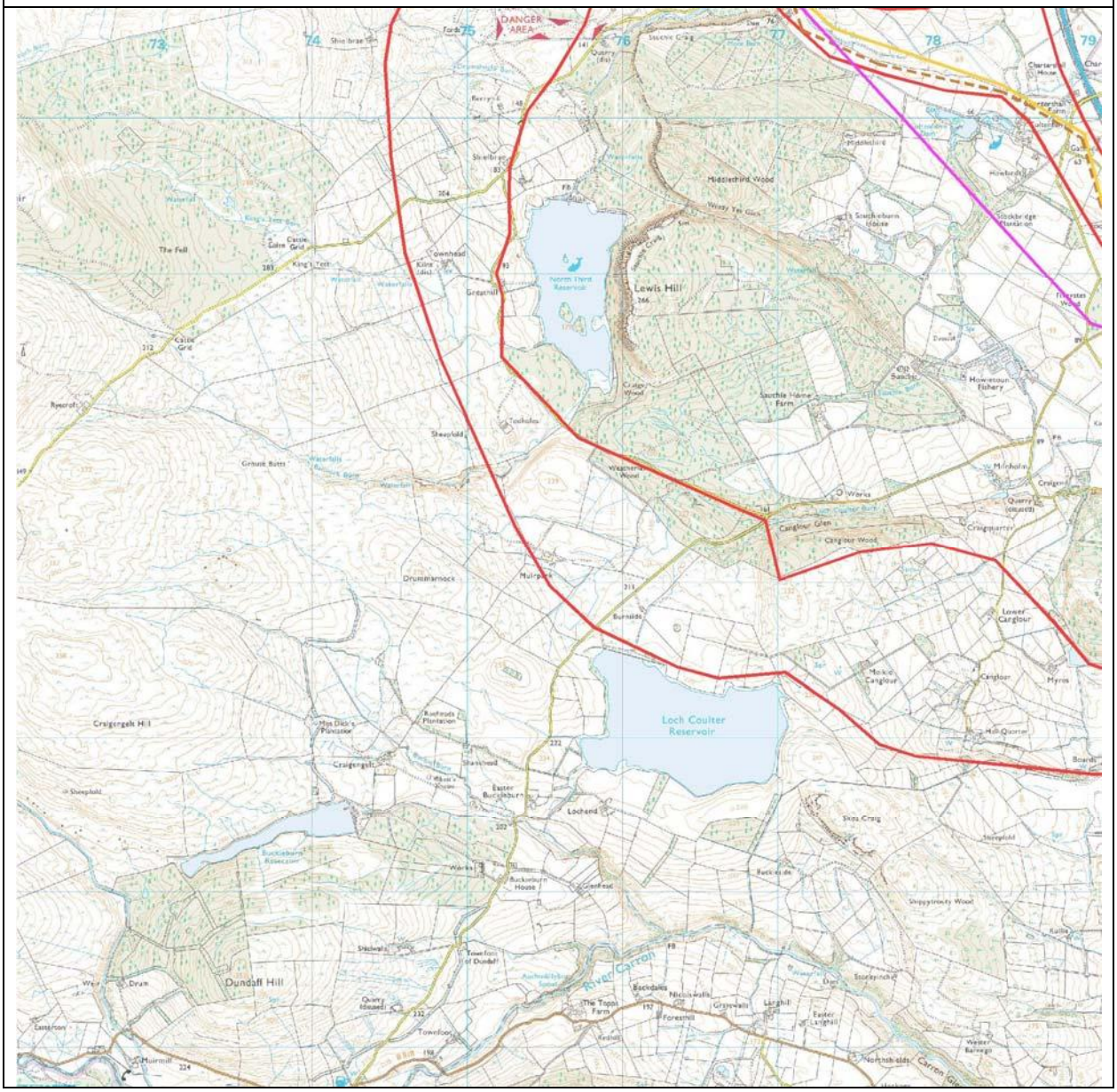


Figure A6- 8 Denny – East Sheet