Scottish & Southern Electricity Networks

LT520-BRCW-GDS-CIV-001

Transmission Engineering

Geo-Environmental Desk Study

LT520 – Braco West Substation

	Name	Title	Date
Author	Chloe Quinn	Civil (Geotechnical) Project Engineer	19/10/2023
Checked by	Meganne Paul-Bird	Geotechnical Project Engineer	20/10/2023
Approved by	Rebecca Simister	Development Project Manager	31/10/2023

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1 Scope of Desktop Study

The purpose of this desk study is to identify the geotechnical and geo-environmental, implications for the feasibility of the site to undertake the construction of the proposed new Braco West 400kV Substation. This desk study aims to provide SSEN Transmission and engaged design partners with information to assist in assessing the health and safety hazards and geo-environmental aspects present.

This desk top study is based on Envirocheck data collected for the site in August 2023 as part of the pre-construction information and other sources of existing site information. The study will focus on two site options which are currently being considered – Option 2 and Option 3, both within close proximity to the existing Braco West 275kV substation.

Based on the information gathered for this desk study, the significant geotechnical and geo-environmental issues are identified to enable assessment of the vulnerability of the project to these issues and any associated hazards.

Where there are insufficient, missing or illegible site records and drawings, the contractor shall, in agreement with SSEN, undertake adequate surveys and investigations to establish a full and complete desktop study. The findings of this study will be used to inform optioneering and further detailed ground investigation works. Detailed design, construction methodology and/or excavation shall not be based solely on the findings contained herein.

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2 Background

2.1 Introduction

A new 400kV substation at Braco West is required to support upgrade of the Beauly-Denny overhead line (OHL) to a 400kV double circuit. The Beauly-Denny 400kV OHL circuit will connect to a newly constructed 400kV Air Insulated Switchgear (AIS) double busbar at Braco West. The new substation will house 2no. 400/132kV SGTs and be future proofed with four 400kV future bays tied into the 400kV double busbar.

A connection (either OHL/UGC tbc) will connect back the existing Braco West substation where 2no. 275/33kV SGTs will be replaced with 2no. 132/33kV GTs. The existing 275kV switchgear will also be removed and replaced.

2.2 Detailed Proposal

The proposed Braco West 400kV substation upgrade will comprise the following elements:

- Construction of a new 400kV substation at Braco West.
- Removal and replacement of existing 275kV AIS switchgear with 400kV AIS switchgear
- Replacement of 2no. 275/33kV SGTs with 132/33kV GTs (including any transformer bund upgrade/replacement Civils works)
- Connection from existing Braco West substation to the new 400kV substation
- Connect new Beauly-Denny 400kV circuit from Kinardochy 400kV double busbar to Braco West 400kV busbar
- Construction of a control building housing battery room, protection and control equipment
- Construction of a permanent access road to the new substation site
- Landscaping and biodiversity requirements
- Upgrade of existing/new access tracks and temporary site compounds and construction laydown areas where required.

2.3 Site Data Summary

A summary of data for the site is provided in Table 2-1 below.

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Table 2-1: Summary of site data.

Item	Description	Other comments
1	**Location:** Braco West Substation, Dunblane, FK15 9LP (NGR) 279100E, 708900N	Sites 2 and 3 located approximately 300m west of existing Braco West 275kV substation. Site footprint (AIS): 390 x 326m
2	**Altitude (m)** Site levels between 267 and 235m AOD.	Site topography moderately sloping to the SE
3	**Air Temperatures (average annual)** (a) Minimum: 0°C (b) Maximum: 18°C (c) Average over any 24 hours: N/A	Nearest Met Office climate station: Drummond Castle (9km from site).
4	Seismic withstand factor (all equipment)	N/A
5	Soil resistivity	N/A – to be determined through GI
6	Basic wind speed Vb (NA to BS EN 1991-1-4:2005 +A1:2010 Figure NA.1) Part 1-4: General actions – Wind actions (m/s)	To be determined by designer
7	Allowable Bearing Capacity (kN/m^2)	To be determined by designer

2.4 Site Location Map

The site is located near to the settlement of Braco, approximately 16km north of Stirling, Scotland, UK.

The location map showing the site options which were assessed is shown in Figure 1. Six sites were chosen to go forward to Stage 2: detailed site selection, with the preferred site(s)determined as Sites 2 and 3. Sites 2 and 3 have been selected based on their close proximity to the existing Braco West substation, their position being adjacent to the line making it an ideal tie in point, there being no major environmental concerns and the ability to utilise an existing access track for construction and general site access.

Sites 2 and 3 were deemed to be the most feasible option on financial, engineering and connectivity grounds, and will therefore be the focus of this desk study report. The report will encompass the general area which covers both sites as they are geographically adjacent.

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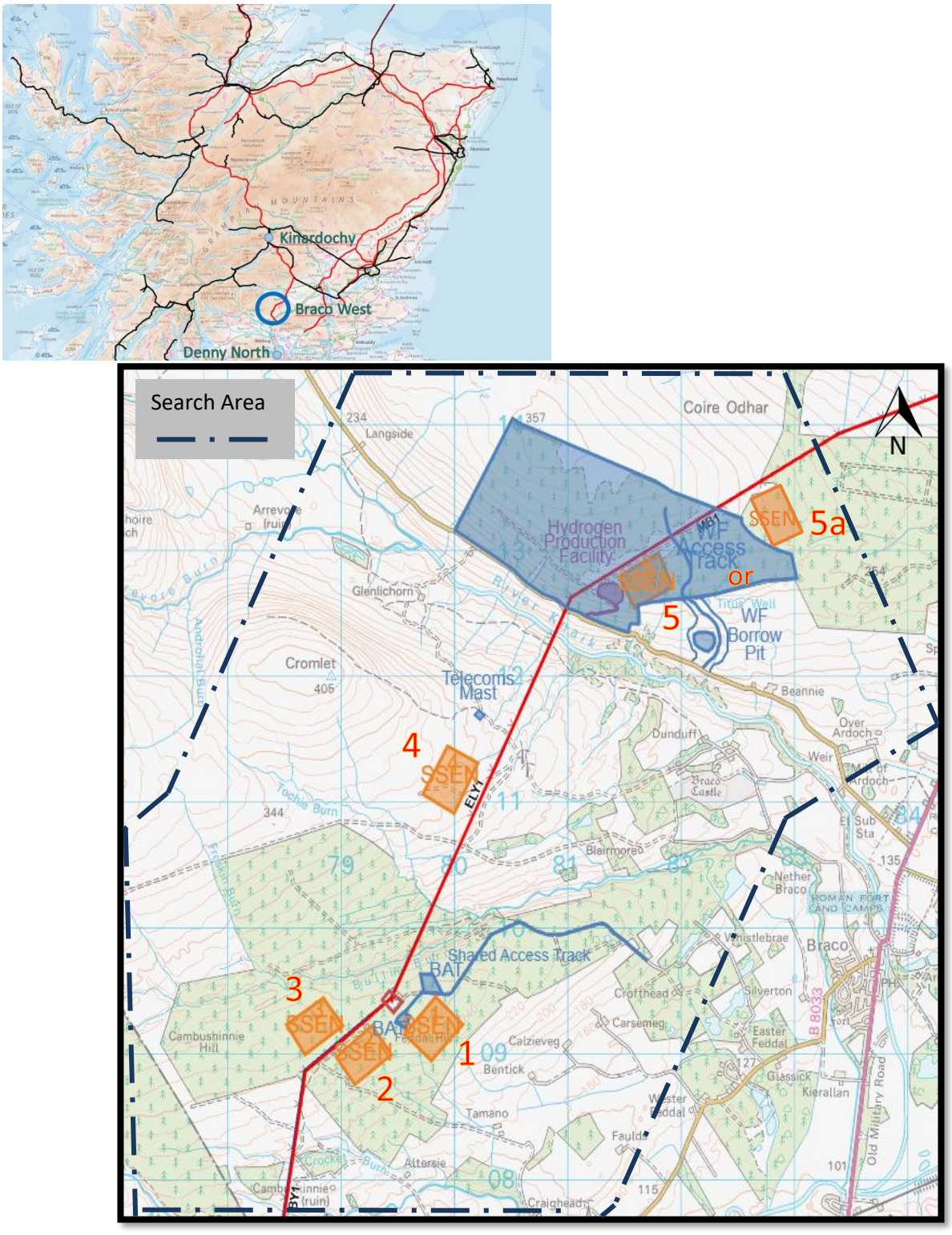

Figure 1: Location of Braco West substation. Preferred sites 2 and 3.

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2.5 Site Description

The proposed site(s) are located approximately 300m west of the existing Braco West substation, itself located around 4km west of Braco, Perth and Kinross. The centre of the Site 2 is located at approximate National Grid Reference (NGR) 279067E, 708983N (56.257903°, -3.953720°) and Site 3 at NGR 279266E, 709077N (56.258800°-3.950558°) respectively. The sites can be accessed by a surfaced farm track, which itself can be accessed from the B8033 which heads south-west out of the village of Braco, turning off from the A822.

Site 2 is approximately rectangular in shape, bounded by access tracks to the north and west and comprising of forestry land. Site 3 is also rectangular in shape and comprised of forestry land, bounded by a forestry track to the south. It should be noted that part of the site has immature trees with the remaining area already felled.

The current design proposes an AIS solution, with the anticipated platform footprint 390 x 326m (refer to Appendix A for draft layout drawing). The terrain at Site 2 is generally steeper than Site 3 and is moderately sloping towards the south-east at an elevation ranging from approximately 250mAOD to 235mAOD (average slope angle of 12%). The slope levels out to the north of the forestry track, with the gentler slopes in the southern section of Site 3 also sloping towards the southeast at an elevation of 267mAOD to 260m AOD (average slope angle 5-10%). There is a topographic high to the north of Site 3 marked on the OS map as Cambushinnie Hill, at a spot height of 270m AOD.

Past land uses for the site(s) are limited to open moorland and forestry, so there is no made ground or contamination anticipated.

3 Technical Information

3.1 Geology

The Envirocheck report, which utilises data from the BGS (British Geological Society (https://www.bgs.ac.uk/map-viewers/geology-of-britain-viewer/), recovered the following information.

3.1.1 Superficial Geology

British Geological Survey (BGS) published data records Class 4/5 peat across the area which covers both sites. Peat is a partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions. It should be noted that the Nature Scot website indicates that peat underlies the western section of the site only. Due to conflicting sources of information and the fact the total extent and depth of the peat is not known, this should be quantified through a peat probing exercise at the sites, or trial pitting as part of the intrusive GI.

Glacial Till was also recorded in the southern half of Site 2. Till is an unsorted and unstratified drift deposit, deposited by a glacier, consisting of a mixture of clay, sand and gravel (potentially with boulders). As till can be variable in its stratigraphy and geotechnical properties, the extent and nature of the deposit should be further quantified through intrusive GI.

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Localised patches of alluvium were also recorded in the northern section of the site area. Alluvium is an unconsolidated deposit comprising a mixture of clay, silt, sand and gravel, deposited by a river, stream or other body of running water.

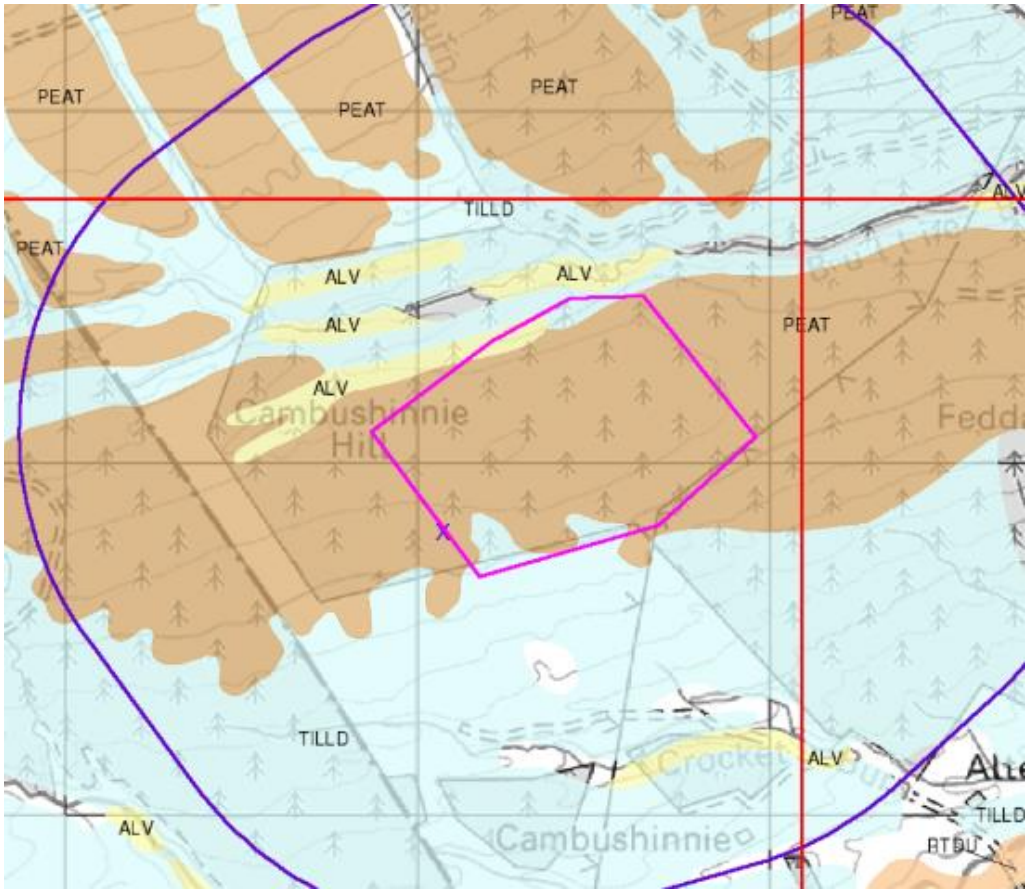

Figure 2: Superficial geology for area covering Sites 2 and 3.

The Scottish Government's soil maps show the site to comprise peaty gley soils. The Carbon and Peatland Map (2016) shows the peat to be dystrophic blanket peat (Scotland's Soils - soil maps (environment.gov.scot)).

Glacial meltwater channels are also marked as linear features across the site trending in a NW-SE direction (Figure 3). Meltwater channels are channels which are cut into the sediment due to the action of water flowing from a melting glacier or ice sheet.

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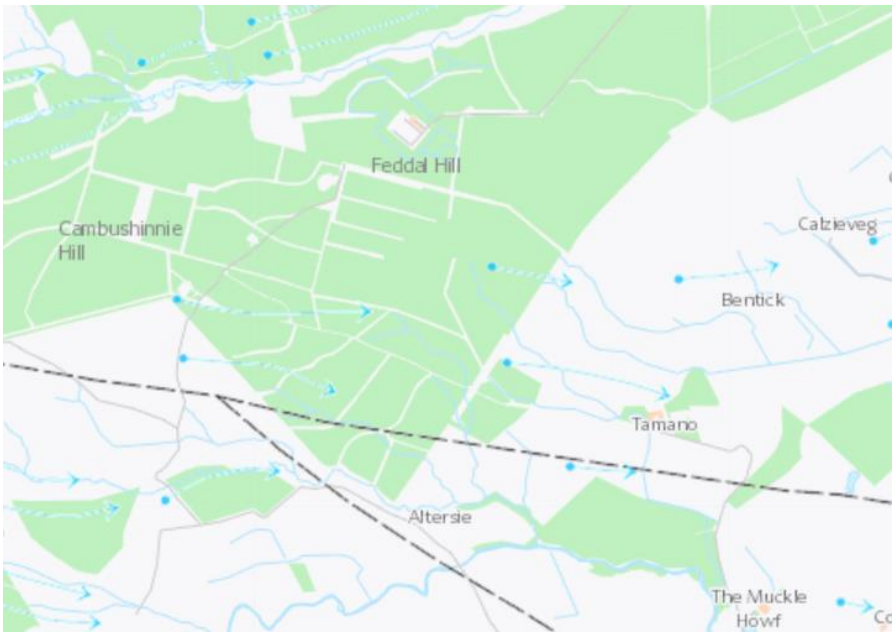

Figure 3: Glacial meltwater channels in the site area (from BGS Geoindex, 2023).

3.1.2 Bedrock Geology

The underlying bedrock comprises the Teith Sandstone Formation and the Cromlix Formation to the south of the site. The Teith formation is described as a reddish-brown, grey, purple and brown, cross bedded sandstone, locally interbedded with siltstone and mudstone intercalations. The Cromlix formation underlies the Teith formation and is described as purple, red and brown mudstones and siltstones.

In the site area, the bedrock is generally dipping towards WNW at an angle of 5°.

There is a fault which trends roughly from E-W to the west of the site area, however this does not cross the site areas itself and the ground profile is therefore anticipated to be consistent across the site and not disjointed as in the case that a fault would bisect the site.

3.1.3 Mining and Ground Stability

The Envirocheck Mining and Ground Stability report (2023) classifies the site(s) of being at high risk potential for compressible ground stability hazards. This is likely due to the nature of the soft peaty soils underlying the site. When peat is loaded, it may compress when loaded during the overlying platform and structures. The Scotland's soils maps (Scotland's Soils - soil maps (environment.gov.scot)) also describe the site as being 'extremely vulnerable' in terms of subsoil compaction risk.

The site has been classified as low risk for all other ground stability hazards including collapsible ground stability hazards, landslide hazards, dissolution stability hazards, running sand and shrinkage and swelling clay hazards.

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3.2 Site History

This section provides a summary of the site history and outlines any past potentially contaminative land uses. The site history was examined using Envirocheck (https://www.envirocheck.co.uk/) with the full results of the report provided in Appendix B.

3.2.1 Summary

A chronological review of the site by using historical maps produced in the Envirocheck report was complete and the results provided in Table 3-1.

Table 3-1: Review of site history using maps provided by Envirocheck (2023).

Year	Map	Change?	Description
1866	Perthshire	N/A	Site open moorland/rough pasture. Some access tracks marked on in eastern half of site area.
1901	Perthshire	No	
1925	Stirlingshire	N/A	No mapping data provided for site.
1952	Stirlingshire	N/A	No mapping data provided for site.
1958	OS Plan	No	Site still open moorland with access tracks to east.
1978	OS Plan	No	
2001	10k Raster Mapping	Yes	Site area now comprises coniferous forestry with access track network.
2006	10k Raster Mapping	No	
2022	VectorMap Local	Yes	Construction of Beauly-Denny overhead line which crosses the site area. More established network of access tracks running alongside power line.

The historical map review has shown that there has been little change at the proposed site in terms of land use. The area began as open moorland and rough pasture, with main land use changing to forestry, which was first indicated in 2001.

The main change relates to the construction of the Beauly-Denny overhead power line which can be seen cutting across the site area in the 2022 map. To accommodate the construction (and possibly forestry in the area) the network of access tracks surrounding the site has improved, creating more access routes to the site area. The tower line first appeared in maps in 2022, which matches up with the period of its construction which was circa 2011-2015.

3.3 Hydrology, Hydrogeology and Flood Risk Assessment

To assess the site hydrology, hydrogeology and flood risk, the following resources were utilised:

- Envirocheck - https://www.envirocheck.co.uk/
- SEPA Flood Maps - https://www.sepa.org.uk/environment/water/flooding/flood-maps/

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Sources were used to find information on nearby surface water features (type of feature e.g. stream, as well as distance and direction from the site), classification of watercourses, potential for groundwater and surface flooding and discharge and abstraction licences in the surrounding area.

3.3.1 Site Hydrology and Hydrogeology

The site is located at a moderate elevation (> 200m) with no notable standing bodies of water nearby. The main nearby hydrological features mapped are the Bullie Burn and Froskin Burn (approximately 300m north of Site 3 and 600m north of Site 2 respectively) and the Muckle Burn, approximately 600m south of Site 2 and 900m south of Site 3. It is likely the hydrological regime of the site area involves draining into the surrounding tributary river network before joining Allan Water further south and then finally draining into the River Forth.

The site is inland, and therefore not deemed to be a coastal location as per SSEN specification PR-NET-ENV-502.

The 1:625,000 scale hydrogeology map available on BGS GeoIndex (GeoIndex (onshore) - British Geological Survey (bgs.ac.uk)) classifies the bedrock, which is part of the Strathmore Group, as a moderately productive aquifer. In terms of movement of water in the bedrock, water is able to move through the rock readily in places, due to its porous nature, with some parts of Strathmore yielding up to 12L/s.

3.3.2 Flood Risk Assessment

The SEPA Flood Map (Figure 4) shows that there is no risk of flooding to either of the sites. There is a high likelihood of river flooding around the Bullie Burn to the north of Site 3, however this will not impact the site itself. There is also a high likelihood of localised surface water flooding in proximity to the perimeter of Site 2, however this will also not impact the site itself.

The Envirocheck flood maps (Appendix B) confirm that there is no immediate risk of flooding to the proposed site(s) considering both Sites 2 and 3. JBA Flood Maps (Undefended) showed that for the 75, 100, 200 and 1000-Year Return flood periods, there is no risk of flooding to the site. For the 1000-Year Return flood periods there is some flooding of between 0.1-0.3m possible around the watercourse to the North of the site, but as this localised, will not impact the site itself.

The CEH flood map further confirms that the area is not at immediate risk from a 1:100-year flood event.

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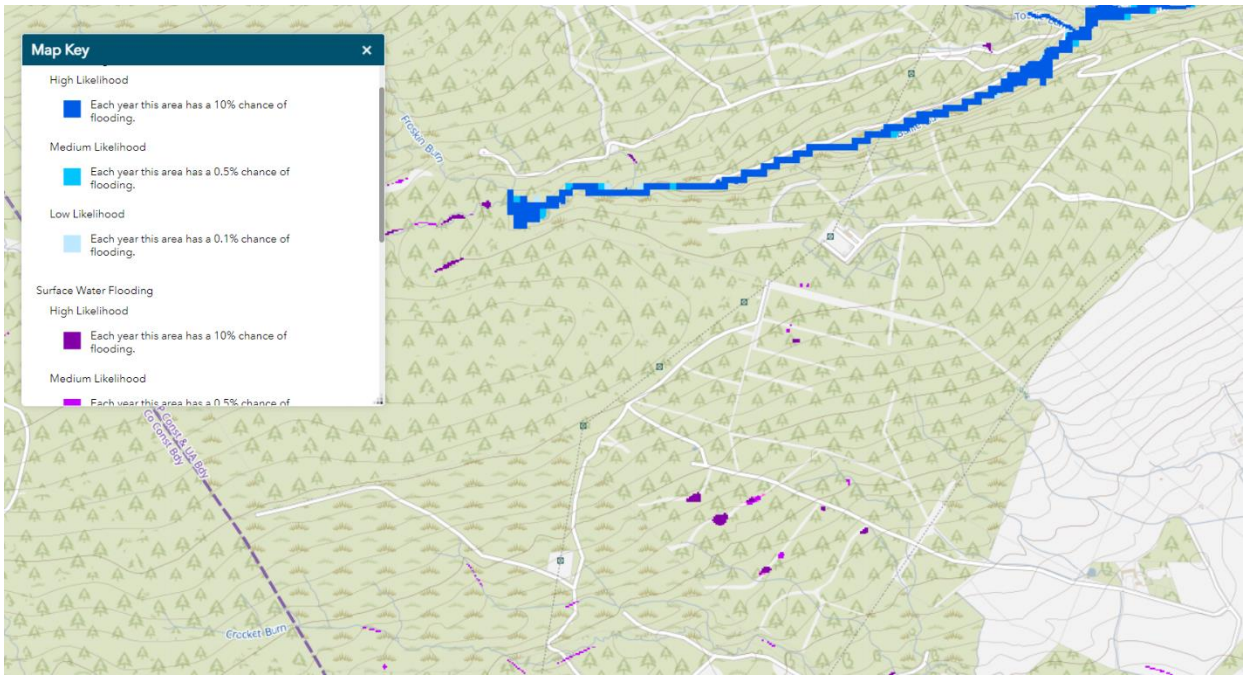

Figure 4: Extract from SEPA Flood Risk Map.

3.3.3 Discharge and abstraction of water

An abstraction refers to removal or diversion of water from the natural environment, by a variety of means, including pumps, pipes, boreholes and wells. Generally, authorisation will be required for SEPA in the event that this would be required for the site, both for a temporary and permanent basis.

There has been no information on existing discharge and abstraction consents provided in the Envirocheck.

3.4 Site Sensitivity

The Envirocheck Site Sensitivity Report (2023) returned the following information (Table 3-2), which is provided in full in Appendix B.

Table 3-2: Summary of Envirocheck Site Sensitivity Report.

Site Sensitivity Variable	Results
Soil Geochemistry (mg/kg)	Arsenic (<15), cadmium (n/a), chromium (60-90), lead (<100), nickel (15-30).
Groundwater Vulnerability	Highly permeable (low soil class)
Source Protection Zones	N/a
Sensitive Land Uses	Potentially infilled land marked as 'unknown filled ground' 700m to the west of the site. Due to highly permeable groundwater, this should be considered

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	when scheduling contaminant testing for the site.
BGS Flood GFS Data	Potential for groundwater flooding to occur at the surface (southern section of Site 2 and northern section of Site 3)
Industrial Land Use	None recorded
Flood Map (Agency and Hydrological)	No risk of flooding for 100-year flood event.
Historical Boreholes	BGS borehole (10-30m depth) located 200m to the west of Site 2. Upon checking no information available. Closest borehole approximately 3km to the northeast of the site from construction of the Beauly-Denny 400kV line.
OS Water Network Data	Inland river and tributary network to the north of the sites (Bullie Burn) and inland river to the south of the sites (Crocket Burn) and associated tributaries, closest approximately 200m south of the site.

3.5 Utility Drawings and Topographical Surveys

3.5.1 Utility drawings

Utility searches were carried out by SSEN's in-house Transmission Support team on the site on 08/09/2023 for the following services:

- BT
- Gas
- Scottish Water
- Virgin
- Electric

All utility drawings can be found in Appendix E. Note that if GI is being carried out more than 3 months after the service plans were requested, these will need to be re-requested.

3.5.1.1 BT

There are no existing BT services in the site area.

3.5.1.2 Gas

No gas assets were found in the area.

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3.5.1.3 Scottish Water

There are no Scottish Water assets in the site area. An alternative water source will therefore have to be considered during construction and operation of the site as a Scottish Water connection is not possible.

3.5.1.4 Virgin

There are no virgin assets registered in the site area.

3.5.1.5 Electric

The existing Beauly-Denny 400kV line bisects Site 2 and Site 3, running adjacent to the access track which tends NE to SW towards the existing Braco West substation.

3.5.2 Topographical Surveys

Currently, there has been no topographic survey carried out for the site.

3.6 Radon

A search of the UK Radon maps (UKradon - UK maps of radon) shows the site falls within the lowest band of radon potential (Figure 5).

Figure 5: Radon potential for site area.

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3.7 Unexploded Ordnance (UXO)

An initial check for UXO's on the Zetica website concluded that the site is at low risk for unexploded ordnance. There no further investigation is necessary.

3.8 Earthing Surveys

The earthing study for the site has not yet been undertaken but the results will be included when available.

3.9 Historic Ground Investigations

3.9.1 Beauly-Denny 400kV GI

The only available historical boreholes in the vicinity of the site are those carried out for the Beauly-Denny 400kV line. The ground conditions in the vicinity of the site are summarised in Table 3-3.

Table 3-3: Ground Condition Summary from Historic GI

BGS Geoindex Borehole ID	Distance from site (km)	Ground conditions (mBGL)	Groundwater (mBGL)
NN81SW18	2.8	0.0-0.2 – Peat 0.2-1.2 – Silty sand with gravel 1.2-2.7 – Silty gravelly SAND (SPT: 46) 2.7 -6.00 – weathered SANDSTONE	None recorded
NN81SW14	3.4	0.0-0.7 – Peat 0.7-1.2 – Gravelly sandy clay 1.2 – 2.7 – Glacial till (SPT: 50) 2.7 – 6.0 – Weathered SANDSTONE	None recorded

In general, the glacial till has high SPT values, suggesting it is a suitable founding medium, as we would expect from a glacial till which is generally an over consolidated glacial deposit. However further in-situ testing is required to confirm the properties of the stratum at the proposed site.

Sandstone is anticipated to be underlaying the site, so this is expected to be found below the glacial till/alluvium or where there is no cover by glacial deposits, directly underlying Peat.

3.10 Asbestos Survey

Due to the site being a remote greenfield site with no past construction history, there is no asbestos anticipated to be present at the site.

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4 Conclusions and Recommendations

4.1 Conclusions

An Envirocheck report and other external sources has been utilised to assess two sites in this desk study (Site 2 and Site 3). From this, the key conclusions are as follows:

- The proposed site(s) is in a landscape made up of extensive peatland. Due to the requirement for excavation of large volumes of peat to form the substation platform (proposed footprint of 390 x 326m), a peat management plan will need to be devised and actioned to reduce the amount of peat disturbed, and to manage the peat that is being excavated, promoting restoration on site and off site where possible.

- There is potential for made ground at the site if observed during the site walkover. If made ground is present, there is also potential for contamination, compressibility hazards and aggressive ground conditions.

- BGS maps and boreholes within 5km of the sites indicate that the subsurface profile is made up of peat underlain by glacial till which is in turn underlain by bedrock. Site walkover observations confirm the presence of peat and shallow bedrock although the location and depth of other superficial deposits (Alluvium and Till) remain unknown.

- Site 2 has steeper topography than Site 3 and so from a geotechnical perspective, Site 3 will likely require less earthworks to establish the platform. To minimise earthworks, a stepped platform arranged could be considered.

- There is no obvious water source available at the site and no indication that a Scottish Water connection might be possible. An alternative water source will therefore need to be considered – likely a borehole or attenuation methods.

- Both Site 2 and Site 3 have a range of mature and immature trees on site. Tree felling works will need to be co-ordinated in advance of any GI works commencing for access to and at exploratory hole locations.

- The sites are positioned within a hydrological setting which might be at risk of flooding, requiring additional assessment. Although the flood maps indicate there is no flood risk to the sites, a further detailed flood risk assessment should be undertaken to confirm this is the case due to the site's proximity to the Bullie Burn and Crocket Burn, which appear to be two of the main drainage outlets for the surrounding catchment. Part of the assessment should include an assessment of the site post development to assess any impacts of the platform on the surrounding hydrological environment. As the site will comprise a free draining platform and is underlain by a moderately productive sandstone unit, it is unlikely there will be an increased flood risk to third parties, however, this should still be considered, and appropriate drainage factored into early platform design.

- The existing Beauly-Denny 400kV line runs between Site 2 and Site 3. Access/egress beneath the line should be managed with appropriate GS6 when required during GI works.

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- The site is a greenfield site and has only been used for forestry in the past, so contamination is unlikely to be an issue at the site and this should be reflected in the GI scope.
- Shallow bedrock is anticipated at the site which is a constraint for development. The competency of the rock at this stage is unknown however significant earth moving plant and/or blasting may be required to achieve platform levels.

4.2 Recommendations

Based on the conclusions of this report, the following is recommended:

- A detailed Ground Investigation made up of:
  - Peat probing – maximum grid of 50m x 50m is recommended based on the anticipated platform size of 350m x 350m
  - Hand dug inspection pits to 1.2m
  - Boreholes advanced to 5m into rockhead (deeper at areas of large rock cut slopes)
  - Trial Pits to be machine excavated to depth of at least 4.5m below ground level (or until bedrock is encountered)
  - Geotechnical (disturbed, undisturbed and bulk) and geo-environmental soil and water sampling
  - Borehole installations
  - Groundwater/gas monitoring
  - Geotechnical and geo-environmental laboratory testing
  - Surveying of exploratory hole locations
- Detailed reporting of the results of the Ground Investigation, including:
  - Ground Investigation Report (GIR)
  - Interpretative Ground Investigation Report
  - Summary presentation of factual/interp report findings
  - AGS 4.0 data (submitted in XLS format)
- As large volumes of peat will require excavation, a peat management plan should be put in place before commencement of the main construction works. This should include:
  - Peat stripping plan

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- Peat stockpile plan
- Compilation of data relating to the volume and type of peat excavated, transported and stockpiled
- Restoration plans.

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5 Revision History

No	Overview of Amendment and Text affected	Previous Document	Revision	Authorisation	Date
01	First draft checked, approved and issued.	N/A	1.0	Rebecca Simister	
02					

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Appendix A Proposed Substation Layout

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