Cambushinnie 400kV Substation

Geo-Environmental Desk Study

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		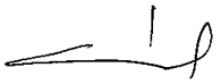	
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Revision History

Revision	Revision date	Details	Authorized	Name	Position
Issue 0	13 June 2024	Draft for client comment.		Judit Gal	Associate Director
Rev 1	02 July 2024	Revised layout and removal of Haul Road		George Baggott	Principal Consultant
Rev 2	29 January 2025	Updated development description and access track		George Baggott	Associate Director

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The methodology adopted and the sources of information used by AECOM in providing its services are outlined in this Report. The work described in this Report was undertaken between 19 January and 01July2024 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances. AECOM disclaim any undertaking or obligation to advise any person of change in any matter affecting the Report, which may come or be brought to AECOM's attention after the date of the Report.

The site walkover conducted of areas accessible to public on 15 January and 26 March 2024 consisted of a general inspection of the study area aimed at identifying any obvious signs and potential sources of ground contamination affecting the proposed development areas. An environmental compliance audit and/ or detailed structural inspection of existing buildings were out with the scope of this report. Similarly, the site visit excluded detailed consideration of the ecological or archaeological aspects of the site, and if such are believed to be of potential significance then it is recommended that specialist advice is sought.

Any risks identified in this Report are perceived risks, based on the information reviewed during the desk study and therefore partially based on conjecture from available information. The study is limited by the non-intrusive nature of the work and actual risks can only be assessed following a physical investigation of the site. The opinions expressed in this report and the comments and recommendations given are based on a desk-based assessment of readily available information and an initial site reconnaissance by an AECOM Engineer.

Unless otherwise stated in this Report, as a formalised development plan or finalised development option was not available at the time of writing, the assessments made cover the wider development boundary.

Reference to historical Ordnance Survey (OS) maps and/or data provides invaluable information regarding the land use history of a site. However, it should be noted that historical evidence will be incomplete for the period pre-dating the first edition and between the release of successive maps and/or data.

Table of Contents

Plates

1. Introduction

1.1 Commission

AECOM Limited has been commissioned by Scottish Hydro Electric Transmission known as Scottish & Southern Electricity Networks ('SSEN Transmission') (the Client) to undertake a Geo-environmental Desk Study for the construction of electricity infrastructure including; a new electricity substation, a tie-in back into it through an Overhead line, a section of Underground Cable (UGC) and access track extensions and upgrades to enable the construction and operation of the proposed Cambushinnie 400 Kilovolt (kV) substation, approximately 400 m southwest of the existing Braco West Substation. This report specifically refers to the proposed substation (including the UGC) and the access track extension and upgrades. A separate Desk Study report has been prepared which discusses the proposed Overhead Line (OHL) Tie-In.

The Geo-environmental Desk Study is required to characterise potential land quality constraints / opportunities, and to provide input as baseline data to the Environmental Impact Assessment.

1.2 Proposed Development and Planning Status

A planning application for the permission for the proposed development has not been submitted at time of writing, however it is understood from the Client that the proposed development will comprise the following:

- Temporary construction compound (including a temporary potable water borehole for welfare during construction, expected volume extracted of less than 10m^3 per day) and laydown area;
- Substation platform of approximately 410 m x 220 m with associated earthworks;
- Two 400/132kV transformers, a new 400kV double busbar and ancillary equipment;
- A new control building (approximately 24 m x 49 m) with a maximum height of 7m above the finished surface level;
- Removal and replacement of some of the equipment from the existing 275kV Braco West Substation, including the transformers, with the substation to continue operating at 132kV;
- Existing access track upgrades between the B8033 and existing Braco West Substation
- Construction of new access track from the existing Braco West Substation to the Cambushinnie substation platform;
- Upgrades to the existing Cambushinnie Hill track;
- Construction of new access track from the northwestern edge of the proposed Cambushinnie substation platform to the SUDS basin;
- Permanent drainage systems;
- One permanent borehole for site water supply located on approach to the main access gate of the proposed substation (expected volume extracted of less than 10m3 per day);
- Landscaping and biodiversity enhancements; and
- Palisade perimeter fence of maximum height of 4m above the finished surface level.

The site boundary encompasses a number of different (and distinct) site areas, as such, for the purposes of this study the various areas of the site boundary will be described using the following terms (with these features labelled where relevant on Figure 1 below):

- **Wider site / the site** – all areas and features within the red line boundary.
- **Proposed substation** – the footprint area of the new substation only, including the track extension and upgrades.
- **Existing substation** – the area covered by the existing 275 kV substation, which is within the red line boundary.
- **Existing Access track** – the track between the B8033 and the existing Braco West substation.

The proposed development site location plans are shown on figures within **Appendix A**. Extracts of the site location plans are provided as **Figure 1** and **Figure 2** below.

Figure 1 Site Location Plan

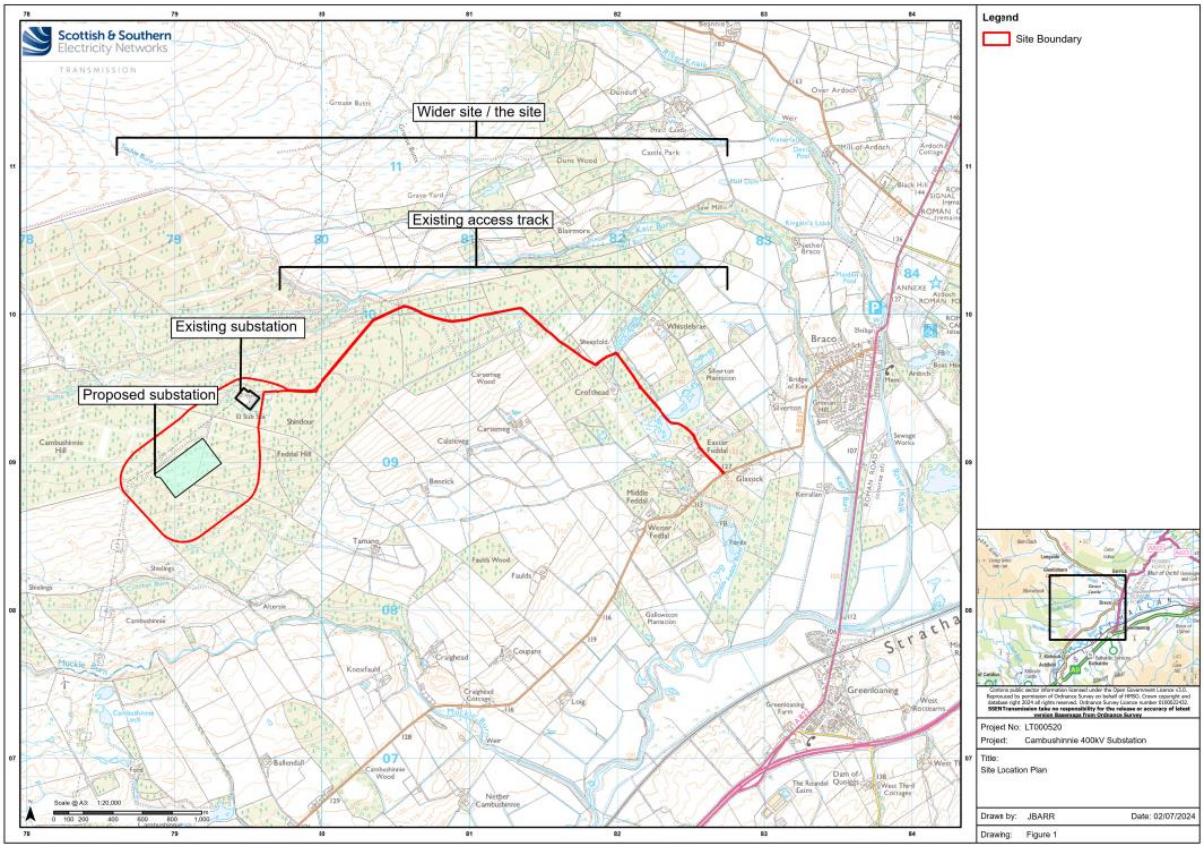
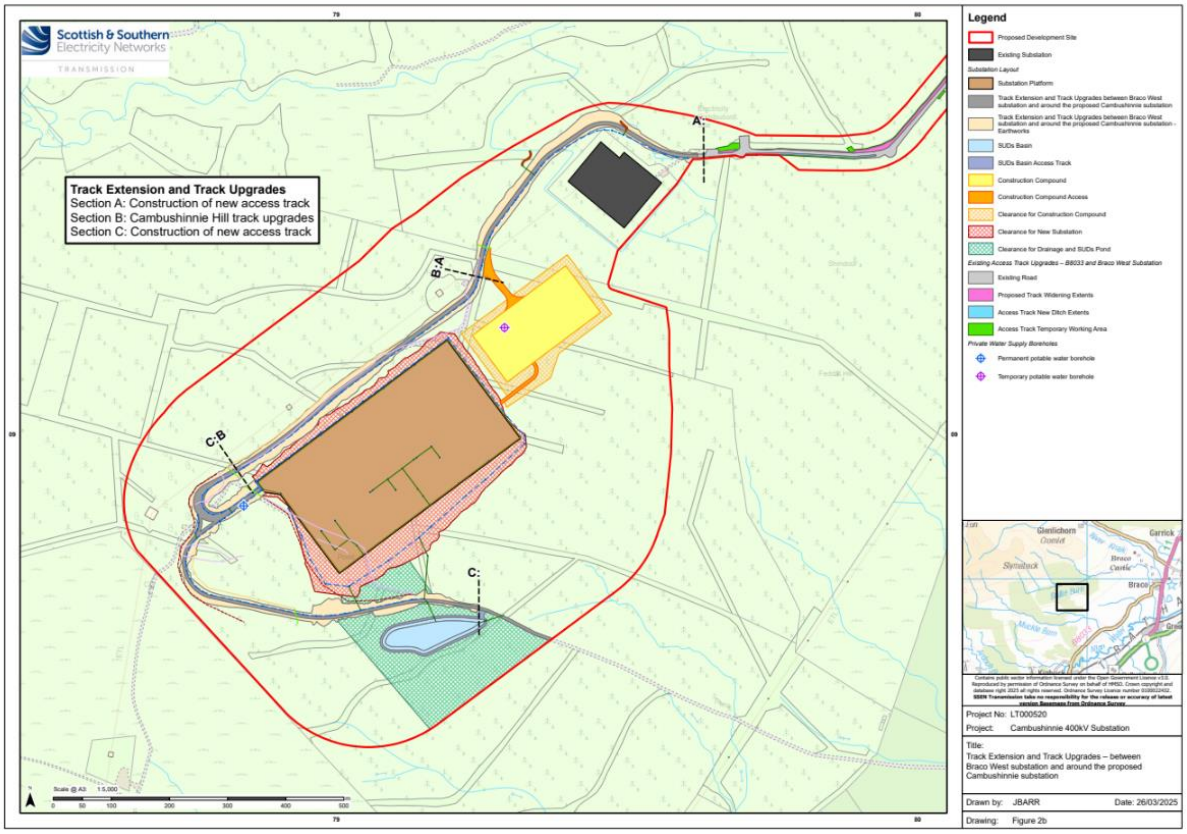


Figure 2 Site Location Plan: Proposed substation and track extension and upgrades



1.3 Scope and Objective of Report

The objective of the Geo-environmental Desk Study is to characterise the environmental setting and sensitivity across the site, along with the potential for contamination to exist and the pathways through which contamination may come into contact with sensitive receptors given the nature of the proposed development. The Geo-environmental Desk Study includes the following key activities:

- Review of aerial imagery for site layout and terrain evaluation to provide a current description of the site's layout and setting within the local area;
- Review of historical land uses for the site and surrounds with a particular emphasis on identifying potential on-site and off-site contamination sources, and potential for made ground;
- A review of the site's geological (including available BGS borehole records), hydrological and hydrogeological setting, publicly available non-coal and coal mining records and geo-environmental information to build up an understanding of the site setting and surrounding environmental sensitivity;
- Request and review relevant records held by the Local Authority Contaminated Land Officer along with public regulatory records provided within Groundsure Reports purchased for the site;
- Review of available records provided by the Client;
- Review publicly available records from consultees including (but not limited to) Historic Environment Scotland website, the Zetica bomb risk maps, UK Radon website, flooding information, the National Library of Scotland etc to further inform the study;
- Develop a preliminary Conceptual Site Model (CSM) for the site to identify the potential contamination sources, pathways, and receptors for consideration in the context of the potential development followed by a preliminary qualitative risk assessment for the site;
- Summarise identified geo-environmental and land quality risks; and
- Recommendations for further geo-environmental assessment, if required.

1.4 Sources of Information

The following bodies were consulted during the assessment:

- Groundsure Enviro+Geo Insight (GSIP-2024-14502-17022) (Appended in **Appendix C**)
- The Mining Remediation Authority Map Veiwer[1]
- British Geological Survey (BGS)[2]
- Scottish Environment Agency (SEPA) Water Classification Hub[3]
- SEPA Flood Risk[4]
- NatureScot Site Link Map[5]
- Historic Environment Scotland[6]

[1] The Mining Remediation Authority, 2023. *Interactive Map* [online]. [Accessed 16 January 2025]. Available at: Mining Remediation Authority Map Viewer
[2] British Geological Survey, 2020. *Onshore Geoindex* [online]. [Accessed 09 May 2024]. Available at: https://mapapps2.bgs.ac.uk/coalauthority/home.html.
[3] SEPA, 2015. *Water Classification* [online]. [Accessed 09 May 2024]. Available at: https://www.sepa.org.uk/data-visualisation/water-classification-hub/
[4] SEPA, 2024. *Scottish Flood Hazard and Risk Information* [online]. [Accessed 09 May 2024]. Available at: https://map.sepa.org.uk/floodmaps/FloodRisk/Search
[5] NatureScot, 2024. Site Link Map Search [online]. [Accessed 09 May 2024]. Available at: https://sitelink.nature.scot/map
[6] Historic Environment Scotland 2024. Explore our sites by region | Historic Environment Scotland | HES

- Zetica UXO Map[7]
- UK Radon Map[8]
- Topography map United Kingdom topographic map, elevation, terrain[9]
- Google Earth satellite imagery[10]

[7] Zetica, 2024. *UXO Risks Map* [online]. [Accessed 09 May 2024]. Available at: https://zeticauxo.com/guidance/risk-maps/
[8] UKradon, 2024. *UK maps of radon* [online]. [Accessed 09 May 2024]. Available at: https://www.ukradon.org/information/ukmaps
[9] United Kingdom topographic map, 2024. United Kingdom topographic map [online]. [Accessed 09 May 2024]. Available at: https://en-gb.topographic-map.com/map-cgt/United-Kingdom/
[10] Google Earth, 2023. [Online]. [Accessed 09 May 2024]. Available at: https://earth.google.com/web/@-3.47981663,150.00030013,-3256.63719952a,18709751.81607485d,35y,165.58670573h,0t,0r/data=OgMKATA

2. Site Description

2.1 Site Location

The proposed substation site is located approximately 3.9 km west of the village of Braco and 4.13km north-west of the A9 dual carriageway. The national grid reference of the centre of the site is NN 79409 09358 and the nearest postcode is FK15 9LP. The site location is shown in **Figure 1** above showing the location of the existing access track with the larger figure included in **Appendix A**.

2.2 Site Walkover and Description

A site reconnaissance survey was undertaken by AECOM staff on 15 January and 26 March 2024. During the reconnaissance observations were made on the topography, land use, drainage and potential sources of contamination identified on site.

The site comprises an area of vacant land for the proposed construction of a new substation in proximity to the existing Braco West Substation, and the existing access track which connects the existing Braco West Substation with the B8033 road. Landscaping and biodiversity requirements have been proposed by the Client, however at the time of writing details of what and where these are to be placed within the wider site have not been made clear. The wider site is predominantly located in an area of agricultural and forestry use.

The proposed existing access track upgrades between the B8033 and the existing Braco West Substation are approximately 3.4km long. The existing access track will be widened to accommodate the required swept path for abnormal loads and resurfaced. Details of these upgrades are shown in **Appendix A**.

The track extension and upgrades are shown in **Appendix A** and on **Figure 2**. The track extension and upgrades will be approximately 2.2km in length and will consist of the following:

- Section A: Construction of new access track between the Braco West Substation and the site accommodation area access.
- Section B: Upgrades to the Cambushinnie Hill track including widening to accommodate the required swept path for abnormal loads and resurfacing of the existing track.
- Section C: Construction of new access track between the northwestern edge of the proposed Cambushinnie substation platform and the SUDS basin.

As the track extension and upgrades are within the substation platform area, it will be discussed concurrently with the substation platform in the remainder of this report.

The existing Braco West Substation is the only structure within 500m of the proposed substation and proposed underground cable (UGC). No residential dwellings are present within 500m of the proposed substation.

Details of the site reconnaissance are incorporated within **Section 2.3** and photos from the survey are included as **Appendix B**.

2.3 Current Site Use, Topography and Geography

The site is set within a predominantly agricultural and forestry area shown as Feddal Hill on maps, located to the west of Braco village and northwest of the A9 dual carriageway and approximately 8.5km north of the city of Dunblane.

2.3.1 On-Site

The proposed substation site comprises predominantly open moorland with coniferous forestry land of both mature and young trees present, forestry access tracks are also found across the site. According to Ordnance Survey mapping the site is situated at an elevation of approximately 250m above ordnance datum (AOD) on a hillside with the ground sloping downward towards the south and southeast. The existing Braco West 275kV Substation is located within the northeast of the site. The existing Braco West 275kV Substation comprises an approximately rectangular area of approximately 150m by 90m, the area is surfaced with a mix of hardstanding, asphalt and gravel. A car parking area for the existing Substation is present to the north-east and is surfaced with gravel hardstanding. The existing Substation site area is surrounded by palisade fencing. Four pylons associated with the

existing Braco West 275kV Substation, and the Beauly-Denny power line are located across the north of the proposed substation site, with the overhead lines running approximately northeast to southwest.

The entrance to the existing access track is located approximately 4.0km to the east of the proposed substation at an elevation of approximately 125m AOD and is orientated northwest from its junction with the B8033 then west to reach the site. The existing access track cuts through agricultural fields and forestry land.

2.3.2 Off- Site

The off-site area described below extends to a boundary of 1km to the north, east, south, and west of the site.

- **North -** An area of plantation forestry comprising predominantly coniferous woodland is present approximately 40m to the north of the site. The forested land slopes downward to the north until it reaches the Bullie Burn approximately 270m north of site, at an elevation of 214m AOD. To the north of the burn the land remains under use as plantation forestry, however, slopes upward to the north. A forestry access track runs east to west approximately 580m north of site.
- **East –** Plantation forestry comprising predominantly coniferous woodland is present to the east of the site. The existing access track are present within the east of site, with additional forestry access tracks branching off it. Crofthead and Easter Feddal farms are present located approximately 140m and 10m to the west of the existing access track, respectively, and Whistlebrae farm is present located approximately 300m to the east, with access to the farms, buildings and dwellings from the site access track. Land to the east of site slopes downward to the east and southeast.
- **South –** Plantation forestry comprising predominantly coniferous woodland is present to the south of site and the land slopes downward to the southeast and south. Tamano and Bentick farms are present located approximately 880m and 960m to the southeast of the site respectively, and Calzieveg and Carsemeg Farms are present located approximately 840m and 740m to the south of the existing access track respectively. The farms appear to comprise farm buildings and pasture and grazing land for animals and crops, and rented accommodation at Tamano farm.
- **West –** Plantation forestry comprising predominantly coniferous woodland is present to the west of site. The land slopes gently upward to the west toward Cambushinnie Hill, approximately 1.10km west of site at an elevation of 270m AOD.

3. Site History

3.1 Introduction

The following account of the historical development of the site and its immediate surroundings are based on a review of historical Ordnance Survey (OS) maps and aerial photography both obtained as part of a Groundsure Report (attached as **Appendix C**), and a review of publicly available web-based mapping services.

AECOM also notes that only indicative map scales are provided. Where dates are stated, these refer to the dates of maps on which the features are present, have changed use or are no longer annotated, and do not necessarily refer to the exact dates of existence of a particular feature. Development that may have occurred between map editions is recorded as occurring on the latter published map, hence there are some limitations to the accuracy to the date of development unless supplementary evidence is available.

3.2 Historical Ordnance Survey Mapping & Aerial Photographs

A review of historical land uses within the Site and surrounding areas has been undertaken using the Groundsure maps and aerial photography and is summarised below. It should be noted that the search has been limited to within 250m of the Site, with only notable land uses beyond this distance included.

Where map dates are not included in table below, there was no significant information present on those maps, or there were no apparent land use changes shown for these dates.

Table 1 Historical Map Review

Date/s	Features within on-site development area	Features within 250m of development area
1862-63 (1:10,560, 1:2,500)	• The site was undeveloped with mainly open moorland across the site. • Two access tracks cross the site from the southeast to northwest. The tracks branch out and intersect one another in the northwest of the site. • An access tracks runs along the northeast of the site, entering site from the east. • Southern and eastern sections of the existing access track are present.	• Crofthead farm and farmhouse, with a pond are shown adjacent to the west of the existing access track in the east. • Glassick farm and farmhouse is shown approximately 160m east, and Feddal House including a corn mill is shown approximately 240m west of where the existing access track meets the B8033 road. • A well is shown adjacent to the east of the access track.
1901 (1:10,560, 1:2,500)	• No significant changes	• The pond adjacent to the access track at Crofthead Farm is now labelled as a Mill Dam. • A sand pit is shown adjacent to the west of the junction of the existing access track and the B8033 road. • Two wells are shown to the south of Feddal House, approximately 200m and 275m south-west of the existing access track. • Fields, access tracks and a small building labelled Cambushinnie are shown approximately 500m south of site. • Silverton Plantation forestry is labelled east of the existing access track. • The corn mill at Feddal House is no longer shown. • A pump is shown adjacent to the east of existing access track replacing the well shown there previously.
1977 (1:10,560, 2,500)	• The access tracks crossing the site are no longer shown.	• The Mill Dam adjacent to the existing access track is no longer shown. • The sand pit adjacent to the existing access track is no longer shown. • A sheep dip is shown adjacent to the existing access track in the north-east. • Carsemeg Wood Sandstone Quarry is shown, located approximately 193m southeast of the exisiting access track.

Date/s	Features within on-site development area	Features within 250m of development area
		• The pump adjacent to the east of the existing access track is no longer shown.
2001 (1:10,560)	• The Site is indicated to be divided into sections of plantation forestry.	• No significant changes
2010 (1:10,560)	• The existing access track is shown along its full length.	• No significant changes
2014 (aerial imagery)	• Existing 275kV substation is shown in the north-east of site area.	• No significant changes
2024 (10,560)	• An access track is shown running northeast to southwest along the north boundary of the site.	• The sheep dip adjacent to the access track is no longer show.

Earliest discernible aerial photography from 1988 indicates the site and surrounding area to comprise undeveloped agricultural and forestry land. By 1991 access roads to the forestry area are visible to the north, east, and south-east of site. By 2014 the Braco West Substation is indicated to the north-east of the proposed substation site.

3.3 Summary of Potential Historical Contamination Sources

This section summarises potential contamination on site and in the vicinity associated with historical features identified in **Section 3.2**. These include:

- Made Ground associated with the construction of the existing Braco West Substation (on-site), the construction of access roads (on-site and off-site), car park (on-site) associated with the existing substation and infilled land associated with the sand pit, ponds and wells (off-site). These could have the potential for contaminants such as metals and inorganic compounds, pH, Polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH) including benzene, toluene, ethylbenzene, xylene (BTEX) and methyl-tert-butyl-ether (MTBE), semi volatile organic compounds (SVOCs), volatile organic compounds (VOCs), sulphates, sulphides, cyanides, phenols.
- Electricity Substation (on-site), with potential for contaminants[11] such as hydrocarbons, heavy metals, sulphates.
- The sheep dip (off-site) could have to the potential to release contaminants such as metals, organo-phosphates and pyrethroids.
- Potential windblown asbestos from historical and current farm buildings (offsite).

[11] Polychlorinated biphenyls (PCBs) discounted as substation constructed post-2010 after use of PCBs had been banned.

4. Existing Information Review

4.1 Introduction

Information provided to AECOM related to the subject site from previous planning developments, and planning applications including one client produced report and information issued by Consultees (i.e. Perth and Kinross Council Contaminated Land Officer) have been reviewed as part of this study. Relevant information relating to the proposed development geological or land quality status, has been subject to a review and summary as part of this report.

4.2 Previous SSEN Transmission Desk Study Report

4.2.1 Geo-Environmental Desk Study LT520 – Braco West Substation (2023)

AECOM has received a Phase 1 Desk Study report for the site undertaken by SSEN Transmission for the purpose of identifying geotechnical and geo-environmental implications of the construction of the new 400kV substation at the site adjacent to the existing 275kV Substation at Braco West, and provide an appraisal of two options for construction (designated as Option 2 and Option 3) and site layout [*report ref. LT520-BRCW-GDS_CIV-001, dated 31 October 2023*]. A copy of this report is available in **Appendix D**.

Two site options for the location of the substation were considered for assessment within the desk study report. Option 2 ('site 2') is located approximately within the proposed substation site area, 300m southwest of the existing Braco West 275kV Substation. Option 3 ('site 3') is located along the north of the proposed substation site area and extends off-site to the north, approximately 300m west of the existing Braco West 275kV Substation. The area considered for Option 2 better represents the subject site area of the proposed substation discussed in the AECOM report. The report reviewed details for the site and surrounding area including historical mapping and environmental setting and formed conclusions and made recommendations for further assessment of the site. The report identified the following key findings:

- The history of the site and surrounding area was found to be open moorland / rough pastureland from 1866 with some access tracks marked in the east of the site area. The site remained unchanged until 2001 by which time the site and surrounding area comprised coniferous forestry with access track network throughout. By 2022 the overhead line of Beauly-Denny crossed the site area with a more established access track network running along the route of the power line. No Made Ground or contamination anticipated within the site areas based on historical use of the site was found.
- Environmental setting of the site was found to comprise of superficial deposits of peat underlying the site areas, with Glacial Till expected to underly the southern area of site 2. Glacial meltwater channels were identified running approximately northwest to southeast across site areas. Geology underlying the site was found to comprise Teith Sandstone Formation and Cromlix Mudstone Formation. A bedrock fault was identified running east to west to the south of the sites. The Envirocheck report referenced in the report found the site to be at high-risk potential for compressible ground stability hazards, associated with the peat deposits.
- Nearby surface water features were identified as the Bullie Burn approximately 300m north of site 3, and Muckle Burn approximately 600m south of site 2. The hydrological regime of the site area was recorded as draining into the surrounding tributary river network before joining Allan Water to the south. The bedrock is classified as a moderately productive aquifer.
- Neither of the sites were identified to be at risk of flooding. However, it was noted that a high likelihood of localised surface water flooding existed in proximity to the perimeter of site 2 though not expected to impact the subject site itself.
- Conclusions of the report were as follows:
    - A peat management plan would be required for the construction of a new substation at either site option to reduce the amount of peat disturbed and manage the peat being excavated.
    - A water source for the duration of construction works would be required to be established, as no such water source or connection was present on or near the site.
    - Further detailed flood risk assessment for both site options was considered necessary.
    - Contamination at the sites was considered unlikely based on the history of the site and surrounding area.

- Shallow bedrock was anticipated meaning a potential constraint for development as the competency of the rock is unknown.

- The report made the following recommendations based on the findings:
  - A detailed Ground Investigation comprising peat probing, hand dug inspection pits, boreholes advanced to 5m into the rockhead, trial pits to 4.5m or to bedrock, soil and water sampling for geotechnical and geo-environmental testing, and gas and groundwater monitoring and well installation.
  - Recommendations for the production of reports were made including a Ground Investigation (Phase 2) Report (GIR), an Interpretative Ground Investigation Report, and a summary of presentation of factual / interpretative report findings.
  - Additional recommendations included a peat management plan to be put in place prior to commencement of the main construction works.

4.2.2 AECOM Comments

Following our review of the desk study report, the following are considered to be relevant to this study:

- The desk study report did not include conceptual site models (CSM) or undertake a preliminary risk assessment (PRA) for the sites. These are considered necessary requirements for a Phase 1, Geo-Environmental Desk Study Report, and are included within this report.
- The desk study concludes and recommends that a peat management plan is likely to be required for the development of either site. This is expected to be the case, with the current SEPA guidance focussing on the generating of waste peat through prevention of generating waste peat, and re-use of waste peat on the site as much as possible.

4.3 Igne, Report on Ground Investigation (2024)

SSEN Transmission commissioned Raeburn Drilling & Geotechnical Limited (RDG) to undertake a ground investigation including peat probing in the area of the proposed substation and UGC (referred to as Site 2 in section 4.2). Further peat probing was undertaken in the area to the immediate north of the proposed substation (referred to as Site 3 in section 4.2). The site works were carried out under the instruction of SLR Consulting. A factual ground investigation report[12] was provided to AECOM for review. The objective of the works was to provide information on the ground conditions for design and construction of the proposed development and in relation to determine any geochemical contamination of the site. The site work was carried out between 15 November and 8 December 2023, in accordance with EN1997-2:2007, BS5930, BS10175 and in house - procedures. Additionally, one round of ground gas was undertaken on the 11 December 2023.

The report on ground investigation comprised borehole and trial pits records, testing records, laboratory results, photographs, and a site plan. A copy of this report is available in **Appendix D**.

The ground investigation works included fourteen boreholes drilled by sonic and rotary core drilling, with three boreholes drilled by continuous percussion using a dynamic sampler and rotary core drilling up to 15.75m below ground level (bgl)[13]. Twenty trial pits were undertaken within the proposed substation and UGC area (referred to as Site 2) and excavated by mechanical means up to 3.00m bgl[14]. Approximately 4,600 peat probes were also undertaken across the proposed substation and UGC (referred to as Site 2) and to the immediate north of the proposed substation area (referred to as Site 3)

Perforated standpipes were installed in nine boreholes between 0.50m bgl and 10.00m bgl to monitor ground gas concentrations for methane, carbon monoxide, carbon dioxide, hydrogen sulphide, and oxygen. In addition, groundwater levels were recorded during ground gas monitoring.

The report identified the following key findings:

- The sites 2 and 3 mentioned above are located within an area of forestry land comprising of mature and semi mature trees on the eastern slopes of Feddal Hill located approximately 5.0 km west of Braco Village, Perth and Kinross.

[12] Igne-Report on Ground Investigation, LT307 Braco West Sites 2 &3, 26 January 2024
[13] Based on BH05
[14] Based on TP21

- Due to two substation sites being proposed as part of the ground investigation these are centered at the following National Grid References Site 2 NN791089 and Site 3 NN787091.
- Both sites are located to the southwest of the existing Braco West Substation.
- The laboratory geotechnical testing was carried out by Terra Tek Limited (Trading as Igne) and included the following: Moisture content, Liquid and plastic limit tests, Bulk Density, Particle Size Distribution, Moisture Condition Value, California Bearing Ratio, Small Shearbox, Los Angeles, Point Load, Unconfined Compressive Strength.
- The laboratory geo-environmental testing was carried out by Terra Tek Limited (Trading as Igne) and included the following testing: Metals, Inorganic Suite, Total Petroleum Hydrocarbon Criteria Working Group / Volatile Petroleum Hydrocarbon Criteria Working Group (TPHCWG / VPHCWG), Total Organic Carbon, Phenol, Organic Matter, pH, Sulfate, Polyaromatic Hydrocarbons (PAH), Asbestos, WAC analysis.
- Chemical contamination testing was carried out on 19 samples of made ground and soil.
- Chemical results were generally close to or below the method detection limit, except for generally higher total chromium, arsenic, zinc, lead, nickel, copper, organic matter and sulphate. Whilst AECOM have not undertaken a formal quantitative risk assessment of the data provided for review, the concentrations do not appear to indicate contamination impacts for a proposed commercial land use.
- No asbestos containing materials were identified within the soil samples analysed.
- The WAC testing (only one completed) did not show any exceedances of inert landfill, stable non-reactive hazardous landfill and hazardous landfill acceptance criteria.
- Groundwater strikes were encountered in three of the trial pits -TP07 at 1.20m bgl, TP09 at 2.00 m bgl and TP13 New at 1.50m bgl, within bedrock and superficial deposits.
- A summary of the geological strata encountered during the ground investigation is presented below:
    - Peat from surface up to 1.90m bgl and described as soft brown to dark brown spongy amorphous[15]. Peat was encountered in all locations with the exception of TP10 New and TP21.
    - Made ground was encountered from surface up to maximum depth of 0.70m bgl[16] in two trial pits (TP21 and TP23) and described as of dark brown/grey to brown slightly gravelly silty fine to coarse sand with occasional roots, or reddish brown gravely clayey fine to coarse sand with medium to high cobble content and occasional pieces of wood.
    - Superficial deposits of sand, gravel and clay were encountered between 0.20m bgl[17] to 5.50m bgl[18], and described as brown to reddish brown very gravelly silty fine to coarse SAND, and red brown sandy CLAY with sandstone boulders, respectively. Gravel was encountered between 0.45m bgl to a maximum depth of 2.70m bgl[19], and described as brown very sandy silty with medium cobble content[20] or reddish brown very sandy silty[21]. Deposits of silt were encountered in BH04 between 0.55m bgl and 1.20m bgl and described as reddish brown slightly gravelly sandy.
    - Bedrock was encountered in all boreholes. However, it was not encountered in trial pits-TP04, TP05, TP09, TP11, TP12 New, TP13 New and TP21.
    - Bedrock of sandstone was encountered between 0.90m bgl[22] and 5.50m bgl[23] (depths of top of the bedrock) and described as medium strong brown grey, slightly moderately weathered and recovered as gravelly silty fine to medium sand with high cobble and medium boulder content; and weak to

[15] Based on BH18
[16] Based on TP21
[17] Based on TP13 New
[18] Based on BH01
[19] Based on BH01, BH02, BH05, BH07, BH08
[20] Based on BH07
[21] Based on BH05
[22] Based on TP01
[23] Based on BH01

medium strong thinly to thickly laminated reddish brown fine to coarse medium grained SANDSTONE recovered as very sandy very gravelly cobbles, respectively.

- Very weak to weak greyish brown MUDSTONE with reddish brown siltstone laminae was encountered between 3.80m bgl[24] to 10.55m bgl[25] (depths of top of the bedrock).
- The maximum bottom depths of bedrock were 15.75m bgl[26] and 15.45m bgl[27] for sandstone and mudstone, respectively.

- Assumed Zone of Core Loss were encountered in BH01, BH02, BH05, BH08 as follows:
  - BH01 between 4.00-4.40m bgl, between natural deposits
  - BH02 1.80m bgl-2.30m bgl, and 9.10-9.30m bgl between natural deposits and bedrock.
  - BH05 between 3.90-4.30m bgl, and 5.40m bgl -5.95m bgl, between bedrock
  - BH08 between 2.70m bgl -3.10m bgl, between natural deposits and bedrock.
- One round of ground gas monitoring data was undertaken at atmospheric pressure ranging between 962mbar and 971mbar. The following ground gas results were recorded:
  - Methane (CH4) at 0%v/v;
  - Carbon dioxide (CO2) between 0 %v/v and 0.10%v/v (steady levels), with higher peaks at 0.20% v/v in BH04 and BH13;
  - Oxygen (O2) between 19.10 %v/v and 19.40%v/v (steady levels);
  - Hydrogen sulphide (H2S) between 0ppm and 1ppm; and
  - Carbon monoxide (CO) at 0 ppm and 2ppm (steady levels).

Groundwater levels were recorded between 2.44m bgl (BH01) and 8.74m bgl (BH19). Locations BH04, BH10, BH13 and BH14 New were recorded as dry.

4.4 Local Authority Consultation

4.4.1 Contaminated Land Officer - Consultation

AECOM has requested information from the Perth and Kinross Council (PKC) Contaminated Land Officer relating to potentially contaminated land within the site within a radius of no greater than 500m from the site. The following information has been issued to AECOM on 29 January 2024 (ref. PKCIR:161), a copy of the correspondence is available in **Appendix E**:

- PKC Contaminated Land Team does not hold records of any issues relating to contaminated for the site.
- No records of any site investigations for the site are held by PKC.

[24] Based on BH02
[25] Based on BH05
[26] Based on BH05
[27] Same as above

5. Environmental Setting

5.1 Published Geology

The following summary of the geology beneath the site is based on a review of geological mapping available from the BGS Geoindex, published BGS 1:50,000 scale map Sheets 39w Stirling (dated 1974), and the Groundsure Report (attached as **Appendix C**).

Extracts of the geological maps indicated above are presented below as **Figures 3** and **4**.

5.1.1 Artificial Ground

There are no BGS designated areas of made ground or artificial ground recorded on-site or within the surrounding area.

Although no Made Ground is shown on published BGS mapping on the site and within 1km, localised Made Ground from the construction of the existing Braco West 275kV Substation and the existing access track is likely to be present within the area of the proposed substation.

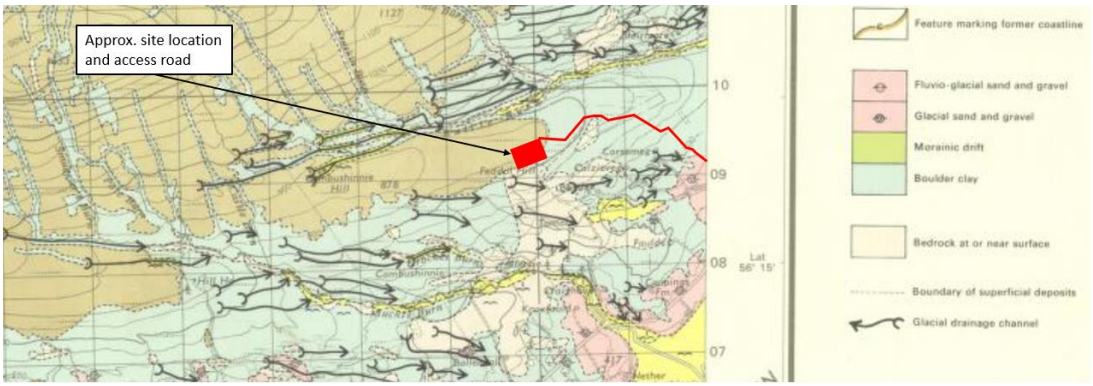
5.1.2 Natural Superficial Deposits

The site is set within Strathallan, in the northern extant of the Scottish Central Lowlands / Midland Valley, approximately 11km south of the Highland Boundary Fault. Regionally, the superficial geology is influenced by glaciation and a subsequent late (and rapid) deglaciation. As the ice retreated westwards from nearby Dunblane and Doune up the River Teith and River Forth valleys, a series of other glacial meltwater channels were formed, laying down significant deposits of outwash gravels[28]. The most significant deposits are to the south along the approximate route of the A9, though localised meltwater channels around the site area are shown on **Plate 3** below. Locally, more recent Quaternary Period superficial geology sits on top of the older glacial deposits forming peat across the site and surrounding area. BGS Geoindex mapping indicates the presence of Peat and Devensian Till (diamicton) across much of the site.

The area of the site which comprises the existing access track are indicated by BGS mapping to be underlain by natural superficial deposits of Glaciofluvial Ice Contact Deposits (comprising gravel, sand and silt), Devensian Till (Diamicton), and Peat. Alluvium (comprising clay, silt, sand and gravel) are indicated within the 1km surrounding area -to the immediate north, immediate south and southeast of the site.

The extract from the BGS 1:50,000 scale map Sheet 39w Stirling, Drift paper map below shows '*Peat'*, '*Boulder clay'*, '*Bedrock at or near surface'*, *'Alluvium of flood plains'*, and '*Glacial sand and gravel'* across the site. This is in general agreement with the Groundsure Report (attached as **Appendix C**) and BGS Geoindex. The paper map also shows routes of '*Glacial drainage channel'* to be present in the south of site.

Figure 3 Drift Geology



[28] Sourced from: '*The Geology of the Stirling District – Explanation of One-Inch Geological Sheet 39'*. The National Environment Research Council, published 1970.

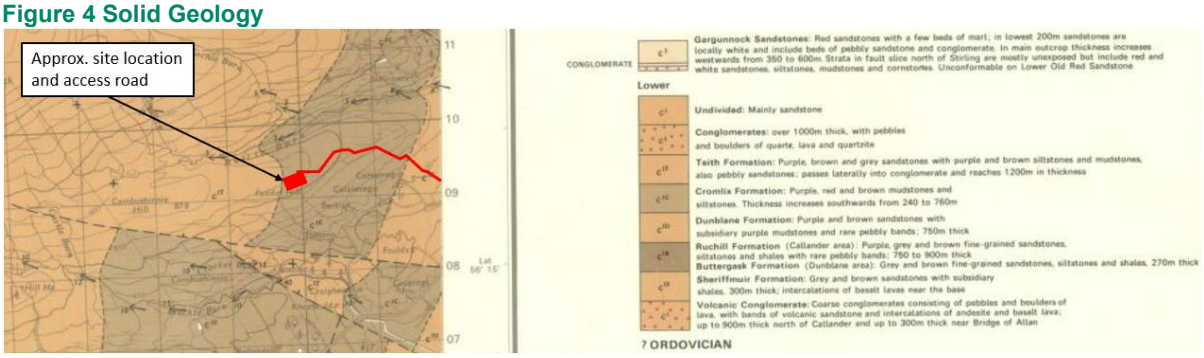
5.1.3 Solid Geology

Regionally, the site is located at the northern extent of the Midland Valley of Scotland[29] and on the Strathmore syncline[30]. The mapped bedrock within the area is associated with the Strathmore Group and Arbuthnott-Garvock Group.

Locally, published mapping shows the bedrock beneath the site is recorded as the Teith Sandstone Formation (sandstone), Dunblane Sandstone Member (sandstone), and Cromlix Mudstone Formation[31] (mudstone and sandstone) all part of the Strathmore and Arbuthnott-Garvock Groups, shown in **Figure 4** below.

The bedrock is disrupted by faults within the 250m of the site. The faults are inferred and present at approximately 28m southwest and 111m southwest of the site.

Figure 4 Solid Geology



5.2 Historical Borehole Records

Historical borehole records available on the BGS Onshore Geoindex[32] have been reviewed on 24 January 2024 to provide an indication of the ground conditions on site. While available borehole logs have been included below which are situated in geologically similar ground, it is noted that the large distance from site to the nearest available borehole logs means that these logs can only provide a background indication for the ground conditions on site, and are unlikely to provide relevant information with regards to groundwater conditions and levels. One borehole record was present in the immediate vicinity of site (BGS Geoindex reference NN70NE9), however, the borehole details of this record were not provided. Seven borehole records were available for the wider surrounding area including; four borehole records located approximately 1.32km northeast of site (BGS Geoindex ref. NN81SW16 – NN81SW19), one borehole record located approximately 2.4km east of site (BGS Geoindex ref. NN80NW19), and two borehole records located approximately 2.5km southeast of site (BGS Geoindex ref. NN80NW1 and NN80NW21). Records of these are included in **Appendix F**.

The BGS historical borehole records encountered the following general sequence:

Topsoil - encountered between 0.0m – 0.60m bgl:

- Comprising black, and black and dark brown topsoil and subsoil (in NN80NW19 and NN80NW21).

Peat – encountered between 0.0m – 0.30m bgl:

- Comprising dark brown pseudo-fibrous peat with abundant small rootlets (in NN81SW16 – NN81SW19).

Devensian Till – encountered between 0.10m – 5.0m bgl:

- Reddish brown slightly clayey gravelly very silty fine sand, gravel of various natural lithologies (in NN80NW19 and NN81SW16 – NN81SW19);
- Dense reddish brown slightly clayey slightly gravelly fine sand with occasional cobbles of sandstone, gravel of various lithologies predominantly sandstone (in all locations).

[29] A specific geological area between the Highland Boundary Fault and the Southern Upland Fault which constitutes southern portion of Scotland between Glasgow and Edinburgh as well as surrounding areas.
[30] Syncline with an axis roughly parallel to the Highland Boundary Fault (running approx. southwest to northeast) of Devonian strata.
[31] Geology names used are the current most up to date as supplied by the British Geological Survey, GeoIndex dataset.
[32] GeoIndex – British Geological Survey (bgs.ac.uk)

Bedrock – encountered between 2.20m – 4.0m bgl (in one location, NN81SW16), unproven depths / base of boreholes at 6.0m bgl:

- Weathered red sandstone with very soft areas encountered (in NN80NW1 and NN81SW16 – NN81SW19);
- Weak thinly laminated to thinly bedded reddish brown sandstone with some thin laminations of siltstone. Fractures sub-horizontal (5 – 10 degrees) closely to very closely spaced, planar smooth and undulating smooth, tight to moderately open with some soft clay infill (in NN81SW16).

Made Ground was not encountered within historical borehole records which is consistent with historical land uses from the surrounding area.

Groundwater was encountered during the drilling of borehole NN80NW1, located approximately 2.5km southeast of the site. The borehole log records the initial water strike depth to be 30ft (9.14m) below the well top, and the standing level of water inside the borehole to be 3ft (0.91m) below the well top, it is not recorded if the well top is flush with the ground or raised.

5.3 Mining and Quarrying

The Mining Remediation Authority Map Viewer website[33] reviewed on 16 January 2025, determined that the site does not lie within a Coal Authority Reporting Area, confirmed by the Groundsure Report (attached as **Appendix C**).

A review of the Groundsure report (attached as **Appendix C)** shows several non-coal small-scale quarrying operations within the surrounding area of site, including the following:

- The Glassick Sand Pit is recorded in the Groundsure report (**Appendix C**) as located on-site, however, inspection of the historical mapping shows the Sand Pit to be located off-site adjacent to the west of the junction of the existing access track and B8033 road. The commodity obtained from the quarry was sand, and the operational status of the pit is 'Ceased', with operations expected to have been ceased prior to 1977 when the sand pit was no longer indicated on mapping.
- The Nether Braco & Silverton Farms quarry located 68m northeast of site for the commodity of sand and gravel, the status of the quarry is 'Ceased'.
- The Carsemeg Wood Sandstone Quarry located 193m southeast of site for the commodity of sandstone, the status of the quarry is 'Ceased'.

A review of the BGS Onshore Geoindex[34] indicates an additional ceased quarry (Blairmore) at approximately 700m northeast of the existing access track.

5.4 Hydrology

The SEPA Water Environment Hub[35], the Groundsure report in **Appendix C** and other publicly available sources have been reviewed to identify relevant hydrological features on-site and in the surrounding area. The hydrology of the area is summarised in **Table 2** below.

Table 2 Summary of On-site and Surrounding Area Hydrology

Feature	Distance & Direction*	Flow Direction	Description
Numerous unnamed surface water courses	On site	Not described	Numerous unnamed water courses are identified by the Groundsure report (**Appendix C**) as existing across the site, both listed as ground surface water courses and as underground water courses. These minor rivers are not listed within the SEPA water environment hub.
Numerous unnamed surface water courses	Off site within 100m of site, majority recorded to the east, also present recorded to the northeast and southwest.	Not described	Numerous unnamed inland surface water courses are identified by the Groundsure report **(Appendix C)** as existing within 100m of the site. Both listed as ground surface water courses and as underground water courses**.** These minor rivers are not listed within the SEPA water environment hub.

[33] Mining Remediation Authority Map Viewer
[34] GeoIndex – British Geological Survey (bgs.ac.uk)
[35] https://www.sepa.org.uk/data-visualisation/water-environment-hub/

Feature	Distance & Direction*	Flow Direction	Description
Mill Burn	On site, also off-site to north and south.	Northeast to southwest.	The Mill Burn is identified in the Groundsure report (**Appendix C**) as a ground surface water course and as a lake, loch or reservoir. On-site it is located across the existing access track in the east of the site. It appears to be a reservoir to the north of the site, then exists as a burn where it crosses the site and continues to the south then southeast.
Unnamed lake, loch or reservoir	151m East	Not described	An unnamed lake, loch or reservoir is identified in the Groundsure report (**Appendix C**), listed as being 151m east of site, review of the mapping shows the expected water body to be present adjacent to the east of the existing access track, to the north of Easter Feddal farm. A further waterbody is shown on mapping to be present adjacent to the west of the existing access track. However, this is not clearly identified in the Groundsure reptrT (**Appendix C**).
Bullie Burn	190m Northeast	East	SEPA classify the Bullie Burn (SEPA ID: 4605) as having a water quality of 'High' in 2014, predicted to be 'High' in 2027, and having an overall condition of 'High'. No pressures affecting the overall condition were identified.
Feddal Burn	169m East	East	The Feddal Burn is identified in the Groundsure report as a ground surface water course, a lake, loch or reservoir, and as a manmade watercourse for water transfer.
Tochie Burn	800m Northeast	East	The Tochie Burn is identified in the Groundsure report (**Appendix C**) as a ground surface water course, which feeds into the Bullie Burn from the north, to the northeast of the propsoed substation site area**.**
Crocket Burn	210m Southwest	Southeast	The Crocket Burn is identified in the Groundsure report (**Appendix C**) as an inland river, ground surface water course.
Keir Burn	150m northeast	Southeast	Originates from Bullie Burn at approximately NN 81210 10340 on steep terrain to the north of the site and enters Allan Water at approximately NN 83462 07899 to the southeast of the site.
Muckle Burn	820m South	Southeast	SEPA classify the Muckle Burn (SEPA ID: 4604) as having a water quality of 'High' in 2014, predicted to be 'Good' in 2027, and having an overall condition of 'High'. No pressures affecting the overall condition were identified.

**All distance measured at closest point to site area.*

The Groundsure report (**Appendix C**) identifies numerous other minor watercourses on-site, predominantly inland rivers as both ground surface and underground watercourses, and off-site as inland rivers, lakes, lochs or reservoirs, and manmade watercourses for water transfer.

5.5 Hydrogeology

Information from the Groundsure Report (**Appendix C**), BGS Onshore Geoindex[36] Aquifer Productivity (Scotland) GIS datasets Version 2 Revised Report[37] and the Scotland's Aquifers and Groundwater bodies[38] have been reviewed in relation to the aquifer classifications for superficial deposits and bedrock underlying the site. These conclude that:

- The Alluvium deposits underlying the area to the immediate north and south of the existing access track site are described as a "Locally Important" aquifer associated with the Quaternary Sands and Gravels. The Groundsure report (**Appendix C**) identifies it as an aquifer in which intergranular flow is significant. The Strathallan Sand and Gravel (SEPA ID: 150731) superficial aquifer is classed as having an overall water quality of 'Good' in 2021 and predicted to be 'Good' 2027.
- The bedrock deposits of the Strathmore Group and the Arbuthnott-Garvock Group are characterised as a Moderately Productive aquifer. With sandstone, siltstones, mudstones, and conglomerates and interbedded lavas locally yield up to 12 L/s in parts. Bedrock permeability in the area is considered to be moderate to high due to fractures in the bedrock. The Groundsure report (**Appendix C**) describes the flow as virtually all through

[36] GeoIndex – British Geological Survey (bgs.ac.uk)
[37] BGS Report, single column layout (nerc.ac.uk)
[38] OR15028.pdf (nerc.ac.uk)

fractures and other discontinuities. SEPA classify the Dunblane groundwater aquifer (SEPA ID: 150628) as having an overall water quality of 'Good' in 2021 and predicted to be 'Good' 2027.

Groundwater flow direction within the aquifer units is expected to be influenced by the local topography. Mapping indicates that the local topography falls downward to the south and south-east, as well as to the north. As such groundwater is thought to flow in a southerly and south-easterly direction towards the Allan Water, and in a northerly direction toward the Bullie Burn. However, the nature and extent of groundwater bodies within the area is unknown, as such no certainty can be placed on the existence or movement of possible groundwaters.

5.6 Flood Risks

The SEPA Flood Maps for planning website[39] was access on 24 January 2024 to assess potential flood risks at the proposed substation site, which are summarised below:

- **River Flooding** – the site is not in an area of designated flood risk from river flooding, suggesting that the flood risk is <0.1% chance. This is also confirmed by the Groundsure Report (**Appendix C**).
- **Coastal Flooding**- The site is not at risk of coastal flooding. This is also confirmed by the Groundsure Report (**Appendix C**).
- **Surface Water Flooding** – SEPA flood mapping indicates the site is at no specific risk from surface water flooding. However, the Groundsure report (**Appendix C**) indicates the site to be at a medium risk of flooding with a 1 in 30 year flooding event having the potential to cause greater than 1.0m of flooding.
- **Groundwater Flooding** – The site lies predominantly within an area of negligible to low risk of flooding from groundwater. The area of the existing access track where it joins the B8033 road lies within an area of moderate risk from groundwater flooding.

The existing access track has potential flood risks summarised below:

- **Surface Water** – SEPA flood mapping indicates the existing access track to run adjacent to two areas with a High Risk from surface water flooding in this area, suggesting a 10% chance of flooding each year. However, the existing access track itself is not covered by High Risk areas.
- **River Flooding** – The existing access track is not at risk of river flooding.
- **Coastal Flooding –** The wider site is not at risk of coastal flooding.

The above does not constitute a formal flood risk assessment, which is outwith the scope of this study.

5.7 Radon

The UK Health Security Agency's UK Radon website[40] was reviewed on 24 January 2024 to determine potential radon risks for the site.

According to the website the site is located within an area where the potential for radon is less than 1%. This is also confirmed by the Groundsure Report (Appendix C). It is therefore anticipated that radon protective measures will not be necessary should the construction of any new buildings within the site be undertaken (none are proposed currently).

5.8 Environmental Designated Sites and Listed Buildings

The NatureScot Viewer[41] "Sitelink", visited on 23 January 2024 and the Groundsure report (**Appendix C**) were used to identify environmental designated sites.

The database indicated that there are no recorded sensitive sites including Sites of Special Scientific Interest (SSSIs), Conserved Wetland Sites (Ramsar Sites), Special Areas of Conservation (SAC), Special Protection Areas (SPAs), National Nature Reserves (NNR), Local Nature Reserves (LNR), or Forest Parks within the development boundary or within 1km, which was confirmed as part of a review of the Groundsure Report (**Appendix C**).

The closest protected sites are the Carsebreck and Rhynd Lochs SSSI, Shelforkie Moss (SAC), South Tayside Goose Roosts (SPA and Ramsar Site), all located approximately 5.5km southeast of the proposed development.

[39] https://map.sepa.org.uk/floodmaps/FloodRisk/Search
[40] UK Radon map
[41] SiteLink (nature.scot)

PASTMAP interactive mapping service[42], which provides access to the databases of Historic Environment Scotland (HES), and the Groundsure report (**Appendix C**) were consulted regarding sites of potential historical and/or archaeological significance. The nearest site of interest identified is Feddal Castle, a Grade B listed building, located 234m east of site. It is considered unlikely that any works undertaken across the site would impact Feddal Castle given the distance between them.

5.9 Unexploded Ordnance

To assess the potential risks from Unexploded Ordnance (UXO) at the site, the Zetica Unexploded Bomb Risk Map[43] was used on 24 January 2024. Zetica provided a Pre-Desk Study Assessment (PDSA) of the UXO and Military Activity risk of the site area, this assessment report can be found in **Appendix G**.

The Zetica PDSA identified the use of Sheriffmuir Range, located approximately 5km south of the site as an area of ad hoc military training before and during both the first and second World Wars (WWI and WWII). The area of Glen Artney Corry Our Range near Muthil, located approximately 8km northeast of the site, was a designated artillery range during WWII with artillery and tank units firing from Glen Artney Corry Our Range towards the Sheriffmuir Range across the site. These ranges were disused by 1945. Strategic targets during WWII located within 5km of the site included transport infrastructure and public utilities; military barracks, camps, depots, and training areas; and anti-invasion defences. No available records indicate that the site was bombed.

The Zetica Bomb Risk Map indicated a Low risk for the site and surrounding area, which is defined by Zetica as an '*area indicated as having 15 bombs per 1000 acres or less*'. The Zetica PDSA reports that the site area is located in the Landward Area (LA) of Perth which recorded bombing during WWII by High Explosive (HE) bombs to a density of 1.1 bombs per 405 hectares. Zetica recommended that a detailed desk study be commissioned to assess, and potentially zone, the UXO hazard level at the site.

5.10 Soil Classification

The National Soil Map of Scotland[44] was reviewed on 25 January 2024 to determine the soil type on site and within the surrounding area. The soil association on site is 'Organic Soils' with the soil group classed as 'Blanket peats' and the major soil subgroup classed as 'Dystrophic blanket peat'. The soil association for the existing access track is predominantly 'Balrownie' with component soils classed as 'Brown earths' and 'peaty gleyed podzols'. The soil association to the immediate south of the existing access track is 'Alluvial Soils' with the soil group classed as 'Alluvial soils and undifferentiated alluvial soils'. The peat coverage across the site and surrounding area is described as 'peat body at surface'. The map recorded the site area to have undergone 'Recent Ploughing'. The most recent land cover data from the map was from 2015 when the site cover was classified as 'coniferous woodland'.

Areas of carbon-rich soil, deep peat and peatland habitats are mapped by NatureScot[45]. The top two classes, 1 and 2, taken together identify the nationally important resource. The classes are defined as follows:

- **Class 1:** Nationally important carbon-rich soils, deep peat and priority peatland habitat, areas likely to be of high conservation value.
- **Class 2:** Nationally important carbon-rich soils, deep peat and priority peatland habitat, areas of potentially high conservation value and restoration potential.

No areas of Class 1 or Class 2 soils are present on-site or in the immediate surrounding area. Soils across the site and surrounding area are classed as Class 4, 5 and 0 (Class 0 being mineral soil, not typically containing peatland) and therefore, not considered to be of national importance.

Soil erosion risk as recorded by the National Soil map of Scotland for the soils on the site are classified as the following:

- Bare soil water erosion is classified as 'Low' with sediment rarely seen to move, though soil run-off may occur.
- Run off or soil wash is seen in some years during very wet periods.
- Soils are considered to be prone to wind erosion.

[42] Historic Environment Scotland Pastmap (2023)
[43] Risk Maps | Zetica UXO
[44] UK Soil Observatory (bgs.ac.uk)
[45] Map | Scotland's environment web

The UK Soil Observatory recorded the pH of soils on-site and in the surrounding area as 4.43, acidic, in 2007.

5.11 Sensitive Ecological Receptors

The Groundsure report (**Appendix C**) did not identify sensitive ecological receptors within 250m of the site. Therefore, a potential risk posed to sensitive ecological receptors from possible contamination at the site is not considered to exist. At the time of writing, the inclusion of landscaping and biodiversity requirements within the development has been mentioned by the Client, however no further details on the type and placement of these has been made.

5.12 Regulatory Database Review

This section presents a summary of current and historical regulatory database entries included within the Groundsure Report (**Appendix C**) pertaining to the site and surrounding land within 250m which could result in soil and groundwater contamination.

Generally, sites with regulated processes, registered radioactive substances, licensed waste management facilities and landfills, hazardous substances, fuel station entries and selected contemporary trade directory entries within 250m of the site, could, depending upon the nature of their activities, represent potential sources of contamination.

Table 3 Summary of Regulatory Database and Records Review

Data Type	Onsite	Within 250m
Historical Industrial Land Uses	The sand pit listed as on-site in Groundsure report (**Appendix C**), map review shows it to be off-site, active between 1901 – 1954, expected to have been infilled.	The corn mill connected to Feddal House, located 171m east of the existing access track, shown only 1863 mapping. A Quarry is listed, expected to be the Carsemeg Wood Sandstone Quarry, located 188m south of the existing access track, shown only 1978 mapping.
Recent Industrial Land Uses	The existing Braco West Substation and four pylons are listed as Electrical Features under the category Infrastructure and Facilities.	None Recorded
Gas Pipelines	A high-pressure underground gas pipeline operated by National Grid, part of Kirriemuir to Bathgate pipe crosses underneath the existing access track between Crofthead and Easter Feddal farms. Pipe is recorded as 900mm in diameter. Wall thickness, depth of burial, and operating pressure (Bar) are not recorded.	None Recorded
British Pits	Glassick Sand Pit recorded as British Pit present adjacent to entrance of existing access track on B8033 road.	Nether Braco & Silverton Farms Sand and Gravel Pit, located 68m east of the existing access track. Carsemeg Wood Sandstone Quarry, located 193m south of the existing access track.
Surface Ground Workings	Glassick Sand Pit present adjacent to entrance of existing access track on B8033 road.	Water body located 13m east of the existing access track, the Mill Dam at Crofthead farm, shown until 1978. Unnamed pond located 205m west of the existing access track at Feddal House, shown on 1863 mapping. Unnamed pond located 235m south-east of the site, shown on mapping between 1862 – 1901.

6. Preliminary Conceptual Site Model

6.1 General

The approach adopted by AECOM in order to assess risk associated with land contamination is in line with the Scottish Government's approach outlined in Planning Advice Note (PAN) 33 Development of Contaminated Land[46]. The Government considers that the most appropriate approach is a '*suitable for use*' one in which risks to human health and the wider environment are assessed within the context of the current or proposed use of the land in question.

The risk assessment described below follows the methodology set out in the Environment Agency's Land Contamination Risk Management (LCRM) guidance[47] which was published in October 2020 and updated in 2023. The LCRM guidance has now replaced the earlier Model Procedures for the Management of Land Contamination (CLR11), which has been withdrawn. AECOM understands that at the time of writing, Scotland's regulator's and SEPA have not yet formally made their position clear on the published LCRM guidance. However, given that the methodology in the LCRM guidance is essentially the same as that in CLR11, the key difference being some of the terminology used, AECOM has adopted the more recent guidance in this assessment.

The basic approach to risk assessment, as followed in this report, involves four steps:

- **Hazard Identification** – establishing contaminant sources, pathways and receptors (the conceptual site model);
- **Hazard Assessment** – analysing the potential for unacceptable risks (what contaminant linkages could be present, what the effects could be);
- **Risk Estimation** – aiming to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it); and
- **Risk Evaluation** – evaluating whether the predicted risk is unacceptable.

The LCRM guidance provides the following staged approach to aid the management of land contamination:

- **Stage 1:** Risk Assessment;
- **Stage 2:** Options Appraisal; and
- **Stage 3:** Remediation.

This assessment undertakes only the Stage 1 Risk Assessment, which LCRM guidance presents as three tiers:

- Preliminary Risk Assessment (Tier 1);
- Generic Quantitative Risk Assessment (GQRA) (Tier 2); and
- Detailed Quantitative Risk Assessment (DQRA) (Tier 3).

This report has been provided to meet the requirements for a Preliminary Risk Assessment (Tier 1).

The methodology adopted is described in detail in LCRM and relies on the development of a site-specific conceptual site model (CSM) consisting of contaminant linkages. A contaminant linkage requires three components:

- A source of contamination, for example due to historical site operations;
- A pathway, a route by which receptors can become exposed to contaminants. Examples include vapour inhalation, soil ingestion and groundwater migration; and
- A receptor, a target that may be exposed to contaminants via the identified pathways. Examples include human occupiers / users of the Site, the water environment, property or ecosystems.

For a potential risk to either environmental and / or human receptors to exist, a plausible contaminant linkage involving each of these components must exist. If one of the components is absent then a contaminant linkage,

[46] Scottish Government (2017) *Planning Advice Note 33: Development of contaminated land.* [Online] available from: Planning Advice Note 33: Development of contaminated land - gov.scot
[47] Environmental Agency (2020) *Land contamination risk management (LCRM).* [Online] available from: Land contamination risk management (LCRM) - GOV.UK

and thereby potentially unacceptable risk, is also unlikely to exist. Where all three components are present, a potentially complete contaminant linkage can be considered to exist. This does not automatically imply the presence of unacceptable risk, but that further investigation of the potential contaminant linkages is required.

6.2 Preliminary Conceptual Site Model

The preliminary CSM has been developed to identify potentially complete contaminant linkages that may require further investigation to assess their existence and/ or potential significance. The potential sources of contamination on or in the vicinity of the site, receptors on or near the site, and pathways on or near the site are discussed within the following sub-sections.

The preliminary CSM assesses the potential risks and constraints associated with the site in its current condition, prior to any proposed redevelopment. Risks associated with the proposed re-development have also been assessed based on expected environmental and ecological sensitivity in line with the planning application and development description.

6.2.1 Potential Sources of Contamination

This section uses the information described in earlier sections of this report to identify potential sources of contamination on and within 250m of the site.

It should be noted that the historical use of the site and surrounding area has presented limited potential for significant contamination to be present. Soil and groundwater contamination within the site boundary or close proximity is considered unlikely, and should any minor contamination exist it is unlikely to represent an impact due to the absence of receptors.

Table 4. Potential Sources of On-site Contamination

Potential On-site Source	Potential Contaminants	Area On-Site Affected	Current/ Historical
Made Ground associated with construction of the existing Braco West 275kV Substation, and potentially associated with access road and tracks.	Metals and inorganic compounds, pH, PAHs, TPH including BTEX and MTBE, SVOCs, VOCs, sulphates, sulphides, cyanides, phenols and ACMs.	Land underneath and near the existing substation and roads. Minor streams pools.	Current and Historical
Electricity Substation	Contaminants may include, chlorinated aromatic hydrocarbons and heavy metals and sulphates.	Land underneath and near the existing substation, particularly the north-east of site area.	Current
Access tracks / roadways	TPHs, PAHs and sulphates and sulphides associated with spillage and combustion of fuel.	The existing access track and car parking area adjacent to existing substation.	Current and Historical

Table 5. Potential Sources of Off-site Contamination (within 250m of the Site)

Potential Off-site Source	Potential Contaminants	Area Off-Site Affected	Current/ Historical
Made ground associated with off-site construction and use of access roads and tracks, and farmhouses and associated buildings.	Metals and inorganic compounds, pH, PAHs, TPH including BTEX and MTBE, SVOCs, VOCs, asbestos, sulphates, sulphides, cyanides, phenols and ACMs.	Land adjacent to the length of the existingaccess track where farms are present.	Current and Historical
Potentially infilled land associated with former quarries, ponds, and wells.	Metals and inorganic compounds, pH, PAHs, TPH including BTEX and MTBE, SVOCs and VOCs.	Land at where the existing access track joins the B8033 road.	Historical
Sheep dip formerly located adjacent to existing access track in the northeast.	Organophosphates, arsenic, and pesticides.	Land surrounding the existing access track in the northeast.	Historical

6.2.2 Potential Receptors

The following potential receptors for contamination have been identified:

Table 6. Potential Receptors

Receptor	Description
Human Health	• Current and future site users, i.e. visitors to site and substation engineers. • Future on-site construction and maintenance workers. • Off-site third-party land users.
The Water Environment	• Bullie and Muckle Burns draining into the Allan Water. • Other minor, unnamed surface water features on site which may ultimately drain into the Allan Water or the groundwater. • Groundwater within the Peat, Glacial, and Alluvial deposits. • Groundwater within the underlying bedrock aquifer (Strathmore Group moderate-high permeability strata, moderately productive aquifer).
The Built Environment	• Proposed and other future developments including concrete foundations of any proposed development. • Public Water Supply.
Sensitive Ecological Receptors	• While no sensitive ecological receptors have been identified within 250m of the site, the inclusion of landscaping and biodiversity requirements has been requested by the Client. The landscaping and biodiversity requirements are considered to present the only ecological receptor.

6.2.3 Potential Pathways

Potential pathways have been identified, which could link the potential sources with the potential receptors. These pathways are discussed by receptor type below in consideration of the proposed development of the site.

Table 7. Potential Pathways

Pathway	Description
Human Health	• Industrial land users (current site users) and future on-site workers by direct contact and/or ingestion of contaminated soil and / or groundwater, inhalation of windblown dust ingestion. The presence of airborne dust may be exacerbated by construction work. • Third party neighbours by windblown dust ingestion, direct contact and/or ingestion of contaminated surface and groundwater. The presence of airborne dust may be exacerbated by demolition of existing structures and construction work.
The Water Environment	• Groundwater within the superficial deposits by leaching and migration of contaminants via shallow Made Ground and natural superficial deposits. • Groundwater within the bedrock aquifer by leaching and migration of contaminants via shallow Made Ground and natural superficial deposits. • Surface water via surface water run-off, and lateral migration of contaminants via shallow deposits and service runs. • Surface water by migration of contaminants via groundwater.
The Built Environment	• Concrete construction materials by direct contact with contaminated soil and groundwater (e.g. hydrocarbons) and aggressive ground conditions (pH and sulphate). • Direct contact of contaminated groundwater.

6.2.4 Discounted Sources / Pathways / Receptors

The following sources, pathways and / or receptors have been discounted:

Ground gas accumulation in open space is excluded. In addition, the following receptors are excluded from the conceptual site model, with the justification presented:

- **Archaeological Receptors** – limited archaeological features have been identified within the surrounding area of site.
- **Asbestos** – the likelihood of asbestos presence as an on-site source is considered to be low, given the date of construction of the existing substation being after the year 2000 and the absence of previous developments on site. Wind-blown asbestos from surrounding land uses off-site cannot be discounted at this stage.
- **Polychlorinated Biphenyls (PCBs)** – the risk from PCBs is discounted given the relatively recent date of construction of the existing substation and electrical infrastructure.

- **Ecological receptors** – the risk to ecological receptors off-site is discounted as no specific sensitive ecological receptors have been identified within 250m of the site. It should be noted that the inclusion of landscaping and biodiversity requirements within the proposed development does present a potential ecological receptor on-site. However, this would require assessment at a later date as the type and sensitivity of the receptor is not currently known.

6.2.5 Qualitative Assessment of Source-Pathway-Receptor

Based on the information provided in this report, the following preliminary risk assessment tables have been formulated, with each identifying possible contaminants and contaminant linkages in the context of the current and proposed development.

At this stage, a qualitative risk assessment has been undertaken for these potential source-pathway-receptor linkages based on current DEFRA (Guidelines for Environmental Risk Assessment and Management)[48], CIRIA C552[49], and the Guidance for the Safe Development of Housing on Land Affected by Contamination[50] see **Appendix G**.

It must be noted that the following assessment is based solely on desktop study information and will require revision following any recommended intrusive site investigation works. The following assessment is based on consideration of both:

- The **likelihood** of an event (probability – takes into account both the presence of the hazard and receptor and the integrity of the pathway); and
- The **severity** of the potential consequence (takes into account both the potential severity of the hazard and the sensitivity of the receptor).

The risks associated with potential on and off-site contaminants identified are detailed in the Table 8 below. The risk matrix colour coding is presented in **Appendix H**:

[48] Guidelines for Environmental Risk Assessment and Management - Green Leaves III (publishing.service.gov.uk)
[49] CIRIA C552 Contaminated land risk assessment, guide to good practice, 2001 (c552 (ciria.org))
[50] R&D66 VOL 1 Guidance for the Safe Development of Housing on Land Affected by Contamination (nhbc.co.uk)

Table 8. Summary of Preliminary CSM and Risk Assessment

Source	Receptor		Exposure Pathway	Probability	Consequence	Risk Category	Justification
On-site Contamination sources including the electrical substation, Made Ground and existing access track / roadways.	**Human Health – On-site**	Current site users and the future site users / visitors post development	Dermal contact with and ingestion of contaminants in soil, soil-derived dust and water. Inhalation of contaminants in soil-derived dust.	Unlikely	Medium	**Low Risk**	As part of the 2023 ground investigation, Made Ground was encountered from surface up to maximum depth of 0.70m bgl in two trial pits (TP21 and TP23), located within the area of the proposed substation and UGC. However, it is expected that the site will be surfaced with hardstanding and therefore site users are unlikely to be in direct contact with Made Ground. Additionally, it is understood that members of the general public will not have access to the substation platform area of the site. However, the likely limited amount of potential contamination significantly reduces risks to site users in future. In addition, the use of appropriate PPE, good hygiene practice and adherence to construction health and safety legislation should mitigate against potential for exposure to construction workers.
		Construction / Maintenance Workers	Dermal contact with and ingestion of contaminants in soil, soil-derived dust and water. Inhalation of ground gas, and contaminants in soil-derived dust.	Low Likelihood	Medium	**Moderate / Low Risk**	
	Human Health – Off-site	Third Party Neighbours	Inhalation of soil-derived dust, ground gas and volatile vapours.	Unlikely	Medium	**Low Risk**	
	Water Environment	Superficial	Leaching of contaminants in the unsaturated zone to groundwater in underlying aquifers.	Unlikely	Mild	**Very Low Risk**	No superficial aquifer has been identified following a review of the available information. Groundwater was recorded in isolated locations in superficial deposits, indicating a perched & discontinuous water body is likely to be present, further supporting the absence of a pervasive and extensive shallow groundwater body.
			Migration of contaminated water through preferential pathways such as underground services, pipes and granular material to groundwater in underlying aquifers.	Unlikely	Mild	**Very Low Risk**	
		Bedrock Aquifers	Leaching of contaminants in the unsaturated zone to groundwater in underlying aquifers.	Unlikely	Medium	**Low Risk**	The 2023 ground investigation trial pits record suggest groundwater strikes between 1.20m bgl and 2.00 m bgl within bedrock and superficial deposits. The likely limited extent of Made Ground and lack of potentially contaminative historical land uses further decreases the risk to groundwater.
			Migration of contaminated water through preferential pathways such as underground services, pipes and granular material to	Unlikely	Medium	**Low Risk**	

Source	Receptor		Exposure Pathway	Probability	Consequence	Risk Category	Justification
			groundwater in underlying aquifers.				
		Surface Water Features inc. Bullie and Muckle Burns, and streams	Lateral migration of contaminated groundwater with discharge to surface watercourses as base flow.	Low likelihood	Medium	**Moderate / Low Risk**	Due to the presence of peat deposits and free draining soils, and the topography of the site, the risk to surface water features off-site via shallow deposits and/or surface run-off cannot be discounted. Contamination migration via granular superficial deposits is possible, though the limited potential contamination sources reduces risks. Additionally, the probability of overland flow occurring is considered unlikely due to the presence of vegetated heathland surrounding the site limiting the flow of water at the surface.
			Discharge of contaminants entrained in surface water run-off followed by overland flow and discharge.	Unlikely	Medium	**Low Risk**	
	The Built Environment	Existing and future structures, Public Water Supply	Direct contact of contaminants in soil and/or groundwater	Unlikely	Mild	**Very Low Risk**	Whilst risks cannot be entirely discounted, potential impacts are considered unlikely due to the isolated location of the site and the general low level of development of the surrounding area. No re-routing of water pipes is expected as part of the proposed development.
	Ecological Receptors	Landscaping and biodiversity requirements on-site	Uptake of contaminants from contaminated soils and groundwater by roots of flora planted on-site. Discharge of contaminants via surface water run-off and overland flow and discharge.	Low likelihood	Mild	**Low Risk**	While risks cannot be entirely discounted, potential impacts are considered unlikely due to the Low likelihood of significant levels of contamination present on-site. The risk to ecological receptors is considered very low. This risk designation is considered to be preliminary and will require reassessment once the type and sensitivity of the proposed landscaping and biodiversity is understood.
Off-site contamination sources including off-site made ground and former pits/heaps.	**Human Health – On-site**	Current site users post development	Dermal contact with and ingestion of contaminants in soil, soil-derived dust and water. Inhalation of contaminants in soil-derived dust. Inhalation of asbestos fibres.	Unlikely	Medium	**Low Risk**	Off-site contamination from neighbouring sources is a possibility, however, it is considered unlikely. Additionally, the proposed construction of a hardstanding covered development reduces the potential risk of contact with contaminated soils. Control rooms presenting confined spaces are expected to be present in the proposed development, however these are unlikely to be permanently manned with only low
		Construction / Maintenance Workers	Dermal contact with and ingestion of contaminants in	Unlikely	Medium	**Low Risk**	

Source	Receptor		Exposure Pathway	Probability	Consequence	Risk Category	Justification
			soil, soil-derived dust and water. Inhalation of ground gas, mine gas and contaminants in soil-derived dust. Inhalation of asbestos fibres.				frequency temporary visits by maintenance workers expected. As such the potential risk posed from accumulation of gas in confined spaces is considered to be mitigated. Risks to construction workers will be managed via adherence to health and safety legislation and regulations.
	The Built Environment	Existing and future structures	Direct contact of contaminants in soil and/or groundwater	Unlikely	Mild	**Very Low Risk**	Whilst risks cannot be entirely discounted, potential impacts can be managed by relatively inexpensive engineered mitigation measures for a small site of this nature.

7. Conclusions and Recommendations

7.1 Conclusions

Potential sources of contamination within the site boundary are considered limited and relate to the existing Braco West Substation and the existing access track. Made Ground is expected to be present to a limited extent associated with the existing Braco West Substation and the existing access track, and unlikely to be present elsewhere across the site or surrounding area.

Contamination from the existing Braco west Substation and within the Made Ground could pose potential risks to human health and the water environment if present but is considered to be unlikely. There is potential for contaminants (if present) to migrate off-site via surface water run-off and transportation through granular and organic soils. However, given the likely limited extent of contamination present from the existing Braco West Substation and Made Ground, it is unlikely to represent a significant impact.

The proposed development of the site comprising a predominantly hardstanding surfaced area reduces potential impacts to off-site human health and environmental receptors by severing pathways. The risk to the on-site human health receptor is expected to be low due to there being no public access to the site, with the site additionally being located in a remote area, expected infrequent and temporary site visits by maintenance workers with the site area not expected to be permanently staffed. While control rooms are expected to be included in the proposed development, the risk to construction workers and maintenance workers is considered low due to the limited identified contamination and the short time period on-site expected of these receptors. The water environment is considered to be the most sensitive receptor, with granular superficial geology potential enabling migration of contamination (if present).

Based on the available desk study information and the proposed development, the site is classified overall as having a **Low to Moderate risk** with respect to contaminated land.

7.2 Recommendations

The Geo-environmental Desk Study has not identified unacceptable risks in accordance with Land Contamination Risk Management guidance at the site. However, it is possible that risks to human health and the water environment receptors are present on-site without having been recorded or reported. It is recommended that the following further work / assessment is undertaken to constrain potential risks:

- Submission of this report to the Perth & Kinross Council Contaminated Land Officer to obtain their approval of the report's findings.

Undertake a detailed desk study to assess the Unexploded Ordnance (UXO) hazard level at the site, as recommended in the UXO Pre-Desk Study Assessment report.

Furthermore, the scope of the Geo-environmental Desk Study has provided a preliminary characterisation of the site's risk profile, however, as with all desk based studies there is a degree of uncertainty associated with them. In addition, as with any site there may be localised differences in Made Ground thicknesses, the presence of obstructions and physical or chemical composition, and unrecorded surface or ground disruptions and site activities. The 2023 GI has identified made ground from surface up to maximum depth of 0.70m bgl in two trial pits (TP21 and TP23) located in the area of the proposed substation and UGC. It is recommended that the Applicant and its construction contractors have an unexpected contamination strategy in place throughout the construction of the proposed development. If contamination is identified at any point during construction work, then contact should be made with a suitably competent environmental consultant for further risk assessment to be undertaken.

Appendix A – Figures

Appendix B – Site Reconnaissance Information

Appendix C – Groundsure Report

Appendix D – Existing Information Review

Appendix E – Local Authority Consultation

Appendix F – Historical Borehole Records

Appendix G – ZETICA Pre Desk Study Assessment Report (PSDA)

Appendix H – Risk Assessment Principles

Risk Assessment Principles

Current best practice recommends that the determination of hazards due to contaminated land is based on the principle of risk assessment, as outlined in the Environment Agency guidance on LCRM.

For a risk to be present, there must be a viable contaminant linkage; i.e. a mechanism whereby a source impacts on a sensitive receptor via a pathway.

Assessments of risks associated with each of these contaminant linkages are discussed in the following sections.

Using criteria broadly based on those presented in the National House Building Council/Environment Agency/Chartered Institute of Environmental Health publication R&D 66 (NHBC/EA/CIEH, 2008), the magnitude of the risk associated with potential contamination at the Site has been assessed. To do this an estimate is made of:

- The magnitude of the potential consequence (i.e. severity);
- The magnitude of probability (i.e. likelihood).

The severity of the risk is classified according to the criteria in the table below.

Description of Severity of Risk

Term	Description
Severe	– Highly elevated concentrations likely to result in significant harm to human health. – Catastrophic damage to crops, buildings or property (e.g. by explosion). – Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects of water quality. – Major damage to aquatic or other ecosystems.
Medium	– Elevated concentrations which could result in significant harm to human health. – Significant damage to crops, buildings or property (e.g. damage to building rendering it unsafe). – Equivalent to EA Category 2 pollution incident including significant effect on water quality. – Significant damage to aquatic or other ecosystems.
Mild	– Exposure to human health unlikely to lead to significant harm. – Minor damage to crops, buildings or property (e.g. surface spalling to concrete). – Equivalent to EA Category 3 pollution incident including minimal or short-lived effect on water quality. – Minor or short-lived damage to aquatic or other ecosystems.
Minor	– No measurable effect on humans. – Repairable effects of damage to buildings, structures and services. – Equivalent to insubstantial pollution incident with no observed effect on water quality of ecosystems.

The probability of the risk occurring is classified according to the criteria in the table below.

Likelihood of Risk Occurrence

Likelihood	Explanation
High	Contaminant linkage may be present that appears very likely in the short-term and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor.
Likely	Contaminant linkage may be present, and it is probable that the risk will occur over the long term.
Low	Contaminant linkage may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Unlikely	Contaminant linkage may be present but the circumstances under which harm would occur even in the long-term are improbable.

An overall evaluation of the level of risk is gained from a comparison of the severity and probability, as shown below.

Risk based on Comparison of Likelihood and Severity

Likelihood	Severity: SEVERE	MEDIUM	MILD	MINOR
HIGH	Very High	High	Moderate	Low
LIKELY	High	Moderate	Moderate/Low	Low
LOW	Moderate	Moderate/Low	Low	Very Low
UNLIKELY	Moderate/Low	Low	Very Low	Very Low