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PRELIMINARY RISK ASSESSMENT AND GROUND INVESTIGATION REPORT FOR A PROPOSED DEVELOPMENT AT CROESFOEL INDUSTRIAL ESTATE, RHOSTYLLEN, WREXHAM

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BGS Geoindex Report	Enclosure A	(4 pages)
Hydrology, Hydrogeology, Site Sensitivity & Flood Risk	Enclosure B	(6 pages)
Historical Maps	Enclosure C	(14 pages)
Consultant's Coal Mining Report supplied by The Coal Authority	Enclosure D	(11 pages)
Environmental Database	Enclosure E	(49 pages)

Appendices

Exploratory Hole Records	Appendix 1	(24 pages)
Soil Contamination Laboratory Test Results	Appendix 2	(18 pages)
Groundwater Contamination Laboratory Test Results	Appendix 3	(5 pages)
Soil Geotechnical Laboratory Test Results	Appendix 4	(11 pages)
UCS Test Results	Appendix 5	(3 pages)

Generic List of Acronyms and Abbreviations

µg/kg	micrograms per kilogram
µg/l	micrograms per litre
ACEC	aggressive chemical environment for concrete
ACM	asbestos containing material
AOD	above Ordnance datum
bgl	below ground level
BGS	British Geological Survey
BH	borehole
BTEX	benzene, toluene, ethylbenzene and xylene compounds
C4SL	Category 4 Screening Level
CBR	California bearing ratio
CH_4	methane
CIRIA	Construction Industry Research and Information Association
CO	carbon monoxide
CO_2	carbon dioxide
COMAH	control of major accident hazards
CPT	cone penetration test
CSM	conceptual site model
DEFRA	Department of Environment, Food and Rural Affairs
DoE	Department of Environment (now part of DEFRA)
DP	dynamic probe
DPSH	dynamic probe super heavy
DQRA	detailed quantitative risk assessment
DS	design sulphate class
DWS	drinking water standard
EA	Environment Agency
EHO	Environmental Health Officer
EQS	environmental quality standard
FRA	flood risk assessment
GAC	generic assessment criteria
GPR	ground penetrating radar
GPS	global positioning systems
GQRA	generic quantitative risk assessment
GW-TV	groundwater threshold value
ha	hectare
H_2S	hydrogen sulphide
HSE	Health and Safety Executive
IPPC	Integrated Pollution Prevention and Control
LAPPC	Local Authority Pollution Prevention and Control
LCRM	Land Contamination Risk Management
LNR	Local Nature Reserve
mb	millibar
MAGIC	Multi Agency Geographical Information for the Countryside
MCERTS	Monitoring Certification Scheme
mg/kg	milligrams per kilogram
mg/l	milligrams per litre
NIEA	Northern Ireland Environment Agency
NGR	National Grid Reference
O_2	oxygen
OS	Ordnance Survey
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PFS	petrol filling station
PID	photo ionisation detector
PHE	Public Health England
PPE	personal protective equipment
PRA	preliminary risk assessment
SAC	Special Area of Conservation
S4UL	Suitable For Use Level
SEPA	Scottish Environment Protection Agency
SGV	soil guideline value
SOM	soil organic matter
SPA	Special Protection Area
SPT	standard penetration test
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SVOCs	semi-volatile organic compounds
TOC	total organic carbon
TP	trial pit
TPH	total petroleum hydrocarbons
TPO	Tree Preservation Order
UKAS	United Kingdom Accreditation Service
UXO	unexploded ordnance
UST	underground storage tank
VOCs	volatile organic compounds
WAC	Waste Acceptance Criteria
WFD	Water Framework Directive
WHO	World Health Organisation
WS	window sampling borehole

PRELIMINARY RISK ASSESSMENT AND GROUND INVESTIGATION REPORT FOR A PROPOSED DEVELOPMENT AT CROESFOEL INDUSTRIAL ESTATE, RHOSTYLLEN, WREXHAM

Executive Summary

Objectives of Report	To carry out a desk study, Preliminary Risk Assessment (PRA) and ground investigation at the site in accordance with the risk assessment framework presented in Land Contamination Risk Management (LCRM), in order to assess the potential geo-environmental risks associated with the proposed development.
Site Description	The site is a former Vauxhall dealership comprising two buildings surrounded by areas of tarmac hardstanding. It is irregular in shape and covers an area of roughly 1.1 hectares. The eastern section of the site is elevated by roughly 1.3m and is separated by a retaining wall. The site is bounded to the north, east and south by vegetation and an industrial estate to the west. Small deformations in the tarmac were noted in the south west and east of the site.
Proposed Development	A Travis Perkins development comprising sales and storage areas. This includes the construction of a new building and installation of racking within an existing building and externally across the site.
Geology	Geological mapping indicates the site to be underlain by Glacial Till. Made ground is also indicated to be present on the south-eastern part of the site. These deposits overlie bedrock geology of the Etruria Formation, consisting of mudstone.
Hydrology **Hydrogeology** **Major Ecological Receptors**	Glanyrafon Brook is located approximately 160m to the south. The superficial Glacial Till deposits are classified as a Secondary Undifferentiated aquifer, whilst the underlying bedrock of the Etruria Formation is classified as a Secondary A aquifer. The site does not lie within a groundwater Source Protection Zone (SPZ). There is no licensed groundwater abstraction indicated within 1km of the site boundary. No major ecological receptors were identified within 1km of the site boundary.
Flood Risk	The site is in an area with very low risk of fluvial flooding.
Brief Site History	The site has remained undeveloped until the construction of the present-day garage sometime shortly after 2006. In the surrounding area, notable developments include a colliery with two mine shafts approximately 300m-400m to the south-east. They are indicated to have become disused by the early-1990s. A large slag heap associated with the colliery has been identified about 300m to the south-east, currently landscaped/vegetated.
Mineral Extraction	The shallowest mine workings beneath the site are indicated at about 300m bgl and were approximately 1.1m thick with the last date of working recorded as 1955. The risk of subsidence as a result of mineral extraction at the site is considered sufficiently low not to warrant any further investigation.
UXO	The risk of UXO contamination being present at the site is considered low.
Initial CSM	The contaminant–pathway–receptor linkage could potentially be completed for this site with respect to human health, the development end use, and surface waters.
Scope of Ground Investigation	Three cable percussion borehole and twenty-one window sampling boreholes including in situ geotechnical testing. Contamination and geotechnical laboratory testing and gas and groundwater monitoring.
Succession of Strata	The site is surfaced by a thin layer of tarmac (typicall <0.1m) over a think layer of granular subbase (mean thickness of 0.27m). The underlying natural material typically comprises firm and stiff sandy gravelly clay to about 4m bgl, over medium dense clayey gravelly sand, with occasional cobbles. Suspected sandstone bedrock was encountered in the cable percussion boreholes at about 7m bgl.
Groundwater	Groundwater monitoring carried out during June and July 2024 indicated groundwater at depths between about 5.50m and 5.98m bgl (100.19m and 99.71m AOD).

Ground Contamination	The levels of contamination in the tested soil and groundwater samples are considered suitable for retention beneath the proposed development, and to present a sufficiently low risk to human health, the water environment and the development end use. However, procedures should be identified for dealing with unforeseen contamination if encountered at locations not explored by the investigation if encountered during earthworks.
Ground Gas	Ground gas monitoring indicates that the site falls into 'Characteristic Situation' Classification CS-2. Ground gas protection measures are therefore recommended.
Off-site disposal	Based on the available information, the tested soils could be classified as inert waste for off-site disposal purposes subject to the landfill operator's certification.
Geotechnical Assessment	The existing on-site buildings are to be converted to Travis Perkins sales and storage areas, with a new building (Building 3) constructed to the rear, in the north-eastern part of the site. The new building is understood to be a single frame lightweight, cladded building. Racking is to be installed within the existing Building 1 and also externally across the site. The anticipated loading for the storage areas within the buildings and to the areas outside is 30kPa. No significant changes to the existing site levels are proposed. **Foundations:** Pad and/or strip foundations bearing on the natural clay of at least *firm* consistency at a depth of at least 1m bgl are considered feasible. Estimated soil bearing resistances for pad and strip foundations of various sizes, constructed at a depth of 1m bgl for a calculated settlement of 25mm are presented in Section 14.0. **New Building Floor slab:** The floor slab of the new building could be ground bearing, provided that it is underlain by a suitable thickness of compacted granular fill. For a slab measuring 40m x 15m in plan (approximate dimensions of the new building), constructed at a depth of 0.3m bgl and imposing a ground bearing pressure of 30kPa, settlement is anticipated to be less than 25mm. **Existing Building 1 Floor slab:** The floor slab of Building 1 was found to comprise reinforced concrete approximately 180mm-thick. Laboratory tests have indicated that the concrete has a measured mean compressive strength of 44.5MPa. **New Pavement:** It is understood that new racking is to be installed externally across the site, which will impose a ground bearing pressure up to 30kPa. The existing sub-base thickness appear inadequate to support a uniformly distributed load (UDL) of 30kPa and would need to be increased, together with the removal of any soft/unsuitable materials. The current equivalent CBR at the formation level (firm clay) is unlikely to be more than 2% and for preliminary design purposes a design CBR <2% is considered suitable.
Buried Concrete	Should conform to DS-1 and ACEC-1s in accordance with BRE Special Digest 1.
Limitations	The limitations of this report are highlighted in Section 14.0.

1.0 INTRODUCTION

DTS Raeburn Limited t/a Igne were commissioned by Travis Perkins Ltd to carry out a Preliminary Risk Assessment (PRA) and ground investigation of a site of a former Vauxhall dealership on Croesfoel Industrial Estate, Wrexham. It is understood that the proposed development is to comprise a Travis Perkins store, warehouse and carpark.

1.1 Preliminary Risk Assessment

The principal objective of the PRA is to assess whether the land is potentially contaminated and/or whether there are other potential geo-environmental liabilities. These could include, but are not limited to, subsidence hazards, the generation or migration of ground gas to beneath the site and other geotechnical abnormalities.

The environmental aspects of the PRA have been prepared utilising a risk-based approach and incorporating the accepted 'pollutant linkage' approach to contaminated land hazard identification (e.g., source–pathway–receptor linkage). This approach is consistent with methodologies contained in both Land Contamination Risk Management (LCRM) (EA, 2020) and Part IIA of the Environmental Protection Act 1990. The latter was introduced by Section 57 of the Environment Act 1995, which came into force in England and Wales in April 2000.

The scope of the PRA included a desk study and site reconnaissance, which comprise the minimum information required for sites where contamination is either known or suspected. The PRA has also been designed to fulfil the objectives of a 'preliminary investigation' as defined by British Standard BS10175:2011+A2:2017 'Investigation of Potentially Contaminated Sites – Code of Practice'.

The following information has been used to formulate the PRA report:

- Site walkover undertaken on 4th June 2024
- Site Specific BGS GeoIndex Report
- Historical OS maps supplied by Landmark Information Group
- Environmental database information prepared by Landmark Information Group
- Correspondence/searches of local authorities and other statutory agencies

1.2 Intrusive Investigation

The main objectives of the ground investigation were to quantitatively assess the risk to the proposed development from ground contamination and to enable the provision of recommendations for the proposed development.

The scope of the investigation comprised cable percussion boreholes and window sampling boreholes to enable in situ testing of the underlying soils and recovery of samples for laboratory analysis. The investigation also included the installation of gas and groundwater standpipes and subsequent monitoring.

This report presents the findings of the PRA and ground investigation together with recommendations for the proposed development.

2.0 SITE AND SURROUNDING AREA

2.1 Site Location

Address	Dickens Garage, Croesfoel Industrial Estate, Rhostyllen, Wrexham LL14 4EJ (Figures 1 and 2)
Co-ordinates	331085, 348475
Site area	0.82 hectares

2.2 Site Description

Hereafter in this report 'the site' refers to the area within the red line boundary indicated in Figure 3. The Figure also indicates the orientations and locations of the photographs taken during the site reconnaissance, which are included as Plates 1 to 16.

The site is a former Vauxhall dealership comprising two buildings surrounded by areas of tarmac hardstanding. The site is irregular in shape and covers an area of approximately 1.1 hectares.

The site is accessed from the west from the Croesfoel Industrial Estate [Plate 1]. The larger of the two buildings (Building 1) occupies the north-western section of the site, consisting of a former show room, offices a mezzanine and area for conducting maintenance of vehicles [Plates 2, 3, 4 and 5]. The smaller building (Building 2), in the southern section of the site appears to have been used for cleaning and valeting services [Plates 6, 7 and 8]. Both buildings are single-story and have metal cladding.

The eastern section of the site is elevated by up to 1.3m above the western section and is separated by a concrete block retaining wall [Plate 9]. A shallow ramp provides access between the western section and the raised eastern section of the site.

The eastern section of the site is generally flat and is bounded to the north, east and south by vegetation which included long grass, bushes and tall shrubs and trees about 4m high [Plates 10 and 11].

Small deformations in the tarmac were noted at various location across the site [Plates 12-15].

2.3 Ecology/Invasive & Injurious Plant Species

Detailed ecological and agricultural surveys were outside the scope of this report; however, no infestations of Japanese Knotweed or other notifiable weeds were noted during the site reconnaissance.

2.4 Surrounding Area

The site is located within Croesfoel Industrial Estate. There are light industrial and commercial developments to the north and north-west of the site, a builders merchants store to the west, a service station to the south-west, a car dealership to the south and residential dwellings to the east and north-east.

The A483 dual carriageway lies approximately 125m to the west of the site, orientated north-south. The land use is primarily agricultural beyond the road network towards the west and south-west.

2.5 Proposed Development

A Travis Perkins development is proposed at the site. The existing on-site buildings are to be converted to sales and storage areas, with a new building (Building 3) constructed to the rear, in the north-

eastern part of the site. Racking is to be installed within the existing Building 1 and also externally across the site. A plan of the proposed development is included as Figure 4.

3.0 GEO-ENVIRONMENTAL SETTING

3.1 Topography

A topographical survey of the site was not available at the time of writing. However, direct measurements of the reduced levels at locations across the site (made during the ground investigation), indicate that the site slopes downwards from north-east towards the south from approximately 108.2m to about 105.5m AOD.

3.2 Geological Setting

3.2.1 Geological Map Information

The geology of the site and surrounding area is shown by a site-specific BGS GeoIndex Report, which has been included as Enclosure A. This indicates the site to be underlain by Glacial Till. Made ground is also indicated to be present on the south-eastern part of the site. These deposits overlie bedrock geology of the Etruria Formation, consisting of mudstone.

3.3 Hydrology, Hydrogeology and Site Sensitivity

Site-specific sensitivity maps provided by Landmark Information Group are included as Enclosure B and were referenced for the following sub-sections.

3.3.1 Hydrology

The nearest surface water feature to the site is Glanyrafon Brook located approximately 160m to the south. No other surface water features were identified within 500m of the site boundary.

3.3.2 Hydrogeology

The superficial Glacial Till deposits are classified as a Secondary Undifferentiated aquifer, whilst the underlying bedrock of the Etruria Formation is classified as a Secondary A aquifer. The site does not lie within a groundwater Source Protection Zone (SPZ). There are no licensed groundwater abstractions indicated within 1km of the site boundary.

3.3.3 Major Ecological Receptors

No major ecological receptors[1] were identified within 1km of the site boundary.

3.4 Flood Risk

The flood map included in Enclosure B indicates the site is located within Flood Zone 1, the lowest risk classification with respect to fluvial flooding.

3.5 Summary

The Glacial deposits underlying the site are designated as a Secondary Undifferentiated aquifer, whilst the bedrock geology is classified as a Secondary A aquifer. The site is not located within a groundwater Source Protection Zone and there is no groundwater abstraction indicated within 1km of the site boundary. A stream is indicated to be present approximately 160m south. The site is therefore not considered sensitive to groundwater but is considered sensitive to surface water. The site is not considered sensitive with respect to major ecological receptors or flooding.

[1] As listed in Table A of Annex 3, DEFRA Circular 01/2006: Environmental Protection Act 1990: Part 2A – Contaminated Land, September 2006.

4.0 SITE HISTORY

The site history has been deduced primarily from a review of historical OS maps obtained from Landmark Information Group.

4.1 Historical Maps and Plans

Table 4.1 summarises the previous uses of the site and surrounding area as identified in maps dated between 1872 and 2024. Copies of the maps referenced in the Table are included in Enclosure C. Any identified uses of the site and the surrounding area that are considered potentially contaminative are shown in ***bold italics***. The distances and directions from the site stated in the table below are approximate.

Table 4.1 Review of Historical Maps

On-site	Surrounding area
1872 (1:2,500) The site is farmland.	The land use surrounding the site is predominantly agricultural.
1879 (1:10,560) No significant changes indicated.	A ***colliery*** is indicated approximately 300m to the south-east.
1900 (1:10,560) No significant changes indicated.	A ***reservoir*** together with several ***spoil heaps*** are indicated approximately 400m to the south-east, associated with the colliery.
1938 (1:10,560) No significant changes indicated.	No significant changes indicated.
1954 (1:10,560) No significant changes indicated.	A ***slag heap*** associated with the colliery is indicated 300m to the south-east. The reservoir 400m to the south-east appears to have been ***infilled***.
1963-1964 (1:10,560) No significant changes indicated.	Residential dwellings have been constructed adjacent the site to the east. A ***garage*** has also been constructed 200m south-east. The slag heap 300m to the south-east appears to have extended towards the south-west.
1976-1979 (1:10,000) No significant changes indicated.	The A483 road network has been established 130m to the west.
1992 (1:2,500) No significant changes indicated.	A large building (health centre) has become established about 50m west of the site, which includes an ***electricity sub-station***. A motel and a ***service station*** have been constructed 50m south-west. A ***garage*** (present day car dealership) has become established 50m to the south.
1993 (1:10,000) No significant changes indicated.	The colliery 300m south-east is indicated as ***disused***. Two disused ***shafts*** are also indicated 400m south-east, within the colliery.
2001 (Aerial Photography) No significant changes indicated.	The present-day industrial building has been constructed 50m to the north. The slag heap to the south-east appears covered in vegetation.
2006 (1:10,000) The site is undeveloped but indicated to be part of an industrial estate.	No significant changes indicated.
2024 (1:10,000) The site is shown in its present-day layout.	The surrounding area is shown in its current layout.

Copies of other 1:10,000, 1:2,500 and 1: 1,250 scale maps including arial photographs have also been consulted, but these do not reveal any significant further information regarding the site or its immediate environs.

4.2 Planning History

A search of the planning applications database of Wrexham County Borough Council has revealed that planning application was granted for the construction of the existing Dickens Garage on site in October 2006 (application reference: P/2006/1187 - Dilys o/Valid From 06/10/2006; erection of vehicle showroom, repair centre and associated car parking).

4.3 Summary

The above information indicates the site has remained undeveloped until the construction of the present-day garage sometime shortly after 2006.

In the surrounding area, notable developments include a colliery with two mine shafts approximately 300m-400m to the south-east. They are indicated to have become disused by the early-1990s. A large slag heap associated with the colliery has been identified about 300m to the south-east, currently landscaped/vegetated.

The possibility of encountering ground contamination beneath the site as a result of the current and previous uses of the site and surrounding area has been taken into account in the preparation of an initial conceptual site model (CSM) which is presented in Section 7.0 of this report.

4.4 UXO Risk

Preliminary research of online databases has indicated that the risk of UXO being present at the site is low.

5.0 MINERAL EXTRACTION

The site is located within a Coal Mining Reporting Area, but not within a Coal Authority defined Development High Risk Area. A Consultant's Coal Mining Report has been obtained for the site, which indicates that the shallowest mine workings beneath the site are present at depths of about 300m bgl and were approximately 1.1m thick with the last date of working recorded as 1955.

Several other mine workings are reported at depths between 310m and 450m bgl. The report also indicates that there are no probable unrecorded shallow workings beneath the site and there are no mine entries within 100m of the site's boundary. A copy of the report is included as Enclosure D.

Bersham spoil tip is indicated at 320m south-east, however, all operations at this site are indicated to have ceased. Two mine shafts associated with Bersham Colliery are also indicated at 375m and 430m south-east of the site, where deep coal used to be extracted. All operations are indicated to have ceased.

The risk of subsidence as a result of mineral extraction at the site is considered sufficiently low not to warrant any further investigation.

6.0 ENVIRONMENTAL DATABASE INFORMATION

Enclosure E contains a database of environmental information prepared by Landmark Information Group Limited. The main points of note within this database are tabulated below. All distances stated are approximate and positional accuracy may be to within 100m in some cases.

Table 6.1 Summary of Environmental Database Information

	No. of incidents		Details of notable database entries	
	0-250m	251-500m	Distance & Direction from site	Additional Information
Discharge Consents	1	7	180m S 290m E 290m E 300m E 305m E 305m E 305m E 465m E	Revoked 1993 Sewage discharge, storm overflow into Glanyrafon Brook, issued 2019, effective Sewage discharge, storm overflow into Glanyrafon Brook, issued 2009, effective Unspecified discharge into Glan-Yr-Afon Brook, issued 1967, revoked 1992 Storm sewage overflow into Glanyrafon Brook, issued 2006, modified Storm sewage overflow into Glanyrafon Brook, issued 2005, revoked 2006, status modified Storm sewage overflow into Glanyrafon Brook, issued 1994, revoked 2008, new consent granted Surface water discharge into Glan Yr Afon Rhostyllen, issued 1983, revoked 1991, consent expired
Local Authority Pollution Prevention and Controls (LAPPC)	1	0	90m S	PFS, authorised
Pollution Incidents to Controlled Waters	2	3	130m S 160m S 270m E 385m NE 485m E	Category 3 – Minor incident, dated 1995, crude sewage Category 2 – Significant incident, dated 1991, chlorinated water Category 3 – Minor incident, dated 1996, algae from blocked sewer Category 3 – Minor incident, dated 1995, leakage of clay/mud/soil Category 3 – Minor incident, dated 1996, algae due to overflow
Licensed Waste Management Facilities	0	1	385m SE 385m SE	Household, commercial and industrial transfer stations, licence issued 2000, effective Household, commercial and industrial transfer stations, licence issued 2000, modified 2005. The entry refers to the same site referenced above.
Registered Waste Transfer Sites	0	1	405m E	Solid, dry, household waste, inert materials, scrap metal, dated 2000, operational
Landfill Sites	0	0	-	-
Potentially Infilled Land (water)	0	3	270m SE 305m E 385m SE	Possibly infilled stream Possibly infilled stream Possibly infilled reservoir
Petrol Filling Stations			90m S 90m S	Operational Obsolete
Potentially contaminated land use (active)	4	9	10m to 470m N, NE, S, SW, SE	Potentially active contaminative land uses within 500m of the site include: Car dealers, garage services, car painters and sprayers, coating services, precision engineers, builders' merchants, food products manufacturers, PVC-U products manufacturers, photocopiers, and commercial cleaning services.
Potentially contaminated land use (inactive)	4	26	80m to 475m N, NE, E, SE, SW	Former activities within 500m of the site included: Sheet metal work, commercial vehicle dealers, garage services, car paint and lacquer manufacturers, metal finishing services, general engineering services, electrical engineers, electric motor sales and service, crane hire, sales and service, food product manufacturers, wood products manufacturers, fencing manufacturers, mortar manufacturers, commercial cleaning services, carpet and upholstery cleaners, freight forwarders and printers.

The Landmark environmental database indicates that the site is unlikely to be affected by onsite contaminative activity. However, a number of potentially contaminative land uses have been identified in the surrounding 500m and are listed in Table 6.1. Notably, there is an active waste management facility 385m south-east of the site. It accepts household and inert commercial and industrial waste. A disused spoil heap and areas of infilled land are also present in the vicinity of the site.

The possibility of ground contamination having been caused at the site because of these activities is discussed further in Section 7.0.

7.0 INITIAL CONCEPTUAL SITE MODEL (CSM)

A qualitative risk assessment of the site was undertaken utilising the information obtained in the preceding desk study section of the report in order to facilitate the development of an initial CSM. This was based on a risk-based approach and incorporated the accepted contaminant–pathway–receptor (C-P-R) linkage approach ('pollutant linkage') outlined in Part 2a of the Environmental Protection Act 1990. This approach also follows the risk assessment framework included in LCRM (EA, 2020) in which three essential elements to any risk are considered:

- A **contaminant** – a substance that is in, on or under the land and has the potential to cause harm or to cause pollution of the water environment
- A **pathway** – a route or means by which a receptor can be exposed to, or affected by, a contaminant
- A **receptor** – something that may be adversely affected by a contaminant

A risk is created only where all three elements are linked together and must first be established for a contaminated land hazard to exist and before any other secondary considerations are given to the effects and the need/requirement for remediation.

Table 7.1 below summarises the potential contaminants, receptors and pathways identified. Contaminants arising from the current and historical uses of both the site and surrounding area have been considered. Ground contamination can only be considered as potential until proven and hence the assessment is qualitative. For the purpose of this assessment the contaminants have been separated according to whether they are likely to have originated from on-site or off-site source activities.

Table 7.1 Initial CSM

Potential Sources (*Associated Contaminants*)
On-site sources: • Former uses of the site as garage (*petroleum hydrocarbons, PAH compounds, metals/metalloids*)
Off-site sources: • Active waste management facility 385m south-east (dependent on nature and source of the deposited waste but may include *petroleum hydrocarbons, PAH compounds, metals/metalloids, VOC and SVOC, sulphate, high/low pH, asbestos, ground gas*) • Spoil heap and infilled land, including reservoir within 500m of the site (dependant on nature and source of infill material but may include *petroleum hydrocarbons, PAH compounds, metals/metalloids, VOC and SVOC, sulphate, high/low pH, asbestos, ground gas*) • Electricity sub-station 50m west, constructed early-1990s (*petroleum hydrocarbons, PAH compounds, asbestos*) • Other active and obsolete contaminative land uses surrounding the site including petrol station, car dealers, garage services, car painters and sprayers, coating services, precision engineers, electrical engineers, builders' merchants, food products manufacturers, PVC-U products manufacturers, wood

products manufacturers, fencing manufacturers, mortar manufacturers, sheet metal work, freight forwarders, printers, photocopiers, and commercial cleaning services (may include *petroleum hydrocarbons, PAH compounds, metals/metalloids, VOC and SVOC, sulphate, high/low pH, asbestos, ground gas*) The responsibility for contamination arising from an off-site source would lie with the respective site owner/occupier.
Potential Receptors

• Humans: Construction workers, future site users, off site residents.
• Development end use: Proposed development, services and utilities.
• Controlled waters:
  • Groundwater: Secondary Undifferentiated aquifer designation of superficial deposits, Secondary A aquifer status of Etruria Formation bedrock
  • Surface waters: Glanyrafon Brook located approximately 160m to the south of the site

Potential Pathways

• Humans: Ingestion, skin contact, inhalation of dust, indoor and outdoor air, vapour
• Development end use: Contact.
• Controlled Waters:
  • Groundwater: Leachate migration into pore water from soil contamination, free product flow (if present), dilution and dispersion into groundwater
  • Surface waters: Surface run-off, hydrological flow within groundwater

The CSM summarises the identified potential sources of ground contamination, potential exposure/migratory pathways and potential receptors, and indicates that it is possible for the accepted contaminated land hazard identification convention (contaminant-pathway-receptor linkage) to be completed for this site with respect to human receptors, the development end-use, and controlled waters as a result of both on-site and off-site sources of contamination.

An intrusive investigation has been undertaken across the site, with the objectives of confirming the levels of ground contamination and the associated risk to the identified receptors, as well as providing geotechnical data for design of the proposed development. Details of the investigation undertaken are presented in Section 9.0 below.

8.0 DETAILS OF GROUND INVESTIGATION

8.1 Investigation and Design Methodology

The ground investigation was undertaken between the 4th and 5th of June 2024 and included cable percussion boreholes (BH01-BH03) and window sampling boreholes (WS01-WS24). Gas and groundwater standpipes were fitted into selected boreholes on completion and monitoring visits were subsequently undertaken.

The scope of the investigation was designed to provide information to undertake the ground contamination and geotechnical aspects of the appraisal, as detailed below.

8.1.1 Ground Contamination Objectives

Twenty-one window sampling boreholes (WS01-WS21) were positioned across the site to enable the recovery of targeted and non-targeted soil samples for contamination, buried concrete classification and off-site disposal classification testing.

Monitoring standpipes were fitted into selected boreholes (BH01-BH03 and WS01-WS02) on completion to enable the retrieval of groundwater samples for laboratory testing and the measurement of ground gas concentrations and groundwater levels.

8.1.1 Geotechnical Objectives

Two cable percussion boreholes (BH01-BH02) and two window sampling boreholes (WS01-WS02) were positioned at the corners of the proposed building to enable the collection of information for foundation design.

Window sampling boreholes (WS19-WS21) we drilled within the existing building in the north-western section of the site to provide information on the suitability of the existing floor slab to support the proposed racking.

A third cable percussion borehole (BH03) was positioned at the opposite end of the site to the proposed building and, together with the remaining window sampling boreholes (WS03-WS18), was utilised to provide geotechnical information to enable recommendations with regard to the proposed racking.

Section 8.2 describes the investigation in additional detail. The locations of the exploratory holes relative to the current site layouts are indicated on Figure 5.

8.2 Exploratory Hole Information

Service Clearance

Prior to commencing intrusive works, statutory service records for the site were obtained and reviewed. Each exploratory hole position was cleared of underground services using electromagnetic and Ground Penetrating Radar (GPR) techniques by a suitably qualified surveyor prior to breaking ground.

Coring

The hardstanding at each borehole location was removed using diamond coring equipment with water as a lubricant and flushing medium.

Cable Percussion Boreholes

Three boreholes (BH01-BH03) were drilled to practical refusal at depths of between 6.00m and 7.42m bgl using standard cable percussion boring equipment to produce boreholes of 150mm diameter. Clean drilling techniques were employed at the site and included casing through made ground (where present) to avoid potential cross-contamination between strata.

SPTs as described in BS EN ISO 22476-3:2005+A1:2011, were carried out during drilling to allow an assessment of the *in-situ* density or stiffness of the ground encountered. Due attention was also maintained to determine whether groundwater was encountered within the strata penetrated.

Window Sampling Boreholes

Twenty-one window sampling boreholes (WS01-WS21) were drilled to depths of between 3.0m and 5.45m bgl. Clean drilling techniques were employed at the site and included casing through made ground to avoid potential cross-contamination between strata.

SPTs, were carried out during drilling above to allow an assessment of the in-situ density or stiffness of the ground.

8.3 Gas and Groundwater Monitoring Installations

On completion, ground gas and groundwater monitoring installations were fitted into BH01-BH03 and WS01-WS02. The installations comprised 63mm HDPE tubes, topped with gas control valves, which were perforated along differing lengths to target specific soil horizons. The response zones were surrounded with clean pea gravel whilst the upper section of the installation comprised a bentonite seal, overlain by concrete securing a protective cover fitted flush with the surrounding ground surface.

8.4 Soil Sampling

Samples and cores recovered from the cable percussion boreholes were collected by drilling crew in new clean bags and containers using appropriate clean tools. Bulk disturbed samples were taken at close intervals during boring in order to provide material for subsequent geotechnical analysis and to give a comprehensive record of strata encountered. The samples were later inspected and logged by an Igne Engineer.

Soil samples from the window sampling boreholes were collected in new clean 1m-length plastic liners, which were opened and sub-sampled by the Igne Engineer.

Samples for contamination testing were recovered from the boreholes, trial pits and bund material by the Igne Engineer in accordance with the guidelines in BS10175:2011+A2:2017 'Investigation of Potentially Contaminated Sites - Code of Practice'. During sampling all reasonable effort was maintained to prevent cross-contamination or general failure of the sampling strategy. All samples were collected in new, clean bags or jars as appropriate using a stainless-steel trowel, which was cleaned prior to the collection of each sample. The recovered samples were temporarily stored in cool boxes with freeze packs in order to maintain low temperatures during transfer to the laboratory. The samples were labelled and dispatched to the laboratory under complete chain of custody documentation.

8.5 Ground Gas and Groundwater Monitoring and Sampling

The concentrations of CH_4, CO_2, O_2, CO and H_2S within each borehole installation, together with the associated flow rates and depth to groundwater were recorded on four occasions during June and July 2024. The monitoring was undertaken during a range of weather conditions and atmospheric pressures, including during a period of low and falling atmospheric pressure when 'worst case' gas concentrations are likely to be recorded in the monitoring wells.

Groundwater samples were recovered from the standpipes within BH03[2] following development by purging at least three times the well volume of water. The samples were recovered using a dedicated disposable bailer, stored in glass jars and vials and transported to the laboratory in insulated, refrigerated cool boxes under completed chain of custody.

8.6 Records of Fieldwork

Detailed records of the exploratory holes have been produced in accordance with BS5930+A1:2020 and are included as Appendix 1. Details of the samples, SPT results and installations are given on the respective logs. Photographs of the recovered concrete cores are presented as Plates 17-19.

The results of the gas and groundwater monitoring are included in Table A, which is presented immediately after the report text.

9.0 LABORATORY TESTING

9.1 Soil Contamination Testing

Table 9.1 lists the contamination tests performed on soil samples during the present investigation, together with a brief summary of the purpose of each test.

[2] Groundwater was not encountered within the other monitoring standpipes.

Table 5.1 Soil contamination tests

Row	Test	No. of tests	Purpose
1	Metals (arsenic, cadmium, chromium, lead, copper, nickel, zinc, mercury and selenium)	14	Included targeted and non-targeted tests based on the findings of the initial CSM and taking account of any evidence of suspected contamination noted during sampling.
2	Polycyclic aromatic hydrocarbons (PAHs) speciated into the USEPA-16 'priority pollutants'	14	
3	TPH (speciated into aliphatic and aromatic fractions in the carbon chain lengths C_5-C_6, C_6-C_8, C_8-C_{10}, C_{10}-C_{12}, C_{12}-C_{16}, C_{16}-C_{21} and C_{21}-C_{35}	14	
4	Benzene, toluene, ethylbenzene and xylene (BTEX)	14	
5	Total organic carbon	2	Used in conjunction with the above analyses to assess whether surplus soils could be classified as inert waste for off-site disposal.
6	Loss on ignition	2	
7	Leachability testing for a series of parameters as required by the Waste Acceptance Criteria (WAC)	2	
8	pH and water-soluble sulphate, total (acid soluble) sulphate and total sulphur	20	To facilitate an assessment of the design classification for buried concrete.

9.2 Groundwater Testing

Groundwater samples were collected from BH03 (the only location where groundwater was encountered) during one round of monitoring and subjected to analysis for the determinants listed in Rows 1-4 and 8 of Table 9.1.

9.3 Geotechnical Testing

Samples collected from the boreholes were subjected to the tests described in Table 9.2 to assist with providing geotechnical recommendations for the design of foundations and pavement.

Table 9.2 Geotechnical tests

Test	No. performed	Purpose
Natural Moisture Content	12	Used in conjunction with *in-situ* testing to determine the strength characteristics of the soil.
Plastic Limit, Liquid Limit, and Plasticity Index	12	
Unconfined Compressive Strength (UCS)	3	Used to determine the strength of the existing building floor slab.

9.4 Results of Laboratory Tests

Soil and groundwater contamination testing was undertaken by I2 Analytical and are presented in Appendices 2 and 3 respectively.

The soil geotechnical testing was undertaken by Igne and the results are included as Appendix 4.

The UCS analysis was undertaken by Isotest and the results are presented as Appendix 5.

10.0 GROUND CONDITIONS

10.1 Succession of Strata

The site is surfaced by tarmac hardstanding (generally <0.1m thick) which is underlain by a dark grey sandy angular to sub-rounded fine to coarse sandstone gravel subbase with a thickness of between 0.07m and 0.62m (mean of 0.27m). This is underlain by typically firm and stiff brown very sandy gravelly clay to about 4m bgl over medium dense brown slightly clayey very gravelly fine to coarse sand, with occasional cobbles. Suspected sandstone bedrock was encountered in the cable percussion boreholes at a depth of about 7m bgl.

10.2 Groundwater

No groundwater was encountered during drilling. Some seepage was encountered during trial pit excavation, however this is considered likely to be from perched accumulations.

Subsequent monitoring of groundwater between 13 June 2024 and 10 July 2024 revealed groundwater levels in BH03 to be between the depths of 5.5m bgl (100.19m AOD) and 5.94m bgl (99.71m AOD). The other boreholes remained dry during this period.

10.3 Evidence of Contamination

No visual or olfactory evidence of contamination was observed at any of the exploratory hole locations during the fieldwork.

11.0 GROUND CONTAMINATION APPRAISAL

11.1 Assessment Methodology

The ground contamination appraisal has been undertaken based on a risk-based approach and incorporating the accepted 'pollutant linkage' (contaminant-pathway-receptor) outlined in Part IIa of the Environmental Protection Act 1990.

The appraisal of the soil contamination at the site has followed the tiered procedure adopted in LCRM and repeated below:

- Development of a CSM summarising the identified pollutant linkages at the site (Preliminary Risk Assessment)
- Selection of appropriate generic screening criteria and comparisons to the measured contaminant concentrations (Generic Quantitative Risk Assessment)
- Derivation of site-specific values where the determinants exceed the generic screening criteria (Detailed Quantitative Risk Assessment) as appropriate.

11.2 Preliminary Risk Assessment

An initial CSM for the site was introduced and discussed in some detail in Section 8.0 and concluded that the contaminant–pathway–receptor linkage could potentially be completed for this site with respect to the human receptors, the development end-use, and controlled waters as a result of both on-site and off-site sources of contamination.

The present investigation has confirmed the presence of <1m of made ground overlying natural material. No groundwater was encountered during drilling or subsequent monitoring to a depth of up to 4.4m bgl.

No evidence of contamination was identified during the intrusive works.

11.3 Quantitative Risk Assessment

For the various receptors, appropriate screening criteria relevant to the potential 'pollutant linkages' were selected. These are summarised below:

11.3.1 Receptor: Short-term Human Health (Construction Workers)

The contamination test results (Appendices 2 and 3) indicate that the soils and groundwater tested present a low risk of harm to construction workers.

The risk of exposure to construction workers and future maintenance workers from contaminated materials is considered short-term and the relevant Health and Safety Executive (HSE) Guidance on Workplace Exposure Limits (EH40/2005, 4th Edition 2020) should be taken into account. A Health and Safety Hazard Assessment for the detailed undertakings should be carried out as stipulated under the Construction Design and Management (CDM) Regulations 2015, with due regard to the laboratory test results included in Appendices 2 and 3. A Working Health and Safety Plan should be prepared, which mitigates the potential risks/hazards to site workers from the specific undertakings as identified in the Hazard Assessment.

In general, for most encounters with exposure to contaminated soils and waters, PPE consisting of overalls, gloves and suitable protective footwear and headgear is considered appropriate. Further advice on PPE is given in HSE Publication HS(G)66 (1991) 'Protection of Workers and the General Public During Development of Contaminated Land'.

11.3.2 Receptor: Long-term Human Health (Site End Users) and Proposed Development End Use

The risk to long-term human health (site end users) has been assessed using a combination of appropriate generic assessment criteria for a commercial development end use, as described in Science Report SC050021/SR3 (EA, 2009). This is considered appropriate for the proposed builders merchant.

The results of laboratory analysis of recovered soil samples from the current investigation have been compared directly to GAC selected from the sources below (listed in order of preference). The maximum concentration of each determinant is presented in Table 7.1 together with the adopted assessment criteria.

1. Category 4 Screening Levels (C4SL) published by DEFRA (2014)
2. Suitable for Use Levels (S4ULs) published by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) (2015)
3. GAC derived by DTS Raeburn using the CLEA UK (v1.071) Model 2014. The derivation of these GAC has taken account of the relevant TOX data and published literature information regarding chemical properties.

Where necessary a soil organic matter (SOM) concentration of 1% has been assumed. The results of site-specific laboratory tests for TOC have indicated this to be suitably conservative.

The results of the comparisons are presented in Table 11.1. Where a maximum value exceeds the GAC, it is highlighted **bold**.

Table 11.1 Soil contamination test results

Determinant	Number of Samples	mg/kg		Source of Criteria	Location of Exceedance
		Maximum Value	Assessment Criteria		
arsenic	14	11	640	1	-
cadmium	14	0.5	410	1	-
chromium (total)	14	32	8,600	2	-
lead	14	37	2,330	1	-
selenium	14	1.6	12,000	2	-
mercury (inorganic)	14	<0.3	1,100	2	-
copper	14	23	68,000	2	-
zinc	14	87	730,000	2	-
nickel	14	29	980	2	-
boron	14	0.5	240,000	2	-
total cyanide [1]	14	<1	16,000	3	-
phenol [2]	14	<1	440	2	-
PAH					
acenapthene [3]	14	1.3	57	2	-
acenaphthylene [3]	14	0.09	86	2	-
anthracene	14	3.6	520,000	2	-
benzo(a)anthracene	14	8.3	170	2	-
benzo(a)pyrene	14	8	35	2	-
benzo(b)fluoranthene	14	9.2	44	2	-
benzo(g,h,i)perylene	14	3.5	3,900	2	-
benzo(k)fluoranthene	14	3.7	1,200	2	-
chrysene	14	8.5	350	2	-
dibenzo(a,h)anthracene	14	1	3.5	2	-
fluoranthene	14	19	23,000	2	-
fluorene	14	1.6	31	2	-
indeno(1,2,3-cd)pyrene	14	3.5	500	2	-
napthalene [3]	14	0.2	76	2	-
phenanthrene	14	12	22,000	2	-
pyrene	14	15	54,000	2	-
TPH & BTEX					
aliphatic C_5-C_6 [3]	14	<0.02	304	2	-
aliphatic C_6-C_8 [3]	14	<0.02	114	2	-
aliphatic C_8-C_{10} [3]	14	<0.05	78	2	-
aliphatic C_{10}-C_{12} [3]	14	<1	48	2	-
aliphatic C_{12}-C_{16} [3]	14	12	24	2	-
aliphatic C_{16}-C_{35}	14	216	1,600,000	2	-
aromatic C_5-EC_7 [3]	14	<0.1	1,220	2	-
aromatic C_7-EC_8 [3]	14	<0.1	869	2	-
aromatic C_8-EC_{10} [3]	14	<0.5	613	2	-
aromatic C_{10}-EC_{12} [3]	14	<1	364	2	-
aromatic C_{12}-EC_{16} [3]	14	8.8	169	2	-
aromatic C_{16}-EC_{21}	14	51	28,000	2	-
aromatic C_{21}-EC_{35}	14	100	28,000	2	-
benzene	14	<0.005	98	1	-
toluene [3]	14	<0.005	869	2	-
ethylbenzene [3]	14	<0.005	518	2	-

Determinant	Number of Samples	mg/kg		Source of Criteria	Location of Exceedance
		Maximum Value	Assessment Criteria		
m&p-xylene	14	<0.005	1,201	2	-
o-xylene	14	<0.005	478	2	-

[1] Calculated using TOX data for inorganic cyanide (R&D Publication TOX5, DEFRA and EA, 2002)

[2] Based on a threshold protective of direct skin contact with phenol (most conservative)

[3] SGV/GAC capped at the lower of the vapour or aqueous saturation limits in soil

Table 11.1 indicates that all of the tested contaminants are below the adopted criteria for long-term human health. It is therefore considered that the test soils present a sufficiently low risk of significant harm to the long-term health of site end users and the proposed development end use.

11.3.3 Receptor: Controlled Waters

The soil contamination test results reviewed in Section 11.3.2 above indicate no residual source of contamination in the test soils.

The development proposals will ensure that the entirety of the site remains encapsulated beneath hardstanding, which will serve to ensure that, even if any localised contamination is present at locations not explored by the investigation, the potential for downward contaminant migration as a result of surface water infiltration will be minimised. These observations thus indicate a low risk to controlled waters from soil contamination.

However, the CSM presented in Section 7.0 has shown that a pathway to controlled waters (the underlying Secondary undifferentiated aquifer of the superficial and bedrock geology and nearby surface water course) from contamination at the site can be completed. Therefore, in keeping with the precautionary principle for risk assessment, a quantitative assessment of the risk to controlled waters has been undertaken by means of laboratory analysis of a recovered groundwater sample.

Table 11.2 presents a comparison of the maximum detected concentration of each determinant to the relevant GAC selected from the sources listed below:

1. GW-TV incorporated by the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.
2. EQS for individual substances in fresh water incorporated by the same legislation as the GW-TV. Where appropriate, a conservative water hardness of 50-100mg/l $CaCO_3$ has been adopted.

Where both a GW-TV and an EQS have been determined for a substance, the more sensitive of the two thresholds have been applied. Where neither a GW-TV nor an EQS have been determined, the adopted GAC has been selected from the following sources:

3. WHO Guidelines for Drinking Water Quality 4th Edition (2011)
4. In the absence of published GAC for TPH and ethylbenzene, a notional screening value of 10µg/l has been adopted

Table 11.2 Groundwater contamination test results

Determinant	Number of Samples	µg/l		Location of Exceedance(s) *Maximum exceedance*
		Maximum Value	GAC (source)	
Metals				
arsenic	1	0.27	7.5 (1)	-
boron	1	22	750 (1)	-
cadmium	1	<0.02	3.75 (1)	-
chromium	1	1.1	37.5 (1)	-
copper	1	0.6	1500 (1)	-
lead	1	<0.2	7.5 (1)	-
mercury	1	<0.05	0.75 (1)	-
nickel	1	<0.05	15 (1)	-
selenium	1	<0.06	7.5 (1)	-
zinc	1	1.5	12.3 (2)	-
Inorganic Suite				
cyanide	1	< 1.0	1(2)	-
phenol, monohydric	1	< 1.0	7.7 (2)	-
PAHs				
naphthalene	1	< 0.01	2 (2)	-
acenaphthylene	1	< 0.01		
acenaphthene	1	< 0.01		
fluorene	1	< 0.01		
phenanthrene	1	< 0.01		
anthracene	1	< 0.01	0.1 (2)	-
fluoranthene	1	< 0.01	0.063 (2)	-
pyrene	1	< 0.01		
benzo(a)anthracene	1	< 0.01		
chrysene	1	< 0.01		
benzo(b)fluoranthene	1	< 0.01	0.075 (1)	-
benzo(k)fluoranthene	1	< 0.01	0.1(3)	-
benzo(a)pyrene	1	< 0.01	0.00017 (2)	-
indeno(1,2,3-cd)pyrene	1	< 0.01		
dibenzo(a,h)anthracene	1	< 0.01		
benzo(ghi)perylene	1	< 0.01		
Total PAH				
Total EPA-16 PAHs	1	<0.16		
TPH & BTEX				
aliphatic C_5-C_6	1	<1.0	10 (4)	-
aliphatic C_6-C_8	1	<1.0		-
aliphatic C_8-C_{10}	1	<1.0		-
aliphatic C_{10}-C_{12}	1	<10		-
aliphatic C_{12}-C_{16}	1	<10		-
aliphatic C_{16}-C_{21}	1	<10		-
aliphatic C_{21}-C_{35}	1	<10		-
aliphatic C_{35}-C_{40}	1	<10		-
aromatic EC_5-EC_7	1	<1.0		-
aromatic EC_7-EC_8	1	<1.0		-
aromatic EC_8-EC_{10}	1	<1.0		-
aromatic EC_{10}-EC_{12}	1	<10		-
aromatic EC_{12}-EC_{16}	1	<10		-
aromatic EC_{16}-EC_{21}	1	<10		-

Determinant	Number of Samples	µg/l		Location of Exceedance(s) *Maximum exceedance*
		Maximum Value	GAC (source)	
aromatic EC_{21}-EC_{35}	1	<10		-
aromatic EC_{35}-EC_{40}	1	<10		-
Benzene	1	<3.0	10(2)	-
Toluene	1	<3.0	74(2)	-
Ethylbenzene	1	<3.0	300(3)	-
m, p-xylene	1	<3.0	500(3)	-
o-xylene	1	<3.0	500(3)	-

Table 11.2 shows that the concentrations of PAHs, hydrocarbons, BTEX, metals and inorganic compounds in the tested groundwater were recorded below the respective GAC. No further assessment is considered necessary.

11.4 Effect of Ground Contamination on Proposed Development

The levels of contamination in the tested soil and groundwater are considered suitable for retention beneath the proposed development, and to present a sufficiently low risk to both short-term and long-term human health, the development end use and controlled waters.

However, procedures should be identified for dealing with unforeseen contamination in the event that this becomes apparent during any below-ground excavation or construction works. Specifically, these should include site visitation, sampling, testing and appraisal by a suitably qualified environmental specialist as appropriate.

11.5 Off-site Disposal of Surplus Soils

The waste classification of any surplus soils requiring off-site disposal from the site should be determined by the receiving tip operator taking account of the contamination laboratory test results included in Appendix 2. The comments below are offered for guidance purposes only.

On the basis of the laboratory analysis undertaken, the tested samples could be disposed of as inert waste under the Landfill (England and Wales) (Amendment) Regulations 2004.

11.6 Soil Gas

Table 11.3 summarises the soil gas monitoring results recorded on four occasions during June and July 2024, including a period of low and falling atmospheric pressure. The full results are included as Table A located immediately after the report text.

Table 11.3 Summary of Soil Gas Monitoring Data

Number of monitoring visits:	4	Dates of monitoring visits:			13/06/24 - 11/07/24		
	Pressure (mb)	CH_4 (%)	CO_2 (%)	CO (ppm)	H_2S (ppm)	O_2 (%)	Flow (l/hr)
Maximum concentration*	1007	0.0	11.4	2	0	20.1	0.0
Minimum concentration*	995[1]	0.0	0.2	0	0	0.5	0.0

[1] recorded during a period of low and falling atmospheric pressure

*Steady state concentrations and flow rate are used for risk assessment purposes.

The assessment framework presented in CIRIA Report C665 (2007) recommends that the requirement for ground gas protection to new buildings should be determined based on a 'gas screening value (GSV). The GSV is calculated by multiplication of the maximum methane (CH_4) or carbon dioxide (CO_2)

concentrations (whichever is the higher) by the maximum gas flow rate. Based on the data summarised above, the calculated GSV is 0 litres/hour which falls into 'Characteristic Situation' Classification CS-1. However, the CIRIA guidance also states that where CO_2 concentrations exceed 5%, consideration should be given to increasing the characteristic situation to CS-2, regardless of flow rate. Beneath the proposed building in the north-eastern section of the site, elevated CO_2 concentrations were recorded in at least two of the four boreholes on three of the four monitoring visits. On this basis, it is recommended that the site is classified as CS-2.

Under the assessment framework presented in BS8485:2015, the proposed development would be classified as a 'Type D' building for gas protection. For a Type D building under CS-2, the guidance indicates that a minimum gas protection score of 1.5 would be required.

The methodology outlined above does not take account of CO concentrations. However, the maximum detected CO concentration was 2ppm which is significantly below the long-term workplace exposure limit (WEL) of 20ppm (over an 8-hour time-weighted average). Therefore, no additional action is considered necessary with regard to CO.

The property is in an Intermediate probability radon area where 1% to 3% of homes are estimated to be at or above the Action Level. Radon protection measures are not considered necessary for the proposed development.

12.0 ENGINEERING PROPERTIES OF STRATA

12.1 *In situ* Penetration Tests

Standard Penetration Tests (SPTs) were performed at regular depth intervals during drilling of the boreholes. Each test result is expressed as an N-value, which is the blow-count from a calibrated drop hammer needed to cause a standard penetrometer to advance 300mm into the ground.

The SPT N-values are given on the borehole logs and they have been plotted against elevation (m AOD) in Figure 6. The plot shows a steady increase in the strength of the soils with depth. The tests indicate that the natural clay is predominantly firm or stiff and the underlying sand and gravel mostly medium dense, becoming dense and very dense with depth. Weathered sandstone was encountered in BH03 at 6.9m bgl (approximately 98.79m AOD) and SPT N-values ≥50 were obtained in this material.

12.2 Plasticity of Fine-grained Soils

Table 12.1 gives the natural moisture content w, liquid limit w_L and plastic limit w_P for 24No. specimens of the natural clay taken from the boreholes. The Table also includes the derived plasticity index[3] I_P.

[3] $I_P = w_L - w_P$

Table 12.1 Water content and plasticity of clay

BH	depth (m)	water content	liquid limit	plastic limit	plasticity index	Classification	shrinkage/ swelling potential
		w (%)	w_L (%)	w_P (%)	I_P		
BH01	0.8	17.8	35	18	17	CL/CI	Low
BH01	1.8	15.9	30	17	13	CL	Negligible
BH03	0.8	18.9	27	15	12	CL	Negligible
BH03	2.7	11.2	38	14	24	CI	Negligible
BH03	4.8	12.2	30	17	13	CL	Negligible
WS01	1.5	22.9	43	20	23	CI	Low
WS02	1.4	16.7	41	15	26	CI	Medium
WS02	3.5	16.1	27	15	12	CL	Negligible
WS04	1.2	20.0	42	20	22	CI	Low
WS04	2.5	15.8	31	16	15	CL	Low
WS05	1.4	18.6	42	19	23	CI	Medium
WS05	2.6	12.0	30	15	15	CL	Low
WS07	1.6	9.5	29	17	12	CL	Low
WS07	2.4	14.1	39	18	21	CI	Low
WS08	1.6	9.2	23	14	9	CL	Negligible
WS09	1.4	10.4	22	13	9	CL	Negligible
WS10	1.5	13.4	27	17	10	CL	Negligible
WS13	1.5	7.7	22	13	9	CL	Negligible
WS15	1.5	11.5	30	14	16	CL	Low
WS16	1.4	13.4	24	13	11	CL	Negligible
WS18	1.6	13.0	28	16	12	CL	Negligible
WS19	1.6	15.6	25	15	10	CL	Negligible
WS20	1.3	17.3	39	18	21	CI	Low
WS21	1.9	13.5	29	15	14	CL	Low
Minimum		7.7	22	13	9		
Maximum		22.9	43	20	26		
Mean		14.45	31.38	16	15.38		

The tests indicate that the natural clay tested is of low to intermediate plasticity and has low to negligible shrinkage and swelling potential. The latter property refers to the tendency of clay soils to expand (heave) or contract, in response to an increase or decrease in water content.

12.3 Particle Size Distribution

Table 12.2 gives the results of two tests performed on samples of natural soils to measure the particle size distribution ('soil grading').

Table 12.2 Particle size distribution

Location and Depth (m)	Soil Type	Fraction (%) size range (mm)			
		cobbles 200-60	gravel 60-2	sand 2-0.06	Silt & clay <0.06
BH01; 5.0	Very clayey/silty, very sandy GRAVEL	0	54	24	22
BH02; 3.0	Very clayey/silty, very gravelly, cobbly SAND	9	22	36	33

13.0 GEOTECHNICAL ASSESSMENT

The existing on-site buildings are to be converted to Travis Perkins sales and storage areas, with a new building (Building 3) constructed to the rear, in the north-eastern part of the site. The new building is understood to be a single frame lightweight, cladded building. Racking is to be installed within the existing Building 1 and also externally across the site[4]. The anticipated loading for the storage areas within the buildings and to the areas outside is 30kPa.

No significant changes to the existing site levels are proposed.

13.1 Foundations

Pad and strip foundations appear to be feasible, for the ground conditions encountered. Foundations should bear on natural clay of at least *firm* consistency at a depth of at least 1m bgl. Any soft, organic or otherwise unfavourable materials should be removed and replaced with suitably compacted granular fill or mass concrete.

Influence of Trees

Mature deciduous trees are present primarily along the eastern and south-eastern boundaries of the site, locally at distances less than 10m from the proposed building. Current development proposals indicate that the trees are to be retained.

Trees abstract water from the ground, which can result in desiccation of the upper soil horizons. Changes in the water content of the near-surface soils caused by trees and vegetation, as well as by seasonal factors can result in shrinkage and swelling of clay soils. Laboratory tests indicate that the near-surface natural clay has low to intermediate plasticity and low to negligible shrinkage and swelling potential. The trees (retained or newly planted) and the volume change potential of the natural clay should be taken into account in foundation design and foundation depths increased where necessary. Guidance is provided in NHBC Standards[5] and also in BRE Digests 298[6] and 412[7], and should be taken into account in detailed design.

Table 13.1 gives estimated soil bearing resistances for square pad and strip foundations supported on natural clay of at least *firm* consistency at a depth of 1.0m bgl, for a calculated settlement limited to 25mm.

Table 13.1 Bearing resistances for pad and strip foundations

(a) Design bearing resistance for square pad foundations

foundation breadth B (m)	1.0	1.5	2.0	2.5
design bearing resistance (kPa)	195	130	100	80
estimated equivalent load (kN)	195	290	400	500

(b) Design bearing resistance for strip foundations

foundation breadth B (m)	0.75	1.0	1.25	1.5
design bearing resistance (kPa)	140	100	85	70

[4] MJM Consulting Engineers, project name: *Travis Perkins Wrexham*, drawing title: *Proposed Site Layout*, drawing reference: *9003-MJM-XX-XX-DR-D-6611*, revision *P02*, dated 16th May 2024
[5] National House Building Council, *Standards* (2024), Chapter 4.2 Building Near Trees
[6] Building Research Establishment (April 1999), Low-rise Building Foundations: The Influence of Trees in Clay Soils, *Building Research Establishment BRE Digest 298*.
[7] M. Crilly (February 1996), Desiccation in Clay Soils, *Building Research Establishment BRE Digest 412*.

The bearing resistances given above are intended for foundations carrying static, vertical loads with insignificant eccentricity.

Foundation excavations should not be left exposed to the elements for long periods of time, in order to avoid softening of the natural clay. If it is not possible for foundation concrete to be poured immediately after excavation, either the bases of the excavations could be protected with a blinding layer of concrete or the last 150mm of soil could be left in place and removed only when concreting is about to start.

Foundation sides could be battered back at an angle in order to prevent collapse.

If higher bearing resistances are required for the anticipated structural loads, then consideration could be given to the use of mini piles. Advice should be sought from specialist mini-piling contractors if this foundation solution is to be adopted.

Ground treatment such as vibro-replacement stone columns may also be feasible. Advice should be obtained from specialist ground improvement contractors if this option is to be pursued.

13.2 New Building Floor Slab

The floor slab of the new building could be ground bearing, on the proviso that it is underlain by a suitable thickness of compacted granular fill. Any soft, organic or otherwise unfavourable materials should be removed and replaced with suitably compacted granular fill. For a slab measuring 40m x 15m in plan (the approximate dimensions of the new building), constructed at a depth of 0.3m bgl and imposing a ground bearing pressure of 30kPa, settlement is anticipated to be less than 25mm.

13.3 Existing Building Floor Slab

Table 13.2 summarises the results of three unconfined compressive strength (UCS) tests performed on concrete core specimens recovered from the locations of WS19, WS20 and WS21 from the floor slab within the existing building in the north-western section of the site.

Table 13.2 UCS test results

Core Location (borehole)	Core Diameter (mm)	Core Thickness (as reported) (mm)	In situ Density (kg/m^3)	Core Compressive Strength (from laboratory tests) (MPa)
C01 (WS19)	150	193-195	2370	41.6
C02 (WS20)	150	184-186	2380	45.7
C03 (WS21)	150	179-182	2380	46.2

The mean compressive strength measured is 44.5MPa.

Steel reinforcements of approximately 6mm-diameter thick were observed in core C01 (WS19), at depths between 60mm and 180mm, in core C02 (WS20) at 85mm and 185mm and in core C03 (WS21) between 70m and 175m from the top of the cores.

A photographic record of the two concrete cores is included as Plates 17-19 while the results of the UCS laboratory tests are presented in Appendix 5.

13.4 New Pavement

It is understood that new racking is to be installed externally across the site, which will impose a ground bearing pressure up to 30kPa.

The existing tarmac hardstanding is underlain by sub-base which is locally very thin (less than 0.2m thick). The thickness of the sub-base varies across the site and localised evidence of settlement across the car park was observed, including relatively large depressions around previous storage areas and manholes. The underlying natural geology comprises typically firm clay, becoming stiff with depth and underlain by granular deposits at circa 3-4m bgl.

The equivalent CBR at the formation level (firm clay) is unlikely to be more than 2% and for preliminary design purposes a design CBR <2% is considered suitable. On this basis, the existing sub-base thickness appears inadequate to support a uniformly distributed load (UDL) of 30kPa and would need to be increased together with the removal of any soft/unsuitable materials.

13.5 Buried Concrete

The site has been classified as 'natural ground' in accordance with the definitions included within BRE Special Digest 1. A 'static' groundwater regime has been assumed.

The concentrations of water-soluble sulphate measured in the tested soils were between 7mg/l and 192mg/l. These values fall into the Design Sulphate Class DS-1 of Special Digest 1 (3rd Edition, BRE, 2005). The soil pH values together with the absence of a laterally continuous groundwater table indicates an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-1s.

The results of additional laboratory tests for total (acid soluble) sulphate and total sulphur indicate that no additional measures are necessary to protect buried concrete against the oxidation of pyrite.

14.0 LIMITATIONS AND USE OF THIS REPORT

IMPORTANT: This section should be read before reliance is placed on any of the opinions, advice, recommendations and conclusions contained in this report.

a) This report has been prepared at the request of Travis Perkins Ltd ('the Client') pursuant to their appointment of Igne Limited in connection with the investigation;

b) Except for Travis Perkins Ltd, no duty is undertaken or warranty or representation made to any party in respect of the opinions, advice, recommendations or conclusions contained in this report;

c) All work carried out in preparing this report has used, and is based upon Igne's professional knowledge and understanding of the current (June 2024) relevant standards, codes, technology and legislation. Changes in the above may cause the opinion, advice, recommendations or conclusions set out in this report to become inappropriate or incorrect. However, in giving its opinions, advice, conclusions and recommendations, Igne have considered pending changes to environmental legislation and regulations of which they are currently aware. Following delivery of this report, Igne will have no obligation to advise the Clients of any such changes or of their repercussions. It may therefore be necessary to review the opinions, advice, recommendations and conclusions of this report following future changes to legislation;

d) Some of the information referenced and included in the report has been provided by third parties and whilst Igne has no reason to doubt the accuracy, these items have not been verified. Igne accepts no responsibility for errors within third party materials referenced and presented in this report;

e) Igne acknowledge that they are being retained, in part, because of their knowledge and experience with respect to geotechnical and environmental matters. Igne will consider and analyse all information provided in the context of their knowledge and experience and all other

relevant information known to Igne. To the extent that the information provided to Igne is not inconsistent and/or incompatible therewith, Igne shall be entitled to rely upon and assume, without independent verification, the accuracy and completeness of all such information and shall have no obligation to verify the accuracy and completeness of such information,

f) The opinions expressed in this report are based on the ground conditions revealed by investigation, together with an assessment of the site and of laboratory test results. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between borehole positions, these are only for guidance and no liability can be accepted for their accuracy;

g) The groundwater and ground gas conditions entered on the various records are those observed at the time of investigation and subsequent monitoring. Groundwater is subject to seasonal variation or changes in local drainage conditions. Ground gas levels may vary depending on variations in weather conditions particularly barometric pressure. Rates of decomposition / degradation of organic matter in the underlying soils can also affect the generation of ground gases.

h) The content of this report represents the professional opinion of experienced geotechnical and environmental specialists/consultants. Igne does not provide associated legal advice and appropriate legal advice should be sought if required.

i) The lack of evidence of the presence of hazardous materials, voids or obstructive features at the subject property does not guarantee the absence of such materials, rather it indicates only that none were found as a result of the services provided.

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E13803/1 – July 2024

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TABLE A - GAS AND GROUNDWATER MONITORING RESULTS

Project: E13803/1 Wrexham

Date: 13/06/2024
Pressure: 996mb (falling)
Weather: Overcast

Borehole	Groundwater Level (m bgl)	Groundwater Level (m AOD)	Flow Rate (l/hr)		Gas Concentration (by volume)									
					CH_4 (%)		CO_2 (%)		O_2 (%)		H_2S (ppm)		CO (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady	Peak	Steady	Peak	Steady
Calibration	-	-	-	-	0.1	0.0	0.3	0.2	21.0	20.9	0	0	0	0
BH01	-	-	0.0	0.0	0.4	0.1	3.0	2.1	8.4	16.7	0	0	1	1
BH02	-	-	0.0	0.0	0.6	0.6	4.5	4.5	3.3	3.3	0	0	1	1
BH03	5.5	100.19	0.0	0.0	0.1	0.0	0.3	0.2	17.1	17.2	0	0	2	2
WS01	-	-	0.0	0.0	0.2	0.1	4.8	4.8	15.7	16.3	0	0	1	1
WS02	-	-	0.0	0.0	0.1	0.0	4.2	3.5	15.8	16.0	0	0	1	0

Date: 25/06/2024
Pressure: 1006mb (steady)
Weather: Sunny

Borehole	Groundwater Level (m bgl)	Groundwater Level (m AOD)	Flow Rate (l/hr)		Gas Concentration (by volume)									
					CH_4 (%)		CO_2 (%)		O_2 (%)		H_2S (ppm)		CO (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady	Peak	Steady	Peak	Steady
Calibration	-	-	-	-	0.0	0.0	0.0	0.0	20.5	20.5	0	0	0	0
BH01	-	-	0.0	0.0	0.2	0.1	3.4	3.4	9.5	9.5	0	0	1	1
BH02	-	-	0.0	0.0	1.3	1.3	11.4	11.4	0.5	0.5	0	0	1	1
BH03	5.58	100.11	0.0	0.0	0.0	0.0	0.6	0.6	15.5	15.5	0	0	2	1
WS01	-	-	0.1	0.1	0.0	0.0	7.1	7.1	10.9	9.7	0	0	2	1
WS02	-	-	0.0	0.0	0.0	0.0	4.6	4.5	14.0	14.0	0	0	1	0

Date: 07/07/2024
Pressure: 1003mb (rising)
Weather: Sunny

Borehole	Groundwater Level (m bgl)	Groundwater Level (m AOD)	Flow Rate (l/hr)		Gas Concentration (by volume)									
					CH_4 (%)		CO_2 (%)		O_2 (%)		H_2S (ppm)		CO (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady	Peak	Steady	Peak	Steady
Calibration	-	-	-	-	0.0	0.0	0.0	0.0	20.8	21.0	0	0	0	0
BH01	-	-	0.0	0.0	0.0	0.0	3.4	3.3	10.7	13.4	0	0	1	0
BH02	-	-	0.0	0.0	1.3	1.0	6.9	6.5	2.1	2.8	0	0	1	1
BH03	5.98	99.71	0.0	0.0	0.2	0.0	0.7	0.6	16.4	17.3	0	0	1	1
WS01	-	-	0.0	0.0	0.1	0.1	5.9	5.6	12.3	13.5	0	0	2	1
WS02	-	-	0.0	0.0	0.0	0.0	3.7	3.6	14.3	14.3	0	0	1	0

Date: 11/07/2024
Pressure: 995mb (falling)
Weather: Sunny, breezy

Borehole	Groundwater Level (m bgl)	Groundwater Level (m AOD)	Flow Rate (l/hr)		Gas Concentration (by volume)									
					CH_4 (%)		CO_2 (%)		O_2 (%)		H_2S (ppm)		CO (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady	Peak	Steady	Peak	Steady
Calibration	-	-	-	-	0.0	0.0	0.0	0.0	21.4	21.4	0	0	0	0
BH01	-	-	0.0	0.0	0.0	0.0	6.5	6.5	8.8	8.8	0	0	1	1
BH02	-	-	0.0	0.0	0.0	0.0	10.7	10.7	5.2	5.2	0	0	1	1
BH03	5.84	99.85	0.0	0.0	0.0	0.0	1.4	1.4	17.5	17.5	0	0	0	0
WS01	-	-	0.0	0.0	0.0	0.0	10.2	10.2	11.2	11.2	0	0	1	1
WS02	-	-	0.0	0.0	0.0	0.0	4.1	4.1	15.2	15.2	0	0	0	0



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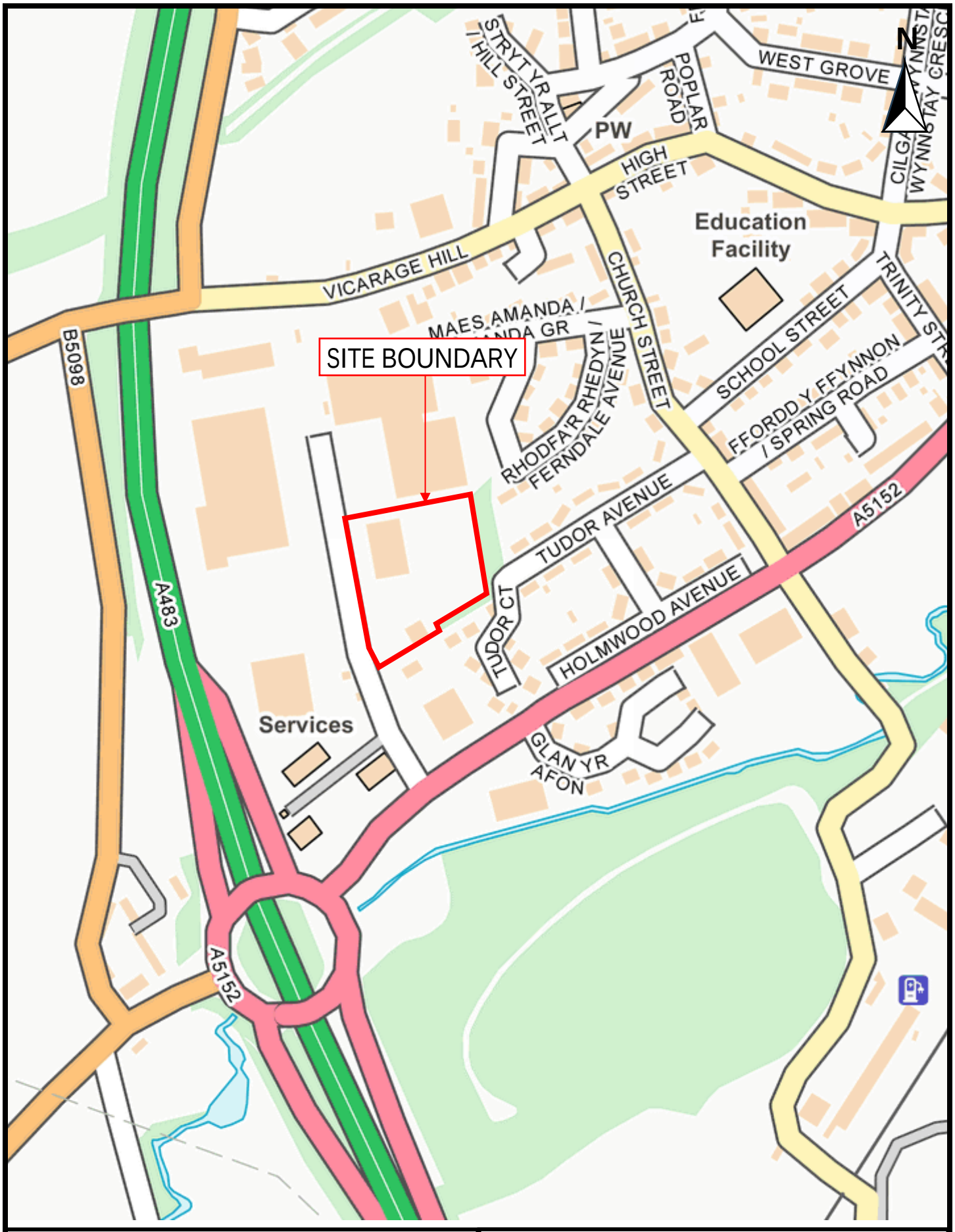
Figure 1

Site Location Plan

Scale 1:200,000 @A4

E13803/1: Wrexham, Travis Perkins

Prepared for: Travis Perkins Ltd



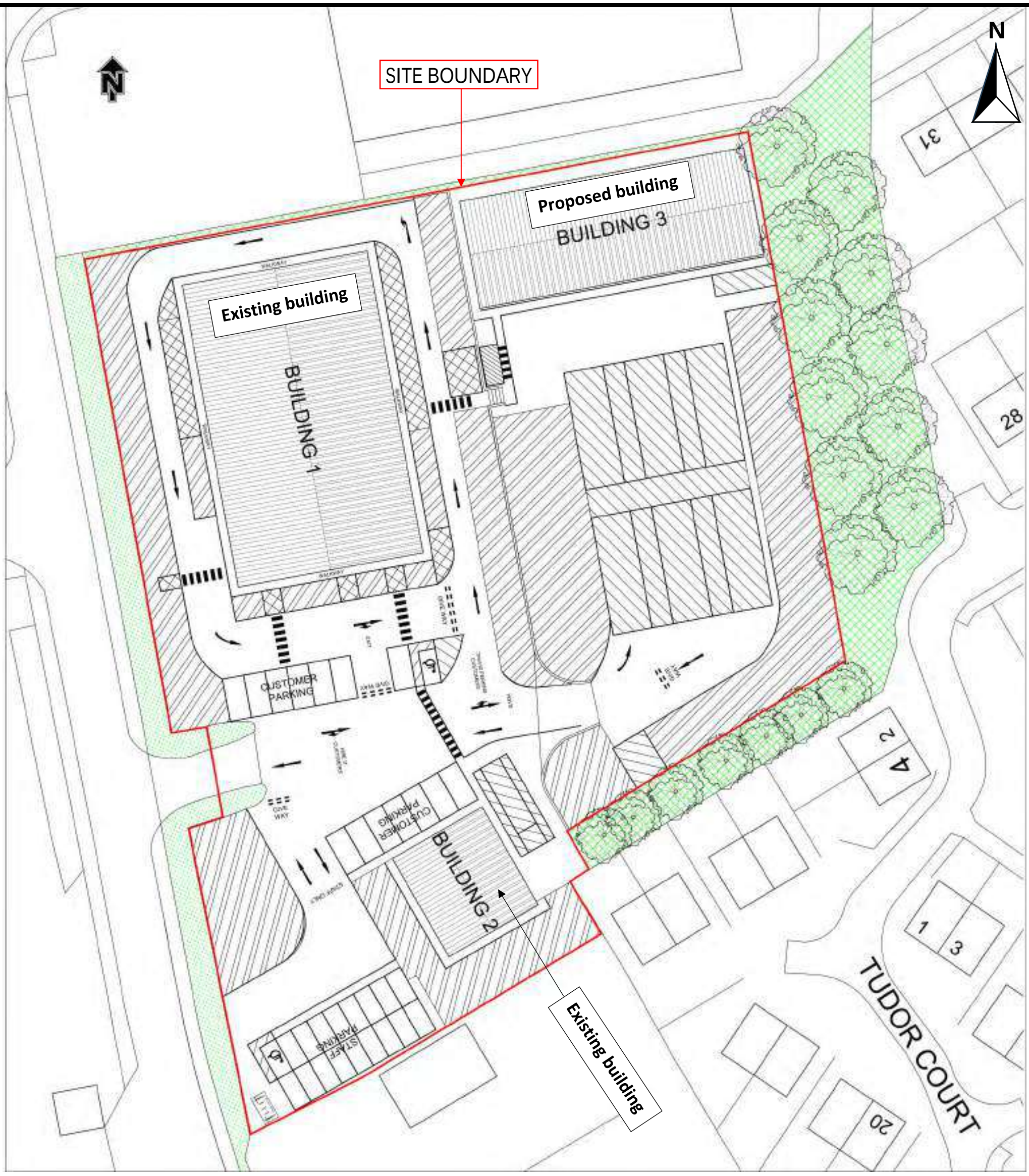
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Figure 2
Street Map
Not to Scale
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Figure 3
Plan Indicating Location of Site Photographs
Scale as Shown
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KEY:

- HGV SERVICING ZONE
- EXTERNAL RACKING/STORAGE ZONES (UP TO 5.5m HIGH)
- KEEP CLEAR
- SOFT LANDSCAPING ZONE

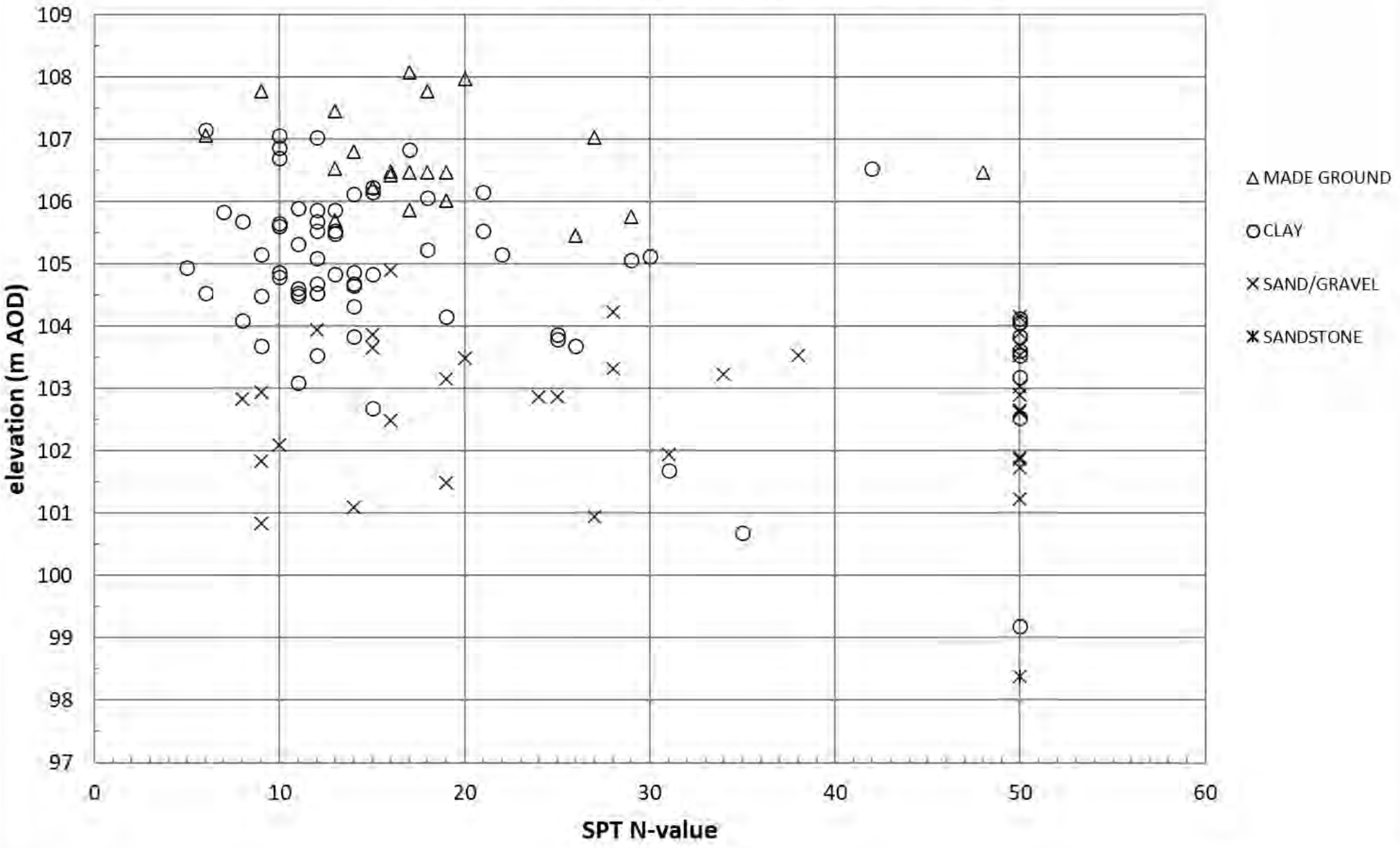
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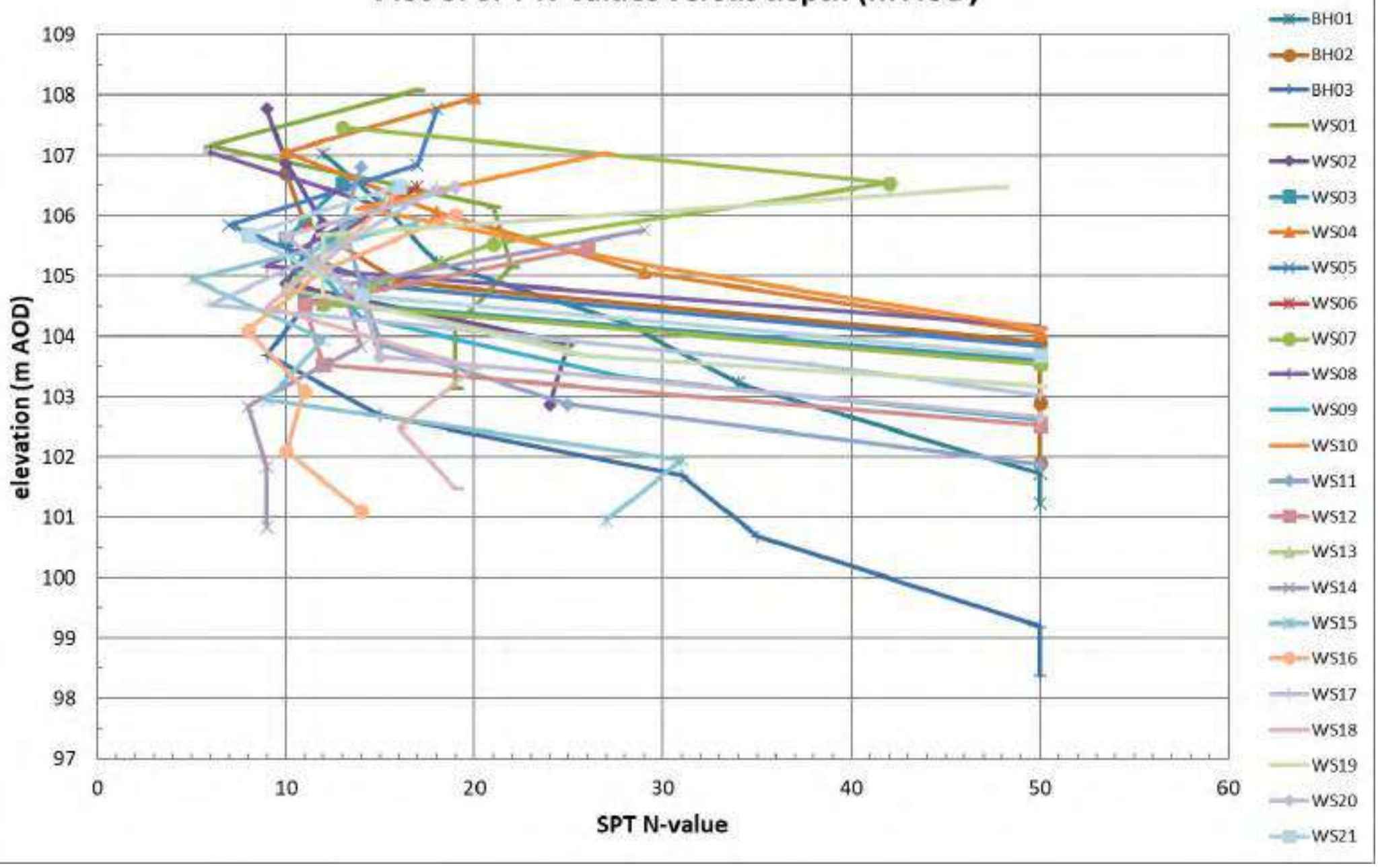
Figure 4
Proposed Development Plan
Scale 1:500 @A3
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Figure 5
Exploratory Hole Location Plan
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FIGURE 6
SPT N-Value versus Depth Plot
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Plate 1: View of the site entrance facing west



Plate 2: View of the main site building facing north

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Plates 1 & 2
Photographic Record
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Plate 3: View of the main site building facing south



Plate 4: View of the main site building facing south west

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Plates 3 & 4
Photographic Record
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Plate 5: View of the servicing area inside the main site building facing south west



Plate 6: View of the car wash and valet building facing south west

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Plates 5 & 6
Photographic Record
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Plate 7: View of the car wash and valet building facing south



Plate 8: View of the car wash and valet building facing south east

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Plates 7 & 8
Photographic Record
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Plate 9: View of retaining wall facing south-east



Plate 10: View of the vegetation bounding the site facing south

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Plates 9 & 10
Photographic Record
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Plate 11: View of the eastern portion of the site and the vegetation bounding the sites southern edge facing south



Plate 12: View of the deformations in the tarmac on the sites western boundary facing south

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Plates 11 & 12
Photographic Record
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Plate 13: View of the deformations (and repair) in the tarmac on the sites western boundary facing north



Plate 14: View of the deformations in the tarmac adjacent to the retaining wall facing north

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Plates 13 & 14
Photographic Record
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Plate 15: View of the deformations in the tarmac adjacent to the retaining wall facing west



Plate 16: View of the deformations in the tarmac adjacent to the main site building facing north

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Plates 15 & 16
Photographic Record
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Plate 15: View of the deformations in the tarmac adjacent to the retaining wall facing west



Plate 16: View of the deformations in the tarmac adjacent to the main site building facing north

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Plate 7: View of the car was and valet building facing south



Plate 8: View of the car wash and valet building facing south east

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Plates 7 & 8
Photographic Record
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Plate 9: View of the access ramp the eastern portion of the site facing east



Plate 10: View of the vegetation bounding the site facing south

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Telephone: +44(0)121 344 5885 email: enquiries.dts@igne.com

Plates 9 & 10
Photographic Record
E13803/1: Wrexham, Travis Perkins
Prepared for: Travis Perkins Ltd

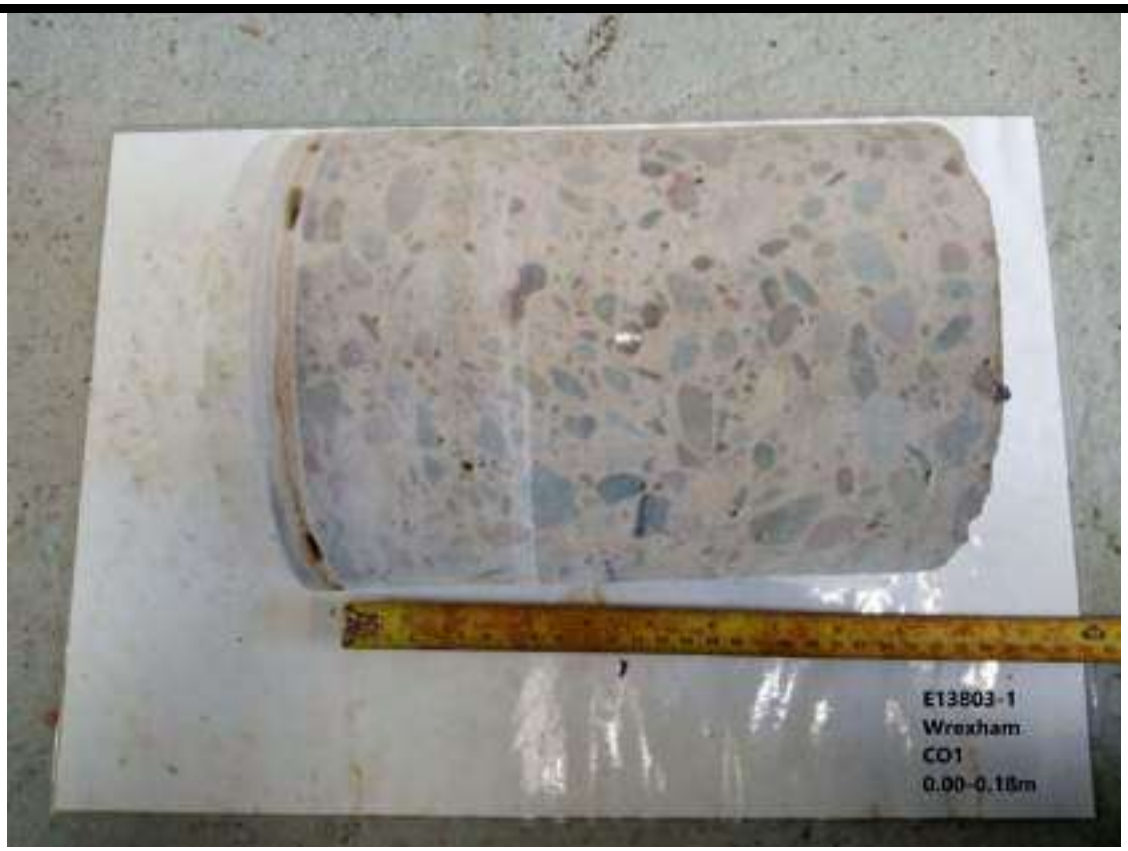


Plate 17: Concrete Core C01 0.00-0.18m



Plate 18: Concrete Core C02 0.00-0.19m

4th Floor 17 Lichfield St, Walsall, WS1 1TU
Telephone: +44(0)121 344 5885 email: enquiries.dts@igne.com

Plates 17 & 18
Photographic Record of Concrete Cores
E13803/1: Wrexham, Travis Perkins
Prepared for: Travis Perkins Ltd



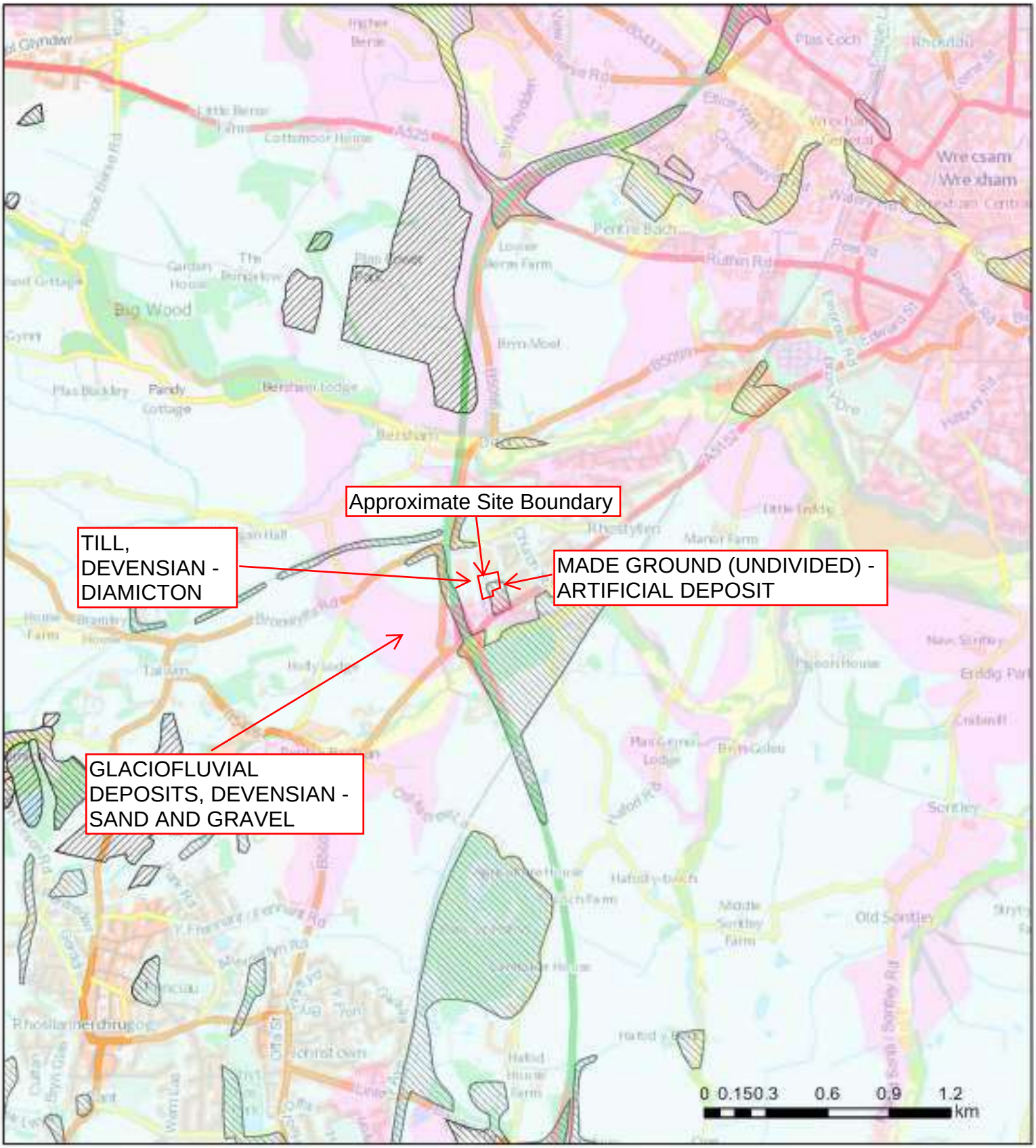
Plate 19: Plate 17: Concrete Core C03 0.00-0.19m

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ENCLOSURE A

BGS Geoindex Report
(4 pages)

Superficial Deposits



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Geolndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

Artificial ground 1:50,000 scale


LANDSCAPED GROUND (UNDIVIDED) - ARTIFICIALLY MODIFIED GROUND


MADE GROUND (UNDIVIDED) - ARTIFICIAL DEPOSIT


WORKED GROUND (UNDIVIDED) - VOID

Superficial deposits 1:50,000 scale

GLACIOFLUVIAL DEPOSITS, DEVENSIAN - SAND AND GRAVEL

GLACIOFLUVIAL SHEET DEPOSITS, DEVENSIAN - SAND AND GRAVEL

TILL, DEVENSIAN - DIAMICTON

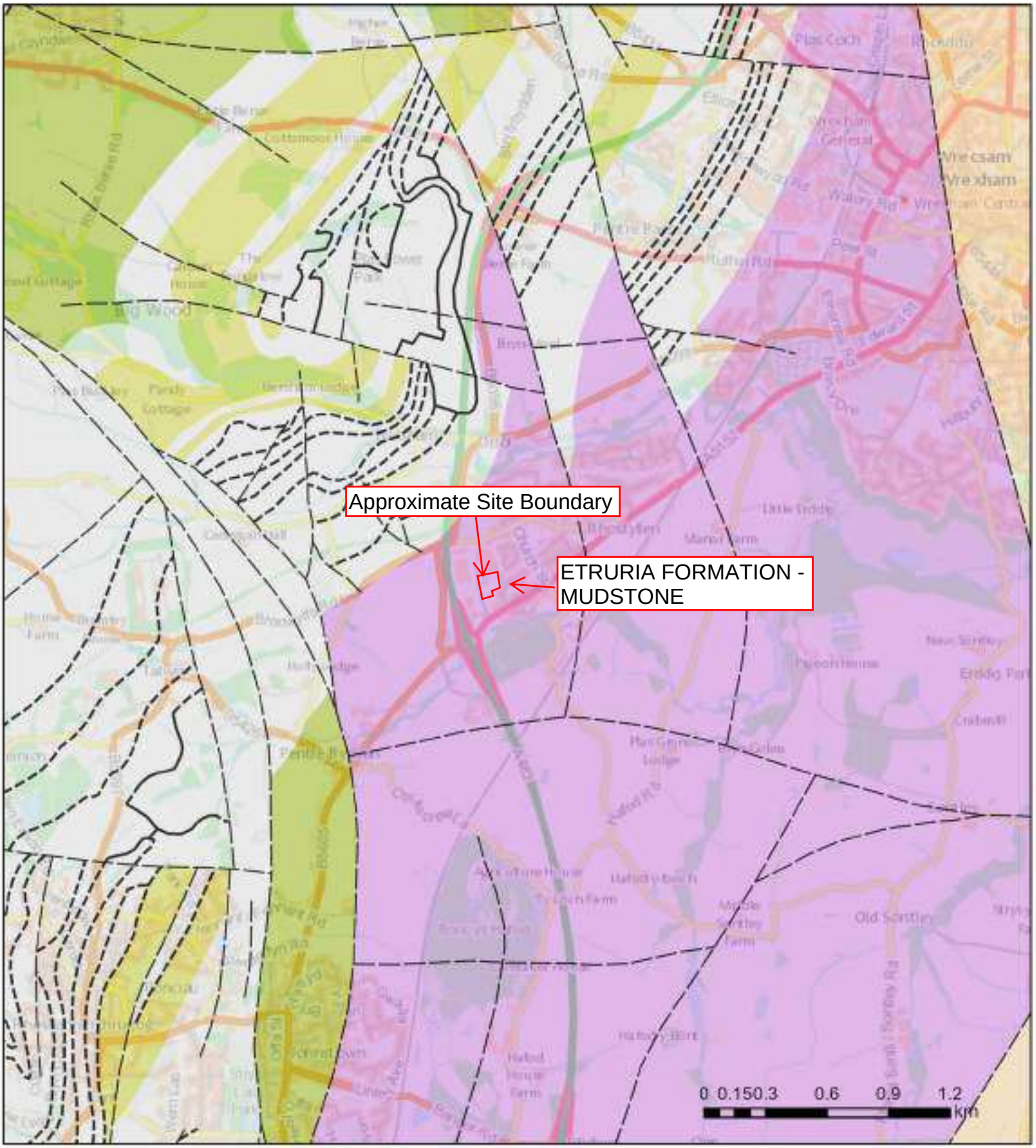
GLACIOLACUSTRINE DEPOSITS, DEVENSIAN - CLAY AND SILT

ALLUVIUM - CLAY, SILT, SAND AND GRAVEL

RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND AND GRAVEL

PEAT - PEAT

Bedrock Geology



Contains OS data © Crown Copyright and database right 2020
Geolndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

Bedrock geology 1:50,000 scale

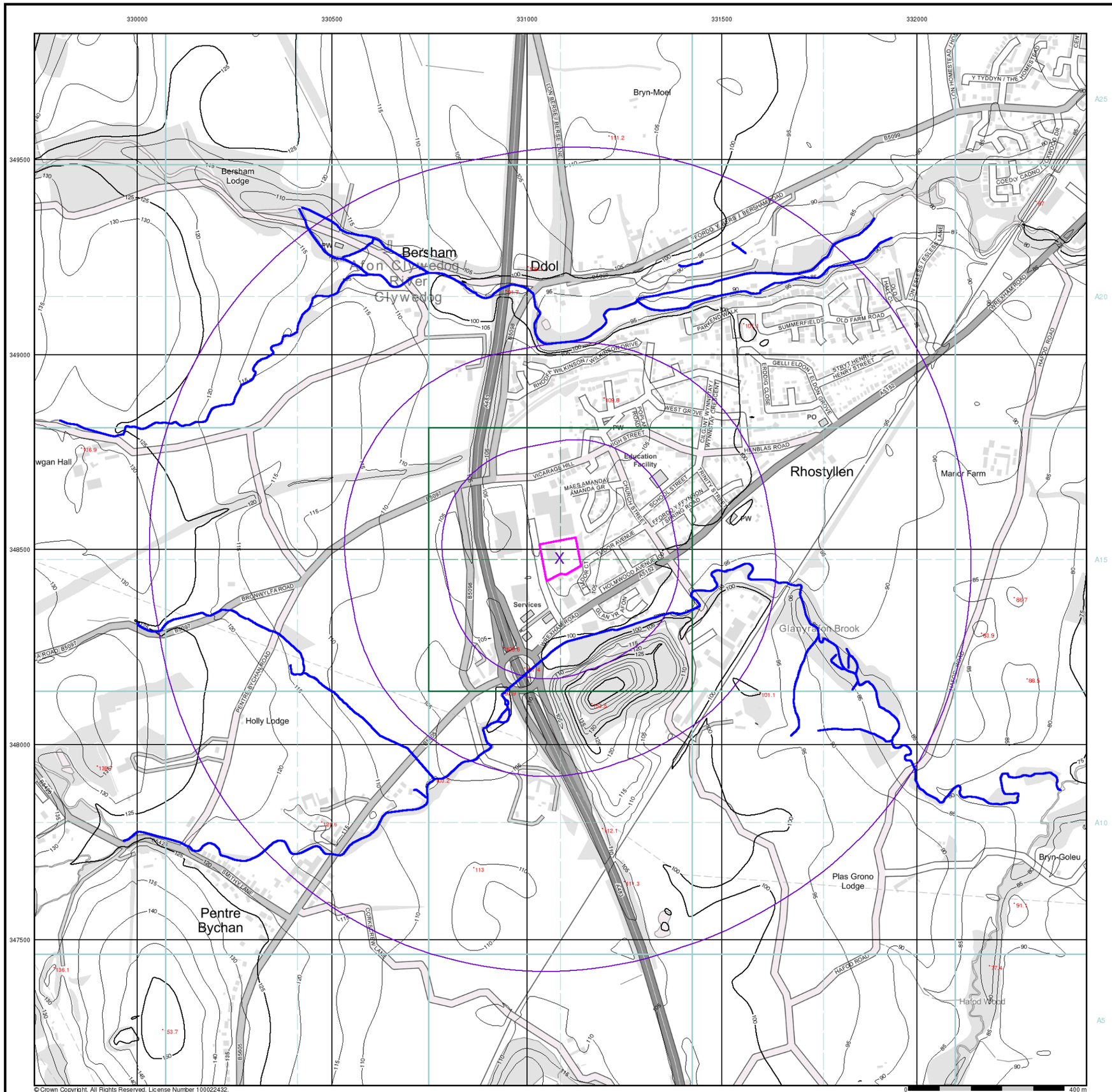
- CEFN MAWR LIMESTONE FORMATION - LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED
- PENNINE LOWER COAL MEASURES FORMATION AND PENNINE MIDDLE COAL MEASURES FORMATION (UNDIFFERENTIATED) - MUDSTONE, SILTSTONE AND SANDSTONE
- ETRURIA FORMATION - MUDSTONE
- LOGGERHEADS LIMESTONE FORMATION - LIMESTONE
- MINERA FORMATION - LIMESTONE AND [SUBEQUAL/SUBORDINATE] SANDSTONE, INTERBEDDED
- HALESOWEN FORMATION - MUDSTONE, SILTSTONE AND SANDSTONE
- GWESPYR SANDSTONE - SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED
- SALOP FORMATION - MUDSTONE, SANDSTONE AND CONGLOMERATE
- KINNERTON SANDSTONE FORMATION - SANDSTONE
- MINERA FORMATION - SANDSTONE
- CEFN-Y-FEDW SANDSTONE FORMATION - SANDSTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED
- BOWLAND SHALE FORMATION - MUDSTONE
- PENNINE LOWER COAL MEASURES FORMATION AND PENNINE MIDDLE COAL MEASURES FORMATION (UNDIFFERENTIATED) - SANDSTONE
- CEFN-Y-FEDW SANDSTONE FORMATION - CHERT
- CEFN ROCK - SANDSTONE

Linear features 1:50,000 scale

- Coal_seam_Inf
- Coal_seam_Obs
- Fault_Inf_Downthrow_unspecified
- Mineral_Vein_Inf

ENCLOSURE B

Hydrology, Hydrogeology, Site Sensitivity & Flood Risk
(6 pages)



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General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

OS Water Network Data

- Canal
- Reservoir
- Foreshore
- Marsh
- Tidal River
- Inland River
- Drain
- Other
- Lake
- Transfer
- Lock Or Flight Of Locks
- Sea

Contours (height in meters)

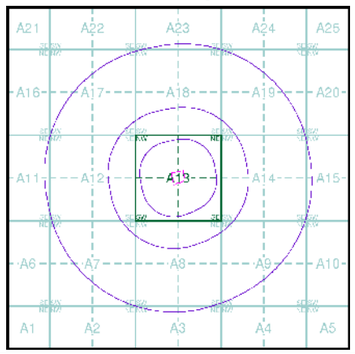
Standard Contour 105 100 95

Master Contour

Spot Height 167.3

- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



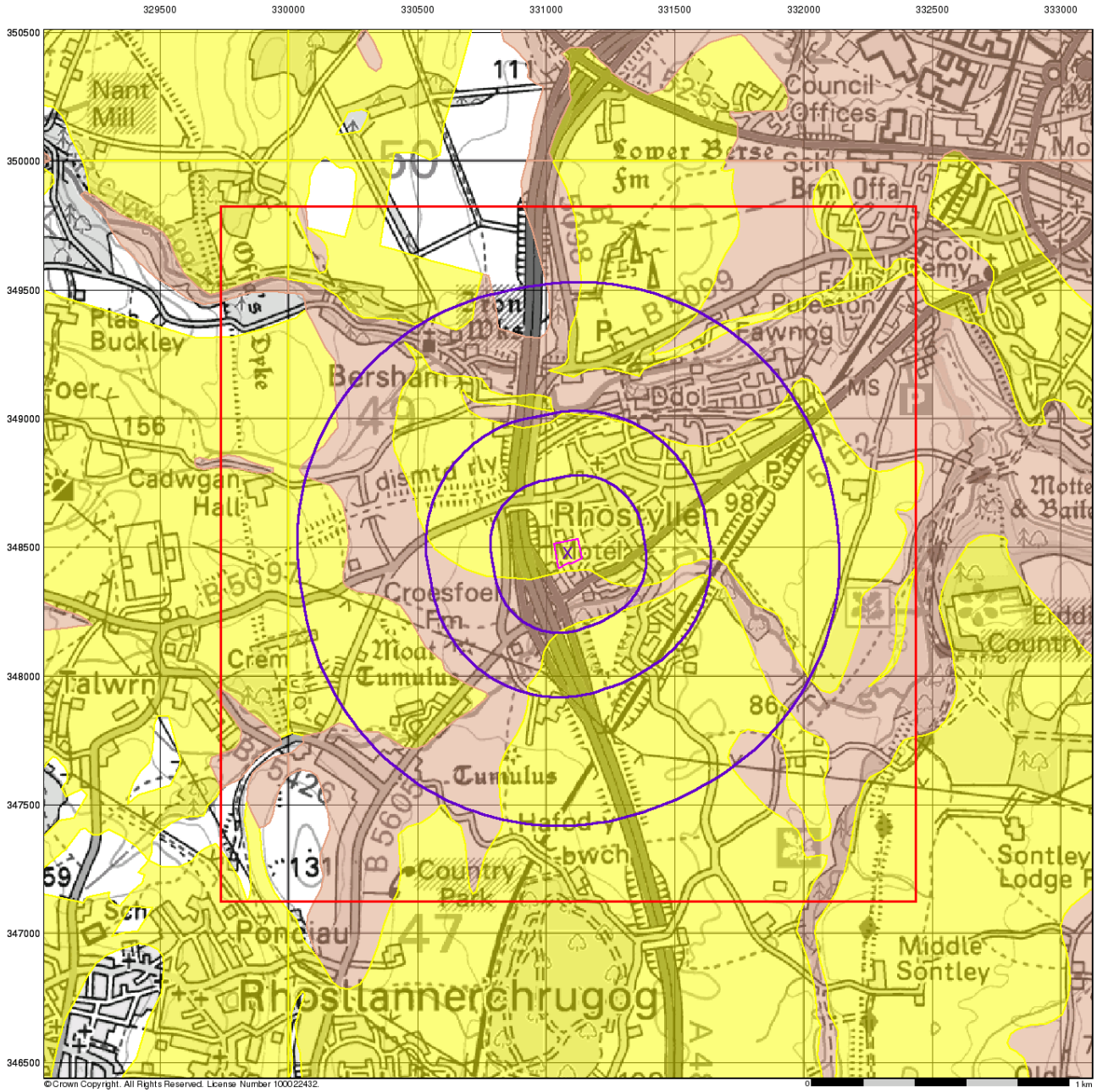
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Customer Ref:	E13803-1
National Grid Reference:	331080, 348480
Slice:	A
Site Area (Ha):	0.82
Search Buffer (m):	1000

Site Details

, The Dickens Group of Comp Ltd, Dickens Garage, Croesfoel Industrial Estate, Rhostyllen, Wrexham, LL14 4EJ

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Superficial Aquifer Designation

General

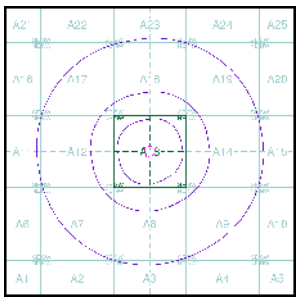
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A

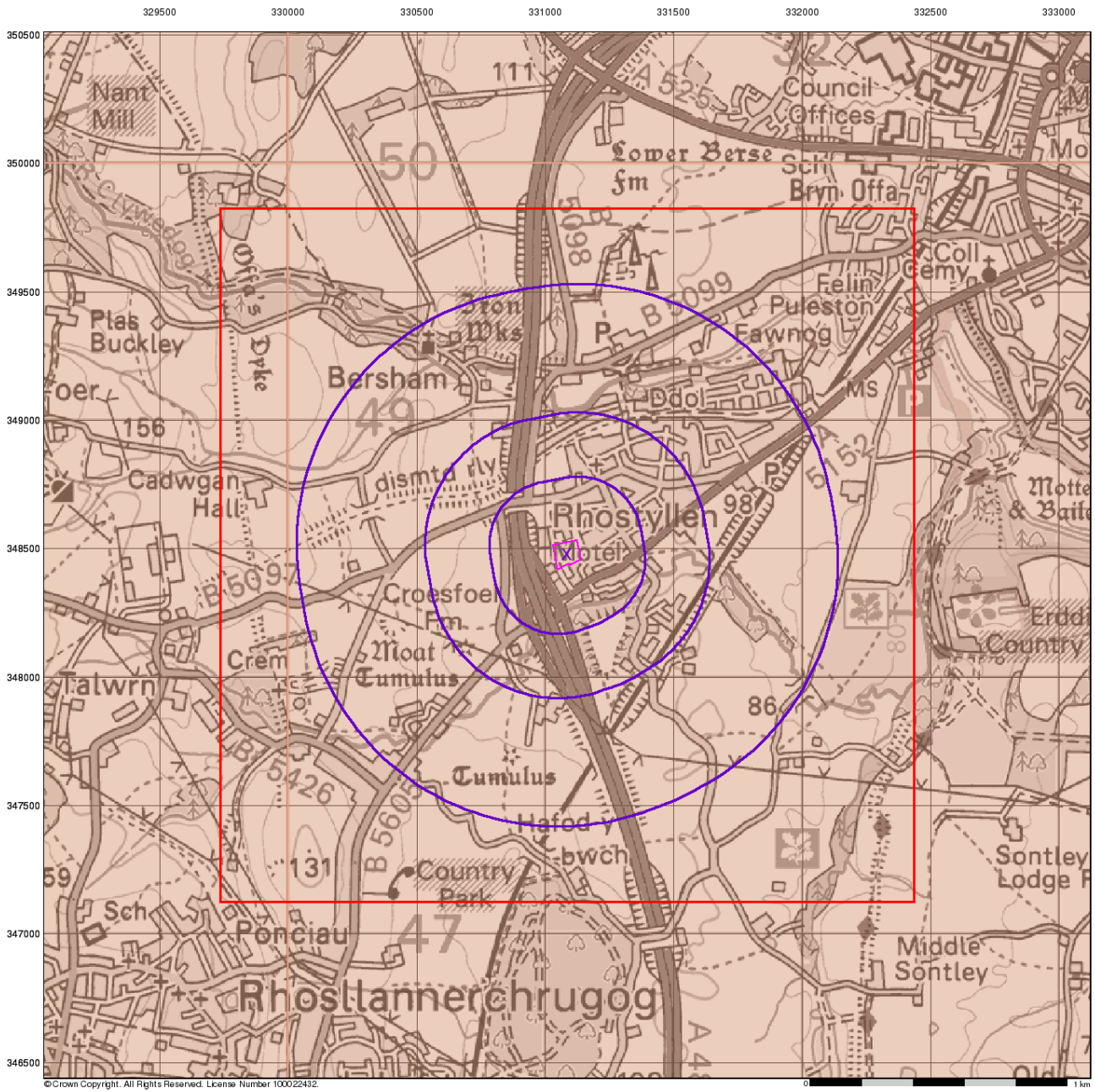


Order Details

Order Number:	347763743_1_1
Customer Ref:	E13803-1
National Grid Reference:	331080, 348480
Slice:	A
Site Area (Ha):	0.82
Search Buffer (m):	1000

Site Details

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Bedrock Aquifer Designation

General

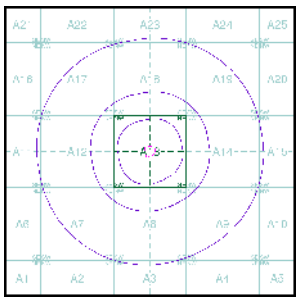
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A

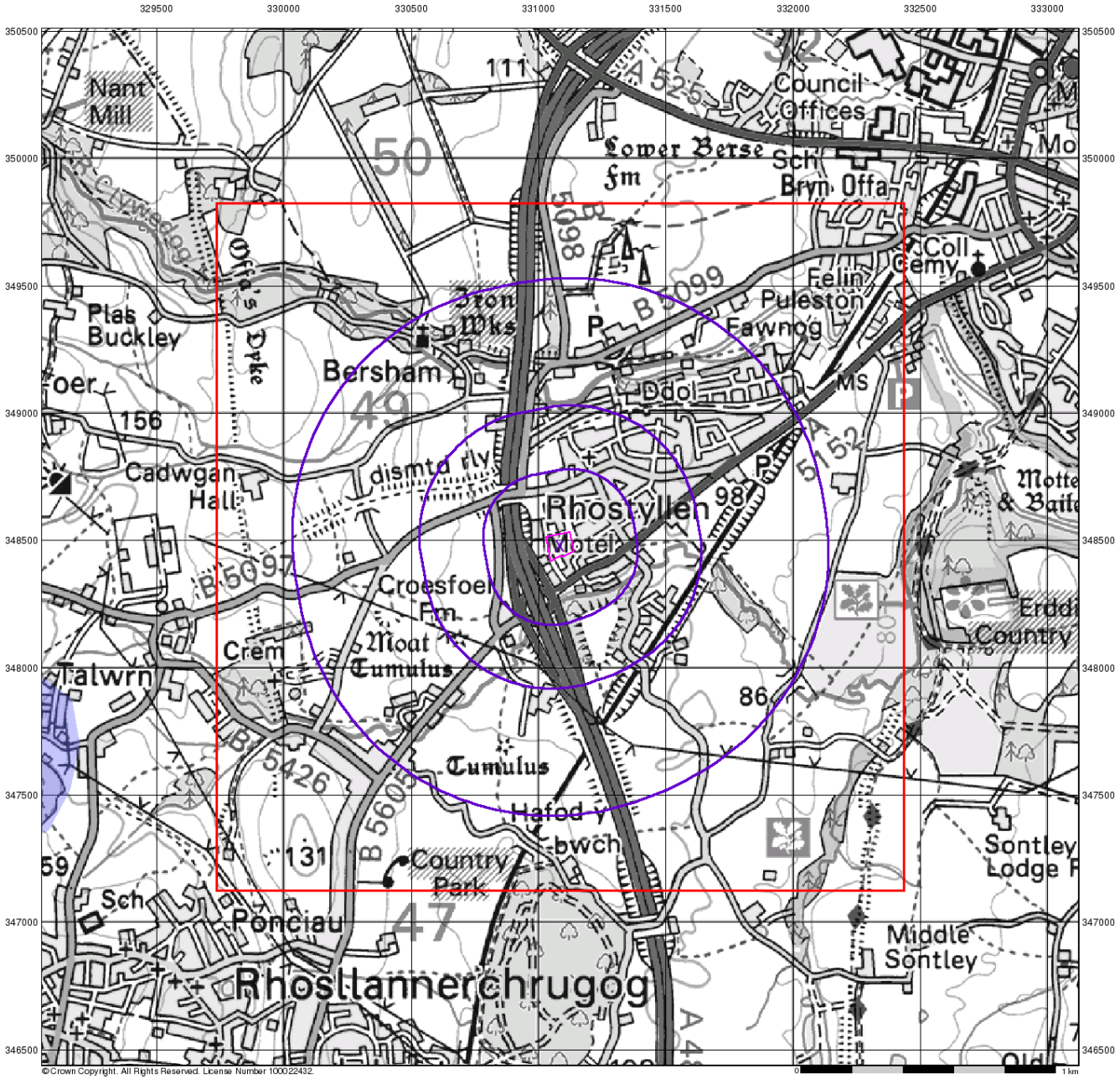


Order Details

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Customer Ref:	E13803-1
National Grid Reference:	331080, 348480
Slice:	A
Site Area (Ha):	0.82
Search Buffer (m):	1000

Site Details

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Source Protection Zones

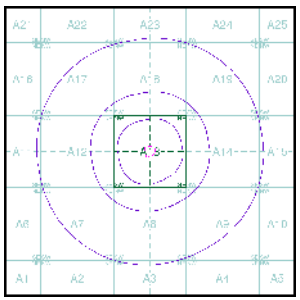
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)

Site Sensitivity Context Map - Slice A



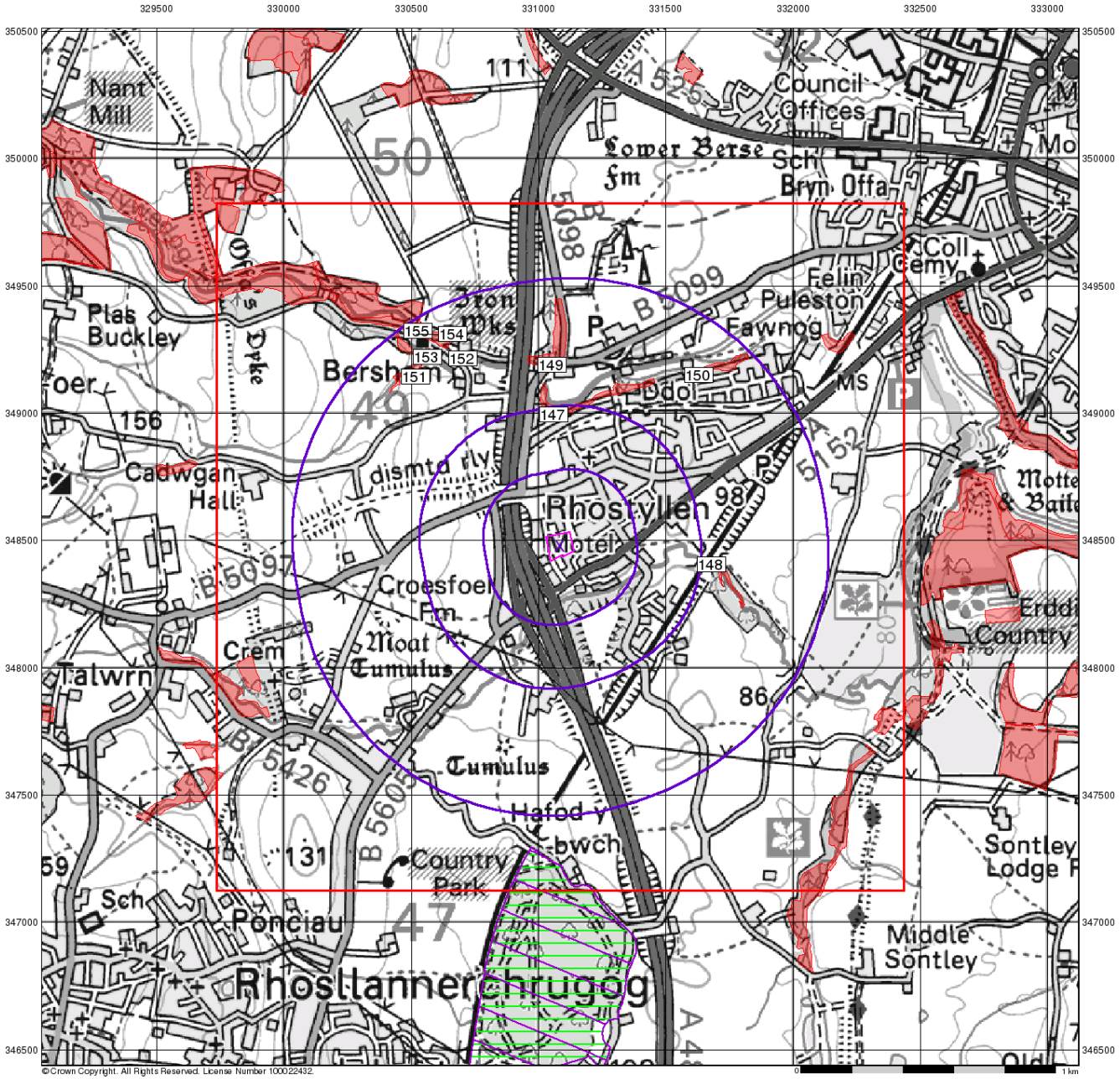
Order Details

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Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Sensitive Land Uses

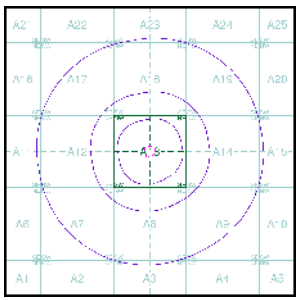
General

Specified Site | Specified Buffer(s) | Bearing Reference Point
Slice | Map ID

Sensitive Land Uses

- Ancient Woodland
- Area of Adopted Green Belt
- Area of Unadopted Green Belt
- Area of Outstanding Natural Beauty
- Environmentally Sensitive Area
- Forest Park
- Local Nature Reserve
- Marine Nature Reserve
- National Nature Reserve
- National Park
- Nitrate Sensitive Area
- Nitrate Vulnerable Zone
- Ramsar Site
- Site of Special Scientific Interest
- Special Area of Conservation
- Special Protection Area
- World Heritage Sites

Site Sensitivity Context Map - Slice A

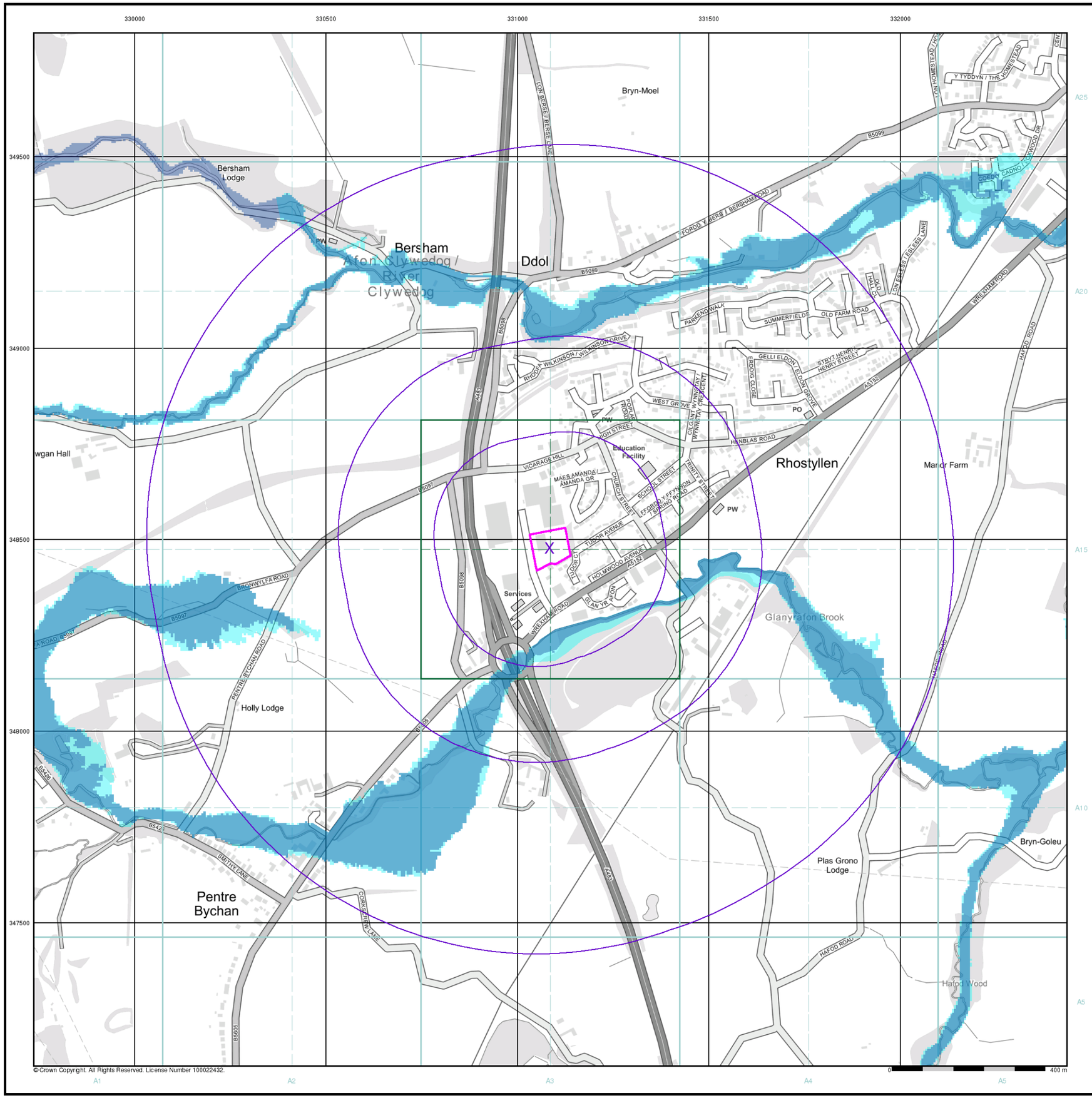


Order Details

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Customer Ref:	E13803-1
National Grid Reference:	331080, 348480
Slice:	A
Site Area (Ha):	0.82
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Site Details

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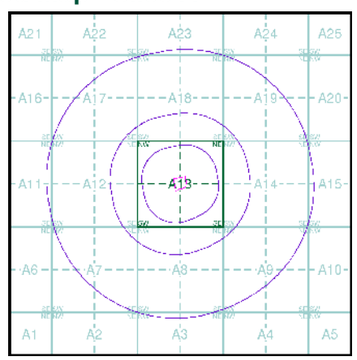
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A



Order Details

Order Number:	347763743_1_1
Customer Ref:	E13803-1
National Grid Reference:	331080, 348480
Slice:	A
Site Area (Ha):	0.82
Search Buffer (m):	1000

Site Details

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Landmark INFORMATION GROUP

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Fax: 0844 844 9951
Web: www.envirocheck.co.uk

ENCLOSURE C

Historical Maps
(14 pages)

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

Gravel Pit
Sand Pit
Other Pits
Quarry
Shingle
Orchard
Osiers
Reeds
Marsh
Mixed Wood
Deciduous
Brushwood
Fir
Furze
Rough Pasture
Arrow denotes flow of water
Trigonometrical Station
Site of Antiquities
Bench Mark
Pump, Guide Post, Signal Post
Well, Spring, Boundary Post
·285 Surface Level
Sketched Contour
Instrumental Contour
Main Roads
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
Sunken Road
Raised Road
Road over Railway
Railway over River
Railway over Road
Level Crossing
Road over River or Canal
Road over Stream
Road over Stream
County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy.
County Borough Boundary (England)
Co. Burgh Bdy.
County Burgh Boundary (Scotland)
R.D. Bdy.
Rural District Boundary
Civil Parish Boundary

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Dunes
Boulders
Coniferous Trees
Non-Coniferous Trees
Orchard
Scrub
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Pylon
Electricity Transmission Line
Sloping Masonry
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge
Geographical County
Administrative County, County Borough or County of City
Municipal Borough, Urban or Rural District, Burgh or District Council
Borough, Burgh or County Constituency
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

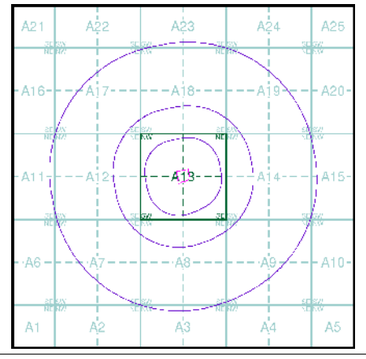
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community boundary
District, Unitary, Metropolitan, London Borough boundary
Constituency boundary
Area of wooded vegetation
Non-coniferous trees
Non-coniferous trees (scattered)
Coniferous trees
Coniferous trees (scattered)
Positioned tree
Orchard
Coppice or Osiers
Rough Grassland
Heath
Scrub
Marsh, Salt Marsh or Reeds
Water feature
Flow arrows
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m Bench mark (where shown)
Triangulation station
Point feature (e.g. Guide Post or Mile Stone)
Pylon, flare stack or lighting tower
Site of (antiquity)
Glasshouse
General Building
Important Building

igne

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Denbighshire	1:10,560	1879	2
Denbighshire	1:10,560	1900	3
Denbighshire	1:10,560	1914 - 1915	4
Denbighshire	1:10,560	1938	5
Denbighshire	1:10,560	1938 - 1954	6
Denbighshire	1:10,560	1954	7
Ordnance Survey Plan	1:10,000	1963 - 1964	8
Ordnance Survey Plan	1:10,000	1976 - 1979	9
Ordnance Survey Plan	1:10,000	1993	10
10K Raster Mapping	1:10,000	2000	11
10K Raster Mapping	1:10,000	2006	12
VectorMap Local	1:10,000	2024	13

Historical Map - Slice A



Order Details

Order Number: 347763743_1_1
Customer Ref: E13803-1
National Grid Reference: 331080, 348480
Slice: A
Site Area (Ha): 0.82
Search Buffer (m): 1000

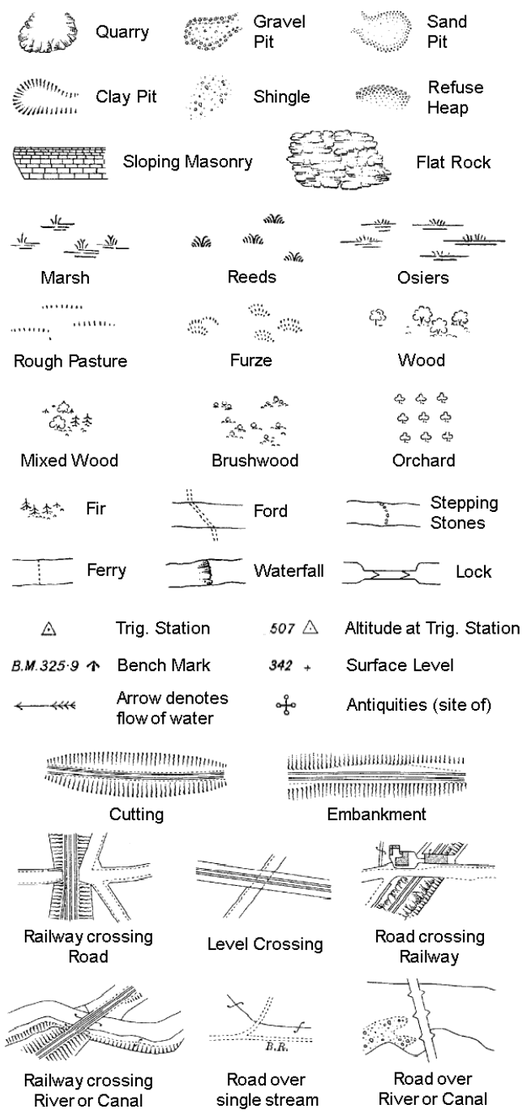
Site Details

, The Dickens Group of Comp Ltd, Dickens Garage, Croesfoel Industrial Estate, Rhostyllen, Wrexham, LL14 4EJ

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Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Historical Mapping Legends

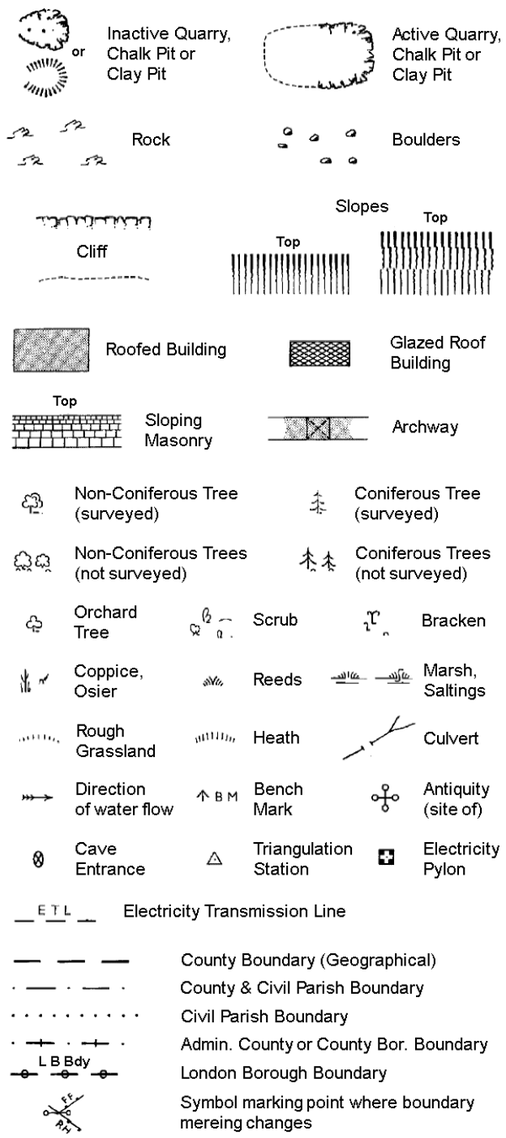
Ordnance Survey County Series and Ordnance Survey Plan 1:2,500



County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy. County Borough Boundary (England)
Co. Burgh Bdy. County Burgh Boundary (Scotland)

B P B S	Boundary Post or Stone	P.C.B	Police Call Box
B.R.	Bridle Road	P	Pump
E.P	Electricity Pylon	S.P	Signal Post
F.B.	Foot Bridge	St.	Sluice
F.P.	Foot Path	Sp.	Spring
G.P	Guide Post or Board	T.C.B	Telephone Call Box
M.S	Mile Stone	Tr.	Trough
M.P M.R	Mooring Post or Ring	W	Well

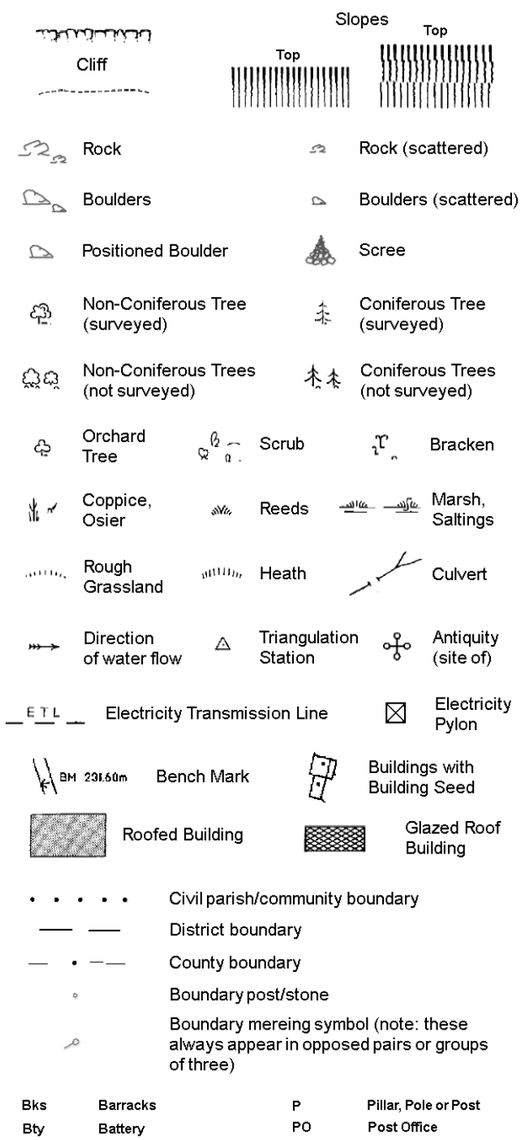
Ordnance Survey Plan, Additional SIMs and Supply of Unpublished Survey Information 1:2,500 and 1:1,250



County Boundary (Geographical)
County & Civil Parish Boundary
Civil Parish Boundary
Admin. County or County Bor. Boundary
L B Bdy London Borough Boundary
Symbol marking point where boundary mereing changes

BH	Beer House	P	Pillar, Pole or Post
BP, BS	Boundary Post or Stone	PO	Post Office
Cn, C	Capstan, Crane	PC	Public Convenience
Chy	Chimney	PH	Public House
D Fn	Drinking Fountain	Pp	Pump
El P	Electricity Pillar or Post	SB, S Br	Signal Box or Bridge
FAP	Fire Alarm Pillar	SP, SL	Signal Post or Light
FB	Foot Bridge	Spr	Spring
GP	Guide Post	Tk	Tank or Track
H	Hydrant or Hydraulic	TCB	Telephone Call Box
LC	Level Crossing	TCP	Telephone Call Post
MH	Manhole	Tr	Trough
MP	Mile Post or Mooring Post	Wr Pt, Wr T	Water Point, Water Tap
MS	Mile Stone	W	Well
NTL	Normal Tidal Limit	Wd Pp	Wind Pump

Large-Scale National Grid Data 1:2,500 and 1:1,250



Civil parish/community boundary
District boundary
County boundary
Boundary post/stone
Boundary mereing symbol (note: these always appear in opposed pairs or groups of three)

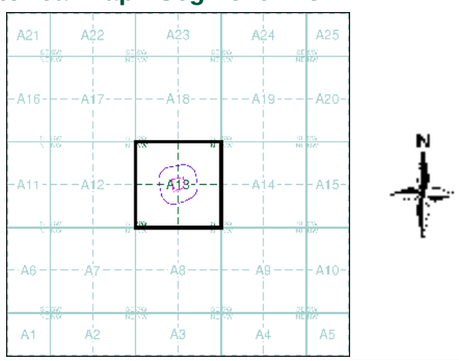
Bks	Barracks	P	Pillar, Pole or Post
Bty	Battery	PO	Post Office
Cemy	Cemetery	PC	Public Convenience
Chy	Chimney	Pp	Pump
Cis	Cistern	Ppg Sta	Pumping Station
Dismtd Rly	Dismantled Railway	PW	Place of Worship
El Gen Sta	Electricity Generating Station	Sewage Ppg Sta	Sewage Pumping Station
El P	Electricity Pole, Pillar	SB, S Br	Signal Box or Bridge
El Sub Sta	Electricity Sub Station	SP, SL	Signal Post or Light
FB	Filter Bed	Spr	Spring
Fn / D Fn	Fountain / Drinking Ftn.	Tk	Tank or Track
Gas Gov	Gas Valve Compound	Tr	Trough
GVC	Gas Governer	Wd Pp	Wind Pump
GP	Guide Post	Wr Pt, Wr T	Water Point, Water Tap
MH	Manhole	Wks	Works (building or area)
MP, MS	Mile Post or Mile Stone	W	Well

igne

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Denbighshire	1:2,500	1872	2
Denbighshire	1:2,500	1899	3
Denbighshire	1:2,500	1912	4
Ordnance Survey Plan	1:2,500	1962 - 1967	5
Ordnance Survey Plan	1:2,500	1967	6
Additional SIMs	1:2,500	1967 - 1981	7
Ordnance Survey Plan	1:2,500	1984	8
Additional SIMs	1:2,500	1984	9
Large-Scale National Grid Data	1:2,500	1992	10
Large-Scale National Grid Data	1:2,500	1994	11
Historical Aerial Photography	1:2,500	2001	12

Historical Map - Segment A13



Order Details

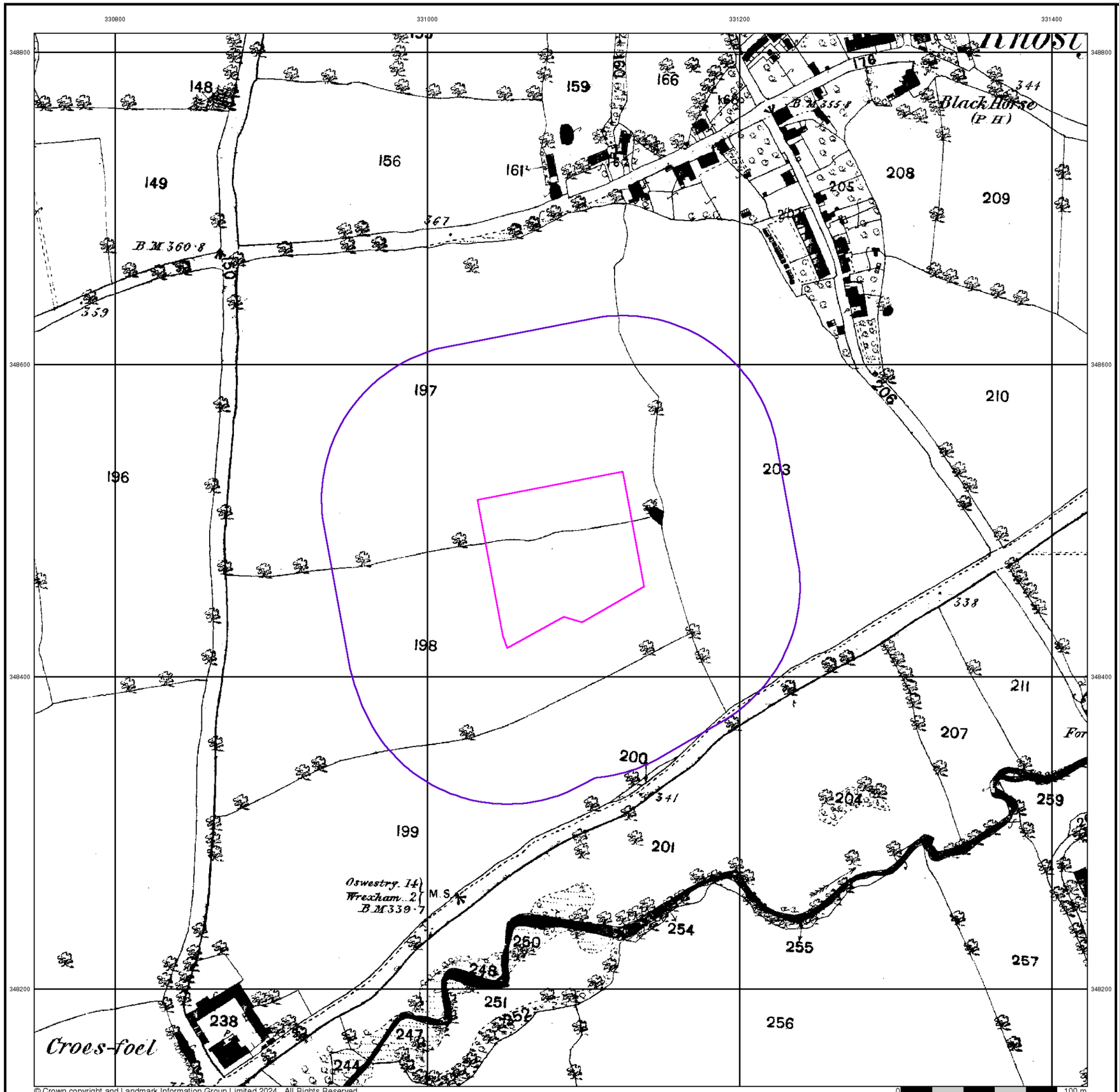
Order Number:	347763743_1_1
Customer Ref:	E13803-1
National Grid Reference:	331080, 348480
Slice:	A
Site Area (Ha):	0.82
Search Buffer (m):	100

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, The Dickens Group of Comp Ltd, Dickens Garage, Croesfoel Industrial Estate, Rhostyllen, Wrexham, LL14 4EJ

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
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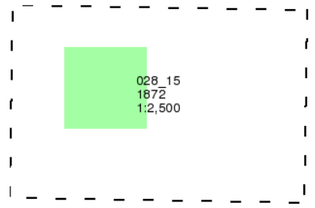
Denbighshire

Published 1872

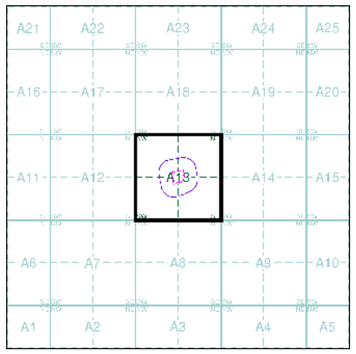
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



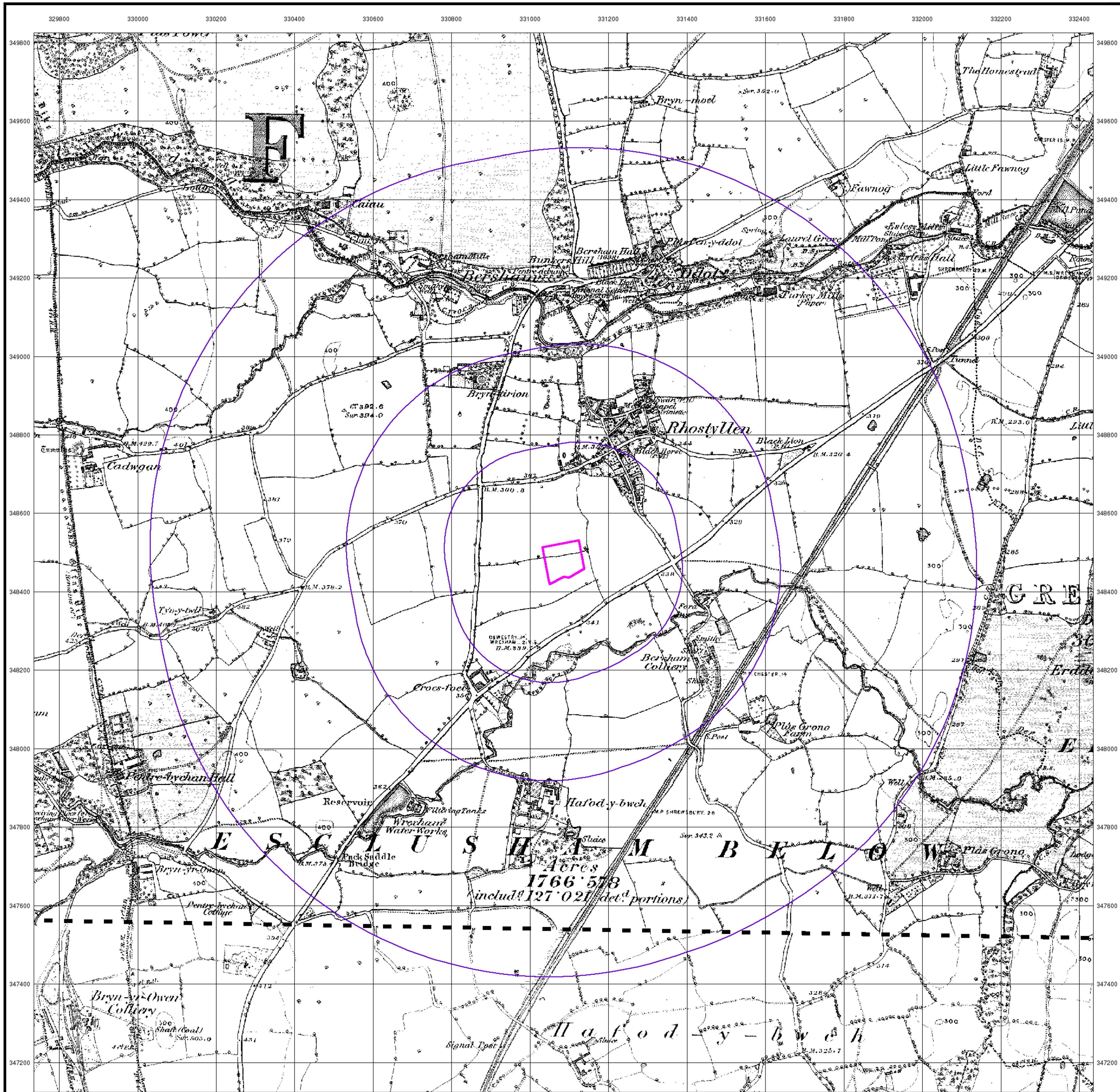
Order Details

Order Number:	347763743_1_1
Customer Ref:	E13803-1
National Grid Reference:	331080, 348480
Slice:	A
Site Area (Ha):	0.82
Search Buffer (m):	100

Site Details

, The Dickens Group of Comp Ltd, Dickens Garage, Croesfoel Industrial Estate, Rhostyllen, Wrexham, LL14 4EJ

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0 400 m

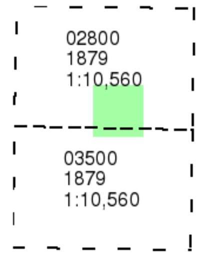
Denbighshire

Published 1879

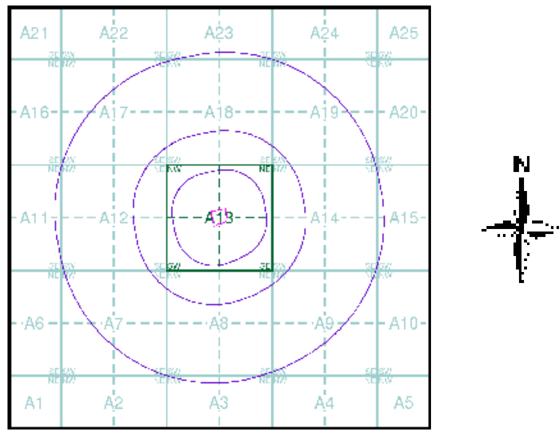
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number:	347763743_1_1
Customer Ref:	E13803-1
National Grid Reference:	331080, 348480
Slice:	A
Site Area (Ha):	0.82
Search Buffer (m):	1000

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