

Eaton Drive, Wrexham
Proposed Development
Geo-Environmental Report
Wales & West Housing



GroundSolve Ltd

Consulting Geotechnical, Engineering Geology and Environmental Engineers

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1.0 INTRODUCTION

Wales and West Housing (WWH) propose to redevelop the site of an existing Community Centre at Eaton Drive, Wrexham. Exact scheme details are yet to be confirmed, however, it is understood current proposals are to demolish the existing building and construct a single three storey apartment block of conventional brick construction.

WWH have appointed Groundsolve Ltd (GSL) to undertake a Phase I and Phase II desk study and site investigation.

This report presents the findings of the desk study and site investigation and gives firm geotechnical recommendations for the development. In addition, conceptual ground models and environmental risk assessments are presented.

2.0 THE SITE

2.1 Site Location and Description

The site is located to the east of Eaton Drive, Queens Park, Wrexham, at National Grid Reference SJ 350 503, see Figure 1.

It is located within a large housing estate, bounded to the west by Eaton Drive; and an asphalt car park to the south, servicing a small shopping centre. Landscaped areas backing onto residential houses define the eastern and northern site boundaries, see Figure 2.

The site is currently occupied by a single storey community centre of timber frame construction, surrounded by overgrown scrubland. The site is bounded by a 2m steel security fence, with the only access being from the south from the carpark.

The site is roughly square in shape, measuring approximately 40m x 36m. A topographical survey has been provided showing the site to comprise a central flat plateau at around 70mAOD. With the north eastern corner sloping steeply upwards from 70.00m to 72.19 to the edge of the proposed development, and the north western boundary sloping downwards from 70.00m to 69.50mAOD. See Figure 2. The site and surrounding topography suggest that cut and fill techniques have been used to level the site prior to construction of the community centre.

Photographs of the site are presented in Appendix A.

2.2 Geology & Hydrogeology

The geology of the site has been studied on the British Geological Survey (BGS) 1:50,000 scale geology plan, Sheet 121, Wrexham with the associated geological memoirs, Reference 1. In addition, the BGS Technical Report of the Wrexham area at a scale of 1:25,000 has been studied, Reference 2.

These show the site to be underlain by glaciofluvial sheet deposits comprising sand and gravel, described as generally well-bedded, sometimes clayey sands and gravels, with beds of clay and till. Reference 2 confirms the thickness of the superficial deposits to be in the order of 30m and shows the site is within an area of potentially workable sand and gravel at or near the surface.

The thick glacial sequence in Wrexham is story of advancing and retreating ice sheets, with the low permeability glacial till being deposited beneath advancing ice sheets, and the sand and gravel being deposited by glacial meltwaters as the glaciers retreated. Hence the ground conditions are generally highly variable over very short distances in the Wrexham area.

The underlying solid geology is noted as the Salop Formation (previously Erbistock Formation), consisting of Mudstones, Sandstones and Conglomerates, formed in the Permian and Carboniferous Period.

There is no faulting affecting the immediate vicinity of the area.

Reference 2 confirms that the site is within an area of deep coal mining, where at least one seam of coal has been worked. It also confirms the Erbistock Formation being underlain by the Coed Yr Allt and Ruabon Marl Formations before the Coal Measures are encountered. Therefore, shallow mine workings cannot be an issue at this site, and no mine shafts are recorded in the vicinity of the site.

Both the superficial deposits and bedrock are classified as a secondary aquifer- A, of high vulnerability.

The underlying groundwater is anticipated to be deep, although, in this area, perched water tables are commonly present where beds of low permeability glacial till are encountered.

2.3 History

The history of the site has been studied on old Ordnance Survey (OS) plans dating from 1879 at a scale of 1:2,500, unless otherwise stated. Recent aerial photographs have also been viewed.

The 1879 OS plan at 1:10,560 scale shows the site located within a wooded area, with open fields to the east and west. A track leading to Abenbury Lodge passes approximately 150m to the west of the site, see Figure 3a.

The 1899 OS plan shows the site as mixed woodland. To the west of the site Abenbury Lodge had been renamed as Dunks Farm. A well and pump are shown within the farm complex. No other changes are shown, see Figure 3b.

The 1911 OS plan shows no changes on site. However, the well and pump at Dunks Farm are no longer shown, and a spring is shown approximately 500m to the southwest of the site, see Figure 3c.

No changes are shown on the 1937 OS plan on, or around the site, see Figure 3d.

By the 1954 OS plan at 1:10,560 scale, extensive residential development of the surrounding area, the "Queens Park estate" had been constructed, comprising rows of terraced housing, along with associated infrastructure. The Dunks Farm had been demolished, and a spring is shown some 250m to the southwest of the site, see Figure 3e.

The 1959 OS plan confirms the residential development and road network around the site, and that the site itself had been partially developed, with a long rectangular building along its eastern boundary, which was called the 'Kingsley Circle Community Centre'. Access being gained to the Community Centre along a path from the southern boundary. It appears that the woodland was still present on site.

The site itself is now completed surrounded by the Queens Park Estate. Hafod-y-Wern Primary School is located some 100m south west of the site. The spring to the southwest was now being fed into a drain running to the southwest, see Figure 3f.

The 1964 and 1968 OS plans, at 1:10,000 scale do not record any further development on or around the site, see Figure 3g and 3h.

The 1992 OS plan shows that the original Community Centre had been demolished and replaced with a new rectangular building located in the middle of the site, in the same location as the existing building. The remaining woodland on and surrounding the site had also been cleared by this time, see Figure 3i.

The 2003 aerial photograph shows no further changes, with the existing building on site and asphalt carpark to the south. It also shows the extent of the Queens Park estate to the south and west, and the school located to the south west, see Figure 3j.

3.0 ENVIRONMENTAL SEARCHES

An Envirocheck report has been obtained for the site, the main points are summarised below, with the report presented in full in Appendix B.

Agency and Hydrological

- The BGS record a potential for groundwater flooding of property situated below ground level on site,
- The closest active discharge consent is 698m to the south of the site for Welsh Water,
- The closest LAPPC is 581m north of the site for a petrol filling station,
- The nearest surface water feature is 398m to the south of the site,
- There are no water abstractions within 1km of the site,
- The closest incident to controlled waters was 312m south east of the site and was a Category 3- minor incident.

Waste

- The closest recorded BGS landfill is 432m south of the site,
- The closest recorded historic landfill is 223m south west of the site. Known as The Dunks this was licensed for waste including industrial, commercial, household and special waste, the site was last used in 1980,
- There is potentially infilled land (non-water) 530m to the north west of the site,
- There is potentially infilled land (water) 224m to the south west of the site.

Hazardous Substances

- There are no hazardous substances recorded on or near site.

Geological

The BGS have presented estimated soil chemistry for the site, as follows:

- Arsenic <15mg/kg,
- Cadmium<1.8mg/kg,
- Chromium 60-90mg/kg,
- Lead <100mg/kg,
- Nickel 15-30mg/kg.

In addition, the BGS supplied the following information;

- There is a BGS recorded mineral site 573m to the north west of site, this is ceased and was used to quarry sand,
- The site is in an area which may be affected by coal mining, and it recommended that a coal mining report be obtained for the development,

- The potential for collapsible ground was very low,
- No hazard of compressible ground,
- No hazard of ground dissolution,
- The potential for landslides is very low,
- The potential for running sand is very low,
- No hazard for shrinking or swelling clay,
- The site is in an area of intermediate probability for radon, with 3-5% of homes estimated to be at or above action level,
- Therefore, Basic radon protection measures are required.

Industrial Land Use

- There closest industrial land use (Dampcure, Damp & dry rot control) is 131m north east of the site.

Sensitive Land Use

- The closest sensitive land is an ancient woodland 551 to the south east of the site.

4.0 PROPOSED DEVELOPMENT

Exact scheme details are yet to be confirmed, however, it is understood that current proposals are for a single three storey apartment block, along with twenty-five car parking spaces and a new vehicular access on to Eaton Drive. The structure itself will be some 32m long and 15m wide. No garden areas are proposed for the development, although, it is assumed that the areas around the building will be subject to landscaping. The proposed site layout is presented in Figure 4.

Whilst final floor slab levels have not been set, Figure 4 presents the external ground levels around the building, which range between 69.25 and 69.50m AOD. Comparison with the ground contours revealed the north east corner of the building to be an elevation of 72.19mAOD, giving a cut of just over 3m. The lowest point of the building on the western side has a lowest ground elevation of around 69mAOD, which is virtually at grade.

Foundation loadings were not available at the time of writing, however, based on previous experience it is anticipated the structure will comprise conventional brick and timber construction, with foundation loads between 75 and 125kN/ m run. Floor slab loadings are not anticipated to exceed 5kN/m² based on the building end use.

The recommendations given in this report are based on the above assumptions. Therefore, they should be reviewed and if necessary revised during the detailed design.

5.0 SITE INVESTIGATIONS

5.1 Previous Investigations

An investigation was carried out by GSL on behalf of d2 Architects on 11th April 2019.

It comprised:

- One machine excavated trial pit to a maximum depth of 3.10m,
- Soakaway test undertaken in the trial pit.

A summary of this investigation is presented below. The trial pit log is presented in Appendix C, along with the soakaway test results, with the location of the pit shown on Figure 2.

The ground conditions encountered during the previous investigation are summarised in the table below:

TP Ref.	Topsoil (m)	Glaciofluvial Deposits (m)	Glacial Till (m)
TP1	0.00-0.15	0.15 – 1.70	1.70 – 3.10m`

Topsoil

The topsoil was described as grass overlying loose, dark brown, sandy silt.

Glaciofluvial Deposits

The glacial deposits near surface were described as medium dense, brown, sandy, clayey silt, with fragments of coal, which overly medium dense, brown, clayey, sandy silt.

A single Particle Size Distribution (PSD) test was completed on the glacial deposits, which confirmed them to be a slightly gravelly, clayey sand.

Chemical testing on a single sample recorded a pH value of 7.9, with a sulphate value, when measured as 2:1 water extract, of 45mg/l.

Glacial Till

The glacial till was described as, soft to firm, brown/ orange, silty, sandy clay.

Groundwater was encountered at 1.70m.

The soakaway tests revealed the ground is not suitable for soakaways as the water failed to drop over a five-hour period.

5.2 This Investigation

This investigation was undertaken on the 10th July 2020, and comprised:

- Five window sample boreholes drilled to a maximum of 5.00m, extended with continuous SPT's to a maximum of 6.50m,
- Unless otherwise stated SPT's were carried out at 1m intervals in the boreholes.

The boreholes were supervised and logged by an engineer from GSL in general accordance with BS 5930, Reference 3.

The locations of the boreholes are presented on Figure 2, with the logs presented in Appendix D.

5.3 Laboratory Work

Physical Testing

Samples of the glaciofluvial deposits were taken for the following physical testing:

- Particle Size Distribution (PSD).

The testing was carried out in accordance with BS 1377:1991, Reference 4. The results are summarised in Section 5.0 and presented in full in Appendix E.

Chemical Testing

Samples for chemical testing were taken from the fluvioglacial deposits encountered within the boreholes, placed in the appropriate containers and a cool box, and taken immediately to the laboratories of Derwentside Environmental Testing Services (DETS) Limited for the following testing:

Metals & Non-metals - Arsenic (As), Boron (B), Cadmium (Cd), Chromium (hexavalent), Chromium (Trivalent), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Phenol, Selenium (Se), and Zinc (Zn).

Petroleum Hydrocarbons - Benzene, Toluene, Ethylbenzene, o-xylene, m-xylene, p-xylene, Aliphatics >C5 – C44, Aromatics >EC5 – EC44.

Polyaromatic Hydrocarbons (PAH) – Acenaphthene, Acenaphthylene, Anthracene, Benz (a) anthracene, Benzo (a) pyrene, Benzo (b) fluoranthene, Benzo (g, h, i) perylene, Benzo (k) fluoranthene, Chrysene, Dibenzo (a, h) anthracene, Fluorene, Fluoranthene, Indeno (1,2,3-cd) pyrene, Naphthalene, Phenanthrene, Pyrene.

Other Contaminants – Sulphide (easily liberated), Water soluble Sulphate (2:1 extract), Cyanide, pH, Soil Organic Matter (SOM).

In addition, asbestos screening was carried out on all samples.

The results are summarised in Section 7.0, with the results presented in full in Appendix F.

6.0 GROUND CONDITIONS

The following general stratigraphy was encountered in the boreholes:

BH No.	Stratigraphy		
	Topsoil (m)	Made Ground (m)	Glaciofluvial Deposits (m)
BH101	0.00 – 0.20	N/E	0.20 – 5.00
BH102	0.00 – 0.20	0.20 – 1.40	1.40 – 5.00
BH103	N/E	0.00 – 0.20	0.20 – 5.00
BH104	N/E	0.00 – 1.00	1.00 – 5.00
BH105	N/E	0.00 – 0.40	0.40 – 5.00

Note: N/E = Not encountered

6.1 Topsoil

Topsoil was encountered in BH101 and 102 to the east of the existing building, where it was generally described as scrub over loose, dark brown, sandy silt, with rootlets.

6.2 Made Ground

Made ground was encountered within BH102 to 105 and comprised a thin layer of concrete overlying loose, brown, slightly clayey, gravelly, fine to coarse sand, with the gravel being subangular to subrounded, fine to coarse of sandstone, limestone, and brick.

A single Standard Penetration Test (SPT') was undertaken within the made ground, which recorded an 'N' value of 4, confirming a loose consistency, see Figure 5.

Chemical testing was on two samples recorded pH values of 7.6, with sulphate values, when measured as 2:1 water extract, of <11mg/l.

6.3 Glaciofluvial Deposits

Glaciofluvial deposits were encountered across the site and were generally described as loose orangish brown, slightly gravelly, slightly clayey, fine to coarse sand, with the gravel being subrounded to rounded, fine to coarse of sandstone. With depth the deposits graded into a clayey, silty sand.

A localised layer of very soft to soft very sandy clay was encountered below 2.30m in BH103.

SPT 'N' values were between 1 and 10 to a depth of 5.00m, with values rapidly increasing below this depth, to between 17 and 26, see Figure 5. However, the values at 1m were between 5 and 10, with an average of 8.

Particle size distribution testing confirmed the glaciofluvial deposits to be a uniformly graded fine sand, with between 13 and 34% of silt/clay.

pH values of 7.2 to 9.4 were recorded, with sulphate values, when measured as 2:1 water extract, between 13 and 17mg/l.

6.4 Groundwater

Groundwater was encountered in all exploratory holes with the exception of BH103 at depths between 2.50 to 4.00m.

7.0 RESULTS OF CHEMICAL TESTING

Soil samples were taken from the glaciofluvial deposits, with the sample depths presented in Table 7.1 below.

BH No	Depth (m)
BH101	0.50
BH103	1.50
BH105	0.50

The results of the soil analyses are presented below, where they have been compared to suitable generic assessment criteria (GACs), in order to allow a generic quantitative risk assessment (GQRA) to be carried out for the site and the proposed development.

The Category 4 Screening Levels (C4SLs) published by DEFRA (2014) have been adopted in the first instance, which have been published for six substances to date. Where a C4SL is unavailable, the “Suitable 4 Use Levels” (S4ULs) published by LQM/CIEH (2015) have been adopted.

These criteria have been derived using the CLEA model for a range of standard end-use scenarios and a range of soil organic matter (SOM) contents. It should be noted that the C4SL values are derived on the basis of a “low level of toxicological concern”, while the S4UL values are based on a “tolerable” or “minimal” level of risk. As such, the S4ULs describe a lower level of risk than the C4SLs and are equivalent to the former Soil Guideline Values (SGVs, published by the Environment Agency) and the previous editions of the LQM/CIEH GAC values.

A “residential without gardens” end-use has been adopted for this analysis, based on the most-conservative SOM content of 1%.

Note: the S4UL values presented below are Copyright Land Quality Management Limited, reproduced with permission; Publication Number S4UL3668. All rights reserved.

	BH101	BH103	BH105			
	0.50	1.50	0.50	Adopted Guideline (mg/kg)	Source	Exceedances
Metals & Non-Metals						
Arsenic	11.00	11	4.4	40	C4SL	0
Boron, Water Soluble	< 0.2	0.3	< 0.2	11000	S4UL	0
Cadmium	0.20	0.2	< 0.1	150	C4SL	0
Chromium III	11.00	8.4	5.8	910	S4UL	0
Chromium, Hexavalent	< 1.0	< 1.0	< 1.0	21	C4SL	0
Copper	26.00	22	11	7100	S4UL	0
Lead	27.00	60	21	310	C4SL	0
Mercury	0.05	0.06	< 0.05	1.2	S4UL	0
Nickel	13.00	6.6	3.5	180	S4UL	0
Phenol - Monohydric	< 0.3	< 0.3	< 0.3	440	S4UL	0
Selenium	< 0.5	< 0.5	< 0.5	430	S4UL	0
Zinc	42.00	30	34	40000	S4UL	0

None of the above values exceeded SGV values for residential land use without gardens.

	BH101	BH103	BH105			
	0.50	1.50	0.50	Adopted Guideline (mg/kg)	Source	Exceedances
Petroleum Hydrocarbons						
Aliphatic C5-C6	< 0.01	< 0.01	< 0.01	42	S4UL	0
Aliphatic C6-C8	< 0.01	< 0.01	< 0.01	100	S4UL	0
Aliphatic C8-C10	< 0.01	< 0.01	< 0.01	27	S4UL	0
Aliphatic C10-C12	< 1.5	< 1.5	< 1.5	130	S4UL	0
Aliphatic C12-C16	< 1.2	< 1.2	< 1.2	1100	S4UL	0
Aliphatic C16-C21	< 1.5	< 1.5	< 1.5	65000	S4UL	0
Aliphatic C21-C35	< 3.4	< 3.4	< 3.4	65000	S4UL	0
Aliphatic C35-C40	< 3.4	< 3.4	< 3.4	370	S4UL	0
Aromatic C5-C7	< 0.01	< 0.01	< 0.01	860	S4UL	0
Aromatic C7-C8	< 0.01	< 0.01	< 0.01	47	S4UL	0
Aromatic C8-C10	< 0.01	< 0.01	< 0.01	250	S4UL	0
Aromatic C10-C12	< 0.9	< 0.9	< 0.9	1800	S4UL	0
Aromatic C12-C16	< 0.5	< 0.5	< 0.5	1900	S4UL	0
Aromatic C16-C21	< 0.6	< 0.6	< 0.6	1900	S4UL	0
Aromatic C21-C35	< 1.4	< 1.4	< 1.4	1900	S4UL	0

None of the above values exceeded SGV values for residential land use without gardens.

	BH101	BH103	BH105			
Polyaromatic Hydrocarbons (PAH)	0.50	1.50	0.50	Adopted Guideline (mg/kg)	Source	Exceedances
Acenaphthene	< 0.03	< 0.03	< 0.03	3000	S4UL	0
Acenaphthylene	< 0.03	< 0.03	< 0.03	2900	S4UL	0
Anthracene	< 0.03	< 0.03	< 0.03	31000	S4UL	0
Benzo(a)anthracene	< 0.03	< 0.03	< 0.03	11	S4UL	0
Benzo(a)pyrene	< 0.03	< 0.03	< 0.03	5.3	C4SL	0
Benzo(b)fluoranthene	< 0.03	< 0.03	< 0.03	3.9	S4UL	0
Benzo(g,h,i)perylene	< 0.03	< 0.03	< 0.03	360	S4UL	0
Benzo(k)fluoranthene	< 0.03	< 0.03	< 0.03	110	S4UL	0
Chrysene	< 0.03	< 0.03	< 0.03	30	S4UL	0
Dibenzo(a,h)anthracene	< 0.03	< 0.03	< 0.03	0.31	S4UL	0
Fluoranthene	< 0.03	< 0.03	< 0.03	1500	S4UL	0
Fluorene	< 0.03	< 0.03	< 0.03	2800	S4UL	0
Indeno(1,2,3-c,d)pyrene	< 0.03	< 0.03	< 0.03	45	S4UL	0
Naphthalene	< 0.03	< 0.03	< 0.03	2.3	S4UL	0
Phenanthrene	< 0.03	< 0.03	< 0.03	1300	S4UL	0
Pyrene	< 0.03	< 0.03	< 0.03	3700	S4UL	0

None of the above values exceeded SGV values for residential land use without gardens.

	WS02	BH101	BH103	BH105			
Other Contaminants / Testing	0.15	0.50	1.50	0.50	Adopted Guideline (mg/kg)	Source	Exceedances
Organic matter	0.1	0.80	5	1.6	-	-	-
pH	-	9.40	7.2	7.2	-	-	-
Sulphide	10	16.00	16	12	-	-	-
Cyanide, Total	0.1	0.20	0.3	0.3	-	-	-
Sulphur (free)	0.75	< 0.75	< 0.75	< 0.75	-	-	-
Sulphate Aqueous Extract as SO4	10	13.00	17	15	-	-	-

None of the above values give cause for concern.

In addition, no asbestos was encountered in any of the samples.

8.0 CONCEPTUAL MODEL AND RISK ASSESSMENT

8.1 General

According to the Contaminated Land Regulations, to determine whether there is a significant possibility of significant harm, the following should be considered:

“The nature and degree of harm, the susceptibility of the receptors and the timescale within which the harm might occur”.

Current good practice therefore requires that the findings from the desk study or site investigation be evaluated for contamination on a site-specific basis using a risk-based approach. Risk assessment involves identification of the hazards and evaluation of the risks associated with these hazards. Risk assessment requires an evaluation of a conceptual “source – pathway – receptor” linkage model and can be qualitative or quantitative.

The basis of an environmental risk assessment involves identifying a ‘source’ of contamination, a ‘pathway’ along which the contamination may migrate and a ‘receptor’ at risk from the contamination.

Current legislation defines the various elements of the pollution linkage as:

- A contaminant ‘source’ is a substance, which is in, or under the ground, and which has the potential to cause harm or to cause pollution of controlled waters,
- A ‘pathway’ is one or more routes through which a receptor is being exposed to, or affected by, a contaminant, or could be so affected,
- A ‘receptor’ is either a living organism, an ecological system, a piece of land or property, or controlled water.

A pollutant linkage indicates that all three elements have been identified. The site can only be defined as Contaminated Land’ if a pollutant linkage exists and the contamination meets the criteria above.

8.2 Hazard Identification

On Site

The desk study has revealed that the site’s historical uses have been as agricultural open land prior to its development as a Community Centre.

There remains minor potential for contaminative material to have been left on site following the demolition of the previous Community Centre on the eastern site boundary. However, this area was excavated during the redevelopment of the site and the building would have been taken off site.

The boreholes from this site investigation and trial pit from the previous investigation failed to reveal any visual or olfactory evidence of contamination, which was confirmed by the chemical testing.

It should be noted that whilst made ground was encountered on site, due to the sites likely development levels, with levels being reduced between 1 and 3m, all of the made ground will be removed from site, see Figure 6.

Off Site

The desk study has revealed that there were no potential contaminative land uses close to the site. However, several old landfills were recorded within 250m of the site and these are discussed below in Section 8.8.

A conceptual ground model is presented below in Table 8.1.

Table 8.1: Source, Pathway receptor

Potential Contamination Sources	Potential Contaminants of Concern	Potential Pathways	Receptor Group
Made Ground/ Demolished building Landfill	Heavy Metals PAH Asbestos Landfill Gas	Inhalation/ingestion of contaminated dust Dermal contact Ingestion of soil Bioaccumulation	Construction Workers Site end users
		Leaching of contaminated materials	Surface and groundwater Building materials and buried services

8.3 Pathways

In relation to any on site contamination reaching potential site users, the following pathways are generally considered for this type of development:

- Ingestion and skin contact with soils on site,
- Inhalation of contaminated dust,
- Direct contact with contaminated material during construction.

8.4 Receptors

The potential impact of a hazard must be assessed with regard to the following target groups:

- Future site users,
- Construction workers,
- Surface and groundwater, both on and off the site,
- Nearby vegetation,
- Building materials and buried services.

8.5 Future Site Users Risk Assessment

The site is to be developed with a three-storey residential block, with associated car parking and landscaped areas, along with a new vehicular access off Eaton Drive.

The desk study did not highlight any potential contaminative sources, and no visual or olfactory evidence of contamination was encountered in any of the boreholes and trial pit, which was confirmed by the chemical testing.

Whilst made ground was encountered on site, the current development levels mean that all of the made ground will be taken off site, with the resulting formation being in the fluvio-glacial deposits, see Figure 6.

The site will then be covered with buildings and hardstandings, ensuring that any residual risk to end users is removed.

However, it would be prudent to undertake a watching brief during shallow excavations. Any potentially contaminated material encountered should be excavated, stored safely on site, tested, and then disposed of at a suitably licensed landfill facility.

8.6 Controlled Waters Risk Assessment

When considering the risk to controlled waters both surface waters and underlying aquifers have to be considered.

In this case, due to the lack of contamination from the site, combined with the absence of any nearby controlled waters means the risk to controlled waters is considered to be negligible.

8.7 Construction Workers

The risk to construction workers is considered to be very low; and can be catered for by appropriate PPE and washing facilities in accordance with current good practice.

8.8 Ground Gases

No significant sources of ground gases have been identified during the desk study or site investigation works, with the exception of several landfills that are only just within 250m of the site. However, the last date of input for these landfills was 1980, consequently, gas generation would be largely complete.

In addition, these landfills were generally placed on low lying areas around watercourses. Since the site is at a significantly higher elevation than these landfills, and there are significant barriers to migration in the form of service trenches, the potential for landfill gas to migrate up gradient and across the barriers, means that the risk to the site is considered to be very low.

Finally, correspondence with the Local Authority has confirmed that they have ceased gas monitoring at this site, as any concerns have been addressed. Therefore, they have advised that gas monitoring would not be required at this site.

However, the site is in an intermediate probability radon area, therefore, basic radon protection measures are required, which will provide sufficient protection from the very low risk posed by landfill gas.

8.9 Building Materials

The investigation has not revealed any contamination that could adversely affect building materials or services, although this should be checked with the statutory suppliers, who should be supplied with the laboratory test results.

8.10 Vegetation

The investigation has confirmed that there is no risk to vegetation on site.

9.0 GEOTECHNICAL RECOMMENDATIONS

9.1 Excavations and Site Preparation

Firstly, it will be necessary to strip the topsoil and vegetation, due to the size of the site and lack of demand for future re use of topsoil, this material should be taken off site to a suitably licensed landfill facility. In addition, there are several trees that will need to be felled and their roots grubbed out.

It will also be necessary to demolish the existing structure on site, with the resulting brick and concrete slab possibly crushed to form a structural fill, such as 6F2, which could be used beneath car parking and access roads as capping. However, this would only probably be possible if this activity is undertaken off site due to the limited space available. It will also be necessary to remove the foundations for the existing building, although based on the proposed development levels this will occur during the reduced level excavation. There may also be obstructions left in the ground from the original Community Centre on the eastern site boundary.

If the crushed material is to be re used on site, it should be compacted in accordance with an approved earthworks specification, such as Reference 5.

It is highly likely that the foundations and floor slabs will require breaking out using pneumatic/hydraulic breakers. Excavations will then be in the fluvioglacial deposits and will be possible using conventional earthmoving equipment. The loose granular nature of the deposits means excavations are unlikely to remain stable and will require temporary support or need to be battered back.

However, it should also be noted that the north east corner of the building is close to the site boundary, and a retaining wall will be required in this area. However, the site boundary will also need to be supported during the temporary works to construct the wall. This is discussed in detail in Section 9.3. Excavation sides should be designed, constructed and supported in accordance with the recommendations given in CIRIA Report No. 97, Reference 6.

Shallow excavations are anticipated to be dry, however, groundwater strikes were recorded at elevations between 66.52m and 67.79mAOD. Therefore, excavations below this level are likely to encounter groundwater, the material at this depth is a very loose to loose sand and is highly likely to exhibit running sand type behavior, see cross sections in Figure 6.

Excavations below the groundwater table within this material will require either full face support, or, temporary dewatering using proprietary dewatering techniques such as well pointing, or, a combination of both.

Finished floor levels across the site lie at approximately 69.50mAOD, as such the site will require significant cut operations as part of the enabling works. The cut will extend along the north and eastern site boundary, and will require excavations of up to 3.00m, see Figure 6.

9.2 Foundations and Floor Slabs

Several options have been considered for the foundations and these are discussed below:

The materials encountered at shallow depth are unlikely to prove suitable for either conventional strip foundations or pads due to their loose nature, which could generate significant settlements, although this should be reviewed once the loads are calculated.

It should be noted that the ground levels will need to be reduced between 1m in the west and 3m in the east, meaning that the formation will be unloaded by approximately 20 to 60kN/m².

Consequently, given the anticipated loads and the ground conditions the most appropriate and cost-effective solution would be a raft foundation designed assuming an allowable bearing pressure of 50kN/m², which will keep settlements within acceptable limits, with settlements being complete during the building of the structure.

Consideration was also given to deep foundation such as conventional piles, vibro stone columns, or vibrated concrete columns (VCC's) to allow transfer of building loads to the underlying materials at depths in excess of 5.50m.

However, to undertake any of these options would require over excavation of the formation to enable a piling platform to be constructed, which would involve importing of approximately 450 to 600mm of stone onto site, which will need to be compacted.

9.3 Slopes and Retaining Structures

The current site comprises a level plateau probably excavated into the slope to form a level building platform during the construction of the existing Community Centre.

As part of the development, it is proposed to reduce levels across the site particularly in the northeastern corner where ground levels will need to be reduced by up to 3.00m. Given the limited site extents within this area along with the building position, which is only 2m from the site boundary, conventional regrading of the slope will not be feasible unless agreement can be reached with the adjacent landowner. If it can be reached then the loose nature of the deposit means a temporary batter no greater than 1:2.5 V:H (21.8°) is recommended.

Therefore, it is likely that some form of engineered retaining solution will be required. At present the preferred wall type or construction technique has not been chosen. However, the restricted site area particularly around the northeastern corner means the use of conventional gravity walls such as Crib lock, CPM blocks or Gabion baskets is unlikely to be unfeasible due to the space required for their construction.

Consequently, the preferred solution is likely to be the installation of some form of cantilever wall formed from either in situ reinforced concrete or precast "L" shaped units. However, the use of such techniques will probably require extensive temporary works to be installed before the wall can be constructed.

Therefore, a solution that can achieve the desired end result and limit temporary works would be most preferable. Such options would include sheet piled wall, although this would have to be designed to be cantilevered, unless it can be propped off the building. This would lead to maximum pile lengths of up to 9m long.

A further solution would be a “King Post”, wall whereby holes are drilled into the ground and steel H sections concreted into the holes. The support is then provided by concrete planks that can be placed between the steel H section as excavation is undertaken. This wall could then be faced if required.

Recommended soil parameters for wall design are presented below in Table 9.1:

Table 9.1: Material Design Parameters

Material	Unit Weight kN/m ³	Phi Value Ø' deg	Apparent Cohesion C' kPa
Loose uniformly graded silty SAND	16*	28**	0

*BS 8002:2015, Reference 7

**Based on SPT N-Value Peck et al, 1967. Reference 8

9.4 Drainage

Original permeability testing carried out as part of the previous investigation encountered low permeability clays and indicated that the ground would be unsuitable for the use of soakaways.

However, the boreholes drilled during this investigation generally encountered a loose orangish brown, slightly gravelly, slightly clayey, fine to coarse sand, which would normally be consider suitable for soakaway drainage. However, PSD testing recorded the material to be a uniformly graded, slightly clayey, silty fine sand. Given that it is the material in the pore matrix that would control the permeability of the material, the percentage of silt/clay being between 13 and 34%, would indicate that it is this finer material that is controlling the permeability.

This would therefore confirm that soakaways are not suitable for the development.

In addition, groundwater strikes were recorded between 68.50mAOD and 67.50mAOD, which given a formation level of around 69.50mAOD, gives little room for water storage.

9.5 Reuse of Materials.

The leveling and regrading of the site will involve the excavation of significant quantities of the natural deposits. However, the proposed site levels are such that there is limited scope for material reuse on site, and as such it is anticipated that the majority of material will need to be taken off site to a suitably licensed landfill facility.

Alternatively, as this material is inert it will be suitable as a capping/cover in other developments and this would be a suitable alternative to landfill.

Material recovered from the demolition of the Community Centre such as brick, concrete foundations and floor slabs could be crushed and, subject to processing to an appropriate specification such as Table 6.1 Reference 5, could be reused on site for temporary working platforms or fill beneath carparks and hardstandings.

Prior to the development, it will be necessary to take samples of the limited volumes of made ground on site to identify a suitably licensed landfill facility.

9.6 Roads and Hard Standings

Formation level for the proposed car park is between 0.80m to 1.00m below existing ground level and as such the completion of in situ California Bearing Ratio (CBR) testing was unfeasible. Formations will be in loose, silty sand, and a conservative CBR value of 10% is recommended for initial design purposes, although this should be confirmed by in situ testing during the development.

Whilst predominantly granular the materials at formation are likely to be loose and will require proof rolling immediately prior to pavement construction. However, it should be stressed that a vibrating roller should not be used on these materials.

9.7 Protection of Buried Concrete

The laboratory test results have indicated that chemical attack of buried concrete will not be an issue. Buried concrete can therefore be designed in accordance with the following classes, Reference 9.

- AC – 1,
- DS – 1.

9.8 Landfill and Radon Gas

The desk study has not identified any nearby sources of landfill gas, which has been confirmed by the Local Authority.

However, the site is in an area of intermediate probability for radon, with 3-5% of homes estimated to be at or above action level.

Therefore, basic radon protection measures are required for the development, which should be installed in accordance with Reference 10. Such measures will be more than sufficient to cater for any residual risk posed by landfill gas.

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7. BS8002:2015 Code of Practice for earth retaining structures.
8. Peck, R.B., Hansen, W. E. and Thornburn, T. H., Foundation engineering, 2nd Edition. 1967
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10. Radon: Guidance on protective measures for New Buildings, BRE 211, 2007.

FIGURES



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SCALE 1:50,000 @ A4

Figure Title

SITE LOCATION

FIGURE 1

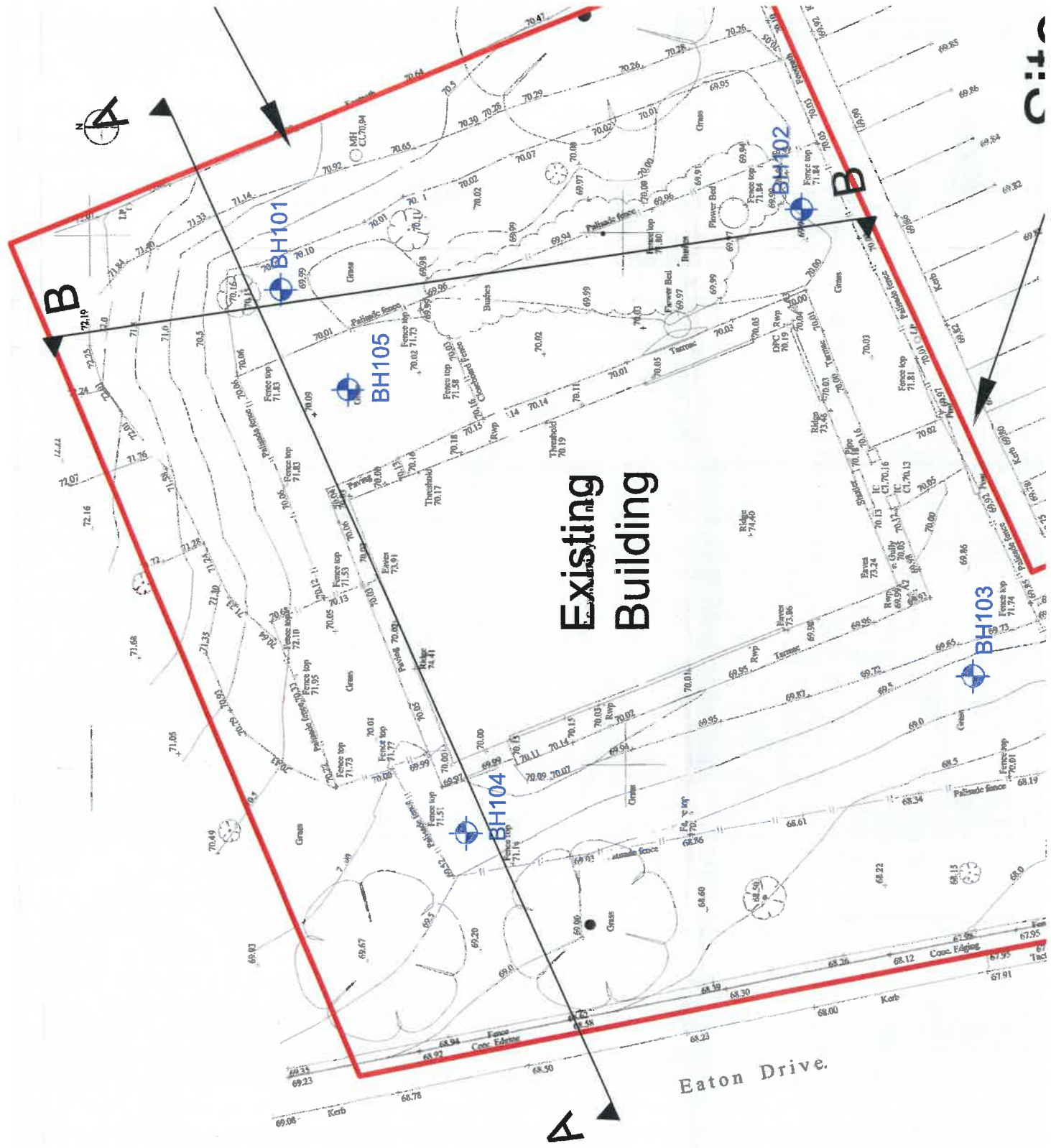


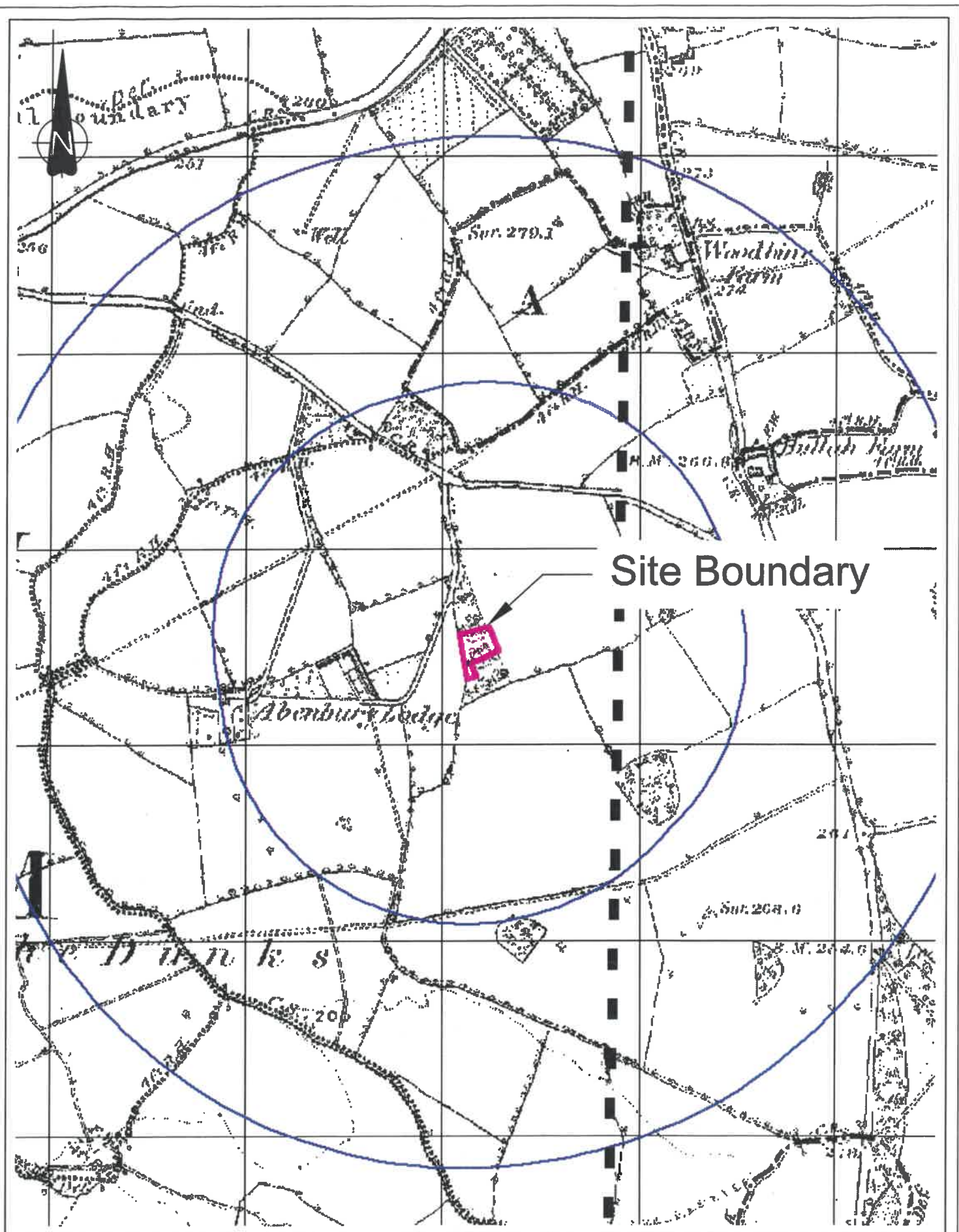
Legend

GSL August
2020 -  BH101

GSL March
2019 -  TP01

Cross Section-
(See Figure 6)





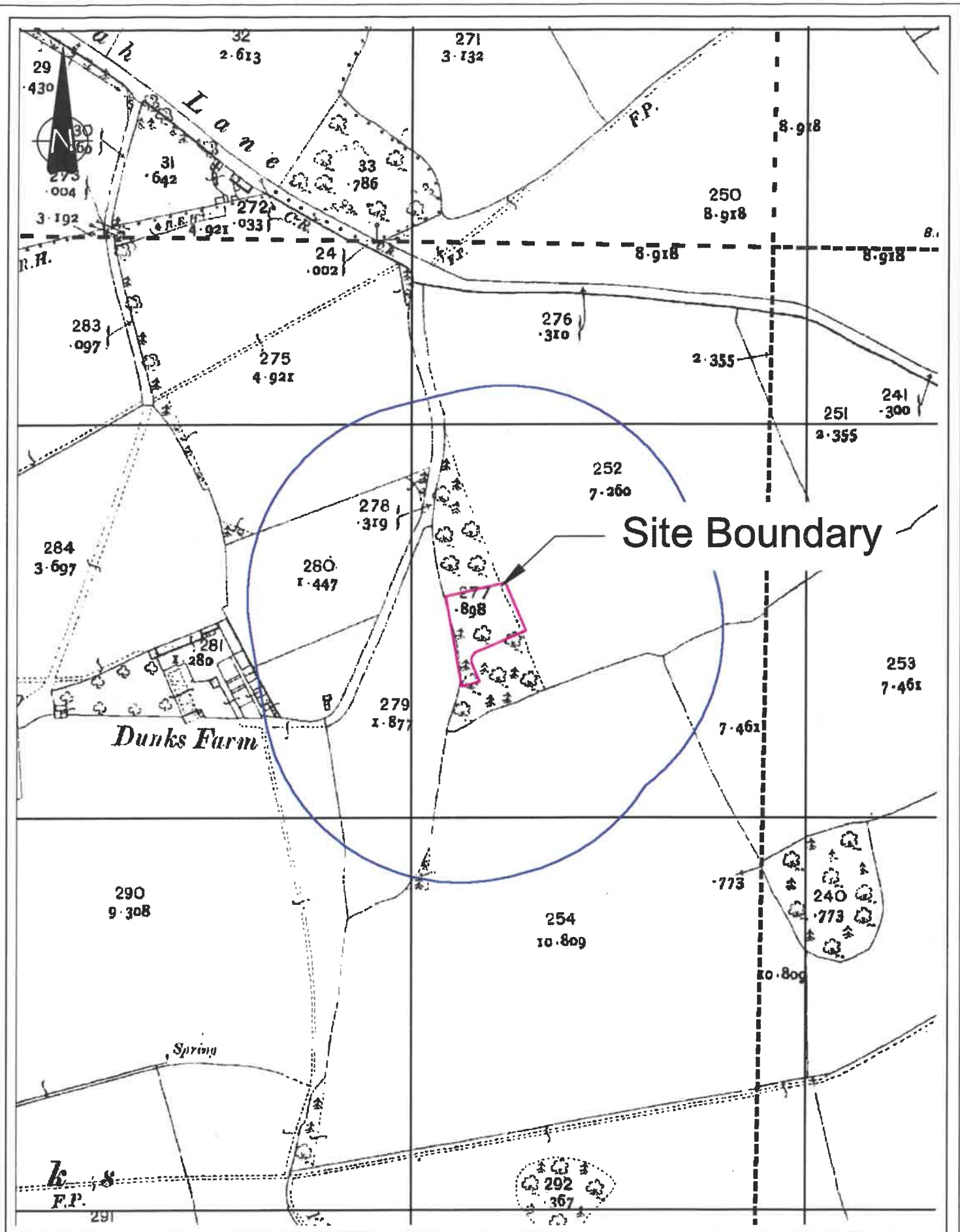
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Figure Title

Site History
1879

FIGURE 3a

FIGURE 3b

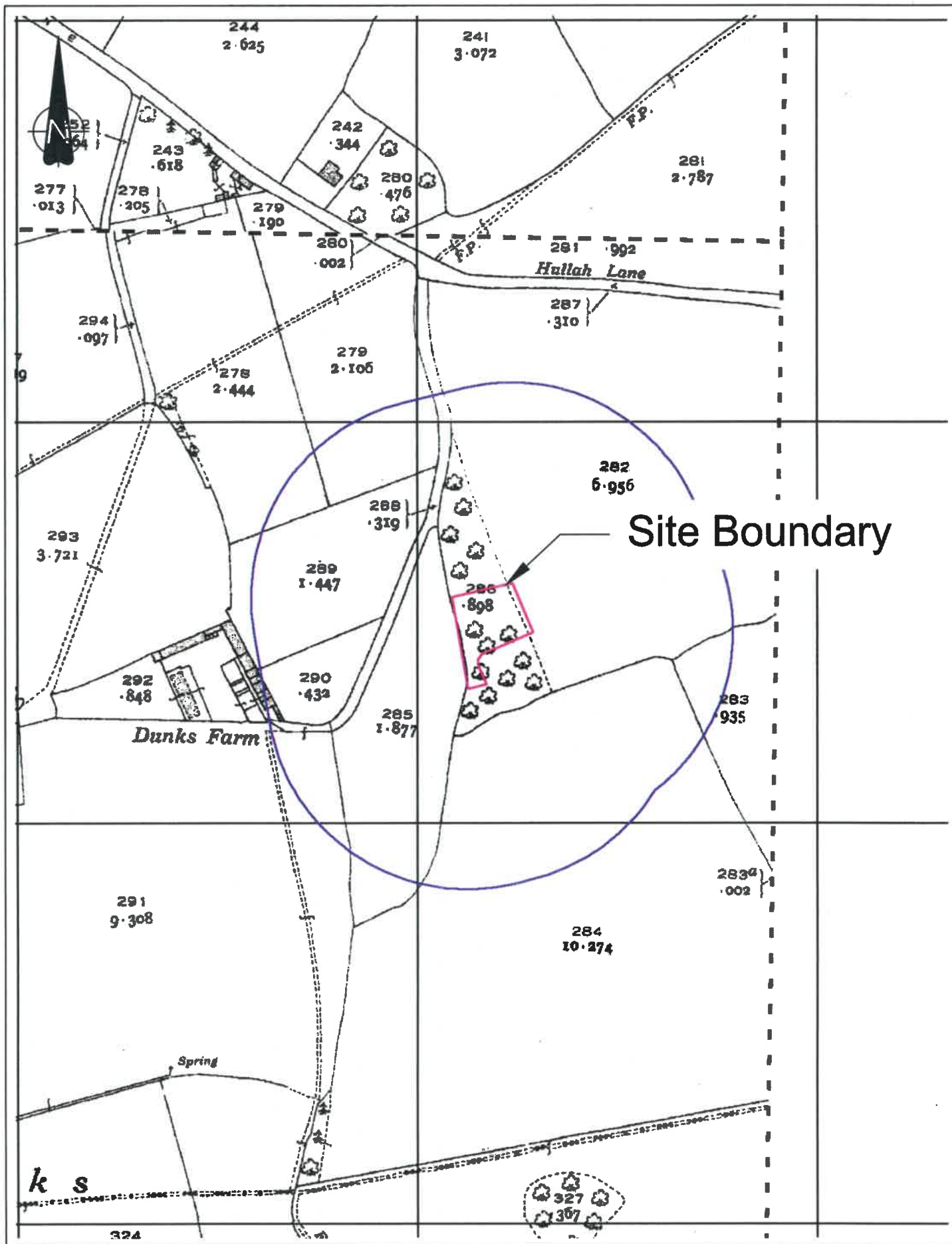


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Figure Title

Site History
1911

FIGURE 3C

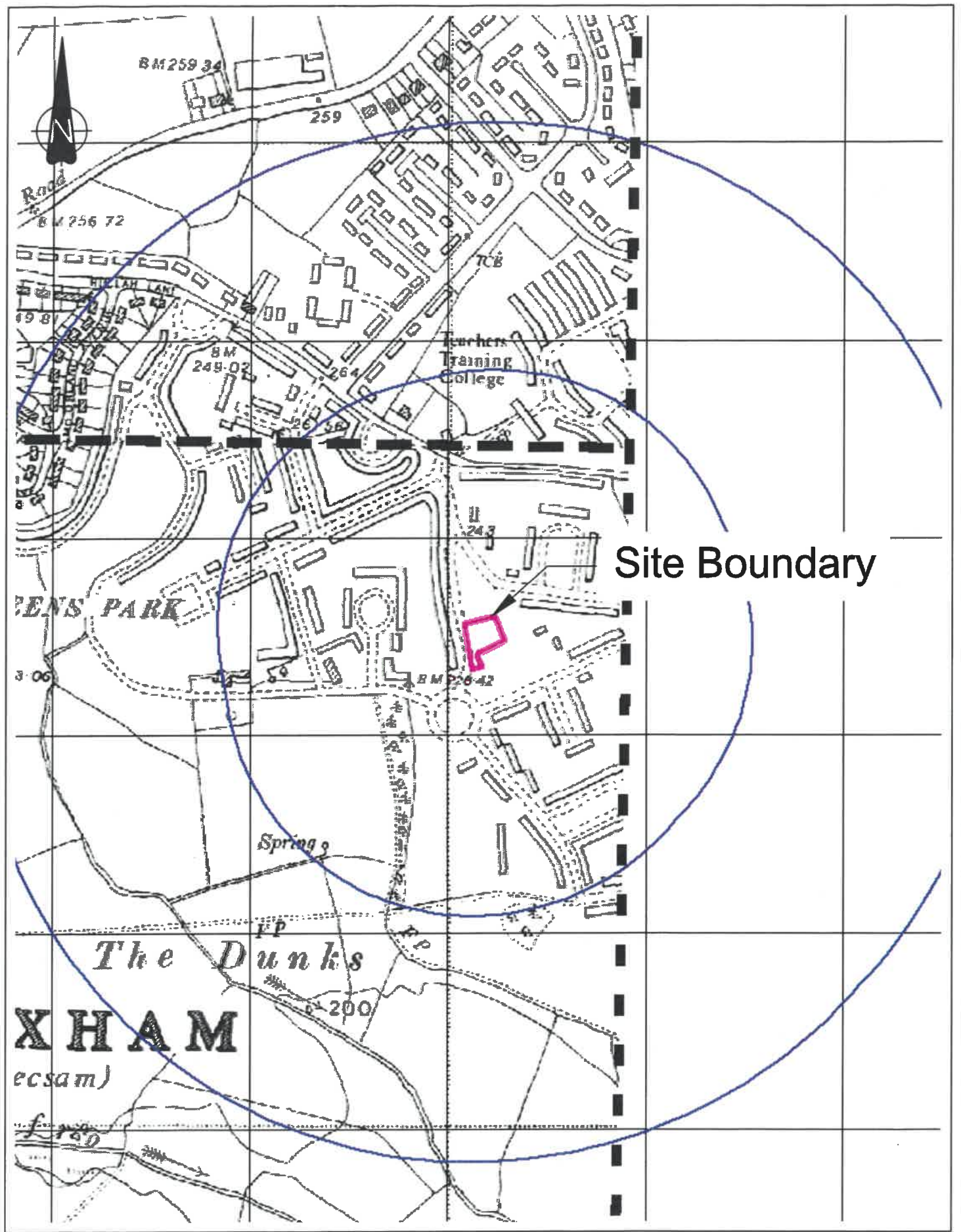


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Figure Title

Site History
1937

FIGURE 3d



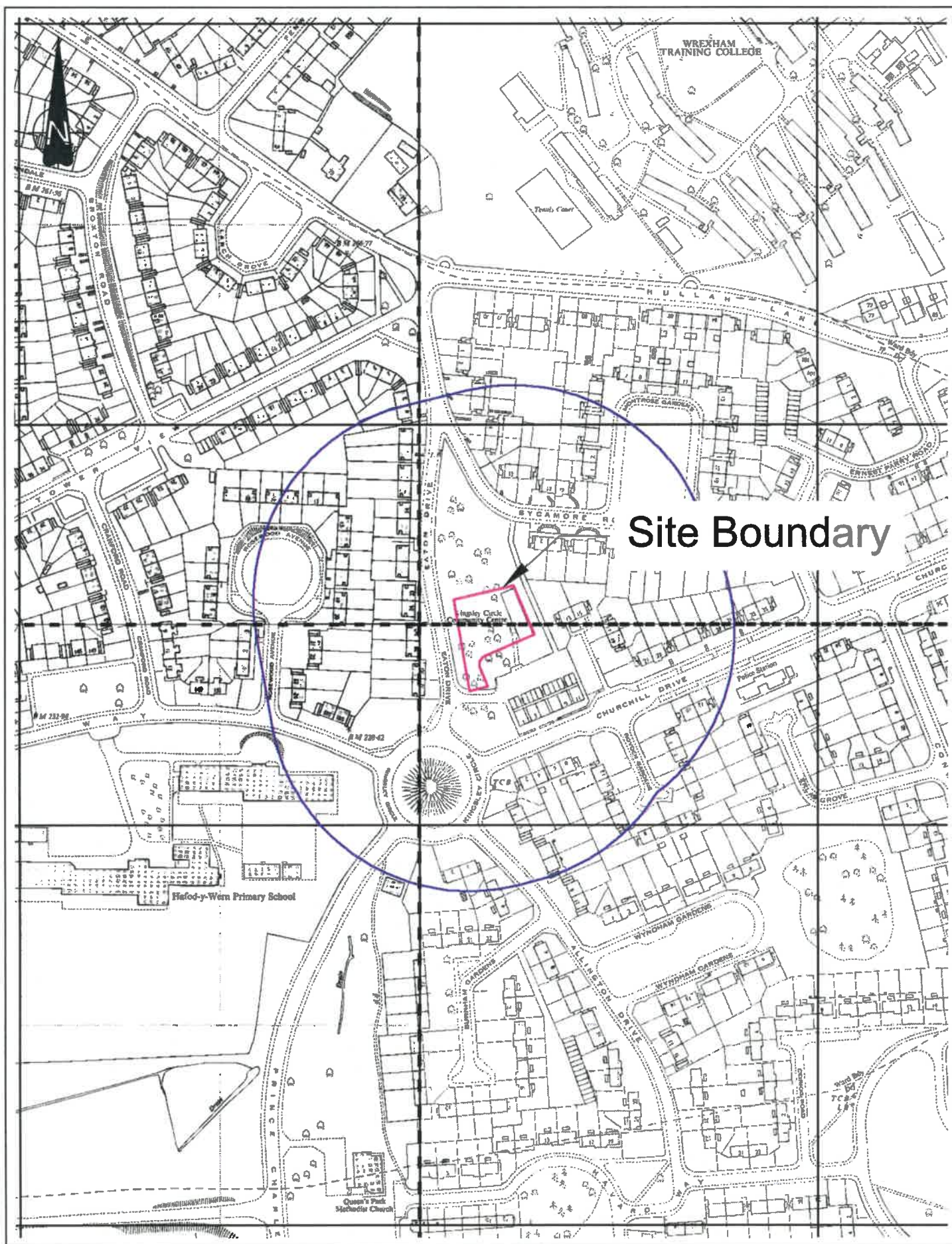
Site Boundary

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Figure Title

Site History
1954

FIGURE 3e

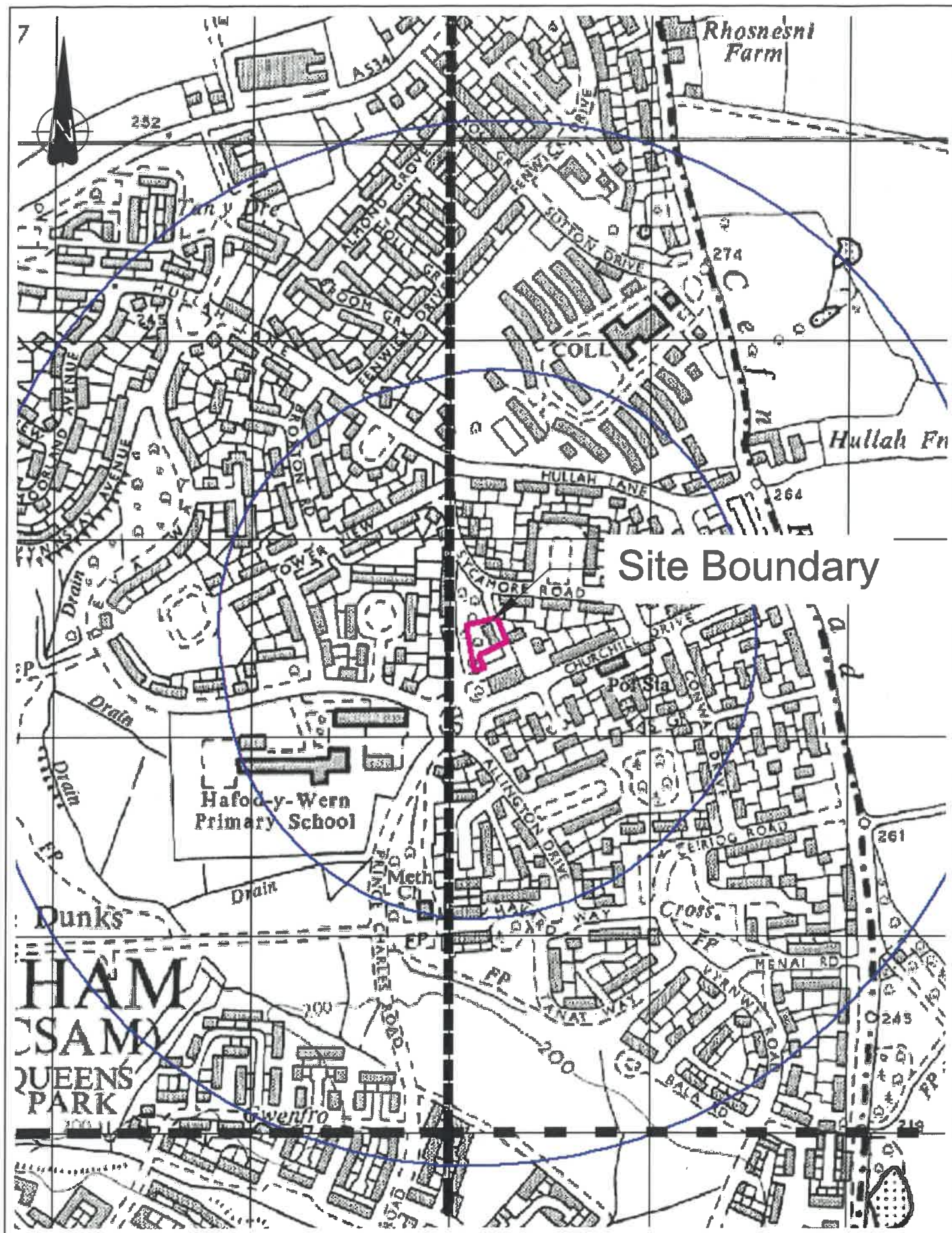


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Figure Title

Site History
1959

FIGURE 3f

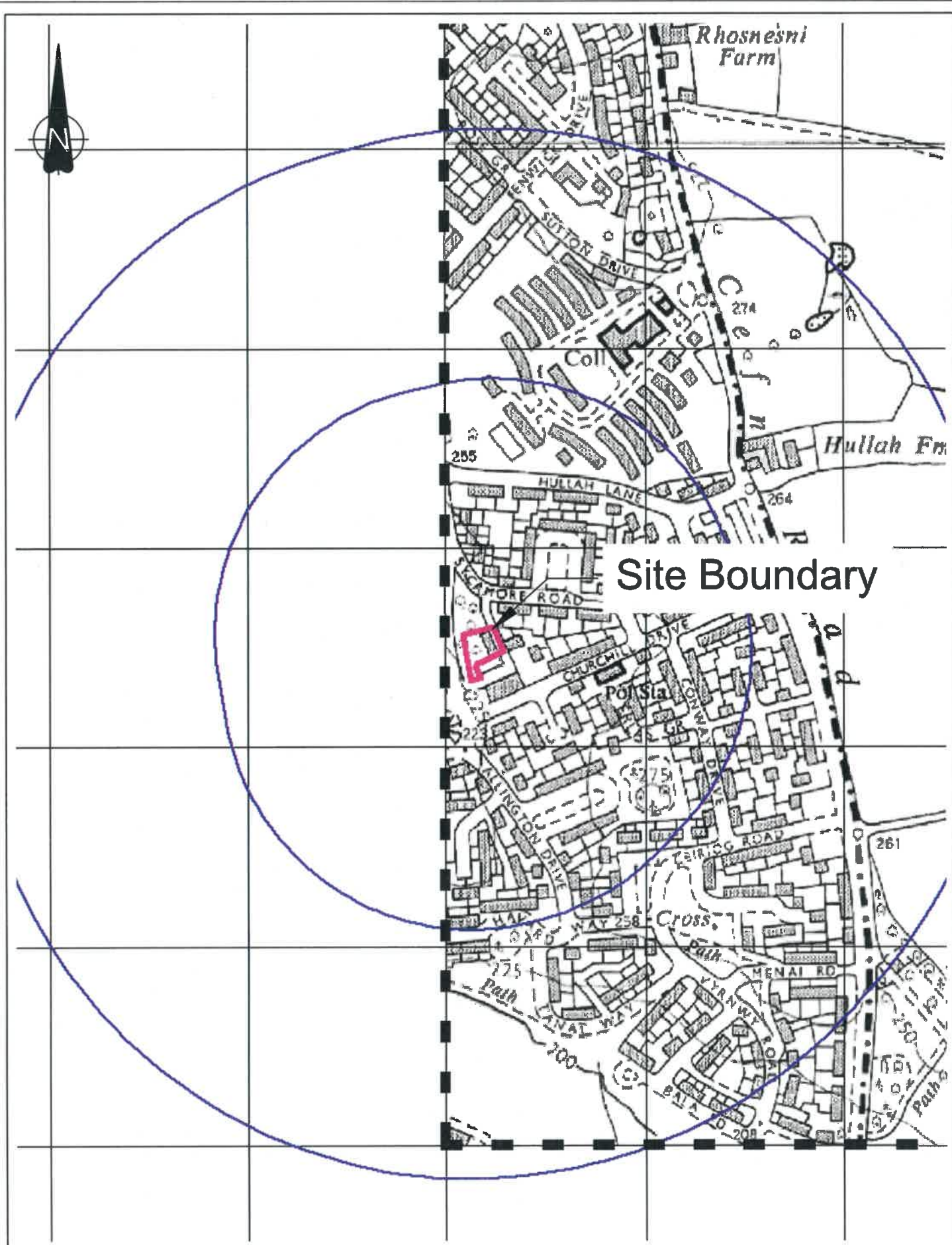


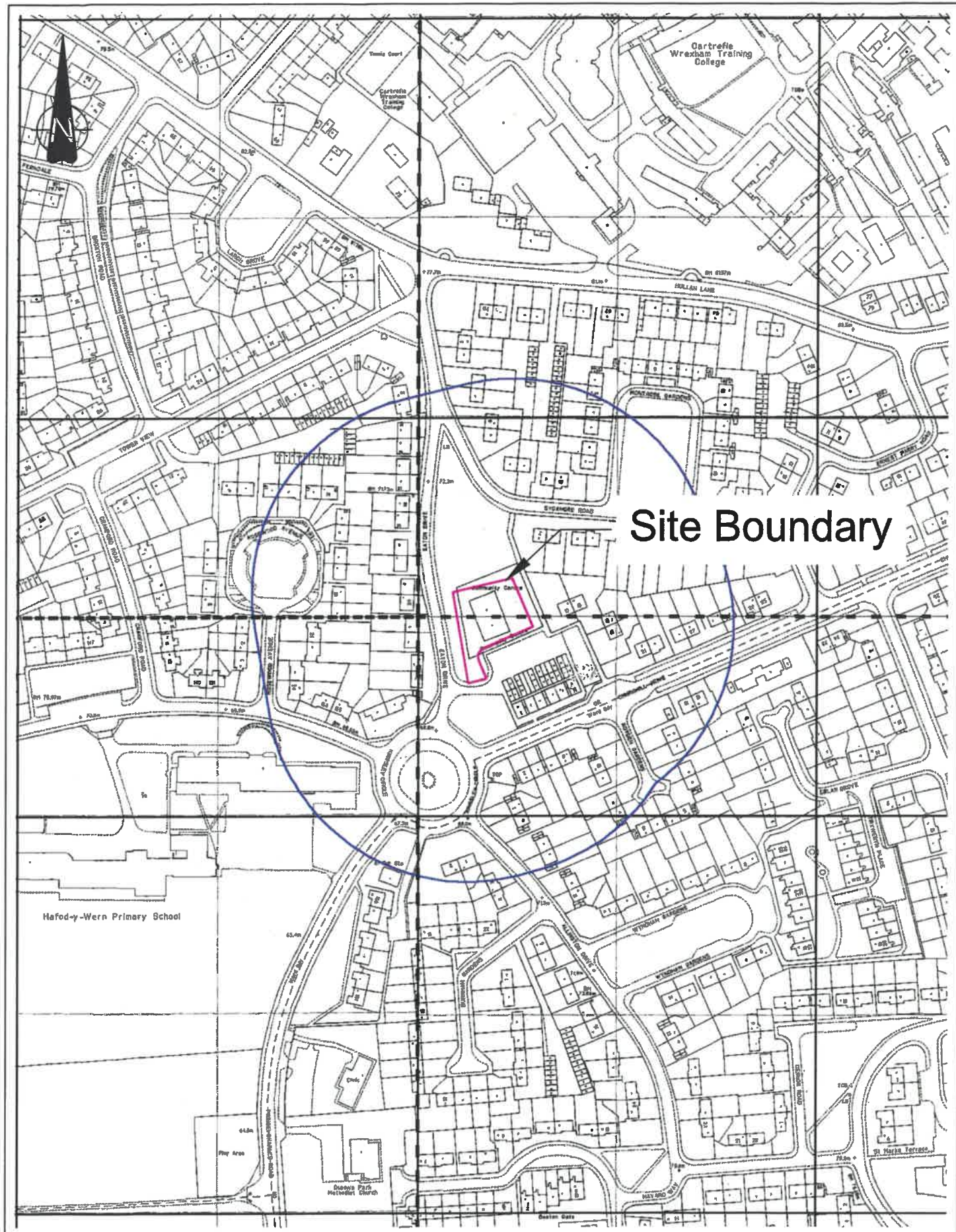
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Figure Title

Site History
1964

FIGURE 3g





SCALE 1 : 2,500 @ A4

Figure Title	Site History 1992
FIGURE 3i	



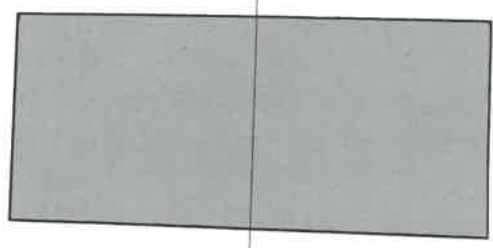
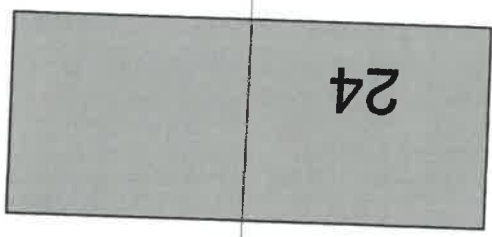
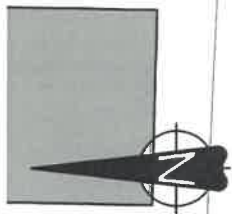
Site Boundary

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Figure Title

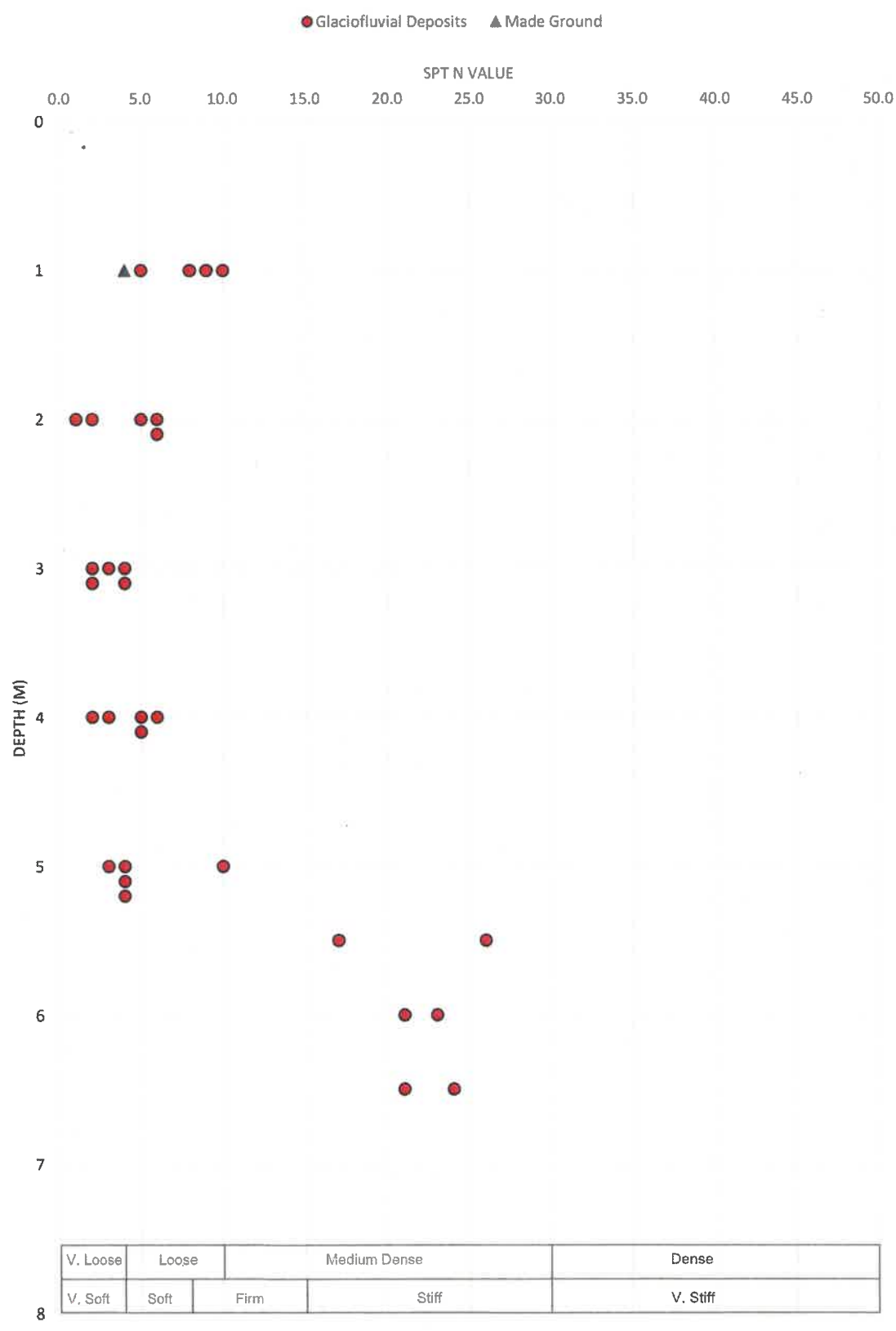
Site History
2003

FIGURE 3j



Turning Area

RECORDED SPT N VS DEPTH



SCALE

Figure Title

SPT 'N' Value
Vs Depth

FIGURE 5