

St Peters Close, Rhosrobin

Proposed Housing

Geotechnical Report

SG Estates



GroundSolve Ltd

Consulting Geotechnical, Engineering Geology and Environmental Engineers

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1.0 INTRODUCTION

SG Estates (SGE) are proposing to purchase and develop a site next to St Peters Close in Rhosrobin, Wrexham. The proposals include some ninety-two residential dwellings, including semi-detached and detached housing, along with apartments.

Consequently, SGE have appointed GroundSolve Ltd (GSL) to carry out a Phase II site investigation at the site. A Phase I desk study has not been commissioned. Initially the investigation was limited to the southern field, but was then extended to incorporate additional information for a drainage strategy for the eastern field.

This report presents the findings of the site investigation, and gives firm geotechnical recommendations for the development. In addition, environmental comments are presented.

2.0 THE SITE

2.1 Site Location and Description

The site is located off Plas Acton and Llay New Roads, in Rhosrobin, Wrexham at National Grid Reference SJ 330, 529, see Figure 1.

It is currently open fields, bounded to the north and west by Plas Acton Road and Cemetery, with the western boundary defined by Llay New Road. The Wrexham Railway Line in cutting runs along the southeastern boundary of the site. Several small residential estates are present around the site, see Figure 2.

The site comprises three separate open fields, north, south and one to the east of the southern field, divided by hedgerows. A public footpath cuts between the northern and southern/eastern fields. Two overhead power lines cross the site, with one trending west to east, and another southwest-northeast, see Figure 2.

A topographic survey has been provided, which confirms the site to have a gentle fall in elevation in a west to east direction, from around 69mAOD in the west to 65mAOD in the eastern field. A recent aerial photograph is presented below.



Recent aerial photograph

Photographs of the site are presented in Appendix A.

2.2 Geology and Hydrogeology

The geology of the site has been studied on the following sources:

- 1:50,000 scale geology plan, Sheet 121,
- Associated geological memoirs, Reference 1,
- Wrexham applied mapping project at a scale of 1:25,000, Reference 2.

These confirmed the south and western parts of the site to be underlain by glacial till (Boulder Clay), with glaciofluvial deposits (Sand and gravel) recorded in the north and eastern sections of the site.

Reference 2 describes the glacial till as mainly silty, sandy clays, with gravel, cobble and occasional boulder. It contains beds of sand and gravel, which may be water bearing. The clays are generally of low to intermediate compressibility, with small consolidation settlements.

The glacial sand and gravel are described as water bearing, medium dense to dense, well sorted, sand and gravel, with occasional cobbles, and interbedded with medium dense, clean sands, and silty, clayey sands.

Reference 2 records the drift thickness at around 15m.

Made ground is recorded along the railway line on the southern site boundary.

The underlying bedrock is Carboniferous in age, the strata differing in age across the site. Underlying the majority of the site is the Coed Yr Allt Formation, with the overlying Bettisfield Formation outcropping on the eastern section of the site. The dip of the strata is gentle in an easterly direction, Reference 1.

The Coed Yr Allt Formation, comprises a grey to green, micaceous sandstone, and grey to green mudstone, with thin coals and limestone beds known as the 'Spirobis' limestone, with local intraformational conglomerate. Whilst the Bettisfield formation is largely mudstone with minor sandstones.

These strata lie above the Ruabon Formation and the underlying Coal Measures, consequently, any coal seams and associated workings would be anticipated to be at significant depth beneath the site. No mine shafts are record in the vicinity of the site, although Reference 2 confirms past deep mining beneath the site.

The major Wrexham fault is shown to the west of the site trending approximately north to south.

Groundwater would be anticipated to be at significant depth beneath the site, although a perched water table on the surface of the low permeability glacial till should be anticipated.

2.3 History

A full desk study has not commissioned for this project, however, a review of Old Maps in GSL archives confirms the site to be open fields from 1872 until the present day. The railway on the southern site boundary was constructed before 1872, with the site occupied by 'Pandy Farm' by 1900, with the introduction of the public footpath. A small pond was recorded just within the south western site boundary. Plas Acton Cemetery was opened in 2009.

3.0 PROPOSED DEVELOPMENT

SGE are proposing to develop the site with ninety-two residential properties on the southern field. The plans include a series of affordable dwellings comprising apartments and two-bedroom housing, as well as private dwellings comprising 3-4 bedroom detached and semidetached houses. A new road is also proposed for access to the site. The current proposed development layout is presented in Figure 3.

Current plans involve directing the surface drainage from the southern field to a soakaway and attenuation pond on the eastern field, however, specific plans are yet to be confirmed.

Building loads and levels have not been provided, however, foundation loads are anticipated to be between 50 to 75kN/m run, with floor slab loadings not exceeding 5kN/m².

Due to the flattish nature of the site, development levels are anticipated to be at/close to grade.

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.

4.0 SITE INVESTIGATIONS

4.1 Previous Investigation

GSL carried out a full Phase II investigation on a site immediately east of this site on the other side of the railway line.

The ground conditions at this site comprised glacial till (clay) and fluvioglacial deposits (sand and gravel).

The glacial till was generally described as firm to stiff, brown, slightly sandy slightly gravelly clay. It generally had a weathered upper layer, which was orange, brown in colour, and slightly weaker, being firm. Physical testing recorded the clay to be of low plasticity.

The fluvioglacial deposits generally comprised loose becoming medium dense, brown, slightly clayey, gravelly, fine to coarse sand, with a low cobble content. PSD testing confirmed that silt/ clay contents were below 10%.

No contamination was encountered on the site, and chemical attack of buried concrete was not an issue. Permeabilities within the sand and gravel were generally between 1×10^{-4} and 7×10^{-6} m/sec.

4.2 This Investigation

4.2.1 Fieldwork

The site investigation was divided into two phases.

Phase I was the site investigation for the southern field, which was undertaken on the 4th August 2021, and comprised:

- Eleven machine excavated trial pits, excavated to a maximum depth of 2.90m,
- Hand Shear Vein (HSV) testing within the glacial till to determine the shear strength of the cohesive soils,
- Sixteen CBR tests undertaken using a TRL probe to depths up to 1.00m.

The Phase II site investigation for the eastern field was undertaken to determine the ground conditions for drainage design, and was carried out between 9th and 10th September, and the 17th to 22nd of September.

It comprised:

- Eleven machine excavated trial pits, excavated to a maximum depth of 3.0m,
- Two trenches to determine the extent of the shallow sand and gravel,
- Four boreholes, to a maximum depth of 10m,
- Installations in two boreholes for groundwater monitoring,
- Soakaway testing carried out in two trial pits (three cycles in each pit),
- Falling Head Tests carried out at approx. 1.0m intervals within sand and gravel in the boreholes.

The trial pits, boreholes and CBR testing was supervised and logged by a GSL Engineer in general accordance with BS 5930, Reference 3. The Soakaway testing was carried out by filling the trial pits quickly with water from a 1,600-gallon water tanker and monitoring the water level in accordance with BRE Digest 365, Reference 4. The falling head tests were carried out in general accordance with BS EN ISO 22282-1, Reference 5.

The locations of the trial pits boreholes and CBR tests from both phases of investigation are presented in Figures 2 and 2a, with the trial pit logs, borehole logs, soakaway tests and CBR results presented in the following Appendices.

- Trial pit logs – Appendix B,
- Borehole Logs- Appendix C,
- Soakaway Tests – Appendix D,
- Falling Head Tests- Appendix E,
- CBR test results – Appendix F.

4.2.2 Laboratory Work

Samples were taken from the trial pits and boreholes for the following chemical and physical analysis:

Physical Testing

- Natural moisture content,
- Atterberg limits,
- pH & water-soluble sulphate (2:1 extract).

The testing was carried out in accordance with BS1377, Reference 6. The results are discussed in Section 6.0, and presented in full in Appendix G.

Chemical Testing

Samples for chemical testing were taken from the topsoil, placed in appropriate containers and a cool box, and taken immediately to the laboratories of Derwentside Environmental Testing Services (DETS) in County Durham for the following testing:

Metals & Non-metals - Arsenic (As), Boron (B), Cadmium (Cd), Chromium (Trivalent), Chromium (Hexavalent), 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, and the results presented in full in Appendix H.

5.0 GROUND CONDITIONS

5.1 General Stratigraphy

The general stratigraphy encountered in the Phase I and II site investigations is summarised below in Table 5.1:

Table 5.1 Summary of Ground Conditions

BH/TP No.	Topsoil (m)	Glacial Till (m)	Fluvioglacial Deposits(m)
TP01	0.00-0.35	0.35-2.10	2.10-2.70
TP02	0.00-0.40	0.40-2.90	
TP03	0.00-0.40	0.40-2.10	2.10-2.60
TP04	0.00-0.45	0.45-2.40	2.40-2.75
TP05	0.00-0.20	0.20-1.60 2.00-2.70	1.60-2.00
TP06	0.00-0.45	0.45-2.70	
TP07	0.00-0.30	0.30-2.70	
TP08	0.00-0.30	0.30-2.30 2.50-2.90	2.30-2.50
TP09	0.00-0.35	0.35-2.60	
TP10	0.00-0.35	0.35-2.70	
TP11	0.00-0.40	0.40-2.75	
TP201	0.00-0.20		0.20-2.00
TP202	0.00-0.25	0.25-2.00	
TP203	0.00-0.20		0.20-1.30
TP204	0.00-0.20	0.20-1.80	
TP205	0.00-0.15	0.15-1.50	
TP206	0.00-0.25	0.25-1.50	
TP207	0.00-0.25	0.25-2.00	
TP208	0.00-0.25	0.25-2.50	
TP209	0.00-0.25	0.25-0.40	0.40-3.40
TP210	0.00-0.30	0.60-1.80 3.10-3.20	0.30-0.60 1.80-3.10
TP211	0.00-0.30	0.30-3.00	
BH01	0.00-0.40		0.40-10.00
BH02	0.00-0.40	2.30-5.00	0.40 – 2.30
BH2A	0.00-0.50	0.50-4.80	4.80-7.50
BH03	0.00-0.60	0.40-4.40	4.40-10.00

Cross sections through the eastern section of the site are presented in Figure 4.

5.2 Topsoil

Topsoil was encountered in all of the exploratory holes to a maximum depth of 0.60m, where it was generally described as grass over loose, brown, gravelly, slightly clayey sand.

pH values between 5.7-8.6 were recorded, with sulphate values, when measured as 2:1 water extract between 12 and 95 mg/l (0.012 to 0.095g/l).

5.3 Glacial Till

Glacial Till was encountered in all exploratory holes, apart from BH01, TP201 and TP203. It was proved to a maximum depth of 4.80m, and generally comprised firm to stiff, brown, mottled blue, sandy, gravelly clay.

Hand Shear Vein Testing (HSV) recorded shear strengths ranging between 40kPa (Soft) and 100KPa (Stiff).

Atterberg limit testing recorded liquid limits between 27 and 34%, plastic limits between 13 and 14%, and plasticity indices between 14 and 17%, indicating a clay of low plasticity. Natural moisture contents were between 13 and 14%.

pH values were between 6.7 and 7.7, with sulphate values, when recorded as 2:1 water extract between <10 and 62 mg/l (<0.01 and 0.062g/l).

5.4 Fluvioglacial Deposits

Fluvioglacial deposits were identified at depth on site, apart from several trial pits and boreholes on the eastern section of the site, where these deposits were encountered at surface, see Figure 2a. It was generally described as loose to medium dense, brown, slightly clayey, gravelly, fine to coarse sand, with a low cobble content.

5.5 Groundwater

No groundwater strikes were recorded in any of the boreholes or trial pits.

Groundwater monitoring was then undertaken in BH01 and BH03, where they were monitored every week for three weeks. During this time groundwater was not recorded in either borehole.

5.6 DCP Testing

Dynamic Cone Penetrometer (DCP) testing was carried out across the southern field, to determine CBR values for pavement design. The results are summarised in Table 5.2 below.

Table 5.2: DCP Results

Test No	Depth (m)	CBR %
DCP1	0-280	7.7
	280-400	13.4
	400-800	18.6
DCP2	0-280	5.3
	280-800	8.3
DCP3	0-280	5.8
	280-400	10.1
	400-800	14.2
DCP4	0-280	3.5
	280-400	8.3
DCP5	0-280	5.7
	280-400	10.1
	400-800	6.0
DCP6	0-280	7.5
	280-400	8.3
	400-800	6.3
DCP7	0-280	5.5
	280-400	12.7
	400-800	14.2
DCP8	0-280	4.5
	280-400	14.2
	400-800	8.3
DCP9	0-280	6.1
	280-400	8.3
	400-800	7.5
DCP10	0-350	5.8
	350-700	8.0
	700-900	20.1
DCP11	0-300	12.7
	300-650	16.1
	650-850	38.6
DCP12	0-280	5.5
	280-400	12.7
	400-800	8.0
DCP13	0-400	15.1
	400-800	9.3
	800-900	45.4
DCP14	0-300	6.5
	300-550	23.9
	550-800	14.2
DCP15	0-800	8.9
DCP16	0-250	8.0
	250-400	23.9
	400-900	16.1

5.7 Permeability Testing

Permeability testing was concentrated in the eastern field in the sand and gravel deposits at surface, where the proposed drainage for the housing development is to be directed.

The results are summarised in Table 5.3 below:

Table 5.3 Soakaway Test Results

TP No.	Depth (m)	Test No.	Infiltration Rate (m/s)
201	2.00	1	2.6×10^{-5}
		2	1.6×10^{-5}
		3	2.0×10^{-5}
203	1.10	1	3.7×10^{-5}
	1.10	2	2.5×10^{-5}
	1.10	3	2.6×10^{-5}

As only a very limited area of sand and gravel at surface was identified, Falling Head Testing was undertaken at approximately 1.0m intervals in the boreholes.

The results are summarised in Table 5.4 below:

Table 5.4 Falling Head Permeability Test Results

BH No.	Depth (m)	Infiltration Rate (m/s)
BH01	3.00-4.00	7.79×10^{-4}
	4.50-5.50	1.37×10^{-4}
	5.50-6.50	9.4×10^{-4}
	7.00-8.00	3.35×10^{-3}
BH2a	5.00-6.00	1.00×10^{-3}
BH3	5.00-6.00	1.50×10^{-4}
	6.00-7.00	4.9×10^{-3}
	8.00-9.00	2.25×10^{-3}

5.8 Services

Two overhead power lines cross the site, with one trending west to east, and another southwest-northeast, both crossing the south and west fields. A sewage line also crosses the site from the south west, and then following the public footpath to the east, see Figure 2.

A medium pressure gas main also crosses the site.

6.0 RESULTS OF CHEMICAL TESTING

Samples were taken from the topsoil for chemical testing, with the sample depths presented in Table 6.1 below.

Table 6.1 Sample Depths

TP No	Depth (m)
TP01	0.20
TP04	0.20
TP06	0.20
TP09	0.20
TP11	0.20

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 with gardens” end-use has been adopted for this analysis, based on the a SOM content of 1.0%.

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

	TP01	TP04	TP06	TP09	TP11			
Metals & Non-Metals	0.20	0.20	0.20	0.20	0.20	Adopted Guideline (mg/kg)	Source	Exceedances
Arsenic	13	8.10	9.20	10	11	37	C4SL	0
Boron, Water Soluble	0.2	0.30	0.50	0.4	0.4	290	S4UL	0
Cadmium	0.2	0.30	0.40	0.4	0.2	22	C4SL	0
Chromium III	16	15	21	18	19	910	S4UL	0
Chromium, Hexavalent	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	21	C4SL	0
Copper	26	17	29	25	25	2400	S4UL	0
Lead	81	53	87	54	56	200	C4SL	0
Mercury	0.09	0.06	0.11	0.07	0.07	1.2	S4UL	0
Nickel	14	12	13	17	18	130	S4UL	0
Phenol - Monohydric	0.3	< 0.3	0.50	0.4	0.4	120	S4UL	0
Selenium	2.4	1.90	1.60	1.9	1.1	250	S4UL	0
Zinc	220	170	66	72	57	3700	S4UL	0

None of the above values exceed the relevant guidance values for residential land use with gardens.

	TP01	TP04	TP06	TP09	TP11			
Petroleum Hydrocarbons	0.20	0.20	0.20	0.20	0.20	Adopted Guideline (mg/kg)	Source	Exceedances
Aliphatic C5-C6	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	42	S4UL	0
Aliphatic C6-C8	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	100	S4UL	0
Aliphatic C8-C10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	27	S4UL	0
Aliphatic C10-C12	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	130	S4UL	0
Aliphatic C12-C16	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	1100	S4UL	0
Aliphatic C16-C21	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	65000	S4UL	0
Aliphatic C21-C35	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	65000	S4UL	0
Aliphatic C35-C40	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	70	S4UL	0
Aromatic C5-C7	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	130	S4UL	0
Aromatic C7-C8	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	34	S4UL	0
Aromatic C8-C10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	74	S4UL	0
Aromatic C10-C12	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	140	S4UL	0
Aromatic C12-C16	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	260	S4UL	0
Aromatic C16-C21	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	1100	S4UL	0
Aromatic C21-C35	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	1100	S4UL	0

None of the above values exceed the relevant guidance values for residential land use with gardens.

Polyaromatic Hydrocarbons (PAH)	TP01	TP04	TP06	TP09	TP11	Adopted Guideline (mg/kg)	Source	Exceedances
	0.20	0.20	0.20	0.20	0.20			
Acenaphthene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	210	S4UL	0
Acenaphthylene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	170	S4UL	0
Anthracene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	2400	S4UL	0
Benzo(a)anthracene	0.1	0.03	< 0.03	0.11	0.03	7.2	S4UL	0
Benzo(a)pyrene	0.08	< 0.03	< 0.03	0.1	< 0.03	5	C4SL	0
Benzo(b)fluoranthene	0.19	0.10	0.10	0.22	0.11	2.6	S4UL	0
Benzo(g,h,i)perylene	0.03	< 0.03	< 0.03	0.05	< 0.03	320	S4UL	0
Benzo(k)fluoranthene	0.04	< 0.03	< 0.03	0.05	< 0.03	77	S4UL	0
Chrysene	0.1	< 0.03	< 0.03	0.12	0.04	15	S4UL	0
Dibenzo(a,h)anthracene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.24	S4UL	0
Fluoranthene	0.21	0.05	0.07	0.21	0.06	280	S4UL	0
Fluorene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	170	S4UL	0
Indeno(1,2,3-c,d)pyrene	0.03	< 0.03	< 0.03	0.05	< 0.03	27	S4UL	0
Naphthalene	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	2.3	S4UL	0
Phenanthrene	0.05	< 0.03	< 0.03	0.07	< 0.03	95	S4UL	0
Pyrene	0.19	0.04	0.06	0.18	0.05	620	S4UL	0

None of the above values exceed the relevant guidance values for residential land use with gardens.

Other Contaminants / Testing	TP01	TP04	TP06	TP09	TP11	Adopted Guideline (mg/kg)	Source	Exceedances
	0.20	0.20	0.20	0.20	0.20			
Organic matter	4	4.20	4.60	4.4	4.3	-	-	-
pH	6.5	-	5.70	8.6	5.7	-	-	-
Sulphide	24	< 10	20.00	< 10	< 10	-	-	-
Cyanide, Total	0.5	0.50	0.70	0.6	0.6	-	-	-
Sulphur (free)	1.3	< 0.75	2.10	1.2	< 0.75	-	-	-
Sulphate Aqueous Extract as SO ₄	95	16.00	19.00	12	15	-	-	-

None of the above values cause any concern.

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

7.0 GEOTECHNICAL RECOMMENDATIONS

7.1 Ground Model

To understand the foundation and drainage recommendations it is useful to understand the depositional history of the soils on site.

Firstly, the glacial till is deposited beneath advancing ice sheets during the last glaciation, with Reference 1 recording an ice thickness in this area of around 400m.

Secondly, as the ice sheets retreat the glacial meltwaters deposit sand and gravel, usually in a fining upwards sequence, as the flow from the meltwaters subsides. Consequently, permeabilities would be anticipated to generally increase with depth.

In addition, the water flow would erode the surface of the glacial till, forming an uneven surface, with some channels cut into the surface of the till. The uneven surface also explaining why the sand and gravel is unevenly spread across the site.

7.2 Excavations and Site Preparation

Firstly, it will be necessary to strip the topsoil, which should be stockpiled on site for later re use. However, there is likely to be a surplus, which could be sold on, or alternatively, it could be used for landscaping bunds in the eastern section of the site.

It will also be necessary to remove the mature hedgerows on the southern field, with the roots grubbed out. Excavations where they are not in building areas can be backfilled with suitable site won material, such as the sand and gravel. Whilst in building areas excavations should be backfilled with suitable imported granular material compacted in accordance with an approved earthworks specification, Reference 7.

Excavations are likely to be unstable in the short term, especially in the sand and gravel horizons. Consequently, excavations deeper than 1.20m will need to be battered back for safety reasons. For any attenuation ponds the side slopes should be cut at a gradient of 1 on 2 (26.5°).

Groundwater seepages are not anticipated, if encountered, they should be slight and easily catered for by pumping from sumps cut within the excavation.

7.3 Foundations and Floor Slabs

The proposed development area is underlain by firm to stiff glacial till, although occasional soft spots were recorded.

Consequently, conventional spread foundations are recommended for the development founded in clay of at least firm consistency, designed assuming an allowable bearing capacity of 100kN/m², which based on the anticipated loadings a 600mm wide excavation bucket width should suffice.

However, there is a slight possibility that the ground conditions may vary across a plot, from sand and gravel to glacial till, especially in the eastern section of the development. Whilst it would be normal practice to locally deepen foundations to ensure a uniform bearing strata, if the sand and gravel proves to be say thicker than 2m, the foundations should be lightly reinforced.

Foundations should be a minimum of 0.90m below final external ground level, and if any trees are within influencing distance of the plots the foundation depths will need to be assessed in accordance with Reference 8, with a low volume change potential assumed.

However, whilst a desk study has not been undertaken, examination of historical plans in GSL archives has identified a backfilled pond to the rear of Plot 7. This is most likely to have been a “Marling Pit” used by local farmers, experience of which shows they are generally around 2m deep. Consequently, it may be necessary to locally deepen foundations in this area.

It would also be prudent to undertake further trial pitting in this area to determine the nature of the backfill to the pond, following which it may need to be removed from site.

Floor slabs can be designed to be ground bearing, designed assuming a “Poor” formation in the clay, as described in Reference 9.

7.4 Drainage

A drainage strategy for the site was undertaken by Waterco in August 2021 for SGE. This report concluded that soakaways were not feasible in the development area, which is underlain by low permeability glacial till. However, two trial pits in the eastern field confirmed the presence of sand and gravel with permeabilities between 1.137×10^{-5} and 1.45×10^{-5} m/sec.

It also concluded that a 20m standoff from the railway cutting is required between the cutting and any infiltration basin.

Soakaway testing in trial pits at shallow depth during this investigation recorded permeabilities between 1.6 and 3.7×10^{-5} m/sec, which is similar to those recorded above. However, deeper testing at depths greater than 3m in the boreholes recorded higher permeabilities between 2.25×10^{-3} and 9.4×10^{-4} m/sec as anticipated from the ground model.

7.5 Reuse of Materials

As discussed above the topsoil on site can be re used.

As the site is fairly flat, it is not envisaged that any cut/fill will be required. However, both the glacial till and sand and gravel will be suitable for re-use as a general structural fill. The sand and gravel has a low fines content, consequently, it will conform to several of the earthwork's classifications given in Reference 7, as will the glacial till. It will also be a more reliable fill material than the glacial till, as it is not susceptible to the effects of wet weather.

It would therefore be prudent to phase the works so that sand and gravel is excavated from soakaways first and then stockpiled for re-use elsewhere.

Based on the Atterberg limit testing the glacial till will also be a suitable fill material. However, it should be recorded that it would be susceptible to deterioration during wet weather and trafficking. Consequently, if required, it should be excavated and recompacted immediately without stockpiling.

It would also be suitable to form an impermeable liner for any attenuation ponds.

7.6 Roads and Hard Standings

CBR testing using a TRL probe has been carried out across the development area.

The results are summarised in Table 5.2, and at the top of the glacial till CBR values between 6 and 14% were recorded. Therefore, in accordance with the above results and GSL experience of such materials, a CBR value of 6% should be assumed for the design.

As mentioned above it should also be noted that formations in the glacial till will be subject to rapid deterioration on exposure to wet weather and trafficking. Therefore, in these areas it would be prudent to leave the formation slightly high until construction is imminent.

It will also be necessary for the formation to be proof rolled and any soft spots identified, excavated typically an additional 300mm and replaced with suitable well compacted granular material.

7.7 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 10.

- AC – 1,
- DS – 1.

7.8 Landfill and Radon Gas

As a desk study has not been commissioned, it is not possible to assess the potential for nearby landfills. However, a desk study on the site immediately to the east failed to record any nearby landfills.

Whilst a small backfilled pond has been identified on site, it is sufficiently small that should it contain degradable material it could all be excavated and removed from site.

The desk study on the adjacent site confirmed it to be in an area where full radon protection measures are required, which should be constructed in accordance with Reference 11. As a minimum this would comprise a suitable membrane beneath internal and external walls. It should also include proprietary “Top Hats” where services enter the building below the slab.

It is therefore recommended that a detailed radon report be obtained for this site.

7.9 Environmental Comments

The historical plans have confirmed that there have been no previous land uses, with the exception of open fields for farming.

In addition, the numerous trial pits and boreholes failed to detect any visual or olfactory evidence of contamination, which was confirmed by the chemical testing. The site can therefore be concluded to be uncontaminated and fit for its intended end use.

Whilst a backfill pond has been identified on site this can easily be treated during, the works.

Finally, in accordance with current good practice, a watching brief should be kept on all excavations. Should any contaminated material be encountered, it should be excavated, stored safely on site, tested and then disposed of at a suitably licensed landfill facility.

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