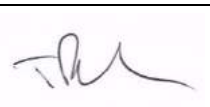
Hydrogeological Risk Assessment - Upgraded Treated Effluent Discharge to Ground

Llansantffraed Court Hotel, Llanvihangel Gobion, Abergavenny

On behalf of

Snaco UK Limited

Quality Management

Prepared by:	Tom Paltridge BSc MSc FGS	
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Contents

Tables and Figures

Tables

Figures

Drawings

Drawing 1a	***Geology map - superficial geology***
Drawing 1b	***Geology map - bedrock geology***
Drawing 2	***Hydrogeological features map***

Appendices

Appendix A	***Site Investigation Report - Ground Investigation Limited, November 2021***
Appendix B	***Infiltration Testing Report - Gibbs Geotechnical Limited, August 2021***
Appendix C	***Percolation Testing Report - Gibbs Geotechnical Limited, November 2021***
Appendix D	***Proposed Site plan***
Appendix E	***Treatment Chain***
Appendix F	***Infiltration Worksheet model – Ammonia***
Appendix G	***Infiltration Worksheet model – Phosphate***
Appendix H	***Infiltration Worksheet model – Ammonia sensitivity analysis***

1 Introduction

1.1 Background

Hydrogeo Limited (Hydrogeo) has been commissioned by Snaco UK Limited (the Client) to undertake a Hydrogeological Risk Assessment for a proposed upgrade to a treated effluent discharge to at Llansantffraed Court Hotel, Llanvihangel Gobion, near Abergavenny, NP7 9BA (the Site).

The proposed development comprises refurbishment and development at the existing hotel in order to create a new wedding function room, to be used as a wedding venue. The proposed development at the Site is understood to increase the existing guest numbers from 120 to 150 persons.

Foul water at the Site is currently treated in an existing package treatment plant (PTP). Water is then conveyed to the south of the Site in a pipe below an access lane, and discharged into a small surface watercourse, which itself discharges into the River Usk a short distance downstream.

The proposed upgrade to the foul water treatment comprises a new PTP and then discharge to ground via a shallow linear soakaway. This represents significant betterment over the existing system in terms of the discharge of nutrients to the River Usk SAC, as there will be no direct connection to any surface water features in the vicinity of the Site.

The objective of this report is to assess the risk posed to environmental and human receptors from the new discharge of treated foul effluent, taking into account the significant betterment afforded to the environment by discharging to ground rather than a surface water feature.

This report has been progressed in support of a planning application to the Local Authority and to supplement a wastewater assessment report progressed by kPa Consulting Engineers Limited.

1.2 Data Sources &Third Party Information

In completing this assessment, Hydrogeo has utilised the following information:

- British Geological Survey (BGS) online data;
- BGS 1:50,000 Geology Map England and Wales - Sheet 232, Abergavenny, Solid and Drift – (1990);

- BGS 1:125,000 Hydrogeological Map of South Wales, Sheet 17 (1986);
- BGS - The physical properties of minor aquifers in England and Wales. Technical Report WD/00/04 (2000);
- Shoothill Gaugemap;
- Ordnance Survey (OS) mapping);
- EA – Annex J5: Effluent discharge to groundwater user manual v2.0 (2014);
- Infiltration Testing Report, Gibbs Geotechnical, Ref: 242, 30th August 2021;
- Percolation Testing Report, Gibbs Geotechnical, Ref: 276-02, 30th November 2021;
- Other site-specific data and reports supplied by the Client.

2 Site Setting

2.1 Site Location

The Site is located approximately 1km north east of the small settlement of Llanvihangel Gobion, and approximately 7km south east of Abergavenny. The grid reference for the main hotel building at the Site is 335671, 210193, and the post code is NP7 9BA.

The Site comprises a main hotel building (Llansantffraed Court Hotel), positioned in sweeping grounds of grassy areas and trees, with a number of associated outbuildings. The Site is surrounded by agricultural farming land, with separate farm buildings immediately to the north.

The Site falls gently towards the south west, from an approximate elevation of 63m above ordnance datum (mAOD) in the north east to 52mAOD in the south west.

The location of the Site has been shown in Figure 2-1, with the boundary of the Site shown in Figure 2-2.

Figure 2-1 Site location

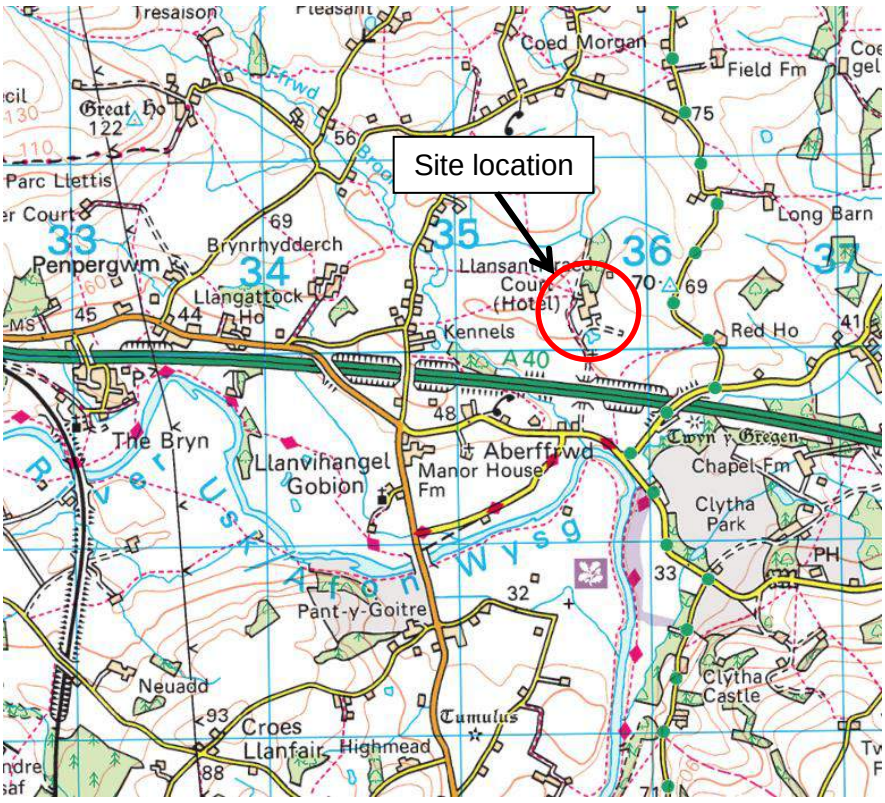
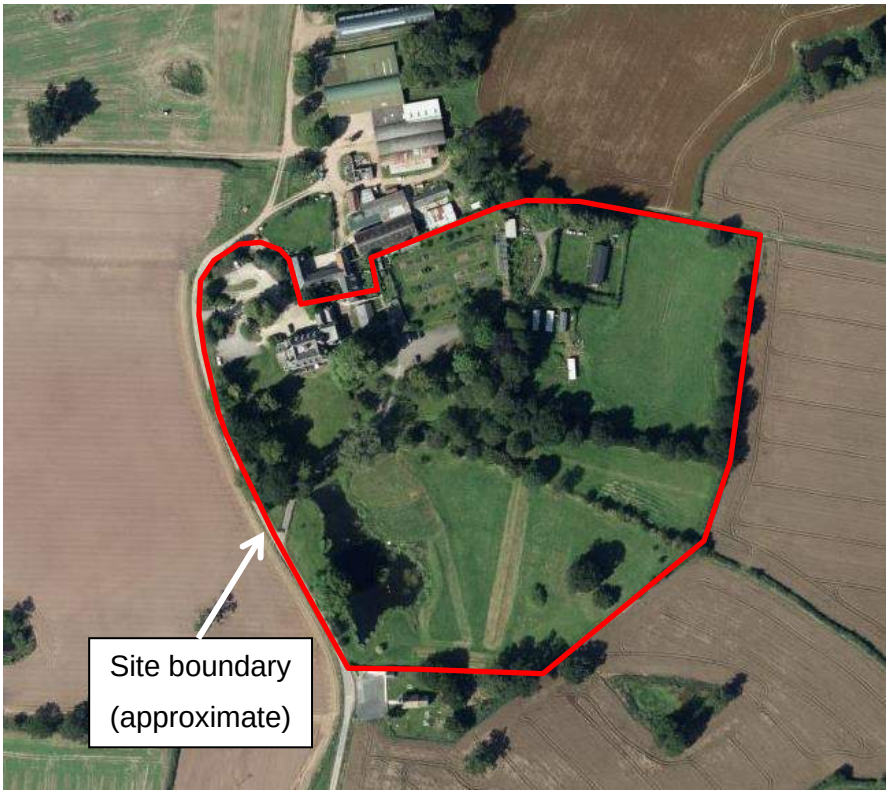


Figure 2-2 Site boundary



2.2 Hydrology

A pond is located within the boundary of the Site, at the south west corner. No surface watercourses are marked on OS mapping providing water to the pond, or discharging from the pond.

Ponds are marked approximately 100m to the north west and north east of the Site. The closest surface watercourse is Ffrwd Brook, located approximately 350m south west of the Site at its closest point, and the brook confluences with the River Usk approximately 550m south of the Site.

2.3 Geology

The geology of the Site and surrounding area has been shown on Drawing 1a (superficial geology) and Drawing 1b (bedrock geology).

Artificial Deposits

No artificial geology is marked at the Site by the BGS.

Superficial Geology

Superficial geology comprises Till: diamicton deposited in glacial conditions within the Quaternary Period, within the last 2 million years.

Bedrock Geology

Bedrock geology comprises the Raglan Mudstone Formation: mudstone and siltstone deposited in a fluvial environment during the Silurian Perion, between 419 and 424 million years ago.

The Raglan Mudstone Formation is conformably underlain by the Downton Castle Sandstone Formation: a sandstone deposited in a shallow marine environment during the Silurian Period, between 419 and 424 million years ago.

The Raglan Mudstone Formation is described by the BGS as "*Red mudstones and silty mudstones with calcretes and sandstones*".

BGS mapping indicates that the bedrock in the vicinity of the Site dips towards the north east, with data points within 1km ranging between 12° to 55°.

Historic Borehole Records

The only historic borehole records held by the BGS in the close vicinity of the Site relate to the construction of the A40 dual carriageway, with the records tracing the current route.

A limited number of deeper boreholes unrelated to the A40 are located within the same bedrock geology, with approximately 5km of the Site; these have been used to gain a general understanding of local groundwater levels (if present).

The records are shown on Drawing 2 and have been summarised below:

<u>Record ID: SO30NE18</u>

- 200m south of the Site;
- Maximum depth: 13mBGL;
- Elevation: ~48mAOD;
- Topsoil to 0.6mBGL, firm red brown silty sandy CLAY with angular gravel cobbles and bounders [TILL] to 9.8mBGL, red and green clayey MUDSTONE [RAGLAN MUDSTONE FORMATION] to 13mBGL;
- Water strike at 9.8mBGL - interface between superficial deposits and bedrock.

Record ID: SO30NE79

- 250m south east of the Site;
- Maximum depth: 8.2mBGL;
- Elevation: ~42mAOD;
- Topsoil to 0.6mBGL, stiff red brown weathered marl with small to medium sandstone gravel [TILL] to 5.0mBGL, red brown MARL and MUDSTONE [RAGLAN MUDSTONE FORMATION] to 8.2mBGL;
- Water strike: 2.3m, 5.2m and 7.2mBGL.

Record ID: SO30NE99

- 2.5km south east of the Site;
- Maximum depth: 61mBGL;
- Elevation: ~55mAOD;
- Clay and silt [TILL] to 6.0mBGL, shales and limestone [RAGLAN MUDSTONE FORMATION] to 61mBGL;
- Resting water level: 2.74mBGL;
- Pumping rate: 4.32m^3/h for 24 hours, drawdown to 20.8mBGL not at steady state.

Site Investigation

A site investigation was undertaken by Ground Investigation Limited in November 2021 for geotechnical purposes. A total of 6 no. window sample boreholes (WS1 to WS6) were advanced across the proposed development area and the ground conditions logged.

The borehole logs are included in the site investigation report (Appendix A) and the ground conditions have been summarised below:

Topsoil

- Topsoil generally recorded to 0.2mBGL, comprising soft, brown, slightly sandy, slightly gravelly, clayey silt, with frequent roots.

Subsoil

- Subsoil recorded to 0.6m to 0.7mBGL, comprising firm, friable, clayey silt, with varying fractions of sand, gravel and frequent roots.

Made Ground

- Made Ground was only encountered in WS6 towards the rear of the accommodation outbuildings; associated with the formation of a relatively recent, slightly raised garden area.
- Made Ground recorded to 0.75mBGL, comprising reworked natural materials of clayey silt, with varying fractions of sand, gravel and roots, with some rare inclusions of brick, coal and gypsum.

Glacial Till

- Glacial Till recorded to the full depth of the investigation between 4.40m and 5.45mBGL, comprising dark orange/red-brown silty clay with varying fractions of mudstone, sandstone and quartzite, and contained some thin roots in the upper horizons.

2.4 Hydrogeology

Groundwater Source Protection Zones

National Resources Wales (NRW) data indicate that the Site is not located within a Source Protection Zone (SPZ). The closest SPZ is located approximately 7.3km west, around Blaenavon.

Groundwater Vulnerability Zone

The groundwater vulnerability of the superficial Till and Raglan Mudstone Formation bedrock at the Site has been listed below:

- Superficial geology: Medium Vulnerability - secondary aquifer
- Bedrock geology: Medium Vulnerability - secondary aquifer

Aquifer Designation

The aquifer designation of the superficial Till and Raglan Mudstone Formation bedrock at the Site has been listed below:

- Superficial geology: Secondary Undifferentiated Aquifer
- Bedrock geology: Secondary A Aquifer

Groundwater

Superficial Geology

The Ground Investigation Limited site investigation (Appendix A) undertaken in November 2021 included observations of groundwater in the superficial Till deposits, as summarised below:

- At the southern part of the investigatory area (WS1 to WS4) damp soils were encountered at depths ranging between 1.3m and 1.5mBGL; wet soils were then noted at around 2-3 mBGL.

Bedrock Geology

The BGS hydrogeology map (1986) for the Site indicates the presence of Till, and confirms that the main hydrogeological significance of these superficial deposits is to limit recharge to, and confining water within, the underlying formations.

The hydrogeology map does not indicates groundwater resources within the Raglan Mudstone Formation (labelled on the BGS hydrogeology map as 'Raglan Marl Formation'), however it does describe the underlying Downton Castle Sandstone Formation as water-bearing, with springs at the base. The BGS confirm that "*Yields are low and large diameter wells are frequently constructed to increase the size of the seepage area. The water is very hard, with total hardness in excess of 450mg/l nearly all due to carbonates*".

The top of a hill is located approximately 200m north east of the Site (72mAOD), with superficial Till deposits widespread throughout this area, including at the hill. Recharge of any discreet water-bearing units within the Raglan Mudstone Formation or the underlying Downton Castle Sandstone Formation is considered to be very limited in the vicinity of the Site.

The Shoothill Guagemap resource has been used to identify any groundwater monitoring boreholes within the vicinity of the Site, or the wider region; none have been found.

Aquifer Properties

The properties of the superficial Till deposits have been described based on percolation and infiltration testing at the Site conducted by Gibbs Geotechnical Limited. The infiltration testing report has been attached at Appendix B and the percolation testing report has been attached at Appendix C.

Permeability

- Soakaway testing at 4 no. locations provided design infiltration rates of between $1.44x10^{-6}$m/s and $2.64x10^{-6}$m/s.
- Percolation testing at 6 no. locations provided average Vp rates of between 6.0s/mm and 142.8s/mm. The 3 no other average Vp rates which identified suitable ground for a treated foul effluent linear soakaway ranged between 36.6s/mm and 63.6s/mm.

2.5 Licensed Abstractions

The closest licensed groundwater abstractions to the Site are a pair located approximately 2.2km north east to the north east of the Site, at Llanarth Court Hospital.

The abstractions are shown on Drawing 2 and have been summarised:

License number: 20/56/31/0143

- License holder: Partnerships in Care Ltd, Llanarth Court Hospital
- Purpose: Drinking, Cooking, Sanitary Washing (small garden) - Commercial / Industrial / Public Services - Medium
- Max. annual abstraction: 19,000m^3
- Max. hourly abstraction: 3m^3
- Approximate elevation: 37mAOD

License number: 20/56/31/0143

- License holder: Partnerships in Care Ltd, Llanarth Court Hospital
- Purpose: Drinking, Cooking, Sanitary Washing (small garden) - Commercial / Industrial / Public Services - Medium
- Max. annual abstraction: 19,000m^3
- Max. hourly abstraction: 5m^3
- Approximate elevation: 39mAOD

2.6 Current/Proposed Current Foul Water Discharge

It is understood that foul water at the Site is currently treated in a PTP; a Klargester Biodisc 9 (equivalent of current BL model). The effluent is then conveyed to the south of the Site in a pipe below the access lane, and discharged into Ffrwd Brook approximately 400m south of the Site. Ffrwd Brook discharges into the River Usk approximately 550m south of the Site.

The proposed new foul treatment, comprising a new PTP and a shallow linear soakaway, represents significant betterment over the existing system. It should be noted that, unlike the current system, there will be no direct connection between the proposed sewage treatment system and any surface water features in the vicinity of the Site, such as Ffrwd Brook and the River Usk.

The proposed layout of the effluent treatment components, including the linear soakaway, have been shown in the site plan attached at Appendix D.

3 Groundwater Risk Assessment

3.1 Introduction

The proposals for the drainage scheme include discharging treated effluent to ground via a shallow linear soakaway.

The EA H1 annex J5: Infiltration Worksheet has been used to assess the risk posed by discharging treated sewage effluent to the superficial and bedrock geology below the Site. The following sections of this report summarise the input values used in modelling and present the results.

Contaminant modelling has been based on ammoniacal nitrogen and phosphate. The results of modelling have been compared with the UK Drinking Water Standard (UK DWS) for ammoniacal nitrogen and the NRW River Usk SAC target for phosphate, in order to determine if the effluent discharge poses a risk to the aquifer and any other groundwater dependent receptors.

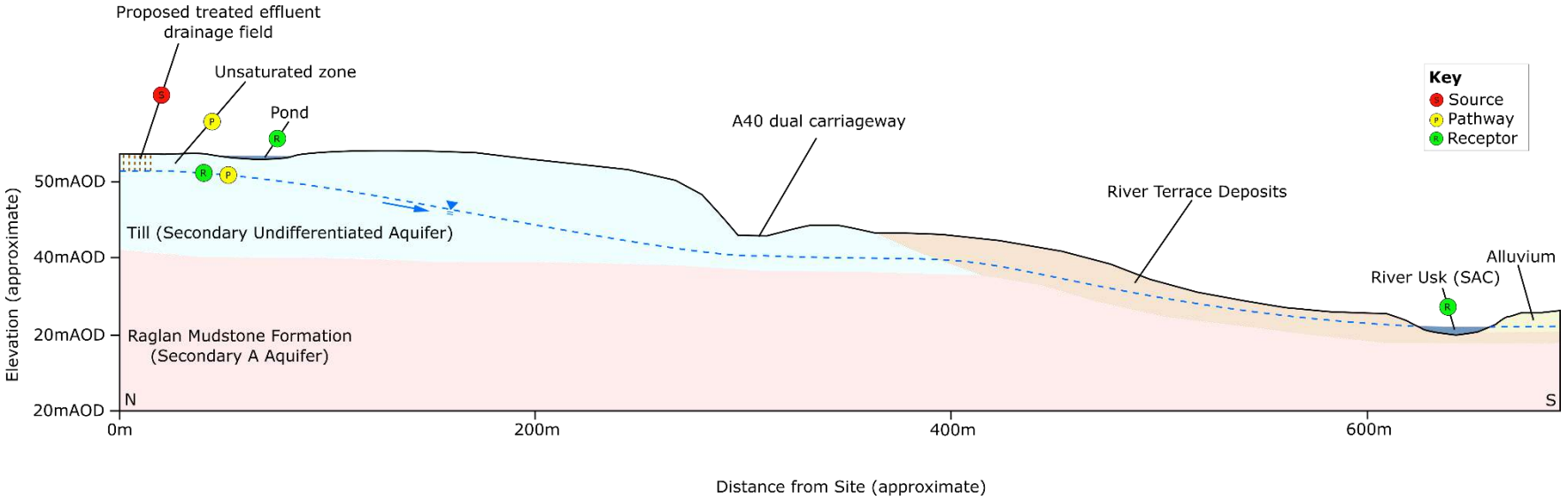
The literature data sources used for modelling are listed below:

- EA – Annex J5: Effluent discharge to groundwater user manual v2.0 (2014);
- BGS historic borehole data (online resource);
- Site-specific testing data/reports provided by the Client;
- ConSim user help files;
- Robertson, W. D., Van Stempvoort, D, R. and Schiff, S. L. (2019). *Review of phosphorus attenuation in groundwater plumes from 24 septic systems*. Science of the total Environment, 662. pp 640-652.

3.2 Site Conceptual Model

A site conceptual model has been developed based on available site investigation and published data. The model has been shown in Figure 3-1.

Figure 3-1 Site conceptual model



3.3 Source Term

The contaminants ammonia (as ammoniacal nitrogen) and phosphate have been used in modelling. The Environmental Assessment Level (EAL) for ammoniacal nitrogen has been set as the UK DWS 0.5mg/l, and the EAL for phosphate has been set as the NRW River Usk SAC target of 0.05mg/l.

The concentration of ammonium in the treated sewage effluent source term has been set at 2mg/l. The concentration of phosphate in the treated sewage effluent has been set at 6mg/l.

A maximum total foul water discharge volume of 20m^3/day is expected for the Site, based on a water consumption of 303 litres/person/day.

The proposals at the Site include untreated sewage effluent passing through a PTP and then being discharged to ground at a shallow linear soakaway. The linear soakaway has been sized by KPA Consulting based on an infiltration rate of 1.44 x 10^{-6} m/s.

3.4 Pathway

The unsaturated zone has been described within the Till superficial deposits, based on the depth to 'wet' soil recorded during the Ground Investigation Limited site investigation (Appendix A).

The saturated zone pathway has also been described within the Till superficial deposits, over a distance of 600m down hydraulic gradient from the linear soakaway towards the River Usk.

3.5 Receptors

Compliance Point

A nominal 50m compliance point has been set for ammonia. The 50m compliance point falls within the boundary of the Site.

Surface Water Receptors

A pond is located within the boundary of the Site, approximately 80m down hydraulic gradient of the linear soakaway. The pond is considered to be ornamental, with no significant/permanent inflows or outflows. It is understood that no water is abstracted from the pond for human consumption, and as such the pond is considered to be a low-risk surface water receptor.

The main modelled surface water receptor is the River Usk. The river is designated as a Special Area of Conservation and is located approximately 600m south of the linear soakaway. Based on all available hydrological, hydrogeological, site-specific and local ground investigation data, it is considered that groundwater within the Till superficial deposits will ultimately provide baseflow to the River Usk.

Groundwater Receptors

The superficial Till deposits are designated as a Secondary Undifferentiated Aquifer, and the bedrock Raglan Mudstone Formation is designated as a Secondary A Aquifer.

Based on historic borehole records (Section 2.3) and BGS geological data groundwater within the Till is likely to have limited connectivity to groundwater present in discreet sandy layers at depth within the Raglan Mudstone Formation.

There are no records of licensed groundwater abstractions down hydraulic gradient of the Site, from either the bedrock or the superficial deposits; as such the aquifers are considered to be low-risk groundwater receptors.

The receptors have been shown on the conceptual site model in Figure 3-1.

3.6 Modelling - Ammonia

Infiltration System

The worksheet input values used for the infiltration system have been listed in Table 3-1.

Table 3-1 Infiltration system input values

Input parameter	Input value	Source	Comment
Concentration of ammoniacal nitrogen	2mg/l	PTP manufacturer specifications	Value supplied by manufacturer
Number of persons	201	Loading calculations	Value supplied by Client
Water use	303 litres / person / day	Loading calculations	Value supplied by Client
Area of Drainage (m^2)	297	Site Plan	Design provided by Client
Discharge rate (m^3/day)	20	Loading calculations	Value supplied by Client

Attenuation in Unsaturated Zone

The input values used for attenuation in the unsaturated zone have been listed in Table 3-2.

Table 3-2 Unsaturated zone input values

Input parameter	Input value	Source	Comment
Drainage layer			
Thickness of drainage layer	0.4m	KPA	Value taken from drawing
Water-filled porosity	0.25 (fraction)	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Bulk density	1.75g/cm^3	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Half life	548 days	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value - between 1 to 2 years
Soil-water partition coefficient (Kd)	2.0l/kg	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Unsaturated zone			
Unsaturated zone thickness	1.0m	Site Investigation Report - Ground Investigation Limited, 18/11/2021. Field Drainage Details 2-2 drawing. Ref: DR007, T02, Dec 2021	Trial pit excavated had standing water at 1.5m below ground level (January 2022)
Water-filled porosity	0.25 (fraction)	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Bulk density	1.75g/cm^3	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Half life	1278 days	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value - between 2 to 5 years
Rapid flow	0 (fraction)	n/a	Assumed no rapid flow through unsaturated zone
Soil-water partition coefficient (Kd)	2.0l/kg	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value

Dilution

The input values used for dilution have been listed in Table 3-3.

Table 3-3 Dilution input values

Input parameter	Input value	Source	Comment
Length of linear soakaway in direction of groundwater flow	4.5m	Site layout plan	Measured distance (field is not uniform shape)
Saturated aquifer thickness	7.8	Site Investigation Report - Ground Investigation Limited, 18/11/2021. BGS historic borehole record ID: SO30NE18	Distance between wet soil in SI (2mBGL) and bedrock depth in historic borehole SO30NE18 (9.8mBGL)
Hydraulic conductivity	0.18m/day	Site investigation calculations	Value supplied by Client ($2.08x10^{-6}$m/s)
Hydraulic gradient	0.04 (fraction)	OS mapping	Surface elevation difference between linear soakaway and River Usk: 24m over 600m distance
Width of linear soakaway perpendicular to groundwater flow	66m	Site layout plan	Measured distance (field is not uniform shape)
Background concentration	0.0mg/l	n/a	Assume zero background concentration of ammonia

Attenuation in Saturated Zone

The input values used for dilution have been listed in Table 3-4.

Table 3-4 Attenuation in saturated zone

Input parameter	Input value	Source	Comment
Half life	1,850 days	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value - 5 years.
Bulk density	1.75g/cm^3	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value.
Effective porosity	0.25 (fraction)	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value.
Distance to compliance point	50m	OS mapping	50m compliance point

3.7 Modelling - Phosphate

Infiltration System

The worksheet input values used for the infiltration system have been listed in Table 3-1.

Table 3-5 Infiltration system input values

Input parameter	Input value	Source	Comment
Concentration of phosphate	6mg/l	PTP manufacturer	Value estimated by manufacturer
Number of persons	201	Loading calculations	Value supplied by Client
Water use	303 litres / person / day	Loading calculations	Value supplied by Client
Area of Drainage (m^2)	297	Site Plan	Design provided by Client
Discharge rate (m^3/day)	20	Loading calculations	Value supplied by Client

Attenuation in Unsaturated Zone

The input values used for attenuation in the unsaturated zone have been listed in Table 3-2.

Table 3-6 Unsaturated zone input values

Input parameter	Input value	Source	Comment
Drainage layer			
Thickness of drainage layer	0.4m	KPA	Value taken from drawing
Water-filled porosity	0.25 (fraction)	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Bulk density	1.75g/cm^3	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Half life	$1x10^{99}$	n/a	Very high value set - no degradation
Soil-water partition coefficient (Kd)	8.7l/kg	ConSim user help files	Suggested value
Unsaturated zone			

Input parameter	Input value	Source	Comment
Unsaturated zone thickness	1.0m	Site Investigation Report - Ground Investigation Limited, 18/11/2021. Field Drainage Details 2-2 drawing. Ref: DR007, T02, Dec 2021	Trial pit excavated had standing water at 1.5m below ground level (January 2022)
Water-filled porosity	0.25 (fraction)	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Bulk density	1.75g/cm^3	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value
Half life	1x10^{99}	n/a	Very high value set - no degradation
Rapid flow	0 (fraction)	n/a	Assumed no rapid flow through unsaturated zone
Soil-water partition coefficient (Kd)	8.7l/kg	ConSim user help files	Suggested value for Phosphate in Boulder Clay

Dilution

The input values used for dilution have been listed in Table 3-3.

Table 3-7 Dilution input values

Input parameter	Input value	Source	Comment
Length of linear soakaway in direction of groundwater flow	4.5m	Site layout plan	Measured distance (field is not uniform shape)
Saturated aquifer thickness	7.8	Site Investigation Report - Ground Investigation Limited, 18/11/2021. BGS historic borehole record ID: SO30NE18	Distance between wet soil in SI (2mBGL) and bedrock depth in historic borehole SO30NE18 (9.8mBGL)
Hydraulic conductivity	0.18m/day	Site investigation calculations	Value supplied by Client (2.08x10^{-6}m/s)
Hydraulic gradient	0.04 (fraction)	OS mapping	Surface elevation difference between linear soakaway and River Usk: 24m over 600m distance
Width of linear soakaway	66m	Site layout plan	Measured distance (field is not uniform shape)

Input parameter	Input value	Source	Comment
perpendicular to groundwater flow			
Background concentration	0.0mg/l	n/a	Assume zero background concentration of phosphate

Attenuation in Saturated Zone

The input values used for dilution have been listed in Table 3-4.

Table 3-8 Attenuation in saturated zone

Input parameter	Input value	Source	Comment
Half life	$1x10^{99}$	n/a	Very high value set - no degradation
Bulk density	$1.75g/cm^3$	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value.
Effective porosity	0.25 (fraction)	Effluent discharge user manual (H1 Annex J5: Appendix A)	Suggested value.
Distance to compliance point	600m	OS mapping	Location of River Usk at closest point down hydraulic gradient of Site

3.8 Results

Ammonia Modelling Results

The results for the ammonia model have been attached at Appendix F and are presented in Table 3-9.

- The concentration of ammoniacal nitrogen at the base of the unsaturated zone below the treated effluent linear soakaway is predicted to exceed the UK DWS.
- The concentration of ammoniacal nitrogen is predicted to fall below the UK DWS at the 50m compliance point.
- The concentration of ammoniacal nitrogen is predicted to fall below the UK DWS at the River Usk receptor, 600m south of the Site.

Table 3-9 Ammonia model results - with degradation

Model parameter	Predicted concentration (mg/l)
Concentration at base of unsaturated zone	1.89

Model parameter	Predicted concentration (mg/l)
Concentration at 50m compliance point	0.389
Concentration at 600m receptor (River Usk)	2.18×10^{-7}

Phosphate Modelling Results

The results for the phosphate model have been attached at Appendix G and are presented in Table 3-10.

The modelling of phosphate primarily relates to the River Usk SAC, therefore the results will focus on this receptor. The phosphate EAL is set at 0.05mg/l.

- The concentration of phosphate is predicted to exceed the EAL at the 50m compliance point. There are no records of licensed groundwater abstractions within 2km of the Site.
- The concentration of phosphate is predicted to exceed the EAL at the River Usk receptor, 600m south of the Site.

Table 3-10 Phosphate model results - with degradation

Model parameter	Predicted concentration (mg/l)
Concentration at 50m compliance point	5.06
Concentration at 600m receptor (River Usk)	1.78

Phosphate Results Discussion

The results for phosphate are considered to be highly conservative; in reality it is expected that the majority of phosphate will be retained within the linear soakaway, the unsaturated zone, and the immediate saturated zone.

Evidence for this assumption can be found in a recent study of phosphorus attenuation at 24 no. septic systems over a 30 year period (Robertson *et al,* 2019)[1]. The study reports an average 90% retention of phosphorus concentration in the drainage fields for non-calcareous sediment. When taking into account the unsaturated and saturated zones, the reduction of phosphorus was found to average 97% at a 10m distance down hydraulic gradient under the same soil conditions. The groundwater depths for the 24 no. septic

[1] Robertson, W. D., Van Stempvoort, D, R. and Schiff, S. L. (2019). Review of phosphorus attenuation in groundwater plumes from 24 septic systems. Science of the total Environment, 662. pp 640-652.

systems studied ranged between 1m and 5mBGL, with an average of 1.9mBGL. These groundwater depths are in line with those recorded at the Site.

The authors of the study conclude that "*To successfully predict septic system P*[hosphorus] *loading at the watershed scale, models need to also include the important effect of P retention in the drainfields and not just focus on sorption*". This implies that the concentration of phosphorus within the saturated zone >10m down hydraulic gradient of the linear soakaway at the Site is likely to be significantly reduced.

Taking the 97% reduction figure recorded in the study and based on a concentration of 6mg/l following treatment in the PTP proposed at the Site (Table 3-5), the phosphorus concentration in the groundwater 10m down hydraulic gradient of the linear soakaway might be in the order of 0.18mg/l.

It is important to take into account the predicted travel time to the River Usk receptor in the phosphate modelling results (Table 3-10). The model predicts a rate of contaminant flow due to retardation of $6.3x10^{-3}$m/d. This equates to approximately 260 years for the phosphate in the discharge to reach the edge of the River Usk. Currently the treated foul effluent at the Site is conveyed from the existing PTP via sub-surface pipes into Ffrwd Brook, which itself flows into the River Usk a short distance further downstream. The travel time to the River Usk for the treated foul effluent in the current scenario at the Site is expected to range between minutes and hours.

The proposed upgrades to the treated foul effluent at the Site therefore represent significant betterment in terms of nutrient discharges, specifically phosphate, to the River Usk SAC.

3.9 Sensitivity Analysis

Further modelling for ammonia has been undertaken on a conservative basis in order to form a sensitivity analysis; with the half-life set an order of magnitude higher in the unsaturated and saturated zones to significantly reduce degradation. The model remaining model inputs are the same as for Table 3-1 to Table 3-4.

No sensitivity analysis has been undertaken for phosphate because the model has been set up assuming no (negligible) degradation, with a half-life of $1x10^{99}$.

Ammonia Sensitivity Analysis Results

The ammonia sensitivity analysis model results have been attached at Appendix H and have been shown in Table 3-11.

- The concentration of ammoniacal nitrogen at the base of the unsaturated zone below the treated effluent linear soakaway is predicted to exceed the UK DWS.
- The concentration of ammoniacal nitrogen at the 50m compliance point is predicted to exceed the UK DWS.
- The concentration of ammoniacal nitrogen at the 600m (River Usk) receptor is predicted to fall below the UK DWS.

Table 3-11 Ammonia model results - without degradation

Model parameter	Predicted concentration (mg/l)
Concentration at base of unsaturated zone	0.94
Concentration at 50m compliance point	1.41
Concentration at 600m receptor (River Usk)	0.097

4 Summary and Conclusions

4.1 Summary

Hydrogeo Limited (Hydrogeo) has been commissioned by Snaco UK Limited (the Client) to undertake a Hydrogeological Risk Assessment for a proposed upgrade to a treated effluent discharge to at Llansantffraed Court Hotel, Llanvihangel Gobion, near Abergavenny, NP7 9BA.

The objective of the report is to assess the risk posed to environmental and human receptors from the new discharge of treated foul effluent, taking into account the significant betterment afforded to the environment by discharging to ground rather than a surface water feature, as is currently the case.

Site data and modelling input values have been sourced from literature and available online resources, and from reporting supplied by the Client.

4.2 Groundwater Risk Assessment

The Environment Agency Infiltration Worksheet v2.0 (2014) has been used to predict the concentration of ammonia as ammoniacal nitrogen and phosphate in the groundwater at a 50m compliance point, and a 600m receptor representing baseflow to the River Usk SAC to the south of the Site.

The closest licensed groundwater abstractions to the Site are a pair located approximately 2.2km north east to the north east of the Site, at Llanarth Court Hospital. These are located up hydraulic gradient from the Site. No records of licensed groundwater abstractions have been identified down hydraulic gradient of the Site towards the River Usk.

For ammonia, the UK Drinking Water Standard for ammoniacal nitrogen (0.5mg/l) has been used in modelling. For phosphate, the NRW River Usk SAC target of 0.05mg/l has been used.

Ammonia

- The model predicts that the concentration of ammoniacal nitrogen at the 50m compliance point will be 0.39mg/l; falling below the UK DWS.
- The model predicts that the concentration of ammoniacal nitrogen at the 600m down hydraulic gradient receptor (River Usk) will be 2.18 x 10^{-7}mg/l; falling below the UK DWS.

Phosphate

- The model predicts that the concentration of phosphate at the 50m compliance point will be 5.06mg/l; exceeding the EAL.
- The model predicts that the concentration of phosphate at the 600m down hydraulic gradient receptor (River Usk) will be 1.78mg/l; exceeding the EAL.

4.3 Sensitivity Analysis

Further modelling for ammoniacal nitrogen has been undertaken with increased degradation in both the unsaturated and saturated zones.

- Under this highly conservative scenario the model predicts that the concentration of ammoniacal nitrogen at the 50m compliance point will be 1.417mg/l; exceeding the UK DWS.
- Under this highly conservative scenario the model predicts that the concentration of ammoniacal nitrogen at the 600m down hydraulic gradient receptor (River Usk) will be 0.097mg/l; falling below the UK DWS.

4.4 Modelling conclusions

Foul water at the Site is currently treated in an existing package treatment plant (PTP). Water is then conveyed to the south of the Site in a pipe below an access lane, and discharged into a small surface watercourse, which itself discharges into the River Usk a short distance downstream.

The proposed upgrade to the foul water treatment comprises a new PTP and then discharges to ground via a shallow linear soakaway. This represents significant betterment over the existing system as there will be no direct connection to any surface water features in the vicinity of the Site.

- Modelling predicts that the concentration of ammoniacal nitrogen will fall below the UK DWS at a 50m compliance point.
- The model predicts that the concentration of phosphate will exceed the EAL at the River Usk receptor 600m down hydraulic gradient of the Site, with a travel time of approximately 260 years. It should be noted that this is a conservative scenario and recent studies indicate significant reduction (97%) in phosphorus concentration within the saturated zone within 10m of the linear soakaway, as described in Section 3.8.

There are no licensed groundwater abstractions within 2km down hydraulic gradient of the Site.

It is considered that the risk posed to human and groundwater receptors from the discharge of treated sewage effluent to ground at the Site is low. The proposal would provide significant betterment to the treated effluent water quality discharging from the site to the River Usk SAC.

Drawings

Drawing 1a

Geology map - superficial geology

HYDROGEO
Groundwater and Environment

HYG1013 Llansantffraed Court Hotel

DRAWING 1a

Geological Map - Superficial Geology

KEY

Site boundary

Superficial Geology

- Alluvium
  Clay, silt, sand and gravel
- River Terrace Deposits 1
  Sand and gravel
- Alluvial Fan Deposits
  Sand and gravel
- Glaciofluvial Sheet Deposits
  Sand and gravel
- Till
  Diamicton

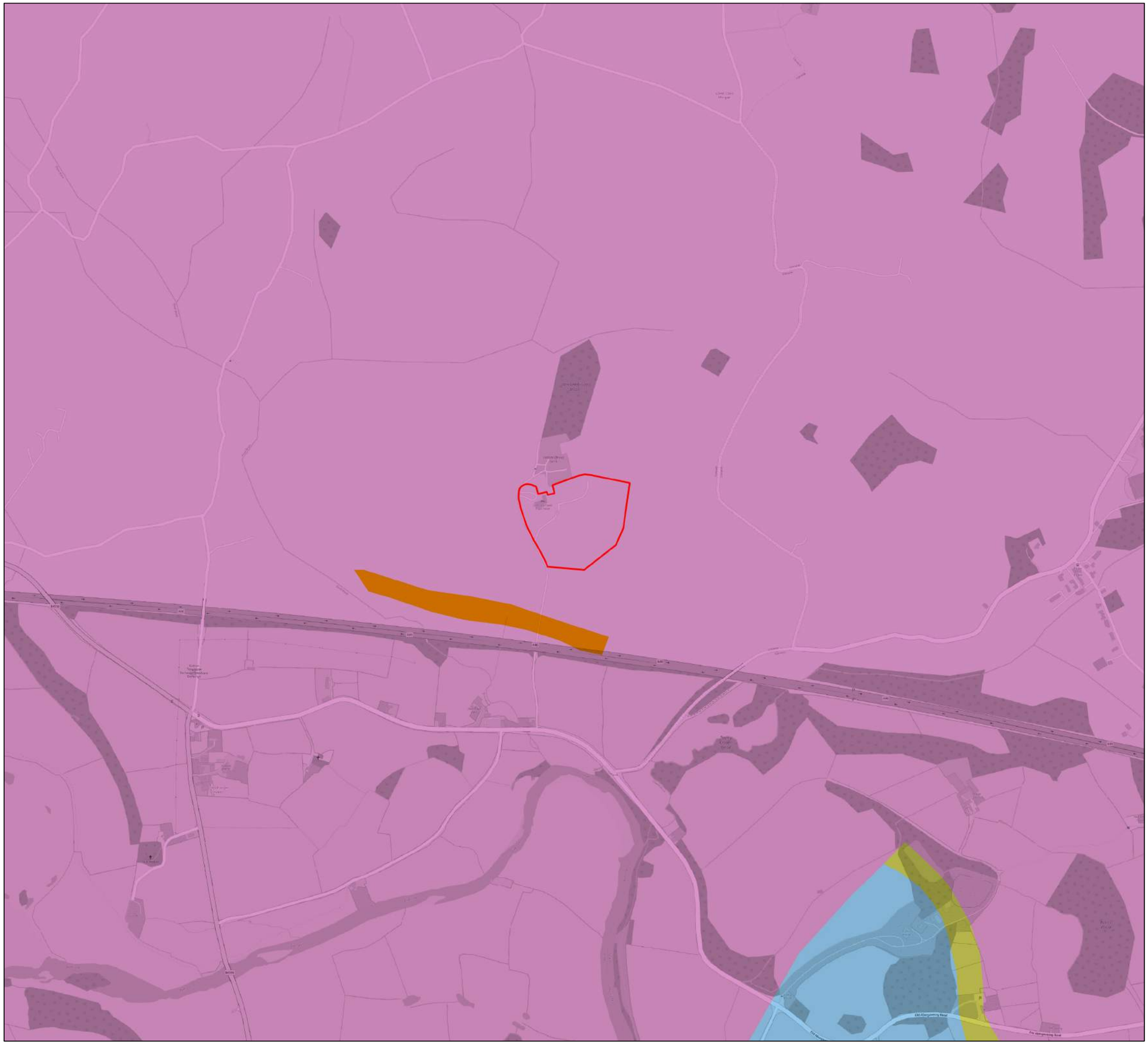
100 0 100 200 300 400 m

N

Date	By	Paper	Scale	Rev
01 2022	TP	A3	1:10,000	1

Drawing 1b

Geology map - bedrock geology



HYDROGEO
Groundwater and Environment

HYG1013 Llansantffraed Court Hotel

DRAWING 1b

Geological Map - Bedrock Geology

KEY

Site boundary

Bedrock Geology

- Raglan Mudstone Formation Siltstone and mudstone
- Raglan Mudstone Formation Sandstone
- Downton Castle Sandstone Formation Sandstone
- Upper Llanbadoc Beds And Llangibby Beds Calcareous mudstone

100 0 100 200 300 400 m

N

Date	By	Paper	Scale	Rev
01 2022	TP	A3	1:10,000	1

Drawing 2

Hydrogeological features map

HYDROGEO
Groundwater and Environment

HYG1013 Llansantffraed Court Hotel

DRAWING 2

Hydrogeological features

KEY

- Site boundary
- BGS historic borehole record
- Licensed groundwater abstraction

250 0 250 500 750 m

N

Date	By	Paper	Scale	Rev
01 2022	TP	A3	1:20,000	1

Appendices

Appendix A

Site Investigation Report - Ground Investigation Limited, November 2021

Ground Investigation
Unit 3 Westfield Court, Barns Ground, Kenn, Clevedon, Bristol, BS21 6FQ
Email: southwest@ground-investigation.com
Tel: 01275 876903

Our Ref.P1581.1.Letter 18th November 2021

kPa Consulting Engineers Limited
Henbury Cottage
Southgate Road
Southgate
SA3 2BT

For the attention of Mr. Kevin Painter

Dear Kevin,

PROPOSED WEDDING VENUE DEVELOPMENT – SANT FFRAED HOUSE, ABERGAVENNY

1. Introduction and Terms of Reference

Ground Investigation Limited has been commissioned by kPa Consulting Engineers Limited, on behalf of the Client, SNACO UK Limited, to carry out a basic ground investigation in connection with the proposed development of a new wedding venue at their recently acquired country house hotel and restaurant, known as Sant Ffraed House in Abergavenny.

The main aim of the investigation has been to provide information to aid in the design of the foundations and ground floor slabs for the development.

2. Site Location and Development Proposals

Sant Ffraed House is located some 10 km to the south-east of Abergavenny, and just to the north of the A40 in Llanvihangel Gobion, at postcode NP7 9BA, and approximate NGR of 335720, 210180.

Sanyt Ffraed House is a large country house set in landscaped grounds, formerly used as a hotel and restaurant. Fundamentally, the main country house overlooks a large lawned area and a lake to the south, with numerous outbuildings, car parking, managed gardens and wooded areas to the north and east. The outbuildings include accommodation, storage, agricultural buildings, greenhouses and sheds, for example.

As part of the change of use from a hotel and restaurant to a wedding venue, we understand that a new contemporary, glazed building is proposed to the south-east of the main country house, within a wooded area overlooking the lake. A smaller accommodation building is proposed just to the east of the existing accommodation buildings, themselves just to the east of the main country house.

We also understand that a new car parking area, possibly including domestic scale garages, is proposed in the existing car parking area to the east of the main country house.

A site plan showing the proposed layout of the development in relation to the existing topography is presented as the base to Figure 1.

3. Geology

An examination of published British Geological Survey (BGS) mapping in the public domain, indicates that an appreciable thickness of Glacial Till is expected to mantle the underlying Raglan Mudstone Formation.

The Glacial Till is expected to comprise a mixture of clay, silt, sand and gravel, with nearby historic borehole records suggesting thicknesses in the order of around 10 m.

The deeper underlying Raglan Mudstone Formation would be expected to comprise red and green clays and mudstones, grading to more competent mudstone with depth.

4. Fieldworks

The fieldworks were undertaken on 4th November 2021, and comprised the sinking of six window sampler boreholes at positions agreed with the Engineer.

A rubber tracked heavy duty Archway Dart rig was used to form the dynamic sampling boreholes, which were intended to provide a detailed record of the near surface subsoils. Lined steel core barrels of 1 m length were percussively driven into the ground, enabling the extraction of virtually continuous disturbed 'core' samples of the subsoil within polythene liners. Sub-samples were collected from the liners, sealed in polythene tubs and amber glass jars, as appropriate, and returned to the laboratory for analysis.

Boring commenced initially at approximately 100 mm diameter, reducing progressively with depth to approximately 65 mm. Standard penetration tests (SPTs) were carried out at 1 m intervals, the results of which are included on the individual borehole records.

As the drilling progressed, details of the strata succession were recorded, together with observations concerning the incidence and behaviour of groundwater ingress and any obvious visual or olfactory evidence of soil or groundwater contamination.

Upon completion, the boreholes were backfilled with arisings and topped up with imported gravel as necessary.

The engineering records of the continuous percussion boreholes are presented in Enclosure A.

5. Geotechnical Testing

Geotechnical classification tests were undertaken on a selection of recovered soil samples. These test included Atterberg limits and natural moisture content, the results of which are presented in Enclosure B.

6. Encountered Ground Conditions

The exploratory holes have established that within the depth of investigation the site is underlain by the following general sequence of strata (from ground level down):

(i) Topsoil;
(ii) Subsoil;

(iii) Made Ground (localised); and
(iv) Glacial Till.

The general characteristics of the encountered strata, as inferred from field observations are discussed below.

Topsoil

A vegetated surface was typically present over a thin horizon of Topsoil, generally extending to around 0.2 m depth. This predominantly comprised soft, brown, slightly sandy, slightly gravelly, clayey silt, with frequent roots.

Subsoil

Beneath the Topsoil, an initial subsoil horizon was encountered, comprising firm, friable, clayey silt, with varying fractions of sand, gravel and frequent roots. This extended to between around 0.6 and 0.7 m depth at the selected positions and generally appeared visibly 'desiccated'.

Made Ground

Made Ground was only encountered in one of the boreholes (WS6) located towards the rear of the accommodation outbuildings, this being associated with the formation of a relatively recent, slightly raised garden area. The Made Ground extended to 0.75 m depth at this position and comprised reworked natural materials of clayey silt, with varying fractions of sand, gravel and roots, albeit with some rare inclusions of brick, coal and gypsum.

Glacial Till

Beneath the surface materials, Glacial Till extended to the full depth of the investigation at between around 4.40 and 5.45 m. Fundamentally, the Glacial Till comprised dark orange/red-brown silty clay with varying fractions of mudstone, sandstone and quartzite, and contained some thin roots in the upper horizons.

In general, an increase in strength of the glacial soils was noted with increasing depth. However, some softening tended to occur with the onset of groundwater. In this regard, N-values recorded from SPTs undertaken within these deposits were relatively low and variable at 1 m and 2 m depths. At 1 m depth for example, the N-values ranged between 5 and 12, and at 2 m depth between 7 and 20, albeit modally 7. From 3 m depth the N-values range between 11 and 34, indicating generally firmer materials from this level, increasing further at 4 m depth to between 20 and >50, and at 5 m depth to between 29 and >50.

Estimations of apparent cohesion undertaken using a calibrated Pilcon hand vane at 1 and 2 m depth, returned values of between 30 and 78 kPa, broadly confirming the strength range indicated by the SPT N-values.

The results of the geotechnical classification tests indicate that the Glacial Till deposits range between low and intermediate plasticity, corresponding to a worst-case medium volume change potential, as defined by the NHBC.

Groundwater

At the lower end of the investigatory area (i.e. towards the south in WS1 to WS4), damp soils were encountered at depths ranging between 1.3 and 1.5 m, whilst wet soils were then noted at around 2-3 m depth. However, subsequent variations in groundwater and hydrological conditions could occur in response to future seasonal or climatic changes. It should be appreciated that the

cohesive subsoils will be susceptible to deterioration in association with groundwater seepages and that any significant groundwater inflows could impact on excavation stability.

7. Discussion and Conclusions

Based on the findings intrusive works described above, the following conclusions have been drawn in relation to the geotechnical aspects addressed by this investigation.

Traditional Foundations

The most significant factor influencing geotechnical conditions on this site is considered to be the potential influence of trees associated with the mature woodland setting of the proposed contemporary glazed structure (and possibly the garages), and the consequent requirement to mitigate the potential influence on construction. The relatively low and variable strength of the Glacial Till is also an important factor in considering the most appropriate foundation type and loading, however, coupled with the relatively shallow groundwater seepages observed.

In the above regard, based on the worst-case medium shrinkage potential established for the soils, the foundations would be expected to be at some 2.0 m depth for a mature moderate water demand tree (e.g. chestnut, sycamore, pine) within the footprint of the proposed building(s), in order to comply with the contemporary requirements of building regulations and warranty providers etc. However, should a high water demand tree, such as an oak or willow be present, then the foundations would need to extend below 2.5 m depth, and a specialist foundation solution could be required. Arboricultural advice may need to be sought in this regard.

At such depths, for traditional spread foundations, based on the minimum SPT N-values at 2 m depth of 7, a presumed bearing capacity of around 60 kN/m^2 could reasonably be assumed for traditional linear strip/trench fill foundations, or around 75 kN/m^2 for square pad foundations, acknowledging the inherent rigidity of the latter. However, at 3 m depth, given the minimum SPT N-value of 11, a presumed bearing capacity of around 95 kN/m^2 could reasonably be assumed for traditional linear strip/trench fill foundations, or 120 kN/m^2 for square pad foundations.

Presumed bearing values of these magnitudes may be sufficient for the proposed wedding venue building and would ordinarily be expected to ensure that total and differential settlements remain within normal acceptable limits (i.e. less than 25 mm). However, acknowledging the inherent variations in glacial soils, care will need to be taken to ensure that each individual foundation extends entirely into similar materials, to ensure that detrimental differential settlement does not occur. Subject to engineering advice, appropriate reinforcement should be provided in this regard in the case of the larger and more settlement sensitive structures, such as the proposed contemporary glazed structure.

Furthermore, at such depths, some form of groundwater control is likely to be required, particularly within excavations that are left open for any significant periods of time.

Notwithstanding the above, the new accommodation building just to the east of the main country house is located in an area where no mature trees or vegetation are in close proximity, such that a relatively traditional foundation solution will likely be suitable. Based on the data revealed by the borehole at this location (i.e. WS6), at 1.0 m depth, and given the SPT N-value of 10, a presumed bearing capacity of around 85 kN/m^2 could reasonably be assumed for traditional linear strip/trench fill foundations, and 110 kN/m^2 for square pad foundations.

All designs and site works should be assessed and supervised by a suitably qualified Geotechnical Engineer. It is recommended that all foundations and other substructures are designed to comply with NHBC guidelines.

Specialist Foundations

Within the wooded area, given the required depth for traditional spread foundations, an alternative solution could involve the use of a specialist system of piles / mini-piles or screw piles, in order to mitigate the risk of damage to nearby tree roots and limit the disturbance to the soils to a minimum. This would also minimise the required depth of excavation, eliminate the requirement for groundwater control, and reduce the volumes of concrete and excavation spoil.

Piled foundations, if utilised, should be designed by an experienced and competent specialist piling contractor who should select appropriate design parameters and guarantee safe working loads, together with maximum total and differential settlements, which should be within acceptable tolerances for the proposed structures. The design should reflect the potential influence of the surrounding trees, together with any recently removed trees/vegetation or proposed planting. In this regard, the near surface soils exhibit plastic characteristics and a worst-case medium shrinkage potential, such that anti-heave precautions would be required.

The piling contractors should satisfy themselves and confirm to the Client that the available site investigation data provides sufficient information upon which to base their design. Any requirement for further data should be identified and the information obtained prior to the pile design being finalised. The piling contractor should monitor the pile installations to ensure that the encountered ground conditions are as good as, or better than, assumed in the design. It should be appreciated in this context that the present investigation has been based on relatively shallow dynamic sampling techniques, such that further investigation could possibly be required to confirm pile design parameters.

All designs and site works should be assessed and supervised by a suitably qualified Geotechnical Engineer.

Ground Floor Slabs

Acknowledging the combination of mature woodland and worst-case medium plasticity soils, the use of suspended floor slabs would be considered the most secure solution.

I trust the enclosed information together with the above comments are sufficient for your purposes. If we can be of any further assistance, please do not hesitate to contact us.

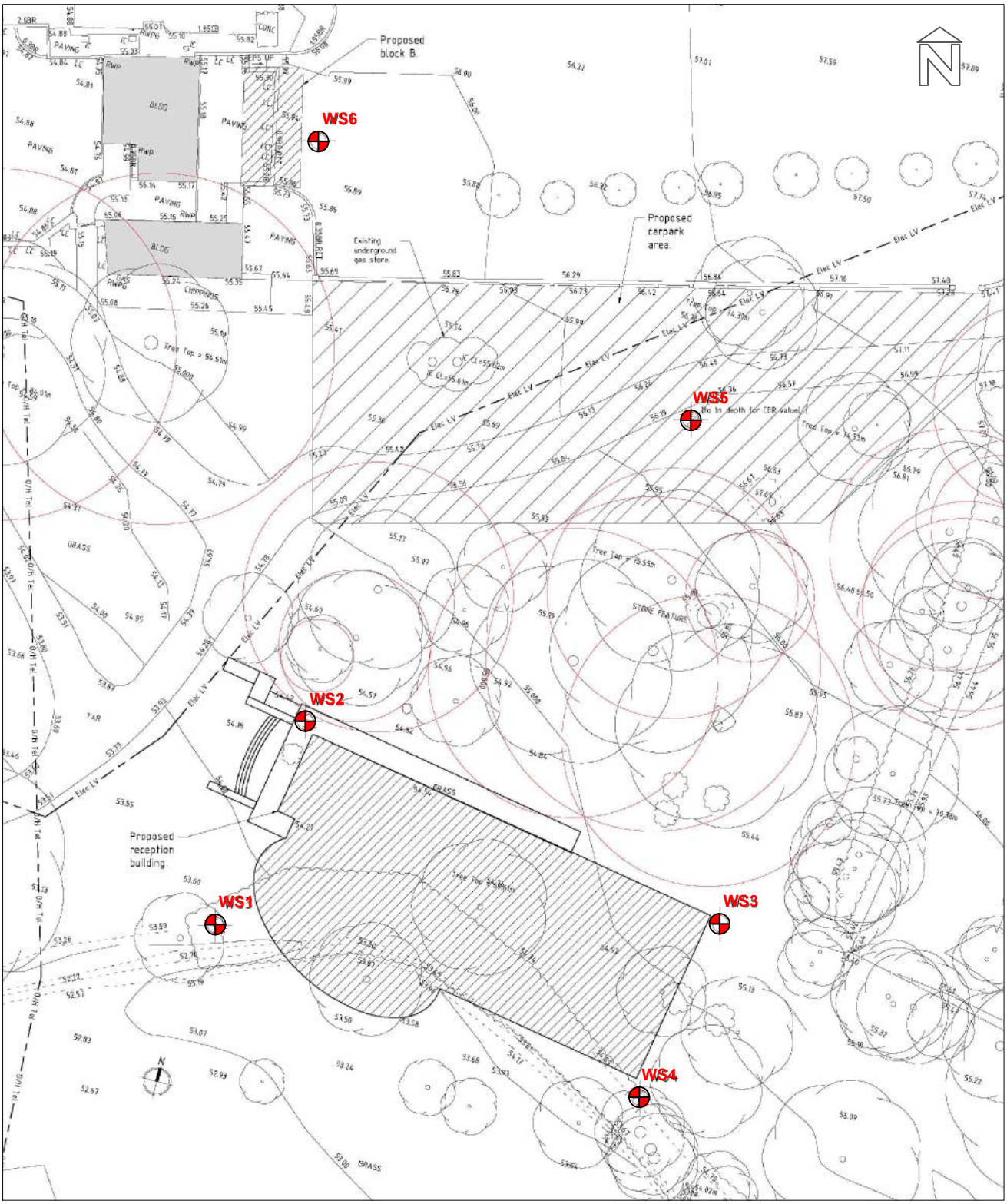
Yours sincerely,

Richard Colwill
CHARTERED GEOLOGIST
BSc (Hons), MRes, CGeol, FGS

Enc.

Figure 1 - Exploratory Hole Location Plan
Enclosure A – Borehole Records
Enclosure B – Geotechnical Test Results

FIGURES



KEY

Window Sampler Borehole

Ground Investigation

Unit 3, Westfield Court, Barns Ground, Kenn, Clevedon, Bristol. BS21 6FQ.
Tel: 01275 876903
Email: mail@ground-investigation.com

SITE: Sant Ffraed House, Abergavenny

CLIENT: SNACO Limited

PROJECT ID: P1581 **SCALE:** NTS

FILENAME: P1581.Fig1.dwg

FIGURE 1

Exploratory Hole Positions

ENCLOSURE A

Ground Investigation

Continuous Percussion Borehole Record

Hole ID
WS1
Sheet 1 of 1 (0.00m-6.00m)
All dimensions in metres
Scale 1:30

Site: Sant Ffraed House, Abergavenny
Client: SNACO UK Limited
Job No: P1581

Method/Plant Used: Archway Dart
Start date: 04/11/21 **End Date:** 04/11/21 **Logged By:** RC
Easting: **Northing:** **Elevation:**

SAMPLES & IN-SITU TESTS				STRATA			
Depth	Type / No	Result / Remark	Water	Legend	Depth (thick.)	Description	Backfill & Inst
0.20-0.60	D				0.20	Grass and moss on soft brown slightly sandy slightly gravelly clayey SILT with frequent thin roots and roots up to c. 10 mm diameter. **TOPSOIL**	
					(0.50)	Firm friable brown (desiccated) slightly sandy slightly gravelly clayey SILT with frequent roots to c. 5 mm diameter. **SUBSOIL**	
0.80-1.00	D				0.70	Soft to firm dark orange/red-brown slightly sandy slightly gravelly silty CLAY with rare thin roots. Gravel is fine mudstone, sandstone and quartzite. **GLACIAL TILL**	
1.00-1.45 1.00	S IVAN	N=8 (1,1:2,1,2,3) Peak=50kPa			(0.60)		
			1		1.30	Firm dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
2.00-2.45 2.00	S IVAN	N=20 (2,6:10,5,3,2) Peak=78kPa	2		(1.20)		
					2.50	Stiff dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
3.00-3.45	S	N=19 (1,3:3,4,6,6)			(2.00)		
4.00-4.45	S	N=24 (4,4:5,5,7,7)			4.50	Very stiff to hard dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
4.80-4.97	S	N>50 (25/60mm36,14/30mm)			(0.47)		
					4.97		

Boring Progress and Water Observations

Date	Time	Hole Depth	Casing Depth	Water Depth

Water Strikes

Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed
1.40	Damp soils			
2.00	Wet			

Hole Diameter

Depth	Diameter (mm)

Casing Diameter

Depth	Diameter (mm)

General Remarks:

1. Borehole location specified by the Client.
2. Descriptions of consistency and density are from field observations and results of SPTs.
3. Borehole backfilled with arisings upon completion and turf replaced at the surface.

Ground Investigation

Continuous Percussion Borehole Record

Hole ID
WS2
Sheet 1 of 1 (0.00m-6.00m)
All dimensions in metres
Scale 1:30

Site: Sant Ffraed House, Abergavenny
Client: SNACO UK Limited
Job No: P1581
Method/Plant Used: Archway Dart
Start date: 04/11/21 **End Date:** 04/11/21 **Logged By:** RC
Easting: **Northing:** **Elevation:**

SAMPLES & IN-SITU TESTS				Water	STRATA			Backfill & Inst
Depth	Type / No		Result / Remark		Legend	Depth (thick.)	Description	
						0.20	Grass and moss on soft brown slightly sandy slightly gravelly clayey SILT with frequent thin roots and roots up to c. 10 mm diameter. **TOPSOIL**	
						(0.50)	Firm friable brown (desiccated) slightly sandy slightly gravelly clayey SILT with frequent roots to c. 5 mm diameter. **SUBSOIL**	
						0.70		
1.00-1.45 1.00	S IVAN		N=5 (1,0:1,1,1,2) Peak=30kPa	1		(1.50)	Soft dark orange/red-brown slightly sandy slightly gravelly silty CLAY with rare thin roots. Gravel is fine mudstone, sandstone and quartzite. **GLACIAL TILL**	
1.80-2.00	D							
2.00-2.45 2.00	S IVAN		N=7 (2,2:1,2,2,2) Peak=52kPa			2.20		
						(1.00)	Soft to firm dark orange/red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine mudstone, sandstone and quartzite. **GLACIAL TILL**	
3.00-3.45	S		N=11 (1,2:1,3,3,4)	2		3.20		
						(0.50)	Firm dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
3.80-4.00	D					3.70		
4.00-4.45	S		N=27 (3,4:5,6,7,9)			(1.10)	Stiff dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
						4.80		
4.90-5.11	S		N>50 (21,4:27,23/75mm)			(0.31)	Very stiff to hard dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
						5.11		

Boring Progress and Water Observations

Date	Time	Hole Depth	Casing Depth	Water Depth

Water Strikes

Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed
1.50	Damp soils			
3.00	Wet			

Hole Diameter

Depth	Diameter (mm)

Casing Diameter

Depth	Diameter (mm)

General Remarks:

1. Borehole location specified by the Client.
2. Descriptions of consistency and density are from field observations and results of SPTs.
3. Borehole backfilled with arisings upon completion and turf replaced at the surface.

Ground Investigation

Continuous Percussion Borehole Record

Hole ID
WS3
Sheet 1 of 1 (0.00m-6.00m)
All dimensions in metres
Scale 1:30

Site: Sant Ffraed House, Abergavenny
Client: SNACO UK Limited
Job No: P1581
Method/Plant Used: Archway Dart
Start date: 04/11/21 **End Date:** 04/11/21 **Logged By:** RC
Easting: **Northing:** **Elevation:**

SAMPLES & IN-SITU TESTS				STRATA			
Depth	Type / No	Result / Remark	Water	Legend	Depth (thick.)	Description	Backfill & Inst
					0.20	Grass and moss on soft brown slightly sandy slightly gravelly clayey SILT with frequent thin roots and roots up to c. 10 mm diameter. **TOPSOIL**	
					(0.40)	Firm friable brown slightly sandy slightly gravelly clayey SILT with frequent roots to c. 5 mm diameter. **SUBSOIL**	
0.60-0.80	D				0.60	Firm dark red-brown slightly sandy slightly gravelly silty CLAY with rare thin roots. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
1.00-1.45 1.00	S IVAN	N=12 (1,1:3,3,4,2) Peak=72kPa			(0.90)		
1.30-1.50	D		1		1.50	Soft to firm dark orange/red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine mudstone, sandstone and quartzite. **GLACIAL TILL**	
2.00-2.45 2.00	S IVAN	N=7 (1,1:1,2,2,2) Peak=56kPa			(1.50)		
3.00-3.45	S	N=34 (4,3:6,6,6,16)			3.00	Stiff dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
4.00-4.40	S	N>50 (8,9:14,14,16,6/20mm)			(1.20)		
					4.20	Very stiff to hard dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
					4.40		

Boring Progress and Water Observations

Date	Time	Hole Depth	Casing Depth	Water Depth

Water Strikes

Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed
1.30	Damp soils			

Hole Diameter

Depth	Diameter (mm)

Casing Diameter

Depth	Diameter (mm)

General Remarks:
1. Borehole location specified by the Client.
2. Descriptions of consistency and density are from field observations and results of SPTs.
3. Borehole backfilled with arisings upon completion and turf replaced at the surface.

T | E | www.ground-investigation.com

Ground Investigation

Continuous Percussion Borehole Record

Hole ID
WS4
Sheet 1 of 1 (0.00m-6.00m)
All dimensions in metres
Scale 1:30

Site: Sant Ffraed House, Abergavenny
Client: SNACO UK Limited
Job No: P1581
Method/Plant Used: Archway Dart
Start date: 04/11/21 **End Date:** 04/11/21 **Logged By:** RC
Easting: **Northing:** **Elevation:**

SAMPLES & IN-SITU TESTS				Water	STRATA			Backfill & Inst
Depth	Type / No		Result / Remark		Legend	Depth (thick.)	Description	
						0.20	Grass and moss on soft brown slightly sandy slightly gravelly clayey SILT with frequent thin roots and roots up to c. 10 mm diameter. **TOPSOIL**	
0.40-0.60	D					(0.40)	Firm friable brown (desiccated) slightly sandy slightly gravelly clayey SILT with frequent roots to c. 5 mm diameter. **SUBSOIL**	
						0.60		
1.00-1.45 1.00	S IVAN		N=11 (1,1:1,2,4,4) Peak=62kPa			(0.80)	Firm dark red-brown slightly sandy slightly gravelly silty CLAY with rare thin roots. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
1.40-1.60	D					1.40		
2.00-2.45 2.00	S IVAN		N=7 (2,2:1,2,2,2) Peak=32kPa	1		(1.20)	Soft to firm dark orange/red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine mudstone, sandstone and quartzite. **GLACIAL TILL**	
						2.60		
3.00-3.45	S		N=17 (3,3:3,4,4,6)			(2.20)	Stiff dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
4.00-4.45	S		N=20 (4,4:4,5,5,6)			4.80		
5.00-5.45	S		N=29 (7,6:7,7,7,8)			(0.65)	Very stiff to hard dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
						5.45		

Boring Progress and Water Observations

Date	Time	Hole Depth	Casing Depth	Water Depth

Water Strikes

Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed
2.00	Wet soils			

Hole Diameter

Depth	Diameter (mm)

Casing Diameter

Depth	Diameter (mm)

General Remarks:

1. Borehole location specified by the Client.
2. Descriptions of consistency and density are from field observations and results of SPTs.
3. Borehole backfilled with arisings upon completion and turf replaced at the surface.

Ground Investigation

Continuous Percussion Borehole Record

Hole ID
WS5
Sheet 1 of 1 (0.00m-6.00m)
All dimensions in metres
Scale 1:30

Site: Sant Ffraed House, Abergavenny
Client: SNACO UK Limited
Job No: P1581
Method/Plant Used: Archway Dart
Start date: 04/11/21 **End Date:** 04/11/21 **Logged By:** RC
Easting: **Northing:** **Elevation:**

SAMPLES & IN-SITU TESTS				Water	STRATA			Backfill & Inst
Depth	Type / No		Result / Remark		Legend	Depth (thick.)	Description	
						0.20	Grass and moss on soft brown slightly sandy slightly gravelly clayey SILT with frequent thin roots and roots up to c. 10 mm diameter. **TOPSOIL**	
0.50-0.70	D					(0.50) 0.70	Firm friable brown (desiccated) slightly sandy slightly gravelly clayey SILT with frequent roots to c. 5 mm diameter. **SUBSOIL**	
1.00-1.45 1.00	S IVAN		N=7 (1,2:1,2,2,2) Peak=42kPa			(1.50)	Soft to firm dark orange/red-brown slightly sandy slightly gravelly silty CLAY with rare thin roots. Gravel is fine mudstone, sandstone and quartzite. **GLACIAL TILL**	
1.50-1.70	D					2.20		
2.00-2.45 2.00	S IVAN		N=8 (2,1:2,2,2,2) Peak=48kPa			(1.20)	Firm dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
3.00-3.45	S		N=33 (5,6:6,7,10,10)			3.40		
						(0.30) 3.70	Stiff dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
4.00-4.41	S		N>50 (6,7:13,13,15,9/30mm)			(0.71) 4.41	Very stiff to hard dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	

Boring Progress and Water Observations					Water Strikes					Hole Diameter		Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)

General Remarks:
1. Borehole location specified by the Client.
2. Descriptions of consistency and density are from field observations and results of SPTs.
3. Borehole backfilled with arisings upon completion and turf replaced at the surface.

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Ground Investigation

Continuous Percussion Borehole Record

Hole ID
WS6
Sheet 1 of 1 (0.00m-6.00m)
All dimensions in metres
Scale 1:30

Site: Sant Ffraed House, Abergavenny
Client: SNACO UK Limited
Job No: P1581
Method/Plant Used: Archway Dart
Start date: 04/11/21 **End Date:** 04/11/21 **Logged By:** RC
Easting: **Northing:** **Elevation:**

SAMPLES & IN-SITU TESTS				Water	STRATA			Backfill & Inst
Depth	Type / No		Result / Remark		Legend	Depth (thick.)	Description	
						0.10	Grass and moss on soft brown slightly sandy slightly gravelly clayey SILT with frequent thin roots and roots up to c. 10 mm diameter. **TOPSOIL**	
						(0.65)	Firm dark brown slightly sandy slightly gravelly silty CLAY with rare thin roots. Gravel is sandstone, mudstone, quartzite and rare brick, coal and gypsum. **MADE GROUND**	
						0.75		
1.00-1.45 1.00	S IVAN		N=10 (1,6:4,2,2,2) Peak=52kPa				Firm dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
1.20-1.50	D					(1.95)		
2.00-2.45 2.00	S IVAN		N=11 (2,4:2,3,3,3) Peak=62kPa					
2.20-2.50	D					2.70		
							Stiff dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	
3.00-3.45	S		N=26 (4,10:6,5,7,8)			(1.50)		
4.00-4.26	S		N>50 (6,15:29,21/30mm)			4.20		
						4.26	Very stiff to hard dark red-brown slightly sandy slightly gravelly silty CLAY. Gravel is fine to coarse mixed lithology, mudstone, sandstone, quartzite. **GLACIAL TILL**	

Boring Progress and Water Observations					Water Strikes					Hole Diameter		Casing Diameter	
Date	Time	Hole Depth	Casing Depth	Water Depth	Strike Depth	Flow Rate	Post Strike Depth	Elapsed Minutes	Depth Sealed	Depth	Diameter (mm)	Depth	Diameter (mm)

General Remarks:
1. Borehole location specified by the Client.
2. Descriptions of consistency and density are from field observations and results of SPTs.
3. Borehole backfilled with arisings upon completion and turf replaced at the surface.

ENCLOSURE B

Laboratory Report

UKAS TESTING
2788

GSTL
GEO Site & Testing Services Ltd

Contract Number: 56608

Client Ref: **P1581**
Client PO:

Report Date: **17-11-2021**

Client **Ground Investigation Limited**
Unit 3, Westfield Court
Barns Ground
Kenn
Clevedon
BS21 6FQ

Contract Title: **Sant Ffraed House**
For the attention of: **Richard Colwill**

Date Received: **08-11-2021**
Date Completed: **17-11-2021**

Test Description	Qty
Moisture Content of Soil BS1377 : Part 2 : Clause 3.2 : 1990 - * UKAS	4
4 Point Liquid & Plastic Limit BS 1377:1990 - Part 2 : 4.3 & 5.3 - * UKAS	4
Samples Received - @ Non Accredited Test	8
Disposal of samples for job	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

Approved Signatories:
Emma Sharp (Business Support Manager) - Paul Evans (Director) - Richard John (Quality/Technical Manager)
Shaun Jones (Laboratory manager) - Shaun Thomas (Site Manager) - Wayne Honey (Quality Assistant / Administrator / Health and Safety Coordinator)

GEO Site & Testing Services Ltd
Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

GSTL	NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX (BS 1377:1990 - Part 2 : 4.3 & 5.3)	
Contract Number	56608	
Site Name	Sant Ffraed House	
Date Tested	15/11/2021	
	DESCRIPTIONS	

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
WS1		D	0.20	-	0.60	Brown sandy silty CLAY
WS1		D	0.80	-	1.00	Brown sandy silty CLAY
WS3		D	0.60	-	0.80	Brown sandy silty CLAY
WS3		D	1.30	-	1.50	Brown gravelly sandy silty CLAY
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
				-		
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				-		
				-		
				-		
				-		
				-		
				-		

Operators	Checked	17/11/2021	Richard John (Advanced Testing Manager)
Clayton Jenkins	Approved	17/11/2021	Paul Evans (Quality/Technical Manager)

UKAS TESTING
2788

NATURAL MOISTURE, LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX
(BS 1377:1990 - Part 2 : 4.3 & 5.3)

GSTL

Contract Number	56608
Project Location	Sant Ffraed House
Date Tested	15/11/2021

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity index %	Passing 0.425mm %	Remarks
WS1		D	0.20	-	0.60	21	35	18	17	100	CL/I Low/Inter. Plasticity
WS1		D	0.80	-	1.00	25	39	17	22	100	CI Intermediate Plasticity
WS3		D	0.60	-	0.80	22	32	20	12	100	CL Low Plasticity
WS3		D	1.30	-	1.50	13	28	13	15	89	CL Low Plasticity
				-							
				-							
				-							
				-							
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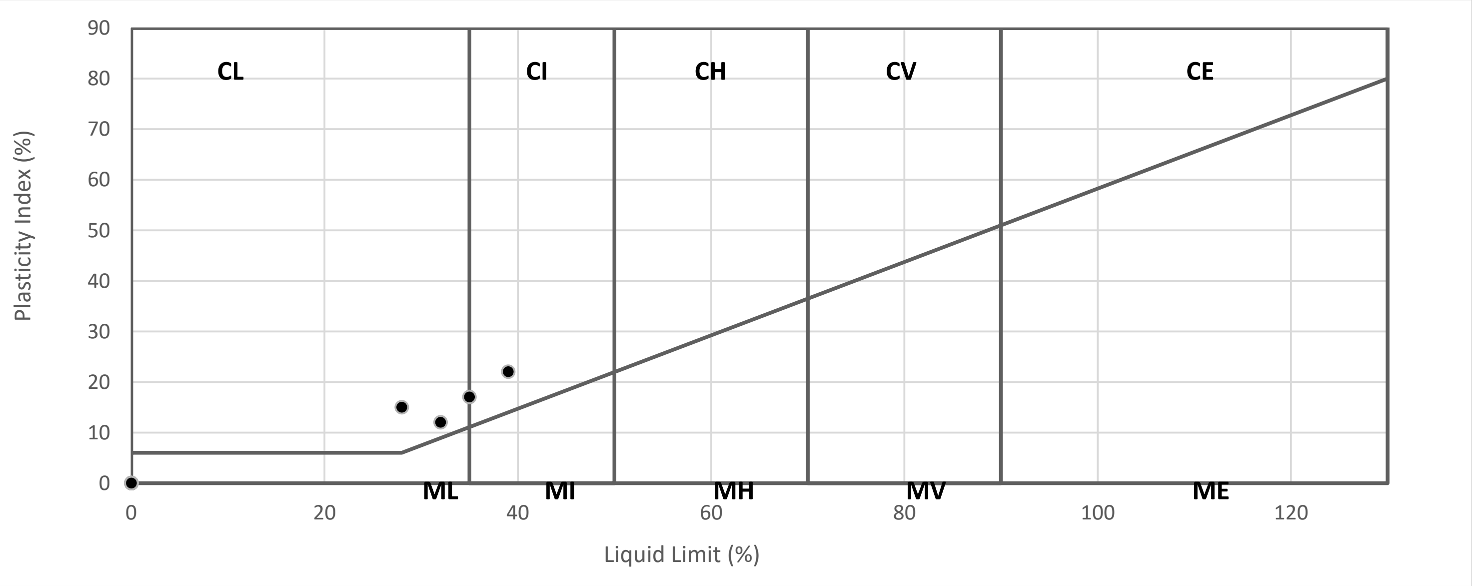
Symbols: NP : Non Plastic # : Liquid Limit and Plastic Limit Wet Sieved

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION
BS 5930:1999+A2:2010



Operators	Checked	17/11/2021	Richard John (Advanced Testing Manager)
Clayton Jenkins	Approved	17/11/2021	Paul Evans (Quality/Technical Manager)

UKAS TESTING 2788

Appendix B

Infiltration Testing Report - Gibbs Geotechnical Limited, August 2021

BRE365 Infiltration Testing For:

Sant Ffread House

Abergavenny

Monmouthshire

NP7 9BA

Prepared for:

SNACO UK Limited

REF: **242**

DATE: 30.08.2021

GibbsGeoTechnical

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Document Control

Project	**Sant Ffread House**
Client	**SNACO UK Ltd**
Ref:	**242**

Document Checking:

Prepared By: **Oliver Gibbs** **Signed:** 

Issue	Date	Status
01	**30/08/2021**	**Written and submitted**
02	**06/11/2021**	**Conclusion updated**
03		

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1 Introduction

1.1 Brief

Gibbs Geotechnical has been instructed by SNACO UK Ltd (the Client) to undertake four soil infiltration tests to the BRE 365 digest standard at Sant Ffread House, Abergavenny, Monmouthshire, NP7 9BA.

National Grid Reference: SO 35672 10218

Latitude, Longitude: 51.587826, -3.0171552

Figure 1 - Site location

Four infiltration tests have been proposed to determine the local geology and permeation rates on site. These tests will be approximately 0.5-1m^3 in size and tested a maximum of 3 times or as many as possible in the timeframe allowed. Refer to **Appendix A** – Site Test Plans

1.2 Site Investigations

The site is a period country house with outbuildings, car park and private road. The main house is located off a private road that passed under the A40 within a large rural area. To the north of the house is a farm building and to the south is an old church.

The tests were spread out around the grounds within separate fields and local woodland in close proximity to a large lake set to the south of the house.

The tests were performed on the 24th of August 2021 by Oliver Gibbs (contractor for Gibbs Geotechnical). At the time of testing the weather was clear and sunny with no rain.

Refer to **Appendix B** – Site photos

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2 Site findings

The following tests were performed to the BRE 365 Digest Standard and to the best of the ability of those involved were possible subject to site constraints and weather conditions. Both pits were dug without encountering bedrock, ground water or other issues to a depth of at least 1.0m

Test locations shown on **Appendix A**.

2.1 Method of testing

Water was available on site and used to fill a 1000 liter water bowser, which was pulled on a trailer. Following excavation of the pits, water from the bowser was then delivered at a rapid rate using a high flow pump drawing. Each pit was fill to the top and monitored. Water levels were taken via measuring staffs left in the pit.

2.2 British Geological Records

Local searches from the British Geological Survey (BGS) online records show the site to have the following superficial soils and bedrock:

Bedrock: Raglan Mudstone Formation - *Siltstone and mudstone, interbedded. Sedimentary bedrock formed between 423.6 and 419.2 million years ago during the Silurian period.*

Superficial soils Till, Devensian - Diamicton. *Sedimentary superficial deposit formed between 116 and 11.8 thousand years ago during the Quaternary period.*

Refer to **Appendix C** for BGS records http://mapapps.bgs.ac.uk/geologyofbritain3d/

2.3 Trial pit soil conditions

Ground water was not found during the test. Soils encountered were logged at the following approximate depths:

Pit 1 - 3

Topsoil:	*0-0.3m*	- Topsoil (traces of black ash and coal)
Superficial soils:	*0.3-1.0m*	- Light Red Brown Clay
Bedrock:	*None encountered*	

Pit 4

Topsoil:	*0-0.2m*	- Topsoil
Superficial soils:	*0.2-1.0m*	- Light Red Brown Clay
Bedrock:	*None encountered*	

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3 Results

Trial Pit	1	Date:	24th August 2021
		Performed by:	Oliver Gibbs
Dimensions	(m)	Weather:	Sunny
Width	0.5	Topsoil:	Grass
Length	1	Superficial soil:	Light red Brown Clay.
Effective depth	1	Comments:	
Total depth of hole	1		

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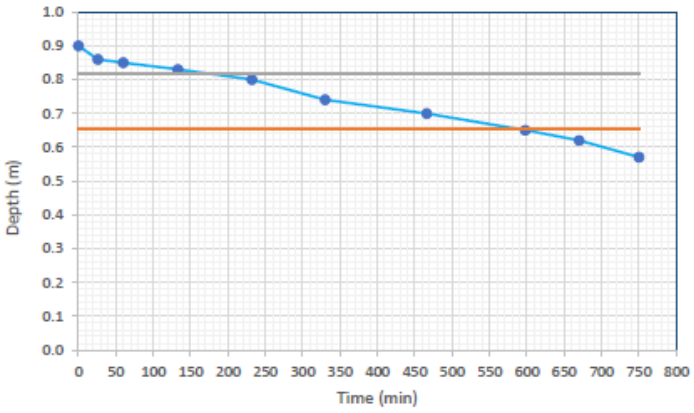
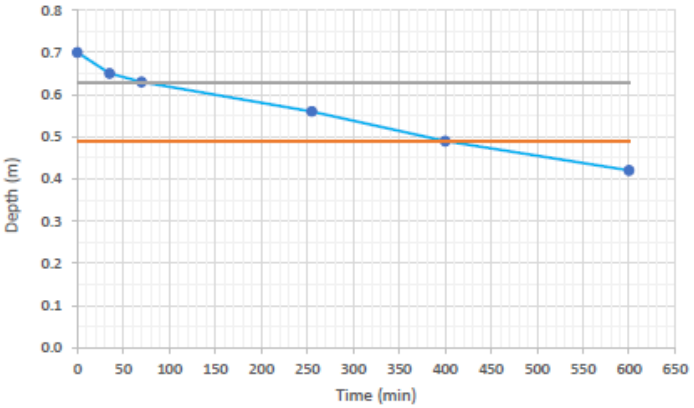
Test No.	Time (min)	Depth (m)
1	0	0.90
	26	0.86
	60	0.85
	133	0.83
	232	0.80
	330	0.74
	466	0.70
	598	0.65
	670	0.62
	750	0.57

time 75% =	170	
time 25% =	600	
Area =	0.5	
Vp 75% =	0.8175	
Vp 25% =	0.6525	
Vp75-25 =	0.0825	m
As50 =	2	m²
tp75-25 =	25800	s
f =	1.60E-06	m/s



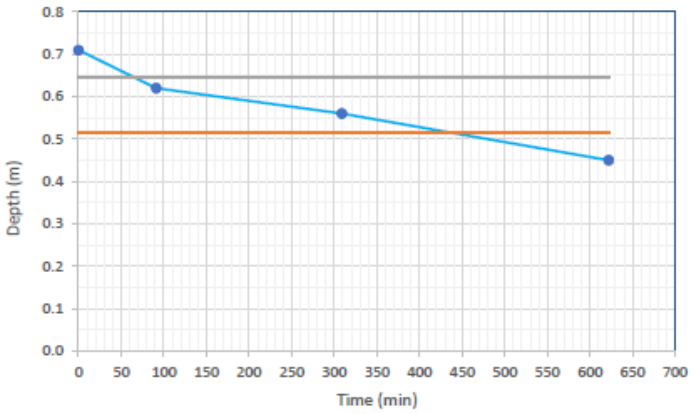
Test No.	Time (min)	Depth (m)
2	0	0.70
	35	0.65
	70	0.63
	255	0.56
	400	0.49
	600	0.42

time 75% =	0.7	
time 25% =	400	
Area =	0.5	
Vp 75% =	0.63	
Vp 25% =	0.49	
Vp75-25 =	0.07	m
As50 =	2	m²
tp75-25 =	23958	s
f =	1.46E-06	m/s



Test No.	Time (min)	Depth (m)
3	0	0.71
	91	0.62
	309	0.56
	622	0.45

time 75% =	65	
time 25% =	440	
Area =	0.5	
Vp 75% =	0.645	
Vp 25% =	0.515	
Vp75-25 =	0.065	m
As50 =	2	m²
tp75-25 =	22500	s
f =	1.44E-06	m/s



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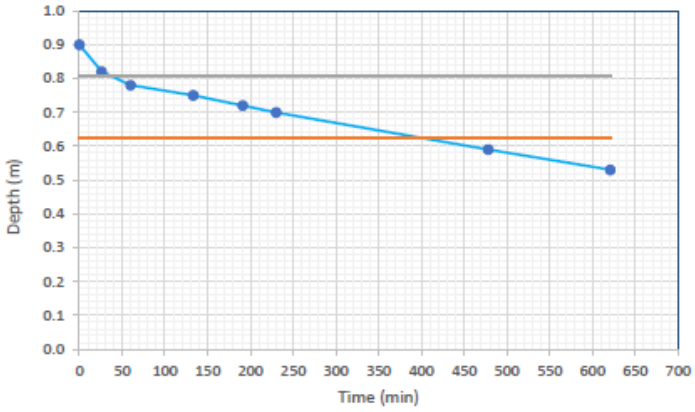
Trial Pit	2	Date:	24th August 2021
		Performed by:	Oliver Gibbs
Dimensions	(m)	Weather:	Sunny
Width	0.5	Topsoil:	Grass
Length	1	Superficial soil:	Light red Brown Clay.
Effective depth	1	Comments:	
Total depth of hole	1		

Test No.	Time (min)	Depth (m)
1	0	0.90
	26	0.82
	60	0.78
	133	0.75
	191	0.72
	230	0.70
	478	0.59
	621	0.53

time 75% = 40
time 25% = 400
Area = 0.5
Vp 75% = 0.8075
Vp 25% = 0.6225

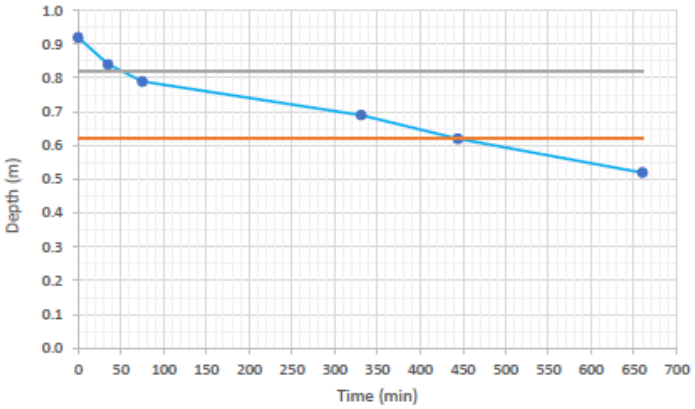
Vp75-25 = 0.0925 m
As50 = 2 m²
tp75-25 = 21600 s
f = 2.14E-06 m/s



Test No.	Time (min)	Depth (m)
2	0	0.92
	35	0.84
	75	0.79
	331	0.69
	444	0.62
	660	0.52

time 75% = 60
time 25% = 460
Area = 0.5
Vp 75% = 0.82
Vp 25% = 0.62

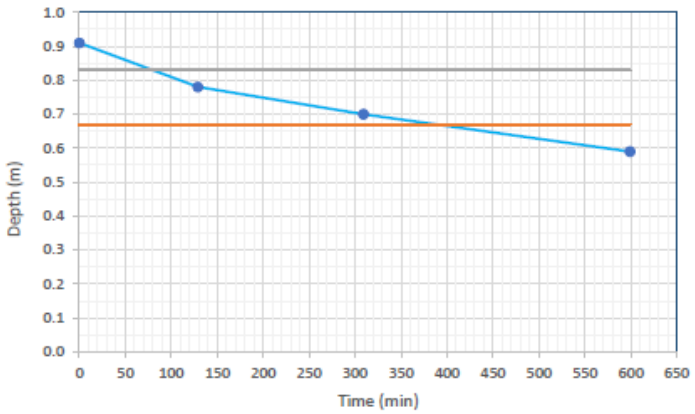
Vp75-25 = 0.1 m
As50 = 2 m²
tp75-25 = 24000 s
f = 2.08E-06 m/s



Test No.	Time (min)	Depth (m)
3	0	0.91
	129	0.78
	309	0.70
	599	0.59

time 75% = 80
time 25% = 390
Area = 0.5
Vp 75% = 0.83
Vp 25% = 0.67

Vp75-25 = 0.08 m
As50 = 2 m²
tp75-25 = 18600 s
f = 2.15E-06 m/s



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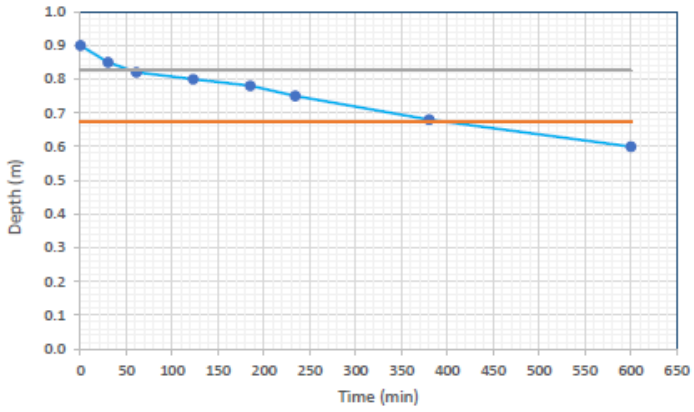
Trial Pit	3	Date:	24th August 2021
		Performed by:	Oliver Gibbs
Dimensions	(m)	Weather:	Sunny
Width	0.5	Topsoil:	Grass
Length	1	Superficial soil:	Light red Brown Clay.
Effective depth	1	Comments:	
Total depth of hole	1		

Test No.	Time (min)	Depth (m)
1	0	0.90
	30	0.85
	61	0.82
	123	0.80
	185	0.78
	234	0.75
	380	0.68
	600	0.60

time 75% = 60
time 25% = 390
Area = 0.5
Vp 75% = 0.825
Vp 25% = 0.675

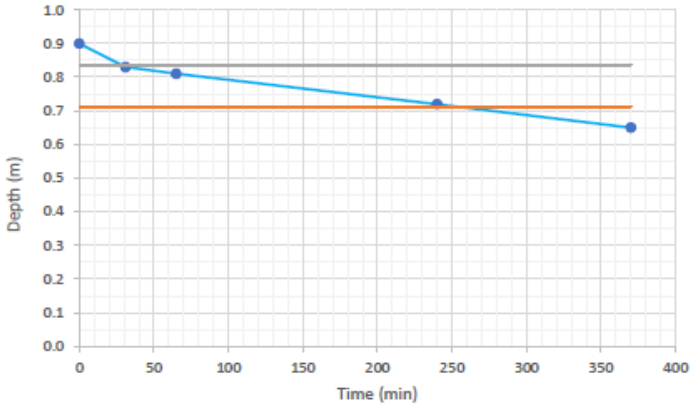
Vp75-25 = 0.075 m
As50 = 2 m²
tp75-25 = 19800 s
f = 1.89E-06 m/s



Test No.	Time (min)	Depth (m)
2	0	0.90
	31	0.83
	65	0.81
	240	0.72
	370	0.65

time 75% = 25
time 25% = 250
Area = 0.5
Vp 75% = 0.8375
Vp 25% = 0.7125

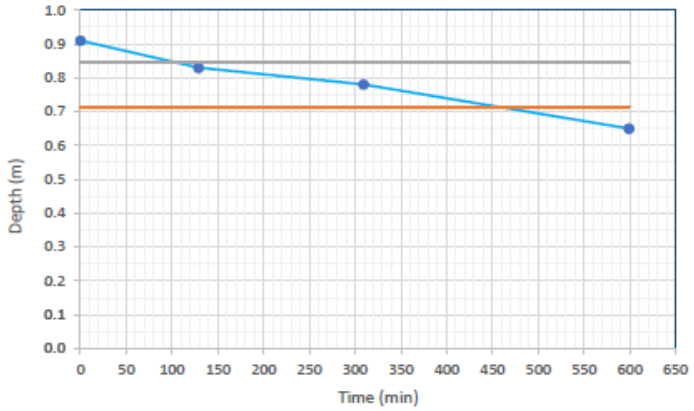
Vp75-25 = 0.0625 m
As50 = 2 m²
tp75-25 = 13500 s
f = 2.31E-06 m/s



Test No.	Time (min)	Depth (m)
3	0	0.91
	129	0.83
	309	0.78
	599	0.65

time 75% = 100
time 25% = 450
Area = 0.5
Vp 75% = 0.845
Vp 25% = 0.715

Vp75-25 = 0.065 m
As50 = 2 m²
tp75-25 = 21000 s
f = 1.55E-06 m/s



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Trial Pit	4	Date:	24th August 2021
		Performed by:	Oliver Gibbs
Dimensions	(m)	Weather:	Sunny
Width	0.5	Topsoil:	Grass
Length	1	Superficial soil:	Light red Brown Clay.
Effective depth	1	Comments:	Within a wooded area.
Total depth of hole	1		

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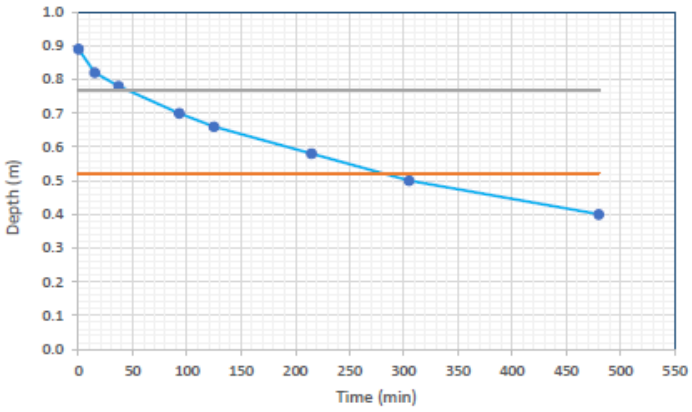
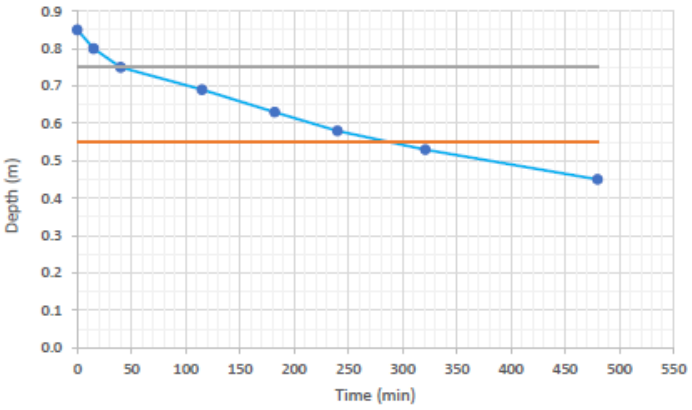
Test No.	Time (min)	Depth (m)
1	0	0.89
	15	0.82
	37	0.78
	93	0.70
	125	0.66
	215	0.58
	305	0.50
	480	0.40

time 75% =	40	
time 25% =	280	
Area =	0.5	
Vp 75% =	0.7675	
Vp 25% =	0.5225	
Vp75-25 =	0.1225	m
As50 =	2	m²
tp75-25 =	14400	s
f =	4.25E-06	m/s



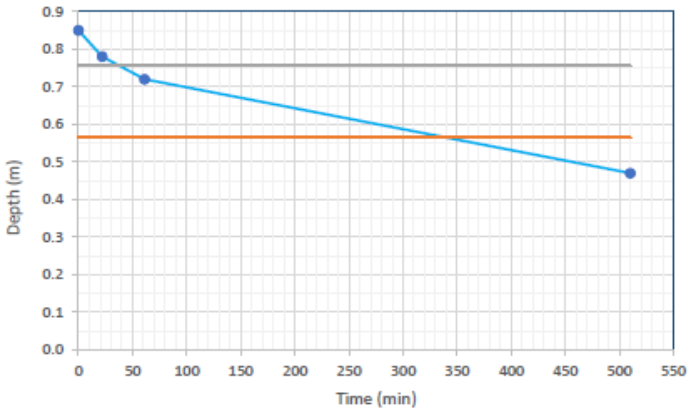
Test No.	Time (min)	Depth (m)
2	0	0.85
	15	0.80
	40	0.75
	115	0.69
	182	0.63
	240	0.58
	321	0.53
	480	0.45

time 75% =	70	
time 25% =	290	
Area =	0.5	
Vp 75% =	0.75	
Vp 25% =	0.55	
Vp75-25 =	0.1	m
As50 =	2	m²
tp75-25 =	13200	s
f =	3.79E-06	m/s



Test No.	Time (min)	Depth (m)
3	0	0.85
	22	0.78
	61	0.72
	510	0.47

time 75% =	40	
time 25% =	340	
Area =	0.5	
Vp 75% =	0.755	
Vp 25% =	0.565	
Vp75-25 =	0.095	m
As50 =	2	m²
tp75-25 =	18000	s
f =	2.64E-06	m/s



Ground water was not encountered. Infiltration results for the three pits determined rates of:

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4 Conclusions

Gibbs Geotechnical has been instructed by SNACO UK Ltd (the Client) to undertake four soil infiltration tests to the BRE 365 digest standard at Sant Ffread House, Abergavenny, Monmouthshire, NP7 9BA.

National Grid Reference: SO 35672 10218

Four infiltration tests have been proposed to determine the local geology and permeation rates on site. These tests will be approximately 0.5-1m^3 in size and tested a maximum of 3 times or as many as possible in the timeframe allowed. Refer to **Appendix A** – Site Test Plans

The tests were spread out around the grounds within separate fields and local woodland in close proximity to a large lake set to the south of the house. The tests were performed on the 24th of August 2021 by Oliver Gibbs (contractor for Gibbs Geotechnical). At the time of testing the weather was clear and sunny with no rain.

The ground was found to be a light red brown clay in line with the BGS superficial soil records of a Till Devensian deposits for a depth of 1m.

Ground water was not encountered. Infiltration results for the three pits determined rates of:

Test Pit 1: 1.60-1.44×10^{-6} m/s
Test Pit 2: 2.14-2.08×10^{-6} m/s
Test Pit 3: 1.89-1.55×10^{-6} m/s
Test Pit 4: 4.23-2.64×10^{-6} m/s

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APPENDIX A: Site Test Plans

Figure 2 - Test pit location

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APPENDIX B: Site Photos

Picture 1 – *Test Pit 1 location*

Picture 2 – *Test Pit 2 Location*

Picture 3 – *Test Pit 2 Ground Strata's*

Picture 4 – *Test Pit 3*

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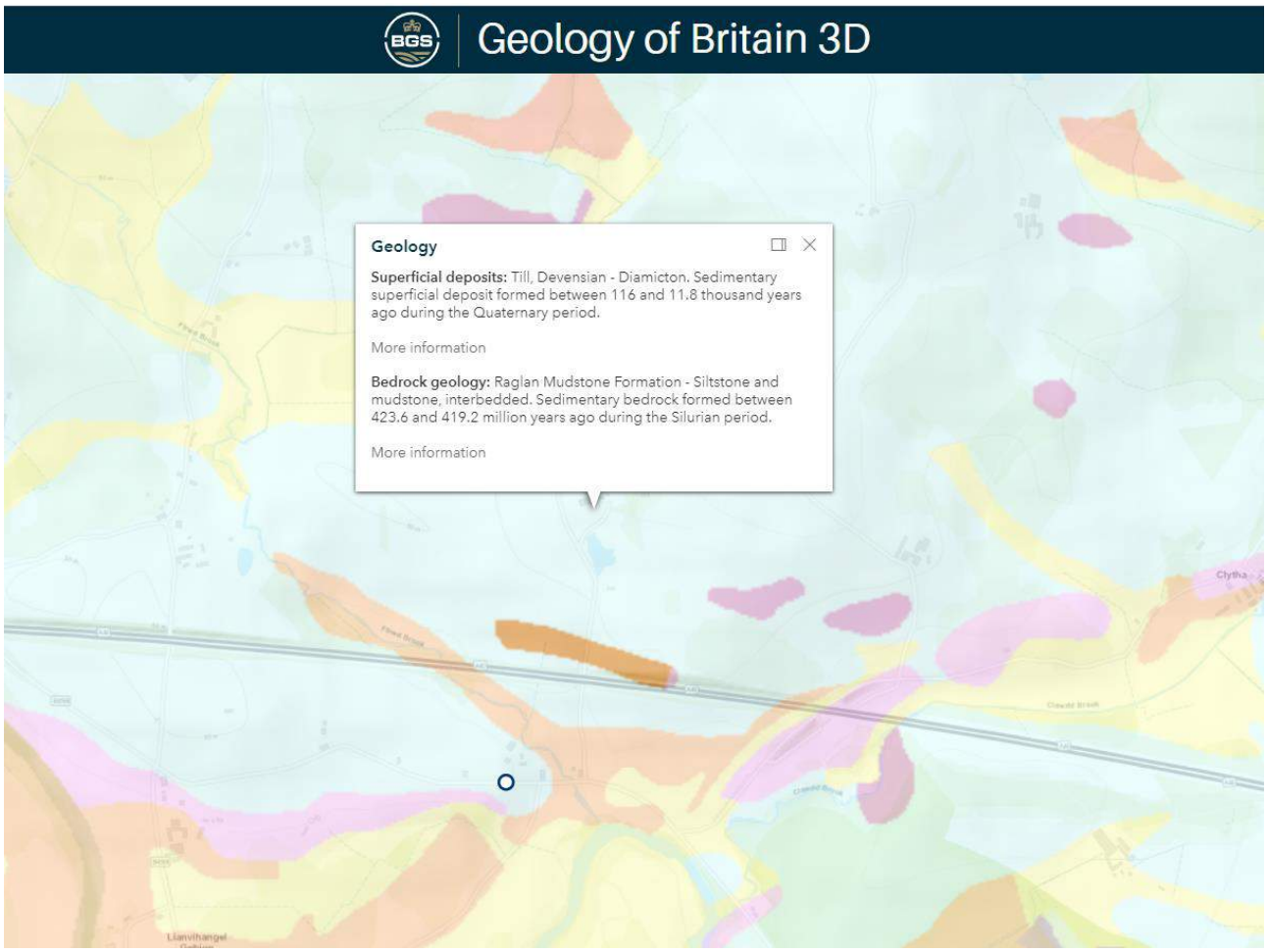
APPENDIX C: BGS Records



Appendix C

Percolation Testing Report - Gibbs Geotechnical Limited, November 2021

BS6297 Percolation Testing For:

Sant Ffread House

Abergavenny

Monmouthshire

NP7 9BA

Prepared for:

Howells

REF: **276-02**

DATE: 30.11.2021

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Document Control

Project	**Sant Ffread House**
Client	**Howells**
Ref:	**276-02**

Document Checking:

Prepared By: **Oliver Gibbs** **Signed:** 

Issue	Date	Status
01	21/11/2021	Written and submitted
02	29/11/2021	Updated with additional tests
03		

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1 Introduction

1.1 Brief

Gibbs Geotechnical has been instructed by Howells (the Client) to undertake two soil percolation tests to the BS 6297:2007 digest standard at Sant Ffread House, Abergavenny, Monmouthshire, NP7 9BA.

Three additional test pits have been performed on request for further information on the soils following discrepancies in infiltration results.

National Grid Reference: SO 35672 10218

Latitude, Longitude: 51.587826, -3.0171552

Figure 1 - Site location

Two percolation tests have been proposed to determine the local geology and permeation rates on site to suit the BS 6297:2007 standards which state following testing procedure:

- *"Excavate at least two holes 300mm square to a depth at least 300mm below the proposed invest level (bottom of pipe) of the infiltration pipe, spacing them along the proposed lone of the subsurface irrigation system. While digging the hole, note and record the changes in soil characteristics at measured depths and the position of the water table if reached.*
- *Saturate the local soil by filling each hole with water to a depth of at least 300mm and allow this to seep away completely*
- *If the water drains rapidly (within 10 mins) the hole should be refilled up to a maximum of 10 times. If the water continues to drain away rapidly the ground is unsuitable.*
- *If water has not soaked away within 6 hours the area is not suitable.*

- *Determine the percolation rate by refilling each hole with water to a depth of at least 300mm and observe the time in seconds for the water to seep away from 75% full to 25% full (i.e a depth of 150 mm).*
- *Divide this time in seconds by 150. This gives the average time in seconds required for the water to drop 1mm.*
- *Repeat the test at least three times in each hole in the location of the proposed trench(es).*
- *Take the average figure from the tests to produce the percolation value Vp (in seconds).”*

The tests will be repeated a maximum of 3 times or as many as possible in the timeframe allowed. Refer to Appendix A – Site Test Plans

1.2 Site Investigations

The site is a period country house with outbuildings, car park and private road. The main house is located off a private road that passed under the A40 within a large rural area. To the north of the house is a farm building and to the south is an old church. The tests were spread out around the grounds within separate fields and local woodland in close proximity to a large lake set to the south of the house.

The tests were performed on the 20th of November 2021 by Oliver Gibbs (contractor for Gibbs Geotechnical). At the time of testing the weather was clear and sunny with no rain. Refer to Appendix B – Site photos

The additional 3No. of tests were performed on the Thursday 25th of November 2021 by Gibbs Geotechnical. At the time of testing the weather was clear and sunny with no rain. Refer to Appendix B – Site photos

2 Site findings

The following tests were performed to the BS 6297:2007 Standard and to the best of the ability of those involved were possible subject to site constraints and weather conditions. Both pits were dug without encountering bedrock, ground water or other issues to a depth of at least 1.0m below ground level.

Test locations shown on Appendix A.

2.1 Method of testing

Water was available on site and carried to the pit via bucks filled from the local watercourse.

The pits were dug 300mm long by 300mm wide and at least 1.0m below ground level, and then saturated prior to testing. These were then filled at least 300mm deep with water and monitored.

2.2 British Geological Records

Local searches from the British Geological Survey (BGS) online records show the site to have the following superficial soils and bedrock:

Bedrock: Raglan Mudstone Formation - *Siltstone and mudstone, interbedded. Sedimentary bedrock formed between 423.6 and 419.2 million years ago during the Silurian period.*

Superficial soils Till, Devensian - Diamicton. *Sedimentary superficial deposit formed between 116 and 11.8 thousand years ago during the Quaternary period.*

Refer to **Appendix C** for BGS records http://mapapps.bgs.ac.uk/geologyofbritain3d/

2.3 Trial pit soil conditions

Ground water was not found during the test. Soils encountered were logged at the following approximate depths:

Pit 1

Topsoil:	*0-0.1m*	- Topsoil
Superficial soils:	*0.1-1.0m*	- Light Red Brown Sandy Clay with Gravel
Bedrock:	*None encountered*	

Pit 2

Topsoil:	*0-0.1m*	- Topsoil
Superficial soils:	*0.1-1.0m*	- Red Brown Sandy Clay
Bedrock:	*None encountered*	

Pit 3

Topsoil:	*0-0.15m*	- Topsoil (Dark Grey Gravel)
Superficial soils:	*0.15-0.8m*	- Light Red Brown Sandy Clay with Gravel

Pit 4

Topsoil:	*0-0.1m*	- Topsoil
Superficial soils:	*0.1-0.8m*	- Light Red Brown Sandy Clay with Gravel
Bedrock:	*None encountered*	

Pit 5

Topsoil:	*0-0.1m*	- Topsoil
Superficial soils:	*0.1-0.8m*	- Light Red Brown Sandy Clay with Gravel
Bedrock:	*None encountered*	

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3 Results

Hole No.	Test No.	Time @ 75% full	Time @ 25% full	Elapsed time 75% - 25%	Total time	Vp (s/mm)
				Hours (h) / Minuets (mins)	*Seconds (s)*	*Seconds/ 150mm*
1	1	10:19	11:20	*1h 1 mins*	3,660	24.4
	2	11:59	13:38	*1h 39 mins*	5,940	39.6
	3	14:00	15:55	*1h 55 mins*	6,900	46.0
Average Vp for Hole 1						36.6
2	1	10:43	15:40	*5h 57 mins*	21,420	142.8
	2	16:40	*Did not reach 25% in 4 hours. Test abandoned*			
Average Vp for Hole 2						142.8
3	1	09:31	09:45	*14 mins*	840	5.6
	2	10:30	10:44	*14 mins*	840	5.6
	3	11:21	11:38	*17 mins*	1,020	6.8
Average Vp for Hole 3						6.0
4	1	09:57	10:56	*59 mins*	3,540	23.6
	2	11:40	13:21	*1h 41 mins*	6,060	40.4
	3	13:40	15:58	*2h 18 mins*	8,280	55.2
Average Vp for Hole 4						39.7
5	1	10:06	12:33	*2h 27 mins*	8,820	58.8
	2	13:45	16:16	*2h 31 mins*	9,060	60.4
	3	16:31	19:30	*2h 59 mins*	10,740	71.6
Average Vp for Hole 5						63.6

Ground water was not encountered. Infiltration results for the two pits determined rates of:

Test Pit 1 Vp= 36.6 s/mm
Test Pit 2 Vp= 142.8 s/mm
Test Pit 3 Vp= 6.0 s/mm
Test Pit 4 Vp= 39.7 s/mm
Test Pit 5 Vp= 63.6 s/mm

Test pit 2 was only able to be tested once and did not sufficiently drain to 25% in the time allowed. The BS 6297:2007 "*If water has not soaked away within 6 hours the area is not suitable*". Soil compositions were noticed to vary between the two locations, from a sandy to gravel clay.

Test Pit 3 appears to be within an area of made ground. A dark grey gravel can be seen to replace the typical brown clay topsoil.

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1.

2. APPENDIX A: Site Test Plans

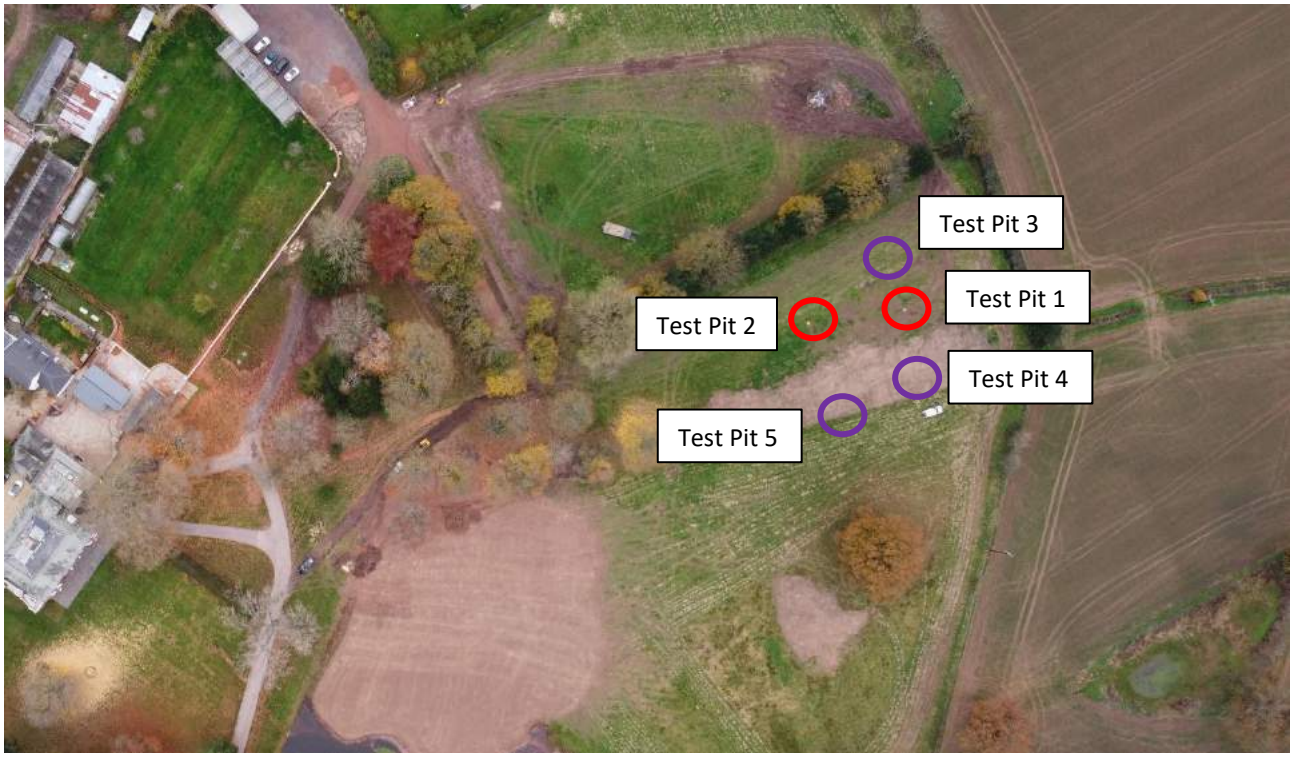


Figure 2 - Test pit location

3.

4. APPENDIX B: Site Photos

Picture 1 – *Test Pit locations and saturation*

Picture 2 – *Test Pit 1 Soil strata*

Picture 3 – *Test Pit 2 Soil strata*

Picture 4 – *Test Pit 1 Testing*

Picture 5 – *Test Pit 2 reinstated*

Picture 6 – *Test Pit 3 Soil Strata*

Picture 7 – *Test Pit 4 Locatio and soils*

Picture 8 – *Test Pit 5 Location and soils*

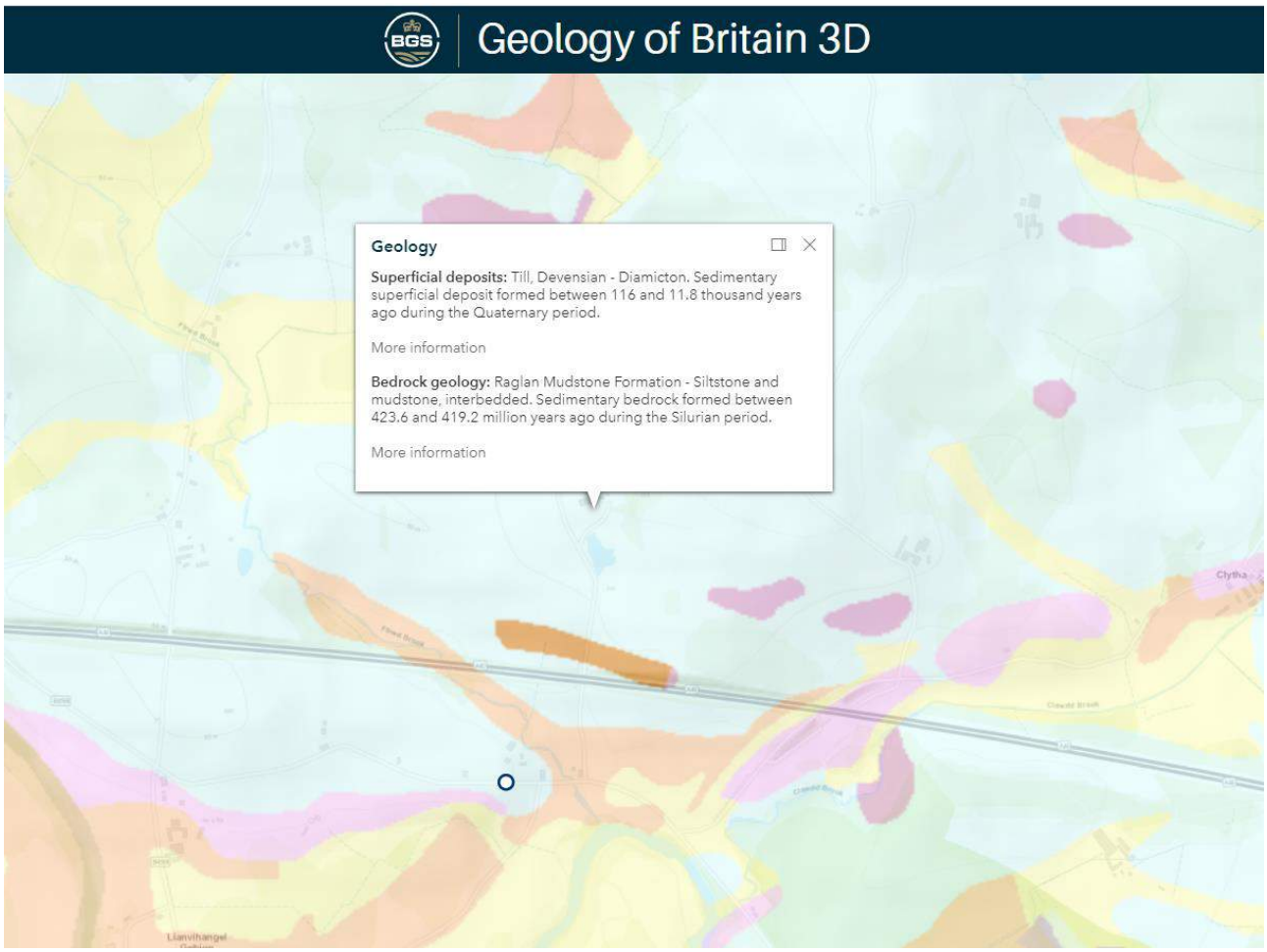
Picture 9 – *Test Pit 5 test*

Picture 10 – *Test Pit 4 test*

5.

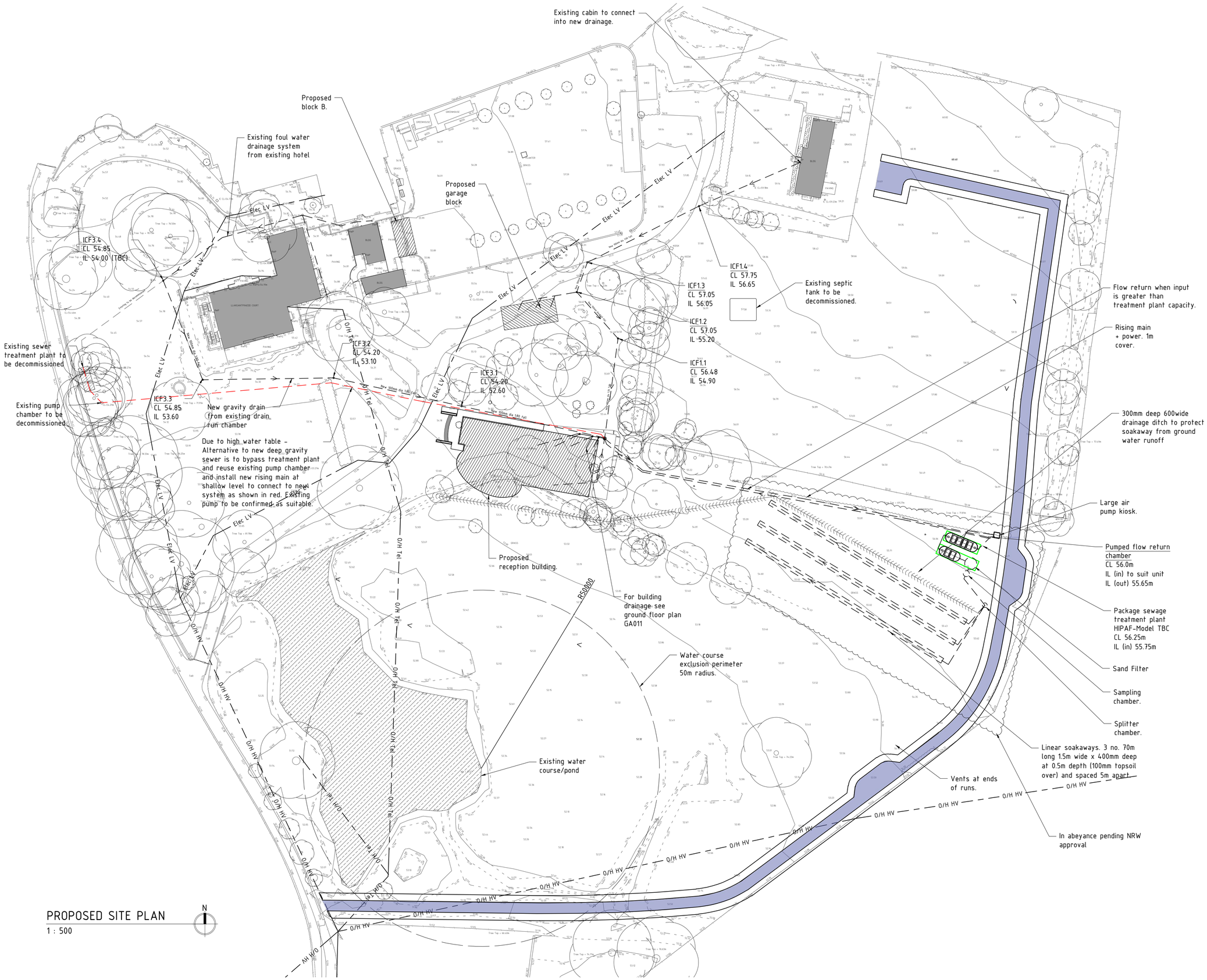
6.

7. APPENDIX C: BGS Records



Appendix D

Proposed site plan



Notes:

This drawing is to be read in conjunction with all relevant Architect's and Engineer's drawings and the specification. This drawing should not be scaled. All dimensions are to be verified by the contractor on site. All discrepancies should be reported to the C.A. prior to the commencement of the works. Only drawings with 'CONSTRUCTION' status are to be used for construction.

DRAINAGE KEY:

SEWERS		
Private Foul Water Sewer		F
Private Surface Water Sewer		S
Private Combined Water Sewer		C
Rising main		RM
Non-operational (To be abandoned)		X
CONNECTION POINTS	**Foul**	**Surface**
Rainwater pipe		RWP
Soil & Vent Pipe	SVP	
Stub Stack	SS	
Soil pipe+air admittance valve	AAV	
Back Drop	BD	BD
Back inlet gully	BIG	
Gully		G
Roddable Gully		RG
Channel drain		Ch
ACCESS POINTS	**Foul**	**Combined** / **Surface**
Rodding Eye	RE	RE / RE
IC-Type 4 - 225x100mm / 180Ø	F	C / S
IC-Type 3 - 450x450mm / 450Ø	F	C / S
MH-Type 1 / 2 - PCC ring Manhole	F	C / S
IC-Type 3 - Slit Trap		S
Others		
Outfall		
Pumping Station		
Package Treatment Plant		
Radon sump and pipe		RS
Cellular Storage (non-filtration)		
Soakaway (filtration)		
Water Butt		WB

DATE:	REV:	DESCRIPTION:	DRWN:	CHKD:
03/02/22	C03	Drainage general updates	CS	KP
27/01/22	C02	General updates	CS	KP
14/01/22	C01	Issued for construction	CS	KP
10/01/22	T04	Hotel drainage taken to new drainage treatment plant	CS	KP
10/01/22	T03	Drainage field amended	CS	KP
05/01/22	T02	Drawing number amended	CS	KP
21/12/21	T01	Levels Added	CS	KP
14/12/21	P02	Drainage field edged in green	CS	KP
04/11/21	P01	Issue for Information	CS	KP

kPa Consulting Engineers Ltd

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TELEPHONE: 01792 455 077
ONLINE: www.kPaConsulting.co.uk

PROJECT:
SNACO UK LIMITED
Sant Ffraed House,
Abergavenny.
NP7 9BA

TITLE:
Proposed Site Plan

STATUS:
CONSTRUCTION

SCALE:	DATE:	DRAWN:	CHECKED:
1:500@A1	DEC'21	CS	KP

JOB No:	DRG No:	REV:
477-07	GA002	C03

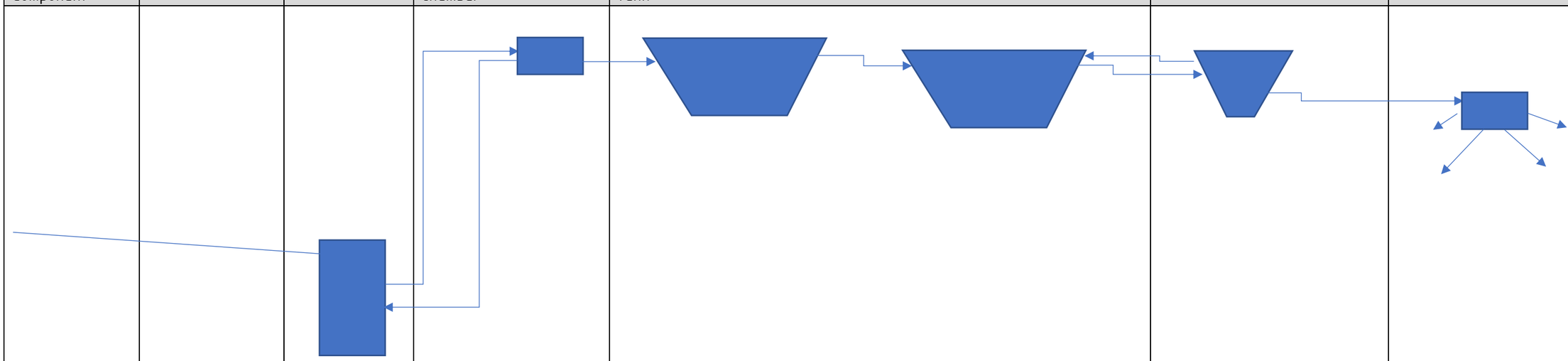
Appendix E

Treatment Chain

kPa Consulting Engineers Ltd.

Sant Ffraed House, Llanvihangel Gobion, Abergavenny, NP7 9BA

Treatment Chain Schematic –rev P02

Chemical/Volume Component	Influent	Pump chamber	Flow calmer and return chamber	Multiple Tank HiPAF utilising Submerged Aerated Filtration treatment tank	Sand Filter	Conventional Soakaway
						
Volume	20,000 (L/Day)	20,000 (L/Day)		20,000 (L/Day)	20,000 (L/Day)	20,000 (L/Day)
BOD	18,000 g/day	900 mg/L		20 mg/L	10 mg/L	10 mg/L
SS				30 mg/L	15 mg/L	15 mg/L
NH3	2,489 g/day	124mg/L		2 mg/L	2 mg/L	2 mg/L
Phosphate	10mg/L (can reduce further through management)	10 mg/L		6mg/L 40% reduction	6 mg/L	6 mg/L

Appendix F

Infiltration Worksheet model – Ammonia

(Excel spreadsheet)

Appendix G

Infiltration Worksheet model – Phosphate

(Excel spreadsheet)

Appendix H

Infiltration Worksheet model – Ammonia sensitivity analysis

(Excel spreadsheet)