Weetwood Services Ltd
info@weetwood.net

Weetwood
Development • Planning • Environment

Land to the East of Bicker Fen, Lincolnshire, PE20 3BN

Foul and Surface Water Drainage Scheme

Technical Note

Project ref:	5086
Prepared by:	Warren Chan BEng (Hons) *Project Engineer*
Checked and Approved by:	Tim Brook BSc (Hons) *Technical Director*
Date:	18 January 2024
Version:	Final v2.1

Introduction

1. A full planning application for the "*Proposed development of a photovoltaic solar array, grid connection, access improvement works and ancillary development on land at Bicker Fen, Boston and South Holland at land to the west of Cowbridge Road, Bicker, Boston*" was submitted to Boston Borough Council and South Holland District Council on 25 August 2022 (application ref: B/22/0356 and H04-0849-22).

2. The proposed site layout plan is presented in **Annex 1**.

3. The planning application was accompanied by a Flood Risk Assessment report (ref: 5086/FRA/Final/v1.1/2022-11-04) and a Hydrological Analysis Technical Note (ref: 5086/TN/Final/v1.0/2022-05-13) prepared by Weetwood.

4. Planning permission was subsequently granted by Boston Borough and South Holland District Council by way of a decision letter notice dated 21 July 2023, subject to the following planning condition relating to surface water drainage:

   Condition 12 (Boston Borough Council) / Condition 15 (South Holland District Council)

   Prior to commencement of the development hereby approved, full details of the means of surface water disposal and foul water drainage shall be submitted to and approved in writing by the Local Planning Authority. The details so approved shall be implemented in full before the development hereby permitted is first brought into use.

   Reason: To ensure that the site is adequately drained, to avoid pollution, and to prevent increased risk of flooding in accordance with Policies 2, 3 and 30 of the South East Lincolnshire Local Plan, 2019 and national guidance contained within the National Planning Policy Framework 2021.

5. This document presents a surface water drainage scheme commensurate with the level of detail required to discharge planning condition 12/15.

Site Details

6. The site is approximately 97.3 hectare (ha) in extent and is located to the west of Bicker, near Boston, Lincolnshire. The centre of the site is at Ordnance Survey National Grid Reference TF 200 376, as shown in **Figure 1**. The site currently comprises of agricultural land.

7. LiDAR data has been used to develop a digital terrain model of the site and surrounding area as illustrated in **Figure 2**. This indicates that ground levels across the site are generally in the range 1.5 to 2. 5 m AOD. Ground levels along Cowbridge Road are between 2.2 to 3.2 m AOD.

8. South Forty Foot Drain is located approximately 1.2 km west of the site.

   Hammond Beck bisects the eastern and western parts of the site. Hammond Beck is pumped into the South Forty Foot Drain at three pumping stations:

   - Donnington North Ing pumping station located approximately 2.5 km upstream of the site
   - Bicker Fen pumping station located 2.5 km downstream of the site
   - Swineshead pumping station located 6.1 km downstream of the site.

There is a network of on-site drainage ditches located within and in the vicinity of the site, which drain to the South Forth Foot Drain.

9. According to the Soilscapes soils dataset produced by the Cranfield Soil and AgriFood Institute[1], soil conditions at the site and within the surrounding area are loamy and clayey soils of coastal flats with naturally high groundwater.

10. British Geological Survey mapping of surface geology[2] indicates the underlying bedrock formation comprises of mudstone (Oxford Clay formation), overlain by clay and silt (Tidal Flat deposits) superficial deposit.

11. According to the MAGIC website[3] the Tidal Flat superficial deposits and Oxford Clay bedrock is classified as an Unproductive aquifer. An Unproductive aquifer are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

12. Infiltration testing was carried out by RGS on 6 December 2023 (refer to **Annex 2**) in accordance with the requirements set out in BRE365[4]. This included the excavation of three trial pits, two of which had to be relocated due to groundwater ingress. Ground conditions generally consisted of topsoil 0.3 – 0.4 m below ground level (bgl), underlain by silty clay 0.4 – 2.4 m bgl, sandy silt 1.2 – 1.8 m bgl, clayey silt 1.2 – 2.1 m bgl, clayey sandy gravel to 2.45 m bgl and sandy silty clay to 3.0 m bgl.

13. Groundwater was struck within trial pits TP01A and TP02A at 1.1 m and 1.6 m bgl respectively.

14. All tests during the site investigation indicate that infiltration is not feasible due to very poor drainage characteristics of the ground material and naturally high groundwater.

Surface Water Drainage at the Existing Site

15. The site currently comprises agricultural farmland. It is possible that field drains are present, but no other formal drainage infrastructure is believed to be present. Given ground conditions and site topography, surface water runoff would be expected to slowly infiltrate where conditions allow and flow overland in a direction determined by topography.

The greenfield surface water runoff rates for the site, calculated using the Greenfield runoff estimation tool on the uksuds.com website, are presented in **Annex 3** and **Table 1** below:

Table 1: Greenfield Runoff Rate

AEP of Rainfall Event	Greenfield Runoff Rate (l/s/ha)
1 in 1	1.2
QBAR	1.4
1 in 30	3.4
1 in 100	5.0

Proposed Surface Water Drainage Scheme

16. According to published research into the impact of solar-farm panels on runoff rates and volumes[5], solar panels do not have a significant impact on the hydrologic response of a site when the ground comprises of well managed vegetation such as good grass cover. In such instances, the research cites that well managed vegetation beneath the solar panels would limit the potential increase in runoff volume to less than 0.35%.

17. Given that the site is virtually flat, and that the proposed development includes managed grassland beneath the solar panels, the impact on runoff rates and volumes from the panelled part of the development is assessed to be negligible. As such, no specific drainage for the panelled part of the site is proposed.

[1] www.landis.org.uk/soilscapes/
[2] https://www.bgs.ac.uk/map-viewers/geoindex-onshore/
[3] https://magic.defra.gov.uk/MagicMap.aspx
[4] BRE Digest 365 Soakaway Design, Building Research Establishment, 2016
[5] 'Hydrologic Response of Solar Farms', Cook LM and McCuen RH, American Society of Civil Engineers, 2013

18. In accordance with PPG para. 056, surface water runoff should be disposed of according to the following hierarchy: Into the ground (infiltration); To a surface water body; To a surface water sewer, highway drain, or another drainage system; To a combined sewer.

19. As detailed in paragraphs 11-13, infiltration testing undertaken by RGS indicates that the disposal of surface water by infiltration is not feasible at the site. It is therefore proposed to direct surface water runoff from access tracks and other areas of hardstanding (inverter/transformer stations, battery storage area, etc.) to the on-site drainage ditches.

20. The total area of hardstanding surfaces within the proposed development has been calculated to be 1.96 ha based on **Annex 1**. For the purposes of this technical note, the site has been subdivided into six drainage areas based on the location of surface waterbodies, as illustrated on **Figure 3**. The contributing area within each drainage area is presented in in **Table 2** below.

21. Black Sluice Internal Drainage Board (IDB)[6] requires surface water runoff to be restricted to 1.4 l/s/ha. This runoff rate will be achieved so far as is practicable; however, it is recognised that a flow control with a diameter of less than 50 mm may pose a risk of blockage to the drainage system. The proposed peak discharge rate for each drainage area is presented in **Table 2** below.

22. Attenuation storage will be provided to store surface water runoff generated across access tracks and other areas of hardstanding.

23. The attenuation storage facilities have been modelled using the Source Control module of MicroDrainage and has been sized to store the 1 in 100 AEP rainfall event including a 40% increase in rainfall intensity to allow for climate change in accordance with Environment Agency guidance[7]. The total required storage volumes are presented in **Table 2** below. Details of the design criteria used for a range of storm durations and return periods are presented in **Annex 4**.

Table 2: Summary of Proposed Surface Water Drainage Scheme
(1 in 100 AEP Event plus 40% Climate Change)

Drainage Area	Contributing Area (ha)	Peak Discharge (l/s)		Attenuation Volume (m^3)
1	0.115	0.2	1.0*	61.4
2	0.455	0.6		339.4
3	0.447	0.6		342.8
4	0.499	0.7		378.7
5	0.316	0.4		217.5
6	0.125	0.2		68.1

*Based on a flow control (e.g. Hydro-Brake) diameter of 50 mm

24. The storage volumes could be accommodated within a Type 3 sub-base material utilised as access tracks serving the development at a depth of 0.3 – 0.5 m.

25. A preliminary surface water drainage layout is provided in **Annex 5**.

26. Table 26.2 of the CIRIA SuDS Manual (2015) identifies low traffic roads as having a low pollution hazard level and indicates that the pollution hazard indices associated with low traffic roads for total suspended solids, hydrocarbons and metals are 0.50, 0.40 and 0.40 respectively.

27. It is recommended that the access tracks are constructed with a Type 3 material to allow surface water runoff to be stored and treated within the pavement structure. Table 26.3 of the CIRIA SuDS Manual indicates that the SuDS mitigation indices for permeable pavements for total suspended solids, hydrocarbons and metals are 0.70, 0.60 and 0.70 respectively.

[6] Email correspondence, Black Sluice IDB (Andy Scott), November 2023

[7] Flood Risk Assessments: climate change allowances (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances)

28. The CIRIA SuDS manual identifies commercial roofs (inverter/transformer stations and battery containers) as having a low pollution hazard level, as such minimal treatment measures would be required to treat the quality of the water.

29. SuDS elements within the curtilage of the solar farm would be the responsibility of the owner of the site. An indicative maintenance schedule is presented in **Table 3**.

Table 3: Maintenance Requirements

Schedule	Required action	Frequency
Type 3 Permeable Access Tracks		
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosphate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required
	Remedial work to any depressions and rutting considered detrimental to the structural performance or a hazard to users	
	Rehabilitation of surface and substructure	Every 10 to 15 years or as required
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth- if required, take remedial action	Three-monthly, 48h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate removal frequencies	Annually
Flow Control Unit		
Routine maintenance	Remove litter and debris and inspect for sediment accumulation	Six Monthly
	Remove sediment from sump	As necessary – Indicated by system inspections
Remedial actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operation	Six Monthly
	Inspect flow control unit and establish appropriate replacement frequencies	Six Monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first year of operation, then every six months

Proposed Foul Water Drainage Scheme

30. It is understood that there is no requirement for foul water drainage at this site.

FIGURES

Figure 1: Site Location

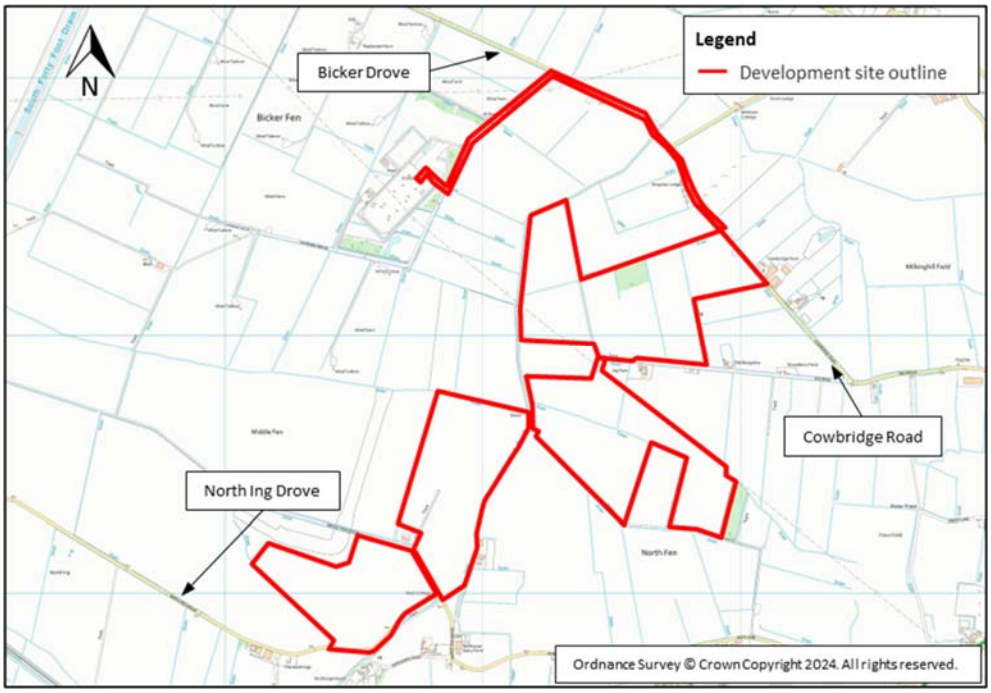


Figure 2: Digital Terrain Model from LiDAR Data

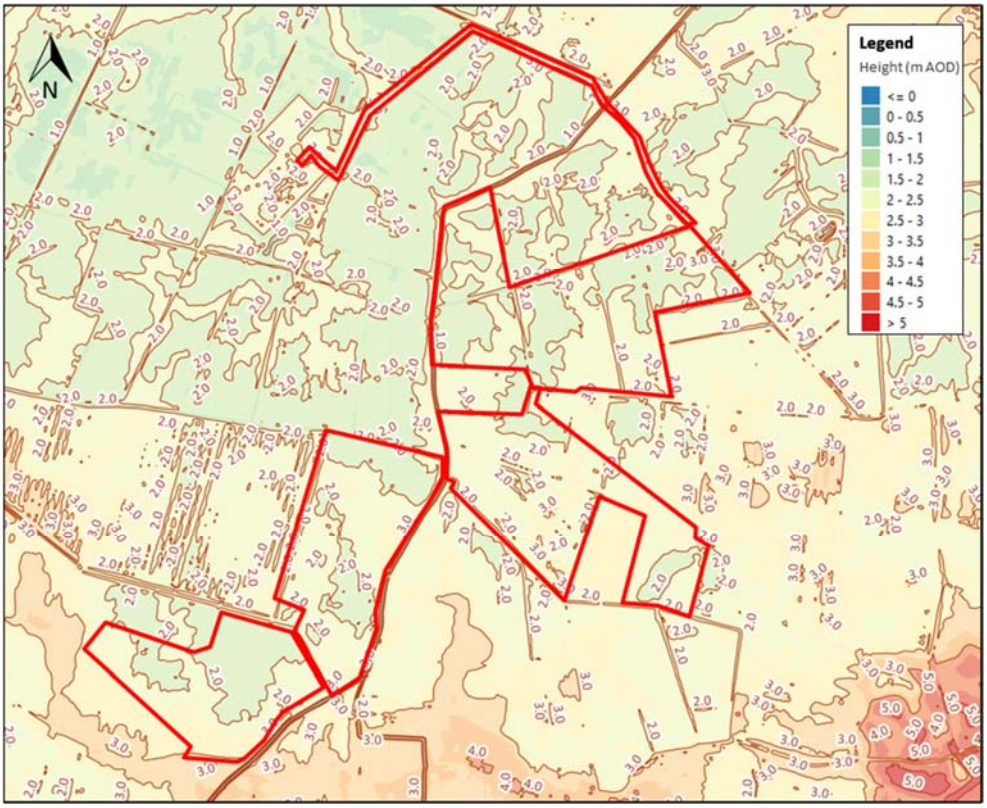
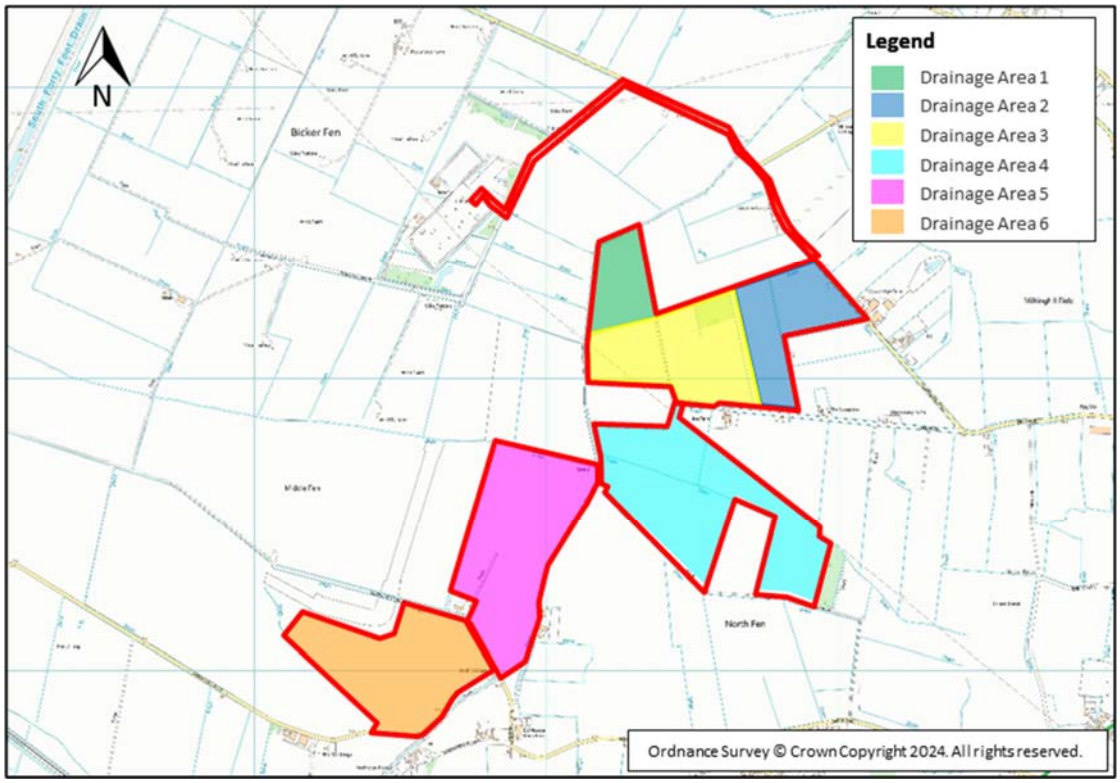


Figure 3: Indicative Drainage Areas



ANNEX 1

Proposed Site Plan

Q:\2901-2950\2920-01 Bicker Fen Solar Farm\Dwgs\CAD\Planning Drawings\2920-01-03 General Arrangement (RevE).dwg

•	Revision History	• Date
D	Battery storage layout updated	28-07-22
E	Access tracks and red line updated	04-08-22

- Application Boundary
- Photovoltaic Panels
- Deer / Stock Fence 2.1m
- Acoustic Fence 5m
- Solar Inverter / Transformer Station
- Solar Storage Building
- Solar Control Building
- Solar Switchgears Building
- Battery Storage Container
- Inverter / Transformer Station
- Control Building
- Switchgears Building
- Access Track
- Low Maintenance Pasture
- Species Rich Grassland
- Hedgerow
- Woodland Shelterbelt
- Existing ditch retained and enhanced
- Existing public right of way
- Existing pylon
- Proposed ditch crossing

Chester Office:
Well House Barns
Bretton
Chester
CH4 0DH

South Manchester Office:
Camellia House
76 Water Lane
Wilmslow
SK9 5BB

0844 8700 007 - www.axisped.co.uk

axis

client: AGR

project: BICKER FEN SOLAR FARM

drawing title: GENERAL ARRANGEMENT FULL LAYOUT

date:	drawn by:	checked:
FEBRUARY 2022	TR	PR
drawing number: 2920-01-03	status: --	
scale(s): 1:5,000@A2	rev: E	

planning environment design

ANNEX 2

Infiltration Testing

Environmental
Geotechnical
Specialists

RGS

SOAKAWAY
LETTER
REPORT

job number	C3956/23/E/5995
date	14/12/23
site address	Bicker Fen Solar Farm Spalding Lincolnshire PE11 4XY
written by	J.Finch
checked by	R.Palmer
issued by	J.Finch

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Rogers Geotechnical Services Ltd
Offices 1 & 2 Barncliffe Business Park, Near Bank, Shelley, Huddersfield, HD8 8LU
01484 604354 Company No. 5130864

Contents

Appendices

Report on Soakaway Testing

Location:	Bicker Fen Solar Farm Spalding, Lincolnshire, PE11 4XY		
For:	AGR Solar 2 Limited		
Report No.	C3956/23/E/5995	Report Date:	December 2023

For and on behalf of **Rogers Geotechnical Services Ltd**

James Finch BSc FGS Graduate Engineer	**Rob Palmer** MSc FGS ACIEH Senior Geo-environmental Engineer

Report Summary[1]

Item	Comments	Section
Geology	Tidal flat deposits over Oxford Clay Formation.	4.
Strata Conditions	Predominantly soft cohesive material, comprising silty CLAY and clayey SILT, with localised sands lenses. Granular material encountered in the base of TP02.	5.
Groundwater	Water strikes recorded within the cohesive material at depth ranging from surface to 1.6m.	5.
Suitability of Soakaways	Not recommended.	7.

[1] This summary should not be relied upon to provide a comprehensive review. All of the information contained in this document should be considered.

1. Introduction

We thank you for your request to undertake percolation testing at the above mentioned site and take pleasure in enclosing the results of this work. The investigation was undertaken on the 6th December 2023 in accordance with your instruction to proceed. This reports describes the work undertaken, presents the data obtained and discusses the results of the tests

2. Limitations

The recommendations made and opinions expressed in this report are based on the ground conditions revealed by the site works, together with an assessment of the site. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between trial pit positions, these are for guidance only and no liability can be accepted for their accuracy.

This report has been prepared in accordance with our understanding of current best practice. However, new information or legislation, or changes to best practice may necessitate revision of the report after the date of issue.

3. Fieldworks

Three trial pits were initially planned to be excavated in order to undertake soakaway testing at the positions proposed in the Statutory Plan (Drawing Number: 2920-01-02). The initial trial pits at TP01 and TP03 encountered rapid ingress of water due to strike of a land drain that hadn't been indicated on service plans and therefore the additional trial pits TP01A and TP03A were undertaken. The location of TP02 was moved to be adjacent to the access roads due to poor conditions within the fields. Rapid surface water inflow was encountered within this initial trial pit, and therefore TP02A was undertaken in the adjacent field. The initial positions TP01, TP02 and TP03 and the final positions TP01a, TP02a and TP03a are presented on a site plan in Appendix 1.

The soakaway tests were undertaken at the base of the trial pits TP01A, TP02A and TP03A at depths rational to the construction of soakaways. The soils exposed in the trial pits were logged on site in general accordance with BS5930: 2015 +A1: 2020, and full descriptions are given on the trial pit records which are presented in Appendix 2. Photographs of the trial pits are included within Appendix 3.

Once excavations were completed, the trial pits were carefully re-instated with the arisings. Whilst every care was taken during the infilling process, including compacting of the infill at regular intervals with the back acting arm of the excavator, it should be appreciated that some mounding of the surface may have resulted. Moreover, the infilled soils may be subjected to settlement over time, such that a depression in the surface may also occur. Therefore, the locations of any pits undertaken in this investigation should be conveyed to the current site user, as the mounds or depressions associated with the pits may present a risk to current site operations. Furthermore, it must be realised that the infilled pits represent an area of disturbance within the site soils, thus the soils at the pit locations may vary characteristically compared to the undisturbed ground. As such, foundations placed in this disturbed material may not perform as anticipated.

4. Geology

The available published geological data for the site has been examined and the following table presents the anticipated geology.

Table 1: Geological Data for the Site

Strata Type	Strata Name[2]	Previous Name[3]	Description[3]
Superficial Geology	Tidal Flat Deposits, 1 - Clay and Silt	-	Tidal flat deposits, including mud flat and sand flat deposits, form extensive nearly horizontal marshy land in the intertidal zone that is alternately covered and uncovered by the rise and fall of the tide. They consist of unconsolidated sediment, mainly mud and/or sand. They may form the top surface of a deltaic deposit.
Solid Geology	Oxford Clay Formation - Mudstone	Forest Clay Clunch Clay and Shale Fen Clay	Silicate-mudstone, grey, generally smooth to slightly silty, with sporadic beds of argillaceous limestone nodules.

5. Strata Conditions

In accordance with the geology of the area, the succession has been shown to include the following:

Table 2: Generalised Strata Profile

Depth m below ground level to underside of layer	**Strata Type**	**Positions Layer Revealed**	**Groundwater Strikes** m below ground level
0.3 – 0.4	Topsoil (Cohesive)	ALL	TP02
+0.4 – 2.4	Silty CLAY	TP01A, TP02, TP02A	TP02A
+1.2 - +1.8	Sandy SILT	TP03, TP03A	TP103
+1.2 – 2.1	Clayey SILT	TP01, TP01A	TP01A, TP01
+2.45	Clayey sandy GRAVEL	TP02A	None
+ 3	Sandy silty CLAY	TP01A	None

'+' denotes that the strata extended below the termination depth of the investigated positions, thus the extent of the deposit is only proven to the depths indicated.

[2] Sources: British Geological Survey (NERC) Map Sheets 78; Wakefield; Solid and Drift Edition, and Geology of Britain Viewer [*online resource from www.bgs.ac.uk*]
[3] Sources: British Geological Survey (NERC) Lexicon of Named Rock Units [*online resource from www.bgs.ac.uk*]

6. Insitu Testing

6.1 Soakaway Test

On reaching the elected soakaway test depth, the pit was trimmed and squared as much as practicable. Water was then introduced into the pit at a controlled rate to prevent collapse of the sides and the level monitored at time intervals relative to a reference bar at ground level. The results obtained from the soakaway tests are presented at Appendix 4 and are summarised below:

Table 3: Soakaway Test Results

Location	Soakage Area Dimensions (average) (m)	Depths of soaked strata (m)	Soil Description (of soaked strata)	Infiltration Rate (m/sec)	*Drainage Characteristics
TP01A	3.22	1.92 – 1.41	Side – Very soft dark brown clayey SILT. Base – *Very soft dark grey slightly sandy silty CLAY.*	N/A	Very Poor
TP02A	1.79	1.8 – 1.63	Side – Firm becoming soft dark grey and orangish brown silty CLAY. Base – *Light brown slightly clayey slightly gravelly medium SAND.*	N/A	Very Poor
TP03A	1.36	1.32 – 1.26	Side – Soft dark grey and orange brown sandy laminated silt. Base – As above	N/A	Very Poor

*Based on the most onerous results for each test.

During the soakaway tests the water level did not fall. Indeed, either due to water ingress or collapse within the pits, the water levels rose during every test. On this basis, the tests could not be completed within the scope of the method provided in BRE Digest 365.

7. Discussion

The soils encountered beneath the site were found to be typical of the Tidal Flat Deposits recorded on the published geological map. The strata conditions and subsequent drainage characteristics appear to be comparable across the site. In this instance, the infiltration testing has revealed that the soils have very poor drainage characteristics. Therefore, soakaways cannot be recommended at this site and an alternative form of drainage should be adopted.

8. References

- Building Research Establishment (BRE) Digest 365, *Soakaway Design*, September 1991.
- British Standards Institution (2015 +A1: 2020) BS 5930: *Code of practice for ground investigations*, B.S.I., London.
- Barnes, G. (2000). *Soil Mechanics Principle and Practice.* 2nd ed. London: Macmillan Press Ltd, p.47.