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Technical Note

Station Road, Great Shelford (21/05276/FUL)

Planning comments re. drainage - response

Project No.	1281
Revision	Rev A
Date	26/01/2022
Client	Churchill Retirement Living
Prepared	L Blackmore
Checked	C Yalden
Authorised	C Yalden
File Ref.	**P:\1281 Station Road, Great Shelford\C Documents\Reports\1281 - Station Road, Great Shelford - Drainage comments - response**

1 Introduction

1.1 This note is in response to the planning response comments received, relating to surface water and foul drainage, for 2 Station Road, Great Shelford, Cambridge, CB22 5LR, Planning reference number 21/05276/FUL.

References

1.2 Rebekah Dowd, Lead Local Flood Authority Officer (10/01/2022). Comments from Lead Local Flood Authority (LLFA), Doc no 201107097.

1.3 Sustainable Drainage Engineer (07/01/2022). Planning Consultation Response (Planning Applications), 21/05276/FUL.

1.4 Pre-Development Team, Anglian Water (23/12/2021). Planning Applications – Suggested information statements and conditions report.

1.5 T.G. Waddams, Planning Liaison, Environment Agency (EA) (18/01/2022). 21/05276 document AC/2021/130808/01-L01. Consultation response on planning application.

1.6 Awcock Ward Partnership (AWP) (10/11/2021). Station Road, Great Shelford, Flood risk and drainage technical note, RevB (submitted).

1.7 Interpave (2018). Design & construction of concrete block permeable pavements, Edition 7.

1.8 SLR (October 2018). Fuel depot, 2 Station Road, Great Shelford. Phase 1 Data Review and Preliminary Land Quality Assessment. Version No.: Draftv2. Submitted in support of planning application S-3809-19-FL.

2 Response to drainage comments received

2.1 The comments relating to drainage as received from the LLFA (10 January 2022), sustainable drainage engineer (7 January 2022), and Anglian Water (23 December 2021) are addressed and acknowledged in turn. The updated preliminary drainage layout (PDL), in response to the comments, supersedes the PDL submitted with the Flood risk and drainage technical note (AWP, 2021) as part of the planning submission (21/05276/FUL).

2.2 The updated preliminary drainage plan (PDL) is included in Appendix A.

LLFA

2.3 Comment 1: Surface Water Treatment. Appropriate pollution mitigation measures required.

2.4 Response LLFA-C1: The water quality from the proposed development is assessed in Section 3 of this note, based on the Simple Index Approach, with required changes applied to the PDL.

2.5 Comment 2: Discharge rate. Required discharge rate of 2l/s. Minimum size orifice of 20mm diameter allowed where risk of blockage from debris is minimal.

2.6 Response LLFA-C2: The attenuation tank capacity has been increased, and the flow control size reduced to achieve a 2l/s discharge rate. The PDL has been updated accordingly.

2.7 Comment 3: Drawings. Inconsistent layouts.

2.8 Response LLFA-C3: Apologies for any inconsistencies. The updated PDL (Appendix A) shows the proposed site layout.

Sustainable drainage engineer

2.9 Comment 1: Ground investigation of adjacent site.

2.10 Response SDW-C1: A geotechnical review is included in Appendix C, and based on the extensive investigations on the adjacent site, with water monitoring included on the proposed development site, infiltration features are not viable. Extracts from the 2018 report by SLR is included in Appendix D, which shows the groundwater table less than 2.5m below ground level.

2.11 Comment 2: Discharge rate. Required discharge rate of 2l/s.

2.12 Comment SDE-C2: Please see response LLFA-C2 above.

2.13 Comment 3: Modelling output for 1:100+CC; recommended to include 1:30; and 1:2 (no surcharge).

2.14 Response SDE-C3: The updated Microdrainage modelling output summary is included in Appendix B for 1:100+CC and now include output for the 1:30+CC and 1:2 year storm.

Anglian Water

2.15 Section 1: AW Assets Affected. None. (No action required).

2.16 Section 2: Wastewater Treatment. Insufficient capacity to treat flow, would be addressed to accept foul flows. (No action required).

2.17 Section 3: Used Water Network. Available capacity for foul flow. (No action required).

2.18 **Environment Agancy (EA)**

2.19 Comment 1: Site not considered to present a high pollution risk to controlled waters based on attenuation drainage proposed (no infiltration drainage proposed). (No action required).

3 Water Quality (Response LLFA-C1)

3.1 The surface water drainage strategy proposed (AWP, 2021) has been assessed below in line with current best practice, CIRIA C753, in terms of water quality for the individual residential development. Based on the Simple Index Approach in CIRIA SuDS Manual C753, the expected water quality for discharge to surface waters can be calculated based on given indices.

3.2 The pollution hazard indices for different land use classifications, Table 26.2 taken form CIRIA C753, show that low traffic roads, such as the access road for the development, has a 'Low' pollution hazard as summarised in Table 3.1.

3.3 The indicative SuDS mitigation indices for discharges to surface waters, Table 26.3 taken from CIRIA C753, has been consulted for values relating to proposed permeable pavements and are shown in Table 3.1.

Table 3.1: Site pollution hazard and mitigation indices

	TSS	Metals	Hydrocarbons
Pollution hazard			
Low (access road)	**0.5**	**0.4**	**0.4**
Mitigation indices			
Permeable Paving	0.7	0.6	0.7
*Only half of mitigation indices, for each secondary feature, to be used towards total mitigation.			

3.4 Based on Table 3.1 above, permeable paving would provide suitable water quality treatment for the access road.

3.5 The area ratio of impermeable to permeable paving has been improved, by providing additional areas (49.5m^2) of permeable paving in parking bays to the north of the site. This requires a suitable road camber to direct surface water flow to the permeable paved areas, which will be integrated with the detail design.

3.6 The impermeable road area (343.2m^2) is now less than twice the total area of permeable pavement (200.5m^2) across the site, which is spread along the access road. A ratio of impermeable to permeable of 2:1 is considered adequate for draining impermeable to permeable areas (Interpave, 2018) to prevent excessive silt loads onto the permeable paving and reduce the risk of surface clogging.

3.7 The additional permeable pavement is provided for pollution control only and has not been considered as part of the attenuation storage volume modelled.

4 Conclusion

4.1 The proposed surface water drainage strategies for 2 Station Road, Great Shelford, Cambridge, CB22 5LR, Planning reference number 21/05276/FUL has been revised based on the comments received from the LLFA, Sustainable drainage engineer and Anglian Water.

4.2 It is hoped that the adjusted strategy and additional information provided is suitable to allow planning approval.

Appendix A Updated PDL

Notes:

1. The proposed development has been assessed in line with the National Planning Policy Framework, to allow the planning application to be progressed and to show that the development can be undertaken in an acceptable manner from a flood risk perspective.

2. The proposed development is located within Flood Zone 1 and is not known to be susceptible to flooding from pluvial, groundwater, infrastructure or artificial sources.

3. To ensure the development is safe throughout its lifetime, the surface water strategy accounts for runoff in up to the 1 in 100 year return period.

4. The strategy also safeguards against climate change (40%), providing betterment over existing conditions, where the rate and volume of runoff would continue to increase due to climate change.

5. The existing site comprises made ground and is likely to be a risk of elevated groundwater which might preclude the use of infiltration drainage. For the purposes of this SWMP it is considered that surface water runoff will be attenuated on-site and discharged to the nearest and most appropriate receiving system.

6. At the discharge of conditions stage and to inform detailed design of the final drainage scheme, it is recommended that a ground investigation is completed and wherever practicable infiltration drainage is promoted.

7. The peak rates of runoff will be limited as close to greenfield as practicable, based on a minimum 100mm diameter flow control.

8. Runoff from the tank and under-drained permeable paving will pass through a new flow control chamber prior to discharging to the existing network via the existing site connection. This will be subject to a CCTV condition survey.

9. The proposed development achieves a substantial betterment compared to existing site conditions, as peak rates of discharge are limited to just 5.9 l/s peak in the 100 year return period storm with 40% climate change, compared to over 172 l/s from the existing brownfield site (97% betterment).

10. The proposed under-drained permeable paving and cellular attenuation will offer sufficient SuDS mitigation to offset the pollution indices for the site, in accordance with CIRIA C753.

11. The impermeable drained catchment will reduce through the development, also reducing the volume of runoff from the site.

12. Beyond the 100-year critical storm, exceedance runoff will be directed towards any residual areas of open space and/or car parking, where any aboveground storage can be utilised.

13. Foul flows generated by the proposed development will be served by the a new private gravity network, tying into an existing connection to the Anglian Sewer foul sewer network.

14. All on-site proposed drainage will remain private and will be designed in accordance with Building Regulations Part H and CIRIA C753 and will become the responsibility of the building operator.

15. As the development will be safe from flooding throughout its lifetime and will actively reduce the flood risk to properties within the downstream catchment, it is recommended that the Local Planning Authority confirm they have no objections to the proposed development.

Area Summary Schedule

Exist. Impermeable Catchment	0.302 ha
Net Developable Area	0.302 ha
Prop. Impermeable Catchment	0.185 ha
Prop. Percentage Impermeable	61%

Equivalent Greenfield Runoff Rates

The greenfield runoff rates have been assessed for the net developable area using the FEH Method. The calculation excludes large areas of open space which will remain undeveloped.

Return Period	Greenfield Rate (l/s)
2yr	0.14
30yr	0.38
100yr	0.56

Attenuation Summary

Complex Attenuation Feature

Catchment	0.185 ha
Hydraulic Control	Hydrobrake @IL+0.000 Ref: MD-SHE-0062-2000-1400-2000
Type	Cellular Storage with Under-drained Porous Parking
Cellular Storage Porosity	95%
Cellular Storage Dimensions	5.5 m x 20.5 m x 1.0 m deep
Porous Parking Porosity	30%
Porous Parking Dimensions	5.0 m x 30.0 m x 0.5 m deep
100yr+40% Volume Required:	**122.5 m³**
100yr+40% Discharge Rate:	**2.0 l/s**

Key

- Site Boundary

Existing Utilities

- Adopted Foul Water Sewer
- Private Surface Water Sewer
- Private Foul Water Sewer

Proposed Drainage

- Impermeable Building Catchment
- Impermeable Highway Catchment
- Underdrained Permeable Paving
- Cellular Storage Tank
- Private Surface Water Sewer
- 300Ø Oversized Private Surface Water Sewer
- Private Yard Gully and Connection
- Private Surface Inspection Chamber
- Flow Control Chamber
- Fin Drain
- Private Foul Water Sewer
- Private Foul Inspection Chamber
- Private Foul Manhole Chamber
- Overland exceedance drain
- Existing Drainage to be Abandoned

Foul Water Strategy

1. Foul Discharge

Generated foul flows are to connect into the existing private foul sewer within the development boundary before discharging into the Anglian Water adopted foul sewer beneath Station Road to the west.

2. Existing foul water network

Existing connection from adjacent site to be retained if live.

4101
CL - 18.5457
IL - 16.917

ST03 ST01 ST02 ST04

16 x Parking Spaces

Amenity

Amenity

Consented Care Home

SWMH1
CL 17.980
IL 16.530

SWMH2

Exceedance Flows

Beyond the capacity of the site, flows would continue off-site as per existing brownfield conditions, albeit at a reduced rate or volume.

Surface Water Strategy:

1. Maintenance

Geocellular Attenuation to be fitted with access turrets for maintenance of feature. Minimum 1no. cover to be vented in accordance with manufacturer recommendations.

2. Cellular Attenuation

Cellular tank to receive flows from external hard paving and roof catchments. Chambers immediately upstream of tank to include silt traps.

3. Flow Control

Proposed surface water control chamber to restrict flows up to 100yr return period and discharge up to 2.0 l/s (as agreed with LLFA). Controlled flows are proposed to discharge into the surface water network to the south east within the extents of the proposed development. 300Ø oversized pipe to enable surcharged runoff to back up to the attenuation tank within the amenity area, and permeable paving within the parking court.

4. Underdrained Permeable Paving

Proposed underdrained permeable paving to receive surface runoff from access road and parking court. To provide treatment and further storage upstream of proposed cellular attenuation tank with fin drain to convey flows into the surface water network.

5. Surface Water Discharge

Retained private surface water connection to the existing on-site surface water network.

REV	DATE	DESCRIPTION	BY	CHK	APD
C	18.01.2021	PLANNING COMMENTS CONSIDERED	VGS	LB	CY
B	10.11.2021	UPDATED LAYOUT AND DRAINAGE TO SUIT	RF	LB	CY
A	02.11.2021	INITIAL ISSUE	TG	LB	CY

CLIENT: CHURCHILL RETIREMENT LIVING

DRAWING STATUS: PLANNING APPLICATION

PROJECT: STATION ROAD, GREAT SHELFORD

TITLE: PRELIMINARY DRAINAGE LAYOUT

PROJECT No:	DRAWING No:	REV:
1281	01-PDL-1001	C

SCALE @ A1: 0 1:200 10 metres

DESIGN BY:

awcockward partnership

Awcock Ward Partnership, Ada House, Pynes Hill, Exeter, EX2 5TU
Tel: 01392 409007 Web: www.awpexeter.com

Appendix B Microdrainage output summary

Summary of Results for 2 year Return Period (+40%)

Half Drain Time : 181 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	16.796	0.146	0.0	1.6	1.6	15.6	O K
30 min Summer	16.825	0.175	0.0	1.6	1.6	18.7	O K
60 min Summer	16.847	0.197	0.0	1.6	1.6	21.1	O K
120 min Summer	16.896	0.246	0.0	1.6	1.6	26.3	O K
180 min Summer	16.906	0.256	0.0	1.6	1.6	27.4	O K
240 min Summer	16.905	0.255	0.0	1.6	1.6	27.3	O K
360 min Summer	16.893	0.243	0.0	1.6	1.6	26.0	O K
480 min Summer	16.876	0.226	0.0	1.6	1.6	24.1	O K
600 min Summer	16.858	0.208	0.0	1.6	1.6	22.2	O K
720 min Summer	16.839	0.189	0.0	1.6	1.6	20.2	O K
960 min Summer	16.804	0.154	0.0	1.6	1.6	16.5	O K
1440 min Summer	16.748	0.098	0.0	1.6	1.6	10.5	O K
2160 min Summer	16.694	0.044	0.0	1.6	1.6	4.7	O K
2880 min Summer	16.664	0.014	0.0	1.5	1.5	1.5	O K
4320 min Summer	16.650	0.000	0.0	1.3	1.3	0.0	O K
5760 min Summer	16.650	0.000	0.0	1.1	1.1	0.0	O K
7200 min Summer	16.650	0.000	0.0	0.9	0.9	0.0	O K
8640 min Summer	16.650	0.000	0.0	0.8	0.8	0.0	O K
10080 min Summer	16.650	0.000	0.0	0.8	0.8	0.0	O K
15 min Winter	16.816	0.166	0.0	1.6	1.6	17.8	O K
30 min Winter	16.851	0.201	0.0	1.6	1.6	21.5	O K
60 min Winter	16.878	0.228	0.0	1.6	1.6	24.4	O K
120 min Winter	16.941	0.291	0.0	1.6	1.6	31.1	O K
180 min Winter	16.958	0.308	0.0	1.6	1.6	33.0	O K
240 min Winter	16.956	0.306	0.0	1.6	1.6	32.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	51.369	0.0	17.0	18
30 min Summer	32.066	0.0	21.4	32
60 min Summer	19.530	0.0	26.3	62
120 min Summer	13.578	0.0	36.9	120
180 min Summer	10.525	0.0	43.0	158
240 min Summer	8.639	0.0	47.0	190
360 min Summer	6.393	0.0	52.2	254
480 min Summer	5.097	0.0	55.6	324
600 min Summer	4.254	0.0	58.0	390
720 min Summer	3.660	0.0	59.9	456
960 min Summer	2.876	0.0	62.7	586
1440 min Summer	2.050	0.0	67.1	836
2160 min Summer	1.473	0.0	72.1	1188
2880 min Summer	1.175	0.0	76.5	1504
4320 min Summer	0.871	0.0	84.9	0
5760 min Summer	0.715	0.0	92.7	0
7200 min Summer	0.621	0.0	100.4	0
8640 min Summer	0.558	0.0	108.0	0
10080 min Summer	0.513	0.0	115.6	0
15 min Winter	51.369	0.0	19.2	18
30 min Winter	32.066	0.0	24.1	32
60 min Winter	19.530	0.0	29.6	60
120 min Winter	13.578	0.0	41.3	118
180 min Winter	10.525	0.0	48.2	172
240 min Winter	8.639	0.0	52.9	224

Summary of Results for 2 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	16.936	0.286	0.0	1.6	1.6	30.6	O K
480 min Winter	16.911	0.261	0.0	1.6	1.6	27.9	O K
600 min Winter	16.884	0.234	0.0	1.6	1.6	25.0	O K
720 min Winter	16.856	0.206	0.0	1.6	1.6	22.0	O K
960 min Winter	16.804	0.154	0.0	1.6	1.6	16.4	O K
1440 min Winter	16.724	0.074	0.0	1.6	1.6	7.9	O K
2160 min Winter	16.659	0.009	0.0	1.5	1.5	1.0	O K
2880 min Winter	16.650	0.000	0.0	1.3	1.3	0.0	O K
4320 min Winter	16.650	0.000	0.0	0.9	0.9	0.0	O K
5760 min Winter	16.650	0.000	0.0	0.8	0.8	0.0	O K
7200 min Winter	16.650	0.000	0.0	0.7	0.7	0.0	O K
8640 min Winter	16.650	0.000	0.0	0.6	0.6	0.0	O K
10080 min Winter	16.650	0.000	0.0	0.6	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	6.393	0.0	58.7	278
480 min Winter	5.097	0.0	62.4	352
600 min Winter	4.254	0.0	65.1	426
720 min Winter	3.660	0.0	67.3	496
960 min Winter	2.876	0.0	70.3	628
1440 min Winter	2.050	0.0	75.2	868
2160 min Winter	1.473	0.0	80.9	1172
2880 min Winter	1.175	0.0	86.0	0
4320 min Winter	0.871	0.0	95.4	0
5760 min Winter	0.715	0.0	104.1	0
7200 min Winter	0.621	0.0	112.8	0
8640 min Winter	0.558	0.0	121.4	0
10080 min Winter	0.513	0.0	130.0	0

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 546487 252112 TL 46487 52112	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.185

Time (mins) From:	To:	Area (ha)
0	4	0.185

Model Details

Storage is Online Cover Level (m) 18.350

Complex Structure

Cellular Storage

Invert Level (m) 16.650 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	112.5	50.0	1.000	112.5	80.0	1.001	0.0	80.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	30.0
Max Percolation (l/s)	41.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.550	Cap Volume Depth (m)	0.500

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0062-2000-1400-2000
Design Head (m)	1.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	62
Invert Level (m)	16.530
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.400	2.0	Kick-Flo®	0.553	1.3
Flush-Flo™	0.272	1.6	Mean Flow over Head Range	-	1.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.4	0.800	1.6	2.000	2.4	4.000	3.2	7.000	4.2
0.200	1.6	1.000	1.7	2.200	2.5	4.500	3.4	7.500	4.4
0.300	1.6	1.200	1.9	2.400	2.6	5.000	3.6	8.000	4.5
0.400	1.6	1.400	2.0	2.600	2.7	5.500	3.8	8.500	4.6
0.500	1.5	1.600	2.1	3.000	2.8	6.000	3.9	9.000	4.7
0.600	1.4	1.800	2.2	3.500	3.0	6.500	4.1	9.500	4.9

Summary of Results for 30 year Return Period (+40%)

Half Drain Time : 463 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	17.010	0.360	0.0	1.6	1.6	38.5	O K
30 min Summer	17.105	0.455	0.0	1.6	1.6	48.6	O K
60 min Summer	17.185	0.535	0.0	1.6	1.6	57.1	O K
120 min Summer	17.289	0.639	0.0	1.6	1.6	68.2	O K
180 min Summer	17.327	0.677	0.0	1.6	1.6	72.4	O K
240 min Summer	17.336	0.686	0.0	1.6	1.6	73.3	O K
360 min Summer	17.314	0.664	0.0	1.6	1.6	70.9	O K
480 min Summer	17.276	0.626	0.0	1.6	1.6	66.9	O K
600 min Summer	17.244	0.594	0.0	1.6	1.6	63.4	O K
720 min Summer	17.215	0.565	0.0	1.6	1.6	60.4	O K
960 min Summer	17.165	0.515	0.0	1.6	1.6	55.1	O K
1440 min Summer	17.072	0.422	0.0	1.6	1.6	45.1	O K
2160 min Summer	16.951	0.301	0.0	1.6	1.6	32.2	O K
2880 min Summer	16.864	0.214	0.0	1.6	1.6	22.9	O K
4320 min Summer	16.753	0.103	0.0	1.6	1.6	11.0	O K
5760 min Summer	16.695	0.045	0.0	1.6	1.6	4.8	O K
7200 min Summer	16.664	0.014	0.0	1.5	1.5	1.5	O K
8640 min Summer	16.650	0.000	0.0	1.5	1.5	0.0	O K
10080 min Summer	16.650	0.000	0.0	1.3	1.3	0.0	O K
15 min Winter	17.056	0.406	0.0	1.6	1.6	43.4	O K
30 min Winter	17.165	0.515	0.0	1.6	1.6	55.0	O K
60 min Winter	17.258	0.608	0.0	1.6	1.6	65.0	O K
120 min Winter	17.380	0.730	0.0	1.6	1.6	78.0	O K
180 min Winter	17.429	0.779	0.0	1.6	1.6	83.2	O K
240 min Winter	17.446	0.796	0.0	1.6	1.6	85.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	117.532	0.0	40.0	19
30 min Summer	75.227	0.0	51.3	33
60 min Summer	45.668	0.0	62.4	64
120 min Summer	28.748	0.0	78.9	122
180 min Summer	21.441	0.0	88.4	182
240 min Summer	17.229	0.0	94.7	242
360 min Summer	12.458	0.0	102.8	360
480 min Summer	9.803	0.0	107.9	412
600 min Summer	8.112	0.0	111.5	476
720 min Summer	6.938	0.0	114.5	536
960 min Summer	5.411	0.0	119.1	672
1440 min Summer	3.810	0.0	125.6	940
2160 min Summer	2.701	0.0	133.4	1316
2880 min Summer	2.132	0.0	140.4	1672
4320 min Summer	1.555	0.0	153.2	2376
5760 min Summer	1.261	0.0	165.4	3056
7200 min Summer	1.085	0.0	177.6	3680
8640 min Summer	0.967	0.0	189.8	4400
10080 min Summer	0.884	0.0	202.1	0
15 min Winter	117.532	0.0	44.8	19
30 min Winter	75.227	0.0	57.7	33
60 min Winter	45.668	0.0	70.2	62
120 min Winter	28.748	0.0	88.4	120
180 min Winter	21.441	0.0	99.1	178
240 min Winter	17.229	0.0	106.2	236

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	17.434	0.784	0.0	1.6	1.6	83.7	O K
480 min Winter	17.395	0.745	0.0	1.6	1.6	79.6	O K
600 min Winter	17.349	0.699	0.0	1.6	1.6	74.7	O K
720 min Winter	17.312	0.662	0.0	1.6	1.6	70.8	O K
960 min Winter	17.248	0.598	0.0	1.6	1.6	63.9	O K
1440 min Winter	17.123	0.473	0.0	1.6	1.6	50.6	O K
2160 min Winter	16.938	0.288	0.0	1.6	1.6	30.8	O K
2880 min Winter	16.813	0.163	0.0	1.6	1.6	17.4	O K
4320 min Winter	16.682	0.032	0.0	1.5	1.5	3.5	O K
5760 min Winter	16.650	0.000	0.0	1.4	1.4	0.0	O K
7200 min Winter	16.650	0.000	0.0	1.2	1.2	0.0	O K
8640 min Winter	16.650	0.000	0.0	1.1	1.1	0.0	O K
10080 min Winter	16.650	0.000	0.0	1.0	1.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	12.458	0.0	115.3	346
480 min Winter	9.803	0.0	121.0	452
600 min Winter	8.112	0.0	125.1	500
720 min Winter	6.938	0.0	128.4	564
960 min Winter	5.411	0.0	133.5	722
1440 min Winter	3.810	0.0	140.8	1026
2160 min Winter	2.701	0.0	149.5	1404
2880 min Winter	2.132	0.0	157.4	1756
4320 min Winter	1.555	0.0	171.8	2376
5760 min Winter	1.261	0.0	185.6	0
7200 min Winter	1.085	0.0	199.3	0
8640 min Winter	0.967	0.0	213.0	0
10080 min Winter	0.884	0.0	226.9	0

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 546487 252112 TL 46487 52112	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.185

Time (mins) From:	To:	Area (ha)
0	4	0.185

Model Details

Storage is Online Cover Level (m) 18.350

Complex Structure

Cellular Storage

Invert Level (m) 16.650 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	112.5	50.0	1.000	112.5	80.0	1.001	0.0	80.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	30.0
Max Percolation (l/s)	41.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.550	Cap Volume Depth (m)	0.500

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0062-2000-1400-2000
Design Head (m)	1.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	62
Invert Level (m)	16.530
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.400	2.0	Kick-Flo®	0.553	1.3
Flush-Flo™	0.272	1.6	Mean Flow over Head Range	-	1.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.4	0.800	1.6	2.000	2.4	4.000	3.2	7.000	4.2
0.200	1.6	1.000	1.7	2.200	2.5	4.500	3.4	7.500	4.4
0.300	1.6	1.200	1.9	2.400	2.6	5.000	3.6	8.000	4.5
0.400	1.6	1.400	2.0	2.600	2.7	5.500	3.8	8.500	4.6
0.500	1.5	1.600	2.1	3.000	2.8	6.000	3.9	9.000	4.7
0.600	1.4	1.800	2.2	3.500	3.0	6.500	4.1	9.500	4.9

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 602 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	17.129	0.479	0.0	1.6	1.6	51.2	O K
30 min Summer	17.260	0.610	0.0	1.6	1.6	65.2	O K
60 min Summer	17.378	0.728	0.0	1.6	1.6	77.9	O K
120 min Summer	17.531	0.881	0.0	1.7	1.7	94.1	O K
180 min Summer	17.586	0.936	0.0	1.8	1.8	101.7	O K
240 min Summer	17.609	0.959	0.0	1.8	1.8	105.2	O K
360 min Summer	17.611	0.961	0.0	1.8	1.8	105.5	O K
480 min Summer	17.586	0.936	0.0	1.8	1.8	101.7	O K
600 min Summer	17.555	0.905	0.0	1.7	1.7	97.0	O K
720 min Summer	17.517	0.867	0.0	1.7	1.7	92.7	O K
960 min Summer	17.449	0.799	0.0	1.7	1.7	85.4	O K
1440 min Summer	17.338	0.688	0.0	1.6	1.6	73.5	O K
2160 min Summer	17.205	0.555	0.0	1.6	1.6	59.3	O K
2880 min Summer	17.085	0.435	0.0	1.6	1.6	46.5	O K
4320 min Summer	16.889	0.239	0.0	1.6	1.6	25.5	O K
5760 min Summer	16.779	0.129	0.0	1.6	1.6	13.8	O K
7200 min Summer	16.718	0.068	0.0	1.6	1.6	7.3	O K
8640 min Summer	16.683	0.033	0.0	1.5	1.5	3.5	O K
10080 min Summer	16.662	0.012	0.0	1.5	1.5	1.3	O K
15 min Winter	17.188	0.538	0.0	1.6	1.6	57.5	O K
30 min Winter	17.338	0.688	0.0	1.6	1.6	73.5	O K
60 min Winter	17.473	0.823	0.0	1.7	1.7	87.9	O K
120 min Winter	17.622	0.972	0.0	1.8	1.8	107.1	O K
180 min Winter	17.760	1.110	0.0	1.9	1.9	116.4	O K
240 min Winter	17.859	1.209	0.0	2.0	2.0	120.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	154.100	0.0	52.6	19
30 min Summer	99.217	0.0	68.0	34
60 min Summer	60.715	0.0	83.5	64
120 min Summer	38.326	0.0	105.4	122
180 min Summer	28.794	0.0	119.0	182
240 min Summer	23.270	0.0	128.3	242
360 min Summer	16.940	0.0	140.1	360
480 min Summer	13.365	0.0	147.3	460
600 min Summer	11.059	0.0	152.5	510
720 min Summer	9.444	0.0	156.1	570
960 min Summer	7.324	0.0	161.4	694
1440 min Summer	5.085	0.0	168.1	968
2160 min Summer	3.529	0.0	174.9	1384
2880 min Summer	2.736	0.0	180.5	1788
4320 min Summer	1.941	0.0	191.8	2464
5760 min Summer	1.543	0.0	202.8	3168
7200 min Summer	1.309	0.0	214.9	3816
8640 min Summer	1.157	0.0	227.6	4496
10080 min Summer	1.050	0.0	240.9	5144
15 min Winter	154.100	0.0	59.0	19
30 min Winter	99.217	0.0	76.3	33
60 min Winter	60.715	0.0	93.5	62
120 min Winter	38.326	0.0	118.2	120
180 min Winter	28.794	0.0	133.4	178
240 min Winter	23.270	0.0	143.8	236

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	17.896	1.246	0.0	2.0	2.0	122.5	O K
480 min Winter	17.835	1.185	0.0	1.9	1.9	119.7	O K
600 min Winter	17.732	1.082	0.0	1.9	1.9	115.1	O K
720 min Winter	17.639	0.989	0.0	1.8	1.8	109.7	O K
960 min Winter	17.575	0.925	0.0	1.8	1.8	99.9	O K
1440 min Winter	17.439	0.789	0.0	1.6	1.6	84.3	O K
2160 min Winter	17.252	0.602	0.0	1.6	1.6	64.3	O K
2880 min Winter	17.072	0.422	0.0	1.6	1.6	45.1	O K
4320 min Winter	16.802	0.152	0.0	1.6	1.6	16.3	O K
5760 min Winter	16.687	0.037	0.0	1.5	1.5	3.9	O K
7200 min Winter	16.650	0.000	0.0	1.4	1.4	0.0	O K
8640 min Winter	16.650	0.000	0.0	1.3	1.3	0.0	O K
10080 min Winter	16.650	0.000	0.0	1.1	1.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	16.940	0.0	156.9	350
480 min Winter	13.365	0.0	165.1	458
600 min Winter	11.059	0.0	170.8	564
720 min Winter	9.444	0.0	175.1	650
960 min Winter	7.324	0.0	181.1	740
1440 min Winter	5.085	0.0	188.4	1050
2160 min Winter	3.529	0.0	195.9	1496
2880 min Winter	2.736	0.0	202.5	1932
4320 min Winter	1.941	0.0	215.0	2548
5760 min Winter	1.543	0.0	227.6	3168
7200 min Winter	1.309	0.0	241.2	0
8640 min Winter	1.157	0.0	255.4	0
10080 min Winter	1.050	0.0	270.3	0

Rainfall Details

Rainfall Model	FEH	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
FEH Rainfall Version	2013	Cv (Winter)	0.840
Site Location	GB 546487 252112 TL 46487 52112	Shortest Storm (mins)	15
Data Type	Point	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.185

Time (mins) From:	To:	Area (ha)
0	4	0.185

Model Details

Storage is Online Cover Level (m) 18.350

Complex Structure

Cellular Storage

Invert Level (m) 16.650 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	112.5	50.0	1.000	112.5	80.0	1.001	0.0	80.0

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	30.0
Max Percolation (l/s)	41.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.550	Cap Volume Depth (m)	0.500

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0062-2000-1400-2000
Design Head (m)	1.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	62
Invert Level (m)	16.530
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.400	2.0	Kick-Flo®	0.553	1.3
Flush-Flo™	0.272	1.6	Mean Flow over Head Range	-	1.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.4	0.800	1.6	2.000	2.4	4.000	3.2	7.000	4.2
0.200	1.6	1.000	1.7	2.200	2.5	4.500	3.4	7.500	4.4
0.300	1.6	1.200	1.9	2.400	2.6	5.000	3.6	8.000	4.5
0.400	1.6	1.400	2.0	2.600	2.7	5.500	3.8	8.500	4.6
0.500	1.5	1.600	2.1	3.000	2.8	6.000	3.9	9.000	4.7
0.600	1.4	1.800	2.2	3.500	3.0	6.500	4.1	9.500	4.9

Appendix C Geotechnical review

Crossfield
CONSULTING
GEOTECHNICAL ENVIRONMENTAL

CHURCHILL RETIREMENT LIVING

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April 2021
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CONTENTS

1. INTRODUCTION

It is proposed to develop a site off Station Road, Great Shelford for residential purposes. The site is currently occupied by several commercial properties (predominantly offices) and a car park. It is understood that the proposed development will comprise a three-storey block of apartments together with car parking and managed soft landscaping. Residents will be of retirement age.

Crossfield Consulting has been commissioned by Churchill Retirement Living to undertake a Desk Study Appraisal of the site to identify possible constraints to the development relating to ground conditions as indicated at the site.

The desk study includes a review of historical maps of the site and surrounding area and an appraisal of the published geological data and information from regulatory authorities. The report presents the results of the study, together with an assessment of the likely ground conditions, including a Preliminary Risk Assessment (PRA) of potential contamination (with a Conceptual Site Model), and an initial appraisal of foundation solutions.

The report has been prepared under the direction and supervision of a Registered Specialist in Land Condition (SiLC).

It is considered that the report complies with the National Planning Policy Framework and is in general accordance with guidance published by the Environment Agency and NHBC together with Policy SC/11: Contaminated Land of South Cambridgeshire Council.

2. THE SITE

2.1 Location

The site is located to the east of Station Road and just to the north of the centre of Great Shelford, and approximately 2km to the south of Cambridge, as shown on Figure 1. The National Grid Reference for the site is TL 4649 5211.

The site is bounded by recently constructed terraced properties/town houses to the north and Station Road to the west. Along the eastern boundary of the site, is a railway line, which appears to be located slightly below site ground levels in a shallow cutting. To the south of the site, is a petroleum fuel depot/distribution centre, which includes several above-ground large bulk tanks, road tanker loading areas, yard and offices.

The general area appears to slope very gently down to the southwest, and towards the River Cam (also known as the Granta), which is approximately 450 m south and southwest of the site.

2.2 Site Description

The following site description is based on the current Ordnance Survey Plan, presented as Figure 2, and photographs accessible via internet-based mapping sites. No site reconnaissance has been undertaken by staff from Crossfield Consulting Limited.

The site is irregular in plan and occupies an area of approximately 0.3 ha. The site and the general surrounding areas appear to be sloping gently down to the southwest.

The site includes several separate single storey and up to three-storey office buildings. The building within the eastern part of the site is understood to be associated with offices for a refrigeration and air conditioning company. The office building within the southern part of the site is associated with an advisory company and all the other offices are vacant. The remaining central part of the site is a car park for the surrounding offices and appears to be asphalt surfaced. There are some decorative bushes present within the southeastern corner and trees in the northeastern corner, but vegetation is largely absent from the site. Bushes are also present along the eastern site boundary with the railway.

2.3 Site History

The site history has been researched with reference to old editions of the County Series and National Grid Ordnance Survey Plans obtained from Emapsite. Extracts from a selection of these plans are presented in Appendix I. The plans indicate that the following development has taken place on and around the site.

The earliest available County Series plan, dated 1886, shows that the site was occupied by several linear buildings, positioned around the perimeter of the site. A pump is recorded immediately beyond the northern site boundary, and is associated with the Railway Inn. Railway lines are present in a shallow cutting immediately to the east of the site, with two sidings extending within the eastern margin of the site. Beyond these, are running lines associated with Shelford Junction, where the lines diverge, south of the site.

By 1903, some residential development had occurred to the west. Two small gravel pits were recorded approximately 200 m to the northeast of the site and beyond the railway.

The 1946 map edition recorded a larger commercial building to the south of the site and by 1959, additional structures were present to the south of the site. The site itself appears to have remained large unchanged.

The 1970 National Grid plan shows a larger building within the eastern part of the site and the buildings within the southern part of the site were associated with a flour mill. Within the eastern margin of the site, the railway sidings had been removed by this date. Immediately south of the site, a fuel depot is recordedand included large above-ground tanks. An electricity substation is indicated immediately north of the site. Substantial residential development had occurred in the general area by this time, including covering the former area of gravel pits.

By 1985, the properties within the site had been identified as a corn mill, and some additional buildings had been constructed at the site. The large building in the eastern margin of the site had been extended by this date, and now extended over the area of the former railway sidings.

The 1992 National Grid plan shows the site as being occupied by a depot and some of the smaller buildings towards the centre of the site had been demolished.

On the basis of available reports regarding the adjoining fuel depot (as referenced), it is understood that the fuel depot was reconfigured with the installation of new above-ground tanks in the early 1990s. Fuel storage then comprised 11 tanks and a total capacity of approximately 500,000 litres, with storage of kerosene, gas oil and diesel together with much smaller quantities of paraffin and waste oil. It is understood that the facility does not include underground tanks.

There are no significant changes shown on site on the 2003 map. However, between 2003 and 2007, the depot building had been demolished and replaced by a small office building, as now present. Since 2008, the Railway Inn and associated car park was redeveloped with housing.

It is noted that the current office buildings along the western and southern margins of the site occupy the same areas as the buildings recorded in 1880s and appear to be essentially the same structures that have been substantially refurbished. The form of the buildings and their names are indicative of their former use, with *The Stables* along the western margin of the site and *Granary House* on the southern side of the site.

3. PUBLISHED GEOLOGY

Geological map data published by the British Geological Survey (BGS) online and in print, on 1:50,000 scale Sheet No. 205 (Saffron Walden), indicates that superficial deposits below the site comprise sand and gravels of River Terrace Deposits.

The solid strata indicated below the site comprise the lowest beds of the Upper Cretaceous Zig Zag Chalk Formation, described as grey chalk. Along the western margin of the site, the thin Totternhoe Stone Member is recorded at crop (a fine calcarenite chalk). On the western side of Station Road, the West Melbury Marly Chalk Formation is recorded (and extends below the Totternhoe Stone Member), and is described as marly chalk with limestone. These chalk strata are indicated to be of approximately 25 m to 30 m thickness and are underlain by the thin Cambridge Green Sand and much thicker Gault Clay strata. The general strata dip is gently down to the southeast.

4. DESK STUDY ENQUIRIES

4.1 Information Sources

Enquiries were made to the GroundSure Environmental and Geological Databases, the Environment Agency,DEFRA and the British Geological Survey (BGS) regarding the site and surrounding area. Information obtained from these enquiries is presented in Appendix II and summarised below. In addition, information has been obtained from the local planning portal and relates primarily to the adjoining fuel depot site, but includes some data located within the site, and relevant factual records are presented in Appendix III.

4.2 Information From Groundsure (including Environment Agency, DEFRA etc) and British Geological Survey

There are no current or historical landfills listed within 250 m of the site boundaries. There are four records of operations within the site having been granted waste exemptions. These relate to either the storage of waste in secure containers or in a secure place.

The database on current industrial land use lists the refrigeration and air conditioning company at the site, though this is just the head office for the company rather than where industrial manufacturing takes place. An electricity substation is recorded immediately east of the site (and is likely to be associated with the adjoining railway line). Shelford Energy, a fuel distributor, is identified as the fuel depot operator to the south and is listed in connection with Discharges of substances identified on List II of European Directive E 2006/11/EC, and regulated under the Environmental Damage (Prevention and Remediation) Regulations 2015.

There are no sites determined as Contaminated Land under Part 2A of the Environmental Protection Act (1990) within 500 m of the site. There are no pollution incidents or facilities with other permits listed within 250 m.

Hydrogeological information indicates that the superficial deposits are classified as a ‘Secondary A’ aquifer. The solid strata, beneath the site, are classified as a ‘Principal’ aquifer. The site does not lie within a

groundwater Source Protection Zone. There are no active groundwater abstraction licences recorded within 1 km of the site.However, a historical record is listed for a facility 480 m southwest of the site.

The nearest active surface water abstraction licence relates to spray irrigation from the River Cam located 553 m south of the site.

With reference to the Water Framework Directive and associated defined surface water bodies, it is noted that the site lies very close to the boundary between catchments. The Environment Agency classifies the surface water body (Granta overview) as 'moderate' quality, although recent (2019) chemical data records "Fail" status. The relevant Groundwater body (Cam and Ely Ouse Chalk overview) is consistently rated 'Poor' quality. The relevant online map published by DEFRA/Magic indicates that the site does not lie within a designated Drinking water Safeguard Zone for surface water or groundwater.

The site does not lie within a flood Zone 2 or Zone 3, as designated by the Environment Agency.

The site is located within a Nitrate Vulnerable Zone, as also identified in the WFD data and this designation usually related to farming restrictions. There are no other environmentally sensitive land or property classifications associated with the site or immediate surroundings.

Natural ground subsidence related hazards below the site have been given a hazard rating of 'very low' by the BGS in relation to ground dissolution of soluble rocks. In this category, few dissolution features are likely to be present, such that the BGS does not advise specific consideration of such features.

There are no current or historical mine workings recorded on, or within close proximity to, the site. With reference to the BGS databases of non-coal mining, the eastern half of the site extends into a BGS Class A area, (the lowest hazard category) where sporadic underground mining of chalk of restricted extent may have occurred (and remain unrecorded). The BGS state that the potential for difficult ground conditions are unlikely and need not be considered. Across the reminder of the site, the BGS considers that the classification of mining risk is so low as not to bewarranted. No natural cavities or mining-related features are recorded within 1 km of the site.

The BRE Document BR211 – *Radon: Guidance on Protective Measures for New Buildings* (2015) and GroundSure geological database information indicates that the site is not within an area where radon precautions are required in new buildings.

With reference to the BGS database of estimated background soil chemistry, it is noted that a relatively high lead concentration of 100 mg/kg is indicated for the Great Shelford area.

A record of a borehole located to the north of the site has been obtained from the BGS. The borehole log records a 3 m thickness of coarse gravel underlain by chalk to 30 m depth. Blue clay of the Gault Formation underlies the chalk to 83 m depth and sandstone/ironstone of the Lower Greensand Formation is recorded to 85 m depth. Groundwater was recorded at approximately 2 m depth in 1960.

4.3 Information Relating to the Site and Adjoining Oil Depot

Appendix III includes relevant factual records as relating to the development site from ground investigations undertaken in 2008 and 2015 and which extended within the site, together with summary data of groundwater monitoring data over the period 2009 to 2018 both within the site and extending into the adjoining fuel depot area, to the south. The associated reports are listed in the References. It is noted that the strata descriptions on these exploratory hole records are not compliant with BS5930 (such that strata strength etc are not accurately recorded).

A number of phases of ground investigation and monitoring have been undertaken, and some data is available for the period 2009 to 2018.

It is understood that some remediation works were carried out in the fuel depot, and it is understood that groundwater treatment was undertaken between 2009 and 2014. This is reported to have comprised a combination of oil skimming and total fluids "pump and treat" with the objective of reducing the thickness of LNAPL floating on groundwater. There is reference to "over 8 million litres (8,000 cubic metres) of groundwater" having been treated and 1,080 litres of oil removed, with a corresponding reduction in LNAPL thicknesses to "a few millimetres" by system closure in 2014. Full details of these works are not currently available and there is no reference to a verification or completion report, nor to any permits/regulatory acceptance of the works.

Only limited documentation is available, and a letter from the Environment Agency dated 17 December 2019 (as include in Appendix III) appears to indicate that the Agency considered that additional remediation works would be necessary for a redevelopment of the fuel depot area. It is not known if there is any subsequent document that address the outstanding issues.

Within the site, and below tarmac and concrete surfacing,a thin horizon of Made Ground is generally recorded,extending to depths of between 0.3 m and 1.4m. However, at one location, in the centre of the site, Made Ground to depths in excess of 2 m is recorded. The base and extent of this deep Made Ground has not been defined. The Made Ground is described as including coal fragments (although there is no indication of such material in the recorded colour of the strata). Locally, beneath the Made Ground, sandy and gravelly clays (River Terrace Deposits) are recorded to approximately 2 m depth in some areas.Elsewhere, these soils are absent.

Below the River Terrace Deposits, and directly beneath made Ground elsewhere, chalk strata are recorded. Within the chalk, hydraulic conductivity values of between 0.14m/d and 1.29m/d with an average value of 0.5m/d (5.8×10^{-6} m/s) are reported.

Slight hydrocarbon odours are recorded in some areas. Groundwater is recorded between approximately 2 m and 3 m depth, with some seasonal fluctuation (of about 0.5 m). Groundwater measurements undertaken within the site both before and after the remediation works indicates that no non-aqueous phase liquids (LNAPL) were recorded within the site during 12 monitoring events prior to remediation works (2009 to 2014) and 8 monitoring events following remediation (2015 to 2018). However, dissolved phase petroleum hydrocarbons have been recorded within the site, as outlined below.

Within the fuel depot area, significant concentrations of petroleum hydrocarbons were recorded, together with in excess of 350 mm thickness of LNAPL. It appears that this related primarily to aliphatic and aromatic hydrocarbons (C_{10} to C_{21} fractions), although other fractions are also recorded at concentrations well above published quality standards, as considered in the completed assessments and submitted to the regulatory authorities. These petroleum fractions were also recorded within the site at levels above published quality standards, although LNAPL appears not to have been detected. The maximum recorded value of Total Petroleum Hydrocarbons (TPH) of 0.42 mg/l is indicated close to the southern boundary of the current site, with decreasing values further into the site (as indicated by the limited data within the site that is presented)

As illustrated in the drawings in Appendix III, it is considered in the reports that the source areas of groundwater impaction relate to recent and former road tanker loading areas towards the centre of the fuel depot and groundwater flow is considered in the reports to be largely away from the development site and extending to the west and southwest.

5. ASSESSMENT OF GROUND CONDITIONS

5.1 Ground Conditions

Based on the available information, it is evident that some Made Ground is present within the site. This includes an area in the central section of the site where Made Ground is recorded to more than 2 m depth. Deeper Made Ground is also likely to be present in the eastern margin of the site, where site development has extended into the area of former railway sidings (indicated to have been located below site levels).

Buried foundations and services will also be present that relate to the existing and former buildings within the site.

The superficial deposits beneath the site are indicated to comprise a limited thickness of sandy and gravelly clays, as recorded to approximately 2 m depth (and absent in some areas).

Below the superficial deposits, and directly below Made Ground in some areas, are chalk strata. These comprise the lowest beds of the Zig Zag Chalk Formation, which rest on 'marly' chalk. In general, these chalk units are of higher strength and lower permeability in comparison to many other chalk strata. The available data confirms that the shallow chalk strata (within approximately 5 m of the surface) are classified as 'low' permeability, as defined in CIRIA C750 (2016).

Groundwater within the site has been recorded between depths of approximately 2 m and 3 m with some slight seasonal fluctuation. Groundwater flow in the vicinity is indicated to be towards the west/southwest.

5.2 Preliminary Environmental Assessment

5.2.1 Potential Sources of Contamination

The site has included stables, a flour mill (and associated granary etc) together with a 'depot'. The depot is listed as being associated with secure waste storage and associated permit exemptions. Although details are not available, as permits appear not to have been required for these operations it is indicated that handling of hazardous substances/materials should not have been included in these site operations. A small section of the site extends over a section of former railway sidings and it appears that the site has been raised in this area above the railway level. Current use of the site comprises offices and some car parking.

A small electricity substation is indicated nearby, but this is understood to be outside the site and located such that coolant leakage/spillage should not enter the site. The area of the substation has been recently developed with residential properties.

Adjoining the site to the south, is a fuel depot, which has been subject to a number of ground investigations and groundwater monitoring over the period 2009 to 2018. In addition, a programme of groundwater treatment/remediation has been undertaken. Currently, a completion/verification report on the remediation works is not available, and it appears that the remediation works are not accepted by the Environment Agency as complete in relation to a proposed residential development of the fuel depot property. Significant LNAPL is reported within the fuel depot area but appears to have been significantly reduced (although not entirely removed) since the remediation works ceased. LNAPL has not been detected within the site, although some dissolved phase petroleum hydrocarbons are recorded within the southern margin of the site. The available data is compatible with a groundwater flow to the west/southwest, as indicated in the available reports.

In view of the foregoing, within the site, there is a potential for some harmful substances to be present as associated with Made Ground materials placed within the site, and the current information includes reference to 'coal fragments'. It is also possible that ashes could be present that may be associated with polyaromatic hydrocarbons (PAHs), sulphates and certain metal compounds. More recent fill materials that include demolition debris, asbestos fibres and/or fragments of asbestos containing materials (ACMs) could also be present.

Although a short section of two railway sidings was formerly present within the eastern margin of the site, these were not associated with any goods loading/unloading and now appear to be buried beneath a thickness of fill materials and the office building on the eastern side of the site. In this context, it is likely that the nature of the fill materials/Made Ground (as outlined above) is of more significance than residues from limited railway operations, now at depth.

It is evident that groundwater within the southern margin of the site has been impacted by petroleum hydrocarbons (with significant dissolved phase concentrations recorded) that appear to have migrated from below the adjoining fuel depot. On the basis of the current data, it appears very unlikely that these petroleum hydrocarbons in groundwater would be associated with a viable source of vapour emissions from volatile fractions. In the context of the remediation works undertaken and continuing degradation of petroleum hydrocarbons, it is unlikely that risks would increase in the future, unless additional unauthorised release/spillage of petroleum fuels into groundwater were to occur.

Based on the information currently available, no significant organic or putrescible materials are indicated as likely within the ground below the site, or within influencing distance, and no viable source of ground gas emissions has been identified at the site or the surrounding area.

5.2.2 Potential Pollutant Linkages and Preliminary Risk Assessment

The available information has been used to produce a preliminary Conceptual Site Model for this site, in accordance with CIRIA C552 (2001) and BS 10175:2011+A2:2017, and this is presented in Table 1.

Based on the Conceptual Site Model, there are certain potential pollutant linkages that have been identified with respect to the proposed development. With regard to human health, the proposed buildings and hardstanding will provide an effective barrier between end users and the existing ground such that there would be no realistic dermal or oral (ingestion) exposure pathways following development.

The proposed development will include areas of managed soft landscaping. Such landscaping will form amenity areas for end users but there will be no private cultivation permitted. Therefore, if shallow soils at the site are impacted with potential contaminants, there could be a risk of dust exposure (largely oral – ingestion and inhalation) if only minimum thicknesses of topsoil are placed in landscaping areas as root mixing and soil organism activity could return impacted soils to shallow depth.

The site appears to be devoid of topsoil, such that it will be necessary to import soils to provide a growing medium for the proposed soft landscaping/planting.

In view of the above, it is likely to be necessary that a capping layer/barrier of controlled imported soils (topsoil, and possibly with subsoil) be placed in areas of proposed soft landscaping. Outside these areas, the proposed hard-surfaced areas and building will mitigate risks relating to oral and dermal exposure pathways.
On the basis of the current (relatively limited) data, a significant source of potential volatiles/vapour emissions from impacted groundwater below the site is not indicated and there is no record currently available to indicate that the existing buildings on site have been adversely affected to date or for a pollutant linkage to be valid regarding vapour emissions from the impacted groundwater below the site. However,

subject to further review and assessment following a ground investigation, it would be prudent to include an allowance for the inclusion in the proposed building substructure of a membrane resistant to petroleum hydrocarbon vapours and in conjunction with underfloor passive ventilation and associated protective details. In compliance with current published guidance, the installation of such precautions is now required to be undertaken by qualified specialists, inspected/verified and documented.

Groundworkers may be exposed to the potential contaminants identified above during construction works. Whilst this is a relatively short-term exposure, it is recommended that appropriate personal protective equipment be provided and worn at all times. Soils should be kept damp during groundworks to mitigate aerial migration/dust emissions to neighbouring properties in compliance with standard good practice. Consideration/risk assessment may be necessary to the possible presence of petroleum vapours and precautions in any below-ground confined-space working.

In view of the reported coal within the Made Ground, it will be necessary to assess any significant volumes of coal materials as found to remain below the proposed building, in the context of combustion risk in the event of a building fire (as detailed in ICRCL 61/84:1986). In the unlikely event that significant volumes of coal materials are encountered below the proposed building, it would be necessary to remove such materials from within 1 m of the ground level below the building, if such materials are shown to be associated with high risk of combustion.

Based on guidance published by UKWIR (2010), the site may be considered as 'brownfield', with respect to the protection of pipes for potable water. Therefore, conventional plastic materials may be constrained or precluded in use for portable water supply pipes in new developments. Hence, it would be prudent to make allowance for the installation of proprietary multi-layer barrier pipes until the policies and requirements of the local water company are known (and such policies may vary from the guidance by UKWIR).

It is not known if Made Ground materials contain sulphates, as may be deleterious to certain buried concrete. It will be necessary to review designs for buried concrete following a ground investigation.

On the basis of the information currently available, no significant sources of potential groundwater contamination are indicated within the site. However, in view of the impaction of groundwater recorded within the site, as relating to migration from the adjoining fuel depot, it will be necessary to consider groundwater protection issues in the design and construction of foundations and infrastructure associated with the proposed development and the following development constraints are identified:

a. Where feasible, foundations and services (including drains) for the proposed development should be located above groundwater levels (to minimise potential interaction with impacted groundwater).

b. Where foundations are required to extend below groundwater, a foundation risk assessment is likely to be required (as below).

c. The installation of services that extend across the southern site boundary and are located below groundwater should preferably be avoided or else detailed to ensure that a possible migration pathway is not introduced.

d. It will be necessary to assess groundwater quality prior to any dewatering that may be required for temporary works/construction below groundwater that is essential for site development. If groundwater is found to be significantly impacted, a temporary discharge to foul sewer could be constrained or precluded.

e. Soakaway drainage is likely to be precluded by groundwater protection requirements (and other issues) as detailed in Section 5.5.

With reference to the possible foundation solutions, as outlined in Section 5.4, it is noted that none of the foundation options introduces a potential migration pathway that would provide a discernible change to lateral groundwater flow, penetrate an aquiclude (none is indicated above the chalk strata), or increase risk to groundwater resources. On this basis, the recommended foundations solutions should be compatible with a suitable foundation risk assessment (as may be undertaken when additional details of the proposed foundation solution are defined).

In view of all of the foregoing, it is indicated that the proposed development should be technically feasible and may be implemented in compliance with published policies regarding contaminated land, groundwater protection and risk assessment.

5.3 Assessment of Ground Stability

The site is not within an area of recorded underground mining or other such mineral extraction or known voids. Although chalk strata can be associated with unrecorded abandoned mineworkings, the site is within the margin of the lowest mining risk category as defined by the BGS and the type of chalk indicated below the site is not usually associated with mining.

In theory, chalk strata can be dissolved by water and solution features can fill with loose superficial deposits. Such deposits can be susceptible to collapse settlement (if loads are applied) or to inundation settlement (if large volumes of water are introduced to the superficial materials). However, based on the geological database information and BGS databases, the site is located within an area classified with a 'very low' hazard rating and where solution features have not been recorded in close proximity. This is compatible with the indicated chalk strata below the site, which comprise 'marly' horizons that are less susceptible to solution effects.

In view of the foregoing, it is considered that risks of poor ground support are very low to negligible in relation to past mining or natural solution features. In the very unlikely situation that anomalous ground conditions are indicated during construction then, additional geotechnical inspection and assessment would be recommended.

5.4 Assessment of Foundations and Ground Floor Construction

It is understood that the proposed development will comprise a three-storey block of apartments. An indicative plan of the proposed development layout is shown on Figure 3.

On the basis of the current information, it is likely that the Made Ground and shallow River Terrace deposits would not be suitable to provide the required foundation support. Hence, consideration may be given to the following alternative foundation solutions, which appear to be feasible at this stage:

- Vibro-replacement ground treatment (formation of 'stone columns') in conjunction with shallow reinforced strip footings. It should be appreciated that it will be necessary to obtain confirmation from specialist designers/contractors that the recorded ground conditions are suitable for their specific system, with particular consideration of the 'marly' chalk strata likely to be present at the base of the treatment. This solution will also require preparation of a detailed foundation risk assessment and consideration of potential upward vapour migration from impacted groundwater would be necessary. This solution, if confirmed, should provide a more economical and more sustainable solution in comparison to piles, as below.

- Piled foundation solutions may also be considered, although it should be noted that pile arisings from bored solutions may include materials impacted with petroleum hydrocarbons and possibly classified

as ‘hazardous’ waste. The vastly increased use of concrete and much increased waste disposal requirements significantly reduce the sustainability of this solution.

In the event that suitable chalk strata and/or River Terrace deposits are identified in the ground investigation at a suitable shallow depth across most of the site, and the deep Made Ground confirmed to be very localised, then it may be feasible to consider the use of trench-fill footings, located within high strength natural strata. However, at this stage, this solution of trench-fill footings is not confirmed to be viable.

In view of the recorded Made Ground, it is recommended that allowance be made for suspended ground floor slabs. Allowance should also be made for a possible requirement for soil volume change effects (potential heave)and associated precautions to floor slabs and foundations near to trees and where unsaturated clays/weathered chalk occur. Reference should also be made to the vapour precautions outlined in Section 5.2.

The site adjoins operational railway lines such that it is likely that construction working methods would need to consider safety issues in relation to the nearby railway.

5.5 Soakaway Drainage

In view of the impacted groundwater recorded below at least part of the site, the significantly impacted groundwater below the adjoining fuel depot (with continued LNAPL evident in the depot area) and with reference to the recorded ‘low’ permeability strata, together with constraints relating to solution feature/ground support risks, the use of soakaway drainage is expected to be precluded for the proposed development, in line with the guidance in BREDG365:2016. On this basis, an alternative SuDS drainage solution should be considered.

6. RECOMMENDATIONS FOR GROUND INVESTIGATIONS

It is recommended that a ground investigation be undertaken at the site to obtain appropriate data to confirm the preliminary environmental assessment and to allow an appropriate foundation solution to be confirmed.

It is recommended that, at an initial stage, an investigation uses windowless sampling techniques, which is likely to be compatible with access restrictions at the site. The investigation should extend through Made Ground to assess the natural strata beneath the site. Samples should be recovered for geotechnical and analytical laboratory testing. It would also be beneficial to obtain data regarding current groundwater quality below the site together with any additional available records regarding remediation and/or any continued groundwater monitoring at the adjoining fuel depot.

Depending on the findings of the first phase of investigation (and assuming the development proposals remain largely as the current plans), supplementary ground investigation may be required when suitable access is available. The scope of works will be dependent on the findings of the first phase of works and could include trial pits and/or boreholes as necessary to confirm ground conditions and obtain additional data for design purposes and support more detailed risk assessment, as necessary. If it is proposed not to install precautions against possible vapour intrusion into the proposed building, then additional groundwater monitoring may be necessary.

7. SUMMARY

It is proposed to develop a site off Station Road, Great Shelford for residential purposes. The site is currently occupied by several commercial properties and a car park. It is understood that the proposed development will comprise a three-storey block of apartments together with car parking and managed soft landscaping. Residents will be of retirement age.

Ground conditions at the site are indicated to comprise a variable thickness of Made Ground associated with past redevelopments at the site. Beneath the Made Ground, a limited thickness of River Terrace Deposits (clays) are recorded in some areas. Below this are chalk strata (of 'marly' materials). Groundwater has been recorded at between 2 m and 3 m depth approximately and in the southern margin of the site has been reported to include significant impaction by petroleum hydrocarbons as apparently migrated from the adjoining fuel depot.

A number of potential pollutant linkages are identified, largely in relation to Made Ground indicated on site. In this context, it is likely that the proposed development will require a capping layer/barrier of imported soils, barrier pipe may be required for water supply pipes, a suitable concrete mix used and possible removal of any shallow deposits of highly combustible coaly materials (if present).

Groundwater in the southern section of the site is recorded to have been impacted by petroleum hydrocarbons that appear to have migrated from the fuel depot adjacent to the site. The currently available data indicates the concentrations of volatile fractions may be unlikely to cause harmful emissions into the proposed building and a valid pollutant linkage appears to be unlikely from the current data. However, subject to additional investigation and assessment, it would be prudent for an allowance to be included at this stage for the inclusion of protective vapour-resistant measures to the building substructure.

The site is underlain at relatively shallow depth by chalk strata. With reference to the desk study information, there are no records of voids or similar features in the vicinity, as relating to past mining or natural solution features. On this basis risks of poor ground support are considered to be very low to negligible, such that development should not be precluded or significantly constrained.

In view of the variable shallow strata and locally deep Made Ground (and in conjunction with the recorded groundwater), the use of trench-fill footings may not be feasible.

A suitable foundation solution should be provided either by vibro-replacement ground treatment in conjunction with shallow reinforced strip footings or a piled solution. The use of ground treatment will require confirmation by a specialist designer/contractor and acceptance of a foundation risk assessment by the regulatory authorities may also be required. However, if confirmed, this solution would offer benefits in terms of cost and sustainability.

A suspended ground floor with suitable underfloor void is recommended.

In view of groundwater protection constraints and together with recorded 'low' permeability strata, relatively shallow groundwater and ground support risk issues, soakaway drainage is indicated to be precluded.

A ground investigation should be undertaken to assess the potential pollutant linkages that have been identified, provide additional monitoring data that may be required and to confirm the most appropriate foundation solution. The infomratoin included in this report indicates that the propsed development should be techncially feasible.

REFERENCES

Site Specifc References (relating to the adjoning fuel depot)

SLR (October 2018) *Fuel Depot, 2 Station Road, Great Shelford: Phase 1 Data Review and Preliminary Land Quality Assessment* Ref. 416.05952.00003 –PLQRA Draft v2

SLR (August 2019) Fuel *Depot, 2 Station Road, Great Shelford: Detailed Quantitative Risk Assessment* Ref. 416.05952.00004 –DQRA Final v2

Technical References

BRE (2015) *BR211 – Radon: Guidance on protective measures for new buildings* BRE Press

BSI (2017) *BS 10175:2011+A2:2017 Code of Practice for Investigation of Potentially Contaminated Sites* British Standards Institution

BSI (2020) *BS 5930:2015+A1:2020 Code of Practice for Ground Investigations* British Standards Institution

CIRIA (2001) *CIRIA C552 – Contaminated Land Risk Assessment: A guide to Good Practice* Construction Industry Research Association

CIRIA (2002) *CIRIA C574 – Engineering in Chalk* Construction Industry Research Association

CIRIA (2015) *CIRIA C753 – Sustainable Urban Drainage Systems – design manual for England and Wales* Construction Industry Research Association

CIRIA (2014) *CIRIA C735 Good Practice on the Testing and Verification of Protective Systems for Buildings Against Hazardous Ground Gas* Construction Industry Research Association

CIRIA (2016) *CIRIA C750 Groundwater control: design and practice* Construction Industry Research Association

CL:AIRE (2017) *Petroleum Hydrocarbons in Groundwater: Guidance on Assessing Petroleum Hydrocarbons Using Existing Hydrogeological Risk Assessment Methodologies* Contaminated Land

Environment Agency (2013) *Groundwater Protection: Principles and Practice (GP3) version 1.1* EA

Environment Agency (2020) *Land Contamination Risk Management (LCRM)* EA

ICRCL 61/84 (1986) *Notes on the Fire Hazards of Contaminated Land* Interdepartmental Committee on the Redevelopment of Contaminated Land HMSO

Ministry of Housing, Communities and Local Government (2019) *National Planning Policy Framework*

NHBC (2021) *Standards* National House Building Council

NHBC and Environment Agency (2008) *Guidance for the Safe Development of Housing on Land Affected by Contamination R&D Publication 66: 2008*

South Cambridgeshire District Council (2018) *South Cambridgeshire Local Plan: Adopted* Ref. SCDC/LP/27.09.2018

GENERAL NOTES

1. This report is provided as a preliminary site appraisal only, in the context of the stated development proposals and should not be used in a different context. Further geotechnical assessment, and possibly detailed investigations, will be required prior to finalisation of ground related designs.

2. Where any data supplied by the Client or by other external sources, including previous site investigation data, have been used it has been assumed that the information is correct unless otherwise stated. No responsibility can be accepted by Crossfield Consulting Limited for inaccuracies within the data supplied by others.

3. Any assessments made in this report are based on the ground conditions indicated by the trial pits and desk study. Variations in ground conditions may occur between exploratory hole locations and there may be special conditions appertaining to the site which have not been revealed by the investigation and which have not been taken into account in the report. The assessment may be subject to amendment in the light of additional information becoming available.

4. The report is provided for the sole use by the Client or its assignees and is confidential to the Client's professional advisers. No responsibility whatsoever for the contents of this report will be accepted to any person other than the Client or its assignees.

5. New information, improved practices and legislation may necessitate an alteration to the report in whole, or in part, after its submission. Therefore with any change in circumstances or after the expiry of one year from the date of the report, the report should be referred to Crossfield Consulting Limited for re-assessment and, if necessary, re-appraisal.

TABLES

TABLE 1

CONCEPTUAL SITE MODEL

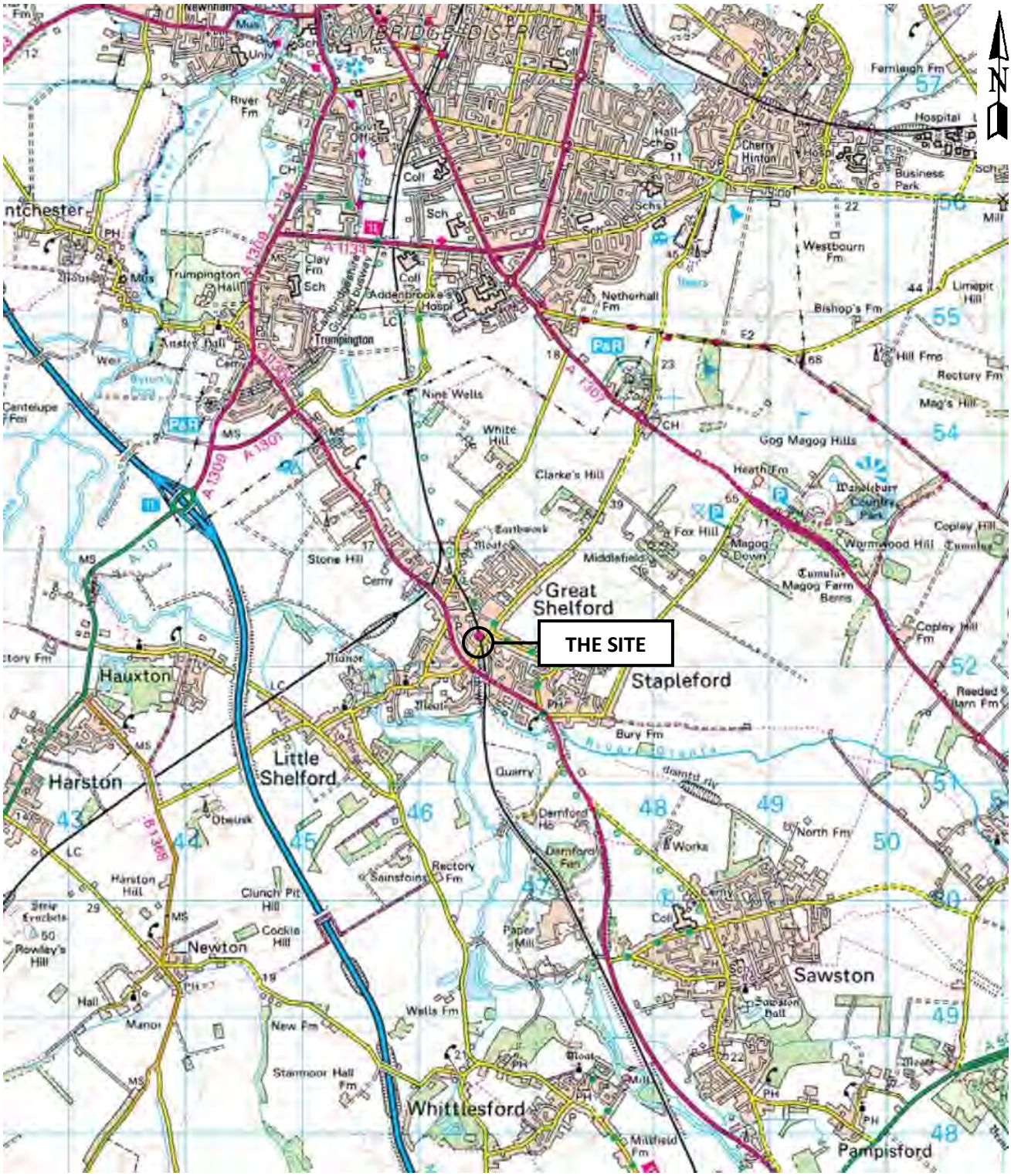
Potential Contaminant Source	Potential Pathway	Receptors and Assessed Pollutant Linkage
Solids *Toxic and Phytotoxic metals:* Potential minor source associated with Made Ground materials *PAHs:* Potential source minor associated with Made Ground materials *Asbestos:* Potential source from demolition materials, if included in Made Ground *Sulphates:* Potential minor source associated with Made Ground materials ***Off-Site Source*** Dissolved phase petroleum hydrocarbons (but no LNAPL) have been recorded within the southern margin of the site, as apparently associated with the adjoining fuel depot.	***Movement of Solids*** Dermal and oral exposure pathways (including air-borne migration) are present during construction phase but will generally not be present following development due to building and hardstanding effective barriers. Limited landscaping areas after development represent possible dust exposure pathways. ***Chemical Permeation/Reaction*** Certain organic compounds (including petroleum fractions) can penetrate or be deleterious to plastic construction materials. Certain concrete mixes can deteriorate if in contact with sulphate-bearing materials. ***Release into Liquid Phase (Leaching)*** Metals and PAHs as possible within the site have generally low solubility. Potential for plant uptake of metals. ***Release into Vapour Phase*** More volatile fractions of petroleum hydrocarbons in groundwater can release vapours, although based on the current data, a significant release of such vapours is not indicated.	***Human Health*** *End Users:* Possible pollutant linkage *Groundworkers:* Possible pollutant linkage *Neighbouring Properties:* Possible pollutant linkage ***Buried Structures & Services*** *Buried concrete:* Possible pollutant linkage *Potable water pipes:* Possible pollutant linkage ***Landscape Areas*** Possible pollutant linkage
Liquids No evidence of potential source on site	***Movement of Liquids*** The strata below the site are indicated to be of low permeability and groundwater flow is indicated not to be directly from the fuel depot into the site. However, some lateral spreading/dispersion of petroleum hydrocarbons into the site is apparent.	***Controlled Waters*** *Groundwater:* Principal aquifer at shallow depth, no source protection zone – Possible pollutant linkage, as relating primarily to off-site source
Ground Gases *Landfill gases:* No evidence of potential source *Other Ground Gas Sources*: No evidence of potential source *Radon:* No evidence of potential source	***Movement of Ground Gases*** Not applicable no source	***Human Health (Ground Gases)*** No pollutant linkage

NOTES

1. The above conceptual model is based on CIRIA C552 (2001) and BS 10175:2011+A2:2017.
2. The Conceptual Site Model is prepared from available desk study information. .

FIGURES

FIGURE 1



SITE LOCATION PLAN

Scale 1: 50,000

FIGURE 2

SITE PLAN
1:1250

INDICATIVE PROPOSED DEVELOPMENT LAYOUT

Scale 1:500

Reproduced from Drawing No. 19/ER010/TN03 by Planning Issues, dated May 2019

APPENDIX I

emapsite™

Site Details:

Client Ref: EMS_681823_895999
Report Ref: EMS-681823_895999
Grid Ref: 546487, 252109

Map Name: County Series
Map date: **1886**
Scale: 1:2,500
Printed at: 1:2,500

N
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Surveyed 1886
Revised 1886
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1888
Revised 1888
Edition N/A
Copyright N/A
Levelled N/A

Groundsure

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Groundsure Insights
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Production date: 01 April 2021

Map legend available at:
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Site Details:

Client Ref: EMS_681823_895999
Report Ref: EMS-681823_895999
Grid Ref: 546487, 252109

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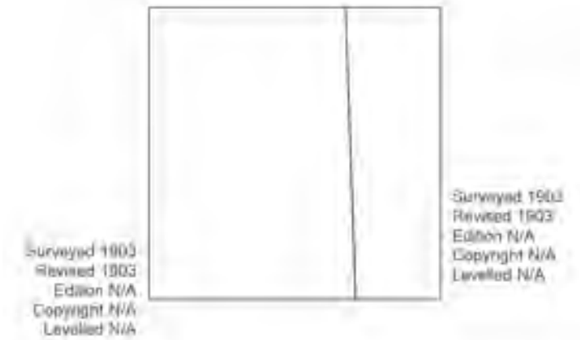

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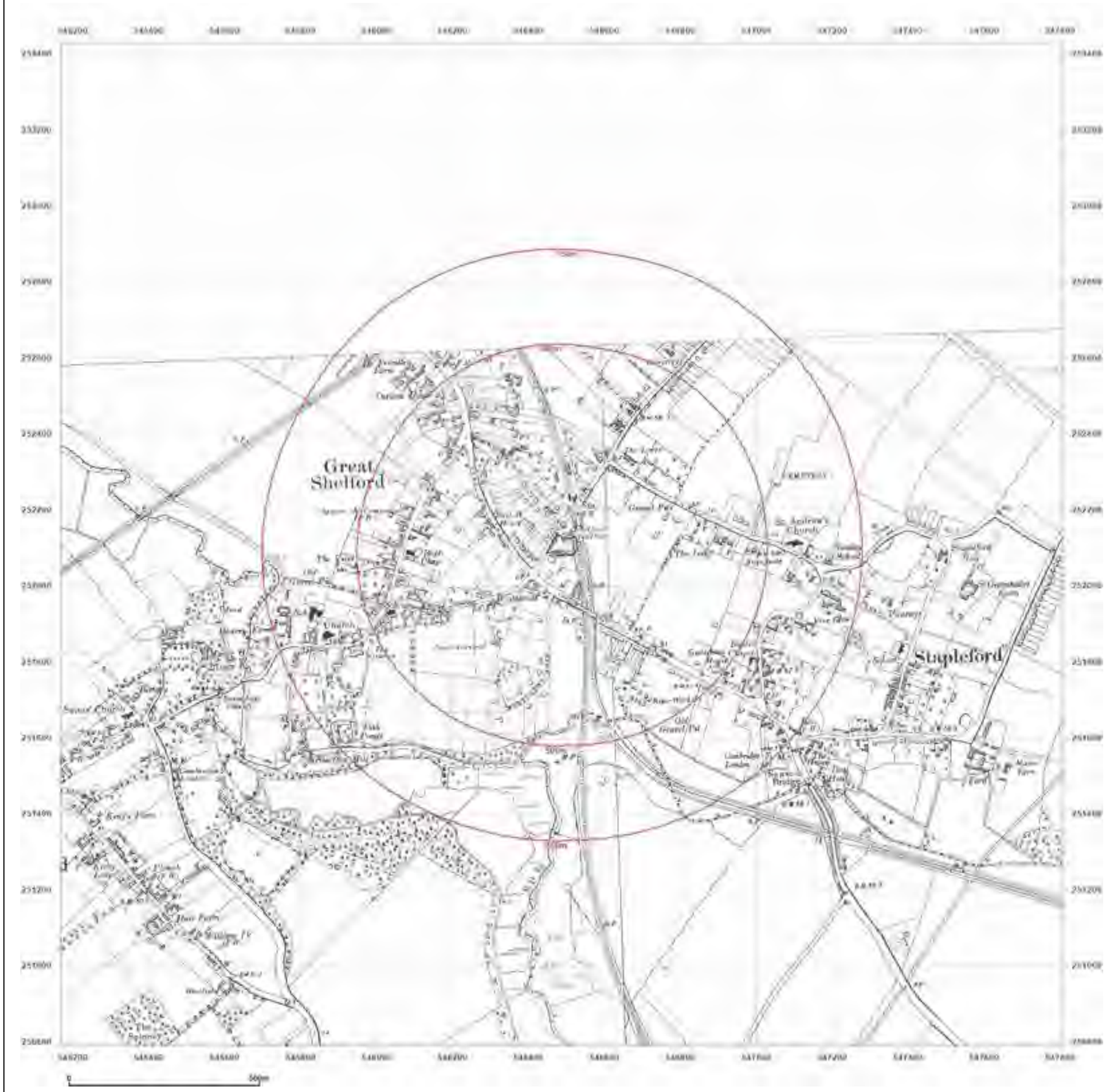
Production date: 01 April 2021

Map legend available at:
www.groundsure.com/sites/default/files/groundsure_legend.pdf



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Report Ref: EMS-681823_895999
Grid Ref: 546487, 252109

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Printed at: 1:10,560

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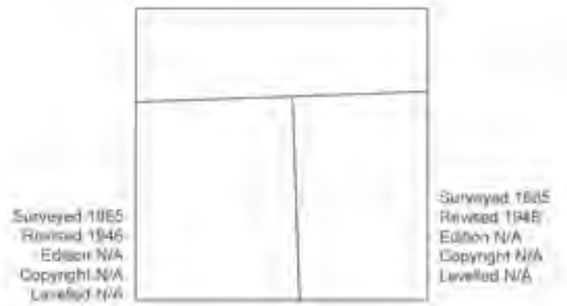

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Production date: 01 April 2021

Map legend available at:
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Site Details:

Client Ref: EMS_681823_895999
Report Ref: EMS-681823_895999
Grid Ref: 546487, 252109

Map Name: Provisional
Map date: **1959**
Scale: 1:10,560
Printed at: 1:10,560

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Surveyed N/A
Revised 1959
Edition N/A
Copyright N/A
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Site Details:

Client Ref: EMS_681823_895999
Report Ref: EMS-681823_895999
Grid Ref: 546487, 252109

Map Name: National Grid

Map date: **1970**

Scale: 1:2,500

Printed at: 1:2,500

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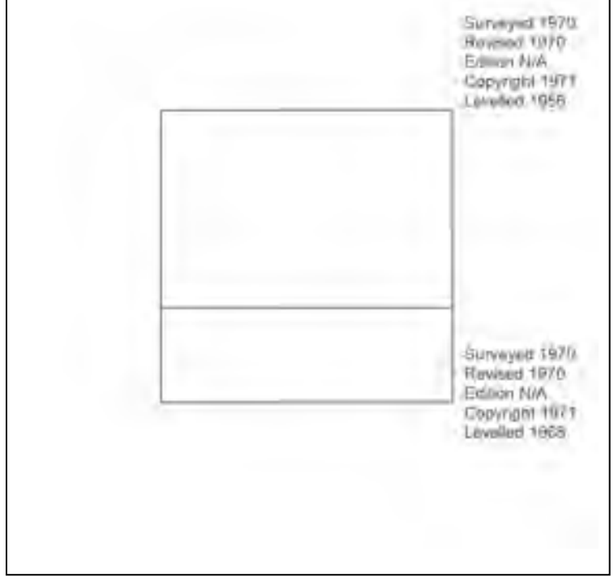

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Site Details:

Client Ref: EMS_681823_895999
Report Ref: EMS-681823_895999
Grid Ref: 546487, 252109

Map Name: National Grid

Map date: **1985**

Scale: 1:2,500

Printed at: 1:2,500

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Site Details:

Client Ref: EMS_681823_895999
Report Ref: EMS-681823_895999
Grid Ref: 546487, 252109

Map Name: National Grid
Map date: **1992**
Scale: 1:2,500
Printed at: 1:2,500

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