ENGINEER OVE ARUP & PARTNERS

OXFORD TO BIRMINGHAM NEW ROUTE–OXFORD TO BANBURY SECTION

LOGGED BY:
FIELDWORK BY:
LAB. TESTING BY: SP52NW34

EXCAVATION METHODS Percussion Boring - Pilcon Wayfarer
150 mm diameter hole
146 and 100 mm diameter Rotary Coring from 0.4 to 19.4 m

GROUND LEVEL 108.95 m O.D.
COORDINATES 454971 E 225919 N
DATES 26.6.79 to 2.7.79

HOLE NO. Y3
SHEET 1 OF 2
FIGURE A

Date/Time at Depth	Depth of Casing	Depth to Water	Piez.	Description of Strata	Strata: Leg.	Reduced Level	Depth	Graphical Representation	Sampling/In situ testing: Depths	Type	No.	Blows	Rec/RQD	Lab. Testing: <425 %	w %	PL %	LL %	γ Mg/m³	c_u kN/m²	Additional Tests and Notes: I_h	d_h	I_v	d_v
27.6.79						108.95	0.00																
18.00	NIL	DRY		TOPSOIL		108.75	0.20																
08.00	NIL	DRY		Subangular to subrounded COBBLES and BOULDERS of white micritic limestone with some firm dark reddish brown silty clay. (Colluvium)					0.40	S			75										
									0.60	D	1		0										
27.6.79													50										
				Moderately strong white highly fractured becoming slightly fractured thinly bedded fine grained fined oolitic and calcarenitic sparry LIMESTONE. (White Limestone - Sliadon)		107.75	1.20		1.30				0										
				From 2.75 to 2.85m weak light orange brown conglomeratic calcareous siltstone.					1.60				83										
				From 2.85 to 2.90m Hardground/erosion layer with rolled micritic pebbles and wispy iron staining.									0										
18.00	1.50	0.00											77										
08.00	1.50	DRY							2.60				0										
				Moderately weak to moderately strong thinly and medium bedded initially moderately fractured fine grained pelletoidal micritic bioturbated LIMESTONE. (White Limestone - Ardley)		106.00	2.90																
				From 3.10 to 4.00m irregular vertical solution weathered joint.									90										
				From 3.40 to 3.90m limestone very fine grained almost percellanous with thin walled gastropods.									19										
				From 3.90 to 6.50m limestone orange and orange brown fine to medium grained very pelletoidal with some sparry walled shells.					3.80														
				Below 6.50m limestone becoming very compact medium to thickly bedded and increasingly siliceous.									95										
28.6.79				From 7.20 to 7.30m limestone moderately weak orange with solution casts of shells.									34								0.85	75		
				Below 7.80m weak initially weathered orange becoming dark grey very silty calcareous sandstone.					4.80												•		1.25	78
													95										
													45										
									5.80												0.20	75	
																					2.63	75	1.97	74
													93										
													64										
									6.80												2.70	72	2.28	75
													98										
18.00	3.00	DRY											97								•		•	
08.00	3.00	6.70		Hard dark grey very silty CLAY and clayey SILT becoming black and carbonaceous. (White Limestone - Shipton)		101.05	7.90		8.00															
						100.65	8.30						95										
29.6.79				Moderately weak to moderately strong grey medium to thickly bedded fine to medium grained pelletoidal micritic LIMESTONE. (White Limestone - Shipton)									40										
				From 8.55 to 8.65m weak to moderately weak clayey pelletoidal calcareous siltstone.					8.80												1.32	77	1.47	67
18.00	3.00	0.00											99										
08.00	3.00	6.70											91										
2.7.79									9.80														

(*Point Load Index < 0.10 MN/m^2)

SP 52NW/34
5496 2592
5497 2592

*WATER ▼ First water strike ▽ Subsequent water strikes

PIEZOMETER Upper seal / Response length / Lower seal

SAMPLE AND TEST KEY: D Small disturbed sample; B Bulk disturbed sample; W Water sample; U Undisturbed sample; Point Load Index I MN/m²; Distance between platens d mm; v = vertical, h = horizontal load; R Rotary core recovery to scale; V Insitu vane test; S Standard penetration test; C Cone penetration test; K Permeability test; I Insitu density test

Blows N = N value 26/150, blows for 150mm drive after seating; 26*, blows for part or whole of seating drive only; (26) Undisturbed sample blow count

V Vane strength kN/m² Natural Remould

Cr Core recovery %; RQD Rock quality designation; <425 Sample % passing 425μm sieve

DEPTH All depths, levels and thicknesses in metres

J. Tipledy BSC. C.Eng.FICE,FIHE
Director
Eastern Road Construction Unit,
80/83 Goldington Road, Bedford.

FIG. A
SHEET 1 OF 2
HOLE NO. Y3

ENGINEER: OVE ARUP & PARTNERS

LOGGED BY:

FIELDWORK BY:

LAB. TESTING BY:

SP52NW34

OXFORD TO BIRMINGHAM NEW ROUTE–OXFORD TO BANBURY SECTION

EXCAVATION METHODS: Percussion Boring - Pilcon Wayfarer 150 mm diameter hole 146 and 100 mm diameter Rotary Coring from 0.4 m to 19.4 m

GROUND LEVEL 108.95 m O.D.

COORDINATES 454971 E 225919 N

DATES 26.6.79 to 2.7.79

HOLE NO. Y3

SHEET 2 OF 2

FIGURE A

Date/Time at Depth	Depth of Casing	Depth to Water	Piez.	Description of Strata	Strata Leg.	Reduced Level	Depth	Graphical Representation	Sampling/In situ testing Depths	Type	No.	Blows	Cr RQD	Lab. Testing <425 %	W %	PL %	LL %	γ Mg/m³	C_u kN/m²	Additional Tests and Notes I_h	d_h	I_v	d_v
2.7.79				(White Limestone - Shiplon as above) From 10.80 to 11.85m alternating weak to moderately weak clayey calcareous siltstone and fine grained silty limestone. From 11.45 to 11.75m hard dark grey silty clayey with very thin limestone interbeds. From 12.50 to 12.80m hard very dark greenish grey jointed moderately carbonaceous very silty clay with silt and fine sand laminae and abundant small oyster shells at base.					11.30				97/75						0.12	77	0.27	69
									12.80				93/70	100	15	14	39			2.42	76	5.65	58
				Hard green very silty CLAY and clayey SILT with vertical black carbonized rootlets. (Hampen Marly Beds)		95.60	13.35																
				Moderately weak greenish grey silty very fine grained calcareous SANDSTONE. (Hampen Marly Beds)		95.30	13.65																
				Hard dark grey becoming dark green very silty in places very fossiliferous CLAY. (Hampen Marly Beds)		95.15	13.80		13.80				98/77	100	18	21	48			2.93	77	3.31	70
				From 13.95 to 14.00m hard black very carbonaceous clay (almost jet).					14.80				95/62										
				From 14.60 to 14.70m moderately weak greyish green very fine grained silty limestone.					15.80				100/83	100	3	20	47						
									15.90			67*/75											
									16.80				93/64	100	11	17	48						
				Initially very weak and very muddy becoming moderately weak to moderately strong dark grey medium to thickly bedded fine to medium grained pelletoidal fossiliferous LIMESTONE. (Taynton Stone) From 17.80 to 18.50m limestone thinly to medium false bedded and calcarenitic.		91.95	17.00						100/98							1.40	77	1.65	73
									17.80														
18.00	3.00	DRY											93/66							1.59	77	2.73	82
						END			19.40														

(* Point Load Index < 0.10 MN/m²)

SP 52 NW/34 5496 2592

* WATER ▽ First water strike ▼ Subsequent water strikes

PIEZOMETER: Upper seal, Response length, Lower seal

SAMPLE AND TEST KEY: D Small disturbed sample; B Bulk disturbed sample; W Water sample; U Undisturbed sample; Point Load Index I MN/m²; Distance between platens d mm; v = vertical h = horizontal loading

Q Rotary core recovery to scale; V Insitu vane test; S Standard penetration test; C Cone penetration test; K Permeability test; I Insitu density test

Blows: N = N value 26/150, blows for 150mm drive after seating 26*, blows for part or whole of seating drive only (26) Undisturbed sample blow count

V Vane strength kN/m² Natural Remould

Cr Core recovery % RQD Rock quality designation <425 Sample % passing 425μm sieve

DEPTH All depths, levels and thicknesses in metres

J. Tiplady BSC. C.Eng.FICE,FIHE
Director
Eastern Road Construction Unit,
59/63 Goldington Road, Bedford.

FIG. A | SHEET 2 OF 2 | HOLE NO. Y3

No 8.

219

March 18th 1925

S635 2625.

SP52NE6

90

BOREHOLE SECTION

BORED & COMMUNICATED BY LE GRANDSUTCLIFF & GELL LTD, SOUTHALL

BORED FOR ; Archibald Nicholson Esqre.
Manor Farm,
Bucknell, Nr, Bicester,

DISTRICT : Bicester IN THE COUNTY OF :Oxford.

POSITION OF BORING: At Manor Farm just N.E. of Bucknell
In a field about ½ mile N.W. of the farm.

MAPS: 6" Ordnance Oxford 17
1" Geo. Old Series 45.N.E. O.D.OF SITE : 320'
N.S. 219

WATER LEVEL BELOW SURFACE: 26' 0" YIELD OF WATER: 360 gallons per hour.

TUBING REMAINING IN BOREHOLE. 25' 0" of 4" top 1' 0 below surface
5' 5" of 5" top 1' 6" " "

STRATA	THICKNESS Ft.	Ins.	DEPTH Ft.	Ins.	
Blue Clay.....	5	9	5	9	Wychwood Beds?
Grey Clay.....	3	3	9	0	
Blue Clay.....	1	0	10	0	
Blue Rock.....	4	0	14	0	Kemble Beds?
Grey Rock.....	4	6	18	6	
Green Clay.....		6	19	0	
Grey Rock.....	5	0	24	0	
Coloured Clays & Rock.....	15	6	39	6	
Grey Rock.....	2	6	42	0	
Blue Clay.....	2	0	44	0	White limestone
Blue Rock.....	3	0	47	0	
Green Clay.....	2	0	49	0	
Blue Rock.....	2	0	51	0	
" Clay.....	5	0	56	0	
" Rock	3	0	59	0	
" Clay.....	5	0	64	0	Hampen Marly? Beds
" Rock.....	3	0	67	0	
" Clay (dark).....	4	0	71	0	
" Rock.....	3	0	74	0	
Whitish Clay.....	1	0	75	0	Taynton Stone
White Rock.....	5	0	80	0	
Blue Rock.....	3	0	83	0	
Grey Green Clay.....	6	0	89	0	Upper Estuarine Clay & Smarts Hill Beds?
" " " Stones.....	4	0	93	0	
Black Sandy Clay.....	34	9	127	9	Sherford Hook
Black Rock.....		3	128	0	
Blue Rock.....		3	128	3	Norton Beds?
Green Rock.....	1	3	129	6	
Gault Clay.....	23	6	153	0	Upper Lias
Gault.....	26	0	179	0	
Rock.....	2	9	181	9	
Clay & Shale.....	2	3	184	0	
Bands of Rock & Loamy Shale	4	6	188	6	Middle Lias
Rock, Clay & Pebbles.....	5	0	193	6	
Loamy Clay & Shales.....	21	6	215	0	
C/F	215	0	215	0	

Forest Marble ?

Great Oolite Series ?

2 ext.

SP52NE6

219/90

March 18th 1925

BOREHOLE SECTION

BORED & COMMUNICATED BY LE GRAND SUTCLIFF & GELL LTD. SOUTHALL

BORED FOR ; Archibald Nicholson Esq.,
Manor Farm,
Bucknell Nr,Bicester.

DISTRICT : Bicester. IN THE COUNTY OF: Oxford.

STRATA	THICKNESS Ft,	Ins.	DEPTH Ft.	Ins.	
C/F	215	0	215	0	
Loamy Clay & Shales, hard bands.....	6	0	221	0	Middle + Lower Lias
Loamy Clay & Shales.....	6	0	227	0	
White Rock.....		6	227	6	
Loamy Clay & Shales.....	12	6	240	0	
Blue Clay ~~(Gault)~~.....	7	0	247	0	
Rock.....	1	0	248	0	
~~Gault~~.....	3	0	251	0	
Total depth of boring.	251	0	251	0	

Great Oolite Series

Lias? Up

A.W.W. 1.VI.39.

Based on Arkell: Jur. Sys. " QJGS 1931 Richardson Geol Mag 1910?

GENERAL REMARKS

Probably not a great deal of water at this site
W.L. dropped considerably during boring about 190-200 ft.

BORING FINISHED: 26th April 1924.

LE GRAND SUTCLIFF & GELL LTD.,

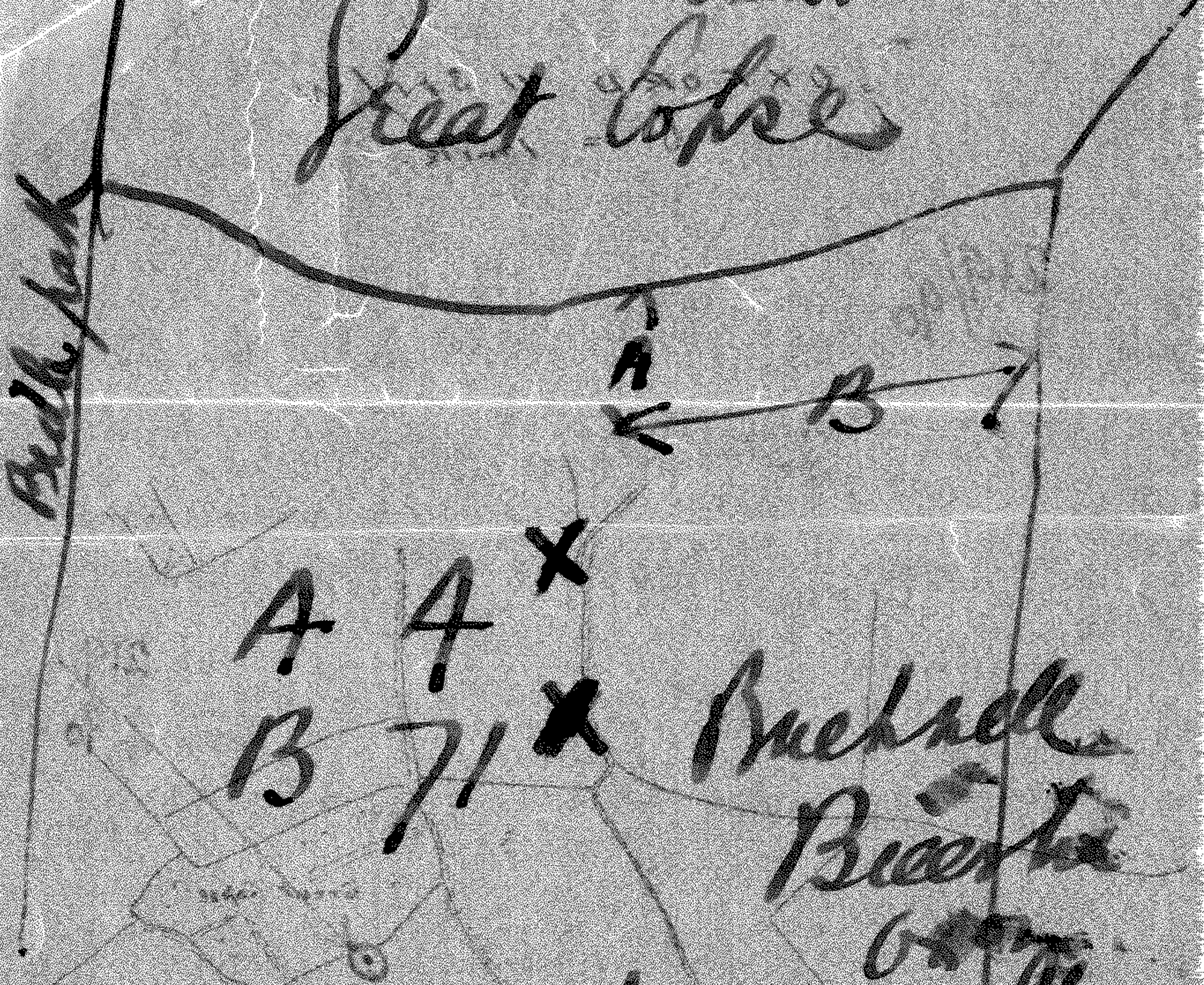
Signature.....

Our Ref,S.B.4/17.
Our Order No. 1150. 23/1/24.

LI/AMP.

SP52NE6

3 The well is still in use
Yield unknown. 800 glns per day
when I want it.



I hope this will help you if you
can understand it, it is right
within a foot or two

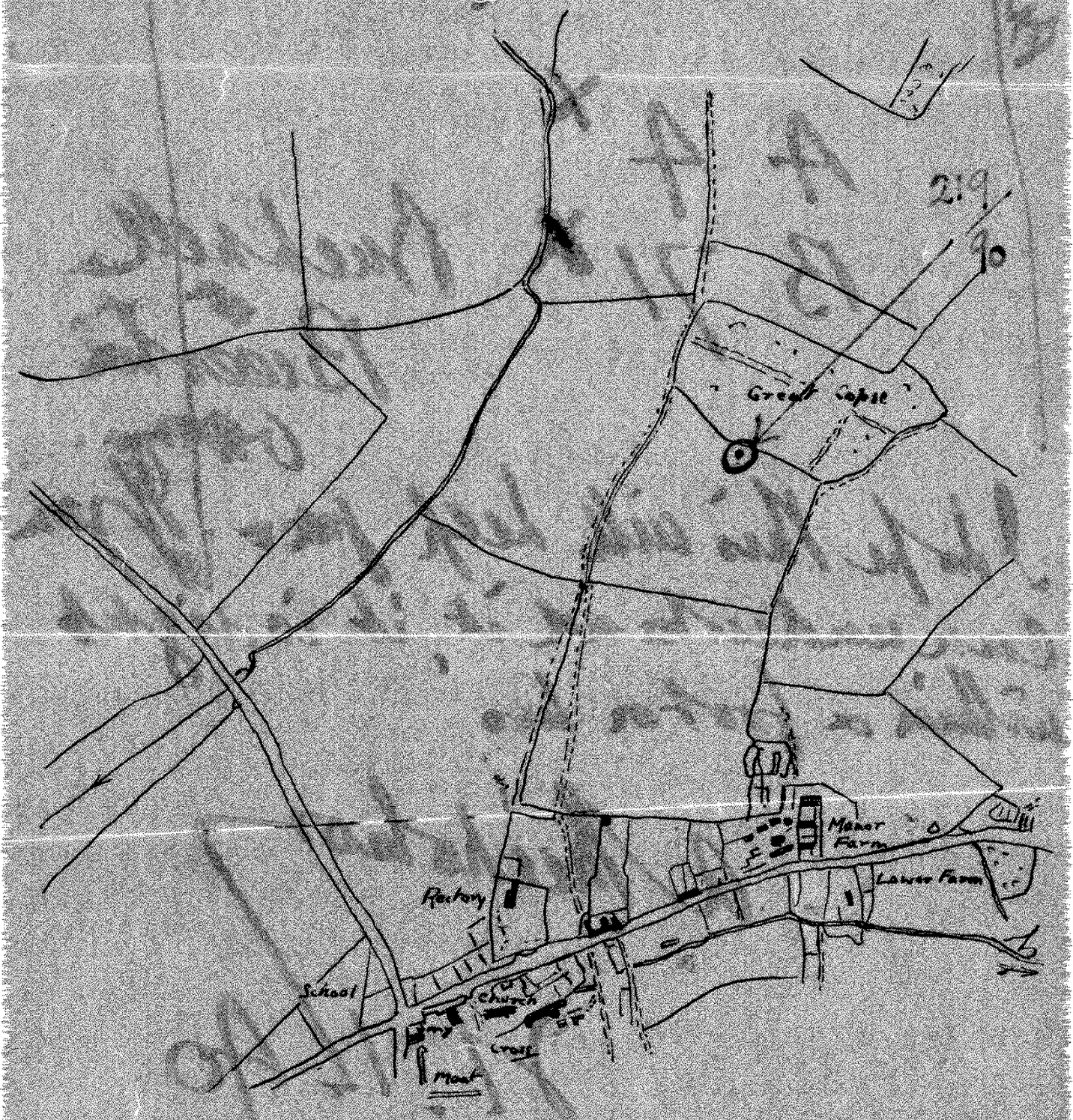
A Nicholson
31.1.40

SP52NE6

OXFORD 11 SW/W

6" = 1 mile.

219/90



5635 2625 SP52NE6

90 21

BOREHOLE SECTION

BORED & COMMUNICATED BY LE GRAND SUTCLIFF & GELL LTD, SOUTHALL

BORED FOR ; Archibald Nicholson Esqr. NGR: SP 5635 2625
Manor Farm,
Bucknell, Nr, Bicester,

SP52NE/6.

DISTRICT : Bicester IN THE COUNTY OF : Oxford.

POSITION OF BORING: At Manor Farm just N.E. of Bucknell
In a field about 1 mile N.W. of the farm.

MAPS: 6" Ordnance Oxford 17
1" Geo. Old Series 45.N.E. O.D.OF SITE : 320' (97.53m)
N.S. 219

WATER LEVEL BELOW SURFACE: 26' 0" YIELD OF WATER: 360 gallons per hour.

TUBING REMAINING IN BOREHOLE. 25' 0" of 4" top 1' 0 below surface
5' 5" of 5" top 1' 6" "

STRATA	THICKNESS Ft.	Ins.	DEPTH Ft.	Ins.	
Blue Clay.....	5	9	5	9	Wychwood Be
Grey Clay.....	3	3	9	0	
Blue Clay.....	1	0	10	0	
Blue Rock.....	4	0	14	0	Kemble Bed
Grey Rock.....	4	6	18	6	
Green Clay.....		6	19	0	
Grey Rock.....	5	0	24	0	
Coloured Clays & Rock.....	15	6	39	6	
Grey Rock.....	2	6	42	0	
Blue Clay.....	2	0	44	0	White limest
Blue Rock.....	3	0	47	0	
Green Clay.....	2	0	49	0	
Blue Rock.....	2	0	51	0	
" Clay.....	5	0	56	0	
" Rock	3	0	59	0	
" Clay.....	5	0	64	0	Hampen Marl
" Rock.....	3	0	67	0	Beds
" Clay (dark).....	4	0	71	0	
" Rock.....	3	0	74	0	
Whitish Clay.....	1	0	75	0	
White Rock.....	5	0	80	0	Taynton Ste
Blue Rock.....	3	0	83	0	
Grey Green Clay.....	6	0	89	0	
" " " Stones.....	4	0	93	0	Upper Estuarine = Smarts Hill B
Black Sandy Clay.....	34	9	127	9	
Black Rock.....		3	128	0	Sweeford Ho
Blue Rock.....		3	128	3	Norton Beds
Green Rock.....	1	3	129	6	
Gault Clay.....	23	6	153	0	Upper Lias
Gault.....	26	0	179	0	
Rock.....	2	9	181	9	
Clay & Shale.....	2	3	184	0	
Bands of Rock & Loamy Shale	4	6	188	6	
Rock, Clay & Pebbles.....	5	0	193	6	Middle Lia
Loamy Clay & Shales.....	21	6	215	0	
C/F	215	0	215	0	

SP52NE6

219/90

March 18th 1925

BOREHOLE SECTION

BORED & COMMUNICATED BY LE GRAND SUTCLIFF & GELL LTD. SOUTHALL

BORED FOR : Archibald Nicholson Esq.,
Manor Farm,
Bucknell Nr,Bicester.

SP52NE6

DISTRICT : Bicester. IN THE COUNTY OF: Oxford.

STRATA	THICKNESS Ft,	Ins.	DEPTH Ft.	Ins.	
O/F	215	0	215	0	Middle + Lower Lias
Loamy Clay & Shales,hard bands.....	6	0	221	0	
Loamy Clay & Shales.....	6	0	227	0	
White Rock.....		6	227	6	
Loamy Clay & Shales.....	12	6	240	0	
Blue Clay ~~(Gault)~~.....	7	0	247	0	
Rock.....	1	0	248	0	
~~Gault~~.....	3	0	251	0	
Total depth of boring.	251	0	251	0	

Great Oolite Series

Lias? Cf

A.W.W. 1.VI.39

Based on Arkell: Jur. Sy. " GJGS 19 Richardson Geol. M. 19

GENERAL REMARKS

Probably not a great deal of water at this site
W.L. dropped considerably during boring about 190-200 ft.

BORING FINISHED: 26th April 1924.

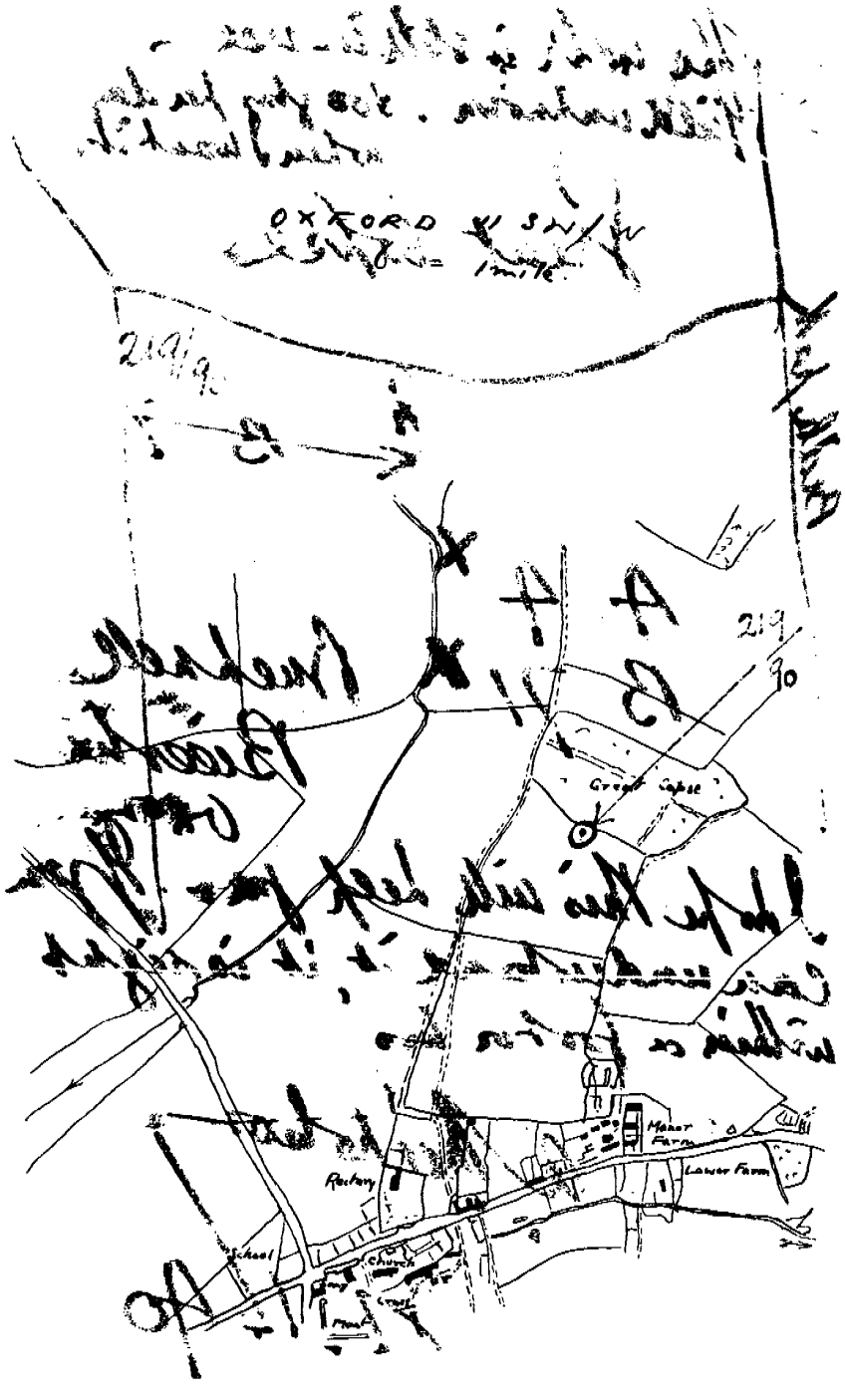
LE GRAND SUTCLIFF & GELL LTD.,

Signature.....

Our Ref,S.B.4/17.
Our Order No. 1150. 23/1/24.

LI/AHP.

SP52NE6



5635 2625 SP52NE6 90 21

BOREHOLE SECTION

BORED & COMMUNICATED BY LE GRANDSUTCLIFF & GELL LTD, SOUTHALL

BORED FOR ; Archibald Nicholson Esqr. NGR SP 5635 2625
Manor Farm,
Bucknell, Nr, Bicester,

SP52NE/6.

DISTRICT : Bicester IN THE COUNTY OF :Oxford.

POSITION OF BORING: At Manor Farm just N.E. of Bucknell
In a field about ¼ mile N.W. of the farm.

MAPS: 6" Ordnance Oxford 17
1" Geo. Old Series 45.N.E. O.D.OF SITE : 320' (97.53m)
N.S. 219

WATER LEVEL BELOW SURFACE: 26' 0" YIELD OF WATER: 360 gallons per hour.

TUBING REMAINING IN BOREHOLE. 25' 0" of 4" top 1' 0 below surface
5' 5" of 5" top 1' 6" " "

STRATA	THICKNESS Ft.	Ins.	DEPTH Ft.	Ins.	
Blue Clay.....	5	9	5	9	FML
Grey Clay.....	3	3	9	0	Wychwood Beds
Blue Clay.....	1	0	10	0	
Blue Rock.....	4	0	14	0	Great Marlstone & L.
Grey Rock.....	4	6	18	6	Kemble Beds
Green Clay.....		6	19	0	
Grey Rock.....	5	0	24	0	
Coloured Clays & Rock.....	15	6	39	6	
Grey Rock.....	2	6	42	0	
Blue Clay.....	2	0	44	0	White limestone
Blue Rock.....	3	0	47	0	
Green Clay.....	2	0	49	0	
Blue Rock.....	2	0	51	0	
" Clay.....	5	0	56	0	
" Rock	3	0	59	0	
" Clay.....	5	0	64	0	Rid Hampen Marly Beds
" Rock.....	3	0	67	0	
" Clay (dark).....	4	0	71	0	
" Rock.....	3	0	74	0	
Whitish Clay.....	1	0	75	0	
White Rock.....	5	0	80	0	Great Oolite Ty Taynton Sta
Blue Rock.....	3	0	83	0	
Grey Green Clay.....	6	0	89	0	ShF
" " " Stones.....	4	0	93	0	Upper Fatturnia C = Swarks Hill Bed
Black Sandy Clay.....	34	9	127	9	HYS
Black Rock.....		3	128	0	NS Sweeford = Hoo
Blue Rock.....		3	128	3	Norton Beds
Green Rock.....	1	3	129	6	
Gault Clay.....	23	6	153	0	Upper Lias
Gault.....	26	0	179	0	
Rock.....	2	9	181	9	
Clay & Shale.....	2	3	184	0	
Bands of Rock & Loamy Shale	4	6	188	6	
Rock, Clay & Pebbles.....	5	0	193	6	Middle Lias
Loamy Clay & Shales.....	21	6	215	0	
C/F	215	0	215	0	

SP52NE6

219/90

March 18th 1925

BOREHOLE SECTION

BORED & COMMUNICATED BY LE GRAND SUTCLIFF & GELL LTD. SOUTHALL

BORED FOR : Archibald Nicholson Esq.,
Manor Farm,
Bucknell Nr,Bicester.

SP52NE 6

DISTRICT : Bicester. IN THE COUNTY OF: Oxford.

STRATA	THICKNESS Ft,	Ins.	DEPTH Ft.	Ins.	
C/F	215	0	215	0	
Loamy Clay & Shales, hard bands.....	6	0	221	0	Middle + Lower Lias
Loamy Clay & Shales.....	6	0	227	0	
White Rock.....		6	227	6	
Loamy Clay & Shales.....	12	6	240	0	
Blue Clay ~~(Gault)~~.....	7	0	247	0	
Rock.....	1	0	248	0	
~~Gault~~.....	3	0	251	0	
Total depth of boring.	251	0	251	0	

Great Oolite Series

Lias? Pp

A.W.W. 1.11.39.

Based on Arkell: Jur. Sys. " QJGS 1931 Richardson Geol Mag 1910

GENERAL REMARKS

Probably not a great deal of water at this site
W.L. dropped considerably during boring about 190-200 ft.

BORING FINISHED: 26th April 1924.

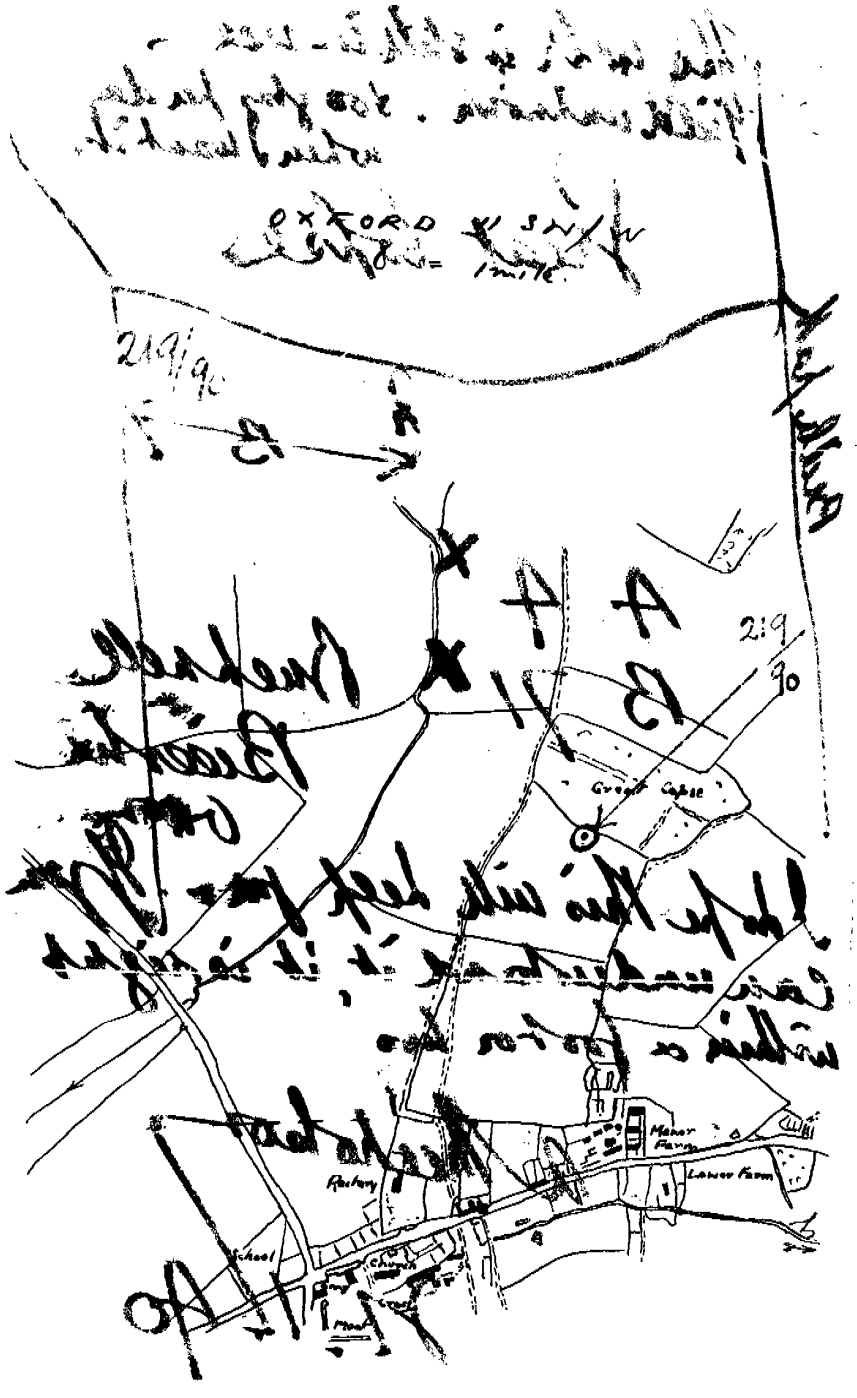
LE GRAND SUTCLIFF & GELL LTD.,

Signature.....

Our Ref,S.B.4/17.
Our Order No. 1150. 23/1/24.

LI/AMP.

SP52NE6



Dr Richard Earl
TurfTrax Ground Management Systems Limited
Unit 1, Highfield Park
Highfield Road
Oakley
Bedfordshire
MK43 7TA

Geological Assessment - Detailed

This report is aimed at customers and clients carrying out preliminary site assessments, who require a detailed assessment of the geology, hydrogeology and any geological hazards around the site.

The report, prepared by BGS geologists, is based on analysis of records and maps held in the National Geoscience Data Centre (NGDC), and includes descriptions of rock types, natural subsidence hazards and mining & quarrying hazard if present. It also contains geological map extracts taken from the BGS Digital Geological Map of Great Britain at the 1:50,000 scale (DiGMapGB-50) and a listing of the key geoscience data sets held in the NGDC for the area around the site. The report also considers radon hazard (in terms of the level of radon protection required in the construction of new dwellings) and the detailed hydrogeology of the site.

Note that for some sites, the latest available records may be quite historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

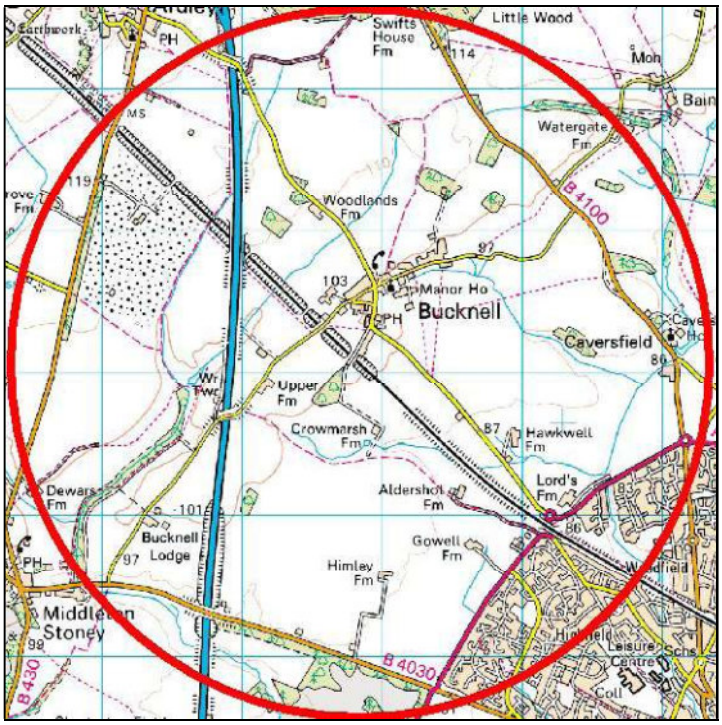
Client's Reference:
NW Bicester

Section 1: Location and extent of report area

Site Address:
Site A: NW Bicester

Area centred at: *455853,225060*
Radius of site area: *2500 metres*

This report is based on the above location details. However, where the client has submitted a site plan, it is used for the assessment in Sections 2, 3 and 4.



Scale: 1:50000 (1cm = 500m)

SITE LOCATION

Section 2: Geological Factors for the site

This table lists some of the principal geological factors that may affect a site, and is based on interpretation of data available to BGS at the time of compilation; additional information may be available in BGS files. The information is designed to act as a checklist and should not be used in place of a detailed site investigation.

Factor	May be significant within site area (Y/N)?	Comments
Shrink-Swell Clay Hazard	No	
Landslide Hazard	Yes	Mudstone beds in the **Bladon Member** and **Forest Marble Formation** may be unstable on steep slopes or in excavations. The **Cornbrash** may be affected by cambering along valley sides, and valley bulging may affect the **Forest Marble** mudstones in valley bottoms.
Ground Dissolution Hazard	Yes	The **White Limestone Formation**, limestone beds in the **Forest Marble Formation** and the **Cornbrash Formation** may be prone to dissolution along joints, leading to minor cavity formation.
Compressible Ground Hazard	Yes	**Alluvium** may include compressible organic-rich layers.
Collapsible Ground Hazard	No	
Running Sand Hazard	Yes	**Alluvium** may include sandy layers with a low running sand hazard potential.
Shallow mining	No	
Aquifer vulnerability		The alluvium and Cornbrash and Forest Marble Formations beneath the site are classified as Minor Aquifers with high soil leaching potential on the Environment Agency's Groundwater Vulnerability map, Sheet 30, Northern Cotswolds. The underlying White Limestone Formation is a Major Aquifer.
Shallow groundwater		Likely within possibly 0.5 m of the ground surface in the Cornbrash; possible artesian conditions in deep boreholes or excavations.
Artificial ground	Yes	Landfill site.
Natural land gas	No	
Level of Radon Protective Measures	Yes	BASIC RADON PROTECTIVE MEASURES ARE REQUIRED FOR THE REPORT AREA.

Section 3: Description of the Geology & Hydrogeology for the site

Topography and surface drainage (see Section 4)**:**
Site elevation ranges from 75 metres above Ordnance Datum (OD) in the stream valley in the south to 120 m in the north-west of the search area.

The slope and principal drainage direction is to the south-east. The drainage is dendritic in pattern and tributaries run in other directions. Two stream networks traverse the search area.

Artificial Ground (see Section 4)**:**
There is an extensive worked ground site in the north-west of the search area, which has been partially backfilled as a landfill site. Elsewhere, there are other small pits, worked mainly for limestone, that are often backfilled. Main roads and railways have cuttings and embankments.

Superficial Deposits (see Section 4)**:**
The streams are flanked by narrow tracts of **alluvium** of late Quaternary age, comprising sandy silty calcareous clay overlying gravelly sandy silty clay, with limestone clasts. The alluvial deposits are up to 150 m wide, are generally between 1 to 2 m in thickness (rarely exceeding 3 m in thickness). They may locally include highly compressible, organic-rich (peaty) layers.

Locally, hollows in these valley sides are floored by thin deposits of **head**, formed by soil creep or hill wash. Their composition reflects that of the local materials from which they were derived, either the bedrock or other types of superficial deposit, or both in combination. Head deposits typically are poorly stratified and poorly sorted, and can be variable in composition. Locally, they are typically composed of variably stony sandy silty clay. Head deposits may be more extensive than shown on the geological map, but if so, probably only as a layer between 0.3 m and 1 m in thickness, and possibly discontinuous.

Rockhead Depth (see Section 4)**:**
Where covered by alluvium or head, rockhead is at 1 to 3 m depth. Its depth beneath the Artificial Ground (especially under landfill sites) is unknown. Over the remainder of the search area, rockhead is close to the surface.

Bedrock Geology (see Section 4)**:**
The search area is underlain at rockhead by various formations and members of the Great Oolite Group, of Mid-Jurassic age, which are dominated by limestones with subordinate mudstone beds.

The oldest exposed formation is the **White Limestone Formation**, forming a broad plateau in the north-west of the search area, and where complete, comprises 10 to 18 m thickness of white to yellow, bedded, peloidal and bioclastic limestone (see **Additional Geological Considerations** below). There may be less than 5 m thickness of beds present in the extreme north-west. Thin calcareous mudstone beds are present in the basal part and dark, carbonaceous mudstones predominate over limestone in the upper part, which is distinguished on the map extracts (see Section 5) as the **Bladon Member**, up to 3 m thick.

The White Limestone Formation is overlain with an erosive contact by the **Forest Marble Formation**, to the extent that the Bladon Member is locally absent. The Forest Marble Formation forms a narrow outcrop between the White Limestone and Cornbrash Formations, and also crops out on the flanks of the stream valleys. The Formation is composed of 3 to 5 m of grey calcareous mudstone with lenticular beds of bioclastic, ooidal limestone, particularly common at the base, where they are widely distinguished on the map extracts.

The **Cornbrash Formation** is the youngest bedrock unit within the site area, cropping out over about half the search area, almost all of the site area, and forming a broad south-east sloping plateau. It comprises about 3 m thick grey to brown bioclastic shelly rubbly-bedded limestone with thin subordinate beds of grey mudstone.

Mudstone beds in the Bladon Member and Forest Marble Formation may be unstable on steep slopes or in excavations.

The limestone-dominated units of the White Limestone, Forest Marble and Cornbrash Formations may be affected by dissolution leading to the widening of joints and the formation of linear vertical voids, which are likely to fill with rubble and soil.

Along valley sides, the Cornbrash Formation outcrops may be affected by cambering. Cambering is a widespread phenomenon in the south and east Midlands, although it is not known whether it affects the strata at this site. Cambering takes place where beds of resistant, permeable rocks such as limestone overlie impermeable clay (or mudstone which weathers and softens to clay) along valley sides and escarpments. The superincumbent load coupled with water movement along the interface causes the soft plastic clay material to squeeze or wash out. Intervening sand beds may exacerbate the effect, but even where such permeable beds are absent, large thicknesses of clay may be lost by squeezing. As a result, the vertical thickness of the clay beds reduces, and the limestone strata are lowered as a ‘camber’, comprising blocks separated by minor faults parallel to the valley axis. The cambered strata may themselves undergo brittle fracture, so forming blocks separated by vertical joints normal to the direction of movement, on which minor vertical displacements may take place (forming ‘dip-and-fault’ structures). The displacements on the faults associated with cambering is usually quite small (up to 3 m), and they may be undetectable at the surface other than in excavations. In addition, the spacing may be too close (tens of metres) for them to be distinguishable at 1:10 560 or 1:10 000-scale. Cambering is thought to have been initiated during Pleistocene periglacial conditions. It is probably not an ongoing process here, but may merge into landslide movement downslope and must be considered a potential engineering hazard.

In narrow valleys a consequence of squeezing of the clay strata may be valley bulging, in which the softer material is forced upwards in the floor of the valley, above its normal position, becoming folded and possibly faulted. This may also cause the downslope ends of cambers to be disrupted.

Downhill (lateral) movement of the blocks may cause wide fissures (known as ‘gulls’) to form. The gulls are likely to fill with loose rock and soil, and in some cases with clay, but can remain as voids. Gulls may also result from the collapse of cavities in limestone formed by dissolution along joints. Such an origin may be evident from a regular pattern or orientation of gulls parallel to local joint sets or not at right angles to the inferred direction of extension. Many gulls develop by a combination of these causes.

Additional Geological Considerations (see Section 4)**:**
The White Limestone Formation is underlain by four further formations of the Great Oolite Group: in ascending order the Horsehay Sand, the mudstone-dominated Sharp's Hill, the Taynton Limestone and the mudstone-dominated Rutland formations, totalling about 20 m in thickness. These are underlain by the 2 to 6 m of the ferruginous sandstones of the Northampton Sand Formation. Beneath these are over 100m of the mudstone-dominated Lias Group.

The bedrock strata dip very gently (less than 0.5°) to the south-east. Faults have been mapped to the north-east of Bucknell, with displacements of up to about 5 m. It is important to understand the nature of geological faults, and the uncertainties which attend their mapped position at the surface. Faults are planes of movement, along which, adjacent blocks of rock strata have moved relative to each other. They commonly consist of zones, perhaps up to several tens of metres wide, containing several to many fractures. The portrayal of such faults as a single line on the geological map is therefore a generalisation. Geological faults in this area are of ancient origin, are today mainly inactive, and are thought to present no threat to property.

Hydrogeology and groundwater vulnerability:
The areas of worked ground, although not within the site area, may contain groundwater that may have an effect on groundwater beneath the site, albeit at depth. The areas of worked ground occur within the White Limestone Formation (see below).

There are small patches of alluvium, and possibly head, within the site area in the floors and flanks of some of the valleys. These deposits are of variable permeability. Groundwater may be present in limited quantities in the less permeable deposits, otherwise it is likely to be in hydraulic conductivity with the Forest Marble Formation bedrock if the bedrock is relatively permeable, or will be perched and drain out if it is more permeable than the bedrock. The deposits are very small in area and thickness and there is no borehole water level information relating to them. However, the water is likely to be in hydraulic continuity with, and at a similar level to, surface water.

The Great Oolite Group limestones transmit water via fractures that can be enhanced by dissolution; water movement through them can therefore be rapid.

With the exception of the Forest Marble Formation cropping out in the floors and sides of the valleys, the whole of the site area is underlain by Cornbrash Formation bedrock. This is a local aquifer and several water strikes have been recorded in shallow, site-investigation boreholes drilled within the site area. The rest water levels are generally slightly higher than the strike levels; both are generally between about 0.5 and 4.0 m below the ground surface.

The Forest Marble Formation, where present beneath the area, may hold small quantities of water in any limestone bands present, but the upper part generally acts as an aquiclude between the Cornbrash Formation and the underlying White Limestone Formation. There are no boreholes drilled through the Forest Marble Formation in the site area that record water strikes within it.

The White Limestone Formation constitutes a major aquifer in the area, with some sources of public supply. There are several boreholes in the wider area, some within the site area, that penetrate this formation. A 34 m deep borehole at Gowell Farm (SP52/19 at SP 5709 2384), drilled pre-1909 to supply Bicester with water, penetrated the complete 25 m thickness of the White Limestone Formation, underlying about 7.2 m of Forest Marble Formation and terminating in the underlying Rutland Formation. Water was struck at 28 m and 32 m below the ground level in the White Limestone Formation. The rest water level rose to the surface after the first strike, and was artesian, with a rest water level about 1 m above ground level (about 88 m above OD) after the second strike. The yield was over 7 l/s. An 80 m deep borehole at Lords Farm (SP52/18 at SP 5746 2424), drilled in 1941, was drilled through a similar sequence and terminated in the Lias. It struck water in the Cornbrash Formation, which was cased out, and at two levels below the White Limestone Formation. The rest water level was at 11 m below ground level (about 68 m above OD) and it yielded 1.7 l/s. Other records of water levels at Lords Farm (SP52/17A, B and C at about SP 569 245) show that the water level was at within 3.6 m below ground level (about 76 m above OD).

There are no water analyses from the Cornbrash and Forest Marble Formations, but anticipate that water from the limestones will be similar to that from the White Limestone Formation. All of the boreholes in the area that have analyses are deeper ones drilled into, and abstracting water from, the White Limestone Formation. A typical analysis, one from 1905 of the water from the Gowell Farm borehole, records total dissolved solids of 380 mg/l, a chloride ion concentration of 16 mg/l, a hardness of 207 mg/l (as $CaCO_3$), and nitrates of 0.2 mg/l. A 1935 analysis of several samples, taken under pumping conditions, record total dissolved solids of about 300-400 mg/l and a chloride ion concentration of 13-32 mg/l. The outcrop, and thus recharge area, of the White Limestone Formation lies to the north-west of the site area, within the search area. There are areas of worked ground in this formation in the search area. Depending upon the unknown depth of the worked ground areas, the water level in the White Limestone Formation may lie above the floor of any quarry or similar excavation. If any such worked ground has been backfilled and it is unlined, it is possible that the backfill material may affect groundwater flow beneath the site and may be in contact with the water within the White Limestone Formation. It is possible that under these conditions, the water in this formation may be, or become, contaminated and may eventually be transmitted down hydraulic gradient to the water in the formation beneath this site.

There are insufficient data to determine a groundwater flow direction, but locally it will probably be towards the nearest stream and regionally, down-dip towards the south-east.

The alluvium, and Cornbrash and Forest Marble Formations beneath the site are classified as Minor Aquifers with high soil leaching potential on the Environment Agency's Groundwater Vulnerability map, Sheet 30, Northern Cotswolds.

Individual sites will always require more detailed assessments to determine the specific impact on groundwater resources. The maps only represent conditions at the surface and where the soil and/or underlying formations have been disturbed or removed, the vulnerability class may have been changed and site specific data will be required.

Natural Land Gas

Section 2 indicates whether or not there is any potential susceptibility of the report area to surface or near-surface emissions of methane and/or carbon dioxide from natural sources or mining. Where methane and carbon dioxide emissions do occur at the surface most appear to be derived from abandoned shallow coal mines although a number of recorded incidences originate from peat and other natural deposits of organic materials, such as in buried ponds or river channels. It should be noted that the exact extent of potential sources of natural land gas, particularly that of peat and other organic deposits, can be difficult to predict.

An indication of potential for gas emissions does not necessarily indicate that there is a problem. That would depend on (1) the quantity of gases in the source rocks or superficial deposits, (2) whether they have been released and (3) whether there are pathways for transmission and locations for accumulation.

The relatively small number of gas emission incidents from coal mining and natural sources recorded in most areas of the UK suggests that the hazard is relatively minor and of local significance compared, for example, with the extensive problems associated with mining related subsidence or gas problems associated with landfill sites. However, in some parts of the coal fields, such as in parts of Northumberland, a relatively high number of gas emission sites have been identified, so the gas hazard is correspondingly greater. Whereas specific problems with methane and carbon dioxide from natural sources and mining can cause severe and, sometimes, expensive or dangerous problems, most gas emissions from natural sources and mining can usually be dealt with readily if they do arise.

A Residential Property or Non-Residential Property, Commercial or Development Site (maximum of 25 hectares) coal mining search from the Coal Authority (http://www.ppsearches.co.uk/coal_mining_searches.htm) will indicate whether any shafts or adits, which may act as pathways for gas, are located within 20 m of the boundary of the property or site. Where the Coal Authority is aware that a property or site being the subject of a search has been affected by mine gas, this information will be included in the Coal Mining Search Report.

If the report area is potentially susceptible to surface or near-surface emissions of methane and/or carbon dioxide from natural sources or mining, (1) caution should be exercised in forward planning on the basis that hazards from natural methane and carbon dioxide impose a constraint on development by virtue of public health or safety implications; (2) developers need to be aware that potential problems may be associated with gas emissions; (3) employers at some places of work may have responsibilities under the Health and Safety at Work etc Act 1974 to monitor gas levels; and (4) there may be a need to consult an appropriate specialist or to seek further information through desk studies and/or site investigations.

The information in this report should not be used in place of a site investigation. The existence of gas emissions at specific sites can only be established by detailed site investigation. The level of risk from methane or carbon dioxide in a particular building or underground cavity can only be established by monitoring the spaces in which it may accumulate.

Radon

Section 2 describes the level of Radon Protective Measures required during the construction of new buildings or extensions to existing buildings, at the site. This determination complies with information set out in *BR211 Radon: Guidance on protective measures for new dwellings (2007edition)*, which also provides guidance on what to do if the result indicates that protective measures are required (please see BRE Website for more details: www.bre.co.uk/radon). This assessment is based on the Radon Potential Dataset produced jointly by the BGS and the Health Protection Agency (for more information please see the BGS website at www.bgs.ac.uk/radon).