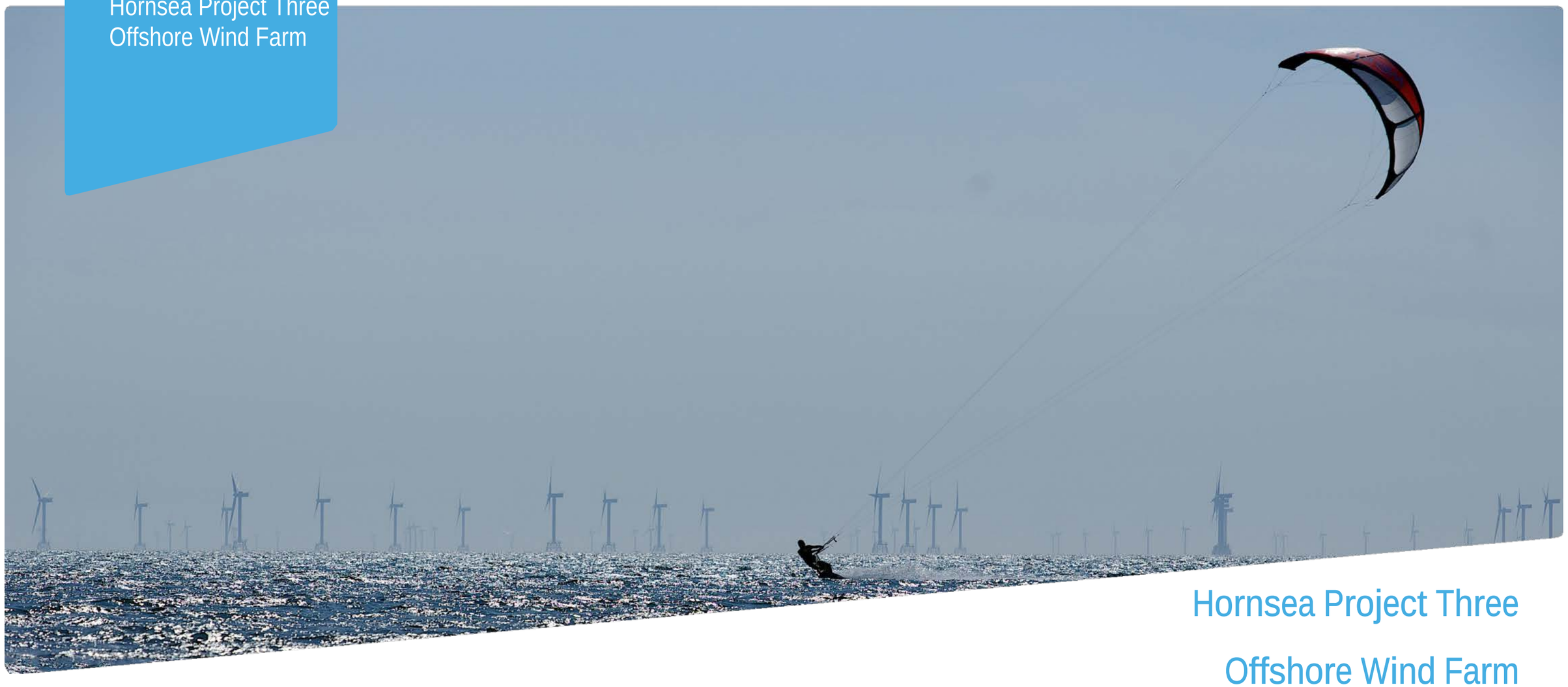
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Preliminary Environmental Information Report:
Annex 1.1 – Borehole Logs (Part 4)

Date: July 2017

Hornsea 3
Offshore Wind Farm

DONG energy

Environmental Impact Assessment

Preliminary Environmental Information Report

Volume 6

Annex 1.1 – Borehole Logs

Report Number: P6.6.1.1

Version: Final

Date: July 2017

This report is also downloadable from the Hornsea Project Three offshore wind farm website at:
www.dongenergy.co.uk/hornseaproject3

DONG Energy Power (UK) Ltd.

5 Howick Place,

London, SW1P 1WG

Front cover picture: Kite surfer near one of DONG Energy's UK offshore wind farms © DONG Energy Hornsea Project Three (UK) Ltd., 2016.

Prepared by: RPS

Checked by: Tracey Siddle and Jennifer Brack

Accepted by: Sophie Banham

Approved by: Sophie Banham

TG 10 NE 49 1644 0581 **Burnthouse Lane, Hethersett**

Surface level (+ 41.0 m) + 134 ft
Water struck at (+ 35.6 m) + 117 ft
Wirth B 1, 8 inch diam.,
December 1969

Waste (18.3 m +) 60 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.6)	2	(0.6)	2
Chalky Boulder Clay	Brown clay with traces of medium sand and fine gravel towards the base.	(4.6)	15	(5.2)	17
	Brown chalky clay.	(13.1 +)	43 +	(18.3)	60

TG 10 NW 14 1356 0944 **Cobb's Grove Plantation, Marlingford**

Surface level (+ 37.9 m) + 124 ft
Groundwater conditions not recorded
Shell and auger, 8 inch diam.,
December 1969

Overburden (0.3 m) 1 ft;
Mineral (4.9 m) 16 ft;
Waste (10.3 m) 34ft;
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.3)	1	(0.3)	1
Glacial Sand and Gravel	Sandy gravel. Gravel: fine to coarse subangular flint, with traces of fine subrounded quartz. Sand: medium with coarse, mainly subangular flint. Brown.	(4.9)	16	(5.2)	17
Chalky Boulder Clay	Slightly sandy brown clay with traces of gravel.	(6.4)	21	(11.6)	38
	Light brown chalky clay.	(0.9)	3	(12.5)	41
	Sandy brown clay with traces of gravel.	(3.0)	10	(15.5)	51
Upper Chalk	Chalk.	(0.9 +)	3+	(16.4)	54

	%		mm			%
Gravel	44	+	64		:	0
		−	64	+ 16	:	23
		−	16	+ 4	:	21
Sand	53	−	4	+ 1	:	14
		−	1	+ ¼	:	33
		−	¼	+ 1/16	:	6
Fines	3	−	1/16		:	3

Depth below surface (ft)	Fines	Sand	Gravel
1 − 4	6	42	52
4 − 7	2	46	52
7 − 10	6	70	24
10 − 13	0	70	30
13 − 17	1	42	57

TG 10 NW 20 1414 0895 North of Algarsthorpe

Surface level (+ 14.1 m) + 46 ft
Water struck at (+ 13.1 m) + 43 ft
Shell and auger, 8 inch diam.,
December 1969

Overburden (2.4 m) 8 ft;
Mineral (6.4 m) 21 ft;
Bedrock (0.9 m +)3 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
Alluvium	Soil and brown silty and peaty clay.	(2.4)	8	(2.4)	8
Sub-alluvium gravel	Gravel.	(6.4)	21	(8.8)	29
	Gravel: fine to coarse subangular flint, with traces of subrounded brown flint and traces of fine subrounded quartz.				
	Sand: medium and coarse subangular flint with subrounded quartz and chalk. Grey and brown.				
Upper Chalk	Chalk.	(0.9 +)	3 +	(9.7)	32

	%		mm		%
Gravel	65	+	64	:	0
		–	64 + 16	:	30
		–	16 + 4	:	35
Sand	32	–	4 + 1	:	13
		–	1 + ¼	:	14
		–	¼ + 1/16	:	5
Fines	3	–	1/16	:	3

Depth below surface (ft)	Percentage Fines	Sand	Gravel
8 – 11	3	33	64
11 – 14	2	32	66
14 – 17	2	27	71
17 – 20	4	34	62
20 – 23	5	36	59
23 – 26	1	32	67
26 – 29	1	33	66

Ref:A/S 40/91

TG10NW/45
1468. 0758.

June 92

TG10/136

161

F SMITH & SON (GRIMSBY) LIMITED

Record of 762mm (30") nominal dia x 87m deep Water Abstraction borehole drilled for Anglian Water Services Ltd Histon Cambridge

1468 0758

VALLEY FARM Nr BARFORD NORLK NGR TG ~~148 076~~

TG10NW

STRATA

		Thickness M.	Depth M.
Top soil	QUATERNARY ALLUVIUM	0.50	0.50
Grey and brown sandy clay		1.20	1.70
Dry White chalk	UPPER CHALK (UPPER CRETACEOUS)	1.80	3.50
Firm and soft yellow chalk with flints		1.00	4.50
Firm and soft yellow chalk		3.50	8.00
Harder chalk and flint		2.00	10.00
Chalk and flint		18.00	28.00
Hard chalk and flint with soft seams		49.00	77.00
Hard chalk and flint with soft sticky seams		10.00	87.00

R&O Hamilton 3-2-93

WATER

RWL 2.81m bgl, reading taken 6 December 1991

LINING TUBE

a) 25.50m x 762mm OD plain mild steel lining tube installed to a depth of 25m BGL. the top being fitted with a weld - on flange drilled NP16.
b) 87.5 x 600mmOD steel casing installed to base of borehole the top being left flush with head flange drilled NP16 casing column made up as follows:-
1) Perforated from base of borehole to 24m BGL (63")
11) Plain from 24m BGL to top flange.
111) Slotting pattern:
Rings of 10 No x 300mm long x 12.5 wide slots with 50mm plain tube between rings adjacent rows of slots staggered.
Total No of slots 1773.

Stabiliser Pack

The annular space between the 600mm OD lining and the borehole wall and betwwen the 600mm OD lining and 762mm OD lining was packed with 40mm natural shingle.

12th January 93
Jones

9656

Eastern L.S. Anglian N.R.A. NN 910097

Ref:A/S 40/91, June 92

Tg10/136

F SMITH & SON (GRIMSBY) LIMITED

Record of 762mm (30") nominal dia x 87m deep Water Abstraction borehole drilled for Anglian Water Services Ltd Histon Cambridge

161

1468 0758
VALLEY FARM Nr BARFORD NORLK NGR TG ~~148~~ ~~076~~

Tg10NW/45

STRATA		Thickness M.	Depth M.
Top soil	Quaternary	0.50	0.50
Grey and brown sandy clay	Alluvium	1.20	1.70
Dry White chalk	Upper Chalk	1.80	3.50
Firm and soft yellow chalk with flints		1.00	4.50
Firm and soft yellow chalk		3.50	8.00
Harder chalk and flint	Upper	2.00	10.00
Chalk and flint		18.00	28.00
Hard chalk and flint with soft seams	Cretaceous	49.00	77.00
Hard chalk and flint with soft sticky seams		10.00	87.00

3.2.93

WATER

RWL 2.81m bgl, reading taken 6 December 1991

LINING TUBE

a) *25.50m x 762mm OD plain mild steel lining tube installed to a depth of 25m BGL. the top being fitted with a weld - on flange drilled NP16.*
b) *87.5 x 600mmOD steel casing installed to base of borehole the top being left flush with head flange drilled NP16 casing column made up as follows:-*

1) *Perforated from base of borehole to 24m BGL (63")*
11) *Plain from 24m BGL to top flange.*
111) *Slotting pattern:*
Rings of 10 No x 300mm long x 12.5 wide slots with 50mm plain tube between rings adjacent rows of slots staggered.
Total No of slots 1773.

Stabiliser Pack

The annular space between the 600mm OD lining and the borehole wall and betwwen the 600mm OD lining and 762mm OD lining was packed with 40mm natural shingle.

JANUARY 1993

Tg10/136

Grouting

The annulor space between the 762mmOD lining and the wall of the borehole was packed with stabiliser gravel and smaller grit to make grout retaining seal at 18.50m BGL and the remaining space filled with cement and grout to

GL.

TEST PUMPING

The borehole was clearance pumped, step tested and yield tested for a period of 14 days approximately 23.3l/sec from approx 21m BGL.

DATES

Commenced: drilling October 1991
Completed: Pumping June 1992

DRILLING MACHINE

Ruston Erie 29T/S Cable Percussion Rig.

DRILLER

C Billings
Pumping
J.Best

NN 910097
TG10/136

Grouting

The annulor space between the 762mmOD lining and the wall of the borehole was packed with stabiliser gravel and smaller grit to make grout retaining seal at 18.50m BGL and the remaining space filled with cement and grout to GL.

TEST PUMPING

The borehole was clearance pumped, step tested and yield tested for a period of 14 days approximately 23.3l/sec from approx 21m BGL.

DATES

Commenced: drilling October 1991
Completed: Pumping June 1992

DRILLING MACHINE

Ruston Erie 29T/S Cable Percussion Rig.

DRILLER

C Billings
Pumping
J.Best

DATA ACQUISITION SHEET

CSC/D/140

P21

NRA region: ANGLIAN (NORWICH)

File Number: PTF 34/13 TECHNICAL FILE (B) TG10/136

Pump Well Identification:

NRA id No:

BGS (WL) No: TG10/136

NGR: TG 1487 0759

Elevation: PROD +25.038m OD (top head plate)
OBS +24.338m OD (" ")

Measuring Point: PROD datum + 0.76m AGL
OBS: HEAD PLATE

Site Name: PRODUCTION BH VALLEY FARM

Locality: MARLINGFORD NORFOLK

Well details:

depth of pumping well: 87 m

diameter: 762mm

casing details: 762mm plain steel to 25m bgl
600mm plain steel to 24m bgl
600mm slotted steel 24 to 87m bgl

☐ observation boreholes

number of obs bhs: 9

obs bh details: Valley farm obs bh r = 37m
earlier pilot bh details CSC/D/138

Aquifer Details:

~~confined~~ / unconfined If confined, confining layer: NA

Aquifer Geology	from	to	Aquifer Geology	from	to
CRAG + bn sandy clay to 1.7m CHALK					

Pumping Test Details:

date of test: STEP TEST : 8.5.92
CONSTANT RATE: 12.5.92 to 26.5.92

length of test: 14 days

RWL: 3.57 mbd

PWL: 20.50 mbd

pumping rate: 24.1 l/s; 2085 m³/d

Additional Well Information:

- ☐ Well Loss Data: B..... C..... Efficiency.....
- ☒ Well Acidified NOT ACIDISED see below
- ☐ Flow Logs
- ☑ Other Geophysical Logs inc CCTV
- ☐ Fissure Information: major inflows from.....to.....
  little flow above 33.5m bd — from.....to.....
  a little below c 63m bd — from.....to.....
  obs bh showed little flow below 59m

Aquifer Parameters:

Analysis Type: COOPER JACOB

	PROD	OBS
Transmissivity:	94	114 m^2/d
Storage Coefficient:	–	0.039

Analysis Type: COOPER JACOB RECOVERY

	PROD	OBS
Transmissivity:	154	162 m^2/d
Storage Coefficient:	–	–

Analysis Type: THEIS

	PROD	OBS EARLY	OBS LATE
Transmissivity:	–	155	90 m^2/d
Storage Coefficient:	–	0.0004	0.076

Other Data:
REPRESENTATIVE AQUIFER PARAMETERS;
T = 130 m^2/d
S = 0.0004
Sy = 0.04

Confidence:

excellent ☐ ☑ ☐ ☐ ☐ very poor

Notes: Not acidised because Chalk not stable & also there is a fish pond nearby
Since original pilot bh collapsed after test pumping a new obs bh was drilled 39m from prodn bh

STEP TEST.

Q(m^3/d)	Duration(min)	Drawdown(m)
686	120	1.93
1048	"	3.64
1589	"	8.18
2505	"	17.57

Constant rate test – Q was not constant – first 60min Q = 1726 m^3/d before being increased – increased again during 22 hrs before end of test.
Cooper Jacob recovery gives different T from drdn – may be better if recovery data corrected
Theis curve fitting probably "subject to significant errors"

FOR EARLIER TESTING OF VALLEY FARM PILOT BH see CSC/D/138

DATA ACQUISITION SHEET

TG10/151 CSC/D/138 P21

NRA region: ANGLIAN (NORWICH) 161

File Number: PUMP TEST FILE 34/13 TECHNICAL FILE TG10 NW/76

Pump Well Identification:

NRA id No:

BGS (WL) No: TG10/151

NGR: TG 1484 0760

Elevation:

Measuring Point:

Site Name: VALLEY FARM MARLINGFORD

Locality: YARE VALLEY

Well details:

depth of pumping well: 80.0m

diameter: 100mm

casing details: plain casing to 30.0m slotted to 50.0m

☒ observation boreholes NONE

number of obs bhs: N/A

obs bh details:

Aquifer Details:

~~confined~~ / unconfined If confined, confining layer: N/A

Aquifer Geology	from	to	Aquifer Geology	from	to
CHALK	2.1	80.0			

Pumping Test Details:

date of test: 3 JUNE 1987 STEP TEST
CONSTANT RATE 6. JUNE 1993

length of test: 3 steps each 120 min, 4th step extended
CONSTANT RATE : 10080 min = 7 DAYS

RWL: 2.1m bmp

PWL: 9.64m bmp

pumping rate: STEP TEST: 465 m^3/d; 576 m^3/d, 804 m^3/d, 1140 m^3/d AV. 747 m^3/d
CONSTANT RATE 1151 m^3/d

6 5R 5 2

TG 10 SE 193

ENGINEER G. MAUNSELL & PARTNERS.
LOGGED BY MSD/GRD
FIELDWORK BY SH
LAB TESTING BY S.C.C.

PROJECT A11 IMPROVEMENT - WYMONDHAM TO CRINGLEFORD.
EXCAVATION METHODS
WHEELED EXCAVATOR (JCB 3C)

GROUND LEVEL 25.321 m O.D.
COORDINATES 617345 E 309520 N
DATES 29/4/82

HOLE NO 27
FIGURE A
SHEET 1 OF 1

DATE/TIME AT DEPTH	DEPTH OF CASING	DEPTH TO WATER	± 0	STRATA DESCRIPTION	LEG	LEVEL m OD	DEPTH m
						25.321	0
				Pale greyish brown silty LOAM. (TOPSOIL.)		24.971	0.35
				Pale yellowish brown gravelly SAND. (GLACIAL SAND AND GRAVEL)		24.631	0.7
				Orange brown with reddish-brown veining uniformly graded fine-medium SAND to silty SAND. (GLACIAL SAND AND GRAVEL)		23.121	2.2

NO	DEPTH m	TYPE	BLOWS	V / Cu Rem
	0			
1	0.5	B		
2	1.0	B		
3	1.5	B		
4	2.0	B		

% <425	W %	PL %	LI %	MCV	γ Mg/m³	Cu kN/m²
	3.3					
	7.7					
	6.5					

OTHER TESTS AND NOTES
PARTICLE SIZE DISTRIBUTION.

WATER
- First water strike
- Subsequent water strikes
- Highest water level in open hole

PIEZOMETER (Installation only, readings elsewhere)
- Upper seal
- Response length
- Lower seal

SAMPLE AND TEST KEY
- D Small disturbed sample
- B Bulk disturbed sample
- W Water sample
- U Undisturbed sample
- P Piston sample
- R Rotary core, recovery to scale
- V Insitu vane test
- S Standard penetration test
- C Cone penetration test
- k Permeability test
- PA Pressuremeter test

Blows N = N value 26/150, blows for 150mm drive after seating 22*, blows for part of which of seating drive only (26) Undisturbed sample blow count

V Vane strength kN/m² Natural / Rem
C Core recovery %
RQD Rock quality designation
<425 Sample % passing 425μm sieve

Mr D E Evans BSc.Tech,MSE,FICE, FIMunE,FIHE
Director (Transport)
Eastern Regional Office (Transport)
49/51 Goldington Road
Bedford

SHEET 1 OF 1
FIG A
HOLE NO 27

BOREHOLE LOG

T6/20 SW/3

2170.0225

BOREHOLE No. 3

BOREHOLE DIAMETER 6"

WATER STRUCK AT -

OE/IPG/MBK/SN05

DATE	WATER LEVEL	DEPTH OF BORING	STRATA DESCRIPTION	DEPTH	O.D. LEVEL	SAMPLE DETAILS		
						LEVEL	NUMBER OF BLOWS	TYPE AND REF.
18.12.65			Topsoil		107.05			
				1'6" (0.46m)	106.05			
			Sand with flint boulders and very small clay content					
						5'0"		0
						8'0" to 9'0"	19	X
18.12.65	Nil	10'0"		10'0" (3.05m)	97.05	10'0"		0
19.12.65	Nil		Sand with flint boulders and very small clay and chalk content			13'0" to 14'0"	21	X
						15'0"		0
						18'0" to 19'0"	20	X
						20'0"		0
						23'0" to 24'0"	25	X
						25'0"		0
						28'0" to 29'0"	24	X
19.12.65	Nil	30'0"		30'0" (9.14m) Bottom of borehole	77.05			

UNDISTURBED SAMPLES □ DISTURBED SAMPLES ○ WATER SAMPLES ▽ S. P. TESTS X

TG 10 SE/97

ENGINEER G. MAUNSELL & PARTNERS.
LOGGED BY MRD/LRD
FIELDWORK BY SH
LAB TESTING BY S.C.C.

PROJECT A11 IMPROVEMENT - WYMONDHAM TO CRINGLEFORD.
EXCAVATION METHODS
WHEELED EXCAVATOR (JCB 3C)

GROUND LEVEL 24.338 m O.D.
COORDINATES 617380 E 304440 N
DATES 29/4/82

HOLE NO 35
FIGURE A
SHEET 1 OF 1

WATER LEVEL/TIME AT DEPTH	DEPTH OF CASING	DEPTH TO WATER	PIEZ	STRATA DESCRIPTION	LEG.	LEVEL m O.D.	DEPTH m
				Pale greyish brown silty LOAM. (TOPSOIL)		24.338	0
				Brownish red subrounded GRAVEL/SAND with old rootlets. (GLACIAL SAND AND GRAVEL)		23.988	0.35
				Yellow and pale grey slightly gravelly uniformly graded medium SAND. (GLACIAL SAND AND GRAVEL)		23.038	1.3
						21.338	3.0

SAMPLING/ IN SITU TESTING NO	DEPTH m	TYPE	BLOWS	V / Cr / RQD
1	0.5	D		
2	1.0	B		
3	1.5	D		
4	2.0	B		
5	3.0	D		

LAB TESTING	% <425	W %	PL %	LL %	MCV	γ Mg/m³	Cv kN/m²
2		4.9					
4		7.0					

OTHER TESTS AND NOTES

PARTICLE SIZE DISTRIBUTION.

PARTICLE SIZE DISTRIBUTION.

WATER
1 — First water strike
2 — Subsequent water strikes
Σ — Highest water level in open hole

PIEZOMETER
Upper seal
Response length
Lower seal
(Installation only readings elsewhere)

SAMPLE AND TEST KEY
D Small disturbed sample
B Bulk disturbed sample
W Water sample
U Undisturbed sample
P Piston sample
R Rotary core recovery to scale
V Insitu vane test
S Standard penetration test
C Cone penetration test
P Permeability test
PR Pressuremeter test

Blows N & N value
26/150 blows for 150mm drive after seating
26* blows for part of whole of seating drive only
U26 Undisturbed sample blow count

V Vane strength kN/m²
Natural
Remould
Cr Core recovery %
RQD Rock quality designation
<425 Sample % passing 425um sieve

Mr D I Evans B.Sc.Tech,MSE,FICE,FIMunE,FIHE
Director (Transport)
Eastern Regional Office (Transport)
49/51 Goldington Road
Bedford

SHEET 1 OF 1
FIG A
FIGURE NO 35

TG 10 SE 18 1957 0233 South-west of Hospital Farm, Swardeston

Surface level (+ 33.2 m) + 109 ft
Water not struck
Wirth B O, 8 inch diam.,
January 1970

Waste (15.5 m) 51 ft;
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	ft	Depth (m)	ft
	Made ground and soil.	(1.2)	4	(1.2)	4
Glacial Sand and Gravel	'Very clayey' sand. Traces of hard chalk fragments. Gravel: fine, subangular traces subrounded, mainly flint, some quartz. Sand: medium and fine, subangular. Light brown.	(0.6)	2	(1.8)	6
Chalky Boulder Clay	Brown sandy clay with some gravel. Gravel: mainly fine, subangular flint. Sand: medium and coarse.	(2.1)	7	(3.9)	13
	Light brown clay with traces of chalk.	(11.6)	38	(15.5)	51
Upper Chalk	Chalk.	(0.9 +)	3 +	(16.4)	54

TG 10 SE 7 1750 0442 East of Hethersett Station

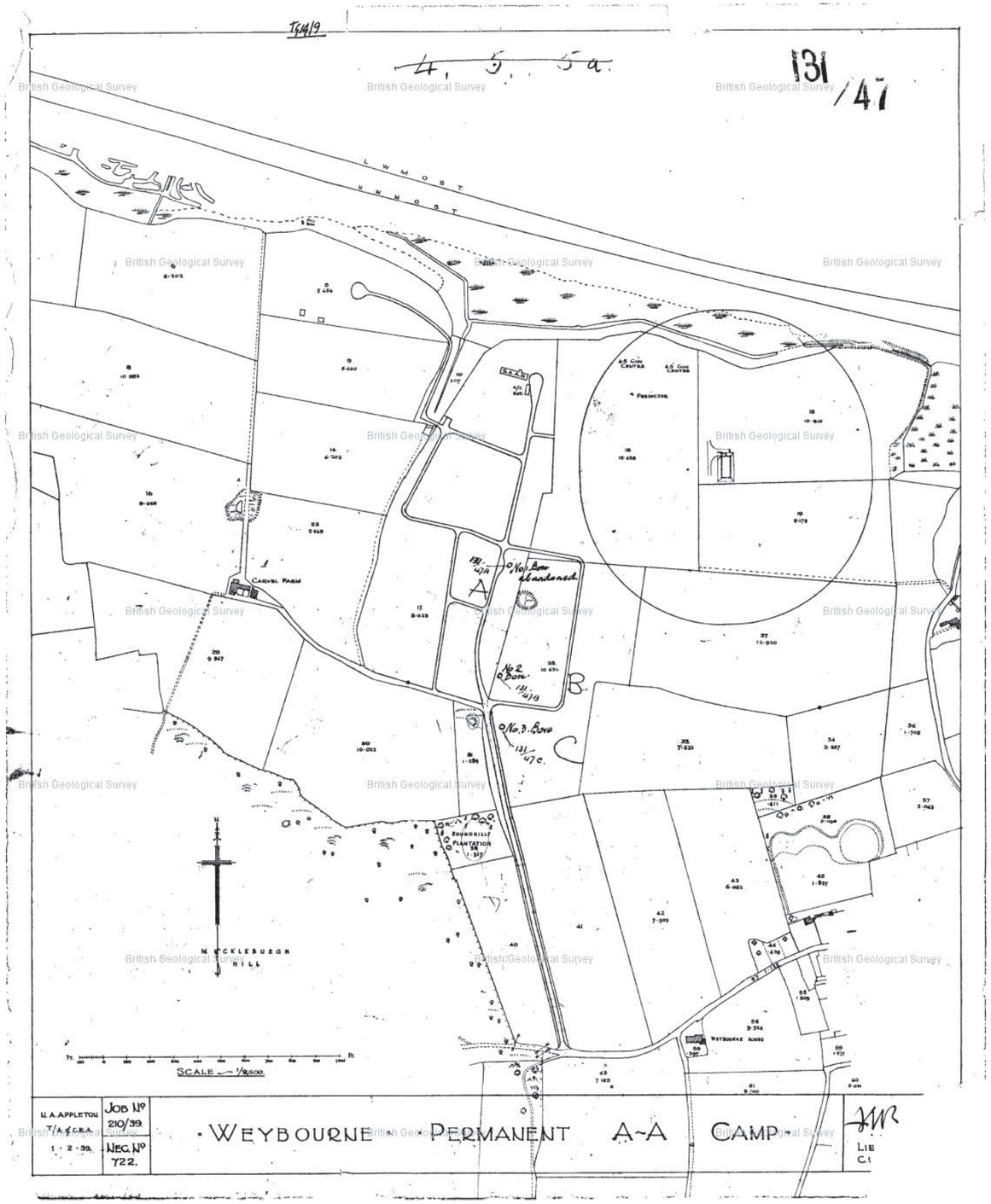
Surface level (+ 29.6 m) + 98 ft
Water not struck
Wirth B 1, 8 inch diam.,
December 1969

Overburden (4.2 m) 14 ft;
Mineral (4.6 m) 15 ft;
Bedrock (0.9 m +) 3 ft +

		Thickness (m)	ft	Depth (m)	ft
Chalky Boulder Clay	Soil and soft brown clay.	(4.2)	14	(4.2)	14
Glacial Sand and Gravel	Pebbly sand. Clayey in parts. Some hard chalk fragments. Gravel: fine and coarse, subangular, flint; with some fine subrounded quartz, occasional flint cobbles. Sand: medium and fine with traces of coarse, subangular flint. Brown.	(4.6)	15	(8.8)	29
Upper Chalk	Chalk.	(0.9 +)	3+	(9.7)	32

		mm		%
Gravel	10	+ 64	:	0
		– 64 + 16	:	4
		– 16 + 4	:	6
Sand	84	– 4 + 1	:	6
		– 1 + ¼	:	57
		– ¼ + 1/16	:	21
Fines	6	– 1/16	:	6

Depth below surface (ft)	Percentage Fines	Sand	Gravel
14 – 17	7	74	19
17 – 20	2	98	0
20 – 23	0	100	0
23 – 26	11	75	14
26 – 29	10	75	15



131/47

TG/208W/1

2209 0220

BOREHOLE LOG

BOREHOLE No. 1

BOREHOLE DIAMETER 6"

WATER STRUCK AT -

CE/IPB/MEK/SM85

DATE	WATER LEVEL	DEPTH OF BORING	STRATA DESCRIPTION	DEPTH	O.D. LEVEL*	SAMPLE DETAILS: LEVEL	NUMBER OF BLOWS	TYPE AND REF.
16.11.65			Topsoil		99.88			
				3'0" (0.91m)	96.88			
			Brown sandy clay with flint boulders & chalk			4'0" to 5'0"	51	X
						5'0" to 6'6"	190	□
						8'0" to 9'0"	52	X
16.11.65	Nil	10'0"				10'0"		0
18.11.65	Nil							
						13'0" to 14'0"	51	X
						15'0"		0
18.11.65	Nil	19'0"				18'0" to 19'0"	36	X
19.11.65	Nil					20'0"		0
						23'0" to 24'0"	43	X
						25'0"		0
						28'0" to 29'0"	50	X
19.11.65	Nil	30'0"		(9.14m) 30'0" Bottom of borehole	69.88			

B.M. on parapet, of railway bridge Map ref. 2220222 taken as 105.86' O.D.

UNDISTURBED SAMPLES □ DISTURBED SAMPLES ○ WATER SAMPLES ▽ S. P. TESTS X

TG 20 SW/90

ENGINEER G. MAUNSELL AND PARTNERS	PROJECT A47 NORWICH SOUTHERN BYPASS	GROUND LEVEL 35.20 m O.D.	HOLE NO. 147
LOGGED BY: GROUND ENGINEERING LIMITED	EXCAVATION METHODS PERCUSSIVE (PILCON WAYFARER)	COORDINATES 621 460 E 303 662 N	FIGURE A
FIELDWORK BY: " " "	200mm casing to 6.25m	DATES 28/4/82	SHEET 1 OF 1
LAB. TESTING BY: " " "			

WATER/TIME AT DEPTH	DEPTH OF CASING	DEPTH TO WATER	Piez.	STRATA DESCRIPTION	LEG.	LEVEL m.O.D.	DEPTH m
4.82						35.20	0.00
30				TOPSOIL		34.80	0.40
				Firm mottled brown and dark brown silty sandy CLAY with some fine to medium subrounded to subangular gravel (Boulder Clay)			0.85
				---- with chalk fragments and cobbles		33.95	1.25
				Medium dense orange brown fine to medium SAND with occasional fine gravel (Glacial Sand and Gravel			1.90
				---- with pockets of brown clay and fine to medium subrounded to subangular gravel			2.00
				---- becoming brown fine to coarse SAND and fine to medium subrounded to subangular GRAVEL			5.00
				Firm pale brown silty CLAY with some fine to medium subrounded gravel and chalk fragments (Boulder Clay)		29.20	6.00
				---- becoming greenish brown with brown stained fissures			6.95
				---- becoming firm to stiff			8.00
4.82 30	6.25	DRY				26.60	8.60
				BOREHOLE COMPLETED			

NO.	DEPTH m	TYPE	BLOWS	V / Cr / RQD	% <425	W %	PL %	LL %	MCV	γ Mg/m³	Cu kN/m²	OTHER TESTS AND NOTES
1	0.45	B				15						
	0.80											
2	0.85	B										
	1.00											
3	1.00	U	(49)		70	15	16	30		1.93	20	
	1.45										φu= 30°	
4	1.45	D										
5	1.90	D										Water added from 1.80m to 6.00m
6	2.00	BC	N=16									
	3.45											
7	3.00	BC	N=11									
	3.45											
8	4.00	BC	N=16									
	4.45											
9	5.00	BC	N=15									
	5.45											
10	6.10	D				14						
11	6.50	U	(45)		87	14	11	25		2.23	42	Consolidation
	6.95											
12	6.95	D										
13	7.50	D										
14	8.00	U	(52)		87	12	12	24		2.20	78	
	8.45											
15	8.45	D										

SAMPLING/ IN SITU TESTING

LAB TESTING

WATER
- First water strike
- Subsequent water strikes
- Highest water level in open hole

PIEZOMETER (Installation only, readings elsewhere)
- Upper seal
- Response length
- Lower seal

SAMPLE AND TEST KEY
- D Small disturbed sample
- B Bulk disturbed sample
- W Water sample
- U Undisturbed sample
- P Piston sample
- R Rotary core recovery to scale
- I Insitu vane test
- S Standard penetration test
- C Cone penetration test
- K Permeability test
- PR Pressuremeter 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

J. Tiplady BSC. C.Eng FICE, FIHE
Director (Transport)
Eastern Regional Office (Transport)
49-51 Goldington Road, Bedford

SHEET 1 OF 1 | FIG. A | HOLE NO. 147

-16/8/82

TG 20 SW/86

ENGINEER G. MAUNSELL AND PARTNERS	PROJECT A47 NORWICH SOUTHERN BYPASS	GROUND LEVEL 26.90m m O.D.	HOLE NO. 144(T)
LOGGED BY: GROUND ENGINEERING LIMITED	EXCAVATION METHODS WHEELED HYMAC	COORDINATES 620 965 E 303 600 N	FIGURE A
FIELDWORK BY: " " "		DATES 29/3/82	SHEET 1 OF 1
LAB. TESTING BY: "			

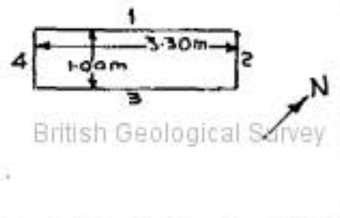
DATE/TIME AT DEPTH	DEPTH OF CASING	DEPTH TO WATER	Piez.	STRATA DESCRIPTION	LEG.	LEVEL m.O.D.	DEPTH m
9.3.82						26.90	0.00
1.00				TOPSOIL(Dark brown silty sandy clay with fine to coarse subrounded to subangular gravel and occasional rootlets)		26.60	0.30
				Firm silty sandy CLAY with occasional fine to medium subrounded to subangular gravel with occasional chalk fragments (Boulder Clay)		26.15	0.75
				Stiff pale greenish brown silty CLAY with some fine to medium subangular gravel (Boulder Clay)			
				Stiff orange brown sandy CLAY with chalk gravel (Boulder Clay)		25.60	1.30
				···· becoming clayey SAND			1.70
				Stiff grey mottled orange brown silty CLAY with abundant chalk gravel (Boulder Clay)		24.90	2.00
		1 ▽					
3.30 9.3.82		2.85		TRIAL PIT COMPLETED		23.40	3.50

SAMPLING/ IN SITU TESTING NO.	DEPTH m	TYPE	BLOWS	V / Cr / RQD
1	0.45	D		
13	0.50	CBR		
2	0.50	B		
	0.60			
3	0.90	D		
4	1.00	B		
	1.10			
5	1.30	D		
6	1.50	B		
	1.60			
14	1.60	U38		
7	1.80	D		
8	1.95	B		
	2.05			
9	2.50	D		
10	2.80	B		
	2.90			
11		W		
12	3.40	B		
	3.50			

LAB TESTING	% <425	W %	PL %	LL %	MCV	γ Mg/m³	Cu kN/m²
		17					
	64	21	NP	NP			
		20				2.01	68
	85	17	16	27			
	78	18	16	25			

OTHER TESTS AND NOTES

1) Pit completed and shored to 3.50m
2) Groundwater was encountered at 2.85m and pumping continued for 1 hour
3) Photographs taken of face 2
CBR (0.50m)
pH and sulphate content
pH and sulphate content



WATER
1 First water strike
2 Subsequent water strikes
▽ Highest water level in open hole

PIEZOMETER
Upper seal
Response length
Lower seal
(Installation only, readings elsewhere)

SAMPLE AND TEST KEY
D Small disturbed sample
B Bulk disturbed sample
W Water sample
U Undisturbed sample
P Piston sample
R Rotary core recovery to scale
V Insitu vane test
S Standard penetration test
C Cone penetration test
K Permeability test
PR Pressuremeter 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

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Director (Transport)
Eastern Regional Office (Transport)
49-51 Goldington Road, Bedford

SHEET 1 OF 1 | A | H.E. NO. 144(T)

1.

161/403 Police House, Swardeston. (Sealed) TG20/50

Surface +116. Shaft 87; rest bore. Lining tubes: 70 x 4 in. R.W.L. +34. P.W.L. -4. Yield 600 g.p.h. (8 h. test). Buckingham, Mar. 1950.

Handpump. 1953. Hardness: total 400. Anal. Before 1960.

† Boulder Clay	...	...	c.30	c.30
UCk	...	...	c.140	170

Estimated log TG 2066 0315

pp. P.N. Hilderth 18.6.69.

6" Quarter Sheet
75 SW E

1.

RECORD OF WELL (SHAFT OR BORE)

(attach copy of analysis if available)

For Survey use only
TG20/50 N.5112
161 403

EXACT SITE OF WELL

At Police House.

Town or Village Swardeston, Norwich

County Norfolk Six-inch quarter sheet 75 SW/E

For Mr. Norfolk County Council State whether owner, tenant, builder, contractor, consultant, etc. :—

Address (if different from above) Thorpe Road, Norwich.

Level of ground surface above sea-level (O.D.) ..... ft. If well-top is not at ground level, state how far ... (above; below; ..... ft.

SHAFT 87 ft.; diameter ..... ft.; Details of headings .....

BORE 83 ft.; diameter of bore: at top 4 ins.; at bottom ..... ins.

Details of permanent lining tubes 70'x4"

Water struck at depths of ..... ft. below well-top.

TEST CONDITIONS

Rest-level of water 82 ft. above ~~below~~ well-top. Suction at ..... ft. Yield on 8 hours' ~~days'~~ test pumping at 600 galls. per hour with depression to 120 ft. below well-top.

Recovery to rest-level in ..... mins. ~~hours~~ Capacity of pump ..... g.p.h. Date of measurements .....

NORMAL CONDITIONS

Description of permanent pumping equipment :

Make and/or type ..... Motive power .....

Capacity ..... gallons per hour. Suction at ..... ft.

Amount pumped ..... galls. per day. Estimated consumption ..... galls. per week.

Well made by J.H. Buckingham. Date of well March, 1950

Information from ....

ADDITIONAL NOTES

Police house visited - no one in.
Site marked by Randpump outside back door.
O.D. 116'
SMA 15.10.53

Continuous chlorine 1.5 grs/gall.
Total Hardness 38°
Very slight trace Iron.

Visited.
Disused & sealed.
24/8/60 BW.

M. Shankland Surveyor

LOG OF STRATA OVERLEAF.

GEOLOGICAL SURVEY AND MUSEUM, SOUTH KENSINGTON, LONDON, S.W.7.	Date Received	1" O.S. Map No.	Site marked on 1" Map	(use symbol) on 6" Map
	9.4.53.		⊙	⊙

(*35243) Wt.1473/1042A 12,000 3/43 A.& E.W.Ltd. Gp.685

BOREHOLE LOG

TG/20 SW/5

2179.0271

BOREHOLE No. 5

BOREHOLE DIAMETER 6"

WATER STRUCK AT -

CE/IPG/MBK/SM85

DATE	WATER LEVEL	DEPTH OF BORING	STRATA DESCRIPTION	DEPTH	O.D. LEVEL	SAMPLE DETAILS		
						LEVEL	NUMBER OF BLOWS	TYPE AND REF.
20.12.65			Topsoil	1'6" (0.46m)	126.09			
			Brown sandy clay with flint boulder and chalk content		124.59			
						5'10"		C
						8'10" to 9'10"	41	X
						10'10"		D
						13'10" to 14'10"	40	X
						15'10"		D
						18'10" to 19'10"	41	X
						20'10"		D
						23'10" to 24'10"	40	X
20.12.65	Nil	24'0"						
21.12.65	Nil					25'10"		D
						28'10" to 29'10"	43	X
21.12.65	Nil	29'0"		(9.14m) 29'0" Bottom of borehole	97.09			

UNDISTURBED SAMPLES □ DISTURBED SAMPLES ○ WATER SAMPLES ▽ S. P. TESTS X

TG20SW/55

2064.0315

161/403 Police House, Swardeston. (Sealed)

Surface +116. Shaft 87; rest bore. Lining tubes: 70 x 4 in. R.W.L. +34. P.W.L. -4. Yield 600 g.p.h. (8 h. test). Buckingham, Mar. 1950.

Handpump. 1953. Hardness: total 400. Anal. Before 1960.

† Boulder Clay	...	...	c.30	c.30
UCk	...	...	c.140	170

Estimated log

pp. P.N. Hulbert 18.6.69.

6" Quarter Sheet

75 SW E

TG/20SW/39.

BOREHOLE LOG

BOREHOLE No. 220 SITE: Norwich

2200.0220.

BOREHOLE DIAMETER 6"

WATER STRUCK AT 10'0" (3.05m)

DATE	DEPTH OF BORING	DEPTH OF CASING	DEPTH TO WATER	STRATA DESCRIPTION	STRATA CHANGE DEPTH	STRATA CHANGE O.D. LEVEL	S.P.T. BLOWS	DEPTH	SAMPLE TYPE
3.1.70				TOPSOIL and SUBSOIL.	(0.76m) 2'6"	115.0 (35.05m) 112.5 (34.29m)			
				SILTY CLAY with gravel sized pieces of CHALK and some FLINTS. Generally firm, light yellowish grey with traces of orange F.M. sand. (Boulder clay)				3'6" to 5'0"	□
	8'0"	8'0"	DRY						
								8'6" to 10'0"	□▽
	10'0"	8'0"	10'0"						
	12'0"	12'0"	DRY						
								13'6" to 15'0"	□
					(5.79m) 19'0"	(29.26m) 96.0			
				SILTY CLAY with gravel sized pieces of CHALK. Firm, turning stiff, grey. (Boulder clay)				18'6" to 20'0"	□
								23'6" to 25'0"	□
3.1.70	25'0"	23'6"	DRY						
4.1.70			DRY						
								28'6" to 30'0"	□
					(10.67m) 35'0"	(24.38m) 80.0		33'6" to 35'0"	□
4.1.70	35'0"	33'6"	DRY	End of borehole					

SCALE: 5 FEET TO 1 INCH

UNDISTURBED SAMPLES □ DISTURBED SAMPLES O WATER SAMPLES ▽ S. P. TESTS X

NO RECOVERY OF UNDISTURBED SAMPLES □NR BULK SAMPLES ⇕

76/20 SW/4

2193.0245

BOREHOLE LOG

BOREHOLE No. 4

BOREHOLE DIAMETER 6"

WATER STRUCK AT -

CE/IRG/ABK/SH65

DATE	WATER LEVEL	DEPTH OF BORING	STRATA DESCRIPTION	DEPTH	O.D. LEVEL	SAMPLE DETAILS LEVEL	NUMBER OF BLOWS	TYPE AND REF.
16.12.65			Topsoil	1'6" (0.46m)	113.18 111.68			
			Brown sandy clay with flint boulder and chalk content			5'0" to 6'6"	114	□
						8'0" to 9'0"	33	X
						10'0"		0
						13'0" to 14'0"	36	X
						15'0"		0
						18'0" to 19'0"	35	X
						20'0"		0
16.12.65	Nil	24'0"				23'0" to 24'0"	37	X
17.12.65	Nil					25'0"		0
						28'0" to 29'0"	37	X
17.12.65	Nil	30'0"		(9.14m) 30'0" Bottom of borehole	83.18			

UNDISTURBED SAMPLES □ DISTURBED SAMPLES O WATER SAMPLES ▽ S. P. TESTS X

TG/20 SW/2
2188. 0218

BOREHOLE LOG

BOREHOLE No. 2
BOREHOLE DIAMETER 6"
WATER STRUCK AT -

OE/IPG/MBK/SN85

DATE	WATER LEVEL	DEPTH OF BORING	STRATA DESCRIPTION	DEPTH	O.D. LEVEL	SAMPLE DETAILS: LEVEL	NUMBER OF BLOWS	TYPE AND REF.
10.12.65			Topsoil	1'0" (0.30m)	94.38 93.38			
			Brown sandy clay with flint boulders			3'0" to 4'6"	85	□
10.12.65	Nil	4'6"		4'0" (1.22m)	90.38			
15.12.65			Brown sandy clay with flint boulders and chalk			5'6" to 6'6"	37	X
						8'0"		0
						10'6" to 11'6"	42	X
						15'0"		0
15.12.65	Nil	19'6"		(5.94m) 19'6" Bottom of borehole	74.88	18'6" to 19'6"	38	X

UNDISTURBED SAMPLES □ DISTURBED SAMPLES O WATER SAMPLES ▽ S. P. TESTS X

BOREHOLE LOG

Sheet 2 of 3

BOREHOLE No. 218
BOREHOLE DIAMETER 6"
WATER NOT ENCOUNTERED

SITE: Norwich TG/20SW/38
2139.0257

DATE	DEPTH OF BORING	DEPTH OF CASING	DEPTH TO WATER	STRATA DESCRIPTION	STRATA CHART: DEPTH	STRATA CHART: O.D. LEVEL	S.P.T. BLOWS	DEPTH	SAMPLE TYPE
4.1.70				TOPSOIL and SUBSOIL.	(0.76m) 2'6"	124.0 (37.80m)			
	5'0"	NIL	DRY	SANDY CLAY with gravel sized pieces of CHALK and some FLINTS. Firm, light yellowish grey.		121.5 (37.03m)	1	3'6" to 5'0"	□
	10'0"	10'0"	DRY		(3.05m) 10'0"	(34.75m) 114.0		8'6" to 10'0"	□
				M.C. SAND. Light yellow brown, occasional fine irregular gravel.			62	12'0" to 13'0"	I O
4.1.70	15'0"	15'0"	DRY		(4.57m) 15'0"	(33.22m) 109.0			
5.1.70	18'0"	18'0"	DRY	SANDY CLAY. Soft light yellow grey.	(5.49m) 18'0"	(32.31m) 106.0		16'6" to 18'0"	↑ O ↓
				SANDY GRAVEL. Light yellow brown graded F.M.C. sand and F.M.C. irregular and rounded gravel. Small pockets of sandy clay also present at top of stratum.			68	20'0" to 21'0"	A O
					(7.92m) 26'0"	(29.87m) 98.0	78	25'0" to 26'0"	X O
	30'0"	30'0"	DRY	SANDY CLAY with GRAVEL. Firm, orange brown, with F.M. rounded gravel.	(9.14m) 30'0"	(28.65m) 94.0		28'6" to 30'0"	□
	33'6"	33'6"	DRY	SANDY GRAVEL. Light yellow brown graded F.M.C. sand and rounded and irregular F.M.C. gravel.			73	31'0" to 32'0"	X
5.1.70	35'0"	33'6"	DRY		(10.67m) 35'0"	(27.13m) 89.0		34'0" to 35'0"	0
				End of borehole					

SCALE: 5 FEET TO 1 INCH
UNDISTURBED SAMPLES □ DISTURBED SAMPLES O WATER SAMPLES ▽ S. P. TESTS
NO RECOVERY OF UNDISTURBED SAMPLES □ NR BULK SAMPLES ↕

(For Survey use only) GEOLOGICAL CLASSIFICATION	NATURE OF STRATA If measurements start below ground surface, state how far ...	THICKNESS Feet ...	 Inches ...	DEPTH Feet	 Inches
9					
? —	Brick shaft.	87			
UCK.	Chalk.	83		170	
#6 bore	Estimated log:				
10-1-69	BC to c. 30'				
	UCK to 170'				
	P.N.H 18.6.69.				
	DATA Bank				

BOREHOLE LOG

TG/20 SW/6

2213.0252

BOREHOLE No. 6

BOREHOLE DIAMETER 6"

WATER STRUCK AT

OE/TPG/ABK/SN85

DATE	WATER LEVEL	DEPTH OF BORING	STRATA DESCRIPTION	DEPTH	O.D. LEVEL	SAMPLE DETAILS: LEVEL	NUMBER OF BLOWS	TYPE AND REF.
21.12.65			Topsoil	1'6" (c 46cm)	89.02 87.52			
			Brown sandy clay with flint boulders and chalk content			5'0"		0
						9'0" to 9'6"	40	X
						10'0"		0
						13'0" to 14'0"	43	X
						15'0"		0
						18'0" to 19'0"	41	X
21.12.65	Nil	20'0"		(6.1cm) 20'0"	69.02	20'0"		0
				Bottom of borehole				

UNDISTURBED SAMPLES □ DISTURBED SAMPLES O WATER SAMPLES ▽ S. P. TESTS X

BOREHOLE LOG

T6/20 SW/7

2215.0274

BOREHOLE No. 7
BOREHOLE DIAMETER 6"
WATER STRUCK AT

DATE	WATER LEVEL	DEPTH OF BORING	STRATA DESCRIPTION	DEPTH	O.D. LEVEL	SAMPLE DETAILS: LEVEL	NUMBER OF BLOWS	TYPE AND REF.
17.12.65			Topsoil		105.72			
				1'6" (0.46m)	104.22			
			Brown sandy clay with flint boulders and chalk content					
						5'0" to 6'6"	124	□
						8'0" to 9'0"	33	X
						10'0"		O
						13'0" to 14'0"	36	X
						15'0"		O
						18'0" to 19'0"	35	X
17.12.65	Nil	19'0"				20'0"		O
18.12.65	Nil							
						23'0" to 24'0"	42	X
						25'0"		O
						28'0" to 29'0"	35	X
				(9.14m)				
18.12.65	Nil	30'0"		30'0" Bottom of borehole	75.72			

UNDISTURBED SAMPLES □ DISTURBED SAMPLES O WATER SAMPLES ▽ S. P. TESTS X

CE/IRG/AEK/SMB5

Additional Well Information:

- ☐ Well Loss Data: B..... C..... Efficiency.....
- ☐ Well Acidified
- ☒ Flow Logs NO
- ☒ Other Geophysical Logs NO
- ☐ Fissure Information: major inflows from.....to.....
  from.....to.....
  from.....to.....

Aquifer Parameters:

Analysis Type: ~~Recovery~~ JACOB SL
Transmissivity: 208 m^2/d
Storage Coefficient:

Analysis Type:
Transmissivity:
Storage Coefficient:

Analysis Type:
Transmissivity:
Storage Coefficient:

Other Data:

Confidence:

excellent ☐ ☐ ☐ ☑ ☐ very poor

Notes: Borehole collapsed on completion of pumping hence not possible to carry out geophysical logging

TG 10 SE 11 1842 0356 South-west of Hall Farm, Intwood

Surface level (+ 31.5 m) + 103 ft
Water not struck
Wirth B O, 8 inch diam.,
January 1970

Overburden (0.9 m) 3 ft;
Mineral (0.9 m) 3 ft;
Waste (16.4 m + 54 ft +

		Thickness (m)	Thickness ft	Depth (m)	Depth ft
	Soil.	(0.9)	3	(0.9)	3
Glacial Sand and Gravel	Gravel.	(0.9)	3	(1.8)	6
	Gravel: coarse with fine, subangular flint with some subrounded quartz. Sand: medium with coarse, subangular. Brown.				
	Very 'clayey' pebbly sand	(0.9)	3	(2.7)	9
	Gravel: fine to coarse, mainly subangular to subrounded flint. Sand: fine to coarse, subangular. Light brown.				
Chalky Boulder Clay	Brown sandy clay with occasional flint pebbles.	(7.7)	25	(10.4)	34
	Light brown chalky clay.	(3.0)	10	(13.4)	44
	Brown sandy clay with thin sand bands.	(1.8)	6	(15.2)	50
	Light brown-orange clay, slightly sandy, with occasional quartz and chalk pebbles.	(3.0+)	10+	(18.2)	60

	%		mm		%
Gravel	61	–	64	:	0
		–	64 + 16	:	42
		–	16 + 4	:	19
Sand	32	–	4 + 1	:	8
		–	1 + ¼	:	21
		–	¼ + 1/16	:	3
Fines	7	–	1/16	:	7

Depth below surface (ft)	Percentage Fines	Sand	Gravel
3 – 6	7	32	61

147/606

TG12 SW/1

ANGLIAN WATER AUTHORITY - NORFOLK AND SUFFOLK RIVER DIVISION

K.A. Buckley.
B.Sc. Tech, C.Eng.,
M.I.C.E., M.I.W.E.S.
Divisional Engineer.

Our Ref.

Your Ref.

P.O. Box 50,
Norwich.
NR1 1BR

- 7 DEC 1982

The Director,
Institute of Geological Sciences,
Exhibition Road,
South Kensington,
London. S.W.7

Notification of new wells and boreholes for water under the Water Resources Act, 1963

Licence Number E7: 34 : 11 : G : 409: dated the 31/1/77

Consent under Section 24(9) dated the 5/3/70

has been issued to Boston Farms Ltd
Oxnead House
Oxnead
Norwich

authorising the construction of a new ~~well~~/borehole at

Nat. Grid Ref: TG 237 2235. Depth 250 ft/~~m~~ Diameter 6 ins/~~mm~~

by the contractors Messrs T.W. Page & Son
Buxton Road
Frettenham

W A Buckley M.

DIVISIONAL ENGINEER

For Institute use only

Geological Classification	Nature of Strata *If measurements start below ground surface, state how far.*	Thickness Feet	Inches	Metres	Depth Feet	Inches	Metres