



**British
Geological Survey**

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Groundwater-surface water interaction investigations at the Boxford Research Site in 2009/10

Groundwater Science Programme

Open Report OR/10/009



BRITISH GEOLOGICAL SURVEY

GROUNDWATER SCIENCE PROGRAMME

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Front cover

View eastwards along River
Lambourn

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Foreword

This report is the published product of a study by the British Geological Survey (BGS) on groundwater-surface water interaction at the Boxford Research Site. It outlines the investigations undertaken during 2009 and 2010.

Acknowledgements

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1 Introduction

1.1 BACKGROUND TO SITE

The site was originally set up as a research facility as part of the Natural Environment Research Council's **Lowland Catchment Research (LOCAR)** Thematic Programme (Wheater and Peach, 2004). This was created to improve the science required to support current and future management needs for permeable lowland catchments through an integrated and multi-disciplinary experimental and modelling programme. As part of the LOCAR work an infrastructure of long-term facilities was established in three catchments, the Pang-Lambourn, Frome-Piddle and Tern (Adams et al., 2004). The Boxford Research Site was one of several sites selected in the Pang-Lambourn catchment.

The site is currently the main focus for the Groundwater-Surface Water (GW-SW) Interaction Project of the British Geological Survey (BGS) Groundwater Science Program. This has significantly developed upon the existing LOCAR infrastructure and resulted in multiple recent publications including: Allen *et al.* (2010), Lapworth *et al.* (2009) and Abesser *et al.* (2008).

Since the site was established in 2002, BGS work has predominantly been centred on Westbrook Farm. Recently, however, the Centre for Ecology and Hydrology (CEH) acquired the land immediately to the south of the farm. This included approximately 500 m of additional river bank and adjacent wetlands - allowing scope for research over a greater area and more varied terrain. The CEH site is known as the Lambourn Observatory. Previous research in the observatory has focussed on the wetlands to the north (Prior and Johnes, 2002) and south (Atkins, 2005) of the Lambourn.

1.2 SITE LOCATION

The Boxford Research Site is situated along the River Lambourn north of the village of Boxford, Berkshire, and centred on SU 4290 7220 (Figure 1.1).

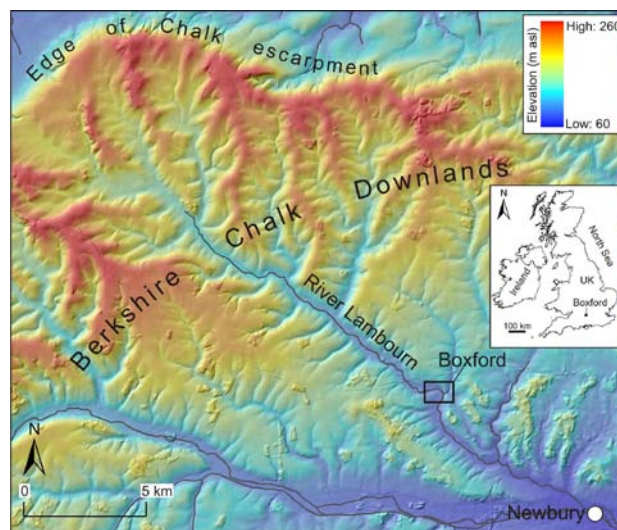


Figure 1.1 Location of the Boxford Research Site UK (NEXTMap Britain elevation data from Intermap Technologies. OS data ©Crown Copyright. All rights reserved. BGS 100017897/2009)

1.3 OBJECTIVES

The main objectives of this report are to provide an up-to-date site infrastructure report and detail all investigations undertaken between January 2009 and March 2010.

2 Site infrastructure

2.1 EXISTING INFRASTRUCTURE AT WESTBROOK FARM

The existing site infrastructure at Westbrook Farm comprised a series of 23 installations completed over eight years (Figure 2.1):

- eight boreholes during 2002 as part of the LOCAR project (Adams *et al.* 2004);
- three boreholes during 2003 as part of an additional LOCAR research project (Wheater *et al.* 2006);
- eight boreholes, three river piezometers and a stilling well as part of the Groundwater-Surface Water (GW-SW) Interaction Project in 2007 and 2008 (Allen and Allen, 2008).

Full borehole logs and completion information are provided in Allen and Allen (2008); this report also details all hydrochemical sampling undertaken prior to December 2008. The only modifications to the records in this report are the borehole datum elevations of N4, N7 and N15. These were resurveyed in July 2009 to account for the casing extensions as 92.355, 92.365 and 92.300 m above Ordnance Datum (OD), respectively.

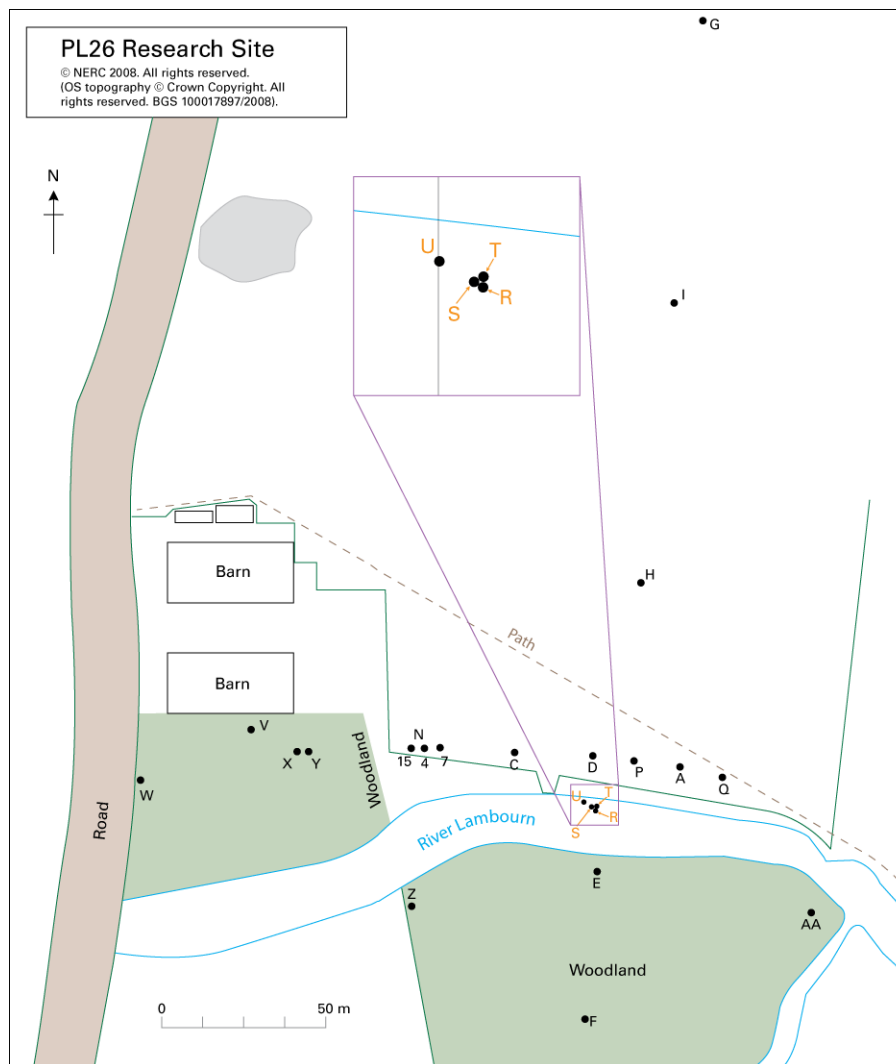


Figure 2.1 Existing site infrastructure

2.2 EXISTING WETLAND INFRASTRUCTURE

The wetland infrastructure (Figure 2.2) was installed by Atkins as part of the Kennet and Lambourn Floodplain SAC (Atkins, 2005). This originally included a series of peat dipwells and gravel piezometers installed in four arrays:

- North transect: 13 dipwells and 6 piezometers installed over a distance of 140 m. Automatic water level loggers were deployed in 5 dipwells and 3 piezometers between February 2003 and October 2005.
- South transect: 10 dipwells and 4 piezometers installed over a distance of 170 m. Automatic water level loggers were deployed in 4 dipwells and 3 piezometers between February 2003 and April 2005.
- North cluster: 19 dipwells and 4 piezometers within an area of approximately 30 x 45 m. Automatic water level loggers were deployed in 5 dipwells between February 2003 and October 2005 and a further 4 dipwells between March 2004 and October 2005.
- South cluster: 22 dipwells and 1 piezometer within an area approximately 20 x 27 m. Automatic water level loggers were deployed in 4 dipwells between February 2003 and March 2004.



Figure 2.2 View from north cluster towards north transect (dipwells marked with red or white flags)

Following the conclusion of this project, a large number of sites were decommissioned. Nevertheless, site reconnaissance by CEH and BGS revealed that the following peat dipwells (P) and gravel piezometers (G) remained in existence:

- North transect: 6 dipwells and 5 piezometers (P1, G1, P5, P6, G6, P8, G9, P10, G10, P13, G13);

- South transect: 6 dipwells and 4 piezometers (P14, G14, P17, P18, G18, P20, G20, P21, P22, G23);
- North cluster: 8 dipwells and 1 piezometer (NP 1, NP 2, NP5, NG 6, NP 7, NP 8, NP 9, NP 10, NP 11); and
- South cluster: 8 dipwells and 1 piezometer (SP1, SP2, SP3, SP4, SP5, SP7, SP8, SP9, G47).

Installations in the clusters were arbitrarily numbered, with the exception of G47, as it was not possible to correlate their field locations with the historical records. Identically numbered dipwells and piezometers are in very close proximity along transects.

2.3 NEW INFRASTRUCTURE

A total of two multi-level boreholes, four river bed piezometers and three stilling wells were installed at the Lambourn Observatory during January and March 2009 (Table 2.1 and Figure 2.3, 2.4). Borehole logs and completion details are included as Appendix A.

Table 2.1 Infrastructure installed in January 2009

Installation	Total depth (mbgl)	Screened interval (mbgl)	Elevation (maod)	Internal diameter (mm)	Lithology
LO1.1	7.20	5.15-7.00	91.20	52	Chalk
LO1.2	3.20	2.15-3.00	91.20	52	Gravel
LO2.1	7.95	6.90-7.75	90.65	52	Chalk
LO2.2	3.10	2.05-2.90	90.65	52	Gravel
LOR1s	-	-	91.43	51	Stilling well
LOR2s	-	-	90.48	51	Stilling well
LOR3s	-	-	91.60	51	Stilling well
LOR1a	1.5	0.1-0.2	91.31	51	River Gravel
LOR1b	1.5	0.2-0.3	91.29	51	River Gravel
LOR1c	1.5	0.3-0.4	91.33	51	River Gravel
LOR1d	1.5	1.4-1.5	91.37	51	River Gravel

Note: # internal diameter 76 mm above river bed

The multi-level boreholes each included separate installations within the chalk and the overlying gravels. Stilling wells were located immediately adjacent to LO1 (LOR1s) and LO2 (LOR2s), with a further emplaced further upstream (LOR3s). A series of river bed piezometers were installed at various depths adjacent to LO1 to examine the vertical profile through the river gravels.

Piezometers and stilling wells consisted of a 1.5 m length, 51 mm internal diameter stainless steel pipe driven completely into the bed. This was coupled to a 1.5 m length, 76 mm internal diameter stainless steel pipe above the bed. A screened interval was created by a series of 6 evenly spaced 6 mm holes over a 100 mm length along the piping. Finally, a stainless steel cylinder was installed from the base of the piezometer pipe to within 20 mm of the slotted section to avoid creating a dead zone of water.

a)



b)



Figure 2.3 a) LO1 site: multi-level borehole, stilling well, and four river bed piezometers b) LO2 site: multi-level borehole and stilling well.



Figure 2.4 River gravel piezometers

In addition to the new infrastructure, access was agreed with the Environment Agency to monitor the EA OBH borehole in April 2009. This borehole was constructed during the Atkins intrusive investigation of 2003. It is drilled to a depth of approximately 30 mbgl into the Chalk: casing is aligned against the first 20 m and the hole is unsupported below this. Caliper, temperature, conductivity and natural gamma logs were all run during May 2003 (Appendix B).

A full site plan detailing the complete site infrastructure is presented as Figure 2.5

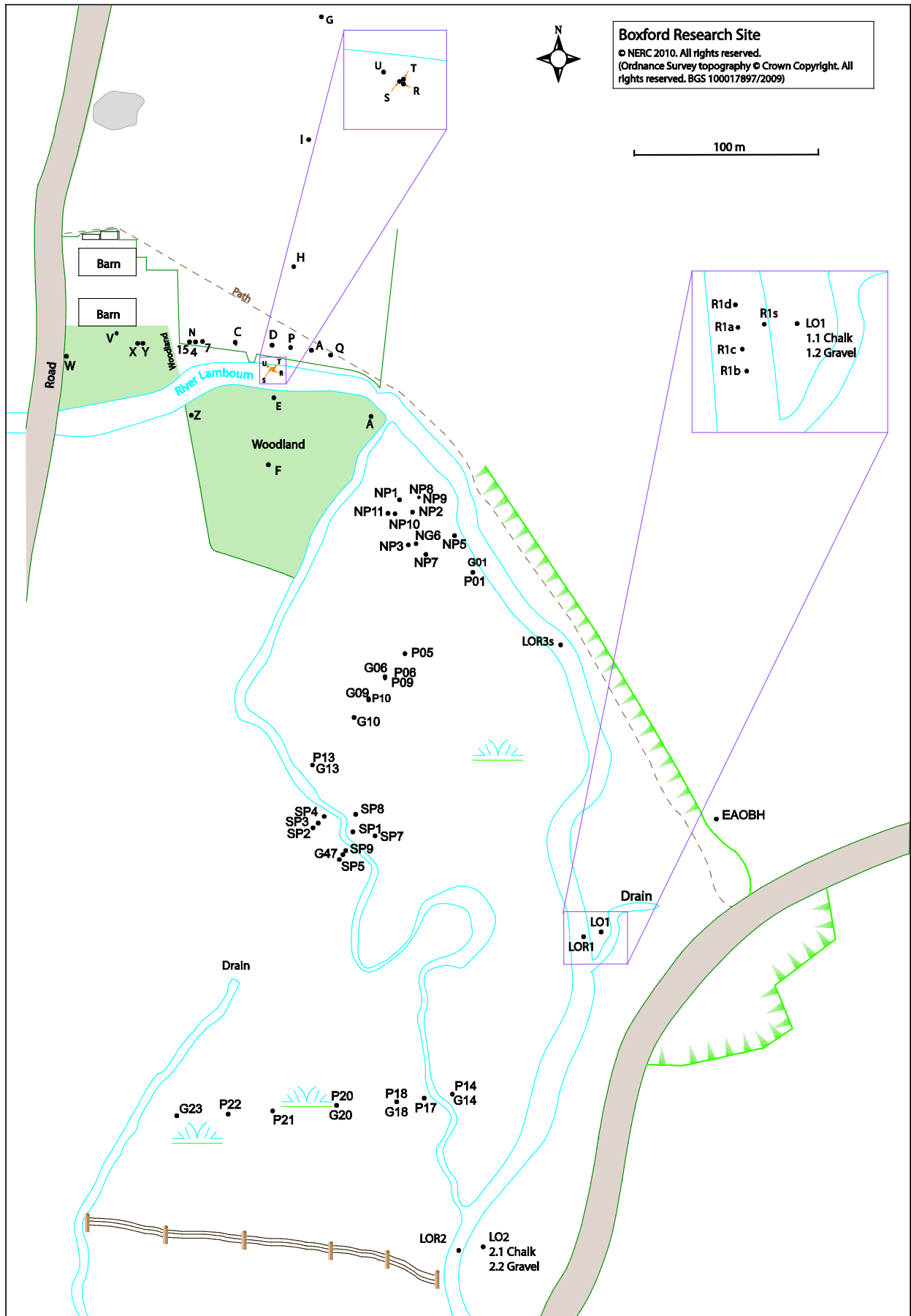


Figure 2.5 Site infrastructure at end of March 2010

3 Site monitoring

3.1 WATER LEVEL MONITORING

3.1.1 Manual measurements

All BGS installations were dipped on a monthly basis between April and September 2009 to monitor water level variations over a six month period. Additionally measurements were taken when instruments were removed or added to sites. All Atkins wetland installations were dipped on approximately a weekly basis between January and June 2009 by CEH and BGS. The reference point for all above ground installations was the top of the casing with the lid removed. The reference point for all boreholes underlying a manhole cover was ground level.

3.1.2 Continuous measurements

A combination of Mini-Trolls, Level Troll 500s and Divers are deployed across the site. Level Troll 500s and Divers are typically set to log at 15 minute intervals; Mini-Trolls log hourly. There are two Diver Baros located at PL26Q and PL26Z. The majority of devices were downloaded on 18th March 2009, 20th August 2009 and 5th January 2010. All Mini-Trolls were downloaded on 25th March and 17th November 2009. A full list of borehole instrumentation is presented as part of Appendix C. Note that all submerged loggers also record water temperature.

3.2 HYDROCHEMICAL SAMPLING

A total of 10 hydrochemical samples were collected on 14th October to establish if there was any variation across the Lambourn Observatory (Table 3.1). These were immediately tested onsite for temperature, pH, dissolved oxygen, conductivity and alkalinity. Subsequently they were analysed for inorganics, oxygen-18, carbon-13 and deuterium.

Table 3.1 Hydrochemical samples collected in 2009

Location	Grid Reference	Sample type
LO1.1	-	Chalk groundwater
LO1.2	-	Gravel groundwater
LO2.1	-	Chalk groundwater
LO2.2	-	Gravel groundwater
River adjacent to LOR1s	-	River water
River downstream STW inflow	-	River water
West Brook at upstream crossing	SU 42861 72282	River water
West Brook immediately upstream of wetland pond	SU 42885 72005	River water
Upwelling northern wetland	SU 42992 71989	Spring water
Upwelling at FH drain	SU 42689 71745	Spring water

3.3 TEMPERATURE SURVEYS

3.3.1 Point survey

Temperature surveys were undertaken in a range of locations across the site to identify potential groundwater upwellings. These included point surveys on a:

- 5 m resolution grid across the wetland north of the Lambourn;
- 1 m resolution transect along the drain in the wetland north of the Lambourn;
- at several Atkins dipwells and piezometers in the wetland;
- 5-10 m resolution transect along West Brook (including more detailed analysis of two temperature anomalies - Figure 3.1);
- a transect along the drain in the southwest of the southern wetland; and
- 5-10 m resolution transect along the River Lambourn bed.

Point measurements were taken using an Oakton T-type thermocouple penetration probe and reader. The temperature sensor is at the end of a probe which is capable of penetrating up to a depth of 0.9 m. Measurements were taken at complete penetration in the peat or, more usually, at the interface of the peat and gravel layers; with the exception of the River Lambourn bed survey at a depth of 0.1 m. All surveys of watercourses included additional measurement of the water temperature. Observations of peat depth using the probe, supported by occasional auger holes, were also recorded in the wetland north of the river.

a)



b)



Figure 3.1 Detailed investigation of a stream bed temperature anomaly as West Brook temporarily transforms in size from (a) to (b)

3.3.2 Distributed temperature system (DTS) fibre optic cable

Two DTS 500 m fibre optic cables were deployed close to the bed of the River Lambourn between PL26U and just downstream of LOR2s on 10th and 11th August 2009. The cables were removed at several points along the river to produce warm air temperature anomalies to help locate specific sections of the cable. The DTS was set to average temperature readings over hourly intervals along each metre of the cable.

4 Conclusions

The research area of the GW-SW Project has been extended to include the new CEH Lambourn Observatory to the south. This includes approximately 500 m of additional river bank and adjacent wetlands.

The observatory was instrumented with two multi-level boreholes, four river bed piezometers and three stilling wells. Moreover, historical Atkins dipwells and piezometers in the wetlands have been located and permission agreed with the EA for access to their Chalk borehole.

Water levels and temperature were continuously monitored in the majority of boreholes using pressure transducers. Frequent manual dips were also undertaken across the site to collate accurate snapshot images of water levels over the hydrological year. A total of ten hydrochemical samples were collected to assess whether there is any variation across the new Lambourn Observatory. Additionally, point temperature surveys and DTS fibre optic cables were utilised to identify potential areas of groundwater upwelling.

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Appendix A – Borehole logs and completions

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No	
			LO1	
			Sheet 1 of 2	
Equipment & Methods		Location		
Forager 55 shell and auger rig 200 mm diameter 0-5.4 mBGL 150 mm diameter 5.4 – 7.2 mBGL		BOXFORD Boxford Water Meadows		
Water levels		Grid Reference		
Water struck at 1.2 mBGL and rose immediately to 0.35 mBGL Water = 1.1m on 05/03/09 am with casing at 5.9 mBGL Water = 1.75 mBGL on 05/03/09 with casing at 6.8 mBGL and hole at 7.2 mBGL rising to 1.70 after 20 mins, 1.64 after 40 mins and 1.58 after 60 mins. Well 1 RWL = 0.84 mBCL on 27/03/09 at 18:00 Well 2 RWL = 0.875 m BCL on 27/03/09 at 18:00		SU 42983 71977 Datum level Cover level casing = 0.55m AGL Well 1 top = 0.10 bCL Well 2 top = 0.11 bCL		
Carried out for		Date		Ground level
British Geological Survey		02/03/09-05/03/09		
Description		Thickness	Depth	Reduced level
Dark greyish brown (10YR4/2) SOIL becoming chalky below 0.3 m		0.50	0.50	
Brown (10YR5/3) very clayey GRAVEL		1.00	1.50	
Brown (10YR5/4) coarse sub-angular flint GRAVEL with cobbles.		0.50	2.00	
Strong brown (7.5YR5/4) coarse sub-angular flint GRAVEL with cobbles.		0.50	2.50	
Brown (10YR5/4) coarse sub-angular flint GRAVEL with cobbles.		0.50	3.00	
As above with some chalk gravel		0.40	3.40	
Very pale brown (10YR7/3) chalk and flint				

GRAVEL in chalky matrix	0.50	3.90	
Very pale brown (10YR7/3) chalk with flint sandy GRAVEL	0.20	4.10	
CHALK with occasional flint. Large flint nodule at 5.0 m.	1.30	5.40	
CHALK with some putty chalk	1.00	6.40	
CHALK and flint with abundant flint between 6.4-6.9 mBGL	0.80	7.20	

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No	
			LO1	
			Sheet 2 of 2	
Completion				
Concrete			0.30	
200mm protective casing with lockable sliding top plate			0.45	
Bentonite pellets			1.50	
Pack (2-4.75mm)			3.40	
Bentonite pellets			4.40	
Pack (2-4.75mm)			7.20	
<u>Well 1</u>				
60mm OD x 52 mm ID MGS GEOCASING			5.15	
60mm OD x 52 mm ID MGS GEOSCREEN (1mm slots)			7.00	
60mm OD x 52 mm ID sump at base of screen			7.20	
<u>Well 2</u>				
60mm OD x 52 mm ID MGS GEOCASING			2.15	
60mm OD x 52 mm ID MGS GEOSCREEN (1mm slots)			3.00	
60mm OD x 52 mm ID sump at base of screen			3.20	
Samples				
0.5-1.5	3.0-3.4	4.4-4.9	6.4-6.9	
1.5-2.0	3.4-3.9	4.9-5.4	6.9-7.2	
2.0-2.5	3.9-4.1	5.4-5.9		
2.5-3.0	4.1-4.4	5.9-6.4		

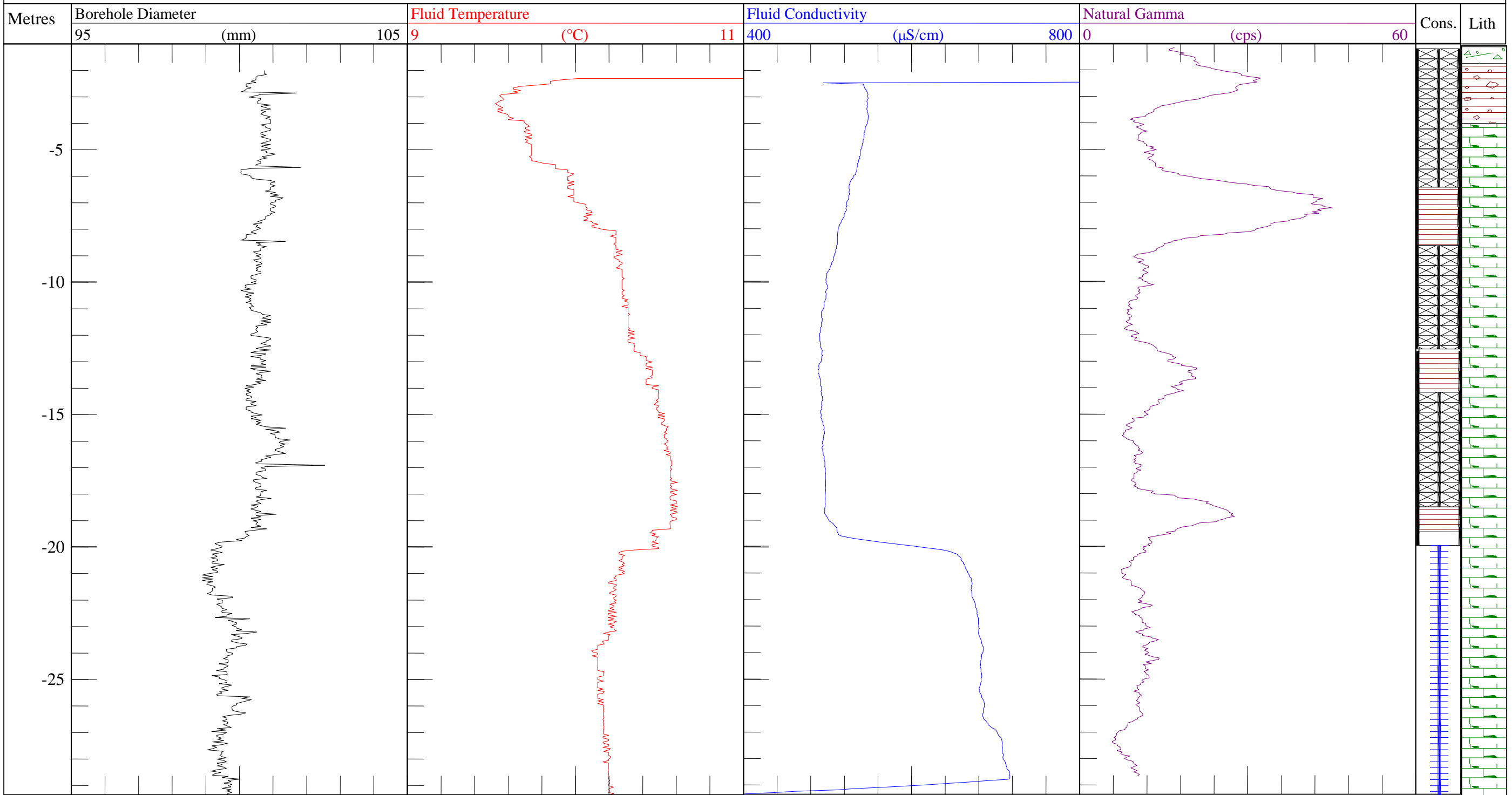
Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No	
			LO2	
			Sheet 1 of 2	
Equipment & Methods		Location		
Forager 55 shell and auger rig 200 mm diameter 0 - 4.6 mBGL 150 mm diameter 4.6 – 8.2 mBGL		BOXFORD Boxford Water Meadows		
Water levels		Grid Reference		
Water struck at c 1.0 mBGL and rose immediately to 0.25 mBGL		SU 42927 71830		
Water = 0.23m on 10/03/09 am with casing at 4.35 mBGL		Datum level		
Well 1 RWL = 0.79 mBCL on 27/03/09 at 19:00		Cover level casing = 0.55m AGL		
Well 2 RWL = 0.73 m BCL on 27/03/09 at 19:00		Well 1 top = 0.10 bCL Well 2 top = 0.09 bCL		
Carried out for		Date		Ground level
British Geological Survey		09/03/09-12/03/09		
Description	Thickness	Depth	Reduced level	
Dark brown (7.5YR3/2) PEAT	1.00	1.00		
Brown (7.5YR5/2 peaty clayey GRAVEL	0.50	1.50		
Very pale brown (10YR7/4) coarse sub-angular flint GRAVEL with cobbles.	0.50	2.00		
Reddish yellow (7.5YR5/4) sandy GRAVEL with cobbles. Gravel: coarse sub-angular flint becoming finer towards base	1.00	3.00		
Very pale brown (10YR8/4) very sandy chalk and flint mainly fine GRAVEL	0.50	3.50		
Black angular flint with some CHALK	0.50	4.00		
CHALK with some flint between 4.0 -4.5 & 5.5 – 6.0 mBGL and abundant flint between 7.0 – 7.5 mBGL. Trace of putty chalk below 7.5 mBGL	4.10	8.20		

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No	
			LO2	
			Sheet 2 of 2	
Completion				
Concrete			0.30	
200mm protective casing with lockable sliding top plate			0.45	
Bentonite pellets			1.50	
Pack (2-4.75mm)			3.50	
Bentonite pellets			5.60	
Pack (natural)			6.10	
Pack (2-4.75mm)			8.20	
<u>Well 1</u>				
60mm OD x 52 mm ID MGS GEOCASING			6.90	
60mm OD x 52 mm ID MGS GEOSCREEN (1mm slots)			7.75	
60mm OD x 52 mm ID sump at base of screen			7.95	
<u>Well 2</u>				
60mm OD x 52 mm ID MGS GEOCASING			2.05	
60mm OD x 52 mm ID MGS GEOSCREEN (1mm slots)			2.90	
60mm OD x 52 mm ID sump at base of screen			3.10	
Samples				
0.0-0.6	2.5-3.0	5.0-5.5	7.5-8.0	
0.6-1.0	3.0-3.5	5.5-6.0	8.0-8.2	
1.0-1.5	3.5-4.0	6.0-6.5		
1.5-2.0	4.0-4.5	6.5-7.0		
2.0-2.5	4.5-5.0	7.0-7.5		

Appendix B – Geophysical logs of EA OBH

BOXFORD CSAC OBH NWI No:SU47/163
 NGR:SU43107188 DATE:7th May 2003
 Reference: GROUND LEVEL

Logged after construction. Water Level=1.05m.



Appendix C – Borehole instrumentation

Installation	Screened section	31/12/08	18/03/09	27/04/09	19/05/09	09/07/09	20/08/09	11/12/09
A1	Chalk	MT 10589 D5 57276	MT 10589 D5 57276	MT 10589 D5 57276	MT 10589 D5 57276	MT 10589 D5 57276	MT 10589 D5 57276	MT 10589
A2	Sand	MT 10445 D5 57241	MT 10445 D5 57241	MT 10445 D5 57241	MT 10445 D5 57241	MT 10445 D5 57241	MT 10445 D5 57241	MT 10445
C1	Chalk	-	-	-	-	D5 57251	D5 57251	D5 57251
C2	Gravel	D5 57261	D5 57261	D5 57261	D5 57261	D5 57261	D5 57261	D5 57261
D1	Chalk	MT 10529	MT 10529	MT 10529	MT 10529	MT 10529	MT 10529	MT 10529
D2	Gravel	MT 10585	MT 10585	MT 10585	MT 10585	MT 10585	MT 10585	MT 10585
E1	Chalk	MT 10554	MT 10554	MT 10554	MT 10554	MT 10554	MT 10554	MT 10554
E2	Gravel	MT 10604	MT 10604	MT 10604	MT 10604	MT 10604	MT 10604	MT 10604
F	Chalk	MT 10317 MD B2869	MT 10317 MD B2869	MT 10317 MD B2869	MT 10317 MD B2869	MT 10317 MD B2869	MT 10317 MD B2869	MT 10317 MD B2869
G1	Chalk	D5 57251	D5 57251	D5 57251	D5 57251	-	-	-
G2	Chalk	MT 11049	MT 11049	MT 11049	MT 11049	MT 11049	MT 11049	MT 11049
G3	Chalk	MT 11094	MT 11094	MT 11094	MT 11094	MT 11094	MT 11094	MT 11094
H1	Chalk	D5 57268	D5 57268	D5 57268	D5 57268	CTD 61818	CTD 61818	CTD 61818
H2	Chalk	D5 57232	D5 57232	D5 57232	D5 57232	-	-	-
H3	Chalk	D5 57240	D5 57240	D5 57240	D5 57240	-	-	-
I1	Chalk	MT 10475	MT 10475	MT 10475	MT 10475	MT 10475	MT 10475	MT 10475
I2	Chalk	MT 10047 D5 57239	MT 10047 D5 57239	MT 10047 D5 57239	MT 10047 D5 57239	MT 10047	MT 10047	MT 10047
I3	Chalk	MT 11151	MT 11151	MT 11151	MT 11151	MT 11151	MT 11151	MT 11151
N4	Gravel	-	-	-	-	-	-	-
N7	Putty Chalk	-	-	-	-	-	-	-
N15	Chalk	-	-	-	-	-	-	-
P	Gravel	MD B3013	MD B3013	MD B3013	MD B3013	MD B3013	MD B3013	MD B3013
Q	Gravel	MD D6874 BD A1446	MD D6874 BD A1446	MD D6874 BD A1446	MD D6874 BD A1446	MD D6874 BD A1446	MD D6874 BD A1446	MD D6874 BD A1446
R	River gravels	CTD 61571	CTD 61571	CTD 61571	CTD 61571	CTD 61571	CTD 61571	CTD 61571
S	River gravels	CTD 61865	CTD 61865	CTD 61865	CTD 61865	CTD 61865	-	-
T	River gravels	CTD 61873	CTD 61980	CTD 61980	CTD 61980	CTD 61980	CTD 61980	CTD 61980
U	River	CTD 61818	CTD 61818	CTD 61818	CTD 61818	D5 57240	D5 57240	D5 57240
V	Gravel	CTD 61812	MD D6977	MD D6977	MD D6977	MD D6977	MD D6977	-
W	Gravel	CTD 61972	MD D6868	MD D6868	MD D6868	MD D6868	MD D6868	-
X	Chalk	CTD 61980	MD D6859	MD D6859	MD D6859	MD D6859	MD D6859	MD D6859
Y	Gravel	CTD 61891	MD D6889	MD D6889	MD D6889	MD D6889	MD D6889	MD D6889

Installation	Screened section	31/12/08	18/03/09	27/04/09	19/05/09	09/07/09	20/08/09	11/12/09
Z	Gravel	CTD 61809 BD D0891	CTD 61809 BD D0891	CTD 61809 BD D0891	CTD 61809 BD D0891	CTD 61809 BD D0891 D5 57268	CTD 61809 D5 57268	D5 57268
AA	Gravel	MD B3014	MD B3014	MD B3014	MD B3014	MD B3014	MD B3014	MD B3014
LO1.1	Chalk	-	-	-	D3x 74625	LT 128522	LT 128522	LT 128522
LO1.2	Gravel	-	-	-	CD3 86282	LT 146731	LT 146731	LT 146731
LO2.1	Chalk	-	-	-	MD B0766	MD B0766	MD B0766	MD B0766
LO2.2	Gravel	-	-	-	CTD 86728	CTD 86728 LT 146754	CTD 86728 LT 146754	LT 146754
LOR1s	River	-	-	-	-	D5 57239	D5 57239	D5 57239
LOR1a	River gravels	-	-	-	-	-	-	-
LOR1b	River gravels	-	-	-	-	-	-	-
LOR1c	River gravels	-	-	-	-	-	-	-
LOR1d	River gravels	-	-	-	-	-	-	-
LOR2s	River	-	-	-	D5 78237	D5 78237	D5 78237	D5 78237
LOR3s	River	-	-	-	-	D5 57232	D5 57232	D5 57232
EA OBH	Chalk	-	-	MD B9105	MD B9105	MD B9105	MD B9105	MD B9105

Notes: BD = Baro-Diver, D5 = 5 m range Diver, MD = 10 m range Micro-Diver, CTD = 10 m range CTD Diver, MT = Mini-Troll, LT = 3.5 m range Level Troll 500, D3x = 100 m range Diver, CD3 = 100 m range CTD Diver.