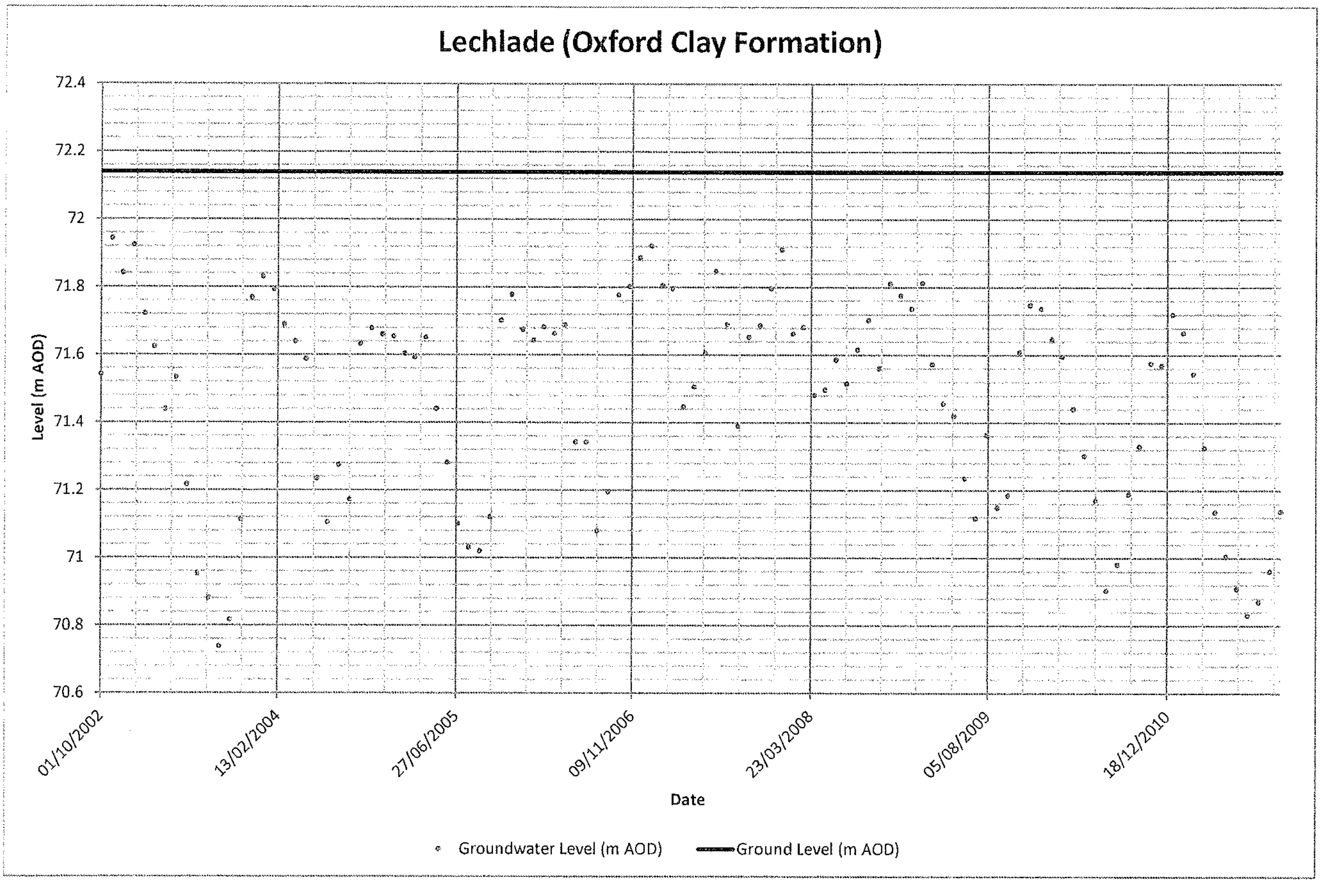
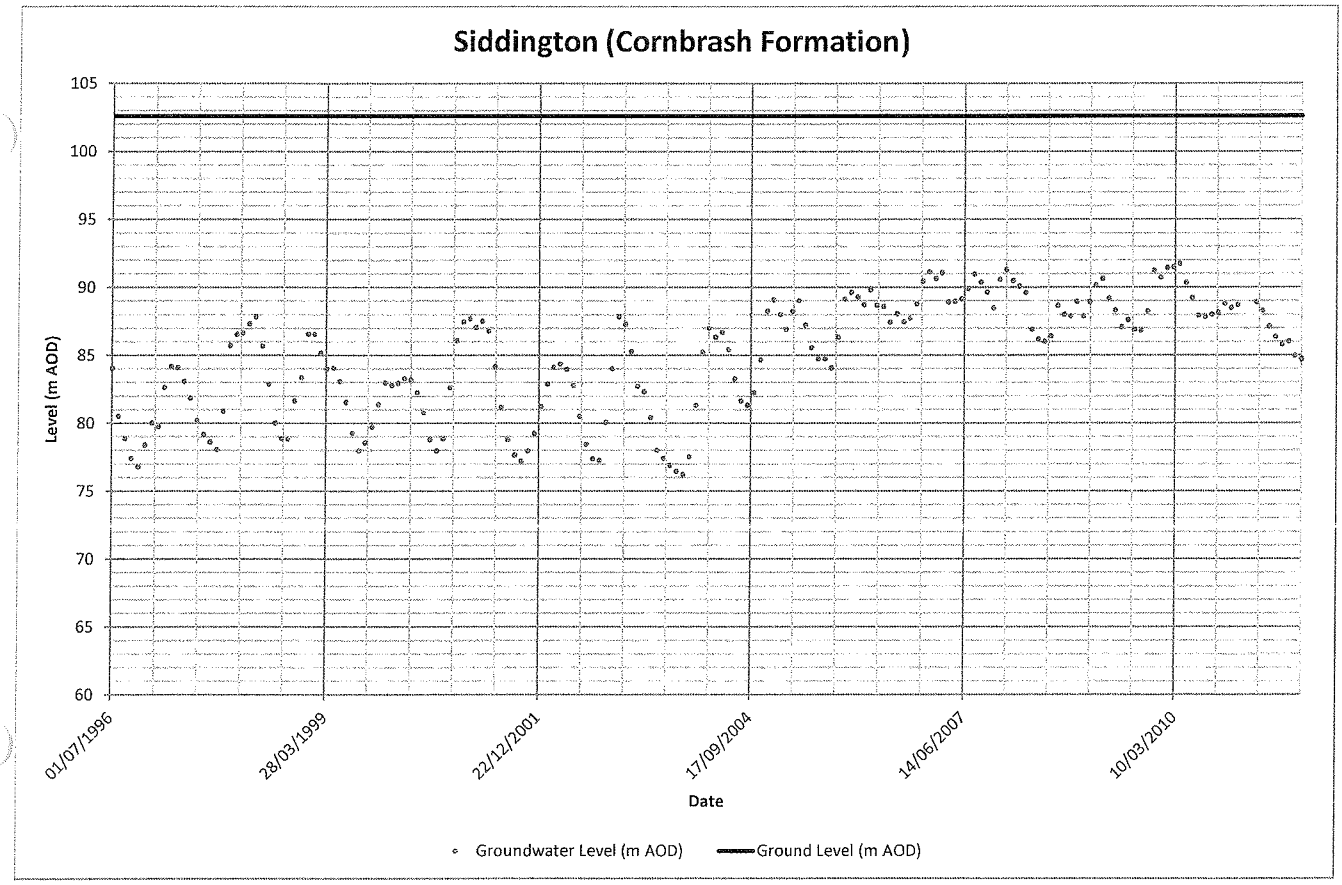
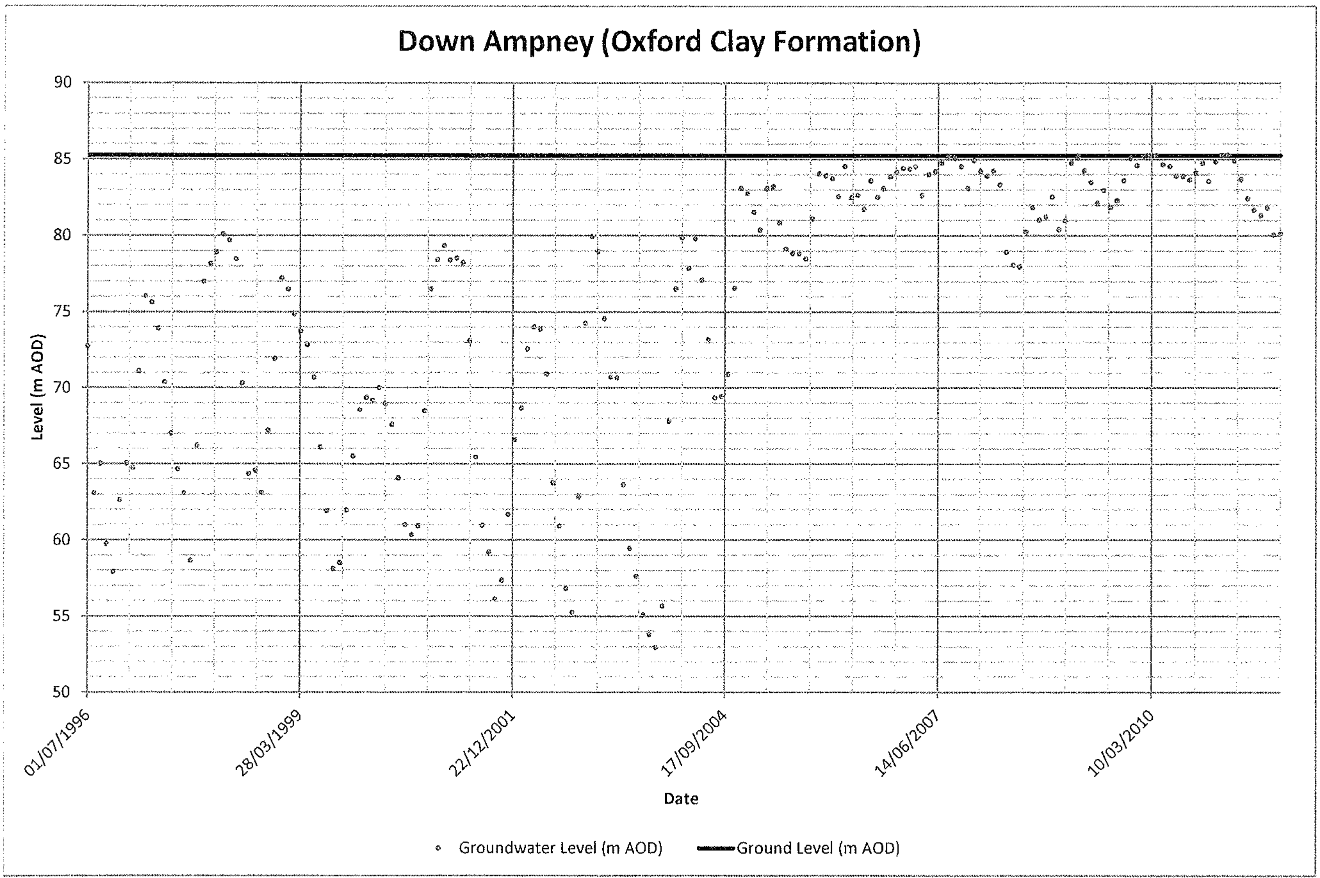
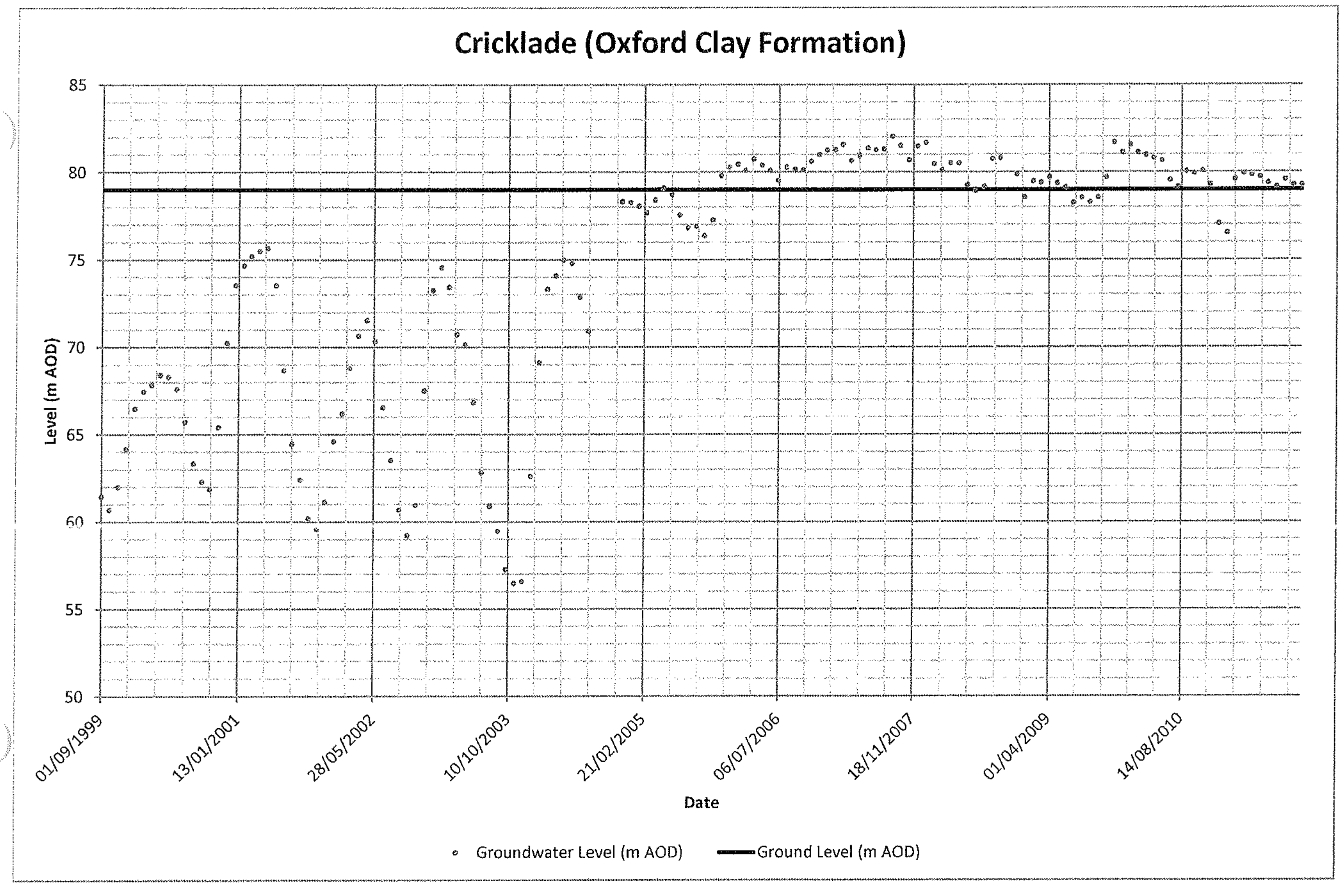

Lechlade (Oxford Clay Formation)
72.4
72.2
72
71.8
71.6
71.4
71.2
71
70.8
70.6
Level (m AOD)
01/10/2002
13/02/2004
27/06/2005
09/11/2006
23/03/2008
05/08/2009
18/12/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)

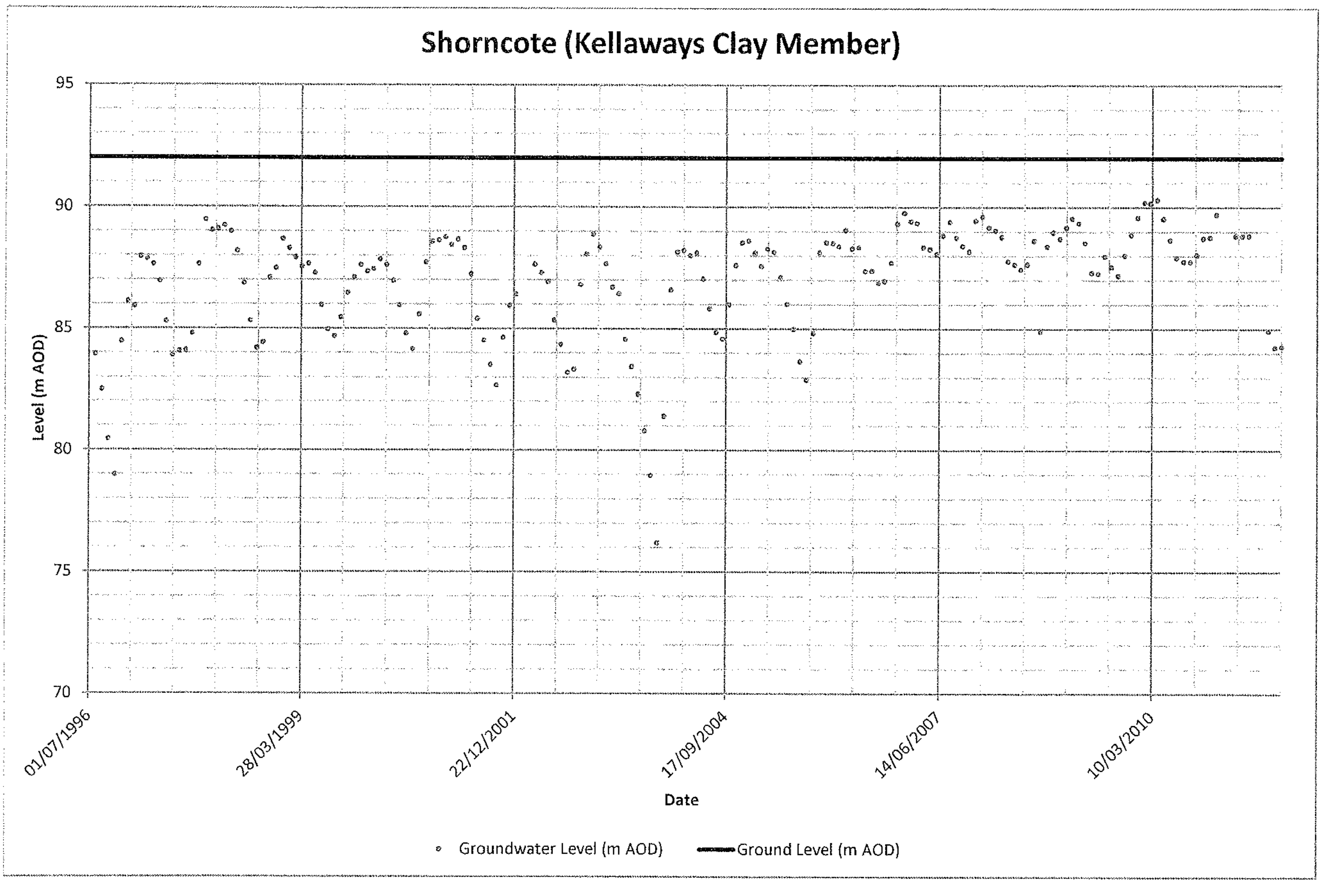


Siddington (Cornbrash Formation)
105
100
95
90
85
80
75
70
65
60
Level (m AOD)
01/07/1996
28/03/1999
22/12/2001
17/09/2004
14/06/2007
10/03/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)

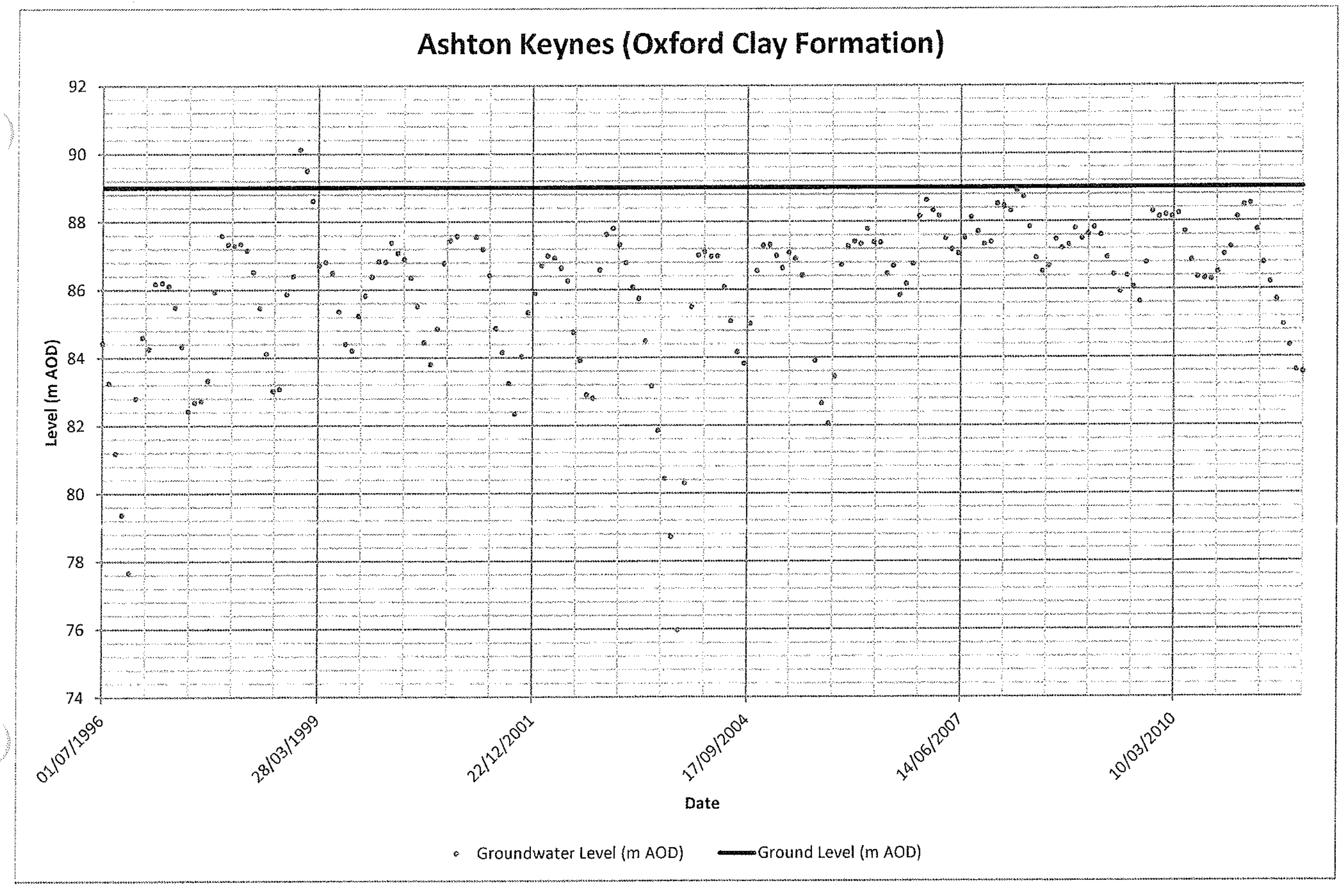

Down Ampney (Oxford Clay Formation)
90
85
80
75
70
65
60
55
50
Level (m AOD)
01/07/1996
28/03/1999
22/12/2001
17/09/2004
14/06/2007
10/03/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)

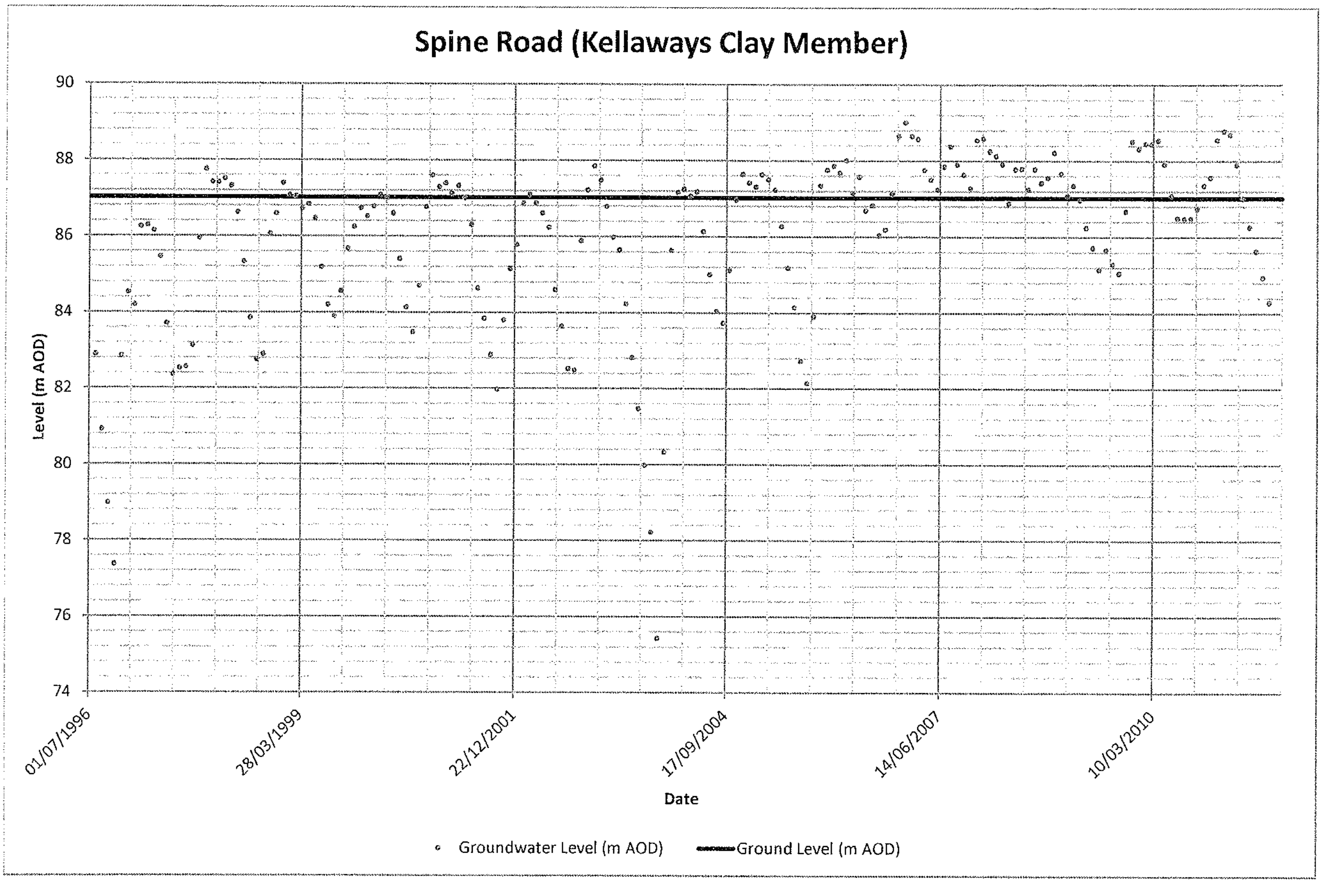


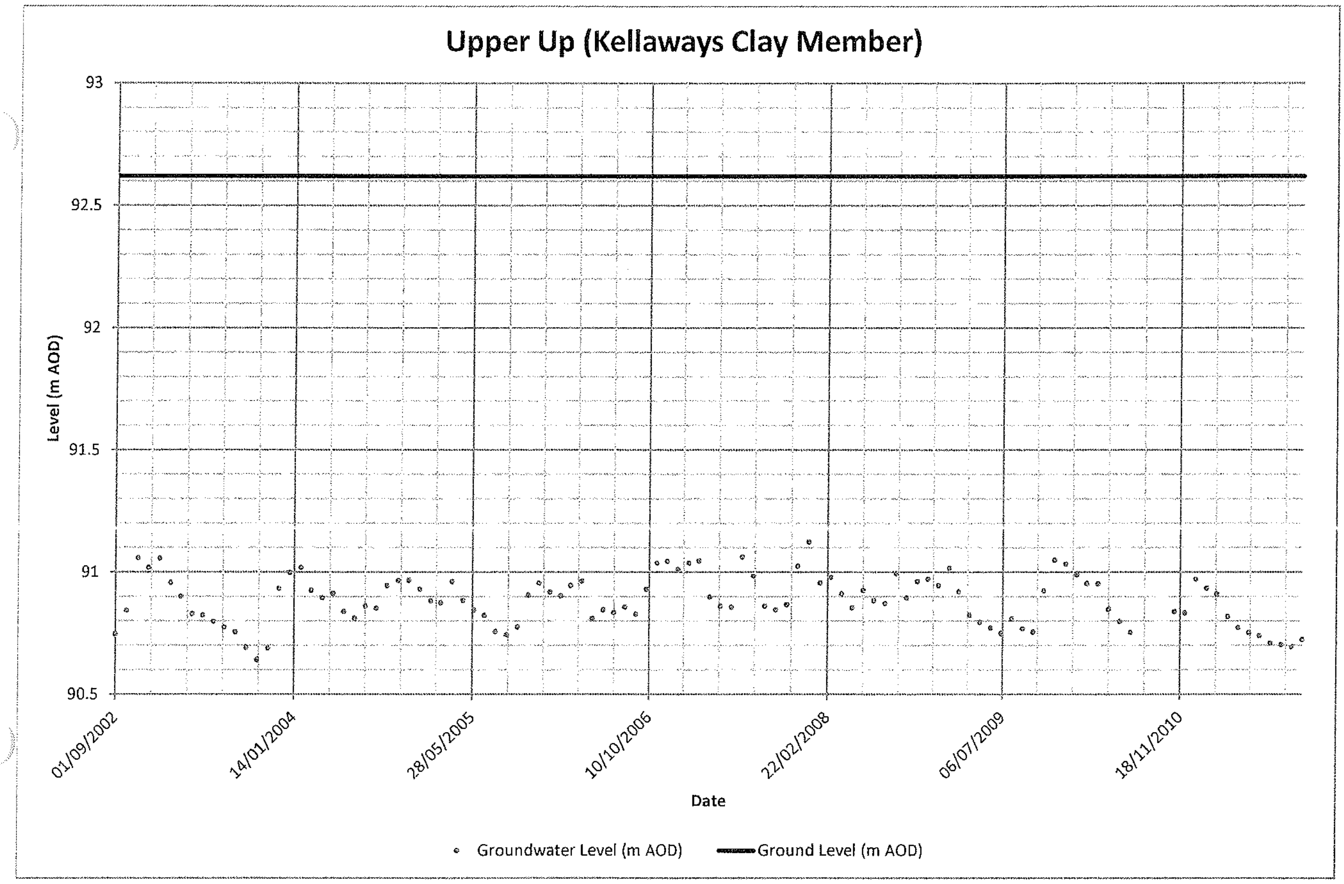
Cricklade (Oxford Clay Formation)
85
80
75
70
65
60
55
50
Level (m AOD)
01/09/1999
13/01/2001
28/05/2002
10/10/2003
21/02/2005
06/07/2006
18/11/2007
01/04/2009
14/08/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)

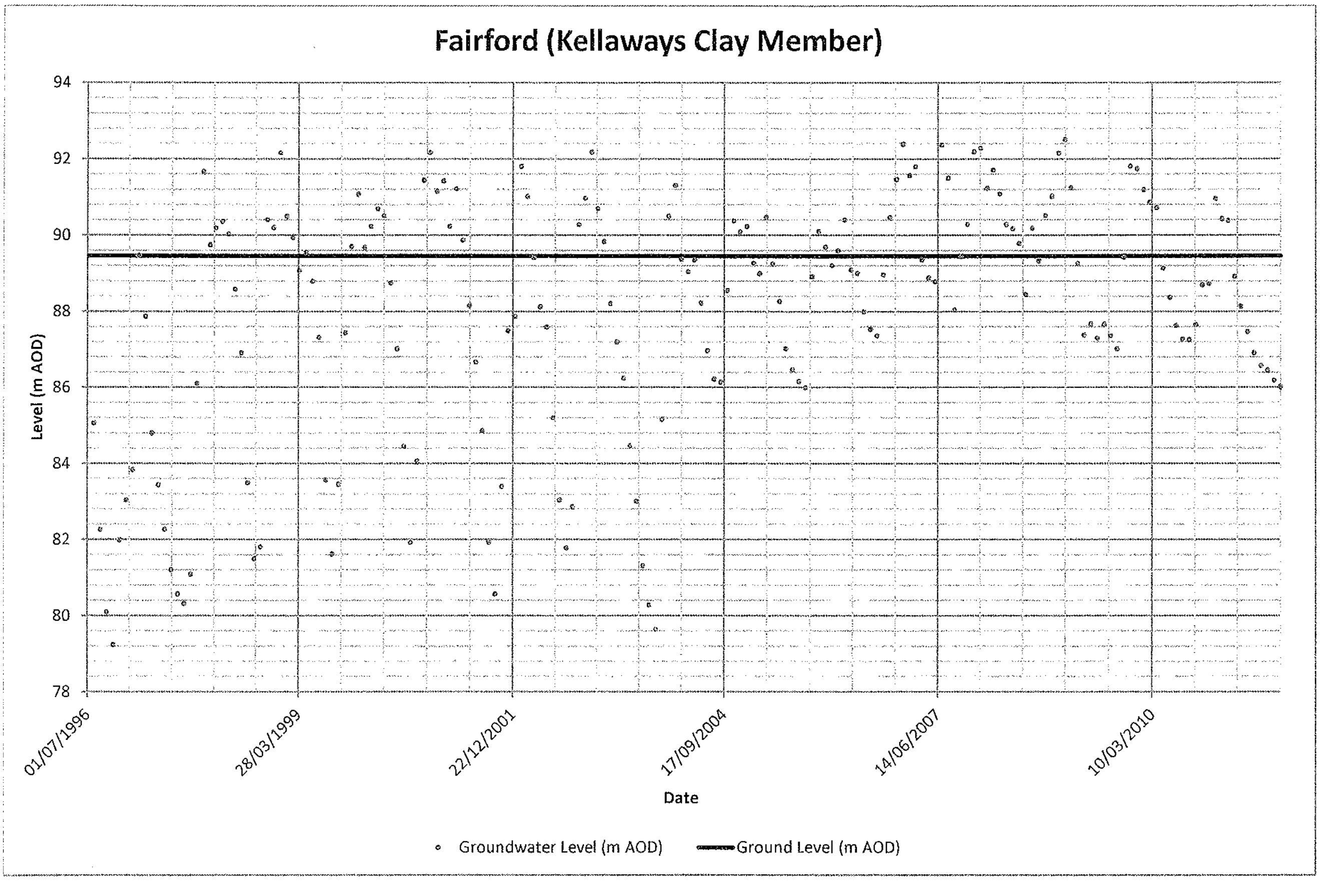


Shorncote (Kellaways Clay Member)
95
90
85
80
75
70
Level (m AOD)
01/07/1996
28/03/1999
22/12/2001
17/09/2004
14/06/2007
10/03/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)

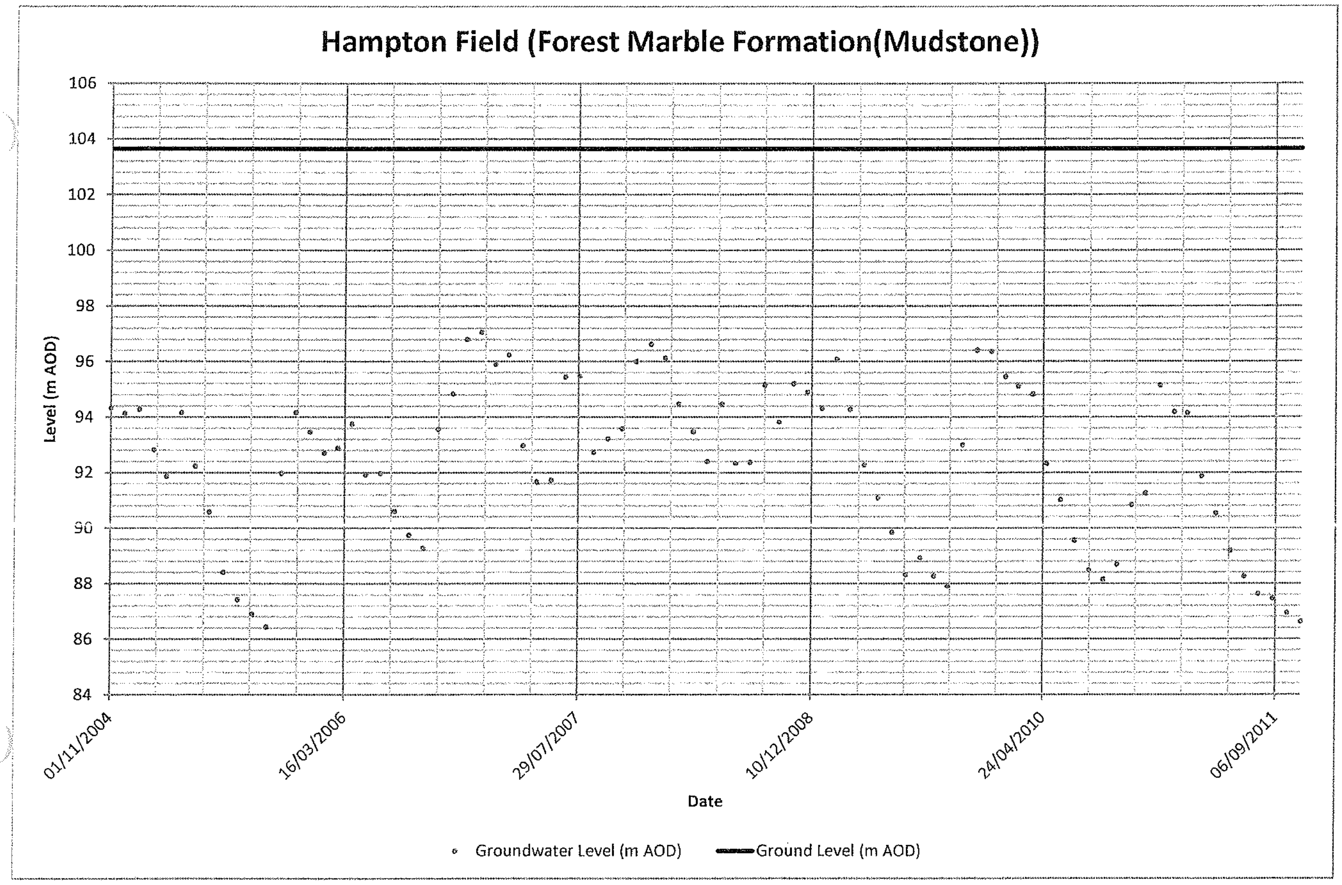

Ashton Keynes (Oxford Clay Formation)
Level (m AOD)
92
90
88
86
84
82
80
78
76
74
01/07/1996
28/03/1999
22/12/2001
17/09/2004
14/06/2007
10/03/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)


Spine Road (Kellaways Clay Member)
90
88
86
84
82
80
78
76
74
Level (m AOD)
01/07/1996
28/03/1999
22/12/2001
17/09/2004
14/06/2007
10/03/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)

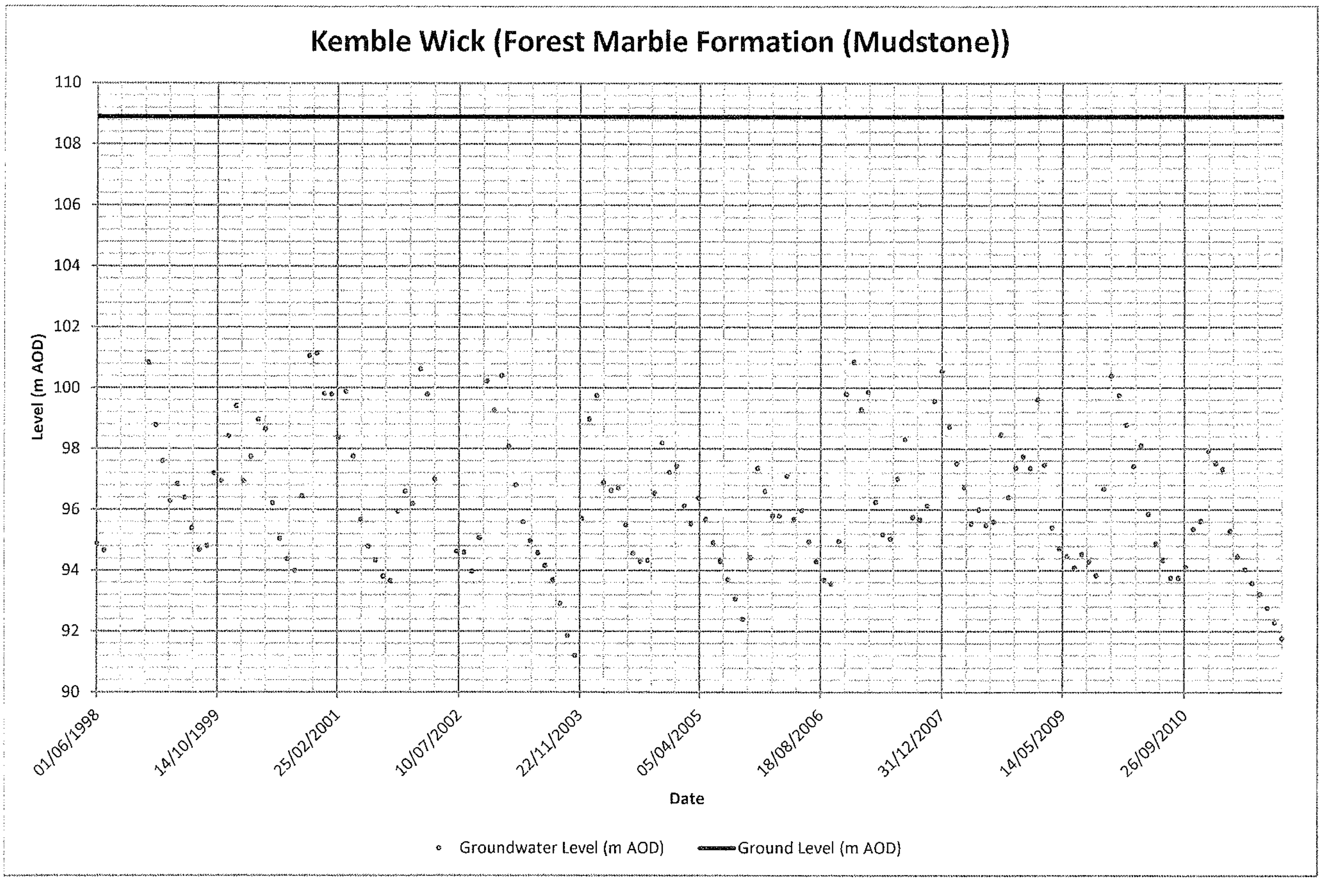

Upper Up (Kellaways Clay Member)
93
92.5
92
91.5
91
90.5
Level (m AOD)
01/09/2002
14/01/2004
28/05/2005
10/10/2006
22/02/2008
06/07/2009
18/11/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)



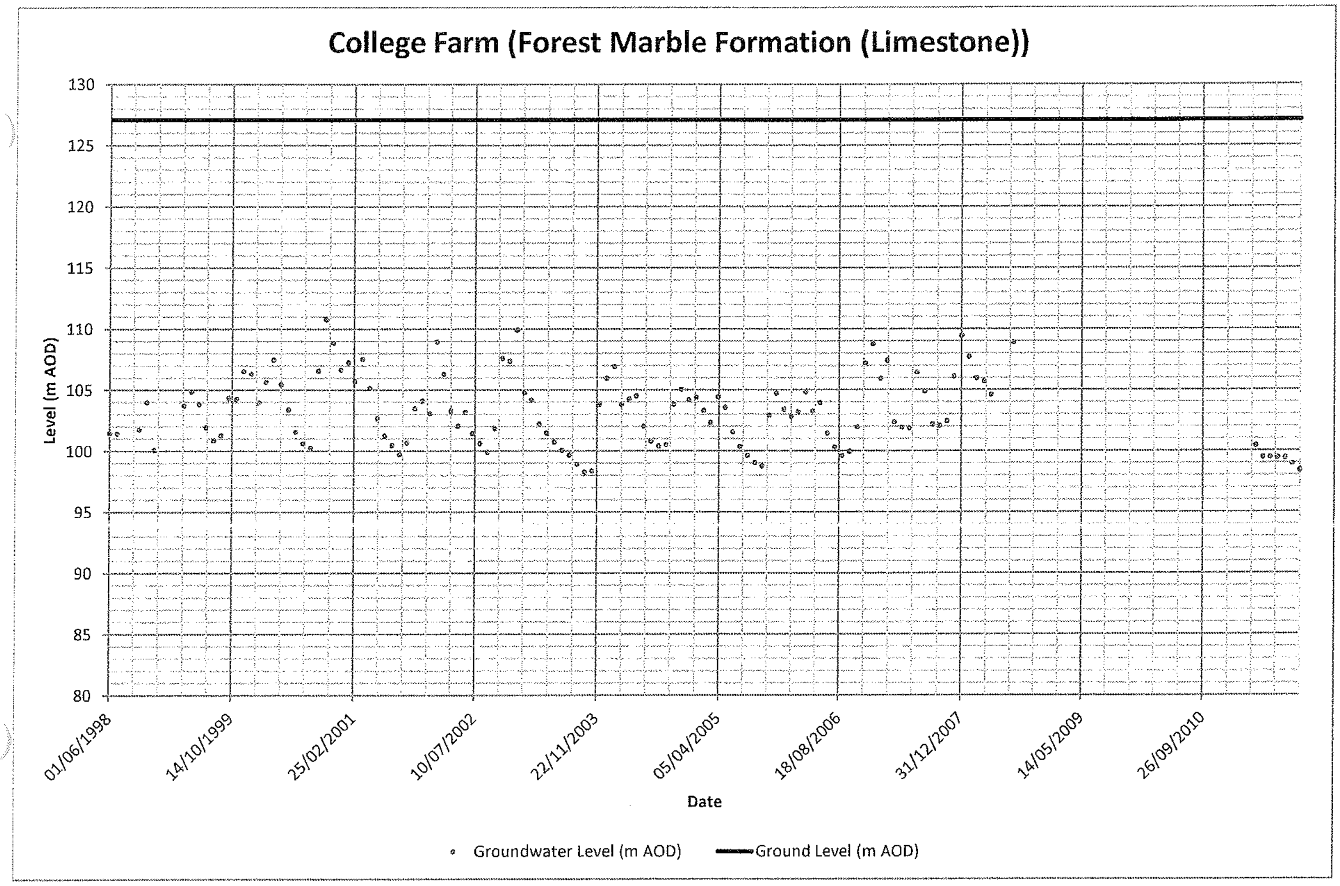
Fairford (Kellaways Clay Member)
Level (m AOD)
94
92
90
88
86
84
82
80
78
01/07/1996
28/03/1999
22/12/2001
17/09/2004
14/06/2007
10/03/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)



Hampton Field (Forest Marble Formation(Mudstone))
106
104
102
100
98
96
94
92
90
88
86
84
Level (m AOD)
01/11/2004
16/03/2006
29/07/2007
10/12/2008
24/04/2010
06/09/2011
Date
Groundwater Level (m AOD)
Ground Level (m AOD)



Kemble Wick (Forest Marble Formation (Mudstone))
110
108
106
104
102
100
98
96
94
92
90
Level (m AOD)
01/06/1998
14/10/1999
25/02/2001
10/07/2002
22/11/2003
05/04/2005
18/08/2006
31/12/2007
14/05/2009
26/09/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)


College Farm (Forest Marble Formation (Limestone))
130
125
120
115
110
105
100
95
90
85
80
Level (m AOD)
01/06/1998
14/10/1999
25/02/2001
10/07/2002
22/11/2003
05/04/2005
18/08/2006
31/12/2007
14/05/2009
26/09/2010
Date
Groundwater Level (m AOD)
Ground Level (m AOD)

Appendix D. Groundwater Matrix Technical Note

Technical note

ATKINS

Project:	Gloucestershire Groundwater Management Plan	**To:**	Jenny Chapman
Subject:	Groundwater Intermediate Assessment	**From:**	Kit Allen
Date:	March 2014	**cc:**	

1. Background

Atkins Limited (Atkins) has been commissioned by Gloucestershire County Council to complete an Intermediate Assessment of Groundwater Flooding. The Intermediate Assessment will further develop the Groundwater Strategic Assessment which was completed in 2013.

The strategic assessment identified broad locations considered to be more or less vulnerable to groundwater flooding and used to identify the locations requiring an intermediate assessment. The broad locations were reviewed in line with current flood management schemes and the areas with potential planning importance within the County and a shortlist of four areas were put forward for further intermediate level assessment.

The areas determined for the further assessment were the following:

- South east of Cotswold District
- Bishops Cleeve
- Innsworth
- Churchdown

2. GIS Datasets

The following GIS datasets were used in the intermediate assessment of the shortlisted areas.

Aquifer Designations
Bedrock and superficial aquifer designations derived from British Geological Survey data assessed for aquifer properties.

British Geological Survey Data
Bedrock and superficial geology data at 1:50,000 scale supplied by Gloucestershire County Council.

Springs
The locations of potential springs required for the analysis were identified using Ordnance Survey Mastermap. No attribution for springs or issues is recorded in the Topographic featureclasses so the Cartographic Annotation featureclass was used. The springs were extracted by filtering using key words such as 'spring' or 'issues' and numerous abbreviated spellings of these from the Cartographic Annotation.

The insertion point of cartographic text was used as the location of the spring as this was found to be on typically within 10m of the end point of a linear watercourse feature. This was considered to be an acceptable level of accuracy for the analysis being undertaken.

Topography and Slope
In the absence of LiDAR data a Digital Terrain Model (DTM) raster dataset was used created using 10m contour data sourced from OS landform panorama. This was created with a 10m cell size which was considered suitable for the assessment.

Slope analysis was carried out on the DTM to identify those areas with a gradient of below 1%.

Historic Flood Map

Data supplied by Gloucestershire County Council dated February 2013, this is an Environment Agency sourced dataset recording the maximum extent of all Historic Flood Events Outlines from river, the sea and groundwater springs.

Vulnerability Matrix
An individual vector grid was produced for each of the four areas for intermediate assessment. A 100x100m grid was used for all study areas with the exception of the larger south east of Cotswold area which used as 500x500m grid. All grids were aligned to Ordnance Survey National Grid.

3. Methodology

The below tables describe the GIS methodology undertaken on each of the datasets analysed as part of the intermediate assessment.

Category	Principal Aquifer	
Assessment	**Option**	**Score**
	Presence	1
	Absence	0
Method Principal aquifers were extracted from the Aquifer Designations bedrock dataset where the final designation was recorded as “Principal”. The resultant features were then assessed against the vulnerability matrix with each cell scored as above.		

Category	Unproductive Bedrock with overlying Secondary A or B Superficial	
Assessment	**Option**	**Score**
	Presence	2
	Absence	0
Method Unproductive bedrock was extracted from the Aquifer Designation bedrock dataset where the final designation was recorded as “Unproductive”. Similarly Secondary A and B superficial designations were extracted from the superficial dataset where the final designation was recorded as “Secondary A” or “Secondary B”. The secondary A or B superficial features were intersected with the unproductive bedrock features to identify only the overlying areas. The resultant areas were then assessed against the vulnerability matrix and each cell scored accordingly.		

Category	Superficial Secondary A Coverage	
Assessment	**Option**	**Score**
	< 25%	1
	>= 25% AND <50%	2
	>= 50% AND <75%	3
	>= 75%	4
Method Secondary A aquifer designated features were extracted from the Aquifer Designation superficial dataset where the final designation was recorded as “Secondary A”. These features were then intersected with the vulnerability matrix grid. The intersected superficial secondary A features were then dissolved by the vulnerability matrix cell reference assigned by the intersection. The area was calculated for each of the superficial secondary A features and the percentage coverage determined. The results were joined to the vulnerability matrix using the cell reference and the scoring updated as above.		

Category	Superficial Sand and Gravel Coverage	
Assessment	**Option**	**Score**
	< 25%	1
	>= 25% AND <50%	2
	>= 50% AND <75%	3
	>= 75%	4
Method		
Superficial sand and gravel features were extracted from the BGS superficial geology dataset where RCS_D was recorded as "sand and gravel". These features were then intersected with the vulnerability matrix grid. The intersected superficial sand and gravel features were then dissolved by the vulnerability matrix cell reference assigned by the intersection. The area was calculated for each of the superficial sand and gravel features and the percentage coverage determined. The results were joined to the vulnerability matrix using the cell reference and the scoring updated as above.		

Category	Slope under 1% Gradient Coverage	
Assessment	**Option**	**Score**
	< 25%	1
	>= 25% AND <50%	2
	>= 50% AND <75%	3
	>= 75%	4
Method		
Slope analysis was undertaken on the topographic raster DTM dataset recording gradient as a percentage. The results were then converted to vector features by grid value and the features with a value of less than or equal to 1 were extracted. These features were then intersected with the vulnerability matrix grid and dissolved by the vulnerability matrix cell reference assigned by the intersection. The area was calculated for each of the features below 1% gradient and the percentage coverage determined. The results were joined to the vulnerability matrix using the cell reference and the scoring updated as above.		

Category	Historic Flood Map	
Assessment	**Option**	**Score**
	Presence	4
	Absence	0
Method		
The vulnerability matrix was assessed against the historic flood map and the presence/absence of features for each cell scored as above.		

Category	Springs	
Assessment	**Option**	**Score**
	Presence	4
	Absence	0
Method		
The vulnerability matrix was assessed for the presence/absence of springs with each cell scored as above.		

The final scores of each the above analysis were added together to produce a final vulnerability risk score. This score was used to geographically represent the level of risk across each of the assessment areas ranging from low risk (3) as green to highest risk (19) as red.

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