RESEARCH REPORT SERIES no. 38-2012

PENGERSICK CASTLE, PENGERSICK LANE, PRAA SANDS, PENZANCE, CORNWALL
TREE-RING DATING OF OAK TIMBERS

SCIENTIFIC DATING REPORT

Martin Bridge

INTERVENTION
AND ANALYSIS

ENGLISH HERITAGE

This report has been prepared for use on the internet and the images within it have been down-sampled to optimise downloading and printing speeds.

Please note that as a result of this down-sampling the images are not of the highest quality and some of the fine detail may be lost. Any person wishing to obtain a high resolution copy of this report should refer to the ordering information on the following page.

Research Report Series 38-2012

PENGERSICK CASTLE, PENGERSICK LANE, PRAA SANDS, PENZANCE, CORNWALL

TREE-RING DATING OF OAK TIMBERS

Dr M C Bridge

NGR: SW 5819 2841

ISSN 2046-9799 (Print)
ISSN 2046-9802 (Online)

The Research Report Series incorporates reports by the expert teams within the Investigation & Analysis Division of the Heritage Protection Department of English Heritage, alongside contributions from other parts of the organisation. It replaces the former Centre for Archaeology Reports Series, the Archaeological Investigation Report Series, the Architectural Investigation Report Series, and the Research Department Report Series.

Many of the Research Reports are of an interim nature and serve to make available the results of specialist investigations in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation. Where no final project report is available, readers must consult the author before citing these reports in any publication. Opinions expressed in Research Reports are those of the author(s) and are not necessarily those of English Heritage.

Requests for further hard copies, after the initial print run, can be made by emailing:
Res.reports@english-heritage.org.uk
or by writing to:
English Heritage, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD
Please note that a charge will be made to cover printing and postage.

SUMMARY
Four ceiling beams associated with the original construction of the tower of Pengersick Castle were dated. All four are clearly coeval, and the three that retained the heartwood/sapwood boundary were found to have been from trees felled in the mid-sixteenth century, indicating this as the likely date of construction of this building. The trees used have quite widely spread heartwood/sapwood boundary dates, and may have been felled over a number of years, the poor cross-matching between them also suggesting that they were from different, or at least disparate, woodland sources.

CONTRIBUTORS
Dr M C Bridge

ACKNOWLEDGEMENTS
This work was commissioned by Dr Peter Marshall of the English Heritage Scientific Dating Team. I am grateful to Stephen Tucker of SMT Associates for his assistance in arranging access and providing the drawings adapted for use in this report. Cathy Tyers also of the English Heritage Scientific Dating Team read and made useful comments on earlier drafts of this report.

ARCHIVE LOCATION
Cornwall and Scilly HER
Historic Environment Service
Kennall Building
Old County Hall
Station Road
Truro TR1 3AY

DATE OF INVESTIGATION
2012

CONTACT DETAILS
Dr M C Bridge
UCL Institute of Archaeology
31–34 Gordon Square
London WC1H 0PY
E-mail: martin.bridge@ucl.ac.uk

CONTENTS

INTRODUCTION

This 'castle' is a Grade 1 listed building sitting within the site of a Scheduled Ancient Monument, though not itself scheduled. Though called castle, it is a fortified manor house that sits about 0.5km from the south coast of Cornwall, some 11km east of Penzance (Figs 1 and 2). There is some dispute as to the date of the extant tower and associated service buildings. A building platform to the north east of the current building was probably the site of a substantial building thought to be associated with Henry Lord of Pengrysek [sic] at the start of the fourteenth century. A John of Pengersick was given the 'capteynshippe' of nearby St Michael's Mount in AD 1522. It is thought that the present buildings were started in the early sixteenth century after the land passed by marriage into the Millaton family, with the tower probably being built in the mid-sixteenth century by William Millaton shortly before his death, and the breakup of the estate following his son's premature death. Later, the buildings became largely uninhabitable, and in the eighteenth century had become barns and other farm buildings. The large ceiling beams supporting the first and second floors in the tower are thought to be original, those on the first floor being notable for their elaborate chamfer stops (Fig 3). The tower was converted into a dwelling in the early twentieth century, and underwent extensive renovation in AD 1968. The building is now owned by the Pengersick History and Education Trust.

Dendrochronological dating of two beams on the first floor, and two on the second floor, and any other useful timbers in the tower potentially associated with the initial construction was requested by Francis Kelly, English Heritage Historic Buildings Inspector, in order to inform an ongoing repair scheme, and settle an academic dispute which suggests possible dates of construction of the tower from the mid-fifteenth to the mid-sixteenth centuries.

METHODOLOGY

This investigation was undertaken in 2012. In the initial assessment, accessible oak timbers with more than 50 rings and where possible traces of sapwood were sought, although slightly shorter sequences are sometimes sampled if little other material is available, and shorter sequences from duplicate cores from a single timber will be measured. Those timbers judged to be potentially useful were cored using a 15mm auger attached to an electric drill. The cores were labelled, and stored for subsequent analysis.

The cores were polished on a belt sander using 80 to 400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their tree-ring sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004a). Cross-matching was attempted by a combination of visual matching and a process of qualified statistical comparison by computer. The ring-width series were compared for statistical

cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted on the computer monitor to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, and higher, and for these to be well replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values however do not preclude same tree derivation.

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward. Depending on the completeness of the final ring, ie if it has only the spring vessels or early wood formed, or the latewood or summer growth, a precise felling date and season can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. The number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. If no sapwood or heartwood/sapwood boundary survives then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (tpq) or felled-after date.

A review of the geographical distribution of dated sapwood data from historic timbers has shown that a sapwood estimate relevant to the region of origin should be used in interpretation, which in this area is 9–41 rings (Miles 1997a). It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study.

Figure 1: Map showing the general locality of Pengersick Castle – within the red box. © Crown Copyright. All rights reserved. English Heritage 100019088. 2012

Figure 2: Detailed map of the Pengersick Castle environs. © Crown Copyright. All rights reserved. English Heritage 100019088. 2012

Figure 3: One of the elaborate chamfer-stops to the first-floor beams at Pengersick Castle. Photograph Martin Bridge

RESULTS AND DISCUSSION

The four large beams, two each at first-floor and second-floor level were sampled, along with the inner lintel of the north window at first-floor level. The latter core revealed that there were too few rings for further analysis. The two beams at second-floor level had the sapwood on the upper side, adjacent to later floor joists, and in addition to one long core taken from the lower edge up through the bulk of the timbers, additional shorter cores were taken at shallow angles into the top corners of the beams in order to try and extract maximum information.

Details of the location of the cores are given in Table 1, and illustrated in Figures 4 and 5. The multiple cores from timbers pgk04 and pgk05 were compared with each other and a single series was produced representing each timber. The raw ring-width data for each core is given in the Appendix.

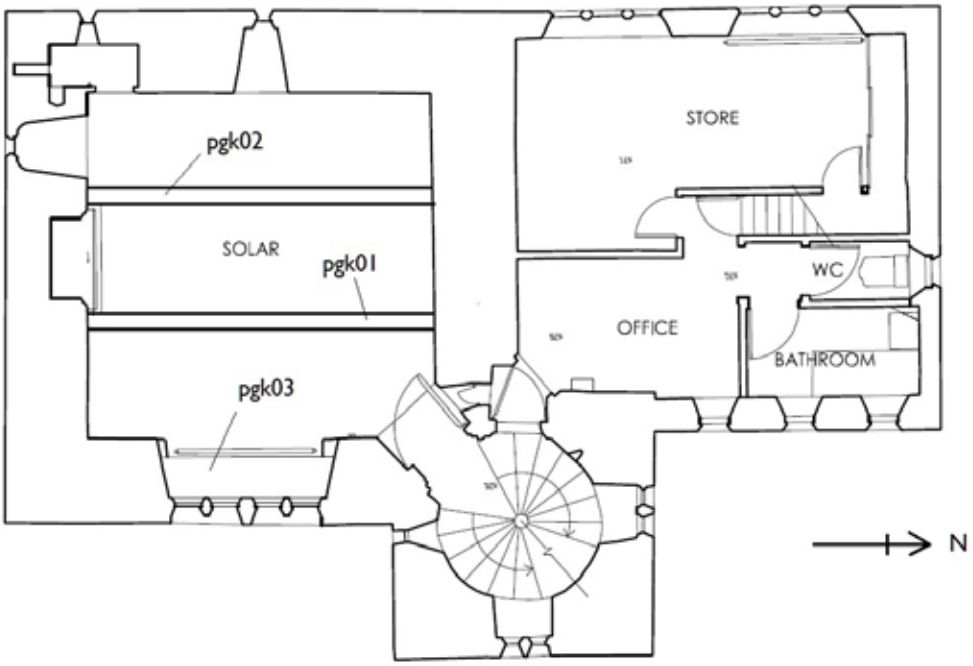

Figure 4: Plan of the first floor, showing the locations of the two beams and the window lintel sampled for dendrochronology

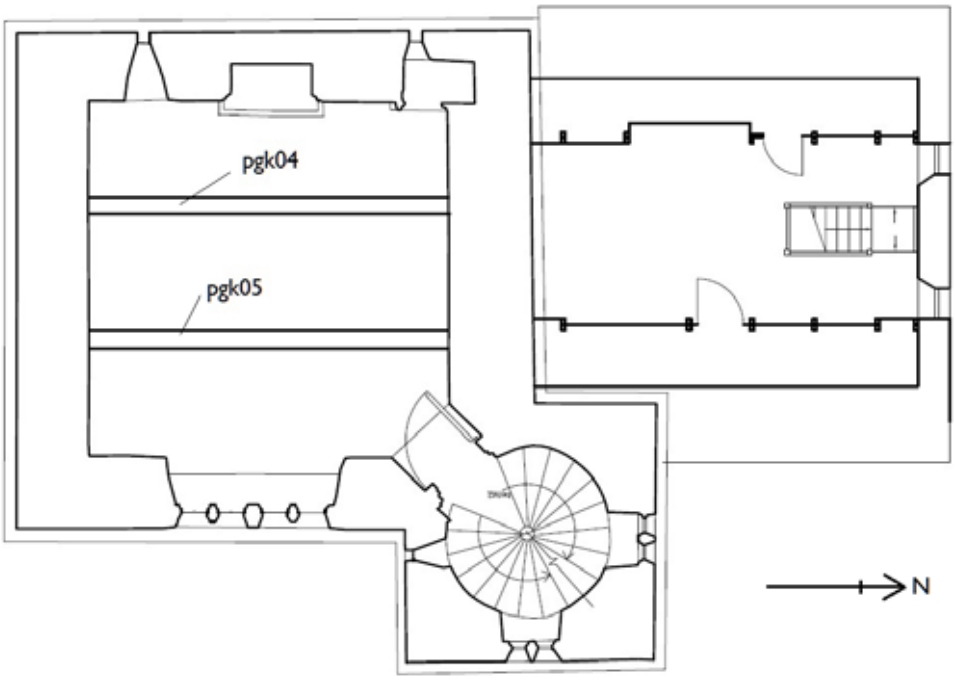

Figure 5: Plan of the second floor, showing the location of the two beams sampled for dendrochronology

The cross-matching between the individual series is shown in Table 2. Although the cross-matching between the individual series is relatively poor, it is consistent, and all four series can be dated independently against the reference material. These four series were combined into a single 188-year site chronology, PENGRSK, which was then compared with the available dated reference material, resulting in it being dated to the years AD 1344–1531. A selection of the strongest matches is shown in Table 3, and the relative positions of overlap are shown, along with the interpreted likely felling date ranges in Figure 6.

All four timbers are clearly of similar date, although there is a difference of 26 years between the heartwood/sapwood boundary dates of the three timbers that retained that boundary. Although this does not rule out that the timbers were all felled at the same time, it does suggest that they may have been felled at slightly different times, some years apart. The relatively poor matching between the series may also suggest different woodland sources for the timbers. The date ranges do however settle the date of the construction of the castle tower, assuming that these timbers were associated with the primary construction, with a mid sixteenth-century date for construction likely. If they are considered as a single group felled at the same time, the mean heartwood/sapwood boundary date is AD 1516, which would give a likely felling date range for the group of AD 1532–57.

BIBLIOGRAPHY

Arnold, A J, and Howard, R, 2006 *Tree-ring analysis of timbers from the Church of St Ildierna, Lansallos, Cornwall*, English Heritage Res Dept Rep Ser, **49/2006**

Arnold, A, and Howard, R, 2009 *St Andrew's Church, Alwington, Devon, Tree-ring analysis of the timbers*, English Heritage Res Dept Rep Ser, **42/2009**

Arnold, A J, Howard, R, and Litton, C D, 2006 *Tree-ring analysis of timbers from the Church of St Martin, East Looe, Cornwall,* English Heritage Res Dept Rep Ser, **46/2006**

Baillie, M G L, and Pilcher, J R, 1973 A simple cross-dating program for tree-ring research, *Tree Ring Bulletin*, **33**, 7–14

Howard, R, Litton, C D, Arnold, A J, and Tyers, C, 2006 *Tree-ring analysis of timbers from Warleigh House, Tamerton Foliot, Bickleigh, South Hams, near Plymouth, Devon,* English Heritage Res Dept Rep Ser, **38/2006**

Miles, D H, 1997a The interpretation, presentation, and use of tree-ring dates, *Vernacular Architect*, **28**, 40–56

Miles, D H, 1997b Working compilation of 58 reference chronologies centred around Wales by various researchers, unpubl computer file WALES97, Oxford Dendrochronology Laboratory

Miles, D H, Worthington, M J, Bridge, M C, Suggett, R, and Dunn, M, 2011 Tree-ring dates, *Vernacular Architect*, **42**, 109-16

Nayling, N, 2000 *Tree-ring analysis of timbers from The White House, Vowchurch, Herefordshire,* Anc Mon Lab Rep, **73/99**

Tyers, I, 2002 *Tree-ring analysis of oak timbers from the Abbot's Hall and Parlour at Wigmore Abbey, near Adforton, Herefordshire*, Centre for Archaeol Rep, **112/2002**

Tyers, I, 2004a Dendro for Windows Program Guide 3rd edn, *ARCUS Report*, **500b**

Tyers, I, 2004b *Tree-Ring Analysis of Oak Timbers from Pendennis Castle, Near Falmouth, Cornwall. Portsmouth,* Centre for Archaeol Rep, **38/2004**

Tyers, C, Arnold, A J, Howard, R, and Hurford, M forthcoming *Dendrochronological Research in Devon: Phase 2 – tree-ring analysis of timbers*, English Heritage Res Rep Ser

Table 1: Details of the samples taken from Pengersick Castle

Sample Number	Timber and position	No of rings	Mean HW ring width (mm)	Dates Spanning (AD)	H/S boundary AD	Sapwood rings	Mean sensitivity	Felling date ranges (AD)
First Floor								
pgk01	East beam	120	1.39	1402–1521	1521	h/s	0.27	1530–62
pgk02	West beam	121	0.95	1344–1464	-	-	0.27	after 1473
pgk03	Inner window lintel	<40	NM	-	-	-	-	-
Second Floor								
Pgk04a	West beam	124	1.29	1351–1474	-	-	0.21	
Pgk04b	*ditto*	122	0.93	1365–1486	-	-	0.23	
Pgk04c	*ditto*	38	0.64	1464–1501	1500	1	0.27	
pgk04	Mean of 04a, 04b, and 04c	151	1.10	1351–1501	1500	1	0.21	1509–41
Pgk05ai	East beam	90	1.56	1352–1441	-	-	0.24	
Pgk05aii	*ditto*	40	0.88	-	-	-	0.26	
Pgk05b	*ditto*	138	1.08	1357–1494	-	-	0.25	
Pgk05c	*ditto*	68	0.93	1464–1531	1526	5	0.27	
pgk05	Mean of 05ai, 05b, and 05c	175	1.17	1352–1531	1526	5	0.24	1535–67

Key: HW = heartwood; Mean sens = mean sensitivity; H/S = heartwood/sapwood boundary

Table 2: Cross-matching between the dated series from Pengersick Castle

	t-values		
SAMPLE	pgk02	pgk04	pgk05
pgk01	4.2	3.5	4.0
pgk02		3.6	2.2
pgk04			3.7

Table 3: Dating evidence for the site chronology PENGRSK AD 1344–1531. File names in bold are regional chronologies

County/region	Chronology name	Short publication reference	File name	Spanning (yrs AD)	Overlap (yrs)	*t*-value
Cornwall	Pendennis Castle, near Falmouth	(Tyers 2004b)	PEN_T17	1358–1541	178	10.2
Devon	Wareleigh House, Tamerton Foliot	(Howard *et al* 2006)	TMFASQ01	1367–1539	157	8.5
Devon	The Ship Inn, Morwellham Quay	(Tyers *et al* forthcoming)	MWQASQ01	1361–1508	188	7.9
Cornwall	St Ildierna/Ildiane Church, Lansallos	(Arnold and Howard 2006)	LANASQ03	1355–1514	188	7.8
Wales	St Woolos Cathedral, Newport	(Miles *et al* 2011)	WOOLOS2	1318–1482	139	7.6
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404–1981	188	7.4
Herefordshire	Wigmore Abbey	(Tyers 2002)	WIGALL46	1055–1729	188	6.8
Devon	Alwington Church	(Arnold and Howard 2009)	ALWCSQ02	1342–1490	147	6.8
Buckinghamshire	White House, Vowchurch	(Nayling 2000)	WVT9	1364–1602	168	6.7
Cornwall	St Martin's Church, East Looe	(Arnold *et al* 2006)	LOOASQ01	1363–1518	156	6.6

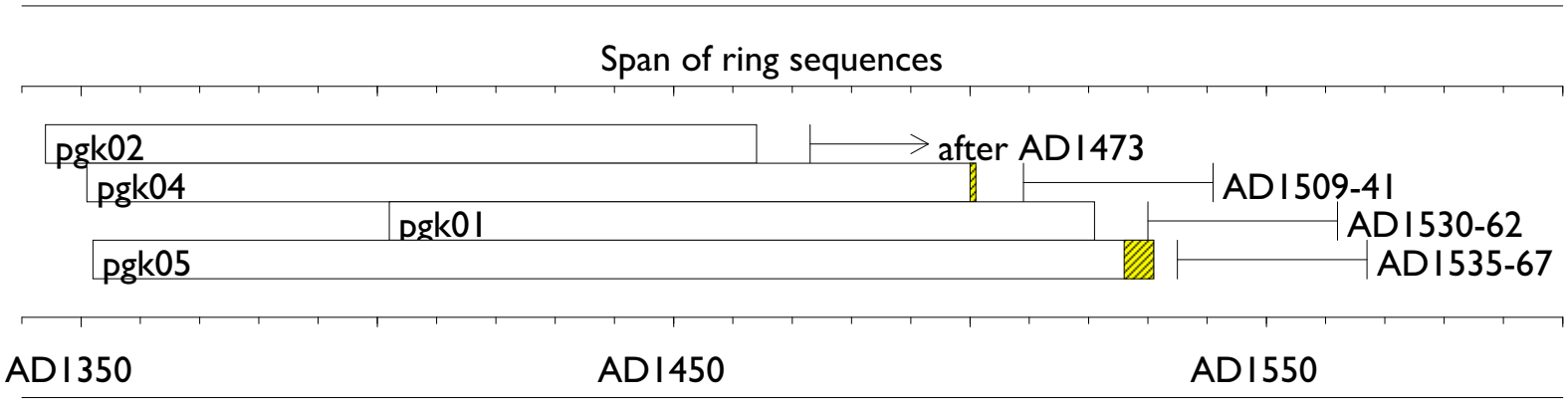

Figure 6: Bar diagram showing the relative positions of overlap of the dated timbers included in the site chronology PENGRSK from Pengersick Castle, Cornwall. White portions of the bars represent heartwood, whilst yellow hatched portions represent sapwood

APPENDIX

Ring width values (0.01mm) for the sequences measured

pgk01

217	507	434	398	444	195	341	161	121	93
157	213	303	189	197	163	141	110	199	196
93	145	186	161	197	197	274	243	217	186
183	190	185	213	161	170	148	93	181	170
90	147	96	133	135	136	148	149	132	107
94	99	210	148	101	116	93	71	126	61
65	80	45	79	123	143	97	91	88	59
63	52	52	96	128	90	92	81	72	89
75	108	127	176	171	190	139	125	121	129
63	93	95	66	144	102	55	79	75	64
87	72	89	127	121	138	147	128	72	114
151	107	149	98	86	89	50	51	48	112

pgk02

141	125	106	117	137	175	160	181	95	122
110	96	113	146	172	179	83	86	157	115
113	98	129	107	51	80	123	88	75	74
39	56	65	82	59	97	75	77	61	76
93	51	92	87	87	111	49	57	48	46
48	97	107	61	40	72	64	42	65	83
70	63	71	79	88	63	55	38	69	91
120	120	87	68	63	42	36	71	29	47
65	49	99	122	170	145	148	126	114	102
144	194	170	193	116	114	89	69	62	81
98	96	103	81	138	111	87	155	89	94
135	85	91	130	136	79	87	73	66	90
54									

pgk04a

451	100	273	207	251	272	235	203	297	242
218	170	157	179	152	145	123	87	102	111
110	106	136	130	102	115	124	136	130	110
151	166	205	215	137	204	197	170	168	116
127	163	137	102	104	130	100	94	115	114
91	112	158	152	85	111	101	94	109	83
60	85	109	136	134	83	102	98	60	98
172	128	128	158	139	122	91	141	122	118
97	147	177	173	131	99	147	124	72	88
67	81	63	95	98	113	105	98	109	104
94	87	94	92	103	90	94	118	82	93
59	98	67	85	112	107	111	125	109	155
121	78	92	64						

pgk04b

127	162	122	122	87	108	95	96	147	152
126	127	147	106	170	138	108	145	210	176
148	106	83	123	126	84	128	158	116	103

123 170 114 99 89 100 59 52 73 89
88 152 85 103 124 103 55 71 89 97
93 69 54 74 52 76 74 69 59 71
95 95 98 120 133 103 81 101 119 105
68 54 77 63 48 79 64 65 59 86
57 66 63 68 78 91 51 75 69 74
78 72 66 88 58 50 36 63 48 58
97 86 79 91 73 95 62 48 62 58
118 112 60 62 56 79 68 70 78 154
134 148

pgk04c
59 75 72 67 86 67 83 69 57 55
53 94 94 55 52 38 55 55 62 56
91 104 83 62 75 52 71 55 49 50
56 50 55 56 50 38 42 88

pgk05ai
160 239 244 231 159 203 245 301 194 205
158 217 234 223 196 212 134 183 162 89
141 141 186 178 105 124 98 143 96 159
182 195 208 259 267 219 254 175 126 135
117 131 135 174 246 147 148 160 147 213
180 228 218 156 212 141 189 186 168 71
93 99 127 125 89 101 89 84 112 107
62 156 152 176 101 124 132 59 67 66
133 123 68 91 117 146 123 105 179 122

pgk05aii
40 56 44 48 50 79 159 83 92 61
81 72 61 67 64 82 67 83 109 88
125 105 124 123 164 117 108 123 117 71
92 59 80 113 86 43 57 56 109 146

pgk05b
124 151 116 94 105 69 114 104 75 91
112 97 94 108 70 63 64 93 86 70
54 52 84 77 78 96 105 100 107 115
116 114 96 93 97 83 84 85 105 161
89 87 120 108 118 102 124 178 119 189
127 146 138 107 74 119 129 134 121 70
106 126 93 162 90 74 132 120 146 91
80 91 107 116 119 210 189 115 130 139
173 140 48 132 100 108 142 106 106 141
92 102 109 126 75 120 102 190 120 120
136 181 155 109 94 97 124 73 103 99
74 102 88 131 103 108 91 112 139 141
79 73 36 58 37 114 110 57 87 121
160 139 115 82 78 92 74 127

pgk05c
123 112 112 98 94 81 135 102 66 154
162 194 117 128 148 56 66 55 147 128

71	90	166	181	160	99	147	117	82	28
36	40	52	49	62	61	70	70	65	123
95	99	88	93	96	64	55	73	99	60
99	108	100	120	65	82	60	82	68	49
64	62	47	77	72	105	179	150		

ENGLISH HERITAGE RESEARCH AND THE HISTORIC ENVIRONMENT

English Heritage undertakes and commissions research into the historic environment, and the issues that affect its condition and survival, in order to provide the understanding necessary for informed policy and decision making, for the protection and sustainable management of the resource, and to promote the widest access, appreciation and enjoyment of our heritage. Much of this work is conceived and implemented in the context of the National Heritage Protection Plan. For more information on the NHPP please go to http://www.english-heritage.org.uk/professional/protection/national-heritage-protection-plan/.

The Heritage Protection Department provides English Heritage with this capacity in the fields of building history, archaeology, archaeological science, imaging and visualisation, landscape history, and remote sensing. It brings together four teams with complementary investigative, analytical and technical skills to provide integrated applied research expertise across the range of the historic environment. These are:

* Intervention and Analysis (including Archaeology Projects, Archives, Environmental Studies, Archaeological Conservation and Technology, and Scientific Dating)
* Assessment (including Archaeological and Architectural Investigation, the Blue Plaques Team and the Survey of London)
* Imaging and Visualisation (including Technical Survey, Graphics and Photography)
* Remote Sensing (including Mapping, Photogrammetry and Geophysics)

The Heritage Protection Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support community engagement and build this in to our projects and programmes wherever possible.

We make the results of our work available through the Research Report Series, and through journal publications and monographs. Our newsletter *Research News*, which appears twice a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities.

A full list of Research Reports, with abstracts and information on how to obtain copies, may be found on www.english-heritage.org.uk/researchreports

For further information visit www.english-heritage.org.uk

ENGLISH HERITAGE

ISSN 2046-9799 (Print)
ISSN 2046-9802 (Online)