Ancient Monuments Laboratory
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Summary

Tree-ring samples were obtained from fifty-one oak timbers from five phases of 26 Westgate Street, Gloucester. Analysis of these samples resulted in the production of a single site chronology of 224 years spanning the period AD 1399-1622. Analysis of the sapwood indicates felling dates: Phase 1-no later than AD 1587, Phase 2-no later than AD 1622, Phase 3-no later than AD 1587, Phase 4-no later than AD 1617, Phase 5-no later than AD 1617.

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Introduction

Number 26 lies on the north side of Westgate Street about 200 yards from the Cross at the centre of the town (SO 831187, see Figs 7 and 8). It is generally regarded as one of the finest houses of the city and is now included on the statutory list as a Grade I structure, a category which forms just 1% of all listed buildings. The immediate environment of Westgate Street has, in the last quarter of a century, been greatly denuded of several other important buildings so that the survival of 26 Westgate Street is of greater significance than might otherwise have been the case.

The elevation which faces onto Westgate Street is now covered with plaster, see Figure 9, and no hint of the concealed timberwork can be seen from this viewpoint. An early nineteenth-century illustration of this elevation is shown in Figure 10. The shop and office fronts of the buildings on either side now butt up to number 26 presenting an almost continuous facade. However, immediately to the east side of the house, behind an inconspicuous door, runs a very narrow, little-used, dead-end alleyway formerly known as Maverdine Lane. The building runs back from Westgate Street for a considerable distance along this alleyway and it is only by entering it and looking up and back towards the street that the true nature of 26 Westgate Street can be seen. A drawing of this elevation is seen in Figure 11. A long-section drawing is provided in Figure 13.

The phases of the building

The east elevation of number 26, facing on to Maverdine Lane, presents a series of jettied stages rising for three stories to an attic topped by gable dormers. The ground floor is constructed of brick, above which is close-studded timber-framing. The main posts are carved and moulded as rope or cord, with the facia and soffit boards also being decorated.

A survey conducted for English Heritage by Stephen Price (Price 1994) revealed seven phases within the building. The schema of the building's development is reproduced here from Price's survey as Figure 12. A section along Maverdine Lane from that survey is also reproduced here as Figure 13. It will be seen that the bays have been numbered from south to north. Price's interpretation of the phasing is as follows.

Phase 1, conjectured to be the earliest, comprises the primary structure of bays 6-8, these being the northernmost portion of the present structure, furthest back from Westgate Street. The mouldings of the pilasters, their bases, and the jetty facia of bays 6-8 suggest a date in the late fifteenth-century.

Phase 2 consists of bays 1-2 on the Westgate Street frontage without the attic gables.

Phase 3 is represented by the stair turret in bay 5 which was added on to bays 6-8.

Phase 4, bays 3-4, was added to the rear of bays 1-2. Price indicates that the moulding details are not closely datable, being found on the more elaborate houses of the late sixteenth- and early seventeenth-centuries in the West Midlands.

Phase 5 included the continuation of the facade of bays 1-4 in front of the stair turret to unify the Maverdine Lane frontage. According to Price's survey this phase probably dates to about AD 1620.

Phase 6 saw the underbuilding in brick with stone dressings along the ground floor of the Maverdine Lane frontage.

Phase 7 sees the rebuilding of the front elevation and the creation of the large room in bays 6-8 at first-floor level.

As stated above, Price suggests that phase 1, bays 6-8, is the earliest on the basis of the dating of the pilasters and facia. Price states that phase 2, consisting of bays 1-2 on the Westgate Street frontage without the attic gables is next. On the basis of scribed carpenters' assembly marks, coupled with carving of the jetty-bracket, bays 1-2, phase 2, pre-date bays 3-4, phase 4. However, the structural evidence is more equivocal. The northernmost frame of bay 2 is "open" with no evidence of framing, whilst the adjoining south frame of bay 3 has evidence of a "closed" timber-framed wall. The most likely explanation is that when bays 1-2 were built they abutted an earlier structure to the north and hence did not require a north wall. According to Price, the stair turret in bay 5 is phase 3. This must pre-date bays 3-4, phase 4, because there is a window at first floor level which now looks internally into bays 3-4, and there is no northern frame in this area for the phase 4 structure.

Furthermore, there is documentary evidence relating to the building. Price suggests, on the basis of documents, that there would have been considerable building work on the site of number 26 in the years shortly after AD 1550 but before about AD 1585. There is a record of a dispute in AD 1597/98 concerning rents due from

> "one howse or tenement and twoe shoppes in the parish of Grace Lane".

Apparently a rent of 20s per annum was being paid out on the property by a John Brown to the Dean and Chapter until AD 1585/86. This rent was disputed by his son, also John Brown, in about AD 1588-90. The general location of the property within the parish is given in the deposition to the court by one Richard Edward who had known the property for 34 years, and stated that he

> thinketh that the same was builded ..... upon the sight of diverse severall small tenements lienge on the west side of a lane called Mawerdyne Lane".

This certainly refers to the correct side of the lane and would suggest building activity in the AD 1550s.

Thus it would appear that the relative construction sequence of the phases of the building can be determined, except for phases 2 and 4 where there is some doubt.

Tree-ring dating was commissioned by Nicholas Molyneux of English Heritage in order to confirm or deny the above suggested interpretation and to establish the absolute construction dates, if possible, for five of the seven phases.

The Laboratory would like to take this opportunity of thanking the owner, Mr Winfield, for his help and kindness in allowing both the survey and the sampling for tree-ring analysis. The Laboratory would also like to thank the staff of the book shop which currently occupies the premises. The management and staff were particularly helpful and accommodating.

Sampling

A total of fifty-one different oak timbers was sampled by coring. Each sample was given the code GLO-B (Gloucester, site "B") and numbered 1-51. A full list of these samples is given in Table 1. There were no detailed plans or cross-sections available showing the position of every timber. The location of almost every core (the exception being sample GLO-B24, from a joist in the attic floor) was therefore recorded at the time of sampling on sketch drawings: Figure 14a/b, the first and second floors of bays 1-4 (Price's phase 2 and 4), Figure 15, the roof of bays 6-7 (Price's phase 1), Figure 16, the stair turret in bay 5 (Price's phase 3), and Figure 17, the east facade along Maverdine Lane (Price's phase 5). A drawing to show the location of sample GLO-B24 could not be made because most of the joists were hidden by floorboards. Following Price's survey the trusses and bays in the sketch drawings are numbered from south to north, that is from the front on Westgate Street to the rear of the building.

Samples GLO-B01-09 were taken at first-floor level from the timbers of bays 1 and 2, trusses 1, 2. and 3, these representing Price's phase 2. Samples GLO-B10-19 were taken at first- and second-floor level from the timbers of bays 3 and 4, trusses 4, 5, and 6, these representing Price's phase 4. A further sample, GLO-B24, was taken from a floor joist in the attic over these bays.

Fourteen samples, GLO-B20-34 (but excluding GLO-B24), were taken from the roof timbers of bays 6-8, that is Price's phase 1 (see Fig 15). These timbers comprise common rafters, collars, and the remains of rails which appear to have once run between queen-struts in the roof.

Eight samples, GLO-B35-42, were obtained from the stair turret in bay 5, Price's phase 3 (see Fig 16). The remaining nine samples, GLO-B43-51, were taken from timbers forming the facade along Maverdine Lane, Price's phase 5 (see Fig 17).

Analysis

All fifty-one samples were measured and the fifty samples with more than fifty-five rings (that is those with sufficient rings for reliable analysis) were compared with each other *en masse* by the Litton/Zainodin grouping procedure (see Appendix). At a value of t=5.0 forty-eight samples cross-matched with each other at the offsets shown in Figure 1. The ring widths from these forty-eight samples were combined at these relative offset positions to form GLOBSQ01, a site chronology of 224 rings. This site chronology was successfully cross-matched with a series of relevant reference chronologies for oak, giving a first ring date of AD 1399 and a last measured ring date of AD 1622. Evidence for this dating is given by the t-values of Table 2.

The remaining three samples, GLO-B15, 22, and 42, were compared statistically using t-values against a wide range of relevant master chronologies. As a result GLO-B15 was dated as spanning the period AD 1553 - 1602 and GLO-B42 as spanning the period AD 1515 - 1586. Details of the cross-matching are given in Table 3. A satisfactory cross-match for sample GLO-B22 could not be found.

For the purposes of illustration the dated samples were then split into their constituent constructional "phases". The resultant bar diagrams are shown in Figures 2-6. At least two samples from each of the constructional phases have retained complete sapwood. By examining, under the microscope, the part-ring after the last complete measured sapwood ring it is possible to give accurate felling dates for individual timbers. The dated samples with complete sapwood are listed in Table 4.

Interpretation

In broad terms, the samples with complete sapwood form two distinct groups corresponding to two periods of felling activity. These occurred in the periods AD 1583 to 1587 and AD 1614 to 1622. Timbers from phases 1 and 3 all appear to be felled in the first period, whilst the timbers from phases 2, 4, and 5 all appear to be felled in the second period. It may be noticed that the timbers from phases 4 and 5 were felled in AD 1616 or AD 1617, whereas in phase 2 one timber was felled in AD 1615, one in AD 1620 and three timbers were felled in AD 1622. The evidence suggests that some form of stockpiling, planned or fortuitous, was occurring. Therefore, while it may be possible that phases 4 and 5 were constructed before phase 2, it is also possible that they are contemporary with phase 2. The tree-ring analysis is unable to determine which is the case.

In more detail it would appear that Price's phase 1, bays 6-8, far from dating to the fifteenth century, was built using timbers felled in the late sixteenth century. The timber was in fact felled between early AD 1586 and early AD 1587.

The timbers of the stair turret in bay 5, Price's phase 3, were probably felled no later than AD 1587. One timber with complete sapwood has a felling date in the early part of that year but another was felled between late AD 1583 and early AD 1584. Therefore, it is quite possible that phase 1 and phase 3 were designed as a single programme.

The felling of the timbers for the next building programme, bays 3-4, Price's phase 4, took place in AD 1616.

The timbers of the Maverdine Lane facade in bay 5, Price's phase 5, were felled in AD 1616 and AD 1617. Therefore it is again quite possible that the building and the felling of timber for phases 4 and 5 are to be seen as a single programme.

Price's phase 2, bays 1 - 2, contains one timber felled in AD 1615, one timber felled in AD 1620, and three timbers felled in AD 1622.

As mentioned above, the tree-ring analysis does not provide conclusive evidence either for or against phases 2, 4, and 5 being of a single construction date.

Only one of the fifty-one samples, GLO-B22, remains undated. It shows no narrow nor complacent rings which might make dating difficult.

Conclusion

The survey conducted by Stephen Price suggested the relative constructional sequence for the building. The only slight doubt about his interpretation was the relationship between bays 1-2 and 3-4, that is phases 2 and 4.

This phasing has been partially confirmed by dendrochronology. The inference from the tree-ring analysis is that almost certainly we have two periods of major construction. The first is Price's phases 1 and 3, using timber felled no later than AD 1587. The second consists of Price's phases 4 and 5, using timber felled no later than AD 1617, and finally, Price's phase 2, using timber felled no later than AD 1622.

If we make the assumption that there is virtually no, or very little, time-gap between the felling of the timber and its use, and that storage and seasoning is not taking place, then it could be said that phase 2 is after phases 4 and 5. However, as one of the timbers used in the construction of phase 2 has a felling date of AD 1615, and another a felling date of AD 1620, there is little dendrochronological evidence to support this assumption.

The documentary sources will now have to be questioned. It would appear that Richard Edwards is mistaken, or that he is not referring to 26 Westgate Street when he states in AD 1597/98 that he has known the property for 34 years. He may mean that he knows the site. There is some disagreement between the interpretation of dates on stylistic grounds and those produced by dendrochronology; the pilasters, their bases, and the jetty facia of bays 6-8 do not date to the fifteenth century.

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Table 1: Details of tree-ring samples from 26 Westgate Street, Gloucester

Sample no.	Sample location	Total rings	Sapwood rings*	First measured ring date	Last heartwood ring date	Last measured ring date
	Phase 2 (bays 1 - 2)					
GLO-B01	West main post truss 1, first floor	152	01c	AD 1448	1598	1599
GLO-B02	West main post truss 2, first floor	86	20C	AD 1534	1599	1619
GLO-B03	East main post truss 2, first floor	119	02	AD 1478	1594	1596
GLO-B04	West main post truss 3, first floor	120	21C	AD 1503	1601	1621
GLO-B05	East main post truss 3 first floor	101	26C	AD 1522	1596	1622
GLO-B06	West intermediate post truss 1, first floor	112	12c	AD 1507	1606	1618
GLO-B07	West cross-rail truss 1 - 2, first floor	121	16C	AD 1494	1598	1614
GLO-B08	West diagonal brace truss 1 - 2, first floor	100	27C	AD 1522	1594	1621
GLO-B09	East top rail truss 1 - 2, first floor	125	03	AD 1483	1604	1607
	Phase 4 (bays 3 - 4)					
GLO-B10	East post truss 4, first floor	61	none	AD 1453	------	1513
GLO-B11	North jamb of east window, bay 3, first floor	88	18C	AD 1529	1598	1616
GLO-B12	South jamb of east window, bay 4, first floor	75	11	AD 1539	1602	1613
GLO-B13	Sillbeam, east window, bay 4, first floor	82	15C	AD 1535	1601	1616
GLO-B14	Central stud-post, east window, bay 4, first floor	173	11	AD 1441	1602	1613
GLO-B15	North jamb of east window, bay 3, first floor	50	h/s	AD 1553	1602	1602
GLO-B16	East post truss 6, first floor	120	none	AD 1423	------	1542
GLO-B17	West post truss 5, second floor	91	13c	AD 1524	1601	1614
GLO-B18	West post truss 6, second floor	59	none	AD 1531	------	1589
GLO-B19	East post truss 6, second floor	75	h/s	AD 1527	1601	1601
GLO-B24	Floor joist III attic roof	85	18c	AD 1529	1595	1613

Table 1: continued

Sample no.	Sample location	Total rings	Sapwood rings*	First measured ring date	Last heartwood ring date	Last measured ring date
	Phase 1 (bays 6 - 8)					
GLO-B20	West cross-rail, bay 7	146	06	AD 1421	1560	1566
GLO-B21	West cross-rail, bay 7	99	none	AD 1414	------	1512
GLO-B22	West cross-rail, bay 8	70	none	-------	------	------
GLO-B23	East cross-rail, bay 7	91	h/s	AD 1469	1559	1559
GLO-B25	Collar, frame 3	86	35c	AD 1496	1546	1581
GLO-B26	West common rafter, frame 2	85	h/s	AD 1470	1554	1554
GLO-B27	West common rafter, frame 3	115	22C	AD 1472	1564	1585
GLO-B28	Collar, frame 2	125	28C	AD 1462	1558	1586
GLO-B29	East common rafter, frame 2	80	h/s	AD 1476	1555	1555
GLO-B30	Collar, frame 14	93	20C	AD 1494	1566	1586
GLO-B31	Collar, frame 19	122	25c	AD 1448	1544	1569
GLO-B32	West common rafter, frame 19	108	28C	AD 1480	1559	1587
GLO-B33	West common rafter, frame 17	87	h/s	AD 1469	1555	1555
GLO-B34	West common rafter, frame 15	116	h/s	AD 1445	1560	1560
	Phase 3 (stair turret in bay 5)					
GLO-B35	North jamb of doorway to turret	120	35	AD 1451	1535	1570
GLO-B36	North mid-rail of east wall	123	none	AD 1399	-------	1521
GLO-B37	East post of north wall frame	163	11c	AD 1419	1570	1581
GLO-B38	West post of north wall frame	62	20c	AD 1522	1563	1583
GLO-B39	East mid-rail of north wall frame	158	26C	AD 1430	1561	1587
GLO-B40	Central mid-rail of north wall frame	130	03	AD 1434	1560	1563
GLO-B41	West mid-rail of north wall frame	149	45C	AD 1435	1538	1583
GLO-B42	North mid-rail of west wall frame	68	22C	AD 1519	1564	1586

Table 1: continued

Sample no.	Sample location	Total rings	Sapwood rings*	First measured ring date	Last heartwood ring date	Last measured ring date
	Phase 5 (lane facade bays 4 - 5)					
GLO-B43	Sill or under-rail of attic gable window	75	none	AD 1502	------	1576
GLO-B44	South jamb of attic gable window	118	h/s	AD 1478	1595	1595
GLO-B45	North jamb of attic gable window	101	14c	AD 1508	1594	1608
GLO-B46	North wall plate of attic gable	70	none	AD 1474	------	1543
GLO-B47	Central stud post below attic gable window	92	h/s	AD 1499	1590	1590
GLO-B48	Sill beam of 2nd floor window	182	18C	AD 1436	1599	1617
GLO-B49	North post of 2nd floor window	100	33C	AD 1517	1583	1616
GLO-B50	Rail from N jamb to post, 2nd floor window	103	11	AD 1501	1592	1603
GLO-B51	North jamb of 2nd floor window	81	13	AD 1528	1595	1608

* h/s = only heartwood/sapwood boundary on sample
c = complete sapwood on timber, all or portion lost in sampling
C = complete sapwood retained on sample, last ring date is felling date of timber

Table 2: Results of the cross-matching of site chronology GLOBSQ01 and relevant reference chronologies when first ring date is AD 1399 and last ring date is AD 1622

Reference Chronology	Span of chronology	t-value	
East Midlands	AD 882 - 1981	10.4	(Laxton and Litton 1988)
Wales and West Midlands	AD 1341 - 1636	10.8	(Siebenlist-Kerner 1978)
England	AD 401 - 1981	10.5	(Baillie and Pilcher 1982 unpubl)
MC10	AD 1386 - 1585	14.2	(Fletcher 1978 pers comm)
Lacock Abbey, Wilts	AD 1448 - 1546	8.6	(Esling *et al* 1990)
Speke Hall, Cheshire	AD 1367 - 1574	8.7	(Howard *et al* 1992)
Folly House, Steventon, Oxon	AD 1437 - 1542	7.9	(Alcock *et al* 1989)
Mercers Hall, Gloucester	AD 1289 - 1541	10.1	(Howard *et al* 1997)
Kingsholme, Didcot, Oxon	AD 1355 - 1548	6.2	(Alcock *et al* 1989)

Table 3: Results of cross-matching ungrouped samples against relevant reference chronologies

Sample no.	FMR date	LMR date	t-value	Reference chronology	
GLO-B15	AD 1553	1602	7.5	Mercers Hall, Gloucester	(Howard *et al* 1997)
GLO-B22	no date				
GLO-B42	AD 1519	1586	4.8	Speke Hall, Cheshire	(Howard *et al* 1992)
			4.3	East Midlands	(Laxton and Litton 1988)
			4.1	England	(Baillie and Pilcher 1982 unpubl)
			4.3	Heathcote, Derbys	(Howard *et al* 1992)
			4.1	Mercers Hall, Gloucester	(Howard *et al* 1997)

Table 4: Samples with complete sapwood

Sample no.	Sample location	Sapwood rings	Felling date (to be compared with last measured ring date in Table 1)
	Phase 1 (bays 6 - 8)		
GLO-B27	West common rafter, frame 3	22C	Early AD 1586
GLO-B28	Collar, frame 2	28C	Late AD 1586 to early 1587
GLO-B30	Collar, frame 14	20C	Late AD 1586 to early 1587
GLO-B32	West common rafter, frame 19	28C	Early AD 1587
	Phase 2 (bays 1 - 2)		
GLO-B02	West main post truss 2, first floor	20C	Early AD 1620
GLO-B04	West main post truss 3, first floor	21C	Early AD 1622
GLO-B05	East main post truss 3 first floor	26C	Mid AD 1622
GLO-B07	West cross-rail truss 1 - 2, first floor	16C	Early AD 1615
GLO-B08	West diagonal brace truss 1 - 2, first floor	27C	Early AD 1622
	Phase 3 (stair turret in bay 5)		
GLO-B39	East mid-rail of north wall frame	26C	Early AD 1587
GLO-B41	West mid-rail of north wall frame	45C	Late AD 1583 to early 1584
GLO-B42	North mid-rail of west wall frame	22C	AD 1586
	Phase 4 (bays 3 - 4)		
GLO-B11	North jamb, east window, bay 3, first floor	18C	Mid AD 1616
GLO-B13	Sillbeam, east window, bay 4, first floor	15C	Mid AD 1616
	Phase 5 (lane facade bays 4 - 5)		
GLO-B48	Sill beam of 2nd floor window	18C	Mid AD 1617
GLO-B49	North post of 2nd floor window	33C	Late AD 1616 to early 1617

Figure 1: Bar diagram of samples in site chronology GLOBSQ01

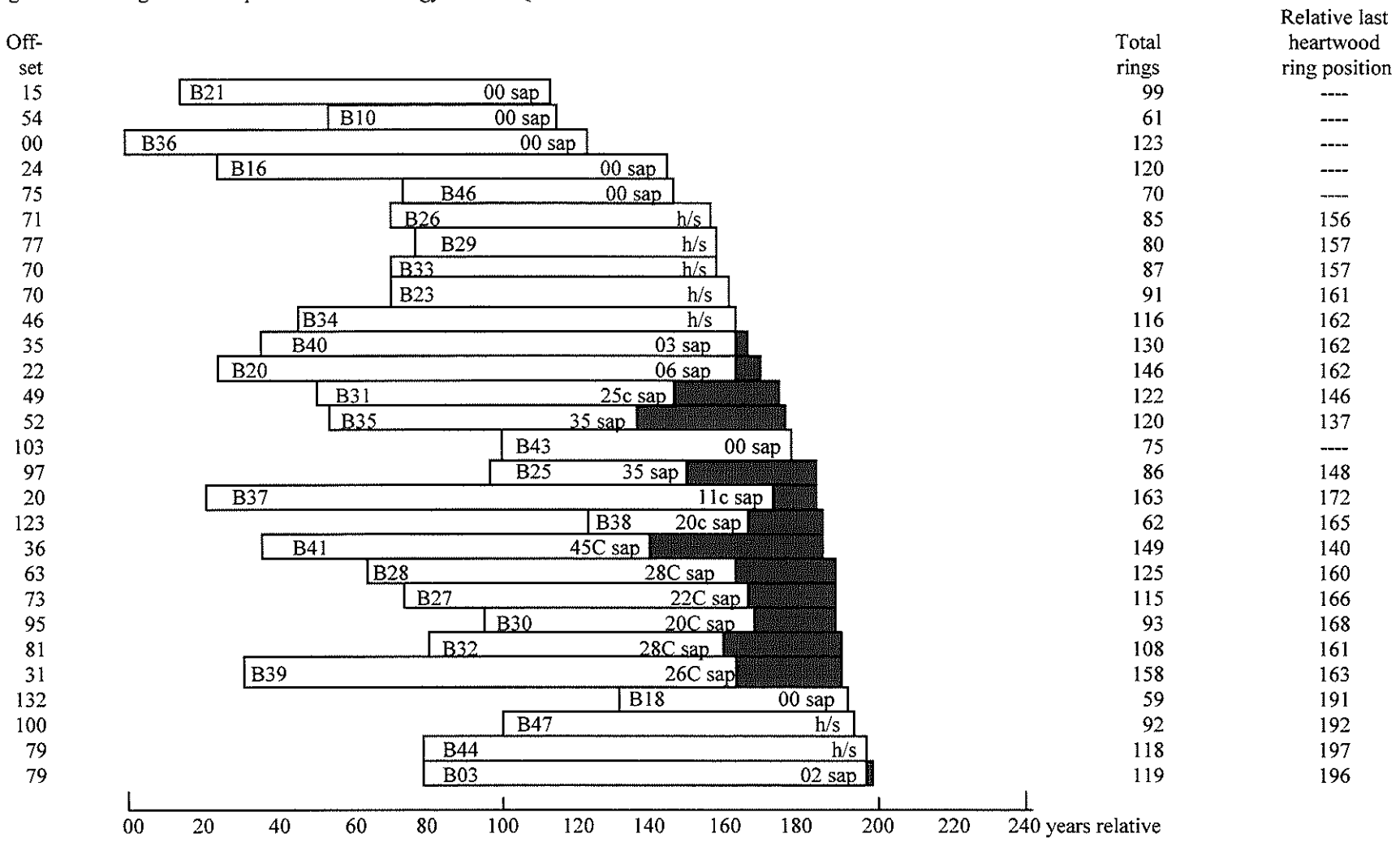
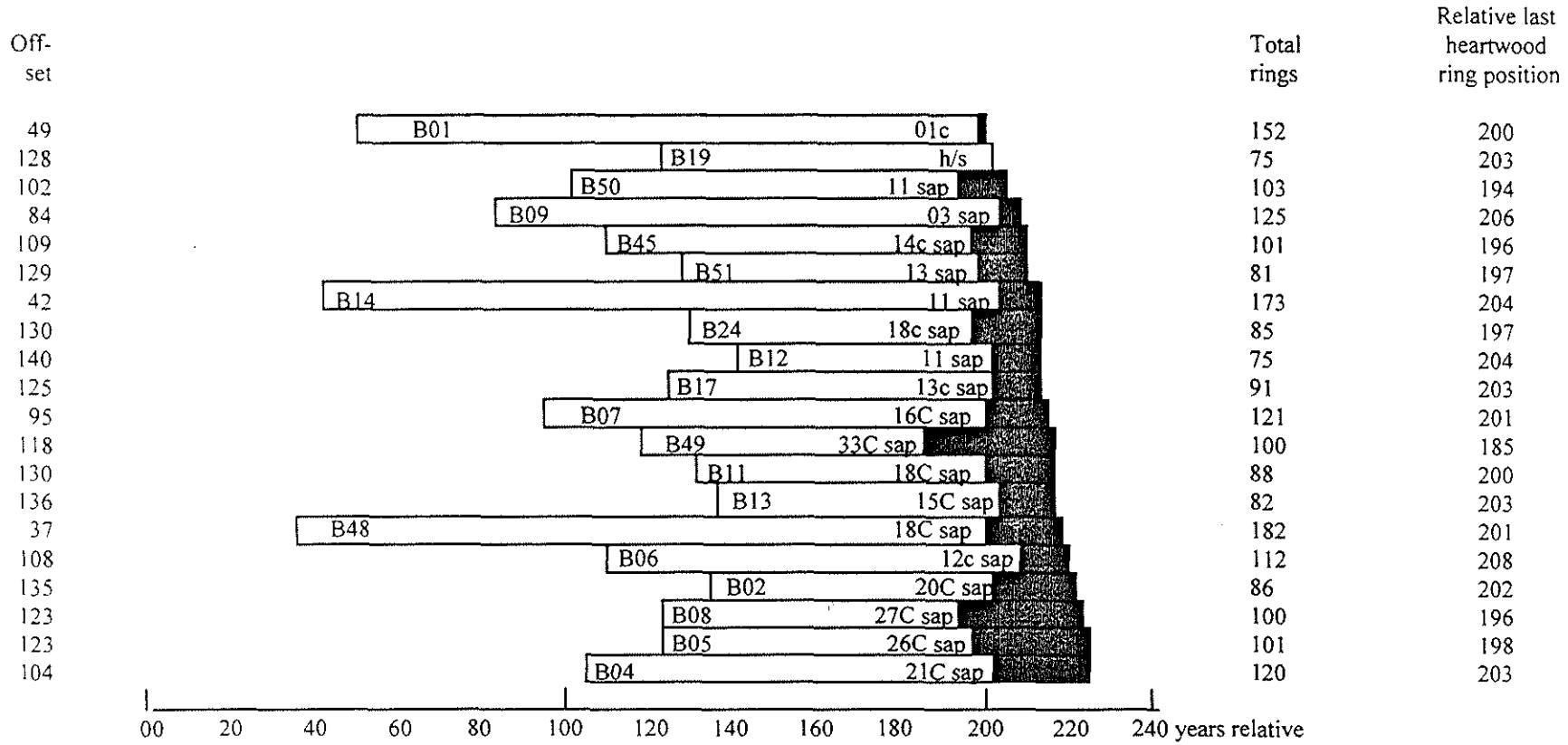
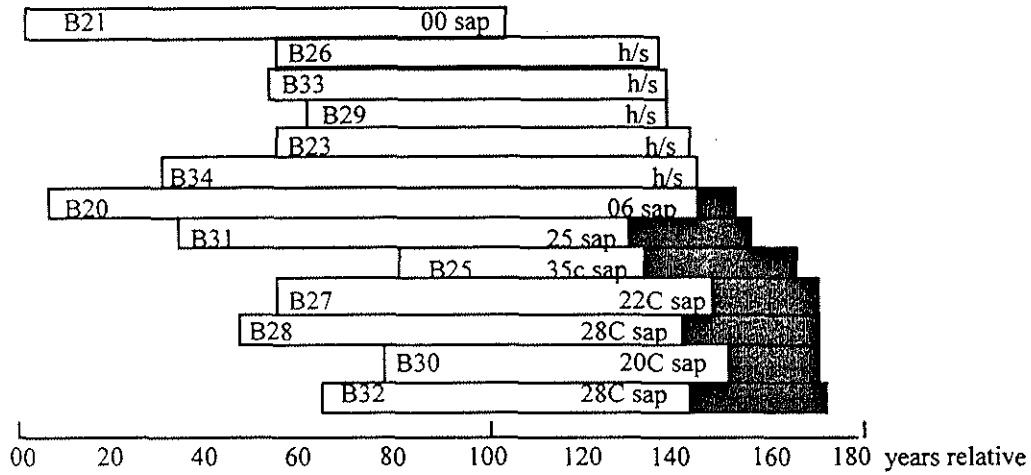


Figure 1: continued



White bar = heartwood rings, shaded area = sapwood rings
h/s = only heartwood/sapwood boundary on sample
c = complete sapwood on timber, all or part lost from sample
C = complete sapwood on sample, last measured ring date is felling date

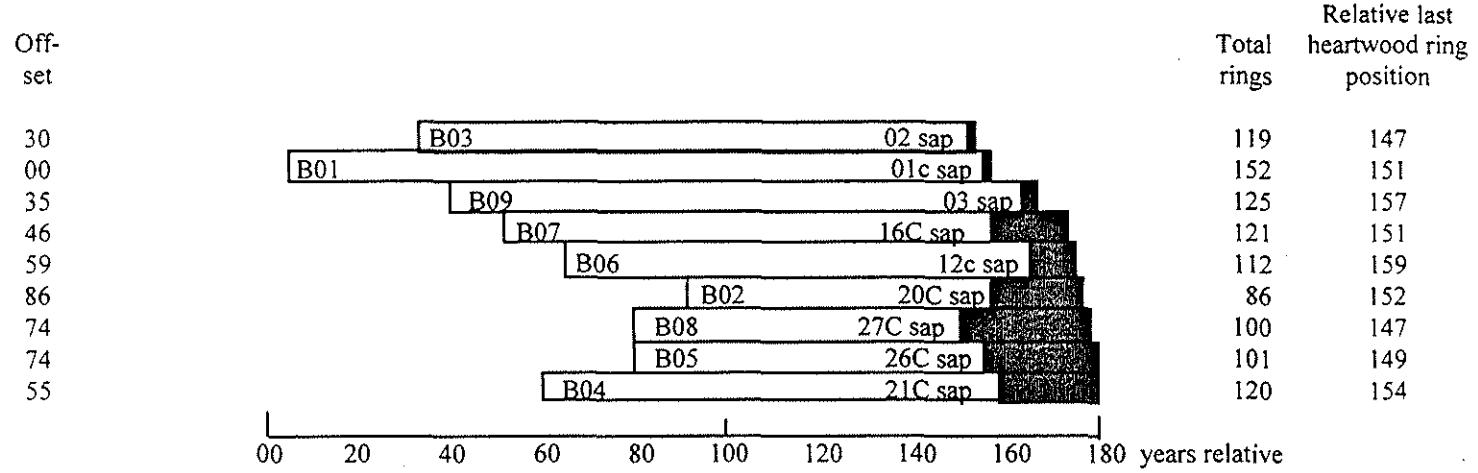
Figure 2: Bar diagram of samples from "phase 1", bays 6 - 8



Off-set	Total rings	Relative last heartwood ring position
00	105	----
56	85	141
55	87	142
62	80	142
55	91	146
31	116	147
07	146	147
34	122	131
82	86	133
58	115	151
48	125	145
80	93	153
66	108	146

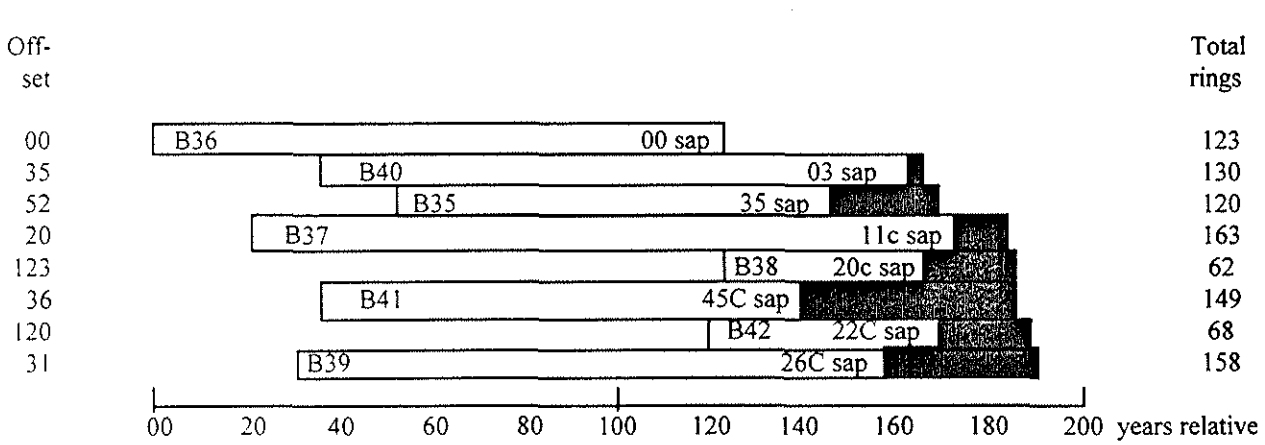
White bar = heartwood rings, shaded area = sapwood rings
h/s = only heartwood/sapwood boundary on sample
c = complete sapwood on timber, all or part lost from sample
C = complete sapwood on sample, last measured ring date is felling date

Figure 3: Bar diagram of samples from "phase 2", bays 1 - 2



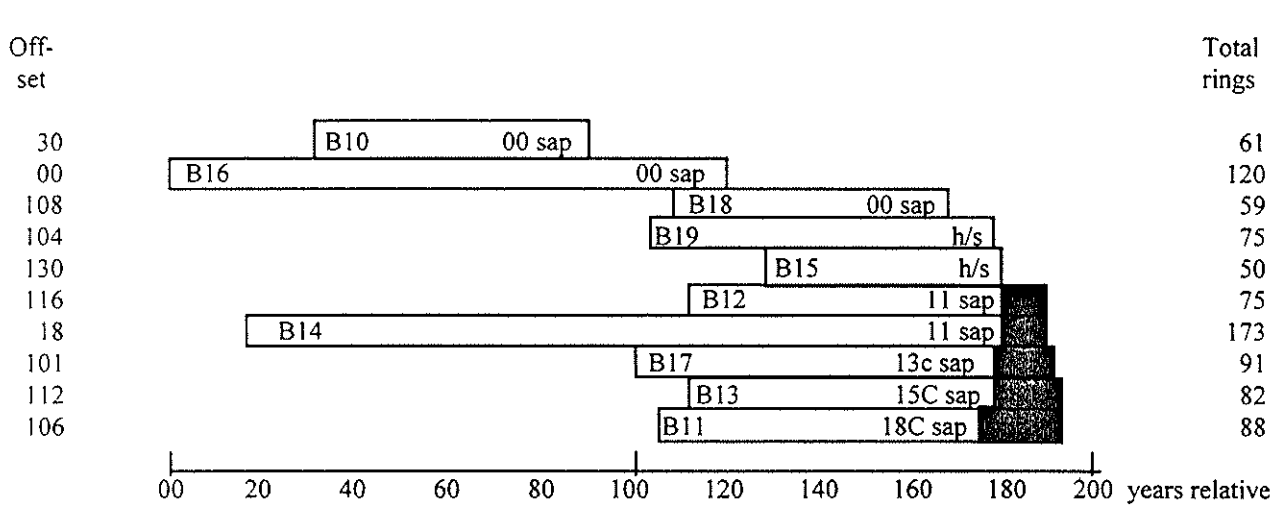
White bar = heartwood rings, shaded area = sapwood rings
c = complete sapwood on timber, all or part lost from sample
C = complete sapwood on sample, last measured ring date is felling date

Figure 4: Bar diagram of samples from "phase 3", Stair turret, bay 5



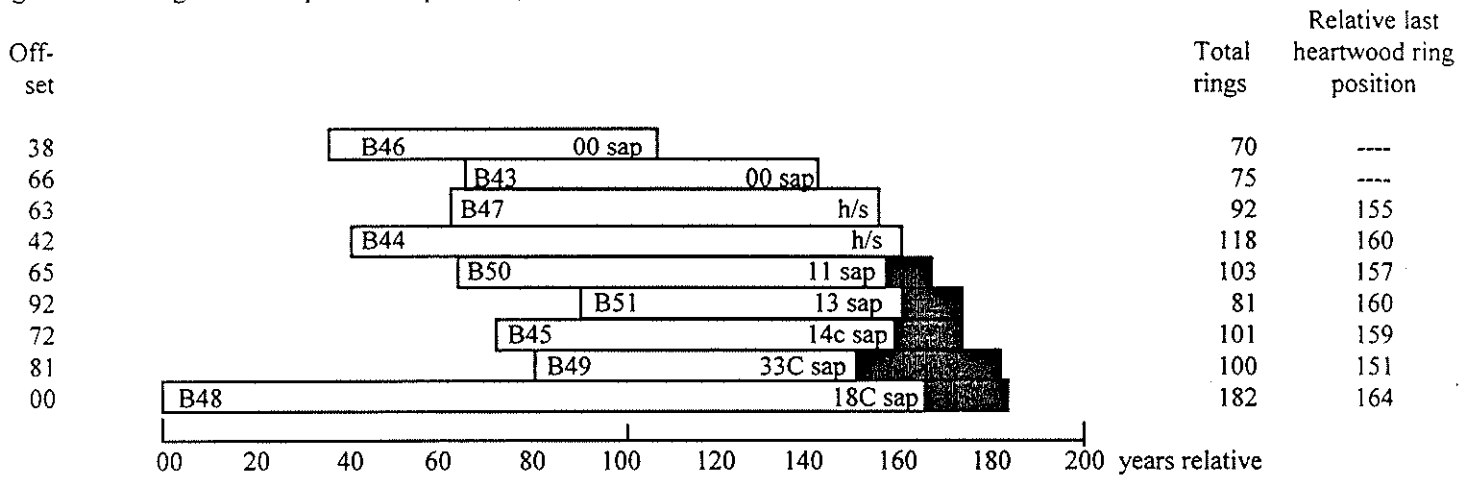
White bar = heartwood rings, shaded area = sapwood rings
c = complete sapwood on timber, all or part lost from sample
C = complete sapwood on sample, last measured ring date is felling date

Figure 5: Bar diagram of samples from "phase 4", bays 3 - 4



White bar = heartwood rings, shaded area = sapwood rings
h/s = only heartwood/sapwood boundary on sample
c = complete sapwood on timber, all or part lost from sample
C = complete sapwood on sample, last measured ring date is felling date

Figure 6: Bar diagram of samples from "phase 5", the Maverdine Lane facade



White bar = heartwood rings, shaded area = sapwood rings
h/s = only heartwood/sapwood boundary on sample
c = complete sapwood on timber, all or part lost from sample
C = complete sapwood on sample, last measured ring date is felling date

Figure 7: Map to show general area of Gloucester

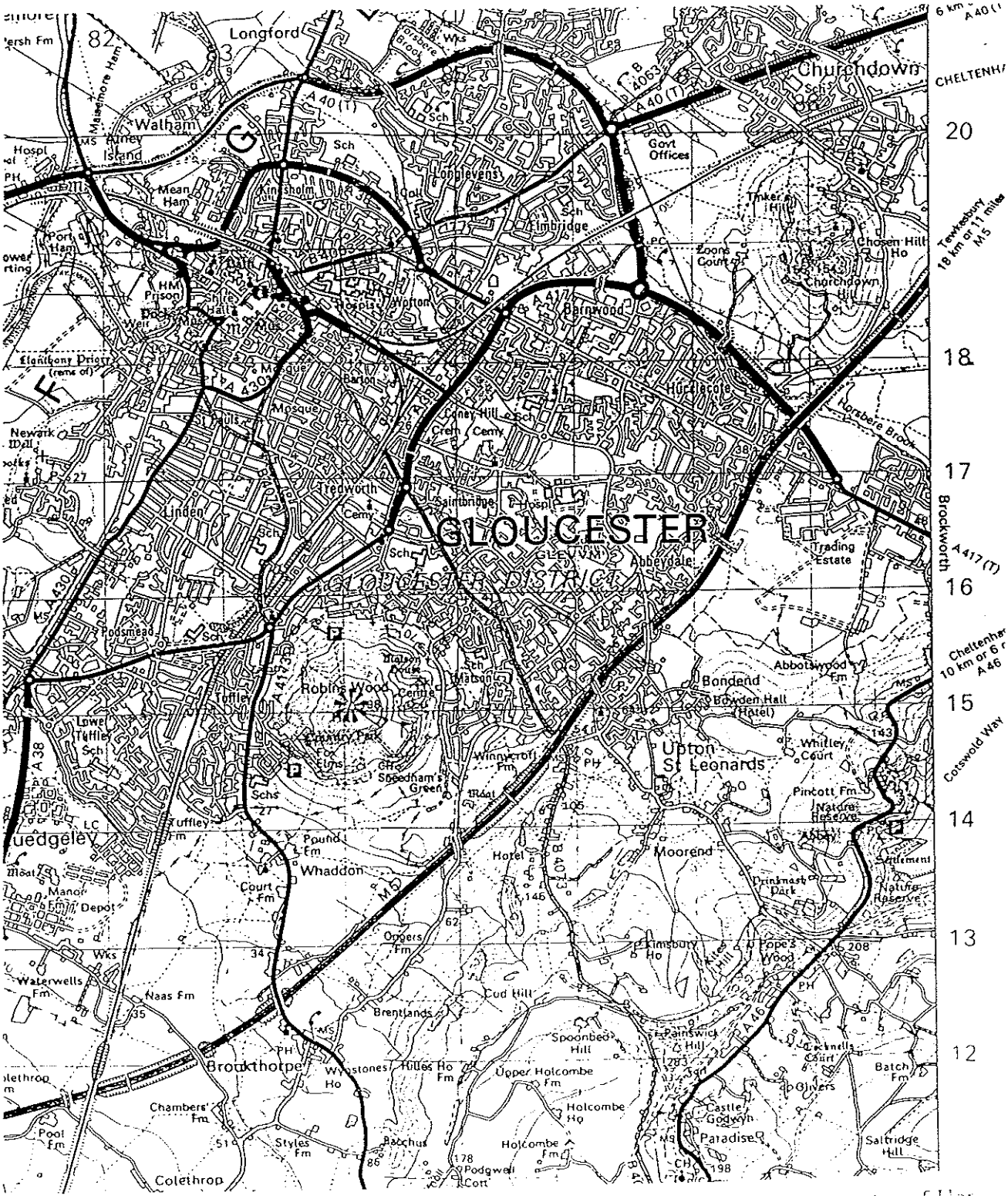


Figure 8: Street map of Gloucester to show location of 26 Westgate street

Figure 9: 26 Westgate Street, Gloucester – photograph to show current appearance of street frontage

Figure 10: 26 Westgate Street, Gloucester - copy of a pencil drawing attributed to J C Buckler showing former, south face, appearance of street frontage

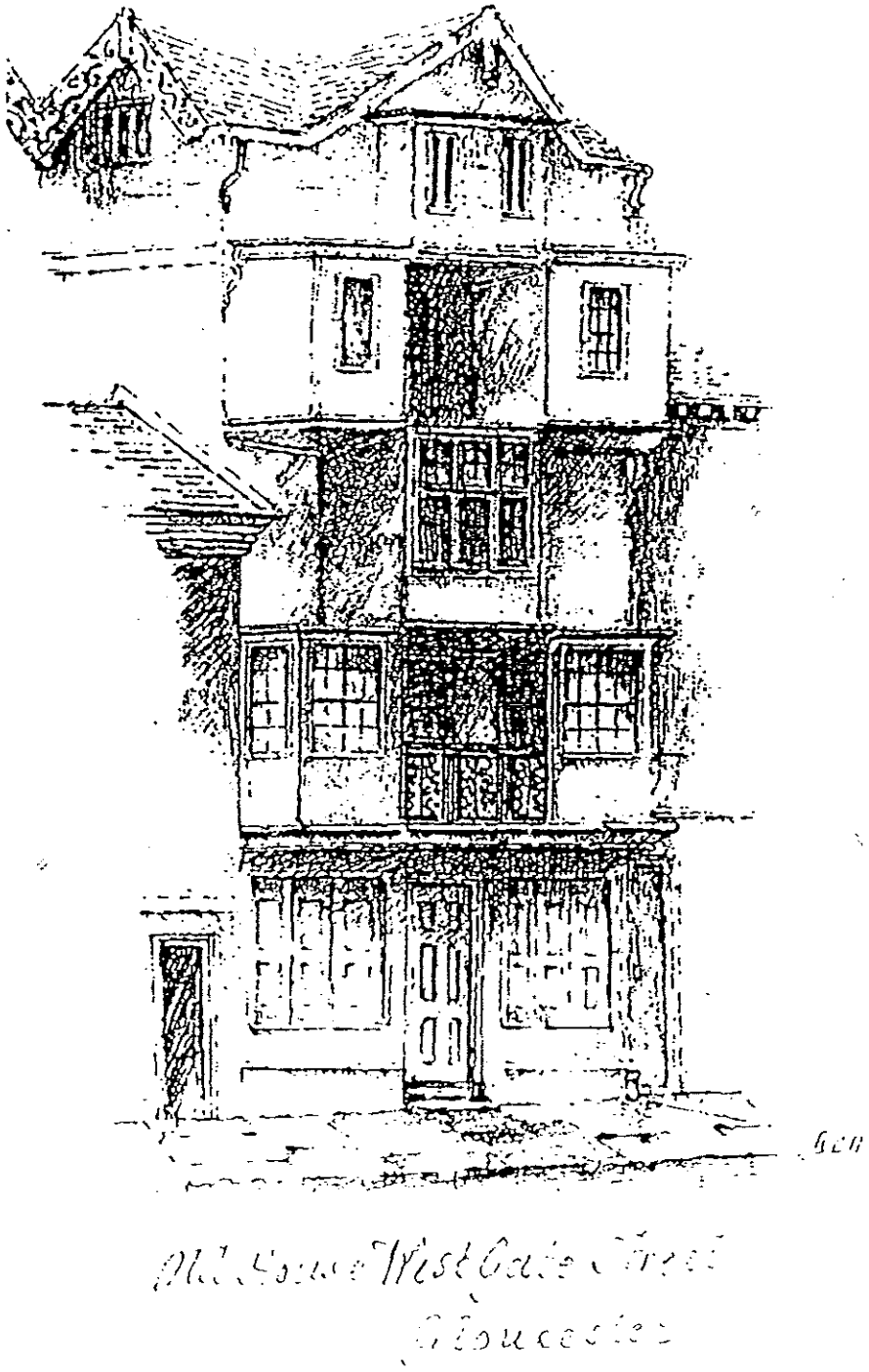


Figure 11: 26 Westgate Street, Gloucester - copy of a sketch showing the east side facing on to Maverdine Lane

"No 154 Westgate Street (Gloucester)
Sketch of Front facing passage..." by F. W. Waller, 1877.

Figure 12: 26 Westgate Street, Gloucester - schema of the building's development taken from Stephen Price's survey

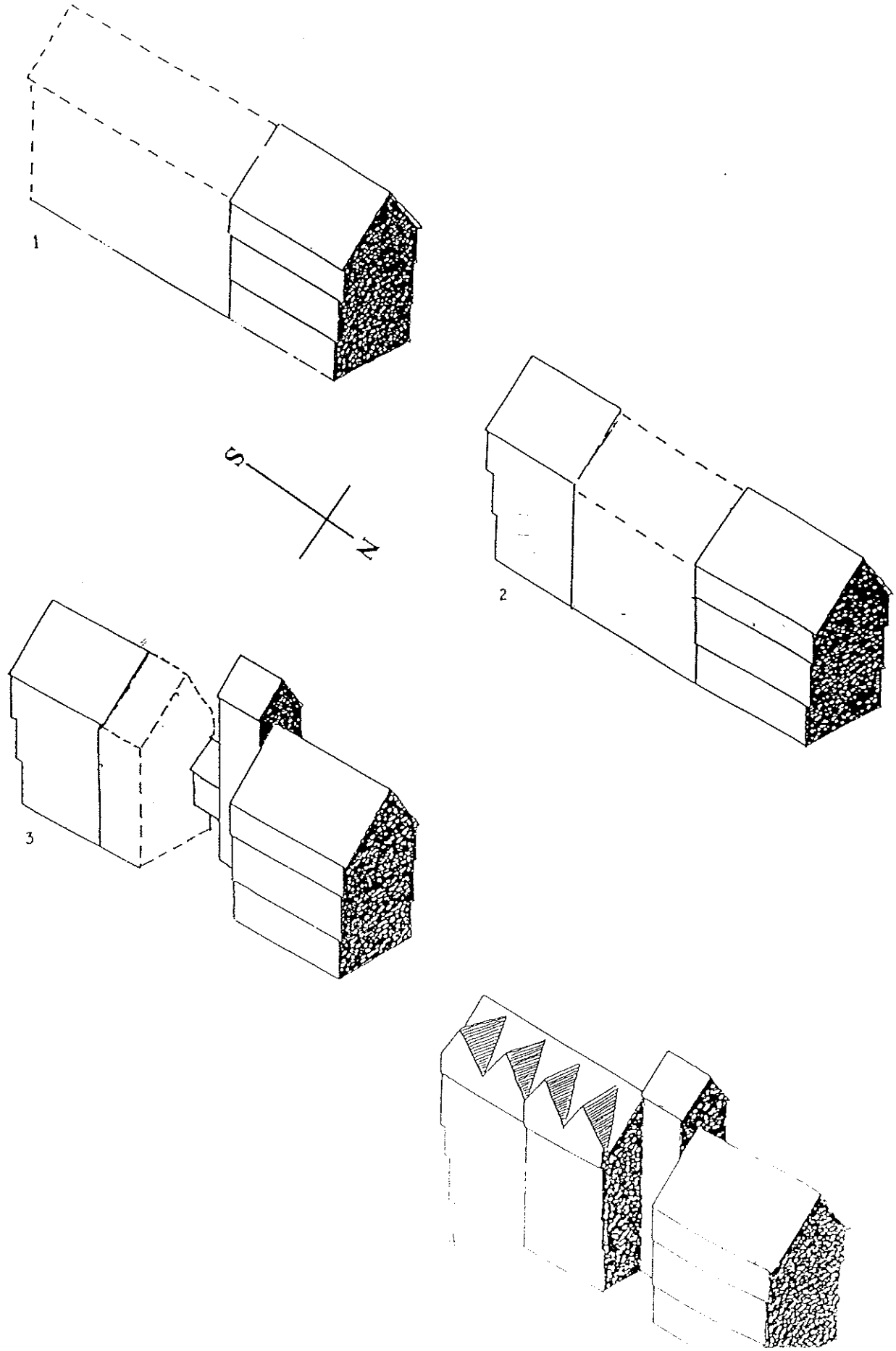


Figure 13: 26 Westgate Street, Gloucester - section along Maverdine Lane

Figure 14a: 26 Westgate Street, Gloucester - sketch diagram to show location of samples GLO-B01 -16 from first floor of bays 1-4 (Price's phase 2 and 4)

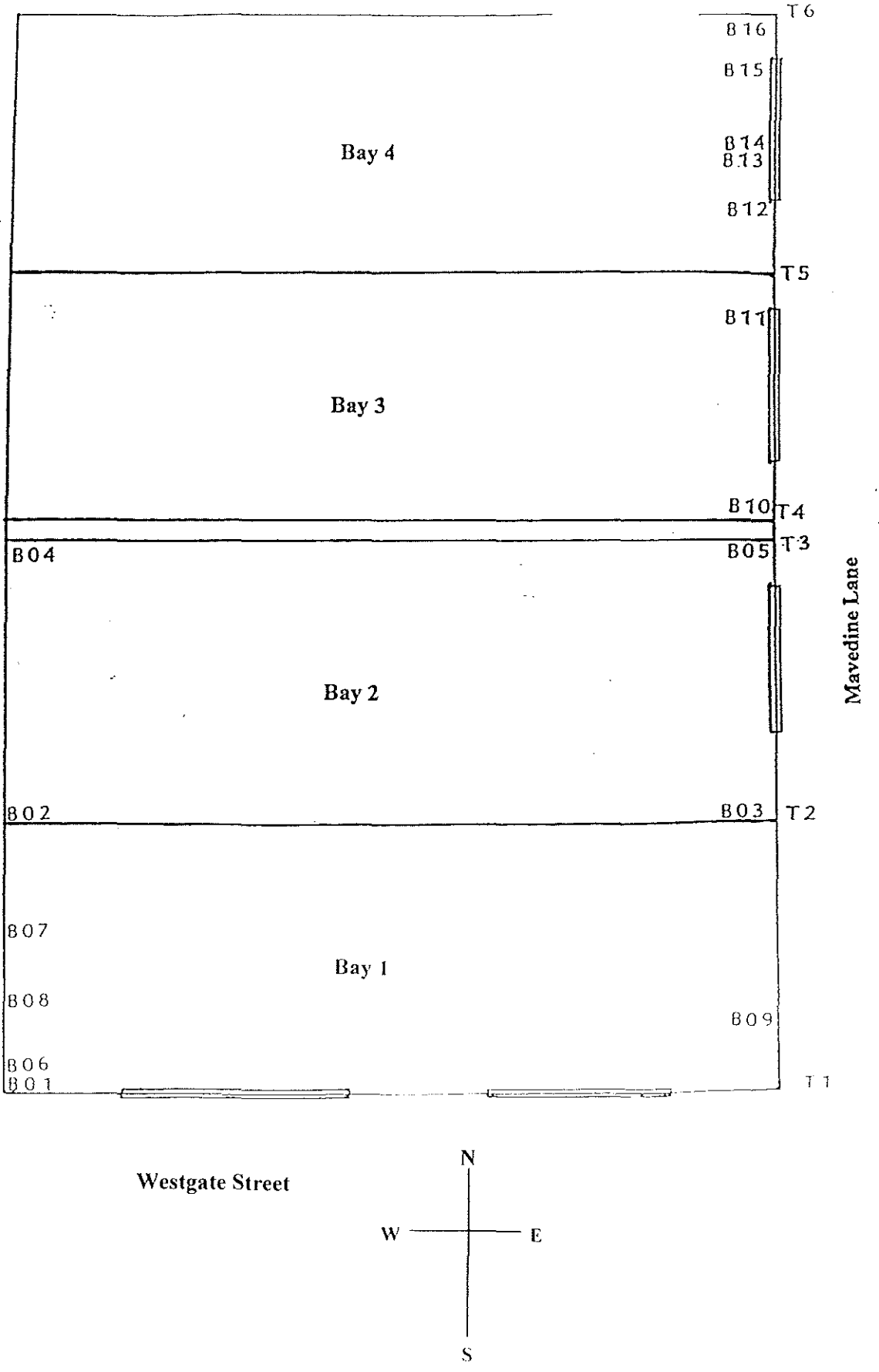


Figure 14b: 26 Westgate Street, Gloucester - sketch diagram to show location of samples GLO-B17-19 from second floor of bays 1-4 (Price's phase 2 and 4)

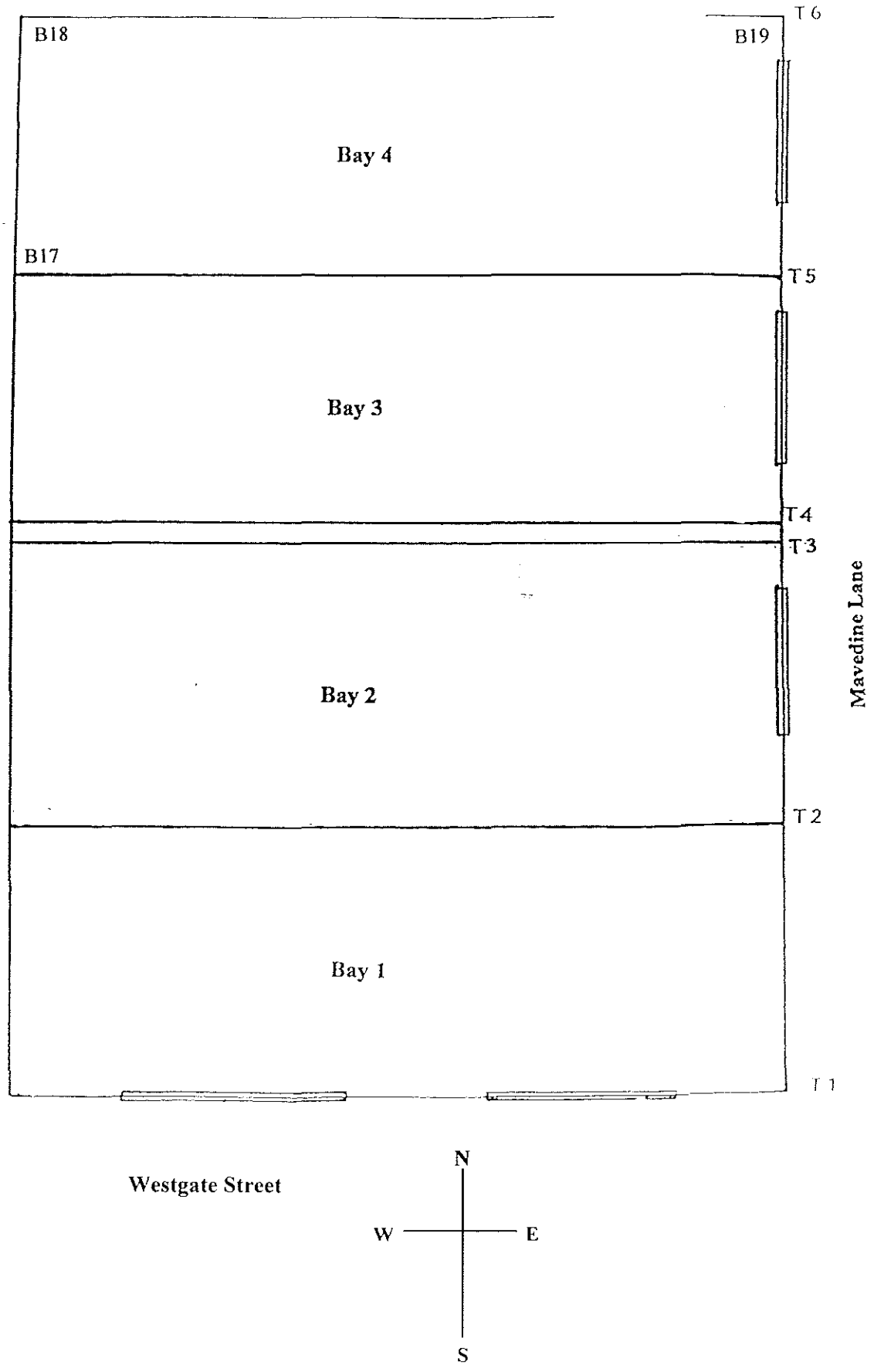


Figure 15: 26 Westgate Street, Gloucester - sketch plan to show location of samples GLO-B20-34 from roof of bays 6-8 (Price's phase 1)

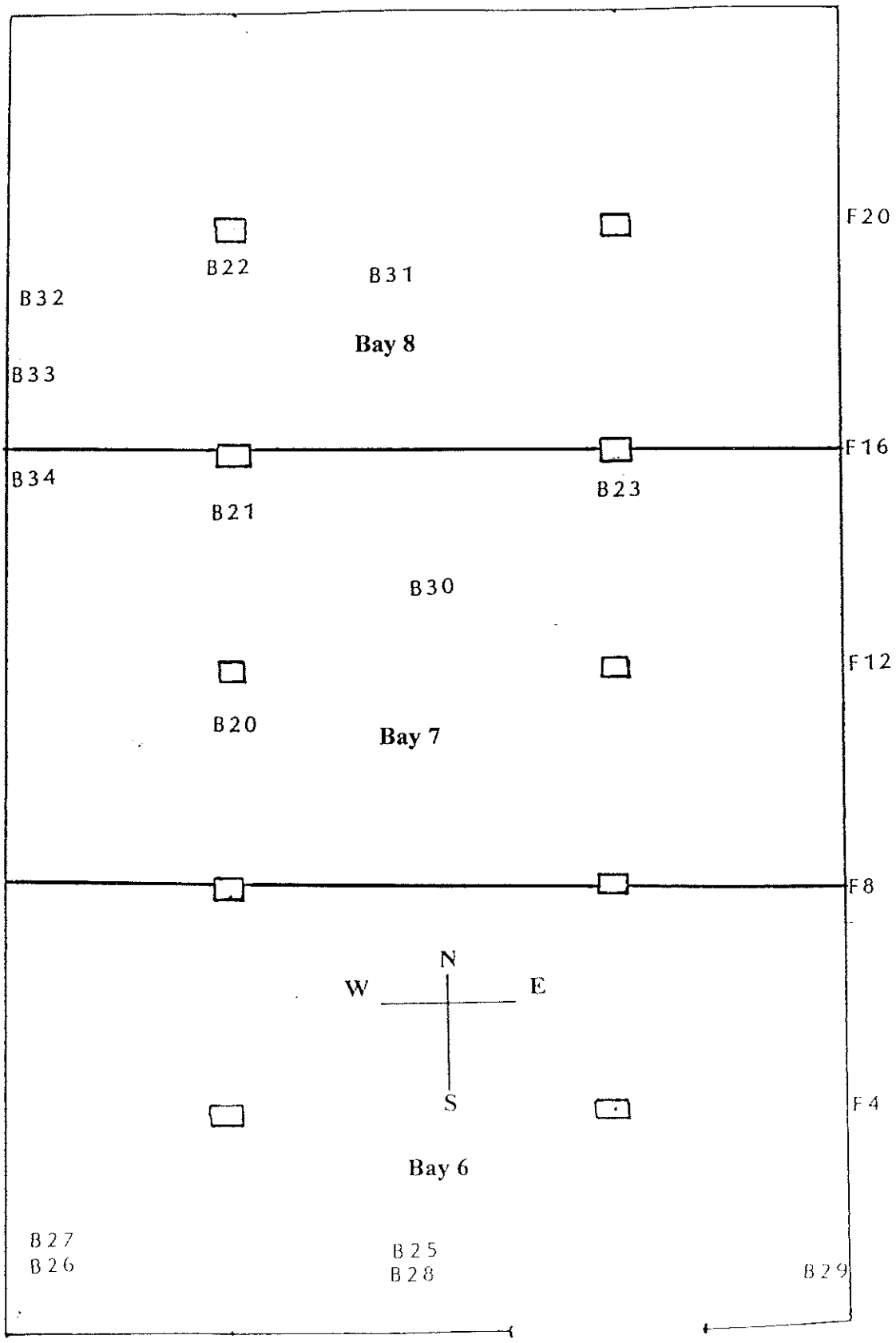


Figure 16: 26 Westgate Street, Gloucester - sketch plan to show location of samples GLO-B35-42 from the stair turret in bay 5 (Price's phase 3)

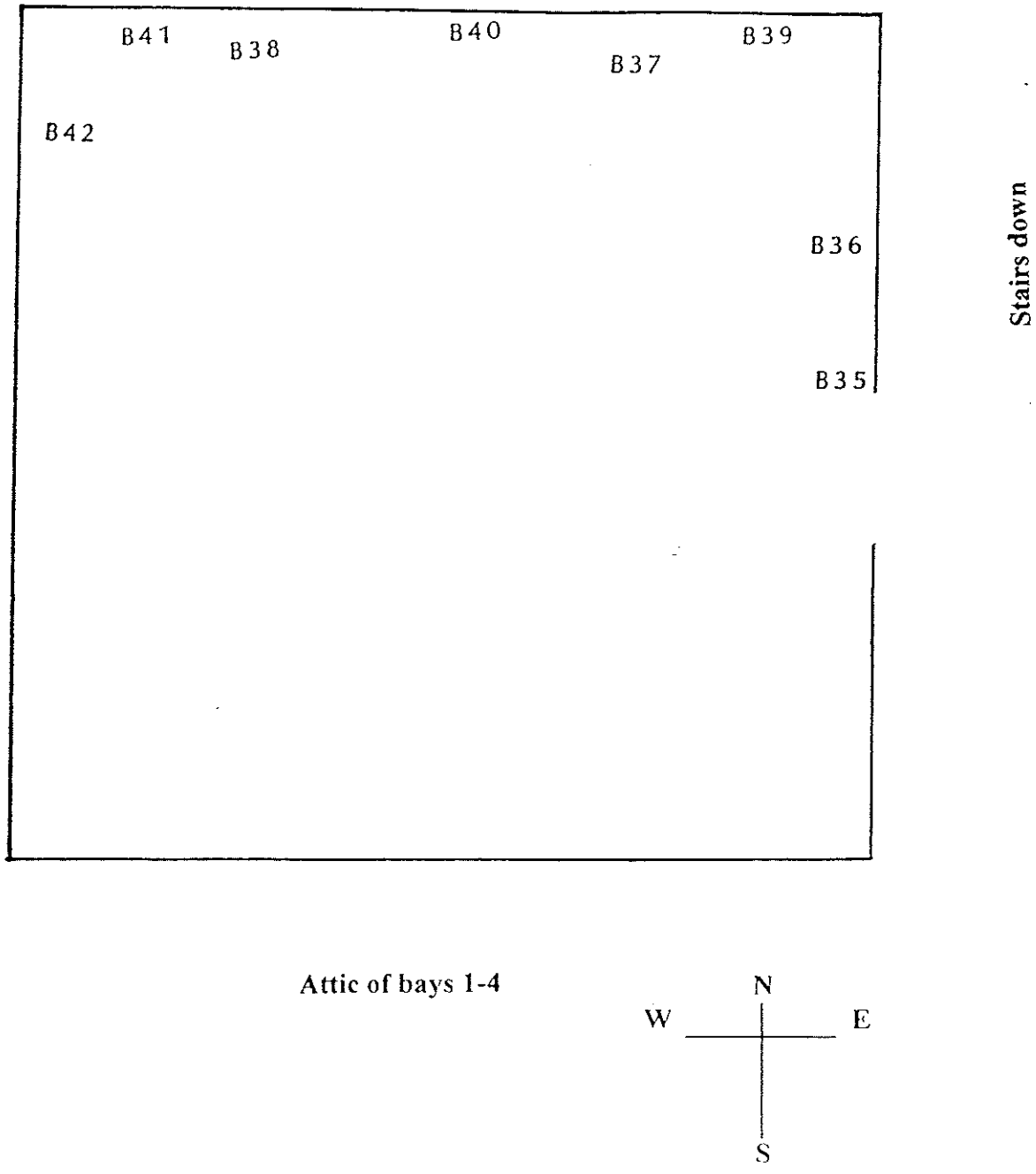
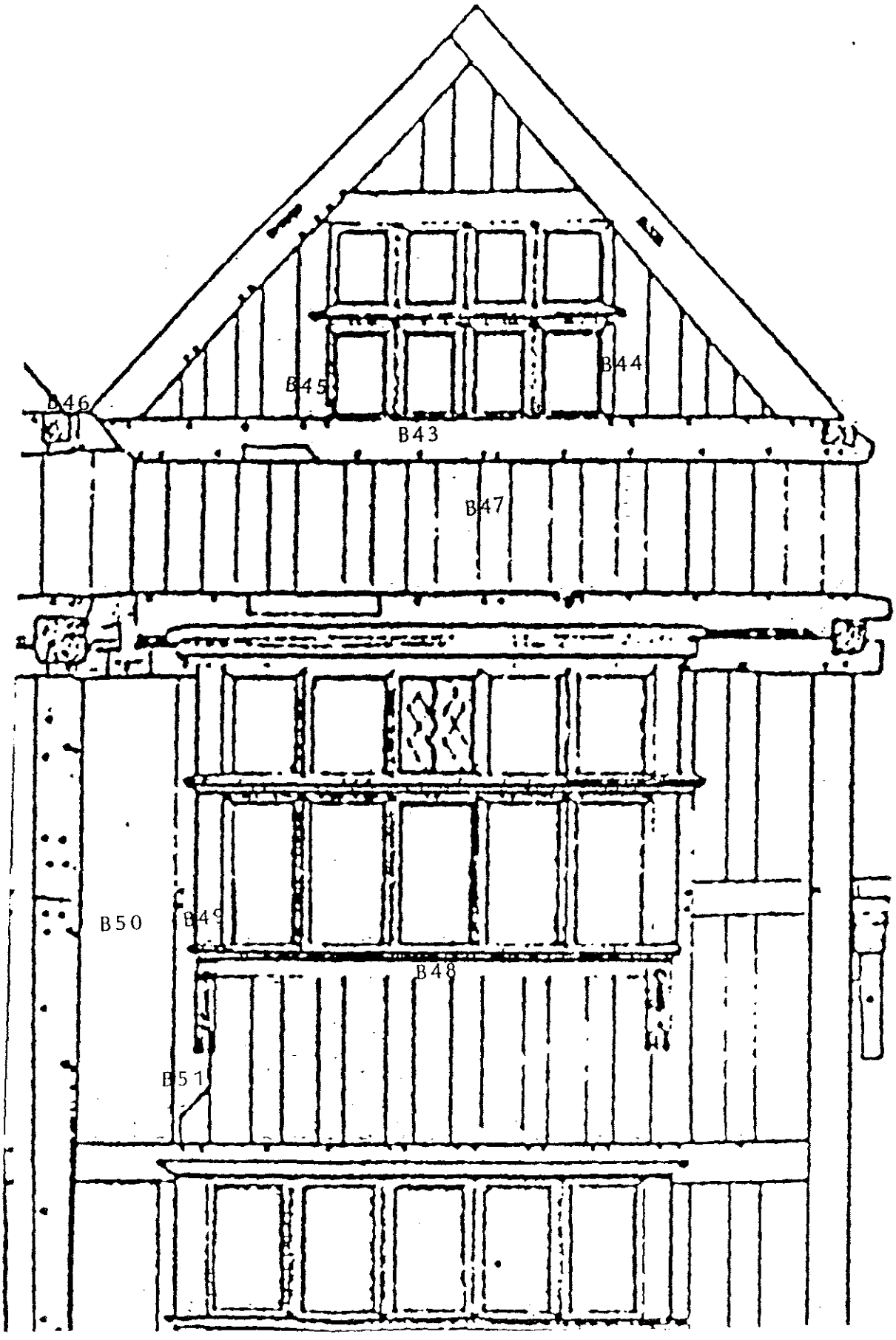


Figure 17: 26 Westgate Street, Gloucester - sketch plan to show location of samples GLO-B43-51 from the east facade along Maverdine Lane in bay 5 (Price's phase 5)



Data of measured samples - measurements in 0.0001 cm units

GLO-B01A 151
219 174 170 272 133 131 90 102 120 105 102 78 101 80 52 72 47 72 74 86
101 100 103 89 71 62 72 78 84 39 49 48 76 122 121 129 138 113 106 125
103 123 125 119 114 139 130 147 182 125 95 118 125 112 83 94 106 126 89 90
87 119 112 108 112 103 84 94 83 75 82 143 70 73 82 52 35 42 40 60
86 69 76 121 68 53 43 51 82 105 91 133 126 121 49 64 74 85 68 50
63 129 81 116 75 85 100 169 81 70 70 91 116 90 134 77 160 87 60 84
85 149 135 62 67 57 64 82 72 64 67 99 129 103 110 110 135 160 90 88
118 72 38 64 86 65 81 103 69 87 100
GLO-B01B 152
208 171 167 269 132 123 77 93 118 103 100 79 100 82 61 62 58 75 73 85
108 109 96 95 63 62 55 84 69 46 47 55 74 133 111 120 131 122 111 140
81 137 140 138 111 140 126 143 182 120 92 113 128 106 83 90 107 130 81 96
86 115 112 114 105 106 81 100 81 80 85 141 65 75 77 61 40 42 37 57
91 57 82 122 68 55 54 44 76 108 87 138 127 115 49 62 80 75 71 58
49 141 73 115 70 88 102 175 84 66 77 94 109 92 130 72 156 103 55 74
98 144 139 68 69 54 65 74 69 65 73 90 134 107 94 104 143 153 83 103
108 67 48 63 79 70 87 95 68 79 105 107
GLO-B02A 86
238 291 196 217 258 343 346 534 279 307 273 220 240 157 184 262 244 329 180 267
386 437 175 185 144 132 212 186 262 154 369 252 136 136 193 292 223 108 69 66
64 96 85 71 79 143 167 183 180 170 255 212 165 188 247 171 135 128 145 153
225 198 166 143 168 123 153 261 324 305 316 204 274 238 315 267 313 230 139 280
156 144 151 211 241 173
GLO-B02B 86
226 289 193 215 259 364 345 551 280 293 275 218 242 160 193 274 246 339 173 266
351 434 182 193 150 127 215 202 281 176 358 243 146 134 187 296 230 124 73 77
64 108 81 80 82 144 159 183 163 169 253 222 154 201 247 177 123 124 152 151
226 208 163 139 140 137 135 236 325 297 320 207 281 227 324 243 309 237 152 267
146 129 157 216 241 177
GLO-B03A 119
266 325 298 452 323 251 221 151 181 283 222 281 201 207 137 173 126 130 229 179
149 183 163 186 205 163 182 243 191 193 153 234 191 202 215 178 141 218 151 218
177 231 129 185 249 195 148 145 204 230 295 248 229 292 136 80 83 80 97 95
100 143 82 117 73 79 76 72 80 61 101 103 89 133 87 99 110 123 93 94
78 109 121 117 195 107 200 118 80 92 128 144 129 113 85 87 69 75 73 65
47 75 91 75 76 88 73 65 50 62 62 82 80 113 110 104 129 138 154
GLO-B03B 119
288 329 297 446 324 241 237 149 172 287 224 274 201 199 148 176 119 123 234 190
156 194 180 198 219 169 190 247 198 183 141 234 192 203 197 183 140 207 170 217
169 228 127 196 249 191 147 142 197 222 311 235 227 280 134 80 91 77 101 98
93 139 91 98 72 70 71 86 70 64 89 99 98 131 91 90 112 118 106 85
86 105 107 142 184 98 184 115 80 83 110 160 126 117 84 96 77 59 87 50
55 73 89 86 83 75 93 60 66 67 63 84 81 117 106 98 129 119 152
GLO-B04A 119
259 192 402 194 261 197 251 228 209 196 210 151 275 222 208 199 296 178 170 287
173 95 87 108 135 188 156 139 251 139 110 98 173 114 133 132 158 172 152 141
148 138 193 108 121 158 201 152 193 143 112 134 233 153 117 117 150 225 154 235
112 178 121 71 87 118 154 152 146 80 101 77 121 116 130 64 62 141 116 88
78 122 148 123 122 120 111 60 65 55 58 59 86 71 55 91 88 81 138 159
124 170 97 145 122 131 123 165 143 106 254 225 100 161 163 165 120 104 196
GLO-B04B 119
231 195 384 202 262 197 256 223 212 197 211 159 279 201 231 208 292 183 186 250
167 98 86 107 133 193 148 157 239 146 95 104 169 118 135 130 150 177 149 134
161 132 183 127 115 168 204 149 190 148 105 134 238 141 120 118 140 220 159 230
122 174 117 79 83 119 158 145 138 73 96 87 123 116 128 62 78 149 118 87
83 117 151 114 122 129 106 52 63 66 61 62 86 71 58 84 88 82 134 163
116 179 108 137 118 145 119 150 150 111 253 214 103 159 146 173 115 104 198

GLO-B06A 95
166 208 266 231 166 216 217 185 181 143 174 164 304 157 172 161 142 77 67 100
132 167 136 135 201 158 133 126 103 104 140 136 189 229 327 156 160 172 180 114
74 115 143 175 292 190 157 164 213 123 132 96 161 185 184 234 125 204 116 70
87 128 163 141 74 45 70 101 117 88 90 90 121 203 211 168 198 214 210 159
160 201 144 95 93 123 170 196 171 141 106 139 167 198 214
GLO-B06B 73
160 157 167 123 77 114 159 149 206 175 188 262 314 172 182 151 188 264 246 254
155 200 128 71 111 120 193 159 70 47 37 78 96 97 73 78 132 187 193 159
174 203 216 167 161 151 115 45 108 112 124 154 123 120 83 125 161 165 193 196
215 272 166 225 175 176 252 246 224 158 234 335 246
GLO-B06C 37
199 175 202 220 175 156 188 116 51 89 101 139 161 157 119 106 126 148 181 236
210 220 252 167 239 201 193 230 239 233 178 264 391 347 316 337 434
GLO-B07A 121
346 380 391 263 157 179 240 221 207 173 216 310 218 209 199 263 241 260 289 197
200 228 207 188 216 251 175 191 200 112 84 111 90 122 131 120 95 145 96 87
71 76 90 81 107 126 140 135 67 98 113 132 93 59 97 93 86 99 85 85
87 122 78 67 44 75 88 66 82 64 86 43 42 42 51 44 64 45 42 38
36 60 49 40 35 40 44 38 39 41 57 45 38 53 55 27 26 29 34 34
38 31 36 39 38 57 64 81 73 67 70 61 78 69 62 78 61 63 44 69
61
GLO-B07B 121
343 383 391 251 156 183 236 227 204 166 224 321 210 215 211 267 245 261 282 218
200 225 208 194 211 255 175 193 198 103 91 88 98 124 143 120 95 146 101 85
68 75 81 81 92 124 143 128 67 111 107 121 94 55 97 102 78 107 84 79
95 122 73 66 48 73 90 69 83 62 81 48 43 41 50 46 56 42 44 41
43 52 45 43 33 40 41 38 37 42 59 47 44 52 49 30 29 30 25 37
30 30 43 36 37 56 64 83 75 60 78 51 81 66 62 79 62 59 49 69
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193 296 278 279 151 142 208 202 201 302 164 189 206 202 136 149 158 168 238 223
236 175 230 123 109 119 144 181 154 116 59 83 57 76 63 47 46 56 68 82
73 75 113 101 92 128 148 140 67 69 72 63 88 77 81 56 77 79 115 110
130 123 141 91 210 172 168 129 160 148 123 103 69 81 66 98 68 58 91 129
GLO-B08B 100
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188 287 268 287 151 124 207 202 210 305 144 179 225 240 143 148 162 178 231 232
240 171 207 124 106 115 148 190 155 121 64 70 59 79 47 47 45 62 79 69
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129 120 125 96 213 165 175 127 158 144 143 104 74 67 68 96 80 55 80 134
GLO-B09A 125
378 183 228 296 360 160 210 229 199 150 86 166 179 206 138 94 114 125 125 119
96 120 88 94 47 74 82 58 55 89 87 61 49 112 115 139 191 115 91 109
106 83 44 137 131 106 98 77 128 78 63 53 135 116 102 85 115 115 122 112
151 120 96 95 101 144 174 146 241 195 173 159 214 155 89 128 175 188 185 175
106 128 82 78 89 88 116 132 93 55 132 166 222 170 218 97 144 222 170 176
157 175 275 160 125 123 108 57 271 267 208 181 202 168 143 158 178 159 145 154
144 224 116 188 156
GLO-B09B 125
420 184 233 298 363 173 198 213 191 158 85 180 168 213 137 96 122 123 110 117
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106 78 51 138 118 114 92 85 119 81 62 58 145 97 110 72 116 109 125 103
161 126 97 91 96 149 175 157 232 195 185 155 218 144 92 135 180 184 182 178
98 135 79 73 69 105 108 131 88 61 131 174 219 172 195 104 146 216 166 159
165 183 254 163 121 113 108 52 269 302 181 167 209 172 141 170 179 162 151 161
163 221 127 186 164
GLO-B10A 61
299 261 233 309 263 254 249 236 155 123 310 136 256 280 245 342 288 268 175 161
133 190 243 133 162 120 177 160 173 156 142 105 88 85 125 95 115 117 126 107

146 117 148 152 168 133 153 149 129 162 126 125 208 167 135 98 145 124 123 137
139
GLO-B10B 61
287 256 233 314 260 266 256 233 158 122 325 123 247 289 238 347 276 258 187 155
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143 118 147 156 167 139 148 153 139 150 128 121 208 167 128 105 148 124 133 122
165
GLO-B11A 88
292 266 341 189 191 236 203 265 243 196 240 285 328 314 298 293 220 170 173 211
275 224 266 180 204 246 334 174 221 231 192 260 249 264 161 252 192 127 105 160
173 170 136 98 90 92 107 143 145 119 156 205 180 173 181 236 275 200 207 215
153 125 103 132 157 217 190 190 135 155 161 166 184 210 184 184 151 212 188 289
200 199 202 148 227 175 196 198
GLO-B11B 88
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174 183 138 89 88 93 114 143 150 123 153 205 170 167 189 230 276 206 206 208
153 117 94 137 141 230 194 192 150 141 166 163 183 225 187 188 144 206 186 233
247 216 198 157 224 169 201 199
GLO-B12A 75
366 384 429 320 324 316 269 203 148 195 210 177 243 159 144 195 273 166 165 151
196 306 365 346 211 308 202 127 106 116 164 162 107 128 109 170 223 223 216 126
176 396 333 384 336 353 359 225 291 383 206 139 164 139 222 384 374 338 290 325
305 242 280 337 320 247 174 295 326 444 540 360 274 162 159
GLO-B12B 75
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128 113 108 92 99 178 158 156 176 231 229 173 288 289 152 117 134 169 126 172
153 161 119 197 175 166 243 297 208 196 159 270 211 301 313 246 256 180 292 274
191 288
GLO-B13B 82
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165 155 139 175 181 170 234 308 194 194 146 263 250 282 269 265 257 156 274 242
202 247
GLO-B14A 173
313 157 203 273 197 243 229 207 211 214 283 126 172 209 202 260 213 248 188 222
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97 123 86 76 55 72 93 143 172 158 238 164 131 111 129 112 123 111 142 163
139 154 137 168 216 98 106 129 120 110 142 108 90 105 142 91 87 92 86 94
83 100 71 143 92 88 78 81 144 97 147 54 54 49 45 39 56 35 47 57
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GLO-B14B 173
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71 62 49 55 69 66 58 63 66 81 74 97 89 90 103 94 63 70 114 74
84 127 93 69 55 73 93 139 181 154 234 156 131 113 128 113 120 115 144 157
141 153 152 160 221 99 103 128 125 111 148 102 91 100 146 91 84 89 88 88
87 104 68 139 92 82 78 83 138 105 144 55 58 50 44 45 47 44 38 58
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100 158 151 171 94 177 155 201 206 226 223 152 230

GLO-B15A 50
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218 234 168 186 179 186 177 154 183 250
GLO-B15B 50
177 269 326 237 186 194 228 295 305 365 210 379 274 160 131 167 238 197 157 106
162 207 206 180 191 157 209 335 311 251 230 341 338 290 298 375 137 93 132 225
211 219 176 177 170 182 186 139 209 251
GLO-B16A 120
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158 202 176 154 152 118 146 136 157 109 137 92 114 134 108 155 122 139 123 112
144 98 123 131 139 126 114 169 154 113 113 97 144 133 98 100 120 112 144 120
129 115 107 176 122 86 121 130 94 94 104 100 99 122 89 85 92 96 88 92
86 76 83 84 66 81 102 96 92 107 88 101 92 88 54 113 160 114 101 122
122 101 79 88 125 137 144 119 159 142 114 114 121 108 135 120 117 120 134 114
GLO-B16B 120
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169 193 172 155 153 110 147 132 148 131 146 80 111 134 109 149 123 145 119 107
135 99 126 130 136 131 115 168 148 110 116 92 145 129 94 95 113 115 147 117
135 110 113 165 111 93 114 135 88 96 97 105 92 125 90 89 89 97 79 71
78 82 76 88 66 80 110 88 98 111 81 107 82 93 71 97 170 118 98 124
121 94 77 89 124 142 135 114 159 145 127 110 104 114 127 117 115 126 117 142
GLO-B17A 87
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242 188 173 165 146 254 215 245 208 256 357 313 194 175 143 204 263 255 289 198
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344 359 230 282 254 231 180 203 222 222 417 289 225 223 109 185 145 208 212 182
218 160 235 206 170 203 213
GLO-B17B 54
396 373 263 421 265 196 189 245 315 298 141 92 95 127 204 115 107 151 198 345
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254 289 283 313 222 263 236 172 200 184 211 148 264 193
GLO-B18A 59
761 450 378 224 234 293 255 254 299 394 454 287 301 385 327 287 279 303 438 283
363 459 480 505 480 348 274 223 302 302 328 375 285 336 195 141 155 153 221 222
83 64 57 78 128 90 80 70 107 123 112 94 118 168 198 189 149 240 265
GLO-B18B 59
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373 459 478 508 478 342 275 221 313 299 320 391 285 340 187 147 143 156 236 223
74 64 54 73 135 81 75 64 100 128 109 103 110 162 221 186 144 234 265
GLO-B19A 75
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110 110 135 131 126 99 54 39 40 39 62 42 71 121 115 96 110 127 145 117
96 120 166 84 58 64 75 152 152 175 138 143 122 113 137
GLO-B19B 46
208 328 274 245 389 299 237 180 158 141 170 162 290 270 254 165 225 234 235 160
125 162 179 158 178 141 123 143 220 124 122 111 137 182 150 171 103 206 131 79
108 98 148 137 126 104
GLO-B19C 27
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162 170 145 140 128 102 151
GLO-B05A 102
389 262 178 141 98 176 333 256 207 452 228 178 178 228 223 223 256 257 260 416
270 245 328 263 200 204 209 353 196 312 178 186 248 459 156 157 230 209 371 240
322 159 358 208 115 73 81 309 160 263 134 72 60 84 64 51 48 74 124 98
109 85 149 198 137 196 221 295 140 119 75 62 134 91 106 84 82 85 88 129
163 118 109 75 191 158 155 151 143 152 113 232 176 159 58 54 59 28 27 40
46 86
GLO-B05B 102
387 261 174 139 114 179 329 248 211 450 223 168 179 233 212 234 252 276 257 416

GLO-B20A 146
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122 93 104 116 115 117 125 129 106 100 106 89 115 97 96 121 88 87 110 107
93 122 103 107 105 110 76 88 110 107 112 116 110 80 70 99 101 87 105 87
93 128 90 88 70 75 80 99 96 105 102 83 93 100 99 103 85 102 90 124
107 96 104 95 112 86 87 92 94 75 100 84 93 75 97 99 96 71 132 115
106 103 75 107 98 127
GLO-B20B 146
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124 86 89 124 114 117 123 120 100 110 107 86 118 90 85 117 71 111 110 107
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99 121 80 94 62 80 81 109 92 103 90 96 99 107 118 92 97 121 85 117
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77 82 76 64 103 90 88 103 57 60 58 53 67 66 36 58 43 47 45 46
56 73 56 77 52 44 40 51 47 60 89 60 63 77 71 58 44 50 76 83
60 91 79 62 65 69 92 81 63 73 83 80 79 51 58 42 59 57 59 39
85 80 116 107 80 83 125 65 73 78 91
GLO-B24A 85
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153 129 216 97 74 60 107 125 139 103 119 221 262 168 184 299 472 282 255 282
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163 204 155 144 176

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105 78 150 202 130 200 210 288 137 128 71 69 116 97 111 85 92 89 89 133
189 110 100 87 171 159 170 154 143 150 117 233 178 157 44 62 54 30 44 42
45 78
GLO-B25A 86
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108 125 129 191 94 144 142 140 102 97 85 91 122 111 111 137 98 91 95 75
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53 77 63 59 51 70
GLO-B25B 86
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59 70 58 65 49 100
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292 173 135 146 151 150 234 196 106 98 77 61 69 81 95 119 121 121 114 156
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147 155 120 117 170
GLO-B26B 85
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170 143 167 155 160 169 148 162 197 250 160 196 251 162 115 83 104 117 130 143
137 176 143 123 82 103 92 112 94 133 126 106 100 133 111 164 104 108 97 136
141 155 120 124 147
GLO-B27A 115
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88 52 70 64 63 76 84 93 59 72 84 70 61 52 52 64 57 67 51 112
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104 53 50 44 51 47 42 63 89 90 56 80 210 124 95
GLO-B27B 115
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90 76 34 48 45 43 40 66 102 78 60 76 202 121 122
GLO-B28A 100
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103 84 82 67 76 88 85 84 75 77 67 67 63 74 74 53 77 68 81 68
69 60 57 87 69 61 73 76 67 78 63 64 64 72 54 63 87 68 76 92
GLO-B28B 118
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