

RESEARCH REPORT SERIES no. 60-2013

# NAPPA HALL, ASKRIGG, NORTH YORKSHIRE TREE-RING ANALYSIS OF TIMBERS

## SCIENTIFIC DATING REPORT

Alison Arnold and Robert Howard



INTERVENTION  
AND ANALYSIS



ENGLISH HERITAGE

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ASKRIGG  
NORTH YORKSHIRE

TREE-RING ANALYSIS OF TIMBERS

Alison Arnold and Robert Howard

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## **SUMMARY**

Analysis undertaken on samples from several areas at Nappa Hall resulted in the construction of three site sequences, two of which are dated. Site sequence NAPBSQ01 contains 67 samples and spans the period AD 1300–1476 and site sequence NAPBSQ02 contains three samples and spans the period AD 1478–1570.

The earliest timbers with precise felling dates are those of the roof over the old kitchen in the Service range, dated to AD 1461 and AD 1462, along with a single timber from the ground-floor ceiling of the Low-end tower dated to AD 1465. In the High-end tower there are a series of timbers felled in AD 1471 and 1472 (ground-floor ceiling) and AD 1476 (turret roof), whilst those from the Hall-range roof were felled in AD 1474. The East wing, Woodshed, and Stable/Coach-house range also contain timbers felled in the AD 1460s and AD 1470s, although in some instances, notably the roofs over the Woodshed and part of the Stable range, are reused in their current locations. The latest timbers, dating to the latter part of the sixteenth century, are from the Tack room ground-floor ceiling and roof in the service range.

## **CONTRIBUTORS**

Alison Arnold and Robert Howard

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## INTRODUCTION

Nappa Hall is a Grade I listed late-medieval manor house located on the north side of the River Ure (Figs 1–3). The complex consists of three ranges around a terraced courtyard (Fig 4). It is thought to have been built around AD 1459 for the Metcalfe family who retained possession until the early nineteenth century and then later regained ownership in the early twentieth century. It is believed to be the most important medieval manor house in northern England and is currently on the Heritage at Risk register.

### North range

This range consists of a central Hall, flanked by a four-storey (solar) tower to its west (High-end tower), a two-storey tower to the east (Low-end tower), and Porch (Fig 5). This range is thought to date to the mid/late-fifteenth century although whether it was constructed as a single phase of work or over a number of years is unclear.

### Hall

The roof over the Hall is of three crown-post trusses, each one consisting of principal rafters, tiebeams, collars, and crown posts (Fig 6). Between the trusses are common rafters and purlins. Purlins in bay 1 are moulded. At the east end of the Hall at ground-floor level is a beam which is thought possibly to be part of a screens passage.

### High-end tower

Ground- and first-floor ceiling structures comprise three large, moulded main beams with common joists between, some of which have been replaced with modern joists; some of the floor boards also survive. The main joists of the second-floor ceiling are loose and lain on the floor below (Fig 7); none of the common joists from this level remain. In the north wall at second-floor level is a garderobe. The roof over this part of the building is a twentieth-century replacement.

In the south-east corner of the High-end tower is a doorway to the spiral stair of the turret, the roof of which consists of three trusses of rafters and tiebeams (Fig 8). This may potentially be a sixteenth-century alteration.

### Low-end tower

The exposed ground-floor ceiling of this part of the building consists of a large main beam with common joists, some of which show signs of reuse and potential smoke-blackening (Fig 9).

## Porch

Coming off the east end of the Hall is a single-storey porch, the roof of which is of a similar form to that of the Turret, ie a low-pitched roof with three trusses of tiebeams, common rafters, a ridgebeam, and purlins (east one missing) (Fig 10). Again, it is unclear as to whether this is mid/late-fifteenth century or a sixteenth-century alteration.

## Woodshed

At the west end of the High end tower is a single-storey extension used to store wood. This building is divided into three areas by stone walls which support a ridgepiece and two sets of purlins, between which are common rafters (Fig 11). This building is likely to be a later addition although some of the roof timbers look more ancient and are possibly reused.

## Service range

To the east of the North range is the Service range; this consists of a combination of buildings, domestic and agricultural in character, and may incorporate part of the medieval kitchens (Fig 12). This range may also have its origins in the fifteenth century and could be slightly earlier than the North range but reworked and extended at a later date.

## Kitchen

The part of this range adjacent to the Low end tower is thought to be the old Kitchen. In its south wall survives the bresummer of the ground-floor smokehood (Fig 13). The roof over the Kitchen consists of principal rafters, tiebeams, purlins, and common rafters. The tiebeams have been cut through at some point and are supported by posts which can be seen to be moulded (Fig 14).

## Tack room

To the south of the kitchen is the Dairy or Tack room. The exposed ground-floor ceiling consists of two main beams with common joists between, some of which show signs of previous use (Fig 15). The roof structure over this room has two principal-rafter trusses with tiebeams, between these are purlins and ridgepiece (Fig 16); there are some signs of reuse amongst some of the timbers here also. It has been suggested that this room might be eighteenth century in date.

To the south of the Tack room is a cow byre with a modern, softwood roof.



## East wing

To the rear of the Kitchen is an extension (Fig 17) with a late nineteenth- /early twentieth-century roof. On the ground floor are some exposed ceiling beams (Fig 18).

## Stable/Coach-house range

### Barn

To the west-side of the courtyard is a long, seemingly single-phase building (Fig 19), thought to have been added in the early nineteenth century when Nappa Hall was used as a hunting lodge by the de Grey family. Possibly a one time barn it is currently used as stables, garage, and store.

The ground-floor ceiling is almost entirely constructed of late nineteenth- /early twentieth-century pine. The roof has nine trusses, again thought to be late-nineteenth/early twentieth century, of principal rafters and tiebeams (Fig 20). A large number of the purlins appear to be reused with some being moulded and/or chamfered; some common rafters also display signs of previous use in the form of empty mortices (Fig 21).

## SAMPLING

A dendrochronological survey was requested by Lucy Jessop, English Heritage, as part of a rapid survey ahead of plans to repair, consolidate, and render the complex habitable. It was hoped to obtain independent dating evidence for the development of the various ranges, adding to the overall understanding of the building, and thus helping to inform decisions relating to its future restoration, conservation, management, and use.

A total of 110 timbers from various areas of the building was sampled by coring. Each sample was given the code NAP-B and numbered 1–110. The location of *in situ* samples was noted at the time of sampling and has been marked on Figures 22–32. Further details relating to the samples can be found in Table 1.

## ANALYSIS AND RESULTS

Sixteen samples, ten from the North range (Hall, High end tower, Porch, and Woodshed), five from the Service range (Kitchen and Tack room), and one from the East wing had too few rings for secure dating and so were discarded prior to measurement. The remaining 94 samples were prepared by sanding and polishing and their growth-ring widths measured; the data of these measurements are given at the end of the report. All samples were then compared with each other by the Litton/Zainodin grouping programme (see Appendix), resulting in 73 samples matching to form three groups.

Firstly, 67 samples, from all areas matched each other and were combined at the relevant offset positions to form NAPBSQ01, a site sequence of 177 rings (Fig 33). This site sequence was compared against a series of relevant reference chronologies for oak where it was found to span the period AD 1300–1476. The evidence for this dating is given in Table 2.

Three samples from the tack room roof and ceiling grouped to form NAPBSQ02, a site sequence of 93 rings (Fig 34). This was dated to spanning the period AD 1478–1570 (Table 3).

Finally, three samples from the tack room roof matched each other and were combined to form NAPBSQ03, a site sequence of 87 rings (Fig 35). Attempts to date this site sequence and the remaining 21 ungrouped samples were unsuccessful and all remain undated.

## INTERPRETATION

Tree-ring analysis has resulted in the successful dating of 70 timbers from all areas targeted, following assessment of dendrochronological potential for sampling. To aid interpretation each area is dealt with separately below and illustrated in Figure 36. Felling date ranges have been calculated using the estimate that mature oak trees in this region have 15–40 sapwood rings.

### Service range

#### Kitchen

Twelve of the samples taken from the roof over this part of the building have been dated, three of which have complete sapwood. Samples NAP-B54 and NAP-B55 have the last-measured ring date of AD 1461, the felling date of the two timbers represented whilst sample NAP-B58, has the last-measured ring date of AD 1462, the felling date of the timber it represents. Seven further dated samples have the heartwood/sapwood boundary ring which in all cases is broadly contemporary and suggestive of a single felling. The average heartwood/sapwood boundary ring date is AD 1439, which allowing for sample NAP-B59 having a last-measured ring date of AD 1460 with incomplete sapwood, gives an estimated felling date within the range AD 1461–79, consistent with these timbers also having been felled in AD 1461 or AD 1462. The two samples without the heartwood/sapwood boundary have last-measured ring dates of AD 1419 and AD 1434, which again mean it is possible that these two timbers were also felled with the rest of the timber. The potential same-tree derivation for the timbers represented by samples NAP-B52 and NAP-B53 (one of the two samples without heartwood/sapwood boundary) combined with the overall level of cross-matching supports the likelihood of all of these timbers being felled in, or around, AD 1461–2.

## Tack room

Five samples taken from the Tack room have been dated, three from the ground-floor ceiling, one from a stair runner, and one from the roof. The stair runner (NAP-B66) and a common joist (NAP-B65) were identified at the time of sampling as being reused. Four of the dated samples have the heartwood/sapwood boundary ring which suggests at least two separate fellings are represented amongst these timbers. The stair runner has the heartwood/sapwood boundary ring date of AD 1456, giving an estimated felling date within the range AD 1471–96. The two main ceiling beams and the principal rafter have similar heartwood/sapwood ring dates, the average of which is AD 1555, giving an estimated felling date for the three timbers represented within the range of AD 1570–95. The final dated sample, taken from the reused common joist has the last-measured heartwood ring date of AD 1410, giving a *terminus post quem* for felling of AD 1425.

## North range

### Low-end tower

Only one sample, taken from a common joist has been successfully dated. This sample has complete sapwood and the last-measured ring date of AD 1465, the felling date of the timber represented.

### High-end tower

Fourteen of the timbers of the ground-, first- and second-floor ceiling frames have been dated. The overall level of cross-matching within this group of ceiling timbers, including at least one potential same-tree match between timbers from different ceilings, again suggests that this is likely to be a coherent group. One of these samples, NAP-B19, has complete sapwood and a last-measured ring date of AD 1471, the felling date of the timber represented. A second sample, NAP-B21, also has complete sapwood with a last-measured ring date a year later giving the timber represented a felling date of AD 1472. Eleven further samples have the heartwood/sapwood boundary which although displaying some variation are broadly contemporary and consistent with a single felling. The average heartwood/sapwood boundary ring date is AD 1444, allowing an estimated felling date range to be calculated for the 11 timbers represented within the range AD 1467–84, consistent with these timbers also having been felled in AD 1471 or 1472. This makes allowance for sample NAP-B22 having the last-measured ring date of AD 1466 with incomplete sapwood. Although treated as being of the same felling as the rest of the timber it should be noted that the heartwood/sapwood boundary ring dates of samples NAP-B26 and NAP-B27 are noticeably earlier than the rest of the timber. The two timbers represented are potentially from the same tree (matching each other at the high value of  $t=13.2$ ) and it could be that these two simply represent a single tree with more

than the average number of sapwood rings (to be felled in AD 1471 sample NAP-B27 would have to have 51 sapwood rings, which is certainly not unknown), or alternatively that they do have an earlier felling date and were left over from the AD 1460s works.

## Hall

Fourteen of the timbers taken from the Hall have been dated, 13 from the roof and one from a lintel over the door between the hall and Low-end tower.

One of the roof samples, NAP-B11, has complete sapwood and a last-measured ring date of AD 1474, the felling date of the timber represented. Nine other roof samples have the heartwood/sapwood boundary ring, which in all cases are broadly contemporary. The average heartwood/sapwood boundary ring date is AD 1449, calculating to an estimated felling date range of AD 1472–89, consistent with an AD 1474 felling. This felling date range allows for sample NAP-B01 having the last-measured ring date of AD 1471 with incomplete sapwood. The other three dated roof samples do not have the heartwood/sapwood boundary ring date and so estimated felling date ranges cannot be calculated for the timbers represented, except to say that with last-measured heartwood ring dates in the first half of the fifteenth century it is possible that these timbers were also felled in AD 1474. The overall level of cross-matching between the individual ring sequences within this group of timbers does however suggest that they are likely to be a coherent group and hence all were probably felled in, or around, AD 1474.

The sample taken from the lintel does not have the heartwood/sapwood boundary ring. However, with a last-measured heartwood ring date of AD 1453, this timber has a *terminus post quem* for felling of AD 1468 which makes it possible that it was also felled in the AD 1470s.

## Turret roof

Five of the samples taken from this structure have been dated. Sample NAP-B41, taken from a common rafter, has complete sapwood and the last-measured ring date of AD 1476, the felling date of the timber represented. Two other samples have similar heartwood/sapwood boundary ring dates, the average of which is AD 1449. This calculates to an estimated felling date for the two timbers represented within the range AD 1464–89, consistent with an AD 1476 felling. The other two dated samples do not have the heartwood/sapwood boundary ring but with last-measured ring dates of AD 1418 (NAP-B39) and AD 1437 (NAP-B42) it is possible that these were also felled in AD 1476. The potential same-tree derivation for the timbers represented by samples NAP-B41 and NAP-B42 supports the likelihood of all of these timbers being felled in, or around, AD 1476.

## Woodshed

Five roof timbers from this building have been dated, all have the heartwood/sapwood boundary ring, the average of which is AD 1441, giving an estimated felling date for the timbers represented within the range AD 1456–81.

## Porch

Only two timbers, both ridge beams, have been dated from the porch roof. One of these has a heartwood/sapwood boundary ring date of AD 1446, giving an estimated felling date range of AD 1461–86 for the timber represented. The other one does not have the heartwood/sapwood boundary ring but with a last-measured heartwood date of AD 1432, has a *terminus post quem* for felling of AD 1457, and hence both ridge beams may well be coeval.

## Stable/Coach-house range

### Barn

Eleven of the samples taken from the roof have been dated. All have the heartwood/sapwood boundary ring present and are clearly coeval. The average of these is AD 1446, giving an estimated felling date for the timbers represented to within the range AD 1461–86.

### East wing

One of the ground-floor ceiling beams in this part of the building has been dated. This sample has the heartwood/sapwood boundary ring date of AD 1455, giving an estimated felling date range of AD 1470–95.

## DISCUSSION

The dendrochronological dating has demonstrated that the majority of the extant oak timber in the various ranges under investigation was felled in the AD 1460s and AD 1470s and thus belongs to the period of ownership by James Metcalf and later, his son Thomas, who inherited the estate in AD 1472. It has also provided evidence for further works being undertaken in the late-sixteenth century.

The date of the Service range was unclear although it had been suggested that it might contain remnants of the medieval Kitchen and could indeed be the oldest part of the complex. This has now been supported by the dendrochronology which has identified the earliest timbers to be those of the roof of the old Kitchen. This is now known to have

been constructed from timber felled in AD 1461 and AD 1462. The dated timber includes two moulded posts thought to have been inserted to support the tiebeams when they were cut through. The fact that these two timbers are the same date as the rest of the timber suggests that beams salvaged from a range/building of the same date as the kitchen, were used for modification. These two samples match especially well with those from the Hall roof and High-end tower floor frames.

The east wing, to the rear of the Kitchen, is also potentially fifteenth century in date, although slightly later, but this is based on the dating of only one timber. A ground-floor ceiling beam located in this extension has been dated to AD 1470–95, suggesting construction of this part of the building may have occurred in the last decades of the fifteenth century.

To the south of the kitchen is the Tack room which is now known to contain timber felled in AD 1471–96 and AD 1570–95. The two earlier timbers, a stair runner and a common joist, can both be seen to be reused whilst the later date relates to the two main ceiling joists and a roof timber. These dates suggest construction of the tack room in the last decades of the sixteenth century, somewhat earlier than previously thought and utilising reused timber from the latter part of the fifteenth century. The reused samples match those from the Hall, the High-end tower, and reused timbers of the Barn particularly well.

The Hall and flanking towers were thought to date to the mid/late-fifteenth century and this has now been confirmed by the dendrochronology with timbers from this period being identified in all elements of this range.

A common joist from the Low end tower ground-floor ceiling has been dated to AD 1465. However, in addition to the usual caveat of dating a building/range on the basis of a single timber, a number of the timbers within this structure displayed signs to suggest previous use, such as smoke blackening and empty mortices. Therefore, it must be recognised that this timber might not be in its original position and cannot securely date the ceiling.

The ground-, first-, and second-floor frames of the High-end tower contain timber which was felled in AD 1471 and AD 1472, with it thought likely that construction followed shortly after. The turret roof on top of this tower appears to be very slightly later, utilising timber which was felled in AD 1476. It had been suggested that this might be a sixteenth-century alteration but it can now be seen to be only slightly later than the tower itself.

The hall roof contains timber felled in AD 1474. In bay 1 is a pair of moulded purlins which were thought to be reused timbers. However, it can be seen that the samples representing these beams (NAP-B13 and NAP-B14) are the same date as the rest of the roof timber and possibly have simply been reset. The lintel over a door adjoining the hall to the east tower has a *terminus post quem* for felling of AD 1468 and could therefore be of the same date as the roof and represent an original doorway and lintel.

The porch roof contains at least one timber of AD 1461–86 and a second timber with a *terminus post quem* for felling of AD 1457, with construction likely to have occurred in the second half of the fifteenth century. Similar to the turret, it had been suggested that this structure was a sixteenth-century addition but can now be said to be broadly contemporary with the rest of the North range, dating to the mid/late-fifteenth century.

The Woodshed roof is now known to contain timbers which were felled in AD 1456–81. However, it is thought likely that these represent reused timbers and, therefore, do not date the building itself but are clearly likely to have been originally associated with the major works in the AD 1460s and AD 1470s.

A number of reused timbers have also been used in the construction of the roof over the eighteenth-century Stable/Coach house-range barn. These have now been dated to AD 1461–86 and are thought likely to have been reused from a range or other building on the site given their similarity in date to other ranges at Nappa Hall and the level at which they match other samples (see below).

Generally, the level of matching seen, not only between samples of the same area but also between different areas, is very good, suggesting the same source of timber was used for the different areas. Indeed, sample NAP-B99, taken from the barn, matches samples NAP-B41 and NAP-B42, taken from common rafters of the turret roof at the very high level of  $t=11.3$  and  $16.3$ , respectively, and is likely to represent timbers cut from the same tree.

Those reference chronologies which match most highly with the two dated site sequences produced from Nappa Hall (Tables 2 and 3) can be seen to be generally in the north-east of the country suggesting that the woodland source utilised is relatively local in both the fifteenth century and the late-sixteenth century.

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## TABLES

*Table 1: Details of samples from Nappa Hall, Askrigg, Wensleydale, North Yorkshire*

Sample number	Sample location	Total rings*	Sapwood rings**	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
Hall						
Roof						
NAP-B01	Tiebeam, truss 2	145	21	1327	1450	1471
NAP-B02	North lower purlin, truss 1–2	112	h/s	1335	1446	1446
NAP-B03	North principal rafter, truss 2	109	--	1320	----	1428
NAP-B04	Crown post, truss 2	92	--	1334	----	1425
NAP-B05	North brace, crown post to principal rafter, truss 2	88	01	1356	1442	1443
NAP-B06	West brace, crown post truss 2 to collar purlin	66	06	1383	1442	1448
NAP-B07	Tiebeam, truss 3	151	06	1308	1452	1458
NAP-B08	North principal rafter, truss 3	114	h/s	----	----	----
NAP-B09	South principal rafter, truss 3	74	03	1381	1451	1454
NAP-B10	East brace, north principal, truss 3	78	23	1392	1446	1469
NAP-B11	Crown post, truss 3	109	26C	1366	1448	1474
NAP-B12	South brace, truss 3	104	--	1315	----	1418
NAP-B13	North middle purlin, truss 1–2 (moulded)	69	03	1389	1454	1457
NAP-B14	South middle purlin, truss 1–2 (moulded)	87	06	1381	1461	1467
Other hall timbers						
NAP-B15	Screen partition beam	58	18C	----	----	----
NAP-B16	First-floor moulded window lintel	NM	--	----	----	----
NAP-B17	Lintel over door between Hall and Low-end tower (Hall side)	99	--	1355	----	1453
NAP-B18	Lintel over door between Hall and Low-end tower (Low-end tower side)	NM	--	----	----	----
High end tower						
Ground-floor ceiling						
NAP-B19	Main beam 1 (north)	167	22C	1305	1448	1471
NAP-B20	Common joist 3, bay 1	99	h/s	----	----	----

NAP-B21	Common joist 5, bay 1	164	27C	1309	1445	1472
NAP-B22	Main beam 2	149	14	1318	1452	1466
NAP-B23	Main beam 3	110	04	1349	1454	1458
NAP-B24	Common joist 3, bay 4	104	04	1346	1445	1449
First-floor ceiling						
NAP-B25	Main beam 1 (north)	110	02	1335	1442	1444
NAP-B26	Common joist 3, bay 2	76	h/s	1353	1428	1428
NAP-B27	Common joist 4, bay 2	144	40	1317	1420	1460
NAP-B28	Main beam 2	117	h/s	1330	1446	1446
NAP-B29	Main beam 3	124	h/s	1319	1442	1442
NAP-B30	Common joist 3, bay 4	70	--	1379	----	1448
Second-floor ceiling beams						
NAP-B31	Loose beam 1	115	12	1351	1453	1465
NAP-B32	Loose beam 2	81	h/s	1367	1447	1447
NAP-B33	Loose beam 3	71	h/s	1388	1458	1458
Lintels						
NAP-B34	Garderobe inner lintel	55	--	----	----	----
NAP-B35	Garderobe outer lintel	NM	--	----	----	----
NAP-B36	North wall, first-floor window, inner lintel	NM	--	----	----	----
Turret roof						
NAP-B37	Tiebeam, truss 2	90	01	1356	1444	1445
NAP-B38	Tiebeam, truss 3	67	--	----	----	----
NAP-B39	Ridge beam	96	--	1323	----	1418
NAP-B40	South wallplate	64	h/s	1390	1453	1453
NAP-B41	South common rafter 2, bay 1	95	14C	1382	1462	1476
NAP-B42	North common rafter 1, bay 2	83	--	1355	----	1437
Low-end tower						
Ground-floor ceiling beams						
NAP-B43	Main east-west ceiling beam	148	19C	----	----	----
NAP-B44	Common joist 2 (from east, north side of beam)	55	15	----	----	----
NAP-B45	Common joist 5	68	16C	1398	1449	1465
NAP-B46	Common joist 6	47	13	----	----	----

NAP-B47	Common joist 7	50	14	----	----	----
Service Range						
NAP-B48	Smokehood beam	50	15	----	----	----
Roof						
NAP-B49	North principal rafter, truss 1(east truss)	88	h/s	1351	1438	1438
NAP-B50	South principal rafter, truss 1	112	09	1341	1443	1452
NAP-B51	Tiebeam, truss 1	57	--	1378	----	1434
NAP-B52	North principal rafter, truss 2	122	h/s	1322	1443	1443
NAP-B53	South principal rafter, truss 2	115	--	1305	----	1419
NAP-B54	North common rafter 2, bay 1	61	29C	1401	1432	1461
NAP-B55	South common rafter 2, bay 1	76	18C	1386	1443	1461
NAP-B56	South common rafter 1, bay 2	NM	--	----	----	----
NAP-B57	South common rafter 2, bay 3	114	h/s	1333	1446	1446
NAP-B58	Ridge, bay 3	81	23C	1382	1439	1462
NAP-B59	North purlin, bay 2	58	15	1403	1445	1460
NAP-B60	North post truss 1 (moulded)	85	h/s	1339	1423	1423
NAP-B61	North post truss 2 (moulded)	107	09	1336	1433	1442
Tack room						
Ground-floor ceiling						
NAP-B62	North main east-west ceiling beam	90	16	1478	1551	1567
NAP-B63	South main east-west ceiling beam	92	14	1479	1556	1570
NAP-B64	Common joist 5 (from east, north side north beam; reused)	NM	--	----	----	----
NAP-B65	Common joist 11 (reused)	111	--	1300	----	1410
NAP-B66	Stair runner (reused)	58	h/s	1399	1456	1456
Roof						
NAP-B67	North principal rafter, truss 1(east truss)	111	h/s	----	----	----
NAP-B68	South principal rafter, truss 1	61	h/s	1499	1559	1559
NAP-B69	North principal rafter, truss 2	65	--	----	----	----
NAP-B70	South principal rafter, truss 2	NM	--	----	----	----
NAP-B71	Tiebeam, truss 1	87	09	----	----	----
NAP-B72	South upper purlin, bay 1	NM	--	----	----	----
NAP-B73	North lower purlin, bay 1	NM	--	----	----	----

NAP-B74	South upper purlin, bay 2	60	--	----	----	----
NAP-B75	South lower purlin, bay 2	96	h/s	----	----	----
NAP-B76	Tiebeam, truss 2	139	03	----	----	----
NAP-B77	South lower purlin, bay 3	66	10	----	----	----
NAP-B78	North lower purlin, bay 2	72	--	----	----	----
East wing						
NAP-B79	Ground-floor beam 1	75	h/s	1381	1455	1455
NAP-B80	Ground-floor beam 2	NM	--	----	----	----
Porch						
Roof						
NAP-B81	Tiebeam, truss 2	85	03	----	----	----
NAP-B82	East wallplate, bay 2	NM	--	----	----	----
NAP-B83	Corbal	123	--	----	----	----
NAP-B84	Ridge beam, bay 1	122	--	1311	----	1432
NAP-B85	Tiebeam, truss 1	NM	--	----	----	----
NAP-B86	Ridge beam, bay 2	58	h/s	1389	1446	1446
Woodshed						
Roof						
NAP-B87	North upper purlin, bay 3	NM	--	----	----	----
NAP-B88	North lower purlin, bay 3	NM	--	----	----	----
NAP-B89	South upper purlin, bay 3	NM	--	----	----	----
NAP-B90	South lower purlin, bay 3	NM	--	----	----	----
NAP-B91	North common rafter 3, bay 3	93	h/s	----	----	----
NAP-B92	North common rafter 4, bay 3	81	h/s	1367	1447	1447
NAP-B93	North upper purlin, bay 2	55	h/s	----	----	----
NAP-B94	South upper purlin, bay 1	152	24C	----	----	----
NAP-B95	North common rafter 5, bay 1	69	04	1382	1446	1450
NAP-B96	North common rafter 3, bay 1	84	h/s	1367	1450	1450
NAP-B97	North lower purlin, bay 1	117	h/s	1316	1432	1432
NAP-B98	North lower purlin, bay 2	122	h/s	1307	1428	1428
Stable/Coach house barn						
Reused roof timbers						

NAP-B99	East lower purlin, bay 4	118	h/s	1329	1447	1447
NAP-B100	East middle purlin, bay 5	110	h/s	1328	1437	1437
NAP-B101	East lower purlin, bay 6	119	h/s	1324	1442	1442
NAP-B102	West middle purlin, bay 6	111	h/s	1345	1455	1455
NAP-B103	West common rafter 5, bay 6	83	h/s	1341	1423	1423
NAP-B104	East lower purlin, bay 7	103	h/s	1350	1452	1452
NAP-B105	East middle purlin, bay 7	107	h/s	1345	1451	1451
NAP-B106	West lower purlin, bay 7	125	h/s	1319	1443	1443
NAP-B107	West middle purlin, bay 7	72	02	1389	1458	1460
NAP-B108	East backing rafter, truss 6	98	h/s	1356	1453	1453
NAP-B109	East lower purlin, bay 9	56	h/s	----	----	----
NAP-B110	West lower purlin, bay 9	87	h/s	1363	1449	1449

\*NM = not measured

\*\*h/s = heartwood/sapwood boundary is the last-measured ring

C = complete sapwood retained on sample, last measured ring is the felling date

*Table 2: Results of the cross-matching of site sequence NAPBSQ01 and relevant reference chronologies when the first-ring date is AD 1300 and the last-measured ring date is AD 1476*

Reference chronology	<i>t</i> -value	Span of chronology	Reference
Tunstall Hall Farm, Hartlepool, Cleveland	9.4	AD 1316–1484	Howard <i>et al</i> 2002a
Seaton Holme, Easington, County Durham	9.0	AD 1375–1489	Arnold <i>et al</i> 2008
Willimoteswick, Bardon Mill, Northumberland	8.9	AD 1330–1575	Arnold and Howard 2009
Kepier Farm Hospital, Durham	8.9	AD 1304–1522	Howard <i>et al</i> 1996
35 The Close, Newcastle-upon-Tyne, Northumberland	8.8	AD 1365–1513	Howard <i>et al</i> 1991
Norton Conyers Hall, West Yorkshire	8.7	AD 1365–1486	Arnold and Howard, 2008 unpubl
Horbury Hall, Wakefield	8.6	AD 1368–1473	Howard <i>et al</i> 1992

*Table 3: Results of the cross-matching of site sequence NAPBSQ02 and relevant reference chronologies when the first-ring date is AD 1478 and the last-measured ring date is AD 1570*

Reference chronology	<i>t</i> -value	Span of chronology	Reference
Hallgarth Pittington, County Durham	7.4	AD 1336–1624	Howard <i>et al</i> 2001
Low Bishopley, Frosterley, Weardale, County Durham	7.0	AD 1501–1581	Arnold and Howard 2011
Grange Farm, Norton, Sheffield, South Yorkshire	6.8	AD 1436–1599	Arnold and Howard 2007a
Dilston Castle, Corbridge, Northumberland	6.5	AD 1402–1611	Arnold <i>et al</i> 2003
Markenfield Hall, Nr Ripon, North Yorkshire	6.4	AD 1388–1589	Howard <i>et al</i> 2002b
Frith Hall, Brampton, Derbyshire	6.2	AD 1480–1602	Howard <i>et al</i> 1993
All Hallows Church, Kirkburton, West Yorkshire	6.2	AD 1306–1633	Arnold and Howard 2007b

# FIGURES

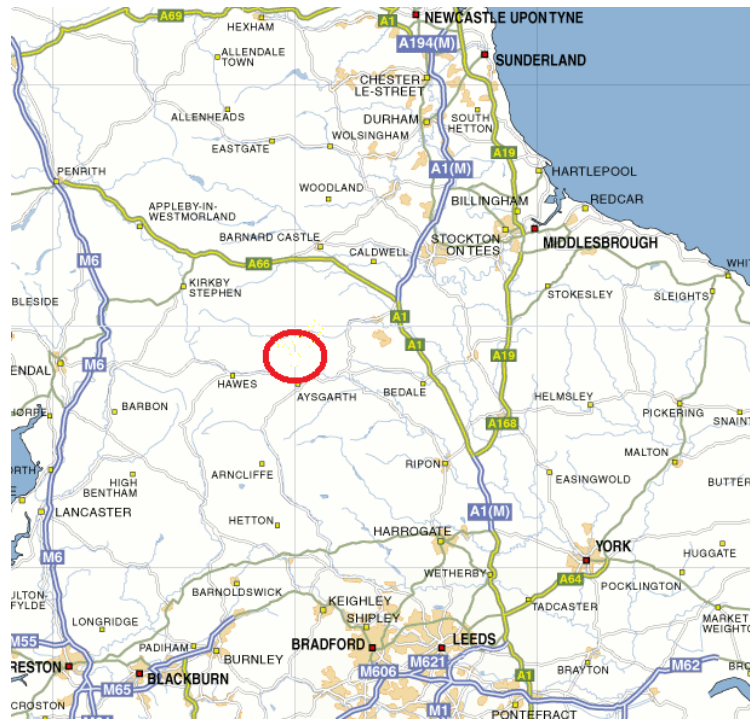


Figure 1: Map to show the general location of Askrigg, circled. © Crown Copyright and database right 2013. All rights reserved. Ordnance Survey Licence number 100024900.

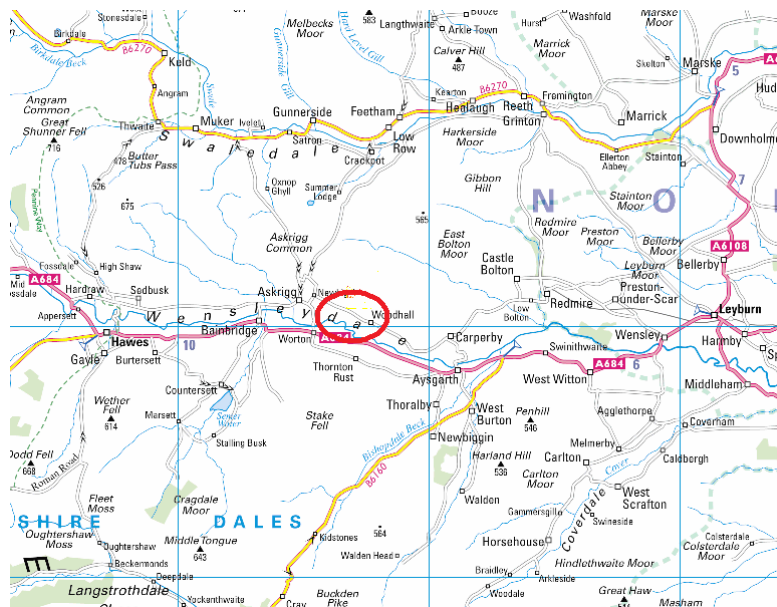


Figure 2: Map to show the general location of Nappa Hall, circled. © Crown Copyright and database right 2013. All rights reserved. Ordnance Survey Licence number 100024900





*Figure 3: Map to show the location of Nappa Hall. © Crown Copyright and database right 2013. All rights reserved. Ordnance Survey Licence number 100024900.*

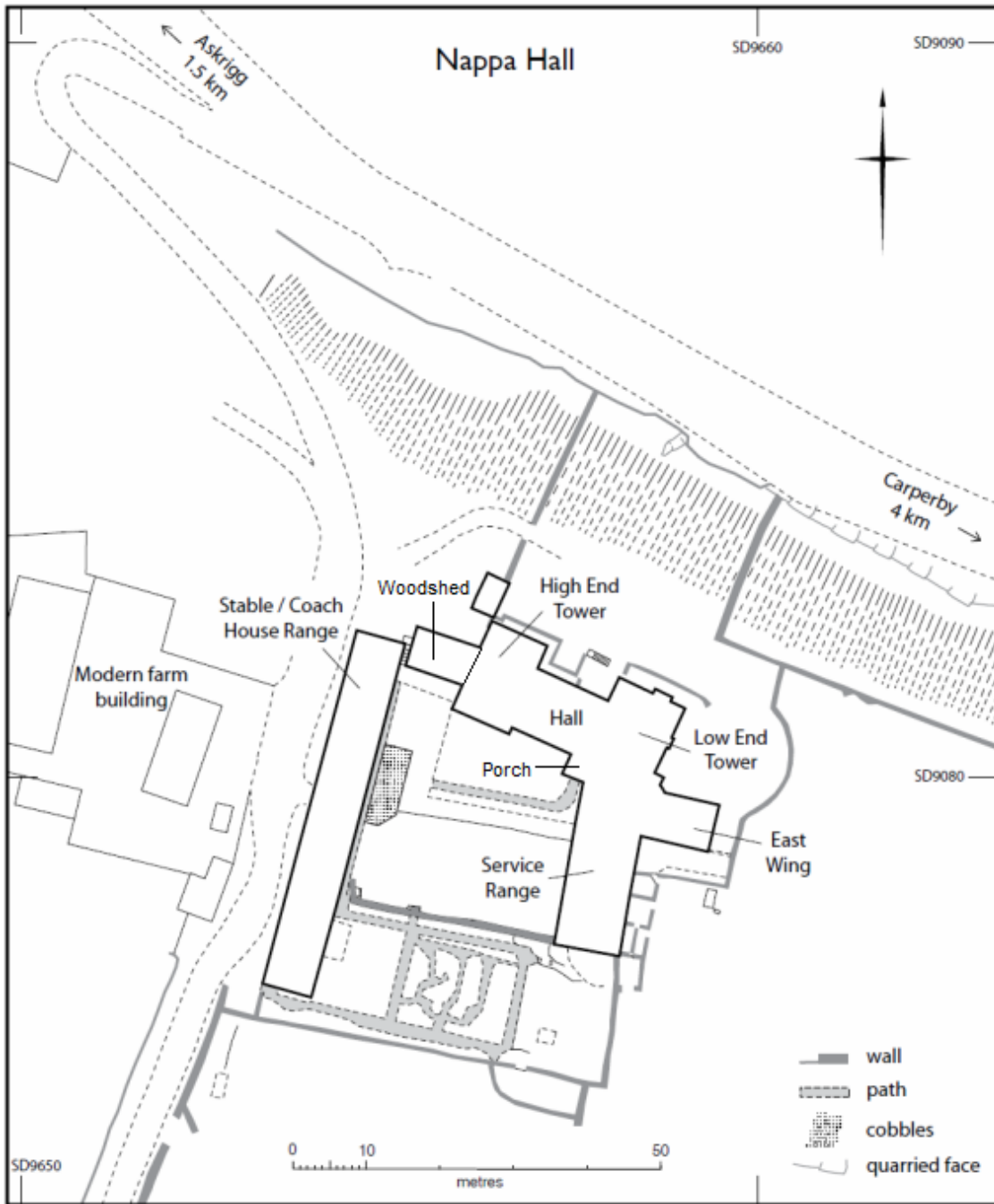


Figure 4: Plan of Nappa Hall, showing the areas investigated (Menuge and Went 2013, Fig 2)



*Figure 5: North range, with Woodshed to left and Low-end tower to right (Alison Arnold)*



*Figure 6: Hall roof, truss 2 in the foreground, photograph taken from the south-east (Robert Howard)*



*Figure 7: High-end tower, first-floor ceiling frame (from above) with main beams from the second floor lain loose by the walls (Alison Arnold)*



*Figure 8: High-end tower, turret roof, truss 2 in foreground, photograph taken from the east (Robert Howard)*



*Figure 9: Low-end tower, ground-floor ceiling frame, photograph taken from the south-west (Robert Howard)*



*Figure 10: Porch roof, truss 2 in foreground, photograph taken from the south (Alison Arnold)*



*Figure 11: Woodshed, roof, bay 2, photograph taken from the south-west (Alison Arnold)*



*Figure 12: Service range, Kitchen to the left and cow byre to the right (Alison Arnold)*



*Figure 13: Service range, Kitchen, smokehood bressummer, photograph taken from the south-east (Robert Howard)*



*Figure 14: Service range, Kitchen roof, truss 1, photograph taken from the west (Alison Arnold)*



*Figure 15: Service range, Tack room, ground-floor ceiling, photograph taken from the north-west (Alison Arnold)*



*Figure 16: Service range, Tack room roof, truss 2, photograph taken from the west (Alison Arnold)*





*Figure 17: East wing, photograph taken from the south (Alison Arnold)*



*Figure 18: East wing, ground-floor ceiling beam, photograph taken from the east (Alison Arnold)*



*Figure 19: Stable/Coach-house range, photograph taken from the south-east (Robert Howard)*



*Figure 20: Stable/Coach-house range, stable roof, truss 6 in the foreground, photograph taken from the north (Robert Howard)*



*Figure 21: Stable/Coach-house range, stable roof, bay 7, photograph taken from the east (Robert Howard)*

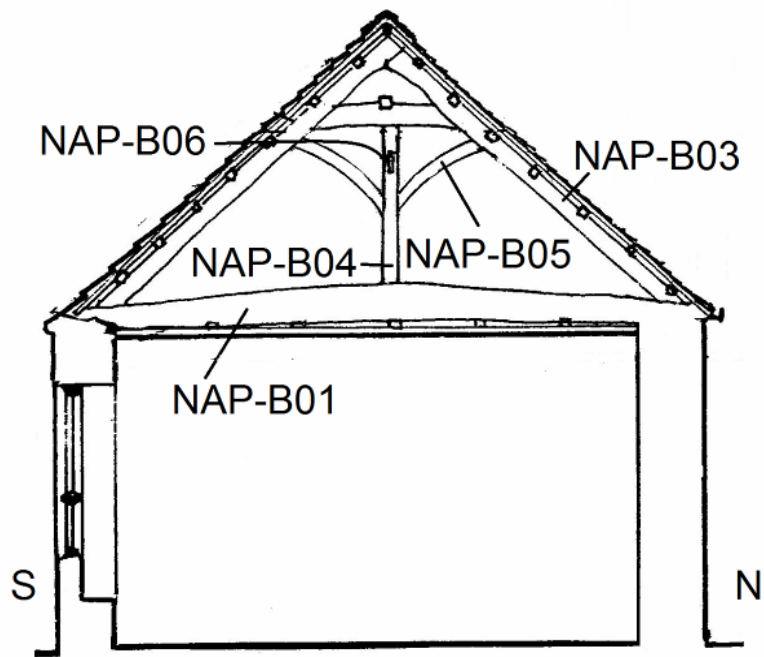


Figure 22: Hall, truss 2, showing the location of samples NAP-B01, NAP-B03-6 (John Warren)

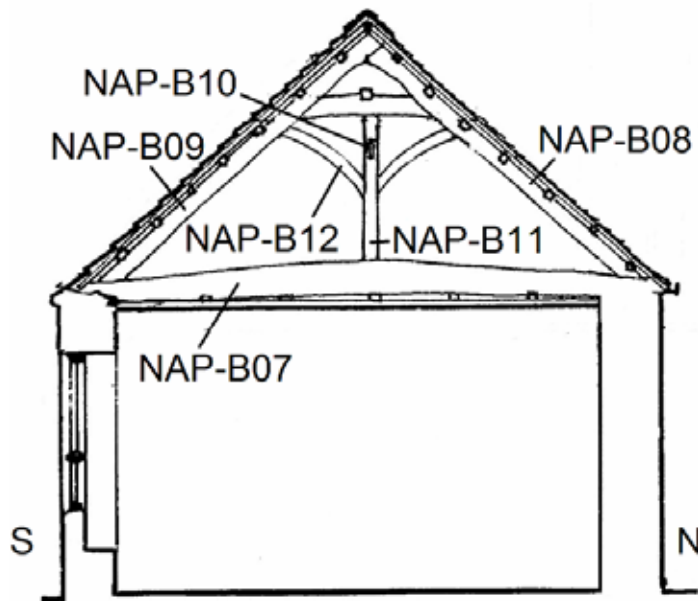


Figure 23: Hall, truss 3, showing the location of samples NAP-B07-12 (John Warren)

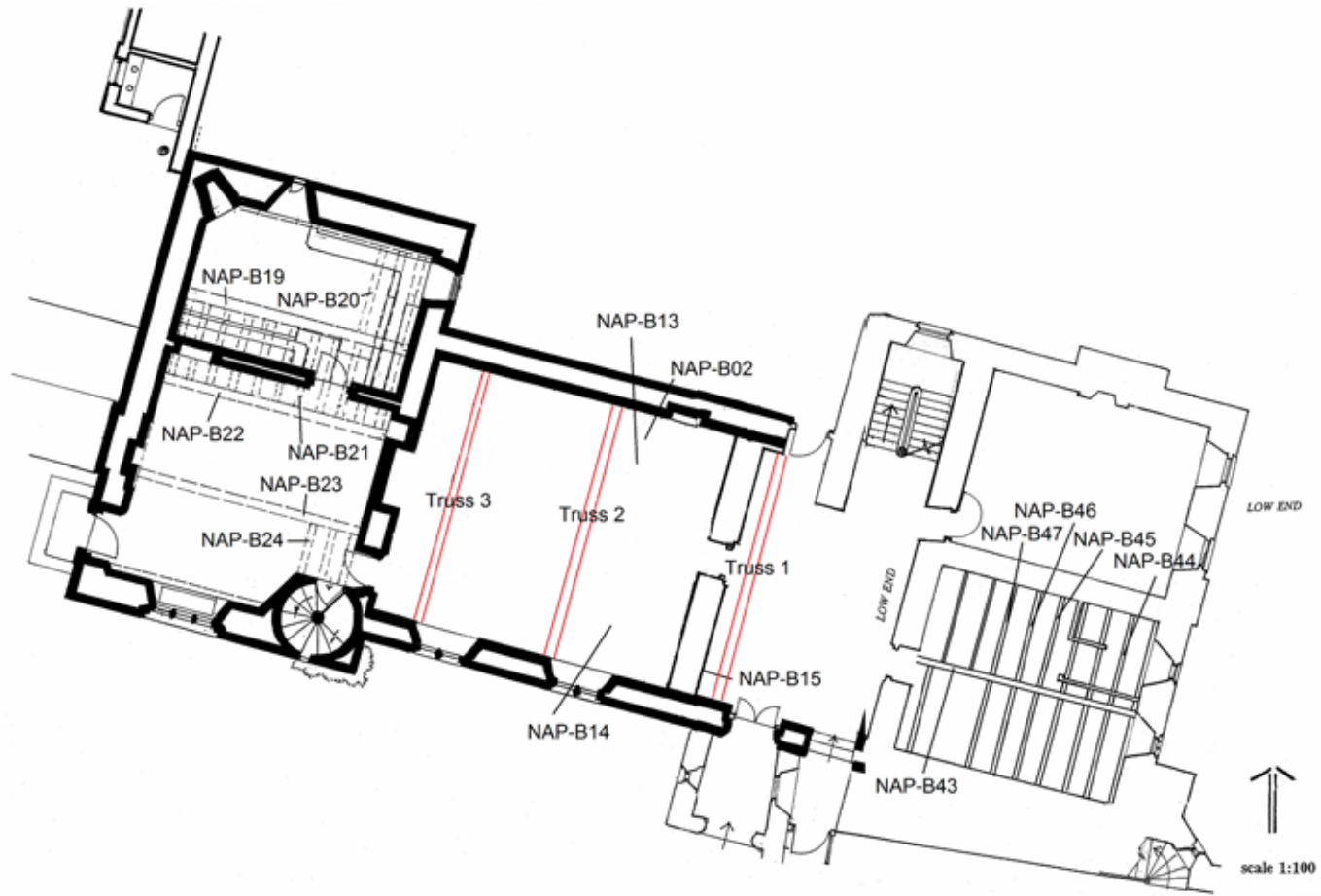


Figure 24: North range, ground-floor plan showing the location of samples NAP-B02, NAP-B13–15, NAP-B19–24, and NAP-B43–47 (John Warren)

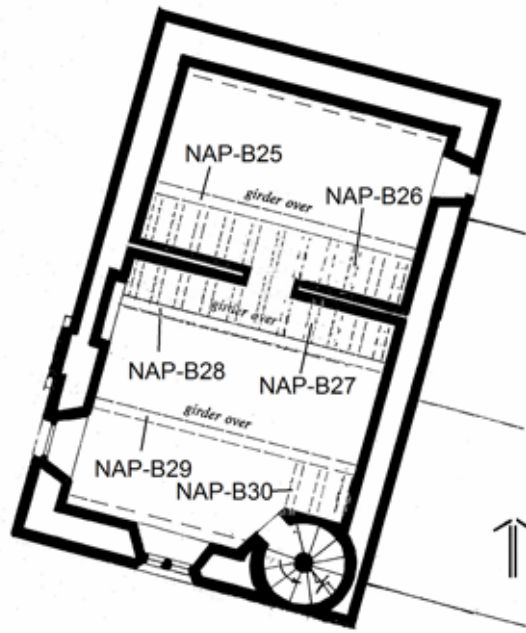


Figure 25: High-end tower, west tower, first-floor plan showing the location of samples NAP-B25–30 (John Warren)

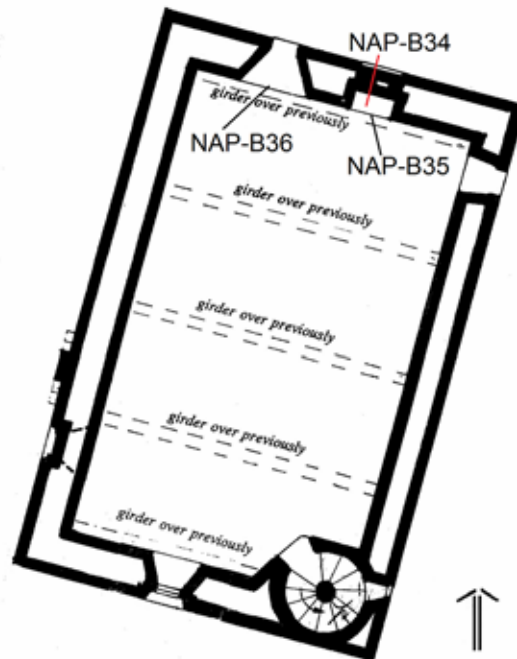


Figure 26: High-end tower, second-floor plan showing the location of samples NAP-B34–6 (John Warren)

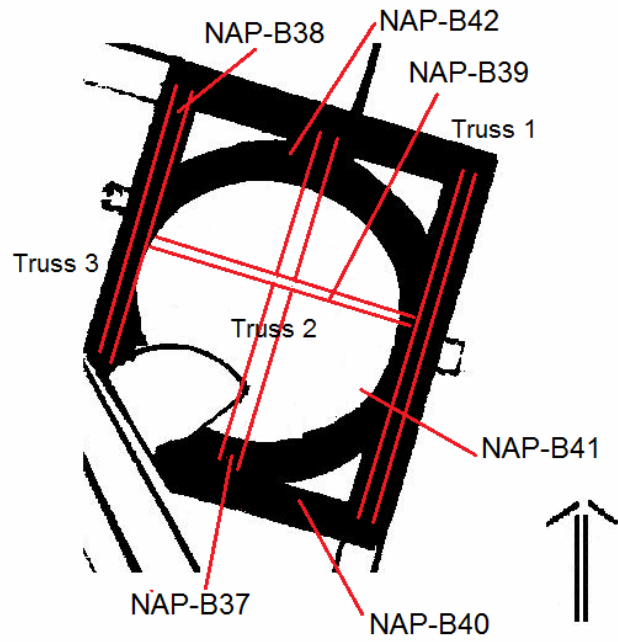


Figure 27: High-end tower, Turret roof, plan showing the location of samples NAP-B37–42 (John Warren)

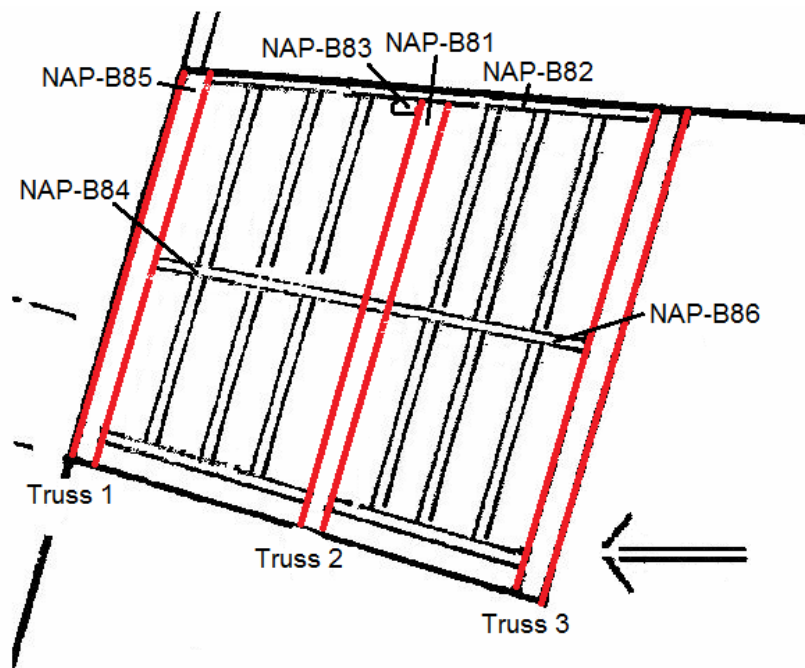


Figure 28: Porch roof, plan showing the location of samples NAP-B81–6 (John Warren)

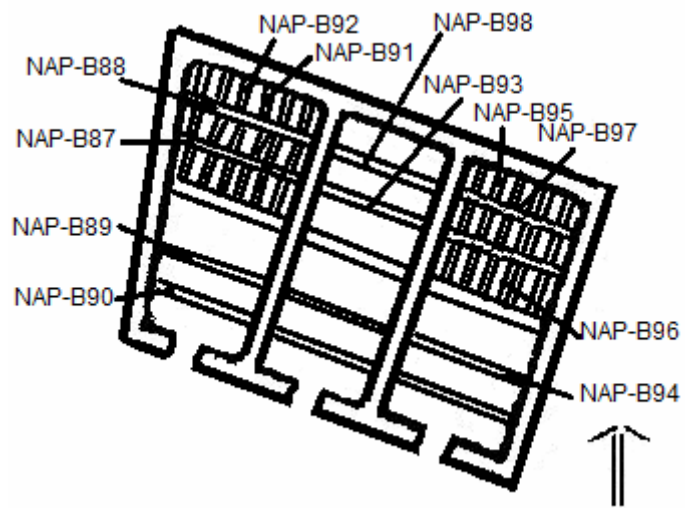


Figure 29: Woodshed, sketch plan showing the location of samples NAP-B87-97



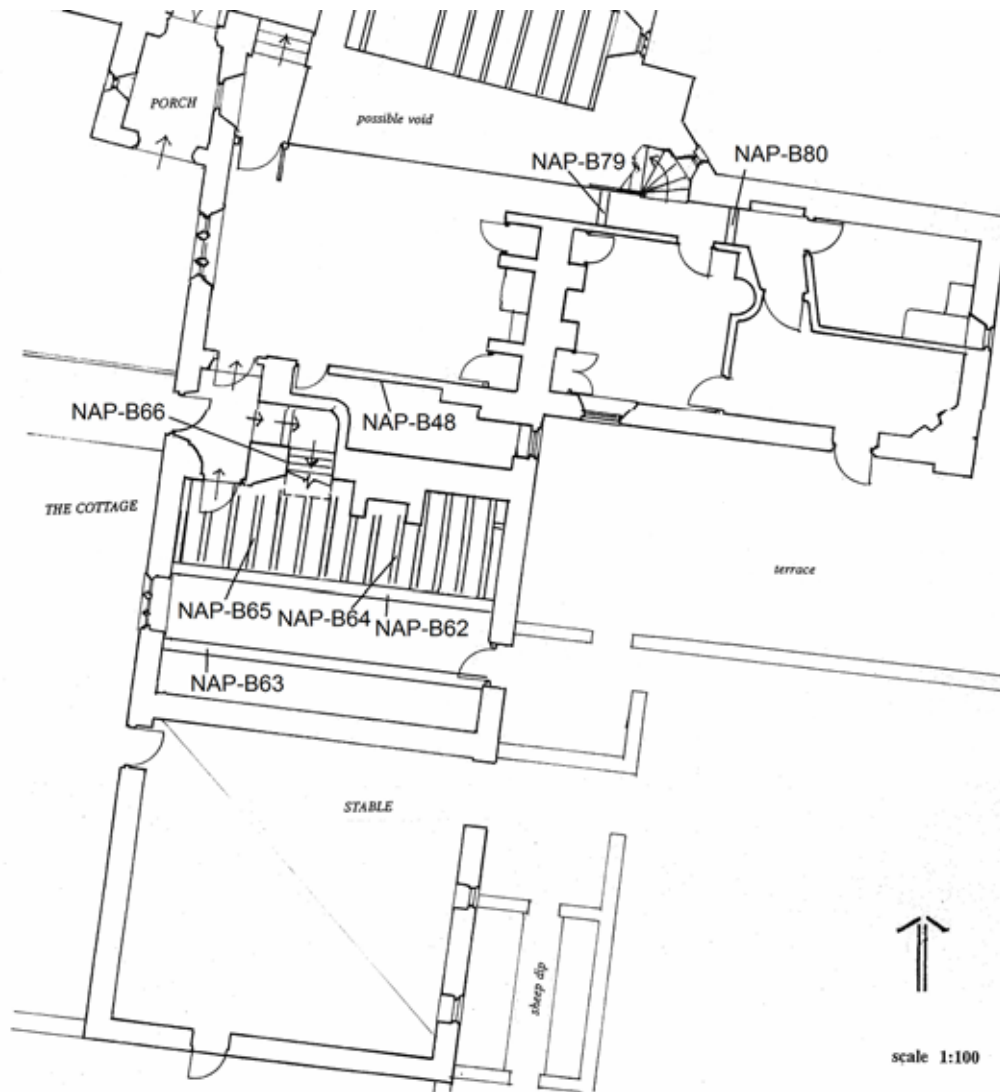


Figure 30: Service range and east wing, ground-floor plan showing the location of samples NAP-B48, NAP-B62–6, and NAP-B79–80 (John Warren)

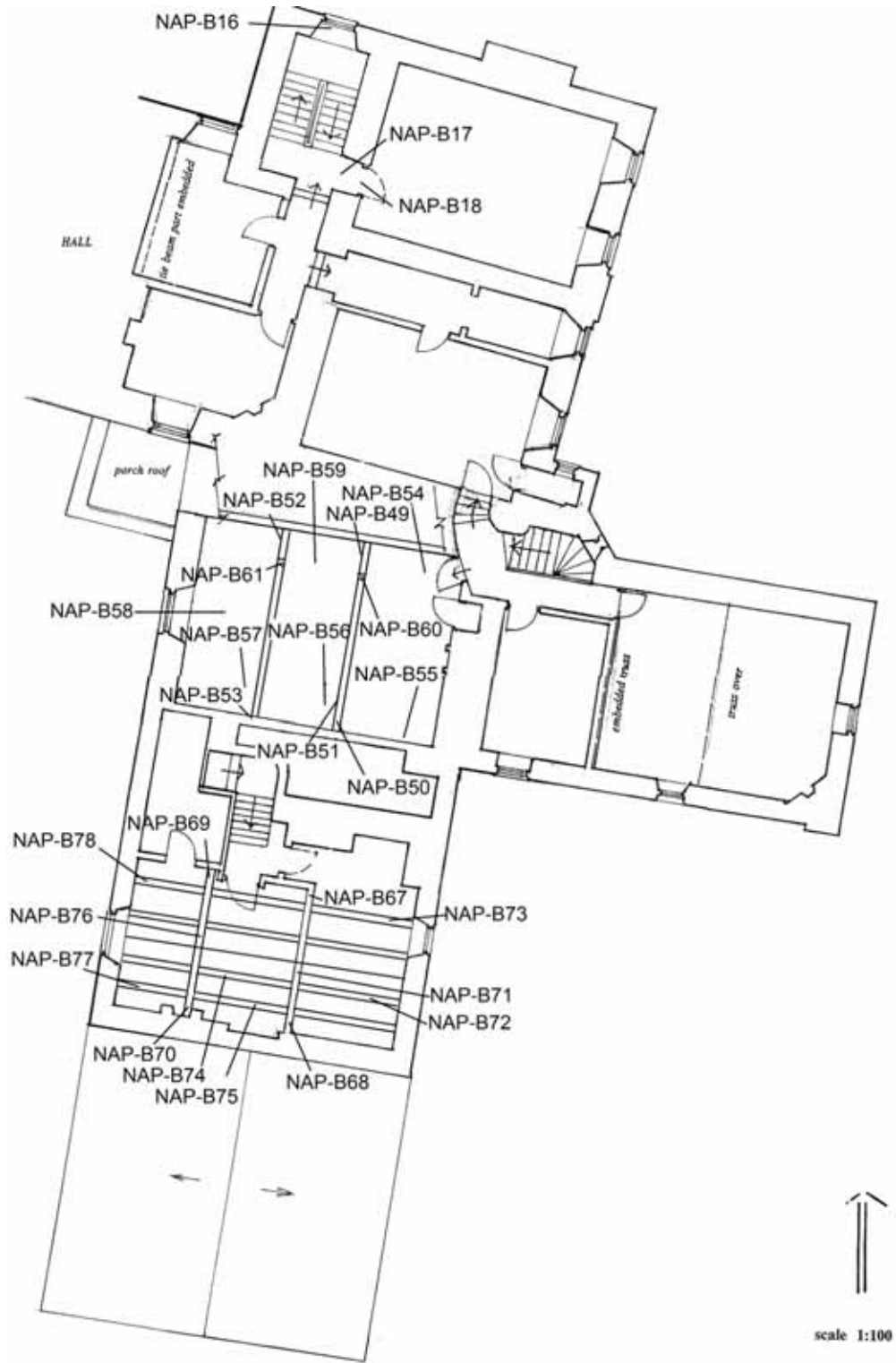


Figure 31: Low-end tower and service range, first-floor plan showing the location of samples NAP-B16–18, NAP-B49–61 and NAP-B67–78 (John Warren)

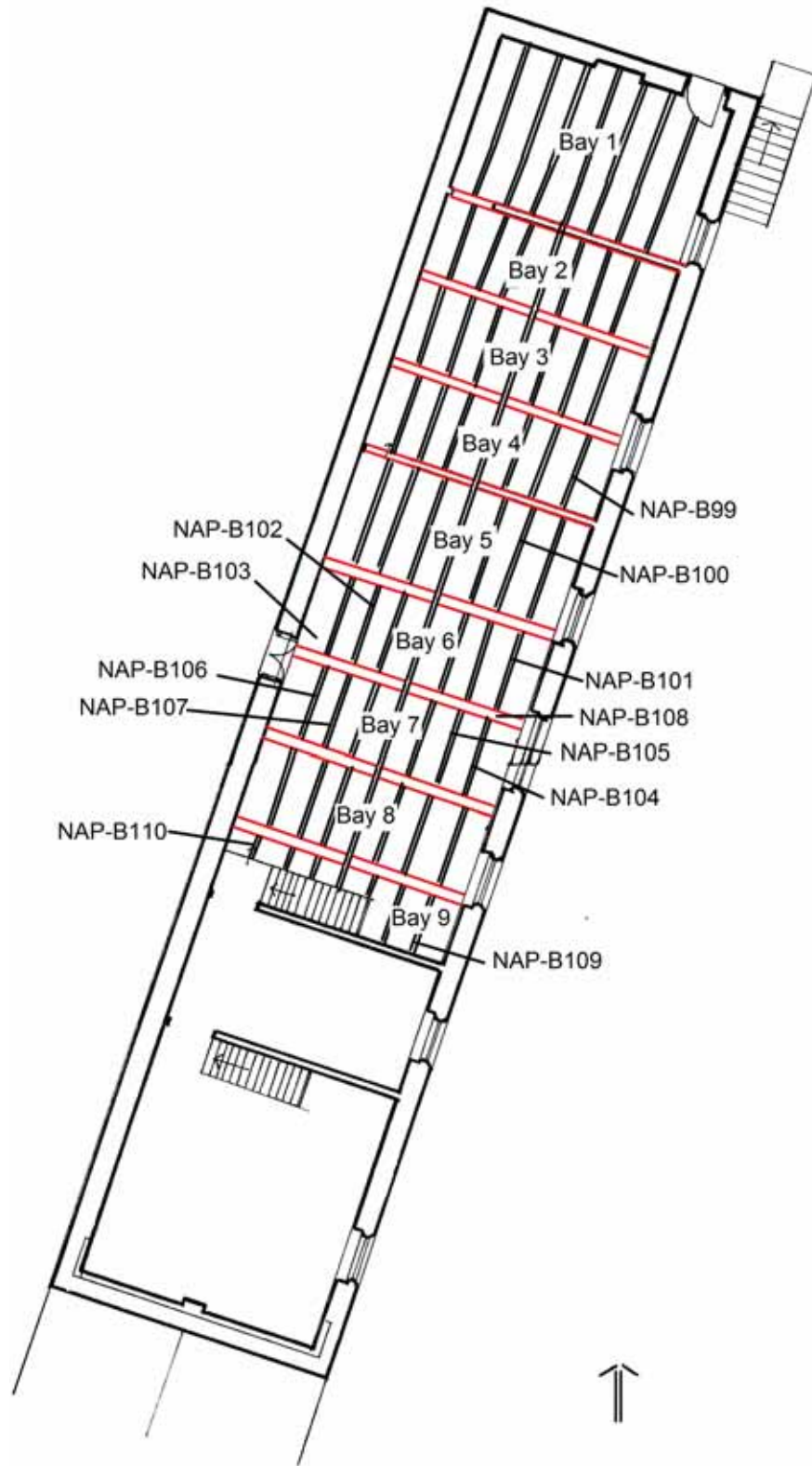


Figure 32: Stables/Coach-house range, first-floor plan showing the location of samples NAP-B99-110 (John Warren)

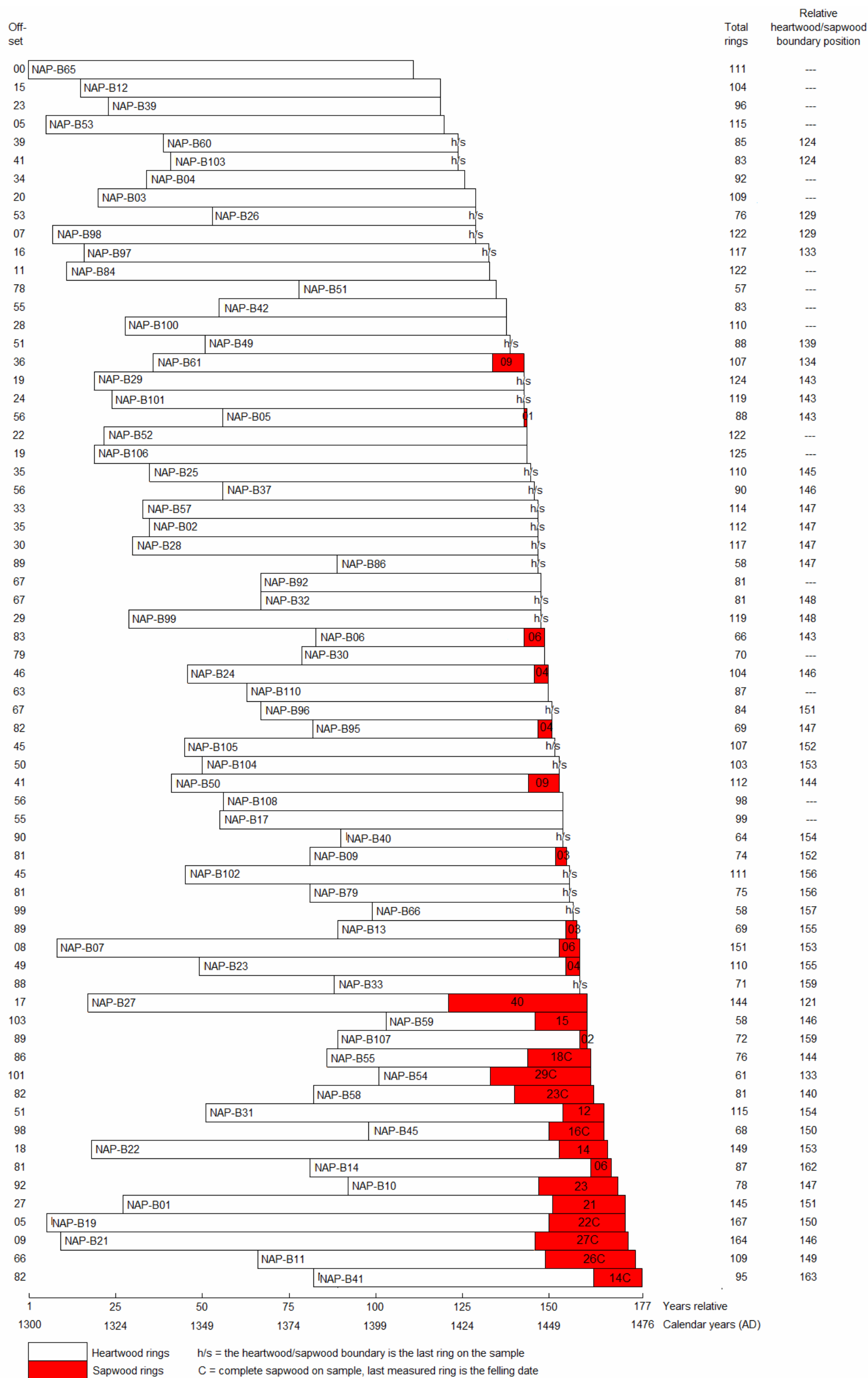


Figure 33: Bar diagram of samples in site sequence NAPBSQ01

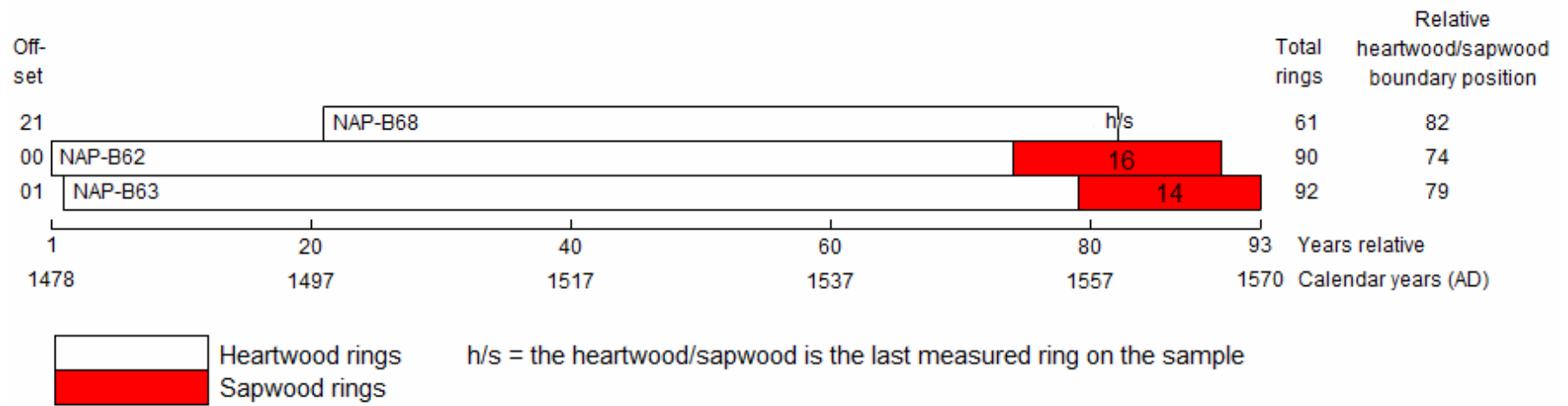


Figure 34: Bar diagram of samples in site sequence NAPBSQ02

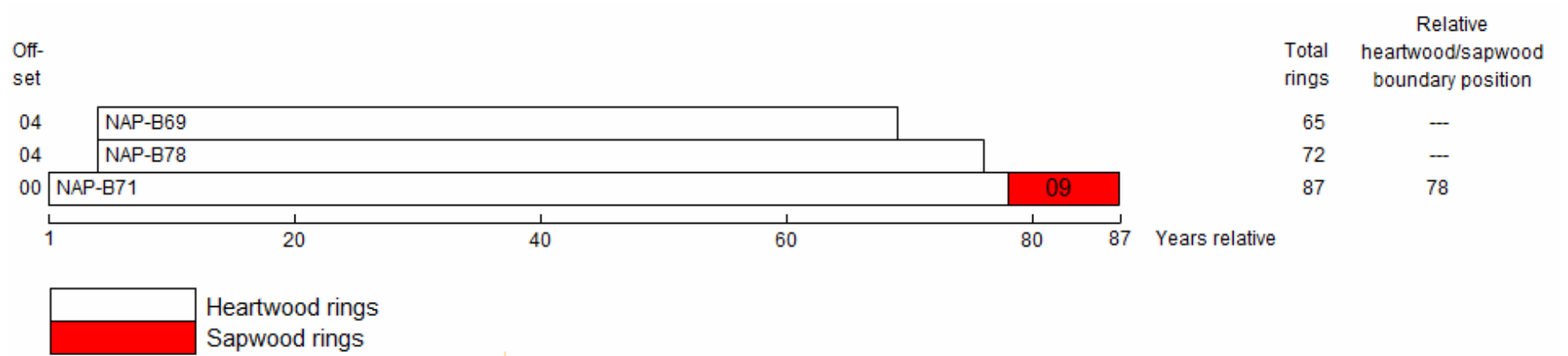


Figure 35: Bar diagram of samples in undated site sequence NAPBSQ03

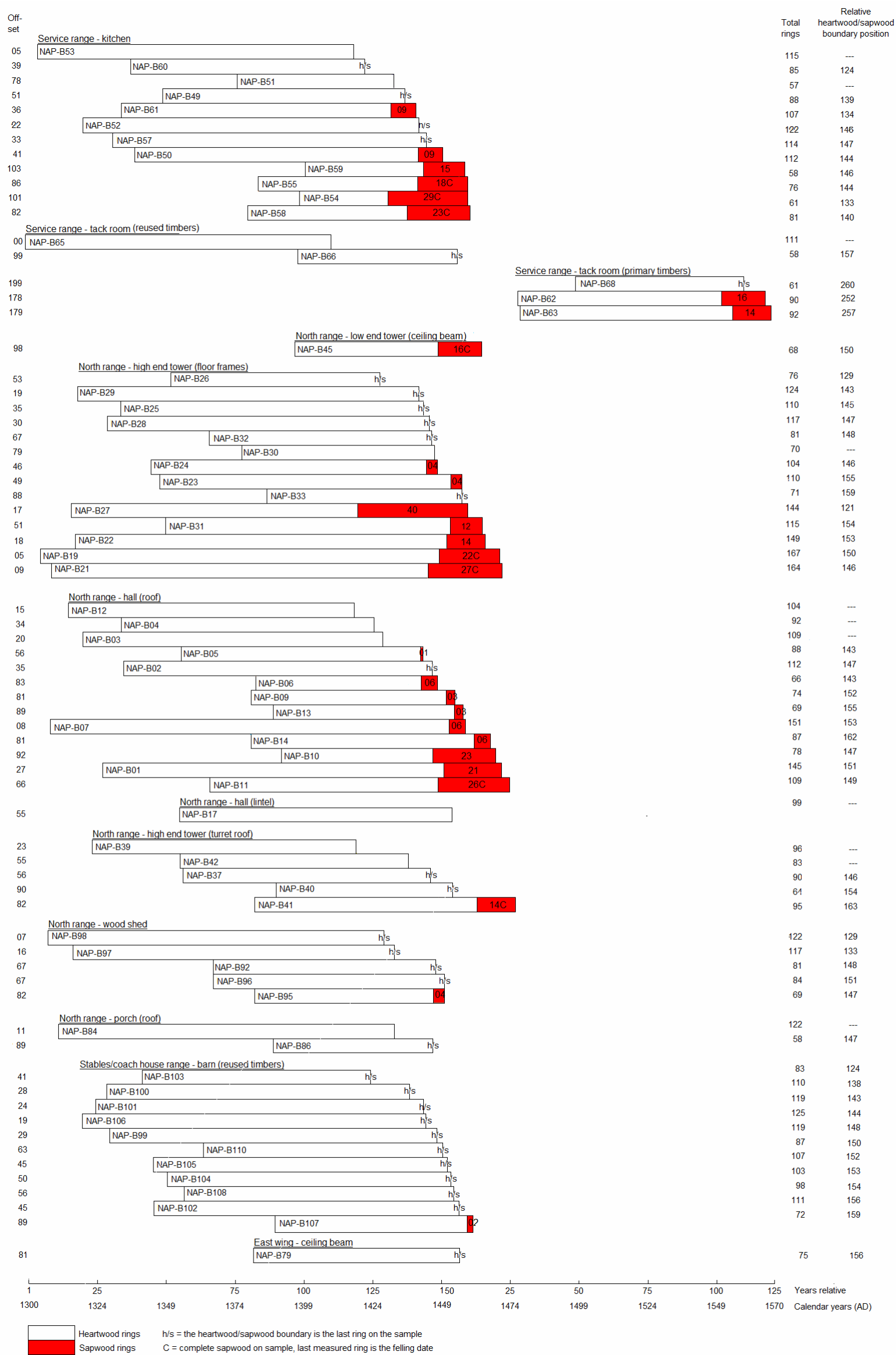


Figure 36: Bar diagram of all dated samples, sorted by area, from Nappa Hall

## DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

### NAP-B01A 128

322 318 255 368 240 298 221 269 243 221 200 249 256 267 192 280 170 138 203 179  
168 204 264 165 113 108 152 149 134 128 139 134 133 78 144 93 128 118 134 125  
99 105 142 115 124 141 107 126 129 69 107 102 138 120 109 117 99 116 95 100  
102 91 87 80 96 101 81 80 74 92 81 62 90 94 111 94 96 91 83 67  
64 79 124 111 107 105 95 80 78 75 81 117 79 94 116 89 99 103 81 92  
107 64 39 26 45 49 53 57 74 74 101 72 58 61 67 79 79 76 84 66  
44 61 88 69 81 82 79 63

### NAP-B01B 100

144 129 138 107 83 95 91 118 102 121 125 103 110 91 99 120 94 100 92 105  
115 96 93 77 91 65 72 87 99 123 99 94 94 75 79 73 94 118 114 93  
110 107 65 84 64 77 95 53 85 85 79 68 69 59 83 77 57 45 37 37  
47 54 46 54 50 77 60 70 71 67 66 69 65 78 46 36 66 61 62 65  
73 65 70 76 81 67 54 69 60 73 76 74 60 65 79 72 88 66 62 76

### NAP-B02A 112

234 259 213 249 281 369 330 352 333 338 421 253 206 195 327 182 153 160 163 150  
117 140 154 175 196 143 167 180 208 225 167 192 141 123 177 156 124 153 152 200  
124 121 112 136 146 153 126 133 128 137 128 155 182 196 190 143 157 126 150 120  
192 151 96 125 111 136 136 104 104 92 94 119 77 98 89 110 72 77 71 68  
62 56 62 78 62 94 77 65 65 51 49 66 54 77 59 49 76 73 52 59  
79 89 117 94 65 95 77 72 113 95 85 65

### NAP-B02B 112

246 263 214 245 289 361 338 349 331 339 416 257 198 203 334 188 151 153 169 148  
119 139 158 169 200 139 161 176 214 226 166 188 146 122 178 154 132 144 156 195  
130 116 106 136 138 148 131 132 122 130 127 159 181 204 182 152 150 133 149 121  
188 152 96 127 105 138 126 110 103 91 97 122 75 94 89 118 70 71 67 78  
67 49 62 84 62 84 83 61 66 51 49 68 59 74 71 47 80 83 56 58  
85 93 125 92 64 105 78 71 112 93 77 72

### NAP-B03A 109

244 277 255 249 254 253 169 224 271 334 365 258 289 198 162 158 89 149 220 214  
211 215 253 216 234 305 230 179 215 239 217 172 149 136 156 126 150 140 142 136  
89 111 106 171 167 155 152 123 127 174 140 183 216 129 162 114 75 68 74 105  
114 106 101 82 104 98 97 122 108 115 104 127 99 116 112 91 119 99 127 136  
177 167 124 127 147 123 158 137 185 161 130 109 138 145 132 103 89 75 117 81  
128 114 76 70 66 45 84 93 88

### NAP-B03B 109

242 274 246 243 257 246 158 237 267 348 357 254 292 214 146 176 110 153 219 218  
217 213 235 221 235 308 233 186 212 283 229 183 135 135 154 126 146 143 133 142  
91 107 114 159 169 165 145 122 127 163 141 173 216 119 162 111 72 74 87 105  
117 102 103 94 111 93 102 118 117 118 111 109 112 119 118 102 115 102 126 118  
191 181 124 131 144 123 162 132 189 163 130 107 137 147 129 115 81 76 119 79  
131 109 78 73 60 44 78 93 86

### NAP-B04A 92

185 184 161 152 229 190 179 176 153 148 136 167 107 108 146 182 124 131 157 175  
153 124 124 133 114 136 101 127 136 154 168 172 209 178 141 191 156 164 204 157  
171 179 235 190 220 255 205 155 174 156 142 175 206 209 185 212 193 161 189 190  
155 163 232 165 165 169 206 194 169 181 193 172 239 143 145 162 205 164 181 155  
140 118 120 112 137 102 172 166 123 170 119 130



NAP-B04B 92

186 164 182 150 227 193 178 176 151 148 135 161 116 108 142 177 123 138 160 175  
156 120 131 136 122 131 107 120 128 166 158 179 208 175 144 195 157 165 204 161  
170 178 243 191 217 251 209 147 180 155 139 171 210 205 188 213 195 161 190 199  
146 155 238 174 164 171 199 191 175 179 198 168 241 140 136 160 212 157 192 151  
155 114 120 116 121 116 172 150 145 141 117 134

NAP-B05A 88

140 193 160 197 102 143 108 213 201 229 200 135 130 230 211 241 219 151 118 89  
75 132 109 201 181 76 131 66 122 99 143 198 149 153 99 124 121 107 118 99  
160 76 81 102 108 129 98 98 138 111 140 83 118 108 159 92 149 106 117 81  
58 59 137 55 129 70 61 54 42 31 69 61 144 139 106 113 95 68 76 115  
140 213 118 105 97 151 104 155

NAP-B05B 88

135 180 152 191 101 145 105 222 197 229 207 135 128 240 206 240 223 147 112 94  
75 133 118 201 175 71 135 71 110 98 144 194 141 158 101 122 121 117 132 108  
148 75 84 98 108 129 98 97 142 107 133 90 116 108 159 90 152 108 117 85  
59 64 137 61 122 73 56 56 39 27 73 62 142 144 100 116 96 80 76 111  
140 208 112 111 94 144 101 145

NAP-B06A 66

111 265 137 158 179 135 136 107 121 121 129 142 151 181 75 84 118 141 168 111  
119 186 120 173 98 110 128 191 112 168 112 145 93 76 99 151 75 134 78 77  
70 53 50 110 93 168 164 94 126 95 68 74 125 164 140 101 90 101 157 123  
234 222 221 96 99 120

NAP-B06B 66

127 236 143 153 187 146 142 107 121 127 120 139 154 173 90 85 131 162 134 121  
135 194 128 174 92 125 128 195 115 157 117 146 109 68 102 165 70 132 82 78  
71 54 53 111 91 165 166 92 128 84 67 79 132 159 148 104 101 99 154 121  
235 236 203 91 117 115

NAP-B07A 86

73 88 119 110 171 121 111 183 191 184 218 130 184 144 84 120 148 172 154 138  
146 167 180 117 194 174 186 165 143 174 150 161 145 168 175 133 120 126 226 173  
153 155 161 185 193 136 180 209 159 165 183 191 108 102 90 65 108 67 94 88  
90 63 65 78 76 89 106 167 105 103 129 77 82 74 76 82 58 62 130 101  
74 140 124 100 89 90

NAP-B07B 151

325 238 274 440 400 351 335 269 182 253 161 156 101 114 113 107 87 84 74 86  
83 80 75 66 93 85 94 85 76 67 85 87 88 139 138 117 82 158 120 101  
181 204 130 144 124 111 117 162 141 119 123 172 133 128 125 192 219 185 286 161  
155 222 181 159 200 155 205 139 109 141 189 227 201 149 158 153 174 119 181 175  
176 178 133 166 127 151 123 156 179 121 132 152 209 179 154 161 168 172 163 125  
177 195 161 180 172 181 119 117 86 86 121 79 108 69 79 80 70 87 83 92  
101 159 93 86 109 67 84 73 89 82 57 59 96 99 83 151 142 127 97 113  
106 153 122 201 266 170 238 165 210 218 131

NAP-B08A 114

264 210 252 234 146 111 109 189 275 298 299 247 244 227 112 161 178 162 219 213  
109 93 71 52 65 114 120 97 73 63 73 130 91 191 240 205 136 75 51 119  
183 197 233 166 106 64 63 65 107 136 144 91 106 77 95 112 218 225 258 210  
219 272 147 85 118 157 221 166 123 99 105 152 185 237 187 177 122 161 133 119  
232 217 229 208 182 163 123 93 119 127 98 166 126 94 117 69 111 166 168 167  
147 106 150 111 167 189 260 217 213 194 206 225 229 144

NAP-B08B 114

243 209 248 237 138 115 112 187 274 290 297 243 251 224 112 157 175 166 223 209  
108 91 70 54 61 119 114 92 77 64 73 127 94 198 234 200 138 71 55 116

181 202 230 160 109 64 57 64 104 142 145 95 113 70 96 109 211 226 251 210  
215 265 154 84 118 154 219 153 126 101 105 151 182 237 190 178 120 161 140 121  
233 218 219 218 168 160 123 90 122 122 102 159 130 95 98 90 111 166 161 162  
145 111 148 115 176 185 248 218 219 192 211 224 229 145

NAP-B09A 74

187 176 173 198 129 182 220 200 188 145 164 155 156 139 162 187 148 162 168 197  
141 121 140 186 154 155 136 128 117 111 109 140 127 130 95 100 75 113 70 118  
109 62 66 61 39 92 103 129 128 116 123 153 61 89 93 125 124 120 107 124  
152 105 168 165 132 99 136 175 159 117 137 186 147 120

NAP-B09B 74

188 202 158 207 138 182 219 206 186 147 166 151 165 146 160 192 142 164 163 186  
148 109 151 181 171 151 137 125 110 113 112 143 121 131 92 98 71 115 67 112  
106 69 57 55 44 86 98 122 124 116 132 129 58 94 91 132 123 121 104 128  
150 111 166 165 131 99 140 180 154 117 133 193 145 111

NAP-B10A 78

102 112 103 87 105 91 73 81 86 65 81 125 141 122 90 88 130 131 158 115  
168 120 108 85 90 90 156 131 169 141 106 129 88 89 118 126 192 239 143 203  
208 111 80 107 97 133 95 86 109 100 114 154 130 71 76 80 74 103 97 102  
154 113 126 120 84 101 103 92 115 121 116 123 122 128 108 135 119 119

NAP-B10B 78

93 107 96 91 114 84 76 77 83 74 76 115 139 115 90 88 129 133 149 114  
158 125 108 83 91 89 151 135 160 130 106 131 80 94 111 125 186 252 133 203  
232 108 82 113 88 141 86 81 117 100 114 152 127 70 79 80 72 103 97 97  
155 115 128 111 88 119 103 104 117 129 122 121 116 121 107 145 124 137

NAP-B11A 109

122 122 90 127 108 103 152 137 127 128 147 164 192 214 131 119 139 119 115 114  
159 152 124 137 132 132 136 159 126 137 177 102 121 98 120 126 123 135 147 136  
156 120 121 122 155 136 151 145 123 111 107 89 108 84 142 116 113 103 102 98  
105 90 123 164 128 130 179 136 141 145 167 187 127 129 141 165 124 138 137 160  
95 122 133 143 135 121 178 174 181 140 129 141 143 129 139 161 147 171 143 125  
127 148 152 154 139 128 118 94 110

NAP-B11B 109

117 126 90 127 109 99 155 144 126 121 156 157 195 216 129 115 157 107 115 115  
159 149 122 142 132 142 136 156 129 135 176 98 125 107 115 129 121 137 141 136  
154 128 117 120 147 131 141 134 129 115 101 99 108 83 136 117 100 100 110 101  
95 91 115 162 128 137 188 141 151 147 163 190 115 130 150 155 124 124 139 145  
95 129 141 148 132 127 176 184 187 151 145 156 159 122 134 167 154 162 144 119  
138 150 147 164 123 133 114 112 119

NAP-B12A 104

246 289 150 120 185 174 223 196 317 263 297 164 253 256 398 424 259 259 150 146  
114 106 118 210 257 219 195 203 183 166 258 185 160 182 184 89 69 81 87 92  
137 147 76 71 86 70 117 79 152 127 88 79 62 49 87 80 78 101 76 78  
61 43 50 63 89 63 56 51 54 58 53 66 70 74 64 55 48 64 93 85  
96 114 96 83 116 111 101 100 130 163 163 176 133 133 85 91 83 101 78 51  
74 81 92 114

NAP-B12B 104

252 282 148 124 182 180 222 182 308 270 294 162 253 259 384 429 258 265 136 135  
107 104 118 215 256 214 199 196 191 164 264 179 157 187 184 85 72 78 92 90  
133 151 72 72 83 76 110 86 140 129 85 84 57 50 86 87 66 102 77 75  
56 41 59 67 77 65 50 51 67 64 39 72 73 81 62 45 53 64 94 79  
100 107 102 75 105 92 105 86 144 178 156 177 134 131 85 88 87 103 76 51  
65 88 97 140

NAP-B13A 69

307 371 367 294 415 329 298 370 249 290 308 388 326 275 349 306 300 303 243 263  
229 223 135 172 168 188 236 155 184 186 135 309 179 179 178 185 147 134 142 206  
236 148 172 175 173 275 259 221 198 200 116 189 208 103 192 156 173 116 87 131  
175 157 120 137 118 163 163 184 143

NAP-B13B 69

308 346 349 307 378 334 317 364 244 295 314 373 337 272 347 300 307 303 241 260  
232 219 136 177 163 203 245 154 187 183 135 312 176 175 181 182 148 128 147 215  
226 155 172 167 186 274 255 220 191 198 120 189 205 116 182 159 173 115 84 140  
169 155 117 145 118 174 143 194 144

NAP-B14A 87

160 197 295 354 290 338 426 420 369 407 469 350 445 464 337 335 310 321 300 395  
375 335 364 302 282 257 223 232 251 249 169 241 188 228 239 217 200 218 160 347  
226 182 215 195 225 166 194 231 272 218 223 268 146 236 205 170 181 137 107 152  
211 122 202 182 170 125 116 137 182 156 121 199 155 153 143 195 188 114 116 164  
145 107 155 168 130 180 152

NAP-B14B 87

144 195 284 385 276 337 408 417 363 402 468 341 443 456 346 327 303 321 312 384  
372 330 370 309 272 265 217 230 242 239 177 234 191 219 241 228 201 224 159 348  
223 183 213 182 223 159 193 226 268 211 223 282 149 224 209 177 172 132 110 144  
213 115 195 181 170 125 137 140 183 157 126 195 153 157 135 194 195 126 113 168  
140 106 158 172 129 178 153

NAP-B15A 58

289 285 335 351 334 275 245 301 305 302 326 273 251 292 363 224 219 207 306 241  
285 174 120 184 190 253 325 348 290 211 267 115 141 154 146 196 147 181 184 240  
264 277 299 265 178 180 222 222 283 206 183 190 215 197 164 153 171 164

NAP-B15B 58

287 299 336 327 314 279 239 310 315 316 325 308 279 277 352 235 221 198 333 246  
268 176 118 182 198 245 316 350 276 227 261 122 144 167 144 194 156 177 186 235  
270 271 300 264 180 188 204 258 239 221 166 188 212 202 167 148 177 166

NAP-B17A 99

237 235 183 122 111 54 134 165 239 256 179 175 142 88 66 122 161 167 122 104  
110 56 83 142 142 130 118 126 109 130 71 63 71 89 52 54 84 83 84 81  
71 89 81 73 109 130 116 111 112 82 108 62 45 77 72 60 59 73 65 68  
62 64 77 62 48 78 71 60 57 49 34 28 47 66 98 113 60 82 52 69  
97 86 80 68 56 81 100 125 133 117 103 79 48 44 74 114 146 210 179

NAP-B17B 99

241 226 188 120 119 56 136 161 237 256 190 165 139 95 68 122 162 166 120 106  
116 50 88 141 137 132 121 119 116 132 64 76 72 78 61 50 84 87 70 91  
71 93 75 67 98 134 122 106 111 88 105 62 53 71 64 56 61 74 64 61  
75 56 69 66 44 79 69 53 64 55 34 27 53 57 105 112 71 80 54 68  
94 86 75 72 56 81 102 129 130 115 100 69 49 58 75 124 157 209 158

NAP-B19A 167

156 267 226 114 195 76 96 49 31 40 45 49 73 80 69 76 64 68 65 41  
80 54 71 86 96 89 95 80 68 65 68 50 109 151 190 175 170 229 94 123  
239 219 179 218 221 136 122 128 285 161 171 152 169 87 81 78 166 81 247 245  
158 89 91 150 137 165 164 159 110 64 81 49 60 88 102 114 92 95 51 59  
71 127 86 91 105 86 101 89 78 147 150 122 161 166 128 173 177 130 222 110  
99 158 123 165 197 204 182 203 175 132 141 61 82 115 100 144 188 154 110 104  
69 92 112 140 259 267 157 142 87 81 81 93 129 160 81 96 93 120 123 141  
142 69 65 65 88 109 132 117 107 95 83 72 59 75 87 64 85 106 110 103  
89 101 123 106 95 103 91

NAP-B19B 167

119 269 229 109 200 79 97 43 35 39 41 53 71 85 68 75 63 70 75 39

79 59 65 82 102 92 94 79 77 67 79 77 113 193 152 167 163 241 91 120  
253 237 166 207 211 130 124 136 261 150 152 170 163 81 86 81 152 78 216 249  
158 88 87 146 149 162 166 157 108 69 69 56 58 82 96 113 85 88 51 56  
75 119 95 84 109 85 91 91 74 154 149 118 158 167 130 166 182 135 222 114  
98 155 122 161 187 184 178 189 173 134 146 67 85 117 94 146 187 147 116 98  
72 89 115 140 258 266 160 139 81 82 88 102 134 166 76 97 96 122 117 146  
140 74 69 74 85 101 138 119 106 94 73 67 60 82 81 65 91 100 112 100  
88 94 128 107 100 103 101

NAP-B20A 99

297 265 260 334 301 170 111 86 103 129 201 282 240 170 167 117 214 175 294 332  
299 150 94 72 154 249 262 270 179 125 77 64 112 189 273 237 166 178 120 191  
162 186 200 181 124 120 139 130 77 97 133 212 181 131 109 109 168 202 205 191  
163 112 110 131 120 191 252 327 310 223 136 106 59 109 103 118 127 65 79 67  
44 65 98 129 168 141 144 171 97 94 131 157 196 137 108 143 135 145 131

NAP-B20B 99

309 271 258 342 303 162 106 86 107 130 193 277 251 155 167 122 209 178 295 329  
305 149 89 74 167 246 263 273 179 115 74 63 122 185 278 227 164 186 124 187  
157 186 199 183 129 118 141 128 82 92 139 203 182 127 108 112 172 195 210 187  
162 120 109 126 124 191 250 327 308 216 143 102 61 107 104 116 134 62 82 65  
41 67 91 135 162 128 161 156 95 98 120 167 187 137 107 140 133 151 136

NAP-B21A 164

359 357 260 289 315 322 287 236 264 182 275 193 178 152 130 108 103 83 90 96  
101 109 64 107 85 74 70 53 53 80 100 105 109 111 91 45 70 66 52 87  
86 57 49 32 51 61 50 63 68 29 36 31 43 26 59 77 75 49 23 21  
59 49 47 67 57 40 29 23 27 39 40 46 45 45 29 43 29 43 68 55  
45 46 60 54 43 65 74 89 49 47 60 59 46 45 87 59 63 81 55 60  
65 75 71 116 81 78 69 50 47 67 60 90 81 57 85 56 36 45 73 91  
83 43 63 58 39 34 46 84 60 72 41 90 56 40 119 79 80 40 41 38  
46 43 77 106 69 75 60 64 51 71 67 70 64 68 68 47 64 59 45 70  
68 60 55 54

NAP-B21B 164

330 362 308 287 292 341 283 216 274 185 285 196 181 148 127 113 98 86 82 99  
102 103 61 108 83 73 70 59 49 75 108 108 105 108 87 50 60 69 60 81  
89 49 53 39 45 58 45 67 64 31 32 35 37 32 59 85 62 59 30 17  
45 59 56 61 60 39 28 19 34 41 36 54 43 40 35 46 26 45 68 54  
55 56 60 49 49 54 75 85 51 47 63 55 50 48 75 70 60 82 62 57  
64 82 75 108 76 83 73 44 47 75 55 95 79 63 76 59 32 53 62 90  
71 56 57 58 31 39 56 75 67 73 36 94 44 51 114 77 78 43 39 46  
47 39 81 98 74 71 58 70 53 76 68 67 60 72 66 53 53 53 52 62  
66 57 53 62

NAP-B22A 149

123 207 175 153 159 217 214 240 164 217 223 214 153 129 112 91 105 79 48 76  
130 142 142 158 156 108 82 137 133 116 167 154 103 73 72 98 99 137 144 132  
92 102 95 132 119 190 188 144 102 68 61 102 114 93 107 74 83 50 33 58  
49 67 68 57 51 50 34 50 51 55 59 55 54 31 48 48 57 57 68 55  
43 41 66 55 55 92 90 98 68 59 72 66 97 96 92 83 83 70 49 68  
109 76 97 84 63 70 37 45 68 74 85 86 70 99 120 69 42 81 94 118  
126 106 118 142 145 168 191 138 87 108 114 127 131 152 224 198 148 168 131 156  
142 169 192 167 160 129 119 157 126

NAP-B22B 149

119 215 191 171 166 228 212 262 148 245 239 215 155 127 105 84 102 71 49 77  
137 144 144 159 173 106 80 141 137 116 171 157 104 79 75 100 94 144 142 137  
91 106 97 137 123 197 194 155 104 65 56 110 114 104 102 83 84 56 32 46

58 61 61 66 64 42 43 58 45 50 63 53 48 37 53 46 56 63 62 52  
45 47 53 59 57 92 96 100 71 56 87 66 94 88 102 78 89 66 57 65  
114 77 91 95 63 72 41 47 67 66 91 91 76 89 125 65 48 79 98 123  
128 98 127 148 144 156 190 131 94 112 115 129 133 139 222 206 142 174 114 147  
155 164 213 173 158 122 118 116 139

NAP-B23A 110

304 156 161 119 120 166 92 150 219 123 164 135 202 120 253 346 379 295 187 168  
364 289 276 314 288 232 177 119 176 214 240 193 196 212 143 174 147 187 222 251  
175 132 170 175 180 183 229 314 165 161 156 188 178 142 201 200 190 196 187 183  
157 229 177 196 161 168 183 125 193 225 172 253 224 112 106 87 57 109 184 233  
336 196 130 152 84 81 124 178 161 150 135 189 216 179 307 343 205 127 141 196  
193 171 140 247 248 233 191 215 177 214

NAP-B23B 110

258 168 153 133 118 164 109 147 190 152 180 150 181 119 267 341 371 308 181 170  
355 290 266 317 283 219 176 116 182 201 236 197 195 209 149 178 142 170 225 233  
177 136 168 171 179 190 227 314 181 169 154 186 179 141 211 194 187 199 181 171  
165 223 179 197 161 160 195 119 191 225 177 244 245 112 107 76 69 107 187 238  
330 200 127 154 80 84 124 177 159 155 132 205 215 176 279 353 212 128 143 198  
202 164 151 235 255 233 173 187 171 223

NAP-B24A 104

123 97 131 148 92 121 150 139 125 103 142 132 130 140 145 152 151 170 167 158  
161 140 95 153 147 145 213 175 172 180 156 150 189 205 137 109 124 116 111 100  
144 149 121 124 121 100 124 152 122 114 140 126 134 105 129 122 113 129 159 136  
176 144 167 174 183 139 153 137 130 99 101 71 102 91 139 104 90 123 88 87  
110 88 141 153 120 114 164 119 111 155 154 167 131 120 162 171 125 160 162 111  
80 77 92 119

NAP-B24B 104

119 108 157 153 95 130 144 137 126 108 140 137 130 147 142 148 148 170 167 159  
164 136 98 140 143 150 208 177 171 181 155 148 189 206 129 103 106 122 105 95  
140 142 119 124 115 90 124 147 114 123 135 131 120 104 133 124 119 137 155 139  
173 148 153 178 176 140 152 138 131 86 109 84 94 97 143 109 108 118 96 78  
104 93 129 154 122 113 167 102 134 139 156 163 147 111 169 166 122 166 152 116  
82 70 102 114

NAP-B25A 110

319 124 144 211 172 147 151 148 176 168 313 203 198 253 315 211 152 132 124 184  
157 150 105 146 155 110 148 154 146 158 161 146 156 123 131 123 115 204 97 109  
86 89 73 100 128 115 84 95 111 107 94 120 131 116 128 109 94 103 156 125  
149 176 124 104 131 155 149 152 132 170 197 160 115 133 170 145 130 186 117 124  
113 46 115 157 84 198 110 93 73 61 80 89 124 144 190 121 120 190 100 103  
128 126 129 92 98 94 131 108 112 128

NAP-B25B 110

325 133 141 212 150 167 150 139 180 185 274 182 199 253 302 217 163 115 134 180  
167 173 111 145 151 108 154 156 145 161 157 145 151 132 149 118 112 194 102 111  
92 85 75 102 129 107 83 102 98 108 100 115 139 108 121 107 100 98 156 125  
142 172 114 107 135 149 145 149 145 173 195 164 110 131 163 147 130 187 127 110  
107 49 117 148 80 205 108 102 72 66 79 84 126 136 176 138 130 185 100 105  
114 137 125 91 101 102 122 101 115 120

NAP-B26A 76

224 212 213 190 177 158 187 125 140 107 161 161 168 170 130 119 177 151 169 240  
174 206 92 43 82 103 144 152 156 150 126 92 122 171 168 174 116 136 143 109  
158 180 163 162 92 103 104 138 128 136 96 127 82 103 70 66 79 78 110 105  
123 73 71 35 28 28 30 31 43 41 35 29 33 28 37 46

NAP-B26B 76

252 211 224 196 177 163 195 112 140 116 159 188 167 165 122 126 173 154 174 232  
171 207 93 46 79 110 146 157 158 141 124 105 124 177 166 153 132 129 154 120  
161 169 158 162 98 102 101 142 122 137 106 134 82 106 66 64 83 77 111 106  
125 76 68 31 31 27 33 31 38 40 29 23 27 27 27 22

NAP-B27A 144

234 332 367 203 290 293 246 177 238 129 180 239 259 241 188 179 179 153 156 134  
169 227 184 168 191 356 182 152 221 162 178 232 256 217 179 112 151 156 243 192  
177 159 194 113 148 143 178 200 181 145 118 140 238 125 134 206 173 250 96 41  
75 88 146 141 144 118 97 65 83 163 146 131 116 103 121 105 128 134 187 185  
90 103 90 146 116 135 90 142 88 75 53 57 67 76 83 87 97 57 53 28  
30 47 31 31 43 42 38 30 32 43 31 40 49 43 37 41 38 32 31 31  
34 36 32 35 35 34 36 37 33 27 20 25 34 27 28 26 32 29 31 34  
30 35 29 36

NAP-B27B 144

232 343 361 206 288 272 235 155 236 126 177 243 257 237 176 183 171 161 153 137  
154 244 182 167 208 337 185 157 223 161 177 229 255 218 182 120 115 181 258 185  
183 152 200 117 148 140 180 201 184 145 116 144 225 121 139 213 172 249 99 37  
84 92 145 154 149 107 98 66 82 155 150 131 119 100 124 103 128 143 181 185  
89 96 95 145 114 133 93 137 90 72 60 54 70 85 75 92 94 49 56 27  
29 41 26 34 45 42 42 30 30 40 37 41 51 44 38 44 35 30 30 33  
30 30 28 31 36 35 40 37 30 29 20 25 30 27 25 30 34 33 29 30  
28 31 39 40

NAP-B28A 117

366 246 209 231 251 107 63 49 56 66 48 55 80 83 62 90 98 102 141 154  
81 75 49 75 77 65 60 80 75 84 72 92 76 145 137 86 66 87 98 130  
108 118 172 200 181 130 62 80 61 68 81 65 87 63 45 71 57 77 79 70  
67 61 74 83 83 99 89 82 75 95 109 93 125 206 207 217 250 267 240 261  
283 288 298 324 232 272 149 171 215 147 231 241 205 212 189 163 189 165 202 286  
225 199 284 152 142 148 203 188 175 151 157 150 138 182 169 144 98

NAP-B28B 117

365 249 184 226 235 104 63 45 60 61 48 56 84 70 62 84 100 104 137 161  
86 61 62 77 66 77 59 79 80 77 80 83 84 150 126 93 63 90 88 140  
114 112 180 196 178 124 68 77 60 73 68 75 73 80 47 59 62 73 75 76  
74 61 68 89 80 99 87 82 83 92 98 110 132 212 212 221 240 280 247 258  
274 274 291 317 231 279 156 165 212 150 232 208 202 212 185 166 209 167 204 291  
222 191 288 159 128 160 196 192 170 159 159 158 136 176 176 134 140

NAP-B29A 124

362 217 183 172 161 144 120 75 111 144 160 188 102 147 95 89 60 68 77 95  
106 105 109 115 76 63 79 77 64 107 110 74 64 53 62 62 59 57 66 50  
47 32 43 32 56 70 54 63 46 47 67 64 58 71 70 86 75 86 126 211  
249 259 206 208 145 212 175 250 281 283 291 246 228 175 201 178 221 230 147 181  
178 225 183 149 180 185 173 138 116 171 155 154 144 157 134 136 112 90 82 146  
94 192 119 103 116 86 85 108 132 147 155 142 151 148 96 99 139 158 162 149  
107 182 170 121

NAP-B29B 124

353 214 188 178 164 150 141 76 122 143 160 190 95 131 93 78 71 67 77 95  
114 95 117 111 74 65 80 84 70 109 116 69 65 53 59 65 60 54 67 53  
42 42 46 27 51 68 64 55 49 40 61 64 60 65 78 82 72 86 128 211  
246 265 204 201 147 199 171 253 276 277 300 242 229 173 192 191 222 227 141 180  
184 221 185 137 191 184 173 136 122 168 155 153 143 153 129 139 120 92 78 147  
90 197 120 98 108 92 88 105 127 161 147 148 145 152 90 93 147 151 150 163  
97 191 169 121

NAP-B30A 70

214 260 149 196 64 82 88 129 124 115 142 121 126 111 110 101 107 134 91 90  
101 155 91 102 152 140 158 113 89 98 126 129 106 144 89 79 80 66 56 98  
50 98 60 42 44 33 45 87 77 109 117 113 76 91 60 93 88 160 130 67  
79 117 154 98 128 171 103 40 57 56

NAP-B30B 70

219 155 115 151 72 85 84 126 127 115 115 113 109 111 131 100 108 133 92 79  
101 139 98 103 144 154 158 110 81 100 115 130 103 163 89 84 80 59 59 97  
54 99 59 45 45 38 42 85 79 118 109 106 60 111 58 84 89 165 130 64  
83 121 153 104 126 173 96 40 53 75

NAP-B31A 115

488 486 418 297 261 258 162 188 147 114 163 102 201 221 188 165 159 122 178 206  
227 211 175 212 235 152 188 213 278 279 202 251 248 207 173 121 162 168 99 65  
94 109 130 159 187 218 165 213 233 294 223 233 282 215 181 111 99 173 169 114  
150 195 175 215 130 157 184 315 146 298 144 141 156 119 89 75 201 236 261 147  
166 165 114 193 243 202 161 153 106 169 209 125 207 169 171 95 85 85 130 188  
185 149 165 144 182 181 181 128 94 100 105 111 126 114 136

NAP-B31B 115

490 490 438 287 235 275 172 178 153 110 168 104 195 219 172 179 157 128 184 193  
228 213 176 192 232 151 169 215 290 268 209 250 234 202 171 119 155 166 103 66  
81 103 131 171 182 214 161 204 239 293 239 230 294 220 183 109 96 168 166 128  
149 179 191 209 132 155 181 307 148 292 141 153 148 112 76 80 194 223 285 142  
169 165 114 196 242 195 172 141 103 170 204 130 202 170 151 97 83 99 125 187  
177 174 142 154 166 174 165 133 88 125 114 125 116 128 109

NAP-B32A 81

319 127 132 155 220 260 201 213 196 96 104 123 173 164 174 169 151 163 159 242  
256 221 140 77 73 57 55 43 57 75 62 60 78 139 100 95 173 140 157 108  
77 98 132 121 121 167 164 164 147 130 143 200 146 214 157 142 205 137 97 85  
125 177 232 169 179 262 134 159 212 157 165 140 88 119 129 121 137 125 135 120  
91

NAP-B32B 81

301 157 122 142 208 255 184 196 186 102 98 111 164 166 187 183 151 168 160 251  
253 211 136 82 56 53 47 45 47 56 67 46 90 132 111 90 175 133 165 114  
72 96 131 124 121 156 170 143 145 119 137 189 140 213 157 138 199 135 101 81  
124 173 229 164 166 270 137 153 212 163 167 135 93 119 126 125 137 130 129 117  
94

NAP-B33A 71

181 159 119 110 204 160 134 138 165 142 150 203 299 382 361 444 494 455 426 241  
292 359 292 267 333 311 333 311 285 274 248 175 184 185 165 191 183 160 201 268  
231 236 234 168 191 135 189 219 243 229 197 139 204 150 142 157 237 194 163 169  
121 170 147 188 284 212 296 239 235 204 261

NAP-B33B 71

183 160 121 107 205 161 133 136 168 144 146 201 306 380 364 456 504 460 429 256  
301 374 287 264 338 307 337 301 267 248 229 181 189 187 169 186 164 157 190 295  
234 237 253 168 193 121 183 214 222 214 195 126 199 157 150 167 229 198 164 160  
137 176 144 184 254 223 306 243 234 204 244

NAP-B34A 55

101 93 85 73 101 83 80 104 114 104 113 118 115 157 174 126 168 182 147 138  
151 238 246 273 257 240 224 180 174 167 210 303 195 191 193 165 134 139 148 182  
117 198 136 139 101 84 114 115 128 145 158 174 167 186 155

NAP-B34B 55

99 103 78 74 107 81 79 112 109 112 115 114 115 142 177 128 162 186 147 134  
150 250 255 270 252 237 219 179 170 171 209 288 199 195 192 166 134 140 139 194  
121 201 137 134 94 88 120 124 125 146 150 156 157 186 159

NAP-B37A 90

323 200 168 103 67 107 130 153 159 161 152 146 115 118 119 153 143 108 84 104  
75 65 112 108 80 75 90 75 70 59 72 74 63 39 54 53 58 46 60 55  
59 61 66 94 86 94 96 114 96 115 108 113 111 109 98 105 123 134 174 156  
142 151 120 83 105 107 97 115 132 65 79 125 101 153 135 122 160 98 179 143  
127 146 91 64 94 116 102 99 148 118

NAP-B37B 90

329 197 170 104 65 108 123 147 163 159 158 148 121 113 110 146 150 100 84 103  
82 74 107 106 79 77 86 75 76 61 64 82 67 38 45 60 49 54 63 50  
60 55 79 85 84 90 102 110 107 101 114 105 116 102 97 108 120 137 170 162  
142 152 120 80 116 98 101 115 126 84 67 125 105 144 148 128 163 91 192 129  
135 137 90 72 83 114 104 104 146 122

NAP-B38A 67

127 154 190 142 196 225 202 144 143 161 119 114 161 159 147 121 101 177 163 159  
157 186 120 174 113 123 152 117 105 89 119 89 101 98 94 99 77 138 165 160  
184 148 191 193 169 180 132 158 181 136 162 198 157 209 186 151 182 158 142 141  
144 134 154 159 142 125 197

NAP-B38B 67

133 158 185 144 194 227 175 145 157 169 126 144 172 176 154 126 101 171 173 160  
147 182 126 180 118 117 151 117 103 83 132 88 101 97 103 95 84 130 170 156  
183 148 186 199 172 174 129 167 178 144 159 190 170 226 182 165 175 159 146 135  
150 144 157 163 134 123 186

NAP-B39A 96

404 368 371 246 283 272 256 222 174 203 178 142 145 126 171 179 196 214 161 240  
131 101 137 111 142 135 193 132 94 141 125 122 112 118 103 56 64 48 80 47  
106 111 109 88 91 71 84 75 88 77 75 77 58 38 56 74 94 73 81 71  
59 70 54 45 67 68 59 46 51 84 77 75 86 93 89 67 94 128 106 84  
116 84 89 65 65 85 74 63 48 70 86 63 59 59 57 68

NAP-B39B 96

403 362 378 254 275 267 251 226 182 204 174 145 154 111 168 175 181 220 158 234  
135 97 134 118 137 122 187 133 87 139 133 128 104 117 109 66 58 49 85 38  
110 117 106 90 82 67 88 87 91 79 67 73 66 36 48 67 90 73 78 73  
69 67 52 46 65 74 55 39 50 90 75 79 88 102 80 63 89 125 76 88  
106 87 84 66 67 91 61 64 53 71 82 64 62 53 67 71

NAP-B40A 64

77 73 91 98 116 125 107 80 102 151 164 173 171 169 150 123 103 84 100 92  
86 70 78 82 64 63 60 65 75 77 95 91 73 72 52 40 42 51 56 67  
50 57 48 47 52 68 45 67 51 43 45 53 53 51 66 50 45 36 23 36  
31 43 63 66

NAP-B40B 64

66 80 92 100 111 115 121 77 101 151 186 151 157 175 155 112 114 71 106 87  
80 63 83 77 64 60 63 67 80 70 97 90 76 66 58 40 42 49 61 58  
50 56 56 34 46 69 46 70 55 39 43 56 50 55 65 53 41 36 25 37  
34 36 63 57

NAP-B41A 95

114 110 112 70 70 86 89 72 73 96 124 149 150 154 159 111 129 177 194 186  
191 171 171 138 133 114 133 141 92 105 127 117 88 66 67 83 94 86 119 96  
79 89 67 47 54 75 84 91 66 62 69 42 55 62 62 67 42 35 37 41  
42 55 54 42 36 31 31 30 32 36 42 55 39 50 40 36 41 34 40 35  
53 51 58 60 66 79 71 58 62 54 47 43 44 46 51

NAP-B41B 95

109 115 116 64 77 81 85 73 76 93 126 151 146 153 163 120 123 176 196 183  
192 168 161 126 135 106 136 118 90 94 127 118 97 65 59 84 100 89 121 94



86 89 67 44 54 75 87 88 75 60 62 46 51 65 62 63 48 40 38 35  
43 48 55 46 32 28 35 32 32 33 45 51 45 44 45 38 37 34 38 35  
50 51 60 62 56 77 72 56 64 56 44 40 43 44 47

NAP-B42A 83

127 156 120 68 45 38 74 130 105 140 116 114 81 48 38 60 62 90 64 46  
65 66 95 115 139 114 111 121 84 100 75 73 93 83 61 62 75 113 158 151  
164 160 125 158 189 223 215 211 206 183 136 140 110 140 115 81 90 121 122 78  
61 60 68 75 72 98 79 61 66 55 39 39 52 58 66 59 48 52 35 49  
50 44 60

NAP-B42B 83

138 159 115 74 53 34 77 123 123 146 104 114 82 53 36 51 70 83 65 53  
60 65 93 131 122 117 104 115 102 96 68 81 99 77 54 66 82 114 153 145  
157 169 117 150 219 231 220 197 219 181 129 138 117 131 120 78 105 125 122 84  
62 65 68 88 74 105 76 76 75 50 40 38 59 66 74 54 50 59 31 45  
54 52 60

NAP-B43A 148

376 285 275 348 306 280 200 176 173 198 164 221 220 128 139 103 159 119 168 184  
165 146 129 123 68 91 99 139 140 127 118 87 110 113 113 97 108 93 61 69  
102 140 149 111 98 136 90 185 145 193 140 173 61 113 163 146 126 139 163 115  
100 107 106 127 147 132 100 110 97 81 93 69 116 138 116 85 142 119 151 119  
182 150 149 174 226 162 229 262 171 258 129 197 164 170 162 189 152 128 148 119  
127 111 130 93 106 90 130 130 111 146 122 114 133 106 108 111 125 120 102 93  
89 108 123 130 144 145 182 130 135 103 124 102 103 105 77 140 139 94 89 96  
90 125 167 94 130 171 101 140

NAP-B43B 148

333 291 193 329 309 255 235 169 182 191 158 213 209 142 168 120 160 113 163 182  
169 149 131 110 94 67 107 143 115 122 128 82 114 109 116 102 104 94 56 75  
95 138 152 115 101 141 87 191 136 198 137 169 68 110 162 143 123 136 164 112  
104 107 103 132 144 129 100 114 97 79 91 69 116 140 116 87 149 114 149 125  
178 149 150 177 232 170 235 257 174 267 135 199 159 168 157 170 150 129 155 113  
131 112 122 101 107 88 136 125 112 145 127 106 137 101 100 115 128 116 102 101  
92 106 126 128 143 146 185 133 129 113 122 98 113 91 87 130 135 100 90 100  
90 118 163 102 132 169 109 113

NAP-B44A 55

170 208 167 167 278 260 220 219 222 236 198 234 141 239 288 260 215 253 199 193  
211 154 78 134 187 206 187 182 201 147 206 285 269 317 249 256 255 325 379 322  
370 288 243 300 358 286 209 171 231 202 180 154 152 148 184

NAP-B44B 55

204 186 179 156 256 260 232 215 226 205 218 227 145 232 295 250 217 249 198 188  
215 150 86 149 185 202 177 179 200 147 211 292 282 301 264 242 269 313 386 313  
350 286 254 279 380 284 190 191 205 187 191 161 181 108 163

NAP-B45A 68

124 215 245 239 183 274 308 261 270 168 196 217 199 131 166 204 249 299 369 336  
408 277 424 303 321 420 286 188 224 229 206 238 161 198 239 140 136 85 68 75  
54 58 64 93 93 129 144 131 82 129 109 137 184 153 134 153 182 107 98 77  
58 72 50 42 45 53 57 61

NAP-B45B 68

125 209 253 254 182 275 317 256 274 171 196 217 196 138 158 209 241 305 360 336  
393 271 438 299 315 425 278 203 229 222 219 248 171 196 231 137 135 83 65 73  
48 65 63 84 103 126 148 120 89 122 124 139 184 152 135 154 179 116 99 68  
63 70 49 44 47 53 55 61

NAP-B46A 47

250 573 377 430 374 252 166 251 236 304 326 156 193 232 205 255 253 180 215 157

155 118 145 159 189 219 181 141 159 104 158 206 167 275 255 240 198 170 104 147  
97 103 105 135 106 105 124

NAP-B46B 47

250 574 399 417 385 255 161 231 235 302 327 160 192 234 207 261 251 178 211 166  
141 120 135 158 188 221 164 139 153 99 161 197 173 273 266 233 198 172 103 142  
106 103 110 138 100 104 128

NAP-B47A 50

210 228 264 275 277 291 325 401 331 630 383 312 465 327 277 279 355 387 424 329  
339 266 194 388 303 347 273 287 188 203 178 181 221 205 171 164 171 177 227 179  
174 212 159 116 183 104 122 102 128 79

NAP-B47B 50

219 243 285 285 281 313 325 417 347 642 371 327 469 353 265 287 357 386 428 330  
338 276 186 388 300 349 279 276 191 204 175 180 230 195 178 151 186 169 228 172  
179 218 163 154 135 111 131 88 124 73

NAP-B48A 50

330 206 294 298 372 242 291 292 306 312 259 275 324 378 268 230 247 285 201 186  
212 238 201 232 258 226 184 189 223 176 177 164 185 202 181 171 262 196 175 178  
181 233 192 199 212 176 194 192 169 191

NAP-B48B 50

301 182 272 312 375 331 279 327 303 297 275 293 340 380 263 230 255 278 197 188  
208 233 205 236 261 222 183 221 228 187 169 164 181 198 181 174 266 200 174 180  
164 230 192 196 216 182 194 191 168 193

NAP-B49A 88

88 106 102 85 62 70 74 81 83 67 92 32 102 103 88 63 55 51 95 88  
89 112 60 87 54 46 91 97 139 49 76 81 91 137 115 160 222 177 183 150  
105 138 124 127 134 204 154 128 146 172 139 144 192 191 149 189 173 148 138 148  
114 121 75 73 62 56 47 84 68 73 57 42 46 39 46 43 43 46 58 53  
54 79 44 68 76 65 76 66

NAP-B49B 88

96 114 90 113 77 70 73 69 83 45 90 33 95 105 78 63 50 44 99 94  
103 111 72 81 61 62 79 110 122 58 74 92 98 149 105 161 217 178 185 153  
111 122 134 122 128 223 153 128 144 176 140 145 188 181 159 183 167 146 143 149  
119 126 76 73 64 53 49 83 65 75 57 40 53 45 40 41 37 41 65 60  
49 68 50 70 72 62 78 77

NAP-B50A 112

184 123 129 140 160 138 138 192 189 122 134 148 144 156 160 182 149 156 160 85  
126 104 185 210 198 178 131 152 174 138 165 231 150 192 128 121 157 242 171 158  
182 203 194 261 199 227 302 276 252 200 140 174 160 176 166 218 160 157 179 172  
121 119 175 169 140 158 121 100 161 139 124 192 90 110 105 105 128 158 101 158  
106 96 86 109 152 163 164 202 102 100 65 74 68 86 99 77 67 58 68 83  
79 66 55 97 93 54 72 75 93 128 184 238

NAP-B50B 112

182 123 120 142 159 125 152 201 193 116 131 141 144 140 172 194 151 153 145 91  
120 95 196 215 208 178 114 135 179 137 172 224 148 184 135 122 158 223 190 150  
184 202 191 255 202 212 300 273 250 199 141 168 157 181 158 220 161 158 180 169  
119 124 167 171 134 158 126 102 159 131 123 190 93 116 98 106 123 155 103 155  
101 101 81 116 145 161 160 192 108 96 58 81 67 94 99 66 77 58 67 80  
88 61 60 90 81 59 70 73 89 131 177 217

NAP-B51A 57

147 231 231 256 373 445 314 205 212 230 187 128 110 80 72 40 36 42 60 51  
62 69 114 128 102 121 106 102 117 103 85 108 79 95 87 69 76 89 85 101  
142 143 210 190 194 300 195 118 147 184 259 266 154 108 199 140 118

NAP-B51B 57

156 239 225 252 362 445 320 199 184 230 202 133 94 104 76 36 40 45 57 50  
50 65 115 113 113 126 97 104 107 92 93 94 85 86 87 75 71 98 84 95  
144 134 217 186 198 280 193 122 137 186 279 264 156 98 202 143 124

NAP-B52A 122

82 92 63 51 51 91 155 155 136 112 180 120 76 85 86 49 62 79 97 112  
112 135 103 127 162 155 267 229 139 104 137 143 167 213 161 142 75 72 47 79  
65 126 137 122 86 53 87 171 119 132 114 84 105 63 47 73 103 146 115 132  
92 85 125 116 194 201 202 144 173 146 128 84 136 69 182 124 106 136 128 173  
177 222 187 176 111 137 127 162 142 144 169 147 119 153 100 154 92 128 188 157  
138 128 132 109 144 121 204 211 196 205 189 138 102 141 150 139 101 86 140 126  
107 117

NAP-B52B 122

76 86 54 59 45 85 166 169 124 115 181 117 79 84 89 51 58 77 100 108  
116 137 105 131 148 168 257 232 149 106 134 145 167 213 160 147 67 75 51 85  
61 129 130 125 80 58 84 164 123 136 107 83 122 60 43 90 101 141 122 121  
97 89 115 122 187 200 211 141 182 139 132 84 133 71 180 127 104 140 133 176  
173 232 181 175 111 136 127 166 142 151 157 148 121 148 97 150 93 128 195 154  
141 127 139 107 137 138 184 216 200 215 185 135 99 137 149 134 106 89 136 127  
103 115

NAP-B53A 115

228 151 211 298 197 274 248 265 254 337 187 324 290 235 309 256 275 246 172 184  
197 141 206 217 190 195 153 210 153 83 97 98 113 184 218 211 179 189 151 117  
161 121 140 191 206 122 97 145 120 127 122 172 137 105 98 60 100 77 137 133  
150 136 77 103 179 172 199 200 112 141 110 54 93 89 132 110 109 121 114 151  
121 196 205 177 141 174 166 147 75 134 81 200 114 94 146 143 181 184 195 165  
165 124 116 123 222 205 177 212 213 160 182 107 187 137 135

NAP-B53B 115

226 142 214 302 186 293 253 274 244 339 184 327 284 226 312 257 288 238 174 180  
194 139 192 216 188 197 146 213 146 94 102 91 108 202 215 213 169 187 144 114  
167 121 139 196 204 122 97 146 127 120 118 168 141 105 93 69 95 78 138 137  
155 135 74 111 164 184 197 196 118 143 100 62 90 83 133 117 116 118 112 165  
123 189 204 178 144 170 166 148 85 123 87 199 105 100 149 156 186 186 203 155  
175 104 135 131 223 193 192 196 210 155 178 128 181 120 143

NAP-B54A 61

126 156 215 181 176 136 169 124 200 162 129 135 125 117 122 98 111 160 169 239  
185 196 201 138 93 96 126 128 176 145 141 120 102 129 142 137 153 138 100 102  
138 123 129 108 76 38 52 70 90 80 64 108 99 91 73 71 60 52 62 66  
62

NAP-B54B 61

122 152 217 178 169 130 161 122 192 169 128 141 122 112 125 97 108 162 166 237  
186 199 218 129 93 95 120 143 193 146 139 115 103 137 141 136 152 136 100 104  
139 120 129 110 70 40 55 66 90 76 69 112 90 88 77 66 64 56 60 65  
62

NAP-B55A 76

221 221 211 116 121 128 146 143 168 118 128 106 103 118 121 80 108 173 142 142  
124 114 130 114 137 117 154 144 127 190 152 169 216 194 260 245 192 229 191 134  
122 217 237 270 157 199 229 141 173 248 159 178 168 103 117 144 126 175 166 114  
78 91 109 129 109 148 111 146 154 128 154 170 158 161 110 123

NAP-B55B 76

211 214 216 119 134 125 143 136 173 124 149 95 103 110 120 90 106 165 138 145  
120 121 132 120 131 123 149 150 120 196 149 167 216 200 262 250 191 226 186 135  
124 217 232 279 155 203 223 143 174 243 153 185 166 115 111 138 138 178 167 123  
78 95 99 121 121 149 103 128 160 128 154 171 158 158 116 120

NAP-B57A 114

204 131 183 144 139 173 173 139 147 156 100 101 144 142 133 139 144 114 98 86  
126 120 120 108 96 99 104 80 104 84 139 131 117 133 108 86 118 113 86 114  
66 87 71 60 74 86 106 104 96 111 93 104 91 110 121 109 111 94 111 87  
119 106 132 128 96 103 104 109 111 108 111 128 156 117 94 95 119 116 116 130  
111 109 99 96 109 123 95 151 145 98 113 85 113 149 143 156 148 155 123 163  
106 115 114 135 145 101 94 106 113 89 106 134 110 80

NAP-B57B 114

167 133 190 141 134 193 175 140 149 164 107 93 153 131 138 138 144 117 97 87  
123 119 122 121 95 93 120 82 101 96 134 130 124 143 109 94 118 107 89 119  
65 79 75 67 73 83 114 112 97 109 92 107 85 102 126 115 104 102 106 89  
122 103 148 114 91 100 103 109 118 99 112 133 154 115 97 106 118 119 111 135  
113 105 102 100 113 111 81 153 148 104 105 87 111 160 136 150 152 167 111 166  
105 101 120 138 138 106 93 105 114 88 108 123 113 93

NAP-B58A 81

174 279 342 238 243 340 230 230 208 164 187 140 139 119 165 110 128 150 195 177  
144 190 193 169 207 172 188 225 207 162 120 132 143 184 174 183 221 226 226 229  
200 254 234 133 91 127 155 192 155 168 199 129 180 181 137 145 142 98 122 123  
122 163 172 99 104 102 129 134 142 107 137 143 144 129 117 131 89 124 131 156  
100

NAP-B58B 81

177 277 345 235 254 340 228 233 213 167 191 140 127 122 166 121 143 158 166 177  
143 185 196 172 212 163 182 227 230 153 116 115 134 176 178 170 230 249 226 240  
207 234 228 136 88 130 156 192 158 166 197 128 182 177 137 153 146 95 126 132  
115 165 177 90 106 93 120 134 143 102 137 130 166 122 123 126 99 124 130 140  
105

NAP-B59A 58

289 324 295 320 266 278 347 279 273 256 273 244 216 179 265 256 158 265 202 158  
232 126 115 110 167 221 282 182 183 173 138 172 140 159 137 123 79 160 171 117  
188 181 138 112 125 130 174 113 173 152 134 139 125 140 144 112 115 98

NAP-B59B 58

279 329 298 327 261 293 345 293 273 246 250 242 215 172 249 259 158 260 200 158  
230 125 120 100 164 225 286 179 186 170 129 161 132 174 138 122 103 155 159 123  
163 168 138 116 127 135 169 143 177 152 129 140 123 143 152 105 117 113

NAP-B60A 85

257 193 247 276 246 243 339 179 213 242 255 159 184 189 172 209 206 191 134 154  
194 166 184 138 195 207 177 239 183 152 175 164 183 231 184 208 153 120 128 170  
253 251 149 153 150 167 110 170 170 159 130 122 130 94 124 91 114 135 98 98  
108 158 125 122 158 134 128 147 102 132 155 161 122 144 126 82 94 83 106 134  
92 136 96 98 105

NAP-B60B 85

229 209 247 273 250 239 344 185 205 238 259 155 175 197 188 211 207 189 138 155  
190 162 182 146 197 209 181 237 198 156 185 163 179 240 184 205 153 121 128 187  
264 250 144 157 170 171 109 171 165 159 137 117 126 103 119 97 105 138 100 94  
111 160 123 120 141 171 106 149 101 136 155 163 118 141 118 91 95 89 99 132  
92 139 92 110 107

NAP-B61A 107

412 282 284 215 210 177 259 212 179 265 219 189 214 423 199 144 100 129 160 130  
131 85 93 108 87 116 98 105 105 140 146 104 82 105 95 80 138 91 122 73  
61 73 82 84 92 64 95 98 88 69 92 113 111 99 95 97 79 100 76 86  
89 76 65 92 130 127 109 128 153 127 127 100 127 144 123 115 126 118 83 54  
45 49 91 66 109 104 87 62 66 77 68 76 93 144 102 89 162 98 133 165  
155 167 146 117 171 192 122

NAP-B61B 107

398 288 286 215 210 172 257 190 181 249 200 193 205 400 184 147 107 121 162 105  
131 81 95 114 79 117 92 105 108 127 146 111 84 105 79 88 144 84 130 71  
61 71 78 87 97 69 92 97 91 64 96 115 113 98 97 93 77 96 80 82  
93 74 72 106 132 107 122 121 151 128 114 101 128 139 113 124 122 113 83 60  
42 51 95 63 120 113 70 71 67 68 78 70 106 144 101 98 151 93 135 161  
145 168 126 116 180 170 136

NAP-B62A 90

347 307 364 342 334 357 432 311 382 481 386 334 233 238 209 286 284 258 353 351  
311 337 284 210 308 283 414 351 316 272 250 280 263 267 299 225 228 254 240 253  
311 314 291 305 321 264 251 197 251 219 251 199 264 192 265 228 261 324 298 306  
262 287 405 254 223 233 230 261 318 380 414 336 316 285 213 154 131 183 144 125  
135 195 190 194 193 216 241 155 139 122

NAP-B62B 90

354 318 357 332 340 357 411 308 378 482 379 335 227 250 198 287 277 258 369 349  
313 328 277 211 292 260 413 343 314 266 240 277 267 261 294 230 227 252 238 256  
310 320 288 302 323 264 249 195 250 224 248 200 266 188 266 228 263 326 288 311  
268 281 407 258 222 227 229 264 323 368 411 337 331 278 188 150 136 181 142 134  
132 175 177 194 182 211 253 153 153 120

NAP-B63A 61

202 231 216 281 267 231 177 153 167 219 149 192 179 136 151 143 147 159 158 155  
126 183 155 179 193 229 233 229 211 249 350 242 251 274 238 146 185 210 189 227  
211 254 184 161 168 225 218 203 192 221 191 205 221 188 293 259 245 213 201 322  
264

NAP-B63B 77

625 620 473 435 390 464 538 517 464 333 347 271 253 346 352 388 529 653 455 300  
445 454 328 430 403 423 406 484 404 475 392 367 328 317 372 380 414 292 255 347  
491 445 420 448 302 350 272 399 323 351 273 292 272 290 285 306 354 356 257 258  
230 232 223 205 215 210 178 230 243 187 140 146 164 107 131 147 168

NAP-B65A 111

141 151 148 97 141 204 253 292 327 307 402 313 350 317 261 167 165 193 210 195  
130 156 130 162 133 123 63 78 150 163 135 123 144 120 86 84 86 107 154 155  
173 154 156 129 118 182 192 139 167 171 83 83 96 119 144 109 126 155 90 75  
69 103 65 169 165 135 92 82 73 132 129 130 186 199 176 119 108 137 159 182  
150 140 143 84 124 145 186 157 155 127 118 129 111 99 114 121 116 109 97 114  
106 97 101 142 92 83 59 101 76 93 117

NAP-B65B 111

138 164 138 96 141 223 251 302 318 303 404 323 371 327 271 172 170 188 207 184  
132 158 129 158 130 132 68 78 154 165 127 123 147 109 82 87 85 112 153 153  
179 154 159 133 113 182 190 136 168 162 89 72 102 108 146 113 133 150 91 75  
77 110 62 189 169 136 103 74 80 137 134 131 191 204 163 130 102 127 163 184  
146 136 140 94 123 139 190 157 159 128 116 125 120 87 128 122 113 112 101 102  
109 104 105 137 100 80 55 101 83 87 109

NAP-B66A 56

159 177 178 157 192 102 153 127 122 196 215 154 142 168 176 137 194 155 187 202  
149 237 213 163 189 135 126 119 202 203 208 217 172 251 119 175 233 156 191 117  
91 125 161 110 146 136 94 69 53 45 83 98 108 131 121 151

NAP-B66B 40

154 208 128 238 214 168 248 130 125 114 168 202 209 224 177 240 108 153 208 143  
180 101 71 128 140 94 145 121 86 82 55 41 77 93 106 128 114 103 129 129

NAP-B67A 111

262 218 164 146 184 225 179 215 189 234 220 101 57 61 41 50 73 65 70 58  
53 50 57 46 74 78 91 116 130 99 105 80 75 110 108 151 186 216 250 315

243 213 228 207 264 226 324 390 278 312 234 306 280 258 368 261 405 284 277 289  
338 220 374 171 291 235 335 183 263 245 314 276 295 319 370 335 303 233 285 329  
290 184 122 90 112 179 131 180 145 177 180 68 70 51 63 54 78 82 82 117  
132 96 98 120 156 148 162 156 139 160 153

NAP-B67B 111

265 214 141 138 198 222 164 210 191 216 218 96 53 65 40 53 66 72 63 65  
56 43 56 53 66 87 84 119 129 99 104 82 72 114 110 148 188 205 252 315  
230 213 222 205 258 233 331 396 278 314 266 291 279 261 371 262 406 278 283 285  
326 217 373 170 310 218 333 179 262 249 312 270 299 305 371 337 303 229 273 330  
292 189 112 92 113 180 124 176 146 181 180 79 48 62 69 50 78 77 90 109  
138 98 98 119 155 145 163 152 135 168 158

NAP-B68A 61

341 442 387 499 459 606 491 495 371 398 364 370 386 358 376 369 370 319 283 302  
388 301 369 371 215 267 251 303 337 283 266 271 254 242 255 309 357 325 306 264  
271 393 278 178 196 244 254 316 317 347 326 341 371 307 291 344 379 386 352 313  
298

NAP-B68B 61

379 410 424 442 481 585 488 480 385 389 381 354 378 353 374 374 375 328 279 307  
391 290 391 357 223 272 261 300 340 285 266 265 254 242 258 308 367 322 305 274  
264 385 281 177 200 237 261 309 327 356 333 349 349 339 282 344 375 406 352 317  
289

NAP-B69A 65

401 281 384 291 371 339 406 365 362 363 197 186 214 238 265 277 211 173 225 316  
208 159 203 220 214 237 247 238 211 185 136 215 194 129 246 309 293 300 266 306  
258 269 394 401 437 404 531 480 454 408 512 381 386 429 531 385 435 423 406 237  
320 286 261 273 255

NAP-B69B 65

395 292 355 292 338 367 391 372 369 361 188 190 229 215 277 271 202 175 225 317  
212 159 197 218 210 216 240 231 210 181 141 207 204 132 247 308 293 301 262 313  
251 277 389 383 443 396 514 485 446 399 516 365 382 429 515 387 423 426 407 236  
337 284 282 260 271

NAP-B71A 87

490 602 538 455 510 358 464 299 370 283 438 291 274 274 238 228 257 204 199 192  
165 117 122 153 123 102 99 126 197 156 160 142 132 163 188 180 116 108 163 178  
175 174 132 156 114 119 164 174 203 263 287 266 278 233 267 204 181 220 199 351  
521 774 390 283 308 299 204 144 126 180 181 239 348 311 324 321 245 255 266 207  
288 282 290 266 342 334 210

NAP-B71B 87

491 601 554 465 506 361 452 307 368 288 438 291 270 274 228 224 267 205 201 188  
169 118 123 149 122 105 107 122 199 151 153 140 136 158 172 179 128 100 156 178  
181 169 141 141 107 116 159 172 196 271 290 260 279 240 265 202 178 218 207 351  
553 751 383 261 309 304 206 136 123 168 187 229 340 304 312 326 247 254 258 208  
293 285 295 279 341 299 221

NAP-B74A 60

303 293 220 210 196 239 271 318 250 347 266 256 310 286 263 340 261 355 300 274  
261 217 229 253 263 276 283 245 202 225 163 190 280 268 242 231 204 176 219 196  
206 231 204 185 196 187 176 167 177 183 226 160 191 247 132 163 214 217 221 162

NAP-B74B 60

326 293 214 216 194 223 309 308 249 384 260 244 305 281 255 298 269 350 294 279  
259 217 241 240 274 278 282 247 204 219 172 183 281 271 247 223 209 165 221 215  
203 235 200 198 200 185 186 156 167 180 219 170 200 239 133 165 219 215 217 162

NAP-B75A 96

241 135 144 184 203 137 148 110 131 127 128 188 143 169 171 145 78 58 51 60

57 71 101 127 147 254 228 167 174 173 250 261 232 204 320 342 278 187 217 236  
279 206 278 189 178 125 145 143 149 174 198 210 180 193 195 157 142 151 168 227  
311 305 254 216 226 240 209 235 185 198 168 171 163 199 197 176 195 161 170 193  
120 139 100 108 112 116 132 147 147 150 227 178 152 138 165 130

NAP-B75B 96

229 137 148 180 205 137 144 106 139 125 117 195 144 173 176 148 79 60 46 58  
69 61 107 129 143 253 228 170 168 174 254 259 228 207 321 341 278 185 219 237  
275 209 276 189 183 133 141 137 145 183 203 205 184 195 193 156 143 143 168 230  
316 298 260 213 225 239 208 228 182 197 169 171 164 206 194 179 189 166 167 193  
114 144 98 108 112 117 131 154 142 160 213 177 147 138 161 111

NAP-B76A 139

180 158 116 133 167 107 136 140 146 127 135 96 112 104 78 97 132 141 106 102  
106 120 134 135 178 138 136 114 140 83 87 118 197 130 125 130 100 108 138 143  
152 160 195 104 84 133 135 184 180 163 154 193 174 126 72 151 188 174 157 214  
122 71 77 115 124 137 48 49 43 37 46 53 44 43 62 67 97 84 81 61  
69 85 67 68 59 66 88 81 74 91 68 75 66 68 81 60 70 65 74 70  
63 74 52 61 62 73 81 112 126 133 96 104 96 113 101 95 120 112 134 120  
68 75 91 94 74 78 67 76 64 78 80 82 88 95 93 82 83 69 70

NAP-B76B 139

188 159 122 137 171 114 138 148 151 129 140 94 120 104 76 105 140 147 111 92  
110 123 132 129 170 151 140 114 134 92 82 119 194 141 134 123 100 114 131 144  
157 175 179 117 83 134 140 186 174 167 158 189 180 123 74 151 191 174 160 205  
124 73 84 110 125 138 45 46 45 45 40 59 47 42 59 71 98 86 82 55  
69 82 68 62 58 71 89 81 74 96 70 75 65 71 88 59 67 66 72 78  
69 70 52 63 60 76 78 113 129 132 101 101 95 112 98 94 128 110 135 119  
70 75 90 95 66 84 72 73 65 81 84 77 92 93 95 83 77 76 64

NAP-B77A 66

228 197 202 284 250 264 217 224 235 166 234 242 258 301 253 238 256 211 215 259  
287 258 241 272 225 214 202 242 296 257 296 274 222 213 314 237 235 204 255 217  
251 164 136 113 137 121 101 98 85 125 123 138 124 184 212 210 261 251 315 246  
299 320 268 277 332 338

NAP-B77B 66

237 205 201 278 256 255 224 222 231 170 226 236 239 297 253 245 249 215 209 253  
287 264 240 272 225 213 204 246 295 258 294 275 221 209 319 235 243 212 257 215  
234 159 131 103 155 141 105 95 89 115 126 140 126 185 205 209 263 256 308 247  
296 308 252 287 324 310

NAP-B78A 72

463 357 480 347 369 252 397 362 263 288 231 180 172 195 250 229 171 116 137 152  
129 124 118 124 165 137 126 117 128 121 124 108 116 81 160 199 235 212 213 225  
162 202 271 309 345 292 362 404 375 346 430 309 239 325 389 371 373 218 219 151  
229 209 156 128 158 232 243 292 370 373 337 352

NAP-B78B 72

463 353 484 338 358 255 402 358 262 285 228 182 169 208 252 234 168 116 132 154  
129 121 117 123 158 138 123 114 128 124 117 105 119 77 159 195 234 218 218 217  
169 201 270 312 343 306 363 403 385 339 426 321 234 321 388 382 368 214 215 150  
229 211 152 133 152 232 236 303 378 362 342 353

NAP-B79A 75

118 84 42 54 61 104 114 93 72 66 106 66 90 73 62 73 75 60 65 83  
77 95 98 64 92 84 51 72 68 100 115 146 159 115 112 63 87 128 93 180  
188 112 158 134 72 111 123 153 190 256 152 171 81 106 187 186 218 214 194 205  
181 145 187 200 167 96 133 160 217 290 281 478 435 531 379

NAP-B79B 75

125 81 48 48 61 107 116 90 74 66 105 72 89 84 53 79 72 68 58 75

77 94 108 61 97 62 67 71 66 100 127 155 160 117 112 63 90 125 95 185  
178 121 161 135 73 110 115 150 207 258 151 170 86 109 193 189 199 193 187 206  
183 143 189 197 158 98 131 157 222 286 276 482 433 533 377

NAP-B81A 85

146 117 140 192 234 246 188 255 142 176 213 224 130 103 163 178 198 193 265 278  
251 192 222 295 457 440 370 355 327 370 341 376 327 309 268 262 367 410 378 428  
256 401 255 223 307 309 333 254 169 137 217 123 211 264 210 292 288 294 222 302  
323 304 315 254 325 326 249 228 205 253 344 289 330 363 404 436 309 408 264 210  
227 191 274 277 203

NAP-B81B 85

143 117 155 188 232 245 187 274 154 160 206 238 121 109 154 183 199 196 284 304  
256 194 208 295 450 444 371 350 332 367 349 376 322 311 267 261 368 406 386 417  
263 388 248 216 307 306 328 255 167 138 225 133 204 288 239 279 283 294 231 296  
327 305 308 263 325 323 253 222 213 250 341 293 329 365 407 440 311 421 258 218  
219 189 283 279 186

NAP-B83A 123

113 101 120 122 102 145 178 194 185 117 74 92 101 95 92 102 97 64 79 117  
88 125 140 191 213 197 165 170 177 229 161 160 133 206 160 161 119 117 120 82  
86 113 160 114 66 66 80 116 186 141 126 128 170 145 176 105 141 157 158 85  
75 101 144 132 134 114 127 166 158 190 155 128 159 143 114 72 84 74 98 108  
126 160 150 105 79 75 103 107 109 124 137 133 126 126 88 67 74 105 149 193  
127 147 106 86 71 72 79 109 136 136 151 119 80 78 94 91 72 34 55 57  
72 107 104

NAP-B83B 123

116 99 119 112 116 147 193 184 183 114 74 94 100 92 93 102 101 61 82 113  
90 124 146 190 215 194 161 180 171 226 162 138 155 216 168 154 125 110 117 91  
88 111 168 111 62 67 92 112 182 134 128 134 168 139 172 107 133 155 172 80  
84 97 128 133 144 114 130 153 185 200 151 126 148 159 108 73 81 76 98 104  
131 153 147 96 96 78 100 103 113 124 138 131 130 132 99 68 65 96 151 198  
129 152 115 87 78 68 92 93 153 139 160 132 65 78 94 94 76 35 50 65  
66 125 112

NAP-B84A 122

441 416 413 402 436 367 391 367 405 228 100 130 136 160 225 163 165 140 149 182  
145 121 117 113 106 117 108 152 143 162 131 160 147 152 192 147 113 96 152 71  
32 36 35 27 22 26 25 40 40 30 27 31 34 39 35 40 33 35 75 58  
63 84 70 97 54 42 60 66 81 70 83 84 77 72 77 83 102 111 106 91  
90 87 97 82 80 93 78 66 64 68 58 59 61 64 73 69 80 101 72 71  
62 73 78 69 54 62 57 75 61 83 80 64 87 61 53 70 61 74 72 61  
62 82

NAP-B84B 122

441 419 478 365 411 430 416 375 391 213 95 125 141 159 229 162 140 148 148 199  
143 120 127 111 103 126 98 155 172 175 144 182 135 152 188 162 107 111 145 69  
31 36 35 24 20 28 25 33 44 31 25 33 31 45 30 28 38 40 71 63  
64 67 64 91 57 38 60 68 82 73 83 76 80 64 69 87 104 106 107 91  
93 84 96 75 85 95 77 65 63 64 53 53 72 65 78 64 80 103 74 73  
59 75 79 68 57 72 50 85 64 82 78 69 83 62 49 71 59 79 72 59  
60 98

NAP-B86A 58

158 147 193 230 182 196 188 292 257 192 249 282 252 136 214 219 217 99 107 125  
137 138 138 151 167 156 155 86 73 135 105 176 161 114 105 49 40 67 81 114  
219 147 205 195 110 122 240 181 146 113 132 195 182 151 127 163 146 131

NAP-B86B 58

166 156 208 231 194 208 191 314 268 203 257 293 269 138 226 224 218 112 104 124



137 159 132 166 193 155 163 86 65 148 119 162 158 110 113 48 39 74 82 112  
223 152 206 204 115 157 230 184 154 111 138 192 185 151 145 164 148 134

NAP-B91A 93

206 283 149 225 245 245 130 70 71 69 59 44 33 33 54 72 65 49 87 71  
74 59 89 116 107 93 82 40 60 67 68 95 109 120 80 65 81 62 82 115  
63 87 87 79 80 98 106 129 124 100 137 125 126 134 128 116 100 89 112 108  
122 101 94 83 96 111 168 162 132 140 162 135 127 132 94 84 111 101 110 146  
138 148 97 94 101 83 85 120 143 133 171 102 87

NAP-B91B 93

228 282 152 226 255 228 119 75 65 67 54 44 34 47 52 66 70 46 86 82  
61 66 84 113 93 83 69 49 53 60 92 86 116 135 74 61 80 77 91 111  
65 86 89 75 84 85 117 134 125 98 138 123 124 138 126 110 97 94 110 108  
127 101 91 80 103 111 166 162 135 144 158 134 140 135 93 86 107 103 113 144  
142 141 100 106 95 96 73 160 141 113 165 116 86

NAP-B92A 81

114 113 211 181 188 148 119 122 108 90 118 116 180 161 130 139 120 139 102 134  
148 159 149 112 163 118 107 124 107 138 113 71 88 109 97 92 117 105 117 71  
79 90 98 104 84 97 89 90 71 50 58 67 71 64 75 41 48 50 48 64  
77 114 99 103 93 89 59 63 96 89 131 79 87 113 148 104 149 116 78 67  
51

NAP-B92B 81

133 104 199 177 152 156 114 129 102 82 108 114 163 153 149 140 103 140 107 137  
151 158 145 127 174 119 104 130 105 134 113 73 90 105 94 94 117 111 109 66  
72 94 87 107 80 104 88 91 78 50 51 71 69 63 72 45 43 49 45 66  
74 107 104 97 93 75 67 58 98 89 128 74 88 113 141 110 159 110 79 59  
56

NAP-B93A 55

89 177 154 201 215 211 248 206 203 197 211 218 171 136 191 138 134 94 59 64  
144 143 159 150 165 106 150 124 84 107 125 158 142 151 152 112 152 90 92 77  
88 80 71 81 45 58 42 76 76 63 64 75 51 72 71

NAP-B93B 55

73 163 154 200 221 234 241 219 207 189 205 225 167 143 182 141 138 97 62 73  
142 141 160 148 161 104 154 123 92 102 129 158 145 143 146 117 149 106 100 88  
95 76 72 84 53 64 53 67 77 59 62 78 56 67 71

NAP-B94A 152

105 72 101 186 173 269 285 217 219 187 283 290 204 330 335 322 269 267 193 277  
220 162 171 132 80 96 110 133 167 184 211 172 123 128 251 275 221 191 163 180  
160 203 214 233 195 143 101 136 188 138 113 108 120 161 172 130 107 128 153 139  
119 221 123 103 149 173 168 128 138 115 99 122 142 132 97 104 87 91 87 90  
90 57 33 101 104 93 102 119 155 125 117 98 73 52 133 139 86 102 86 76  
70 99 146 103 119 133 135 103 123 128 179 174 132 141 130 133 135 144 94 64  
57 95 98 101 54 88 115 106 91 98 88 90 86 75 77 79 85 75 74 82  
77 104 119 100 104 121 130 125 133 107 117 105

NAP-B94B 152

102 70 94 181 178 277 283 213 222 199 289 295 215 348 305 321 268 272 200 292  
221 153 173 130 72 108 119 126 166 183 227 168 127 128 256 271 225 192 157 193  
164 203 220 226 194 148 99 136 193 135 115 109 112 170 171 135 109 131 160 149  
120 219 112 109 145 178 162 131 141 116 93 125 144 126 100 106 85 91 82 98  
89 59 33 94 110 90 107 123 143 132 114 95 75 55 129 135 89 105 91 72  
70 93 142 117 109 139 145 101 116 127 183 175 128 142 127 132 141 136 95 67  
53 91 108 95 56 85 119 108 89 90 100 94 68 77 71 79 91 67 77 79  
78 97 119 103 110 112 137 113 138 112 113 108

NAP-B95A 69

144 194 167 147 150 234 187 137 190 207 230 213 174 140 199 236 262 216 245 212  
233 227 191 223 205 145 162 186 136 131 202 179 158 145 171 119 128 91 197 171  
141 224 138 109 79 92 128 192 125 98 138 100 111 105 104 108 72 71 84 83  
69 126 117 128 73 93 124 88 89

NAP-B95B 69

145 195 169 149 147 236 184 142 182 208 225 212 175 140 198 240 247 224 247 205  
240 244 190 221 207 147 160 184 141 132 187 185 156 138 171 112 127 97 180 168  
135 222 141 106 81 94 135 186 121 104 142 96 109 110 98 109 74 79 83 86  
70 124 121 117 79 88 121 108 98

NAP-B96A 84

127 104 140 137 132 144 137 144 111 60 89 121 122 95 129 151 149 220 134 186  
193 211 198 161 210 154 149 184 221 290 174 142 133 191 160 161 255 213 164 150  
129 127 165 183 179 213 153 104 116 89 130 135 97 135 114 127 80 98 108 112  
132 161 169 141 118 157 95 119 135 150 162 128 82 147 162 119 154 147 116 61  
76 108 93 109

NAP-B96B 84

129 105 130 146 130 153 133 148 106 59 98 117 124 96 127 151 150 222 128 190  
193 219 197 158 207 161 152 183 232 290 174 149 129 198 158 158 257 212 164 151  
122 140 155 177 179 211 157 104 112 88 133 139 96 134 118 106 93 100 118 120  
136 176 178 140 119 160 95 107 148 148 158 129 86 141 155 116 160 142 117 62  
78 98 103 109

NAP-B97A 117

202 218 278 326 233 260 297 352 159 184 90 67 98 64 88 116 206 126 86 57  
48 60 63 94 135 163 130 110 67 62 66 91 148 106 69 72 120 105 84 82  
108 47 52 60 52 71 59 80 93 79 71 53 38 48 63 56 72 46 58 52  
40 52 59 63 57 58 47 60 47 42 41 43 46 35 38 38 48 51 47 62  
62 48 51 73 92 74 80 89 75 78 43 34 44 41 32 37 48 30 30 35  
31 38 45 46 47 41 46 42 32 33 32 42 37 34 43 34 29

NAP-B97B 117

202 201 288 329 227 257 296 347 152 186 95 68 100 75 98 131 205 127 79 51  
51 50 63 107 144 160 136 114 80 62 75 96 138 105 75 73 121 106 85 67  
115 48 60 55 50 64 64 84 98 73 66 53 30 50 67 56 79 53 47 42  
42 47 66 63 48 51 57 64 48 44 44 34 50 34 29 50 49 52 48 60  
55 49 40 70 96 68 86 98 71 78 45 30 49 39 33 37 45 30 35 34  
27 30 54 47 43 48 40 45 31 32 32 41 45 47 35 30 29

NAP-B98A 122

107 295 389 253 262 250 220 248 350 515 305 217 226 153 187 103 114 111 192 103  
216 210 225 164 166 193 123 228 68 50 45 58 57 48 42 56 59 42 41 44  
49 84 80 67 54 99 113 83 79 106 74 56 53 49 79 59 85 124 86 87  
69 51 49 60 70 98 46 59 67 39 47 74 75 73 68 71 64 58 48 56  
53 55 35 31 59 48 63 56 50 52 48 59 66 76 76 70 82 64 76 40  
47 39 37 37 38 44 42 39 38 37 31 31 31 38 50 35 43 41 34 25  
35 47

NAP-B98B 122

103 286 386 255 275 255 224 252 356 505 339 219 228 151 185 108 118 101 187 114  
226 227 219 167 173 192 121 229 67 49 41 62 60 49 45 47 60 47 34 47  
59 78 74 74 53 98 98 85 84 117 66 58 57 44 74 72 94 125 89 75  
79 50 45 66 70 83 54 61 57 41 51 77 74 68 74 68 64 65 48 50  
59 45 37 40 61 43 63 53 59 44 46 56 66 80 69 74 82 63 80 47  
39 40 41 32 38 38 45 40 37 33 31 37 34 34 45 45 45 33 28 29  
35 48

NAP-B99A 118

147 167 167 220 170 87 57 48 92 131 163 208 154 172 146 59 73 66 101 126

129 87 88 114 130 145 148 133 112 49 45 34 75 127 109 159 123 114 79 46  
41 56 61 76 59 49 59 45 69 110 114 121 128 126 154 109 90 74 98 84  
62 63 91 101 167 139 149 177 94 157 176 194 227 215 196 211 135 123 78 144  
124 77 82 110 117 89 66 58 73 94 80 134 100 89 79 52 38 40 71 64  
103 85 74 86 51 60 74 66 73 56 40 46 43 45 56 50 64 54

NAP-B99B 119

161 182 191 239 176 95 55 59 88 145 172 191 162 207 152 60 89 66 100 127  
135 95 94 118 139 143 152 141 111 52 50 31 78 127 117 161 124 119 82 54  
38 54 77 77 58 53 56 53 71 111 107 129 136 128 161 115 92 71 97 88  
55 64 84 116 162 142 148 174 99 160 174 200 229 221 185 219 129 124 86 145  
123 84 83 114 123 87 68 58 76 94 79 136 107 85 80 56 44 35 75 70  
103 87 69 90 51 64 74 67 72 57 34 52 42 44 53 44 51 40 37

NAP-100A 110

157 150 157 165 156 144 87 99 63 94 111 98 113 83 104 57 53 58 64 89  
99 136 100 77 103 94 90 78 85 101 73 65 49 70 54 102 94 114 98 88  
66 60 96 89 119 100 74 79 68 76 81 67 67 62 91 78 82 79 83 76  
100 67 71 72 110 115 97 89 111 80 62 105 128 113 113 115 113 114 107 101  
116 136 118 78 130 118 88 103 99 138 146 98 105 125 136 126 124 79 72 97  
116 142 91 95 110 94 107 112 97 105

NAP-100B 110

154 150 155 168 145 137 80 108 63 99 102 110 113 78 95 49 53 69 57 94  
93 145 104 84 99 108 91 80 84 102 77 62 48 75 58 100 93 112 93 84  
71 63 96 93 116 111 59 78 68 75 70 50 63 63 87 84 74 85 71 97  
86 77 63 84 93 123 102 91 112 87 62 110 118 118 125 103 109 121 101 92  
122 131 103 86 120 123 96 99 103 141 146 95 87 120 135 114 116 77 76 110  
105 133 93 90 120 90 105 111 96 99

NAP-101A 119

186 193 134 124 123 113 137 168 150 162 106 100 78 111 141 159 149 125 159 117  
97 91 60 83 102 143 101 105 101 105 98 109 120 89 76 62 46 75 76 97  
114 129 127 112 94 105 107 125 137 116 95 65 68 73 99 97 107 86 111 111  
84 82 81 101 86 77 84 71 104 97 89 102 107 89 89 93 135 120 119 116  
132 114 125 100 108 101 88 80 106 101 92 98 85 109 114 98 105 102 90 95  
79 79 80 94 114 125 86 85 101 57 117 122 109 88 72 60 79 77 99

NAP-101B 119

204 187 137 129 113 111 146 168 153 165 108 103 81 113 139 157 159 134 153 113  
103 93 65 81 105 148 94 105 104 110 100 104 126 95 80 55 55 74 75 98  
111 131 128 118 85 112 102 130 141 126 85 72 65 74 105 105 101 85 109 115  
77 89 85 98 88 84 78 83 94 101 91 94 114 94 86 95 139 116 108 99  
135 111 128 100 103 105 87 81 106 101 93 101 85 106 117 89 111 100 94 96  
78 84 66 107 107 140 86 89 91 63 116 118 114 91 74 64 80 86 93

NAP-102A 111

271 215 223 242 190 119 180 195 168 153 105 147 109 67 122 94 107 116 103 134  
111 123 134 85 154 113 122 165 100 135 128 81 142 145 120 72 81 84 87 93  
80 68 62 76 35 43 64 62 63 64 67 70 63 56 80 87 91 93 126 110  
103 73 66 91 97 105 109 104 89 105 92 77 104 138 101 122 91 89 105 84  
55 54 77 81 120 116 119 116 65 104 105 91 96 50 56 56 79 77 88 92  
78 56 67 50 59 82 84 93 85 85 101

NAP-102B 111

257 213 219 248 188 135 175 201 160 154 105 143 113 57 120 92 107 104 112 137  
113 129 122 85 156 110 130 157 103 140 131 67 138 142 117 81 72 85 93 115  
87 65 67 72 47 34 62 69 54 65 66 81 61 57 80 84 90 93 126 107  
104 71 69 89 92 110 105 103 97 98 90 82 99 137 98 128 94 86 111 80  
58 53 76 78 129 109 132 99 67 104 102 100 93 60 50 50 87 72 92 94

80 59 51 54 62 76 87 96 87 80 112

NAP-103A 83

187 271 163 100 160 134 164 172 187 158 122 140 157 131 104 124 115 84 90 52  
66 47 110 103 105 82 96 70 91 104 105 106 93 74 71 39 50 69 72 69  
61 59 63 54 61 55 62 86 61 50 68 74 98 73 92 114 95 61 95 138  
139 157 246 114 138 124 109 130 168 177 128 120 108 104 80 92 82 121 85 129  
113 96 96

NAP-103B 83

181 262 158 111 161 129 161 159 188 154 112 152 152 138 115 115 128 75 91 53  
70 52 116 104 98 83 101 66 89 111 101 107 101 68 72 35 50 70 73 71  
62 64 61 58 58 53 64 83 51 59 73 77 115 49 90 121 97 55 99 137  
141 158 253 112 135 129 113 135 167 174 125 122 107 104 76 95 84 126 96 110  
121 81 89

NAP-104A 103

199 173 278 219 249 209 263 196 95 110 81 124 57 180 258 266 198 217 124 132  
175 210 224 149 147 143 70 129 217 241 216 214 187 157 195 111 122 121 139 96  
74 145 162 75 108 146 175 105 103 143 215 167 191 295 192 231 123 147 198 201  
159 141 165 193 166 151 120 166 239 143 195 190 176 180 178 81 63 97 131 156  
169 131 163 128 155 168 106 139 122 94 120 143 133 127 157 127 71 70 58 83  
142 124 212

NAP-104B 103

202 180 264 243 252 218 264 195 100 111 81 122 59 178 268 264 192 221 127 129  
177 213 240 150 151 141 77 131 220 248 213 219 189 157 190 112 128 120 146 93  
76 150 158 93 103 141 167 108 100 148 223 164 193 296 200 233 138 152 190 210  
159 136 167 195 168 151 124 166 233 147 185 202 173 181 179 80 65 102 130 154  
171 135 162 135 151 171 104 140 137 84 119 138 130 122 157 130 60 76 53 77  
145 130 206

NAP-105A 107

123 125 85 129 270 165 107 123 139 129 171 221 185 164 152 104 74 117 163 166  
178 176 159 96 177 167 164 158 115 102 77 44 78 87 134 123 134 154 108 95  
92 161 167 179 201 147 152 120 119 110 120 152 125 141 123 153 146 123 129 142  
161 160 158 182 143 187 153 180 146 130 130 91 115 149 100 132 124 86 79 75  
66 82 90 116 108 100 87 110 81 91 100 110 103 99 76 106 84 85 99 108  
100 57 67 60 69 65 63

NAP-105B 107

106 126 88 129 263 163 107 110 117 145 198 242 192 163 154 101 80 109 160 162  
176 181 157 84 168 162 161 148 107 100 73 48 78 82 130 122 138 158 102 95  
93 159 170 181 198 153 146 118 124 101 121 152 126 144 119 161 143 126 148 148  
162 161 158 177 152 183 149 174 145 128 134 95 113 146 102 133 120 84 81 81  
66 82 95 108 122 94 89 110 83 88 107 107 103 100 77 98 91 79 99 117  
90 61 58 56 68 67 75

NAP-106A 125

325 347 325 199 226 188 217 144 163 183 188 201 191 192 168 185 83 77 113 134  
146 136 98 145 110 65 88 67 106 130 156 128 133 174 157 133 133 160 130 90  
93 59 94 100 135 168 146 139 125 84 87 103 106 133 107 136 131 91 102 125  
147 150 143 131 110 110 84 86 78 94 64 48 61 64 64 74 72 105 73 81  
102 137 139 133 187 168 166 117 80 108 129 90 83 119 110 103 161 117 178 256  
161 194 170 167 212 178 112 88 111 155 234 202 133 171 130 140 147 131 155 121  
86 115 122 145 144

NAP-106B 125

324 336 326 193 239 177 209 143 163 184 185 194 186 192 170 184 88 74 113 136  
144 127 95 143 99 72 81 73 101 130 149 124 133 171 157 134 134 159 122 95  
87 61 91 100 136 161 148 138 127 82 89 106 103 135 104 134 129 88 103 127

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101 135 134 135 186 170 165 120 78 107 133 86 87 115 114 104 159 120 174 261  
160 199 170 166 213 178 110 90 111 151 234 200 135 165 132 146 157 130 163 113  
87 123 119 140 139

NAP-107A 72

67 76 123 83 78 114 111 150 121 120 140 188 224 214 260 256 203 111 105 122  
155 123 123 154 150 118 128 104 126 148 120 174 189 164 172 139 116 110 167 152  
191 187 149 180 124 164 181 168 135 88 101 79 116 109 130 143 124 101 118 85  
88 125 120 97 127 132 139 132 145 118 94 80

NAP-107B 72

76 77 116 76 90 107 120 148 122 118 144 182 228 221 255 264 201 101 105 132  
150 116 116 162 150 134 124 113 124 148 108 176 195 162 183 151 119 113 169 150  
191 185 153 179 116 168 181 168 140 92 90 79 115 103 126 143 120 96 120 89  
92 122 117 98 132 130 135 135 141 122 97 83

NAP-108A 98

113 111 70 65 77 75 91 91 127 117 75 59 34 44 49 49 53 41 43 64  
38 47 62 79 69 70 56 50 59 42 51 49 57 45 45 55 63 61 62 77  
88 72 71 93 128 84 91 109 90 110 68 65 72 77 65 55 64 75 61 75  
65 74 95 62 62 87 72 90 74 47 41 62 69 94 87 68 69 66 76 81  
71 70 60 49 61 60 67 67 77 69 53 45 42 55 70 71 82 81

NAP-108B 98

121 133 62 68 63 77 85 99 130 99 90 50 37 45 54 50 46 53 61 74  
55 50 68 91 68 72 57 56 57 45 45 54 52 47 42 59 61 67 58 71  
96 75 71 90 124 78 96 100 78 129 67 62 73 93 72 52 78 62 67 78  
61 81 89 52 68 61 74 88 72 42 41 65 75 89 86 67 75 59 73 89  
72 75 57 51 67 60 62 69 80 70 53 42 50 59 63 76 78 83

NAP-109A 56

346 476 535 514 447 438 450 409 392 311 234 295 316 313 331 372 304 263 356 443  
270 357 322 415 297 270 264 230 253 226 238 248 221 212 196 212 182 213 236 243  
185 180 167 169 162 190 157 153 137 138 187 144 146 162 203 170

NAP-109B 56

355 484 534 511 451 430 437 415 391 311 215 292 332 320 336 375 305 273 350 443  
275 365 310 392 308 263 260 229 260 223 239 243 225 212 197 208 193 200 242 238  
187 178 162 172 164 189 156 155 136 140 187 144 146 162 197 151

NAP-110A 87

173 213 264 200 216 119 129 154 198 217 135 140 141 102 110 139 135 114 111 124  
87 88 82 82 83 85 81 61 69 79 76 85 78 104 95 89 110 156 133 125  
167 161 142 113 93 113 132 110 96 114 132 118 190 123 178 208 163 212 175 153  
182 132 92 93 111 161 206 157 127 181 132 159 162 159 160 119 86 132 139 130  
155 204 159 106 79 56 75

NAP-110B 87

186 213 260 199 222 117 133 147 198 217 141 146 136 101 112 131 139 120 113 123  
86 82 87 78 83 84 81 67 71 82 72 88 74 108 89 96 109 158 132 133  
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## APPENDIX: TREE-RING DATING

### The Principles of Tree-Ring Dating

Tree-ring dating, or dendrochronology as it is known, is discussed in some detail in the Laboratory's Monograph, *An East Midlands Master Tree-Ring Chronology and its uses for dating Vernacular Building* (Laxton and Litton 1988) and *Dendrochronology: Guidelines on Producing and Interpreting Dendrochronological Dates* (English Heritage 1998). Here we will give the bare outlines. Each year an oak tree grows an extra ring on the outside of its trunk and all its branches just inside its bark. The width of this annual ring depends largely on the weather during the growing season, about April to October, and possibly also on the weather during the previous year. Good growing seasons give rise to relatively wide rings, poor ones to very narrow rings and average ones to relatively average ring widths. Since the climate is so variable from year to year, almost random-like, the widths of these rings will also appear random-like in sequence, reflecting the seasons. This is illustrated in Figure A1 where, for example, the widest rings appear at irregular intervals. This is the key to dating by tree rings, or rather, by their widths. Records of the average ring widths for oaks, one for each year for the last 1000 years or more, are available for different areas. These are called master chronologies. Because of the random-like nature of these sequences of widths, there is usually only one position at which a sequence of ring widths from a sample of oak timber with at least 70 rings will match a master. This will date the timber and, in particular, the last ring.

If the bark is still on the sample, as in Figure A1, then the date of the last ring will be the date of felling of the oak from which it was cut. There is much evidence that in medieval times oaks cut down for building purposes were used almost immediately, usually within the year or so (Rackham 1976). Hence if bark is present on several main timbers in a building, none of which appear reused or are later insertions, and if they all have the same date for their last ring, then we can be quite confident that this is the date of construction or soon after. If there is no bark on the sample, then we have to make an estimate of the felling date; how this is done is explained below.

### The Practice of Tree-Ring Dating at the Nottingham Tree-Ring Dating Laboratory

1. **Inspecting the Building and Sampling the Timbers.** Together with a building historian the timbers in a building are inspected to try to ensure that those sampled are not reused or later insertions. Sampling is almost always done by coring into the timber, which has the great advantage that we can sample in situ timbers and those judged best to give the date of construction, or phase of construction if there is more than one in the building. The timbers to be sampled are also inspected to see how many rings they have. We normally look for timbers with at least 70 rings, and preferably more. With fewer rings than this, 50 for example, sequences of widths become difficult to match to a unique

position within a master sequence of ring widths and so are difficult to date (Litton and Zainodin 1991). The cross-section of the rafter shown in Figure A2 has about 120 rings; about 20 of which are sapwood rings – the lighter rings on the outside. Similarly the core has just over 100 rings with a few sapwood rings.

To ensure that we are getting the date of the building as a whole, or the whole of a phase of construction if there is more than one, about 8–10 samples per phase are usually taken. Sometimes we take many more, especially if the construction is complicated. One reason for taking so many samples is that, in general, some will fail to give a date. There may be many reasons why a particular sequence of ring widths from a sample of timber fails to give a date even though others from the same building do. For example, a particular tree may have grown in an odd ecological niche, so odd indeed that the widths of its rings were determined by factors other than the local climate! In such circumstances it will be impossible to date a timber from this tree using the master sequence whose widths, we can assume, were predominantly determined by the local climate at the time.

Sampling is done by coring into the timber with a hollow corer attached to an electric drill and usually from its outer rings inwards towards where the centre of the tree, the pith, is judged to be. An illustration of a core is shown in Figure A2; it is about 150mm long and 10mm diameter. Great care has to be taken to ensure that as few as possible of the outer rings are lost in coring. This can be difficult as these outer rings are often very soft (see below on sapwood). Each sample is given a code which identifies uniquely which timber it comes from, which building it is from and where the building is located. For example, CRO-A06 is the sixth core taken from the first building (A) sampled by the Laboratory in Cropwell Bishop. Where it came from in that building will be shown in the sampling records and drawings. No structural damage is done to any timbers by coring, nor does it weaken them.

During the initial inspection of the building and its timbers the dendrochronologist may come to the conclusion that, as far as can be judged, none of the timbers have sufficient rings in them for dating purposes and may advise against sampling to save further unwarranted expense.

All sampling by the Laboratory is undertaken according to current Health and Safety Standards. The Laboratory's dendrochronologists are insured.



Figure A1: A wedge of oak from a tree felled in 1976. It shows the annual growth rings, one for each year from the innermost ring to the last ring on the outside just inside the bark. The year of each ring can be determined by counting back from the outside ring, which grew in 1976





*Figure A2: Cross-section of a rafter, showing sapwood rings in the left-hand corner, the arrow points to the heartwood/sapwood boundary (H/S); and a core with sapwood; again the arrow is pointing to the H/S. The core is about the size of a pencil*



*Figure A3: Measuring ring widths under a microscope. The microscope is fixed while the sample is on a moving platform. The total sequence of widths is measured twice to ensure that an error has not been made. This type of apparatus is needed to process a large number of samples on a regular basis*



Figure A4: Three cores from timbers in a building. They come from trees growing at the same time. Notice that, although the sequences of widths look similar, they are not identical. This is typical

2. **Measuring Ring Widths.** Each core is sanded down with a belt sander using medium-grit paper and then finished by hand with flourgrade-grit paper. The rings are then clearly visible and differentiated from each other with a result very much like that shown in Figure A2. The core is then mounted on a movable table below a microscope and the ring-widths measured individually from the innermost ring to the outermost. The widths are automatically recorded in a computer file as they are measured (see Fig A3).

3. **Cross-Matching and Dating the Samples.** Because of the factors besides the local climate which may determine the annual widths of a tree's rings, no two sequences of ring widths from different oaks growing at the same time are exactly alike (Fig A4). Indeed, the sequences may not be exactly alike even when the trees are growing near to each other. Consequently, in the Laboratory we do not attempt to match two sequences of ring widths by eye, or graphically, or by any other subjective method. Instead, it is done objectively (ie statistically) on a computer by a process called cross-matching. The output from the computer tells us the extent of correlation between two sample sequences of widths or, if we are dating, between a sample sequence of widths and the master, at each relative position of one to the other (offsets). The extent of the correlation at an offset is determined by the *t*-value (defined in almost any introductory book on statistics). That offset with the maximum *t*-value among the *t*-values at all the offsets will be the best candidate for dating one sequence relative to the other. If one of these is a master chronology, then this will date the other. Experiments carried out in the past with sequences from oaks of known date suggest that a *t*-value of at least 4.5, and preferably at least 5.0, is usually adequate for the dating to be accepted with reasonable confidence (Laxton and Litton 1988; Laxton *et al* 1988; Howard *et al* 1984–1995).

This is illustrated in Figure A5 with timbers from one of the roofs of Lincoln Cathedral. Here four sequences of ring widths, LIN-C04, 05, 08, and 45, have been cross-matched with each other. The ring widths themselves have been omitted in the bar diagram, as is usual, but the offsets at which they best cross-match each other are shown; eg the sequence of ring widths of C08 matches the sequence of ring widths of C45 best when it is at a position starting 20 rings after the first ring of C45, and similarly for the others. The actual *t*-values between the four at these offsets of best correlations are in the matrix. Thus at the offset of +20 rings, the *t*-value between C45 and C08 is 5.6 and is the maximum found between these two among all the positions of one sequence relative to the other.

It is standard practice in our Laboratory first to cross-match as many as possible of the ring-width sequences of the samples in a building and then to form an average from them. This average is called a site sequence of the building being dated and is illustrated in Figure A5. The fifth bar at the bottom is a site sequence for a roof at Lincoln Cathedral and is constructed from the matching sequences of the four timbers. The site sequence width for each year is the average of the widths in each of the sample sequences which has a width for that year. Thus in Fig A5 if the widths shown are 0.8mm for C45, 0.2mm for C08, 0.7mm for C05, and 0.3mm for C04, then the corresponding width of the site

sequence is the average of these, 0.55mm. The actual sequence of widths of this site sequence is stored on the computer. The reason for creating site sequences is that it is usually easier to date an average sequence of ring widths with a master sequence than it is to date the individual component sample sequences separately.

The straightforward method of cross-matching several sample sequences with each other one at a time is called the 'maximal *t*-value' method. The actual method of cross-matching a group of sequences of ring-widths used in the Laboratory involves grouping and averaging the ring-width sequences and is called the 'Litton-Zainodin Grouping Procedure'. It is a modification of the straightforward method and was successfully developed and tested in the Laboratory and has been published (Litton and Zainodin 1991; Laxton *et al* 1988).

**4. Estimating the Felling Date.** As mentioned above, if the bark is present on a sample, then the date of its last ring is the date of the felling of its tree (or the last full year before felling, if it was felled in the first three months of the following calendar year, before any new growth had started, but this is not too important a consideration in most cases). The actual bark may not be present on a timber in a building, though the dendrochronologist who is sampling can often see from its surface that only the bark is missing. In these cases the date of the last ring is still the date of felling.

Quite often some, though not all, of the original outer rings are missing on a timber. The outer rings on an oak, called sapwood rings, are usually lighter than the inner rings, the heartwood, and so are relatively easy to identify. For example, sapwood can be seen in the corner of the rafter and at the outer end of the core in Figure A2, both indicated by arrows. More importantly for dendrochronology, the sapwood is relatively soft and so liable to insect attack and wear and tear. The builder, therefore, may remove some of the sapwood for precisely these reasons. Nevertheless, if at least some of the sapwood rings are left on a sample, we will know that not too many rings have been lost since felling so that the date of the last ring on the sample is only a few years before the date of the original last ring on the tree, and so to the date of felling.

Various estimates have been made and used for the average number of sapwood rings in mature oak trees (English Heritage 1998). A fairly conservative range is between 15 and 50 and that this holds for 95% of mature oaks. This means, of course, that in a small number of cases there could be fewer than 15 and more than 50 sapwood rings. For example, the core CRO-A06 has only 9 sapwood rings and some have obviously been lost over time – either they were removed originally by the carpenter and/or they rotted away in the building and/or they were lost in the coring. It is not known exactly how many sapwood rings are missing, but using the above range the Laboratory would estimate between a minimum of 6 (=15-9) and a maximum of 41 (=50-9). If the last ring of CRO-A06 has been dated to 1500, say, then the estimated felling-date range for the tree from which it came originally would be between 1506 and 1541. The Laboratory uses this estimate for sapwood in areas of England where it has no prior information. It

also uses it when dealing with samples with very many rings, about 120 to the last heartwood ring. But in other areas of England where the Laboratory has accumulated a number of samples with complete sapwood, that is, no sapwood lost since felling, other estimates in place of the conservative range of 15 to 50 are used. In the East Midlands (Laxton *et al* 2001) and the east to the south down to Kent (Pearson 1995) where it has sampled extensively in the past, the Laboratory uses the shorter estimate of 15 to 35 sapwood rings in 95% of mature oaks growing in these parts. Since the sample CRO-A06 comes from a house in Cropwell Bishop in the East Midlands, a better estimate of sapwood rings lost since felling is between a minimum of 6 (=15-9) and 26 (=35-9) and the felling would be estimated to have taken place between 1506 and 1526, a shorter period than before. Oak boards quite often come from the Baltic region and in these cases the 95% confidence limits for sapwood are 9 to 36 (Howard *et al* 1992, 56).

Even more precise estimates of the felling date and range can often be obtained using knowledge of a particular case and information gathered at the time of sampling. For example, at the time of sampling the dendrochronologist may have noted that the timber from which the core of Figure A2 was taken still had complete sapwood but that some of the soft sapwood rings were lost in coring. By measuring into the timber the depth of sapwood lost, say 20mm, a reasonable estimate can be made of the number of sapwood rings lost, say 12 to 15 rings in this case. By adding on 12 to 15 years to the date of the last ring on the sample a good tight estimate for the range of the felling date can be obtained, which is often better than the 15 to 35 years later we would have estimated without this observation. In the example, the felling is now estimated to have taken place between AD 1512 and 1515, which is much more precise than without this extra information.

Even if all the sapwood rings are missing on a sample, but none of the heartwood rings are, then an estimate of the felling-date range is possible by adding on the full complement of, say, 15 to 35 years to the date of the last heartwood ring (called the heartwood/sapwood boundary or transition ring and denoted H/S). Fortunately it is often easy for a trained dendrochronologist to identify this boundary on a timber. If a timber does not have its heartwood/sapwood boundary, then only a *post quem* date for felling is possible.

**5. Estimating the Date of Construction.** There is a considerable body of evidence collected by dendrochronologists over the years that oak timbers used in buildings were not seasoned in medieval or early modern times (English Heritage 1998; Miles 1997, 50–5). Hence, provided that all the samples in a building have estimated felling-date ranges broadly in agreement with each other, so that they appear to have been felled as a group, then this should give an accurate estimate of the period when the structure was built, or soon after (Laxton *et al* 2001, fig 8: 34–5, where ‘associated groups of fellings’ are discussed in detail). However, if there is any evidence of storage before use, or if there is evidence the oak came from abroad (eg Baltic boards), then some allowance has to be made for this.

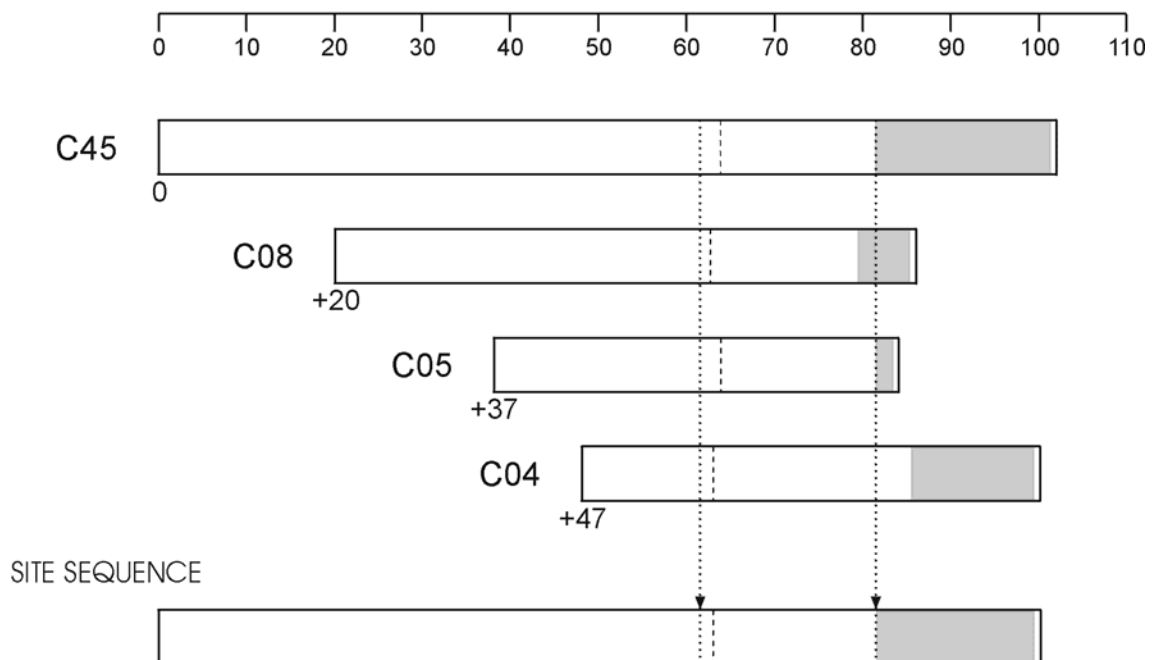
**6. Master Chronological Sequences.** Ultimately, to date a sequence of ring widths, or a site sequence, we need a master sequence of dated ring widths with which to cross-match it, a Master Chronology. To construct such a sequence we have to start with a sequence of widths whose dates are known and this means beginning with a sequence from an oak tree whose date of felling is known. In Figure A6 such a sequence is SHE-T, which came from a tree in Sherwood Forest which was blown down in a recent gale. After this other sequences which cross-match with it are added and gradually the sequence is 'pushed back in time' as far as the age of samples will allow. This process is illustrated in Figure A6. We have a master chronological sequence of widths for Nottinghamshire and East Midlands oak for each year from AD 882 to 1981. It is described in great detail in Laxton and Litton (1988), but the components it contains are shown here in the form of a bar diagram. As can be seen, it is well replicated in that for each year in this period there are several sample sequences having widths for that year. The master is the average of these. This master can now be used to date oak from this area and from the surrounding areas where the climate is very similar to that in the East Midlands. The Laboratory has also constructed a master for Kent (Laxton and Litton 1989). The method the Laboratory uses to construct a master sequence, such as the East Midlands and Kent, is completely objective and uses the Litton-Zainodin grouping procedure (Laxton *et al* 1988). Other laboratories and individuals have constructed masters for other areas and have made them available. As well as these masters, local (dated) site chronologies can be used to date other buildings from nearby. The Laboratory has hundreds of these site sequences from many parts of England and Wales covering many short periods.

**7. Ring-Width Indices.** Tree-ring dating can be done by cross-matching the ring widths themselves, as described above. However, it is advantageous to modify the widths first. Because different trees grow at different rates and because a young oak grows in a different way from an older oak, irrespective of the climate, the widths are first standardized before any matching between them is attempted. These standard widths are known as ring-width indices and were first used in dendrochronology by Baillie and Pilcher (1973). The exact form they take is explained in this paper and in the appendix of Laxton and Litton (1988) and is illustrated in the graphs in Figure A7. Here ring-widths are plotted vertically, one for each year of growth. In the upper sequence of (a), the generally large early growth after 1810 is very apparent as is the smaller later growth from about 1900 onwards when the tree is maturing. A similar phenomenon can be observed in the lower sequence of (a) starting in 1835. In both the widths are also changing rapidly from year to year. The peaks are the wide rings and the troughs are the narrow rings corresponding to good and poor growing seasons, respectively. The two corresponding sequence of Baillie-Pilcher indices are plotted in (b) where the differences in the immature and mature growths have been removed and only the rapidly changing peaks and troughs remain, that are associated with the common climatic signal. This makes cross-matching easier.

*t*-value/offset Matrix

	C45	C08	C05	C04
C45		+20	+37	+47
C08	5.6		+17	+27
C05	5.2	10.4		+10
C04	5.9	3.7	5.1	

Bar Diagram



*Figure A5: Cross-matching of four sequences from a Lincoln Cathedral roof and the formation of a site sequence from them*

The bar diagram represents these sequences without the rings themselves. The length of the bar is proportional to the number of rings in the sequence. Here the four sequences are set at relative positions (offsets) to each other at which they have maximum correlation as measured by the *t*-values. The *t*-value/offset matrix contains the maximum *t*-values below the diagonal and the offsets above it. Thus, the maximum *t*-value between C08 and C45 occurs at the offset of +20 rings and the *t*-value is then 5.6. The site sequence is composed of the average of the corresponding widths, as illustrated with one width.

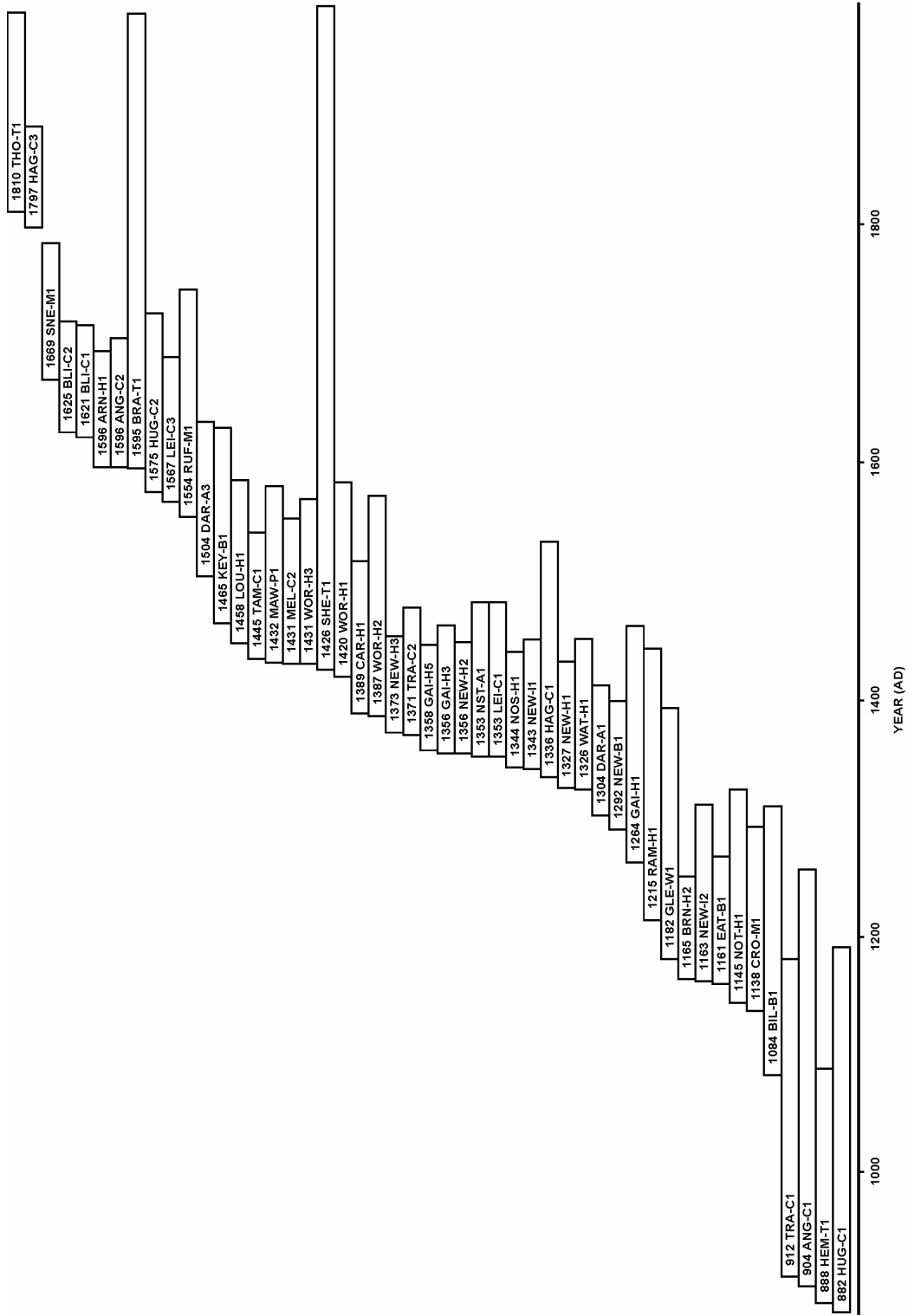
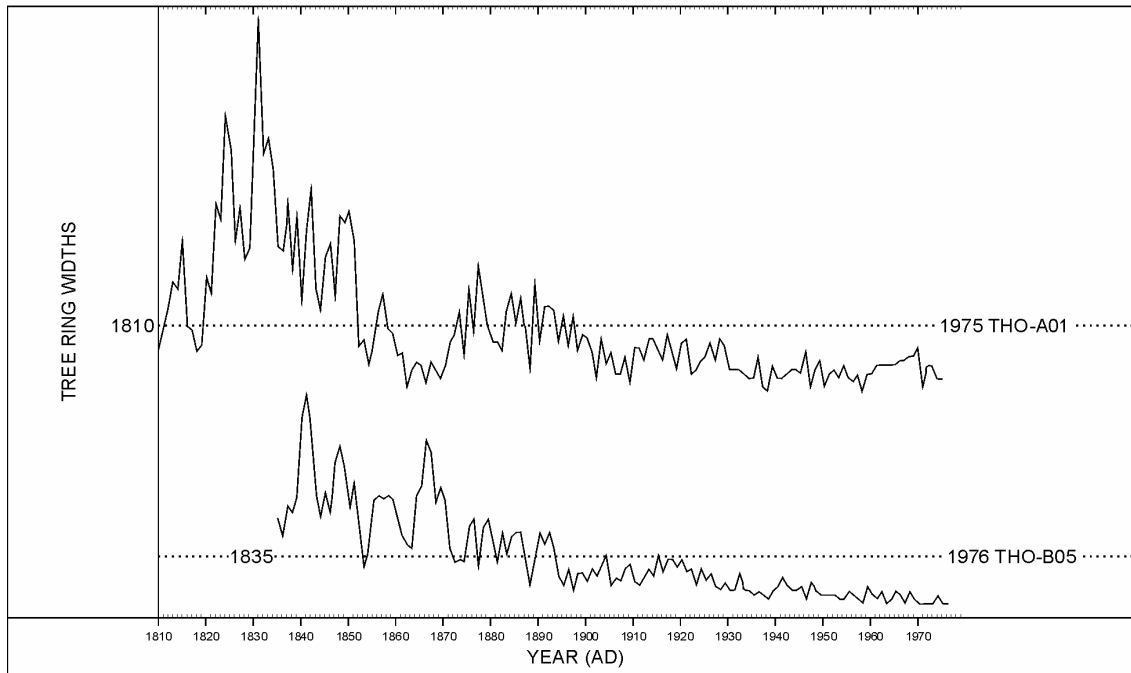


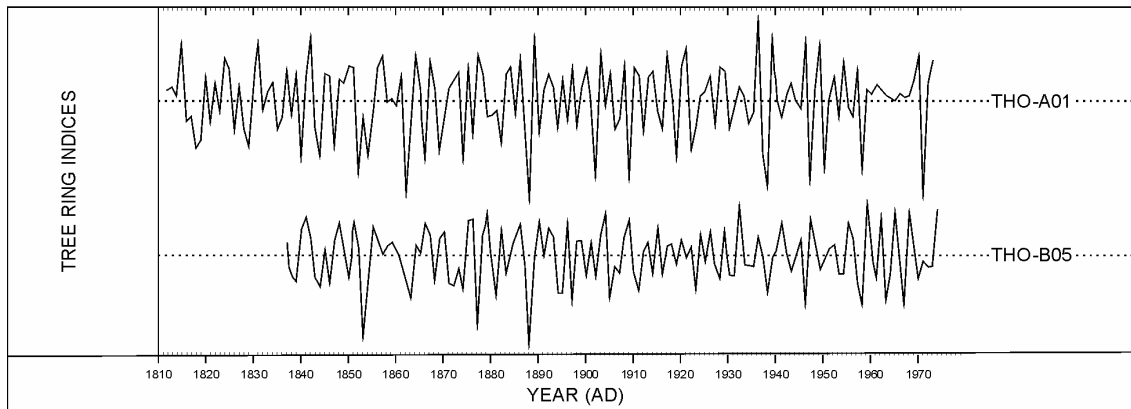
Figure A6: Bar diagram showing the relative positions and dates of the first rings of the component site sequences in the East Midlands Master Dendrochronological Sequence, EM08/87



(a)



(b)



*Figure A7 (a): The raw ring-widths of two samples, THO-A01 and THO-B05, whose felling dates are known*

Here the ring widths are plotted vertically, one for each year, so that peaks represent wide rings and troughs narrow ones. Notice the growth-trends in each; on average the earlier rings of the young tree are wider than the later ones of the older tree in both sequences

*Figure A7 (b): The Baillie-Pilcher indices of the above widths*

The growth trends have been removed completely

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