ntrdl the nottingham tree-ring dating laboratory

THE BELLFRAME
CHURCH OF ST GREGORY
FLEDBOROUGH
NOTTINGHAMSHIRE

SURVEY, RECORDING AND
TREE-RING ANALYSIS OF TIMBERS

Alison Arnold, Robert Howard & George Dawson

NGR: SK 48124 37227
SEPTEMBER 2015

THE CHURCH OF ENGLAND
Diocese of Southwell & Nottingham

heritage lottery fund
LOTTERY FUNDED

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

NTRDL, 20 Hillcrest Grove, Sherwood, Nottinghamshire NG5 1FT;
Telephone 0115 960 3833 / 07980 305583

SURVEY, RECORDING, AND TREE-RING ANALYSIS OF TIMBERS FROM THE BELLFRAME OF THE CHURCH OF ST GREGORY, FLEDBOROUGH, NOTTINGHAMSHIRE

ALISON ARNOLD
ROBERT HOWARD
GEORGE DAWSON

SUMMARY

Dendrochronological analysis was undertaken on samples taken from timbers of the bellframe at this church.

Site sequence NBFMSQ01, contains four samples and spans the period AD 1501–1648. Interpretation of the sapwood suggests felling of the four timbers occurred in Spring AD 1649.

A second site sequence is undated.

SURVEY, RECORDING, AND TREE-RING ANALYSIS OF TIMBERS FROM THE BELLFRAME OF THE CHURCH OF ST GREGORY, FLEDBOROUGH, NOTTINGHAMSHIRE

INTRODUCTION

The Grade I Listed Church of St Gregory is located in the village of Fledborough, to the south-east of Retford (Figs 1 and 2). It comprises a nave and south porch, north and south aisles, chancel, and west tower. The earliest fabric belongs to the lowest stage of the tower which is thought to date from the twelfth century. The nave and aisles date from the thirteenth century with the clerestory being fourteenth century. A chantry chapel was established in AD 1343 and demolished in AD 1764 and the chancel was virtually rebuilt in AD 1890. Repairs were undertaken in the tower in AD 1602 and in AD 1636 money was used for general church repairs, further work was undertaken in AD 1718.

Fledborough church is now redundant and was vested in the care of the Churches Conservation Trust in 1991.
(http://southwellchurches.nottingham.ac.uk/fledborough/hintro.php).

The Bell frame

The oak bellframe for two bells is of pegged jack-braced design, Pickford Group 6.B (Figs 3–9). It is of rough construction and probably dates to the early-seventeenth century.

The frame sits on a twentieth century wooden planked floor which in turn sits on six modern 20cm by 20cm oak beams. In the ninteenth century the bells were rehung with replacement wheels, etc, and the frame strengthened with new timbers cut into the top sills of all three trusses to house the plain bearings. These new timbers are marked on the drawings. At the same time bolts were put though many joints in an effort to stabilise the frame.

The Bells

Treble. [+ 97] SANCTVS [: 98] GREGORIVS

Tenor. [+ 44] PRAYSE THE LORD 1600

Badge numbers are taken from the Church Bells of Nottinghamshire.

The treble bell is medieval, by an unknown founder, and dates from the period AD 1350–70. The only other known bell with this lettering on it is at Gautby, Lincolnshire.

The tenor bell was cast by Henry II Oldfield of Nottingham.

Physical data:

	Diameter(cm)	Weight (Cwts)	Canons
Treble.	66.0	circa 3.5	6
Tenor.	75.0	circa 5.0	6

PRINCIPLES OF TREE-RING DATING

Tree-ring dating relies on a few simple, but fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees) grow by adding one, and only one, growth-ring to their circumference each, and every, year. Each new annual growth-ring is added to the outside of the previous year's growth just below the bark. The width of this annual growth-ring is largely, though not exclusively, determined by the weather conditions during the growth period (roughly March to September). In general, good conditions produce wider rings and poor conditions produce narrower rings. Thus, over the lifetime of a tree, the annual growth-rings display a climatically determined pattern. Furthermore, and importantly, all trees growing in the same area at the same time will be influenced by the same growing conditions and the annual growth-rings of all of them will respond in a similar, though not identical, way.

Secondly, because the weather over any number of consecutive years is unique, so too is the growth pattern of the tree. The pattern of a short period of growth, 20 or 30 consecutive years, might conceivably be repeated two or even three times in the last one thousand years. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth, that is, anything in excess of 60 years or so. In essence, a short period of growth, anything less than 50 rings, is not reliable, and the longer the period of time under comparison the better.

The third principal of tree-ring dating is that, until the early-to mid-nineteenth century, builders of timber-framed houses usually obtained all the wood needed for a given structure by felling the necessary trees in a single operation from one patch of woodland

or from closely adjacent woods. Furthermore, and contrary to popular belief, the timber was used "green" and without seasoning, and there was very little long-term storage as in timber-yards of today. This fact has been well established from a number of studies where tree-ring dating has been undertaken in conjunction with documentary studies. Thus, establishing the felling date for a group of timbers gives a very precise indication of the date of their use in a building.

Tree-ring dating relies on obtaining the growth pattern of trees from sample timbers of unknown date by measuring the width of the annual growth-rings. This is done to a tolerance of 1/100 of a millimetre. The growth patterns of these samples of unknown date are then compared with a series of reference patterns or chronologies, the date of each ring of which is known. When a sample "cross-matches" repeatedly at the same date against a series of different relevant reference chronologies the sample can be said to be dated. The degree of cross-matching, that is the measure of similarity between sample and reference is denoted by a "t-value"; the higher the value the greater the similarity. The greater the similarity the greater is the probability that the patterns of the samples and references have been produced by growing under the same conditions at the same time. The statistically accepted fully reliable minimum t-value is 3.5.

However, rather than attempt to date each sample individually it is usual to first compare all the samples from a single building, or phases of a building, with one another, and attempt to cross-match each one with all the others from the same phase or building. When samples from the same phase do cross-match with each other they are combined at their matching positions to form what is known as a "site chronology". As with any set of data, this has the effect of reducing the anomalies of any one individual (brought about in the case of tree-rings by some non-climatic influence) and enhances the overall climatic signal. As stated above, it is the climate that gives the growth pattern its distinctive pattern. The greater the number of samples in a site chronology the greater is the climatic signal of the group and the weaker is the non-climatic input of any one individual.

Furthermore, combining samples in this way to make a site chronology usually has the effect of increasing the time-span that is under comparison. As also mentioned above, the longer the period of growth under consideration, the greater the certainty of the cross-match. Any site chronology with less than about 55 rings is generally too short for satisfactory analysis.

SAMPLING STRATEGY

A total of nine samples was taken from various timber elements of this bellframe with each sample being given the code NBF-M and numbered 01–09. The location of all samples

was noted at the time of sampling and has been marked on Figures 5–8. Further details can be found in Table 1.

ANALYSIS & RESULTS

One of these samples (NBF-M07) was found to have too few rings for secure dating and so was rejected. The other eight samples were prepared by sanding and polishing and their growth-ring widths measured. These measurements were then compared with each other resulting in six samples matching to form two groups.

Firstly, four samples matched each other and were combined at the relevant offset positions to form NBFMSQ01, a site sequence of 148 rings (Fig 10). This site sequence was then compared against a series of relevant reference chronologies for oak where it was found to match consistently and securely at a first-ring date of AD 1501 and a last-measured ring date of AD 1648. The evidence for this dating is given by the *t*-values in Table 2.

Two other samples also matched each other and were combined to form NBFMSQ02, a site sequence of 52 rings (Fig 11). Attempts to date this site sequence and the remaining two ungrouped samples were unsuccessful and all remain undated.

INTERPRETATION

Four of the samples have been successfully dated. One of these, NBF-M03, has complete sapwood and the last-measured ring date of AD 1648. When this sample is looked at under the microscope it is possible to see the Spring growth cells of the following year. This demonstrates that the timber represented was felled in the Spring of AD 1649. The other three dated samples have the heartwood/sapwood boundary ring which can be seen to be broadly contemporary (Fig 10). The average heartwood/sapwood boundary ring date of these three samples is AD 1621, allowing an estimated felling date to be calculated for the three timbers represented to within the range AD 1636–61, consistent with these timbers also having been felled in Spring AD 1649.

Felling date ranges have been calculated using the estimate that 95% of mature oak trees from this region have 15–40 sapwood rings.

DISCUSSION

Prior to the tree-ring dating being undertaken this bellframe was thought to date to the early-seventeenth century. It can now be seen that it is constructed utilising timber felled

in Spring AD 1649, giving it a mid-seventeenth century date, slightly later than previously thought.

Samples NBF-M03 and NBF-M06, taken from a brace and top cill respectively, match each other at a high value of *t*=13.6, demonstrating that the two timbers represented were almost certainly cut from the same tree.

BIBLIOGRAPHY

Arnold, A J, Howard, R E, Laxton, R R, and Litton, C D, 2001 Nottingham University Tree-Ring Dating Laboratory results, *Vernacular Architect*, **32**, 92–8

Arnold, A J, Howard, R E, and Litton, C D, 2008 Nottingham Tree-Ring Dating Laboratory, *Vernacular Architect*, **39**, 119–29

Esling, J, Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1989 Nottingham University Tree-Ring Dating Laboratory: Results, *Vernacular Architect*, **20**, 39–41

Fledborough, St Gregory, http://southwellchurches.nottingham.ac.uk/fledborough/hintro.php

Howard, R E, Laxton, R R, Litton, C D, and Simpson, W G, 1994 Nottingham University Tree-Ring Dating Laboratory: results, *Vernacular Architect*, **25**, 36–40

Howard, R E, Laxton, R R, and Litton, C D, 1998 unpubl 103 Church Street, Misterton, Nottinghamshire, unpublished computer file *MSTASQ01*, NUTRDL

Howard, R E, Laxton, R R, and Litton, C D, 2005 *Tree-ring analysis of timbers from the Riding School, Bolsover Castle, Bolsover, Derbyshire*, Centre for Archaeol Rep, **40/2005**

Laxton, R R, and Litton, C D, 1988 *An East Midlands master tree-ring chronology and its use for dating vernacular buildings*, University of Nottingham, Dept of Classical and Archaeol Studies, Monograph Series, **III**

ACKNOWLEDGEMENTS

The Laboratory and George Dawson would like to thank Dawn Whitton for facilitating access and Professor John Beckett and Dr Chris Brooke for the information on the Southwell and Nottingham Church History website. Thanks are also given to Dr Chris Brooke for his comments on early drafts of this report. The research was undertaken as part of the Southwell and Nottingham Church History Project and this element was joint funded by The Heritage Lottery Fund and Nottinghamshire County Council.

Table 1: Details of samples taken from the bellframe at the Church of St Gregory, Fledborough, Nottinghamshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
NBF-M01	North brace, truss A	55	21C	----	----	----
NBF-M02	North jack brace, truss A	122	01	1501	1621	1622
NBF-M03	North brace, truss B	109	15C	1540	1633	1648
NBF-M04	South brace, truss B	52	15	----	----	----
NBF-M05	South jack brace, truss B	49	11	----	----	----
NBF-M06	Top cill, truss D	91	10	1542	1622	1632
NBF-M07	West jack brace, truss D	NM	--	----	----	----
NBF-M08	Top cill, truss C	79	h/s	----	----	----
NBF-M09	Bottom cill, truss C	70	h/s	1551	1620	1620

*NM = not measured

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

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

Table.2: Results of the cross-matching of site sequence NBFMSQ01 and relevant reference chronologies when the first-measured ring date is AD 1501 and the last-measured ring date is AD 1648

Reference chronology	*t*-value	Span of chronology	Reference
103 Church St, Misterton, Nottinghamshire	10.9	AD 1480–1653	Howard *et al* 1998 unpubl
Sherwood Trees, Nottinghamshire	8.0	AD 1426–1981	Laxton and Litton 1988
Langford Manor, Nottinghamshire	7.8	AD 1467–1632	Esling *et al* 1989
Yew Tree Farm (aisled barn), North Leverton, Nottinghamshire	7.2	AD 1476–1618	Arnold *et al* 2008
Brewhouse Yard Museum, Nottinghamshire	6.7	AD 1544–1701	Howard *et al* 1994
Bolsover Castle,(Riding house), Derbyshire	6.3	AD 1494–1744	Howard *et al* 2005
Yew Tree Farm, Kirton, Nottinghamshire	6.2	AD 1443–1688	Arnold *et al* 2001

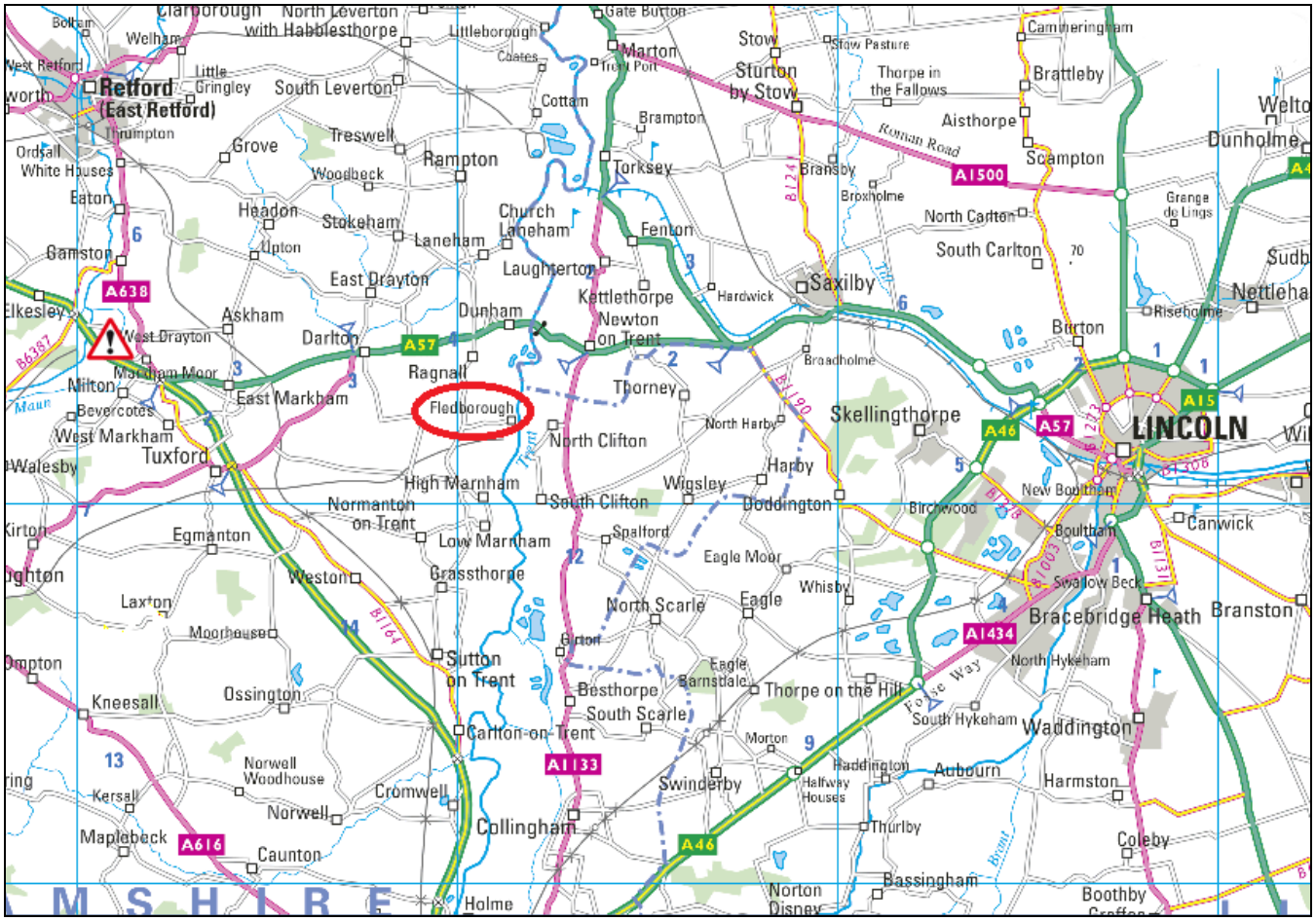

Figure 1: Map to show the general location of Fledborough, circled (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright

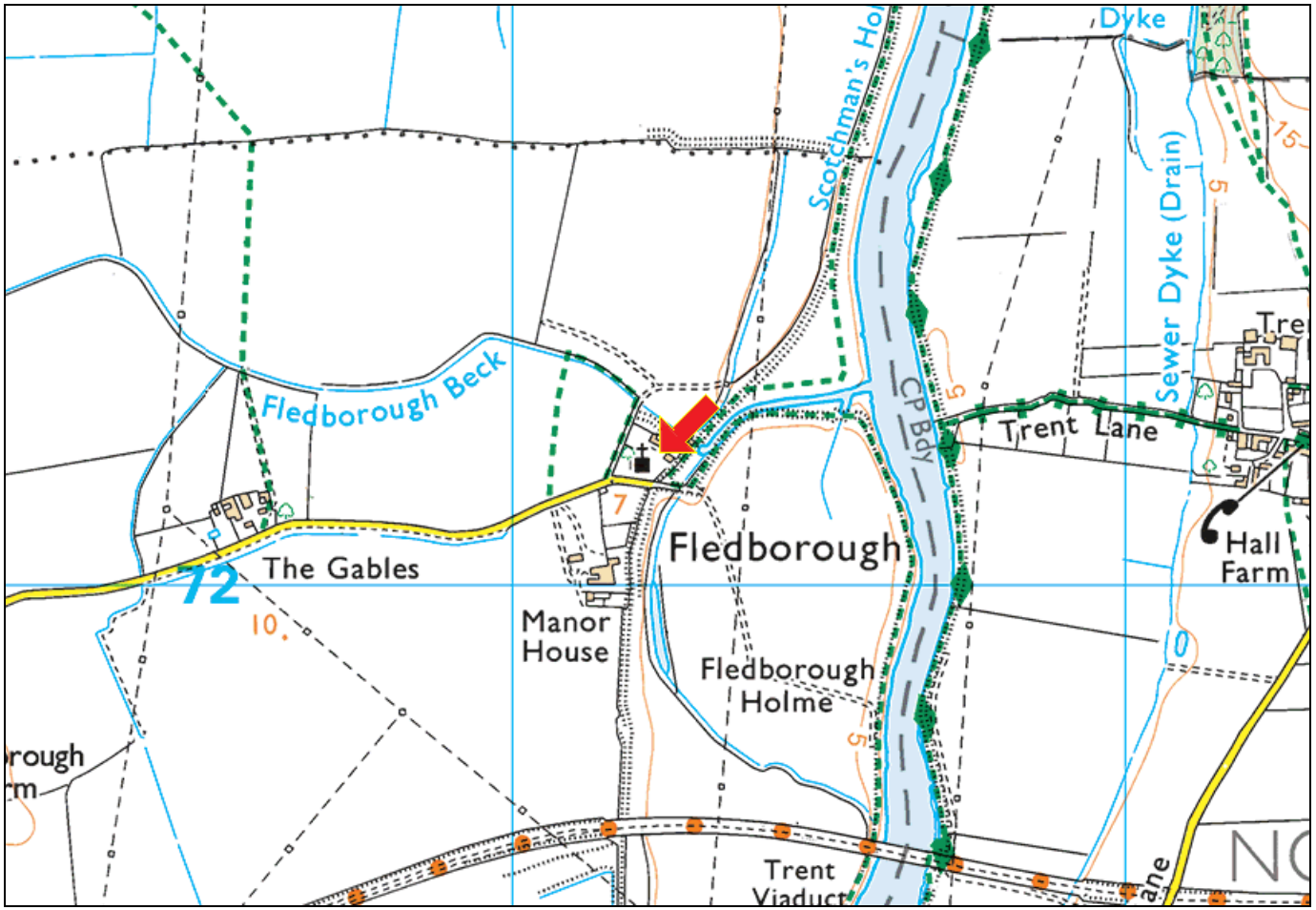

Figure 2: Map to show the location of Church of St Gregory, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

Figure 3: The bellframe, photograph taken from the north-east

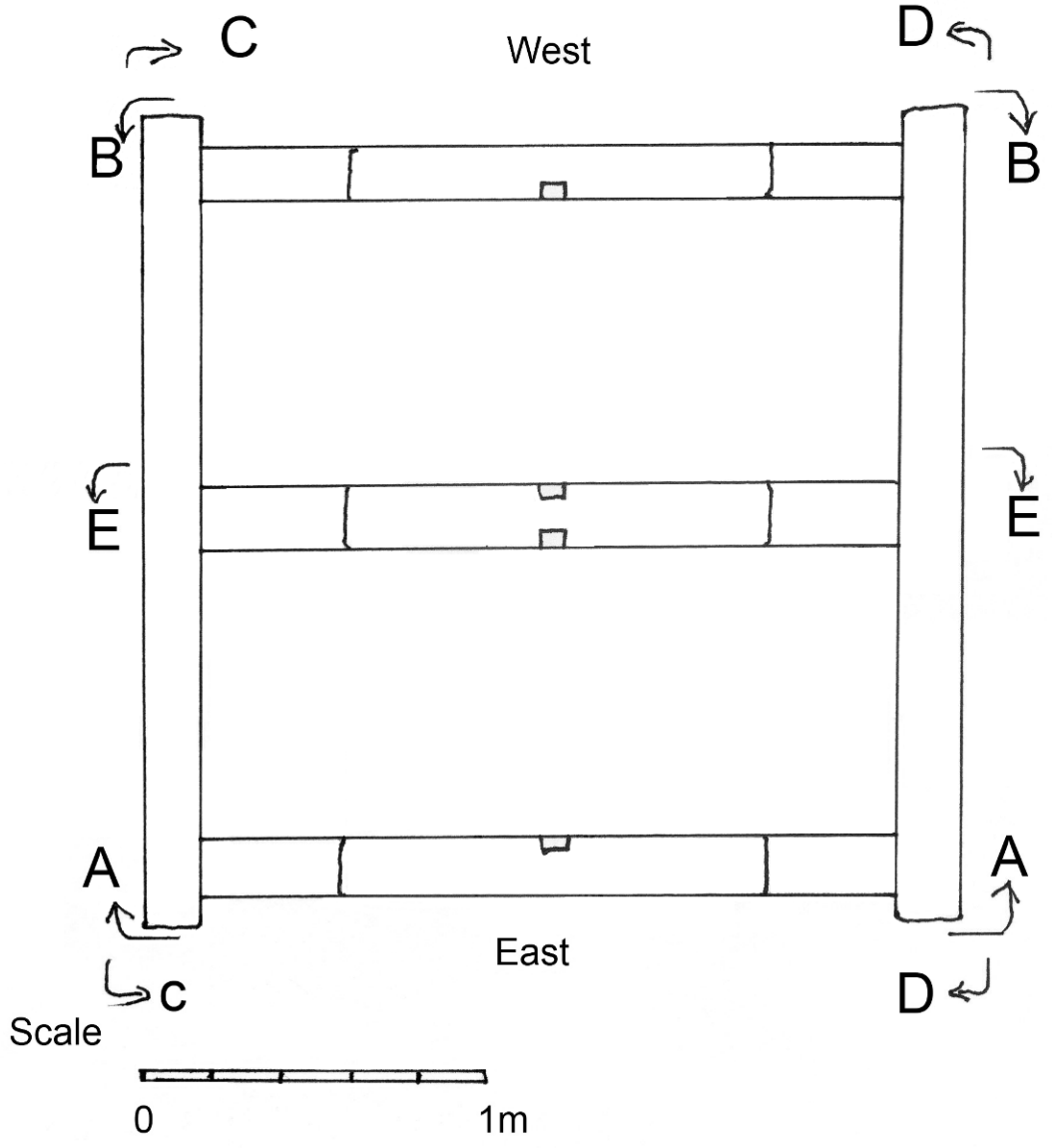

Figure 4: Plan, showing truss labelling

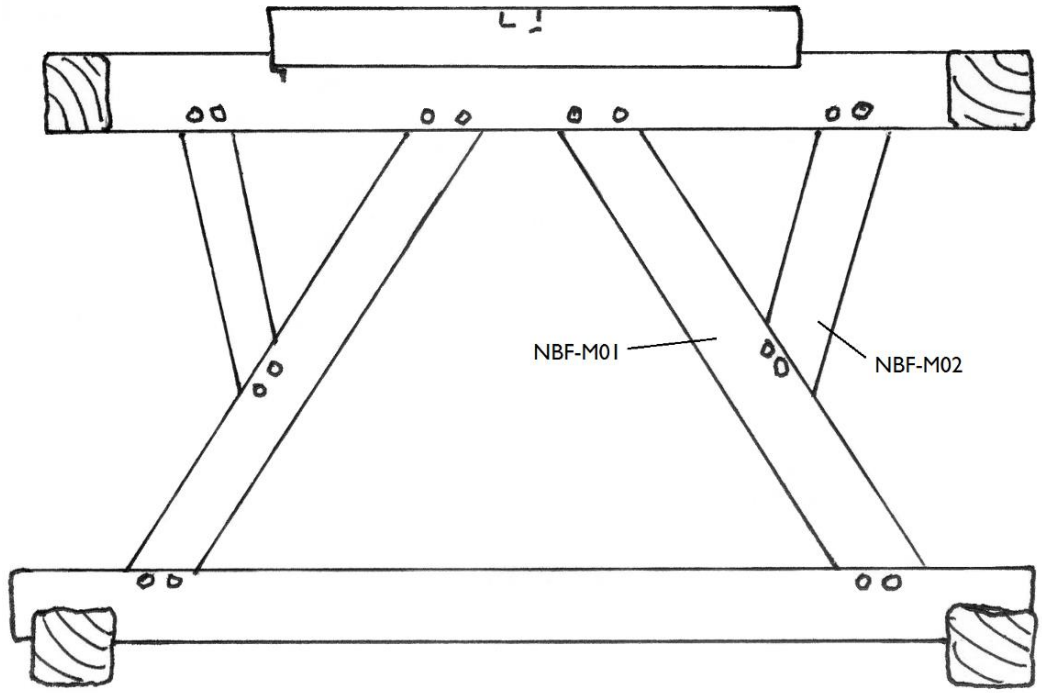

Figure 5: Truss A, showing the location of samples NBF-M01 and NBF-M02

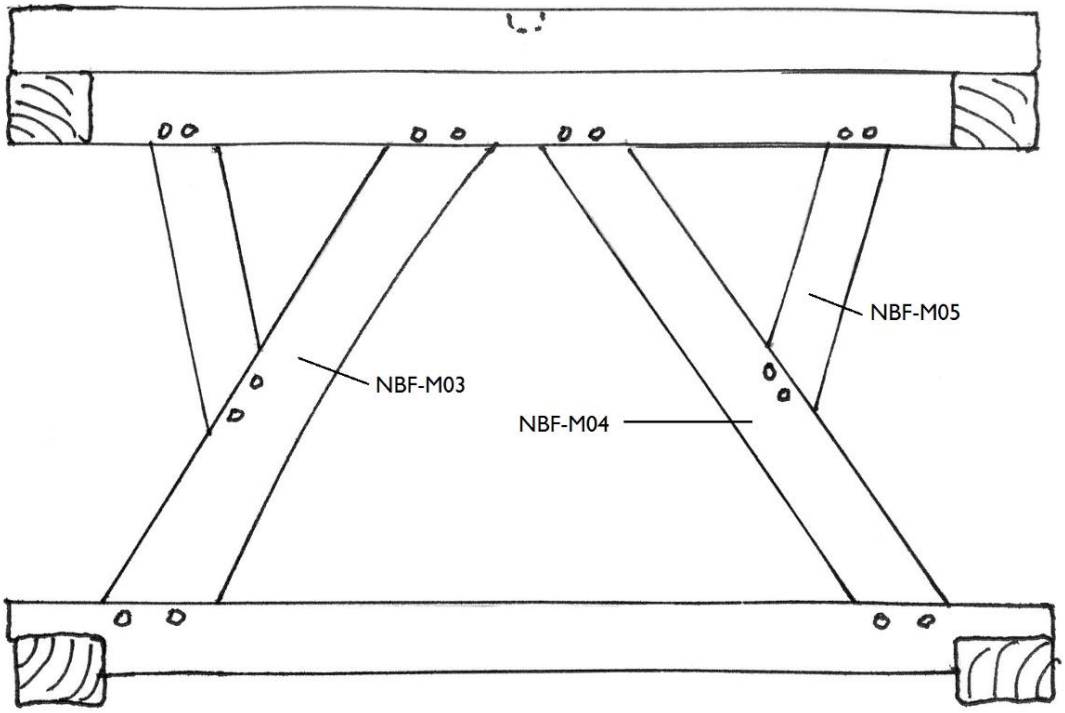

Figure 6: Truss B, showing the location of samples NBF-M03–5

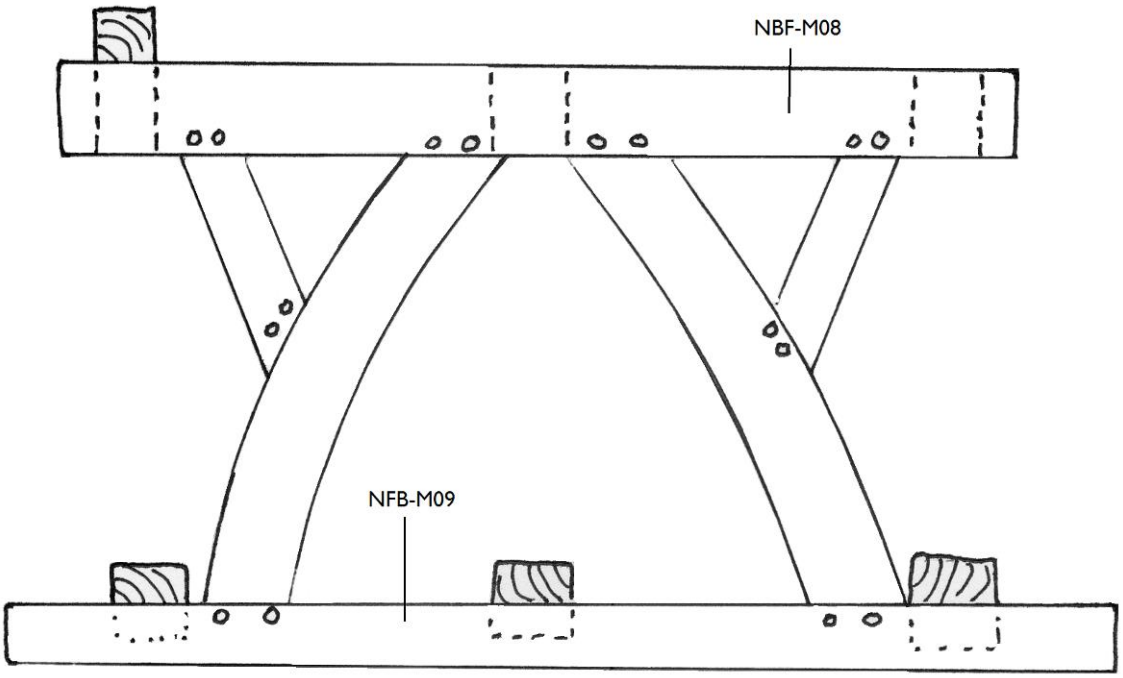

Figure 7: Truss C, showing the location of samples NBF-M08 and NBF-M09

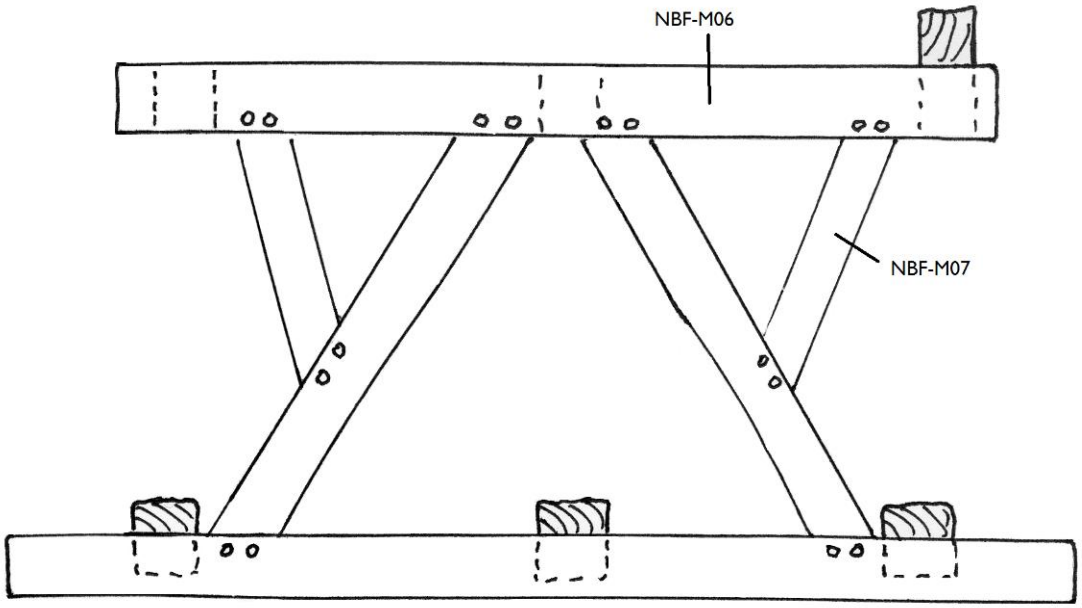

Figure 8: Truss D, showing the location of samples NBF-M06 and NBF-M07

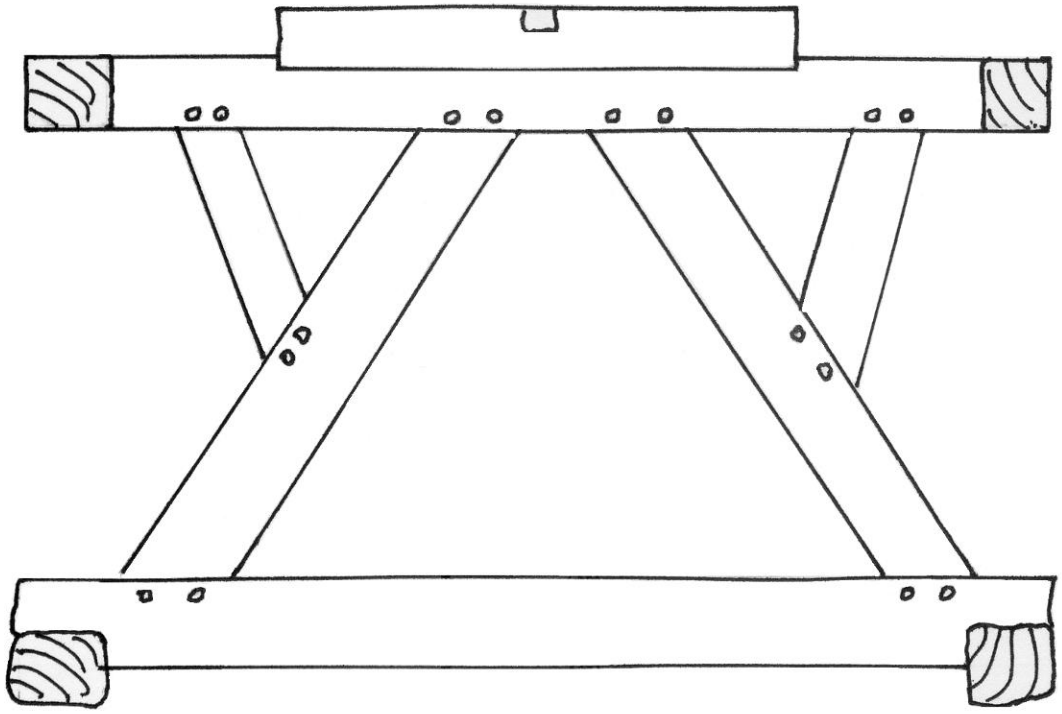

Figure 9: Truss E

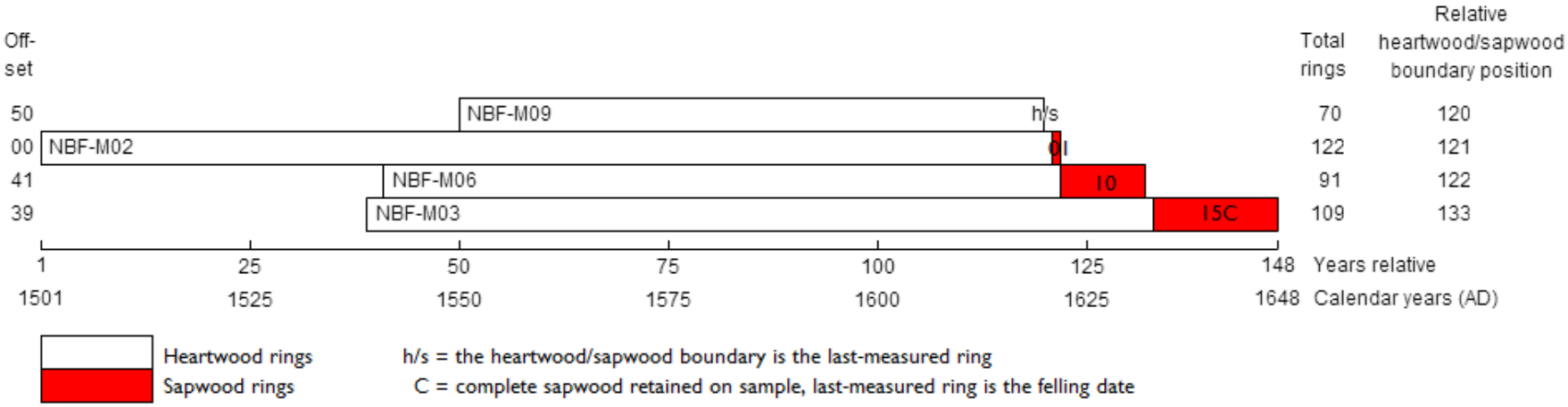

Figure 10: Bar diagram of samples in site sequence NBFMSQ01

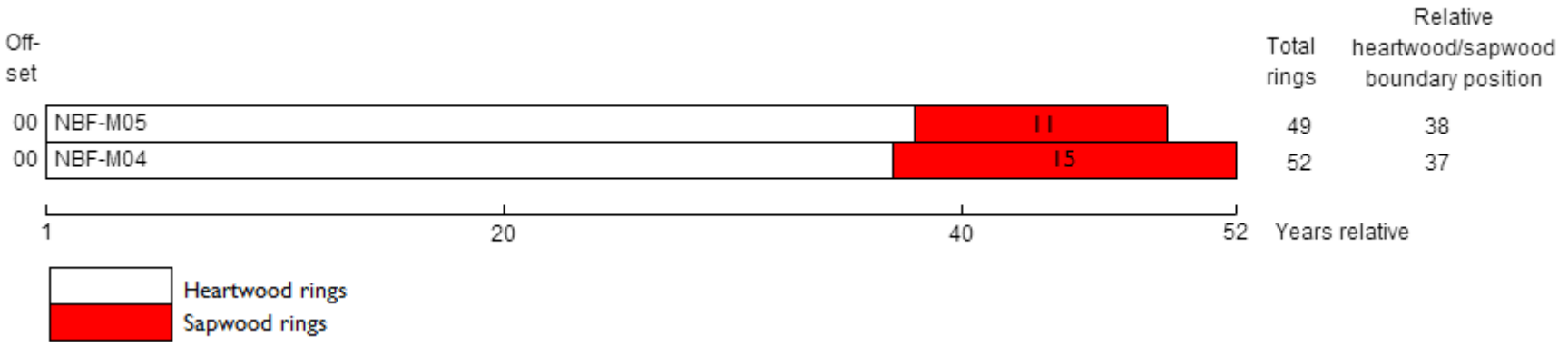

Figure 11: Bar diagram of samples in undated site sequence NBFASQ01

DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

NBF-M01A 55
395 605 601 515 516 460 313 558 500 324 384 410 281 238 258 254 225 261 171 199
265 317 251 172 166 131 214 224 236 230 209 239 224 263 141 162 179 204 109 95
87 99 64 92 147 186 141 165 188 174 202 160 161 129 89
NBF-M01B 55
373 601 589 507 529 459 324 565 475 330 391 418 289 233 254 258 224 270 184 195
242 296 247 172 160 133 221 221 230 238 197 236 232 261 152 162 182 203 102 95
82 98 67 88 144 183 147 166 187 175 214 143 161 140 98
NBF-M02A 122
333 431 253 197 152 151 119 75 115 78 163 103 112 96 60 130 59 57 74 92
99 109 52 101 80 93 150 196 162 49 95 106 108 116 89 119 148 124 98 117
129 53 59 66 73 97 104 127 161 100 75 62 50 38 39 43 46 55 88 84
96 152 123 66 102 69 102 90 129 168 111 93 107 76 77 64 108 69 131 137
185 118 100 80 125 128 112 51 79 80 91 130 131 169 136 85 95 104 74 66
85 98 144 173 142 193 142 129 103 116 154 145 191 123 120 107 104 154 181 180
182 256
NBF-M02B 122
337 434 251 187 168 154 110 76 102 83 160 98 110 98 65 118 58 54 80 87
93 93 68 89 85 90 143 184 162 65 96 105 106 130 71 127 159 121 98 113
115 52 55 61 81 89 112 126 163 100 97 55 64 39 38 37 45 82 95 101
103 143 124 67 102 65 95 116 124 169 111 98 103 74 75 72 100 72 125 132
190 116 95 78 126 123 114 58 73 79 92 132 125 176 134 82 101 104 70 67
86 100 151 170 141 191 141 122 108 127 161 142 208 125 117 93 96 150 181 181
178 260
NBF-M03A 109
288 263 109 106 64 95 126 208 256 282 209 198 158 174 123 89 97 99 175 257
249 214 303 192 135 131 131 196 201 239 249 254 190 186 119 82 116 174 139 181
214 275 176 158 116 177 201 211 89 88 77 113 128 140 171 164 123 181 274 151
120 106 129 177 210 161 219 200 176 106 157 161 136 176 145 123 110 110 162 147
177 170 234 209 111 100 97 152 142 175 136 155 207 170 137 101 53 64 88 113
172 175 61 100 120 109 134 84 108
NBF-M03B 109
297 271 105 108 65 98 130 202 249 294 204 204 151 176 127 89 100 97 184 255
239 204 296 189 131 135 132 196 204 248 249 254 189 187 102 92 120 176 151 181
211 266 169 156 116 203 206 216 86 88 71 117 123 141 168 169 129 163 258 156
130 116 128 165 205 149 211 200 184 112 149 154 139 182 149 125 112 113 150 145
167 176 240 214 105 98 104 150 145 176 139 158 208 163 146 100 53 69 97 109
170 176 67 94 126 102 116 83 70
NBF-M04A 52
266 463 487 438 403 410 425 404 394 273 323 315 196 271 268 201 169 197 198 231
257 190 165 180 243 239 216 49 49 92 55 83 56 98 93 115 154 126 157 187
192 130 154 121 135 153 213 264 306 160 120 125

NBF-M04B 52
267 462 486 454 404 414 421 406 400 272 313 311 193 277 267 206 166 205 196 232
259 196 169 178 242 244 224 46 59 82 60 85 62 91 99 116 153 133 145 197
185 138 149 123 137 147 205 254 303 154 120 129
NBF-M05A 49
104 268 267 285 270 262 300 313 251 221 265 278 195 305 312 276 216 231 218 224
293 227 190 142 216 191 181 65 88 157 119 148 175 229 153 167 198 162 180 248
162 128 141 93 123 146 128 179 194
NBF-M05B 49
99 261 250 286 259 271 362 311 260 228 266 266 192 306 311 279 224 232 217 222
294 221 184 157 209 194 182 67 82 164 128 148 176 233 146 166 205 162 176 253
201 87 153 100 126 142 129 187 188
NBF-M06A 91
118 85 54 118 131 177 262 304 231 275 162 145 121 104 134 126 226 260 194 221
256 170 109 109 121 179 190 189 277 277 195 174 101 98 118 156 125 165 195 221
149 134 117 294 287 232 103 87 80 129 152 143 163 164 102 172 157 104 73 78
110 234 295 210 146 186 137 100 105 161 134 151 112 91 81 90 149 128 135 161
221 182 114 103 118 176 112 157 120 111 142
NBF-M06B 91
106 153 90 101 118 165 226 286 230 250 163 143 118 98 123 122 211 253 189 205
238 162 117 109 121 160 174 155 261 282 173 172 96 97 111 145 131 155 192 223
140 133 104 280 261 241 104 85 77 121 146 127 158 167 107 172 167 101 71 80
113 239 291 209 143 186 134 97 104 152 131 142 114 86 81 86 147 130 133 165
220 184 113 106 113 170 112 164 115 129 141
NBF-M08A 79
203 317 199 257 189 223 293 305 215 174 274 301 306 196 276 266 323 276 228 223
325 242 256 238 205 123 182 199 175 132 160 143 258 177 119 286 230 295 317 328
76 52 52 83 68 63 80 115 70 58 79 96 121 128 96 152 150 102 138 116
130 120 174 135 193 195 134 129 125 94 164 123 183 127 107 61 52 59 63
NBF-M08B 79
220 316 194 260 186 228 288 317 208 172 287 314 287 194 264 268 311 265 231 233
317 249 248 259 210 138 188 198 165 126 156 151 270 163 111 285 239 314 323 321
77 45 52 75 72 62 83 120 70 59 81 96 124 125 101 156 150 97 146 114
131 112 179 133 188 201 128 122 102 95 171 128 166 131 113 55 43 68 58
NBF-M09A 70
263 169 184 188 171 118 136 217 249 190 291 298 288 205 127 115 134 192 214 317
414 246 276 101 87 172 123 84 180 203 261 213 267 168 246 312 302 143 127 86
133 168 273 377 370 283 235 234 118 102 113 146 235 241 222 301 345 208 145 175
206 230 252 165 130 145 99 146 156 119
NBF-M09B 70
285 164 193 200 170 123 140 213 248 194 287 302 293 207 130 104 147 186 211 318
430 247 277 91 85 165 124 93 183 200 261 212 260 167 242 303 312 151 126 81
134 174 271 374 372 288 236 231 120 100 116 145 233 245 223 299 343 238 140 180
213 223 263 164 134 151 99 130 142 118