Historic England

Archaeological Condition Assessment & Updated Project Design

Flag Fen: Investigating the survival and preservation of the archaeological remains to inform a management strategy

Mark Knight

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CAMBRIDGE ARCHAEOLOGICAL UNIT

Archaeological Condition Assessment

Flag Fen - Investigating the survival and preservation of the archaeological remains to inform a management strategy

Mark Knight

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Location:	TL 2267 9889
Site Code:	FFB '21
HE Project No:	7902

PROJECT DATA

Site name	Flag Fen
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SUMMARY

The Autumn 2021 condition assessment involved five trenches and one off-site environmental test-pit. Three trenches were opened above the Flag Fen post alignment and two above the Flag Fen platform. The post alignment trenches exposed three 1.4m wide transects across the rows of posts and top of the associated horizontal wood mass. One trench was excavated to its base, revealing an earlier land surface and enabling a comprehensive assessment of the worked wood and related deposits. The platform trenches sought to determine the northern and southern limits of the monument and to obtain samples.

The westernmost post alignment trenches revealed desiccated, oxidized sediments characterised by fissures and voids as well as masses of invasive nettle roots. The condition of the worked wood in these exposures was poor, and demonstrably poorer than previously recorded. The easternmost post alignment trench was different, in that here the sediments were wet, unoxidized and of greater depth. The platform trenches exposed an equivalently deep sediment sequence and indicated the monument's southernmost extent but not its northernmost.

Analyses of plant remains, pollen and insects describe an equivalent decline in preservation as the wood and this applies across the different interventions, and especially along the western half of the post alignment.

The latest investigations at Flag Fen provide new detail concerning the contextual and topographical setting of the monument. Modelling the palaeo-topography demonstrates a correspondence between contour and condition, with the best preserved parts of the monument (the central eastern half) being situated within the deepest part of the Flag Fen Basin. These deeper contours appear to define an earlier linear embayment located along the eastern edge of the greater basin. This deep, largely waterlogged, silt and peat-filled trough accords essentially with the projected location of the Flag Fen platform.

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The excavation was commissioned by Historic England and overseen by Zoe Outram (Science Advisor), Will Fletcher (Team Leader) and Esther Blaine.

The Project Manager was David Gibson, and site work was overseen by Mark Knight. Project administration and logistics was provided by Samantha Smith and Alex Bovaird. The field team was made up of Laura Hogg, Petra Jones, Allan Kirk, David Matzliach, Lizzy Middleton, Iona Robinson Zeki, Lucia Speariett, Georgia Vance and Christopher Wakefield. Survey was carried out by Donald Horne with photographs and graphics prepared by David Matzliach, Charlotte Walton, Brian Crossan and Laura Hogg. Finds and samples were processed and catalogued by Emma Rees and Chris Boulton, overseen by Emily Bamfield.

Jacqueline Mooney and David Savory at Flag Fen are thanked for their support and assistance throughout the site work.

Plant was provided by Lattenburys.

1. INTRODUCTION

1.1 Project summary

1.1.1 The timbers forming the internationally-significant post alignment at Flag Fen (Figure 1) are degrading. There is now a risk of catastrophic loss to the preserved archaeology.

1.1.2 In order to address this risk, and remove the site from the Heritage at Risk register, Historic England wishes to develop a management plan for the site (Figure 2). It had previously commissioned the Cambridge Archaeological Unit (CAU) to undertake a desk-based review and conservation assessment (Brittain et al 2020).

1.1.3 The CAU's report highlighted the lack of objective information on the survival and state of preservation of parts of the site (particularly the middle western stretch of the post-alignments), as well as the ambiguity regarding the character and extent of the platform component.

1.1.4 To address these gaps, and provide data necessary for an effective management plan, Historic England commissioned a targeted trench-based evaluation of the site coupled with specialist scientific analysis of its preserved remains (waterlogged wood, pollen, plant remains, and insects).

1.1.5 A project design produced by the CAU and York Archaeological Trust (YAT) proposed the excavation of four trenches along the post-alignment (three west of the platform and one to the east), together with two transects of test-pits north and south of the timber platform (Figure 3). In addition, a single, 'off-site' environmental test-pit was recommended (intentionally located in an area of deep deposits). In the event, only three trenches were opened along the post-alignment (the westernmost proposed trench was withdrawn because of the proximity of a high pressure gas main).

1.1.6 The trenches and test-pits were located to facilitate the recovery of samples for scientific data and condition/preservation analysis.

1.1.7 The archaeological excavations were undertaken in accordance with an approved Written Scheme of Investigation (WSI), which was prepared by the Cambridge Archaeological Unit (Wiseman et al. 2021).

1.2 Project background

1.2.1 The Flag Fen post-alignment is an internationally significant Bronze Age monument (Pryor 2001).

1.2.2 The Bronze Age site survived because it has been in a waterlogged peatland environment since its construction. However, draining the surrounding fens for agriculture has lowered groundwater levels, so that the timbers are no longer submerged. There is evidence that the timber and other organic remains are degrading, and there is a risk of significant loss of preserved archaeology.

1.2.3 The site is a Scheduled Monument (no. 1406460). Because of the potential loss, it has been on Historic England's Heritage at Risk Register since 2012. Historic England wishes to develop a management plan for the site.

1.2.4 In 2020, Historic England commissioned the CAU to prepare a review of all existing information on the site, with the goal of understanding:

- the condition of the surviving archaeology
- what further work is required in order to generate the evidence required to properly inform the management plan
- what proportion of the site has been investigated, and what remains undisturbed
- what parts of the site may now be graded for its archaeological value.

1.2.5 Amongst the CAU's findings was that whilst there have been many intrusive investigations on the site since it was discovered in the 1980s, there is only limited information available about its preservation and the rate of change in the site's conditions. Much of the information on the timber is now decades old, and some was lost in the fire of 2000. There is very little information available about the condition of the peats and the environmental remains they contain in the central and western parts of the site. The CAU's report recommended targeted excavations to recover objective information about the state of preservation and to establish the extent of the timber platform.

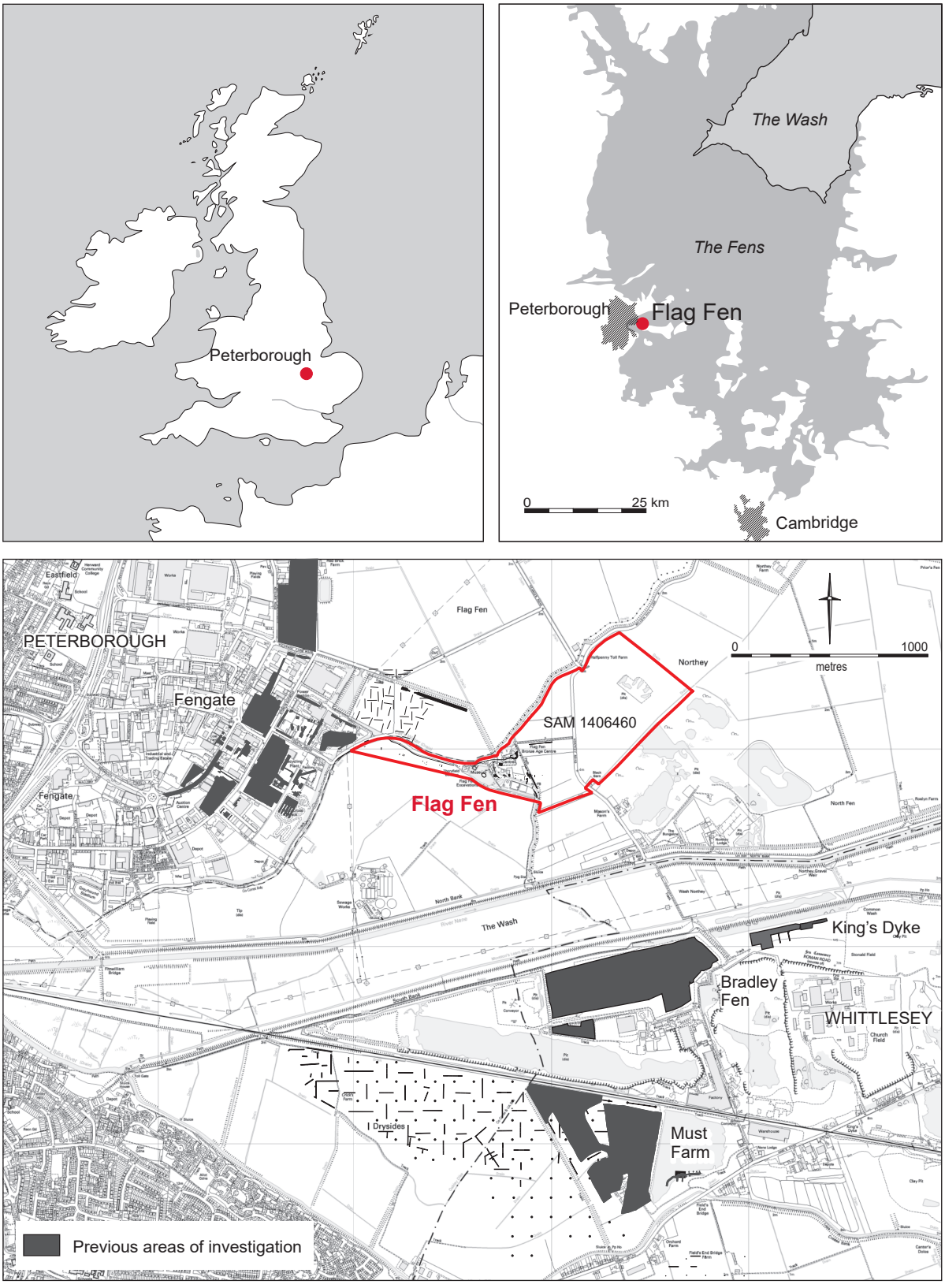


Figure 1. Location of Flag Fen (SAM 1406460) and distribution of archaeological investigations in the Flag Fen Basin

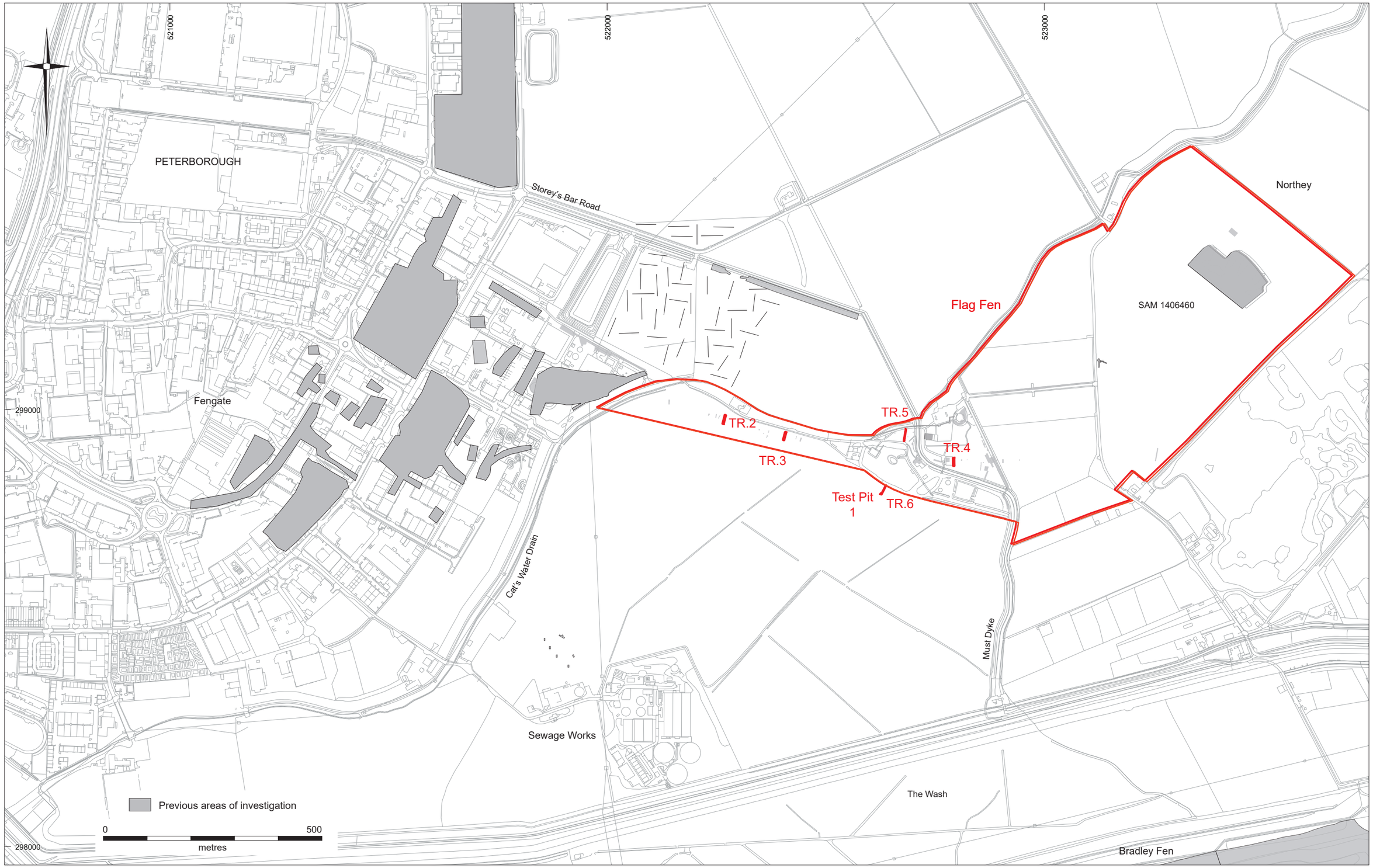


Figure 2: Detailed location of Flag Fen (SAM 1406460) and adjacent archaeological interventions

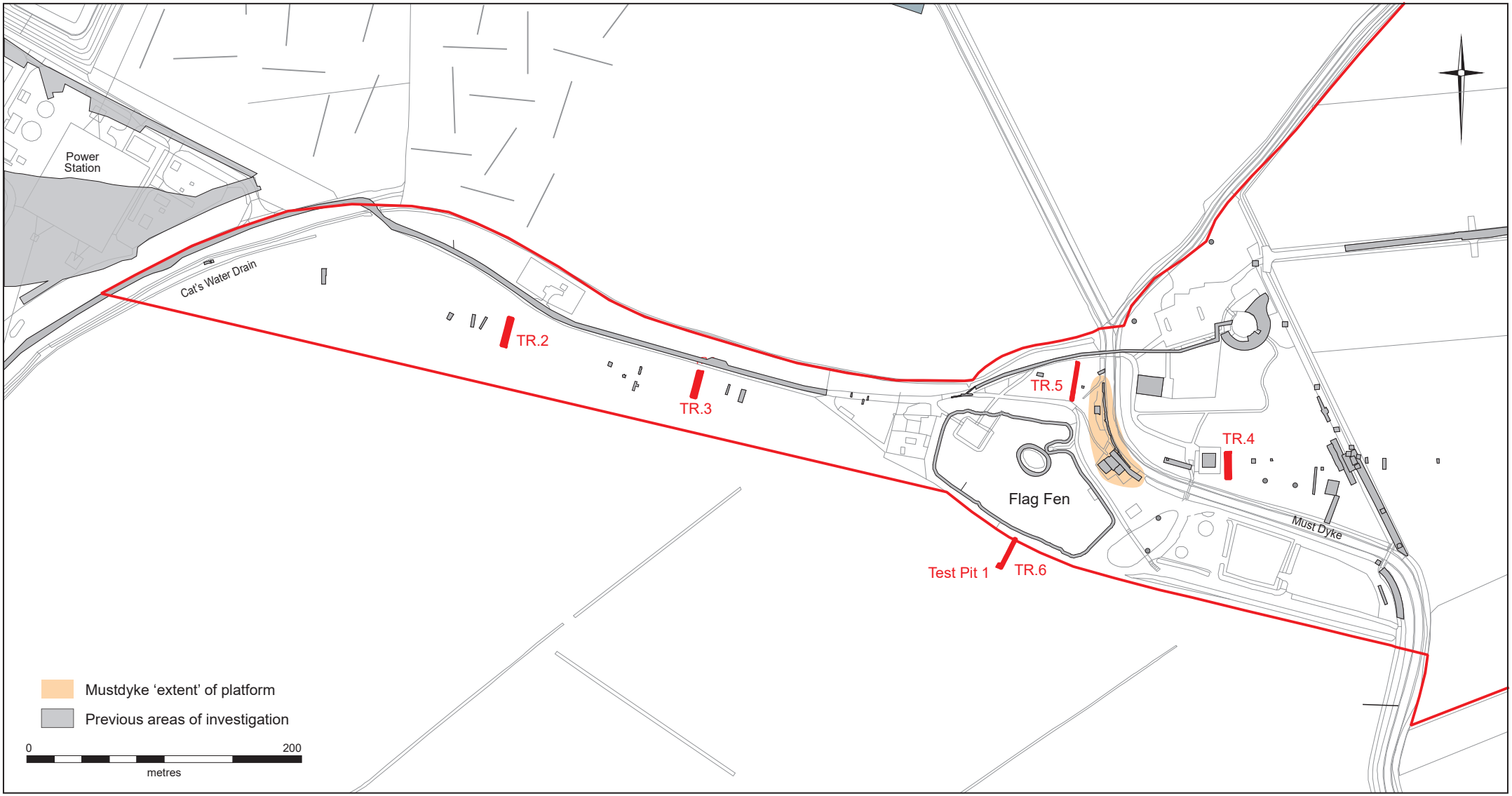


Figure 3: Detail of archaeological interventions specific to the Flag Fen post alignment and platform investigations. The 2021 archaeological condition assessment trenches are shown in red (Trenches 2-6; Test pit 1)

2. ARCHAEOLOGICAL BACKGROUND

2.1.1 Since its discovery in 1982, the Flag Fen site has been subject to multiple, largely small-scale archaeological interventions focused almost exclusively on the established footprint of the preserved timber monument and/or its relationship to adjacent landfall (Pryor 2001; Bamforth and Pryor 2010; Wilkins et al. 2013).

2.1.2 The Flag Fen monument can be split up into two key component parts: Post alignment and Platform. Of the two, the post alignment is the best understood and also the most investigated (no less than twenty individual interventions, the first in 1982, the last in 2012; Figure 2 and Figure 3). In contrast, the actual form and extent of the platform remains enigmatic, and, beyond its original cross-section exposure in the side of Mustdyke and the post alignment/platform Area 6, has been subject to limited investigation.

2.1.3 The interrelationship between the post alignment and platform is also unclear, other than the former spans the 'middle' of the latter. Currently, these intersecting architectural entities are difficult to pull apart and it is difficult to distinguish where one begins and the other ends. Stratigraphically there is no discernible division, and the existing dating evidence suggests the two constructions are broadly contemporary.

2.2 The Flag Fen Post alignment

2.2.1 Spanning the northern neck of the Flag Fen Basin (between Fengate, Peterborough and Northey Island, Whittlesey), the post alignment was approximately 1100m long and 10m wide. The alignment comprised at least five parallel rows of posts or piles, driven on average 1m into the underlying deposits of peat, buried soil and gravel. Collectively, the post-rows have been estimated to involve as many as 22,000 uprights (Bamforth 2010, 76), the bulk of which were oak.

2.2.2 Dendrochronological analysis showed the post alignment to comprise trees felled in the first quarter of the thirteenth century BC through to trees felled in the last quarter of the tenth century BC. Together these felling dates describe a monument built, maintained and modified over a period of at least 360 years (c. 1280-920 BC).

2.2.3 Pryor's interpretation of the post alignments envisions the rows of posts as a succession of closely spaced parallel boundaries or barriers, beside and in between which ran a series of narrow timber walkways made of layers of wood (Pryor 2001,164). Critically, the walkways are understood as being constructed directly onto the waterlogged sediment.

2.2.4 The composition of the walkways showed some variation between levels and between where they were located in relation to the different post rows. This horizontal component consisted of at least five levels and comprised roundwood, timbers (including mortised pieces) and debris (including woodworking debris).

2.2.5 In summary, the horizontal wood component has been interpreted as being made up of foundation material in conjunction with layers of logs, 'plank and long timber walkways', 'short plank, chip and sand' walkways, flooring, wattle revetments, thresholds and traverse partitions/partition boundaries. Throughout, the horizontal wood component is described as being *in-situ* and as having trampled or worn surfaces with undersides affected by wet rot.

2.2.6 Wooden artefacts (12 fragments), metalwork (223 items), pottery (489 sherds), animal bone (1598 pieces) human bone (MNI 9) and quernstones (6 in total) have been recovered from the different interventions across the post alignment and platform, with the bulk of the material

coming from the extensive Power Station excavations of the post alignment or the intensive Area 6 investigations of the post alignment/platform. Although the dendrochronology dates the site to between the fourteenth and tenth centuries BC, material culture associated with the constructions have a much longer chronology.

2.3 The Flag Fen Platform

2.3.1 If the post alignment is primarily characterised by its multitude of uprights, the platform is differentiated by its widespread, multi-layered distribution of 'horizontals' together with its seemingly discrete setting towards one end of the alignment.

2.3.2 The platform is thought to encompass an area of between 1.5 to 2.2ha (depending on which exposures of horizontal wood are used in its reconstruction). Currently, the platform's northerly and easterly extent has been determined primarily by the Mustdyke cross-section (French & Pryor 1993), whereas its southerly and westerly boundaries have been established via watching brief observations made during the construction of the Great Mere and the narrow trench excavated to install its plastic 'skirt' (Pryor 2001).

2.3.3 In Area 6, seven horizons were identified and these were interpreted as the platform foundation comprising brushwood and roundwood over a layer of split logs (Layers 7-5), and the platform itself, comprising a mix of split timbers, roundwood and worked timbers (Layers 3-1); spreads of sand and gravel interceded some of these layers.

2.3.4 The platform strata also incorporated wooden artefacts (including a wheel, axe hafts, a scoop and a log vessel), metalwork (including a flesh hook, spearheads and a chape), parts of ten pottery vessels (Middle Bronze Age and Late Bronze Age) and four saddle querns.

2.3.5 Pryor's interpretation of the platform envisages a 'series of consolidated areas interspersed with watercourses and pools' that was nevertheless circumscribed by a 'revetted perimeter walkway' that, in its construction, bore a resemblance to the 'main walkway' of the post alignment (Pryor 2001, 165).

2.3.6 Access to the platform was gained by way of the post alignment and via specific gaps in the post rows. In essence, the platform was bisected by the post alignment, separating the edifice into north and south. Pryor suggested this division corresponded to a 'hostile' (north) and 'safe' (south) side. The implication being that the northside was outside and the southside was inside (Pryor 2001, 166). Encapsulated in this understanding is the idea of the post alignment as a barrier or boundary.

3. ORIGINAL RESEARCH THEMES, OBJECTIVES AND QUESTIONS

3.1.1 The goal of these investigations is to obtain information necessary to inform a management plan for the site, so appropriate action can be taken and ultimately see the site removed from the Heritage at Risk register (http://historicengland.org.uk/advice/heritage-at-risk/serach-resgiter/list -entry/43262).

3.1.2 The aim of this project is to carry out targeted intrusive investigations in order to improve the baseline information for the site and allow us to gain an understanding of the preservation of the archaeological and paleoenvironmental remains (Historic England 2021).

3.1.3 It will allow questions to be investigated about how the preservation of key archaeological remains varies across the site/trenches.

3.1.4 The objectives outlined in the Project Brief (Historic England 2021) were as follows:

i. To characterise the remains of the Post Alignment through archaeological excavation.

ii. To characterise the remains of the Platform through archaeological excavation.

iii. To obtain samples from the Post Alignment to undertake scientific assessment of their current state of preservation.

iv. To obtain samples from the Platform to undertake scientific assessment of their current state of preservation.

v. To obtain samples from deposits associated with the Post Alignment to characterise their potential for informing on the use of the structure.

vi. To obtain samples from deposits associated with the Platform to characterise their potential for informing on the use of the structure.

vii. To obtain samples for palaeoenvironmental assessment from an ‘off site’ locality.

viii. To obtain samples, in consultation with the Historic England Scientific Dating Team, to provide a robust chronology for the palaeoenvironmental assessment.

ix. To undertake site archive completion and assessment work in a timely manner and to HE standards, in order to develop proposals for analysis work based on the assessment report.

4. ASSESSMENT METHODOLOGY

4.1.1 The archaeological work was carried out in accordance to the Written Scheme of Investigation (Wiseman et al. 2021) approved by Historic England and Peterborough City Council, prior to commencement of works. The excavation was undertaken in accordance with the Chartered Institute for Archaeologists' Standard and Guidance for Archaeological Evaluation (CIFA 2014, updated 2020) and Code of Conduct (2014).

4.1.2 Fieldwork was undertaken on 13/10/21 – 26/11/21

4.1.3 Fieldwork was divided into three parts: 1) the post-alignment, 2) the platform, and 3) an off-site test pit to retrieve paleoenvironmental samples.

4.1.4 A sampling strategy was agreed with HE's Scientific Advisor for the East of England and the HE Environmental and Dating specialists at the start of the project.

4.1.5 *Trenching over the post alignment*: The original project design proposed a total of four trenches across the post alignment: one to the east of the platform and three to the west. However, the location of a large high pressure gas main in the vicinity of the planned western-most trench, Trench 1, meant that only two trenches were opened west of the platform (Figure 3).

4.1.6 The post alignment trenches (Trenches 2, 3 and 4) were 20m in length, allowing for variation in the position of alignment and to highlight the character of deposits to either side of the monument and the presence /absence of associated artefacts. The topsoil and alluvium was stripped by mechanical 360° excavator to the level of the very tops of the uprights. To this level the trenches were double-bucket width (3.9m) whereupon a 1.4m wide transect along the centre of each trench was hand excavated for its full length. The manually excavated transects were designed to expose the uppermost layer of horizontal timbers to be recorded to detail.

4.1.7 As proposed, a full vertical sequence of timbers was exposed in one of the post alignment trenches (Trench 2). This amounted to the exposure of two levels of wood (upper and lower) which were recorded in plan (employing photogrammetry) and extensively sampled. Here the old land surface was exposed throughout its length.

4.1.8 Manual excavation within the three post alignment trenches also involved the digging of a single test-pit in each to: 1) enable sampling of the full deposit profile, and 2) the extraction of selected vertical timbers for analysis.

4.1.9 Sampling of timbers and deposits was consistent across the trenches as advised by the project specialists. Horizontal and vertical timbers were selected for extraction and laboratory assessment under the guidance of relevant project specialists. Sampling followed the retention and discard policy established at the start of the project in consultation with HE and the conservation team.

4.1.10 The original project design proposed that water levels would be recorded in all three trenches twice weekly. In reality, this approach became more or less redundant, as the water table was absent from all but the deepest interventions. To prevent preserved remains drying out, all trenches were watered regularly and covered with thick black plastic sheeting when fieldwork was not being carried out.

4.1.11 As the scale and extent of metalwork deposition along the length of the post alignment is unknown, a metal detector survey was carried out at all stages of stripping and excavation.

Any metal objects (as well as other artefacts) were retrieved and stored with a view to preserving information on the chemical and environmental conditions around the post alignments.

4.1.12 Desiccated peat was stored separately from topsoil and alluvium, and reinstated in the appropriate sequence at the close of the fieldwork.

4.1.13 Archaeological features and deposits were surveyed using differentiated GPS and recorded using the CAU recording system and pro-forma sheets.

4.1.14 Photographs were taken of all features using a high resolution digital camera and sections were hand-drawn at an appropriate scale (either 1:10 or 1:20).

5. PROJECT ARCHIVE

5.1 Evaluation Records

5.1.1 All site records have been collated, and key data entered into an Excel spreadsheet. Hand-drawn plans and sections have been scanned and stored in the digital archive. The number of records is shown in Table 1.

Record Type	Number
Contexts	35
Features	0
Context register sheets	2
Context Sheets	35
Feature register sheets	0
Trench Sheets	0
Test Pit Sheets	0
Plan/Section register sheets	1
Plans	0
Section drawings 1:10 (blue sheets)	8
Large drawing sheets (A0, A1 and A2)	0
Environmental register sheets	1

Table 1: Quantification of excavation archive

5.2 Finds and Environmental

5.2.1 Finds have been washed and dried, counted and weighed, bagged and labelled and placed in archive boxes. A spreadsheet of all finds and quantities has been created. Total quantities of each category of finds are summarised in Table 2.

Finds	Number	Weight
Flint	5	17g
Pottery	10	69g
Human bone	3	59g
Animal bone	16	415g
Environmental bulk samples	18	(180l)

Table 2: Quantification of finds archive

6. EVALUATION RESULTS

6.1 Introduction

6.1.1 A total of five trenches (Trenches 2-6) and one test-pit (TP 1) were excavated (Figure 4; Table 3). Three trenches were opened above the post-alignment (Trenches 2, 3 & 4) and two above the platform (Trenches 5 & 6). A single environmental test-pit was opened 'off-site', attached to the southern end of Trench 6.

	Trench	Surface dimensions	Excavation dimensions	Actual area exposed
Post alignment	*2*	21.40 x 3.80m	20.40 x 1.40m	28.56m^2
Post alignment	*3*	19.70 x 3.80m	17.80 x 1.40m	24.92m^2
Post alignment	*4*	19.40 x 3.80m	16.50 x 1.40m	23.10m^2
Platform	*5*	28.12 x 1.75m	1.00 x 1.00m (x2)	2.00m^2
Platform	*6*	24.30 x 1.75m	24.30 x 1.75m	42.52m^2
Off-site	*TP1*	2.50 x 2.00m	1.00 x 1.00m	1.00m^2
Totals:	*6*			*122.10m^2*

Table 3: Trench dimensions.

6.1.2 The post-alignment trenches exposed three long, stepped transects (3.9m at the top, 1.4m wide at the base) across the rows of posts and the top of the associated horizontal wood mass. Trench 2, located along the western half of the alignment, was excavated to its base, revealing an earlier land surface and facilitating a comprehensive assessment of the worked wood and related deposits.

6.1.3 The two platform trenches (Trenches 5 and 6) were more limited in their objective, seeking only to determine the northern and southern extremities of the timber monument and to obtain samples for condition testing. Trench 5 incorporated two 1x1m test-pits excavated to the top of the preserved wood layer. Instead, Trench 6 was excavated to the depth of the wood layer with the machine. The soft, waterlogged character of the associated sediments made it impractical to hand dig a test-pit, especially with the proximity of the water-filled mere.

6.1.4 The western-most post-alignment trenches, Trenches 2 and 3 (Figure 5), revealed desiccated, oxidized sediments typified by fissures and voids as well as masses of invasive roots. Unsurprisingly, the condition of the worked wood in these exposures was poor and, as demonstrated in the waterlogged wood assessment (Appendix 1A), measurably poorer than recorded in 2012 and 2005. In these two trenches, the water table was encountered but only in the much deeper, sub-natural sondages opened specifically to expose the buried worked points of individual piles.

6.1.5 The eastern-most post-alignment trench, Trench 4, was different, in that here the enveloping sediments were saturated, unoxidized and, beneficially, of much greater depth. Superficially at least, much of the worked wood in Trench 4 appeared to better preserved and the water table broadly matched the top of the horizontal wood mass.

6.1.6 The southern platform trench, Trench 6, exposed an equivalent deep, well-preserved sediment sequence to Trench 4. Fragments of worked wood (including part of a mortised beam) found at its far northern end probably defines the southerly margin of the Flag Fen Platform. Trench 5 also located elements of the platform, but not its northerly limit, which almost certainly extends beyond the current Scheduled Ancient Monument boundary.

6.2 Trench and soil profile summary

6.2.1 The soil profiles identified in the five trenches and one test-pit demonstrated some broad consistency, as well as context-specific differences (Table 4). A buried soil was identified in every trench/test-pit excavated to natural (Trenches 2, 3, 4, and Test-pit 1). Trench 5 exposed a section through the northern camber of the Roman road or Fen Causeway, which included make-up deposits of its agger, as well as remnants of its original surface.

6.2.2 Trench 4 and Trench 6/Test-pit 1 revealed a much thicker sequence of peats and silts related to an earlier/smaller saturated basin or embayment situated below the platform and eastern end of the alignment.

Descriptor	Trench/Test-pit					Description
	2	3	4	5	6/1	
Made ground				[40]		Redeposited peat, gravel (make-up Roman Road), concrete
Plough soil	[04]	[11]	[30]	[41]	[20]	Dark brown silty loam
Post-Roman alluvium			[31]	[42]		Light red-brown silty clay
Shelly silt				[43]		Mid brown shelly, silty clay with abundant whole shell
Clayey silt				[44]		Red-brown silty clay
'Rusty' silt				[45]		Medium dark grey silty clay (alluvium?) – slightly peaty
Roman Road (+surface)				[47]		Red-brown silty sand (compact) with rare limestone capping
Silty clay				[46]		Medium dark grey silty clay (alluvium?) – slightly peaty
Desiccated peat	[05]	[12]		[48]	[21]	Dark orange-brown peat (desiccated)
Peat		[13]	[32]		[22]	Black-brown peat (semi-desiccated)
Silty clayey peat	[01]	[14]	[33]	[49]	[23]	Dark grey-brown organic silty clayey peat (corky)
Silty peat	[02]	[15]	[34]		[24]a	Dark grey-brown silty peat with rare small rounded pebble
Silty peat (shelly)			[35]		[24]b	Dark grey-brown silty peat with occasional/frequent shell frags
Silty clay					[25]	Dark grey silty clay (buttery)
Silty peat			[36]		[26]	Dark brown-black silty peat
Buried soil	[03]	[16]	[37]		[27]	Dark grey silty loam with common gravel and small charcoal
	Natural					Sandy gravel/clayey gravel

Table 4: Deposit sequence (Trenches 2-6 and Test-pit 1).

	Trench/Test-pit				
	2	3	4	5	6/1
Top of trench (height OD)	2.02m	1.80m	1.47m	0.70m	1.15m
Depth	1.62m	1.40m	1.72m	1.75m	2.05m
Base of trench (height OD)	0.40m	0.40m	-0.25m	-1.05m	-0.90m

Table 5: Trench/Test-pit depths/heights.

Figure 4: Aerial view (looking west) of Flag Fen showing the location of the five assessment trenches and single test -pit (Trenches 2-6; Test-pit 1); Peterborough Power Station marking the ‘end’ of the post alignment

Figure 5: Excavation of Trench 3 (looking south-east) revealing the post alignment piles and the associated horizontally deposited wood.

Figure 6: *West to east profile showing top of trench (current surface) and height of natural (mOD).*

6.2.3 A simple west to east profile (Table 5; Figure 6) incorporating the height of natural and current ground surface from four of the five trenches (Trenches 2, 3, 6 and 4) illustrates the change in depth towards the eastern end of the post alignment and the earlier 'basin' sharing the same location as the platform.

6.3 Archaeological features and deposits

The post alignment trenches (Figure 7)

6.3.1 An old land surface was identified in all three post alignment trenches (Trenches 2, 3, and 4). In Trench 2 the buried soil was 0.05-0.18m thick (Context [003]). In Trenches 3 and 4 the same horizon was only exposed within narrow (pile-extraction) interventions and measured 0.05m thick.

6.3.2 Limited excavation of the buried soil in Trench 2 produced five pieces of worked flint (Appendix 1H) and a single fragment of Bronze Age pottery (Appendix 1G).

6.3.3 An *in-situ* tree stump together with a preserved fallen tree stump in a tree throw represented the earliest waterlogged wood associated with the old land surface (Context [003]). The two trees were situated within the central-southern half of the trench and stratigraphically below the accruing spreads of horizontally deposited wood.

6.3.4 The configuration of the vertically driven piles and stakes did not cut the trees (there was no obvious stratigraphic relationship). Some uprights were located between the fan of roots associated with the tree stump.

6.3.5 In gross spatial terms, the distribution of horizontally deposited wood in Trench 2 was off-set to the distribution of vertically-driven piles and stakes. The uprights revealed in Trench 2 were restricted to the centre/southern half of the trench, whereas the spread of horizontal wood occupied the central/northern half of the trench (continuing northwards beyond its catchment). A similar off-set was also apparent in Trench 3 with the horizontal spread extending 6.00m beyond the most northerly uprights.

6.3.6 The horizontal wood mass in Trench 2 was located in a dark grey-brown silty peat ([002]) and was exposed in its entirety, in two spits (upper and lower). The spread of deposited wood comprised large and small timbers, lengths of roundwood and large quantities of timber debris (Appendix 1A).

6.3.7 Nine fragments of pottery, two pieces of animal bone and three pieces of human bone were found in the same context. The pottery fragments were found as a tight cluster at the centre of the trench and within the footprint of the post alignments. The sherds belonged to the same vessel (Appendix 1G). Analysis of the three human bones suggests that these were from the same individual. These were also deposited within the footprint of the alignments.

6.3.8 The deposit sequence in Trench 4 was deeper and as a consequence involved two additional layers of silty peat ([36] and [35]), above an old land surface that had accrued prior to the spread of horizontally deposited wood and presumably prior to the insertion of the vertically-driven piles and stakes of the post alignment.

6.3.9 As well as deep, Trench 4 was also waterlogged (to the extent that water filled the open trench overnight). This was in part down to the location of Preservation Hall and its overflow pump as well as the intrusive soak-away fed by the same building's drainpipe. Equally however, the unoxidized condition of the surrounding sediment, in combination with its greater depth, suggests that the deposits/wood have remained waterlogged for a long time (and long before the construction of Preservation Hall). The apparent enhanced preservation difference impacted on the excavation strategy and the decision to only expose a quarter of the spread of horizontally deposited wood (central-north). As a consequence, it was not possible to discern the broader spatial relationship between the piles and the horizontals.

The platform trenches

6.3.10 Trench 5 and Trench 6/Test-pit 1 represented straightforward presence/absence apertures seeking to distinguish the extent of the platform (Figure 3). Key to this exercise was demonstrating areas of contemporary sediment without horizontally deposited wood.

6.3.11 No in situ uprights were encountered in either aperture.

6.3.12 The test-pit exercise in Trench 5 involved two deep 1m x 1m test-pits, both of which reached the horizontal wood layer associated with the platform. Trench 5 failed in its objective of demonstrating the northern limit of the platform. An augur was used to record the full depth of the northern most test-pit.

6.3.13 In contrast, Trench 6/Test-pit 1 was very nearly wood-free, except for a small number of worked horizontal pieces located at its extreme northern end of Trench 6. The worked wood included a mortised beam characteristic of the horizontal wood spread representing the platform.

6.3.14 Both Trench 5 and Trench 6/Test-pit 1 recorded deep sequences that included a developed peat horizon preceding the construction of the platform.

6.3.15 As anticipated, part of the Roman Fen Causeway was exposed at the southern end of Trench 5. Its agger was constructed upon an alluvial deposit that overlay a series of silts and peats located above the platform spread.

6.3.16 Two hand-dug 1.00 x 1.00m test-pits (4m apart) situated at the northern end of Trench 5 exposed horizontal elements of the platform at 1.60m below the current surface. The wood was located beneath a sediment sequence that comprised peat [49], desiccated peat [48],

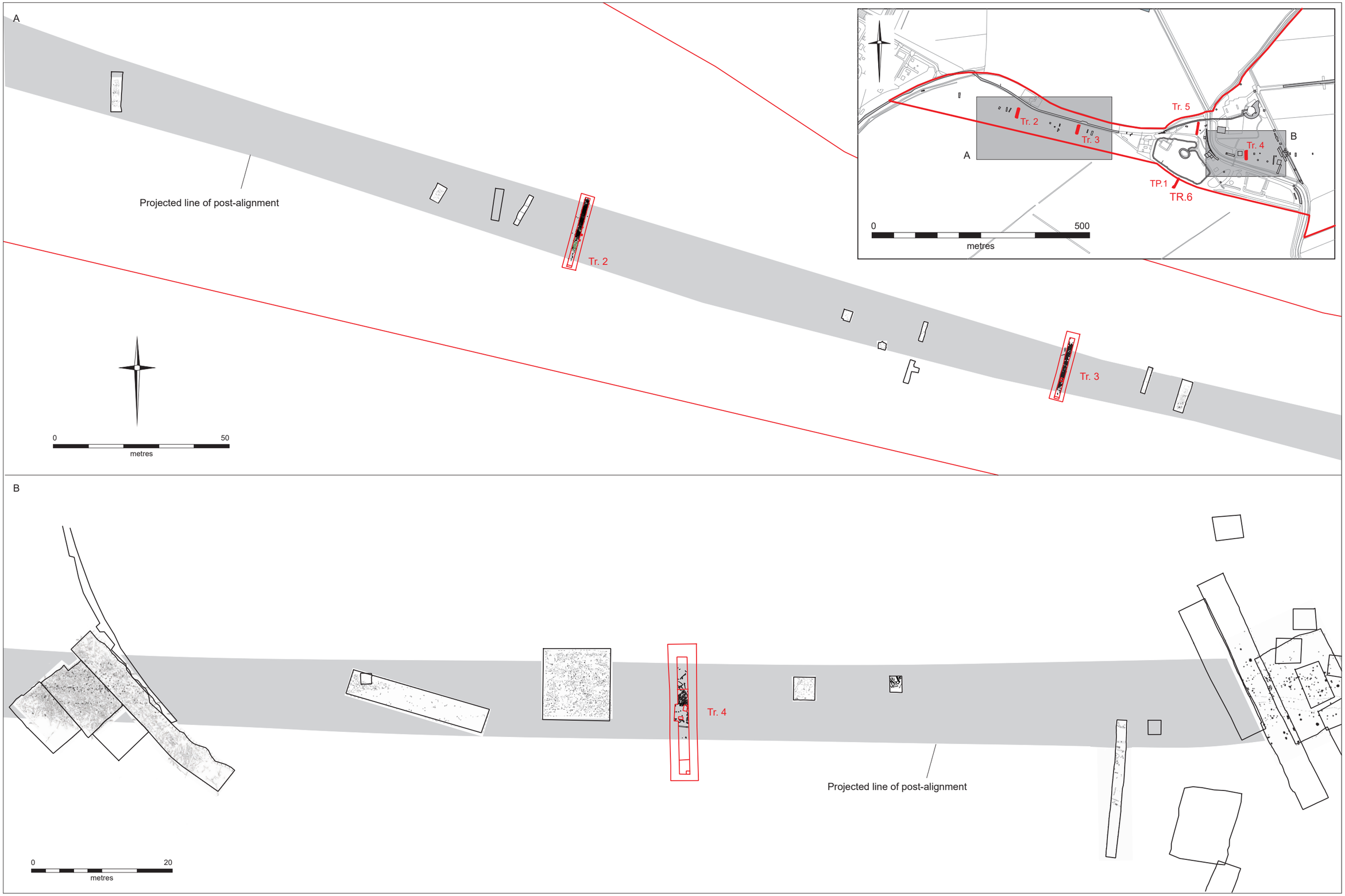
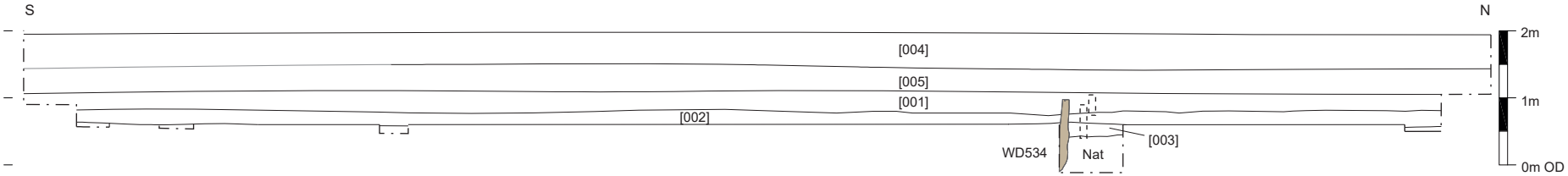
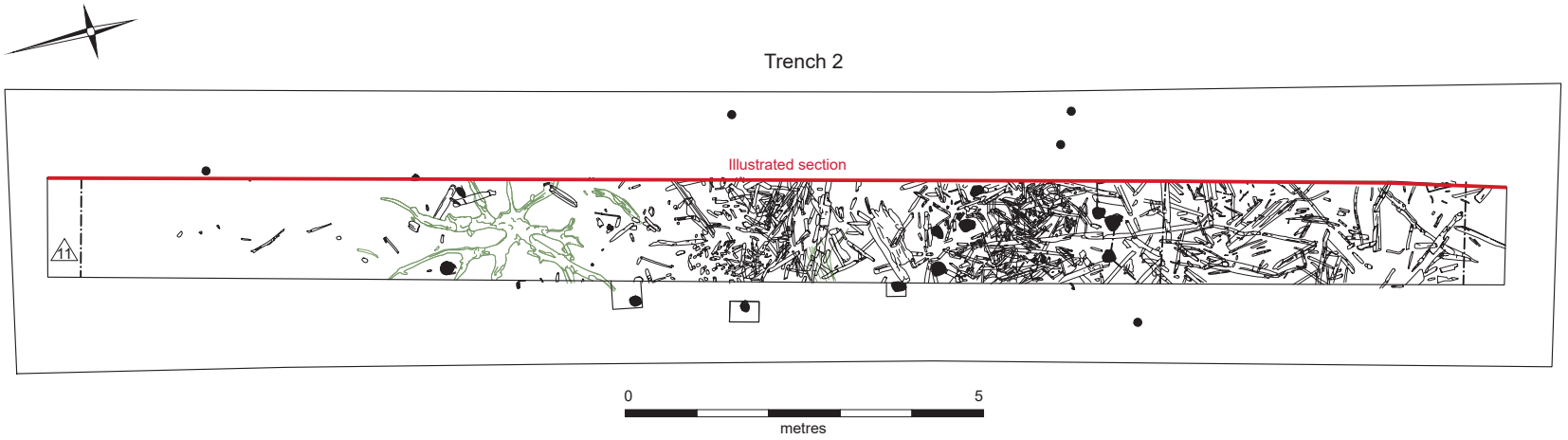


Figure 7: Location of 2021 condition assessment trenches in relation to previous post alignment investigations. Top: western post-alignment (Trenches 2 and 3); Bottom: eastern post alignment (Trench 4)

Figure 8. ‘Peat’ condition: Trench 3 - Fully excavatged surface of horizontally deposited wood layer and pile tops (looking north).





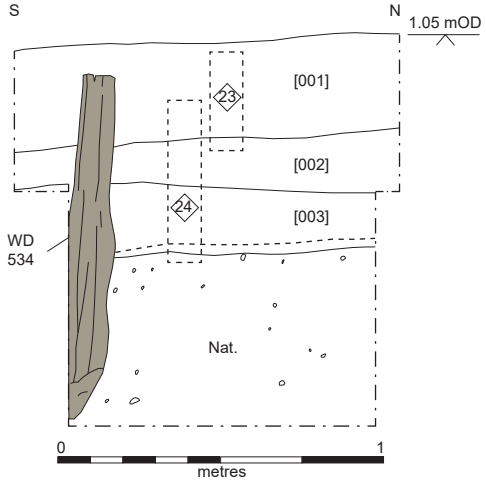


Figure 9: Post alignment Trench 2 - section, plan (wood upper layer) and overhead photograph (wood lower layer)

Figure 10: Post alignment Trench 3 - fully excavated surface of horizontally deposited wood layer and pile tops (looking north)

and alluvium [46]. The alluvium horizon was in turn sealed by a series of deposits mostly associated with the agger of the Fen Causeway or Roman Road situated at the southernmost end of the trench [47] and its aftermath [45] [44] [43] [42]. A plough soil [41] sealed the surviving surface of the road, whilst the northern end of the trench also revealed a thick layer of made-up ground [40] comprising redeposited gravel, equivalent in composition (if not location) to the make-up of the Roman Road.

6.3.17 The primary purpose of the text-pits was to identify wood-free, open-ground beyond the scope of the platform and then to work back to establish its limit. The test-pitting was restricted to two test-pits because the position of Trench 5 very obviously did not reach beyond the extent of the platform.

Peat condition (Figure 8)

6.3.18 The succession of sediments below, contemporary with, and immediately above the post-alignment and platform's remains involved buried soils, organic silts, peats and alluviums. The condition of this succession differed spatially, with the key determining factor being altitude/depth. Straightforwardly, the deeper contours of the Flag Fen Basin coincided essentially with the best preserved sections of the two features together with the wettest, least oxidised deposits; contour and condition went more or less hand-in-hand. The most desiccated, oxidised deposits were situated at, or above, ordnance datum in Trench 2 and Trench 3, and included the matrix around the upper portions of the post-alignment uprights and the associated horizontal wood spread (Figure 8). Here, the predominant soil colour was orange brown.

6.3.19 Waterlogged, unoxidized deposits survived below -0.50m OD in Trench 6/Test-pit 1, and were situated stratigraphically below the construction level of the wooden structures (Figure 8).

6.3.20 At -0.50m to 0.00m OD, the post-alignment contemporary peat and organic silt horizons in Trench 4 were saturated but also moderately oxidised, as indicated by the slightly brown rather than black colouration (Figure 8). In both test-pits in Trench 5, the surface exposures of the peat matrix around the platform appeared to be equivalent in condition to the deposits recorded in Trench 4 and shared a similar altitude (Figure 8).

Post alignment - Trench 2 (Tables 4 & 5; Figures 7 & 9)

6.3.21 Trench 2 (length: 19.70m; width 3.60m (top), 1.40m (stepped-base); depth: 1.62m; height of natural: 0.40m OD)

6.3.22 The 1.4m wide, hand excavated slot within Trench 2 exposed the tops/upper portions of 28 *in -situ* piles and stakes together with a horizontal spread of worked wood (843 pieces) that extended beyond the northern most extent of the uprights.

6.3.23 The sediment sequence within Trench 2 comprised a thin layer of buried soil [003], beneath a succession of organic silts [002] [001], desiccated peat [005] and ploughsoil [004]. The sequence was characterized by oxidized, desiccated peats towards the top and damp, but not waterlogged peaty silts towards the base. Nettle roots and drying cracks pervaded all but the bottom most deposit (i.e. the iron-panned gravel natural).

6.3.24 The preserved horizontal wood was deposited either on the surface of the buried soil ([003]) within the peaty organic silt layer immediately above it ([002] upper spit). The southern extent

of the horizontal wood mass coincided with an *in-situ* tree stump (oak) and overlay a preserved tree throw. The two trees (oak) appeared to pre-date the horizontal wood layer and be associated with the old land surface prior to it becoming saturated.

6.3.25 The 'headroom' between the tops of uprights and the top of the horizontal wood mass was approximately 0.26m.

6.3.26 Nine pieces of animal bone were found in the silty peat that overlay the horizontal wood layer. A small number of pot sherds (10 in total), two pieces of animal bone and three pieces of human bone were recovered from the matrix associated the horizontal wood mass [002]. In addition, a small number of worked flints were located within the underlying old land surface [003].

6.3.27 In the course of the excavation the trench was dry, except for a single sondage dug through the gravel natural to extract a small group of uprights. A water pump was required only for the excavation of the base of the posts.

Post alignment - Trench 3 (Tables 4 & 5; Figures 7,10 & 11)

6.3.28 Trench 3 (length: 20.00m; depth: 1.40m; height of natural: 0.40m OD)

6.3.29 The 1.5m wide hand excavated slot within Trench 3 exposed the tops and upper portion of 29 *in-situ* piles together with a horizontal spread of worked wood that extended beyond the northern-most extent of uprights (by at least 8m).

6.3.30 The sediment sequence matched that of Trench 2, although these deposits appeared even more desiccated and oxidized as well as more affected by insect and root bioturbation. Notably missing from the trench profile was any vestige of a moist (unoxidized) silty peat (as observed in Trench 2).

6.3.31 The 'headroom' between the tops of uprights and the top of the horizontal wood mass was approximately 0.23m.

Post alignment - Trench 4 (Tables 4 & 5; Figures 7 & 12)

6.3.32 Trench 4 (length: 16.50m; depth: 1.72m; height of natural: -0.25m OD)

6.3.33 The 1.5m wide hand excavated slot within Trench 4 exposed the tops and upper portions of 34 *in-situ* piles and stakes. The trench also exposed a partial, central section of the associated horizontal spread of worked wood.

6.3.34 In contrast to the other two post alignment trenches (Trench 2 and 3), the sediment sequence in Trench 4 was characterized by a succession of unoxidized, wet to waterlogged peats [32][33] and silty peats [34][35][36] which overlay a thin buried soil [37] above a clay-rich gravel natural. The top of the peat was cut by a series of parallel alluvium-filled furrows [31] which in turn were sealed by the ploughsoil/turf horizon [30].

6.3.35 The preservation conditions associated with these deposits was markedly better than those uncovered in Trenches 2 and 3 (the absence of oxidisation, drying cracks and/or intrusive roots was noticeable by comparison). Accordingly, the 'headroom' between the tops of uprights and the top of the horizontal wood mass was also greater, measuring approximately 0.52m.

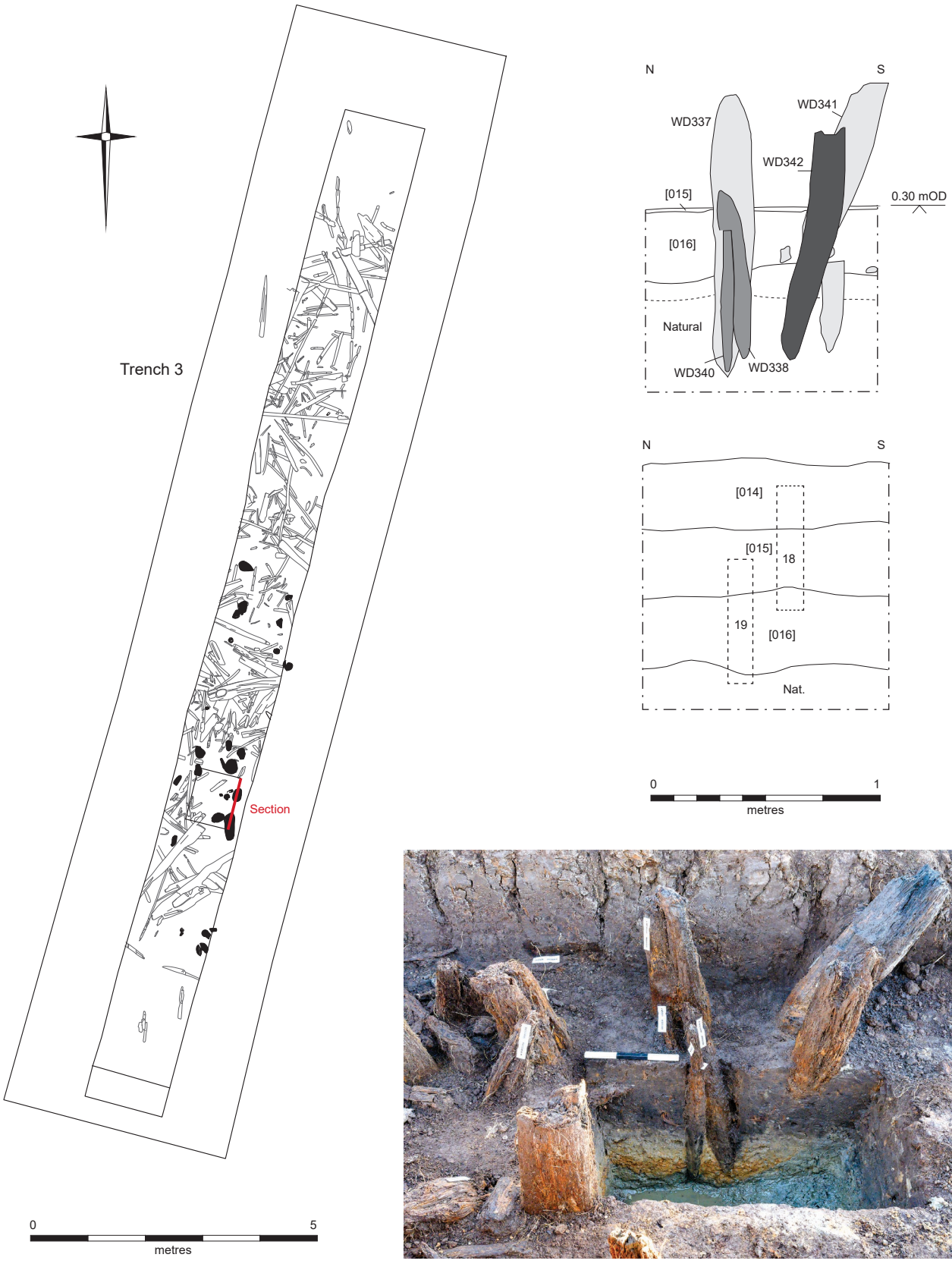


Figure 11: Post alignment Trench 3 - plan, ‘pile-sondage’ sections (indicating pollen monoliths) and photograph (looking east)

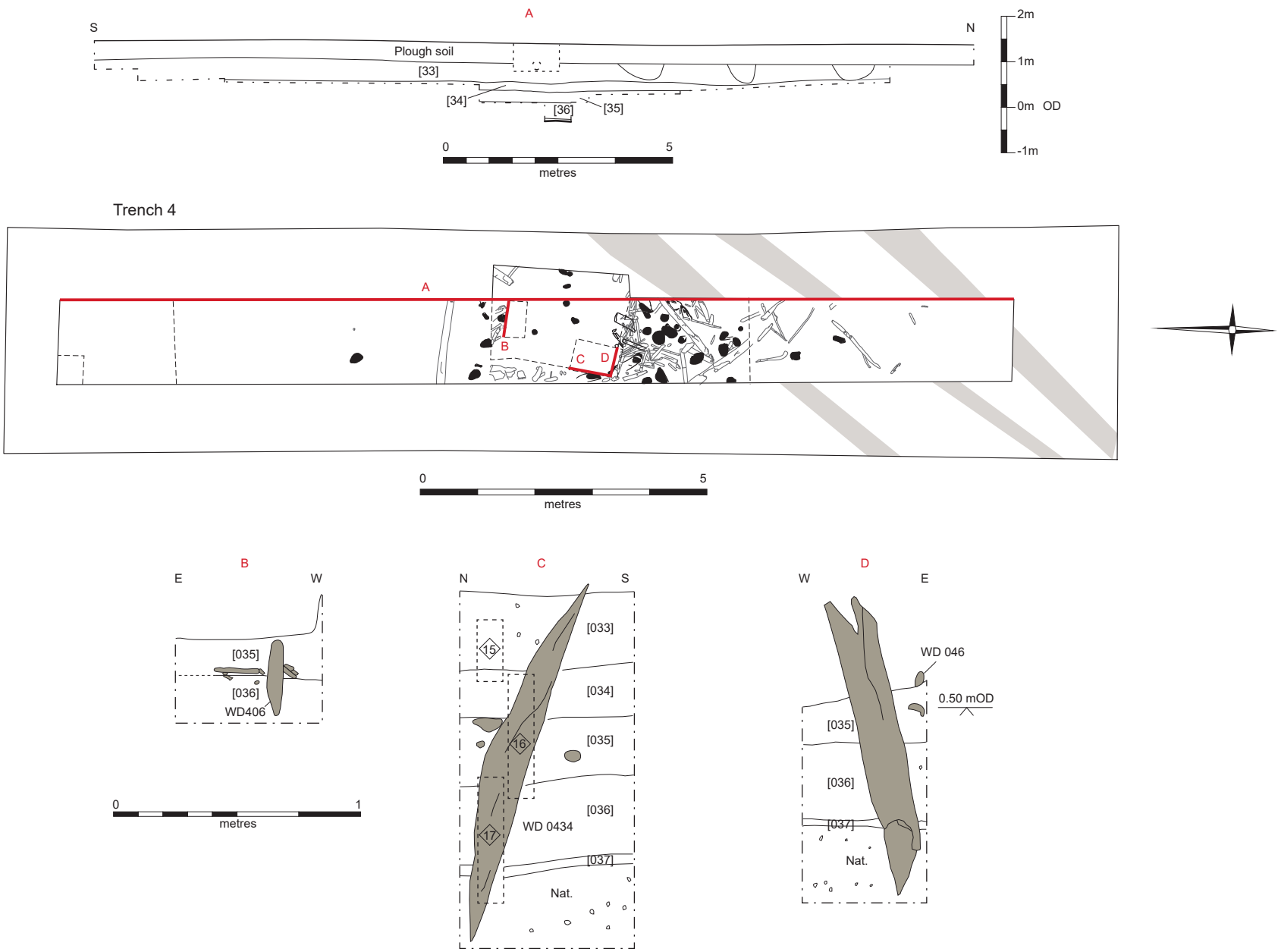


Figure 12: Post alignment Trench 4 - Section, plan and ‘pile-sondage’ sections (indicating pollen monoliths)

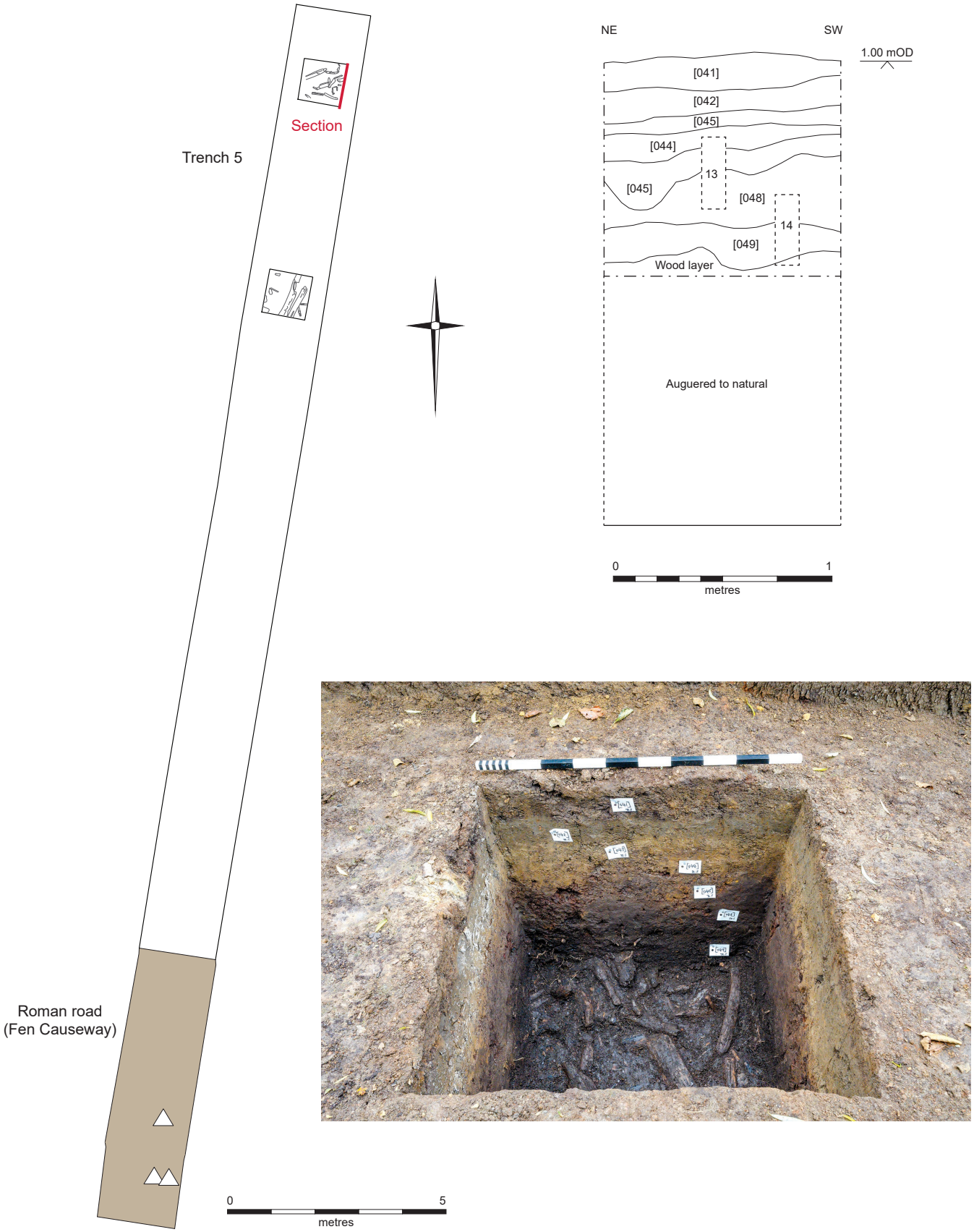


Figure 13: Platform Trench 5 - location of platform-extent test-pits, north test-pit section and photograph (west facing)

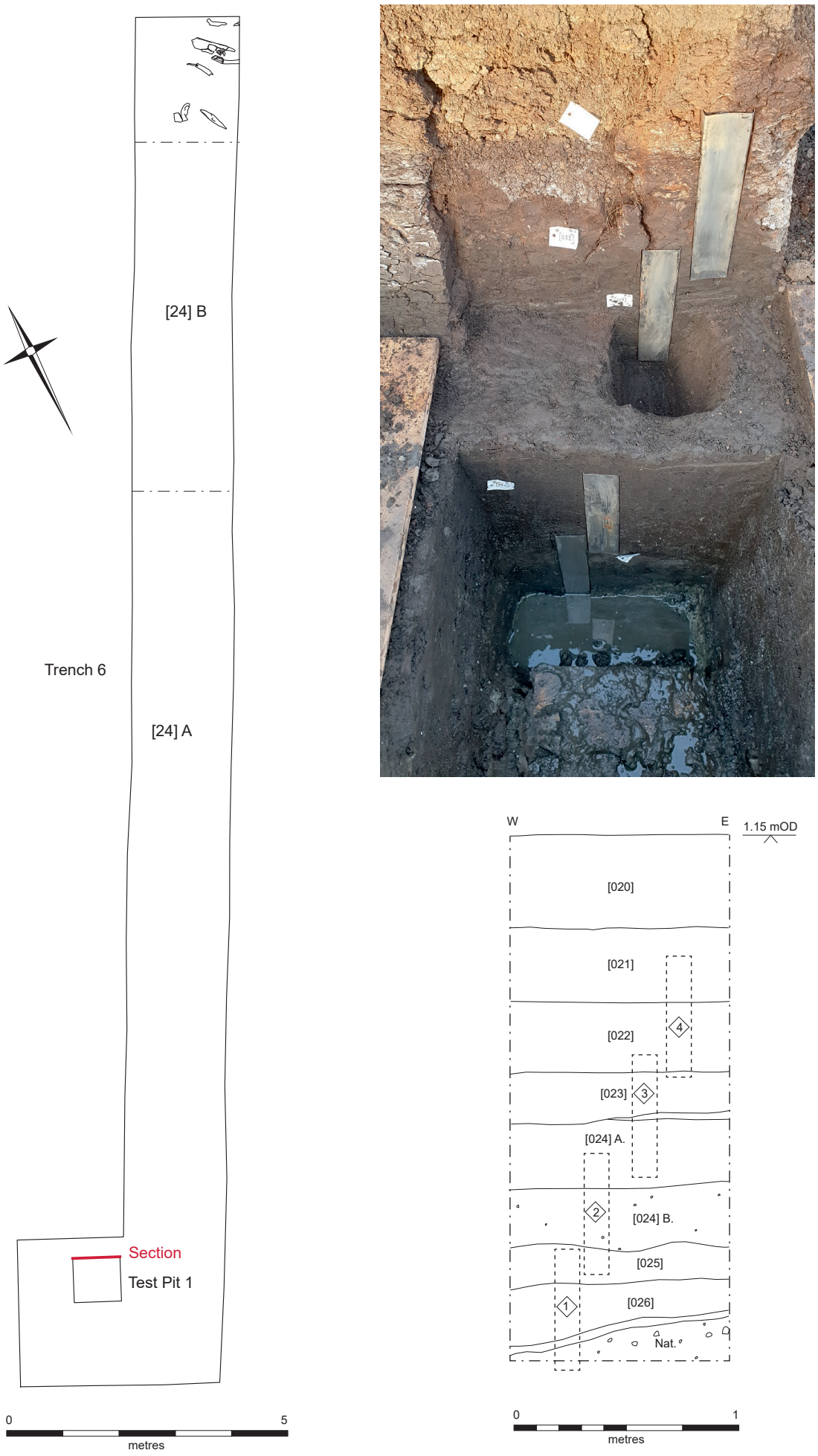


Figure 14: Platform Trench 6 and Environmental Test-pit 1 - plan of southerly distribution of horizontally deposited wood, relative position of off-site test-pit and test-pit photograph and section

6.3.36 The central area of the post alignment in Trench 4 was truncated by a large rubble-filled soak-away constructed when the nearby Preservation Hall was erected (the drainpipe for the building's roof fed directly into this feature). The square-shaped intrusion punched a 2.40m x 1.80m (1.75m deep) hole through the horizontal wood mass, leaving only the worked-point ends of the piles situated beneath its footprint. The location of the soak-away may have had a beneficial effect on the preservation conditions in that it focused water into key deposits, although the same unoxidized conditions persisted across the trench and not just around the soak-away.

Platform - Trench 5 (Tables 4 & 5; Figure 13)

6.3.37 Trench 5 (length: 28.75m; depth: 1.75m; height of natural -1.05m OD)

6.3.38 Two hand-dug 1.00 x 1.00m test-pits (4m apart) situated at the northern end of Trench 5 exposed horizontal elements of the platform at 1.60m below the surface. The wood was located beneath a sediment sequence that comprised peat [49], desiccated peat [48], and alluvium [46]. The alluvium horizon was in turn sealed by a series of deposits mostly associated with the agger of the Fen Causeway or Roman Road situated at the southernmost end of the trench [47] and its aftermath [45] [44] [43] [42]. A plough soil [41] sealed the surviving surface of the road, whilst the northern end of the trench also revealed a thick layer of made-up ground [40] comprising redeposited gravel, equivalent in composition (if not location) to the make-up of the Roman Road.

6.3.39 The integral test-pit exercise in Trench 5 was unable to resolve the northernmost extent of the platform as the horizontal wood mass was shown to continue northwards beyond the limit of the intervention (and beneath the adjacent footpath) .

Platform - Trench 6/Test-pit 1 (Tables 4 & 5; Figure 14)

6.3.40 Trench 6 (length: 20.00m; depth: 1.63m) and Test-pit 1 (dimensions 3.00 x 3.00m; depth 2.05m; height of natural: -0.90m OD)

6.3.41 The Trench 6/Test-pit 1 combination revealed a deep sequence of dark, unoxidized waterlogged peats and silts that included, towards its base, a thin horizon of 'buttery clay' (equivalent in texture and consistency to the Late Neolithic/Early Bronze Age, marine derived Fen Clay). A very thin vestigial buried soil was recorded at the very base of the exposed section in Test-pit 1.

6.3.42 The main characteristic of Trench 6/Test-pit 1 was the absence of worked wood, aside from a small scatter of horizontal pieces at its northernmost end (and where the southern extent of the platform was previously projected by Pryor). This scatter included a large mortised beam.

6.4 Artefacts and environmental summary

6.4.1 *Waterlogged wood (Bamforth and Robinson Zeki; Appendix 1A)*: A large assemblage of waterlogged wood, 1010 pieces in total, was uncovered in the five trenches of the evaluation. The excavated material incorporated the *in-situ* vertically-driven piles of the later Bronze Age Flag Fen post alignment, as well as spreads of horizontally-deposited wood, including large and small timbers, lengths of roundwood, and large quantities of timber debris. The latter material is thought to be predominantly derived from, or related to the construction of, the

fabric of the alignment's walkway, or its associated platform. Assessment of the condition of the wood assemblage found a distinct decline in the preservation of the surface detail of the wood, as compared with the results of earlier phases of excavation at Flag Fen. This equates to a loss of significant information in terms of woodworking traces and also has implications for the future viability of dating and identification samples taken from the site. The advanced deterioration of the wood is linked to dewatering as well as mechanical root damage caused by vegetation over the western extent of the alignment. While the wood condition has demonstrably decreased in recent years, the wood excavated in this evaluation still has great potential to increase our understanding of the post alignment and platform through analysis of the surviving evidence for its construction in greater detail, incorporating species identifications and new scientific dates to build a more nuanced picture of the features' development than has previously been available.

6.4.2 *Dendrochronology (Tyers; Appendix 1B)*: The dendrochronological analysis has confirmed that at present the material on the alignment is still capable of producing viable tree-ring samples, and that the data from them provides replicates of the data produced in the 1990's. The material was quite de-lignified, with some of the samples resembling sponges. Sapwood survival is poor, and the oak heartwood is in some instances approaching a condition where dendrochronology would no longer be possible. The 2021 composite data comprises 39 samples covering the period 1336-990 BC with a single outlier 970-938 BC. Three pairings were identified that comprise same-tree pairs all from Trench 3, with a possible four pairings in Trenches 2 and 4.

6.4.3 *Timber condition (Panter; Appendix 1C)*: The 2012 study demonstrated that whilst the timbers retained their overall shape and form, the cellulose content was either highly degraded or absent from the cell wall structure, and there was evidence for lignin breakdown too. Based on these results all three timbers investigated during this assessment are highly degraded with little 'sound' wood remaining. The overall condition of these timbers is broadly in line with the results from a condition assessment conducted on timbers excavated in 2012 (Panter 2013), the majority of which were Class III, highly degraded timbers.

6.4.4 *Plant macrofossils (Smith; Appendix 1D)*: All six waterlogged plant remains sub-samples assessed here have produced taxa highly indicative of seasonally flooded to fully aquatic environments, with a few indicators for other habitats (especially grassland or woodland) present. In most cases, waterlogged plant remains were observed to be iron stained and, in some cases, showed clear signs of warping/ twisting/shrinkage; all of which suggest that these deposits have dried out at some point in the past, possibly the recent past. In general, the quantity, diversity and preservation of plant remains seems markedly poorer than previous work the author conducted on similar waterlogged plant remains sub-samples (Smith 2013) from the 2012 intervention at Flag Fen by Dig Ventures.

6.4.5 *Insects (Smith; Appendix 1E)*: The insect fauna consisted of fragments of beetles (Coleoptera) and caseless caddis flies (Trichoptera spp.). The six faunas are all similar in their nature and do provide information on the water conditions present, but often only give a limited indication of the nature of the surrounding landscape. Insect remains often were eroded, fragmented and folded suggesting poor preservation in all three trench sequence samples assessed here. Only one sample was large in size and well-preserved. If the insect fauna from further excavation are shown to have an equally poor level of preservation, further analysis may not be warranted.

6.4.6 *Pollen (Hopla & Gearey; Appendix 1F)*: The spectra are dominated by arboreal taxa Alnus glutinosa (alder), with some Betula (birch), Corylus avellana-type (hazel) and Quercus (oak)

with herbs in the form of Poaceae (wild grasses) and Cyperaceae (sedges) well represented, reflecting a wet alder carr, with aquatics in the form of Sparganium (burr-reeds) and Typha latifolia-type (reedmaces etc.). In general, the preservation of samples from Trench 2 appears to be the worst, although the pattern indicates that this increases with depth, rather than up the profile. Preservation and concentration of pollen in in Trenches 5 and 6 can be categorised as 'adequate', if not excellent. Both sets of pollen assessments (as reported here and for 'Digventures') thus indicate variable preservation in the sediments of the Flag Fen Basin.

6.4.7 *Prehistoric pottery (Brudenell; Appendix 1G)*: The investigations yielded a small assemblage of plain handmade prehistoric pottery totalling ten sherds weighing 69g, with a mean sherd weight (MSW) of 6.9g. All the pottery was recovered from Trench 2, with nine sherds (62g) deriving from Context 2 and one sherd (7g) from Context 3. The material from Context 2 was tightly clustered toward the centre of the Trench. Though none of the sherds refit, these are likely to belong to the same vessel: a round-bodied Late Bronze Age coarseware bowl dated on typo-chronological grounds to c. 1150-800 BC

6.4.8 *Flint (Banfield; Appendix 1H)*: The excavations produced five worked flints weighing 16.6g. The assemblage comprises a small selection of flakes that accord with types typically encountered in assemblages dated to the Neolithic to Early Bronze Age period.

6.4.9 *Human bone (Neal; Appendix 1I)*: Three disarticulated human bone elements were found in Trench 2 and the morphometric character and MNI of the bone assemblage suggests a single individual.

6.4.10 *Animal bone (Rajkovača; Animal bone)*: Trench 2 contained four individual finds of faunal remains; fish and avian fauna were represented alongside a cow tibia and a heavily eroded pig-sized limb bone fragment. Although this material showed a poor state of surface preservation, it was possible to positively identify pike.

7. DISCUSSION

7.1 Preservation conditions and archaeological understanding

7.1.1 The waterlogged wood assessment states: 'while the wood condition has demonstrably decreased in recent years, the wood excavated in the evaluation still has great potential to increase our understanding of the post alignment and platform' (Bamforth and Robinson Zeki; Appendix 1A). In this nuanced verdict both facets of the Flag Fen survival and preservation narrative are encapsulated.

7.1.2 Categorically, the preservation condition of the waterlogged wood can be shown to be in distinct decline but, on an encouragingly optimistic note, there is still a large amount of fresh, interpretively significant archaeological detail to be assembled. As set out above, a correspondingly qualified optimism can be applied to the site as whole, including its biological remains, related stratigraphy (the context of Flag Fen) and depositional history (the 'taphonomy' of Flag Fen).

7.1.3 Accordingly, the discussion section of this assessment of the Flag Fen post alignment and platform comprises two parts: preservation condition; and archaeological understanding.

7.1.4 The two parts are considered integral, especially as this way we will better understand what is (or is not) being preserved. Equally, to answer this, we need to better understand the monument's original architectural extent and form, both spatial and temporal.

7.1.5 This point is particularly important because, as things stand, the majority of the horizontal wood component of the post alignment and the platform is understood to represent the preserved remains of *in-situ* later Bronze Age architecture (i.e. 'as-built'); Pryor's purposefully constructed walkways/consolidated areas in a waterlogged environment. The vertical component, the five rows of the hundreds of driven piles and stakes, being a series of barriers or boundaries, beside, behind and between which people negotiated the fen via a series of architecturally discrete, sediment-fast walkways.

7.1.6 Such an understanding however is conditional on interpretation.

7.1.7 If the same horizontal wood component is instead interpreted as a composite of the waterlogged vestiges of multiple phases of construction (i.e. *in-situ* woodworking debris) combined with the long-term accumulation of re-deposited superstructure elements (i.e. 'as collapsed or demolished'), we are presented with a very different wood assemblage to assess.

7.1.8 First of all, under this interpretation, a significant proportion of the horizontally deposited wood endured a (dry) 'use-life' as superstructure prior to deposition into a (wet) preservation environment.

7.1.9 Second, the principal purpose of the rows of driven piles and stakes was not as boundaries or barriers, but as piled-foundations of a long-maintained raised walkway or bridge (the above water remnants of which eventually made up a large part of the horizontal component). The multiple rows of uprights representing a straightforward manifestation of numerous phases of construction, repair, and replacement (alignment-wide and/or restricted to specific sections).

7.1.10 Third, such a distinction brings into question the very existence of the Flag Fen platform as a discrete architectural entity. Instead implying that the distribution of horizontally deposited wood that constituted this feature is in reality a better preserved, and therefore broader extension of the horizontally deposited wood associated with the post alignment elsewhere

Figure 15. Post alignment Trench 3 - first exposure of wood mass showing dry ‘dusty’ sedinment and nettle root penetration

Figure 16. Post alignment Trench 2 - small sondage exposing full depth of piles and groundwater table relative to the top of the natural

Figure 17. Post alignment Trench 4 - Preservation Hall drainage pipe above the intrusive sump. Standing water in part caused by the pumping out of the on display post alignment inside Preservation Hall

along its length. Hither, the relationship between preservation conditions and archaeological understanding goes hand in hand.

7.2 Preservation condition

Post alignment

7.2.1 The two western trenches (Trenches 2 and 3) were very similar in depth (1.40-1.62m; height of natural: 0.40m OD), deposit sequence and condition. Both interventions exposed desiccated, oxidized sediments typified by fissures and voids as well as masses of invasive roots (Figure 15). In the fully excavated Trench 2, the matrix around the upper layer of the horizontally deposited wood involved the dried out deposits ([001]), whereas the matrix around the lower layer was a peaty silt deposit ([002]) that was moist, less oxidised, with far fewer fissures and voids and less invasive roots (Figure 16). Trench 3, although not excavated to the same comprehensive extent as Trench 2, revealed an equivalent vertical sequence displaying very similar preservation conditions.

7.2.2 The eastern post alignment trench, Trench 4, differed in depth, deposit sequence and condition from the western post alignment trenches. For a start, it exposed a much deeper sequence of moist to saturated, unoxidized deposits situated above, around and below the horizontally deposited wood. Absent were the open fissures and invasive roots that characterised the western post alignment trenches.

7.2.3 The increased depth (1.72m; height of natural: -0.25m OD) together with the presence of pre-post alignment, pre-horizontally deposited wood 'wet' deposits showed that this part of the eastern post alignment was located in a what appeared to be a persistently saturated zone (Figure 17). The underlying clay-rich natural and thicker waterlogged basal sediments being indicative of a deeper localised trough or basin in this part of the Flag Fen Basin.

7.2.4 The visible difference in conditions between the western and eastern post alignment trenches was also made evident by the preservation state of the waterlogged wood (Table 6). Detailed analysis of the wood from the western interventions recorded condition scores mostly of 2 (poor) and 1 (very poor), whereas the wood within the eastern intervention scored mostly 3 (moderate) and 2 (poor).

	Post alignment		
	West		East
Condition Score	**TR 2**	**TR 3**	**TR 4**
5 Excellent	0.26%	3.00%	3.17%
4 Good	0.26%	1.51%	1.58%
3 Moderate	4.21%	9.09%	50.79%
2 Poor	58.49%	78.78%	42.85%
1 Very poor	32.80%	1.51%	0.00%
0 Non-viable	3.95%	6.06%	1.58%

Table 6: *Post alignment: waterlogged wood condition scores by percentage.*

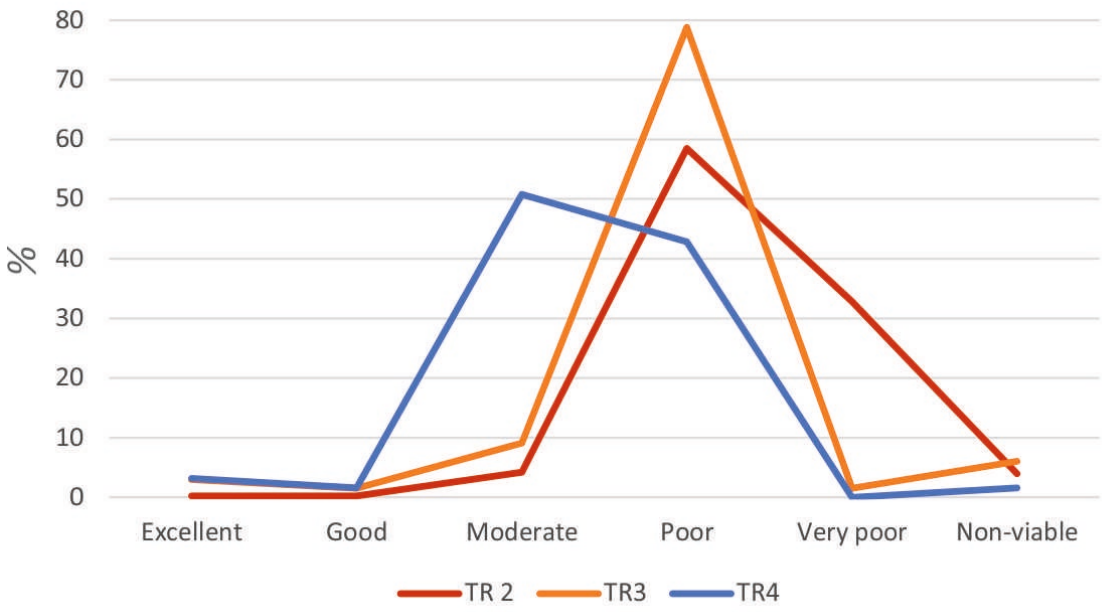


Figure 18: Post alignment: waterlogged wood condition scores by percentage by trench.

7.2.5 Pin test and water content condition assessments of single oak piles from Trench 2 and Trench 4 show the timbers to be highly degraded with little 'sound' wood remaining. The pin test results for the pile from Trench 2 showed resistance at 10mm (tip) and 15mm (top) whereas the pile from Trench 4 showed no resistance.

7.2.6 The two piles (WD76 and WD404) had water content in excess of 400% and are described as Class III, 'highly degraded with little of no sound core surviving'. The tip were better preserved (water content between 185% and 400%), 'small hard core of sound wood remains'.

7.2.7 The wood condition scale (5-0) is based on assessing the clarity of surface data on the material and its potential for use in various forms of wood analysis (species identification, dendrochronology, woodland management and technology analysis) and differs from the pin test and water content methodology. Accordingly, highly degraded timbers can score moderate (Condition score 3) in terms of wood analysis.

7.2.8 As part of a separate piece of work involving a broader survey associated with an archaeological evaluation of land around the adjacent Flag Fen Sewage Works, a supplementary geophysical survey was carried out targeted specifically along a large section of the western post alignment (Pope-Carter 2022). The survey was carried out by Magnitude Surveys and included an Electromagnetic survey and Ground Penetrating Radar (Figure 19). No features suggestive of significant archaeology were identified. However, the electromagnetic survey did highlight areas of high and low conductivity. The areas of high conductivity showed a strong correlation with areas of greater depth and/or areas in the vicinity of deeper water bearing features, such as the Cat's Water Drain (located around the western end of the survey) and the Great Mere (at the eastern end). Significantly, away from these features, the same survey showed a broad zones of low conductivity corresponding with the main area of the western post alignment and its associated, relatively shallow/dry deposits as characterised in Trench 2 and Trench 3.

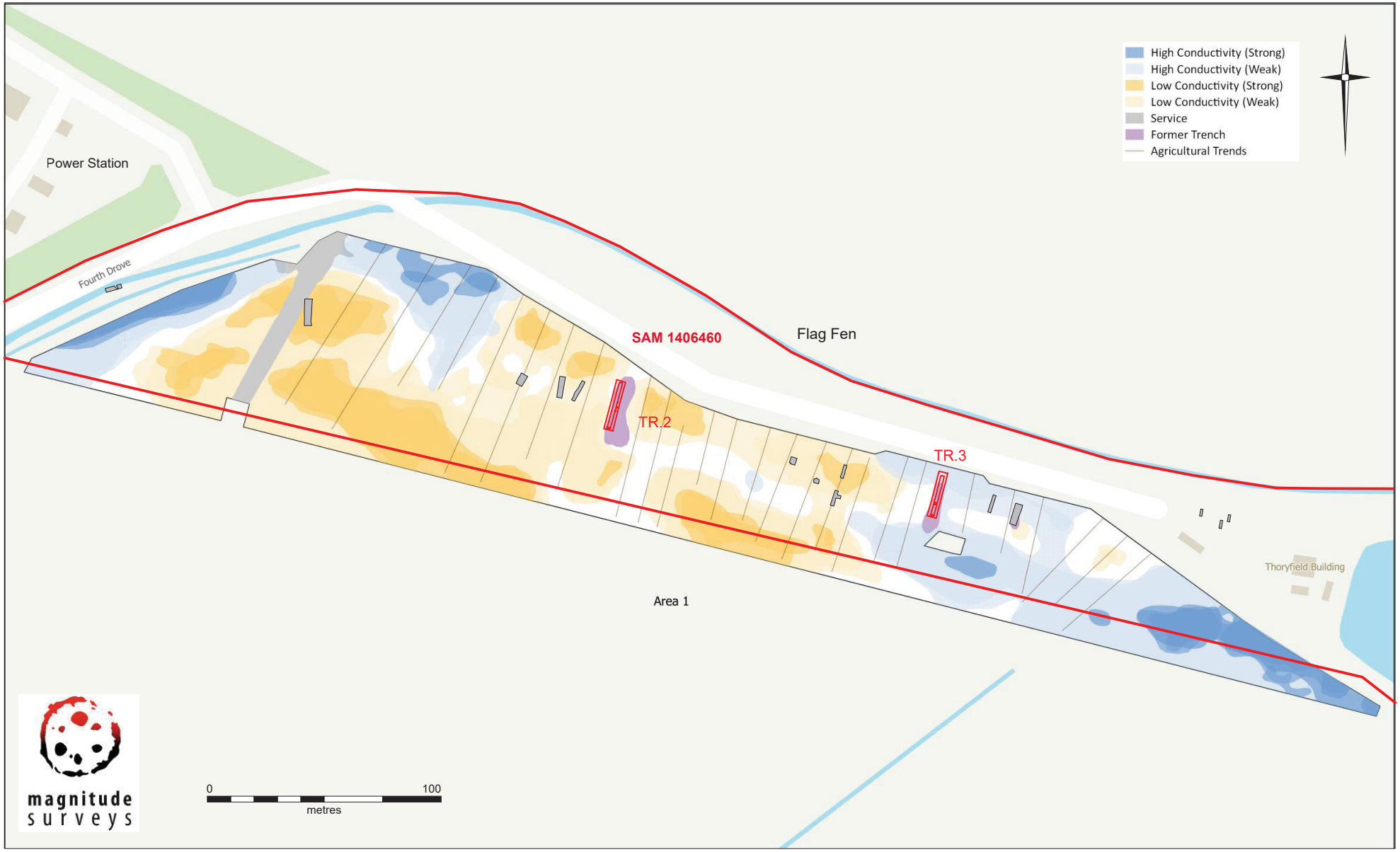


Figure 19: Anglian Water commissioned geophysical (electomagnetic) survey with the western post alignment trenches overlaid

Platform

7.2.9 The increased depth profile and damper deposit sequence observed in Trench 4 was also observed in the southern platform trench, Trench 6/Test-pit 1 (depth 2.05m; height of natural -0.90m OD), located 150m to the southwest. The northern platform trench, Trench 5, was similarly deep (1.75m), although its depth was only determined using an auger.

7.2.10 The uppermost profile of Trench 6/Test-pit 1 was desiccated, oxidised and characterised by fissures, voids and invasive roots. Below 0.80m, and beyond the reach of the invasive roots, the sediment profile was unoxidized with the water table being encountered at 1.70m. The interceding sediment was moist and during the excavation of Test-pit 1 the exposed section face oozed moisture.

7.2.11 The single piece of horizontally deposited wood exposed at the northern end of Trench 6 recorded a condition score of 4 (good) and this was found within a wet peaty silt layer that also contained fragments of well-preserved natural wood (Figure 20).

7.2.12 Trench 5 revealed a profile that included 0.60m of made ground above the former ploughsoil. Beneath the ploughsoil was a 0.38 thick alluvial deposit that overlay a layer of desiccated peat that was oxidised and characterised by deep fissures and voids and thick rootlets belonging to a small tree growing to the east of the trench. A layer of horizontally deposited wood was exposed at the base of the dry peat horizon. Three pieces of wood from this context produced condition scores of 2 (poor). During the excavation of one of the two Trench 5, 1m x 1m test-pits, a bank vole was observed passing through one of the drying cracks.

Post alignment and platform

7.2.13 The waterlogged wood and dendrochronology assessments examined material from all five trenches, whereas the waterlogged plant, insect, pollen and timber assessments focused on samples from two trenches, incorporating material from the post alignment (Trench 2), the platform (Trench 5), and off-site, from the environmental test-pit (Test-pit 1).

7.2.14 The waterlogged plant, insect and pollen assessments involved samples taken from different depths and deposits of different age. Preservation was best in the off-site sequence (Test-pit 1) and worst in the northern platform intervention (Trench 5), although Trench 2 was also poor. The Trench 5 samples were from immediately above the horizontally deposited wood associated with the platform and from deposits that showed obvious signs of drying out. The Trench 2 samples were from immediately above and around the horizontally deposited wood horizon, whereas the off-site, Test-pit 1 samples involved deposits equivalent to those from above and below the levels associated with horizontal elements of the post alignment and platform.

- *Waterlogged plants*: In general, the quantity, diversity and preservation of plant remains seems markedly poorer than previous work the author conducted on similar waterlogged plant remains sub-samples from the 2012 intervention at Flag Fen by Dig Ventures (Smith 2013). All three sequences produced plant remains with clear iron staining, which is generally taken to be an indication of a peat deposit drying out. This does suggest that the waterlogged archive is not stable and preservation is on the decline, possibly through dewatering and/or more frequent droughts at the site.
- *Insects*: The insect faunas from Flag Fen consisted of fragments of beetles (Coleoptera) and caseless caddis flies (Trichoptera spp.). Insect remains often were eroded, fragmented and folded suggesting poor preservation in all three trench

Figure 20. Platform Trench 6 - preserved platform wood at the northern end of the trench,

sequence samples assessed here. In terms of the numbers of individuals recovered, the faunas are mainly small or moderate in size. Only sample <10> from Test-pit 1 is large in size and well-preserved.

- *Pollen*: Overall, it is difficult on the basis of these data to draw firm conclusions concerning the impact, if any, of drainage/dewatering of the organic deposits on the pollen record. In general, the preservation of samples from Trench 2 appears to be the worst, although the pattern indicates that this increases at depth, rather than up profile (the indication from the corresponding plant remains suggest the sediment sequence became increasingly wet up the profile; damp ground to fully aquatic). Preservation and concentration of pollen in Trench 5 and Test-pit 1 can be categorised as 'adequate', if not excellent.

Archaeological understanding

7.2.15 The five new interventions at Flag Fen give fresh insight into the context of the post alignment and platform. In addition, the five trenches provide new information regarding the site's palaeo-topography and associated palaeo-environmental sequence (Figure 21).

7.2.16 The presence of an old land surface at the base of all the fully-bottomed trenches (including the deepest interventions) serves to confirm that the basal contours of the Flag Fen Basin were once dry and formed part of an earlier, low-lying terrestrial landscape. Equally, the subsequent succession of peaty silts and peat exemplify the time-transgressive, progressively wet environment that transformed this dry earlier Bronze Age landscape into a small fen embayment.

7.2.17 The site's palaeo-topography describes a deeper trough or much earlier, narrower embayment situated along the eastern edge of the Flag Fen Basin, passing below the projected location of the platform as well as the central eastern section of the post alignment. This area of increased depth was the first to be affected by the rising groundwater table and the first to witness development of peat. In effect, the platform and the central eastern section of the post alignment were located in an area that was wetter earlier and longer than the rest of the Flag Fen Basin. The platform trenches (Trench 5 and Trench 6/Test-pit 1) and the eastern-most post alignment trench (Trench 4) were situated in this zone and all demonstrated a pre-existing accumulation of peaty sediments before the construction of the post alignment/platform.

7.2.18 Much shallower contours lay below the rest of the post alignment, especially the western section. In Trench 2, there was clear evidence of the saturation of these contours and the construction of the post alignment occurring in relatively quick progression. Here there was barely any separation between the top of the buried soil or old land surface and the horizontally deposited wood (and by inference, the insertion of the first piles). The preserved (oak) tree stumps in Trench 2 attest to a drowned environment. The absence of any depth of wet sediment prior to the first deposits of horizontal wood might even suggest that the first oak piles came from nearby trees suffering from the rising groundwater.

7.2.19 Due to their extended length, Trenches 2, 3 and 4 (16.5m, 20.00m and 19.70m respectively) represented the first interventions outside of Area 6 (1984-2001) and the Power Station excavations (1989) to properly explore the full width of the post alignment and its related horizontal wood mass (as opposed to short partial perpendicular exposures averaging 5.70m in length). Even then, it turned out that both Trench 2 and Trench 3 were unable to demonstrate with any confidence that the full width post alignment was observed. In both

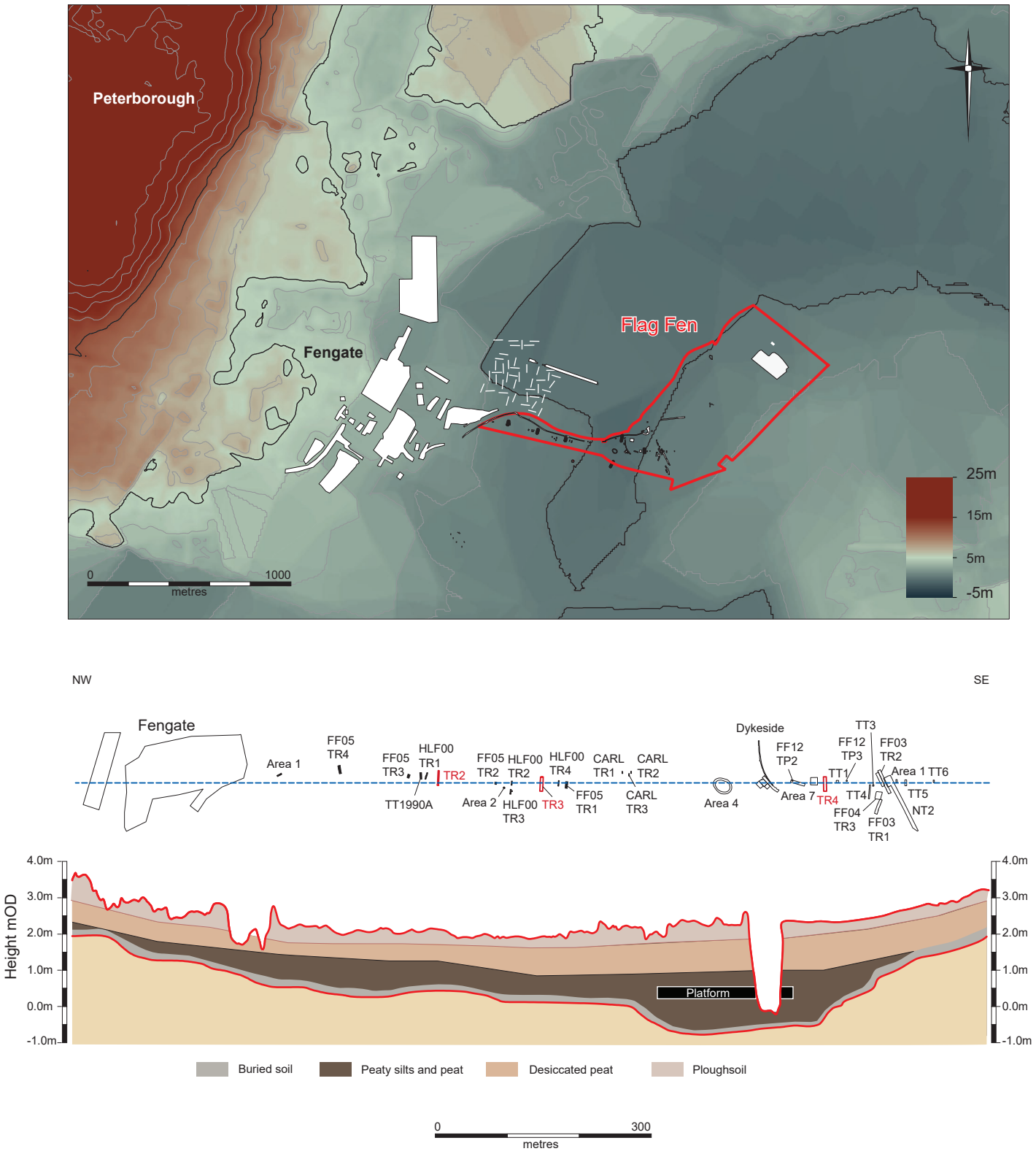


Figure 21. Flag Fen Basin palaeo-contour model (top) and Flag Fen post alginment and platform deposit profile (bottom)

Trench 2

Trench 3

Trench 6

Figure 22: Post alignment paired piles (uprights made from the same tree) in Trenches 2, 3 and 4

interventions the horizontal deposited wood was seen to continue northwards and the number of post rows exceeded the anticipated five, or at the very least, could not be easily grouped into the established five row model.

7.2.20 Such an observation might indicate that previous investigations had somewhat taken for granted the 'five row model'. Each intervention (however small), tentatively designating uprights to rows 1-5 on the basis of previous observations.

7.2.21 Remarkably, dendrochronology analysis of uprights from all three post alignment trenches demonstrated the presence of parallel paired piles: uprights from different 'rows' situated opposite each other, made from the same tree. For this patterning to be recorded in each 1.40m wide trench, suggests that such parallel 'pairing' was common throughout the length of the alignment. This attribute alone casts doubt on the interpretive validity of the five row model (Figure 22).

7.2.22 Similarly, the broad, seemingly unconfined distribution of horizontally deposited wood along the western post alignment bore a distinct resemblance to the horizontally deposited wood along the eastern post alignment where it is interpreted as the platform.

Palaeo-topography, deposit sequence, context and extent

7.2.23 Fundamental to the future management of the Flag Fen monument is a clearer understanding of the palaeo-topography, the deposit sequence and, with these, the context and scale of the preserved wooden architecture (post-alignment/platform) and the episodes of deposition related to the duration of its use (Table 7). All of these components are integral, and, as this condition assessment has illustrated, there exists a very evident relationship between depth, deposit type, context and extent of preservation.

7.2.24 Presently, the most extensive distribution of preserved wood (i.e. the platform) corresponds more or less exactly with the deepest parts of the Flag Fen Basin. The spread of horizontally deposited wood sits in a low-lying trough (-0.50m to -1.00m OD). Within the context of the Flag Fen Basin, these contours were the first to be affected by the rising groundwater table and subsequent peat growth. As a result, a waterlogged environment prevailed here some time before the first timber constructions. In contrast, the higher contours of the Flag Fen Basin (1.00m to 0.00m OD), such as the extended 'landfall' associated with the western half of the post-alignment had a different relationship, with the first timber constructions occurring shortly after these contours became saturated. Straightforwardly, the deepest parts of the basin have been the wettest the longest and, it seems, have remained wet.

7.2.25 Moreover, central to interpreting the extent and context of the post-alignment and platform is determining indisputable negative evidence (i.e. areas without uprights and/or horizontally deposited worked wood). Thus far, detailed, in-depth interventions have, on the whole, been very much monument focused and piecemeal. This has led to a somewhat skewed and largely predetermined understanding of the post-alignment and platform. For example, the bulk of the post-alignment interventions have been situated inside its anticipated path and, as a consequence, have been effective at exposing and characterising elements of its core but very poor at determining its structural breadth or full lateral extent. Equally, the Five Row model (first identified in Area 6) has been assumed to prevail throughout the post-alignment's length, notwithstanding that the majority of interventions beyond Area 6 have revealed only partial views comprising two or three rows at most. Or, as with the Northey Landfall investigations (Trench NT2; Britchfield 2010, Fig.3.18), revealed a multitude of

uprights that cannot be accommodated into just five rows. In the same way, the full sideways extent of the post-alignment's associated spread of horizontally deposited wood has never been properly established (the untested area north of the western half of the post-alignment being a prime example). In summary, there are multiple small trenches revealing component parts of the post-alignment/platform but very few demonstrating 'wood-free' spaces outside of their architectural or depositional reach.

		Methodology		
Research question	**Detail required**	**Auger survey**	**Test-pitting**	**Extended Trenches/open areas**
1. Palaeo-topography	Height of natural; top of buried soil (Pre-Flandrian land surface)	***Very good***: Clear record of height of natural. Buried soil might be ambiguous	***Excellent***: Clear record of height of natural/top of buried soil	***Excellent***: Clear record of height of natural/top of buried soil
2. Deposit sequence	Stratigraphy of the Flag Fen Basin	***Good***: Coarse-grain deposit sequence	***Excellent***: Clear record of deposit sequence	***Excellent***: Clear record of deposit sequence
3. Extent of worked wood	Presence/absence vertical piles and/or horizontally deposited wood	***Poor****:* Hit and miss	***Fair***: Presence/absence only, extremely limited characterisation	***Excellent***: Presence/absence, full characterisation, dendrochronological samples

Table 7: Investigation methodologies in relation to research question.

7.2.26 With these particular questions in mind, it is imperative that future investigations/interventions always incorporate an excavation methodology that includes establishing definitive negative evidence, a full deposit profile (including presence absence of a buried soil) together with the height of natural.

Assessment of preservation - Zones of vulnerability

7.2.27 The 2020 assessment of preservation presented four areas or zones of preservation/vulnerability (Brittain et al 2020, Fig.22) based on changes in height (palaeo-topography) and the character of the geological and deposit profile (deposit sequence). This condition assessment has been able to refine the model with the use of fresh height data and deposit sequences (Figure 23; Table 8).

	West	*Centre*	*East*	
Vulnerability	High (*orange*)	Medium-high (*yellow*)	Low-medium (*purple*)	High (*orange*)
Length (m)	385m	141m	250m	77m
Length (%)	45.1%	16.5%	29.3%	9.0%
Top contour	1.00m OD	0.00m OD	-0.50m OD	1.00m OD
Base contour	0.00m OD	-0.50m OD	-1.00m OD	0.00m OD

Table 8: Four parts/three zones.

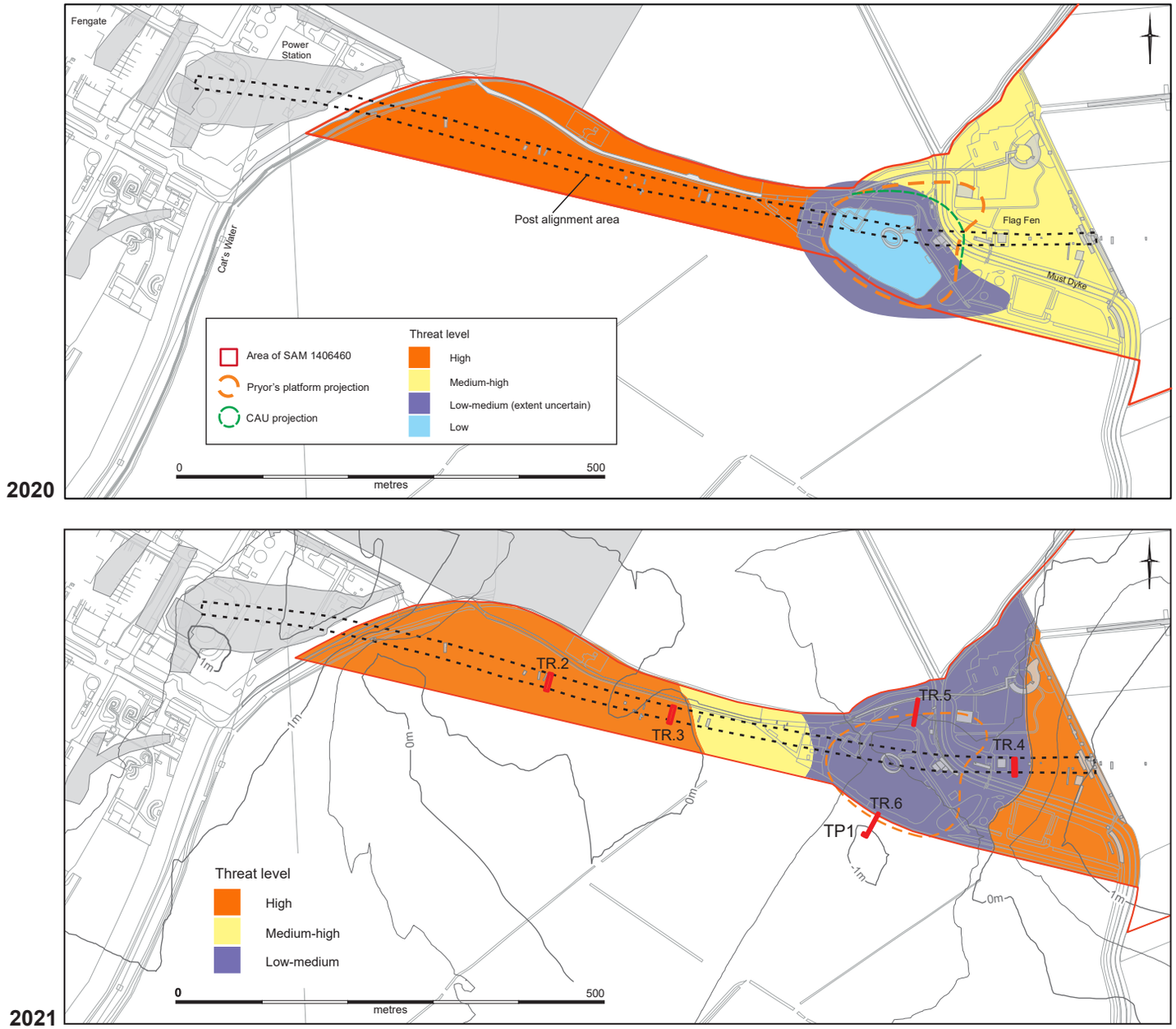


Figure 23. Scales of vulnerability: 2020 (after Brittain et al.); 2021 (Bottom of the Flag Fen Basin/Pre-flandrian contour shown at 0.50m intervals)

7.2.28 The zones illustrate many different attributes including the extended ‘landfall’ gradient (orange) associated with the western half of the post-alignment, especially in contrast with the relatively steep, short landfall at the eastern end. Similarly, the deep (purple) zone corresponds more or less exactly with the projected location of the platform. The easternmost of the four 2005 condition assessment trenches along the western half of the post-alignment identified the slightly enhanced preservation which corresponds to the centre (yellow) zone and with the slightly enhanced conductivity recorded in the electromagnetic survey (Figure 19).

8. POTENTIAL PRODUCTS – FLAG FEN SEMINAR, RESEARCH FRAMEWORK AND PUBLICATION

8.1 Product 1 – Flag Fen seminar

8.1.1 As a follow-up to this report and updated project design a Flag Fen specialists seminar is proposed. The seminar would bring together key specialists and stakeholders to discuss the results of the 2021 condition assessment (both in relation to previous condition assessments and in relation to earlier investigations/interpretations of the monument).

8.1.2 A seminar represents an opportunity for critical discussion of the findings and a chance to consider priorities in terms of a management strategy for Flag Fen and in terms future research. In particular, outlining options open to HE in developing a management plan for the site.

8.1.3 The main outcomes of the seminar would be the beginnings of an outline for a research framework specific to the Flag Fen SAM (Product 2), and potentially, a short paper/journal publication detailing the recent work in relation to the changing context of the Flag Fen Basin (Product 2).

8.2 Product 2 – Flag Fen Research Framework

8.2.1 As discussed in this report, gaps in current knowledge include:

1) the immediate paleo-topography of the Flag Fen Basin
2) the related deposit sequence
3) the actual extent, context and chronology of the wooden architecture

8.2.2 It can be argued that the site has never been fully evaluated.

8.2.3 The prevailing characterisation of Flag Fen is premised on a succession small and very small interventions, for the most part situated above the body or core the monument. Outside the establishment of its two ends, at the Power Station (Pryor 2001) and Northey Landfall investigations (Pryor and Bamforth 2010), there remains limited, definitive negative evidence.

8.2.4 To help remedy this situation a Flag Fen specific Research Framework is proposed. The framework needs to include a history of investigation that explicitly draws attention to gaps in knowledge. To do this it needs to start by identifying the actual, as opposed to assumed, spatial-temporal extent of the vertical and horizontal elements of the timber monument.

8.2.5 In turn, this ‘what we know’ characterisation needs to be complemented by a more refined understanding of the history/taphonomy of deposition. For example, the absolute dating of three pieces of human bone from 2021 assessment (Trench 2) demonstrated an unambiguous disparity between the presumed temporal extent of the monument and the full temporal extent of deposition.

8.2.6 In light of this, there remains a very distinct possibility that the established chronology of the Flag Fen post-alignment/platform is, in reality, an artefact of the limitations of dendrochronology. Currently, the non-ring porous component, a significant component of the overall monument, including rows of non-oak piles, remain undated.

8.2.7 All future research is conditional on continued preservation.

8.2.8 The best preserved elements of Flag Fen can be related to depth. The deepest contours of the Flag Fen Basin correlate with the best preserved elements of the monument. Equally, the deepest parts of the wooden architecture, the driven pile tips, consistently represent the best preserved architectural elements. Accordingly, the condition scores of the vertical piles improved at depth and towards their worked ends, whereas the condition scores for horizontal elements only improved within the deepest parts of the basin.

8.2.9 By the same token, the taphonomy of the submerged pile tips (in situ architecture) is very different to the taphonomy of the largely redeposited horizontal timbers (ex situ architecture). The former being inserted into a waterlogged environment at the point of construction (start of use), the latter entering the waterlogged environment at the point of discard or failure (end of use). If true, this divergence in depositional history represents a shift in interpretation that impacts our understanding of preservation and our understanding of the monument.

8.2.10 Future research must advocate a methodology that attends to spatial and temporal distribution of deposition.

8.3 Product 3 – Flag Fen publication

8.3.1 The last detailed publication to come out of Flag Fen was in 2010, thirteen years ago (Pryor and Bamforth 2010). Since then several major new discoveries, including the Must Farm palaeochannel investigations (Robinson et al. 2015), the Must Farm post-alignment and pile-dwelling settlement (Knight et al. 2019), the Horsey Hill marshfort and post-alignments (Gibson and Knight 2009) and the Bradley Fen fenceline/bank and ditch (Knight and Brudenell 2020), have brought fresh insight on the extent and context of later Bronze Age activity within the Flag Fen Basin.

8.3.2 The number of well-preserved Middle to Late Bronze Age post-alignments bridging the Flag Fen Basin now equals three: 1) Flag Fen (Fengate to Northey), 2) Must Farm (Whittlesey to Horsey Hill) and 3) Horsey Hill (Horsey Hill to Stanground). Thus the context of the Flag Fen post-alignment has changed fundamentally. The site is no longer inimitable. Instead it represents one piece in a broader configuration of timber causeways spanning the deeper and increasingly wetter contours of the Flag Fen Basin, all related to a rising groundwater table from around 1450 BC onwards.

8.3.3 The Flag Fen, Must Farm and Horsey Hill investigations were different both in their circumstance and scope, with the Horsey Hill being a conventional planning evaluation (circa 5% sample) involving a criss-cross grid pattern of 50m long trenches. Tellingly, the extensive and intensive sample strategy employed at Horsey Hill exposed a whole series of causeways of different date (Late Bronze Age, Late Iron Age and Roman) and character (wood and stone), all crossing the same narrow bridging point.

8.3.4 In comparison, the ‘site-centred’ apertures on the Flag Fen and Must Farm alignments mean that we cannot rule out the presence of similar parallel causeways of earlier and later dates at these bridging points. Certainly, the Roman Fen Causeway at Flag Fen runs parallel to the Bronze Age post-alignment, and there remains a very strong possibility that at least some of the various, random uprights identified in the lake lining exposure (Pryor 2001) are parts of other alignments situated south of Flag Fen.

8.3.5 In light of this plethora of new detail, and how it fundamentally repositions Flag Fen (both in terms of its circumstance and significance), now is an appropriate time to publish a brief contextual summary of the Flag Fen Basin 1500 to 100 BC. First and foremost, the publication would underline the interrelationship between the Basin's topography, the rising groundwater table in the Bronze Age and Iron Age and the construction of extensive pile-built edifices. This would inform the spatial-temporal setting of the different alignments as well as the scale of activity contemporary with Flag Fen. The publication is an opportunity to kickstart fresh interest and new research from the national and international academic audience.

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10. APPENDIX 1A: WATERLOGGED WOOD ASSESSMENT

Mike Bamforth and Iona Robinson Zeki

10.1 Introduction

10.1.1 A large assemblage of waterlogged wood remains was revealed across the five trenches of the evaluation. The material incorporated the in situ vertically-driven piles of the later Bronze Age Flag Fen post alignment, a timber walkway which crossed the Flag Fen Basin, as well as spreads of horizontally-deposited wood, including large and small timbers, lengths of roundwood, and debris. The latter material is thought to be predominantly derived from, or relate to the construction of, the fabric of the alignment's walkway, or its associated platform. 1010 pieces of wood were recorded with the aim of characterising both its condition and its character (Table 18). Of the 1010 items examined, 484 (48%) were recorded in detail and 246 samples were retained for further work (see method, below). In this assessment report, undertaken following Historic England guidelines (Brunning & Watson 2010), the wood assemblage is characterised in terms of its composition and context, with particular attention paid to the preservation of the wood, as a key indicator of the survival of the site as a whole, as outlined in earlier modelling of site-wide condition (Brittain et al. 2020a,b) and specified in the Project Design (Wiseman et al. 2021, 14). This report also assesses the potential of the assemblage in terms of investigating: woodworking evidence, with reference to both practices employed and structural outcomes; selection of wood as a raw material; woodland reconstruction; and woodland management practices. It also assesses the potential of wood samples for use in scientific dating. Recommendations are made with regards to the conservation and retention of waterlogged wood. Separate programmes of decay analysis and dendrochronological analysis are being carried out by York Archaeological Trust (YAT) and Ian Tyers.

10.1.2 For clarity and continuity, the terms 'timber platform' and 'post alignment' used by Pryor (2001), later publications (Pryor & Bamforth 2010; Brittain et al. 2020a,b) and the Scheduled Monument listing (No. 1406460) to describe the major wooden landscape features at Flag Fen, are used throughout this report.

Orientation	Trench 2	Trench 3	Trench 4	Trench 5	Trench 6	Total
Vertical (*in situ* piles and stakes)	28	29	34	0	0	91
Horizontal	843	37	33	3	1	919
Tree stump	2	-	-	-	-	2
Total no wood items recorded	873	66	67	3	1	1010

Table 18. Waterlogged wood by trench.

10.2 Method

10.2.1 In order to achieve a broad characterisation of a large wood assemblage within the time constraints of a short evaluation programme, wood recording was undertaken at two levels of detail: full recording and rapid recording. Prior to recording, all wood in a context was exposed and cleaned. The wood layer was then systematically photographed by surveyor Donald Horne, as part of photogrammetric recording. This allowed the production of orthographic images (photographs and digital plans) of the wood layers, which could then be annotated

with relevant information, such as numeric identifiers, during wood recording. Recording was undertaken by the authors and Lucia Speariett with assistance from Christopher Wakefield.

Full recording

10.2.2 484 wood items were fully recorded. Each discrete piece of wood was assigned a unique wood number (WD), spatially located on the relevant orthographic image and then lifted and recorded using a CAU wood-recording form, developed from that created and used by the Fenland Archaeological Trust. The approach to recording the material from the 2021 Flag Fen evaluation was intentionally aligned with that applied at Flag Fen in the past, with an aim to allowing comparison of material with that recorded during earlier phases of work at Flag Fen. Terminology and recording methodology broadly followed that previously applied (Taylor 2001; Bamforth 2010), with additional terminology for the description of the angle and shape of cut roundwood derived from Coles & Orme's categorisation (1985, 25–29) and for the description of timber conversion by Orme & Coles (1983) and the Museum of London (Spence 1994, Fig. 32). Impressions of tool blades (stopmarks) were recorded using a profile gauge. Most recording was undertaken on-site, with some additional recording of the larger items undertaken off-site after the completion of the field programme. Exemplars of items with relatively complex woodworking (piles and jointed timbers) were selected for illustration at a scale of 1:5. Illustration was undertaken both in the field, with material in situ, and off-site during post-excavation processing.

10.2.3 The condition of each item was assessed using the 0–5 scale developed by the Humber Wetlands Project (Table 19), which was applied during assessment of condition of some material during earlier phases of excavation at Flag Fen (Bamforth 2020, 27; Brittain et al. 2020b, 63). This scale is based on assessing the clarity of the surface data on the material and its potential for use in various forms of wood analysis (Table 19; Table 20). Where the condition score of an item varied, the nature of that variation was noted, but the highest score appropriate was applied to the wood record as a whole. Height data (in m OD) was recorded for tops of piles, horizontal wood horizons and tips of piles, where exposed, so that condition scores can be related to height/water-table. In addition to 'scoring' each item on this scale, observations about the condition of each item were made in terms of the types of preservational transformation present (such as loss of surface detail due to decay, more significant alteration due to drying-related distortion or penetration by modern roots). Observational condition recording, undertaken in this manner, is distinct to the decay analysis carried out by Ian Panter of York Archaeological Trust which characterises the biodeterioration of the wood. The results of these two approaches may not always correlate, as waterlogged wood that has undergone extensive molecular transformation will not necessarily have undergone corresponding morphological transformation at the macroscopic scale, i.e. waterlogged wood in degraded molecular/cellular condition may still retain potential for the various forms of wood analysis which can be undertaken to characterise ancient woodworking.

Condition score	Technology analysis	Woodland management	Dendro-chronology	Species identification
5 excellent	+	+	+	+
4 good	+	+	+	+
3 moderate	+/-	+	+	+
2 poor	+/-	+/-	+/-	+
1 very poor	-	-	-	+/-
0 non-viable	-	-	-	-

***Table 19**. Waterlogged wood condition scale (after Van de Noort et al. 1995, Table 15.1)*

Condition score	Wood surface characteristics
5 excellent	All original woodworking evidence is clearly visible and well presented, if present. It will look 'as new'.
4 good	All the relevant data is clearly visible. The primary conversion, tool-facets and stopmarks will all be visible, if present.
3 moderate	A clearly visible primary conversion and some tool-facets are likely to be visible, if present.
2 poor	Suitable for species identification. The form of the item is probably visible and with possible signs of woodworking evidence, if present. The conversion may be apparent, if present.
1 very poor	So degraded as to not be able to see its form. A piece of the item may be in a suitable condition to allow species identification.
0 non-viable	Barely recognisable as wood.

***Table 20.** Waterlogged wood condition scale wood surface preservation characteristics (after Bamforth 2020, Table 7)*

10.2.4 After recording, wood was sub-sampled for further work, as appropriate (Table 21). Suitability of material for dendrochronological analysis was assessed following Historic England guidelines (English Heritage 1998). >50 growth rings are generally required to achieve a date via ring-width measurement, however, because of the difficulty of accurately estimating ring-counts in the field and because of the existence of a robust dendrochronological site chronology (Neve with Groves 2001), which increases the likelihood that items at the lower end of ring-count viability can be successfully dated, all oak material with >30 growth rings was sampled for his purpose. In addition to the dendrochronological (dendro) samples, a small number of samples were taken for potential radiocarbon (C14) dating. These samples were taken from small diameter oak roundwood and/or sapwood (to avoid dating 'old wood'), i.e. they are samples of oak material not suitable for dendrochronological analysis, but of which specific questions relating to chronology might be asked. Many of the non-oak items, sampled for identification (ID) would also be suitable for use as radiocarbon dating samples.

Sample type	Trench 2	Trench 3	Trench 4	Trench 5	Trench 6	Total
Dendro sample	23	23	19	0	1	66
C14 sample	3	9	7	0	0	19
ID sample	103	16	20	0	0	139
Decay analysis sample	8	5	5	3	1	22
Total no samples	137	53	51	3	2	246

Table 21. Wood sample type by trench. NB some individual wood items were sampled more than once for different purposes.

10.2.5 Sub-sampling for identification to taxa (ID) was undertaken were taxa could not be established in the field. In practice this meant that where oak (Quercus sp.) could be confidently identified from macroscopically visible features (using the naked eye or a hand lens (x10 magnification)), this identification was recorded in the field and no identification sample was retained, whilst in all other cases (i.e. all unidentified wood including non-oak items and possible oak items) the item was considered for identification sampling. Selection of wood for identification sampling was based on the size of the wood group to which it belonged (Table 22), with a minimum percentage of wood to be sampled for each group established with the aim of creating a representative sample of unidentified material. In most cases, sampling of non-oak material far exceeded those minimum percentages with 139 items sampled overall (Table 25, below).

No items in Wood Group	Minimum % of viable unidentified items to be sampled
≤10	100%
11–100	50%
101–199	20%
≥200	10%

Table 22. Unidentified wood sampling strategy. Viable wood had a Condition Score ≥2

10.2.6 In addition to the dating and identification samples outlined above, 22 samples were taken for decay analysis by York Archaeological Trust. Decay analysis samples were taken from all trenches and samples were selected to represent the range of material exposed in the trench (Table 23). Two vertical piles were selected per trench (in trenches where vertical piles were found), as well as three horizontal samples per context (or excavated spit within context). Only one condition sample was retained from Trench 6 as only one piece of wood was recorded from that trench. Timber and roundwood, oak and unidentified wood were selected from each trench so that in each context, preservation of these different wood types would be included in the assessment.

Trench	Orientation	Context	Wood No	Type	Taxa identification	Condition Score
Trench 2	Vertical	na	WD076	Upright pile (timber)	*Quercus* sp.	5
			WD316	Upright pile (roundwood)	*Unidentified*	3
	Horizontal	[002] (upper spit)	WD008	Timber	Unidentified	2
			WD089	Roundwood	Unidentified	2
			WD215	Timber	*Quercus* sp.	2
		[002] (lower spit)	WD478	Roundwood	Unidentified	2
			WD533	Timber	*Quercus* sp.	3
			WD675	Roundwood	*Quercus* sp.	2
Trench 3	Vertical	na	WD337	Upright pile (timber)	*Quercus* sp.	4
			WD342	Upright pile (timber)	*Quercus* sp.	5
	Horizontal	[015]	WD367	Roundwood	*Quercus* sp.	2
			WD455	Timber	*Quercus sp.*	2
			WD457	Roundwood	*Unidentified*	2
Trench 4	Vertical	na	WD404	Upright pile (timber)	*Quercus* sp.	4
			WD406	Upright pile (roundwood)	*Quercus* sp.	5
	Horizontal	[035]	WD429	Roundwood	Unidentified	2
			WD687	Timber	*Quercus* sp.	3
			WD690	Timber	*Quercus* sp.	3
Trench 5	Horizontal	[049]	WD691	Timber	Unidentified	2
			WD692	Timber	*Quercus* sp.	2
			WD693	Roundwood	Unidentified	2
Trench 6	Horizontal	[024]	WD697	Timber	*Quercus* sp.	4

Table 23. *Decay analysis samples. For key to Condition Scores, see Table 10*

10.2.7 On completion of full recording and sampling of waterlogged wood, items were discarded or left *in situ.* All wood recording sheets with associated sketches were scanned to form part of the digital archive. Data was entered into an excel spreadsheet, a copy of which was exported for use in the creation of a GIS database to allow spatial interrogation of the wood data.

Wood groups and rapid recording

10.2.8 All wood items recorded using either the 'full' or 'rapid' approach were assigned a Wood Group number (WG). In this assemblage, wood group numbers were applied to wood which shared certain defined morphological traits, as defined by 'wood type' (Table 25; Table 27), with additional preservational or functional groupings applied where apparent. (As clear interpretation of function was not possible for most of the material, the latter type of grouping was limited to in situ¬ piles and stakes.) Wood groups were assigned on a trench-specific basis.

10.2.9 The process of wood grouping was undertaken so that similar wood could be interpreted together during spatial analysis, and so that equivalent wood groups could be compared between trenches. It was also applied to allow rapid recording in Trench 2, where a large quantity of wood was revealed with minimal or no evidence of woodworking. In wood groups

Figure 24. Pile uppers

A

B

Figure 25: Nettle root penetration Trench 3

were this was the case, a percentage of the wood was fully recorded while the remainder was recorded rapidly, the minimum full recording percentage being determined by the quantity of wood in the group and the type of evidence present (Table 24). This ensured that a representative sample of the group was recorded in detail, while avoiding the logging of redundant detail (Table 25).

10.2.10 Rapid recording was achieved simply by assigning an item to the appropriate wood group. This was done either by marking the item with a wood group number on the plan, or by assigning the item a wood number (WD) and then attaching a wood group code to that number in the wood register. Occasionally simple additional details, such condition score or species, were noted during rapid recording using the latter method.

10.2.11 Some wood items were found to be unrecordable (occurring only as tiny fragments or 'dust'). All such items were rapidly recorded by wood group code only.

Level of woodworking evidence in wood group	Minimum % of Wood Group to be fully recorded (WG = ≤50 items)	Minimum % of Wood Group to be fully recorded (WG = 51–200 items)	Minimum % of Wood Group to be fully recorded (WG = >200 items)
Unworked	50%	25%	10%
Simple working	100%	50%	25%
Complex working	100%	100%	100%

Table 24. Recording strategy for wood groups in Trench 2

Wood Group	Trench	Orientation	Woodworking evidence present?	Wood group description	No fully recorded	No rapid recorded	Total	Fully recorded as % of total grouped	Field identification (*Quercus* sp.)	Unidentified wood viable for ID	No id samples taken	No id samples as % of unidentified wood viable for ID
1	2	H	n	Unworked roundwood, condition score 1	31	200	231	13.4	0	0	0	na
2	2	H	y	Worked roundwood	18	0	18	100	2	16	15	93.8
3	2	H	y	Timber, fully converted	16	0	16	100	15	0	0	na
4	2	H	y	Timber, modified roundwood	7	0	7	100	5	2	1	50
5	2	H	n	Unworked roundwood, condition score 2	60	166	226	26.5	5	141	46	15
6	2	H	y	Timber debris	121	116	237	51.1	122	13	11	8.5*
7	2	H	y	Woodchip	46	7	53	86.8	33	14	12	57.1
8	2	H	n	Unrecordable, condition score 0	0	31	31	0	0	0	0	na
9	2	V	y	Upright pile	24	0	24	100	13	5	4	80
10	2	H	n	Unworked bark	10	2	12	83.3	0	9	0	na
11	2	H	n	Unworked roundwood, condition score 3	5	0	5	100	0	5	5	100
12	2	H	n	Root	3	0	3	100	1	0	0	na
13	3	V	y	Upright pile	24	0	24	100	20	4	4	100
14	3	H	y	Timber, fully converted	10	0	10	100	10	0	0	na
15	3	H	y	Timber debris	7	0	7	100	6	1	1	100

Wood Group	Trench	Orientation	Woodworking evidence present?	Wood group description	No fully recorded	No rapid recorded	Total	Fully recorded as % of total grouped	Field identification (*Quercus* sp.)	Unidentified wood viable for ID	No id samples taken	No id samples as % of unidentified wood viable for ID
16	3	H	n	Unworked roundwood	11	0	11	100	1	9	8	88.9
17	3	H	n	Unrecordable, condition score 0	0	4	4	0	0	0	0	na
18	3	H	y	Worked roundwood	4	0	4	100	1	3	3	100
19	4	V	y	Upright pile	34	0	34	100	25	5	5	100
20	4	H	y	Worked roundwood	2	0	2	100	0	2	2	100
21	4	H	n	Unworked roundwood	16	0	16	100	0	16	11	68.8
22	4	H	y	Timber debris	6	0	6	100	6	0	1	na
23	4	H	y	Woodchip	6	0	6	100	5	1	1	100
24	4	H	n	Unrecordable, condition score 0	0	1	1	0	0	0	0	na
25	2	H	y	Roundwood debris	5	0	5	100	1	3	3	100
26	4	H	y	Timber, fully converted	2	0	2	100	2	0	0	na
27	3	H	y	Woodchip	1	0	1	100	1	0	0	na
28	2	H	n	*In situ* tree stump	2	0	2	100	2	0	0	na
29	5	H	y	Timber, fully converted	1	0	1	100	1	0	0	na
30	5	H	y	Timber, modified roundwood	1	0	1	100	0	1	0	na
31	6	H	y	Timber, fully converted	1	0	1	100	1	0	0	na
32	5	H	n	Unworked roundwood	1	0	1	100	0	1	0	na
33	2	V	y	Upright or angled stake	4	0	4	100	1	3	3	100
34	3	V	y	Upright or angled stake	5	0	5	100	5	0	0	na
Total					484	526	1010	47.9	278	251	133	17.1%

Table 25. *Wood groups from all trenches with recording type and species/identification sampling information. (H = horizontal; V = vertical). * = this figure is below the target of 10% for wood groups with >200 items. This is because the total of unidentified wood viable for id includes all rapid recorded items, a high percentage of which were oak in WG6. If the percentage of oak/non-oak in the fully recorded assemblage is projected to the rapid recorded assemblage, then the number of id samples as a % of unidentified wood viable for id would be 31.5%, and therefore is a suitable sample for a group of that size.)*

Trench specific methodology

10.2.12 The excavation methodology differed by trench and this variation had a direct impact on the quantity of wood available for recording and the manner in which wood recording was approached in each trench.

10.2.13 *Trench 2* – This trench was the target of comprehensive excavation and consequently produced 873 pieces of wood (86% of the total wood assemblage) (Table 18). The horizontal wood mass, located in [002] was exposed in its entirely, in two spits (recorded as upper and lower spit in the wood database). All 843 pieces of wood exposed in this context were lifted and recorded, using a combination of the full and rapid recording techniques outlined above (see Table 18, Table 25 and Table 27). After the removal of the horizonal wood, small sondages were dug to expose a selection of piles and stakes from across the width of the

post alignment. Ten uprights (seven piles and three stakes) were fully excavated, removed and recorded from these sondages. These items represent 36% of the 28 piles and stakes identified in the trench. The remaining 18 uprights were not further exposed, and were instead recorded as part-excavated items, with the maximum information available recorded and sampling undertaken wherever possible. Some pile tops were only exposed within the machine-dug steps on either side of the hand-dug portion of the trench and in most cases only very basic metrics were recordable for these items. The unexposed, unrecorded, lower portions of these piles were left in situ. Two tree stumps/root masses were also recorded in Trench 2. In both cases these were only partially revealed, with those elements of the stump/root mass located in context [002] and buried soil [003] exposed and recorded, and those roots penetrating into the underlying natural left in situ.

10.2.14 *Trench 3* – Excavation in this trench revealed the full spread of the upper layer of horizontal wood in context [015]. The distribution of this wood was fully recorded in plan, but actual wood recording in this layer was limited to an area approximately 1m2, towards the southern end of the trench (Figure 11). Here, all horizontal wood was fully recorded prior to excavation of a small sondage for the extraction of some of the alignment's piles. In addition, 6 horizontal timbers from across the remainder of the trench were lifted and recorded because of the presence of identifiable joints and/or because of their potential for dendrochronological dating. Three items selected for decay analysis, were also recorded in full. In total 37 pieces of horizontal wood from Trench 3 were recorded (Table 18). If the wood mass in Trench 3 is assumed to be similar to that in Trench 2, where full excavation of the horizontal wood was undertaken, this would suggest that the recorded Trench 3 horizontal wood represents a c.4.4% sample of the wood present within that layer, with a bias in that sample towards the recording of timber. Excavation by sondage permitted the extraction of four piles and one stake, a 17% sample of the 29 uprights identified within the trench. As in Trench 2, the remaining 24 part-excavated piles were recorded and sampled if accessible.

10.2.15 *Trench 4* – In this trench, the approach to wood recording employed followed that used in Trench 3, although in this case the full spread of the horizontal wood in [035] was not excavated, with only the uppermost wood items in that context, and those in the immediate area of the soakaway, exposed. Wood recording was undertaken on 33 pieces of horizontal wood (Table 18), with most of those recorded items located on the northern side of the soakaway, where wood lifting was undertaken to allow the subsequent excavation and removal of a number of piles. Located to the south of the 'platform' area, Trench 4 had notably different preservation conditions to Trenches 2 and 3 and therefore may not have the same size or composition of wood assemblage, however it is clear that the wood recorded represents a very small proportion of the wood present within the horizontal spread in [035]. Three piles located around the area of the soakaway were fully excavated (8.8% of the 34 piles identified in the trench). The remaining 31 part-exposed pile uppers were recorded and sampled where possible.

10.2.16 *Trench 5* – 28 pieces of wood were exposed in two hand-dug test pits within Trench 5. Three were selected as decay analysis samples and were fully recorded. The remainder were left in situ.

10.2.17 *Trench 6* – Due to the depth of sediment in this trench, access to [024], and exposure of, the horizon containing horizontal wood associated with the alignment/platform was limited. Some partially exposed in situ rooting was observed as well as a single piece of worked wood, which was fully recorded.

10.2.18 The manner in which wood recording was enacted in the three trenches which targeted the post alignment provided one very thoroughly recorded sample of the horizontal wood associated with the alignment (Trench 2) and two very partial samples (Trench 3 and Trench 4). The limited recording undertaken in Trenches 3 and 4 was necessitated by the evaluation's timescale and did facilitate the acquisition of appropriate decay analysis samples, as directed in the Project Design. However, the authors wish to note that the stipulation in the project design that most recording in these trenches should be undertaken *in situ* (Wiseman et al. 2021, 33) was not executable, as removal of material was required to perform meaningful recording. Moreover, after excavation, exposure and reburial, the condition of the horizontal wood left in situ in Trenches 3 and 4 is likely to quickly deteriorate, and therefore the suitability of an excavation design which entailed exposure, but not removal and recording of the wood is called into question (High et al. 2018, 191–2). Therefore, as an assessment of the suitability of the wood recording methodology, as prescribed by the Project Design and project timescale, it should be noted that any future work entailing exposure of these horizontal wood deposits should be structured around a strategy based on lifting and recording an appropriate, representative sample of the wood present and not based on the premise of in situ recording.

10.3 Character of assemblage

10.3.1 The composition of the wood assemblage from all trenches is given in Table 26. In this assessment, timber is used to refer to converted stems, while roundwood is used to refer to unconverted stems, in-the-round. Roundwood made up over 54% of the total assemblage, with timber debris as the other material type which occurred in very high numbers (25% of the assemblage).

Wood type	Qty	% of assemblage
Roundwood	546	54.1
Timber debris	250	24.8
Timber	78	7.7
Woodchip	60	5.9
Bark	12	1.2
Roundwood debris	5	0.5
Root	3	0.3
Tree	2	0.2
Indistinguishable	54	5.3
Total	1010	100

Table 26. Wood assemblage by type, all trenches

10.3.2 While the information in Table 26 gives a broad overview of the material types, it is not necessarily comparable with equivalent tables in past reports of Flag Fen, as the terms timber and roundwood have been applied slightly differently over time (Taylor 2001, Table 7.1 and Table 7.18; Bamforth 2010, Fig. 4.3). When comparison of wood between phases is attempted, metrics are likely to give the easiest method by which to compare the type of material present in the different areas.

10.3.3 When assessing the wood from the current phase of investigation, it is useful to consider the material by wood groups, based on the wood categories listed in Table 17, but divided by context and according to the presence/absence of woodworking evidence (Table 27). This allows further distinctions in the distribution of material types to be explored.

10.3.4 Just under half the wood in the assemblage had evidence of woodworking present (468 items, 46.3% of the total assemblage). This included piles and stakes, as well as timbers, timber debris, trimmed roundwood, roundwood debris and woodchips. The remaining 507 items (unworked roundwood, bark, roots, tree stumps) did not display any woodworking evidence, although that does not necessarily mean that they were not either fragmented pieces of larger worked items or unworked pieces brought by humans to the site as part of the construction of the feature. 35 pieces of wood were too degraded to categorise (3.5% of the total assemblage).

Uprights

10.3.5 A total of 91 uprights were recorded, in the three trenches which crossed the Flag Fen 'post alignment'. The term 'post' generally refers to an upright which has been set within an excavated hole, whilst large uprights driven directly into the ground or underlying sediment are referred to as 'piles' and smaller driven uprights are called 'stakes' (Corkhill 1979; Knight et al. 2019). In all cases where it was possible to determine the method of insertion, all the uprights examined had been driven rather than set. The same is true for all the uprights previously encountered as part of the alignment and platform at Flag Fen (Taylor 2001; Bamforth 2010). Thus, although traditionally referred to a 'post alignment' (Pryor 2001; Pryor & Bamforth 2010), 'pile alignment' would be a more accurate label for this feature. Of the 91 uprights recorded, 82 are interpreted as piles of the principal alignment whilst nine smaller items are interpreted as stakes.

10.3.6 The uprights at Flag Fen have been a focus of interest and research. The route of the main alignment, the nature of the uprights that have been excavated, the dendrochronological potential of many of these and projections of the possible total number used in the alignment have all been investigated (Pryor 2001). Recent investigations have often attempted to fit the uprights encountered into Pryor's multiphase, 'Five Row' model (Bamforth 2010; Brittain 2010a; Britchfield 2010).

Piles

10.3.7 Of the 82 piles, 24 were encountered in Trench 2 (WG9), 24 in Trench 3 (WG13) and 34 in Trench 4 (WG19) (Table 27). 78 were subjected to detailed recording whilst four examples from Trench 4 were rapidly recorded. Of the material recorded in detail, 14 piles were fully excavated and 68 part excavated. As might be expected, many of the piles were substantial with fully excavated examples ranging from 428–1548mm long with recorded diameters ranging from 83–203mm.

10.3.8 The presence or absence of timber conversion was noted for all the recorded piles where it was clear. 26 remained in the round, 24 were radially cleft and eight were tangentially cleft. Where visible, the bases have been trimmed to a point in a variety of styles. As might be expected based on identifications of uprights from other areas of the alignment (Taylor 2001; Bamforth 2010), the majority (58) have been macroscopically identified as oak. 13 samples were taken from the unidentified piles and it is suggested that these are all identified.

10.3.9 The uprights recently encountered offer a chance to add to previous research and there are some key areas of interest. The increasing use of digital data, particularly GIS, opens up the possibility of not only interrogating the traditional conversion and taxa values of the uprights but also trying to add more nuance in terms of other characteristics and indeed, the opportunity to spatially search these data. By also including size, age and ring growth characteristics it may be possible to carry out a finer grained interpretation of the uprights.

This approach was particularly successful for the Holme timber circle ('Sea Henge') where a fine grained interrogation of the uprights' characteristics provided key insights into the construction of the monument (Brennand & Taylor 2003). Several 'pile groups' have been tentatively identified during the excavation and may cut across the traditional rows of the alignment, perhaps describing discrete phases of activity in a given area. It is suggested that the new data (and if possible, previous data from nearby previously excavated trenches) are used to try and identify pile groups and phasing, before comparing the data against Pryor's traditional Five Row model (Pryor 2001).

10.3.10 Although uprights have generally been submitted for dendrochronological analysis when suitable, in large part driving the chronology of the alignment and platform, there is something of a blind spot in terms of the dating of both short-lived oak and, perhaps more significantly given the role of non-oak taxa in what are perceived to be earlier phases of construction (Taylor 2001), non-oak uprights. It is therefore suggested that not only should the non-oak uprights that have been sampled be identified to taxa (n=13), but that, pending the results of the dendrochronological and the pile group analysis, they should be considered for radiocarbon dating.

Stakes

10.3.11 Nine vertical or angled stakes were recorded across Trench 2 (WG34) and Trench 3 (WG33). Predominantly formed of cleft oak, these were all recorded in detail and four were fully excavated. It was noted that many of these stakes' tops survived at a height lower than most of the surrounding horizontal wood, or even below that horizon, in the buried soil. For this reason, stakes like these would only be found by full excavation involving the removal all layers down to the 'natural', and therefore, the number of stakes reported here, may under-represent the number of stakes actually present in these trenches, as complete removal of all layers, including buried soil was not undertaken in any trench.

10.3.12 The stakes are a small but significant part of the assemblage and although not many have been revealed by the current investigations, it would be interesting to try and understand their role. Are they contemporary with the piles? Do they fit with Pryor's (2001) model of wattle walls associated with Rows 2 and 5 or were they perhaps used to stake horizontal items in place? It is interesting to note that similar stakes were found in association with the piles of the Horsey Bridge later Bronze Age pile alignment in the southern Flag Fen Basin (Robinson Zeki 2022).

10.3.13 All three samples of non-oak stakes should be identified and the stakes should be considered alongside the wider assemblage and against Pryor's (2001) Five Row model.

Woodworking evidence	Orientation	Description	Trench 2		Trench 3		Trench 4		Trench 5		Trench 6		All
			Wood group(s)	No items	Wood group(s)	No items	Wood group(s)	No items	Wood group(s)	No items	Wood group(s)	No items	No items
Present	Vertical or angled	Pile	WG9	24	WG13	24	WG19	34	-	-	-	-	82
		Stake	WG33	4	WG34	5	-	-	-	-	-	-	9
	Horizontal	Timber	WG3, WG4	23	WG14	10	WG26	2	WG29, WG30	2	WG31	1	38
		Timber debris	WG6	237	WG15	7	WG22	6	-	-	-	-	250
		Worked roundwood	WG2	18	WG18	4	WG20	2	-	-	-	-	24
		Roundwood debris	WG25	5	-	-	-	-	-	-	-	-	5
		Woodchip	WG7	53	WG27	1	WG23	6	-	-	-	-	60
Absent	Horizontal	Unworked roundwood	WG1, WG5, WG11	462	WG16	11	WG21	16	WG32	1	-	-	490
		Unworked bark	WG10	12	-	-	-	-	-	-	-	-	12
		Root	WG12	3	-	-	-	-	-	-	-	-	3
	Other	*In situ* tree stump	WG28	2	-	-	-	-	-	-	-	-	2
	Horizontal	Unrecordable	WG8	30	WG17	4	WG24	1	-	-	-	-	35
Total				873	-	66	-	67	-	3	-	1	1010

Table 27. *Wood assemblage by type, presence/absence of woodworking evidence and trench*

Timber

10.3.14 There are a total of 78 items classed as timber (Table 26), 40 of which were upright piles considered above and 38 of which were horizontal. All of the horizontal timbers were recorded in detail, and are considered here. In keeping with the remainder of the assemblage, the majority of the material was recovered from Trench 2 (23 items assigned to WG3 and WG4) with a moderate volume from Trench 3 (10 items assigned to WG14) and occasional items from Trench 4 (2 items, WG26), Trench 5 (2 items, WG26 and WG30) and Trench 6 (1 item, WG31) (Table 10).

10.3.15 Reconstructed diameters of the parent logs of these converted items vary from a relatively slight c.60mm up to two examples derived from large trees with a trunk diameter in excess of 500mm. Almost all the timbers (35 items) have been identified as oak, much of which is straight grained and slow grown, indicative of good quality material. It is suggested that samples of the two timbers not taxonomically identified be processed for identification.

10.3.16 By the definition used to record this assemblage, all the timber was cleft, most commonly in the radial plane, with a moderate quantity of tangential conversions also present. 18 items showed tool faceting from trimming or shaping with an edged tool, probably an axe. There were nine examples of joints or possible joints, which occurred exclusively in the timber assemblage and which had all been cut into oak timbers (Table 28). As these timbers were generally fragmentary, they were illustrated in situ where possible. It is suggested that a full catalogue of the jointed material is produced and that their location and original function is considered.

Wood No	TR	Context	WG	Sapwood present?	Condition	Split	Dimensions (mm)	Joint	Drawn?
25	2	2 upper spit	3	No	3	Rad 1/16	1029 x 148 x 55	Broken sub-circular mortise at one end, next to blind mortise	Y
141	2	2 upper spit	3	No	2	Tan 1/6	1230 x 440 x 65	Broken mortise at one end	-
359	3	15	14	Poss	2	Rad 1/32	>1762 x 231 x 92	One end has a prong, which could relate to a joint	-
375	3	15	14	Poss	3	Tan	>1861 x 355 x 44	Possible sub-rectangular mortise	Y
381	3	15	14	Poss	3	Tan	>1288 x 255 x 58	Mortise at proximal end	Y
382	3	15	14	Poss	3	Rad 1/16th	>1490 x 159 x 47	Probable broken mortise at one end	Y
454	3	15	14	Poss	2	Rad 1/4	>1073 x 115 x 66	Prong sticking out at one end	-
604	2	2 lower spit	3	No	3	Tan	310 x 260 x 40	Broken mortise	-
697	6	24	31	No	4	Tan	>914 x 189 x 44	Sub-rectangular mortise	-

Table 28. Jointed oak timbers

10.3.17 If one follows Pryor's Five Row model for the post alignment, then the assumption is that the timber from Trenches 2, 3 and 4 originally either formed elements of ground level trackways

or elevated partitions sat atop the upright piles (Pryor 2001, Fig. 19.1, Fig. 19.2 and Fig. 19.3). The timber recovered from Trenches 5 and 6 may be part of Pryor's (2001) extensive timber platform or, given recent investigations which have called parts of this structure into doubt (Bamforth 2013; Brittain 2020a), perhaps other associated structures. It is suggested that the form, size and location of the timbers are analysed and compared against this model in an attempt to further understand our interpretation of the structures. With this in mind, it would be desirable to acquire radiocarbon dates for some of the horizontal timber, with a particular focus on the jointed items and the timbers from Trenches 5 and 6, should no dates be established by dendrochronological analysis.

Timber debris

10.3.18 There was a relatively large assemblage of timber debris consisting of 250 items, accounting for 25% of the total assemblage. A total of 134 items were recorded in detail with the remaining 116 subjected to rapid recording. All the timber debris was recovered from post alignment trenches, with the majority recorded from Trench 2, with occasional items from Trench 3 and 4 (Table 19).

10.3.19 The timber debris was, by nature of its categorisation, all converted (Table 26). There was a low incidence of tool faceting in this material, noted on only seven items. Some 120 items were identified as oak, much of which was slow grown and straight grained. It is suggested that the 13 taxonomic identifications samples that were taken are all processed with the aim of being able to compare the taxonomic make-up of the timber debris assemblage with that of the timber and woodchip assemblages.

10.3.20 There were several clusters of timber debris where it was suggested during the recording process that they may in fact represent the remains of disintegrating uprights. A detailed analysis of the timber debris would help elucidate to what extent this assemblage is the remains of disintegrating uprights or trackway superstructure, the remnants of in situ woodworking or imported material to stabilise or raise the ground surface.

Roundwood

10.3.21 As is often the case with fully recorded prehistoric wood assemblages, roundwood is the largest category with 546 items accounting for 54.1% of the wood (Table 26). 30 roundwood items that formed vertical piles or stakes are considered separately above. Most of the horizontal roundwood was recovered from Trench 2 (480 items) with occasional examples from Trench 3 (15 records), Trench 4 (18 records) and Trench 5 (1 record) (Table 27). A total of 148 pieces of horizontal roundwood were recorded in detail with the reminder subjected to rapid recording.

10.3.22 The prevalence of working amongst the horizontal material is somewhat low with only 24 items with facetted, trimmed ends recorded. This may be an artefact of condition. As would be expected, the largest unconverted material was used for the upright piles of the post alignment (Bamforth 2010) (Table 29), whilst roundwood used as stakes was somewhat smaller, and a similar size to the horizontal roundwood with evidence of woodworking. The horizontal roundwood with no evidence of woodworking has the smallest mean diameter. It is possible that much of this material may originally have had trimmed ends, but that the tool facets have degraded away. As part of the analysis phase, it would be desirable to compare prevalence for evidence of working against condition and also to compare the prevalence of worked material against previous assemblages as a proxy measure of condition.

Orientation/ use/ working evidence	No items	Diameter range (mm)	Average diameter (mm)
Vertically driven roundwood piles	30	65–224	132.2
Vertically driven roundwood stakes	2	31–65	48
Horizontal roundwood (woodworking evidence present)	24	22–110	52.6
Horizontal roundwood (woodworking evidence absent)	490	11–94	34.7
Total	546	11–224	54.4

Table 29. Roundwood diameters

10.3.23 The vast majority of the small diameter roundwood recovered from both the post alignment and platform during previous excavations was formed of relatively straight, knot- and sidebranch-free material that might variously be described as ‘rods’ or ‘poles’, and that is distinctly different from more irregular ‘brushwood’. This material will have been deliberately selected as easier to transport and to use. Much of the material considered in the current assessment was of a similar nature to this, but there was also some more brushwood-like material, featuring frequent small sidebranches and crooked stems. Plotting the spatial distribution of the straighter more rod/pole-like material and the more brushwood-like material may help to elucidate function.

10.3.24 When considering the smaller diameter, horizontal, roundwood recorded from the platform, although much of it seems to have been imported to raise the ground surface, some had also been used as wattle (Taylor 2001; Bamforth 2010). Pryor’s (2001) multiphase, Five Row model of the post alignment suggests the use of wattle work as both cross alignment ‘partitions’ and linear features, often bounding the extents of the post alignment (Pryor 2001, Fig. 19.1, Fig. 19.2 and Fig. 19.3). A consideration of the size, form, species and distribution of the smaller diameter roundwood may help to elucidate function and provide evidence against which to test Pryor’s (2001) Five Row model.

10.3.25 Nine examples of horizontal roundwood were identified as oak and 92 taxonomic identification samples were taken. It is suggested that all these samples are processed and that ring counts and season of felling is recorded where appropriate, in an attempt to interrogate species selection and to consider possible traces of woodland management.

Roundwood debris

10.3.26 The five items classified as roundwood debris should be considered alongside, an in the same terms as, the roundwood assemblage and the three taxonomic identification samples taken should be processed.

Woodchips

10.3.27 The 60 woodchips recorded make up 5.9% of the assemblage (Table 26) and were predominantly recovered from Trench 2 (53) with occasional examples from Trench 3 (1) and Trench 4 (6) (Table 27). Full records were generated for all but seven examples from the lower spit of Trench 2. The assemblage includes both radially aligned and tangentially aligned woodchips alongside material derived from small diameter roundwood. There are no cross-grain woodchips.

10.3.28 Woodworking is a reductive technology and woodchips are a common by-product of the process, being detached by a single blow of an edged tool (generally an axe). Carrying out different tasks can produce different types of woodchips. Shaping the base of a large pile, such as those at Flag Fen, can produce in the region of 500–800 woodchips (Sands 1997, 50). If the pile is in the round, these will generally be tangentially aligned woodchips with perhaps a few cross-grained examples present. Shaping or hewing the face of a radially cleft timber would produce radially aligned woodchips. If woodchips are a primary deposit, they indicate woodworking in the immediate vicinity, as has been suggested for some of the material recovered from the Flag Fen platform (Bamforth 2010; Taylor 2001), and can be indicative of the type of tasks being carried out. However, at Flag Fen and elsewhere, woodchips and other material could have been imported to raise or stabilise the ground surface (Bamforth 2010; Gearey et al. 2011; Gearey et al. 2016).

10.3.29 The majority of the woodchip assemblage has been identified as oak (39), much of which is straight grained and relatively slow grown. Of the remainder, 13 have been sampled for taxonomic identification. It is suggested that the 13 identification samples are processed and the results are considered alongside the remainder of the worked wood assemblage and previous findings. This should be undertaken with the particular aim of describing the type of woodworking they may be derived from, the extent to which that correlates with the rest of the worked wood assemblage and, via this, whether the woodchips are likely to be primary waste from in situ woodworking or secondary material imported to stabilise the ground.

Unworked bark

10.3.30 The 12 pieces of bark recorded came from Trench 2 and represent 1.2% of the assemblage. They do not show any traces of working. Full records of the bark were generated for all but 2 examples from the lower spit of Trench 2. It is not unusual to find low volumes of bark within a worked wood assemblage. The bark ranges from 7–24mm thick with all but one item 10mm thick or thicker, describing material that is likely to be derived from a mature tree of relatively large diameter. This bark may have become detached naturally, for example after peeling away from an in-the-round pile-upper, or perhaps could be the result of deliberate debarking (although this would often leave a trace in terms of tool facets on the edges of the bark, which was not observed) or, similar to the woodchip assemblage, already loose bark may have been imported to stabilise or raise the ground level. Bark cannot be readily identified to taxa and given the lack of woodworking evidence, no further detailed analysis is advised for this part of the assemblage.

Root

10.3.31 The three pieces of root were all encountered from Trench 2. It is suggested that a brief appraisal is carried out to check the distribution of the roots in relation to the tree stumps, with which they are probably associated.

Tree stumps

10.3.32 Trees have previously been found growing on the timber platform (Taylor 2001), but this is the first time that trees have been found growing within the bounds of the post alignment and it is of interest to understand whether these trees pre-date, post-date, or are contemporary with the alignment. The two trees were both recorded in contexts 2 and 3 within Trench 2. Both have been identified as oak. WD287 survived only as the buttress, the lowest, splayed section where the trunk was transitioning into the roots. The buttress area measured 560 x 500mm. WD676 was a tree that had fallen to the northeast and the base of the trunk was

present in the trench as well as the roots within an intact root bole with associated gravel natural upcast. A 625mm length was exposed within the bounds of the evaluation trench, with a maximum trunk diameter of 295mm recorded.

10.4 Condition of material

10.4.1 A key research goal of the recent excavations was to determine the preservation of the waterlogged wood and how this may have changed over time (Wiseman et al. 2021). Alongside data that have traditionally been used in the recording of some of the legacy Flag Fen assemblage, including height above Ordnance Datum (OD) , the condition scoring system designed by the Humber Wetland Project (Table 19) and other proxy indicators such as the presence of tool faceting, sapwood survival and vertical compression (Taylor 2001; Bamforth 2010; High et al. 2018; Bamforth 2020), a series of additional values relating to surface transformations including modern root damage, white mould and radial drying cracks were also recorded (Table 33).

10.4.2 When used alongside models of the preservation horizon for waterlogged wood (the height above which no wood survives) and the 'headroom' (the height distance between the survival of the top of the upright posts and the top of the horizontal wood), these data allow us to interrogate the condition of the waterlogged wood at the point of excavation and to consider possible change over time when compared to values recorded during previous investigations.

10.4.3 As well as a temporal dynamic, with Flag Fen becoming dewatered over time (Pryor 2001; Brittain 2010b; Brittain et al. 2020a,b), there is also a spatial dynamic common to most waterlogged assemblages with wood generally better preserved further down a sequence, in wetter deposits, than in the higher, drier reaches. At Flag Fen, this altitude dynamic is also affected by distance from the large mere (which was constructed with the intention of raising the water-table) and distance from dykes and drains, which cause a draw-down effect (Pryor 2001; Brittain 2010b; Brittain 2020a,b). Although this assessment report does not have the scope for a full analysis of the findings related to condition, some interesting observations are already apparent.

Condition scores

10.4.4 Some 892 items accounting for 88.3% of assemblage were scored for condition, consisting of all the fully recorded material alongside material subjected to rapid recording where the condition score was intrinsic to the wood group.

		FFB21		FF05 / V series	
Condition score		**Total**	***%***	**Total**	***%***
Excellent	**5**	6	*0.7*	-	-
Good	**4**	5	*0.6*	15	*12.4*
Moderate	**3**	70	*7.8*	101	*83.5*
Poor	**2**	526	*59.0*	5	*4.1*
Very poor	**1**	250	*28.0*	-	-
Non-viable	**0**	35	*3.9*	-	-
TOTAL		**892**	***100.0***	***121***	***100.0***

Table 30. FFB21 and FF05/V Series condition scores (Bamforth 2010, Fig. 4.20)

10.4.5 Although something of a blunt tool, if the condition scores for the assemblage are considered as a whole, it is somewhat alarming to see that only 1.2% of the assemblage was in good or

excellent condition and as such is assured to be suitable for detailed technological analysis, 7.8% was in moderate condition, which can be considered the boundary for detailed technological analysis and an alarming 90.9% falls below this boundary, scoring poor, very poor or non-viable (Table 30). In terms of a frame of reference, when compared to the 'V series' assemblage, which was recorded along the western extent of the post alignment in 2005, and which is broadly comparable with much of the current assemblage, we see a drop of at least a condition point over the 16 years between the investigations – from being at the boundary for full technological analysis, to below it. Although this is a subjective scoring system, it involved the same individual (M. Bamforth) working to the same criteria and conscious of the need for consistency.

10.4.6 The reason a condition score of 3 is considered the boundary for full technological analysis relates to the survival of tool facets and other surface traces that describe the reductive working of wood. Although other forms of evidence will still be recordable below this boundary, such as conversion, original diameter and species, it is the fine surface traces which have revealed so much about Bronze Age woodworking at Flag Fen. As such, the presence or absence of tool facets and stopmarks can be considered a proxy indicator of condition (Bamforth 2010; High et al. 2018).

10.4.7 Across the trenches, condition scores are broadly consistent, although wood condition Trench 4 was slightly better than Trenches 2 and 3. The single item recovered from Trench 6 stands out as being in good condition, a reflection of its greater depth (Table 31 and Table 34).

Condition score		TR2	TR3	TR4	TR5	TR6	Total	%
Excellent	5	2	2	2	-	-	6	*0.7*
Good	4	2	1	1	-	1	5	*0.6*
Moderate	3	32	6	32	0	-	70	*7.8*
Poor	2	444	52	27	3	-	526	*59.0*
Very poor	1	249	1	-	-	-	250	*28.0*
Non-viable	0	30	4	1	-	-	35	*3.9*
TOTAL		759	66	63	3	1	892	*100.0*

Table 31. Condition scores by trench

10.4.8 Looking deeper into the condition scoring data, it is interesting to note that the horizontal wood and the part excavated piles (where only the degraded tops were scored) have similar condition scores (Table 32; Figure 24). Fully excavated piles show better condition scores, as the lower points are generally deeper and therefore better preserved. Within this, there are already apparent trends, with alder piles generally being shallower and having lower condition scores than oak piles that were often driven deeper. There is broad scope for modelling the condition scores against height OD and orientation to better understand preservation and how it is contingent on these factors.

Proxy indicators of condition

10.4.9 Although condition scoring at Flag Fen is far from universal, particularly for the earliest A and B Series, there are a series of data points that have traditionally been recorded that can serve as proxy indicators of condition. These include the survival or degradation of oak sapwood, the presence of tool facets created by trimming and hewing, the presence of stopmarks, and the compression ratio for unconverted horizontal roundwood. The almost universal recording of these data points will allow a detailed consideration of condition over time and space but

require more effort to analyse when compared to the relative simplicity of a single condition score.

10.4.10 One proxy indicator that was particularly frequent and noteworthy is the prevalence of mechanical damage to the wood by intrusive roots (Table 33). This was particularly notable in Trenches 2 and 3 with invasive nettle roots penetrating to a depth of 1.9m, to the base of some of the uprights, and visibly causing pronounced mechanical damage. The roots not only followed the wood/matrix transition but were frequently noted to pass through both horizontal and vertical pieces of wood (Figure 33; Figure 25).

Condition score	Trench 2						Trench 3			Trench 4			Trench 5	Trench 6
	Horizontal [002 upper spit	Horizontal [002] lower spit	Horizontal [002] spit undifferentiated	Horizontal [002] all	Vertical part ex.	Vertical full ex.	Horizontal [015] all	Vertical part ex.	Vertical full ex.	Horizontal [035] all	Vertical part ex.	Vertical full ex.	Horizontal [049] all]	Horizontal [024] all
5	0	0	0	0	0	2 (20%)	0	0	2 (40%)	0	0	2 (66.7%)	0	0
4	0	0	0	0	0	2 (20%)	0	0	1 (20%)	0	0	1 (33.3%)	0	1 (100%)
3	15 (5.3%)	11 (5.3%)	0	26 (3.6%)	1 (5.3%)	5 (50%)	4 (10.8%)	1 (4.2%)	1 (20%)	14 (42.4%)	18 (66.7%)	0	0	0
2	216 (76.0%)	137 (65.9%)	78 (32.8%)	431 (59.0%)	12 (63.2%)	1 (10%)	28 (75.7%)	23 (85.8%)	1 (20%)	18 (54.6%)	9 (33.3%)	0	3 (100%)	0
1	42 (14.8%)	60 (28.8%)	141 (59.2%)	243 (33.3%)	6 (31.6%)	0	1 (2.7%)	0	0	0	0	0	0	0
0	11 (3.9%)	0	19 (8%)	30 (4.1%)	0	0	4 (10.8%)	0	0	1 (3.0%)	0	0	0	0
Total scored wood	284	206	238	730	19	10	37	24	5	33	27	3	3	1

Table 32. Condition scores of wood by orientation and trench. Percentages express frequency of wood with condition score as % of total scored wood for that context or orientation group. Fully excavated (full ex.) and part excavated (part ex.) piles are separated to demonstrate differentiation in condition scores of between material which survives close to the preservation horizon and material which extends towards the lower contexts.

	Trench 2		Trench 3		Trench 4		Trench 5		Trench 6		All trenches	
	Qty	% of trench assemblage	Qty	% of trench assemblage	Qty	% of trench assemblage	Qty	% of trench assemblage	Qty	% of trench assemblage	Qty	% of total assemblage
Ancient rot (pre-depositional decay)	16	4.5	1	1.5	1	1.6	1	33.3	1	100	20	4.1
Surface decay/loss of surface detail	338	95.8	64	98.5	62	100	3	100	0	0	467	96.5
Compression/distortion	312	88.4	62	95.4	60	96.8	3	100	0	0	437	90.3
Radial cracking	231	65.4	55	84.6	35	56.5	2	66.7	0	0	323	66.7
Desiccation	34	9.6	2	3.1	0	0	0	0	0	0	36	7.4
White mould	152	43.1	61	93.8	31	50	0	0	0	0	244	50.4
Iron oxide salt deposition	331	93.8	65	100	39	62.9	0	0	0	0	435	89.9
Modern root damage	254	72.0	65	100	0	0	3	100	0	0	322	66.5
Trench assemblage	*353*		*65*		*62*		*3*		*1*		*484*	

Table 33. Incidence of transformations of surface preservation.

Height OD

10.4.11 Height above OD has been almost universally recorded for wood excavated at Flag Fen and is both of use in its own right and can also be used in conjunction with condition scores to adjust for the effect that height can have on preservation. During recent investigations into the preservation of the wood assemblage over time, the value ascribed to 'headroom' has also been a useful metric. Headroom describes the distance between the degraded tops of uprights which indicates the preservation horizon for waterlogged wood and the top of the horizontal wood. Towards the western extent of the post alignment, at the Power Station site, this value is zero, suggesting that the upper levels of horizontal wood have degraded away where they pass though the preservation horizon.

10.4.12 Considering the three trenches of the current evaluation for which headroom can be calculated, Trench 4, to the east of the platform, has a headroom value markedly similar to that recorded in previous interventions in the vicinity (Table 34; Figure 26). The two trenches excavated in the western extent of the post alignment actually have slightly more 'headroom' than previous interventions in the vicinity (Table 34; Figure 26).

Trench	Highest upright (m OD)	Highest horizontal (m OD)	Maximum headroom (m)
Trench 2	1.201	0.900	0.301
Trench 3	0.802	0.483	0.319
Trench 4	0.952	0.499	0.453
Trench 5	-	0.220	-
Trench 6	-	-0.450	-

Table 34. Maximum heights and headroom by trench

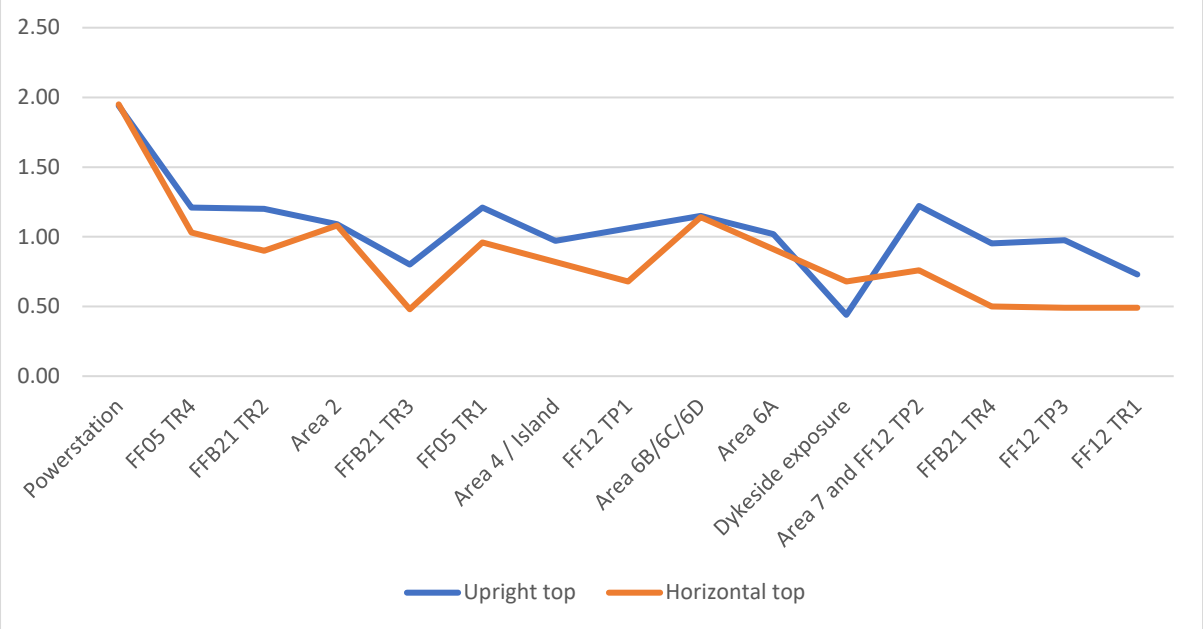

Figure 26: Height m OD of uprights and horizontal wood for selected interventions, west to east. Where data is not available, a mean of the adjacent values has been used.

Dendrochronology

10.4.13 A condition score of 2 is associated with the beginnings of difficulties in completing dendrochronological analysis (Table 19) as, in addition to the loss of surface data, the internal structure of the wood starts to break down. Previous phases of work at Flag Fen have produced many samples for dendrochronological dating which have been successfully processed and dated (Tyers 1999; Neve with Groves 2001). Although it has been possible to carry out dendrochronological analysis on the material from the current assemblage, which contained a high percentage of wood graded as condition score 2, this is becoming a borderline case as the wood is "very soft, almost like a sponge, and very difficult to get surfaces onto" (Appendix 1B). As material degrades further, loss of sapwood will also affect the possibility of securing estimated felling dates for sequences that do cross-match. This may preclude the construction of a fine gained chronology of the site's construction.

Trenches 2 and 3 – western post alignment

10.4.14 Targeted over the western extent of the post alignment, in close proximity to several previous investigations, the majority of wood from both Trenches 2 and 3 scored a 2/poor for condition (Table 31). Although we can see that there is slightly more headroom in these two trenches than those located to either side (Figure 26), the condition scores have moved from 3/moderate to 4/good in 2005 to 2/poor in the current campaign. This describes a drop in condition from at or above the boundary for full technological analysis to below it, with the loss of much of the surface detail (Table 35). There are several other trenches in this area against which it would be useful to consider the newly acquired preservation information.

Condition score		FF05/TR4	TR2	FF05/TR2	TR3	FF05/TR1
Excellent	5	0.0	0.3	0.0	3.0	0.0
Good	4	7.9	0.3	100.0	1.5	19.0
Moderate	3	89.5	4.2	0.0	9.1	78.6
Poor	2	2.6	58.5	0.0	78.8	2.4
Very poor	1	0.0	32.8	0.0	1.5	0.0
Non-viable	0	0.0	4.0	0.0	6.1	0.0
N=		38	759	2	66	42

***Table 35**. Condition score percentages for the FF05 and FFB21 trenches along the western extent of the post alignment*

Trench 4 – eastern post alignment

10.4.15 Trench 4 scores slightly better for condition than the trenches excavated over the western extent of the post alignment, with the majority of the material scoring a 3/moderate (Table 31). A previously unknown soakaway from the roof of the Preservation Hall may have contributed to the material in this trench being in somewhat better condition than might otherwise have been expected (Figure 16). In terms of the preservation horizon and the headroom, this trench seems broadly in keeping with other trenches in the vicinity (Figure 24).

10.4.16 To the east of Trench 4, previous analysis of the wood condition recorded in a pair of adjacent trenches excavated at the eastern landfall of the post alignment in 2012 (FF12, Trench 1) and 2003 (Northey Landfall Project FF03, Trench 2) showed that a drop in condition from 3/moderate to 2/poor coincided with a drop in the survival of both tool facets and sapwood (Bamforth 2013, 27; Bamforth 2020).

10.4.17 Moving west we can consider another set of interventions near to Trench 4, between the eastern Northey landfall and the Preservation Hall. Although there are no detailed records for Time Team Trench 1 excavated in 1999, a consideration against the records for FF12 Test Pit 3 suggests a decrease in both the preservation horizon and the survival of tool facets in this area over this time frame (Bamforth 2013, 27; Bamforth 2020). Comparing the condition scores between FF12 Test Pit 3 and Trench 4 we can see that there is a slight difference in condition between the two recorded assemblages, with a higher proportion of the latter being in poor condition (Table 36).

		Trench 4		FF12 TP3	
Condition score		Total	%	Total	%
Excellent	5	2	3.2	0	0.0
Good	4	1	1.6	3	4.5
Moderate	3	32	50.8	38	56.7
Poor	2	27	42.9	25	37.3
Very poor	1		0.0	1	1.5
Non-viable	0	1	1.6	0	0.0
TOTAL		63	100.0	67	100.0

Table 36. *FFB21 Trench 4 and FF12 Test Pit 3 comparative condition scores (Bamforth 2013)*

10.4.18 As the wood was never lifted, detailed records were not generated for Area 8 (the Preservation Hall), which lies to the west of Trench 4, and there is no discussion of the condition of the wood exposed in the publication beyond a brief mention that 'the less well preserved wood fragments were removed" (Pryor 2001, 88).

Trench 5 – north of platform

10.4.19 Three pieces of wood were scored for condition in this trench, all of which were assigned a 2/poor. There is little legacy wood preservation data to compare this against. The limited wood recorded to the west in Area 3, interpreted by Pryor as being the northern extent of the timber platform, was not lifted or recorded in detail (Pryor 2001, 85–6). Dig Ventures FF12 Test Pit 1 to the east did not encounter any worked wood, although a layer of possible roots interpreted as alder carr was encountered between 0.7–0.6 m OD (Bamforth 2013), somewhat higher than the material encountered in Trench 4 at 0.22m OD (Table 34).

Trench 6 – south of platform

10.4.20 The single piece of horizontal wood scored for condition from this trench was assigned a 4/good (Table 23). This is a notably higher condition score than that of the horizontal wood in the other trenches. The condition of this material is a reflection of its depth, which was between 0.7m and 1.4m deeper than the horizontal wood in the other trenches (Table 34), as well as its proximity to the large mere. There are no other nearby trenches against which to compare this Trench.

10.5 Statement of potential

10.5.1 Although the main aim of the current project is to assess the condition of the archaeological remains, the wood assemblage from this evaluation should also be considered in terms of its own archaeological merit, as it is a large quantity of worked wood derived from a Scheduled Ancient Monument (SAM) and represents part of a nationally significant assemblage of

Bronze Age worked wood. There is an opportunity not only to better understand the preservation of the archaeological remains, how that may be changing over time and how such changes may affect future analysis, but also to further our understanding of the monument itself, particularly in terms of the paucity of dating of non-oak material. The importance of taking the opportunity to analyse the material from this evaluation, is underlined by the assessment of this material's condition, which indicates ongoing deterioration of the wood which may compromise future analysis of the monument.

Preservation analysis

10.5.2 A wealth of fine grained preservation and condition data has been collected from the current campaign, the basic findings of which have been considered above. This seems to show a drop in condition over time for many of the wooden remains not protected by the large mere, particularly those at the western extent of the post alignment. A fine grained analysis of this new data, the relationships between condition, height OD, distance from the large mere and the survival of fine grained woodworking evidence, when considered alongside the results of the condition analysis carried out by YAT, may show us which areas of the monument are most at risk. Furthermore, a comparison of these findings against legacy data will help to model the potential drop in condition that has taken place over time.

Woodworking evidence

10.5.3 The 1010 wood records represent a large assemblage of prehistoric wood, derived from a SAM, some 46.3% of which displays evidence of working. Although much of the fine grained woodworking data has been lost, a large volume of basic data has been recorded. In terms of the horizontal timber, particularly the jointed material, there is some scope to consider the possible original function of items within the post alignment, platform or other structures. Alongside morphology and taxa, the woodworking evidence has some capacity to determine whether woodchips and timber debris are likely to have been generated by in situ woodworking, imported to raise or stabilise the ground or, in the case of some of the timber debris, derived from disintegrating upright piles or trackway horizontals. Woodworking will be considered alongside species and morphology in an attempt to identify and interrogate possible pile groupings that may describe discrete phases of cross-row activity within the alignment.

Selection of raw materials, woodland reconstruction and woodland management study

10.5.4 An interrogation of the horizontal roundwood assemblage in term of poles and rods versus brushwood may help to understand how smaller diameter material was selected and used within the post alignment and perhaps identify areas of collapsed wattle. Utilising the species identification, ring counts and season of felling studies, some limited inference regards woodland management may also be possible.

10.5.5 In terms of larger roundwood and timber, it has been hypothesised that non-oak material may have been used more in the earlier phases of the construction at the alignment and platform (Taylor 2001). Species identification analysis alongside radiocarbon dating would allow this theory to be investigated.

10.5.6 Furthermore, the results of species identification, alongside the morphology of the timber and the results of the growth ring studies associated with dendrochronological analysis may help to inform about the type of woodland being exploited.

Scientific dating

10.5.7 Samples of all 66 oak items with more than 30 growth rings have been submitted to Ian Tyers as part of a separate dendrochronological analysis programme (Table 12). In addition to that programme, the wood assemblage has good potential to provide samples for radiocarbon dating to target specific question not answered by the results of dendrochronological analysis. These are likely to be focused on non-oak piles, undated oak piles and horizontal timbers, and undated in situ trees, with the aim of building a more nuanced chronological understanding of the features, through which Pryor's models of post alignment construction and the extent and nature of the timber platform, can be re-assessed. An enhanced chronology for the construction and maintenance of the features at Flag Fen will also allow improved modelling of the relationship between episodes of activity on the alignment/platform and changes in the local and regional environment and will permit more accurate consideration of the temporal relationship between the activity at Flag Fen and other later Bronze Age trackways of the southern Flag Fen basin at Must Farm and Horsey Bridge (Knight et al. 2019; Knight 2022).

10.5.8 The precise targets of radiocarbon dating should only be selected after dendrochronological analysis, pile group identification and woodworking analysis have taken place.

10.6 Archive

10.6.1 Although several jointed items were excavated that would normally have been candidates for conservation (Brunning & Watson 2010), their relatively poor condition and fragmentary nature meant that they were not in a state suitable for this process and they were instead drawn in situ and included in the photogrammetric model of the trench. The remaining material encountered was not considered to be of suitable condition or archaeological interest to warrant conservation. It is suggested that the suite of samples that have been recovered are retained until the end of the analysis phase and then discarded.

10.6.2 The archive, at the completion of this assessment, is summarised in Table 37.

	Archive type	Quantity	Notes
Wood samples	Physical	246	To be discarded after completion of analysis
Wood register/ wood recording sheets	Physical	150	-
Wood drawings	Physical	5 sheets permatrace	Digitised versions to be produced during analysis stage
Wood assessment report, catalogue and data tables	Digital	1 .docx 2 .xslx	Additional files to be generated during analysis
Wood photographs	Digital	95 (.tif) (plus duplicates in .raw)	-

Table 37. FFB21 wood archive

11. APPENDIX 1B: TREE-RING ANALYSIS OF OAK TIMBERS

Ian Tyers

11.1 Summary

11.1.1 Dendrochronological analysis of oak timbers excavated at Flag Fen, near Peterborough, Cambridgeshire was undertaken. The dated timbers were from the late Bronze Age and replicate tree-ring chronologies originally constructed in the 1990's. This report archives the newest dendrochronological results, and integrates them with previous studies on this important site

11.2 Introduction

11.2.1 This document is a technical archive report on the tree-ring analysis of oak timbers from Flag Fen, Cambridgeshire excavated in 2021. Elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the material.

11.2.2 Flag Fen lies c 3 km east of Peterborough in Cambridgeshire (Figure 1). The internationally-significant site at Flag Fen is a Bronze Age monument, consisting of a kilometre-long post alignment constructed from five rows of posts, along with a timber platform, located towards its eastern end. First identified in 1982 by Francis Pryor (Pryor 2001), there have been a number of subsequent excavations across the site. A full Gazetteer of the interventions is provided in Brittain et al (2020; Fig. 7)..

11.2.3 Timbers from Flag Fen, and Fengate at its western end, were subject to an extensive programme of dendrochronological analyses during the late 1980's up to 1994, culminating in the publication in 1999 of results for c. 250 dated timbers identified from the analysis of c. 690 timbers (Neve 1999; 1992; 2001). A single composite sequence, called, FFB_T225, which was dated 1406 to 937 BC was produced from these studies. This chronology was amongst the first Bronze Age tree-ring data sets produced from English excavations, and formed a core block within the prehistoric tree-ring chronology. The Flag Fen sequence has been used subsequently to date a number of Bronze Age timber features from the nearby area, particularly the Must Farm and Horsey Bridge sites. Timbers from contemporary features further afield also cross-match well with these datasets; including sites from Essex, Kent, Nottinghamshire and Somerset.

11.2.4 The analysed timbers for the 1999 report were the most suitable candidates from amongst a much larger total number of excavated or exposed timbers. For example the westernmost end, Fengate, comprised 154 dated samples from 350 analysed, selected from c. 1500 exposed timbers.

11.2.5 The chronology published in 1999 covered the period 1406-937 BC. The material was worked on at Flag Fen by Janet Neve and the analysis and dating of this material was undertaken in collaboration with dendrochronologists from Sheffield University, Queens University Belfast and the Museum of London. Sapwood survival was poor, and bark-edge survival was extremely rare with only ten examples. The dated assemblage indicated a long period of activity throughout the alignment and platform from the thirteenth century BC through to mid tenth century BC.

11.2.6 The only additional tree-ring samples analysed from Flag Fen between the 1999 report and the present report comprised a small number of samples from a 'Time Team' excavation, located in Gazetteer Area 34, which yielded a single datable timber (Tyers 1999).

11.2.7 The nearby excavations at Must Farm, and Horsey Bridge have both yielded 2 composite tree-ring sequences that are broadly contemporary with the beginning and end sections of the Flag Fen 1999 datasets. Using this newer material to re-assess the older Flag Fen material has slightly changed the chronologies used here compared to the published version, several tenth century BC timbers have been identified and a mistake was identified in the first 2 decades of the original sequence where it was reliant on a single timber. The 2022 version of this dataset as used here is two separate long replicated tree-ring chronologies. One of these, called FF91, is combined from 103 timbers, representing 91 trees excavated from Gazetteer Areas 2, 4, 6, and 13 and dates from 1390-955 BC inclusive, whilst the other is called FG139, and is combined from 157 timbers representing 139 trees excavated from Gazetteer Area 16, the Fengate Power Station, which marks the currently known western extent of the alignment. This sequence dates from 1364-918 BC inclusive. There has been no change to the date of the chronology since 1999, but there has been an amendment at the beginning and some additions at the end.

11.2.8 The new FFB21 excavations in 2021 comprised a series of 3 transects across the alignment, Tr. 2, Tr. 3 and Tr. 4, and two investigations into the extent of the platform, Tr. 5 and Tr. 6, their locations are illustrated in Figure 2 and Figure 3, Tr. 1 was abandoned due to the presence of a gas pipeline. This material was excavated as part of a project titled "Flag Fen: Investigating the survival and preservation of the archaeological remains to inform a management strategy". Flag Fen is an internationally-significant post-alignment which is now degrading in situ. Historic England wishes to address this risk, and remove the site from the Heritage at Risk register. Excavations were undertaken to enable scientific analysis of preserved remains in order to provide objective information on the survival and state of preservation of parts of the site and the extent of the platform.

11.2.9 At this stage none of the material from the site extends into the ninth century BC. As a result we cannot currently identify a tree-ring date for the pile dwelling at Must Farm, dated c 860–835cal BC (68% probability) by radiocarbon wiggle-matching of the tree-ring sequences (Marshall et al in prep). The radiocarbon evidence suggests the inner end of the short-lived trees used for the pile dwelling at Must Farm must be tantalisingly close to overlapping the latest absolutely dated material from Flag Fen, Horsey Bridge and Must Farm.

11.3 Methodology

11.3.1 The timbers were sampled by the removal of cross-sectional slices by handsaw at locations that provided a combination of the maximum numbers of rings, and/or retained likely original outer surfaces. Each sample was subsequently placed in a deep-freeze for at least 48 hours in order to consolidate the timber. A surface equivalent to the original horizontal plane of the parent tree was then prepared with a variety of bladed tools. This preparation revealed the width of each successive annual tree ring. Each prepared sample could then be accurately assessed for the number of rings it contained, and at this stage it was also possible to determine whether the sequence of ring widths within it could be reliably resolved.

11.3.2 Tree-ring dating employs the patterns of tree-growth to determine the calendar dates for the period during which the sampled trees were alive. The amount of wood laid down in any one year by most trees is determined by the climate and other environmental factors. Trees over

relatively wide geographical areas can exhibit similar patterns of growth, and this enables dendrochronologists to assign dates to some samples by matching the growth pattern with other ring-sequences that have already been linked together to form reference chronologies.

11.3.3 Timbers intended for dendrochronological analysis need to be free of aberrant anatomical features such as those caused by physical damage to the tree, which may prevent or significantly reduce the chances of successful dating.

11.3.4 Standard dendrochronological analysis methods (see eg English Heritage 1998) were applied to each suitable sample from the site. Complete or partial sequences of the annual growth rings were measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The sequences of ring widths were then plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition, cross-correlation algorithms (eg Baillie and Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated. Highly correlated positions were checked using the graphs and, if any of these were satisfactory, new composite sequences were constructed from the synchronised sequences. Any t-values reported below were derived from the original CROS algorithm (Baillie & Pilcher 1973). A t-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high t-values at the same relative or absolute position need to have been obtained from a range of independent sequences, and that these positions were supported by satisfactory visual matching.

11.3.5 Not every tree can be correlated by the statistical tools or the visual examination of the graphs. There are thought to be a number of reasons for this: genetic variations; site-specific issues (for example a tree growing in a stream bed will be less responsive to rainfall); or some traumatic experience in the tree's lifetime, such as injury by pollarding, defoliation events by caterpillars, or similar. These could each produce a sequence dominated by a non-climatic signal. Experimental work with modern trees shows that 5–20% of all oak trees, even when enough rings are obtained, cannot be reliably cross-matched.

11.3.6 Converting the date obtained for a tree-ring sequence into a useful date requires a record of the nature of the outermost rings of the sample. If bark or bark-edge survives, a felling date precise to the year or season can be obtained. If no sapwood survives, the date obtained from the sample gives a terminus post quem for its use. If some sapwood survives, an estimate for the number of missing rings can be applied to the end-date of the heartwood. This estimate is quite broad and varies by region. This report uses a range of 10-46 rings for the local English material from Flag Fen (English Heritage 1998, p 11, Arnold et al 2019, Fig 9). The BC scale used by dendrochronologists, and as used in this report, has no year zero, the year 1 BC immediately precedes the year AD 1.

WD	TR	Cross-section	Rings	Sap	AGR	Date of measured seq.	Interpreted result
13	TR2	85 x 30mm	83	-	0.94mm	1120-1038 BC	after 1028 BC
15	TR2	140 x 25mm	58	-	2.39mm	1072-1015 BC	after 1005 BC
25	TR2	135 x 60mm	52	-	1.64mm	-	-
41	TR2	75 x 15mm	50	-	1.11mm	-	-
45	TR2	65 x 65mm	76	-	0.71mm	-	-
46	TR2	55 x 5mm	59	-	0.88mm	1125-1067 BC	after 1057 BC
59	TR2	85 x 15mm	51	-	1.66mm	1102-1052 BC	after 1042 BC
67	TR2	40 x 10mm	47	-	0.64mm	-	-
76	TR2	145 x 140mm	53	-	2.85mm	1109-1057 BC	after 1047 BC

WD	TR	Cross-section	Rings	Sap	AGR	Date of measured seq.	Interpreted result
79	TR2	160 x 25mm	128	-	1.24mm	1279-1152 BC	after 1142 BC
81	TR2	90 x 20mm	110	4	0.71mm	1142-1033 BC	1027-991 BC
92	TR2	180 x 105mm	23	H/S	3.89mm	-	-
93	TR2	180 x 160mm	36	12	2.33mm	-	-
106	TR2	105 x 50mm	52	-	1.88mm	1095-1044 BC	after 1034 BC
113	TR2	185 x 105mm	113	?H/S	0.91mm	1131-1019 BC	1009-973 BC?
145	TR2	160 x 110mm	52	-	3.10mm	1099-1048 BC	after 1038 BC
216	TR2	75 x 60mm	33	-	1.75mm	970-938 BC	after 928 BC
272	TR2	55 x 30mm	44	-	1.08mm	1050-1007 BC	after 997 BC
297	TR2	110 x 80mm	72	-	1.32mm	1336-1265 BC	after 1255 BC
299	TR2	110 x 45mm	30	?H/S	1.50mm	-	-
325	TR3	155 x 150mm	59	-	1.99mm	1137-1079 BC	after 1069 BC
326	TR3	95 x 65mm	50	-	1.10mm	-	-
327	TR3	150 x 120mm	58	-	2.04mm	1071-1014 BC	after 1004 BC
330	TR3	125 x 115mm	122	?H/S	1.00mm	1161-1040 BC	1030-994 BC?
331	TR3	110 x 70mm	65	-	0.87mm	-	-
333	TR3	110 x 90mm	24	5	4.65mm	-	-
334	TR3	110 x 75mm	63	-	1.61mm	1180-1118 BC	after 1108 BC
337	TR3	185 x 145mm	40	11+Bw	3.16mm	1070-1031 BC	1031 BC winter
340	TR3	55 x 55mm	44	-	1.23mm	-	-
341	TR3	145 x 120mm	64	?H/S	1.99mm	-	-
342	TR3	150 x 140mm	166	-	0.90mm	1326-1161 BC	after 1151 BC
343	TR3	165 x 110mm	85	-	1.95mm	1094-1010 BC	after 1000 BC
346	TR3	120 x 120mm	32	3	1.70mm	-	-
348	TR3	40 x 40mm	52	-	0.76mm	1132-1081 BC	after 1071 BC
359	TR3	170 x 40mm	192	-	0.84mm	1235-1044 BC	after 1034 BC
363	TR3	60 x 50mm	31	-	1.66mm	-	-
375	TR3	120 x 45mm	163	-	0.69mm	1288-1126 BC	after 1116 BC
381	TR4	215 x 40mm	54	-	2.07mm	1124-1071 BC	after 1061 BC
382	TR3	165 x 50mm	83	-	1.88mm	1162-1080 BC	after 1070 BC
384	TR4	210 x 60mm	46	-	2.01mm	1156-1111 BC	after 1101 BC
387	TR4	80 x 70mm	43	-	1.88mm	1147-1105 BC	after 1095 BC
390	TR4	190 x 85mm	81	3	2.22mm	1157-1077 BC	1070-34 BC
393	TR4	150 x 140mm	58	?H/S	1.23mm	-	-
394	TR4	235 x 190mm	56	-	2.08mm	-	-
395	TR4	135 x 65mm	38	-	1.72mm	-	-
397	TR4	130 x 125mm	35	-	1.43mm	1198-1164 BC	after 1154 BC
399	TR4	200 x 110mm	67	?H/S	1.56mm	-	-
400	TR4	215 x 115mm	77	?H/S	1.43mm	-	-
402	TR4	175 x 165mm	60	13+Bw	2.01mm	-	-
404	TR4	160 x 150mm	86	-	1.67mm	1187-1102 BC	after 1092 BC
406	TR4	125 x 125mm	23	?H/S	2.38mm	-	-
408	TR4	125 x 45mm	34	-	3.26mm	-	-
411	TR4	150 x 95mm	110	-	1.33mm	1114-1005 BC	after 995 BC
412	TR4	145 x 75mm	114	-	1.17mm	1116-1003 BC	after 993 BC
416	TR4	50 x 20mm	43	-	1.35mm	1148-1106 BC	after 1096 BC
441	TR4	70 x 45mm	36	-	1.22mm	1025-990 BC	after 980 BC

WD	TR	Cross-section	Rings	Sap	AGR	Date of measured seq.	Interpreted result
453	TR4	140 x 60mm	85	?H/S	1.51mm	1144-1060 BC	1050-14 BC?
455	TR3	85 x 60mm	36	-	2.13mm	-	-
456	TR3	70 x 10mm	33	-	1.91mm	1158-1126 BC	after 1116 BC
458	TR3	80 x 50mm	70	-	1.09mm	1104-1035 BC	after 1025 BC
459	TR3	100 x 50mm	66	-	1.37mm	1117-1052 BC	after 1042 BC
604	TR2	130 x 50mm	106	-	0.51mm	-	-
676	TR2	240 x 200mm	99	-	1.98mm	-	-
690	TR4	240 x 130mm	42	10+?B	3.46mm	-	-
694	TR2	155 x 140mm	54	-	1.71mm	1166-1113 BC	after 1103 BC
697	TR6	190 x 50mm	92	-	1.91mm	1108-1017 BC	after 1007 BC

Table 38: *Details of the analysed Quercus sp. (oak) dendrochronological samples from Flag Fen, site code FFB21.*

11.4 Results

11.4.1 Samples from 66 excavated timbers were supplied for dendrochronological analysis (Table 38). These timbers were assessed to contain 30 or more rings. All the selected dendrochronological samples were oak (Quercus spp.). The three alignment transects provided very similar numbers of samples; 23 samples from Tr. 2, 23 samples from Tr. 3, and 19 samples from Tr. 4. The platform area provided only one sample, no samples were selected from Tr. 5, and only one sample from Tr. 6. All the submitted material was analysed. Sapwood was exceedingly rare with only six samples retaining measurable sapwood rings, and only one of these was complete to bark-edge. A further six samples were probably complete to the heartwood/sapwood transition. Some of the material was long lived, with the two longest sequences containing 192 years and 166 years, at the other end of the scale two of the samples contained less than 30 rings. The material was quite de-lignified, with some of the samples resembling sponges.

11.4.2 The sequences were compared with each other and with the other Flag Fen Basin composite and individual datasets. Three pairings were identified that comprise same-tree pairs (Figures 28-30) all from Tr. 3. These were combined for Table 40. Another strongly matched pair was identified between one of these samples and a sample from the 1990's analyses (Figure 7), Three further pairings were identified that also may be same-tree pairs (Figures 8-10), but which are treated separately in Tables 39-41. In total 40 of the new sequences were directly cross-matched to each other (Figure 27, Tables 39-45), and/or directly matched to the various Flag Fen composite series (Tables 39-45, Figure 27). The FFB21 composite data comprises 39 samples covering the period 1336-990 BC (this sequence is called FFB21_T39) with a single later outlier of 970-938 BC (Sample 216, Table 42). The site therefore provides a similar sequence to the earlier series though with less samples it perhaps unsurprisingly starts later and ends earlier. It does provide a further useful replicate sequence for dating other contemporaneous material across the Basin area (Figure 35, Table 45).

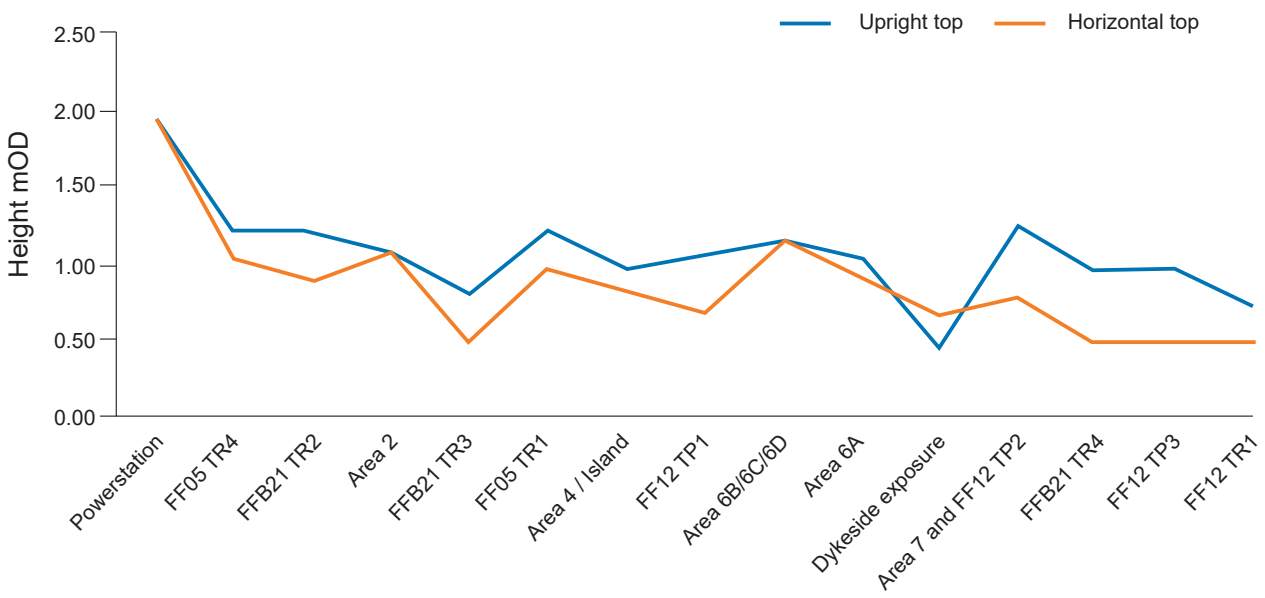

Figure 26. Height (m OD) of uprights and horizontal wood for selected interventions west to east.

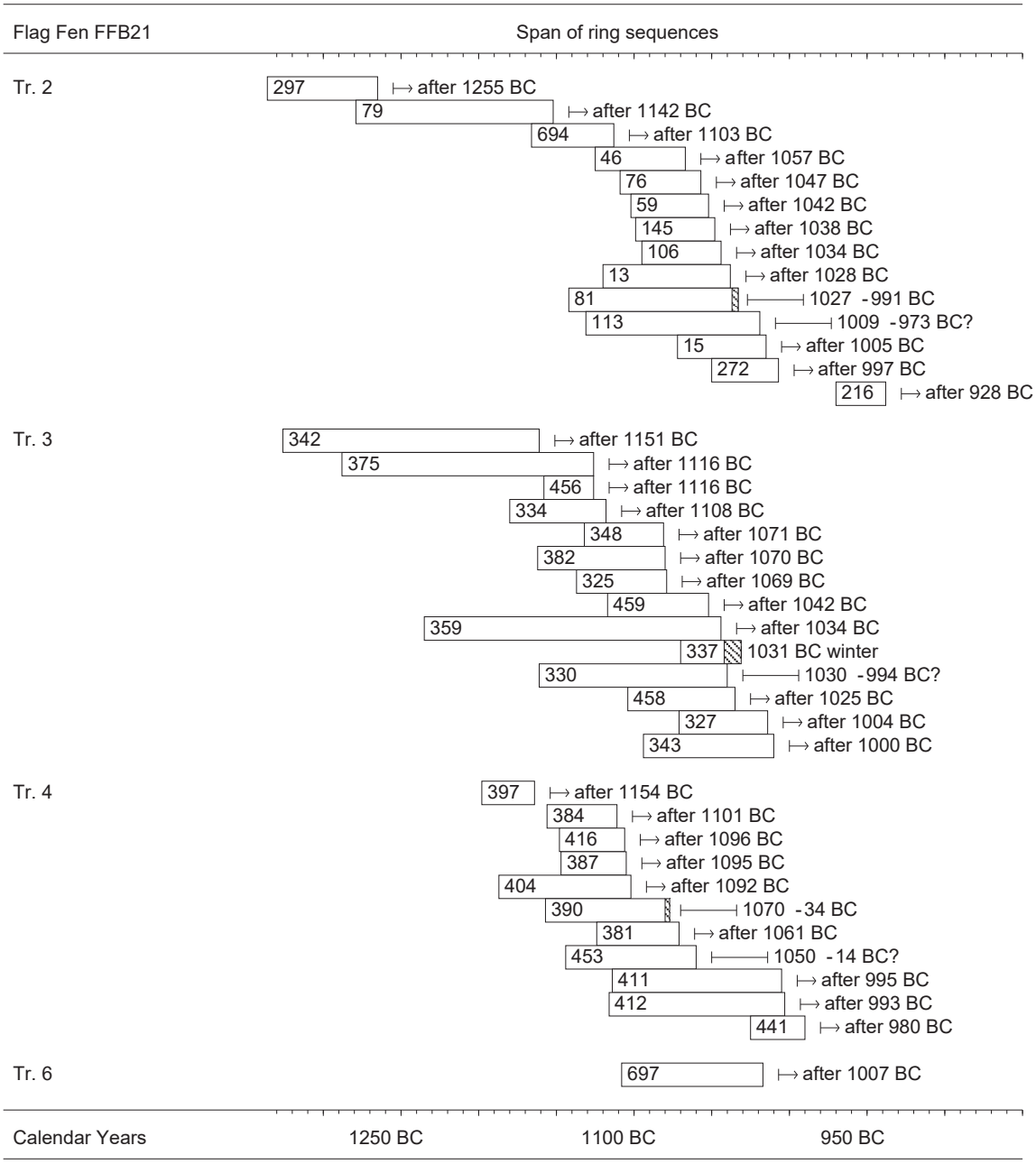

Figure 27. Bar diagram showing the absolute dating positions of the dated tree-ring sequences obtained from Flag Fen FFB21. The interpreted terminus post quem date, felling date range, or felling date is also shown for each sample.

KEY. White bars are oak heartwood, hatched bars are oak sapwood.

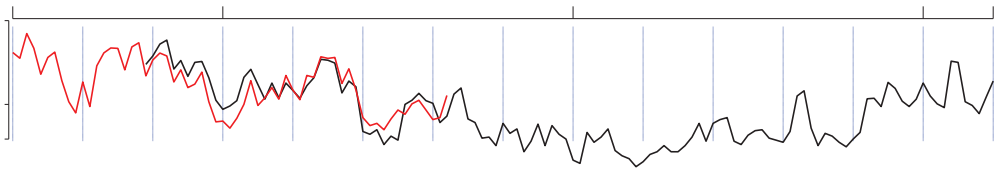

Figure 28. Diagram showing the tree-ring sequences from FFB21 Tr. 3 330 (black) and FFB21 TR. 3 334 (red), t-value 7.14. These appear likely to be from a single tree. These are combined as 330+334 in Table 40.

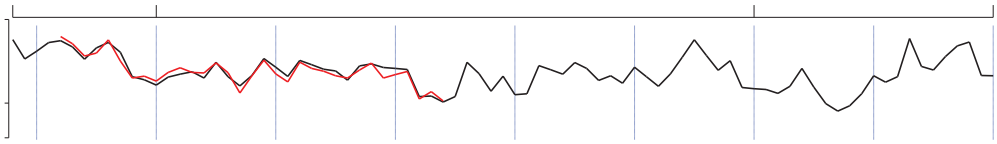

Figure 29. Diagram showing the tree-ring sequences from FFB21 Tr. 3 382 (black) and FFB21 Tr. 3 456 (red), t-value 13.38. These appear likely to be from a single tree. These are combined as 382+456 in Table 40.

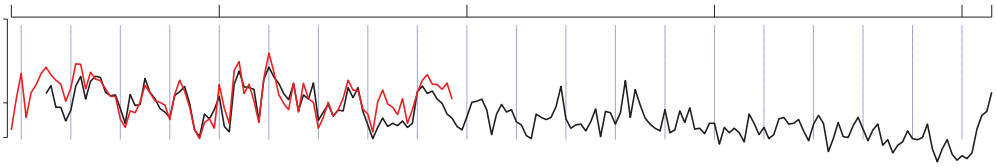

Figure 30. Diagram showing the tree-ring sequences from FFB21 Tr. 3 359 (black) and A3182 (red) from Area 6A of Flag Fen (Neve 1999), t-value 15.21. These appear likely to be from a single tree.

a)	13	15	46	59	76	79	81	106	113	145	272	297	694
13		-	3.75	-	-	\	5.00	-	-	3.55	\	\	\
15			\	-	-	\	3.44	-	-	-	-	\	\
46				-	-	\	9.34	-	4.01	-	\	\	\
59					3.17	\	3.15	-	4.40	4.09	\	\	\
76						\	3.71	-	-	7.70	\	\	\
79							\	\	\	\	\	-	-
81								3.42	4.90	3.15	-	\	-
106									-	-	\	\	\
113										-	3.10	\	-
145											\	\	\
272												\	\
297													\
b)													
Tr.3	5.97	-	4.41	7.63	3.85	7.16	7.70	7.77	7.84	5.46	4.92	3.27	3.11
Tr.4	4.91	4.33	3.57	3.47	4.37	-	6.85	5.38	4.83	3.61	6.46	\	5.74
FF	6.08	4.48	4.32	6.26	4.99	10.49	8.63	6.04	6.77	7.05	5.63	7.70	5.02
FG	6.51	5.52	3.98	6.29	5.04	9.14	8.78	7.49	6.39	6.83	6.17	9.06	4.80

Table 39: *Showing t-values (Baillie and Pilcher 1973) between a) the FFB21 Flag Fen Tr. 2 sequences, and b) their t-values to the FFB21 Tr. 3 and Tr. 4 composites, and the Flag Fen Areas 2, 4, 6 and 13, and Flag Fen Area 16 composites. – t-values less than 3.0, \ overlap less than 15 years. Tr. 3 is the FFB21 Tr. 3 T14 composite 1326-1010BC, Tr. 4 is the FFB21 Tr. 4 T11 composite 1198-990BC, FF91 is the Flag Fen Areas 2 4 6 & 13 composite (Neve 1999, T91/S103 2022 version) 1390-955 BC, and FG139 is the Flag Fen Area 16 Fengate composite (Neve 1999, T139/S157 2022 version) 1364-918 BC.*

a)	325	327+343	330+334	337	342	348	359	375	382+456	458	459
325		-	-	\	\	3.05	-	\	-	-	4.35
327+343			-	-	\	\	-	\	4.21	-	-
330+334				-	-	-	3.25	-	-	-	-
337					\	\	-	\	\	-	-
342						\	3.12	5.24	\	\	\
348							-	\	4.96	-	-
359								3.07	-	-	-
375									-	\	\
382+456										-	3.13
458											-
b)											
Tr. 2	4.62	6.05	5.12	4.52	6.14	4.67	5.81	-	3.40	4.35	3.79
Tr. 4	3.98	6.82	5.30	3.84	4.61	4.70	4.93	-	5.04	4.27	-
FF91	5.45	8.24	5.87	5.08	8.48	4.91	9.55*	6.70	8.41	6.14	3.67
FG139	6.04	7.48	7.68	4.35	9.77	4.59	10.72	5.41	6.21	4.96	4.78

Table 40*: Showing t-values (Baillie and Pilcher 1973) between a) the FFB21 Flag Fen Tr. 3 sequences, and b) their t-values to the FFB21 Tr. 2 and Tr. 4 composites, and the Flag Fen Areas 2, 4, 6 and 13, and Flag Fen Area 16 composites. – t-values less than 3.0, \ overlap less than 15 years. Tr. 2 is the FFB21 Tr. 2 T13 composite 1336-1007BC, Tr. 4 is the FFB21 Tr. 4 T11 composite 1198-990BC, FF91 is the Flag Fen Areas 2 4 6 & 13 composite (Neve 1999, T91/S103 2022 version) 1390-955 BC, and FG139 is the Flag Fen Area 16 Fengate composite (Neve 1999, T139/S157 2022 version) 1364-918 BC. * This appears to be the same tree as timber A3182 from Flag Fen Area 6A, see Figure 6, this t-value will be raised by this pairing.*

a)	381	384	387	390	397	404	411	412	416	441	453
381		\	-	-	\	-	-	-	-	\	-
384			-	4.87	\	3.11	\	\	-	\	-
387				-	\	4.01	\	\	3.80	\	3.30
390					\	-	5.97	4.43	-	\	6.66
397						5.78	\	\	\	\	\
404							\	-	4.65	\	-
411								7.66	\	3.52	5.02
412									\	-	4.77
416										\	-
441											\
b)											
Tr.2	-	3.04	4.73	5.65	-	4.74	7.97	8.25	3.94	4.68	6.30
Tr.3	-	-	-	6.31	3.54	6.04	6.60	7.53	3.27	3.07	6.35
FF91	3.35	5.30	5.25	8.49	4.60	8.12	8.94	7.47	5.09	6.37	7.55
FG139	3.57	3.51	5.13	6.68	5.96	8.79	9.35	8.68	5.53	5.89	6.31

***Table 41**: Showing t-values (Baillie and Pilcher 1973) between a) the FFB21 Flag Fen Tr. 4 sequences, and b) their t-values to the FFB21 Tr. 2 and Tr. 3 composites, and the Flag Fen Areas 2, 4, 6 and 13, and Flag Fen Area 16 composites. – t-values less than 3.0, \ overlap less than 15 years. Tr. 2 is the FFB21 Tr. 2 T13 composite 1336-1007BC, Tr. 3 is the FFB21 Tr. 3 T14 composite 1326-1010BC, FF91 is the Flag Fen Areas 2 4 6 & 13 (Neve 1999, T91/S103 2022 version) composite 1390-955 BC, and FG139 is the Flag Fen Area 16 Fengate (Neve 1999, T139/S157 2022 version) composite 1364-918 BC.*

	FFB 216 970-938 BC
Flag Fen Areas 2 4 6 & 13 (Neve 1999, T91/S103 2022 version) 1390-955 BC	3.40
Flag Fen Area 16 Fengate (Neve 1999, T139/S157 2022 version) 1364-918 BC	4.80
Horsey Bridge HOB22 #17 (Tyers 2022) 971-902 BC	3.25
Magna Park MAP08 #100 (Tyers 2022) 1004-924 BC	3.58
Must Farm MUS11 #1769 (in prep) 990-933 BC	4.32
Must Farm MUS15 #7325 (in prep) 1032-907 BC	7.10

***Table 42**: Showing example t-values (Baillie and Pilcher 1973) between FFB21 sample 216 from Tr. 2 and contemporaneous reference data*

	FFB 697 1108-1017BC
Flag Fen Areas 2 4 6 & 13 (Neve 1999, T91/S103 2022 version) 1390-955 BC	6.40
Flag Fen Area 16 Fengate (Neve 1999, T139/S157 2022 version) 1364-918 BC	6.45
Flag Fen FFB21 Tr. 2 T13 (this report) 1336-1007BC	5.49
Flag Fen FFB21 Tr. 3 T14 (this report) 1326-1010BC	5.25
Flag Fen FFB21 Tr. 4 T11 (this report) 1198-990BC	3.58
Horsey Bridge HOB22 & MAP08 T5 (Tyers 2022) 1094-902 BC	4.89
Must Farm MUS11 & MUS15 settlement T5 (in prep) 1065-907 BC	5.61

***Table 43**: Showing example t-values (Baillie and Pilcher 1973) between FFB21 sample 697 from Tr. 6 and contemporaneous reference data*

	Tr. 3 T14	Tr. 4 T11

Tr. 2 T13	10.38	10.28
Tr. 3 T14		10.46

***Table 44**: Showing t-values (Baillie and Pilcher 1973) between the FFB21 Flag Fen Trench composites. Tr. 2 is the Tr. 2 T13 composite 1336-1007BC, Tr. 3 is the Tr. 3 T14 composite 1326-1010BC, Tr. 4 is the Tr. 4 T11 composite 1198-990BC. These were combined with single timber 697 from Tr. 6 to form the site composite FFB21 T39 used in Table 36.*

	FFB21 T39 1336-990 BC
Flag Fen Areas 2 4 6 & 13 (Neve 1999, T91/S103 2022 version) 1390-955 BC	21.57
Flag Fen Area 16 Fengate (Neve 1999, T139/S157 2022 version) 1364-918 BC	22.55
Flag Fen Area 34 Time-Team D4 (Tyers 1999) 1293-1116 BC	8.36
Horsey Bridge HOB22 #3+4 (Tyers 2022) 1268-1200 BC	5.12
Horsey Bridge HOB22 #38 (Tyers 2022) 1431-1232 BC	6.23
Horsey Bridge HOB22 & MAP08 T5 (Tyers 2022) 1094-902 BC	6.29
Must Farm MUS06 & MUS15 causeway T12 (in prep) 1400-1285 BC	7.11
Must Farm MUS11 & MUS15 settlement T5 (in prep) 1065-907 BC	7.58
Cambridge St Clements Garden SCG15 (Tyers 2016a; b) 1257-948 BC	7.04
Kent, Swalecliffe (Masefield et al 2003) 1432-1085 BC	8.99
Notts, Newington Quarry nr Misson NQ02 (Tyers 2003) 1580-954 BC	7.33

***Table 45**: Showing t-values (Baillie and Pilcher 1973) between the composite FFB21 T39 sequence and contemporaneous reference data*

11.5 Discussion

11.5.1 These excavations were undertaken to enable scientific analysis of the preserved remains in order to provide objective information on the survival and state of preservation of parts of the site and the extent of the platform. The dendrochronological analyses have confirmed that at present the material on the alignment is still capable of producing viable tree-ring samples, and that the data from them provides replicates of the data produced in the 1990's. Sapwood survival is poor, and the oak heartwood is in some instances approaching a condition where dendrochronology would no longer be possible. We can use the new data to review the previous work, and suggest some approaches to future analysis on the site. It is not clear whether there will be any further systematic excavations on the site.

11.5.2 One notable feature of the site bar-diagram (Figure 27) is that the 3 FFB21 alignment transects have provided very similar numbers of dated samples, 14, 14 and 11 respectively. There are very similar distributions of tree-ring data from each transect. FFB21 Tr. 4 provides the first major group of data from east of the platform, and it is slightly shorter as well as being less well replicated than FFB21 Tr. 2 and Tr. 3. This overall similarity might suggest that there is a relatively uniform survival of timbers of different periods along much the alignment. These excavations provide a baseline that suggests sampling further transects, of the same size, most likely will yield similar numbers of datable timbers. The excavations around the platform, FFB21 Tr. 5 and Tr 6, have yielded much less timber.

11.5.3 A characteristic of each transect, and also from each of the previously excavated areas is that the dates of the bark-edges, and the dates of the samples with some sapwood are all different. Both types of survival yield dates of some interpretable value in the context of the alignment.

However, at present these mostly appear to be random distributed across the centuries. The FFB21 sequences include one datable sample with bark-edge, sample 337 from Tr. 3 which was felled in winter 1031 BC. The earlier analyses identified no bark-edge dates from the western, Fengate, end, and just 10 from the various interventions along the alignment and the platform area. None of these felling events are found in more than a single sample (contrasting with both multi-phase Fiskerton, and single phase Must Farm where multiple samples have been identified for each felling event). The present pattern may suggest this is a multi-phase structure with innumerable repairs or additions. However the almost complete absence of bark-edge and sapwood bearing samples may be hiding any evidence for periodic activity.

11.5.4 FFB21 Tr. 2, Tr. 3 and Tr. 4 were 1.4m wide transects. If they are representative of the tree-ring data recoverable from the rest of the alignment then each 100m of alignment is likely to include c 1500 timbers suitable for analysis, with c 1000 of those likely to yield dates. The present Basin chronology is already sufficiently strong for most dendrochronological purposes. Opportunities to extend the sequence backwards or forwards appear to be small. If there is a hiatus between Flag Fen and the Must Farm pile dwelling then only samples with sapwood from the latest phases of Flag Fen activity have any potential to cross the gap present in the local data set. Focussing any future analyses on samples with sapwood and bark potentially provides a more targeted opportunity for aiding the archaeological interpretation of the Flag Fen monument, and it could also potentially narrow the gap to Must Farm. If FFB21 Tr. 2, Tr. 3 and Tr. 4 are representative of the wider monument this would perhaps limit analysis to c 25-50 samples per 100m of alignment. Rapid on-site assessment of timbers using the working practises at CAU have proven capable of dealing with large numbers of timbers at the various Basin excavations. The Flag Fen ‘platform’ area may be markedly different in character, though the earlier work from Area 6 suggests that the same approach could be taken here too. Because of its heavily degraded condition the material from the site is perhaps not really suitable for use in training, on the other hand anybody that could be taught to analyse this material would be well suited to handle almost any other archaeological assemblage.

11.5.5 The earlier work had focussed on material with 50 or more rings, with only a handful of samples with 40-50 rings analysed. Using the shorter material from FFB21 has not identified any previously unknown phases of activity. None of the new sequences assists with dating any earlier undated sequences, and none of the new material advances the Basin chronologies any closer towards the date of the Must Farm pile dwelling.

11.5.6 The 1999 report divided the then available dendrochronological data into horizontal and vertical elements, and also divided them into the different post rows. Here we will present a slightly different way of looking at the bulk data, dividing it into four linear groupings or zones along the alignment. This is made possible by FFB21 Tr. 4, the first reasonably large group of samples analysed from east of the platform. We can also now use the Must Farm and Horsey Bridge material, both excavated long after 1999, as comparators for the Flag Fen material. Figure 36 uses the histograms of the replication data from the various composite chronologies. Histograms are another way of looking at a sites bar diagram, they occasionally reveal subtleties that are not evident from inspection of the bar diagram itself. The histogram for an assemblage of data is produced by adding up how many individual timbers are present for each year of data. Each single sample has a weighting of one for each ring in it, where there are two samples that have the same year in them the composite sequence has a histogram value of two for that year, where 100 samples have the same tree-ring in them the histogram value is 100 for that year. The end result is that each composite sequence can be weighted by the number of components for each ring.

11.5.7 There is no straightforward connection between these data weightings and actual archaeological events for a multi-phase, multi-period dataset, with poor sapwood survival, like those derived from the Flag Fen alignment. For most well replicated data sets the histograms have a variety of shapes; lumps, peaks, troughs, plateaus and cliff-faces. Figure 37 illustrates a typical single phase histogram where bark-edge survival is good, the Must Farm pile-dwelling has a plateau and a single very precipitous cliff-face. The histogram from Fiskerton is typical of a multi-phase structure, it has a peak followed by a series of smaller cliff-faces with steps between. There are a lot of caveats to the use of these diagrams in an interpretative way. There will be numerous non-random events affecting the taphonomy and survival of the timbers on these sites, there will be events that have left no archaeological traces, and timber usages that have left no traces in the dendrochronological data. For a site like Flag Fen where only the hardiest of materials, oak heartwood, is surviving at all there must be many of the less hardy wood types that have entirely disappeared. The general absence of sapwood tells us that timber survival is not complete across the monument. It is equally important to recognise that there will have been differences in the age distribution of the trees that were exploited for different parts of its construction. The surrounding woodland will have been non-uniform, and selecting materials from these will affect the weighting diagrams even for contemporaneous events at different parts of the alignment. Nevertheless comparing like-for-like histograms of the weightings from four different zones of the alignment suggests some systematic differences in the timber assemblages recovered along the length of the alignment. Similarly it is very clear that there are profound differences between the assemblages recovered along the alignment and those from the nearby structures at Must Farm and Horsey Bridge. For Figure 36 the Fengate/Area 16 material is the single composite previously mentioned, FG139. Combining FFB21 Tr. 2 and Tr. 3 with two earlier samples from Area 2, which lies between them, provides a data set from half way between Fengate and the platform. Removing Area's 2, 4 and 13 from the FF91 composite, leaves just Area 6 data, which is the major assemblage from the platform. Combining the single Area 34/Time Team sample with FFB21 Tr. 4, which is nearly adjacent, provides a data set from east of the platform. Eight series from Flag Fen Areas 4 and 13, the short and later outlier from FFB21 Tr. 2, sample 0216, the single timber from FFB21 Tr.6, sample 0697, and the single timber from Pode Hole are the only Flag Fen Basin data not included in this diagram. The chronological positions of some of these can be seen in Figure 35. The earlier data has 'same trees' combined into single series, adding these as separate series would subtly change these histograms, but not change their overall shapes. The four Flag Fen zonal histograms are placed in order with the westernmost at the top to easternmost at the bottom. The Horsey Bridge and Must Farm datasets are both in two sections, these sites are c 2.8km south and c 2.3km south-east of Flag Fen respectively on the edge of the same mere, both these sites have timbers with better preservation than Flag Fen.

11.5.8 These four combined zones of Area 16, Tr.2-3, Area 6, and Tr.4 for Fengate, Flag Fen, and FFB21 have peak replication of recovered and datable tree-ring data in the decades either side of 1100 BC, three of those groupings peak at 1119-1115, 1113-1105 and 1124-1106 BC, whilst Tr. 2-3 peaks slightly later than the others, at 1070-1067 BC.

11.5.9 All four of these zones have long tails both backwards and forwards, where the data replication falls away until these composite tree-ring sequences end. These tails also appear to have patterns within them. For example both Area 16 and Area 6 appear to have a shoulder on the right flank of their peaks, this may potentially indicate a drop off in the rate of deposition of datable timbers around 1000 BC. This pattern is not obvious in the other two zones, but since they are much less replicated it is perhaps not yet visible.

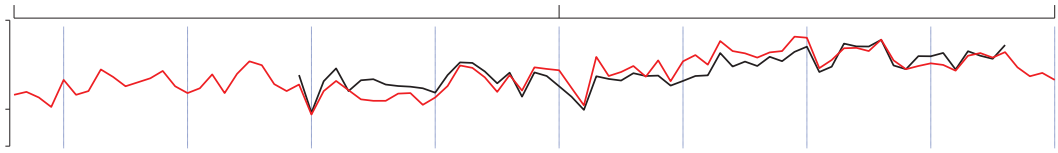

Figure 31. Diagram showing the tree-ring sequences from FFB21 Tr. 3 327 (black) and FFB21 Tr. 3 343 (red), t-value 11.50. These appear likely to be from a single tree. These are combined as 327+343 in Table 40.

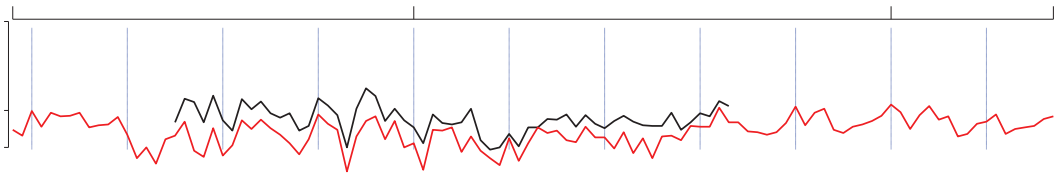

Figure 32. Diagram showing the tree-ring sequences from FFB21 Tr. 2 46 (black) and FFB21 Tr. 2 81 (red), t-value 9.34. Despite this high correlation they have quite different growth rates and appear less likely to be from a single tree, though they could be from opposite radii or different heights in a distorted tree. These are kept separate in Table 39.

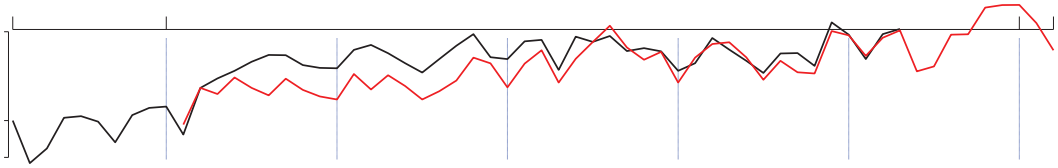

Figure 33. Diagram showing the tree-ring sequences from FFB21 Tr. 2 76 (black) and FFB21 Tr. 2 145 (red), t-value 7.70. Despite this lower correlation (compared to the pairings in Figures 4-8) they have a very similar growth trend, they grew much faster as they got older. These may be from a single tree, but they are kept separate in Table 39.

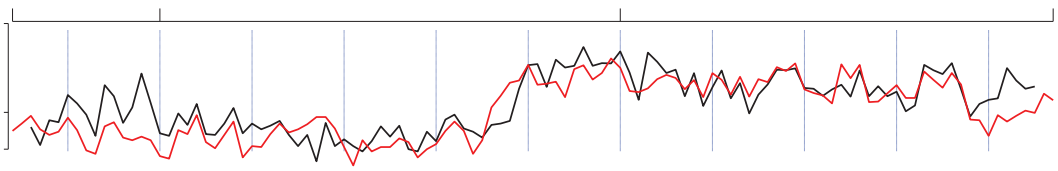

Figure 34. Diagram showing the tree-ring sequences from FFB21 Tr. 4 411 (black) and FFB21 Tr. 4 412 (red), t-value 7.66. Despite this lower correlation (compared to the pairings in Figures 4-8) they have a very similar growth trend, particularly the marked step in growth in the middle of the graph. These may be from a single tree, but they are kept separate in Table 41.

11.5.10 There is a lump of data at the oldest/left end of the Area 16 data set, i.e. the Fengate/western extreme end of the alignment. This lump has a broad plateau of tree-rings covering 1336-1294 BC. Inspection of the 1999 bar diagrams suggests this is a group of 15 trees in 17 vertical piles, with Y1007 ending at 1311 BC, through to Y0119 ending at 1267 BC. Y0138 is the only one with any sapwood, ending at 1294 BC. This group looks like it may be a mid-thirteenth century BC pile structure. If they represent a single phase they potentially were all felled between c 1255 and 1245 BC. If the location records survive, and if they have been digitised, it ought to be possible to pull this group out on a GIS diagram. There is no similar early group present in the data from the other three zones of the alignment. There is a very similar early group produced by material from a causeway that underlies the pile dwelling at Must Farm, it has a plateau 1361-1325 BC, which might suggest the Must Farm causeway is slightly earlier than the feature at Fengate.

11.5.11 Returning to the zonal histograms, their long level sections between c 1300 and c 1200 BC from all four zones along the alignment could imply little activity across the site from the mid-thirteenth through to the mid twelfth century. Alternatively it may indicate that the activity during this period did not involve inserting large oak timbers into the structure, or that this activity was not at levels where they have survived. The steep rises from these to their peaks were potentially periods of similar or little activity, as these tree-rings are mostly the inner rings of the larger trees used from c 1100 BC onwards.

11.5.12 Another tentative suggestion derived from these diagrams is whether there may be an east-west trend in latest rings along the alignment. This pattern may be due to less replication in some areas, but the latest rings currently from the western end are more than half a century later than the latest rings from the eastern end. Fengate/Area 16 ends at 918 BC, FFB21 Tr.2-3 ends at 938 BC (this from the outlier late timber from Tr. 2 not on Figure 36, but seen in Figure 35), the platform/Area 6 ends at 955 BC, and FFB21 Tr. 4 ends at 990 BC.

11.5.13 The replication strength of the Flag Fen data at this point ensures most decent samples from this period recovered from the vicinity would include datable sequences. This allows us to compare Flag Fen with sites from the immediate area. We have already noted the early group within the Fengate material and its similarity to the early causeway underlying Must Farm. Comparing the rest of Flag Fen histograms with those from Horsey Bridge and Must Farm it is evident that neither Horsey Bridge nor Must Farm have any tree-ring data from 1200-1100 BC, which is the peak period for data along most of the Flag Fen alignment. Whilst there may be activity on both sites, of course, it evidently does not involve datable oak timbers ending up in preserved locations. Both sites contain much smaller assemblages but they both produced later tree-rings than any so far recovered from the Flag Fen alignment, 902 BC from Horsey, and 907 BC from Must, compared to 918 BC from Fengate/Area 16. This may be due to better sapwood and outer heartwood survival, but it may indicate later structural activity is happening off the alignment rather than on it. The same thing occurs at the older end, with a single long lived tree from Horsey extending several decades beyond the oldest data recovered from the Flag Fen platform.

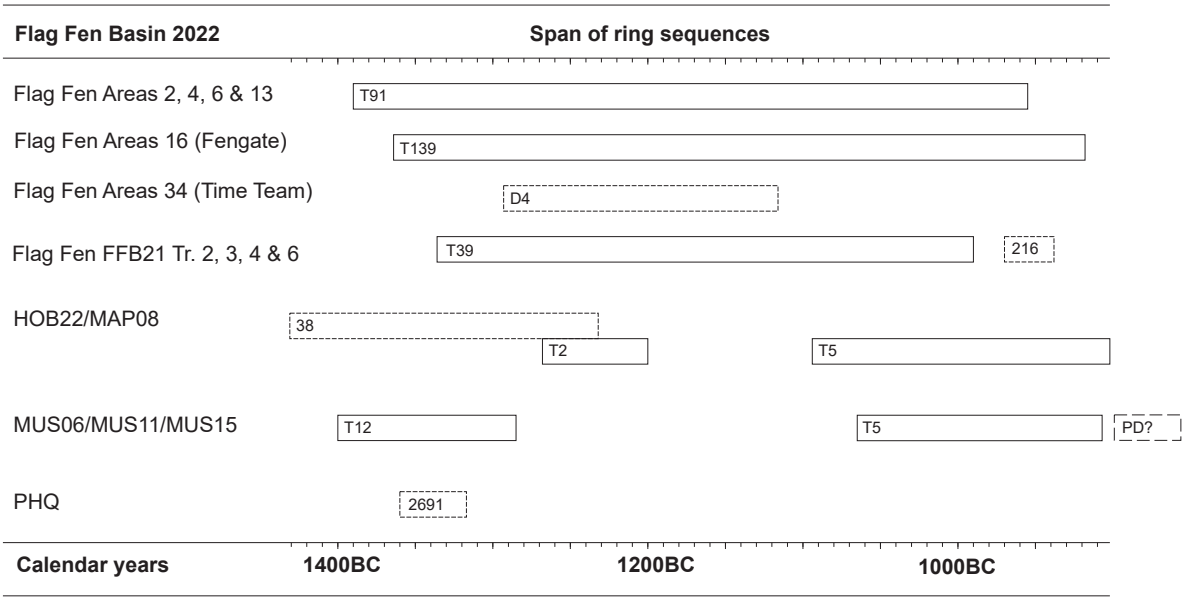

Figure 35. Bar diagram showing the current state of the Flag Fen Basin tree-ring chronologies. The top 3 refer to the Gazetteer Area's in Brittain *et al*. 2020; Fig.7. The FFB21 material is from Trenches as marked on Figure 2. The composite data sets (solid line bars) are labelled with T2, T5 etc, the number of samples in the composite. The single timber sequences (dotted line bars) are marked with their reference numbers. D4 is a single timber from Northey Island a few meters east of the Flag Fenplatform in Gazetteer Area 34 (Brittain *et al*. 2020; Fig.7), 216 is the outlier late timber from the FFB21 excavations, 38 is a single long lived timber from Horsey Bridge, 2691 is a single short lived sequence from PodeHole Quarry, c. 5km north-east of Flag Fen. Horsey Bridge (HOB22 & MAP08) and Must Farm (MUS06, MUS11, MUS15) are c. 2.8km south and c. 2.3km south-east of Flag Fen respectively. Site names and report references are in Table 45. The dashed line bar marked PD is the estimated position of the Must Farm pile dwelling sequence. This has an end-date of c 860–835cal BC (68% probability) by radiocarbon wiggle-matching of the tree-ring sequences (Marshall *et al* in prep).

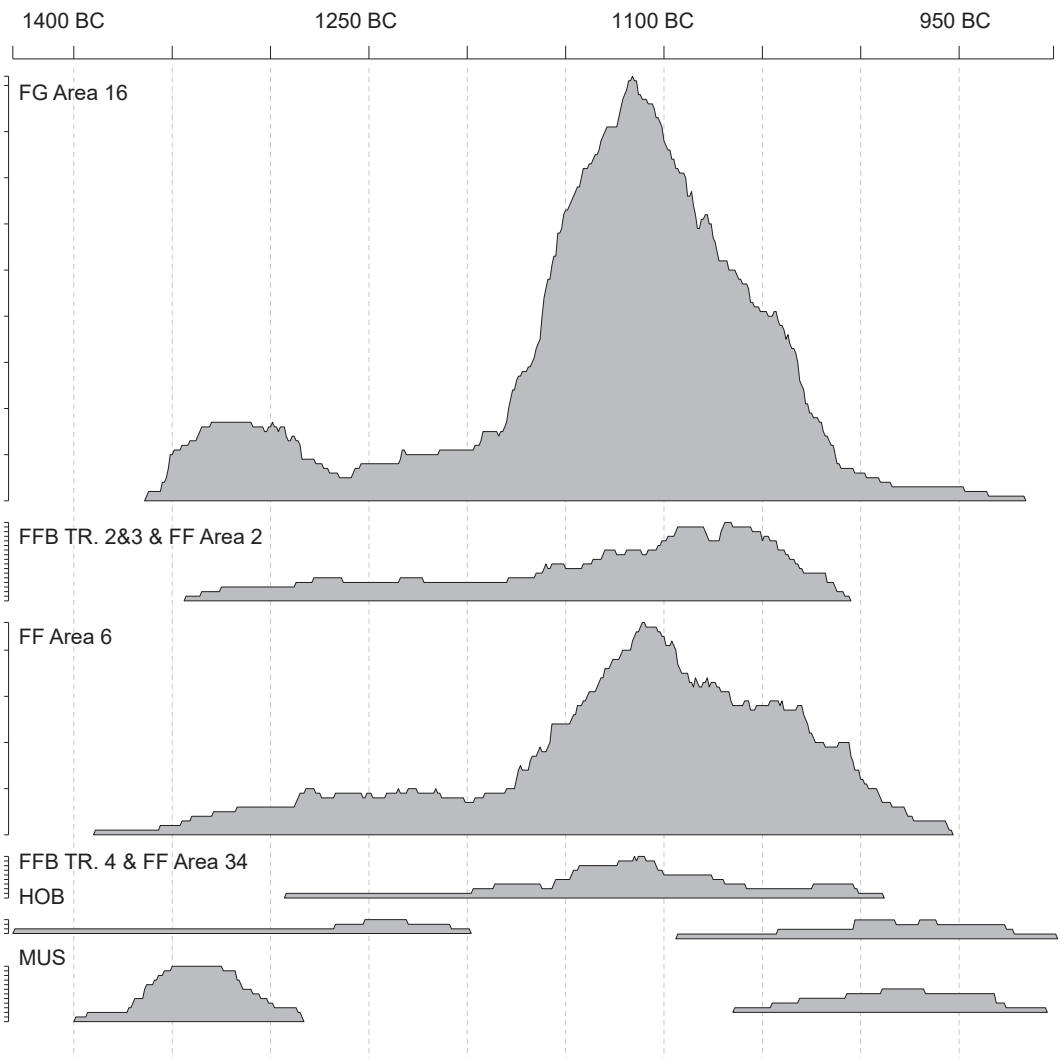

Figure 36. Diagram illustrating the histograms of data replication for the chronologies from the Flag Fen alignment. The upper 4 histograms are in west to east order across the alignment. HOB and MUS are the Horsey Bridge and Must Farm histograms for comparison.

12. APPENDIX 1C: Condition Assessment of timbers from Flag Fen 2021

Ian Panter (York Archaeology)

12.1 Introduction and Methodology

12.1.1 Twenty-two timbers selected for decay analysis were recovered from four trenches, and this report considers the basic condition assessment of three of those timbers: two vertical stakes from Trenches 2 and 4, and one horizontal timber from Trench 5. Characterisation has been conducted using the pin test and maximum water content methodologies. The pin test was used across all surfaces of each timber and water content was measured using either core samples extracted using a Haglölf increment borer, or from fragments broken off by hand. Processing followed the usual methodology (Panter, 2013). These three timbers were selected because sediment samples from the same trenches are also being assessed.

12.2 Results

WD0076 (Trench 2 post-alignment, oak pile (converted roundwood); Figure 38).

In two sections. The upper section, circa 500mm long, appears more eroded, with longitudinal desiccation cracks visible as well as rootlets growing through the wood. Some distortion to growth ring pattern. The lower section, circa 550mm long, appears less eroded although the surfaces are iron stained and encrusted with a hard clay/silt like concretion. The tip is worked with several facets. There are no desiccation cracks visible on the lower section.

Pin test results:

From top of stake to c. 250mm mainly condition b, with the pin easily penetrating to a depth of around 15mm before resistance is encountered.

Between 250mm and 800mm – all condition a, very soft wood, with no resistance to the pin.

Between 800mm and tip of stake – where wood is exposed through the encrustation condition is primarily a, with pockets of condition be, again the pin penetrates to a depth of c. 10mm before resistance is encountered.

Maximum water content:

Sample 1: fragment detached from top of stake = 336%

Sample 2: core c. 100mm from stake top = 554%

Sample 3: core c. 250mm from stake top = 386%

Sample 4: core c. 500mm from stake top = 723%

Sample 5: core c. 800mm from stake top = 525%

Sample 6: core c. 1000mm from stake top= 531%

Sample 7: stake tip sawn off = 258%

WD0404 (Trench 4 post-alignment, oak pile (converted roundwood); Figure 38).

In three sections, the uppermost fragment is eroded and distorted, and compressed. The two deeper sections exbibit no signs of desiccation cracks, and the rays and growth rings show

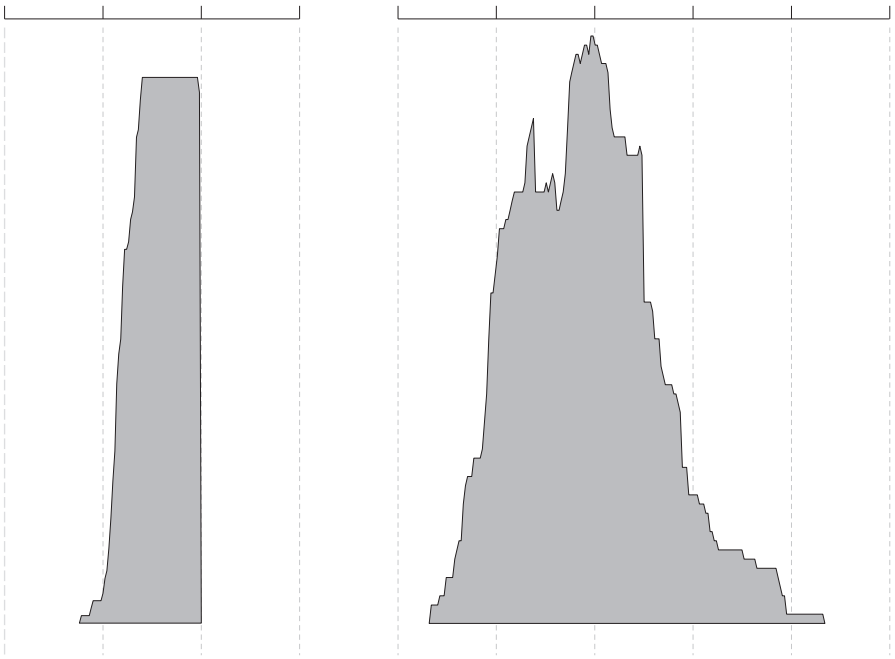

Figure 37. Diagram illustrating the kind of histogram shapes that should be produced by either a one-phase structure or a structure with a series of major felling events. Left; Must Farm late Bronze Age pile-dwelling, single phase, an undated 60 year sequence of 73 oak and ash samples. Right; Fiskerton Iron-Age structure with intermittent construction events, a dated 185 year sequence of 85 oak samples. Horizontal scaling the same as Figure 12, but neither are using absolute dates. Both sites have abundant bark-edge survival and the longer vertical drops on the right hand side of each histogram identify the construction event at Must Farm, and several construction events at Fiskerton. Flag Fen is clearly not a single phase structure, if 50-100 bark-edge samples could be obtained and dated from the Flag Fen alignment it may begin to identify whether it also has intermittent irregular multi-phase construction events, like Fiskerton, or if it instead represents a type of continuously amended structure.

no distortion from compression or desiccation. All surfaces are very soft and easily compressible by hand. When pressed, water is seen to exude out of the wood.

Pin test results:

All areas tested were condition a – very soft, no resistance to the pin.

Maximum water content:

Sample 1: fragment broken off from top of stake = 586%

Sample 2: core from c. 400mm from top = 458%

Sample 3: core from c. 700mm from top = 447%

Sample 4: core from c. 900mm from top = 541%

Sample 5: core from c.1100mm from top = 536%

Sample 6: detached tip of stake = 305%

WD0629 (Trench 5 platform, oak horizontal (converted roundwood); Figure 38).

In four fragments, surfaces eroded but no desiccation cracks, nor root growth through the timber. The ray pattern has been distorted suggesting ongoing compression of the timber during burial.

Pin test results:

All areas were condition a – no resistance to penetration.

Maximum water contents:

The timber is too thin to core so fragments were detached from the upper (labelled) and lower surfaces to see if there was any vertical and horizontal variation.

Sample 1: “upper” surface = 383%

Sample 2: “lower” surface = 364%

Sample 3: “upper” surface = 329%

Sample 4: “lower” surface = 388%

12.3 Conclusion

12.3.1 Based on these results all three timbers investigated during this assessment are highly degraded with little “sound” wood remaining. The presence of rootlets, distorted ray patterns, the presence of desiccation cracks, and wood surfaces that can be depressed by hand all paint a picture of severe decay.

12.3.2 Using the “de Jong” classification for characterising decay based on water content (de Jong, 1977) the timbers exhibiting the most decay are the two vertical elements (timbers 76 and 404) which have water contents in excess of 400%. These can be described as Class III, “highly degraded with little or no sound core surviving”. The tips of each stake appear to be better preserved, with water contents of 258% and 305%, these fragments can be considered as Class II wood, with water contents between 185% and 400%, where a comparatively “small hard core of sound wood remains”. Pockets of less decayed wood were also recorded from

timber 76, and such heterogeneity is characteristic of oak. The horizontal element (timber 629) appears to have undergone the least decay with water contents less than 400% and hence a Class II wood, although the pin test revealed no zones of harder, less decayed wood surviving.

12.3.3 The overall condition of these timbers is broadly in line with the results from a condition assessment conducted on timbers excavated in 2012 (Panter, 2013), the majority of which were Class III, highly degraded timbers.

13. APPENDIX 1D: ASSESSMENT OF WATERLOGGED PLANT REMAINS

Wendy Smith (Museum of London Archaeology)

13.1 Introduction

13.1.1 The following report presents the assessment results for waterlogged plant macrofossils from three trenches at Flag Fen (Table 46).

	Feature	Context No.	Sample No.
Trench 2	*Post-alignment*	[002]	<26>
Trench 2	*Post-alignment*	[003]	<27>
Trench 5	*Platform*	[048]	<12>
Trench 5	*Platform*	[049]	<11>
Test-pit 1	*Off-site*	[22]	<10>
Test-pit 1	*Off-site*	[26]	<5>

Table 46: Samples assessed for waterlogged plant remains.

13.1.2 The assessment was carried out to determine:

- If plant remains were present?
- If the plant remains present were of interpretable value?
- If the plant remains present were well-preserved?
- If the plant remains provide information on water conditions in the area.
- If the plant remains provide information on the nature of the surrounding environment?
- If any of the plant remains suggest human activity in the vicinity?

13.2 Method

13.2.1 A 1L sub-sample was collected from all six archaeoentomological samples, which are reported separately by David Smith (Appendix 1E). For the purposes of assessment, a 500 ml sub-sample was processed by bucket flotation with the flot and heavy residue fractions retained over a 0.3mm geological sieve. All residual unprocessed sediment has been retained in case required for future analysis.

13.2.2 Both the flot and heavy residue were rapidly scanned under a low-power EMZ Meiji microscope at magnifications between x10 – x20. In the case of Trench 5 samples, the sediment was compacted and difficult to disaggregate. This material was soaked in hot water over several days prior to processing, in order to gently disaggregate any plant material within layers of sediment. Sediment from the heavy residues in Trench 2 and Trench 5 samples did not fully break down and, therefore, nodules of peat are present. This may mean that some plant remains were not visible during assessment.

13.2.3 The results presented here should be seen as provisional for the following reasons:

- The flot and heavy residues from each sample were scanned rapidly and, therefore, small-sized, fragmentary or encrusted items may be overlooked.
- If sample flots or heavy residues consistently generated a similar suite of waterlogged plant remains during rapid assessment, the entire flot/ heavy residue may not be fully scanned. The proportion scanned of the flot or heavy residue is indicated in Table 47.

- No comparative material or identification keys were consulted during this assessment; therefore, all identifications should be seen as provisional.

13.2.4 Scoring of waterlogged plant macrofossils is based on a semi-quantitative scale; whereby, 1 = 1 item, + = < 5 items, ++ = 5 – 25 items, +++ = 25 – 100 items and ++++ = > 100 items. Nomenclature and taxonomic order for plant remains follows Stace (2010).

13.3 Results

13.3.1 Table 47 presents the assessment results for waterlogged plant remains from six samples collected from three trenches at Flag Fen (FFB21). In most cases, waterlogged plant remains were observed to be iron stained and, in some cases, showed clear signs of warping/ twisting/ shrinkage; all of which suggest that these deposits have dried out at some point in the past, possibly the recent past. In general, the assemblages are dominated by aquatic and waterside plants or plants of marsh/ damp ground; however, there are a few indicators for grassland or drier ground in the vicinity. The range of taxa recovered does differ between trenches and this mainly due to the samples being from different contexts (contemporary with the post alignment; post-platform; and pre-monument) and in different parts of the site/landscape.

13.3.2 The results will be discussed separately for each Trench below.

Trench 2 – Post-alignment [002] <26>

13.3.3 Context [002] was entirely comprised of aquatic and/or waterside taxa and, due to the modest quantity of plant remains observed, appears to be of limited interpretable value. Taxa noted in rapid scanning include bur-marigold (*Bidens* sp.), common/ slender spike-rush (*Eleocharis palustris* (L.) Roem. & Schult./ *uniglumis* (Link) Schult.), crowfoot (*Ranunculus* subg. BATRACHIUM (DC.) A. Gray), duckweed (*Lemna* sp.), indeterminate arrowhead/ water-plantain (*Sagittaria* spp./ *Alisma* spp.), nodding bur-marigold (*Bidens cernua* L.), sedge (*Carex* sp. – 3-sided) and water-plantain (*Alisma* spp.). Except for taxa such as arrowhead/ water-plantain (*Sagittaria* spp./ *Alisma* spp.) and duckweed (*Lemna* sp.), which can be fully aquatic, most of the taxa recovered are typical of waterside environments; although *Eleocharis palustris* (L.) Roem. can occur in shallow bodies of water (Walters 1949). Nodding bur-marigold (*Bidens cernua* L.) can occur in damp to aquatic environments, from marshes to slow-flowing streams/ rivers or by shallow bodies of water and often is associated with land subject to winter flooding (Online Atlas of the British and Irish Flora https://plantatlas.brc.ac.uk/plant/bidens-cernua).

Trench 2 – Post-alignment [003] <27>

13.3.4 Context [003] produced a richer and wider range of plant macrofossils than sample [003] from Trench 2. The greater depth of this deposit vis a vis sample <26> may account for the better preservation of waterlogged plant remains. Plants typical of damp ground (including marshes), waterside and/or aquatic environments dominate this assemblage and include taxa such as, bur-marigold (*Bidens* sp.), common/ slender spike-rush (*Eleocharis palustris* (L.) Roem. & Schult./ *uniglumis* (Link) Schult.), crowfoot (*Ranunculus* subg. BATRACHIUM (DC.) A. Gray), gypsywort (*Lycopus europaeus* L.), marsh pennywort (*Hydrocotyle vulgaris* L.), sedge (*Carex* sp. – 3-sided) and water-plantain (*Alisma* spp.). In addition, leaf fragments of common reed (*Phragmites australis* (Cav.) Trin. ex Steud.) were noted frequently. These taxa suggest a complex mixture of wetland environments from shallow, slow-flowing bodies

of water (indicated by crowfoot and water plantain) to possibly seasonally flooded grasslands (indicated by bur-marigold and marsh pennywort) were present.

13.3.5 One damaged, four-sided achene tentatively identified as cottongrass (*Eriophorum* sp.) was noted, which is worth further discussion here. Although common cottongrass (*Eriophorum angustifolium* Honck.) is the most common variety of cottongrass in the UK and typical of moorland environments, especially in the Peak District (e.g. Stace 2010: 943, https://plantatlas.brc.ac.uk/plant/eriophorum-angustifolium), three other taxa are possible*: E. latifolium* Hoppe, *E. gracile* W.D.J. Koch ex Roth and *E. vaginatum* L. species. In particular, slender cottongrass (*Eriophorum gracile*) has a more southerly distribution in England (Stace 2010) and typically occurs in the wettest parts of bogs, in poor fens or the edge of alder carr (https://plantatlas.brc.ac.uk/plant/eriophorum-gracile). Habitat loss due to drainage or changes in land management has restricted the modern distribution of slender cottongrass and the Online Atlas of the British and Irish Flora (op. cit.) notes that it is now extinct in Dorset and Norfolk and declined in Surrey.

13.3.6 In addition to plants typical of damp to aquatic conditions, a few taxa which are more typical of drier conditions were noted, including: dock (*Rumex* spp.), goosefoot (*Chenopodium* spp.) and thistle (*Carduus* sp./ *Cirsium* sp.). These taxa often are encountered in grassland habitats, but none were identified to species level and in all three cases species within these genera can occur in a variety of environments, including seasonally flooded grasslands to wetlands.

Trench 5 - Platform [048] <12>

13.3.7 This sub-sample was largely unproductive and has little or no interpretative value. One eroded white water-lily (*Nymphaea alba* L.) seed and a few crowfoot (*Ranunculus* subg. BATRACHIUM (DC.) A Gray) achenes were noted. White water lily is indicative of slow-flowing bodies of water and this also can be the case for crowfoots, although some crowfoots (e.g. common water-crowfoot – *R. aquatilis* L.) also can occur in shallow water in marshes, ditches or ponds (https://plantatlas.brc.ac.uk/plant/ranunculus-aquatilis).

13.3.8 Small fragments of wood were abundant in both the flot and heavy residue fractions of this sample. It is not clear whether this material is related to the wood platform at the base of this sequence or not

Trench 5 – Platform [049] <11>

13.3.9 This deposit was richer than the upper sample (<12>) from this sequence, however, is still small-sized (< 50 identifiable items) and, therefore, is also unlikely to be of much interpretable value.

13.3.10 Like sample <12> from this sequence, white water-lily (*Nymphaea alba* L.) seed and a few crowfoot (*Ranunculus* subg. BATRACHIUM (DC.) A Gray) achenes were noted in this sample. In addition, alder (*Alnus glutinosa* (L.) Gaertn.), indeterminate blackberry/ raspberry seeds (*Rubus* section *Rubus* – seeds were 'beaked'), pondweed (*Potamogeton* spp.) and rough chervil (*Chaerophyllum temulum* L.) were noted. Despite the small size of this assemblage, it does suggest a mixture of habitat types from slow-flowing bodies of water (crowfoots, pondweed and white water-lily), to shallow water or waterside environments (crowfoots) to grassland (rough chervil) were present. Bramble (*Rubus* section *Rubus*) today is a plant which is reduced in range through active management, as it can spread and colonize areas rapidly and occurs in a wide variety of habitats. Brambles/ blackberries/ raspberries

are highly interfertile and considered an extremely complex group to separate to species level (Stace 2010: 241–2). It currently is not possible to determine whether these 'beaked' seeds (which are possibly more typical of raspberry seeds) do mean a red raspberry was produced rather than a blackberry or if the shape of the seed may be linked to possibly overly wet growing conditions, since that basic taxonomic data on seed shape variability does not appear to have been recorded (e.g. Wada and Reed 2008: 67).

13.3.11 Like sample <12>, small-sized wood fragments were frequently noted in this sample and may be related to the wooden platform timbers at the base of this sequence (e.g. either through woodworking debris and/or decay/ fragmentation/ wear of the platform itself).

Test-pit 1 - Off-site [022] <10>

13.3.12 Unlike the two other sequences assessed here, the upper sample assessed in the Test-pit 1 sequence (sample <10>) is richer and more diverse than the lower sample (sample <5>, see discussion below). Common reed (*Phragmites australis* (Cav.) Trin. ex Steud.) fragments often were noted in the flot from sample <10> and were relatively abundant in the heavy residue fraction.

13.3.13 Other plant taxa noted included crowfoot (*Ranunculus* subgenus BATRACHIUM (DC.) A Gray), dock (*Rumex* spp.), indeterminate arrowhead/ water plantain (*Sagittaria* sp./ *Alisma* sp.), possible aquatic mint (*Mentha* sp.), rough chervil (*Chaerophyllum temulum* L.), sedge (*Carex* sp. – 3-sided), silverweed (*Potentilla anserina* L.), possible unbranched bur-reed/ floating bur-reed (*Sparganium* cf. *emersum* Rehmann/ *angustifolium* Michx.), water plantain (*Alisma* spp.) and yellow iris (*Iris pseudacorus* L.). These taxa represent a range of habitats from fully aquatic, slow-flowing bodies of water for plants such as crowfoots, water plantain and yellow iris to grassland (possibly damp or seasonally flooded grassland) for taxa such as dock, rough chervil, sedge and silverweed.

Test-pit 1 - Off-site [026] <5>

13.3.14 This lower sample from the Test-pit 1 sequence was not as rich or diverse as the upper deposit (sample <10> - see discussion above). Preservation was reasonably good for this deposit, and common reed (*Phragmites australis* (Cav.) Trin. ex Steud.) leaf fragments were much more abundant in sample <5> than sample <10>. In addition, small-sized (2 – 4 mm) waterlogged wood fragments were frequently observed in this sample.

13.3.15 Plants typical of shallow, slow-flowing water include club-rush (*Schoenoplectus* spp.), crowfoot (*Ranunculus* subg. BATRACHIUM (DC.) A Gray) and possible water-dropwort (cf. *Oenanthe* sp.). Water-dropworts (*Oenanthe* sp.) are typical of slow-flowing shallow water but some species in this genera (e.g. *Oenanthe aquatica* (L.) Poir) are tolerant of drought (Stace 2010: 816) or can occur on seasonally flooded land (https://plantatlas.brc.ac.uk/plant/oenanthe-aquatica). Bittersweet (*Solanum* cf. *dulcamara* L.) is a climbing vine that can occur in a variety of habits, but most frequently grows in damp environments, such as 'tall herb fens', wooded wetlands (swamps) or waterside environments (Stace 2010: 578; https://plantatlas.brc.ac.uk/plant/solanum-dulcamara).

13.3.16 Rough chervil (*Chaerophyllum temulum* L.) is more typical of grassland or woodland edges and rarely occurs in damp environments (https://plantatlas.brc.ac.uk/plant/chaerophyllum-temulum).

13.4 Discussion

13.4.1 All six waterlogged plant remain sub-samples assessed here have produced taxa highly indicative of seasonally flooded to fully aquatic environments, with a few indicators for other habitats (especially grassland or woodland) present. There is no evidence for human activity from any of the samples rapidly scanned for this assessment.

13.4.2 In general, the quantity, diversity and preservation of plant remains seems markedly poorer than previous work the author conducted on similar waterlogged plant remains sub-samples from the 2012 intervention at Flag Fen by Dig Ventures (Smith 2013). All three sequences produced plant remains with clear iron staining, which is generally taken to be an indication of a peat deposit drying out. This does suggest that the waterlogged archive is not stable and preservation is on the decline, possibly through dewatering and/or more frequent droughts at the site.

13.4.3 Plant macrofossils have been studied previously at Flag Fen. In the late 1970s, JRB Arthur (1978) reported on plant macrofossils from Large Pit W17 and Well B3 at the Storey's Bar Road Sub-site. The taxa recovered were primarily typical of rough ground/ grassland, the sample sizes were very small (largest sample being 18.73g) and a limited range of taxa was recovered. In the 1990s at the Fengate excavations at the Power Station site (1968 – 1997) Scaife (2001: 352) analysed pollen from four profiles associated with the main platform and its immediate environs. This plant macrofossil assessment was carried out only to determine of cultivated and/or economic plants were evident; but since they were absent, no further analysis was undertaken and no assessment/ analysis of plant macrofossils indicative of the natural environment appears to have been considered. Hall and Fischer (1986) have reported on Bronze age macrofossils from the 1984−85 excavations at Flag Fen which are dominated by aquatic and waterside taxa, but argued these results are "likely to include much contamination" (Hall and Fisher 2004). Finally, Gay Wilson (1984) produced a fourth report on Fengate, but the author was unable to consult the full results because unfortunately the microfiche bearing this data has parted company with the book in the University of Birmingham library and although the book is available digitally, the microfiche is not. However, Wilson's (1984: 259) summary of findings does note that the assemblage from Cat's Water was dominated by grassland and aquatic taxa, which is generally consistent with the findings here.

13.4.4 There are a lot of assumptions about Flag Fen and its surrounding area. The 1984 Fengate Excavations report (Pryor 1984: 200) blithely states: "[t]he peat Fens were never permanently settled in antiquity, although it is highly probably they were extensively exploited for hay, grazing and winter protein." In light of the recent discover at Must Farm approximately 2km south of Flag Fen, this statement has been overturned.

13.4.5 Pollen data, much of which is not securely dated, largely informs our understanding of the vegetational history of the Flag Fen archaeological site. Plant macrofossil analyses have been limited (e.g. Scaife 1984) or curtailed (e.g. Smith 2013 – these assessment results were never continued to full analysis) and possibly a bias against the value of waterlogged plant macrofossil analyses at Flag Fen in general has resulted from the remarkably negative 1986 report by Hall and Fisher (1986). Perhaps most damningly, Hall and Fisher (1984: 3) stated:

> *This modest survey of peats associated with a prehistoric structure in a waterlogged environment has provided rather limited information of value to the archaeologist or archaeobotanist. The range of taxa recorded primarily gives evidence of the surrounding*

wetland vegetation, which could in broad terms at least, have been predicted by the context of the site and the nature of the deposits.

13.4.6 It is the author's belief that the brief Hall and Fisher (1984) report appears to be more like a rapid scan than full analysis. Moreover, times have now changed and there is increasing interest to know what plants existed in such areas in the past in order to inform the management of sites of scientific interest (including wetlands) and decisions in relation to re-wilding schemes.

13.5 Recommendation for Further Analysis and Conclusions

13.5.1 In terms of the archaeobotanical assemblages assessed here, the four samples from Trenches 2 and Test-pit 1 are considered the most productive. Given concerns over further deterioration of preservation on site, it is recommended that these samples are taken to full analysis (fully sorted and quantified) to at least capture the extant archaeobotanical data at this juncture.

13.5.2 What is clear from this assessment is that the opportunity to study well-preserved plant macrofossils from Flag Fen may be in jeopardy. As such, regardless of poor preservation or more especially, in cases where preservation appears to be relatively good, it is the author's recommendation that any future opportunities for archaeobotanical sampling at Flag Fen and in the wider area must be taken.

13.5.3 Must Farm is likely to supersede Flag Fen for archaeological importance in the region for the Bronze age and by its very nature – human settlement with remarkable waterlogged preservation – certainly will become the preeminent archaeobotanical dataset for Bronze age England. Nonetheless, the wetlands around Whittlesey provide remarkable preservation of both on-site archaeological and off-site wetland environments, all of which offer the unique opportunity to fully understand both environmental archaeological situations for any area of Britain during the Bronze age.

Table 47: Assessment results for waterlogged plant remains from 2021 Excavations at Flag Fen (FFB21)

Trench Number Sample Number Context Number Description	TR2 <27> 002 Base of sequence	TR2 <26> 003 Middle of sequence	TR5 <11> 049 Base of sequence	TR5 <12> 048 Middle of sequence	TR6 <5> 26 Base of sequence	TR6 <10> 22 Upper middle of sequence		
Volume	500 ml	500 ml	500 ml	500 ml	500 ml	500 ml		
FLOT								
Proportion Scanned	100%	50%	66%	75%	50%	50%		
Latin Binomial							HABITAT	English Common Name
Nymphaea alba L.	-	-	-	1	-	-	W/ SfW	white water-lily
Nymphaea alba L. - internal structure	-	-	1	-	-	-	W/ SfW	white water-lily
Ranunculus acris L./ *repens* L./*bulbosus* L. - type	-	+	-	-	-	-	TG/ TM/ TD	meadow/ creeping/ bulbous buttercup
Ranunculus subgenus BATRACHIUM (DC.) A Gray	++	+++	+	+	+	-	T-D/M/Ws/W	crowfoot
Rubus section Rubus (somewhat beaked seed)	-	-	+	-	-	-	V	bramble/ blackberry
Potentilla anserina L.	-	-	-	-	-	1	G/ Wp	silverweed
Alnus glutinosa (L.) Gaertn. - female involucre fragment	-	-	1	-	-	-	DW/ Ws	alder
Rumex spp.	1	-	-	-	-	-	V	dock
Rumex spp. - within perianth	-	-	-	-	-	+	V	dock
Chenopodium sp.	1	-	-	-	-	-	V	goosefoot
Solanum cf. *dulcamara* L.	-	-	-	-	1	-	Wo/ R/ Ws/ W	bittersweet
Lycopus europaeus L.	+	-	-	-	-	-	F/D/Ws	gypsywort
Mentha spp. - unidentified	+	-	-	-	-	1	-	mint (presumably aquatic)
Bidens cernua L.	-	+	-	-	-	-	M/Ws	nodding bur-marigold
Bidens sp.	+	+	-	-	-	-	T-D/T-M/ T-Ws	bur-marigold
Hydrocotyle vulgaris L.	+	-	-	-	-	-	B/ F/ M/ Ws	marsh pennywort

Trench Number Sample Number Context Number Description	TR2 <27> 002 Base of sequence	TR2 <26> 003 Middle of sequence	TR5 <11> 049 Base of sequence	TR5 <12> 048 Middle of sequence	TR6 <5> 26 Base of sequence	TR6 <10> 22 Upper middle of sequence		
Chaerophyllum temulum L.	-	-	+	-	-	+	G/ WH	rough chervil
cf. *Chaerophyllum temulum* L.	-	-	1	-	-	-	G/ WH	possible rough chervil
Lemna sp.	-	1	-	-	-	-	W/ T-SfW	duckweed
Sagittaria spp./*Alisma* spp.	-	+	-	-	-	1	W/ SfW	arrowhead/ water-plantain
Alisma spp.	++	+	-	-	-	1	W/ SfW	water-plantain
Potamogeton spp.	-	-	+	-	-	-	W/ SfW	pondweed
Iris pseudacorus L.	-	-	-	-	-	1	F/M/Ws	yellow iris
Eriophorum sp.	1	-	-	-	-	-	T-B/T-F	indeterminate cottongrass
Eleocharis palustris (L.) Roem. & Schult./ *uniglumis* (Link) Schult.	1	1	-	-	-	-	TWs/ ?W	common/slender spike-rush
Carex spp. - 2-sided	1	-	-	-	-	-	T-D/ T-Ws	sedge
Carex spp. - 3-sided	-	1	-	-	-	+	T-D/ T-Ws	sedge
Phragmites australis (Cav.) Trin. ex Steud. - leaf fragments	++	-	-	-	++++	++++	ShW/ Ws/ M/ F/ B	common reed
OTHER REMAINS								
Minute (<2mm) rootlets	++++	-	++	-	++++	++++	-	-
Minute (<2mm) unidentified wood fragments	-	-	++++	++++	-	-	-	-
Small (2 - 4 mm) unidentified wood fragments	-	-	+	-	-	-	-	-
Larger (4 - 10 mm) unidentified wood fragments	-	-	-	-	-	-	-	-
Insect fragments (primarily Coleoptera)	+	++	-	+	+	++	-	-
Chara	+	-	-	-	-	-	SfW	green algae
Daphnia	+	-	-	-	-	-	SfW	waterflea
Diptera - puparia	-	+	-	-	-	-	-	fly
Worm cases	+	-	+	-	+	-	-	-

Trench Number	TR2	TR2	TR5	TR5	TR6	TR6		
Sample Number	<27>	<26>	<11>	<12>	<5>	<10>		
Context Number	002	003	049	048	26	22		
Description	Base of sequence	Middle of sequence	Base of sequence	Middle of sequence	Base of sequence	Upper middle of sequence		
HEAVY RESIDUE								
Proportion scanned	33%	50%	25%	33%	33%	33%		
Latin Binomial							HABITAT	English Common Name
Ranunculus acris L./ *repens* L./*bulbosus* L. - type	1	-	-	-	-	-	TG/ TM/ TD	meadow/ creeping/ bulbous buttercup
Ranunculus subgenus BATRACHIUM (DC.) A Gray	++	+	1	-	++++	1	T-D/M/Ws/W	crowfoot
cf. *Lepidium* sp. (dark seed - campestre type)	1	-	-	-	-	-	T-G	pepperwort
Rumex sp.	1	1	-	-	-	-	V	dock
Rumex sp. - with perianth	-	-	-	-	-	1	V	dock
Chenopodium sp.	1	-	-	-	-	-	V	goosefoot
Chenopodium sp./ *Atriplex* sp.	1	-	-	-	-	-	V	goosefoot/ orache
Mentha spp. - unidentified	-	-	-	-	1	-	-	mint (presumably aquatic)
Carduus sp./ Cirisum sp.	1	-	-	-	-	-	TG/ V	thistle
Bidens sp.	1	-	-	-	-	-	T-D/T-M/ T-Ws	bur-marigold
Chaerophyllum temulum L.	-	-	-	-	1	-	G/ WH	rough chervil
Oenanthe spp.	1	-	-	-	-	-	T - D/ Ws/ W	water-dropwort
cf. *Oenanthe* spp. - fragment	-	-	-	-	1	-	T - D/ Ws/ W	possible water-dropwort
Alisma spp.	++	1	-	-	-	1	W/ SfW	water-plantain
Sparganium cf. *emersum* Rehmann/ *angustifolium* Michx.	-	-	-	-	-	1	Ws/ SfW	possible unbranched/ floating bur-reed
Schoenoplectus spp.	-	-	-	-	+	-	T-Ws	club-rush
Eleocharis palustris (L.) Roem. & Schult./ *uniglumis* (Link) Schult.	1	1	-	-	-	-	TWs/ ?W	common/ slender spike-rush
Carex spp. - 3-sided	-	-	-	-	-	+	T-D/ T-Ws	sedge
Phragmites australis (Cav.) Trin. ex Steud. - leaf fragments	+	-	-	-	++++	++	ShW/ Ws/ M/ F/ B	common reed

Trench Number	TR2	TR2	TR5	TR5	TR6	TR6		
Sample Number	<27>	<26>	<11>	<12>	<5>	<10>		
Context Number	002	003	049	048	26	22		
Description	Base of sequence	Middle of sequence	Base of sequence	Middle of sequence	Base of sequence	Upper middle of sequence		
Unidentified	-	-	-	-	1	-	-	-
Unidentified - tree bud	1	-	-	-	-	-	-	-
Unidentified - tree bud scale	-	-	-	-	+	-	-	-
OTHER REMAINS								
Minute (<2mm) herbaceous rootlets	++	-	-	-	++++	-	-	-
Minute (<2mm) unidentified wood fragments	-	++++	++++	++++	-	-	-	-
Small (2 - 4 mm) unidentified wood fragments	++++	++++	++++	++++	++++	+	-	-
Larger (4 - 10 mm) unidentified wood fragments	+	-	++	+++	+	+	-	-
Insect fragments	++	+	+	+	+	+	-	-
Worm cases	+	+	-	-	-	+	-	-

Key to semi-quantitative scale: 1 = 1 item, + = < 5 items, ++ = 5 - 25 items, +++ = 25 - 100 items and ++++ = > 100 items. Nomenclature and taxonomic order follow Stace (2010).

14. APPENDIX 1E: ASSESSMENT OF THE INSECT REMAINS

David Smith (University of Birmingham Environmental Archaeology Services)

14.1 Introduction

14.1.1 This report presents an assessment of the insects from a series of samples taken at Flag Fen, Peterborough from three trenches excavated in 2021 (Table 48). This work was undertaken to establish the extent to which preservation conditions may, or may not, have changed at the site in the last decade.

	Feature	Context No.	Sample No.
Trench 2	*Post-alignment*	[002]	<26>
Trench 2	*Post-alignment*	[003]	<27>
Trench 5	*Platform*	[048]	<12>
Trench 5	*Platform*	[049]	<11>
Test-pit 1	*Off-site*	[22]	<10>
Test-pit 1	*Off-site*	[26]	<5>

Table 48: Samples assessed for insect remains.

14.1.2 This assessment was carried out in order to determine if insect remains were present, if they were well-preserved especially in comparison to Mark Robinsons original work on this type of remains Robinson 1991; 1992) and subsequent assessment work carried by Smith (2013). In addition, it was hoped that this assessment would indicate if the deposits still had potential to help understand and interpret the aquatic environment associated with Flag Fen, its surrounding landscape and if insect remains might help us understand the use and function of the site itself. It also aimed to establish if further analysis of the insect faunas from this excavation is warranted.

14.2 Methods

14.2.1 The samples were processed using the standard method of paraffin flotation as outlined in Kenward et al. (1980). The system for ‘scanning’ faunas, as outlined by Kenward et al. (1985) was followed for this assessment.

14.2.2 When discussing the faunas recovered, the following considerations should be taken into account:

14.2.3 Identifications of any insect remains present are provisional, especially as modern comparatives were not consulted during assessment. In addition, many of the taxa present could be more precisely identified, possibly down to species level, during a full analysis, which can generate information that is more detailed.

14.2.4 The number of insects were rapidly recorded for this assessment and, therefore, are likely to be notional and potentially subjective. As a result, the faunas described here should be regarded as incomplete and possibly biased.

	Post alignment		Platform		offsite	
Trench/Test-pit	2		5		1	
Context	003	002	049	048	026	022
Sample	27	26	11	12	5	10
Weight	6kg	6kg	4kg	5kg	6kg	6kg
Volume	7l	7l	5l	6l	9l	7l
HEMIPTERA						
Family, genus and spp. Indet.	++					
COLEOPTERA						
Carabidae						
Elaphrus spp.	+					
Blethisa multipunctatum (L.)	+					
Dyschirius spp.	+	+				++++
Bembidion spp.	+++	++	+			
Trechus spp.				+		+
Agonum spp.				+		
Pterostichus spp.	++		+	++	++	++
Calathus spp.						
Halididae						
Haliplus spp.	+					
Dytiscidae						
Hygrotus inaequalis (F.)	+					
Hydroporus spp.				+	+	++
Colymbetes fuscus L.				+	+	+
Agabus spp.		+				
Dytiscus spp.						+
Gyrinidae						
Gyrinus spp.						+
Hydraenidae						
Ochthebius spp.	+++++	++	+++++	+++++	+++++	++++
Hydraena spp.						+
Limnebius spp.			+			+++
Hydrophilidae						
Coelostoma orbiculare (F.)	++	++	+	+	+	+++
Enochrus spp.					++	
Laccobius spp.						+
Cercyon spp.	++	+	+	++	++	
Hydrobius fuscipes Leach				+		++
Chaetarthria seminulum (Hbst.)						+
Orthoperidae						
Orthoperus spp.				+		+
Staphylinidae						
Micropeplus spp.					+	
Lesteva spp.						++
Trogophloeus spp.	+				++	+++
Olophrum spp.				+		+
Stenus spp.	++	+		++		+++
Lathrobium spp.				+		

	Post alignment		Platform		offsite	
Trench/Test-pit	2		5		1	
Context	003	002	049	048	026	022
Sample	27	26	11	12	5	10
Philonthus spp.	+	+		++		+
Tachinus spp.				+		
Aleocharinidae Genus & spp. Indet.	++					
Elateridae						
Elateridae Gen. & spp. indet.					+	
Helodidae						
Helodidae Gen. & spp. Indet.					+	
Dryopidae						
Oulimnius spp.	+	+				
Dryops spp.	+	+	+		+	+
Cryptophagidae						
Atomaria spp.		+			+	
Coccinellidae						
Coccidula rufa (Hbst.)		+				
Anobiidae						
Anobium punctatum (Geer)						
Scarabaeidae						
Aphodius spp.	++	++	+	++		++
Phyllopertha horticola (L.)		+				
Scolytidae						
Scolytidae Gen. & Spp. Indet.			+			
Chyrsomelidae						
Donacia/ Plateumaris spp.	+	+	++	++++		+++
Phyllodecta spp.		+				+
Prasocuris phellandrii (L.)	+					
Chaetocnema spp.	+					++
Curculionidae						
Apion spp.	++					
Sitona spp.				+		+
Bagous spp.	+					++
Notaris spp.		+		+		
*Tanysphyrus lemnae (*Payk.)		++	+	+		+++
Ceutorhynchus spp.	+					
Gymnetron spp.	+					+
TRICOPTERA						
Genus and spp. Indet.					+	++++

Table 49: *Insects recovered from Flag Fen 2022 (Nomenclature follows Lucht 1987)*

14.3 Results

14.3.1 The insect taxa recovered are listed in Table 49. The taxonomy follows that of Lucht (1987) for the Coleoptera (beetles). Table 50 indicates the extent of preservation, the relative size of faunas and the degree to which they are interpretable. It also makes further recommendations

and indicates the amount of time required to complete the full analysis of each sample. The insect faunas from Flag Fen 2021 consisted of fragments of beetles (Coleoptera) and caseless caddis flies (Trichoptera spp.). Insect remains often were eroded, fragmented and folded suggesting poor preservation in all three trench sequence samples assessed here. In terms of the numbers of individuals recovered, the faunas are mainly small or moderate in size. Only sample <10> from Test-pit 1 is large in size and well-preserved. The six faunas are all similar in their nature and do provide information on the water conditions present, but often only give a limited indication of the nature of the surrounding landscape. There are no indicators for human settlement or waste deposits. This may mean that their interpretative value is limited.

Trench 2 – Post-alignment [002] <26> and [003] <27>

14.3.2 Samples <26> and <27> produced moderately sized faunas which were both very eroded. The water beetles present are dominated by a range of genera that are associated with slow-flowing or even stagnant waters. For example, Hygrotus inaequalis, Ochthebius spp. and Coelostoma orbiculare (Foster and Friday 2011; Hansen 1986). The Donacia / Plateumaris spp. reed beetles, the leaf beetle Prasocuris phellandrii and the weevil Notaris spp. all are associated with waterside vegetation. The small weevil Tanysphyrus lemnae is only associated with duckweed (Lemna spp.) (Koch 1992). A number of carabid ground beetles; such as, Elaphrus spp., Dyschirius spp. and Blethisa multipunctata are associated with soft muddy banksides on streams/ rivers or bodies of water (Luff 2007). A small number of Aphodius dung beetles and the chaffer Phyllopertha horticola usually are associated with grassland and pasture (Jessop 1986); as are the weevils Apion spp., Ceutorhynchus spp. and Gymnetron spp. There are no indicators for the presence of either woodland or human settlement/ settlement waste materials.

Trench 5 - Platform [048] <12> and [049] <11>

14.3.3 Samples <11> and <12> produced a very small and badly eroded insect fauna made up of a similar range of water beetles that were recovered from Trench 2. Apart from a few fragments of Aphodius dung beetles, which typically indicate grassland or pasture, there are no indicators for nature of the surrounding environment.

Test-pit 1 - Off-site [022] <10> and [026] <5>

14.3.4 Sample <5> produced a small / moderate and eroded insect fauna; whereas, sample <10> was moderate/ large in size and was well-preserved. Both samples contain a similar range of water beetles associated with slow-flowing water as seen in Trench 2. A number of taxa associated with slow-flowing water also were recovered; such as, Hydroporus spp., Agabus spp., Colymbetes fuscus, Limnebius spp., Enochrus spp., Laccobius and Chaetarthria seminulum and the aquatic weevil Bagous spp. The recovery of aquatic leaf beetles (Donacia / Plateumaris spp.) and the Notaris weevils again suggest the presence of stands of waterside vegetation and the recovery of Tanysphyrus lemnae suggest duckweed was present. Sample <10> also contained a small number of dung beetles (Aphodius spp.), clover weevils (Sitona spp.) and the plantain (Plantago spp.) feeding weevil (Gymnetron spp.). This suggests grazing land and/ or pasture was present in the vicinity.

14.4 Discussion

14.4.1 Strikingly, these faunas suggest that the preservation of insects at Flag Fen is now quite poor. This is in clear contrast to the high level of preservation seen and recorded at Flag Fen by

Robinson in the early 1990s. Smith's (2013) assessment of the potential of the insect remains recovered from undated deposits at the same location in 2012 also recorded very good preservation of insects at that time. This unfortunately suggests that preservation at Flag Fen is actively declining and potential already substantially has been lost.

14.4.2 The insects recovered essentially match the faunas recovered by Robinson (1991, 1992) and those described by Smith (2013) though they are much more limited in their extent, range and potential to reconstruct the surrounding landscape. The range of synanthropic species recovered by Smith (2013) such as the woodworm (Anobium punctatum) and mould beetles (Lathridiidae and Cryptophagidae) were not recovered from the 2021 deposits. The most likely explanation is that this results from the recovery of comparatively small and eroded faunas that were sampled in 2021, as compared to earlier interventions at Flag Fen which included archaeoentomological sampling from the 1990s and 2010s.

14.5 Recommendations For Further Analysis

14.5.1 In terms of the insect faunas described here, and the remaining samples from the 2021 excavations at Flag Fen, it is recommended that the faunas from Trench 2 and Test-pit 1 are fully identified. Mainly this is because of their location at Flag Fen rather than any preservation or potential. Certainly, Robinsons 1991 faunas and those from Smith assessment in 2013 had a much higher interpretative value than the faunas recovered here. These faunas will not tell a distinctly different story to that of the Robinson (1991, 1992) analyses and may be duplication of effort, but with much poorer material.

14.5.2 In terms of further excavation at Flag Fen, it is recommended that sampling for insect remains does occur, but there must be a full assessment stage on all samples collected, and as swiftly as feasibly possible, to stabilise and preserve insect remains for analysis. If the insect faunas from further excavation are shown to have an equally poor level of preservation, further analysis may not be warranted. However, going forward, Historic England must recognise the serious deterioration of preservation conditions at Flag Fen (possibly beyond) and more actively support any environmental analysis from the region in light of clearly increasing information loss within the extant environmental archive.

Trench/ Context	Preservation	Size of fauna	Aquatic environment?	Terrestrial landscape?	Recommendation	
2/[003]	Moderately eroded	Moderate	Slow flowing fresh water suggested by a range of water beetles such as *Hygrotus inaequalis, Ochthebius* spp. and *Coelostoma orbiculare* and the aquatic weevil *Bagous* spp. Range of waterside weeds and vegetation suggested by *Donacia/ Plateumaris* spp. and *Prasocuris phellandrii.* Soft muddy bank sides suggested by *Elaphrus* spp. Dyschirius spp. and *Blethisa multipunctatum.*	Grassland and pasture suggested by small numbers of Aphodius spp. dung beetles and Apion spp., Ceutorhynchus and Gymnetron weevils.	Should be taken to full analysis as will produce clear indications as to water conditions and some indication of the nature of the surrounding landscape	1.5hrs (To complete full analysis)
2/[002]	Eroded	Moderate	Slow flowing fresh water suggested by a range of water beetles such as Ochthebius spp. and Coelostoma orbiculare Range of waterside weeds and vegetation suggested by the reed beetles Donacia/ Plateumaris spp and the Notaris spp. weevil. Duck weed by the weevil Tanysphyrus lemnae.	Grassland and pasture suggested by small numbers of Aphodius spp. dung beetles and the chaffer Phyllopertha horticola.	Should be taken to full analysis as will produce some indications as to water conditions and some indication of the nature of the surrounding landscape	1.0hrs
5/[048]	Very eroded	Small	Slow flowing fresh water suggested by a limited range of water beetles such as Ochthebius spp. and Coelostoma orbiculare Range of waterside weeds and vegetation suggested by the reed beetles Donacia/ Plateumaris spp. Duck weed by the weevil Tanysphyrus lemnae.	Aphodius dung beetle may suggest pasture	Limited potential and only really indicates water conditions	0.5hrs

Trench/ Context	Preservation	Size of fauna	Aquatic environment?	Terrestrial landscape?	Recommendation	
5/[049]	Very eroded	Small/moderate	Slow flowing fresh water suggested by a range of water beetles such as *Hydroporus* spp., *Colymbetes fuscus, Ochthebius* spp. and *Coelostoma orbiculare.* Range of waterside weeds and vegetation suggested by the reed beetles *Donacia/ Plateumaris* spp and the *Notaris* spp. weevil. Duck weed by the weevil *Tanysphyrus lemnae*.	*Aphodius* dung beetles and *Sitona* spp clover beetle may indicate grassland	Limited potential and only really indicates water conditions with limited insights into the surrounding landscape	0.5hrs
TP1/[026]	Moderately eroded	Small/moderate	Slow flowing fresh water suggested by a range of water beetles such as *Hydroporus* spp., *Colymbetes fuscus,* and *Ochthebius* spp. *Coelostoma orbiculare, Enochrus* and Helodidae. No indicators of waterside vegetation and poolside conditions	No indication of landscape conditions	Limited potential as only really indicates water conditions	1.0hrs
TP1/[022]	Good	Moderate/large	Slow flowing fresh water suggested by a range of water beetles such as *Dytiscus* spp., *Hydroporus* spp., *Agabus* spp. Colym*betes fuscus, Ochthebius* spp., *Limnebius* spp and *Coelostoma orbiculare* Laccobius spp., *Chaetarthria seminulum* and the aquatic beetle *Bagous* spp. Range of waterside weeds and vegetation suggested by the reed beetles *Donacia/ Plateumaris* spp and the *Notaris* spp. weevil. Duck weed by the weevil *Tanysphyrus lemnae*.	Pasture and grassland indicated by *Aphodius* spp., *Sitona* spp. and *Gymnetron* spp.	Good potential. Very clear indication of water conditions and fairly good indications of surrounding landscape	1.5hrs

Table 50: *Summary of the nature of the insect faunas from Flag Fen 2021.*

15. APPENDIX 1F: ASSESSMENT OF POLLEN SAMPLES

Dr Benjamin Gearey and Dr Emma-J. Hopla

15.1 Introduction

15.1.1 This report outlines the results of palynological assessment of samples from Flag Fen, sampled during assessment excavation by Cambridge Archaeology Unit (CAU). Preservation in situ of the archaeological remains at Flag Fen has long been a concern, due to the position of the local watertable with respect to the organic deposits and the state of the burial environment. A number of monitoring studies have been carried out to determine microbial activity, pH and fluctuations in the groundwater (Brittain, 2004; also Lillie and Cheetham 2002, Davies et al. 2015). These studies indicated the organic archaeology appears to have degraded since initial excavations at the site, with evidence this process has accelerated in recent years (Brittain, 2004: 12). A recent study concluded that: "…much of the Bronze Age wooden structure of Flag Fen is located within the zone of seasonal groundwater level fluctuation and therefore potentially at risk of enhanced degradation relative to wood in the underlying zone of permanent saturation." (Davies et al. 2015: 52). The impact of this on the palaeoenvironmental record was not assessed, although other data are available (see below).

15.2 Methods

15.2.1 Palaeoenvironmental assessments (including insects and plant remains, reported separately, see Appendix 1D and 1E) were carried out on sub-samples recovered from excavations by CAU in 2021. Monolith samples were collected from the following Trenches and sub-sampling for pollen assessment carried out in the Environmental Laboratory, University of Birmingham:

15.2.2 Trench 2 was excavated over the post alignment; five sub-samples [context numbers]. 0.0, 0.8 [001], 0.16 [002], 0.32 and 0.40m [003]. The

15.2.3 Trench 5 was excavated over the 'platform'; four sub-samples; 0.0, 0.8 [046], 0.16, 0.28m [047]

15.2.4 Test-pit 1 excavated as an 'off site' sequence: seven sub-samples. Sample Tin 4: 0.00.16m [021], 0.32, 0.48m [022]. Sample Tin 1; 0.0m [025], 0.16, 0.32m [026]

15.2.5 Samples of 1cc were prepared using standard extraction approaches including HF treatment and Acetylation. A count of at least 125 total land pollen (TLP) was attempted. Pollen nomenclature largely follows Moore et al. (1991). Condition of the palynomorphs was assessed on a per sample basis, using a semi-quantitative scheme (one to five) as per the following scale:

1 = Very Poor: Strong evidence of chemical and physical degradation (c. 70-100% grains counted), critical ID's to species level would be very difficult or impossible for many groups

2 = Poor: (c. 40-70%) of grains showing degradation

3 = Medium: (c. 20-40%) of grains showing degradation

4 = Good: some grains might have evidence of degradation (c.10-20%) but mainly identifiable

5 = Very good: all grains identifiable with negligible/no evidence of degradation.

15.2.6 Assessment of individual grain conditions was not carried out at this stage. Pollen concentration was also assessed on a semi-quantitative five point scale, where 1=very low concentration and 5=very high concentrations.

15.3 Results

15.3.1 The results are presented in Table 51 (including m OD of sample depths); brief summaries of each trench sequence follows:

Trench 2 (post alignment)

15.3.2 The spectra are dominated by arboreal taxa *Alnus glutinosa* (alder), with some *Betula* (birch) *Corylus avellana*-type (hazel) and *Quercus* (oak) with herbs in the form of Poaceae (wild grasses) and Cyperaceae (sedges) well represented, reflecting a wet alder carr, with aquatics in the form of *Sparganium* (burr-reeds) and *Typha latifolia*-type (reedmaces etc.). The overall diversity of recorded taxa is rather low, but this is generally a feature of sequences from the basin, and is to be expected at assessment level counts.

15.3.3 Overall, both the concentration and preservation of pollen deteriorates with depth down profile (from 5, 4 respectively at the top, to 0, 1 in the lowermost sample). This gradient is reflected most clearly in the reduction in the TLP count obtained per sample, with 145 grains (0.0m) to only 4 grains (0.40m). Preservation and concentration appear to be especially poor in Context [003].

Trench 5 (platform)

15.3.4 As for Trench 2 (above), the pollen spectra are dominated by trees and shrubs, with grasses and sedges also well represented. Overall, the concentration and preservation of pollen in these four samples is adequate (scores of 3/4, 3 respectively), with TLP counts of over 125 obtained for all samples, and low percentages of unidentifiable grains. There is no discernible difference in preservation/concentration across contexts or depth.

Test-pit 1 (offsite/environmental)

15.3.5 The spectra are again very similar to those of the previous two trenches (above). The seven samples from this trench do not display significant variation, with adequate concentrations and preservation of pollen (2/3, 3 respectively), with one sample, effectively mid-way down the sequence, (Tin 4, 0.0m [021]) displaying slightly higher pollen concentrations (4) and preservation (4). Again, counts for unidentifiable pollen are rather low and TLP counts of over 125 grains were obtained for all the samples.

15.4 Discussion

15.4.1 Overall, it is difficult on the basis of these data to draw firm conclusions concerning the impact, if any, of drainage/dewatering of the organic deposits on the pollen record. In general, the preservation of samples from Trench 2 appears to be the worst, although the pattern indicates that this increases at depth, rather than up profile (see also below). Preservation and concentration of pollen in Trench 5 and Test-pit 1 can be categorised as ‘adequate’, if not excellent.

Raw Count	Test-pit 1 <1>			Test-pit 1 <4>				Trench 2 <24>					Trench 5 <14>			
	0cm	16cm	32cm	0cm	16cm	32cm	48cm	0cm	8cm	16cm	32cm	40cm	0cm	8cm	16cm	28cm
mOD	-0.6	-0.76	-0.92	0.6	0.44	0.28	0.12	0.85	0.77	0.69	0.53	0.45	0.55	0.47	0.39	0.27
TREES AND SHRUBS																
Alnus	28	9	52	16	3	8	27	115	26	1	4	0	8	15	46	64
Betula	1	4	2	2	0	5	6	1	0	2	4	0	4	6	5	10
Corylus avellana-type	13	16	18	8	3	9	8	7	9	0	2	1	6	6	4	9
Hedera helix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pinus	0	0	1	0	0	0	1	1	1	1	1	0	0	2	1	1
Quercus	16	21	10	3	6	7	8	4	15	4	3	0	8	13	11	13
Salix	15	1	0	2	8	2	12	6	7	0	0	0	1	5	17	12
Tilia	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	1
Ulmus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	73	52	86	33	20	31	62	134	58	8	14	1	27	47	84	112
HERBS																
Poaceae	17	91	5	70	86	57	35	6	31	5	16	2	51	11	16	5
Cyperaceae	42	24	36	36	20	37	30	5	35	9	14	0	38	65	36	18
Apiaceae	9	0	0	3	0	0	4	0	2	0	0	1	2	3	6	1
Artemesia	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0
Caryophyllaceae	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1
Chenopodiaceae	1	0	0	0	1	0	0	0	4	0	0	0	0	1	3	0
Cirsium-type	0	0	0	2	0	0	0	0	0	1	0	0	0	1	2	0
Filipendula	0	0	1	1	1	2	2	0	1	0	0	0	0	1	1	1
Lactuceae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Plantago lanceolata	3	2	0	1	1	0	0	0	2	3	0	0	6	4	0	0
Potentilla-type	0	0	0	0	0	4	0	0	0	1	0	0	0	1	0	0
Ranunculus-type	1	0	0	0	1	0	0	0	0	1	0	0	1	2	1	0
Thalictrum	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0
Urtica	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
TOTAL	73	117	43	114	113	100	72	11	76	22	30	3	101	89	66	26
AQUATICS																
Sparganium	28	6	2	6	8	24	18	2	25	6	1	0	14	22	16	6
Typha latifolia	0	0	0	0	0	3	1	0	0	0	0	0	1	2	0	0
TOTAL	28	6	2	6	8	27	19	2	25	6	1	0	15	24	16	6
SPORES																
Pteropsida (monolete) indet.	13	2	5	8	25	98	15	1	13	11	10	0	90	34	24	8
Pteridium	1	0	6	0	0	4	0	1	0	0	0	0	0	0	0	0
TOTAL	14	2	11	8	25	102	15	2	13	11	10	0	90	34	24	8
UNIDENTIFIED	4	0	3	0	7	1	9	1	4	3	11	0	0	7	5	0
TOTAL	380	354	287	322	339	521	345	299	348	97	121	8	466	395	385	304
TLP	146	169	129	147	133	131	134	145	134	30	44	4	128	136	150	138
CONCENTRATION	3	4	3	4	3	2,3	2,3	5	2,3	1	1	0	3	3	3,4	3,4
PRESERVATION	3,4	4	2,3	4	3	3	3	4	2,3	3	2	1	3	3	3	3,4

Table 51a. Pollen results (raw count).

Percentages	Test-pit 1 <1>			Test-pit 1 <4>				Trench 2 <24>					Trench 5 <14>			
	0cm	16cm	32cm	0cm	16cm	32cm	48cm	0cm	8cm	16cm	32cm	40cm	0cm	8cm	16cm	28cm
mOD	-0.6	-0.76	-0.92	0.6	0.44	0.28	0.12	0.85	0.77	0.69	0.53	0.45	0.55	0.47	0.39	0.27
TREES AND SHRUBS																
Alnus	19.2	5.3	40.3	10.9	2.3	6.1	20.1	79.3	19.4	3.3	9.1	0.0	6.3	11.0	30.7	46.4
Betula	0.7	2.4	1.6	1.4	0.0	3.8	4.5	0.7	0.0	6.7	9.1	0.0	3.1	4.4	3.3	7.2
Corylus avellana-type	8.9	9.5	14.0	5.4	2.3	6.9	6.0	4.8	6.7	0.0	4.5	25.0	4.7	4.4	2.7	6.5
Hedera helix	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Pinus	0.0	0.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	2.0	1.0	1.0
Quercus	16.0	21.0	10.0	3.0	6.0	7.0	8.0	4.0	15.0	4.0	3.0	0.0	8.0	13.0	11.0	13.0
Salix	15.0	1.0	0.0	2.0	8.0	2.0	12.0	6.0	7.0	0.0	0.0	0.0	1.0	5.0	17.0	12.0
Tilia	0.0	0.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Ulmus	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
TOTAL (TLP)	59.8	40.2	69.8	24.7	18.5	25.8	51.6	95.8	49.1	15.0	26.7	25.0	23.1	39.9	65.7	88.9
HERBS																
Poaceae	11.64	53.85	3.88	47.62	64.66	43.51	26.12	4.14	23.13	16.67	36.36	50.00	39.84	8.09	10.67	3.62
Cyperaceae	28.77	14.20	27.91	24.49	15.04	28.24	22.39	3.45	26.12	30.00	31.82	0.00	29.69	47.79	24.00	13.04
Apiaceae	6.16	0.00	0.00	2.04	0.00	0.00	2.99	0.00	1.49	0.00	0.00	25.00	1.56	2.21	4.00	0.72
Artemesia	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.34	0.00	0.00	0.00
Caryophyllaceae	0.00	0.00	0.00	0.68	0.00	0.00	0.75	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.72
Chenopodiaceae	0.68	0.00	0.00	0.00	0.75	0.00	0.00	0.00	2.99	0.00	0.00	0.00	0.00	0.74	2.00	0.00
Cirsium-type	0.00	0.00	0.00	1.36	0.00	0.00	0.00	0.00	0.00	3.33	0.00	0.00	0.00	0.74	1.33	0.00
Filipendula	0.00	0.00	0.78	0.68	0.75	1.53	1.49	0.00	0.75	0.00	0.00	0.00	0.00	0.74	0.67	0.72
Lactuceae	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00
Plantago lanceolata	2.05	1.18	0.00	0.68	0.75	0.00	0.00	0.00	1.49	10.00	0.00	0.00	4.69	2.94	0.00	0.00
Potentilla-type	0.00	0.00	0.00	0.00	0.00	3.05	0.00	0.00	0.00	3.33	0.00	0.00	0.00	0.74	0.00	0.00
Ranunculus-type	0.68	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	3.33	0.00	0.00	0.78	1.47	0.67	0.00
Thalictrum	0.00	0.00	0.00	0.00	1.50	0.00	0.00	0.00	0.00	3.33	0.00	0.00	0.00	0.00	0.00	0.00
Urtica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL (TLP)	50.00	69.23	33.33	77.55	84.96	76.34	53.73	7.59	56.72	73.33	68.18	75.00	78.91	65.44	44.00	18.84
AQUATICS																
Sparganium	28	6	2	6	8	24	18	2	25	6	1	0	14	22	16	6
Typha latifolia	0	0	0	0	0	3	1	0	0	0	0	0	1	2	0	0
TOTAL	28	6	2	6	8	27	19	2	25	6	1	0	15	24	16	6
SPORES																
Pteropsida (monolete) indet.	13	2	5	8	25	98	15	1	13	11	10	0	90	34	24	8
Pteridium	1	0	6	0	0	4	0	1	0	0	0	0	0	0	0	0
TOTAL	14	2	11	8	25	102	15	2	13	11	10	0	90	34	24	8
UNIDENTIFIED	4	0	3	0	7	1	9	1	4	3	11	0	0	7	5	0
TOTAL	380	354	287	322	339	521	345	299	348	97	121	8	466	395	385	304
TLP	146	169	129	147	133	131	134	145	134	30	44	4	128	136	150	138
CONCENTRATION	3	4	3	4	3	2,3	2,3	5	2,3	1	1	0	3	3	3,4	3,4
PRESERVATION	3,4	4	2,3	4	3	3	3	4	2,3	3	2	1	3	3	3	3,4

Table 51b. Pollen results (percentages).

15.5 Fenland Archaeological Trust

15.5.1 In terms of previous analyses from the Flag Fen Basin, Scaife (2001: 352) studied plant remains from the post-alignment excavations at the Power Station site (1986–1997) with analyses of pollen from four profiles associated with the main platform and its immediate environs. The plant macrofossil assessment was only carried out to determine if cultivated and/or economic plants were evident; but since they were absent, no further analysis was undertaken. Hall and Fischer (1986) reported on Bronze Age macrofossils from the 1984−85 excavations at Flag Fen, but concluded that these results are "…likely to include much contamination…".

15.6 Dig Ventures

15.6.1 In 2011, Dig Ventures carried out a season of archaeological excavation with the aim of assessing the state of preservation of the organic archaeological remains through a series of test pit excavations to recover samples of archaeological wood for analysis (Wilkens et al., 2012). As part of this programme, Birmingham Archaeo-Environmental (University of Birmingham) took a series of samples for palaeoenvironmental assessments, aimed at determining the state of preservation of the pollen, insect and plant macrofossil records from three test pits (Gearey et al., 2013). Very little study had been carried out on the palaeoenvironmental record since the original investigations at the site (Pryor, 2001) and the impact of the deterioration of the burial environment referred to above, is poorly understood.

15.6.2 The three test pits were all situated directly over the timber alignment (and one over the edge of the putative 'platform'; TP1) and thus directly associated with the organic archaeology. The sampling strategy was designed to recover samples of wet-preserved sediment from the three test pits. Assessment of the archaeological wood from the test pits was also carried out separately (Panter 2013). Continuous monolith sequences were sampled from each test pit for pollen assessment and associated bulk samples for General Biological Assessment (waterlogged plant remains and beetles) were also collected in spits of 10 to 20cm from open faces adjacent to the monoliths. In Test Pit 1, eleven spits were collected between 1.03m below ground surface and 2.27m below ground surface, usually in 10cm intervals, except for the top and bottom spits.

15.6.3 Plant macrofossils were assessed from alternate samples (odd numbers) for TP1 and the complete sequence from TP2 and the two samples only from TP3. This decision was cost related, as the purpose of the original assessment was to establish whether sub-fossil remains were well preserved and potentially interpretable throughout the section. Four spits between 1.04m and 1.84m were sampled in Test Pit 2 at 20cm intervals. Three samples (2 bulk samples and one spit sample) were collected from Test Pit 3.

15.6.4 All bulk samples from Test Pits 2 and 3 were analysed, with the exception of sample 1 from Test Pit 3, context 3002; which was extremely clayey and did not disaggregate. The samples from Test Pits 2 and 3 focused solely on the 'fen peat' deposits, which contain the organic archaeological remains of the post-row and platform. The Test Pit 1 sequence includes samples from this fen peat unit (1.27, 1.51 and 1.75m) and also from the underlying organic muds/gytjja (1.99m) and basal organic silts (2.23m). In Test Pit 1, good pollen preservation was evident in the uppermost sample (1.27m) but poor preservation and concentration in two other samples from the fen peat (1.51 and 1.75m). Likewise, preservation and concentration was variable in Test Pit 2 and apparently best in Test Pit 3.

15.6.5 The preservation of the insect remains on the other hand appeared to be much better. The 5 point recording scheme of Kenward (in Davis et al. 2002) for fragmentation, preservation and the extent of reddening of material for insect analysis was employed and in all the faunas examined preservation was excellent. Despite the fact that the upper deposits appear to be situated above the watertable for some of the year at least, preservation of insect remains does not yet appear to have been compromised. This pattern is very similar to the results of recent preservation assessments of sub-fossil remains from the later prehistoric wetland site of Beccles, Suffolk, where insect remains seem to have survived desiccation much better than pollen (Gearey et al., 2016). However, the more recent analyses of both the insect and plant macrofossil remains, indicate that this situation might have changed, presenting a possible scenario whereby palaeoenvironmental remains are degrading over timescales that can be measured in years.

15.6.6 Both sets of pollen assessments (as reported here and for Dig Ventures) thus indicate variable preservation in the sediments of the Flag Fen Basin. Scaife (2001) did not report any issues regarding low pollen concentrations or poor preservation in his analyses, which may indicate the impact of recent changes in the burial environment. Assessment of preservation of palaeoenvironmental proxies is always complicated by the fact that it is necessary to disentangle the impact of processes that might have affected the quality of preservation during antiquity from recent or sub-recent changes in the burial environment.

15.6.7 For Trench 2, preservation and concentration deteriorates with depth, perhaps reflecting less favourable conditions during sediment accumulation rather than recent processes related to drainage and desiccation (possibly also related in the previous pollen data from Dig Ventures' Test Pit 1, see above). Further, more detailed work would be required to investigate this (see below) and to clarify to what extent the pollen record is actively deteriorating and to better assess the rate at which this is happening.

15.7 Conclusions and Further Work

15.7.1 The assessments reported here imply that the preservation of pollen in Test-pit 1 is slightly better than Trench 2 or Trench 5, but it is hard on the basis of these rather limited data to determine a very clear picture of differences within and between trenches. Further, full analyses of sub-samples would be necessary to identify if there are marked variations in pollen preservation across the deposits and to assess the possible impact of drainage on the archive. This could be achieved by closer interval sub-sampling (0.04m) and possibly enhanced recording of the condition of individual grains. Such research in conjunction with further analyses of insects and plant macrofossils would provide a clearer picture of the overall condition of the palaeoenvironmental record and allow a more informed understanding of the relationship with drainage and the deterioration of the archaeological record (see Albert 2016; Dark, 2017).

16. APPENDIX 1G: PREHISTORIC POTTERY

Matthew Brudenell

16.1 Summary

16.1.1 The investigations at Flag Fen yielded ten sherds of prehistoric pottery (69g), with a mean sherd weight (MSW) of 6.9g. All the pottery was recovered from Trench 2, with nine sherds (62g) found clustered together in the centre of the trench. These are interpreted as belonging to the same vessel: the partial profile of a plain Late Bronze Age coarseware bowl dated c. 1150-800 BC.

16.2 Introduction

16.2.1 The investigations at Flag Fen yielded a small assemblage of plain handmade prehistoric pottery totalling ten sherds weighing 69g, with a mean sherd weight (MSW) of 6.9g. All the pottery was recovered from Trench 2, with nine sherds deriving (62g) from Context 2 and one sherd (7g) from Context 3. The material from Context 2 was tightly clustered toward the centre of the Trench. Though none of the sherds refit, these are likely to belong to the same vessel: a round-bodied Late Bronze Age coarseware bowl dated on typo-chronological grounds to c. 1150-800 BC. The sherd from Context 3 was recovered at the far northern end of the trench. The fabric of this sherd is different to those from Context 2 but can only be assigned a generic Bronze Age to later Iron Age date.

16.2.2 This report provides a quantified summary of the pottery, highlighting comparisons with other contemporary ceramics recovered from Flag Fen and the wider Flag Fen Basin.

16.3 Methodology

16.3.1 All the prehistoric pottery has been fully recorded following the recommendations laid out by the Prehistoric Ceramic Research Group (2011). After a full inspection of the assemblage, two fabric types were identified on the basis of dominant inclusion type, density and modal size. All sherds were counted, weighed (to the nearest whole gram) and assigned to fabric type. Sherd type was recorded, along with evidence for surface treatment and the presence of soot and/or residue. Rim and base forms were described using a codified system recorded in the catalogue, and were assigned vessel numbers.

16.3.2 All pottery was subject to sherd size analysis. Sherds less than 4cm in diameter were classified as ‘small’ (six sherds) and sherds measuring 4-8cm were classified as ‘medium’ (four sherds). There were no ‘large’ sherds measuring over 8cm; the largest sherd was 6cm. The quantified data is presented on an Excel data sheet held with the site archive.

Fabrics

V1: Common fine to coarse poorly-sorted plate-like voids (1-4mm in size) from leached shell, in a soft, fine silky textured clay matrix. Voids are visible at the surface of the sherds, and in cross-section on sherd breaks. Fragments of partially dissolved shell are still visible in one sherd (3g; SF 7, Context 2, Trench 2). Nine sherds, 62g, all from Context 2.

Local parallels: The fabric is broadly similar to Late Bronze Age fabric S1 at Must Farm (Brudenell forthcoming), Horsey Bridge (Brudenell 2022), and The Elliot Site (Brudenell and Knight 2009, 97), though at Must Farm the shell is fully intact. They also have characteristicsin

common with the descriptions of Fabrics 2 and 6 for pottery from the Power Station and Area 6 investigations at Flag Fen (Barrett 2001, 249-50).

V2: Moderate medium linear and oval voids (2-4mm in size), probably from dissolved shell, and possibly grog (?), in a fine textured clay matrix. One sherd, 7g from Context 3.

Local parallels: The fabric is broadly similar to Late Bronze Age fabric V1 at Must Farm (Brudenell forthcoming) and Horsey Bridge (Brudenell 2022).

16.4 Condition

16.4.1 The sherds are in a stable, moderately well-preserved condition. They are classified as either 'small' or 'medium' in size, ranging from 1.5-6.0cm in maximum length, with a fairly low MSW of 6.9g. The sherds have a 'corky' appearance due to the leaching of shell, and all have slightly rounded, weathered/abraded edges. However, patches of carbonised residue survive on three of the sherd interiors (28g). In general, the condition seems broadly consistent with that described for other later prehistoric ceramics recovered from Flag Fen (Barrett 2001; Pryor 2010a; b).

16.5 Assemblage summaries

Trench 2 – [02]

16.5.1 A group of nine sherds (62g) was recovered from Context 2 (SF nos. 4-10), clustered in the centre of the trench. The sherds are all in fabric V1 and are very similar in appearance, having mottled mid to dark grey exterior surfaces with wall thicknesses of 6-8mm. Though none of the fragments refit, their proximity and similarities in attributes suggest they belong to the same vessel. The group includes a single diagnostic sherd (SF 6) comprising the rim and shoulder of a round-bodied coarseware bowl (Brudenell 2012; Form K) with a short everted tapered rim with a marked internal neck bevel. The form is typical of Late Bronze Age Plainware Post Deverel-Rimbury (PDR) assemblages from the region dated c. 1150-800 BC (Barrett 1980; Brudenell 2012).

16.5.2 Three of the sherds retain (28g) carbonised residue on their interior surface.

Trench 2 – [03]

16.5.3 A single sherd in fabric V2 was recovered at the northern end of the trench in Context 3 (SF 18). The sherd is abraded and is either part of a base or weakly defined shoulder. The sherd is not closely datable and can only be assigned a broad Bronze Age to later Iron Age date.

16.6 Discussion

16.6.1 The prehistoric sherds recovered from Context 2, Trench 2 (nine sherds, 62g) are interpreted as non-adjoining fragments from a single round-bodied Late Bronze Age coarseware bowl; a form typical of Plainware PDR assemblages from the region (Barrett 1980; Brudenell 2012). The bowl is far from complete (less than 10% represented), and the mouth diameter and height cannot be established. The remaining sherd in the assemblage from Context 3 (7g, fabric V2) cannot be closely dated.

16.6.2 The bowl from Context 2 finds parallel with other PDR ceramics recovered from Fag Fen, including material from the Power Station and Area 6 investigations (Barrett 2021, closest

parallel on page 252, Fig 9.3, no. 16). The condition is also similar to material previously described from the site (Pryor 2010a; b). More broadly, it joins a relatively small but growing group of Late Bronze Age assemblages recovered from the wider Flag Fen Basin, the exemplar for which is the material from Must Farm (Brudenell forthcoming).

16.7 Recommendations

Trench 2 assemblage

16.7.1 All the pottery has been fully recorded and no further quantification is required. However, it is recommended that the partial vessel profile of the bowl (SF 6) is illustrated.

Flag Fen prehistoric pottery

16.7.2 1.7.2 No complete overview of the prehistoric pottery from Flag Fen has been attempted for more than 20 years (Barrett 2001). Understandings of the character, date and composition of prehistoric ceramic assemblages from the wider Basin, however, have changed significantly in the intervening years, the results of which have implications for the material from Flag Fen and its interpretation. A full re-quantification and review of the Flag Fen prehistoric pottery is now needed to better understand the chronology, distribution, and depositional dynamics of ceramics at the monument. Questions to be addressed concern how much of the material is contemporary with the construction life of the alignment (the later Middle Bronze Age and first part of the Later Bronze Age), and how much post-dates it, i.e., its later use-life/post-decay activity at the end of the Bronze Age and Iron Age. Questions remain as to why pottery is present along the alignment, whether there are meaningful patterns or concentration to this material (e.g., is there more pottery from the ‘platform’?), and what these might reveal about activity and occupation.

17. APPENDIX 1H: FLINT

Emily Banfield

17.1 Summary

17.1.1 The 2021 excavations at Flag Fen produced 5 worked flints weighing 16.6g. The assemblage comprises a small selection of flakes that accord with types typically encountered in assemblages dated to the Neolithic to Early Bronze Age periods.

17.2 Introduction and methodology

17.2.1 All specimens were analysed macroscopically, with inspection at a magnification of x30 as required. Classification of artefacts was undertaken following standard examples (for example, see Ballin 2021 and Butler 2005).

17.2.2 This report provides a quantification and summary of the worked flint assemblage, highlights the potential of the material, and includes recommendations for further work.

17.3 Character of the assemblage

17.3.1 The flint comprising this small assemblage is of good quality, fresh and in a good state of preservation. Two specimens appear to have been struck from flakes that were already heavily patinated, with the fresh surfaces preserved in the buried soil that they were recovered from.

17.4 Contextual summary

17.4.1 All specimens derive from the buried soil beneath the timber alignment [003].

17.5 Discussion

17.5.1 This flint assemblage comprises a combination of secondary and tertiary flakes struck from mid-brown and black-grey mottled flint (Table 52). Two of these <1015> and <1016> have been struck from flakes that were already heavily patinated, suggesting the reworking of older pieces. Only one specimen <1014> evidences retouch with minute working to produce a serrated edge.

Cat No.	Qty	Wt(g)	Notes	Context	Context description	Trench no.	SF No.	Secondary flake	Tertiary flake
1013	1	3.8	Mid brown mottled flint	003	Buried soil beneath post alignment	2	11		1
1014	1	0.8	Mid brown flint	003	Buried soil beneath post alignment	2	16	1	

Cat No.	Qty	Wt(g)	Notes	Context	Context description	Trench no.	SF No.	Secondary flake	Tertiary flake
1015	1	6.6	Black/grey mottled flint. Flake struck from a heavily patinated piece with some cortex intact	003	Buried soil beneath post alignment	2	17	1	
1016	1	4.8	Mid brown mottled flint. Flake struck from a patinated piece	003	Buried soil beneath post alignment	2	18		
1017	1	0.6	Mid brown mottled flint	003	Buried soil beneath post alignment	2	19		1

Table 52

17.6 Statement of potential

17.6.1 Whilst this assemblage is small, it nevertheless contributes to understanding of the prehistoric Flag Fen environs, which are of international significance. The data holds potential utility for folding into ongoing narratives of activity at Flag Fen, thereby contributing to broader understandings of human response to wetland sites.

17.7 Recommendations for further work

17.7.1 More complete analysis of assemblage should be undertaken, including records of metric data

17.7.2 Detailed descriptions of key pieces should be included in the full archive report

17.7.3 The full archive report should include illustrations of key artefacts

17.8 Discard

17.8.1 All specimens should be retained for future research.

18. APPENDIX 1I: HUMAN OSTEOLOGY

Ben Neal

18.1 Introduction

18.1.1 Three disarticulated human bone elements from Trench 2 are discussed.

18.2 Methodology

18.2.1 Age at death estimation (Table 53) was based on the degree of epiphyseal and apophyseal union (Cunningham et al. 2016). Zonation followed the criteria set out by Knüsel & Outram (2004). Stages of preservation followed the notation system developed by Mckinley (2004: 16) (Table 54). Bone dimension was measured using a 150mm digital sliding calliper (with a resolution of 0.01mm and accuracy of ± 0.02mm). The assemblage was studied for any salient traumatic and pathological change referencing paleopathological and modern clinical examples.

Sub-Adult				Adult				
Neonate	Infant	Juvenile	Adolescent	Adult	YA	YMA	OMA	MA
<6months	0-4	5-12	13-18	18+	18-25	26-35	36-45	46+

***Table 53**: Age estimation. YA = Young Adult. YMA = Young Middle Adult. OMA = Old Middle Adult. MA = Mature Adult.*

Attribute	Score	Definition
high	0	Surface morphology clearly visible with fresh appearance to bone and no modifications
	1	Slight and patchy surface erosion
medium	2	More extensive surface erosion than grade 1 with deeper surface penetration
	3	Most of bone surface affected by some degree of erosion; general morphology maintained but detail of parts of surface masked by erosive action.
low	4	All of bone surface affected by erosive action; general profile maintained and depth of modification not uniform across whole surface.
	5	Heavy erosion across whole surface, completely masking normal surface morphology, with some modification
Very low	5+	As grade 5 but with extensive penetrating erosion resulting in modification of profile

***Table 54:** Skeletal preservation.*

18.3 Results

18.3.1 The following two tables summarise the human bone and its condition.

SF. No.	Context	Position	Age	Sex	Element	Side	Zone
2	001	disart.	18+	indet.	Humerus	right	1,2,11
14	002	disart.	18+	indet.	Thoracic vertebrae (lower)	axial	complete
15	002	disart.	18+	indet.	Thoracic vertebrae (upper)	axial	complete

Table 55: *Summary. disart.= discarticulated. indet.= indeterminate.*

SF. No.	Preservation	Other Taphonomy	Pathology
2	1	Dark-brown stained, spiral/sawtoothed fracture margins, longitudinal cracking, soft sheen patina	None observed
14	1	Dark-brown stained, soft sheen patina	Singular Schmorl's node on the superior and inferior endplate: superior = 3.74mm deep, c.10mm dia. Inferior = 2.94mm deep, c.9mm dia.
15	1	Dark-brown stained, soft sheen patina	None observed

Table 56: *Summary of condition.*

18.4 Provenance of the material in Trench 2

18.4.1 SF. 2 was located within the overlying peat matrix of the wood mass associated with the post-alignments. SF.2 was part of a cluster of artefacts including a small group of potsherds and two pieces of animal bone.

18.4.2 SF.14 and SF.15 were located to the south of the main wood mass but within the same silty-peat matrix and in the vicinity of the in situ tree-stump.

18.5 Discussion

18.5.1 Although this disarticulated assemblage was recovered from two separate contexts, the morphometric character and MNI of the bone assemblage suggests a single individual.

18.5.2 Schmorl's nodes seen on the lower thoracic vertebrae (SF.14) indicate small herniation's of the intervertebral disc's nucleus pulpous; although this is age related, the condition is essentially a physiological process rather than a disease and often inevitable where a constant erect posture puts continuous increased pressure on the spine (Ombregt 2013).

18.5.3 The post-mortem fracture patterns of the humeral fragment (SF.2) suggest variably timed agency; the curved and saw-toothed fracturing suggests breakage when the bone was relatively fresh – or at least when the collagen content of the bone was high enough to offer elastic resistance before failure.

18.5.4 The soft sheen patina on all the bone elements indicates a polishing action; a number of agencies can be attributable, from repeated handling to extended/repeated contact with a fine grain substrate or a similar density material to bone.

18.6 Statement of potential

18.6.1 The research potential of this small assemblage lies in its relationship to the post-alignment and, in particular, its relationship to the small number of human bones excavated at the adjacent Power Station (25 pieces in total) and Platform (3 pieces in total) sites (Halstead, Cameron and Forbes 2001).

18.7 Recommendations

18.7.1 If phasing of the bone is uncertain, it is recommended samples are taken for radiocarbon analysis (see Appendix 1K). If the polishing agency wants to be differentiated, analysis using microscopy would be desirable.

19. APPENDIX 1J: FAUNAL REMAINS

Vida Rajkovača

19.1.1 A small assemblage of animal bone came from Trenches 2 and 5. Trench 2 contained four individual finds of faunal remains, fish and avian fauna were represented alongside the cow tibia and the heavily eroded pig-sized limb bone fragment. Although this material showed poor state of surface preservation, it was possible to positively identify a pike (Table 57). Recovered from Trench 5 was a group of extremely well-preserved horse elements, most likely all of one adult individual standing 148cm at shoulder height. Left and right tibiae were identified, right femur fragment, left humerus fragment and a complete third metatarsus which was used for withers estimate calculation.

Trench	Context	SF.no.	Species	Element
2	[001]	1	Pike	Opercular
2	[001]	3	Pig-sized	Limb bone fragment
2	[002]	12	Unidentified Bird (?*Galliformes*)	Coracoid
2	[002]	13	Cow	Tibia
5	[043]	NA	Horse	Femur, Tibiae, MT3, Humerus, Vert, Rib (same individual)

Table 57. *List of animal bone specimens recovered from Trenches 2 and 5.*

19.1.2 The position of Trench 2 finds and their association with the post-alignment clearly indicate Bronze Age date for this material, and the presence of pike, cattle and pig-sized elements represent expected pattern for this period in this part of the Fen basin. The coracoid is heavily eroded and almost certainly not of domestic chicken, but probably of the order of closely related Galliformes. The horse bone group is evidently of later date, most likely associated with the nearby Roman road activities, only further supporting the significance of this animal in maintaining a network of settlements across the region.

20. APPENDIX 1K: HUMAN BONE: RADIOCARBON AND STABLE ISOTOPE ANALYSIS

Peter Marshall

20.1.1 The three radiocarbon measurements (Table 58) are statistically consistent at the 5% significance level (T'=0.5, T'(5%)=6.0, v=2) and could therefore be of the same actual age. This therefore provides further support for the interpretation that this small disarticulated assemblage, although recovered from two separate contexts, derives from a single individual. The ?individual died in the third–fourth centuries cal BC (Fig 39) and is therefore considerably younger than the post-alignment.

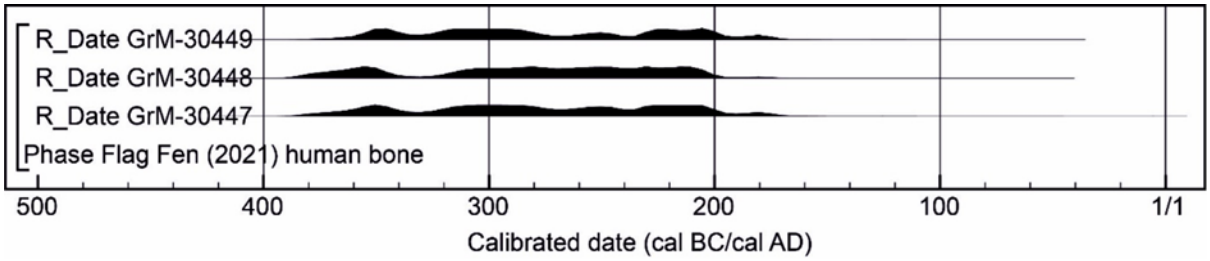

Figure 39: Probability distributions of dates from Flag Fen (2021) human bone (Trench 2)

Lab No.	Sample reference, material & context	$\delta^{13}C_{IRMS}$ (‰)	$\delta^{15}N_{IRMS}$ (‰)	C/N ratio	Radiocarbon age (BP)	Calibrated date (95% probability)
GrM-30447	**SF2.** Human bone, disarticulated adult, right humerus, from within the overlying peat matrix of the wood mass associated with the post-alignments. Part of a cluster of artefacts including a small group of potsherds and two pieces of animal bone.	–19.7±0.4	10.4±0.3	3.2	2210±26	380–170 cal BC
GrM-30448	**SF14.** Human bone, disarticulated adult, axial thoracic vertebrae (lower), from south of the main wood mass but within the same silty-peat matrix and in the vicinity of the in situ tree-stump.	–20.4±0.4	10.5±0.3	3.2	2225±26	380–200 cal BC
GrM-30449	**SF15.** Human bone, disarticulated adult, axial thoracic vertebrae (upper), from south of the main wood mass but within the same silty-peat matrix and in the vicinity of the in situ tree-stump.	–19.9±0.4	10.7±0.3	3.2	2200±24	365–175 cal BC

Table 58: Flag Fen (2021) human bone: radiocarbon and stable isotope measurements.

21. APPENDIX 2: ARCHIVE

21.1 Archive location

21.1.1 The archive is currently held in the CAU's Cambridge facilities, pending a decision on any further mitigation. If no further mitigation is required, the physical archive will be deposited in Peterborough Museum. If further work on site will be undertaken, the evaluation archive will be incorporated into the final excavation archive.

21.2 Standards

21.2.1 The project archive will be prepared and deposited in line with the MoRPHE guidelines (Historic England 2006, reissued 2015), CIfA Standard and guidance for the collection, documentation, conservation and research of archaeological materials (2014, updated 2020), the CIfA Standard and guidance for archaeological evaluation (2014, updated 2020), the United Kingdom Institute for Conservation Guidelines No. 2 (2012) and the requirements of the Peterborough Museum.