AN ARCHAEOLOGICAL EVALUATION AT CROSSNESS SEWAGE TREATMENT WORKS, THAMESMEAD, LONDON BOROUGH OF BEXLEY

DECEMBER 2007

PRE-CONSTRUCT ARCHAEOLOGY

An Archaeological Evaluation at Crossness Sewage Treatment Works, Thamesmead, London Borough of Bexley

Site Code: CXS 07

Central National Grid Reference: TQ 4883 8052

Written and Researched by G. Seddon (PCA), C.R. Batchelor, N.P. Branch and P. Austin (Archaeoscape)

Pre-Construct Archaeology Limited, December 2007

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Commissioning Client: Scott Wilson Ltd on behalf of Thames Water

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1 ABSTRACT

1.1 This report details the results and working methods of an archaeological evaluation, undertaken by Pre-Construct Archaeology Limited at Crossness Sewage Treatment Works (STW), Thamesmead, London Borough of Bexley. The National Grid Reference of the site is TQ 4883 8052. The evaluation was undertaken between the 5th September and 11th October 2007 and was commissioned by Scott Wilson Ltd on behalf of Thames Water. The project was managed for Pre-Construct Archaeology Ltd by Chris Mayo, and the site was supervised by Guy Seddon.

1.2 The proposed development is divided, for the purpose of this document, into three areas – the nature reserve (Area 1), the area to the south of the sludge powered generator (Area 2) and the playing field in the south west of the site (Area 3). The investigation comprised of the excavation of three trenches, one in each area, with recording of all archaeological features revealed.

1.3 The evaluation identified the presence of thick peat deposits in Areas 1 and 2. In Area 3 the remnant of a preserved prehistoric forest was revealed which may date to the Late Mesolithic (6203 cal yr BP). This represents the earliest known colonisation of yew woodland on the southern bank of the River Thames during the Late Holocene.

2 INTRODUCTION

2.1 Following extensive geotechnical investigations and a palaeo-environmental borehole survey (Archaeoscape 2007, site code EAW06), an archaeological evaluation was undertaken by Pre-Construct Archaeology Ltd between 5th September and 11th October 2007 at Crossness Sewage Treatment Works (STW), Thamesmead, London Borough of Bexley. The work was commissioned by Helen Clough of Scott Wilson Ltd on behalf of Thames Water, prior to a proposed expansion of the STW. The site was monitored by Mark Stevenson of the Greater London Archaeological Advisory Service (GLAAS). The evaluation was carried out in accordance with a Written Scheme of Investigation produced by Scott Wilson Ltd and approved by Mark Stevenson.

2.2 The site is centred on National Grid Reference TQ 4883 8052. It is located to the east of the Thamesmead estate, with the River Thames forming the northern boundary and Eastern Way forming the southern boundary. To the east of the site is the Crossness Nature reserve and to the west of the site is a golf course (Figure 1).

2.3 The evaluation was designed to establish whether there were any archaeological deposits on the site that could be affected by the development of the site and if so to ascertain their extent, character, significance and condition.

2.4 A number of trees were found intact on the site. These were retained and examined by Archaeoscape. The results of the Archaeoscape report are incorporated in this document where relevant, and the full report is contained as an appendix.

2.5 The site was allocated the site code CXS 07.

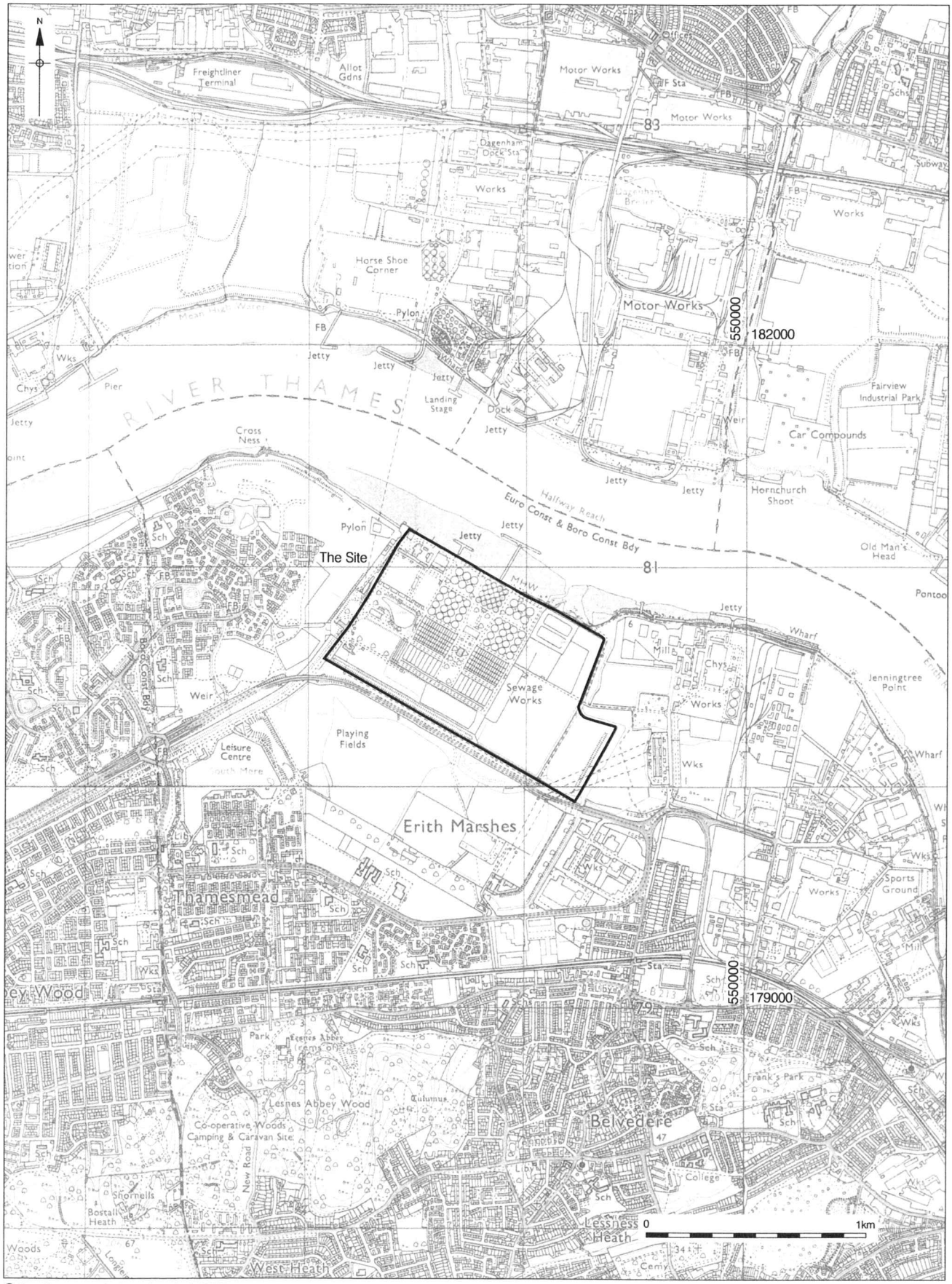


Figure 1
Site Location
1:25,000 at A4

3 GEOLOGY AND TOPOGRAPHY

3.1 The site is located on the south bank of the River Thames floodplain on the tidal estuary. The British Geological Survey Map (Sheet 257 Romford) shows that the site is located on alluvium.

3.2 The current main treatment works site is relatively flat, at a level of c. 5.5m OD. This area was raised during construction of the original STW to prevent flooding. However, the archaeological evaluation was carried out on the lower lying areas surrounding the main site. Area 1 was relatively flat at a level of 0.5m OD. Area 2 slopes gently from 0.5m OD in the south to 5.0m OD in the north. This slope was created by material being dumped on the northern part of the site in the later 20th century. Area 3 was also flat, at a level of 1.0m OD and was previously levelled to create a playing field.

4 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

4.1 The following is a brief summary of the known archaeological potential of the subject site. The summary is taken from the Written Scheme of Investigation produced by Scott Wilson Ltd. (Clough 2007).

Palaeo-environmental

4.2 The marshes of the Thamesmead area are characterised by alluvial deposits (silty clays and peats) that are known to be rich in palaeo-environmental evidence. Deposits of peat and alluvium have been identified on the Crossness STW site in all of the geotechnical investigations and geo-archaeological boreholes. The pollen samples from the geo-archaeological boreholes suggest that elm woodland declined ca. 9203 cal yr BP. The site was then colonised by yew, which declined by ca. 4303 cal yr BP. Lime woodland next colonised the site but this declined by ca. 3402 cal yr BP. The decline of the elm and yew cannot be conclusively linked to human activity, but there is unequivocal pollen-stratigraphical evidence for human activity directly causing the decline of the lime woodland (Archaeoscape 2007).

Prehistoric

4.3 The STW site contains no known finds dated to the prehistoric period. However, the lower peat samples taken from the STW site (Archaeoscape 2007) were radiocarbon dated to the early Neolithic period, indicating that a period of estuarine regression began at this time.

4.4 From the early Bronze Age to the later Iron Age the site at Crossness was not frequently inundated and probably comprised of marsh conditions, which would have been exploited by the local population. However, it is unlikely that the marshes were actually occupied at this time. The later Iron Age saw a renewal of marine conditions in the (transgression) as the formation of the peat ceased and the site became inundated (Archaeoscape 2007).

4.5 Plant seeds recovered at Summerton Way c. 600m to the north-west of the STW site, suggested that the local environment during the pre-Roman period was damp marshland with natural ditches and channels caused by a regression of marine conditions.

Roman (43-410 AD)

4.6 Excavations at Summerton Way c. 600m to the north-west of the site indicated that in this particular area the marshes might have in fact been dry enough for settlement. Roman pottery, mortar, tiles and a cinerary urn containing bone were found in 1865 c. 300m to the west of the STW site suggesting that the STW site and its environs may have been the focus of a small settlement.

Early Medieval Period to Post-Medieval Period

4.7 There is no evidence in the vicinity of the site for activity in the early medieval period. During the medieval and post-medieval period, the site was open marshland, with a number of sea walls and drainage ditches constructed on and around the site.

4.8 The site was developed in the late 19th century when the Crossness STW was first constructed. The land was raised in the area of construction to prevent flooding. The site was extended in the 1950s

5 METHODOLOGY

5.1 The evaluation was carried out in accordance with the 'Written Scheme of Investigation' (WSI), prepared by Scott Wilson Ltd and approved by Mark Stevenson of English Heritage (GLAAS).

5.2 The trenches were excavated at the locations shown on Figure 2, and were set out using electronic survey equipment. Trenches 2 and 3 were battered for safety.

5.3 Trench 1 was located in Area 1, where a new reed bed is proposed as part of the ecological mitigation works. The trench measured 10m x 2m and was excavated to a depth of 2.10m below ground level, using a stepped trench.

5.4 Trench 2 was located in the south of Area 2, which will be impacted on by the proposed development. Trench 2 measured 4m x 4m at base and was excavated to the bottom of the peat horizon, approximately 6m below ground level.

5.5 Trench 3 was located in Area 3, within the footprint of the new development. This trench also measured 4m x 4m at the base and was also excavated to the bottom of the peat horizon, 5.18m below ground level.

5.6 The clay overburden was excavated to the top of the peat horizon using a mechanical 360° excavator, fitted with a flat bladed bucket, under archaeological supervision. The overburden was stockpiled separately alongside the trenches and at a safe distance.

5.7 The trenches were excavated in 200mm spits until the desired depths were reached, in accordance with the WSI. The trenches and spoil heaps were examined to establish if cultural or ecofactual materials were present.

5.8 The trees encountered in Trench 3 were surveyed and recorded in situ then removed using the machine under archaeological supervision.

5.9 All features and deposits that were recorded were surveyed in 3D using an EDM.

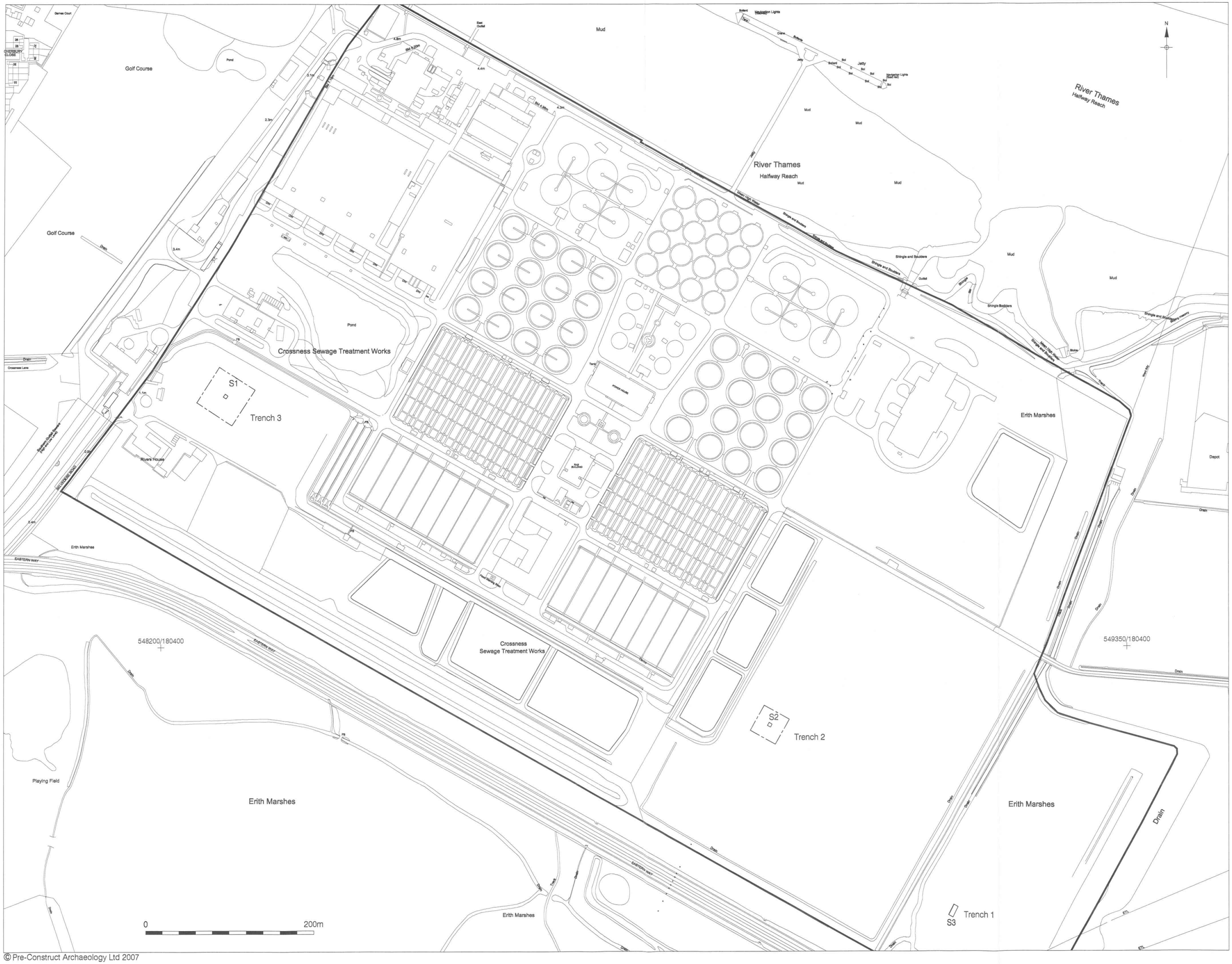


Figure 2
Trench Location
1:4,000 at A3

6 ARCHAEOLOGICAL SEQUENCE

Trench 1

6.1 The earliest deposit identified in Trench 1 was peat layer [20]. It had a thickness greater than 0.50m, a maximum height of –1.56m OD and a minimum of –2.08m OD. Within the peat, at a depth of between –1.70m and -1.82m OD, was a lens of clayey silt, [21]. Lens [21] may have been the remnant of a washed out flood deposit, perhaps representing a short period of marine transgression.

6.2 Peat deposit [20] was sealed by another, slightly darker layer of peat, [19]. Layer [19] was only visible to the south of the trench and contained frequent small pieces of wood. It was found at a depth of between –1.50m and –1.64m OD and had a thickness greater than 0.58m (not fully excavated).

6.3 Overlying the peat deposits was deposit [18]. It was a firmly compacted, mid yellowish brown deposit and had a thickness of between 0.76m and 1.22m. This deposit probably relates to the drainage and utilisation of the marshes during the medieval and post-medieval period.

6.4 Sealing deposit [18] at a height between 0.03m and –0.02m OD was a topsoil layer [17], which had a thickness of between 0.50m and 0.80m.

Trench 2

6.5 Layer [16] was the earliest deposit located in Trench 2. It comprised a firmly compacted dark grey layer of clayey silt. It had a maximum height of –3.90m OD and fell slightly to the west to a depth of –3.94m OD.

6.6 Sealing layer [16] was a 2.04m thick deposit of peat, layer [15]. It had a maximum height of –1.90m OD and a minimum height of -1.91m OD.

6.7 Overlying layer [15] was deposit [14]. This was a firmly compacted, light yellowish brown clayey silt with a thickness of 2.40m, a maximum height of 0.28m OD and a minimum height of 0.25m OD. It is probable that this layer relates to the drainage and utilisation of the marshes in the medieval and post-medieval periods.

6.8 On top of deposit [14] was a layer of screened material [13]. It contained hypodermic needles, condoms, etc, from the sewage works, dumped in the late 20th Century,

prior to the construction of the Sludge Powered Generator. This was located at a height of 0.84m OD sloping eastwards to a height of 0.75m OD and had a thickness of 0.50m.

6.9 Capping the screened material was a layer of crushed brick [12]. This had a thickness of 0.54m and had a maximum height of 1.36m OD falling to the east to a minimum height of 1.23m OD

6.10 Topsoil layer [11] was the latest layer in the sequence. This had been redeposited in order to cover layer [13]. It was 0.88m thick and had a height of 2.26m OD, sloping down to the east to a height of 2.08m OD.

Trench 3

6.11 The earliest deposit located in Trench 3 was a 'clean' clayey silt layer, [10], at a maximum height of c. -4.06m OD, sloping down to –4.12m OD in the east.

6.12 Sealing layer [10] was a layer of peat, [9], which contained fragments of wood. It had a thickness of 0.46m and had a maximum height of –3.74m OD, sloping downwards to the east to a minimum height of –3.76m OD.

6.13 Peat layer [9] was overlain by a dark grey silty clay, [8], which had small pockets of peat and fragments of wood within it. Layer [8] probably represents an episode of flooding and had a thickness of 1.20m, with a maximum height of –2.54m OD and a minimum height of –2.67m OD.

6.14 Another peat layer, [7], overlay layer [8]. It had a thickness of 0.92m, a maximum height of -1.63m OD and a minimum height of –1.74m OD. It contained the preserved remains of 9 fallen trees and 9 stumps dating to the Late Mesolithic period. The trees seemed to be divided into three distinct levels within the deposit. The majority of them had fallen over in either a southerly or eastern direction; many still retained some of their roots whilst others were little more than the remnants of in situ rootstock. That the trees bore no sign of human activity indicates that they fell due to natural causes, probably flooding and high winds (see Appendix 4). Nine horizontal fallen trees (sample numbers 6, 10, 11, 13, 14, 15, 16, 17 and 18) were sampled and one stump <12> was also sampled. The tree levels and alignments are shown on Figure 3.

6.15 Layer [6], a very dark brown peaty clayey silt, sealed peat deposit [7]. It contained moderate amounts of semi-decayed wood and had a thickness of 0.85m. Layer [6]

probably represents a later episode of flooding on the site. It had a maximum height of –0.88m OD, sloping slightly down to the east to a height of –0.89m OD.

6.16 Another two layers, [5] and [4], representing consecutive flooding episodes sealed layer [6]. Layer [5] was a light yellowish brown clayey silt with a thickness of 0.50m and lay at a height of between –0.42m and 0.50m OD. Above this layer, deposit [4] was a dark brownish grey clayey silt. It had a thickness of 0.24m and a height of –0.17m OD. Sealing layer [4] was a light yellowish brown deposit [3]. It had a height of between 0.33m and 0.30m OD and had a thickness of 0.46m. This layer was similar in nature to deposit [14] (seen in Trench 2), and may also be related to the drainage of the marshes in the medieval and post-medieval period.

6.17 Within a dip in the surface of layer [3] was a levelling layer of crushed brick, layer [2]. This was probably laid down to level the surface when the area was being transformed into a playing field. Layer [2] was in turn sealed by imported topsoil, layer [1], which had a thickness of 0.60m and level of c. 0.90m OD.

Wood Samples

6.18 Ten wood samples were taken from Trench 3. The depth and location of the samples is shown on Figure 3. The samples were analysed by Archaeoscape (Appendix 4). The results of the previous phase of palaeo-environmental sampling were also used to interpret the environmental information from the site.

6.19 All of the ten samples were identified as Taxus baccata (Yew). This indicated that the peat surface between –2.00m and –1.30m was invaded by yew dominated woodland during the Holocene period (11,550 calendar years BP (about 9600 BC) until present). Based on the results of the work in the south-east of the site, the woodland was dated to ca. 6203 cal yr BP, which makes it the earliest known colonisation of yew woodland on the southern bank of the River Thames during the Holocene. The woodland on the Crossness site declined from ca. 4303 cal yr BP, which correlates with the decline of yew woodland in the general area during this period. There is no evidence at Crossness for human activity influencing the decline of the woodland, although this evidence has been found at other sites in the Lower Thames Valley.

6.20 The majority of the trees were aligned in a north west-south east direction and were located within 1m thickness of peat. This suggests that the trees were contemporary with each other and that their decline may be due to a significant event. The event may comprise a catastrophic event such as rapid flooding of the site, or a change in climate or hydrology leading to an increase in bog surface wetness. However, it is

also possible that the similar orientation is a coincidence linked to the small number of samples analysed.

548269.6600/180732.1520

N

0.90m OD

S1

Trench 3

548311.7700/180705.1550

<17>

<18>

<12>

<6>

<7>

<5>

<8>

<4>

<15>

<16>

<10>

-4.12m OD

<11>

<13>

<14>

<3>

<9>

<1>

548242.5760/180690.2110

<2>

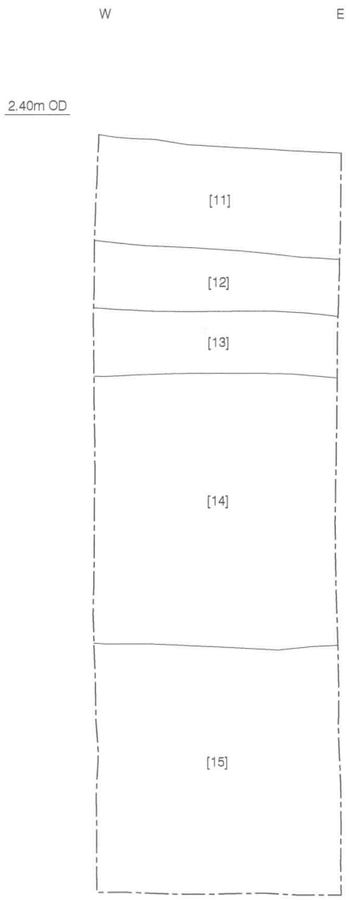
548284.3960/180662.9370

0 10m

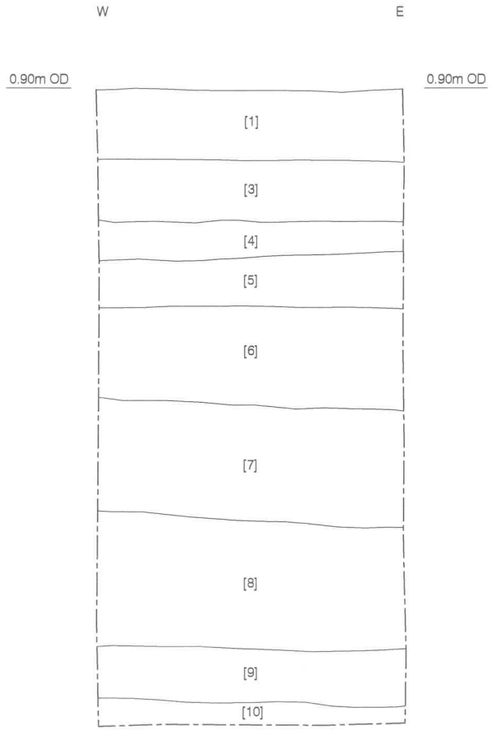
Levels on timbers

Stump <1>		-1.406m OD
Stump <2>		-1.294m OD
Stump <3>		-1.358m OD
Stump <4>		-1.566m OD
Stump <5>		-1.394m OD
Tree <6>	S	-1.379m OD
Tree <6>	N	-1.286m OD
Stump <7>		-1.234m OD
Stump <8>		-1.437m OD
Stump <9>		-1.507m OD
Tree <10>	SW	-1.854m OD
Tree <10>	NE	-1.581m OD
Tree <11>	NW	-1.561m OD
Tree <11>	SE	-1.831m OD
Stump <12>		-1.324m OD
Tree <13>	SE	-1.831m OD
Tree <13>	NW	-1.823m OD
Tree <14>	SE	-1.785m OD
Tree <14>	NW	-1.867m OD
Tree <15>	S	-1.866m OD
Tree <15>	N	-1.773m OD
Tree <16>	N	-1.614m OD
Tree <16>	S	-1.998m OD
Tree <17>	W	-1.597m OD
Tree <17>	E	-1.931m OD
Tree <18>	NW	-1.507m OD
Tree <18>	SE	-1.639m OD

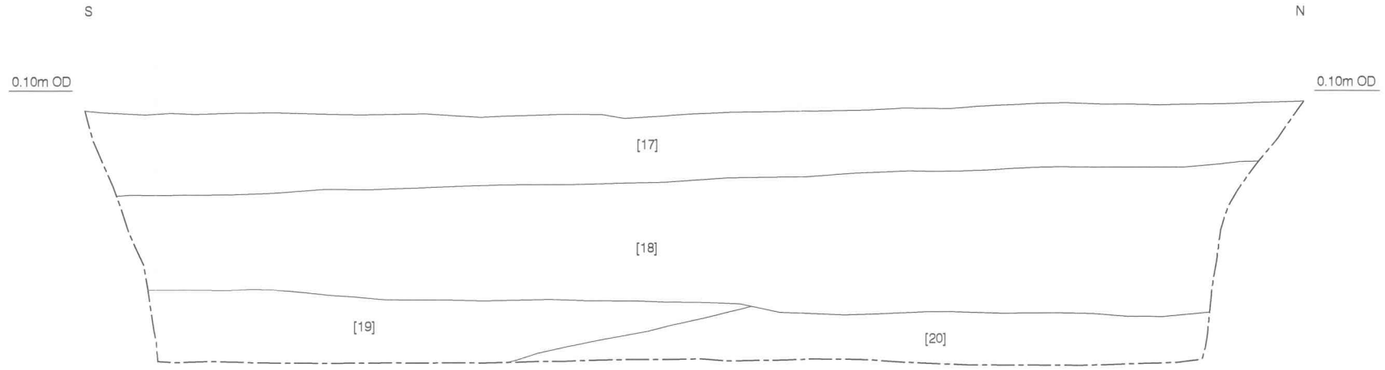
Figure 3
Plan of timber remains in Trench 3
1:250 at A3



Section 2
South facing
Trench 2



Section 1
South facing
Trench 3



Section 3
East facing
Trench 1

0 2m

Figure 4
Sections 1, 2 & 3
1:50 at A3

Figure 5: View of Trench 2, looking north-west

Figure 6: View of Trench 3, looking south-west

Figure 7: View of buried tree from Trench 2 (scale: 2.0m)

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 The evaluation at the Crossness STW proved the presence of well-preserved peat deposits across the site as well as evidence of episodic flooding events.

7.2 The analysis of the waterlogged wood samples suggested that a yew woodland was present on the site during the late Mesolithic period. If the age estimate is correct, the results from the site possibly represent the only known record for yew growth during the Late Holocene in the Lower Thames Valley.

7.3 No evidence of human activity was found during the exercise and it seems unlikely that the decline of the ancient forest located on the site was related to human intervention.

7.4 It is recommended that carbon dating is carried out on two of the wood samples in order to ascertain if the woodland can be more confidently dated to the Late Mesolithic. A research grant from Royal Holloway University Geography Department has been awarded in order to carry out this work. The results of the wood sampling exercise and the previous palaeo-environmental work from the site (EAW06) will be published in a suitable journal (see Archaeoscape 2007).

7.5 No other further work is recommended.

8 ACKNOWLEDGEMENTS

8.1 Pre-Construct Archaeology Limited would like to thank Helen Clough of Scott Wilson Ltd for commissioning the work on behalf of Thames Water, and Mark Stevenson of GLAAS for monitoring the work on behalf of London Borough of Bexley. Thanks also to Laing O'Rourke for providing on-site facilities and plant.

8.2 The author would like to thank Josephine Brown for the illustrations, Chris Mayo for the project management and editing and Graham Thomas of Laing O'Rourke for the on site surveying.

9 BIBLIOGRAPHY

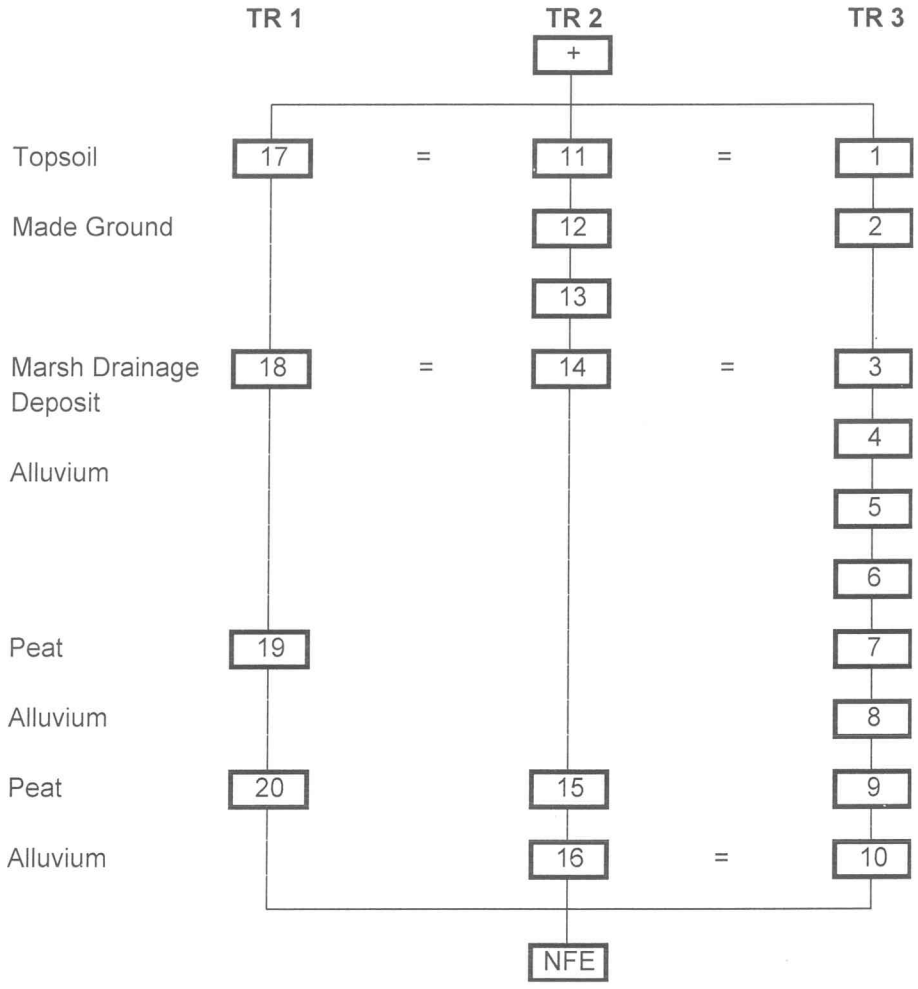
Archaeoscape 2007, 'Thames Water Utilities Ltd, Thames Tidal Quality Improvements, Crossness, London Borough of Bexley: Environmental Archaeological Assessment', unpublished client report for Thames Water

Clough, H. 2007, 'Crossness Sewage Treatment Works: Written Scheme of Investigation for Archaeological Trial Trenching' unpublished report, Scott Wilson Ltd.

APPENDIX 1: CONTEXT INDEX

Site Code	Context No.	Plan	Section / Elevation	Type	Description
CXS 07	1		1	LAYER	TOPSOIL
CXS 07	2		*	LAYER	LEVELING LAYER OF CRUSH
CXS 07	3		1	LAYER	CLAYEY SILT
CXS 07	4		1	LAYER	CLAYEY SILT
CXS 07	5		1	LAYER	CLAYEY SILT
CXS 07	6		1	LAYER	PEATY CLAYEY SILT
CXS 07	7		1	LAYER	PEATY CLAYEY SILT
CXS 07	8		1	LAYER	CLAYEY SILT (WITH BITS OF WOOD)
CXS 07	9		1	LAYER	PEAT
CXS 07	10		1	LAYER	CLEAN CLAYEY SILT
CXS 07	11		2	LAYER	TOPSOIL
CXS 07	12		2	LAYER	LEVELING/SEALING CRUSH
CXS 07	13		2	LAYER	DUMPED SCREENED MATERIAL
CXS 07	14		2	LAYER	CLAYEY SILT
CXS 07	15		2	LAYER	PEAT
CXS 07	16		2	LAYER	CLAYEY SILT
CXS 07	17		3	LAYER	TOPSOIL
CXS 07	18		3	LAYER	CLAYEY SILT
CXS 07	19		3	LAYER	PEAT
CXS 07	20		3	LAYER	PEAT
CXS 07	21		3	LENS	CLAYEY SILT

APPENDIX 2: SITE MATRIX



APPENDIX 3: OASIS FORM

OASIS ID: preconst1-33433

Project details

Project name	Crossness Sewage Treatment Works
Short description of the project	An archaeological evaluation was undertaken by Pre-Construct Archaeology Limited at Crossness Sewage Treatment Works (STW), Thamesmead TQ 4883 8052. The investigation comprised the excavation of three trenches, one in each area, with recording of all archaeological features revealed. The evaluation identified the presence of thick peat deposits in Areas 1 and 2. In Area 3 the remnant of a preserved prehistoric forest was revealed dating to the Late Mesolithic period and representing the earliest known example of yew dominated woodland on the south bank of the Thames.
Project dates	Start: 05-09-2007 End: 11-10-2007
Previous/future work	Yes / Not known
Any associated project reference codes	CXS 07 - Sitecode
Type of project	Field evaluation
Site status	Local Authority Designated Archaeological Area
Current Land use	Other 15 - Other
Significant Finds	PLANT MACRO REMAINS Neolithic
Methods & techniques	'Sample Trenches'
Development type	Service infrastructure (e.g. sewage works, reservoir, pumping station, etc.)
Prompt	Planning condition
Position in the planning process	Not known / Not recorded

Project location

Country	England
Site location	GREATER LONDON BEXLEY ERITH Crossness Sewage Works
Postcode	SE28
Study area	52.00 Square metres
Site coordinates	TQ 4883 8052 51.5034823256 0.144614447894 51 30 12 N 000 08 40 E Point
Height OD	Min: -4.12m Max: -3.94m

Project creators

Name of Organisation	Pre-Construct Archaeology Ltd

Project brief originator	Scott Wilson Ltd
Project design originator	Helen Clough
Project director/manager	Chris Mayo
Project supervisor	Guy Seddon
Type of sponsor/funding body	Utility Company
Name of sponsor/funding body	Thames Water

Project archives

Physical Archive Exists?	No
Digital Archive recipient	LAARC
Digital Archive ID	CXS07
Digital Contents	'Environmental','Stratigraphic','Survey'
Digital Media available	'Database','Images raster / digital photography','Text'
Paper Archive recipient	LAARC
Paper Archive ID	CXS07
Paper Contents	'Environmental','Stratigraphic','Survey'
Paper Media available	'Context sheet','Drawing','Map','Matrices','Photograph','Plan','Report','Section','Survey'

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)
Title	An Archaeological Evaluation at Crossness Sewage Treatment Works, London Borough of Bexley
Author(s)/Editor(s)	Seddon, G
Date	2007
Issuer or publisher	Pre-Construct Archaeology
Place of issue or publication	London

Entered by	H Clough (hclough@pre-construct.com)
Entered on	19 December 2007

APPENDIX 4: WOOD ANALYSIS

CROSSNESS SEWAGE WORKS, CROSSNESS, LONDON BOROUGH OF BEXLEY: ANALYSIS OF WATERLOGGED WOOD (SITE CODE: CXS07)

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INTRODUCTION

This report summarises the findings arising out of the analysis of ten waterlogged wood samples recovered from a deeply stratified peat sequence (*ca.* 5m in thickness; *ca.* -6.5 to -1m OD) within archaeological Trench 1 by Pre-Construct Archaeology Ltd at Crossness Sewage Works, London Borough of Bexley (National Grid Reference: centred on TQ 483 806; Site Code: CXS07; Figures 1 and 2). The site is on the floodplain of the estuarine Thames on the south side of Halfway Reach, about 0.5km from the modern waterfront. The underlying geology is mapped by the British Geological Survey (1:50,000 Sheet 257) as alluvium overlying Lower Tertiary Lambeth Group sediments. Recent palaeoenvironmental investigations carried out to the southeast of Trench 1 as part of the mitigation works for the STW extension (Figure 2; <BH403>; Batchelor *et al.*, 2007; Site Code: EAW06; NGR: TQ 5488 1805) involved analysis of a thinner peat unit (*ca.* 2m in thickness; -4.56 to -2.18m OD), which undoubtedly represents only part of the sequence recorded in Trench 1. Indeed, deposit modelling conducted by Batchelor *et al* (2007) indicated that although peat accumulated throughout the area, there is evidence for spatial variations in the thickness of the unit due to the morphology of the sub-surface topography and extensive erosion of the peat surface, particularly in the south eastern part of Crossness Sewage Works. The peat unit at site EAW06 accumulated from between *ca.* 7567 and 6203 cal yr BP until sometime after *ca.* 2529 cal yr BP. The biostratigraphical (zooarchaeological and archaeobotanical) records from the site indicated that the peat surface comprised dense, mature fen carr woodland dominated by alder (*Alnus glutinosa*) with an understorey of shrubs, herbs, aquatics and ferns. Yew (*Taxus baccata*) became an important component of the carr woodland from *ca.* 6203 cal yr BP but declined shortly after *ca.* 4303 cal yr BP. Of importance, the colonisation of yew woodland was tentatively correlated by Batchelor *et al* with a period of drier, more stable climatic conditions during the Middle Holocene, which may have enabled yew to invade the fen carr community. The reason for the decline of yew woodland at the start of the Bronze Age was unclear. Analysis of waterlogged wood

recovered from Trench 1 was conducted, therefore, to enhance this model of vegetation history during the period of peat formation for this part of the Lower Thames Valley.

Figure 1: Location of the Crossness Sewage Works, London Borough of Bexley (CXS07) (reproduced from Ordnance Survey digital map data ©Crown copyright 2007. All rights reserved. License number 0100031673)

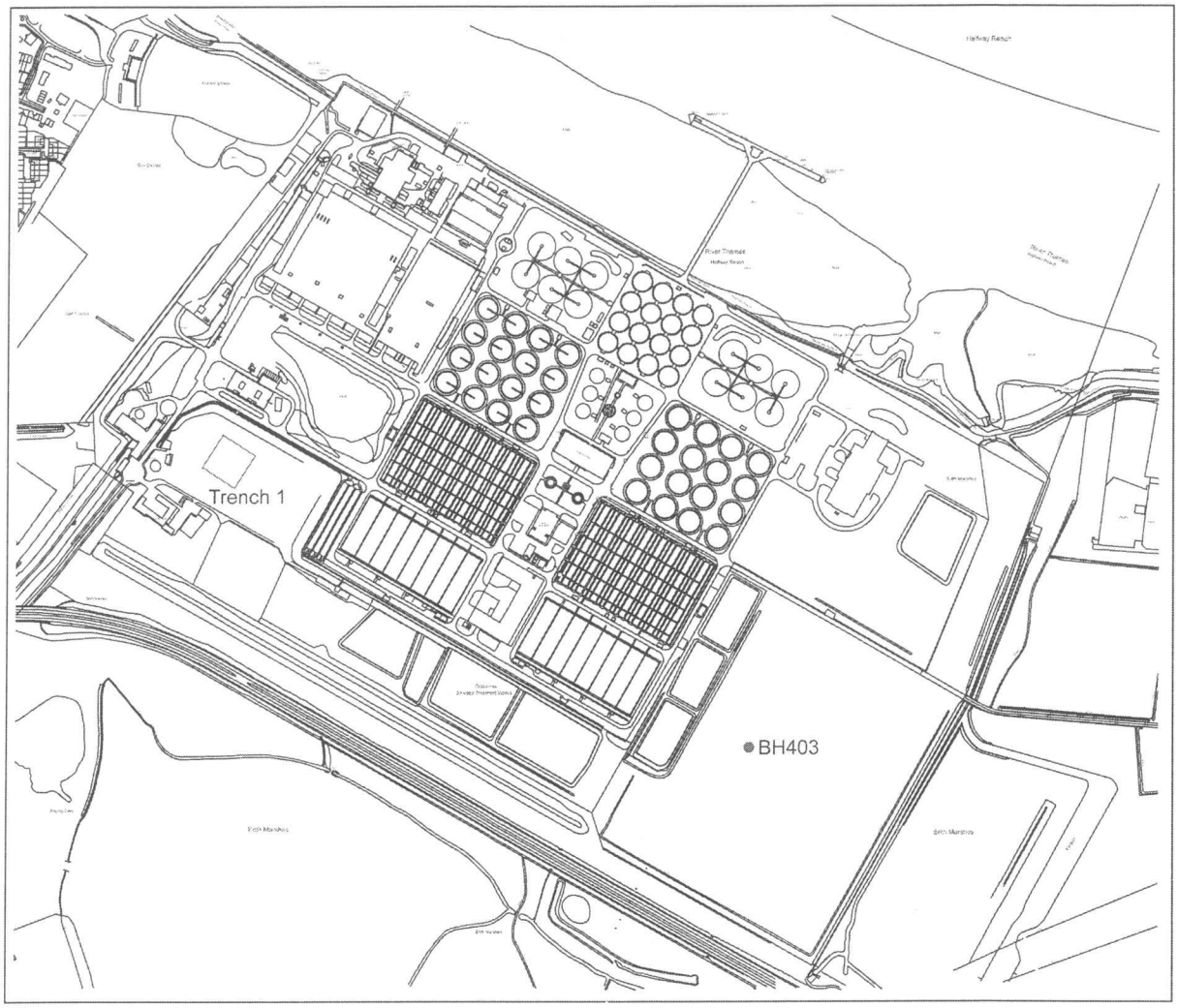

Figure 2: Location of the Trench 1 at Crossness Sewage Works, London Borough of Bexley (CXS07)

METHODS

Field investigations

Ten waterlogged wood samples were recovered from Trench 1, and 3-dimensional co-ordinates were taken from the start (X1 and Y1) and end (X2 and Y2) of each sample to record the orientation and depth (m OD) of each specimen (Table 1).

Table 1: Details of samples taken at Crossness Sewage Works, London Borough of Bexley (CXS07)

Sample number	Max height OD	Min Height OD
<6>	-1.29	-1.38
<10>	-1.58	-1.85
<11>	-1.56	-1.83
<12>	-1.32	*
<13>	-1.82	-1.83
<14>	-1.79	-1.87
<15>	-1.77	-1.89
<16>	-1.61	-2.00
<17>	-1.60	-1.93
<18>	-1.51	-1.64

Waterlogged wood analysis

Examination of the ten samples followed standard procedures for the examination of waterlogged wood as described in Hather (2000). Taxa were identified with reference to descriptions in Hather (*ibid.*). Nomenclature follows Stace (1997). The results are displayed in Table 2.

RESULTS, INTERPRETATION AND DISCUSSION OF THE WATERLOGGED WOOD

All of the ten samples were identified as *Taxus baccata* (yew); one of the three coniferous taxa native to the UK (Table 2). Although the samples were well preserved and provided complete transverse sections for study it is not recommended that dendrochronological work be carried out on any of the samples because of the eccentric growth patterns characteristic of this taxon and the lack of an established chronological sequence.

These results indicate that *Taxus baccata* invaded the peat surface between *ca.* -2.00m and -1.30m OD resulting in the formation of yew dominated woodland. The reason for the colonisation is uncertain, but four possible causes were proposed for the colonisation of yew at Crossness Sewage Works site EAW06 during the Middle Holocene (see Batchelor 2007; Batchelor *et al.*, 2007):

1. Natural local changes in the hydrology of the fen peat surface created drier, stable conditions more suitable for yew colonisation
2. Yew is an aggressive tree and may have out-competed alder and other deciduous taxa growing on the peat surface
3. The onset of drier climatic conditions may have created favourable conditions for the expansion of yew onto the peat surface
4. Human exploitation of alder wood may have created an opportunity for yew to invade the previously closed, mature fen carr woodland.

Based upon the results of the recent palaeoenvironmental investigations at Crossness Sewage Works site EAW06 (Figure 2; <BH403>; Batchelor *et al.*, 2007), the colonisation of *Taxus* has been radiocarbon dated to *ca.* 6203 cal yr BP, which marks the earliest known colonisation of yew woodland on the southern bank of the River Thames during the Holocene. *Taxus* is not recorded elsewhere on the south bank until at least *ca.* 5900 cal yr BP (Corinthian Quay; Scaife, 2002). *Taxus* is also recorded at a later date at Erith (from *ca.* 5000 cal yr BP), both in the pollen and plant macrofossil records (Seel, 2001). The colonisation of *Taxus* at Crossness Sewage

Works is also prior to most sites on the north bank of the Thames. Only Hornchurch Marshes (Branch *et al.,* in prep.) and recent research at Tilbury Fort (Batchelor, 2007) indicate an earlier date of *ca.* 6500 cal yr BP. The record from Crossness Sewage Works site EAW06 (Figure 2; <BH403>; Batchelor *et al.*, 2007) suggests that human activity was taking place within the vicinity of the site while *Taxus* was colonising (from *ca.* 6200 to 5750 cal yr BP). However, when correlated against chemical concentration and oxygen isotope ice core records (see O'Brien, 1995; Grootes and Stuiver, 1997; Johnsen, 1997), the data also suggest that *Taxus* colonised the peatland surface at Crossness Sewage Works during a period of relatively stable, drier climatic conditions from *ca.* 6220 to 5750 cal yr BP. Therefore, although local environmental changes, vegetation succession and human activity may be possible causes for the colonisation of yew woodland, there is compelling evidence for climate change being the main forcing factor.

The decline of *Taxus* at Crossness Sewage Works site EAW06 (Batchelor *et al.*, 2007) was dated to *ca.* 4303 cal yr BP, with the age range 4510 to 4090 cal yr BP encompassing the date of the decline at many sites on both the north and south banks of the River Thames, suggesting a broadly synchronous event. These include Woolwich Trade Park (Batchelor, 2007), Corinthian Quay (Scaife, 2002), Woolwich Manor Way (Batchelor, 2007) and Aveley Marshes (Batchelor, 2007). There are exceptions where the decline occurs later, for example Royal Albert Dock (*ca.* 3500 cal yr BP; Batchelor, 2007) and Hornchurch Marshes (*ca.* 3600 cal yr BP; Branch *et al.*, in prep.). The decline in *Taxus* also appears to be correlated with a period of warmer and more stable climatic conditions as indicated by ice core records. Therefore, the decline in *Taxus* does not correlate with a period of climatic change, which suggests that the climate was probably not responsible for the decline of *Taxus* at Crossness. There is no pollen-stratigraphical evidence from Crossness Sewage Works site EAW06 to indicate that the decline in *Taxus* woodland was caused by human activity (Batchelor *et al.*, 2007). However, many other sites in the Lower Thames Valley do contain evidence for human activity during the period of the *Taxus* decline, for example Woolwich Trade Park (Batchelor, 2007), Beckton Sewage Works (Scaife, 1995), Corinthian Quay (Scaife, 2002) and Hornchurch Marshes (Branch *et al.*, in prep.). Elsewhere, there is definitive evidence for the utilisation of *Taxus* by human groups during the Early to Middle Bronze Age (Carew *et al.,* in prep; Batchelor, 2007). The data from Crossness Sewage Works site EAW06 appear to indicate, however, that the decline in *Taxus* was caused by local factors, such as competition (Batchelor *et al.*, 2007).

Based upon the results of the radiocarbon dating and identification of yew pollen from Crossness Sewage Works site EAW06, and the corresponding OD heights (*ca.* -4.20m and -2.70m OD; Batchelor *et al.*, 2007), the growth of yew at Crossness Sewage Works site CXS07, Trench 1 (above -2m OD), could be tentatively assigned to a Late Holocene, rather than Middle Holocene, age (last 3000 years). The possible Late Holocene growth of yew at Crossness Sewage Works site CXS07 also suggests that *Taxus* persisted for longer in the northwest of the site than in the southeast (yew declined at site EAW06 at *ca.* 4303 cal yr BP). Alternatively, a new population of *Taxus* may have colonised the northwest of the site at a later date than in the southeast. Whatever the reason, if this age estimate is correct, then the results from site CXS07 possibly represent the only known record for yew growth during the Late Holocene in the Lower Thames Valley. Alternatively, peat accumulation may have occurred at a faster rate in the northwest of the site than in the southeast, which, if correct, suggests that one or more populations of yew were growing on the peat surface contemporaneously but at slightly different elevations i.e. at both site CXS07 and at site EAW06. In order to test these hypotheses, two radiocarbon dates will be obtained from selected wood specimens. Funds have already been secured for the radiocarbon dates from a small Royal Holloway, Department of Geography research grant. The results of the radiocarbon dating will be incorporated within the final publication text for submission to a peer review, international journal.

The reason for the decline of yew at Crossness Sewage Works site CXS07 is unclear. In order to examine this problem, the 3-dimensional co-ordinates for each yew wood specimen were recorded and are displayed in Table 2 and Figure 3. The results indicate that yew wood samples <10> and <14> were orientated in a northwest-southeast direction, while all other samples (<6>, <11> to <13> and <15> to <17>) were orientated in an east-west direction. In addition, the results displayed in Table 2 indicate that 70% of the yew wood specimens lay between a minimum depth of -1.91 ± 0.09m OD, and maximum depth of -1.70 ± 0.12m OD. Sample <18> was located at between -1.64 and -1.51m OD, while samples <6> and <12> were located at *ca.* -1.30m OD. The similar depth of each of the yew wood specimens suggests that there was a single population of yew trees that persisted for a relatively short period of time (*ca.* 500 years). In addition, the similar orientation of the samples indicates that the decline of yew was possibly a significant event. Two possible causes for this decline may be proposed:

1. A catastrophic event, such as rapid flooding of the site

2. A change in climate or hydrology, leading to a progressive, longer-term increase in bog surface wetness
3. A natural decline in the yew woodland cover, with the similar orientation being a coincidence linked to the small number of samples analysed.

If the wood specimens are Late Holocene in age, then either flooding due to rising relative sea levels or climate change may have been possible causes for its demise.

Table 2: Waterlogged wood results, Crossness Sewage Works, London Borough of Bexley (CXS07)

Sample number	Species ID	Depth (m OD)		Suitability for dendrochronology
		max	min	
<6>	*Taxus baccata*	-1.29	-1.38	No
<10>	*Taxus baccata*	-1.58	-1.85	No
<11>	*Taxus baccata*	-1.56	-1.83	No
<12>	*Taxus baccata*	-1.32	*	No
<13>	*Taxus baccata*	-1.82	-1.83	No
<14>	*Taxus baccata*	-1.79	-1.87	No
<15>	*Taxus baccata*	-1.77	-1.89	No
<16>	*Taxus baccata*	-1.61	-2.00	No
<17>	*Taxus baccata*	-1.60	-1.93	No
<18>	*Taxus baccata*	-1.51	-1.64	No

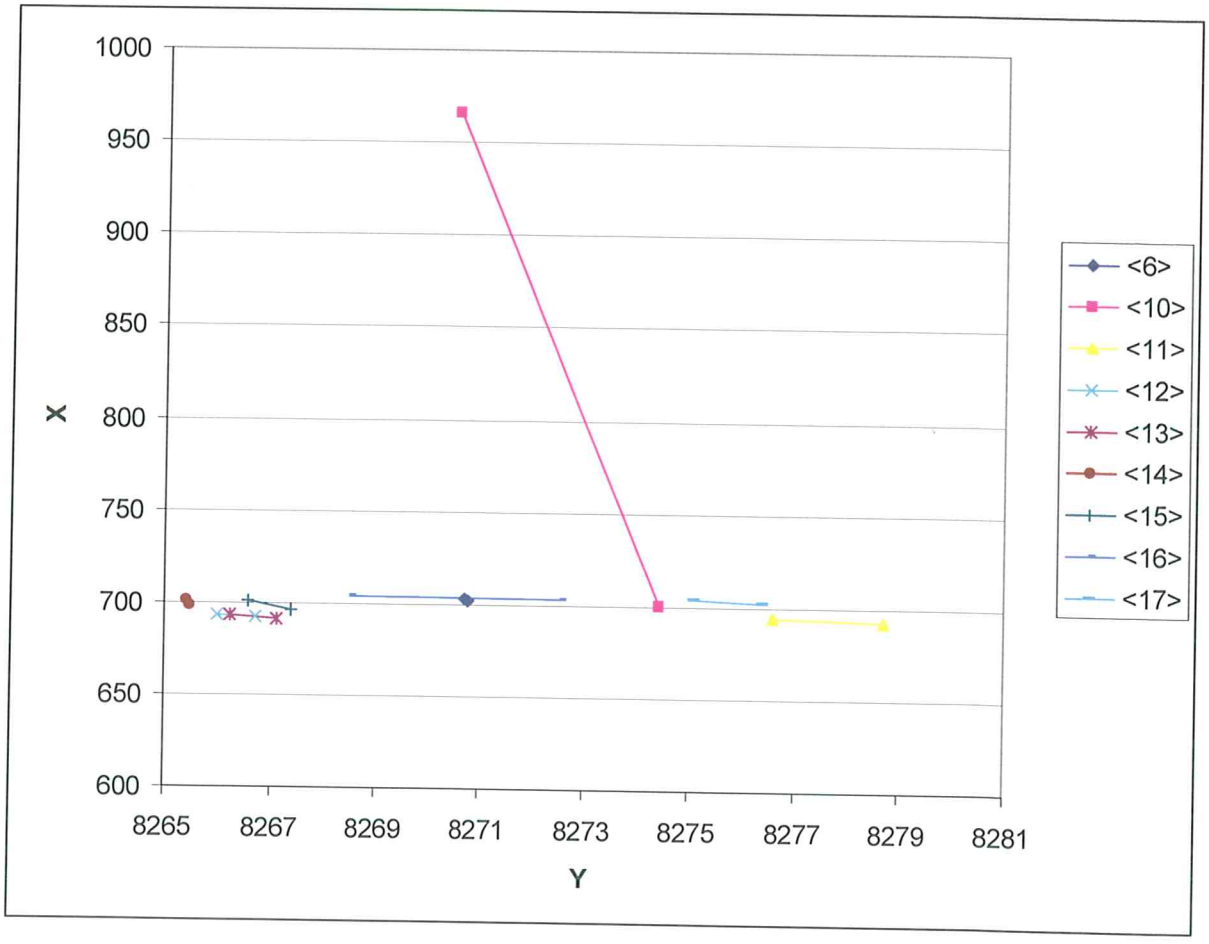

Figure 3: Orientation of the waterlogged wood samples taken at Crossness Sewage Works, London Borough of Bexley (CXS07)

CONCLUSIONS

The new waterlogged wood data from site CXS07, Trench 1, enhance the existing palaeoenvironmental record from site EAW06, borehole <BH403> (Batchelor *et al.*, 2007), and indicate that yew (*Taxus baccata*) was a dominant component of the fen carr woodland at Crossness Sewage Works during the Middle Holocene, and possibly into the Late Holocene.

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