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THE WADEWAY: INVESTIGATION OF THE MEDIEVAL CROSSING POINT FROM LANGSTONE VILLAGE TO HAYLING ISLAND

By JULIE SATCHELL
with contributions by PAUL DONOHUE, ROB SCAIFE *and* SIMON BRAY

ABSTRACT

Chichester Harbour Conservancy's 'Rhythms of the Tide' project has provided the opportunity to investigate the Wadeway, a now disused causeway between the north of Hayling Island and the adjacent mainland at Langstone. Results of this work, by means of survey, excavation, radiocarbon dating and palaeoenvironmental analysis, have demonstrated that the Wadeway is medieval in date and is most likely to have been constructed in the early to mid 14th century. Establishing the age of the Wadeway has allowed the feature to be interpreted within its historic context and has also added to

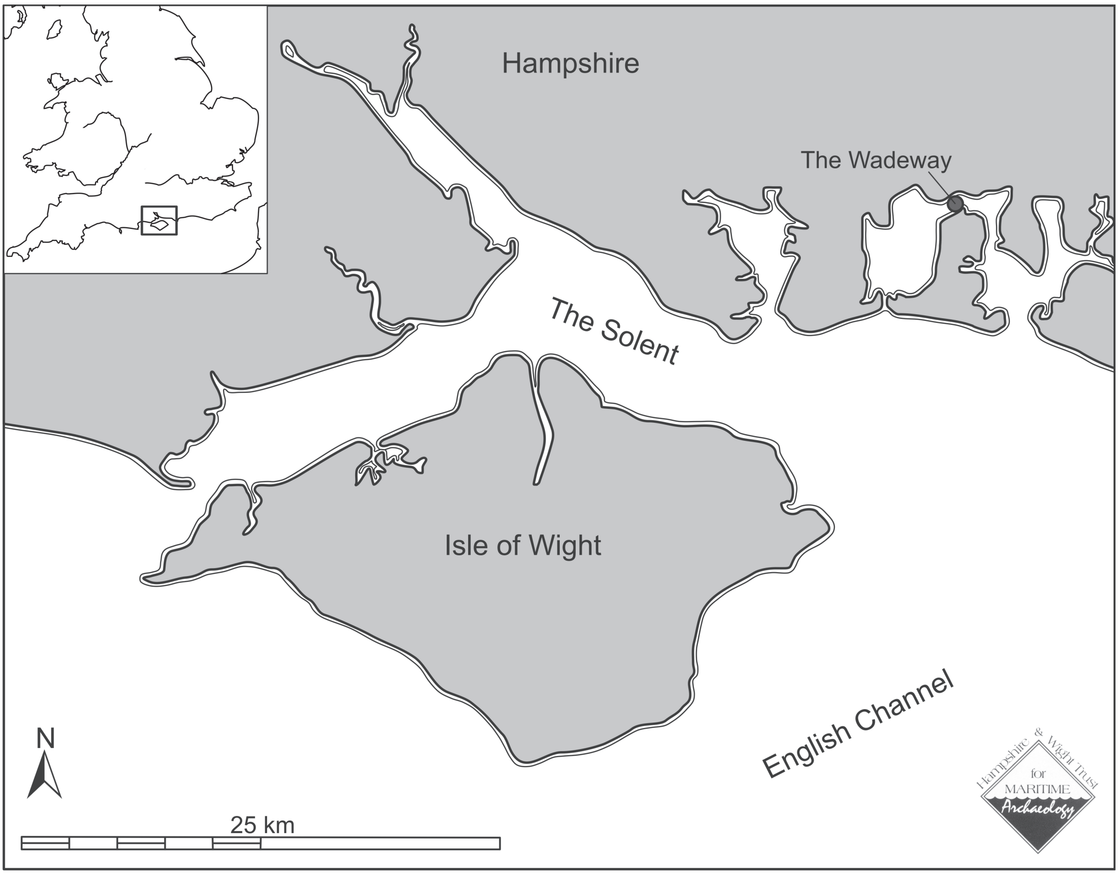

Fig 1 Location of the Wadeway in relation to Chichester and Langstone Harbours and the wider Solent region

Fig 2 The Wadeway looking south towards Hayling Island

our knowledge of the development of Chichester and Langstone Harbours.

INTRODUCTION

There has long been speculation over the age of the Wadeway which runs between Langstone Village and Hayling Island, Hampshire (Fig. 1). The Wadeway (centred on NGR SU 723045) is a raised track way which was used at low tide to cross to the island. Today it is still clearly visible, although there are areas where later construction works have cut through the feature making it hazardous to use. Due to the quantity of archaeological evidence on Hayling Island from a range of periods, speculation has variously dated the Wadeway as Bronze Age, Iron Age, Roman or medieval. It is clear that human activity on the island would require access to the area, although prior to–recent work the Wadeway had not been assessed in terms of its relationship to sea level, or been subject to intrusive investigation.

A preliminary survey of the surface features visible in the northern segment of the Wadeway in 2000 (Satchell 2000) demonstrated there may have been multiple phases of construction, with different materials making up the surface of the feature and various arrangements of posts and timbers used to define the edges. In 2005–6 Chichester Harbour Conservancy's 'Rhythms of the Tide' project, funded by the Heritage Lottery Fund (Maritime Archaeology 2005; MoLAS 2007) provided the opportunity to undertake further investigations.

The results of this work have demonstrated that the Wadeway is medieval in date and is most likely to have been constructed in the early to mid 14th century. Establishing the age of the Wadeway has allowed the feature to be interpreted within its historic context and has also added to our knowledge of the development of Chichester and Langstone Harbours. The Wadeway is likely to have been constructed in response to the sea level rises and storm surges that had a dramatic affect on the south of Hayling Island where areas of land were lost to the sea, and hence demonstrates evidence of communities responding to coastal change.

LOCATION AND CONTEXT

The Wadeway runs from the village of Langstone in the north towards Hayling Island in the south (Fig. 2) and is divided into three segments. The northern segment runs south-east from Langstone until it is severed by a channel. The second segment continues south-east from the channel, changing direction at its mid point to south-south-west until severed by another channel known as New Cut. It then continues to run south-south-westerly towards the salt marsh adjacent to a promontory jutting out near North Common (Fig. 3). The site is easy to discern at low tide; although its significance as a transport route has been somewhat overshadowed by the modern bridge crossings. For many centuries it would have been a key maritime feature of this area of Langstone and Chichester Harbours.

Archaeological and historic setting

Human occupation and use of the area around Hayling Island is well represented in the archaeological record. There is evidence of Bronze Age occupation/use including round houses, a timber feature to the north of the island and an axe hoard (Williams & Soffe 1987; Lawson 1999), in addition to significant Iron Age and Roman features including Tournerbury fort (Bradley & Fulford 1975) and the multi-period temple site east of Stoke village (King & Soffe 1994; 2013). Remains on the mainland are no less numerous with a villa being located in Langstone village (Gilkes 1998) and a Roman road running close to the Wadeway. Evidence gathered from neighbouring Langstone Harbour has suggested the area on which the Wadeway was constructed was saltmarsh in the Romano-British period, and is therefore likely to have been waterlogged (Allen & Gardiner 2000).

During the early medieval period population expansion was mirrored with a rise in settlements, trade and activity around the harbour. Marine related industries in the area include fishing, oyster farming, saltworking and boat building (MoLAS 2004, 60). Saltmarsh around the coastal fringes was reclaimed for agricultural activities. With maritime connections and productive agricultural land, Hayling Island would have been in a strong strategic position. However, it was subject to increased flooding due to sea level rise in the late 13th and 14th Centuries (MoLAS 2004, 60).

The first documentary evidence which implies the possible existence of a crossing point to Hayling Island comes from the Domesday Book which refers to the settlement of Wade. Reference to the village of Wade is repeated in the 1260s during the reign of King John (Page 1908) and the village of West Wade is mentioned in a lease of the lands to the Duke of Arundel (Morley 1987, 9).

During the post-medieval period (1540–1900) industrial and maritime activity greatly increased along the south coast. Common features around both Langstone and Chichester Harbours include watermills, windmills, brickworks, salterns and field systems (MoLAS 2004, 69). It is during this period, in 1552, that the first direct historical references to the Wadeway appear (Morley 1987); some refer to paying for passage across, others are concerned with maintenance and cleaning. With the expansion of activity in the area the Wadeway would have been an important part of the transport network.

A 1775 survey of Hayling Island indicates that 'a considerable time before and after low water Carriages and Horses pass from Havant into the Island; when the tide is in, the water is crossed in a Ferry Boat' (Morley 1987). Further evidence that the Wadeway is an established

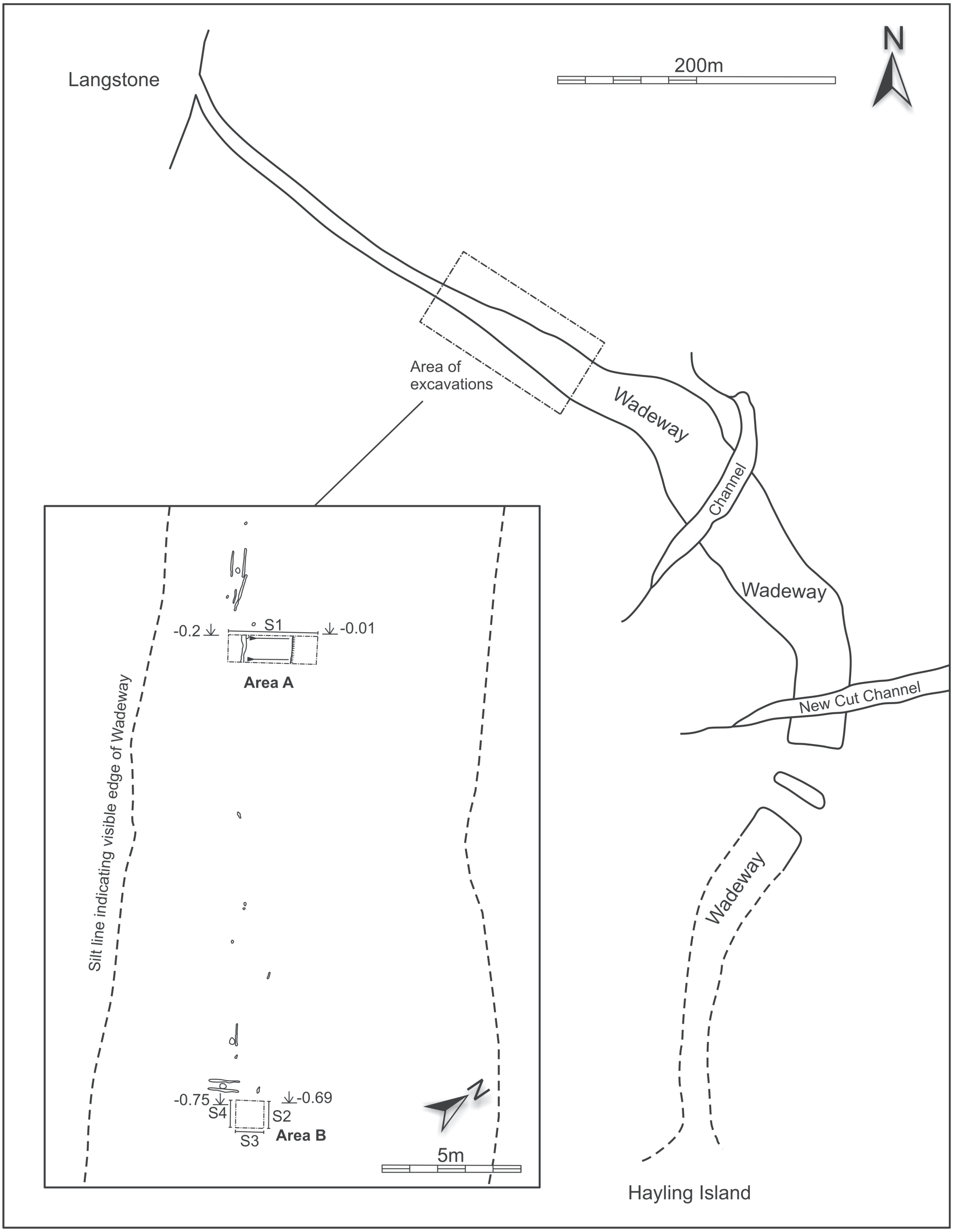

Fig 3 Site plan showing Wadeway segments and location of the excavation trenches

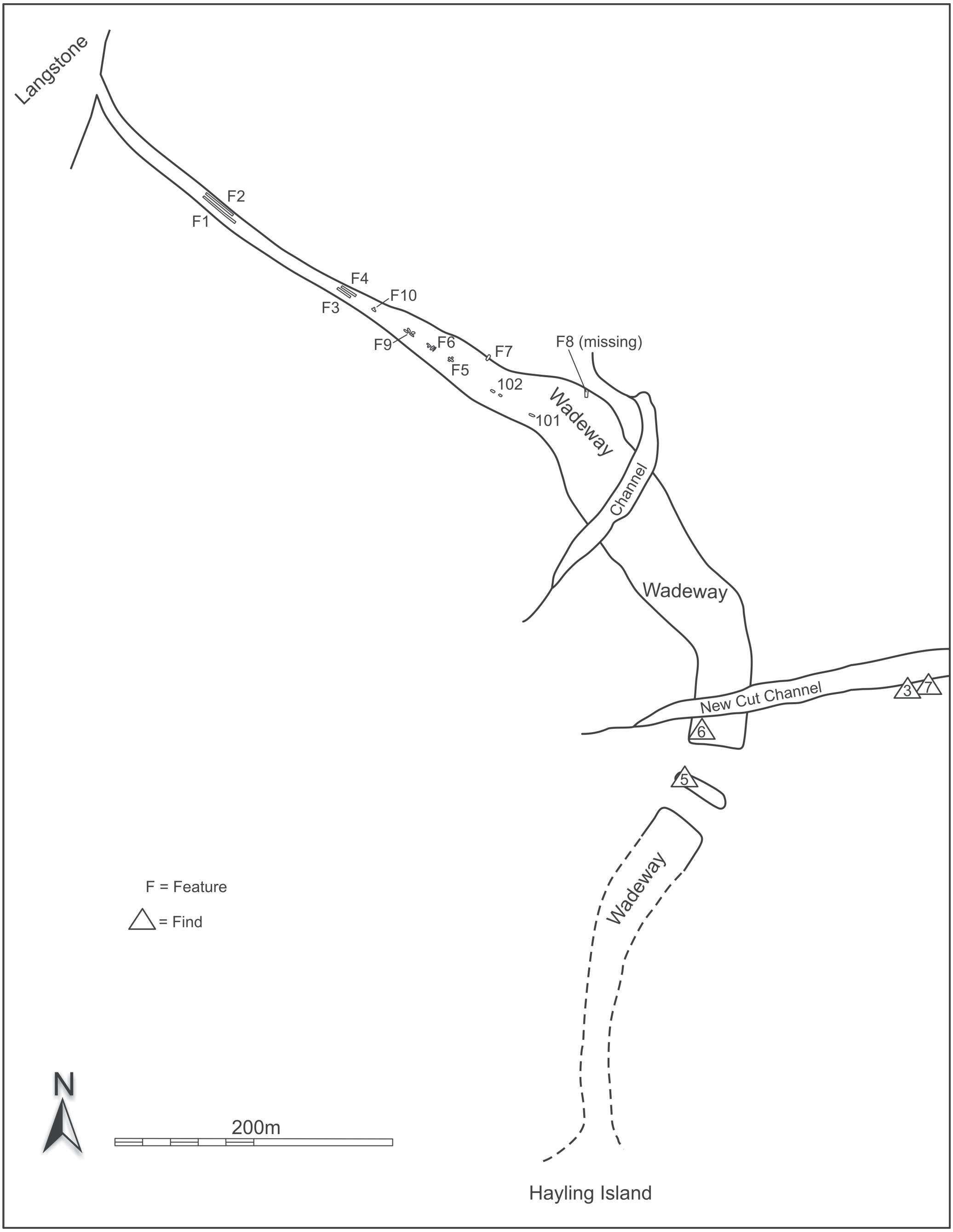

Fig 4 Plan showing wooden features within the Wadeway as recorded during the walk over survey

route is found within cartographic sources; Taylor's 1759 map shows the Wadeway marked as 'Horse Road', while Milne's 1791 map shows 'Horse Road at Low Water'. By the time of the 1810 Ordnance Survey map two routes are illustrated, the Wadeway which is still shown as an intact crossing and Hayling Bridge to the west. However, soon after this date the use of the Wadeway significantly declined due to the accessibility of alternative crossings that were not dictated by the tidal cycle.

Throughout the 19th century the transport infrastructure to Hayling Island was developed to include a canal, railway bridge and a toll bridge. In the early 19th century, plans were developed for the construction of a canal between Portsmouth and Arundel passing through Chichester. This was approved by an Act of Parliament in 1817, which sealed the fate of the Wadeway through which New Cut was dug for the canal in either 1820 or 1821 (Morley 1987, 12–13). In 1823, a company was formed to oversee the construction of a toll bridge to Hayling Island. The Act that authorised the construction prohibited any other conveyance for hire or reward, by land or by sea, within one thousand yards of the bridge (Morley 1987, 14–15).

Since the early 19^{th} century the Wadeway has remained part of the landscape of the harbour with little disturbance other than minor incursions by bait diggers at its southern end. As a feature of interest, its age and construction have often been the subject of speculation, although recent investigations have been able to answer a number of long-held questions.

SURVEY, EXCAVATION AND SAMPLING

To investigate construction methods used within the Wadeway and to gather dating evidence, a phased approach to fieldwork was undertaken. Initial work included a walkover survey followed by auger transects which were completed in June 2005 (Maritime Archaeology 2005). These were followed by excavation in January 2006. As the Wadeway lies relatively high in the tidal range, it is uncovered for a reasonable period during neap tides to allow investigation.

Walkover survey

The walkover survey aimed to investigate the surface deposits and features, gauge the current condition of the Wadeway and plan for future excavation. Survey began at the northern end of the Wadeway, near the village of Langstone, walking south to the northernmost channel that cuts through the Wadeway. As many of the features encountered in the northern segment had been subject to preliminary survey in 2000 (Satchell 2000) it was possible to compare their condition over the intervening five years, Fig. 4 provides the location of the features within the Wadeway.

The northern segment of the Wadeway, measuring around 250m in length, is the most intact, with its surface being highly compacted and easily definable. The majority of the timber features associated with the Wadeway are found in this area. Features 1 and 2, and 3 and 4, form two pairs of timbers which clearly mark the edge of the Wadeway, with naturally deposited marine silts lying either side. After 250m there is an abrupt change in the surface composition to loose flint gravels (Fig. 5). Here it also widens and becomes less definable. Further clusters of timber elements, such as feature 6, consist of a combination of upright and horizontal timbers. These features mark the edge of the Wadeway on the western side, but are less distinct on the eastern side. The uprights secure the horizontal timbers which are revetment to hold the Wadeway sediments in place.

Comparison of the timber features with the results of the survey undertaken in 2000 demonstrated a number of changes. Features 1, 2, 3, 4, 9 and 10 had slightly more silt coverage, while feature 8, the remains of a tree, was no longer present. Features 5, 6 and 7 had suffered some erosion to the timber and were not as prominent as in 2000. South of feature 7 a number of sections of timber structure appear to have been uncovered since the 2000 survey; these were designated as features 101, 102 and 103. They consisted of a number of vertical worked posts with associated horizontal cross-timbers, and are similar to other features, specifically 9 and 10. The timber features show a general similarity in form and orientation

Fig 5 The abrupt change in sediments within the northern segment of the Wadeway, looking north towards Langstone Village

Fig 6 Damage caused by bait digging in the southern section of the Wadeway

which suggests they are part of a single phase of construction.

The middle segment of the Wadeway appears as an 'island' as it is flanked by the two channels (see Fig. 3). The surface consists of highly compacted 'mettled' gravels similar to the northern segment, although the lateral integrity is somewhat different. Despite kelp vegetation cover in this area, the Wadeway is visible as a defined feature; there are no timber structures within this segment. Some evidence of tidal erosion along the seaward edges of the Wadeway was noted.

The southernmost segment, closest to Hayling Island, is the least definable and most eroded area. In some parts the feature appears to have totally eroded away, further splitting this segment into three areas. Some remnants are visible adjacent to the New Cut (see Fig. 3) where there is an area of gravels lying in very dark grey sediments. This forms a noticeable mound, c. 20m in length, which is clearly distinguishable from the surrounding mudflats. Within this area five posts were visible. These are similar to those observed within the northern segment, but no associated horizontal revetting was recorded.

For the next 30m the Wadeway is not visible. This may be due to erosion or because the surviving remains are buried. Further south there is another increase in gravels which is not clearly defined, but can be distinguished from the surrounding mud flats and stretches for 10m before once more becoming indistinct. After a further 20m there is another 25m stretch of the Wadeway with slightly more integrity and increased amounts of gravels. There appear to be some red-orange sand-gravels integrated within the composition, similar to the northern segment near Langstone, although in smaller quantity. South of this area there are no visible traces of the Wadeway. There is a slight rise in the topography within which a number of small 'islands' of scrub grass are interspersed with salt marsh and small channels.

During the walkover survey bait digging was observed in the southern segment. This had left the area heavily truncated and damaged with one post split and removed by the activities (see Fig. 6). The physical evidence on site suggests that bait digging has been ongoing for an extended period of time and may have had a detrimental effect on any potentially buried remains relating to the Wadeway in this area. Also within the southern segment a number of worked flints were located, these included a core and five pieces of worked flint (Table 1, shown on Fig. 4 and detailed in Appendix 8.1). These provide further indication of prehistoric use of the area to the north of Hayling Island, but also demonstrates how bait digging is disturbing sediments containing archaeological material.

Auger survey

The auger survey investigated the subsurface deposits of the Wadeway and adjacent sediments using transects which were taken at a range of points along the length (Fig. 7). The interpreted profiles shown in Fig 7 show a selection of the auger results and the sediment

Table 1 Worked flint finds from the Wadeway

Find no	*Object type*	*Context*	*Notes*
3	Flint core	Unstratified	Recovered from the east of the Wadeway
4	Worked flint	Unstratifed	Found with find no 3 (not shown separately on Fig. 4)
5	Worked flint	Unstratified	Found on the surface of the Wadeway
6	Worked flint	Unstratified	Found on the surface of the Wadeway
7	Worked flint	Unstratified	Recovered from the east of the Wadeway
8	Worked flint	Unstratified	Found with find no 7 (not shown separately on Fig. 4)

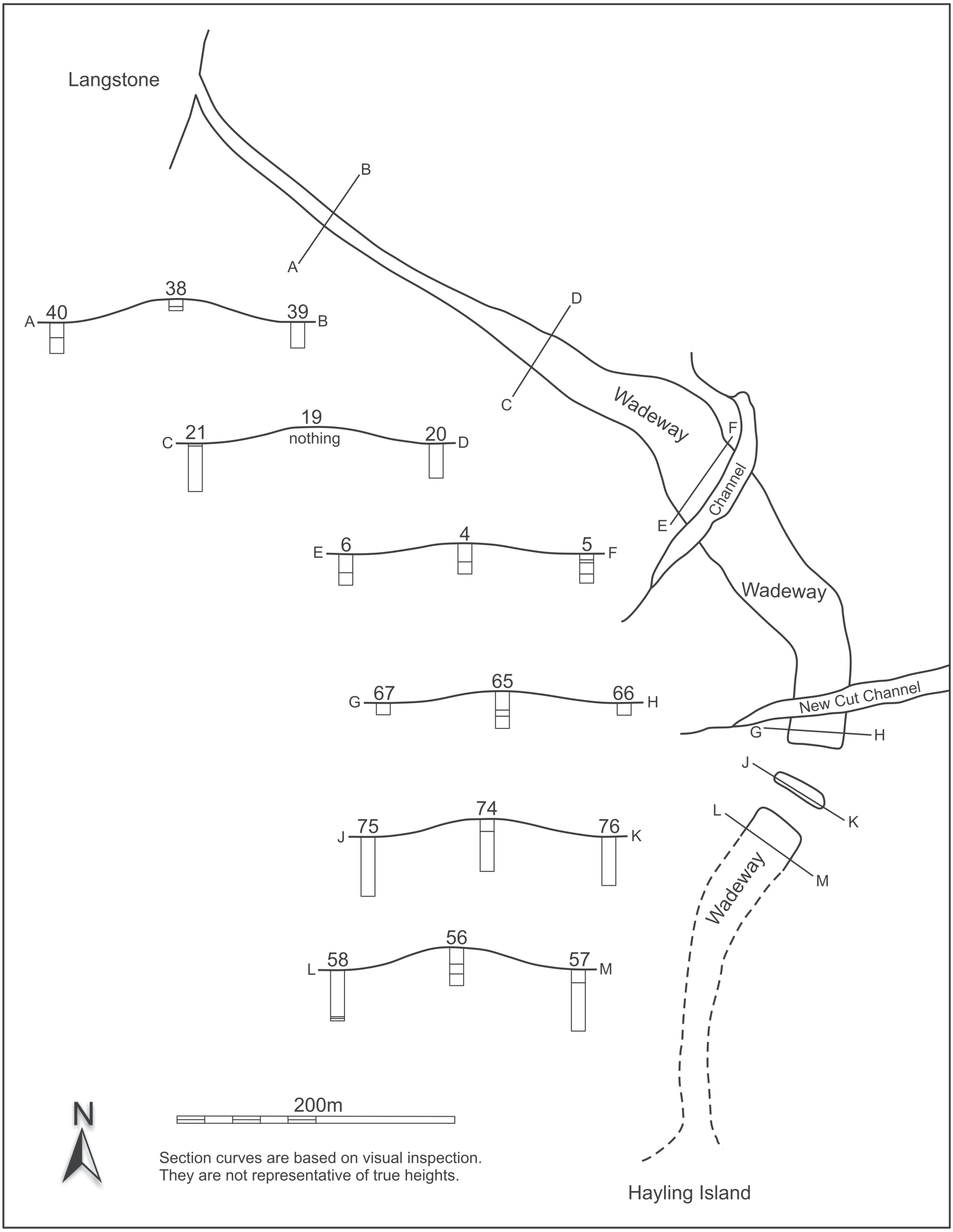

Fig 7 Results of the auger survey including the position of transects and deposits encountered

units encountered within them, however, it should be noted that the vertical heights of the augers are estimated.

On the northern segment the augers confirmed that the Wadeway is relatively intact with a compacted metalled surface over much of this area. Where it was possible to penetrate the Wadeway with the auger it showed the compacted red-orange sandy gravels of the surface sediment, and below this a deposit of dark grey clay with gravel. Beyond the change in surface composition (as noted during the walkover survey – see Fig. 5) it was possible to penetrate further, demonstrating that the layer of loose grey flint gravel within very dark grey silts continued to a depth of 0.3m. In some places beneath this layer a dark grey silty clay with occasional shell inclusion was encountered. To either side of the Wadeway the sediments consisted of homogeneous silts over a clay layer with chalk inclusions.

The less compact nature of the southern segment of the Wadeway allowed easier extraction of auger samples. These revealed an upper deposit consisting of grey-brown sandy silts with frequent gravel inclusions. The thickness of this was up to 0.3m just south of New Cut, but reduced to 0.1m further to the south. Below this upper layer lies marine silt, grey-brown to mid-grey in colour, with some shell inclusions and up to 0.3m thick. The lowest deposit encountered was a light grey, firmly compacted clay with chalk inclusions, it was not possible to reach the base of this deposit using the auger.

The samples taken from adjacent to the Wadeway have an upper deposit of marine silts of grey-brown to mid-grey colour with some shell and gravel inclusions; the depth of this varies with a maximum of 0.9m. Below this lies a light grey, firm clay with chalk inclusions which extended below the auger depth, this deposit is comparable to that encountered below the Wadeway deposits.

Excavation

In order to further investigate the composition of the Wadeway and recover dating evidence two trenches were excavated; their position is shown in Fig. 3. The main trench, Area A, was located to gather information on the form of the structure and its constituent parts. It stretched half way across the Wadeway and into the surrounding deposits. Area B was a smaller trench situated further south to compare to the results from Area A. A program of sampling was undertaken for specialist analysis. Detailed descriptions of the contexts are included in the project archive.

Area A

The section from Area A, Fig. 8, illustrates the deposits that make up the Wadeway and provides information on its construction. The trench measured 3.25 x 1 x 1.2m. The upper surface deposit (context 004) is a hard structural layer, the density and coverage of which suggest that it was the final layer of construction before the Wadeway became obsolete. Its addition may indicate a widening of the feature, perhaps for the use of larger traffic such as carriages. Below this, context 005 formed a relatively compact layer, consisting of larger flints than were found in 004. These were irregular and sharp and would have made a rougher surface that those within context 004. Two timbers were found abutting this layer, they are likely to have been part of a revetment to hold the deposits in place. Evidence of this can also be seen in other locations along the Wadeway surface (see Walkover Survey above). There was no visible cut or post pipe for the timbers, meaning they are most likely to have been driven into the soft marine silts and have become buried as more material was deposited in the area. The less compact nature of context 005 and the larger flint size suggests this was an aggregate layer that may be associated with the surface layer 004.

Context 006 is another structural layer of the Wadeway, made up of highly compacted flints and gravels. Fig. 8 shows the marked difference in the profile of the Wadeway at this point; here the feature narrows with context 006 abutting vertically the surrounding context 009. The base structural deposit (context 007) contains large flints and is of medium compaction. The large, irregular flints suggest this was not a surface layer, but was an aggregate layer in support of 006 above. Its looser nature would allow some drainage, while providing support for the above layer.

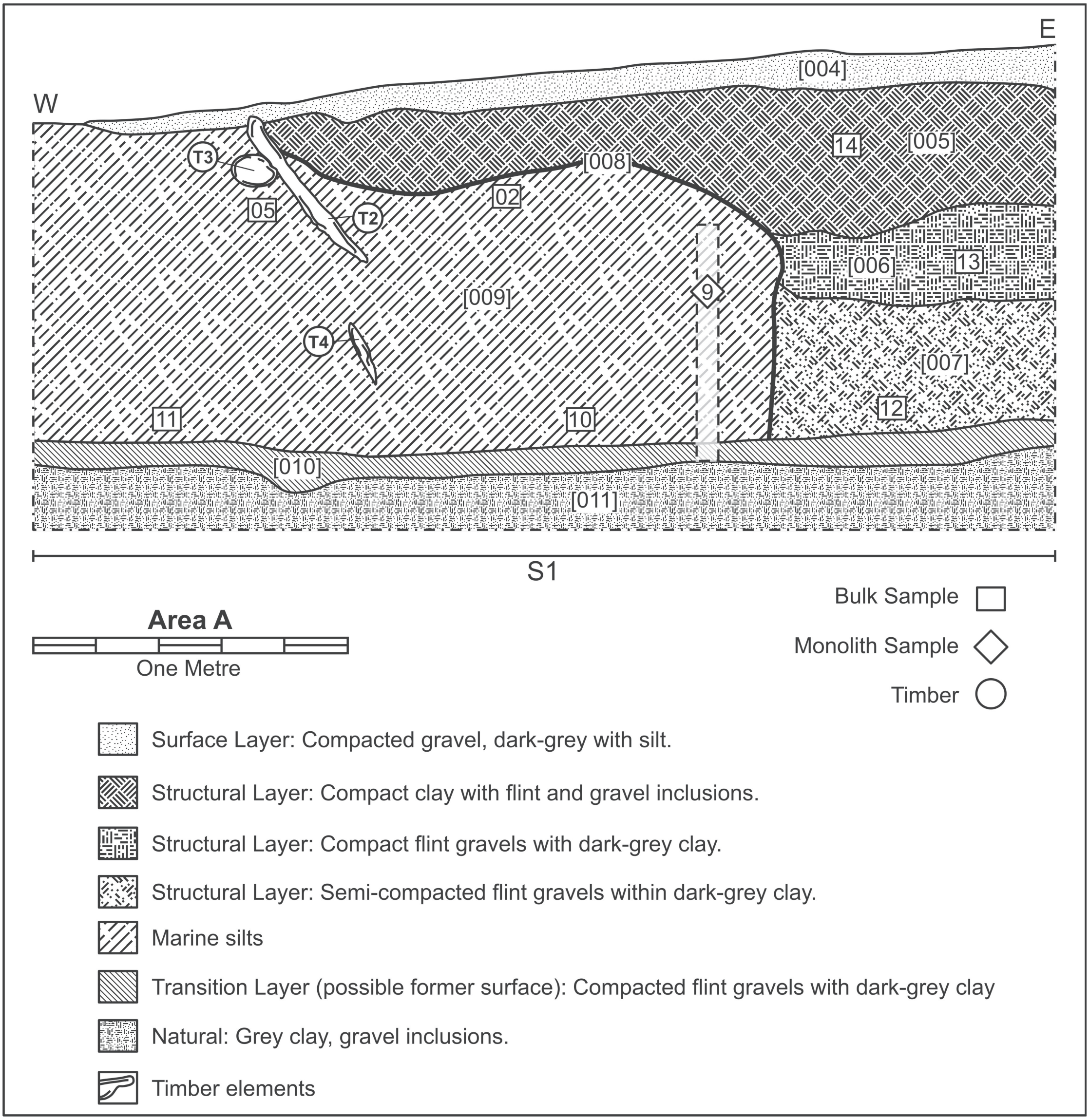

Fig 8 South-facing section drawing from excavation Area A

The cut for the Wadeway (context 008) appears to have two definable sections; the upper being a gentle slope and the lower being almost vertical. As the excavation trench only spanned half the Wadeway it is not possible to determine whether the opposite side of the feature has a similar form. The cut itself stops at layer 010, at a depth of –115.01cm OD, and does not penetrate, suggesting this material was believed to be compact enough to support the Wadeway.

Context 009 is formed of a deep accretion of marine sediments. This grey clayey silt has some flint, shell and vegetation inclusions, but is homogeneous in appearance and does not have visibly definable stratigraphy, its

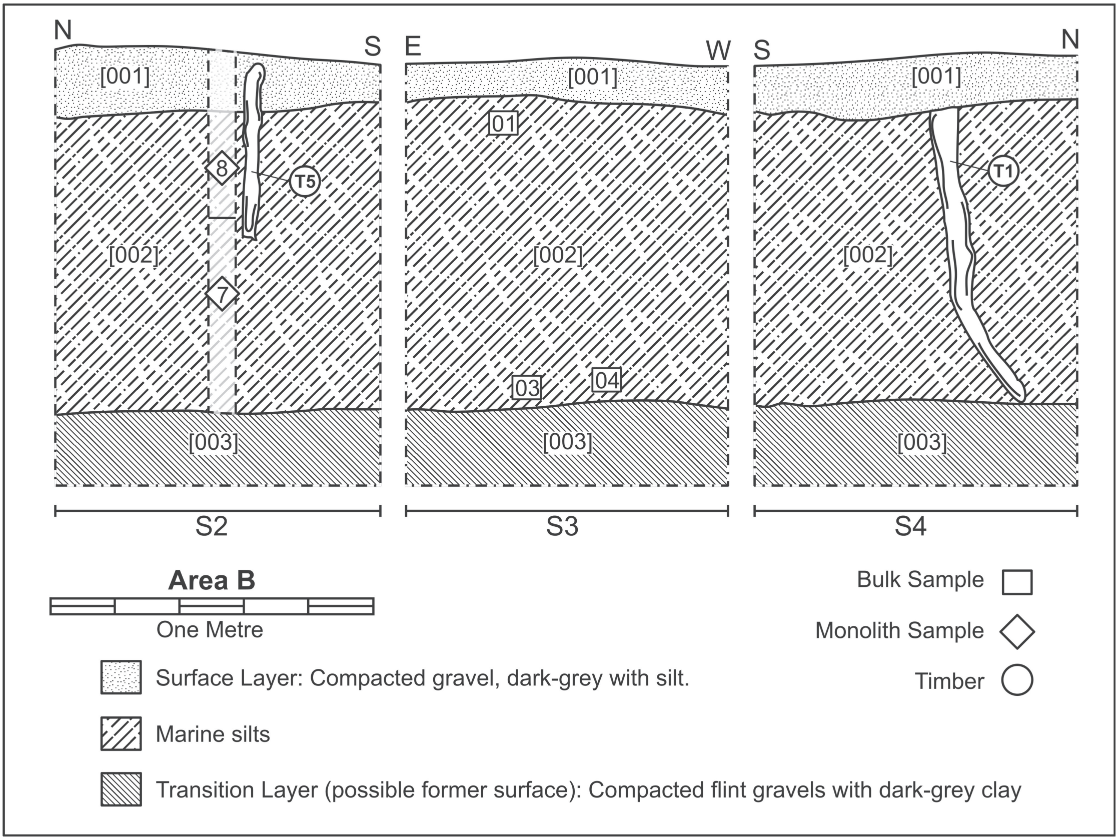

Fig 9 West-, north- and east-facing sections drawings from excavation Area B

maximum thickness is 0.98m. Lying below 009 and the Wadeway feature is context 010, a thin layer of dark grey highly compacted clay with large amounts of flint inclusions. This layer had a sharp boundary interface with contexts 007, 008 and 009, which was flat and well defined. Context 011 consists of mid grey clay with frequent flint and occasional chalk inclusions, its upper surface height being –123.01cm OD. Its presence below all other layers and its lateral extent suggests that this is the base natural in this area.

Area B

A smaller trench measuring 1 x 1 x 1m (Fig. 3) was dug further south within the northern segment, to compare the lateral composition of the structure. As shown in Figs 9 & 10 the deposits encountered were similar to those within Area A. Although this trench was inside the timber revetment as indicated by surface features, it was not far enough east to reveal the full cut of the feature seen in Area A (assuming that this continues to the south).

From the position of excavation Area B continuing to where the feature is severed by the northern channel, the Wadeway lies beneath a covering of loose shingle. This is believed to have built up due to a rise in topography formed by the Wadeway which trapped shingles transported during storm events. Evidence of this movement was seen between the two phases of fieldwork when more of the Wadeway surface had been uncovered. It is below this shingle that the upper structural surface context 001 was located. This is comparable in nature to 004 in Area A, confirming its lateral extent across the Wadeway.

Fig 10 Photograph of east-facing section of excavation Area B

Below context 001, the homogeneous marine sediments, context 002 were located. This deposit is the same as context 009 in Area A, its maximum thickness in this trench was 0.88m. The lowest context within Area B was 003, identical/similar to the layer of dark grey highly compacted clay with large amounts of flint inclusions (context 010) in Area A. The height to the top of this layer in Area B was –107.69cm OD. Working conditions meant it was not possible to extend this trench any deeper, however, it is clear that context 003 in this Area is thicker than in Area A.

Although this trench did not include the full range of structural deposits seen within Area A, it has confirmed the lateral extent of a number of the contexts. Pieces of wood driven vertically into the marine sediments were also found in this location providing further evidence of construction activity.

Samples

A range of samples were recovered during the excavation including bulk, monolith and timber samples; their positions are shown in Figs 8 & 9. It was possible to take monolith samples from the surrounding sediments of the Wadeway, but the very highly compacted nature of the gravels within the feature made it impossible to gain monolith samples from these. Instead a relatively large number of bulk samples were recovered from each of the contexts. Following excavation, the samples were subject to palaeoenvironmental and mollusc analysis, and were also sampled for radiocarbon dating. A summary of all samples recovered is included in Table 2.

Table 2 Summary of all samples recovered during the Wadeway excavation.

No	*Type*	*Area*	*Context*	*Position*	*Reason*
001	Bulk	B	002	Centre of trench, 20cm depth	Assessment and comparison win context 009
002	Bulk	A	009	Upper part of layer between 1.5-2m, from west baulk, 0.35m deep	Environmental assessment. Contains some vegetative matter
003	Bulk	B	002	Near base of layer. 1.10m depth.	Assessment.
004	Bulk	B	002	Near base of layer. 1.10m depth.	Assessment.
005	Bulk	A	009	West of timbers. 0.4m from west baulk, 0.35m depth	Assessment of marine sediments in relation to timbers.
007	Monolith	B	002	From 0.52cm to base of excavation at 1.12m. Relationship with sample 008.	Assess stratigraphy and environment
008	Monolith	B	001 & 002	From surface to 0.51m depth.	Assess stratigraphy and environment.
009	Monolith	A	009 & 010	From 0.64m to 1.24m.	Assess stratigraphy and environment
010	Bulk	A	009	Base of context. 2m from west baulk, 1.15m from surface	Assessment. RC dating from this sample
011	Bulk	A	009	West side area A, outside of the timber revetment, towards the base, depth 1m from surface	Comparison with sample 010, transition point between feature and marine sediments.
012	Bulk	A	007	Within context.	Lower structural deposit. Assessment RC dating from this sample
013	Bulk	A	006	Within context.	Structural deposit, comparison with 007 and 005. Assessment
014	Bulk	A	005	0.4m from surface.	Assessment and RC dating.
T1	Timber	B	002	Dimensions: length 1.1m with a diameter of 0.25m	
T2	Timber	A	009	Dimensions: length 0.6m with a diameter of 0.20cm	

ANALYSIS OF SAMPLES

Palaeoenvironmental analysis by Rob Scaife

Pollen analysis was undertaken on sediments associated with the make-up of the Wadeway to establish the local environment during and after construction. One of two monolith profiles and a sequence of spot samples produced sub-fossil pollen from which conclusions as to the age of the sequence and its depositional environment have been made.

Pollen method

Pollen sub-samples of 2ml volume taken from the sample monoliths and bulk samples were processed using standard techniques for the extraction of the sub-fossil pollen and spores (Moore & Webb 1978; Moore *et al.* 1992). Micromesh sieving (10u) was also used to aid with removal of the clay fraction where present in these sediments. The sub-fossil pollen and spores were identified and counted using an Olympus biological research microscope fitted with Leitz optics. A pollen sum of up to 300–500 grains of dry-land taxa per level was counted for each level for the column <9> and 100–150 for the spot samples. A pollen diagram for the former (Figs 11 & 12) has been plotted using Tilia and Tilia Graph with percentages calculated as follows.

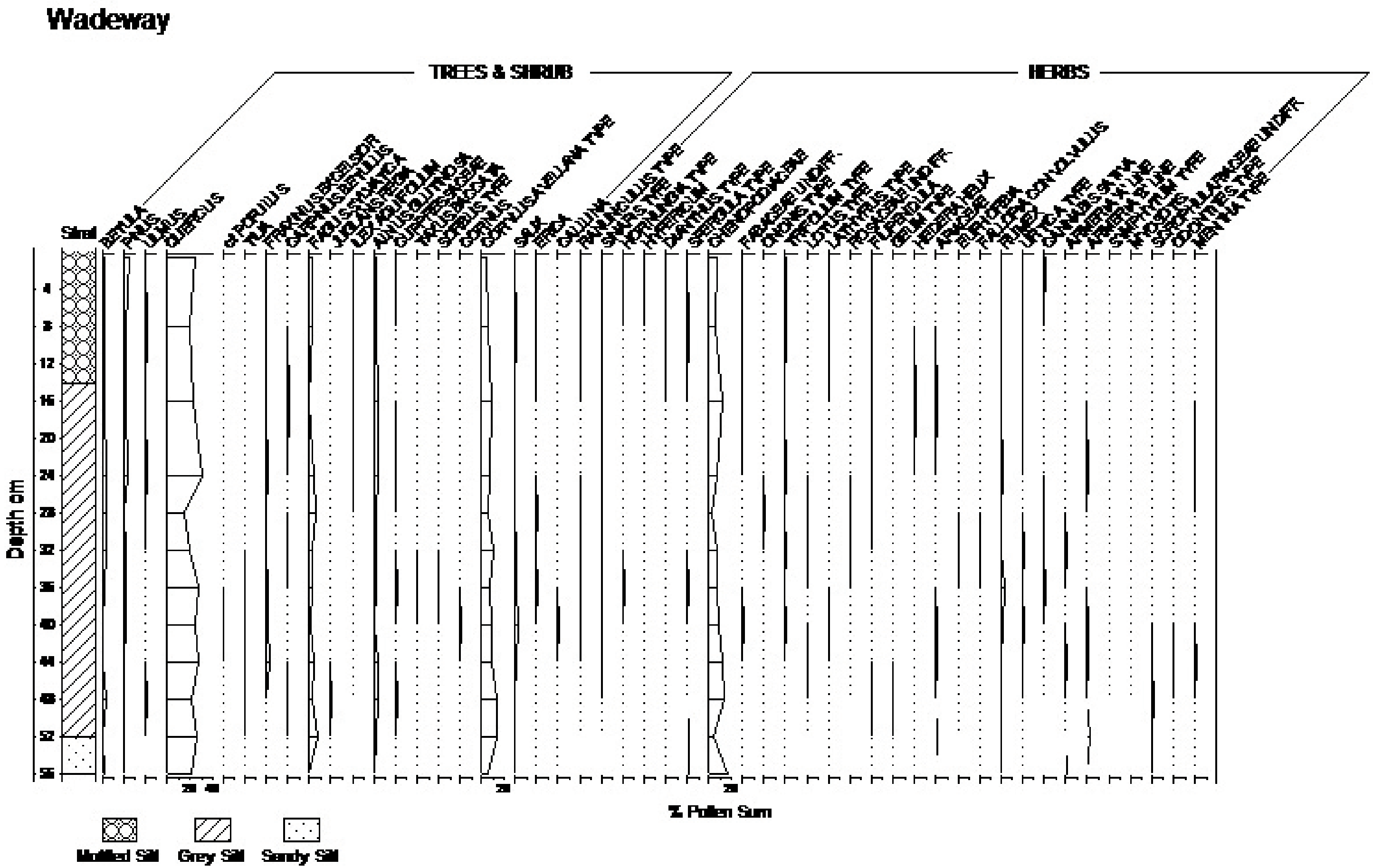

Fig 11 Pollen diagram of monolith 9 from the Wadeway excavation, part 1

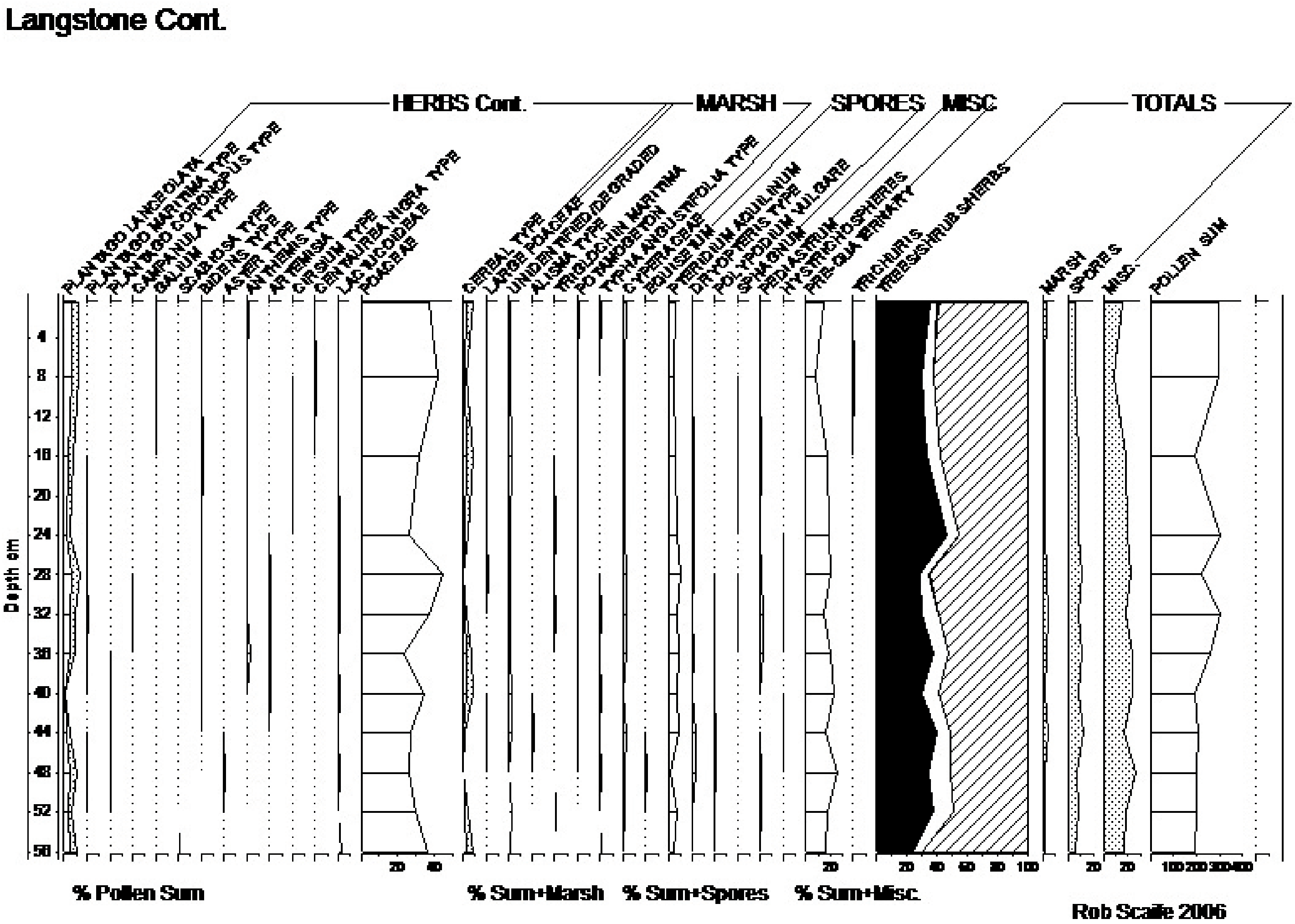

Fig 12 Pollen diagram of monolith 9 from the Wadeway excavation, part 2

Sum = % total dry-land pollen (tdlp).
Marsh/aquatic = % tdlp + sum of marsh/aquatics.
Spores = % tdlp + sum of spores.
Misc. = % tdlp + sum of misc. taxa.

Taxonomy, in general, follows that of Moore and Webb (1978) modified according to Bennett *et al.* (1994) for pollen types and Stace (1992) for plant descriptions. These procedures were carried out in the Palaeoecology Laboratory of the School of Geography, University of Southampton.

The pollen data

Two sequences of samples have been examined. First is Monolith 9, one of two monolith profiles (see Fig. 8 for position of sample). Second are spot samples obtained from specific contexts associated with the causeway (see Figs 8 & 9; Table 2). The pollen assemblages recovered are characterised as follows.

Monolith 9

This monolith profile comprises a basal sandy silt (52–56cm) which overlies basal gravels of probable Devensian age (context 010). These are overlain by context 009 grey and grey brown mottled silts (with clay) (10YR 4/2) which become increasingly pale brown towards the top of the profile. These sediments are salt marsh and/or mud flat origin as evidenced by the mollusca (*Hydrobia* sp.) and the pollen assemblages which include halophytes. The stratigraphy of the monolith revealed:

Depth cm	
0 to 14cm	Grey silts (10YR 4/2), with brown mottling Alluvial/salt marsh silts with some gleying/oxidation.
14 to 52	Grey, typical salt marsh silts (10YR 4/2). Contains fragmented mollusca including Hydrobia.
52 to 60	Basal gritty sand/silt with flint gravel base.

A total of 12 pollen samples were examined from the monolith profile, taken at 4cm and 8cm intervals. Pollen was, in general, well preserved but as expected somewhat sparse in these salt marsh sediments. Overall, the pollen assemblages are homogeneous throughout with little variation from which to define any local pollen assemblage zones. The overall characteristics of the profile are as follows (also see Figs 11 & 12):

Trees and shrubs; These form some 25–30% of total pollen and comprise a diverse range of types. *Quercus* (oak; 20–30%) is most imprint with *Fagus sylvatica* (beech; to 6%) and Corylus avellana type (hazel and sweet gale; 10–15%). There are lesser occurrences of *Betula* (birch), *Pinus* (pine), *Ulmus* (elm), *Fraxinus excelsior* (ash), *Alnus glutinosa* (alder). Sporadic occurrences of *Populus* (poplar), *Ilex aquifolium,* (holly) and *Juglans regia* (walnut). Shrubs comprise largely *Corylus avellana* type noted with small numbers of *Salix* (willow), *Sorbus* type (hawthorn or whitebeam) and *Cornus* (dogwood). Dwarf shrubs include *Erica* (heather) and *Calluna* (ling).

Herbs; These are dominant throughout (to 70%) comprising a diverse range of taxa. Poaceae (grasses; to 48%) are dominant with Chenopodiaceae (goosefoots, oraches and glassworts; to 16% at the base of the profile) and *Plantago lanceolata* (Ribwort plantain; to 6%). Of particular note are occasional but usually poorly represented halophytes including *Plantago maritima* (Sea plantain), *Spergula* type (Spurrey), possible *Triglochin maritima* (sea arrow grass) and Plumbaginaceae (*Armeria* 'A' and 'B' line). *Cannabis sativa* type (hemp and hop) occurs sporadically but especially in the lower half of the profile. Cereal pollen and weeds of arable ground are similarly consistent but in small numbers.

Freshwater marsh and aquatic; There are generally small numbers which comprise Cyperaceae (sedges; 1–2%), occasional *Sparganium* type (reed-mace and bur reed), Alisma type (water plantain), *Potamogeton* type (pond weed and arrow grass). Cysts of aquatic algal *Pediastrum* are present.

Spores of ferns; Pteridium aquilinum (bracken; 7%) is consistent and most important. Other taxa present include *Equisetum* (horsetail), *Dryopteris* type (monolete spores of typical ferns) and *Polypodium* (polypody fern). *Sphagnum* moss spores occur sporadically.

Miscellaneous taxa; There are substantial numbers of reworked pre-Quaternary palynomorphs of Tertiary age. Also noted are Hystrichospheres (marine dinoflagellates). A single and unexpected egg of the intestinal parasite, *Trichuris* (whip worm) was recorded at 8cm.

Pollen analysis of the spot samples

In addition to the column samples, bulk samples were obtained for plant macro-fossil analysis from within the different site/stratigraphical contexts. A total of ten sub-samples taken from these spot samples have been examined to compare with data from the column profile described above. These samples were taken from both excavation areas.

As with the Monolith 9 sample, pollen was variably preserved and was not abundant. Samples were prepared as detailed above. Counts of 100–150 pollen grains plus spores were made from each sample. These data are presented in Table 3.

Area A

Spot samples 12 (context 007), 13 (006) and 14 (005) come from a pit or ditch feature (context 008) which cuts into the principal sediments of the site (context 009); monolith 9 was taken from contexts 009 and 010. Spot samples 2, 5, 10 and 11 also come from this context and thus pre-date the ditch/pit fill.

Samples 10 and 11 come from the lowest sediment overlying basal ?Devensian gravels, context 009. The pollen spectra of these two samples are dominated by herbs with Poaceae (grasses) and Chenopodiaceae (goosefoots, oraches and glassworts). This indicates grassland/pasture. Cultigens in these samples include *Cannabis* type (hemp and hop) and cereal pollen. Trees and shrubs are also present which include largely *Quercus* and *Corylus avellana* type (hazel) which come from local growth. In the higher levels/samples 2 and 5, herbs remain important although in sample 5 *Quercus* (oak) is important and may relate to the timber stake obtained from adjacent to the sample. Beech (*Fagus sylvatica*) is usually very poorly represented in pollen spectra and of specific note here, are the numbers which also occur in this sample. This perhaps indicates nearby growth of beech on well drained (gravel) soils.

From the pit/ditch, samples 12 (lowest), 13 and 14 (uppermost), the pollen spectra are of similar character to those of the upper part of surrounding sediments (samples 2 and 5). Overall the pollen spectra contain oak and hazel pollen also with evidence of pasture herbs. *Cannabis* type is also noted in the upper sample.

Area B

Three spot samples have been examined, two from the base of the sequence (3 and 4) and from the top of the profile (1) (see Table 3). In the former, values of *Quercus* (oak) are higher than in the upper sample. *Fagus sylvatica* is also important in sample 3. Herbs are, however, also important with grasses and other pasture/grassland taxa (e.g. *Plantago lanceolata*). Halophytes (salt marsh plants) are also present with Chenopodiaceae, *Spergularia* type, *Armeria* type (sea lavender or thrift) and *Plantago maritima* (sea plantain).

Discussion of spot samples

These spot samples were examined for comparison with the analysis of column 9. Overall, it appears that all of the samples fall within the same groups as identified from Monolith 9 and, as discussed below, appear to be of Romano-British date at earliest. Although the taphonomy of the pollen in these sediments may be complex due to the alluvial and salt marsh environment in which the sediments accreted, some suggestions can be made regarding the local vegetation environment. These are essentially as described for the more continuous sequence of Monolith 9. Oak and hazel pollen probably come from the wider region and is typical of pollen spectra from the historic period. Beech is usually poorly represented in pollen spectra and its presence here is significant and suggests growth locally on the better drained (?gravel) soils of Langstone. Although trees and shrubs are present, herbs are important with evidence of grassland/pasture in surrounding areas plus strong evidence for salt marsh communities on the site itself. Cereal and hemp/hop pollen are in evidence also indicating local cultivation (although possibility of fluvial transport is noted).

Although pollen analysis is not a technique for dating, the data here confirm suggestions made from analysis of Monolith 9 that the sediments were laid down during the Roman and post-Roman period at earliest and not later than c. AD 1600–1700. The latter date is based on the fact that pine and elm might be expected in greater numbers in upper levels as a consequence of planting from this date onwards (Long *et al.* 1999). Because of the possibility of hemp pollen (rather than hop) a Saxon to medieval age is thought likely.

Discussion

The principal aims of this study were to characterise the environment in relation to the construction of the causeway and attempt to establish the age of the structure and associated sediments by comparison with the known regional vegetation chronology.

With regard to the second objective, it is clear that these were laid down in the historic period and most probably in the Roman and post-Roman period at earliest. This is based on the absence of dominant woodland and especially the absence of lime/linden (*Tilia*) which is

Table 3 Pollen count results for spot samples from Areas A and B

Sample	*2*	*5*	*10*	*11*	*14*	*13*	*12*	*1*	*3*	*4*
Section	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*4*	*4*	*4*
Area	*A*	*A*	*A*	*A*	*A*	*A*	*A*	*B*	*B*	*B*
TREES & SHRUBS										
Betula	1				1		3	1	7	
Pinus		1	1		1	1	1	1	2	2
Ulmus				1	1	1		5	1	
Quercus	10	36	5	19	9	26	18	25	49	20
Fraxinus excelsior		1		1					1	3
Carpinus betulus									1	
Fagus sylvatica	1	6	1		1	1	3	1	5	3
Alnus glutinosa	1	1	1	4	2	1		1	1	
Corylus avellana type	9	1		7	1	1		3	3	2
Salix										1
Hippophae rhamnoides		3								
Erica			1				1			
HERBS										
Ranunculus type	1	1							1	
Thalictrum				1						
Sinapis type	1				1					
Hornungia type							1			
CHENOPODIACEAE	1	9	1	11	3	3	9	7	5	5
Cerastium type					1					
Euphorbia	2									
Spergularia type								3		
Filipendula ulmaria								1	1	
Armeria 'B' line									1	
ROSACEAE	1						1			
APIACEAE						1	1	1	3	
Polygonum sp.					1				1	
Fallopia convolvulus										1
Rumex	1				3					1
Cannabis type	1	1			1			1		
Scrophulariaceae				1	1				1	

Table 3 (cont.) Pollen count results for spot samples from Areas A and B

Sample	*2*	*5*	*10*	*11*	*14*	*13*	*12*	*1*	*3*	*4*
Section	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*4*	*4*	*4*
Area	*A*	*A*	*A*	*A*	*A*	*A*	*A*	*B*	*B*	*B*
Mentha type						1				
Pedicularis type										1
Plantago major type										1
Plantago lanceolata	6	4		5	2	2		10	9	4
Plantago maritima									1	
Scabiosa	1									
Bidens type	1	2								
Anthemis type	1			3		1	1		1	
Aster type		2								
Cirsium type							1			
Artemisia						1			1	
Centaurea nigra type										1
Centaurea scabiosa type	1									
LACTUCOIDEAE			1	1	2					
POACEAE	43	33	11	49	81	48	40	87	59	45
Cerealia	8	3			3	5	4	1	2	1
POACEAE (Large)					2	3		2		
MARSH										
Potamogeton type					1				1	
Sparganium type	1								1	
Cyperaceae	2	1	1	2	1	1	5		1	
SPORES										
Dryopteris type					5	3		3		
Pteridium aquilinum	5	5	4	3		1		10		3
Sphagnum								1	1	
Polypodium						1				
MISC.										
Pediastrum	5			8	3	2	1	1	1	1
Pre-Quaternary	5	9	5		12	9	2	9	10	8

known to have been widespread and dominant in the region during the middle Holocene until the middle Bronze Age (although there is some degree of asynchroneity). Presence of walnut (*Juglans regia*) at 48cm (at the base of the profile) infers a Roman or post-Roman age as this tree is widely considered to be a Roman introduction to Britain and West Europe as whole. Presence of hemp (*Cannabis sativa*) is also to some extent diagnostic of the medieval period although this pollen taxon is difficult to separate from hop (*Humulus*) which has closely similar pollen morphology.

In spite of the absence of dominant woodland, there is a diverse range of woodland types present. Oak and hazel are typically important for the suggested age of the material (medieval) representing remaining, probably managed woodland. However, there are also other taxa which are of local importance. These include beech (*Fagus sylvatica*), ash (*Fraxinus excelsior*) and holly (*Ilex*). These are all poorly represented in pollen spectra and occurrence is usually seen as indicative of local growth. Given that this profile comprises largely mineral sediments, these will have been derived from elsewhere along with fluvially transported pollen and spores. Thus, the assemblages recovered here are representative of the wider fluvial catchment. Other taxa include birch, elm, hornbeam, walnut, Cuppressaceae (probably juniper but possibly introduced species) and yew. Pine pollen is sparse throughout most of the profile and, as a substantial producer of anemophilous pollen this is regarded as of long distance/extra local origin. However, there is an expansion in the upper levels of the profile which may be diagnostic representing more local input from introduction of planted pines during the 18th Century (for discussion see Long *et al.* 1999).

The diverse herb assemblages contain evidence of a range of different communities/ habitats. These include;

Salt marsh: As expected, there is clear evidence for salt marsh and possibly mud flat conditions with pollen of halophytes including Chenopodiaceae (goosefoots, oraches and glassworts), *Plantago lanceolata* (sea plantain), Plumbaginaceae (thrift and sea lavender) and possible sea arrow grass (*Triglochin maritima*). A marine or brackish water environment is also evidenced from the diatom assemblages observed from the same profile.

Freshwater: Although a salt marsh habitat, the pollen as noted is derived to a large extent from the fluvial catchment. Consequently, pollen from freshwater and marginal communities would be expected. Here, these include sedges (Cyperaceae) with some fen reed taxa including water plantain and bur reed/reed mace. *Pediastrum* is also present.

Cultivated plants: There is a constant but minimal record of cereal pollen of wheat and barley type and a single grain of *Secale cereale* (oat). Of interest is *Cannabis/Humulus* type (hop and hemp). It is not possible to ascertain with certainty whether hop or hemp is represented. The former, a native plant, is a typical plant of fen carr woodland for which there is little evidence here (small values of alder) and also cultivation. Hemp was, however, cultivated during the medieval period for fibre and the suggested age for this material would tentatively suggest cultivation in the near region.

Grassland/pasture: Poaceae (grasses) is the dominant pollen taxon and although this taxon is referable to many vegetation communities, presence of *Plantago lanceolata* and other typical pasture type suggests that grassland was dominant in the near region.

Molluscan analysis by Simon Bray

Cored molluscan faunal remains taken from the Wadeway samples were assessed for species composition. The range of fauna taken from cores or midden sites can indicate the habitat and environmental conditions from where they were collected. Using this method, changes in environmental conditions in relation to context *may* indicate changes in palaeoclimates, local hydrology and shore exposure environments. The data should be treated with caution as all fauna are part of the historical death assemblage which can be transported through wave action rather than indicate residency at a site. However, species abundances and general knowledge of the area can be used to give an overview of prevalent conditions during the period relevant to the sample.

Methods
Samples were analysed in relation to their contexts (009, 007 and 005). Molluscan fauna were not superabundant in these samples thus a brief assessment of those present and their relative abundances has been made. Although community composition is discussed, it is only supplied as a guideline. The general condition of some of the shells made full identification problematic and in some cases juvenile stages may also have made features less clear.

Results
Context **009.** Samples consisted of 8 laver spire shell (*Hyrobia ulvae*), 1 rough periwinkle (*Littorina saxatilis*) and 1 individual which may have been the little periwinkle (*Melarhaphe neritoides*), but is more likey to be a worn shell of *L. saxatilis.* The abundance of *H. ulvae* is indicative of a sheltered shore, saltmarsh habitat, however *L. saxatilis* is normally an exposed shore animal (although there is a morph, which exists in sheltered locations) (see Table 4 for summary from all contexts).
Context **007.** This consisted entirely of *H. ulvae* shells (see Table 4 for further details of habitat indication).
Context **005.** Shells from context 005 (younger material from higher in the stratigraphic sequence of Area A) consisted of a variety of species. Although fragmented, there were approximately 12 *H. ulvae*, 1 *H. ventrosa* that is normally associated with brackish and estuarine conditions and is largely restricted to the sound and east coasts, 1 fragmented *L. mariae (fabalis)* (flat periwinkle), normally on moderately exposed shores associated with fucoid algae, and one *L. littorea* (edible periwinkle) again normally associated with exposed to moderately exposed shores and feeding on algae species present.

Finally there was one species of bivalve, which could not be identified as distinguishing shell marks were largely worn away. Bivalves of this nature may generally be associated with sheltered, estuarine, habitats where they burrow in the fine sediment and filter nutrients from the water column above.

Discussion
The abundance of *Hydrobia* species and presence of a burrowing bivalve and potentially sheltered shore morphs of *L. saxatilis* suggest an estuarine habitat, potentially with

Table 4 Summary of mollusc species from the Wadeway samples and the habitats indicated by their presence

Species	*Present in sample number*	*Habitat Indications*
Hydrobia ulvae	005/007/009	Very abundant in estuaries and on salt marshes. Often eats sea lettuce (*Ulva lactuca*) which can proliferate in fresh water influence. Generally associated with brackish and estuarine conditions.
Littorina saxatilis	005/009	Normally occurs in upper tidal zone of exposed shores, but different morph can exist in saltmarsh on base of *Spartina* species and in brackish lagoons on seagrass, fucoids etc.
Littorina mariae	005	Common in the intertidal zone, especially on rocky shores, feeds on fucoid algae
Littorina littorea	005	Exposed to moderately exposed shores, larger individuals (as here) usual on lower shore. Feed on algae.
Bivalve (indet.)	005	Unidentified bivalve (shell very worn) but may indicate muddy fine sediment habitat (in which they often burrow), expert ID required.

lowered salinity due to moderate freshwater inflow. *Hydrobia* species are common, reaching densities of up to sixty thousand per square metre, they tolerate lowered salinities and are generally associated with salt marshes, mud flats and ephemeral algae.

L. saxatilis is normally associated with exposed rocky shores, but a specialist morph tolerant to estuarine conditions (Janson 1982), can exist sometimes only a few metres away from the fully marine, but in an entirely different salinity regime; the two populations do not mix. It is not possible to state whether those here are estuarine, but in the context against the other species and their morphology, this conclusion seems likely.

The two outliers to the above habitat indications are the *L. littorea* and *L. mariae* which are both normally associated with more exposed shores. It may be that extreme storm events washed the individuals (when dead) into the strand line species assemblage in a manner similar to saltation, which has been seen in shells of *L. littorea* (Amos *et al.* 2000). However, the sheltered nature of the shore may make this unlikely and another possibility may be that material from gravel/ cobble shores at the estuary mouth was transported in to reinforce the walkway.

Conclusion

The assessment suggests that the molluscan species here were from an estuarine, potentially lowered salinity environment. As some are associated with very fine muds the habitat was probably very low energy and may have been colonized by salt marsh plants providing abundant organic material. The outlier species are unlikely to have originated within this habitat and may have been transported through a storm event or possibly through rebuilding of the walkway.

Timber evidence

A number of timbers were encountered during the excavation; these are shown in Figs 8 & 9 labelled with a 'T' prefix ,with further detail shown in Fig. 10. Three were present in excavation Area A (T2, T3 and T4) and two in Area B (T1 and T5). Two of these timbers were recovered as samples, T1 from Area B which measures 1.1m in length with a diameter of 0.25m, and T2 from Area A which measures 0.6m in length with a diameter of 0.20cm.

T1 and T5 were vertical or near vertical, T4 was at an angle of around 20 degrees from vertical and T2 was angled around 40 degrees. T3 was a horizontal timber, which was being held in place by the adjacent uprights, demonstrating a similar method to the features visible within the Wadeway surface. None of the timbers had any associated root systems, and so were deliberate additions as part of the Wadeway construction. Prior to their use the timbers had their bark removed and there is some evidence that the lower ends were reduced to a tapered point, as can be seen in Fig. 10. The condition of the timbers was excellent, having been sealed within the surrounding anaerobic deposits.

Evidence from Area A suggests that the position of the timbers is associated with the deposition of context 005 within the Wadeway structure. This context abuts the timbers, which indicates they have been deliberately placed to act as a revetment to retain the deposits. This is corroborated by evidence from Area B where two further wooden stakes were encountered. Although there is no evidence of the deposits numbered context 005 in Area A within Area B, it is clear that the vertical stakes are in a similar alignment and position as those in Area A and can be considered to be a continuation of revetment. There are also similarities in the size of the upright timbers with those encountered within the southern segment of the Wadeway.

Dating

In the absence of other dating evidence for the Wadeway, material was selected for radiocarbon dating. This sought to determine the date of the structure, and, if there were multiple phases of construction, when these occurred. Due to the low levels of organic material present in the deposits each sample was processed using water and micromesh sieves to separate organic material from the sediment prior to selecting samples for AMS dating. Material from three contexts was dated; from context 005 (organic material taken from sample no 14 near the centre of the context), context 007 (organic material from sample no 12 taken near the base of the context) and context 009 (plant material taken from sample no 10 from near base of context) was dated.

The results demonstrated that context 009, into which the Wadeway was cut, dated to Cal AD 1030–1220 (Beta 231738). Two dates were provided for context 007, the lower Wadeway deposit, Cal AD 1260–1320 and Cal AD 1350–1390 (Beta 231736), while context 005 the upper Wadeway deposit dated to Cal AD 1390–1420 (Beta 231737). These results support the interpretation from the palaeoenvironmental analysis that the salt marsh deposits did not build up until the post-Roman or early medieval period. The date range for context 009 is larger than those for the structural deposits for the Wadeway which may reflect the length of time over which this deposit built up. The date indicates the surrounding deposits built up in the 11th and 12th centuries around 200 years before the Wadeway was constructed. The lower deposit has dated the initial construction of the Wadeway to the early to mid 14th century, with the upper deposit dating to around 1400. This means there is some potential for a slightly later phase of construction, although due to the closeness of the date ranges it is impossible to determine whether there was a significant gap between the deposition of these layers.

INTERPRETATION AND HISTORICAL CONTEXT OF CONSTRUCTION

Excavation has revealed a base 'natural' (context 010) which is a pre-Holocene sediment. This is overlain by context 010, Devensian gravels, which are likely to have been associated with a former channel in this area and were laid down before 8000 BC. There is little difference in the surface height of this deposit between the trenches (c. 0.10m) suggesting it is relatively consistent laterally. On top of the Devensian gravels there is a substantial deposit (009) of marine clays (up to 0.98m thick). The Wadeway construction cut was excavated through these marine clays until the compact Devensian gravels were reached. It is likely that the cut [008] is continuous, although there is some possibility that it has been widened at a later date.

Gravels have been laid into the construction cut. These were definable as separate layers due to differences in compaction and varying amounts of clay within the gravel matrix. The slight rise of context 007 against the western edge of the cut is further evidence of dumps of material into the area. It is not possible to definitively answer whether all four gravel layers (contexts 004, 005, 006 and 007) represent a single phase of construction, or whether the more laterally extensive layers 004 and 005 represent a slightly later phase of construction. Palaeoenvironmental analysis of spot samples from these layers (see above) did not indicate any significant difference between them. Additionally, the height of context 006 in relation to the surrounding deposit into which the feature was cut (009) indicates this would not be high enough to stand proud of the marine muds, which adds further weight to a single phase of construction. Palaeoenvironmental analysis of monolith 9 suggests the marine sediments may have been accreting beyond the early medieval period, so it is possible that rising sea level could still have been impacting the area after an initial building phase of the Wadeway. Furthermore, historical sources refer to a court order from AD 1610 indicating the Hayling Island inhabitants should take stone from South Moor for the maintenance of the Wadeway (Morley 1987), suggesting that there was a need to add deposits of stone to the surface of the structure over time.

The difference in the profile of the feature from the vertical edge of the cut adjacent to contexts 006 and 007, which forms a narrower central area of the feature, to the significantly widened and less defined edge adjacent to contexts 004 and 005 provides evidence of construction activity. The excavated width of the central area of the Wadeway is 0.90m, so assuming that the trench is centrally placed within the feature, this would provide a central width of around 1.80m. Applying this logic further up the feature, the distance across the

Wadeway between the wooden upright posts would have been c.4.8m. The feature may have been planned to have a very compact central area wide enough for carts with a wider spread upper surface, retained by the wooden revetting that would be less frequently used, but would allow passing of traffic travelling in opposite directions.

Beyond the northern segment of the Wadeway the construction may have differed as there is less evidence of a definable central section. This may have been due to the depth of marine sediments reducing as the topography drops away, with the area to be consolidated being shallower. Alternatively there may have been more structure which has now been lost to erosion and damage. There is a considerable topographic drop from the height of the Wadeway surface close at its northern end to where it is cut through by the first channel; between the two areas of excavation, which are 36 metres apart, there is a drop of 0.68m. As this northern section has a higher relief and is slightly more exposed to the forces of wind and storms it may have required more robust construction.

Environment of construction, sea level and harbour development

The Devensian gravels below the Wadeway form a compact layer that is darker in colour than the underlying context 011 which, based on comparison with evidence from Langstone Harbour (Allen 2000, 52–53), is believed to be 'natural'. Context 010 clearly predates the marine inundation of the area, and its relationship to the marine silts of context 009 means it is significant for interpreting the development of the harbour. Tweed (1999, 37) suggested the Wadeway follows a natural watershed, and therefore is on the highest topographic route through tidal marshes, this is supported by the fact that all streams to the west enter into Langstone Harbour, and those to the east into Chichester Harbour (Reger 1996). It is likely that context 010 represents the surface of a natural raised area, which was later inundated by deposits of marine sediments. Both contexts 010 and 011 are likely to be associated with earlier river channels which existed in the area, with 010 possibly consisting of fluvially transported gravels.

Dating evidence suggests that the area on which the Wadeway was constructed did not become tidal until AD 1030–1220. As waterlogged conditions expanded, the 'isthmus' to the island would have become increasingly narrower as more estuarine sediments were deposited. This eventually resulted in the construction of the Wadeway some time between 1260 and 1390. Palaeoenvironmental analysis of the sediments that have accumulated above the Devensian gravels (context 009) indicates an environment of salt marsh and mud flats, which began to be laid down during the Roman and Post-Roman periods. Further up the monolith profile, the pollen encountered appears to indicate a medieval date, which suggests the marine deposits are still accumulating until this period. Radiocarbon dating confirmed the date of the build up of marine salt marsh deposits to the 11th and 12th centuries.

With the ridge Devensian gravels providing a relatively compact surface this would have remained a final 'land bridge' until witnessing an increasingly estuarine environment and surge conditions recorded as occurring in the 12th–13th centuries (Galloway 2009). It is possible that other deposits may have built up on top of the Devensian gravels prior to the development of fully marine conditions, which may have been eroded away during the environmental processes associated with stormy conditions. However, the shelter afforded by Hayling Island, and the molluscan evidence suggesting a generally low energy estuarine environment, would indicate that there had not been significant 'stripping' of deposits prior to the salt marsh build up. Other coring and palaeoenvironmental work in the harbour has suggested that salt marsh may have been at its greatest extent from the Roman (AD 43–410) to early medieval (AD 410–1066) periods (MoLAS 2007, 24). With the area of the Wadeway being relatively high in the tidal regime, the build up of salt marsh specifically within this area from the early medieval period onwards is not inconsistent with the analysis from other areas of the harbour.

With salt marsh conditions and higher water levels building up on either side of the natural watershed provided by the gravel deposits, storm surges could have contributed to finally 'breaking through' the feature, allowing tidal conditions and severing access to Hayling Island.

The Wadeway was constructed in a period of environmental change when there was a general trend towards cooler temperatures from around the mid 13th century, known as the 'little ice age' (Galloway 2009). Prior to this cooling, which is associated with an increase in stormy conditions across Europe, the sea level in the 12th century is believed to have been around 20cm higher than today (Planet Earth 2009). A recent study in the Thames Estuary has provided interesting comparative evidence for the Wadeway study; Galloway (2009) details that the south and east coasts were battered by storms, with the most damaging ones occurring in 1236, 1286–88, 1334, 1375, 1404 and 1421. This increase in the frequency and severity of marine flooding is highly likely to have been one of the catalysts for the construction of the Wadeway.

There is recorded evidence of the sea encroaching on Hayling Island, particularly in the 14th century when there was extensive flooding. In 1324–5 the losses of Hayling Priory through the ravages of the sea were valued at £42, this was due to the priory buildings and the whole hamlet of East Stoke having been submerged (Page 1908). This direct indication that the south end of the island was subject to significant flooding and damage implies that the north end would also have felt the effects; this may have been when the land connection via the salt marsh was finally severed.

The extent of the losses of land in this period in a number of areas of the south coast (Tubbs 1999), suggests environmental conditions of such force that the topography of the harbour and its associated channels and islands could have been substantially altered. In such a shallow harbour a small rise in sea levels or large ingress of water would have had a major impact. This could have brought about significant hydrodynamic changes that may have included the breaching of the area of the Wadeway and the onset of more marine conditions.

Historical context of construction

The confirmation of the construction of the Wadeway in the early to mid 14th century AD has allowed its historical context to be researched. From the 12th century onwards there was a significant religious presence on Hayling Island. A priory was established in the early 12th century, to which was attached St Mary's church, built in the late 13th century with further additions in the 15th century (Soffe 1995). In the north of the island St Peter's church was built in the late 12th or early 13th century, again with some 15th century additions (Page 1908). There was clearly ongoing construction work on significant buildings during the period within which the Wadeway was constructed, and continuing after. This is likely to have required direct access from the mainland to the Island for the passage of materials and workers. Although these could have been transported by boat, it would have been more cost effective to maintain direct land access.

It is tempting to assume that the religious establishments on the island may have contributed to the construction of the Wadeway. In 1067 William I bestowed the manor of Hayling to the abbey of St Peter of Jumièges. Following ongoing wranglings over this situation with the Bishop of Winchester, who controlled the northern section of the Island as part of Havant Manor, Henry II was forced to issue a charter of confirmation in 1174. The charter indicated that the abbey did not have possession of all of the island, but did have manorial rights over the whole, which included the ferry rights. Although this reference may indicate a ferry was needed to travel between the island and the mainland at this time, it may also refer to other ferry services that no doubt travelled between villages across both Langstone and Chichester Harbours.

It was the priory located in the south of the island that was hardest hit by the 14th century storm surges. Doubleday and Page (1973) record that 'From the beginning of the reign of Edward I the sea had been making gradual encroachments on the west shore of the island…. But in 1324–5 the whole line of our south coast suffered much depredation, and a very considerable portion of the island of

Hayling was definitely submerged beneath the waters, including the priory church and conventual buildings'. The subsequent assessment of the loss to the sea in 1325 revealed '206 acres of arable land had been inundated and destroyed by the sea since 1294'.

Further information from the Victoria County History indicates that the lands in the north of the island remained in the possession of the Bishops of Winchester, as part of the manor of Havant, from at least 1284 until 1553 (Doubleday & Page 1973). As landholders in the area of the Wadeway at the time of its construction, they may have been directly responsible for it. Land holdings through manors in the 13th, 14th and 15th centuries were complex, with numerous parcels of land being retained or let (Page 1908). With a number of landholders having an interest in retaining a direct link from the island, the task of building and maintaining the Wadeway may have been split between them. By comparison, Galloway (2009) has found that in the Thames Estuary area it is the landholders and communities who were responsible for constructing responses to storm surges and flooding. He states 'The defence of reclaimed marshlands from river and sea flooding was governed by local custom or laws which obliged all those enjoying the protection of walls and drainage ditches to contribute to the cost of their maintenance' (2009, 11).

Although the Wadeway is not strictly a 'flood defence' it is part of the transport infrastructure for the local community. There are records from 1552 related to a 'toll for passage' over the Wadeway, and some of the proceeds from these charges may have been used for the upkeep of the structure. Morley (1987) also recounts that in 1610 a court ordered that the Hayling Island inhabitants should take stone from South Moor for the maintenance of the Wadeway. In the 1740 parish accounts for North Hayling include payments for cleaning the Wadeway, when Gaffer North is paid 1s 6d. In the same year Thomas' Book details how the expenses for cleaning the Wadeway were to be shared between the two parishes of North and South Hayling. From these brief references it is not possible to deduce how the initial construction of the Wadeway was organised and funded, but it does provide some evidence for responsibility for its ongoing use.

SIGNIFICANCE AND FUTURE WORK

The Wadeway is a significant feature in relation to the historic development of Hayling Island, and is a comparatively rare type of archaeological feature within the Solent. Once thought to be unique in the region, a review of cartographic sources has revealed the potential for another 'wadeway' structure that once provided access to Thorney Island from Emsworth village, to be preserved under sediments. The Yeakell and Gardner topographic survey of Sussex produced in 1787 covers the upper harbour area. It pre-dates the reclamation of the channel between the mainland and Thorney Island in the 1870s, and shows a tidal causeway marked 'Causeway for carriages at low water'. Additional information comes from the Victoria County History which states 'Until the 19th century this [Thorney Island] was crossed by a causeway leading to Emsworth, which was only completely uncovered at low water of the spring tides, but was otherwise 'nearly half-leg deep at low water'. There is now a road across the old 'wade way', and another farther east' (Salzman 1953). In terms of future research this is potentially a very interesting parallel to the Wadeway. There is evidence of religious activity on Thorney Island with a church initially constructed in the 12th and 13th centuries (Salzman 1953), and the island's topography suggests that it is likely to have been similarly affected by the 13th century environmental changes. This raises questions over whether both of these tidal causeways could have been constructed at a similar time and whether there is a coordinated scheme of development in the face of change.

The archaeological investigation of the Wadeway has added significantly to knowledge of its method and context of construction. There is further potential for historical sources to reveal more about the environmental events affecting the islands within Chichester Harbour, which may lead to further references to the construction of the Wadeway. Galloway's study (2009) of storm flooding, coastal defence and land-use around the Thames Estuary between 1250 and 1450 has provided interesting comparative evidence of environmental conditions and responses to this from another south coast estuary. He has gained data from a range of sources, some of the most instructive being the Calender of Patent Rolls, Manuscript Inquisitions held at the National Archives at Kew and various manorial account rolls; these sources may reveal similar evidence for the Chichester Harbour area.

The period in which the Wadeway was constructed is one of considerable pressure for Hayling Island. The 14th century brought multiple serious flooding and loss of land, the need to defend against attacks by the French, and having to cope with the arrival of the Black Death and subsequent loss of almost half the population (Page 1908). These forces are likely to have added to the need to maintain access to the Island; the Wadeway provided this route for the following 500 years.

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Authors: Authors: J*ulie Satchell (Hampshire & Wight Trust for Maritime Archaeology); Paul Donohue (formerly HWTMA); Rob Scaife (School of Geography, University of Southampton); Simon Bray (School of Civil Engineering and the Environment, University of Southampton). Contact email: julie.satchell@hwtma.org.uk*