EXCAVATIONS AT THE DORTER UNDERCROFT, WESTMINSTER ABBEY

Peter Mills

With contributions by Naomi Crowley, Anne Davis, Richenda Goffin, Alison Locker, Catherine Mortimer, Alan Pipe, Mark Samuel, John D. Shepherd, Hedley Swain and Ian Betts, Lyn Blackmore, Jon Cotton, Karen Waugh, Barbara West, D. F. Williams

SUMMARY

Excavations at the dorter undercroft of Westminster Abbey revealed evidence of extensive mid 11th-century flooding. In the latter part of the 11th century a road was built and a possible precinct ditch was dug, to be followed soon afterwards by a substantial wooden structure, probably a building. Some details of the present undercroft (built late 1060s–early 1070s) were recorded, together with evidence for late 12th-century and early 16th-century uses of the building.

INTRODUCTION

The existing undercroft of the dorter (monks' dormitory) at Westminster Abbey was built in the late 11th century and since 1908 has served as the museum of Westminster Abbey. In 1985 the Dean and Chapter decided to refurbish the building, bringing it up to modern museum standards. The renovation included the installation of air-conditioning via a series of underfloor ducts, requiring trenches disturbing one fifth of the floor area. In 1986 the Museum of London's Department of Greater London Archaeology carried out a limited excavation at the south end of the undercroft in order to identify details of the undercroft and examine earlier uses of the site.

HISTORY (Fig 1)

Westminster Abbey lies on Thorney Island, the gravel and sand island formed where the River Tyburn meets the Thames (Fig 2). There has been occasional occupation here since the prehistoric period and sporadic discoveries have suggested that a Roman settlement of some sort existed.

According to 11th century and later traditions the minster was founded in the 7th century but this is uncorroborated by contemporary documentary evidence, although some Middle Saxon material was recovered during the excavation. The earliest surviving charter relates to the refoundation of the minster as a Benedictine abbey by St Dunstan *c.*958–61 (Brooks 1992, 22). This charter refers to the restoration of an existing church and to the reassertion of control over an extensive landed estate said to have been given by Offa, either Offa of Essex (*c.*700) or Offa of Mercia (757–?96), and confirmed at the time of Archbishop Wulfred (802–32). After that date there are few references to the abbey until the 11th century when Edward the Confessor decided to rebuild it. According to his chronicler Westminster was chosen because 'of his devotion to St Peter (the patron saint of Westminster); because of the prominent position of the place near London and the Thames; and because he planned to be buried there' (Gem 1986, 13).

The first phase of the church, the construction of the east end, was completed in 1065 and can be assumed to have started *c.*1050. The second phase of building the nave and commencing the eastern claustral range was begun in or after 1066; whether there was a significant break between the phases is not known. Details of the

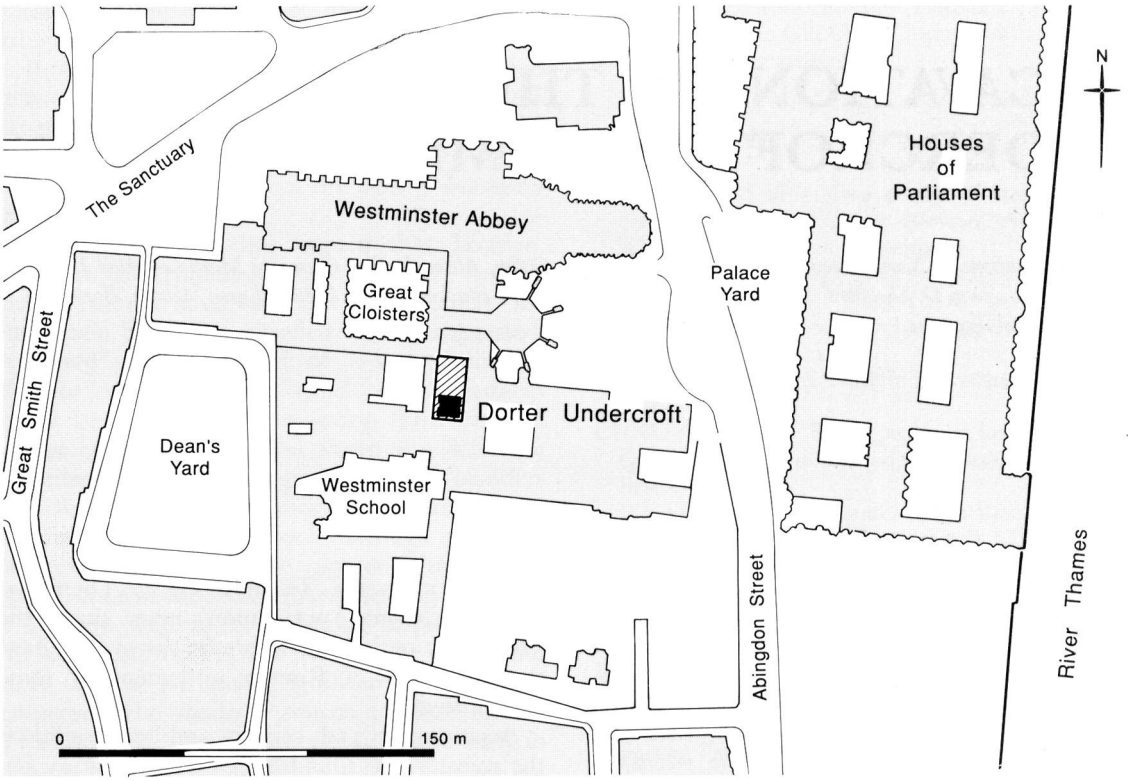

Fig 1. Plan of the area showing modern streets and the site outline (reproduced from OS 1:1250)

church, over 98m in length (322ft), were recorded earlier this century (Tanner and Clapham 1933, 235). Almost all the 11th century buildings have been replaced but the undercroft dorter, the Pyx chapel, and parts of the frater survive. The construction date of the surviving 11th century-elements has been discussed by Dr Richard Gem; in his view the historical and stylistic evidence indicate that the dorter undercroft was probably begun in the late 1060s or early 1070s (Gem 1980, 60; 1986, 17).

The abbey was dissolved in 1540, becoming a cathedral attended by a Dean and twelve prebends. The cathedral status was removed in 1550, though the prebends remained. The Benedictine abbey was restored by Mary in 1556 but in 1560 the Dean and chapter were re-introduced by Elizabeth I (Knowles and Hadcock 1953, 80).

BUILDING DESCRIPTION

The dorter undercroft lies on the east side of the cloister south of the chapter house. In the medieval period the undercroft or cellar of the dormitory was initially used for storage but was later subdivided to provide separate rooms with different functions (see Fig 6 below).

Seven bays of the undercroft have survived. Most of the doors and windows have been replaced but the internal layout has largely survived. A series of central piers, some with moulded bases, others with square plinths, support quadripartite groin vaults and transverse arches. The capitals were originally splayed with square *abaci* but several were subsequently decorated with carvings in the 12th century (RCHM 1924, 81). The east and west walls have wall arches.

The two northern bays are now divided off by a late 12th-century screen wall to form the Pyx Chapel. The two bays to the south of the Pyx Chapel were separated by a 13th-century wall (RCHM 1924), now demolished to form an entrance to the Chapel of St Dunstan. The area south of St Dunstan's Chapel was the warming house.

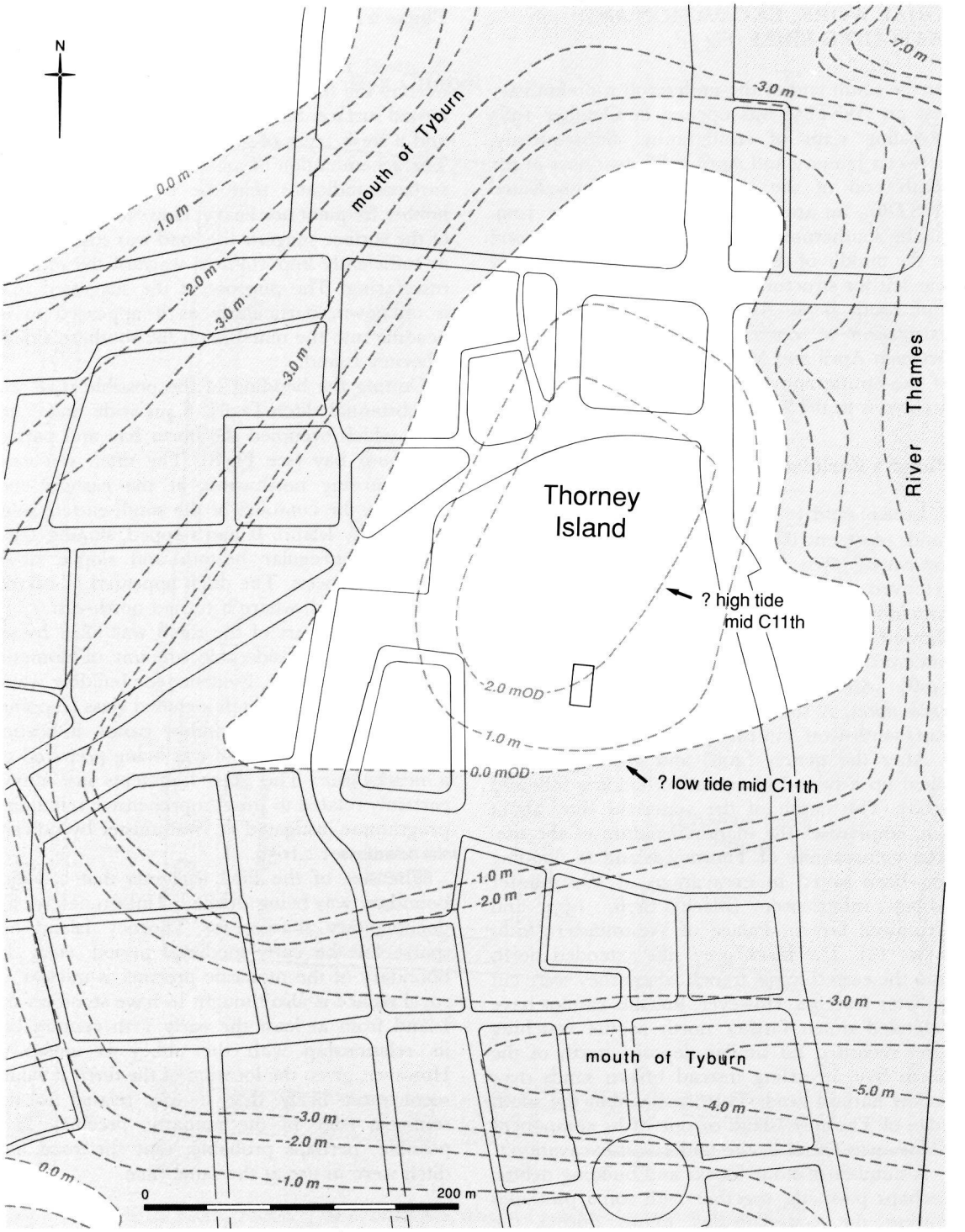

Fig 2. Suggested contour map of Thorney Island based on research by Chris Thomas (Sloane et al 1995).

TRIAL WORK, EXCAVATION AND WATCHING BRIEF (Fig 3)

At the south end of the undercroft a preliminary test pit (WST85) was opened in October 1985 revealing *c.*2m of stratigraphy. Subsequently, between January and April 1986, two bays at the south end of the undercroft were excavated (WST86), an area approximately 10m by 10m. As the southernmost pier of the undercroft stood in the middle of the area, a baulk some 2m wide was left for structural reasons between the north and south bays. After the completion of the excavation a watching brief was carried out between April and May 1986 and further details of the stratigraphy were recorded. The project archive is in the Museum of London.

Phase 1 Earliest occupation, *c.*1050 (Fig 4a)

A brown sand [381], sealing the natural yellow sand, represented the primary topsoil within the excavated area. Although later features had removed all but two small patches of this soil the watching brief north of the excavated area showed that a similar soil lay elsewhere in the undercroft. The topsoil was cut by a quarry [408] which extended beyond the limit of excavation. A small gully [394], running north-east/south-west, cut the quarry.

After the quarry [408] and gully [394] had silted up a period of extensive flooding followed [468]. The depth of the waterlaid silts, about 1m, emphasises the marginal nature of the site. The vulnerability of Thorney Island to flooding has been noted in excavations at Westminster Abbey misericorde (Black 1976, 135) and Cromwell Green, Palace of Westminster (Mills 1980, 18). The black/grey silts extended north into the eastern cross trench where they were cut by later features. However, the silts cannot have extended much further north as the watching brief recorded no similar deposits north of the north bay, revealing instead brown sands over yellow natural sand. This implies that the south edge of Thorney Island or one of its component islands was found in the undercroft excavation.

A number of stone blocks and building debris, perhaps postpads, together with some postholes cutting the waterlain-silts found during the excavation may represent traces of a simple structure, such as a jetty or mooring posts, in the marsh around Thorney Island. The pottery suggests a date for the phase of *c.*1050.

Phase 2 Road and ditch [238], 1050+ (Fig 4b)

A gravel surface [214] on bedding sand [251] overlay the flood silts. This probably represented a road surface. Silts accumulated over the surface and a fresh layer of gravel [250] was laid down. The accumulation of material on both the gravel surfaces indicates that the traffic using it was neither frequent nor heavy. However, the renewal of the surface suggests the road was still regarded as sufficiently important to warrant the effort of resurfacing. The purpose of the suggested road is unknown, particularly as it appeared to be heading into the marshes on the southern side of Thorney Island.

Cutting the bedding of the possible road was a substantial ditch [238], 6.4m wide and 1.7m deep which occupied the north bay and part of the south bay (see Fig 8). The ditch ran east-west, turning northwards at the eastern end, following the contours of the south-eastern edge of Thorney Island. It had stepped, sloping sides, a slightly irregular bottom and sloped down towards the west. The ditch appeared to narrow at the east end, where it turned north-east.

The lower part of the ditch was filled by silt containing a considerable amount of domestic and building refuse. Evidence for building works recovered from the ditch included glass chippings and pieces of grosed window panes, indicating that glazing for windows was being prepared on a nearby site. The glass fragments are almost certainly related to the comprehensive rebuilding programme instigated at Westminster by Edward the Confessor *c.*1050.

The size of the ditch suggests that a major boundary was being defined. Unfortunately, the documentary sources for Thorney Island are sparse for the early medieval period: even the boundary of the monastic precinct is unclear. A royal palace is also thought to have stood on the Island from at least the early 11th century but its relationship with the abbey is unknown. However, given the location of the ditch it would seem most likely that it was related to the southern edge of the monastic precinct. It is possible, perhaps probable, that the road and ditch were in use at the same time.

Phase 3 Ditch backfilling, 1050+

The primary fills of the ditch [238] were clearly derived from erosion and domestic debris but

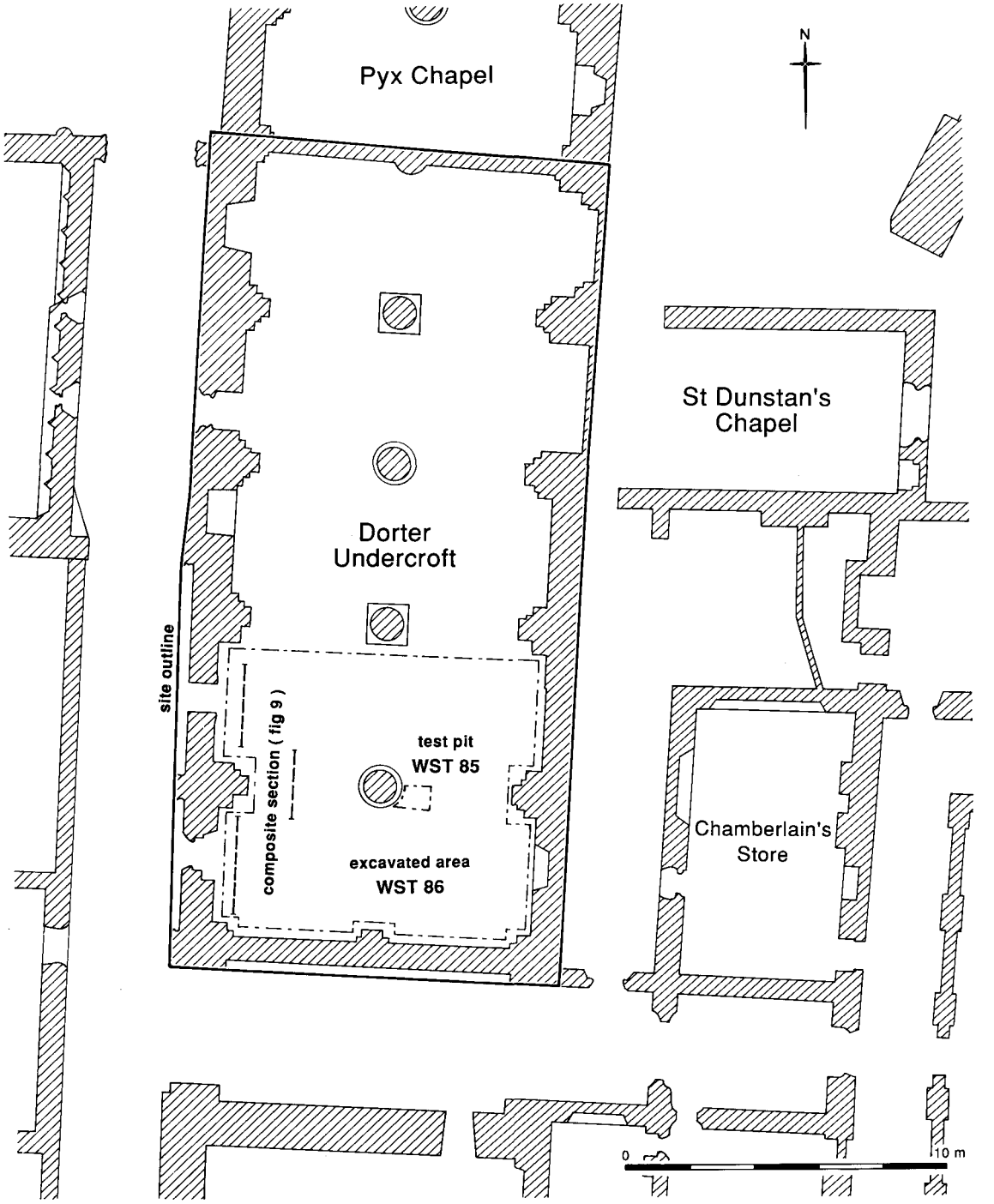

Fig 3. Plan of the site showing position of the excavated area, illustrated section and location of trench WST85.

the upper levels were the result of systematic backfilling. Dumps of distinctive orange clay, sand and gravel lay over the soft, silty refuse layers filling the lower half of the ditch. The first layers of clay and sand were cut by shallow slots, apparently ruts, possibly representing tracks left

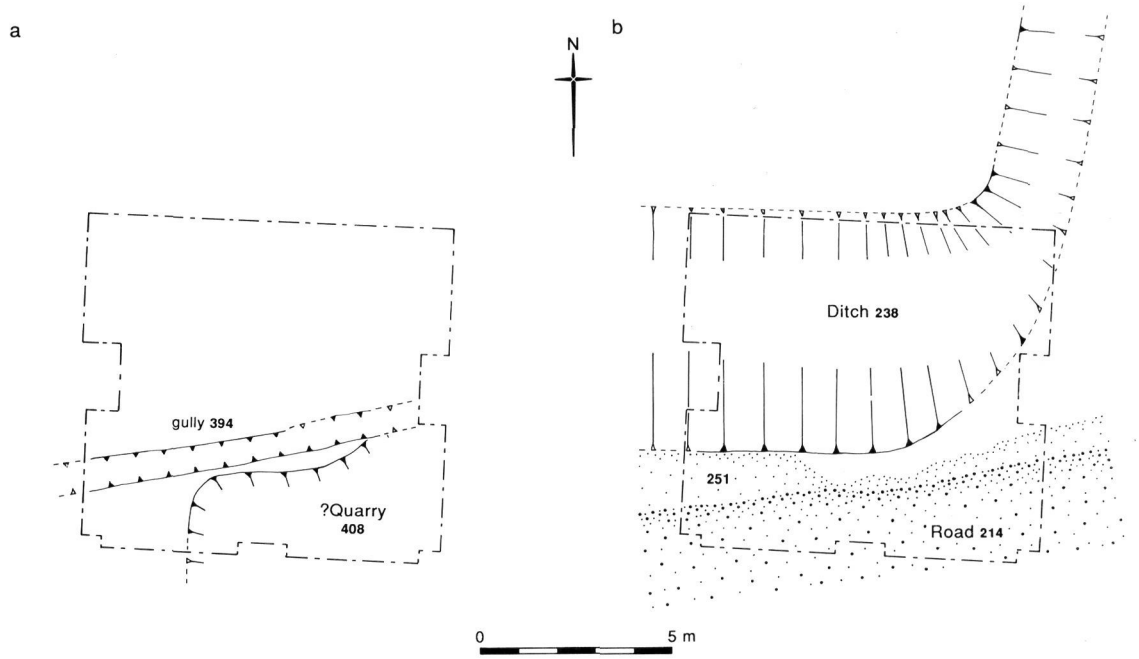

Fig 4. a. Interpretative plan Phase 1; b. Interpretative plan Phase 2

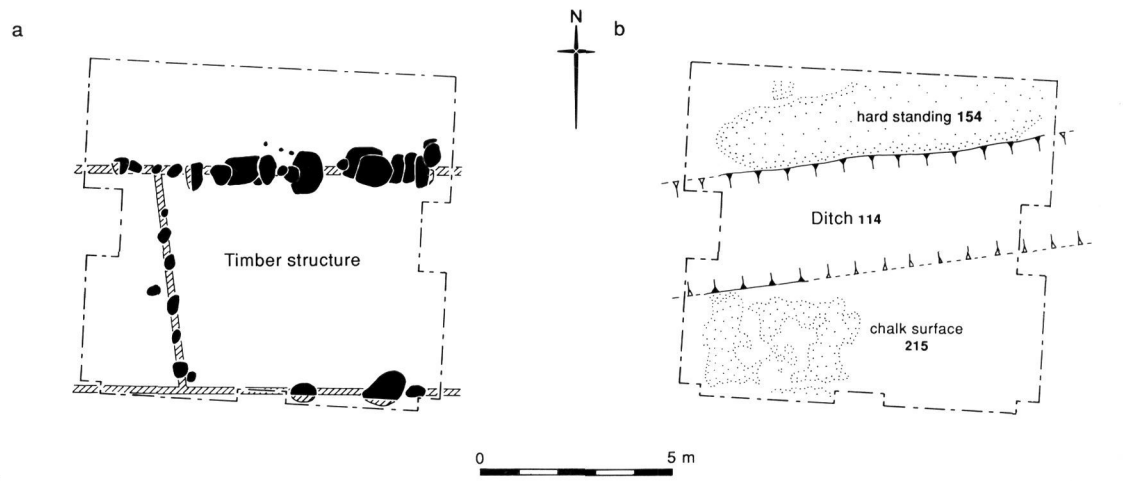

Fig 5. a. Interpretative plan Phase 4; b. Interpretative plan Phase 5

by a wheelbarrow used to bring in backfill material. Further dumping sealed the ruts and the fill of the ditch.

The ditch was almost certainly backfilled to provide additional building land on the southern edge of Thorney Island. The grandiose abbey planned by Edward the Confessor required a vast space, larger indeed than the available space on the Island itself, so land reclamation proved necessary.

Phase 4 Timber structure, 1050+ (Fig 5a)

Following the backfilling of the ditch and the abandoning of the possible road a timber structure was built. The structure extended beyond the limit of excavation but was at least 8.75m by 6.5m. It is probable that the structure was a building but could possibly have been fencing or animal pens. The siting of the structure over the backfilled ditch, the position

of which would have been probably known if not actually visible, implies that the building was only intended to be a temporary structure. The reason why the building was in that location is unclear.

The posts on the north side, that is those cut into the ditch fill, were more numerous than those on the south. This presumably was the result of the soft fill requiring additional posts to support the thrust of the structure. Postholes at right angles to the two postlines formed a partition. In some of the postholes a postpipe was visible but in most no indication of the size of the timbers survived.

Unfortunately, later features and two reductions of the floor level (Phases 8 and 9) within the undercroft removed most of the deposits associated with the structure. Those deposits not removed were largely within the central baulk and, therefore not available for excavation. The scanty deposits uncovered were stratigraphically loose and could belong to a number of other phases. Traces of burning slightly impinged on the excavated area but seemed to be fairly shallow. The burnt areas have been associated with the timber structure but could equally represent two or three bonfires associated with the hard standing (Phase 5).

As a result of later destruction and constraints on excavating the central baulk it is unclear what purpose the structure served. Assuming it was a building it could have been a storehouse, workshop or even a barrack block for labourers involved in the construction programme of the Confessor's abbey.

Little evidence survived for the length of time the timber structure remained in use or for the cause of its destruction. The only indication was a pit [184] which appears to have been dug to remove two of the posts of the timber structure. This would suggest that the structure was short-lived, being dismantled rather than abandoned. The absence of evidence for posts rotting *in situ* tends to confirm this.

The reason why the structure was dismantled or abandoned could not be determined with certainty but pottery recovered suggests the structure was in use during the construction of the church (*c.*1050–1070s; Gem 1980, 54; 1986, 14). As it became necessary to lay out the new cloister and associated buildings south of the church any temporary structures would have to have been cleared away. It should be noted that the pottery from the ditch, the possible road, the timber structure and the succeeding layers is chronologically very close (see pottery report below), implying that the sequence of these events took place in a comparatively short time.

Phase 5 Hard standing and ditch [114]

(Fig 5b)

A series of chalk and greensand dump layers [154] which overlay the ditchfill and the northern postline appear to have been make-up for a crude surface. The general increase in building rubble and debris in deposits indicates construction work taking place nearby, the surface probably forming a hard standing for the masons during their work on nearby buildings. The solid construction of the chalk and greensand surface may have been necessary to counteract the subsiding fill of the ditch [238]. A thin skim of crushed chalk [215] in the south bay may also represent the debris from building work but the underlying gravels of the possible road would have made a consolidated hard surface unnecessary.

Slightly cutting the hard standing in the north bay and the chalk skim in the south bay was a broad, shallow ditch [114], deepening to the west. This may have been cut to provide short-term drainage for the hard standing. The cutting of this ditch removed much of the area between the north and south postlines of the timber structure and separated much of the upper stratigraphy of the two bays.

Phase 6 Ditch backfilling and general levelling up

The partially silted up ditch [114] seems to have been deliberately backfilled. One layer [209] extended beyond the ditch into the south bay, apparently forming part of the levelling up the site for the new dorter. This layer contained an unusual decorated polychrome Late Saxon tile. A series of silty deposits, themselves cut by a scatter of stakeholes and postholes lay over the backfilling of the ditch. These deposits represent the last period when the site was open before the construction of the dorter undercroft.

The backfilling of ditch [114] indicates the construction sequence had progressed down the eastern side of the cloister range to the point that

the area needed to be prepared for the new buildings, including the dorter block.

Phase 7 Construction of the undercroft, late 1060s-early 1070s (Fig 6)

At this point the dorter undercroft was built. The building is described briefly in the introduction to this report and fuller descriptions can be found in RCHM 1924 and Gem (1980 and 1986); see also worked stone report below. The original floor is assumed to have been at the junction of the ashlar and the chalk foundations at *c.*3.5m OD. For structural reasons little of the undercroft foundations or adjacent stratigraphy could be examined. However, some limited information was gained regarding the construction of the building and its relationship to the adjacent deposits. The footings were loosely mortared, large to medium chalk blocks, apparently trench built to the offset level, then built as coursed rubble. The blocks were set in yellow sandy mortar.

A chalk footing [465] for the south-east corner of the undercroft cut through the levelling up over the backfilled ditch [114] (Phase 6). Other parts of the footings for the undercroft [130], [202], [338] and [461] were partially exposed but the investigation of the adjoining deposits was limited or prohibited. It has been assumed that these footings were contemporary with the footing [465].

Phase 8 First reduction of floor level, late 12th century (Fig 7a)

The excavation and watching brief revealed compact sand layers with patches of mortar, demonstrating that the floor level of the undercroft was reduced in the southern three bays from 3.5m OD to 2.9m OD. Pottery from features cut into this reduced floor suggest a late 12th-century date for the new floor level.

The new floor level probably formed part of a general rearrangement of the interior of the undercroft. The Pyx chapel was created in the 12th century by walling off the two northern bays of the undercroft and by the early 13th century the next two bays were walled off to form St Dunstan's Chapel. Alterations in the remainder of the undercroft are reflected by 12th-century carvings on some of the capitals showing the presence of (now vanished) screen walls. This shows that the undercroft was subdivided into a series of smaller rooms, including probably a warming room, its use in the later medieval period. The reason for the floor reduction may have been to permit greater air circulation in the warming room. Scorching on the late 12th-century carved capital on the southernmost pier perhaps indicates the use of braziers, the smoke from which would have been difficult to remove.

It was difficult to discern a coherent pattern in the scatter of cut features but the shallow gully [71/103] might represent the base of a wooden staircase from the south-west door to the lower floor level. The features were radically truncated by the later floor reduction in Phase 9. However, despite considerable damage, two small areas of occupation deposits survived, producing some late 12th/early 13th-century pottery. Although physically separated, the layers may represent a single period of occupation. Later intrusions make any further interpretation difficult.

Phase 9 Second reduction of floor level, 16th century (Fig 7b)

Perhaps just before the dissolution of the abbey in 1540, or conceivably in 1556–1560 when the abbey was refounded, the undercroft was extensively remodelled, the warming room refitted and a second floor reduction took place. The top of the new floor lay generally at *c.*3.1m OD (original 11th-century floor level at *c.*3.5m OD). The reduction in the late 12th century (Phase 8) had removed the floors associated with the construction of the undercroft and this second reduction removed most subsequent occupation deposits apart from fragments of occupation debris. The 16th-century reduced floor also occupied the three bays at the southern end of the dorter undercroft. It is likely that, as suggested for the late 12th-century floor reduction (Phase 8), it was carried out to allow better ventilation in the warming room.

Once the floor level had been reduced a series of walls, partitions and a fireplace were inserted. A partition wall was built between the central column and the west vault respond. The wall was subsequently thickened. On the east side of the central column another partition wall was built which was considerably more substantial than the western walls. The proximity of the central column to the east wall precluded detailed examination but the test pit (WST85) showed the foundations of the east wall to be 0.5m deep.

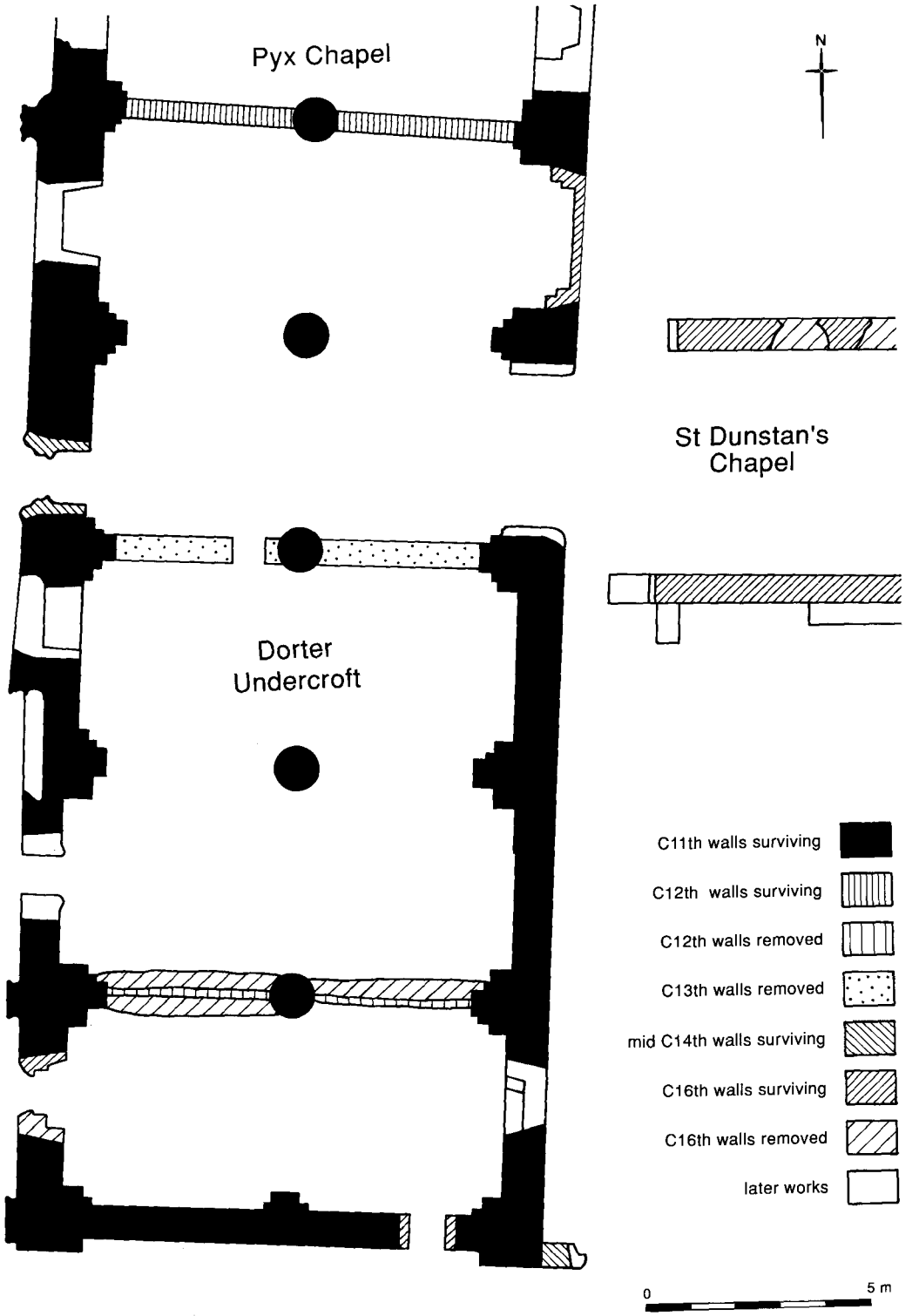

Fig 6. Historical ground plan of dorter undercroft showing construction dates (from RCHM)

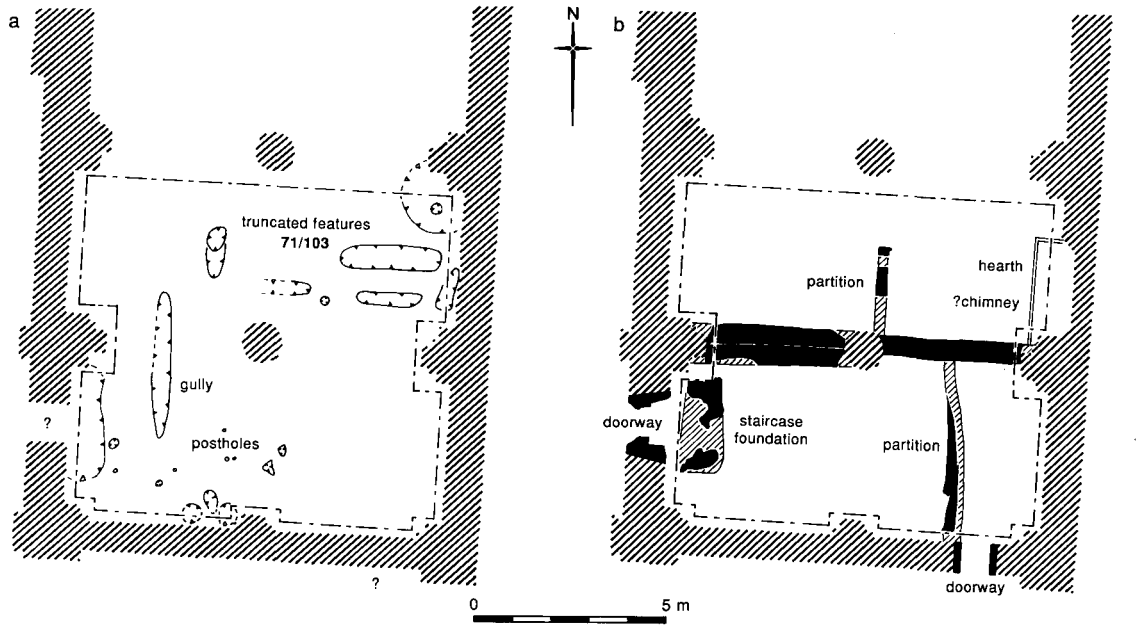

Fig 7. a. Interpretative plan Phase 8; b. Interpretative plan Phase 9

In the north bay a further subdivision seems to have been created by the insertion of a partition, perhaps in preparation for the construction of a sizeable pitched tile hearth. Although no remains of a chimney survived a butt joint and offset in the east wall of the north bay indicate that an external chimney was built for the fireplace.

In the south bay a clay floor [77] formed a compact surface. The remnants of a charcoal layer over the clay floor demonstrating that considerable burning took place in the room. A possible stone staircase was built by the south-west door, overlying a primary charcoal layer. The south-west doorway appears to be 16th century but could be a rebuild of an earlier doorway. Slots at the eastern end of the clay floor probably represent a wooden partition forming a separate room. A door, 16th-century in date, inserted in the south-east corner gave access to the screened-off eastern area.

Phase 10 Restorations, 16th–17th centuries

After the Dissolution the undercroft seems to have been used for storage. From the later 16th century onwards structural consolidation was undertaken, presumably as a result of visible subsidence. It could not be determined whether the underpinning took place at one time or represents a series of emergency measures in response to localised cracks and movement.

Phase 11, 17th–19th centuries

After the underpinning and repairs had been carried out the partition walls were demolished and rough floors were laid down, showing the building was still used for storage rather than domestic purposes. Further indications of structural problems are implied by postholes in both bays which may have been dug for posts propping up the vault. The make-up for the 20th-century floor sealed these.

THE FINDS

Introduction

Due to the relatively uncomplicated nature of the stratigraphy and small number of finds recovered, reports are presented in a traditional fashion with the minimum of integration.

In order to maintain easy cross-referencing with original records no attempt has been made to re-number contexts or registered finds for this report. As with the stratigraphic sequence,

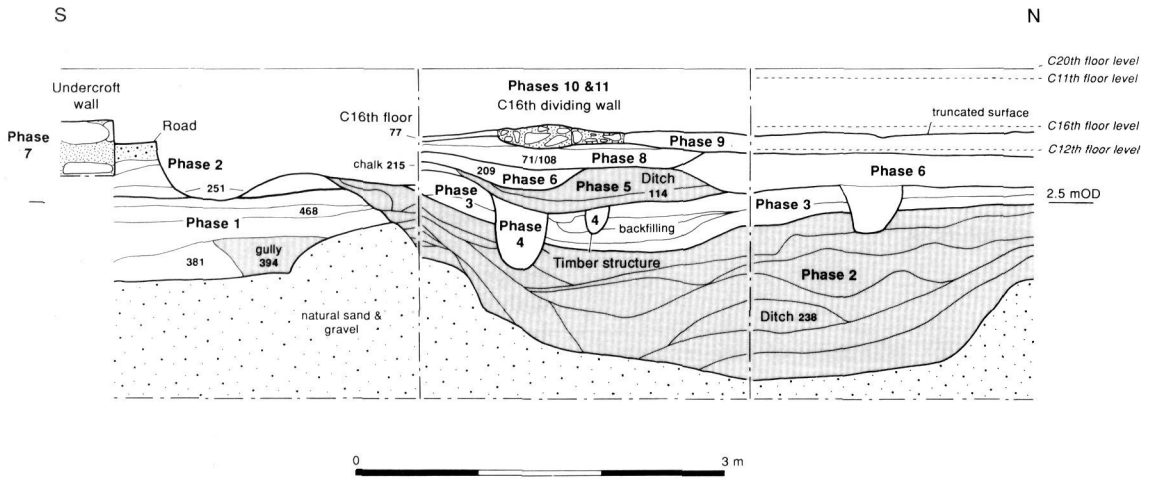

Fig 8. Composite N-S section showing sequence of deposits

contexts are given in square brackets []; numbers for registered finds in angular brackets < >.

As only selected feature and context numbers are discussed and illustrated in the sequence report above, it is necessary to identify the origin of those contexts which produced finds but are not referred to in the text. To this end all contexts in the finds reports are suffixed with their phase number ([393]1, for instance, is from context 393 from Phase 1 which is not reported on individually in the site report). In addition, a concordance of published feature-numbers-to-fill numbers containing published finds is listed below:

Phase	Feature	Fill
1	468	334
		339
		344
		349
		364
		368
		379
2/3	238	235
		238
		366
		372
		373
		392
		399
		402
		411
		418
		420
		421
		422
5	114	127
		189
		193

The pottery

Richenda Goffin

Introduction

The site provides a continuum of activity from the Late Saxon through to the post-medieval period. The residual pottery reflects the sporadic occupation of Thorney Island, perhaps from the Early Iron Age onwards. Some of the 8th/9th-century material may originate from the period following the foundation of the minster. This was traditionally thought to have occurred in the early 7th century, although the earliest documentary evidence suggests that it may have been later, in the 8th century (Brooks 1992, 22).

The most significant period of activity in terms of the ceramic assemblage is that which predates the construction of the dorter undercroft. The quantity of pottery, its well-stratified deposition, and the date of the construction of the undercroft, which has been postulated on stylistic and historical grounds as being sometime in the late 1060s or the early 1070s (Gem 1986, 17), provides a useful assemblage which can be compared to material from City sites and beyond. It will also contribute to establishing and refining the chronology of the development and distribution of Late Saxon/early medieval pottery types in this area of south-east England.

A total of 1,263 sherds of pottery (19,939 grammes), were recovered from WST85 and

WST86. The pottery was identified using the fabric identification descriptions and codes used by the Museum of London Archaeology Service. A description of the main fabrics for the Late Saxon/early medieval period can be found in Vince and Jenner (1991).

The prehistoric pottery

Hedley Swain

Fourteen sherds (95 grammes) of flint-tempered pottery were recovered, including a sherd with finger-nail decoration. These were dated to the early-mid 1st millennium BC.

The Roman pottery

Karen Waugh

Twenty seven sherds (356 grammes) of residual Roman pottery were present. Nearly all fragments were small and very abraded. The fabrics present ranged in date between AD 70 and 300.

The Middle Saxon pottery

Lyn Blackmore

A total of 32 sherds were recovered. The majority are of Ipswich-type ware. This ware is conventionally dated to *c.*650–850, although recent research suggests that it did not appear in the Middle Saxon settlement of *Lundenwic* until *c.*730 (Blackmore 1988, 85–7, 101–8; Blackmore 1989, 77–80, 104–7); it rapidly gained in popularity and remained the dominant ware until *c.*850/870.

In addition there is a small sherd of shelly or shell-limestone tempered ware, and a sherd of sandy ware. The former type is again associated with the later 8th and 9th centuries (Blackmore 1988, 88; Blackmore 1989, 83–4, 104–7). The latter, an abraded rim sherd, could be of Saxon or prehistoric date.

Imports are limited to a pitcher in a sandy orange ware from the Badorf/Walberberg area of Cologne Vorgbirge. This vessel which was probably spouted (Blackmore and Redknap 1988, fig 3 no.9) is strengthened by applied strips and has one of three original handles; similar wares have been found at Barking Abbey and at the Peabody site in the Strand (Blackmore 1989, 90). Badorf-type wares mainly seem to be found in 9th-century contexts in London, although the ware was probably reaching London from the late 8th century (Blackmore 1988, 92, 102–3; 1989, 104–7).

The above material, albeit residual, is of interest in that it comprises wares which are associated with the second and third ceramic phases of *Lundenwic*, with none of the chaff-tempered wares or earlier imports associated with the 7th and earlier 8th-century occupation. In this the site resembles others around the fringes of *Lundenwic* (*eg* Shorts Gardens to the north; the National Gallery basement (Blackmore 1989), Trafalgar Square and the Treasury site in Whitehall (Green and Thurley in prep), the finds from which suggest that the original settlement along the Strand gradually expanded inland and westwards. The Westminster Abbey finds are thus indicative of some activity in the area of the minster between *c.*750–850, a view which is supported by the presence on the site of other 8th to 10th-century finds.

The medieval and later pottery

Richenda Goffin

The fabrics discussed in the report are listed in Table 1, with their codes and date ranges according to current research from London sites.

Since many examples of similar material have been extensively illustrated in previous publications, pottery was only selected for drawing if it demonstrated unusual forms or decorations (see Fig 9). A full range of pottery types covering this period is illustrated in Vince and Jenner 1991, 19–119.

The significance of the early medieval pottery from pre-undercroft levels has been mentioned in the introduction. A brief summary of the pottery present in all the main phases is given here, followed by a discussion of the assemblage in comparison to similar excavated groups from the City and elsewhere.

Phase 1 (*c.*1050)

A single sherd of Late Saxon Shelly ware (LSS) was present in the silty sand overlying natural. No pottery came from the fills of the quarry [408], and an undiagnostic shelly sherd came from the gully [394] which cut it. The black and

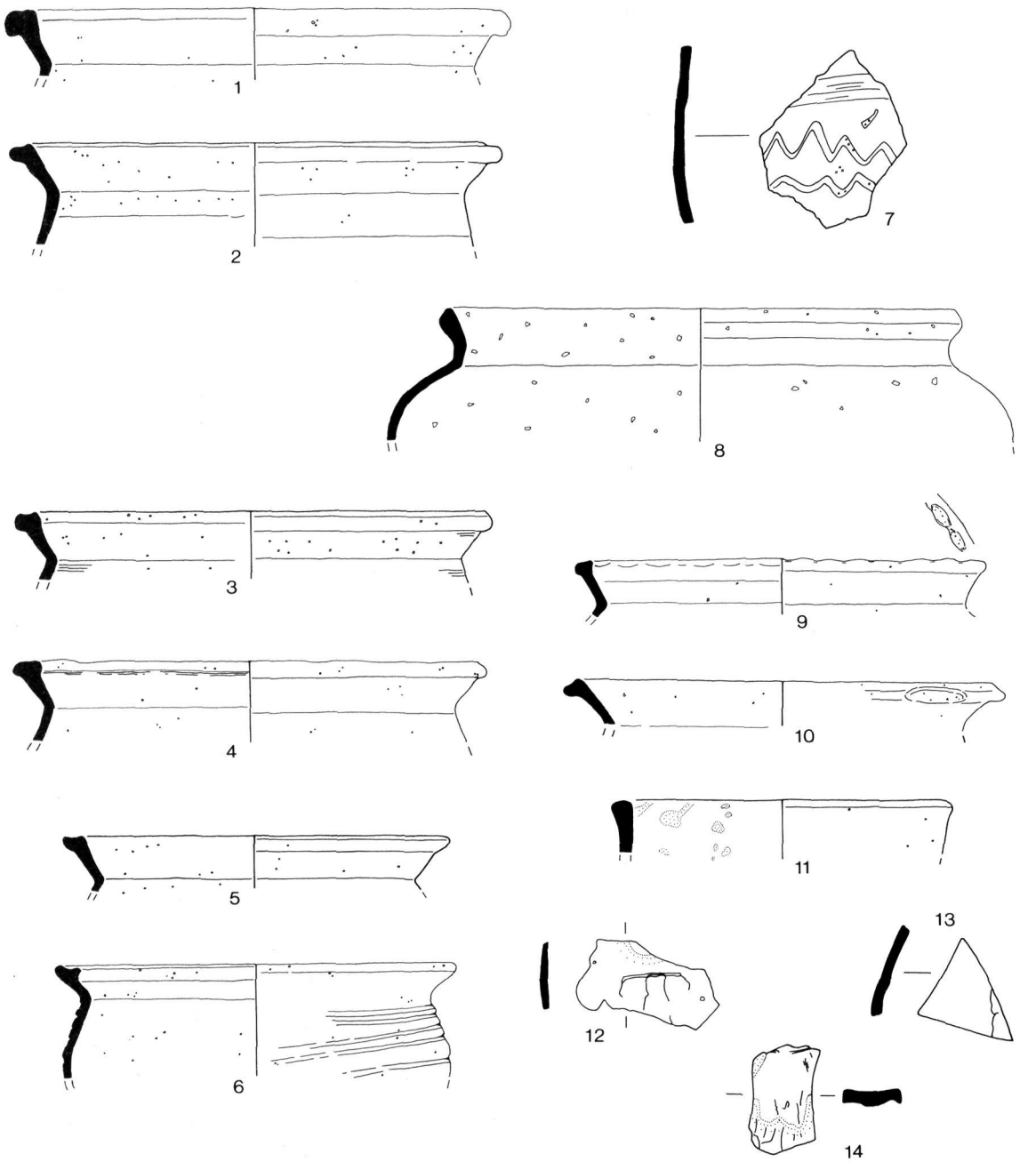

Fig 9. Early medieval pottery: 1–7 Early Surrey ware (1050–1150); 8 Early Medieval Sand and Shelly ware (1000–1150); 9–10 Local Greyware (1050–1150); 11 Winchester-type ware (970–1100); 12–14 Andenne-type wares (?1050–1200), 1:4

grey silty layers which covered the whole of the south bay contained a quantity of residual material (379 grammes, 17.8%), (prehistoric, Roman and Middle Saxon). LSS accounted for 57%; ESUR 4.8%; EMS 3.7%, with small quantities of EMSS and LOGR.

Phase 2 (1050+)

Small quantities of Late Saxon Shelly ware and a Local Greyware cooking pot were found in the sand makeup for the gravel surface [251]. There is a sherd link between the greyware vessel and

Table 1. Main pottery fabric types

Pottery type	Code	Date range
Late Saxon Shelly	LSS	900–1050
Early Medieval Sandy	EMS	970–1050
Early Medieval Sand and Shell	EMSS	1000–1150
Early Medieval Flinty	EMFL	1000–1100
Early Medieval Shelly	EMSH	1050–1150
Red Painted ware	REDP	970–1250
Winchester ware	WINC	970–1100
Andenne ware	ANDE	1050–1200 ?possibly 1000+
Early Medieval Chalky	EMCH	1050–1150
Early Surrey ware	ESUR	1050–1150
Local Greyware	LOGR	1050–1150
Coarse London-type ware	LCOAR	1080–1200
London-type ware	LOND	1080–1380 (mainly 1150+)
Kingston-type ware	KING	1230–1400
Coarse Border ware	CBW	1270–1500
Siegburg Stoneware	SIEG	1300–1550
Post Medieval Redware	PMR	1600–1800
London Stoneware	LONS	1670–1900

several other fragments in three different fills of ditch [238]. Three sherds of pottery from silt and sand layers over the gravel surface are LSS.

Eleven thousand eight hundred and ninety grammes of pottery were recovered from silt layers in the bottom part of ditch [238]. By weight, ESUR accounted for 74.3%; LSS 6.3%; EMSS 6.8%; LOGR 2.2% with small amounts of EMS. One point seven percent of the pottery was residual (prehistoric, Roman and Middle Saxon).

Phase 3 (1050+)

The half-filled ditch [238] was backfilled by sand and clay containing small sherds, mainly of LSS with ESUR and EMSS. These layers were cut by a series of linear features which contained no pottery.

Yellow sand dumped over these deposits contained a typical LSS rim cooking pot sherd, a LOGR body sherd and ESUR body sherds. This was in turn cut by three stakeholes, which were sealed by a thick layer of silty sand containing an ESUR rim sherd with the same well-made everted rim as another sherd found in the ditch fill.

Phase 4 (1050+)

The ceramic material associated with the timber structure which was raised over ditch [238] and the gravel surface is similar to that from within the ditch, indicating that no significant period of time had elapsed between the two events. One EMSS sherd links the fill of posthole [326] with the ditch fill [373]. Also present are some well-developed ESUR cooking pot rims, and a fragment of an EMSS spouted bowl which was recovered from the fill of a posthole on the northern side [332].

Much of the interior surface of the structure had been removed by later features, especially the ditch [114]. On the north side of the south bay a possible hearth and floor surfaces contained ESUR and LSS.

Partially sealing the northern postholes was a sandy silt containing ESUR. One sherd had an almost lid seated rim profile which was very similar to another found in [403], possibly belonging to the same vessel.

Phase 5

A number of deposits ([246], [252], and [257]) which sealed the silts contained building material and small amounts of ESUR and EMSS. Context [257] contained a sherd of Red Painted ware (REDP), probably from the same vessel as the three sherds found in [227], a green sandstone rubble layer. An irregular surface [154], sealed the dumping, which contained a sherd of EMSS and a sherd of LSS.

A narrower ditch ran along the same alignment as the larger previous ditch. It contained sherds of ESUR, ANDE and a sherd of intrusive London stoneware of post-medieval date.

Phase 6

Three contexts which may form the deliberate backfilling of the ditch contained ESUR, LSS, and EMSS.

A number of silty layers lay over the backfilling of the ditch and the remnants of the occupation levels of the timber structure. The fills of scattered postholes [112], [143] and [198] contained sherds of LOND, ESUR, and EMSS.

Phase 8 (late 12th century)

After the construction of the undercroft a small quantity of pottery was deposited which may have represented evidence of a deliberate levelling of the floor. In the northern bay this consisted of sherds of ESUR, LOND, and ANDE. One sherd of ESUR was found in the southern bay.

A number of features cut the sandy layers described above. In the northern bay several fragments of London-type ware were recovered. Some of these sherds were decorated in Rouen-style, and can be dated to the late 12th/early 13th century. A shallow pit [175] also contained a similar group of sherds of London-type ware. There was also a sherd of post-medieval redware in [132] – a long subrectangular scoop in the north bay. Further sherds of London-type vessels with North French and Rouen style decoration were found in the fill of a posthole cutting into the sandy surface.

In the northern bay a series of thin occupation layers [84] and [108] contained small quantities of ANDE, EMS, EMSS, ESUR and MG as well as some sherds of highly decorated LOND jugs, of a similar date to those just mentioned (late 12th/early 13th century). The partition wall between the central column and the west vault respond contained a sherd of a Siegburg drinking jug, probably a Jacobakanne of 15th-century date (Hurst *et al* 1986, 180).

Phase 9 (16th century)

A dump of rubble in the north bay contained a sherd of Kingston-type ware, with a sherd of Coarse Border ware (1270–1500) in the hearth area.

Phase 10 (16th–17th centuries)

Floor layers and occupation debris patches following the rebuilding of the foundations in the northern bay, contained pottery that ranged in date through the 16th–17th centuries; there was also some earlier material. Contexts [30], [43] and [44] contained pottery of late 14th-century date.

Phase 11 (17th–19th centuries)

Late 16th-century pottery was found in a layer of ash and clay [69], which was dumped over the east side of the south bay, forming a floor surface. The west partition wall was covered by a layer with pottery dated to 1600–1750. Contexts [21] and [26], however, contained pot of 14th/15th century date.

In the northern bay five postholes cut the rubble and mortar floor. Pottery from the fill of a posthole [14] was of late 16th-century date. Over these postholes was a deposit of demolition material dated 1600–1800. The fill of the brick drain also contained pottery of this date.

The pottery in relation to the site

Most of the pottery from the excavation came from activity which occurred before the undercroft was built in the late 11th century (82.8% by weight, 16,515 grammes). A summary of the main fabrics and their weight, percentage by weight, and estimated vessel equivalents can be seen in Table 2.

The narrow range of pottery fabric types in the features predating the undercroft construction suggests that these periods of activity took place within a comparatively short space of time. This is reinforced by the existence of sherd links between features in Phases 1 and 2 and Phases 2 and 4. The only pottery considered as being possibly of later date is two sherds of London-type ware found in the fill of posthole [111]6 in the phase of activity immediately predating the construction of the undercroft. Current research suggests that London-type wares (LOND and LCOAR) have been found in well-stratified deposits in the City as early as *c.*1080. Sherds at Billingsgate, for example, were found in a deposit dating between *c.*1085 and *c.*1108 (Vince 1991, 268). However, one of the sherds from the posthole comes from an early rounded London-type jug with red slip decoration, which is generally dated in the City to the second half of the 12th century (Pearce *et al* 1985, 19). It seems likely that this sherd is intrusive.

The disproportionate quantity of Late Saxon Shelly ware present in the backfill of ditch [238]2, *c.*44%, confirms the suggestion that there was secondary dumping over the initial ditch filling.

The dating of the first reduction of the floor levels is unclear, since the ceramic evidence is sparse, as much of the original deposits were removed by the later reduction of the floor. Once again the presence of several sherds of

Table 2. Main fabric types with percentages and rim EVEs from pre-undercroft features. Weights are given in grammes. EVEs = estimated vessel equivalents (see Orton 1975)

Phase 1						
Fabric	LSS	ESUR	EMSS	EMS	LOGR	Pre-med
Weight	1213	102	59	78	39	379
Eves	0.61	0.12	0.08	—	0.12	—
%Weight	57	4.8	2.8	3.7	1.8	17.8
TOTAL 2128g						
Phase 2						
Fabric	LSS	ESUR	EMSS	EMS	LOGR	Pre-med
Weight	744	8845	815	296	260	205
Eves	0.91	4.87	0.74	0.05	0.29	
%Weight	6.3	74.3	6.8	2.5	2.2	1.7
TOTAL 11890g						
Phase 3						
Fabric	LSS	ESUR	EMSS	Pre-med		
Weight	241	153	33	92		
Eves	0.25	0.11	0.04			
%Weight	43.9	27.8	6.0	16.7		
TOTAL 549g						
Phase 4						
Fabric	LSS	ESUR	EMSS	Pre-med		
Weight	99	373	208	10		
Eves	—	0.39	0.17			
%Weight	14.1	53.1	29.6	1.4		
TOTAL 702g						
Phase 5						
Fabric	LSS	ESUR	EMSS	LOGR	Pre-med	
Weight	118	432	55	22	191	
Eves	0.07	0.31	—	0.05		
%Weight	10.8	39.7	5.0	2.0	17.5	
TOTAL 1088g						
Phase 6						
Fabric	LSS	ESUR	EMSS	LOND	Pre-med	
Weight	2	83	15	6	52	
Eves	—	—	—	—		
%Weight	1.3	52.5	9.5	3.8	32.9	
TOTAL 158g						

Early Surrey wares, some Local Grey ware and a small quantity of plain London-type ware with some Andenne sherds suggests that it could have occurred *c.*1080 onwards, and that it was cut by features containing pottery of late 12th/early 13th-century date.

The floor surface was reduced a second time and a tile hearth built. Pottery evidence suggests that this took place *c.*1300–1500 (Coarse Border ware and Siegburg stoneware jug).

The significance of the pottery in relation to the ceramic sequence of the London area

Forms and decorative techniques (Fig 9)

The range of forms within the early medieval fabrics appears to reflect the proportions of vessel types in other assemblages excavated from within the City. Seven point two percent of Late Saxon Shelly (by weight) was positively identified as dishes, 3.2% was from a spouted pitcher. The remainder consisted of cooking pot rims and body sherds which were unassignable to a particular form. The type and quantity of vessel forms of EMS, EMSS and EMCH also appear to reflect similar proportions to those excavated from the City, with cooking pots making up most of the assemblage. Some EMSS cooking pots were large (Fig 9, 8). Only one sherd of EMS was identified as coming from a dish, and only a single example of a spouted bowl in EMSS was noted. Cooking pots were the only form identified in Local Greyware. Both EMSS and LOGR included rims with thumb impressions around the top of the vessel, a decorative feature which

appears frequently among the fabric types of this period (Fig 9, 9–10). Almost all the Early Surrey wares were cooking pots, although there was evidence of storage jars or pitchers, in the form of rim sherds and large body sherds. The wares varied considerably in colour, fabric, rim form, and surface decoration. The majority of cooking pot types were well made, with well-developed rim forms, although some were unevenly shaped (Fig 9, 1–5). Many had everted necks with rim forms that almost formed a lid seating, while others had simpler everted rims. Several sherds had incised banding round the shoulder and/or the girth (Fig 9, 6–7). It has been suggested that this effect was achieved with a wooden tool with a jagged edge (Vince & Jenner 1991, 29).

The Early Surrey ware sherds found in post-undercroft deposits were compared to vessels made in the same fabric from earlier on in the sequence. The rim forms were similar, with a mixture of simple everted and more elaborate styles. There appears to be little typological development in form within the different phases. Overall the range of forms and decorative techniques for the Early Surrey ware recovered from Westminster is very similar to the material excavated from the City.

Fabrics

The early part of the assemblage predating the undercroft was compared with the research undertaken on the Late Saxon/early medieval pottery sequence in the City of London. Although much work has been done to establish a chronology of fabric types from excavations in the City, the research has been enlarged and refined by subsequent work, mainly by Vince and Jenner (1991). By studying the pottery from a series of waterfront excavations in the City, it has been possible to establish a series of ceramic phases for this period, based on relative dating and, where possible, dendrochronological and coin evidence. Ceramic developments can therefore be suggested, which can be modified if necessary in the light of additional data from new sites.

Shell-Tempered Wares

Evidence from waterfront sites in the City suggests that the mainly wheel-thrown Late Saxon Shelly ware (LSS) was used in association with hand-made EMS and EMFL fabrics in the mid 10th to early 11th century (Ceramic Phase (CP) 2), forming nearly 70% of the assemblages in stratified contexts by weight. In the early to mid 11th century (CP3), it appears with EMS and EMSS, making up nearly 50% of the total pottery. LSS is present in the New Fresh Wharf deposit associated with CP3, which was dated from dendrochronology to *c.*1030. LSS is also present in a comparable deposit at Billingsgate dated *c.*1039–40. However, it is thought not to have been in use *c.*1055, although over 20% is still present in assemblages dating from the mid to late 11th-century (CP4) (Vince & Jenner 1991, 49).

The interpretation of the presence of LSS in 11th-century deposits in the City is the subject of much debate (Vince & Jenner 1991, 42–4; Jones 1991, 80–1). Petrological examination of the clay from which Late Saxon Shelly pottery was made indicates a possible source in Oxfordshire (Vince & Jenner 1991, 49). The discussion therefore centres on the question of identifying LSS as the same fabric as Oxford B ware, which is found in the Oxford area. LSS is present in City deposits belonging to CPs 3 and 4 (1020–1100), some years after Oxford B type ware was no longer being produced in the Oxford area, after the sacking of the city in the early 11th century (Mellor 1980). Since there appears to be too high a quantity of LSS present in CP3 assemblages to be residual, one possibility is that the City of London continued to be supplied by the Oxfordshire potters, although they were no longer distributing their wares closer to home markets. Another possibility is that the clay came from a different, albeit similar source. Further research, both on the petrological analysis of LSS and on its presence on other well-dated sites in the Greater London area should enable a fuller picture of the production and distribution of this ware during this period to emerge, together with other similar shelly wares. The lack of Early Medieval Shelly ware (EMSH) from Westminster Abbey is noticeable, since it is present in City assemblages in small quantities *c.*1055, although much more prevalent in the latter part of the 11th century through to the mid 12th (Vince & Jenner 1991, 64). The shell inclusions in this fabric suggest that an outcrop of the Woolwich Beds, perhaps in north-west Kent, may have been the likely source (Vince & Jenner 1991, 63).

Early Surrey and Local Greywares

The earliest City deposits containing small quantities of Early Surrey wares can be dated at

Billingsgate to a group dated between 1039–40 and 1055, although it is much more prevalent in CPs 4 and 5 (mid 11th to mid 12th century). Although Local Greyware is present in deposits in CP4, it is much more common in CP5 (late 11th to mid 12th century (Vince & Jenner 1991, 75, 79).

The association of Late Saxon Shelly with Early Surrey ware and Local Greywares found at Westminster does not altogether reflect this pattern. The first substantial ceramic group from flood deposits in Phase 1 consists of 1,213g of LSS and 102g of ESUR (57% and 4.8% by weight respectively), with small amounts of EMSS, EMS and LOGR. On present evidence this suggests a deposition date of *c.*1050, although it is possible that ESUR and/or LOGR was being distributed in this part of London slightly earlier than in the City. The fills of the large ditch [238]2 contained a considerable quantity of LSS, and this increased in the backfilled deposits which represent secondary dumping. However, the dominant fabric is ESUR, with smaller quantities of LOGR and EMSS and EMCH. The presence of these fabrics may suggest that the ditch was filled around 1050, or even shortly predating the undercroft itself, allowing for the other phases of activity which took place before its construction.

Unassigned or Unusual Fabrics

130g of pottery recovered from the pre-undercroft layers were made from a distinctive fabric which has not been assigned a formal identification code in the reference material for the London area. The fabric is soapy, and usually oxidised with a grey core. It is micaceous, with sparse translucent quartz and sparse flint inclusions usually less than 1mm in diameter. The two rim sherds are of simple everted type.

In addition, 63g of another distinctive fabric, which also could not be formally identified, came almost exclusively from pre-undercroft contexts. The sherds were partially oxidised with grey cores. They were characterised by abundant large angular and sub-angular quartz inclusions up to 1mm, flint inclusions up to 3mm, and abundant inclusions of shell up to 5mm in length.

A single sherd from a Winchester ware pitcher from the ditch-fill [238]2 is a very unusual find for sites in the London area (Fig 9, 11). Small quantities of this pottery type have been found in the City (Vince 1985, 39; Vince 1991, 271).

Imports

84g of Andenne-type ware (ANDE) was recovered from WST85 and WST86. The vessels represented are fragments of glazed pitchers, one decorated with an applied strip and one with rouletted decoration (Fig. 9, 12–14) (Borremans & Warginaire 1966, 30). The earliest sherds in the sequence come from the main ditchfill ([418]2 and [421]2), in association with ESUR, EMSS, and EMS. Other sherds from later features are found with ESUR and LOND. Vince suggests that Andenne-type wares are found first in City deposits in small quantities as early as the first half of the 11th century, although they are absent from deposits of that date at Billingsgate and New Fresh Wharf. They were present in the succeeding levels from these sites, dating to the late 11th century. At St Nicholas Acon church, pits containing ESUR, STAM and ANDE with a coin dated to 1018–24 or later, were sealed by the earliest structure of the Church, which is first recorded *c.*1080 (Vince 1985, 40). Andenne-type ware is however, most common in City deposits dating from the late 11th to the middle of the 12th century (CP5) (Vince & Jenner 1991, 106).

99g grammes of Red Painted ware was also recovered, probably from a single vessel. The fabric was hard, although not properly fused like stoneware, and the vessel was salt-glazed. It was probably made near Cologne or Bonn in the Rhineland and may date to the late 11th century or later (Hartwig Ludtke, pers comm). The sherds came from a surface associated with a phase after the demolition of the timber structure, and were found with ESUR, EMFL and EMSS.

Conclusion

The pre-undercroft ceramic assemblages (Phases 1–6) from Westminster Abbey appear to provide a snapshot of pottery fabric types from a narrow date range, *c.*1040 to the early 1070s. More substantial, well stratified assemblages from beyond the City need to be studied before conclusions on the significance of the Westminster Abbey pottery can be reached. Such sites as Bermondsey Abbey and Merton Priory (both MoLAS in prep) may provide more material. Pottery has been recovered from pits and ditches at the nearby Treasury site, Whitehall Palace, but this is of mainly 12th-century date (Huggins in prep).

The early medieval pits at Winchester Palace just south of the City on the other side of the Thames contain considerable quantities of comparable material of mid 11th to late 12th-century date (Goffin in prep). The features, though, cannot be tied to sequences of great stratigraphic value, and provide no additional dating evidence. However, the fabrics, their relative proportions and associations with each other appear to be consistent with the ceramic chronology established within the City. It is hoped that future work on large assemblages of similar pottery from recent excavations, such as Guildhall Buildings, may enable existing chronologies to be refined still further, especially for key fabrics such as Late Saxon Shelly, Early Surrey ware and Local Greyware.

The pottery from the Westminster Abbey excavations provides a useful addition to the chronology of fabric types in London. The archaeological activity occurring immediately before the construction of the undercroft appears to coincide with a period of ceramic transition which predates the imminent political upheavals. How far the assemblage is characteristic of patterns of distribution in this area of London cannot yet be ascertained. Are there 'significant differences between the supply of London, and, for example, that of Lambeth and Westminster?' (Vince 1985, 42). The evidence so far suggests that this is not the case.

The accessioned finds

Richenda Goffin

A total of 155 accessioned artefacts were recovered from the excavations in the undercroft. The finds represented a wide range of material types: flints, quernstone fragments, worked stone, metalwork, window glass and ceramic objects. Much of the ironwork was in a poor state of survival and little could be identified even after x-radiography.

The accessioned finds were catalogued and computerised, according to the standard procedures used by the Museum of London. Where necessary, objects were conserved and X-rayed. Selected objects are on display at the Undercroft Museum in Westminster Abbey.

This report discusses the main artefacts from the site that could be identified, with illustrations. The other artefacts have been included in specific reports, such as the glass and the worked stone, or are unpublished but available at archive level.

The small quantity of residual worked flint, together with pottery recovered from the site, suggests some activity in the vicinity of the site during the prehistoric period.

No features of Roman date were excavated although some sherds of abraded Roman pottery and considerable quantities of ceramic building material were recovered. The stamped tile <13> is of particular significance (Fig 14, 28). No other artefacts dating to this period were found.

Evidence of Middle Saxon activity from the original foundation of the minster is sparse, consisting of some sherds of pottery dated *c.*750–850. Other artefacts, such as some of the decorated metalwork, may be of Middle Saxon date, but these could also be attributed stylistically to the Late Saxon period and the refoundation of the minster under Dunstan in the 10th century.

Many artefacts were recovered from the fills of the ditch [238]2. In particular, small quantities of window quarries and grozing debris indicate considerable activity associated with new construction work undertaken on behalf of Edward the Confessor.

A fragment of polychrome relief tile of Late Saxon date may be associated either with building modifications undertaken during the time of Dunstan or with the later rebuilding undertaken by Edward the Confessor.

Certain objects found in post-undercroft deposits can be associated with the life of the abbey during the medieval period. These include the double-sided ivory comb <17> (Fig 11, 22), the bone writing implement <70> (Fig 11, 25), and copper alloy buckle <2>. Further evidence of the buildings themselves was supplied by the ceramic building material and worked stone.

Catalogue

Silver

<43> Fragment of coin of Ecgberht of Wessex dated *c.*AD 835–9 ECGBE(RT)REX. Diameter 20mm. As North 1.579 (rev, cross potent), but two arms of cross (opposing) replaced by wedges (Mike Hammerson, pers comm). This coin of 9th-century date is extremely rare. Discussed and described in Stott 1991, 285–6. [379]1. Fig 10, 15.

Copper alloy

TWEEZERS

<41> Copper alloy tweezers with copper alloy suspension loop. Gradually expanding and slightly flared shafts, with

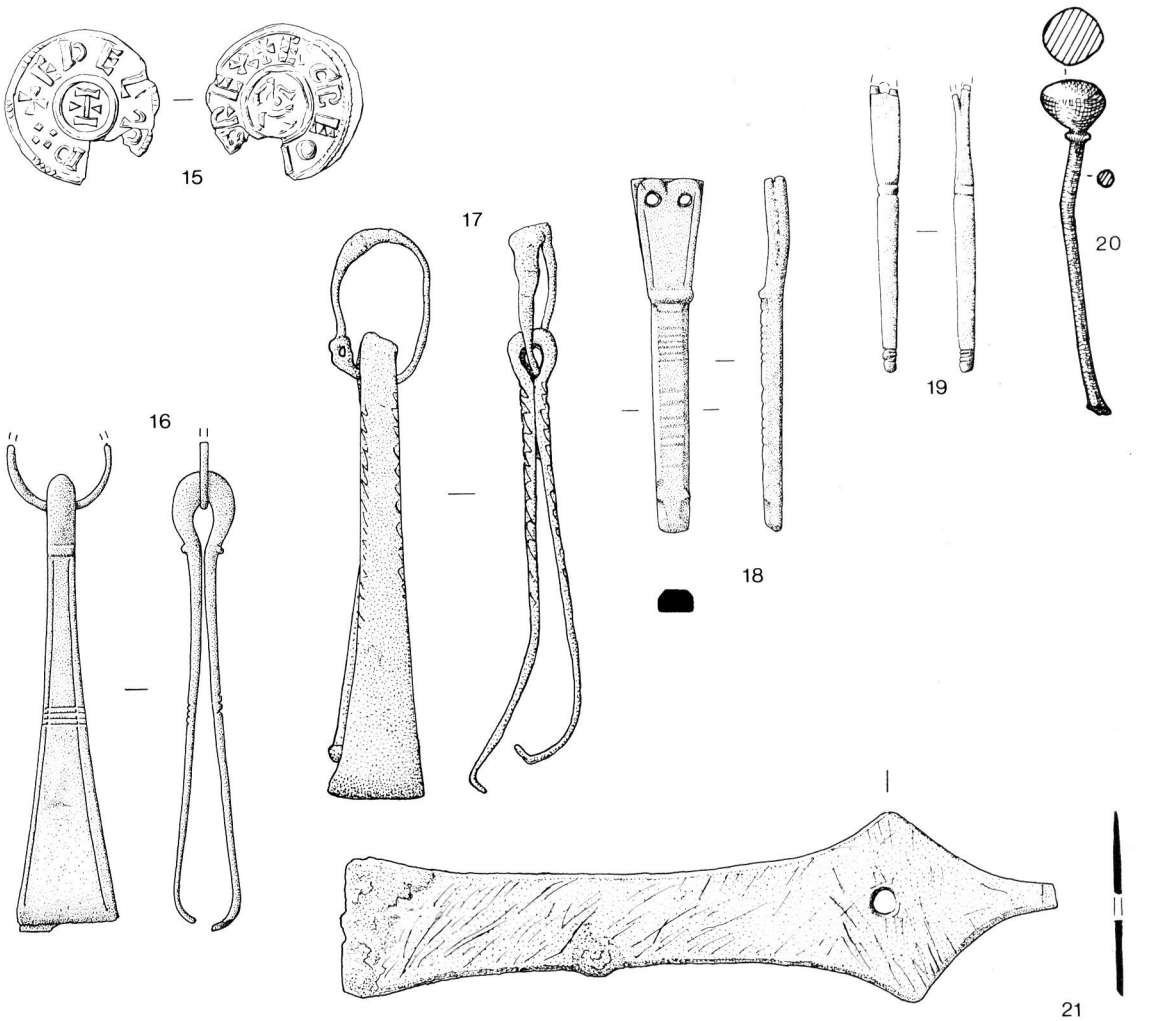

Fig 10. Silver and copper alloy objects: 15 silver coin of Ecgberht; 16–17 copper alloy tweezers; 18–19 copper alloy strap ends; 20 copper alloy pin; 21 copper alloy clasp, 1:1

inturned arms. Both sides decorated with continuous incised lines running parallel to the shaft sides. Shallow tranverse incised decoration half-way down shaft. Length: 61mm. [375]2. Fig 10, 16.

<12> Copper alloy tweezers with copper alloy wire suspension loop, twisted at the end. Gradually expanding and slightly flared shafts, with inturned arms. Both sides decorated with diagonal shallow slashes on the upper half of shaft. Length 62mm. [265]2. Fig 10, 17.

Both sets of tweezers are well preserved, although <12> is slightly bent. <41> in particular is of extremely good quality and carefully decorated. It was found on the earliest ground surface over the natural subsoil, which also had some Late Saxon Shelly ware (900–1050). <12> was recovered from one of the silt and sand layers, which built up over a gravel surface in Phase 2. This tweezer-type, with expanding and incurved arms appears to have a long lifespan, so dating is problematic. Such implements follow in the tradition of Roman tweezers, and similar types have also been found in pagan Anglo-Saxon graves, such as at the cemetery at Monkton, Thanet, and Lyminge, both 6th century in date (Chadwick *et al* 1974, 70, fig 9, no.2; Warhurst 1955, A, nos 3 and 4, fig 6).

Tweezers with these characteristics continued to be made into the 9th century and beyond. Five types of tweezers were recovered from the excavations at Whitby Abbey (North Yorks), several of which are not dissimilar to those from Westminster Abbey. The closest in shape to both pairs, although not in terms of decoration, is Peers and Radford 1943, 61, no.13, fig 13. A second set has a similar type of decoration to <12>, with curved impressions running down both sides of the shaft (*ibid* no.10, fig 13). The abbey at Whitby was in existence from AD 657–867 when it was destroyed by the Vikings.

Similar tweezers are also found in Late Saxon deposits, although it is possible that they are Middle Saxon and

therefore residual. A pair of gilded silver tweezers of this shape were recovered from the upper fill of a Period I ditch at North Elmham, which contained a few sherds of Late Saxon pottery (Goodall 1980, 506). The closest parallel to <41> typologically is a pair of tweezers with the same incised decoration along the shaft which was recovered from a ditchfill at Shepperton Green, dated 1050–1150 (Clark 1979, 118, no.7).

Closer to the site at Westminster, two pairs of copper alloy tweezers (of Middle Saxon date) were recovered from excavations at Peabody Buildings in the Strand (Blackmore 1989, 119, nos 211–212). They were less well preserved than the Westminster Abbey examples, and the shafts were less flared.

STRAP ENDS

<50> Copper alloy strap end with stylized zoomorphic decoration. Length 46mm, width at widest point 9mm. [381]2. Fig 10, 18.

The strap end is styliform in shape, with two rivet holes at the split end. The shaft is decorated with a collar and transverse grooves which have been shallowly and crudely incised. The terminal is decorated with a stylized portrayal of an animal head, with a rounded snout and indentations for the shape of the head and eyes. The reverse side is flat.

The object was recovered from the same fill as tweezers <41>. In view of the accompanying pottery and the stylistic details which will be discussed below it seems likely that it is of Late Saxon date.

The strap end comes from a well researched category of Saxon artefacts. A brief discussion of the different types and functions can be found in Wilson 1964, 62. Although such items can be found in 7th-century Saxon graves in Britain, they are more usually associated with the 9th century. Elaborately decorated examples with finer representations of animals on the terminals have been found in hoards such as the Trewhiddle hoard which was deposited *c.*875. Strap ends with animal-head terminals are also found in early 10th-century hoards although later on in the century they become much heavier.

Strap end <50> appears to represent a degenerate form of the zoomorphic type. It is more elongated in shape than most 9th-century examples and crudely executed with little detail. It does however share the same basic features as the fine example in the Ashmolean Museum, registered as from Ixworth, Suffolk (Hinton 1974, 22, no.16). Here, the strap end is long and slender with a single rivet. It is more finely decorated with a collar, the ovoid shaft probably originally decorated with niello, and a delicately modelled head further embellished with a niello panel. Although the strap end is recognised as being of a less common type than usual, it is still thought to date stylistically to the 9th or early 10th century.

The Westminster strap end is far closer in style to one from Portchester Castle (Cunliffe 1976, 216, fig 136, no.52). This has a similar long and narrow shape, and transverse grooves in bands on the shaft. It has a faceted terminal which may be a crude representation of an animal head.

<25> Copper alloy strap end, slightly broken at rivet end. Surviving length 38mm. Rounded shaft with flattened split plate with single rivet hole. Rounded terminal, decorated with incised bands all the way round the shaft. Incised bands at the other end of the shaft before flattening out for the attachment plate. [344]1. Fig 10, 19.

This strap end was found in a flood deposit early on in the archaeological sequence. Although Late Saxon shelly ware was present in fill [344]1, there was also a quantity of Early Medieval Sand and Shell pottery (1000–1150).

Although smaller and simpler in terms of decoration than <50>, strap end <25> is well made and delicate. It ressembles a smaller strap end recovered from dark earth deposits at Peabody Buildings (Blackmore 1989, 121). Another parallel can be found at Maxey, Northants (Addyman 1964, 63, fig 17, no.1).

<45> Copper alloy pin. Pin with slightly flattened globular head and collar at the junction between the head and shaft. [393]1. Fig 10, 20.

Similar pins, although with more biconical-shaped heads, have been found at the Middle Saxon sites of the National Gallery Extension and Peabody Buildings (Ross 1989, 119), also at Shorts Gardens (MoLAS in prep), all in the Strand. Although they are usually associated with the Middle Saxon period, there are examples of similar pins in later features, but these may be residual. An example is the simple type of pin with an ovoid head recovered from a ditch fill dated 1050–1150 at Shepperton Green (Clark 1979, 118).

<49> Copper alloy clasp. Surviving length 96mm, widest point 25mm. Shaped, but undecorated and crudely fashioned. The clasp may have belonged to part of a casket, being part of a hinged attachment. It is possible that it was a book clasp, although these were usually more highly decorated. There is no evidence of any hooked attachment at the end to which a strap would have been attached to keep together vellum pages. It was found in the fill of [238]2, with pottery of Late Saxon, early medieval date. Fig 10, 21.

<2> Copper alloy plain circular buckle with single loop frame and transverse pin, diameter 27mm. This simple undecorated buckle was recovered from a clay floor associated with the refurbishment of the undercroft as the abbey warming room in the early 16th century. Such buckle types are difficult to date, but most examples recovered from the Billingsgate Lorry Park watching brief come from Ceramic Phase 11, (*c.*1350–1400), with some from CPs 9, 10 and 12 (Egan & Pritchard 1991, 57–59). [77]9.

<54> Copper alloy fragment, length 103mm, diameter 3mm at widest point. The shaft is not completely circular, but appears to be more rectangular towards the centre. The fragment was recovered from the fill of the ditch [238]2, and may be Late Saxon in date. [411]2.

<71> Copper alloy fragment, perforated, possibly part of a mount or fitting. Undecorated. Perforations *c.*2mm in diameter, spaced at an interval of 30mm. Length 50mm, width 12mm, thickness 0.5mm. [77]9.

<81> Copper alloy jetton. French, 14th century. Also from clay floor [77]9.

<1> Copper alloy Nuremberg token, *c.*1607–10. Obverse: HENRI.IIII.D.G.FRANCOR.ET.NAVAR.REX; Reverse: REGIS.SACRA.FOEDERA.MAGNI (Identification Mike Hammerson). [6]11.

<36> Copper alloy ovoid disc, not a coin. [238]2.

<51> Concreted mass of copper alloy corrosion, nothing visible on the x-ray. [403]2.

Lead

<10> Scrap of lead. [236]5; <11> Solid lead fragment. [245]5; <23> Scrap of lead. [213]3; <53> Strip of twisted lead. [411]2.

These fragments of lead could not be recognised as being from identifiable artefacts such as window cames. They were found in late Saxon layers predating the construction of the undercroft. Other unidentifiable lead fragments were recovered from contexts [322]4 and [418]2, also of a similar date.

Iron

<16> Fragment of whittle tanged iron ?blade with wood handle, identified as ash (*Fraxinus*) (Ian Tyers, pers comm). The fragment is in a very poor state of preservation and very little of the ?blade survives. [235]2.

<74> Iron shoe for attachment to wooden spade. Length 225mm, width at widest point 109mm. Post-medieval in date, pottery 1550–1750. [50]11.

Ivory

<17> Complete double-sided comb made from walrus ivory (Ian Ridler, pers comm). Fine teeth on one side and coarse teeth on the other. Dimensions: length 59mm, width 35mm. Incised lines on both sides of the fine teeth side of the comb indicate the depth to which the teeth should be cut. The overall shape is oblong, but the piece from which the comb is cut is chunky and lozenge-shaped in section. This means that the teeth themselves are deep, although from above they look quite slender. The comb has a narrow solid zone *c.*3–4mm in width. Indications of transverse wear marks on teeth. [109]10. Fig 11, 22.

Comb <17> was recovered from the fill of a pit [109]10, which was probably dug to check the underpinning on the west side of the north bay. Among other earlier medieval pottery from the pitfill were four sherds of London-type ware (1150–1350).

This one-piece comb can be dated stylistically to a type associated with the 11th/12th century (MacGregor 1985, 81). Many examples, particularly in bone, have been recovered from sites in northern Europe, such as those from the Plessenstrasse, Scheleswig (Ulbricht 1984, tables 61–63). However, single-piece combs of this type are rarely found on British excavations. This may be due largely to the combination of the nature of the raw material used for the manufacture of combs, which during this period was often boxwood, with the type of soil conditions in which they were buried (Pritchard 1991, 366).

An exception is the elephant ivory comb recovered from a construction trench at Tackley Church Oxfordshire (MacGregor 1986, 38). This is smaller than the Westminster Abbey comb, and has a wider decorated solid zone. It is thought to be of 11th-century date. A small one-piece bone comb, probably of similar date, was found at Wallingford, Oxfordshire (Hedges 1881, 184).

Walrus ivory appears to have been used from the Alfredian period until the end of the 12th century, when supplies of elephant ivory were once more forthcoming after the period of prolonged disruption of trading routes (Ian Ridler, pers comm). Arthur MacGregor notes how it was used for the production of devotional and secular objects from the 10th to the 12th or 13th centuries, and was traded by Scandanavian merchants as far as the Middle and Far East (MacGregor 1985, 40).

Worked bone

<24> Bone needle, made from pig fibula, pierced at distal end with hole 4.5mm in diameter. Proximal end broken. Surviving length 65mm. [339]1. Fig 11, 23.

Bone implements like this have been found in Middle Saxon features in the Strand sites and in Late Saxon/early medieval City deposits of the 10th to 12th centuries (Blackmore 1989 132, Pritchard 1991, 207).

<37> Fragment of worked antler tine, probably from red deer. Cut at both ends. [368]1. Fig 11, 24.

<70> Bone writing implement, parchment pricker (?). Length 95mm. Polished and turned with incised transverse decoration incised on top half of shaft. Rounded and well carved head. Pointed end has the remains of a corroded iron tip. [77]9. Fig 11, 25.

Such implements are often recovered from monastic sites (Geddes 1985, 150–1). Several were recovered from excavations at Bermondsey Abbey (Beard in prep). Although sometimes considered as being stylii, it is likely that these implements were used to prick out straight lines on vellum before the lines were ruled properly with lead or ink.

Miscellanea

<62> Small fragments of egg shell were recovered, attached to a fragment of ragstone. This has not yet been identified, although burnt it is thought most likely to be chicken egg (Jane Sidell pers comm). [209]6.

Flints

Jonathan Cotton

A total of seven worked flints were recovered from the site, which were all residual. Similar material has been recorded on other sites in the vicinity such as Cromwell Green (Collins 1980, 27).

<14> Blade core, probably Mesolithic or early Neolithic. [300].

<151> Reworked crested blade, very heavily abraded. Bulb of percussion removed. Early Mesolithic or even Late Glacial (10,000–6,000BP). [193]5. Fig 11, 26.

<150> Struck distal end of broad blade narrow flake. [339]1.

<38> Retouch of broken blade or narrow flake. [364]1.

<79> ?failed removal fragment from blade core. [352]3.

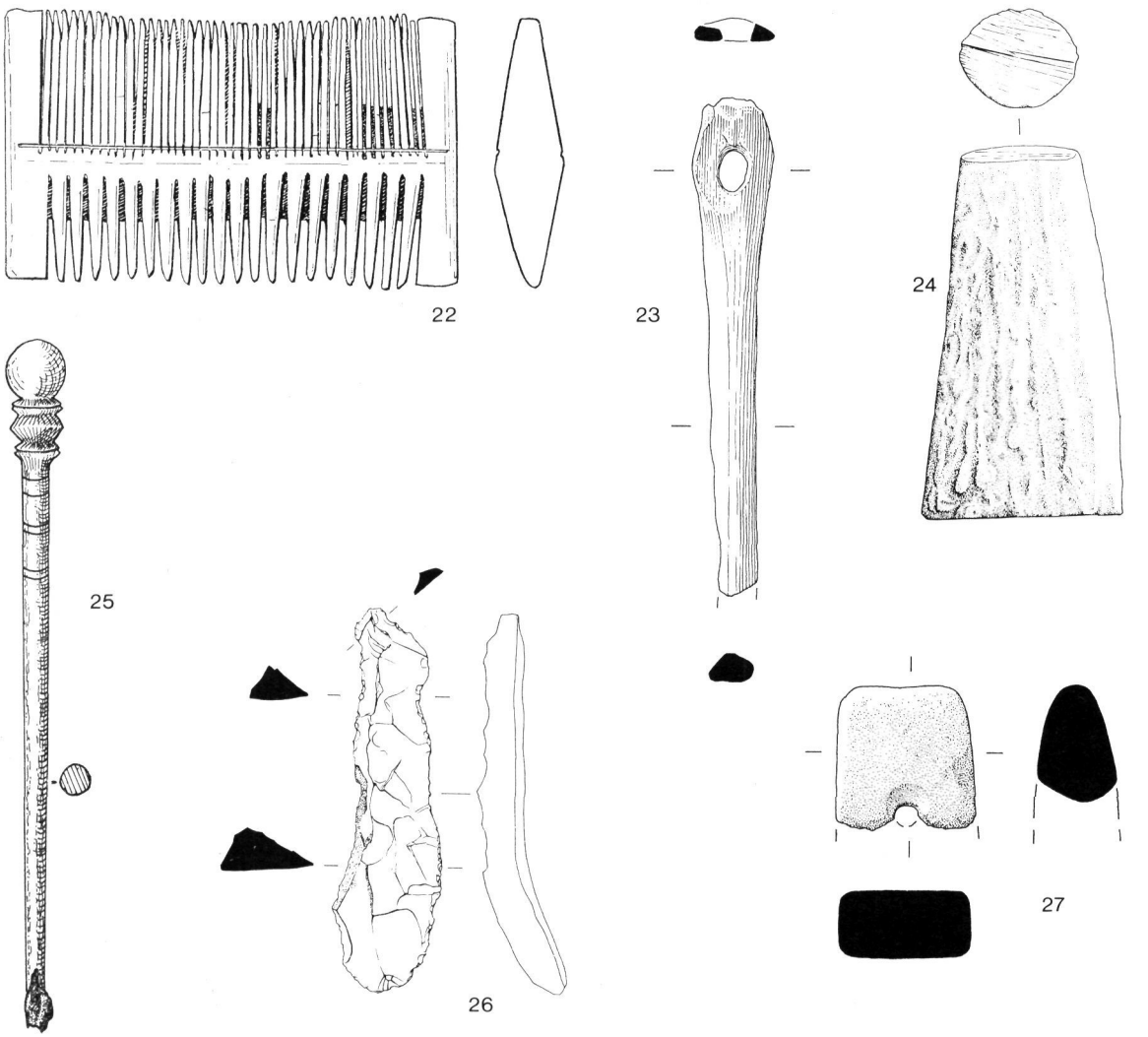

Fig 11. Bone, ivory, antler and stone objects: 22 ivory double sided comb; 23 bone implement; 24 worked antler tine; 25 bone writing implement; 26 flint blade; 27 stone hone fragment, 1:1

Hones

(Petrological identifications by Ian Betts)

<44> Fragment of large perforated hone. Dimensions: Surviving length 35mm, width 36mm, depth 22mm. Soft, very fine grained sandstone. [379]1. Fig 11, 27.

<75> Fragment of stone, possible worn by grinding. One edge has a white deposit still adhering. Hard, fine grained laminated micaceous sandstone. [364]1.

<77> Fragment of stone used for blade sharpening. Several impressions of blades on one surface. Hard, fine grained, partly laminated sandstone. [399]2.

Lava quern fragments

D. F. Williams

<70> [402]2, and <80>, [166]8.

These two quern fragments were made from a grey, fairly coarse vesicular lava which contained conspicuous dark phenocrysts of pyroxene. A small sample was thin sectioned and studied under the petrological microscope. This revealed that the most prominent minerals are frequent grains of green and colourless clinopyroxene, mainly augite, set in a groundmass of small lath-shaped crystals of andesine/labradorite felspar, opacite, leucite and some xenomorphic nepheline. The composition of the rock is particularly distinctive and it can be classified as a nepheline-tephrite.

This type of rock is found in the lavas of the Mayen-Niedermendig area of the Eifel Hills of Germany, a region well-known in both Roman and Saxon times for supplying quernstones and millstones (Parkhouse 1976; Kars 1980; Peacock 1980). The Westminster Abbey lava quernstones undoubtedly originate from this part of Germany.

Window and vessel glass

Catherine Mortimer & John D. Shepherd

Introduction

A detailed study of the window glass from Winchester (Biddle & Hunter 1990) highlighted the need for the publication of more well-dated early medieval assemblages. Such assemblages are rare and so the window glass from this site is a particularly important addition to the small corpus of sites currently available for study. Although it does not dramatically affect our overall understanding of the production and use of window glass during the early medieval period, this assemblage, including as it does some grozing debris from 11th-century contexts, has been catalogued in full below.

One hundred and seventy-four fragments of window glass totalling 782.46cm squared were submitted for examination. One hundred and fifty six fragments (Nos 1–157, a total of 656.98cm squared) come from contexts dated from the 10th to the 19th centuries and the remaining 17 (Nos 158–174, 125.48cm squared) come from poorly dated or unstratified layers. The majority of the fragments are plain fragments with no grozing or decoration and so not normally worthy of detailed analysis. Only six fragments of vessel glass (Nos 175–180) were recorded, including a single fragment of a Late Saxon vessel decorated with opaque yellow trails (No.175).

The window glass is catalogued first, followed by the few vessel glass fragments. In both cases the fragments are arranged according to their stratified context. This is particularly important with regard to the window glass as numerous medieval windows in churches throughout Europe show that the date of use and ultimate deposition may have little relationship with the date of manufacture. It is probable, therefore, that the window glass from, say, the 13th or 14th century contexts is much earlier in date. The Winchester definitions of durable and degraded glass can be applied here also.

It should be stressed that there is very little possibility of any window glass pre-dating the 10th century occurring among this assemblage. In this respect, the Westminster assemblage from the 11th century contexts presents a most valuable sealed group of early medieval window glass. The possibility that it is the waste from the glazing of the building on the site only enhances its value. Larger panes must have been brought to the site for cutting and grozing down into quarries. Such debris takes us one step closer to the glassworker and his glasshouse.

The window glass is catalogued according to dated context. The chemical analysis and discussion of seven samples of window glass from the 10th and 11th-century contexts follows the window glass catalogue. The catalogue of the few vessel fragments from this site follow this and includes a chemical analysis of the early medieval fragment decorated with an opaque yellow spiral trail.

Catalogue

John D. Shepherd

Window glass from 11th-century contexts

One hundred and forty three fragments of window glass and numerous small splinters of grozing debris (trimmed waste from the edges of quarries) came from contexts dated on ceramic evidence to the 11th century. One hundred and twenty two of these, a total area of 501.34cm squared are of non-durable glass and 21, *c.*84.68cm squared are durable (*ie* soda-based window glass (Biddle & Hunter 1990, groups 1 to 3)). The significance of these two groups is not evident at this stage since, as the analyses below show, there appears to be no difference in composition between the two types (compare Samples A-C, non-durable fragments, with Samples E-G, durable fragments). However, it is only in contexts of this date that the two types of glass appear together in quantity. Only two other fragments of durable glass come from the site, No.153 from a late 13th or 14th-century context and No.157, from a 17th to 19th-century context. It is most probable that these two fragments are residual from this earlier glazing programme.

The presence of the grozing debris must indicate that panes were being cut and the resulting quarries were being made up into leaded windows on site. It is most probable, therefore, that the window fragments found in association with this waste are themselves waste material, perhaps discarded off-cuts from once larger panes. It is tempting to suggest that the quarry (No.4) snapped during grozing, a common mishap when trimming a piece of glass so small, and was thrown away.

The grozing debris is difficult to quantify. The individual chips are large, *c.*5mm wide maximum but the majority are *c.*2–3mm wide. This compares with the state of the grozing on the few fragments here which retain a grozed edge. This

is much coarser than the fragments of late 7th or 8th-century window glass, such as those from Monkwearmouth (Cramp 1970) and Jarrow (Cramp 1975) and compares well with glass of similar date from Winchester (Biddle and Hunter 1990).

NON-DURABLE GLASS.

1. [284]5 <88> Fragment from a possible quarry. Indeterminate colour. 4mm/7.88 cm squared.

2. [424]2 <61> An edge fragment. Rolled lip. Indeterminate colour. 3mm/10.24 cm squared.

3. [424]2 <61> Fragment from the edge of a quarry. One coarsely grozed side. Indeterminate colour. 4mm/13.8cm squared.

4. [424]2 <61> Fragment from a small rectangular quarry, broken across the short width, with a grozed notch in one corner. Indeterminate colour. 4mm/9.20cm squared.

5–87. [424]2 <61> A further eighty-three fragments of degraded glass with no distinguishing features also come from [424]. These are:

2mm	28 fragments	total area – 34.96cm squared
2.5mm	17 fragments	total area – 69.26cm squared
3mm	18 fragments	total area – 21.00cm squared
4mm	17 fragments	total area – 74.88cm squared
5mm	3 fragments	total area – 2.08cm squared

88. [113]6 <99> Fragment from the edge of a square or rectangular quarry with three grozed sides. Natural green in the core. 3mm/10.32cm squared.

89. [258]5 <94> Fragment from a probable triangular quarry. Two cut(?) edges. Indeterminate colour. 4mm/13.44cm squared.

90. [370]2 <42> Right-angle corner fragment from a quarry. Grozed on two sides. Indeterminate colour. 5mm/2.88cm squared.

91. [417]2 <57> Part of an irregular-shaped quarry. Indeterminate colour. 3mm/13.36cm squared.

92. [417]2 <108> Part of a small rectangular quarry. Three grozed sides, fourth side missing. Indeterminate colour. 3mm/7.92cm squared.

93. [414]2 <95> Edge fragment with a rolled lip showing traces of a lead mark along the edge. Indeterminate colour. 2–3.5mm/7.00cm squared.

94–98. Five fragments with rolled edges. Irregular thicknesses on individual fragments, 3 to 5.5mm. Indeterminate colour.

[188]6 <82>	5.72cm squared
[211]5 <87>	7.52cm squared
[396]2 <17>	11.16cm squared
[399]2 <104>	4.00cm squared
[417]2 <108>	8.36cm squared

99–123. Twenty-five fragments of degraded glass, indeterminate colour, with no distinguishing features.

2.5mm degraded glass, indeterminate colour.

[213]3 <22>	23.92cm squared
[213]3 <81>	4.92cm squared
[403]2 <89>	1.48cm squared
[417]2 <107>	15.20cm squared, 3 fragments

3mm degraded glass, indeterminate colour

[154]5 <+>	2.44cm squared
[213]3 <81>	3.40cm squared
[258]5 <100>	1.60cm squared, 5 small fragments
[322]4 <19>	6.60cm squared
[392]2 <48>	5.92cm squared
[417]2 <56>	30.28cm squared, 3 fragments

3.5mm degraded glass, indeterminate colour

[322]4 <101>	7.80cm squared
[399]2 <104>	4.40cm squared
[414]2 <111>	3.52cm squared 3 small fragments
[417]2 <108>	3.12cm squared

4mm degraded glass, indeterminate colour

[213]3 <81>	5.48cm squared
[370]2 <42>	15.40cm squared

5mm degraded glass, indeterminate colour

[417]2 <108>	30.88cm squared, 5 fragments

DURABLE GLASS

124. [424]2 <61> Fragment from the corner of a quarry of unknown shape. Coarsely grozed on two sides. With grozing debris adhering to it. Dull yellow-brown glass. 3mm/7.16cm squared.

125–144. [424]2 <61> A further twenty fragments of durable glass came from [424]2. These are:

2mm	7 fragments	total area – 10.40cm squared
2.5mm	13 fragments	total area – 67.12cm squared

GROZING DEBRIS

145. [424]2 <61> Small lumps of concretion containing numerous splinters and chips of glass, the product of grozing. See also No.88. It is not possible to determine whether they come from durable or non-durable glass.

Chemical analysis of window glass from [424]2

Catherine Mortimer

Chemical analysis was performed using energy-dispersive X-ray micro-analysis in a scanning electron microscope (a Cambridge S200 SEM with Link Systems AN10000 X-ray analyser) as in previous projects (Mortimer 1991).

Description of samples

Much of the material examined has blue corrosion products on the surface, ranging from pale blue to dark blue. Some of this corrosion gives the glass a very crumbly appearance and the glass feels rather light, but in many of these cases solid glass is preserved in the middle of the fragment (non-durable, *eg* Samples A-C). Much of the material is covered by further layers of concreted material consisting of smaller chips of glass, pieces of stone and what appears to be mortar. A small proportion of the fragments are solid, relatively dense and still transparent, showing a natural mossy green colour (durable – *eg* Sample G). There are a few examples of brown-tinted or clear blue-green glass which is also well preserved (durable, *eg* Samples E and F). It is not possible to determine precisely the nature of the grozing chip (Sample D).

The seven samples from Context [424] are as follows:
A Thick mid-blue corrosion deposits, the original colour of the glass is not evident in the hand sample: pale mossy green in cut section, depth of corrosion at least 1mm. Non-durable.

B as for A. Non-durable.
C as for A but with added concretions. Non-durable.
D Tiny fragment from grozing debris, tinted pale green. Indeterminate.
E Tinted pale green, light corrosion deposits. Durable.
F Tinted brown, light corrosion deposits. Durable.
G Tinted strong blue-green, good preservation, small patches of concretion. Durable.
Analysis showed that the samples are all chemically similar despite the range of appearances (Table 3).

All the glass is potash glass, with high lime, magnesia and phosphorous pentoxide values. The results of analyses on a relevant glass standard suggest that the method is reasonably accurate and reproducible (Table 4).

Table 4. Comparison of results of three analyses by SEM-EDAX with quoted values for the glass standard Corning D

Sample	A	B	C	Average	Corning D
Na_2O	1.39	1.44	1.61	1.48	1.32
MgO	3.82	3.95	4.00	3.93	4.09
Al_2O_3	4.59	4.64	4.45	4.56	5.43
SiO_2	54.49	54.27	53.44	54.07	55.24
P_2O_5	4.05	4.14	3.63	3.94	4.0
CaO	14.55	14.76	14.56	14.63	15.05
K_2O	10.97	10.91	11.05	10.97	11.46
TiO_2	0.60	0.53	0.60	0.58	0.40
MnO	0.35	0.74	0.57	0.55	0.57
Fe_2O_3	0.37	0.45	0.31	0.38	0.50
CuO	0.20	0.49	0.15	0.28	0.40
SnO_2	nd	nd	0.11	0.04	0.13
PbO	0.23	0.35	0.36	0.31	0.27
TOTAL	95.84	96.79	94.98	95.87	98.86

NOTE: Sulphur, chlorine and chromium were not detectable by SEM-EDAX (detectable limits = *c* 0.2% in all cases): these elements were not analysed for in the quoted compositions for Corning D. nd = not detected

Discussion of chemical analyses

Potash glass, also known as 'forest glass' or 'green glass', was a common type of glass in use during the medieval period. The major oxide contents of glass reflect the raw materials used; potash glass was made using plant ash (*eg* from trees and ferns) as alkali, together with a silica-rich material, such as sand. Apart from potash, such glass has typically at least percent levels of calcium, magnesium, phosphorous and aluminium oxides, much of which originated in the alkali. Variation in oxide content may indicate the use of different types of plant, variation in the degree of purification of the raw materials, or differences in high-temperature technology.

Material visually comparable with the Westminster samples formed the largest sub-grouping of early medieval window glass at Winchester ('non-durable' glass, Biddle & Hunter 1990, group 4). Analysis of 17 fragments of this glass type from early 10th-century contexts at Wolvesey Palace (Newton 1990) and Cathedral Green (Yates 1990) shows the material to be a potash glass with very similar chemical compositions to the Westminster material, as a comparison of some of the major oxides demonstrates (Figs 12 and 13). At Lurk Lane, Beverley (Humberside), a 9th-century fragment of window glass was found to be high in potash, lime and magnesia (Henderson 1991, n4).

The evidence from Winchester suggests that this glass type was introduced during the 9th century, but only became common in the 10th and 11th centuries, when it was used interchangeably with 'durable.' Subsequently potash glass was commonly used for windows. Later (12th to 15th-centuries) potash vessel glass tends to have lower lime, phosphorous and potash levels (Mortimer 1991, table 2); analyses for later potash window glass is not available. The evidence from the Westminster glass assemblage therefore conforms to this pattern.

The source of the 11th-century potash glass from Westminster, and of the technology that produced it, is clearly of some interest. Potash glass is thought to have been introduced from the Continent but it is not known whether potash glass was made in England at this early stage, or merely imported from other areas. The Westminster excavation did not produce furnace or crucible fragments, nor did it produce any molten dribbles or other waste, so it is unlikely that the glass was made on the site, or even melted or worked at high temperatures at the site.

The Westminster material cannot be compared with excavated evidence for potash glassworking, since this is

Table 3. Chemical composition of window glass fragments from [424]2 < 61 >

Sample	A	B	C	D	E	F	G
Na_2O	0.6	1.0	0.7	1.0	0.6	0.9	1.0
MgO	5.5	5.0	3.9	4.5	4.4	5.1	5.8
Al_2O_3	1.1	0.8	0.5	0.7	0.4	1.0	0.9
SiO_2	47.9	51.1	52.0	50.5	50.7	54.3	56.4
P_2O_5	6.9	5.7	5.6	5.8	5.4	3.6	4.2
CaO	21.9	19.5	19.6	19.0	17.3	19.5	22.0
K_2O	13.9	16.5	18.3	16.3	15.8	12.9	11.3
TiO_2	0.3	0.2	nd	nd	nd	0.2	0.1
MnO	0.8	0.4	0.3	0.3	0.3	0.7	0.2
Fe_2O_3	0.6	0.4	0.3	0.4	0.4	0.7	0.6
TOTAL	99.6	101.2	101.5	98.9	95.6	99.0	102.6

NOTE: S, Cl, Cr_2O_3, SNO_2 and PbO were analysed for but were at, or below detectable limits in these samples (which are *c*.0.2% for all except PbO, which is *c*.0.1%). nd = not detected

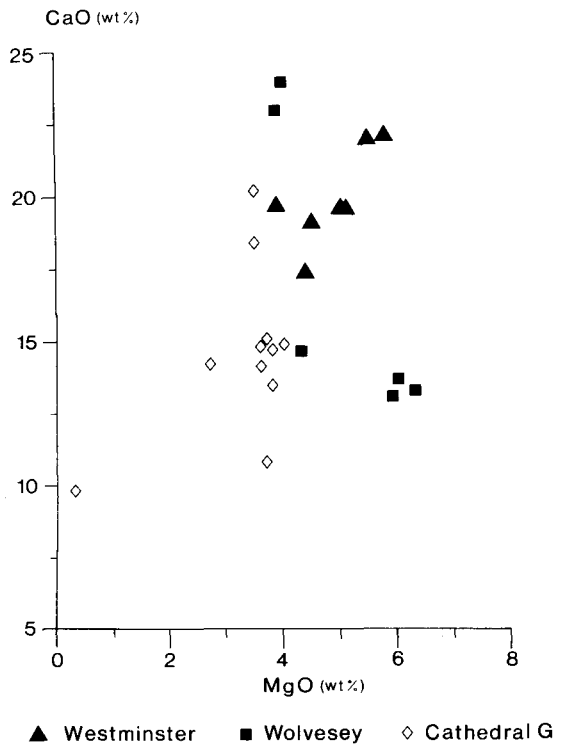

Fig 12. Early medieval potash glass; Westminster (WST86) and Winchester (Wolvesey and Cathedral Green) finds. Lime (CaO) versus magnesia (MgO) content

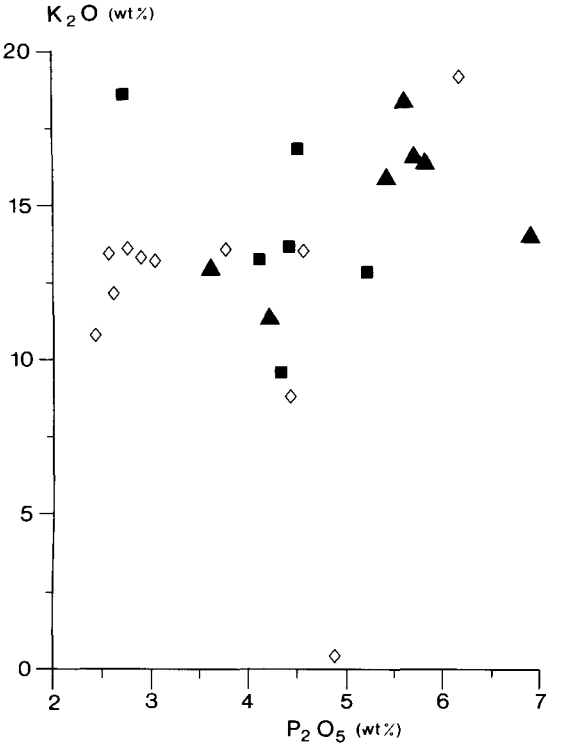

Fig 13. Early medieval potash glass; Westminster (WST86) and Winchester (Wolvesey and Cathedral Green) finds. Potash (K_2O) versus phosphorus pentoxide (P_2O_5) content (see Fig 12 for Key)

lacking for the 11th century, both in this country and abroad. Evidence from two 9th or 10th-century English glassworking sites have recently been examined at Glastonbury Abbey, Somerset and Barking Abbey, London (Heyworth 1992), but the glass here is presumably soda glass. At the time of writing chemical analysis has not been carried out on this material. Data for glassworking of this period in other areas of north-west Europe currently consists of small amounts of evidence (crucibles, droplets *etc*) from a few sites, notably Paderborn and Cordel in Germany (Evison 1989) and more substantial evidence from Haithabu, also in Germany (Dekwna 1990). The potash worked at Cordel was a mixed alkali glass (*ie* nearly equal amounts of soda and potash were present) (Evison 1989, 137). The majority of the glass worked at Haithabu was soda glass, but six examples of potash glass were identified through analysis as well as two beads of mixed alkali glass (Dekwna 1990, tables 3–11). The Haithabu potash glass is of two types, one of which has similar potash and soda contents as the Westminster glass, but lower lime levels (11.3–12%) and the other which has lower potash levels (8.6–11.6%) but lime levels roughly comparable with the Westminster glass (15.5–24%); phosphorous levels are uniformly lower than those at Westminster (2.05–3.48%) and alumina levels are higher (1.2–2.6%). So, although the Haithabu glassworking included potash glass, the type is not directly comparable to that at Westminster. The evidence at Haithabu does not contain material diagnostic of glassmaking, only of glassworking. Glassworking at the site was probably based on glass imported from other areas of Europe, so the wide variety of glass types is not surprising. The Haithabu material pre-dates the Westminster material, since occupation at the site finishes by *c.*AD 1000. The description of the finds at another early medieval glassworking site, San Vincenzo al Volturo (Molise, Italy), suggests that soda glass was worked (Moreland 1985) but this has yet to be confirmed by analysis.

Evidence about the place of manufacture can be sought in the glass composition itself. Very little contemporary glass from the Continent has been analysed. Three 9th to 12th-century pieces from three sites in France are potash glass with broadly similar compositions to the Westminster glass (Barrera & Velde 1989, Annex III. The analyses from periode 1 are from vessels, not from production sites). There are far more analyses of finished glass and of production debris from later periods, both in this country and on the Continent (*eg* Kenyon 1967; Barrera & Velde 1989).

Different types of plant ash have different chemical compositions (Sanderson & Hunter 1981, Turner 1956), so attempts have been made to chemically characterise glass made by particular traditions or in particular areas (Berrera & Velde 1989, 92–4). The small number of fragments currently available means that it is not practical to carry out such work for the early medieval period. In the high medieval and post-medieval period, compositional patterning can be seen between groups of debris from individual production sites, but it is still not possible to provenance material by chemical means.

In summary, the Westminster window glass could have

been made on the Continent, imported in the form of large rectangular sheets, and the quarries shaped on site, producing the copious grozing debris. Equally, it is possible that the glass was made somewhere in England, transported from there and finished on site. The variation in observed colour has no analogue in the compositional data; all the glass fragments analysed had similar compositions. Differences in preservation may be due to different deposition environments and differences in colour may be due to differences in the oxidisation states and relative quantities of iron and manganese.

Window glass from late 12th to 14th-century contexts

Only one very small fragment of non-durable glass came from contexts broadly dated to the late 12th to 14th centuries. No durable glass or grozing debris was recorded.

146. [112]6 <84> 3mm degraded glass, indeterminate colour. 1.60cm squared.

Window glass from late 13th or 14th-century contexts

Six fragments, including a durable fragment, came from contexts dated to the late 13th or 14th century. No grozing debris was recorded. The total area is only 40.44cm squared.

147. [84]8 <90> Edge fragment with a rolled lip. Non-durable glass, indeterminate colour. Irregular 4 to 5mm thick/6.72cm squared.

148–152. [84]8 <90> Five fragments of 4mm degraded glass, indeterminate colour. 4mm thick/total area 30.12cm squared.

153. [84]8 <90> One fragment of durable, natural green glass. 2.5mm thick/3.60cm squared.

Window glass from 15th and 16th-century contexts

None recorded.

Window glass from 17th to 19th-century contexts

Four fragments, including one with traces of dark red paint, come from the latest contexts on the site. This fragment appears to be medieval, but is too small to enable it to be dated precisely.

Non-durable Glass

154. [16]11 <109> Fragment of degraded glass, indeterminate colour. Painted with a foliage design of which only traces survive. 2mm/13.20cm squared.

155–156 Two fragments of degraded glass, indeterminate colour, with faint lead marks on one edge.
[9]11 <110> 1.5mm/5.92cm squared
[105]5 <91> 3.5mm/7.12cm squared

Durable Glass

157 [16]11 <109> A small fragment of durable, natural green glass. 2mm/2.68cm squared.

No grozing debris was recorded.

Window glass from unstratified, undated and poorly dated contexts

Seventeen other fragments of non-durable glass, were recorded on the site in insecure contexts. No durable glass or grozing debris was found.

158. [420] <93> Fragment from a large triangular quarry. Three cut edges. Indeterminate colour. 3mm/23.32cm squared.

159. [109] <92> Fragment from a small triangular quarry with three grozed edges. Indeterminate colour. 2.5mm/4.60cm squared.

160. [205] <96> Distorted edge fragment with a rolled lip. Indeterminate colour. 2 to 4mm/8.24cm squared.

161–174. Fourteen fragments of degraded glass, indeterminate colour, with no distinguishing features.
3mm degraded glass, indeterminate colour
[242] <83> 4.28cm squared
[301] <15> 2.08cm squared
3.5mm degraded glass, indeterminate colour
[34] <102> 6.88cm squared
[183] <105> 6.36cm squared
4mm degraded glass, indeterminate colour
[+] <85> 23.00cm squared, 3 fragments
[34] <98> 14.16cm
5mm degraded glass, indeterminate colour
[299] <20> 4.00cm squared, 5 small fragments
4.5 to 7mm irregular thickness degraded glass, indeterminate colour.
[65] <103> 28.56cm squared

Vessel glass

John D. Shepherd

Only six fragments of vessel glass were recovered from the site, emphasising the importance of the window glass assemblage. The most important is the pale green fragment decorated with opaque yellow trails, probably a spiral. This colour of decoration is not common in this country although it is known on some Scandinavian forms from the 8th century. The pale green body colour of the Westminster fragment matches that of two similarly decorated fragments, probably funnel-shaped vessels, from Southampton (Hunter 1980, 63, GL20/26 & 65, GL24). Hunter notes that this green tint contrasts with the blue tint of the majority of the glass from Southampton. It may be of significance, therefore, that the green tint is shared by many of the Scandinavian vessels.

11th-Century Contexts

175. [368]1 <40> A small fragment of free-blown glass from a vessel of indeterminate form. Pale green glass

decorated with a ?spiral trail of opaque yellow glass. 8th to 10th century.

14 TO 16TH-CENTURY CONTEXTS

176. [44]10 <97> Small fragment from the side of a free-blown vessel of indeterminate form. Natural blue green glass with a slight surface decomposition.

FROM UNSTRATIFIED, UNDATED AND POORLY DATED CONTEXTS

177. [+] <86> Fragment from the side of a vessel of indeterminate form. Non-durable glass, indeterminate colour. Medieval.

178. [+] <86> A small fragment from the side of a vessel with a folded horizontal 'figure-of-eight' rib. Non-durable glass, indeterminate colour. Medieval.

179. [34]11 <-> Two fragments from the base of a bottle. Free-blown; natural green glass with a surface decomposition layer. Pushed-in domed base. Medieval.

180. [7]11 <-> Fragment of thick olive green glass from the body of an 'English' wine bottle. Post-medieval.

Chemical analysis of No.175

Catherine Mortimer

Compositional analysis of the vessel glass and the trail of No.175 has allowed this fragment to be compared with other mid to late Saxon material.

A small section was cut from the sample so as to include a portion of the trail. The sample was mounted in epoxy resin, polished to 1m, carbon-coated and analysed using an energy dispersive X-ray analysis system (Oxford Instruments ISIS) attached to an electron microscope (Leica Cambridge S440i). Analysis was carried out using the default ZAF calculations at 15kV, 1000pA, 50 seconds live counting time. The analytical results are shown below. Corning glass standard A was analysed under the same conditions and this indicated that the analytical technique gave acceptable answers for the vessel glass matrix, although the magnesia (MgO) values calculated may be a little high and the alumina and lime (Al203 CaO) values a little low. Analysis of the trail material was more complex, as the layer is heterogeneous, but approximate values are given in Table 5.

Analysis showed that the vessel was made from a soda-lime-silica glass. Many comparable compositions have been found in other mid to late Saxon vessel material (*eg* Sanderson & Hunter 1984). This composition, with its low amount of magnesia, is comparable to Sayre and Smith's 'Roman' type of soda glass (1961) which is thought to be based on the use of a mineral soda source, natron (hydrated sodium carbonate) and can be contrasted with the high magnesia content of some later soda glass. The 'Roman' type of soda glass does not necessarily imply a Roman source for the glass artefact or the use of Roman glass as cullet.

The cross-section of the trail showed many crystals of lead-tin oxide. When viewed, using the back-scatter detector, these were very bright, reflecting the high atomic number of the compound. Many of these crystals were quite large and clustered together in groups 10–20pi long, but a fine bright 'mist' in some areas suggests that there are smaller crystals, probably of the same composition, present. Three other types of structure were occasionally also observed in the trail – rather darker grey crystals of tin oxide, dark rounded 'bubbles' (containing mostly sodium, calcium and silica) with lead-tin oxide crystals within them and very dark, parallel-sided crystals, containing sodium, calcium and silica.

The overall or bulk PbO:SnO squared ratio calculated for the trailed glass is greater than 1:1. This gives the trail its yellow colouration, because of the dominance of yellow PbSnO crystals; a ratio of *c.*1:1 would have resulted in many more white SnO squared crystals (Freestone *et al* 1990, 275). Antimony-opacified glasses were often used in the Roman period, but tin-opacified glasses are normal for the post-Roman period (*eg* Rooksby 1962).

Table 5 Comparison of results of the analysis of No. 185 by SEM-EDAX with the quoted values for the glass standard Corning A

	No.175 Pale green matrix	Op yellow trail	Corning A EDX Analysis	Standard values
NA_2O	17.4	10.2	14.5	14.52
MgO	1.5	0.7	3.2	2.81
Al_2O_3	2.1	1.2	0.6	1.01
SiO_2	65.7	36.3	65.5	66.56
P_2O_5	0.6	0.9	0.4	na
SO_3	1.4	na	nd	na
K_2O	1.1	1.8	3.1	2.93
CaO	6.6	1.6	4.6	5.3
TiO_2	nd	nd	1.0	0.8
MnO	1.6	tr	1.1	1.18
FeO	1.3	0.5	1.2	Fe_2O_3 = 1.09
SnO_2	na	10.4	na	0.3
CuO	na	tr		
PbO	na	25.1	na	0.1

NOTE: nd = not detected; na = not analysed; tr = trace

Building materials

Richenda Goffin and Naomi Crowley

The building materials were catalogued and quantified by fabric and form by context, using the standard Museum of London recording sheet and fabric codes. The results of the identifications are only briefly summarised in this report; detailed information is in the archive.

Roman

Although no features of Roman date were excavated, the building material from the features which predated the construction of the undercroft consisted almost entirely of brick and tile made

from Roman fabrics. The forms represented were bricks, tegulae, imbrices and occasionally fragments of combed flue tile. Some fragments showed evidence of reuse, as mortar was present on broken edges.

The most significant fragment of Roman ceramic building material was a tegula <13> which was recovered from a post-hole cut into the fill and levelling of the large ditch [238]2. This was inscribed with ... P.PR..B, the stamp of the Procurators of the province of Britain (Hassall & Tomlin 1987, 371) (Fig.14, 28). Tiles with these stamps have been found on many sites in the City of London, but are less common beyond. They have been comprehensively catalogued (Collingwood & Wright 1991).

Several fragments of Roman brick with signature marks were recovered, including one from [109]10 which has a type previously unrecorded. There was also a fragment from

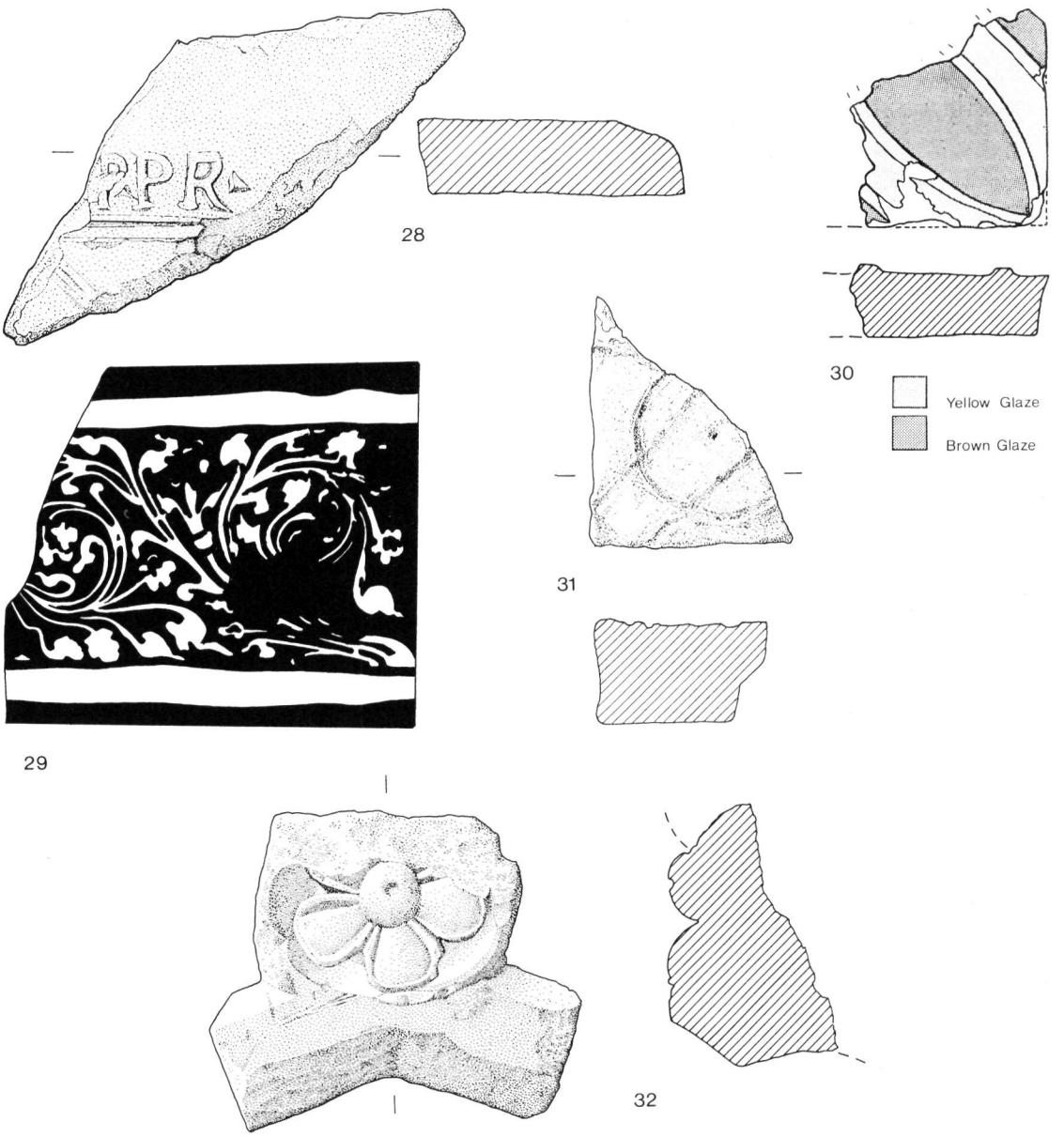

Fig 14. Ceramic building material and stone objects: 28 Roman stamped tile; 29 medieval inlaid floor tile; 30 polychrome relief tile; 31 decorated and glazed tile; 32 Tudor rose finial, 1:2

[213]3 which bore the impression of a hobnail boot print.

In addition to the ceramic building material, a quantity of stone fragments was also recovered, including fragments of Kentish ragstone, oolitic limestone, sandstone and a fragment of Purbeck marble limestone.

Further quantities of Roman ceramic building material were found in the dumps following the reduction of the floor level after the construction of the undercroft. In addition, two fragments of marble were recovered ([98]8 and [87]8). The fragments are composed of a white matrix which has dark grey and purple veining. There is no parallel for this in the Museum of London fabric collection. It is not a marble type known to be used in Roman London.

Medieval

Five hundred and fifty grammes of peg tile in fabrics 2271 and 2586 was recovered from ditch fills [418]2, [420]2 and [422]2. Information from excavations in the City suggests that fabric 2586 was manufactured from the late 12th century onwards, so this material is undoubtedly intrusive.

The scatter of features cut into the reduced floor level after the undercroft construction contained a mixture of building material. As well as fragments of tegulae, there was a small quantity of medieval peg tile fragments (325g) and a piece of moulded Reigate stone.

Evidence of the substantial modifications which took place when the undercroft was remodelled for use as a warming room is reflected in the building material. Ten fragments of painted wall plaster were found in a mortar dump of likely medieval date, along with a peg tile. An abraded fragment of white slipped floor tile was found in a mortar rubble laid down as preparation for a new floor. More fragments of peg tile, made from several different fabrics, were recovered from a tile hearth. One was made from fabric 2271, the first appearance of which, from other London sites, is thought to be *c.*1180.

The structural consolidation which then occurred involved rebuilding the foundations on the west side of the north bay. The new work incorporated a fragment of carved Reigate stone, which is of early 16th-century date (see below). The only other building material associated with these changes was 675g of Roman brick and tile which was recovered from a pit [110]10 dug to check the new underpinning.

Other medieval building material recovered from floor layers and occupation debris in the north bay includes more redeposited tile, including 1,505gs of peg tile, and 1,895gs of plain glazed floor tiles. One fragment was a Flemish import, of probable late 15th/early 16th century date. Two inlaid floor tiles were also recovered from this deposit. <68> was a large fragment of a good quality tile with the same design as a border tile from the floor of Westminster Abbey Chapter House (Type E1264) (Fig 14, 29). It features a scroll-type design with leaved terminals. The date of the pavement which contained this tile-type is uncertain, although it seems likely that it was laid down between 1253 and 1258 (Eames 1980, 172). A second inlaid floor tile <67> from this deposit was not so well made, also in poorer condition. The design consists of a central petal with a roundel and fleur-de-lys in each of the corners, (E2342). It was a product of the Penn industry, one of the most prolific and successful tile manufacturing centres of 14th-century date.

Further evidence of patches of flooring was identified in the south bay. Dumps and layers forming a rough floor at the west end of the bay contained 6,975gs of floor tiles. These included fragments of plain glazed Penn tiles and plain green and yellow glazed tiles which were the products of another tile producing centre, distinguished by the term 'Westminster'. The exact provenance of these tiles is a subject for further research; their name derives from their presence in the floor of the muniment room and St Faith's chapel in Westminster Abbey (Eames 1980, 207). The dating of this industry is also unclear, although decorated tiles of this fabric

Table 6. Summary of quantities of Roman (RCBM) and medieval (MCBM) ceramic building material and stone from the main features predating the construction of the undercroft. Weights in grammes

	RCBM	Stone	MCBM
Phase 1	35000	6225	
Phase 2	40625	7500	550
Phase 4	10075		
Phase 5	10820	3350	
Phase 6	2800	25	
TOTAL	99320	17100	550

appear to date to the second half of the 13th century. A fragment of a Flemish floor tile in fabric 2323 was also found, dated to the late 15th or 16th century.

In addition a large fragment of a ceramic hip tile made in fabric 3090 was recovered. This was part of a curved tile with nail holes at the top, designed to be set on the ridge between two angles of the roof.

The evidence of more postholes suggests further attempts at inhibiting structural problems in the later post-medieval period. The fills of two of these holes contained 300g of peg tile fragments. A shallow pit in the rubble floor in the south bay contained a fragment of a brick which may have been made from a Roman fabric and which had been re-used. It had been covered with a green lead glaze, over which mortar had been applied (see below).

Fragments of three plain glazed floor tiles were recovered from demolition debris over four of the postholes.

Peg tiles

Rectangular ceramic roof tiles with two peg holes were one of the most common forms of roofing used in London from the late 12th century onwards. The main fabrics found in the deposits at Westminster Abbey are 2271 and 2276. Fabric 2271 appears to have been produced from *c.*1180 until the end of the 15th century. The exact sites of production are not known, but it is thought that the tiles were made at various kiln sites in the London area using the deposits of sandy clay found in Quarternary deposits throughout the Thames Valley. Many of these tiles have a clear lead glaze splashed onto the lower half of the tile to provide some rainproofing.

Peg tile fabric 2276 was also present in the excavations at Westminster. It seems to have replaced fabric 2271, among others, from the end of the 15th century. At St Mary Spital peg tiles in this fabric first occur in the period 1400–1538 (Crowley forthcoming).

Fabric 2273 is also represented in the excavations. Peg and bat tiles were manufactured in this fabric between 1135–1200 in the Fleet Street area. Excavations at Niblett Hall, Inner Temple, revealed a truncated kiln with wasters of shouldered peg tiles or bat tiles (unpublished).

Early ceramic tiles

Ian Betts

Three fragments of early medieval tile justify individual description.

Polychrome relief tile

Broken corner fragment measuring: ? × ? × 21mm (thickness excluding raised ribs 17–19mm). Fig 14, 30.

A fragment of decorated polychrome relief floor tile was found in the backfill of the broad shallow ditch [209]6. The upper surface of the tile shows a raised lentoid shape and the remains of two straight lines. The pattern on the top surface has been highlighted by the use of brownish-yellow and brown glaze in different areas of the design. It is possible that the tile was never used for its original purpose as there are mortar traces attached to the top surface. The sides of the tile, which taper inwards towards the base, are scraped smooth lengthways, while the base has also been scraped smooth. Tiles of this type are referred to as polychrome relief tiles.

The white and pale pink coloured clay matrix is characterised by the presence of frequent sub-rounded to sub-angular quartz grains (mostly 0.1–0.5mm) which gives the fabric a granular appearance. There is a scatter of bright red and orange iron oxide inclusions (mostly up to 0.7mm with occasional larger inclusions up to 2.5mm), together with a single fragment of quartzite.

This is one of two polychrome relief tiles found in London. The other tile was recovered from excavations just south of the medieval Guildhall in the City of London in 1993 (Bateman 1994, 169). Both belong to a distinctive group of predominantly decorated tiles found elsewhere – at Canterbury, Coventry, Bury St Edmunds, St Albans, Peterborough, Winchester and York (Keen 1993, 67). The design on the Westminster tile has not been found elsewhere although the lentoid element has a parallel on tiles from Bury St Edmund's and Winchester.

All the tiles in this group are believed to be of Late Saxon date, although it is only known for certain that they were manufactured sometime during the mid 10th to the later 11th-century (Keen 1993, 80). Late Saxon tiles may have been used as decoration in Edward the Confessor's church, construction of which started in *c.*1050 and continued until the 1070s (Wilson *et al* 1986,

14) in which case the example found may represent a broken tile discarded during building work. A second possibility is that the tiles may be associated with building work which followed the refoundation of Westminster as a Benedictine Abbey in the mid-10th century. Decorative tiles could have been added at any time prior to the building's demolition which presumably took place upon completion of Edward's 11th-century church (*ibid*, 11).

No Late Saxon tiles have been found in their original position so their initial purpose is not clear. There is no evidence of wear on the upper surface of the Westminster example which would suggest that if it was ever part of a building it is unlikely to have been used as flooring. It has been suggested by Keen (1993, 82) that such tiles were probably used as either facing to an altar, or as part of a retable above, or as walling on either side of an altar.

The fabric of the Westminster tile matches very closely that used to make the late Anglo-Saxon tiles found at Winchester, St Albans and Bury St Edmunds. There seems little doubt that all these tiles originated from a single kiln source, probably in the Winchester area. Biddle and Barclay (1974, 152) have pointed out the close similarity in fabric between late Anglo-Saxon polychrome relief tiles and locally-produced Winchester Ware glazed pottery of similar date.

Decorated glazed wall? tile

Broken corner fragment measuring: ? × ? × 28–30mm. Fig 14, 31.

The second early ceramic tile example came from the fill of large Ditch [238]2. This tile is totally different in both appearance and fabric type from the polychrome relief tile discussed above. The top of the tile is covered by a poor quality brown lead-glaze which has badly bubbled during firing. Part of the glaze has a greenish-brown tinge where it covers a small area of cream coloured slip. The glaze covers a shallow incised decoration comprising a circle crossed by two diagonal lines. The circle was clearly made by a compass as the mark of the compass point is still visible in the centre. The tile has a thickness of 28–30mm which is significantly thicker than the polychrome tile. The sides and the base have fine moulding sand attached which would indicate manufacture in a wooden mould. Neither of the two surviving sides are bevelled and there are no signs of wear on the upper glazed surface which would suggest that it was not used as flooring.

The clay matrix comprises frequent very small sub-rounded to sub-angular quartz grains and calcium carbonate inclusions (up to 0.2mm), with occasional isolated larger quartz grain (up to 0.4mm). There are frequent fairly rounded dark red, orange and black iron oxide inclusions (up to 0.5mm) and two large white calcium carbonate inclusions measuring 2mm. Most of the tile is reduced, resulting in a light grey coloured interior, but the margins of the tile are reddish-brown.

The clay used to make the tile is similar in appearance to Roman tiles made at Radlett in Hertfordshire (although these have less calcium carbonate) which are found in large quantities in London. This does not necessarily imply that the Westminster tile came from Radlett, but it does indicate that it was probably made from clays found somewhere in the Greater London or Hertfordshire area. The fabric also shows certain marked similarities with medieval London-type ware pottery believed to have been manufactured using clays found in the London area.

A possible clue for the purpose of the Westminster tile can be found in the abbey itself. Tiles with identical coloured glaze were used as wall decoration in the 11th-century rebuilding work. These tiles still survive *in situ* in the east wall of what was the reredorter or lavatory block (now the Little Cloister) and the west wall of the refectory which ran along the south side of the cloister (now in an area known as Cheyneygates). The reredorter or lavatory block was constructed in the 1060s or early 1070s but the refectory seems slightly later, a late 1070s or 1080s date seems likely (Gem 1986, 17). If the decorated tile from [238]2 belongs to the same series, then it may have been a broken fragment which was discarded during building work in the 1060s or early 1070s.

Plain glazed wall? tile

A corner fragment measuring: ? × ? × 35mm (broken length of 126mm).

A second fragment of what may be a wall tile came from a shallow pit cut into the rubble floor of the south bay of the undercroft.

Extremely fine sandy fabric comprising frequent very small quartz (up to 0.1mm) and

common dark red and black iron oxide. The quartz is too small to accurately determine grain shape.

The tile fragment is clearly reused as mortar covers the upper glazed surface. The greenish-brown glazed surface is slightly irregular and the sides have been left sanded rather than knife-trimmed, both features suggest that it may have been intended as walling rather than flooring. There is, however, evidence of wear on the upper glazed surface which indicates that it must have been used for flooring, at least at some stage during its life. It is not certain whether this tile belongs to the same series as those used in the 11th-century building work, although both have a similar red coloured clay body. The glaze colour of the *in situ* Cheyneygate wall tiles are, however, darker in colour, although one tile has a patch of lighter glaze of similar appearance.

Worked stone

Mark Samuel

Introduction

The southernmost five bays of the undercroft (the 'Monks' Common Room') were heavily painted over shortly after the completion of the excavation when the undercroft was converted into a museum. At the same time a new door was driven through the wall (Mrs Maters, pers comm). The Treasury or Pyx Chapel (the two bays immediately to the north of the Undercroft Museum) has escaped any recent alteration. The special circumstances of the Pyx Chapel have meant that it has been, in effect, hermetically sealed for much of its existence. This means that important features, such as the original tooling and renders, have survived very well.

This report describes the Pyx Chapel as it is not possible to describe the building materials used in the Undercroft Museum. It is unlikely that there is any significant variation in materials, although the Pyx Chapel is not in the immediate vicinity of the 1986 excavation.

The undercroft structure is described in as general terms as possible, but it is necessary to make some points that only apply to the Pyx Chapel, as these have some bearing on the later history of the undercroft, otherwise known entirely from documentary sources.

The extent of the undercroft

The total original extent of the undercroft is uncertain. It originally extended further north. The fabric suggests that the Pyx Chapel directly communicated with further structures to the east which have now vanished (see below).

The original ground level of the undercroft was uniformly truncated by *c.*0.80m. This must have occurred when the two blocking walls on the north and south sides of the Pyx Chapel were inserted. The east and west responds have a projecting ground table marked by a simple chamfered plinth absent from the intervening east and west walls. The responds are dressed with large quoins. These are normally Greensand, but one respond apparently consists entirely of Tufa(?). One of the distinguishing factors of the undercroft is the manner in which Greensand, Caen stone, Clunch and Tufa were used in a completely interchangeable manner.

The east end of the second bay from the north in the Pyx Chapel shows two phases of blocking. The wall rib was largely hidden by flanking blockings flush with its outer face that formed the reveals of a door. This opening is respected by the pattern in the 13th-century tiled floor. The door was subsequently partially blocked to form a new opening. This may have occurred when the chapter house was built (1245–60). A similar blocking can be seen in the opposite west wall. The walls to either side of the blocked door are covered by the same plaster screed as the wallrib, and it is possible that the west opening was an original feature of the undercroft.

The central round piers of the undercroft have wide mortar joints, and the courses vary in height. The outer casing of the piers was Greensand, but some blocks of what appears to be Caen stone were also used. The exterior of the blocks was tooled with a boaster chisel to create a vertical corrugated effect. This probably formed a keying for plaster.

The capitals were positioned in a roughly-finished state, and it is generally assumed that there was no intention to carve them. The capitals variously consist of Greensand and an unidentified hard coarse-grained stone. The large 'blocky' form of the capitals in their uncarved state suggests that the original intention was to carve them *in situ* at the time of the undercroft's construction. For some reason, this was never carried out. The styles of carving, where present, are very varied and may be of different dates.

The simple groined vault is similar to Lanfranc's Canterbury crypt, perhaps the closest surviving analogue. Another very similar undercroft once existed in Southwark and was recorded by Victorian antiquarians prior to its destruction during the building of London Bridge Station (Corner 1859). In that case, the undercroft seems to have been a cellar for a house but the technical similarity of the two undercrofts is striking.

The vault webs that survive in the Pyx Chapel are almost certainly original. They are notably irregular, and the groins are poorly defined, the webs blending into a single surface well below the apex. The north compartment's vault webs have an irregular stepped surface. The 'steps' are the impressions of thin planks used for the centering, a characteristically Norman method of vault construction also seen at Durham Cathedral in the high nave vault (Wilson 1990, 27).

The webs are coated with a thick layer of mortar *c.*30mm thick. This almost entirely conceals the structure of the vault, but damage to one of the groins reveals a large block of dressed Greensand. It shows that the masons built the vaults out of carefully fitted stones, rather than simply pouring mortar and rubble on the centering and waiting for it to set. Usually, the groins were built of dressed stone and the intervening webs formed from mortar and rubble. This means that, despite their groined appearance, the vaults are 'ribbed' in the structural sense. Given the rarity of 11th-century vaults, the Westminster undercroft may be of importance in understanding the obscure origins of the diagonal vault rib. Conclusive evidence of 'structural ribs' is however lacking.

The simple oblong-section semi-circular arches that separate the compartments of the vault were probably completed in advance of the vault proper. The intermediate arches are wide and only the corners are dressed with square voussoirs, the median part of the arch being mortar and rubble. The 'wallribs' are a single voussoir in depth and are not bedded into the walls. The voussoirs are less sharply radiused than the arch, any lack of conformity being taken up by the varying thickness of the mortar beds. They were finished with boaster (wide-bladed) chisels resulting in a diagonal corrugated surface. This surface provided a secure keying for a thin plaster screed and traces of two plaster coats remain. The arches were painted a dark colour (red?) at some date, and as there is no apparent build up of paint it is possible that this is an early, if not original feature. No signs of decorative patterns survive.

The voussoirs are dressed from Greensand and Clunch in roughly equal quantities, and Caen also occurs more rarely. In one wallrib, the Greensand and Clunch can be seen to alternate, but this cannot have been a decorative effect. The majority of the voussoirs are scored with an 'X'. These vary greatly in size and shape and are probably not masons' personal marks but setters' marks. Two instances of 'hourglass' masons' marks occur on the (visible) voussoirs, but no other certain marks are visible. The many marks at lower level are probably graffiti.

The two blocking walls that demarcate the Pyx Chapel are very probably contemporary. They are built entirely from re-used Greensand, Clunch and Caen Stone ashlars. The petrology, tooling and the irregular form of the ashlars strongly suggests that they derive from a demolished part of the same undercroft. The round pier embedded in the south wall was cut back flush with the inserted wall using a *Claw Tool* with rectilinear 'claws' made by sawing into the blade of a boaster chisel at regular intervals. This tool does not seem to have been employed before *c.*1250 (author's observation).

Conclusions

Upper Greensand is the sandy equivalent of the Gault formation and it was formed in shallow water (Sherlock 1960, 17). It owes its colour to the presence of dark green grains of fresh glauconite and consists largely of sponge spicules and colloidial (uncrystallised) silica. Its softness and fine grain allows it to be quickly cut into mouldings, ornaments and other dressings, but it deteriorates rapidly if unprotected from the weather, and the Normans no doubt took against it for that reason. Caen stone is an impermeable Oolitic limestone and it is, except in academic folklore, a much more resistant stone. The extensive use of Reigate stone in the Confessor's church has long been recognised (Jope 1964, 96) but the apparent near-disappearance of this building stone in the London area after the Norman invasion requires further research.

After the Conquest, Caen stone from Normandy or English stone that resembled it were favoured as freestones to the near-exclusion of all others (author's observation) and it was not

until the final decades of the 12th century that Greensand was again exploited on a wide scale. The Saxo-Norman masons of the undercroft must have had access to developed quarries of chalk (of which Clunch is a hard variety) and Greensand, and it is probable that the two were mined together, perhaps from quarries in the neighbourhood of Reigate and Merstham, Surrey. These quarries were intensively exploited in the later medieval period (Salzman 1951, 129). The quarrying of Greensand seems to have halted with the Norman Conquest. Chalk continued to be exploited but only for foundations and the rubble core of walls.

The occasional use of a stone with a close general resemblance to Caen stone in the undercroft deserves further study and a more scientific identification is required. The belief that there was virtually no importation of freestone from north France before the Conquest (Jope 1964, 112) needs re-examination.

The survival of plaster screeds on the arches clearly illustrates that the builders of the undercroft rendered over and painted all the stonework with the exception of the capitals. The mixed use of stone was therefore immaterial to the final effect.

The concentration of tufa(?) in one respond does not necessarily indicate a difference in date. It is more likely that the masons simply used whatever source of stone came to hand. There is however little other evidence to suggest that stone was being re-used. Almost all the stone was probably freshly quarried.

The excavated fragments of worked stone

The assemblage of architectural material is for the most part very fragmentary. The fragments have been described, the tooling recorded with rubbings and, where necessary, measured drawings have been made of the moulding profiles.

<4> Rose finial. Greensand. 1350–1500. [159]10. Fig 14, 32.

This element consists of a Tudor Rose carved to form the finial on the apex of a small pointed arch. The treatment of the reverse indicates that it was set into a field or wall face. The rose has a large central stamen and six petals. It was painted red and traces of the paint survive.

An ornamental fragment on this scale would certainly have been internal and would have derived from the microarchitecture of a late medieval internal church structure, such as a reredos, sedilia or tomb monument.

The stylistic similarity of this fragment to the carved roses on the tomb of Henry VII has already been pointed out (Mills, pers comm). The tomb of Henry VII was severely damaged during the Commonwealth and it is possible that this fragment derives from subsequent cleaning of the interior of the church. This would allow the date of the context to be fixed with some precision.

<66> Window jamb/label stop. Caen stone. 1275–1350.

The fragment is the largest from the excavation, apparently representing about 50% of the original dressing. It derives from the external part of a glazing reveal and its upper bed represents the springing line of the window tracery. There are traces of a label stop for the hood moulding which has been cut away.

The moulding is finished with a serrated (sharp) claw tool, a chisel that seems to have been favoured in Britain and France *c.*1240–1300.

There is a single 'black letter' word carefully cut into the jamb moulding. Stylistically it must date from *c.*1350–1525. The rubbing of the inscription cannot be interpreted (John Clark, pers comm).

<68> Fragment of carved drapery? Greensand. [16]11.

This small fragment of relief sculpture is painted red. It is too small to be oriented or dated.

<144> Roll with fillet. Greensand. 1280–1350. [70]11.

This small fragment has spalled off a larger moulding. It incorporates a roll, elliptical or 'squashed' in section with an asymmetrical positioned sharp fillet as a termination. The profile of the roll consists in effect of two waves.

The exterior of the roll was finished with a boaster *c.*6cm wide. This suggests that the fragment is of 13th-century date.

<145> Ashlar(?) fragment. Greensand. 1050s? 1180–1275? [50]11.

The coarse and erratic diagonal boasting suggests that this small fragment may derive from an undercroft arch voussoir similar to those *in situ*. It has therefore been sampled for possible petrological study.

<146> Ornamental casing. Greensand. 1400–1550.[50]11.

This small block formed part of a projecting bead moulding. It was carefully tooled to fit its surrounding elements with joints of minimal thickness. The precision and small size of the piece indicate that it derives from the decorative casing of a freestanding tomb.

<147>&<148> String course. Greensand. 1180–1275. [156]8.

These two fragments probably derive from the label of a string course. The simple chamfered mould can only be broadly dated by its tooling. The lack of weathering suggests that it was part of an internal feature.

<149> Moulding fragment. Greensand. 1300–1500. [44]10.

This roll fragment can be broadly dated by its tooling, as it is finished with a comb, a tool that does not seem to have been widely used until *c.*1300.

ENVIRONMENTAL EVIDENCE

The animal bones

Alan Pipe (identification and recording by Barbara West)

Introduction

This report describes and attempts to interpret the bird and mammal bone assemblages reco-

vered by hand-collection and wet-sieving from the excavations, and to consider their implications for understanding local human activity. Analysis and interpretation of the data were carried out by the author.

Methods

The hand-collected bones

The hand-collected bird and mammal bones were identified and described in terms of species and skeletal element by Barbara West, using reference collections at MoL/MoLAS and the British Museum (Natural History) ornithology department, Tring. The material was recorded directly onto computer using the codes and techniques adopted by the MoLAS Environmental Archaeology Section.

Bones were weighed to the nearest 0.1 gramme using an electronic balance, and measured to the nearest 0.1 millimetre using manual Vernier calipers and following von den Driesch 1976. Withers ('shoulder') heights of the major domestic mammals were calculated using conversion factors given in von den Driesch and Boessneck 1974. Estimates of age at death were made using data on epiphysial fusion and tooth eruption and wear from Payne 1973; Schmid 1972; Silver 1971; and Wilson, Grigson and Payne 1982. Fragmentation was described using the zone method devised by Rackham 1986.

The wet-sieved bone

Soil samples were wet-sieved through 1mm nylon mesh using a Siraf tank. The residues were then visually sorted for animal and plant remains following MoLAS Environmental Archaeology Section procedures. Bird and mammal remains were identified in terms of species and anatomy using MoLAS reference collections and references as for the hand-collected material. They were then described in terms of species-composition, anatomy, abundance, preservation and fragmentation onto paper record sheets.

For both categories of material, bones that were too fragmented or poorly preserved to allow definite identification to species or skeletal part, particularly ribs, vertebrae and long-bone fragments, were assigned to the approximate categories: 'unidentified bird', 'thrush species', 'duck', 'goose-size', 'unidentified mammal', 'cow-size', and 'sheep-size'.

Results

Fragments and weights

A total of 8,445 fragments (75.48kg) were recovered by hand-collection. These were grouped into 74 contexts and 5 phases. Table 7 summarises the total bone recovery by hand-collection.

A scanty assemblage of very highly fragmented bird and mammal bone was recovered from the wet-sieved material. No amphibian or small mammal bones were recovered from any phase. The recovery is summarised in Table 8.

Context [403] (sample 22) in Phase 2, contained an adult chicken metacarpal. This bone compares very closely with an example illustrated as bantam-sized by Cohen and Serjeantson 1986, 53. This context and contexts [235] and [345] from Phase 2 also contained bones from a wild duck species (not mallard) and from an unidentified thrush. The remainder of the assemblage included material only from Phases 2 and 4 and contained only very small unidentifiable mammal fragments.

As Phase 2 yielded the largest sample of hand-collected poultry and wild duck bones, the wet-sieved material corresponds to expected recovery of smaller fragments from these species and is not discussed further as a distinct assemblage.

Species-composition

Hand-collected bones were recovered from a range of domestic and wild species. The domesticates were cattle: (*Bos taurus*), sheep/goat (including sheep *Ovis aries*), pig (*Sus scrofa*), horse (*Equus caballus*), domestic cat (*Felis catus*), domestic goose (*Anser anser*), domestic duck/mallard (*Anas*

Table 7. Total recovery of hand-collected bone

Phase (No./description)	Date	Nos	Wt (g)
5 Surfaces/hrd. standing	1050+	99	401.3
4 Timber structure	1050+	410	1654.6
3 Ditch backfill	1050+	696	2935.8
2 Road/yard and ditch	1050+	3496	30636.7
1 Earliest occupation	*c.*1050	3744	39853.2
TOTAL		8445	75481.6

Table 8. Recovery of wet-sieved bird and mammal bone

Context	Sample	Phase	Supplies	Bone	Abundance
[235]		2	duck unid	metacarpal	1
[322]		4	duck unid	metacarpal	1
[345]		2	duck unid	metacarpal	1
[365]	9	2	unid mammal	unidentified	<20
[391]	17	2	unid mammal	unidentified	<100
[391]	17	2	roe deer	metacarpal	1
[403]	22	2	chicken	metacarpal	1
[403]	22	2	duck unid	metacarpal	1
[403]	22	2	thrush unid	metatarsal	2

platyrhynchos) and chicken (*Gallus gallus*). A diverse assemblage of wild species was recovered. These included birds: crane (*Grus sp.*), white stork (*Ciconia ciconia*), tufted duck (*Aythya fuligula*), wild goose (*Anser sp./Branta sp.*), widgeon (*Anas penelope*), pintail (*Anas acuta*), teal (*Anas crecca*), goldeneye (*Bucephala clangula*), buzzard (*Buteo buteo*), marsh harrier (*Circus aeruginosus*), jackdaw (*Corvus monedula*), snipe (*Gallinago gallinago*), woodcock (*Scolopax rusticola*), blackbird (*Turdus merula*) and fieldfare (*Turdus pilaris*); and mammals: mole (*Talpa europaea*), rabbit (*Oryctolagus cuniculus*), hare (*Lepus europaeus*), roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*) and dolphin (probably bottle-nosed dolphin *Tursiops truncatus* or white-sided dolphin *Lagenorhynchus albirostris*).

Table 11 summarises the recovery of species from each phase in terms of fragment count, weight and percentage of total weight. In each case, the weight of cattle was combined with that of 'cattle-size' and that of sheep/goat combined with 'sheep-size' to give a more realistic estimate of the total weight of cattle and ovicaprids.

Table 9 gives the relative abundance by weight of cattle, sheep/goats and pigs for each phase if these three species are considered as 100% of the bone from each phase. The assemblages from Phases 4 and 5 are too small for further detailed consideration although the groups are dominated by cattle with sheep/goat and pig providing lower and roughly equal weights.

Some information on ecology and economy may be drawn from the recovery of wild species. Red and roe deer fragments were recovered in very small numbers from Phases 1 and 2; one roe deer fragment was recovered from Phase 3. These species are both indigenous and occur, by preference, in open deciduous woodland (*eg* Corbet & Ovenden 1980).They may therefore be assumed to have been available for hunting in reasonable proximity to the site, although the small numbers in which they were recovered suggest small-scale, opportunistic sport hunting rather than planned exploitation of a food resource.

An unidentified dolphin, probably bottle-nosed or white-sided, was recovered from Phase 2. Both these species are widely distributed and are known to occur in the North Sea and therefore, presumably, the outer Thames Estuary. It may probably be asssumed that a wide range of cetacean species was available and was exploited around British coasts, certainly a Norwegian whale fishery is known to have existed in Saxon times (Jackson 1978, 3). Butchered porpoise bones have been recovered from medieval London sites *eg* context [187] at Calvert's Buildings, Southwark (site code CB81), and this dolphin maxilla fragment may well indicate a consumed animal.

Brown hare was recovered from Phases 1, 2 and 5. This is an esteemed food species and,

Table 9. Recovery of major mammal domesticates

Phase/% weight Species	1	2	3	4	5
Cattle	77.70	69.7	70.39	62.40	53.74
Sheep/goat	15.64	15.23	20.26	18.11	22.73
Pig	6.66	15.07	9.35	19.49	23.53
Total weight	35777	28732	2650	1442	368
Cattle, sheep/goat, pig in grammes					

again, may be assumed to have been deliberately hunted in adjacent open country. Rabbit was recovered as single bones from Phases 2, [251], and 5, [211]. However, as this species is generally regarded as a Norman introduction, and obviously has considerable burrowing capacity, these contexts must be regarded with some caution.

The edible bird species include: ducks, *ie* mallard, teal, tufted duck, goldeneye, widgeon; wild geese; waders, *ie* snipe, woodcock, crane and white stork; and thrushes, *ie* blackbird and fieldfare. All these species would have occurred locally even if only on a seasonal basis, fieldfare, for example, are winter visitors to the southern British Isles. The recovery of these species, each in small numbers of fragments, again implies small-scale use of probably extensive local wild resources plus possibly some disposal of chance local casualties. The Thames itself plus its marshy and seasonally flooded margins may be expected to have carried large, although seasonally fluctuating, populations of waterfowl and waders in close proximity to the site.

Two raptor species, buzzard and marsh harrier, were recovered. Buzzards can be expected to have been common throughout mainland Britain at this period; they are catholic feeders (Sharrock 1987) and able to exploit a wide range of prey species and carrion. Although not as esteemed as, say, goshawk or peregrine falcon, they are used in falconry, particularly for ground game. It is impossible to determine whether these fragments indicate such a use, and the species may have been recovered as a chance kill or as a local casualty.

Marsh harriers are very much confined, as a breeding species, to *Phragmites* reed beds and tend to feed in such terrain plus adjacent open country (Sharrock 1987). They may be expected to have been common in and around the marshy Thames margins close to the site. They are of no real use for falconry and, again, these bones probably reached the site as the result of a chance kill or local casualty.

The remaining bird species – stock dove and rock dove ('feral pigeon' ?) and jackdaw – are very tolerant of man and commonly occur in and around towns as opportunistic feeders *eg* on food scraps and spilled grain.

Analysis of assemblage by phase

In each phase, the assemblage is dominated by cattle, sheep/goats and pigs in terms of bone-weight. For Phases 1–4, cattle provide 62.4–77.7% of the total of these three species, with sheep/goat and pigs respectively providing 15.23–20.26% and 6.66–19.49% of the total. There appears to be little overall variation in the relative proportion of the major domesticates between phases although it should be stressed that only Phases 1 and 2 provide adequate samples. If these two phases are compared, then there does appear to be a real, although slight, increase in the relative weight of pig bones at the expense of cattle in Phase 2, with the incidence of sheep/goat remaining constant. In all phases, the incidence of poultry and wild game species is insignificant in terms of bone-weight, although the species-composition is generally diverse (see Table 11).

Phase 1 (Earliest Occupation)

This bone-group is dominated in terms of fragment count and weight by the major domesticates. The relative contributions to the bone-weight were: cattle (69.8%), sheep/goat (14.0%), pig (6.0%) and horse (5.7%). Domestic poultry provided only 0.7% of the total fragment count and 0.10% of the total weight. Wild game species accounted for only 0.3% of the fragment count and 0.6% of the total weight.

Phase 2 (Road/Yard and Ditch)

This bone group is dominated in terms of fragment count and weight by the major domesticates. The relative contributions to the bone-weight were: cattle (65.4%), sheep/goat (14.3%), pig (14.1%) and horse (1.2%). Domestic poultry accounted for only 0.4% of the fragment count and 0.7% of the total weight. Wild game species accounted for only 1.5% of the fragment count and 1.3% of the total weight.

Phase 3 (Ditch Back-fill)

This bone group is dominated in terms of fragment count and weight by the major domesticates. The relative contributions to the bone-weight were: cattle (63.0%), sheep/goat (18.3%), pig (8.4%) and horse (0.2%). Domestic poultry accounted for only 0.7% of the fragment count and 0.2% of the total weight. Wild game species accounted for only 0.4% of the total fragment count and 0.5% of the total weight.

Phase 4 (Timber Structure)

This bone group is dominated in terms of fragment count and weight by the major domesticates. The relative contributions to the

bone-weight were: cattle (54.4%), sheep/goat (15.8%) and pig (17.0%). Domestic poultry accounted for only 4.6% of the fragment count and 2.28% of the total weight. Wild game species accounted for only 1.2% of the total fragment count and 0.2% of the total weight.

PHASE 5 (SURFACE/HARD STANDING)

This bone group is too small to justify discussion of relative weights. However, the species represented were cattle, sheep/goat, pig, rabbit, hare and domestic chicken.

Carcase-part representation and butchery

Using the zone method of Rackham 1986 in combination with age-estimates it is possible to suggest an approximate relative contribution to the total meat-weight provided by the three major domestic mammal species. Thus, a possible total minimum number of individual animals from the *complete* assemblage is cattle (5), sheep/goat (7) and pig (7). Although these estimates are quoted merely to give an impression of the total number of individual animals processed through the site, they do illustrate the rather small size of the identifiable sample available and suggest that caution is necessary in the interpretation of the results.

CATTLE

In each phase all major areas of the carcase were recovered. However only the samples from Phases 1–3 are large enough to justify comment on the relative importance of particular carcase areas. All three phases contain only very small quantities of horn core but relatively large weights of head, upper limb, lower limb and feet with smaller quantities of vertebrae and ribs. Although areas of good (*eg* upper-limb and vertebrae), moderate (*eg* lower-limb) and poor (*eg* feet) meat-bearing quality are represented, the upper and lower limbs tend to predominate, together making up more than 50% of the group weight. The apparent relative lack of vertebrae and ribs is probably a reflection of the allocation of much of the highly fragmented material from this body area to the approximate 'cow-size' category, plus the lack of identifiable zones (Rackham 1986) recovered.

Butchery marks were recorded from Phases 1–4. Although only Phases 1 and 2 provided sufficient material to indicate patterns of carcase processing, the marks from Phases 3 and 4 appear to correspond to the patterns seen in Phases 1 and 2. The samples from both phases indicate thst the carcases were chopped sagittally into sides. The head was also split, presumably to allow extraction of the brain. Vertebrae, ribs and costal cartilages showed transverse cuts and chops resulting from further sub-division of the sides. The fore and hind-limbs were detached at the shoulder and hip and then further disarticulated at the elbow, wrist, knee and ankle to produce manageable joints for distribution, cooking and consumption. There was also definite sagittal chopping of long-bones, particularly the humerus, radius, metacarpal, femur, tibia and metatarsal. This would have allowed extraction of the marrow for future consumption.

SHEEP/GOAT

In all phases the bone-weights were too small to justify detailed comment. However, although all major carcase parts were represented, again areas of good/moderate meat-bearing quality; the upper and lower limbs, were predominant. Small quantities of horn core were recovered from Phases 1 and 2.

Although butchered bones were recovered from Phases 1–4, these were mainly derived from Phases 1 and 2. Again the main processing pattern appears to be splitting of the head, sagittal splitting of the body into sides, followed by transverse division of the vertebral column to produce 'chops'. The limbs also showed knife-cuts and chop marks indicating removal from the body and then sub-division into smaller 'joints'. In some cases, particularly on the pelvis and tibia, there were also indications of meat removal/'boning out' using both knives and cleavers. Two sheep horncores, both from context [334] in Phase 1, had been chopped through at the base, one had also been knife-cut several times at the mid-shaft. This indicates that the horny outer sheath had been removed, probably for use as a raw material in the manufacture of small objects *eg* knife handles, spoons, and gaming pieces.

PIG

In each phase, all areas of the carcase are represented although only in Phases 1 and 2 is the sample of sufficient size to allow comment. In both these cases the head, upper and lower limb predominate; in Phase 1 the upper-limb and in Phase 2 the head provided the majority of the bone-weight. In all cases, the feet and

vertebrae/ribs are very much a minor component of the samples. The feet are areas of low meat-bearing value although the lack of ribs and vertebrae is again probably a reflection of the difficulty of allocating this material to species when highly fragmented.

Butchered material was recorded from Phases 1 and 2. This again showed sagittal splitting of the skull, including separation of the mandibles, although no definitely butchered vertebrae were recovered. One skull had been transversely chopped posteriorly indicating that the animal had probably been decapitated. The limbs showed evidence of disarticulation at the hip, shoulder, and knee with some indications of 'boning out' of the pelvis and radius. Knives and cleavers had been used for both operations.

HORSE

This species was represented by only teeth, upper limb (humerus and femur) and feet (metapodials and phalanges). Three butchered bones were recovered. A femur, [413] and a metatarsal, [334] from Phase 1 showed chop-marks; a humerus from Phase 2, [351] had been chopped distally at the knee. These marks probably all resulted from disarticulation into manageable joints, possibly for consumption by dogs or other kept animals.

RED DEER

This species was represented by upper limb (humerus) and lower limb (radius and calcaneum). No butchery marks were present.

ROE DEER

This species was represented by skull (and antlers), upper and lower limb and metapodials. A radius from Phase 3, [213], had been knife-cut at the proximal end. This would have resulted in disarticulation at the elbow joint and confirms that the species was consumed, probably after primary processing at the site.

CHICKEN

This species was principally represented by bones from the wing (scapula, humerus, radius, ulna and metacarpal), leg (femur and tibia) and feet (metatarsal). Chops were noted on femurs from Phases 2, [373], and 3, [213] presumably as a result of removal of the leg. Knife-cuts were recorded on femurs [345], tibia [369] and a metatarsal [372] from Phase 2 and a tibia from Phase 4 [322]. These may have arisen from production of joints or as accidental marks produced during eating.

GOOSE

A knife-cut and chopped humerus was recovered from the fill of ditch [238]. This was probably a result of the removal of the wing and subsequent 'carving' and division during consumption.

Conclusion

In general, the carcase-part representation of all three major domesticates suggests utilisation of complete carcases with consumption of areas of both low and high meat-bearing quality. The general bias appears to be towards consumption of the upper and lower limb; areas bearing good quality meat. The high incidence of skull and mandibles for all three species implies that primary butchery and possibly slaughter was carried out at, or close to, the site. The relative lack of horn cores recovered from cattle and sheep/goat imply that in general little if any horn-working was carried out on-site. There is no evidence for antler working.

Age-structure of the population

CATTLE

Evidence from the teeth: Although the available material is rather sparse for the whole assemblage, some general inferences may be made. No neonates or juveniles were recovered and all the animals appeared to be adults in at least the second year of life, most were probably in at least the third/fourth year. This applies to material from all phases although only Phases 1 and 2 provided adequate samples for comparison.
Evidence from epiphysial fusion: The material from all phases shows a very similar age distribution although only Phases 1 and 2 provide sufficiently large samples to justify comment. The fusion data strongly imply that all the animals consumed were adult; no neonates or juveniles were recovered from any phase. The animals were predominantly in at least the second year of life when slaughtered, with a large proportion in at least the fourth year of life. In Phase 1 individuals were allocated to the second, fourth and eighth (minimum) year of life. In Phase 2 the overall age distribution was very similar although there were also a few individuals in the third year. This age distribution implies that

although the younger individuals may have been reared solely for beef production, a large proportion of the animals were slaughtered and consumed after having previously fulfilled a primary function *eg* milk production, traction or breeding.

SHEEP/GOATS

Evidence from the teeth: As the sheep/goat sample was very small and consisted mainly of single loose teeth with a very few mandibles, there is insufficient material to merit comparison between phases. There were no neonate, infant or juvenile individuals recovered from any phase. All the material was derived from adult animals probably in the second, third and fourth year of life *ie* animals that had probably fulfilled a primary function *eg* milk or wool production, prior to slaughter for meat.

Evidence from epiphysial fusion: Epiphysial samples were obtained from all phases although only those from Phases 1–4 are sufficiently large to discuss in any detail. The animals from Phase 1 are all sub-adult or adult; no neonates or infants were recorded. The animals were in the first, second, fourth and fifth years with a few individuals possibly older than this. This indicates consumption of lamb and mutton with exploitation of animals reared specifically for meat, and of those having fulfilled a primary function.

Phases 2, 3 and 4 show a broadly similar picture although in each case there is a small proportion of very young animals probably of three months or less. This may imply that sheep and/or goats were reared at the site.

PIG

Evidence from the teeth: For all phases the assemblage appears very similar in terms of age. There are no neonate or infant animals and all the material appears to derive from juvenile or sub-adult animals in the first and particularly second years of life *ie* animals purposely reared for optimum meat production.

Evidence from epiphysial fusion: For all phases, the epiphysial fusion corresponds to the pattern suggested by the larger samples from Phases 1 and 2, indicating that a very small proportion of older animals, probably in the third year, is also present.

Pathology

Pathological changes were very sparsely represented throughout the whole assemblage and were confined to cattle, sheep/goat pig, and chicken.

CATTLE

One horn-core from a Phase 1 context, [413], showed a constriction/indentation 1cm above the base. An innominate (pelvis) from context [299] in Phase 3 bore a well-healed fracture of the ilium. Rib fragments from contexts [387] and [392], both in Phase 2, showed callus formation indicating healed fractures. A maxillary molar from context [392] showed considerably greater height of the posterior cusp in comparison with the anterior. This presumably implies a weakly developed or missing posterior cusp in the corresponding mandibular molar. There was probably little effect upon feeding ability.

SHEEP/GOAT

Pathological changes were recorded only from Phase 1 material and were confined to the distal humerus and proximal radius; the 'elbow joint'. One humerus from context [349] bore extra bony growth on the lateral edge of the distal articulation; extra bony growth was also recorded on proximal articulations of radii from contexts [370], [379] and [413]. These changes are not completely understood but may have originated from physical trauma, *eg* kicks, sustained when the animals were penned close together.

PIG

One tibia recovered from context [334] in Phase 1 showed a large proximal swelling. There were no indications of fracture and the effect may have been the result of infection or haematoma.

Measurements

Although measurements were taken from all sufficiently well-preserved fused bones, there are no groups large enough to justify statistical comparison between phases or feature-types. The recovery of complete bones does, however, allow calculation of approximate withers ('shoulder') heights for the major domesticated mammals. Table 10 summarises the data for cattle and sheep/goat (including one definitely identified sheep). As no complete fully-fused pig bones were recovered, no withers heights were calculated for this species.

The calculated heights for cattle are similar to values previously determined for Saxo-Norman material (*eg* Armitage, 1982).

Table 10. Withers heights of major domestic animals (from von den Driesch and Boessneck 1974)

Phase	Species	Bone	Ht range (mm)	Ht mean ht (mm)	Number in sample
1	Cattle	metatarsal	1081–1199	1142	4
2	Cattle	radius		1274	1
2	Cattle	metacarpal	1065–1183	1097	6
3	Cattle	metatarsal		955	1
1	Sheep/goat	humerus	552–636	594	2
1	Sheep/goat	radius		630	1
1	Sheep/goat	metacarpal		621	1
1	Sheep	metacarpal		625	1
1	Sheep/goat	calcaneum	534–646	583	3
2	Sheep/goat	radius	526–648	587	2
2	Sheep/goat	metacarpal		619	1
2	Sheep/goat	tibia	554–592	571	3
2	Sheep/goat	calcaneum		558	1
3	Sheep/goat	calcaneum	605–618	612	2

Conclusions

This assemblage generally represents a pattern of animal consumption based primarily on cattle and to a lesser, and roughly equal extent, on sheep/goats and pigs.

The carcase-part representation of these species implies that the bulk of the meat diet arrived at the site in the form of intact carcases of the major domesticates, probably on the hoof, and was butchered *in situ*. This also applies to the roe deer remains. The consumption of all body areas and the presence of a range of age-classes implies that consumers of a range of economic status were present. There is no real evidence for the disposal of discrete groups of either 'elite' or particularly low-status domestic waste.

The relative lack of cattle and sheep/goat horn-cores implies that these had probably been removed for use in horn-working elsewhere. There are no indications of bone or antler working on the site.

There is a diverse, although not abundant, component of wild mammal and bird species indicating some low-level exploitation of local faunal resources.

The overall pattern of diverse species-exploitation and cattle-dominated domesticate use closely resembles that described for late Saxon York (O'Connor, 1994) in which it has been interpreted as representative of 'a market big enough to draw in commodities from a wide area by consumer demand'. This would appear to correspond with the interpretation of Westminster Abbey as very much more indicative of the consumer end of the supply chain than any other Saxon London site (Rackham, 1994).

The Fish Bones

Alison Locker

Introduction

Soil samples were taken from a number of Saxon features and context groups from which fish bones were recovered. Some bones were hand collected on site. Table 12 indicates the total number for each species or group in the different phases and contexts. Ninety eight percent of the fish bone came from ditch [238]2, where a number of samples were taken at various points.

Soil samples were sieved down to 1mm to ensure the recovery of the very smallest species. The following species and families were identified: Elasmobranch indet., roker (*Raja clavata*), Rajidae, sturgeon (*Acipenser sturio*), eel (*Anquilla anquilla*), herring (*Clupea harengus*), salmon (*Salmo salar*), Salmonidae, smelt (*Osmerus eperlanus*), pike (*Esox lucius*), tench (*Tinca tinca*), bream (*Abramis brama*), barbel (*Barbus barbus*), dace (*Leuciscus leuciscus*), chub (*Leuciscus cephalus*), roach (*Rutilus rutilus*), Cyprinidae, cod (*Gadus morhua*), haddock (*Melanogrammus aegleinus*), whiting (*Merlangius merlangus*), ling (*Molva molva*), Gadidae, garfish (*Belone belone*), tub gurnard (*Trigla lucerna*), Triglidae, thin-lipped grey mullet (*Liza ramada*), Muglidae, bass (*Dicentrarchus labrax*), mackerel (*Scomber scombrus*), brill/turbot (*Scophthalmus rhombus/Scophthalmus maximus*) and plaice/flounder (*Pleuronectes platessa/Platichthys flesus*).

The identifications are largely to species level, with some categories confined to group or family where specific identification was not possible. For the cyprinids, species were identified largely from

Table 11. Total species recovery from phases 1–5 (NB all weights are given in grammes)

	PHASE 1			2			3			4			5		
Species	**Nos**	**Wt**	**%wt**	**Nos**	**Wt**	**%wt**	**Nos**	**Wt**	**%wt**	**Nos**	**Wt**	**%wt**	**Nos**	**Wt**	**%wt**
Cattle	974	27800	69.8	683	20025	65.4	135	1865	63.0	69	900	54.4	14	198	49.3
Sheep/goat	1593	5595	14.0	906	4377	14.3	184	537	18.3	73	261	15.8	43	84	20.9
Pig	152	2383	6.0	341	4330	14.1	41	248	8.4	31	284	17.0	22	87	21.6
Horse	21	2289	5.7	4	351	1.2	1	5	0.2	0	0	0	0	0	0
Cat	1	4	<0.1	4	16	0.1	0	0	0	0	0	0	0	0	0
Red deer	2	138	0.4	2	121	0.4	0	0	0	0	0	0	0	0	0
Roe deer	3	46	0.1	12	250	0.8	1	11	0.4	0	0	0	0	0	0
Brown hare	1	<1	<0.1	5	8	<0.1	0	0	0	0	0	0	1	11	2.7
Rabbit	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.2
Mole	2	1	<0.1	0	0	0	0	0	0	0	0	0	0	0	0
Dolphin	0	0	0	1	72	0.2	0	0	0	0	0	0	0	0	0
unid. mammal	941	1509	3.8	1245	791	2.6	225	263	9.0	151	149	9.0	12	19	4.8
Chicken	21	29	0.1	154	200	0.7	5	6	0.2	13	23	1.4	1	1	0.2
Goose, dom.	3	8	<0.1	6	16	0.1	0	0	0	1	5	0.3	0	0	0
Goose, wild	3	12	<0.1	0	0	0	0	0	0	0	0	0	0	0	0
'goose-size'	0	0	0	4	13	<0.1	0	0	0	1	7	0.4	0	0	0
Mallard	0	0	0	15	17	0.1	0	0	0	2	2	0.1	0	0	0
Pintail	0	0	0	1	1	<0.1	0	0	0	0	0	0	0	0	0
Teal	0	0	0	1	<1	<0.1	0	0	0	1	1	0.1	0	0	0
Tufted duck	0	0	0	3	2	<0.1	0	0	0	0	0	0	0	0	0
Goldeneye	0	0	0	1	1	<0.1	0	0	0	0	0	0	0	0	0
Widgeon	1	1	<0.1	0	0	0	0	0	0	0	0	0	0	0	0
Duck	2	1	<0.1	8	4	<0.1	0	0	0	2	1	0.1	0	0	0
Crane	1	17	<0.1	0	0	0	0	0	0	0	0	0	0	0	0
White stork	1	8	<0.1	0	0	0	0	0	0	0	0	0	0	0	0

the characteristic pharyngeals which were numerous. Other less specifically identifiable vertebral centre and skull fragments were assigned to 'cyprinid'. Similarly, plaice and flounder were specifically identified from premaxillae and dentaries with other skull fragments and vertebral centra categorised as plaice/flounder or where less determinable as flat-fish.

Measurements (recorded in the archive) were taken on dentaries and premaxillae using Wheeler and Jones (1976) and Morales and Rosenlund (1979) to estimate the range of whiting total lengths. Although the accurate measurement of small specimens is difficult the suggested total length range for whiting is approximately 36 to under 50cms, of average size (Wheeler 1978, 153). The size of cyprinid pharyngeals suggested that small immature specimens were present as well as larger more mature individuals.

Discussion

Excluding ditch [238]2 the amount of fish bones recovered was small *ie* not exceeding 84 identifiable bones in any one group. The small size of these samples limits the viability of comparison between these groups and the ditch. However, there is some similarity between all the groups, which can be seen in Table 12 with species that could be caught inshore or in estuarine/freshwater conditions predominating. The proportion of freshwater species is exaggerated by the partial skeleton of a roach from pit [211]5.

The large sample of fish bones from the mid 11th-century ditch [238]2 is dominated by herring (31%), smelt (17%) and plaice/flounder (15%) in descending order of occurrence. Cyprinidae (8%), whiting (8%), elasmobranch/roker/ray (7%), eel (6%) and pike (2%) were also of importance, the remaining species comprise less than 1% each.

This distribution also reflects species that can be caught in shallow marine, estuarine and freshwater conditions. Both herring and whiting occur in large shoals and could have been netted in the shallower waters of the southern North Sea. Roker, plaice, flounder and turbot could have been trapped or caught on lines along the shoreline or in shallow waters. Smelt (related to salmon) are migratory, breeding in freshwater or

at the edge of the tidal influence (Wheeler 1979, 151). These small fish were netted in large numbers as they entered the Thames. Eels were also commonly caught in the Thames by hook, trap or net. Exclusively freshwater fish are represented by the cyprinids, of which dace and roach were most common. Tench, barbel and chub were also identified. Of these species only roach and tench are now considered worth eating. Pike was also present in 13 out of the 15 samples from this ditch and appears to have been regularly eaten, if not in large quantities. Of the remaining species, all of which comprise less than 1% of the whole ditch sample, only cod and haddock suggest any offshore fishery. The remainder could all have been caught in marine inshore waters or in the Thames itself and were not purchased in large quantities. The single identification of sturgeon is of interest, it was highly regarded, a 'royal' fish, owned by the crown and used to be found in the Thames when it returned from the sea to spawn.

Table 12. Fish bone remains

	1	2	3	4	5	6	7	8
Elasmobranch				99		2		
Roker				329	2	2	1	
Sturgeon				16	1	4		
Ray			5	231		2		
Eel			1	561	7	2		
Herring		1	10	2903		7		2
Salmon				1				
Salmonid				78		1		1
Smelt		1		1608		2	2	1
Pike				195		3		
Tench				5				
Bream				4			1	
Barbel				4				
Dace				27				
Chub				1				
Dace/Chub				74				
Roach				42	1		21	1
Cyprinid				643			2	
Cod			4	48		4	1	
Haddock				19	1			
Whiting			1	791		11	2	
Ling			1					
Gadoid					1			
Sm Gadoid			1	31				
Lg Gadoid			3	16		2		
Garfish				35				
Tub Gurnard				17		2	1	
Gurnard				87				
TLG mullet				35				
Mullet				1				
Bass				3	1			
Mackerel		1		43		1		
Brill/Turbot				8			1	
Plaice	1			185		30	5	
Flounder				53				
Plaice/Flounder			1	1205	6	9		
Flatfish indet.		1		33	1			
TOTAL	1	4	27	9431	21	84	37	5

KEY: 1. Phase 1[381]; 2. Phase 1[408]; 3. Phase 1[468]; 4. Phase 2[238]; 5. Phase 3; 6. Phase 4; 7. Phase 5 surfaces; 8. Phase 5[114]. Numbers refer to numbers of bones recovered

Comparison with the fish identified by Jones (1976) from the excavations in the sub-vault of the misericorde of the abbey suggest a similar species composition although most of the samples are later in date, *ie* 12th to 13th century. However, both in the 12th/13th century, and in the smaller samples dated up to the 16th century the emphasis is more on deep water fish such as cod, haddock and, in one instance, ling. The small numbers of cod, haddock and only one vertebra of ling in the earlier deposits from the undercroft may reflect a change in the availability, with a greater exploitation of deep water in the medieval and post-medieval period.

Since abstinence from meat was strictly observed by the Benedictines up until the end of the 12th century (Bond 1988, 70), fish would have been an important part of the monastic diet until this date and still made a significant contribution afterwards.

The marine fish could all have been purchased locally, except for ling which would have been imported from a more northerly port, salted or dried. The freshwater fish would either have been purchased or caught on the river where the monastic house may have retained fishing rights. Certainly in the 15th century the abbey had fishing on the river Colne shown on a map of 1460 (*ibid*, 72) and it is possible that in earlier periods they may have had rights in other areas. The presence of small immature cyprinids, unlikely to have been purchased for eating may be evidence to support this. Alternatively they may represent the stomach contents of a carnivorous fish such as the pike.

Plant remains

Anne Davis

Introduction

Soil samples for environmental analysis were taken from a number of features on the site, most of them Late Saxon/early medieval in date,

Table 13. Charred plant remains from phases 1, 4 and 11

Species	Common name	Habitat	⟨ph. 1⟩				⟨ph. 4⟩		⟨ph. 11⟩
		context no.:	413	349	344	335	322	333	22
		sample no.:	24	6	4	2	0	0	1
Triticum aestivum L. s.l.	bread/club wheat	FI		10	8		2		
Triticum sp.	wheat	FI		2	4				
Triticum sp.	wheat, rachis	FI			4				
cf. Triticum sp.	wheat	FI	2	2					
Secale cereale	rye	FI	4	27	6			1	
Secale cereale	rye rachis	FI		3	1				
cf. Secale cereale	rye	FI	8	9	5		3		
cf. Secale cereale	rye rachis	FI							1
Triticum/Secale sp.	wheat/rye	FI		4	1				1
Secale/Hordeum sp.	rye/barley rachis	FI			1	1	1		
Hordeum sativum	barley	FI	1	9	5	2			2
Hordeum sativum	barley, rachis	FI			2				
cf. Hordeum sativum	barley	FI		1			1		1
Hordeum/Triticum sp.	barley or wheat	FI	1	3					
Avena sp.	oat	AFI		6	2				
cf. Avena sp.	oat	AFI		4	5				
Cerealia	indet. cereal	FI	14	30	30	10	5	2	2
Cerealia	indet. cereal, culm node	FI		2	11				1
Cerealia	indet. cereal, rachis	FI							
Ranunculus cf. flammula	lesser spearwort	EG			1				
Silene sp.	campion/catchfly	ABCDF		1					
cf. Myosoton aquaticum	water chickweed	E		1					
Stellaria cf. media	chickweed	AB		1	4				
Stellaria spp.	chickweed/stitchwort	ABCDEG					5		
cf. Stellaria spp.	chickweed/stitchwort	ABCDEG			2				
Caryophyllaceae indet.	—	—		3					1
Caryophyllaceae/Chenopodiaceae	—	—		2	1	1			
Chenopodium cf. album	fat hen	ABFH			1				
Chenopodium murale L.	nettle-leaved goosefoot	BD							
Chenopodium sp.	goosefoot etc.	ABCDFH		1	2	1			
cf. Chenopodium sp.	goosefoot etc.	ABFH				1			
Atriplex sp.	orache	ABFGH			1				
Chenopodium/Atriplex sp.	goosefoots/oraches	ABFGH			1				
Malva sp.	mallow	BCDF							1
cf. Trifolium sp.	clover	BDI		1	1				
Vicia/Lathyrus spp.	vetch/tare/vetchling	CD			4				
Rumex acetosella L.	sheep's sorrel	AD		1	4	1			
Rumex spp.	docks	ABCDEFG	1	2	38	2			
Urtica dioica L.	stinging nettle	BCDEFGH			1				
Corylus avellana L.	hazel	CF							
Solanum nigrum L.	black nightshade	BF			1				
Prunella vulgaris L.	self-heal	BCDG			1				
Lamium sp.	dead-nettle	ABC			1				
Plantago lanceolata L.	ribwort	D		2	4				
Galium sp.	bedstraw	ABCDE		1			1		
Sambucus nigra L.	elder	BCFGH		2					
Anthemis cotula L.	stinking mayweed	ABGH		6	16		1		
Compositae indet.	—	—		2					
cf. Compositae indet.	—	—							
Juncus spp.	rush	ADEH			1	1			
Eleocharis palustris/uniglumis	spike-rush	E		2					
cf. Eleocharis sp.	spike-rush	E			3				
Carex spp.	sedges	CDEH		2	9				
Poa type	poa	ABDE			2				
Bromus spp.	bromes	ABD		3					
cf. Bromus spp.	bromes	ABD			3				
Avena/Bromus spp.	oat/brome grasses	ABCDFI	5	4	4		1		2
Phleum type	—	—		3	2				
Gramineae indet.	—	ABCDEFHI		6	6	3		2	
Indeterminate	—	—		18	13				1

KEY to habitat codes: A. Weeds of cultivated land; B. Ruderals. Weeds of waste places and disturbed ground; C. Plants of woods, scrub, hedgerows; D. Open environment (fairly undisturbed); E. Plants of damp/wet environment; F. Edible plants; G. Medicinal and poisonous plants; H. Commercial/industrial use; I. Cultivated plants.

Table 14. Waterlogged plant remains from phases 1, 4 and 11 (for KEY see Table 13)

Species	Common name	Habitat	413	349	344	335	322	333	22
		context no.:	413	349	344	335	322	333	22
		sample no.	24	6	4	2	0	0	1
Ranunculus sceleratus L.	celery-leaved crowfoot	E				1		1	
Papaver somniferum L.	opium poppy	BGHI		1					
Stellaria cf. media	chickweed	AB		1					
Chenopodium rubrum/glaucum	red/glaucous goosefoot	AB						1	
Malva sp.	mallow	BCDF		1					
Fragaria vesca L.	wild strawberry	CDF		2					
Conium maculatum L.	hemlock	CEG			1				
Apium graveolens L.	celery	EFI							1
Urtica urens L.	small nettle	AB						1	
Urtica dioica L.	stinging nettle	BCDEFGH			12	1			
Prunella vulgaris L.	self-heal	BCDG							2
cf. Marrubium vulgare	white horehound	BG				30			
Labiatae indet.	—	—						1	
Sambucus nigra L.	elder	BCFGH	8	2	4			1	
Juncus spp.	rush	ADEH		1200		50			
Eleocharis palustris/uniglumis	spike-rush	E		2					
Cyperaceae indet.	—	—		1					
Gramineae indet.	—	ABCDEFHI		14	1				
Indeterminate	—	—			2				

and probably contemporary with the building of the 11th century abbey.

From Phase 1, a single sample was taken from a gravel fill of the possible quarry [408], and three from silty flood deposits overlying the disused quarry. The largest number of samples came from primary fills (Phase 2) and levelling layers (Phase 3) of the massive boundary ditch [238]. All these phases date to the mid to late 11th century.

Two postholes from the north side of the Phase 4 timber structure were sampled, but any deposits associated with the occupation of the building were not available for excavation.

A single sample dates from the post-medieval period (Phase 11) and was taken from a patch of flooring in the abbey undercroft.

Processing

A total of 29 samples was processed using a modified Siraf flotation tank with a 0.25mm mesh to catch the floating material and a 1.0mm mesh to retain the residues. The flots were dried prior to sorting for plant remains. Sample size varied from 2kg to 37kg but the majority were smaller than 10kg. Twenty four flots were sorted in the laboratory, five of the smallest ditch samples being omitted, and seeds were identified with the help of the modern reference collection at the Museum of London.

The plant remains identified are shown in Tables 13–16.

Results

The richest assemblages of plant remains came from Phase 1 flood deposits and the Phase 2 ditch fills. Both charred and waterlogged material was recovered from most samples, but the charred remains were generally in poor condition – often distorted and fragmented. Waterlogged seeds were well preserved in some of the ditch fills.

Charred plants

Charred cereal grains, chaff and weed seeds were found in all samples. Identification to species was impossible in many instances, and in some contexts the majority of grain was composed of unidentifiable fragments.

Rye (*Secale cereale*) was the most abundant cereal identified in the majority of samples and also on the site as a whole, although it always occurred mixed with other cereals. In addition to the firm identifications of rye grains a number of specimens were impossible to distinguish from wheat due to their poor preservation.

Wheat grains were also present in almost all samples. This was almost certainly bread or club wheat (*Triticum aestivum* s.l.), although it is

Table 15. Charred plant remains from ditch 238, phase 2 (for KEY see Table 13)

Species	Common name	Habitat															
		context no.:	421	418	417	414	403	396	391	389	388	366	365	345	352	323	213
		sample no.:	27	26	29	28	22	19	17	15	14	11	9	8	10	7	3
Triticum aestivum L. s.l.	bread/club wheat	FI	4	6		2		5				3	4	8	2	1	
Triticum sp.	wheat	FI					1	1	1		1		4	7			
cf. Triticum sp.	wheat	FI	1	1					1			1			1		2
cf. Triticum sp.	wheat, rachis	FI		1													
Secale cereale	rye	FI	3	6	1	1		6				4	4	6	3		2
Secale cereale	rye rachis	FI										2					
cf. Secale cereale	rye	FI		5		2	4	3			1	2	9	7	3		3
cf. Secale cereale	rye rachis	FI															1
Triticum/Secale sp.	wheat/rye	FI		3			1	3				1	1	5			2
Secale/Hordeum sp.	rye/barley	FI													1		
Secale/Hordeum sp.	rye/barley rachis	FI							1						1		
Hordeum sativum	barley	FI		2		1		1	2	1		2	5	11		1	1
Hordeum sativum	barley, rachis	FI		1					1				3		1		
cf. Hordeum sativum	barley	FI	1	1		1		2				3	5	7			2
Hordeum/Triticum sp.	barley or wheat	FI						4					4	8	2	2	1
Avena sp.	oat	AFI	1	4				1		1				3			1
Avena sp.	oat awn	AFI		1													
cf. Avena sp.	oat	AFI		4		1							6	7			
Cerealia	indet. cereal	FI	7	21	1	5	2	12	8	4	2	12	35	30	7	3	20
Cerealia	indet. cereal, culm node	FI		1													2
Cerealia	indet. cereal, rachis	FI		2													
Ranunculus sp.	—	ABCDEG								1							
cf. Raphanus raphanistrum	wild radish/charlock	A											1				
cf. Myosoton aquaticum	water chickweed	E											2				
Myosoton/Stellaria sp.	chickweed/stitchwort	ABCDEG				7											
Stellaria media (L.) Vill.	chickweed	AB	2	1	6	1						1					
Stellaria cf. media	chickweed	AB		3													8
Stellaria graminea L.	lesser stitchwort	CD							1								
Stellaria spp.	chickweed/stitchwort	ABCDEG	2	2	2					1		1			2		1
cf. Stellaria spp.	chickweed/stitchwort	ABCDEG															6
Caryophyllaceae indet.	—	—				1						1					8
cf. Caryophyllaceae	—	—															9
Caryophyllaceae/Chenopodiaceae	—	—			1			1				1					1
Chenopodium sp.	goosefoot etc.	ABCDFH												1			
Chenopodium/Atriplex sp.	goosefoots/oraches	ABFGH				1											
Chenopodiaceae indet.	—	—								1							
Malva sp.	mallow	BCDF			1	1	1	2	1								1
cf. Trifolium sp.	clover	BDI		2													
cf. Vicia faba	celtic bean/horsebean	FI		1													
Vicia/Lathyrus spp.	vetch/tare/vetchling	CD	1	1				1					2	1			1
cf. Vicia/Lathyrus sp.	vetch/tare/vetchling	CD							1								

Vicia/Lathyrus/Pisum sp.	vetch/tare/vetchling/ pea	ABCDEFI												2					
cf. Potentilla sp.	cinquefoil/tormentil	BCDEFGH				2													
Prunus avium/cerasus	sloe/cherry	CFGI						1											
Polygonum sp.	—	ABCDEFG								1									
Rumex cf. acetosella	sheep's sorrel	AD											1						
Rumex spp.	docks	ABCDEFG	1	1		1		1						1					2
Corylus avellana L.	hazel	CF	1							1	1								1
cf. Corylus avellana	hazel	CF		1															
cf. Menyanthes trifoliata	bogbean	EFG							1										
Plantago cf. lanceolata	ribwort	D	1	1															
Galium cf. aparine	cleavers	BCG	1																1
Galium sp.	bedstraw	ABCDE							1	1			2	1					1
Sambucus nigra L.	elder	BCFGH											1						1
Anthemis cotula L.	stinking mayweed	ABGH	13	28		2	1						4				1		3
Chrysanthemum segetum L.	corn marigold	AHI		4															
Leontodon autumnalis/hispidus	hawkbit	BD		1															
Compositae indet.	—	—		1															
Eleocharis palustris/uniglumis	spike-rush	E																	1
Cyperaceae indet.	—	—		2															
Poa type	poa	ABDE	5	3															6
Bromus spp.	bromes	ABD		3									2						
cf. Bromus spp.	brome	ABD												2					
Avena/Bromus spp.	oat/brome grasses	ABCDFI	9	26		2	1	4		3			4		2	2			3
Gramineae indet.	—	ABCDEFHI		1	3		1					1	4	3					
Indeterminate	—	—	2	7		2	2		2	3			10	3					6

Table 16. Waterlogged plant remains from ditch 238, phase 2 (for KEY see Table 13)

Species	Common name	Habitat	421	418	417	414	403	396	391	389	388	366	365	345	352	323	213
		context no.:	27	26	29	28	22	19	17	15	14	11	9	8	10	7	3
		sample no.:															
Ranunculus acris/repens/bulbosus	buttercups	ABCDEG			12								1	1			
Ranunculus sceleratus L.	celery-leaved crowfoot	E			10	9	3	5	23	1		1	134		9	1	
Ranunculus sp.	—	ABCDEG							1								
Papaver somniferum L.	opium poppy	BGHI								1			2				
cf. Capsella bursa-pastoris	shepherd's purse	AB							3				7				
Rorippa islandica (Oeder) Borbas	marsh yellow-cress	E						1	4	1		2	46		3		
Reseda luteola L.	weld/dyer's rocket	ABGHI				2			2				1	1			
Hypericum sp.	St. John's wort	CDE								1							2
Silene sp.	campion/catchfly	ABCDF			1												
Stellaria media (L.) Vill.	chickweed	AB							8				21				
Stellaria cf. media	chickweed	AB											6				
Stellaria graminea L.	lesser stitchwort	CD											2				
Stellaria spp.	chickweed/stitchwort	ABCDEG							1	1							
cf. Stellaria spp.	chickweed/stitchwort	ABCDEG			1								5				
Chenopodium album L.	fat hen	ABFH			26	1							2				
Chenopodium cf. album	fat hen	ABFH			9												
Chenopodium cf. murale	nettle-leaved goosefoot	BD			3												1
Chenopodium rubrum/glaucum	red/glaucous goosefort	AB			2	4			1				29		1		1
Chenopodium spp.	goosefoot etc.	ABCDFH			3	2											
Atriplex sp.	orache	ABFGH			3	1											
cf. Atriplex sp.	orche	ABFGH				1											
Chenopodium/Atriplex sp.	goosefoots/oraches	ABFGH			10												
Malva sp.	mallow	BCDF										3		4			
Potentilla cf. argentea	hoary cinquefoil	D							1								
Potentilla cf. erecta	tormentil	CDEGH											2				
cf. Pontentilla sp.	cinquefoil/tormentil	BCDEFGH							1								
Aphanes arvensis agg.	parsley piert	ABD											1				
Conium maculatum L.	hemlock	CEG			68												
Apium graveolens L.	celery	EFI			1				1	1			13				
Apium nodiflorum (L.) Lag.	fool's watercress	E							1				2				
Apium sp.	—	EFI				1									1		
cf. Umbelliferae indet.	—	—															1
Rumex acetosella L.	sheep's sorrel	AD											1				
Rumex spp.	docks	ABCDEFG			10												
Urtica urens L.	small nettle	AB					1										
Urtica dioica L.	stinging nettle	BCDEFGH			6	6			12	3		1	41				1
Ficus carica L.	fig	FGI			1	3											
Hyoscyamus niger L.	henbane	BDG			1												
Prunella vulgaris L.	self-heal	BCDG												1	1		
cf. Marrubium vulgare	white horehound	BG			15												
Labiatae indet.	—	—				3				1							1
cf. Labiatae indet.		ABCFEFI										2					
Sambucus nigra L.	elder	BCFGH	1	1	9	4				1		7	2	3	1		4
Sambucus nigra/ebulus	elder/danewort	BCFGH										1					
Juncus spp.	rush	ADEH			300	15		1				2	50			700	32
Eleocharis palustris/uniglumis	spike-rush	E			72	1			1						1		
Carex spp.	sedges	CDEH			5	2							3				
Cyperaceae indet.	—	—							1								
Gramineae indet.	—	ABCDEFHI			5							1	2			52	9
Indeterminate	—	—			4							1		2			

impossible to be certain from the grains alone. A few rachis fragments of wheat were found, which were also suggestive of bread or club wheat.

Hulled Barley (*Hordeum sativum*) was frequently found, but was not particularly abundant. Several of the barley grains were twisted, indicating the presence of the 6-row variety. Preservation of grains and rachis fragments was not sufficiently good to work out ratios of straight to twisted grain, so it is not known whether two-row barley was also present.

Oats (*Avena* spp.) were quite common in the samples but, because of their poor condition, could not in many cases be reliably separated from brome grasses (*Bromus* spp.). This obviously made it difficult to compare them with the other cereals in terms of abundance. No florets were found so it was not possible to tell whether the grains were from cultivated oats or from a wild variety growing as a weed of other crops.

Several rachis fragments (pieces of the stalk onto which cereal grains are attached) from wheat, rye and barley were found. When present in higher quantities and better condition, rachis fragments can help to identify more precisely the species or variety of cereal present, but this was not possible with the Westminster samples.

A few culm nodes and fragments of hay or straw were found, but only in very small numbers except in the flood deposits which contained slightly more.

Most of the charred weed seeds found in these samples are from plants which grow habitually in cultivated fields and are likely to have arrived on site with the cereal crops already described. Examples of these are stinking mayweed (*Anthemis cotula*), corn marigold (*Chrysanthemum segetum*), brome grass (*Bromus spp.*) and wild radish (*Raphanus raphanistrum*). Many species are very catholic in their habitat requirements, and are common on all sorts of disturbed and waste ground as well as in arable fields. Clover (*Trifolium spp.*), vetches (*Vicia/Lathyrus spp.*) and ribwort (*Plantago lanceolata*) are characteristic of grassland, and several species *eg* bog bean (*Menyanthes trifoliata*) and spike rush (*Eleocharis palustris/uniglumis*) grow in damp habitats. All these are commonly found in association with cereals, growing in appropriate habitats in and around corn fields.

The only charred food plants found, apart from the cereals, were fragments of hazel nut shell (*Corylus avellana*), which are common on most Saxon sites, and single examples of cherry (*Prunus avium/cerasus*) and celtic bean (*Vicia faba*).

Waterlogged seeds

Waterlogged preservation was best in the ditch fills, as might be expected, although it was very variable. Despite the flots having been dried, a number of fragile seeds were recovered from the samples, so it is hoped that losses were not too great. In some samples only robust, woody seeds survived, suggesting that drying of these deposits had taken place at some stage prior to excavation, leading to the decomposition of most of the organic remains.

The species occuring most frequently and in the highest numbers, particularly from the ditch fills, were those which grow in marshy places or on muddy banks by rivers and ditches, such as celery-leaved crowfoot (*Ranunculus sceleratus*), marsh yellow-cress (*Rorippa islandica*), wild celery (*Apium graveolens*) and spike-rush (*Eleocharis palustris*).

Also common were plants of disturbed ground, including waste places, fields and gardens. Stinging nettle (*Urtica dioca*), elder (*Sambucus nigra*), red or glaucous goosefoot (*Chenopodium rubrum/glaucum*) and hemlock (*Conium maculatum*) are frequently found on rubbish tips and other nitrogen-rich waste places, while chickweed (*Stellaria media*), fat hen (*Chenopodium album*) and white horehound (*Marrubium vulgare*) also grow in waste places as well as on cultivated ground.

The only waterlogged remains of food plants found were a few fig seeds (*Ficus carica*) from two of the ditch fills, and wild strawberry (*Fragaria vesca*) from a flood deposit. There was no sign of the brambles after which Thorney Island was traditionally named (Weinreb & Hibbert 1983).

Discussion

Rye was the most common cereal found in all feature types at Westminster Abbey, but in all cases it was mixed with other cereals. Charred plant remains from sites in the mid Saxon settlement of *Lundenwic* tend to be dominated by barley and wheat, with rye and oats as minor components, probably weeds of the two major cereal crops (Davis forthcoming). Late Saxon/early medieval samples from the City contained slightly higher proportions of oats and

rye however, and were the major cereals in one assemblage which was interpreted as animal fodder (Jones *et al* 1991). Rye was common at sites in East Anglia (Murphy 1983) and at late Saxon Stafford (Moffet 1994). The features sampled here do not necessarily give a balanced picture of cereal use on the site as a whole, as these deposits probably represent the disposal of only a small part of the domestic waste produced.

Study of the chaff and weeds associated with charred cereals can often provide information on the stage of crop processing reached before the assemblage was burnt, and occasionally on methods of cultivation and harvesting (Hillman 1981). This is difficult where products of several crops may be mixed, as in domestic waste, as it is impossible to know which chaff and weeds came from which crop.

It is possible to say, however, that much of the charred grain found at Westminster was fully cleaned and ready for consumption, as there are few residual weeds and chaff in most samples. The best examples of fully cleaned crops come from the upper layers of the ditch fill.

In contrast, in samples from lower down the ditch [238]2 ([414], [417], [418] and [421]) and one of the flood deposits ([344]1), over 60% of identified items are weeds suggesting that at least some of the fine sieving neccessary to get rid of small weed seeds may have taken place on site. The assemblages found in these samples may thus include semi-clean grain complete with its impurities, or fully cleaned grain mixed after disposal with cleaning waste. Context [418]2 for example contained the usual mix of rye, oats wheat and barley but with about twice as many weed seeds as cereal grains. Many of these were weeds commonly associated with cereal crops, notably stinking mayweed and corn marigold, as well as a relatively high number of oats and brome grasses.

Flood deposit [344]1 also contained many weeds, as well as rachis fragments of wheat, rye and barley, suggesting that at least one of the components was a semi-cleaned crop product. The other flood deposit, [349]1, had fewer weeds, but both these samples contained slightly more grassland weeds than others, and some fragments of cereal or grass stems, and may thus have included burnt hay. Sample [349]1 shows a greater domination of rye than usual, and also contains only rye rachises, so may be less mixed than most.

The prominence of rye, and also oats and brome grass, in so many samples at Westminster Abbey, combined with the possibility of hay in some samples, and the lack of remains of other human plant foods, may suggest that these deposits contained remains of animal fodder or stable sweepings rather than domestic waste.

Rye is usually considered to be a low-status food for humans, and rye bread was eaten by the poorer people in the Middle Ages. Most of the samples were contemporary with the construction of the abbey, and an alternative interpretation is that the cereal waste may have derived from the building workers living on site at this time.

The low incidence of food plants, apart from cereals, agrees with evidence from earlier mid Saxon sites in London (Davis forthcoming). However, as waterlogged preservation was good, in some ditch fills at least, it must be assumed that the plant element of domestic waste was disposed of elsewhere.

The ditch fills contained waterlogged seeds from plants of disturbed habitats, including those which often grow near buildings and on rubbish tips, mixed with those from damp, muddy places in or by ditches and streams. This suggests that the ditch contained water all or most of the time, although deposits were not waterlain, and the other seeds fell or blew in from the surrounding area.

CONCLUSIONS

The refurbishment of the Undercroft Museum provided a rare opportunity to examine in part the development of one of England's foremost monasteries. Importantly the excavation has shown that from *c.*1050 to *c.*1060 a complex outbreak of activity took place, so providing a tight chronological framework for the pottery, metalwork and environmental material recovered.

The waterlain silts uncovered show that until the middle of the 11th century the occupation on the south side of Thorney Island was not intensive. The excavation demonstrated, however, that the site was near enough to the abbey for dumping refuse and for personal items such as tweezers and a silver coin to be lost. A scatter of prehistoric, Roman and Middle Saxon material suggests some limited presence in the area but the finds and environmental material recovered confirm the stratigraphic evidence that the

southern part of Thorney Island was desolate marshland until the mid 11th century.

The construction of *c.*1050 of a rammed gravel surface, perhaps a road, across an area of boggy ground reflects a change in the importance of this part of Thorney Island. Furthermore, the digging of a substantial ditch indicates that a boundary, almost certainly that of the abbey, was being defined in a very noticeable way.

The ditch initially silted up through erosion and waste disposal. The rubbish dumped into the moist fill of the ditch is of particular interest in the development of the Late Saxon/early Norman ceramics and the dump of window glass similarly has revealed examples of 11th-century technology. The environmental material has indicated that the ditch acted as a general rubbish dump for the abbey, hence the promiscuous blend of exotic food debris, sturgeon and dolphin, with the more mundane peasants' rye bread.

The subsequent backfilling of the ditch enlarged the area of Thorney Island which could be used for building. The implication is that the higher, dry sand and gravel heart of Thorney Island was too small for the anticipated new abbey of Edward the Confessor. Clearly, the effort of digging the ditch would have been considerable so it is difficult to understand why the ditch should have been excavated, then, soon afterwards, deliberately backfilled. Perhaps the final plan for the abbey was much more extensive than anticipated when the large ditch was dug. The commencement of this second phase of building in or after 1066, and the accession of William the Conqueror may indicate that at the time there was a revision of the Confessor's scheme which resulted in a larger cloister and hence long claustral ranges.

The timber structure built over the backfilled ditch and abandoned road was probably a building, perhaps a temporary workshop, an interpretation reinforced by the evidence that it was dismantled rather than abandoned.

The preparation of a rough but serviceable area of hard-standing is probably related to the progressing construction of the abbey's east range during the 1060s, the marked increase in building debris demonstrating that stonecutting and preparation were happening nearby. A ditch was probably cut to help drain the area, perhaps regularising subsidence along the line of the large precinct ditch, and then the site was levelled in the late 1060s in preparation for the construction of the undercroft and dorter.

The undercroft itself could be only superficially investigated, structural constraints preventing examination of the foundations. The 11th-century floor levels were removed by a reduction in the floor level in the late 12th century, probably to allow greater ventilation in the smoky warming room. The floor was reduced again in the 16th century as part of a reorganisation of the undercroft, screens and a fireplace completing the transformation of the building into a number of smaller rooms. The abrupt end of moanastic life saw the southern part of the building turned over to storage until the Undercroft Museum was established in the early 20th century.

The excavation, although limited in scale and resources, has provided a useful insight into the occupation of Thorney Island. The closely dated ceramic, building and environmental material is providing further data on the development and changes in late Saxon London, and further light has been shed on the late Saxon growth of the abbey and the development of an element of its claustral range during the medieval period.

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