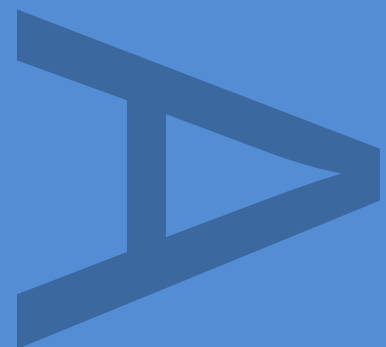


**MARY ROSE NEW MUSEUM
PORTSMOUTH HISTORIC
DOCKYARD
PORTSMOUTH
HAMPSHIRE**

**ASSESSMENT OF AN
ARCHAEOLOGICAL WATCHING
BRIEF**

**PMRP 08
APRIL 2011**



PRE-CONSTRUCT ARCHAEOLOGY

DOCUMENT VERIFICATION

MARY ROSE NEW MUSEUM
PORTSMOUTH HISTORIC DOCKYARD
PORTSMOUTH
HAMPSHIRE

ARCHAEOLOGICAL WATCHING BRIEF

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**Archaeological Watching Brief at the Mary Rose New Museum,
Portsmouth Historic Dockyard, Portsmouth, Hampshire**

Site Code: PMRP 08 (Phase III)

Accession Number: 2008/323

Central National Grid Reference: SU 62850 00650

Written by Stuart Watson

Pre-Construct Archaeology Limited, April 2011

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April 2011

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CONTENTS

1	Abstract	3
2	Introduction	5
3	Planning Background	9
4	Geology and Topography	11
5	Archaeological and Historical Background	12
6	Archaeological Methodology	16
7	The Archaeological Sequence	22
8	Original and Revised Research Questions	57
9	Importance of the Results, Further Work and Publication Outline	64
10	Contents of the Archive	67
11	Bibliography	68
12	Acknowledgements	69

Appendices

Appendix 1	Context Index	70
Appendix 2	Building Material Assessment by Dr Kevin Hayward	74
Appendix 3	Metal and Small Finds Assessment by Dr Märit Gaimster	83
Appendix 4	Clay Tobacco Pipe by Chris Jarrett	85
Appendix 5	OASIS Form	87
Appendix 6	Dock Furniture Removed for Storage	92

Illustrations

Figure 1	Site Location	7
Figure 2	Location of Excavated Areas and Bollards	8
Figure 3	Excavated Areas Showing Images of Selected Features	36
Figure 4	Plan of Structure [37]	37
Figure 5	Plan of OP101	38
Figure 6	Plan of OP102 and Trench 1 East	39
Figure 7	Plan of OP103	40
Figure 8	Plan of OP104	41
Figure 9	Plan of Trench 4	42
Figure 10	Sections 50-54	43

Figure 11	Sections 55-62	44
Figure 12	Bollards	45

Plates

Plate 1	OP101. Capstan base [40]	46
Plate 2	OP101. Dock-wall [47] and puddling clay lining [48]	46
Plate 3	OP101. Natural deposit [46] cut by the dry dock	47
Plate 4	OP102. Chute/buttress structure [68]	47
Plate 5	OP102. Culvert [36]	48
Plate 6	OP102. Culvert [36] in relation to [33] and [68]	48
Plate 7	OP102. Chute [68] with timber post [78]	49
Plate 8	OP103. Capstan base [80]	50
Plate 9	OP104. Vertical stone support slabs [79] edging chute/buttress	50
Plate 10	OP104. Chute/buttress [74] with timber post [82]	51
Plate 11	OP104. Timber deck [83] to right of chute/buttress [74]	52
Plate 12	OP104. Detail of timber deck [83]	52
Plate 13	OP104. Detail of timber joist from deck [83], after removal	53
Plate 14	OP104. Cutting of staircase [86]	53
Plate 15	Area B. Structure [37]	54
Plate 16	Area B. Detail of stone foundation [34]	54
Plate 17	Area B. Detail of culvert [35], part of structure [37]	55
Plate 18	Trench 1 east. Structure [39] with cobbled floor surface [42]	55
Plate 19	Detail of cobbled floor [42] abutting foundation of building 1/92	56

1 ABSTRACT

- 1.1 This report details the results of an Archaeological Watching Brief undertaken by Pre-Construct Archaeology Limited on the initial phase of enabling ground works prior to the construction of a new museum to house the preserved remains of Henry VIII's flagship, The Mary Rose within Dry Dock No. 3 at Portsmouth Historic Dockyard, Hampshire. The Dry Dock itself is a Scheduled Ancient Monument, and a Grade I Listed Building.
- 1.2 The investigation was focused on the dry dock and the immediate surrounding area, with a principal aim to further our understanding of the construction methods employed in the building of the dock, completed in 1803.
- 1.3 The archaeological investigation revealed previously unknown elements of the construction of Dry Dock No. 3. These included; parts of the buttress system supporting the dock, the outer edge of the dock wall, the construction cut for the dock, and backfilling material. During the investigation various large stone-built dock-side structures, both contemporary with, and post-dating the Dry Dock itself, were revealed, along with a stone-built drainage culvert that may pre-date the dock.
- 1.4 A further watching brief was conducted at a later date on the excavation of a linear trench for the installation of new drainage to serve the temporary toilet facilities in the Victory arena. This exposed remains of early 20th century brick walls probably associated with either the now demolished Trafalgar building, or an earlier 20th building that was on the same site.

2 INTRODUCTION

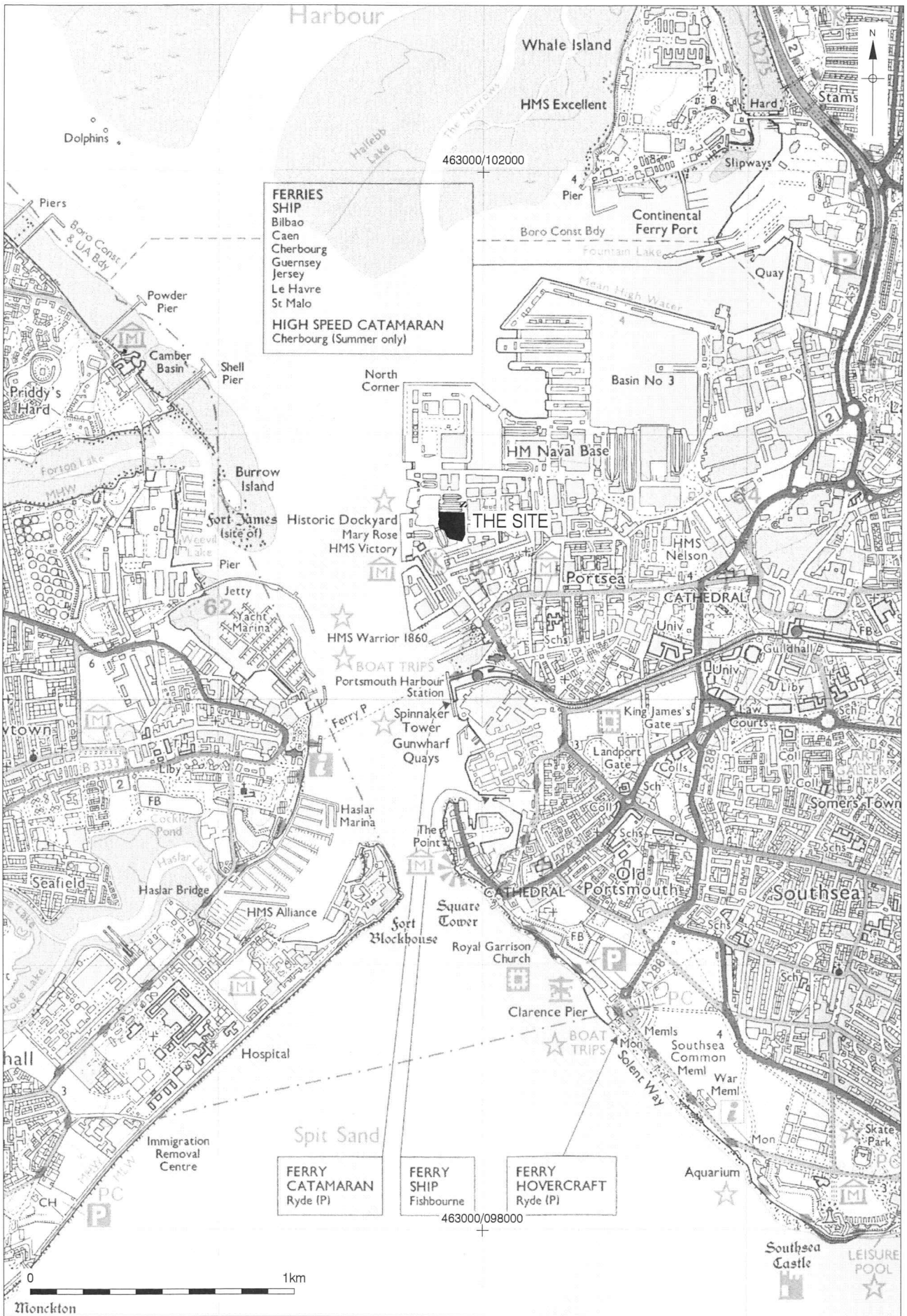
- 2.1 The Mary Rose Trust (hereafter known as the Client) have received Heritage Lottery funding to design and construct a new world-class museum and visitor centre to house the preserved remains of The Mary Rose, Henry VIII's ill-fated flag-ship which sank in 1545. The vessel was salvaged in 1982 and has since undergone an extensive programme of preservation while housed in a temporary structure (known alternatively as the Wemyss Building or the Mary Rose Ship Hall) within Dry Dock No. 3, itself an historically important structure reflected by its designation as a Scheduled Ancient Monument. The new museum will be built over the existing Wemyss Building, which will remain in use until the new building is completed.
- 2.2 This document is a report on the archaeological monitoring of a number of intrusive works undertaken as part of the enabling works for the new museum. These works include the proposed foundation piles, which will have a severe localised impact upon the fabric of Dry Dock No. 3 and their immediate surroundings. An archaeological watching brief was required to monitor the enabling works, and this formed part of the archaeological mitigation strategy for the project. Scheduled Monument Consent was granted by the Department of Culture Media and Sport (DCMS), under section 2 of the Ancient Monuments and Archaeological Areas Act 1979, for the construction of the new Mary Rose museum over and within the Scheduled monument of Dry Dock no 3 on 13 March 2009. This consent was granted subject to a number of conditions set out by English Heritage which must be adhered to. These conditions relate to the implementation of a number of mitigation measures for essential archaeological supervision and detailed recording before and during the proposed works. The conditions are contained within the Consent letter and the Heritage Impact Assessment produced by Gifford (see report number 14879/GE/R10).
- 2.3 The archaeological watching brief was conducted by Pre-Construct Archaeology Ltd, between the 4th January and 9th April 2010 and was commissioned by Gifford on behalf of The Mary Rose Trust.
- 2.4 A later watching brief was conducted on 21st and 22nd July 2010 during the installation of new drainage and was commissioned by Gifford on behalf of The Mary Rose Trust.
- 2.5 The site is situated within the western central section of the Historic Dockyard in Portsmouth and is bounded by Main Road to the east, by Basin No. 1 to the west, the public access area for HMS Victory to the south and Dock No. 4 to the north (Fig. 1). The area of the investigation was concentrated on the area around the perimeter of, and adjacent to, Dry Dock No. 3 within the Portsmouth Historic Dockyard.

- 2.6 The archaeological works were carried out in accordance with the Written Scheme of Investigation¹ prepared for the site and follows English Heritage² and IFA guidance papers³. The archaeological works were inspected and monitored by Helen Moore of Gifford and Dr Richard Massey of English Heritage.
- 2.7 The National Grid Reference of the site is SU 62850 00650.
- 2.8 The site was given the code PMRP 08
- 2.9 The watching brief was undertaken by Stuart Watson and the project was managed by Tim Bradley of Pre-Construct Archaeology Limited.

¹ Bradley, T & Moore, H. December 2009

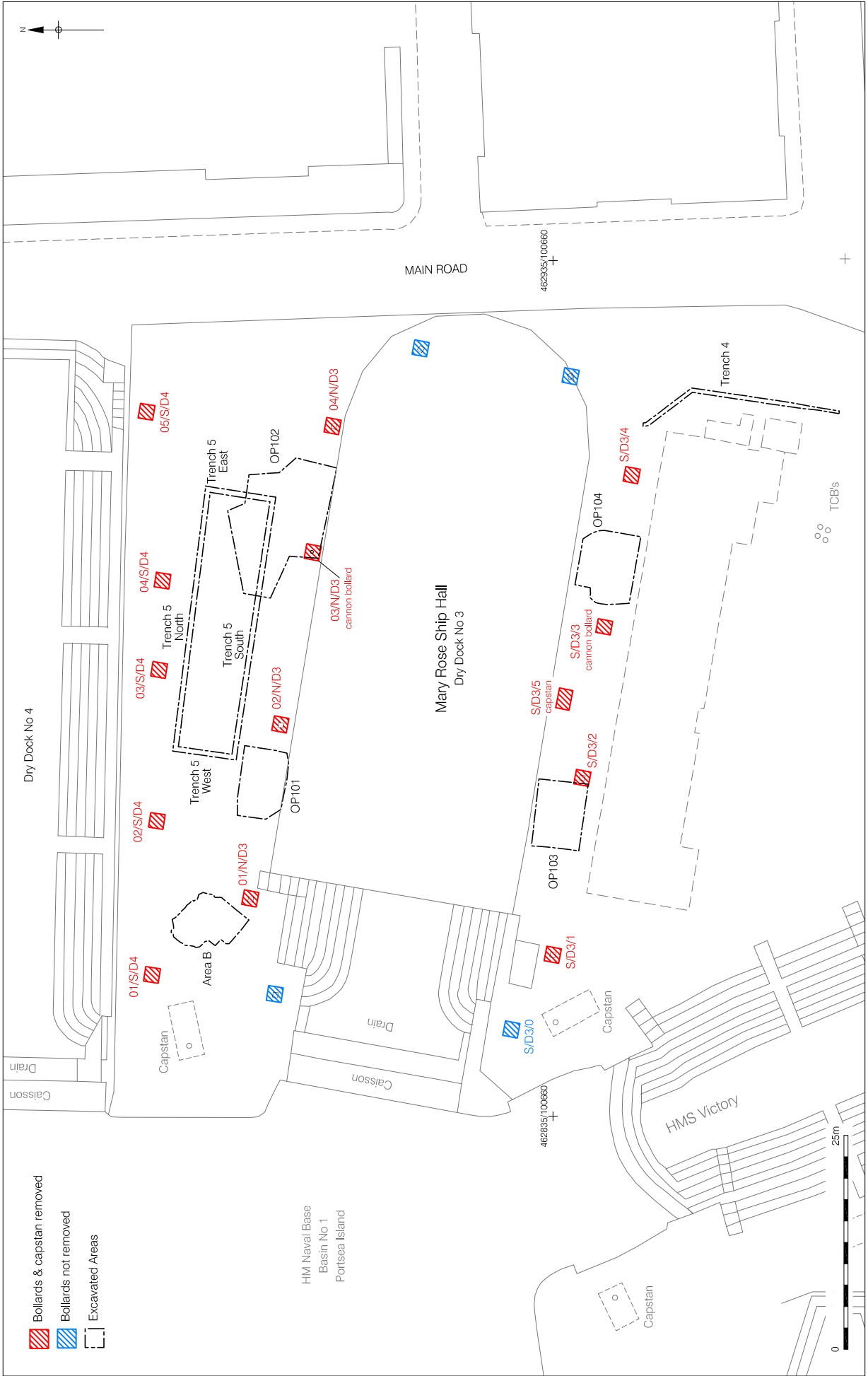
² English Heritage Guideline Papers (revised June 1998)

³ Institute of Field Archaeologists 1993. *Standards in Archaeological Practice*.



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Figure 1
 Site Location
 1:20,000 at A4



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Figure 2
 Plan Showing the Location of Excavated Areas and Bollards
 1:500 at A4

3 PLANNING BACKGROUND

3.1 The development site falls under the jurisdiction of national, regional and local planning guidance. Dry Docks Nos. 1-6 and Basin No. 1, lie within the area designated as Portsmouth Historic Dockyard, a unique archaeological resource that has a nationally important status. The Dry Dock complex has been designated as a Scheduled Ancient Monument (SAM) under the Ancient Monuments and Archaeological Areas Act 1979. This act requires that permission must be obtained from the Department of Culture Media and Sport (DCMS) to undertake any works within the site of the SAM and English Heritage, as the guardians of the national heritage, must be consulted on, and approve all proposed works.

3.2 At the time of the initiation of this project Archaeology and Planning (PPG16, 1990) was the national policy which provided guidance to managing archaeology within the planning process, supported by regional and local plans which provides more detailed guidance specific to a particular area. Planning and the Historic Environment (PPG15, 1994) supported PPG16 and provided legislative guidance on the identification and protection of historic buildings, conservation areas and other elements of the historic environment. However, during the onset of this project the above national policies have now been superseded in March 2010 by PPS5, Planning for the Historic Environment.

3.3 The Historic Dockyard at Portsmouth is part of Conservation Area 22 designated by Portsmouth City Council, and planning permission is required for certain types of development within the conservation area. Conservation Area Consent is required for the demolition of any buildings within the area, and with new national planning guidance implemented this year, a Heritage Statement is required to support this type of application. Portsmouth City Local Plan 2005 and the Hampshire County Council Structure Plan Saved Policies 2007 provide guidance specific to the local area, while retaining many of the points under the policy PPG16.

3.4 Designations Applied To This Site

3.4.1 The dock structure forms part of the Scheduled Ancient Monument (SAM) comprising of Basin No. 1, Dry Dock Nos. 1-6 and the associated masonry sea walls. The monument is scheduled as a single item in accordance with Section 2 of the Ancient Monuments and Archaeological Areas Act 1979 (AMAAA) (As Amended) County Monument No. 397 for the County of Hampshire.

3.4.2 The docks are also a Grade I Listed Building (number 476637).

3.4.3 The application site is located within Conservation Area 22, designated by Portsmouth City Council.

3.4.4 The site enabling works required a number of elements of archaeological mitigation as detailed in the Heritage Impact Assessment⁴, Enabling Works: Dry Dock Stone Removal⁵ and Scheduled Monument Consent. These works are as follows:

- Archaeological monitoring and recording during the excavation and removal of the various elements of the Dry Dock furniture (21 bollards and capstans)
- Archaeological monitoring and recording during the grubbing out of the foundations of buildings 1/91-1/95 following their demolition
- Archaeological monitoring and recording during the excavation of two geotechnical trial pits on the north and south sides of the western side of the Dry Dock
- Archaeological monitoring during the controlled stone removal of two staircases and the slides on the north and south sides of the Dry Dock on its eastern side, and the excavation of the pile cap trenches in these locations prior to the pile probing
- Excavating an archaeological trench to incorporate the zone of impact of the north pavilion piles and the ground beams and new services, within the footprint of the demolished buildings 1/92-1/93. The trench will be excavated to c. 1m deep in order to investigate historic made ground, Dry Dock construction, and whether traces of 17th – 18th century saw-houses have survived.
- Archaeological monitoring and recording during the excavation of a service trench running south to north from temporary toilets in the Victory arena to an existing manhole chamber to the south east of Dry Dock No. 3.

3.4.5 Two previous phases of archaeological work have been undertaken at this site, Phase I in 2008⁶ and Phase II in 2009⁷. The results of these earlier works have been confirmed by, added to, and clarified by, this current study.

⁴ Moore, H. 2008

⁵ Moore, H 2009

⁶ Sayer, K. 2009

⁷ Humphrey, R. 2009

4 GEOLOGY AND TOPOGRAPHY

- 4.1 The geological information is based on a review of the British Geological Survey Map (Sheet 331, Portsmouth) and logs from a limited number of exploratory holes previously carried out on the site and within the area.

Geology	Thickness (m)
Made Ground	1.50 to 7.00
Recent Deposits – Alluvium	0.00 to 1.00
Bracklesham Group – Wittering Formation	6.00 to 10.00
Bagshot Sands	5.10 to 6.50
London Clay	>18.80

- 4.2 The Bracklesham Group was found to extend from -9.50 and -11.60mOD and comprised orange-brown silty sandy clay and grey slightly clayey sandy silt and grey sand with black pebbles.
- 4.3 The Bagshot Sands were described as a very dense orange-brown, pale brown and pale grey silty fine and medium sand and were encountered from -9.50 to -11.60mOD and extended to depths ranging from -14.80 to -17.90mOD.
- 4.4 The London Clay Formation was encountered at depths ranging from -14.80 to -17.90mOD and is described as very stiff silty clay with partings of sand. Below this depth shell fragments are present and discontinuous layers of siltstone.
- 4.5 The ground surface around the dock comprises a mixture of uneven stone cobbles and larger stone slabs, concrete slabs and tarmac at the eastern end of the dock. There are a large number of metal drain and service covers, and pipes and pumps related to the conservation materials (polyethylene glycol) of the Mary Rose surrounding the dock. The current ground surface is at approximately 3.93mOD.

5 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

- 5.1 The following information is taken from the Written Scheme of Investigation⁸.
- 5.2 It is thought that the origins of Portsmouth town began at some point soon after the Domesday survey, as the Norman invasion and closer ties to the continent made Portsmouth the ideal place to establish a port and settlement.
- 5.3 The first mention of a dock in Portsmouth was in 1212. King John ordered a 'good and strong wall' to be constructed to protect the King's dock at Portsmouth together with storehouses to contain the accoutrements belonging to the king's ships and galleys. The dock at this stage was located just outside Portsmouth town in what is now known as Vernon Creek. The dock during this period apparently consisted of a small creek where a ship was hauled as far as possible at high water, and where a fence and mud bank were constructed when the tide was out to hold back the returning tide. This dock did not stand the test of time and eroded away. After twelve years it was filled in.
- 5.4 It was not until Henry VII's reign (1485 -1509) that another dock is recorded. In 1496 Henry VII's dry dock at Portsmouth became the first to be constructed in England. It was built on the site of the present Historic Dockyard where the King had purchased eight acres of land to build his dock and yard and was approximately where Dry Dock No. 2 is today.
- 5.5 When Henry VIII came to the throne in 1509 the navy was enlarged to counter the perceived threat from France and Spain, and as a consequence of this the dockyard was enlarged by nine acres, and fortified and new buildings were constructed. Henry VIII's flagship the Mary Rose was constructed in Portsmouth dockyard, begun in 1509.
- 5.6 Further expansion of the dockyard occurred during the first Dutch war of 1652-4.
- 5.7 Under Charles II in 1665 new fortifications were erected around the town and dockyard, which are described as an earthen rampart with a wooden palisade protected by a moat, and were completed by 1667.

⁸ Bradley T with Moore H 2009

5.8 The Dry Docks

- 5.8.1 As France became increasingly powerful, the dockyard at Portsmouth once again became important. In 1689 William III initiated a major building programme of major importance in military and civil engineering terms. The plan was designed by Edward Dummer, Surveyor to the Navy Board, and included the construction of a square non-tidal basin, (known as the Great Ship Basin and in the second half of the nineteenth century Basin No 1), and a dry dock which led from it later known as Dry Dock No. 5.
- 5.8.2 The Seven Years War between Britain and France (1756-63) highlighted changes needed to improve the efficiency of the dockyard and from 1761 the dockyard was re-organised and new buildings were constructed.
- 5.8.3 In 1793 England was at war with France again, and the Napoleonic wars continued until 1815. This stimulated further changes to the basin and the building of the dry docks we see today.
- 5.8.4 The group of docks arranged around Basin No. 1 can be traced back to the late 17th century with Dry Dock Nos. 4 and 5, originally known as South and North Dock respectively, being the oldest remaining in existence. Dry Dock No. 3 was constructed later in 1803 as part of the extension and improvements to Basin No. 1 undertaken in the late 18th/early 19th century. No significant details of the original construction have been located but it is likely that the dock was constructed in the same fashion as Dry Dock No. 4, which was built some 30 years earlier. The head of the dock is in its original form, however the walls and gate area have undergone alteration over the years and these are listed below:
- 5.8.5 1858: The dock was extended by the replacement of the lock gates with a boat or floating caisson. This work involved the construction of granite buttresses; the original walls appear to be constructed of limestone, possibly Portland stone, and extension of the piled timber dock floor.
- 5.8.6 1924: The upper altars of the south wall were in-filled with mass concrete to facilitate the construction of a platform to support crane rails.
- 5.8.7 1934: The dock floor was reconstructed; this involved the removal of some of the timber decking and the casting of an *in-situ* concrete floor slab.
- 5.8.8 1980s: The dock remained in operational use with the Ministry of Defence until the early 1980s when it was identified as the home for the Mary Rose.

- 5.8.9 1983: The Mary Rose and associated support barge were placed in the dock. A number of brick and concrete plinths were constructed on the dock floor and altars to facilitate this. A lightweight roof structure, including a reinforced concrete ring beam at ground level, was also constructed to protect the ship as conservation work proceeded.
- 5.8.10 1989: A permanent concrete dam replaced the boat caisson dock gate. The area between and around the docks would most likely have been a poorly graded and compacted fill comprising of whatever material was readily available at the time. During the first half of the 20th century a series of one and two storey buildings were erected in these areas, some of which have been subsequently demolished or deemed unsafe due to subsidence.
- 5.8.11 Historical photographs show that these docks have been used to dock naval vessels in the region of 3,500 imperial tons displacement although it is quite possible that the navy may well have docked heavier vessels than that in these docks.
- 5.8.12 The culvert system running beneath and around Dry Dock No. 3 is an integral part of the docks and as such forms part of the Scheduled Ancient Monument. The system was designed to drain and flood the docks during docking operations, and to remove surface water drainage/leakage from the docks when they were 'dry'. Due to the various modifications and conditions within the historic dockyard this system is now only used to remove drainage.

5.9 Dock Construction

- 5.9.1 While this current investigation uncovered new information regarding the original construction of Dry Dock No. 3 (which will be discussed in the appropriate section below) some of the details, particularly the floor of the dock, are surmised from information gleaned from the records of Dry Dock No. 4.
- 5.9.2 The dock floor, sidewalls and entrance sill would be founded on a timber grillage with close-boarded planking over the grillage to support the masonry above. The planking would have been exposed in the floor of the dock to provide a working platform. The information on Dry Dock No. 4 indicates that the timber grillage would be supported on an arrangement of timber square section piles driven into the underlying London Clay and Bracklesham Sands.
- 5.9.3 Below the grillage the ground was excavated and backfilled with stone or a basic coarse aggregate concrete. The transverse timber elements of the grillage most

probably acted as horizontal struts to resist inward sliding movement of the dock walls and in this regard they were important structural members.

- 5.9.4 The walls of the dock act as massive gravity retaining structures relying on their dead weight and propping action from the timbers, to resist sliding and overturning. The exposed faces of the walls are lined with Portland limestone and granite masonry to form the stepped altar profile. Typical details for Dry Dock No. 4 show the masonry supported by brickwork and backed with concrete for added mass and stability.
- 5.9.5 A later reinforced concrete structure, constructed in 1924, is present along the south wall of the dock supporting a dockside crane rail.
- 5.9.6 The dock floor was reconstructed in 1934; this involved the removal of some of the timber decking and the casting of an *in-situ* concrete floor slab over the whole of the dock floor.
- 5.9.7 A reinforced concrete dam was constructed in 1989 to seal the dock from the adjacent Basin No.1.
- 5.9.8 Various concrete and brickwork plinths and beams have been constructed as part of the works to support the Mary Rose and the public viewing galleries.

6 ARCHAEOLOGICAL METHODOLOGY

6.1 The following represents a summary of the methodology employed during the fieldwork. The site was recorded as a watching brief and the archaeological work was sub-divided into the following areas (Fig. 2):

6.2 Observation Pits OP101-OP104

6.2.1 Observation pit OP101 was located against the north-western side of the outer wall of Dry Dock No. 3 dock wall and was excavated to clear the area for a proposed pile cap for the construction of the new museum. Its final excavated dimensions were 8.16m east-west by 5.42m north-south by 3.40m deep giving a final excavated area of 40.85m². The ground surface here was recorded at between 3.16mOD and 3.29mOD.

6.2.2 Observation pit OP102 was located on the north-eastern corner of Dry Dock No. 3 and was principally excavated to remove a stone built chute and staircase structure to clear the location for a proposed pile position. The final excavated dimensions of OP102 (the pit required several extensions to access the lower parts of the chute) was 3.79m east-west by 3.79m north-south by maximum 4.50m deep giving an excavated area of 15.15m². The ground surface here was recorded at 4.25mOD.

6.2.3 Observation pit OP103 was located on the south-western corner of Dry Dock No. 3 and was excavated to clear the area for a proposed pile cap for the construction of the new museum. Its final excavated dimensions were 5.80m east-west by 5.00m north-south by 2.50m deep. The ground surface here was recorded at between 3.34mOD and 3.46mOD.

6.2.4 Observation pit OP104 was located on the south-eastern corner of Dry Dock No. 3 and was principally excavated to remove a stone built chute and staircase structure to clear the location for a proposed pile position. The final excavated dimensions of OP104 was 8.5m east-west by 6.6m north-south by 3.5m deep giving a final excavated area of 50.86m². The ground surface here was recorded at 4.00mOD.

6.3 Grubbing out of foundations of buildings 1/92 to 1/95 and Area B.

6.3.1 Four early 20th century buildings were demolished on the north side of Dry Dock No. 3. These included buildings 1/92 to 1/95 and the grubbing out of the foundations formed part of the watching brief.

6.3.2 During the grubbing out of the foundations of building 1/95, at the north-western end of Dry Dock No. 3, a large stone built dockside feature, [37], was uncovered; this area was subsequently allocated the designation 'Area B'.

6.4 Grubbing out of foundations of building 1/91, the Trafalgar Building.

6.4.1 One large 20th century building, the Trafalgar building, was demolished during the enabling ground works on the southern side of Dry Dock No. 3 and the monitoring of the grubbing out of the foundations formed part of the watching brief.

6.5 Archaeological trenches

6.5.1 A rectangular grid of trenches was excavated on the northern side of Dry Dock No. 3 to encompass the footprint of ground beams to support the new development. In total four trenches were excavated, the dimensions of which are given below:

- Trench 5 north (TR5 N) measured 29.42m east-west x 0.60m north-south x 0.70m deep.
- Trench 5 south (TR5 S) measured 29.70m east-west by 0.60m north-south by 0.60m deep.
- Trench 5 east (TR5 E) measured 8.10m north-south by 0.60m east-west by 0.50m deep.
- Trench 5 west (TR5 W) measured 6.24m north-south by 0.60m east-west by 0.60m deep.

6.6 Dockside furniture removal

6.6.1 Various items of dockside furniture were removed during the works, the majority of which were dockside mooring bollards, located around the north and south sides of Dry Dock No. 3 and the south side of Dry Dock No. 4. The excavation and removal of these items was archaeologically recorded and the Dry Dock furniture was carefully removed and stored to enable future re-instatement in the new landscaping.

6.7 Service trench; Trench 4

6.7.1 Trench 4 was located south of Dry Dock No. 3 in the south-eastern corner of the site, and was excavated for a new drainage pipe connecting toilets situated in the Victory arena to an existing manhole c.10m south of Dry Dock No. 3. It measured 17.50m north-south before turning north-west for a further 7.00m. Its total excavated length was 24.50m long by 0.50m wide by 0.60m deep at its southern end increasing to 0.80m deep at its northern terminus, giving a final excavated area of 12.25m². The ground surface here was recorded at between 4.78mOD at the southern end and 4.62mOD at the northern end.

6.8 Methodologies employed in each Area

6.8.1 Dry Dock Furniture Removal

6.8.1.1 The removal of 18 items of Dry Dock furniture (21 items were original scheduled for removal: see below), principally dock-side bollards, including two re-used cannon barrels, was archaeologically monitored and recorded. Each bollard was assigned a unique code and scaled drawings of examples of the bollards were made after lifting, along with a photographic record (Appendix 6). After removal the bollards were stored for future re-instatement during the landscaping works for the new museum. A small sample (<1>) was taken from the base of bollard 01/S/D4 after removal from its original location south of Dry Dock No. 4, as discarded metal fittings had accumulated over time within the hollow body of the bollard.

6.8.2 Monitoring during grubbing out of foundations

6.8.2.1 Various late 19th century to early to mid 20th century buildings which stood on the northern and southern sides of Dry Dock No. 3 were demolished to make way for the new development. These included buildings 1/92 to 1/95 on the northern side (principally ex-Navy stores, the earliest dating to 1901 or slightly earlier) and building 1/91 on the southern side known as the Trafalgar building used for Crew quarters for HMS Victory, and containing nuclear decontamination facilities, civil defence lecture rooms, and visitor toilets. After demolition the foundations were grubbed out by mechanical excavator, the process being archaeologically monitored.

6.8.2.2 During the grubbing out of the foundations of building 1/95, at the north-west corner of Dry Dock No. 3, a large stone built dockside feature was uncovered, [37]. This location was subsequently allocated the designation 'Area B'. This feature was only partly uncovered during this phase of works as the foundations of building 1/95 did not encompass the complete plan of the structure. It may, however be impacted by drainage works during the Main Works phase and it is hoped to be able to fully expose it at this time. After recording the feature was backfilled with sand and Type 1 material and left *in-situ*.

6.8.3 Observation Pits OP101-OP104 and stone removal of chutes.

6.8.3.1 Four observation pits (OP101, OP102, OP103 and OP104) were excavated at the locations of the main pile caps (both north and south of the dry dock). OP101 was located on the north-west corner of Dry Dock 3; OP102 on the north-east corner;

OP103 on the south-west corner and OP104 on the south-east corner. All four observation pits revealed substantial archaeological features which were recorded.

6.8.3.2 Observation pits OP102 and OP104 were both located where stone built chutes used as timber slides are angled into Dry Dock No. 3 from ground level (the top of the Dry Dock). The piles for the new museum building were to be constructed in these locations, and so consequently as part of the Scheduled Monument Consent a Specification was prepared by Gifford for the careful unique numbering, recording, 3D surveying and removal of each piece of stonework. The stones will be retained long-term to enable future re-instatement. The stonework was carefully removed by a specialist contractor (Arnold Brickwork Ltd) and each stone three dimensionally surveyed by Total Station, catalogued and photographed by the main contractor (Warings).

6.8.3.3 Prior to the commencement of the stone removal, it was not known how the Dry Dock slides were constructed, and as a consequence the number of stones to be removed and retained was an unknown quantity. The original plan was to store all the removed stones with a long term view of re-instatement. However, during the excavation it became apparent that the chutes were a more substantial feature than anticipated, and were observed to continue down to at least 4.5m below ground level and probably further (perhaps up to 10.0m deep, the depth of the Dry Dock itself). This presented a logistical problem in storing such large volumes of stone, as well as the difficulties of very deep excavation. After consultation between Gifford, The Mary Rose Trust and English Heritage, it was agreed to retain only those stones which presented a 'seen face' in the original structure. This substantially reduced the amount of stone to be retained. The stonework was eventually removed down to a depth of 3.5m (the depth of the pile cap) and the pile itself was to be augured through the remaining stone to formation depth.

6.8.3.4 A similar problem was posed by the staircases adjacent to the chutes, which were to be removed and recorded in the same way, further compounding the storage problem. However, after discussions with engineers from Gifford, the pile location was re-designed to lessen impact on the staircases, requiring only a 0.60m wide 'slice' down through the outer radius of the staircase to be cut using a diamond saw. This was discussed and agreed with Dr Richard Massey at English Heritage.

6.8.3.5 A steel trench box was temporarily placed in the base of OP101 and OP104 to provide safe working conditions within the deep trenches, allowing the investigation and recording of features below the staircase and the lower parts of the dock wall.

6.8.3.6 All other archaeological features uncovered in the Observation Pits were recorded using standard recording methods and subsequently removed by the contractors.

6.8.4 Proposed Archaeological Trench

6.8.4.1 The original WSI⁹ specified the excavation of a large (7.2m x 27m x 1m deep) archaeological trench within the footprint of the demolished buildings 1/92-1/93. This was to mitigate the impact of pile caps and ground beams of the north pavilion of the new museum by allowing the investigation of historic made ground, and to see whether traces of the 17th to 18th century saw-houses survived. However, after agreement with Gifford and English Heritage, this plan was scaled back in favour of small trenching located in the footprint of the proposed ground beams due to economic constraints. Four trenches were thus opened (Trench 5 north, Trench 5 south, Trench 5 east, Trench 5 west) with only one of which (Trench 5 east) revealing archaeological deposits. After recording the trenches were backfilled with crush material.

6.8.5 Service trench for new drainage; Trench 4.

6.8.5.1 An additional site visit was undertaken on 21st and 22nd July 2010 after the enabling works had been completed. This was to monitor the excavation of a service trench for the installation of new drainage. The excavation of the trench had previously been monitored as Trench 1 in 2009¹⁰, however this phase of work involved a reopening of the trench and excavation to a greater depth. The new work was undertaken by contractors from Dyno-Rod Limited using a small tracked mechanical excavator. The trench, designated as Trench 4, was 24.50m long by 0.50m wide to depths of between 0.60m at the southern end to 0.80m deep at its northern terminus. The trench was excavated adjacent to the eastern side of the now demolished building 1/91, known as the Trafalgar Building, whose basement foundation walls were still visible on the surface. The remnants of early 20th century brick walls were observed, and are thought to be associated with either the Trafalgar Building or an earlier

⁹ Bradley, T with Moore, H 2009. 1.1.3 , 4.6.4.

¹⁰ Humphrey, R. 2009

working shed that occupied the same site in the 1900s. After recording, a new cast iron waste pipe was installed and the trench backfilled.

- 6.9 All principal archaeological features were located and levelled using a combination of GPS and Total Station. Certain levels were calculated from a Temporary Bench Mark established on site which had a value of 3.93mOD.
- 6.10 A comprehensive photographic record was made of all the principal features on site using 35mm colour slide and black and white film as well as extensive use of high resolution digital format photography.
- 6.11 All archaeological deposits were recorded to recognized standards outlined in the Method Statement¹¹.
- 6.12 All finds recovered from the site were removed to Pre-Construct Archaeology Ltd offices in Brockley, London for processing. The completed archive and finds will be deposited with the appropriate repository, Portsmouth City Museum.

¹¹ Bradley, T with Moore, H 2009

7 THE ARCHAEOLOGICAL SEQUENCE

7.1 The watching brief revealed there to be a good state of preservation, at relatively shallow depths, of a number of previously unknown structural remains around the perimeter of Dry Dock No. 3. These included the foundations of 19th century dockside equipment and the foundations of 19th century additions to the dock infrastructure (Fig. 3).

7.2 The watching brief of observation pits OP101-OP104 revealed important information on the construction methods of the Dry Dock as well as identifying the foundations for the Dry Dock chutes/timber slides as likely to have been designed as buttresses for structurally supporting the dock. A natural geological deposit was also recorded.

7.3 An earlier drainage culvert that may pre-date the construction of the dock was also identified.

7.4 PHASE 1: NATURAL

7.4.1 A natural geological deposit [46] was observed in the base of OP101 (Fig. 11 Section 56, plate 3). This was a soft light yellowish brown with green/grey hue medium sand with no inclusions and is interpreted as part of the Bagshot sands. The top of this deposit was recorded at 0.19mOD, 3.40m below ground level. This deposit had been truncated by the construction cut [44] for the dry dock which is discussed below.

7.4.2 No other *in-situ* natural deposits were observed during the watching brief. All of the intrusive works on the site were cut down into the extensive made ground deposits that overlie the site to a depth of approximately 3.40m below ground level.

7.5 PHASE 2: MID TO LATE 18TH CENTURY, PRE-CONSTRUCTION OF DRY DOCK No. 3

7.5.1 Exposed in the base of OP102, adjacent to the north-west corner of chute [68] was a stone built culvert [36] (Figs. 3 & 6, plates 5 & 6). Constructed from limestone slabs (measuring 600mm by 300mm by 113mm thick) these spanned a stone- and cobble-lined channel part filled with a fine grey silt. The slabs were regularly laid and bedded with soft earthy brown mortar, spot dated to 1750-1850. The walls of the culvert were very crudely built from a mix of limestone and cobbles to a height of at least 0.30m. The culvert was aligned at an angle of c. 45° in relation to the Dry Dock and was exposed for a length of 2m in the first instance and later observed (during the extension of OP102) to continue on the same alignment for at least another 5m. The southern end of [36] had been truncated away, probably by the construction of chute

[68]. This fact, allied with the late 18th / early 19th century spot date, would indicate a structure pre-dating the construction of the Dry Dock which is interpreted as a drainage culvert. The top of this feature was recorded at 2.61mOD, 1.32m below ground level.

7.5.2 [36] was cut into layer [52] a re-deposited layer of natural yellow clay, probably deposited as a result of an episode of ground consolidation following construction of the culvert. The level on the top of this deposit was recorded at 2.44mOD.

7.6 PHASE 3: 1799-1803 THE CONSTRUCTION OF DRY DOCK No. 3

7.6.1 Observed in the base of OP101 and cutting the natural geological deposit [46] was construction cut [44] (Fig. 11 Section 56, plate 3). This was a linear feature orientated east-west, presumed, but not observed, to be a vertical cut. It is interpreted as the construction cut for Dry Dock No. 3. This feature observed in the confines of a Trench Box set in the base of OP101 measured 1.70m east-west and is presumed to continue around the full extent of the dock. The top of the cut was recorded at 0.19mOD. Filling the cut was [45] a stiff reddish brown clayey silt with frequent inclusion of Ceramic Building Material, whole pieces and fragments of brick, fragments of limestone and lenses of lime mortar. Only the top surface of this deposit was exposed and recorded at 0.19mOD. Brick samples recovered from this context (oversized red brick fabric type 3033) have a spot date of 1750-1850 (Appendix 2), which is contemporary with the construction of the dock.

7.6.2 Part of the outer face of the dock wall [47] was exposed in the north facing section of OP101 (Fig. 11 Sections 55 & 56, plate 2). This had two distinct forms to its construction. The lower part consists of regularly coursed 300mm by 200mm limestone blocks, laid as a vertical wall bonded with off white lime and sand mortar. The vertical drop began at 2.10m below ground level at 1.57mOD and was observed to continue down to at least 2.70m below ground level at 0.97mOD. The upper section of the wall was crudely built with a more rubble like appearance and formed a convex overhang that projected 0.9m to the north, and was encountered at 0.60m below ground level at 3.07mOD. This part of [47] was constructed from roughly shaped rectangular limestone blocks of varying size, the average measuring 200mm x 100mm, laid in irregular courses and bonded with the same mortar as the lower section. Part of the rubble overhang was removed to accommodate the pile cap in OP101 exposing 0.60m of its internal structure which demonstrated it was built in the same rubble form and was not masking a continuation of the vertical part of the wall, at least to that depth. Both these sections of wall constitute the outer wall of Dry Dock No. 3.

- 7.6.3 Abutting the lower vertical section of wall [47] was a band of clay [48] (Fig. 11 Section 56, plate 2). This was a very fine plastic pinkish red clay with occasional inclusions of flint and organic matter applied in a narrow band 0.20m thick at a consistent depth of 2.20m below ground level at 1.47mOD. This band of clay was observed to continue parallel with wall [47] along the full east-west extent of OP101, and was also observed at similar depths abutting the lower parts of the chutes and staircases in OP102 and OP104. This band of clay [48] is interpreted as a layer of puddle clay, acting as a waterproof membrane around Dry Dock No. 3.
- 7.6.4 The above deposits were sealed by a sequence of 19th century dump layers [49], [50] and [51] totalling 3.0m thick, as made ground deposits (Fig. 11 Section 56). These in turn were sealed by a 0.40m thick layer of modern made ground, the top of which formed the current ground level at 3.67mOD.
- 7.6.5 The principal feature in OP102 was a stone built chute, [68], part of Dry Dock no 3 (Figs. 3, 6 & 11 Section 60, plates 4 & 7). This was visible as a surface feature at ground level and consisted of rectangular granite headstones marking the top of the granite chute, which angled down into Dry Dock No. 3 by approximately 50°. The top of the structure measured 1.60m north-south by 3.00m east-west. Individual stones varied in size between 500mm by 700mm by 300mm deep and 500mm by 500mm by 300mm deep. The granite stones had a fine dressed finish and were laid very tight to each other, no mortar being used in the vertical bedding planes. Iron slats were used to close off the chute when not in use which were fitted into rebates cut into the stone. The top of this feature (which also formed the current ground level) was recorded at 4.25mOD.
- 7.6.6 Below the granite headstones, which formed the first course of the chute, the subsequent courses of the structure were built from limestone blocks. This had a larger overall dimension than the top layer, at 2.00m north-south by 3.60m east-west and continued vertically at these dimensions until the fourth layer down (at 1.40m below ground level) when the structure started to corbel in on itself to the final dimensions of 1.00m north-south by 3.10m east-west. The limestone blocks were irregular in size with an average dimension of 900mm by 600mm by 270mm deep, each layer being approximately 3.00m thick. Only the outer faces of the limestone blocks were dressed; within the core of the structure the stone was roughly shaped and in places was little more than rubble infill. As the structure was exposed further down the coursing and finish of stone became progressively rougher and more irregular. The limestone was bonded with a white hard Portland mortar. The normal dating of this material has a range of 1830-1950 (Appendix 2). This late date from a structure known to have been completed in 1803 is discussed below (8.10.2) and is

indicative of the innovations in naval engineering and use of cutting edge materials in the construction of the Dry Docks during this period.

- 7.6.7 Cut into the stone of the 9th course of the chute, at 2.72m below ground level, was a circular post hole, [76], containing a timber post [78] (Figs. 6 & 11 Section 60, plate 7). Placed slightly west of centre and towards the southern side of the chute, the post hole [76] was cut into the stone by semi-circular cuts over four corners forming a 0.23m diameter hole, with vertical sides at least 0.80m deep but continuing down to an unknown depth. The level on the top of the cut was 1.53mOD. Within the post hole was set a vertical timber post [78]. It was in good condition, although the top was decayed and it measured 0.20m in diameter. While only 0.80m of its length was exposed it was observed to continue vertically down to an unknown depth, and the level on the top of the post was recorded at 1.45mOD. In cross-section the post was an un-converted whole and the species was identified as Spruce (*Picea*) possibly native grown or as a Baltic import¹². The post and its hole were sealed by the next course (course 8) and it is presumed that this functioned as an aid to construction.
- 7.6.8 The chute [68] was removed to a depth of 3.50m below ground level (eleven courses in total) but was observed to continue vertically down to 4.50m below ground level and is presumed to continue further. The extent and depth of the stonework of this structure suggests it to act as a supporting buttress of the dock.
- 7.6.9 Exposed at the same time as the chute was a curved stone-built staircase [85] on the eastern edge of OP102 (Figs. 3 & 6). The structure, built from regular limestone blocks, enclosed stone stairs that exited parallel with the dock at the surface and turned 90° down into the dock itself. Part of the northern face of the staircase was exposed to its full depth of 3.20m below ground level at 1.05mOD, where the structure appeared to end. However, an exploratory probe of the ground below the staircase encountered a solid obstruction and it is presumed that some form of stone sub-structure existed below the staircase. The original plan was to remove all of the staircase, but concerns over the amount of stone that would be needed to be removed to clear the pile position, particularly the unknown quantity below the staircase, resulted in a change in the pile design that called for only a narrow 'slice' off the face of the staircase to be removed, minimising the impact on the structure, the majority of which was preserved *in-situ*. The same methodology was applied to staircase [86] in OP104.
- 7.6.10 A second post hole, [77], was observed cut into the western edge of the staircase [85] (Fig. 6, plate 7). This had a semi-circular profile, with an open face to the west but

with no post present. It had a diameter of 0.34m and was 0.90m in height as exposed but seen to continue down. As in the case of post hole [76], this too was sealed over at a similar height, with a level at the top of 1.55mOD.

- 7.6.11 A 0.20m thick band of reddish pink puddled clay [48], discussed in 7.6.3 above was observed at the base of the chute and the staircase.
- 7.6.12 The frequent extensions to the depth of the observation pit, as well as two episodes of temporary backfilling (allowing working access to the Mary Rose ship hall) made recording the stratigraphic layers of OP102 impossible. However, those deposits that could be observed seemed to consist of layers of 19th century made ground to at least 3.5m below ground level. No construction cut for the dry dock could be discerned in this observation pit.
- 7.6.13 In OP104 a stone-built chute which was part of Dry Dock 3 was exposed and was allocated the overall structure number [74] (Figs. 3 & 8, plate 10). This included the chute's upper surface [75], vertical support slabs [79], a post hole [84] and a timber post [82]. The chute structure [74] was visible as a rectangular surface feature as part of the dock side furniture of Dry Dock No. 3. The upper surface consisted of granite headstones [75] outlining a granite chute angled down into the dock. The top surface of the structure measured 4.00m north-south by 3.00m east-west. Individual stones varied in size between 700mm by 700mm and 700mm by 400mm. The granite stones had a fine dressed finish and were laid very tight to each other, no mortar being used in the vertical bedding planes. Iron slats were used to close off the chute when not in use which were fitted into rebates cut into the stone. The top of this feature was at ground level at 4.00mOD.
- 7.6.14 Below the granite headstones, the rest of the structure [74] was built from limestone. This was built with a larger overall dimension than the top course measuring 2.00m north-south by 3.60m east-west and continued vertically at these dimensions until the fifth course down (at 1.46m below ground level) where the structure overhung the next course down by a distance of 1.0m to the north. Abutting the southern face of the 5th course of chute [74] were seven rows of vertically set limestone slabs [79] (Fig. 8, plate 9). This masonry measured 3.00m east-west by 1.60m north-south by 0.55m deep. The slabs were roughly shaped but had a smoothly dressed surface and were of irregular sizes averaging 700mm by 230mm by 900mm. The slabs were bonded with a soft grey lime mortar. The levels along the upper surfaces were recorded at between 3.42mOD and 2.78mOD with the base of the masonry at 2.49mOD. It is

¹² Dr Glen McConnachie, Mary Rose Trust Conservation Manager. pers. comm.

presumed that the slabs acted as support to counteract the large overhang of the chute at this point.

- 7.6.15 While broadly similar in construction to the chute on the northern side of the dock, [74] showed variations in the details of its construction. Short lengths of squared timber had been used as chocks to support the slide stones at course 3 and course 5 and the stones were more irregular in shape and of less consistent thickness. As in the case of chute [68], the limestone was bonded with a white hard Portland mortar.
- 7.6.16 As in the case of chute [68] a circular post hole [84] containing a timber post [82] was cut into the stone of course 9 of the chute [74], at 2.33m below ground level. Located east of centre and towards the southern side of the chute, the post hole [84] was cut into the stone forming a 0.23m diameter hole. Its sides were vertical continuing down to an unknown depth. The level on the top of the cut was 1.67mOD, 2.38m below ground level. Still *in-situ* within the post hole was set a vertical timber post [82]. It was in good condition, with no decay evident; the top being squared off and measuring 0.23m in diameter. Only 0.80m of its length was exposed but it was observed to continue vertically down to an unknown depth. The level on the top of the post was recorded at 1.67mOD. No evidence was present of any damage to the top of the post, from pile driving for example, and it is presumed to have been placed in the ground, the stones being built up around it. In cross-section the post was an un-converted whole and the species was presumed to be a soft wood, possible Spruce (*Picea*) as in the case of [78] or Pine (*Pinus*). The post and its hole were sealed by the next course (course 8) and it is presumed that this post functioned as an aid to construction.
- 7.6.17 Chute [68] was removed to a depth of 3.50m below ground level (eleven courses extracted in total) but was observed to continue vertically down. The extent and depth of the stonework suggests that this acted as a supporting buttress of the dock.
- 7.6.18 As in the case of OP102, a curved stone built staircase [86] was exposed in OP104 adjacent to the east of the chute (Figs. 3 & 8, plate 14). The level at the top of the staircase was c. 3.80mOD and at the base c.0.63mOD. This structure was a mirror image of the staircase in OP102 in its size, form and construction but this example had been built into a timber platform [83] (discussed below). The revised pile position only required a narrow 0.60m wide 'slice' to be removed from the southern face of the staircase, the majority of the structure being left *in-situ*.
- 7.6.19 Constructed below the staircase [86] was a timber platform [83] (Figs. 8 & 11 Section 62, plates 11 & 12). This consisted of timber planks aligned north-south measuring 1700mm long as exposed by 360mm wide by 80mm thick. These were attached by

large square-headed handmade iron nails to substantial timber joists that were aligned east-west and measured 1300mm as exposed by 300mm wide by 300mm thick. The gaps in between the joists, which were spaced at approximately 0.40m intervals, were packed with irregular shaped limestone blocks approximately 600mm by 300mm by 200mm. All the timbers were in good condition. The structure was only partly exposed during the excavation but was seen to extend approximately 0.50m beyond the southern side of the staircase as well as continuing under it. The timber deck also filled the narrow gap between the chute and the staircase, abutting the chute's eastern edge. The highest level on the top surface was recorded at 0.63mOD, the lowest at 0.59mOD and it was encountered at 3.37m below ground level. While it was not obvious if the planks had been re-used, a complex series of rebates, mortises and slots present on the joists together with other fittings (including a small piece of tabby woven woollen cloth¹³ and a large iron bolt driven through the timber) strongly suggests re-use, most likely originating as a ships timber (plate 13). This structure is interpreted as a construction platform for the staircase.

7.6.20 In OP104 to the west of the chute and abutting its western side was a stone-built foundation [81] (Figs 3, 8 & 11 Section 61). This feature was only partly exposed as it was located on the western boundary of OP104. Structure [81] was crudely built from a combination of limestone blocks measuring 450mm by 300mm by 300mm and large cobbles with a diameter of 150mm and was bonded with a hard white mortar, which suggests a date of 1780-1850 (see Appendix 2). The structure measured as exposed 3.20m north-south by 1.40m east-west. It was not possible to record the section of [81] in any detail other than by photography due to the unstable nature of the trench edge, but it was observed to extend down to approximately 2.50m below ground level. The level on the top of [81] was recorded at 3.44m, 0.56m below ground level, and the base was estimated at 0.94mOD. Only the eastern edge of [81] was removed, due to the location of the pile position leaving the majority of the structure *in-situ*. This structure appears to mirror the position of a similar structure [33] on the northern side of the dock in OP102. However, stone and mortar samples suggest a late 18th - early 19th century date, earlier than structure [33]. The dating evidence and the fact that this structure abuts the chute rather than being truncated by it, places this feature in Phase 3, contemporary with the dock. It is not clear what function this structure served, as so little of it was exposed but its size would suggest a possible foundation to a capstan base.

7.7 PHASE 4: 19th CENTURY DOCKSIDE FEATURES AND EARLY 20TH CENTURY

¹³ M. Gaimster PCA finds specialist, pers. comm.

19th century dockside furniture removal

- 7.7.1 Fourteen items of dockside furniture were removed during this phase of works the majority of which were dockside mooring bollards, with one being a small capstan (Fig. 2). All were 19th century in date with one example marked 'VR' for Victoria Regina. Twelve were cast iron bollards with a square profile, specifically made for the task, and two were cannon barrels re-used as bollards. The bollards were given the overall group number [87]. The majority of the bollards were for use with Dry Dock No.3, while five (01/S/D4 to 05/S/D4) were designed to be used with the adjacent Dry Dock No. 4.
- 7.7.2 The square profile bollards were 3.06m in length and 0.54m square at the top tapering down to 0.36m square at the base (Fig. 12). The bollards were hollow and the cast walls were 30mm thick. Only the top 0.90m protruded above ground (which was painted white) and the corners had been rubbed away, probably by the sawing action of wire ropes, and replacement plates had been welded over the worn corners to extend the life of the bollard. 60mm diameter holes were drilled through all four faces and the top. The bollards were set in 2.00m square foundations of concrete or in some examples large blocks of limestone and concrete.
- 7.7.3 Two examples of re-used cannon barrels were removed, one from the north eastern side of the dock (03/N/D3) and one from the southern side (S/D3/3) (Fig. 12). Both were identical in size and shape and were cast iron naval gun barrels 2.80m long. The muzzle (blocked with a stopper ball) had a 120mm calibre. In both cases the trunnions were intact, but both had the knob on the cascabel broken off, a common practice to make guns unusable, as the shaft of the knob was a weak point on the barrel. The guns were in good condition but concretions on the metal surface prevented any markings from being seen. It is likely that both guns were captured foreign pieces perhaps French or Spanish from the late 18th early 19th century¹⁴ Both cannon bollards were set in concrete foundations 2.00m square, with only the top 0.90m protruding above the ground and painted white.
- 7.7.4 A small capstan (S/D3/5) located on the southern side of the dock was also removed. Measuring 0.50m in diameter by 0.20m high this was a flat drum capstan made from steel, probably 20th century in date, bolted to the concrete surface surrounding the dock.
- 7.7.5 Four other square profile bollards were scheduled for removal, but because of both health and safety issues (two were located on overhangs to the dock), and access

¹⁴ Mary Rose Trust staff pers.comm.

problems (two were encased within the modern concrete retaining wall of the Mary Rose ship hall) this was not achieved during the duration of the watching brief.

7.7.6 Detailed scale drawings of one example of the square profiled bollard and both examples of the cannon bollards were made on site after removal (Fig. 12), along with a photographic record.

7.7.7 All the bollards were stored after removal for later reinstatement in the new landscaping surrounding the museum.

7.8 Other Phase 4 Features

7.8.1 Areas of 19th century granite cobble setts were removed from the ground surface surrounding the dock. After lifting no archaeological deposits were encountered below the setts, which were stored and retained for later use.

7.8.2 Within OP103 a large stone built feature, [80], was observed and recorded (Figs. 3 & 7, plate 8). This was a large rectangular structure measuring 3.60m north-south by 3.50m east-west by 2.50m deep in total and constructed from irregular roughly dressed limestone blocks measuring on average 400mm by 600mm by 500mm. It was partly bonded in very hard brown Roman type mortar on the upper surface and a soft grey mortar between the courses, both with a suggested date of 1800-1950 (see Appendix 2). Set into the centre of the structure was a square recess measuring 700mm² that was backfilled with stone and CBM rubble to a depth of 0.50m. The southern side had been truncated by the construction cut for 20th century basements to the Trafalgar building which had recently been demolished. The upper surface along the southern edge of [80] had been removed to form the base of a modern service trench. The structure is interpreted as a capstan base and mirrors a similar structure on the north side of the dock in OP101 ([40]. The level on the top surface was recorded at 3.03mOD, approximately 0.40m below current ground level and was sealed by the cobbled setts that formed the ground surface. After recording this structure was removed.

7.9 Structures in Area B

7.9.1 During the grubbing out of the foundations of building 1/95, at the north-western end of Dry Dock No. 3, a large stone built dockside feature, [37], was uncovered in Area B (Figs. 3, 4 & 11 Section 53, plates 15, 16, 17).

7.9.2 Structure number [37] relates to a series of associated features in Area B consisting of a large stone built foundation structure [34], surrounded by a stone-built culvert system [35] and a later brick-built drain culvert [38]. Structure [37] was only part exposed as it was in an area not directly impacted on by the enabling phase of works

and it is assumed to be far more extensive than that exposed during this current investigation.

- 7.9.3 Foundation [34] was a large, massively built stone structure 4.50m². It was constructed predominantly from large Portland limestone blocks (measuring 1000mm² with smaller examples 1000mm by 700mm and 300mm². Occasional examples of 1000mm² granite blocks were also present). The stonework was irregularly laid, with a smoothed and dressed finish on the upper surface. The stonework on the sides of the structure, exposed to a depth of 0.75m below ground level, exhibited a roughly dressed finish. The bonding material was hard brown Roman type mortar suggesting a date of 1800-1950 (Appendix 2). Set into the middle of the structure was a rectangular recess 2.20m north-west by south-east x 1.10m north-east by south-west with a single 'staple' type iron ladder rung inserted into the inner side of the eastern wall of the recess. On each of the northern and southern edges there was a small niche and a small rebate cut into the stone. Set into the stone on each of northern and southern sides were a pair of iron ring fittings. The rectangular hole was part backfilled with modern hardcore and this element of the structure appears to be the blocked off opening of an inspection chamber. A modern intrusion of a rectangular concrete base for a mooring ring had been inserted into the mass of the structure on its western side. On the south-western corner two of the stone blocks were dislodged during machining, but were retained for reinstatement. The eastern side of the structure was excavated down to a depth of 0.77m, where the structure was observed to continue down to an unknown depth. The highest level on the top surface of [34] was recorded at 3.12mOD and the lowest at 2.77mOD and the feature was encountered at approximately 0.40m below ground level. The structure was constructed at an approximate 60° angle relative to Dry Dock No. 3.
- 7.9.4 Flanking [34] on its northern and western sides was a stone built culvert system [35]. This consisted of large flat limestone slabs 1500mm x 600mm x 300mm thick, rather crudely laid, on top of better built limestone blocks 300mm x 600mm x 300mm forming the walls to a 0.50m wide culvert below. The culvert ran north-west to south-east parallel with structure [34] before turning due west on the corner of [34] in the general direction of a large capstan assembly 6.0m to the west at the seaward end of the dock complex. Levels were recorded on the upper surface of the culvert at a high of 3.08mOD and a low of 2.66mOD. The culvert had a 0.47m deep void under the base of the slabs and the base was filled with soft grey green silt. The level at the base of the culvert was 2.34mOD. Tool marks were noted on the inner vertical face of the culvert stone. The total dimensions of the culvert [35] were 6.40m east-west x 2.00m north-south along the northern edge of [34] and 4.00m north-south x 1.40m along the western edge of [34].

- 7.9.5 Built into the north-east corner of culvert [35], effectively blocking off its eastern end, was the remains of a brick-built drain gully [38]. Constructed from red unfrosted brick in a sub-English bond pattern, the courses were bonded with a soft earthy brown mortar. This feature would originally have continued along the eastern side of [34] enclosing a large diameter ceramic waste water pipe, laid onto a 5mm thick mortar bed. The brickwork of [38] turned east on the corner of [35] and was observed continuing eastwards beyond the limit of excavation. The surviving brickwork measured 1.40m east-west x 0.60m north-south and survived to a height of 0.40m. The levels were recorded at between 2.63mOD at the highest and 2.33mOD at lowest. The brick and mortar was spot dated to 1750-1850 (Appendix 2).
- 7.9.6 After recording all the component elements of structure number [37], this feature was backfilled and preserved *in-situ*.
- 7.9.7 In the eastern half of OP101 a large stone-built structure, [40], was exposed (Figs. 3, 5 & 11 Section 55, plate 1). Measuring 3.00m north-south by 3.00m east-west by approximately 2.50m deep this large rectangular structure consisted of a top course of large (900mm by 700mm by 900mm) dressed and smoothed limestone blocks bonded with a hard brown Roman type cement built onto lower courses of smaller irregularly sized roughly hewn limestone blocks, bonded with a hard white mortar. A central circular indent, 0.64m in diameter, was formed by semi-circular cutting of the upper stones to house a short 0.50m high by 0.58m in diameter circular concrete pillar with iron banding, possibly the central spindle of a capstan. The top of [40] was recorded at 3.75mOD, 0.18m below modern ground level and the base of [40] was estimated at 1.25mOD, 2.50m below ground level. Stone and mortar samples suggest a date of 1780-1900 (Appendix 2) and this structure is interpreted as a mid 19th century capstan base. This structure was mirrored by a similar structure [80] in OP103 on the south-western side of Dry Dock No. 3. The structure was overlain by a modern concrete surface; the top of which formed the current ground level at c. 3.93mOD. After recording this feature was removed.
- 7.9.8 Within OP102 and abutting chute [68] on its north-eastern corner, was a partly truncated stone built foundation, [33] (Figs. 3, 6 & 10 Section 50, plate 4). Constructed from limestone slabs of various sizes the larger of which was 500mm by 400mm by 115mm thick, this structure measured 1.60m north-south by 1.50m east-west by 0.80m deep and was bonded with a hard white Portland mortar with a suggested date of 1830-1950 (Appendix 2). The top of the structure was recorded at 3.70mOD, approximately 0.30m below ground level, and the base at 3.08mOD. The western side appeared intact and was stepped down in a series of footings, while the eastern, northern and part of the southern side had all been truncated away. The

structure abutted the north-east corner of the chute which it appeared to post-date. The structure was built onto [54] a 0.40m thick rubble hardcore layer localised to directly below [33] acting as its sub-structure. Where the structure has been truncated, possibly by trenching to build the early 20th buildings 1/91-93, the area has been backfilled with modern made ground deposits including a layer of clinker [53]. This feature is interpreted as a possible foundation to a timber building which is known to have roofed over the Dry Dock in the mid 19th century.

7.10 The Trafalgar Building

7.10.1 The Trafalgar building was observed to have extensive deep basements (c.2.50m deep) running almost the entire length of the area. After the foundations had been removed down to ground level the concrete bases of the basements were broken up by a breaker attached to a mechanical excavator (but not removed) to facilitate piling. The voids left by the basements were backfilled to current ground level with Type 1 crush material. The depth and extent of the cellars would have had a severe impact on any potential surviving archaeological deposits and for that reason no further investigation of the footprint of the Trafalgar Building was thought necessary.

7.11 Archaeological Trenches

7.11.1 **Trench 5 North:** was excavated to a depth of 0.65m and revealed archaeologically low grade deposits of a sequence of interleaved 19th century dump layers and made ground deposits [55], [56], [57], [58], [59], [60] and [61] with a total thickness of 0.40m, overlain by 0.30m thick layer of modern made ground, the top of which formed the current ground level at 3.16mOD (Figs. 3 & 10 Section 52). No significant archaeological deposits were encountered in this trench.

7.11.2 **Trench 5 South:** was excavated to a depth of 0.60m and revealed archaeologically low grade deposits of a sequence of interleaved 19th century dump layers and made ground deposits [71], [72] and [73] which in total was 0.50m thick, overlain by a 0.10m thick layer of modern made ground, the top of which formed the current ground level at 3.19mOD (Figs. 3 & 11 Sections 58 & 59). No significant archaeological deposits were encountered in this trench.

7.11.3 **Trench 5 East:** The lowest deposit encountered was a 0.15m thick layer, [62], of dark greyish black silty clay interpreted as re-deposited natural clay used as 19th century ground make-up, the level at the top of which was 3.51mOD (Figs. 3, 6 & 10 Section 54). This in turn was overlain by [63] a 0.15m thick layer of mid-orange brown gravelly silty sand interpreted as 19th century made ground, the highest level of which was

3.53mOD. Both these layers were overlain by a floor surface given the overall structure number [39] (plate 18), consisting of cobble stones, [42], a mortar bed, [66], a mortar layer, [43], and at the northern end of the trench a wall, [41], which was encountered at 0.25m below ground level. A 0.12m thick band of rounded cobbles of dark reddish brown stone, [42], between 80mm and 180mm in diameter, (highest level 3.55mOD) which had been laid on a 0.10m thick bed of dark reddish brown silty mortar, [66], (highest level of 3.62mOD) was observed. Both these features extended the entire length of the trench to 5.00m and width of 0.60m. These in turn were overlain by [43], a 0.25m thick bed of soft light grey lime mortar, the highest level of which was recorded at 3.76mOD. At the northern end of the trench and abutted by [43] was [41]. This was the remains of a wall built from small irregular shaped and roughly finished blocks of limestone, Granite, cobble stones (identical to those in [42]) and very occasional timber. The overall effect was of a very crudely built structure that measured 0.50m north-south by 0.62m east-west and survived to a height of 0.08m recorded at 3.59mOD. While not exposed in the trench itself, this floor surface was seen to abut the brick foundation wall of building 1/92 approximately 2.00m to the south-east of Trench 5 east (plate 19). The building (demolished as part of the enabling works) dates to c. 1901 and the floor surface appears to be associated with it, and is thus ascribed to the early modern period. The remainder of the sequence in Trench 5 east consisted of interleaved layers of 19th-20th century made ground deposits [64], [65], [67] overlain by a 0.10m thick layer of modern made ground, the top of which formed the current ground level at 3.81mOD.

- 7.11.4 **Trench 5 West:** The lowest deposit encountered was a 19th century dump deposit, [70], which consisted of a 0.15m thick layer of black clinker material (Figs. 3 & 11 Section 57). The top of this deposit was recorded at 2.73mOD. This was overlain by layer [69] a 0.30m thick layer of mid grey brown silty sand with occasional fragments of CBM and is interpreted as 19th century made ground. The top of this deposit was recorded at 2.86mOD. This was overlain by a 0.30m thick layer of modern made ground the top of which formed the current ground level at 3.16mOD. No significant archaeological deposits were encountered in this trench.
- 7.11.5 **Trench 4 (Fig. 9):** The service trench excavated adjacent to the east of the now demolished Trafalgar building revealed the remains of four brick walls [88], [89], [90] and [91]. All were constructed from well made, well fired frogged red brick measuring 220mm by 100mm by 60mm. All were bonded with hard light grey cement mortar.
- 7.11.6 Wall [88] ran east-west transversely across the southern end of Trench 4 and was two courses wide, extending down for a further six courses and beyond the base limit of

excavation. The height on the top of the masonry was estimated at 4.58mOD, 0.20m below current ground level.

- 7.11.7 Walls [89] and [90] were located in the central part of Trench 4. Wall [90] ran east-west across the trench but had been severely truncated by modern services and little remained. Wall [89] was only observed on the western side of the trench and may have been the remains of a pier or buttress, but only three courses survived, the top of which was recorded at 4.32mOD, 0.30m below ground level. The wall appeared to have been built onto a localised layer of clinker type material, [92], as a bedding layer.
- 7.11.8 Wall [91] ran north-south across the north-west angled section of Trench 4 at its northern end. Consisting of two brick courses wide, but only one brick course deep, the top had been heavily truncated by modern services. The brickwork had been built onto a 0.10m thick concrete slab supported by 0.10m thick layer of concrete and ballast. The top of this wall was noted at 4.25mOD, 0.35m below ground level.
- 7.11.9 All the walls were of similar fabric and are very similar to the brickwork of the Trafalgar Building foundations and are therefore dated to the 20th century.
- 7.11.10 The rest of the trench sequence consisted of levelling layer [95] a deposit of sandy gravel (probably re-deposited natural) overlain by a silty sand with inclusions of ceramic building material and occasional finds of clay tobacco pipe fragments (dated 1680-1710, Appendix 4) a made ground deposit. At the southern end of the trench the above layers were overlain by tarmac forming the current ground level, while at the northern end the layers were sealed by granite cobble setts, which appear to have been laid in the modern era as they were set in a thick bed of modern concrete.

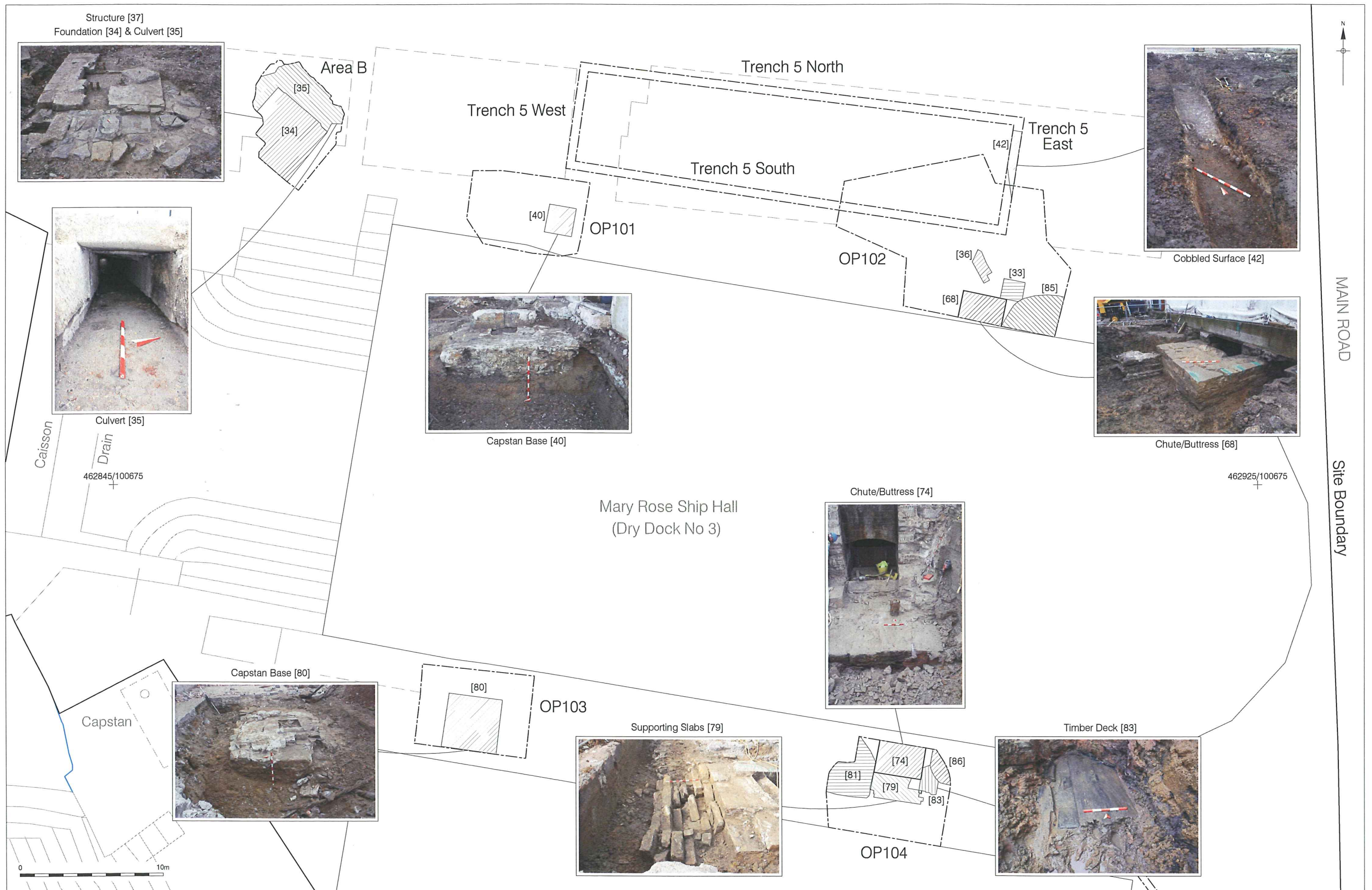


Figure 3
Excavated Areas showing images of selected Excavated Features
1:250 at A4

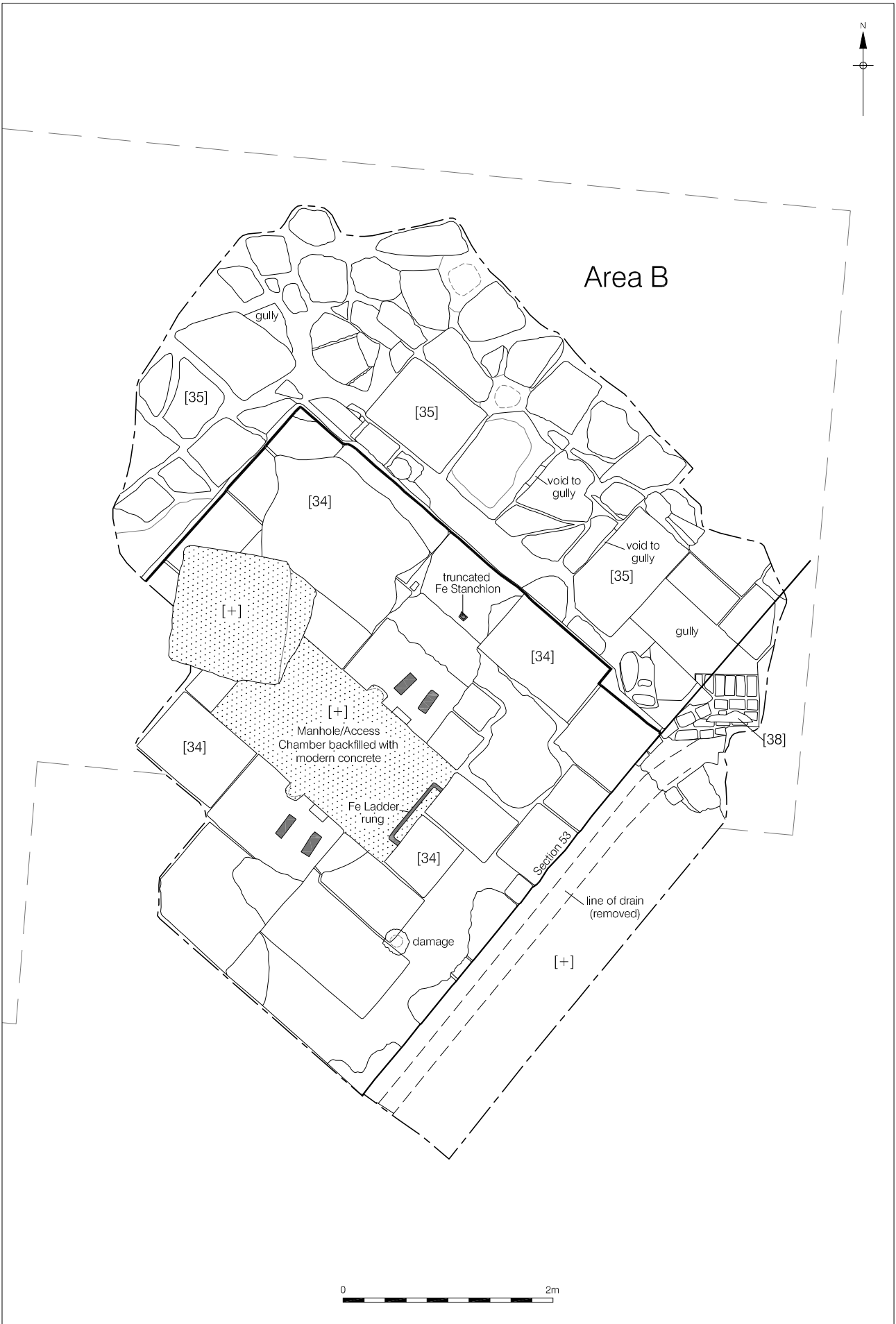


Figure 4
 Plan of Structure [37], Possible Hydraulic Power System including [34] Foundation and [35] Gully System
 1:50 at A4

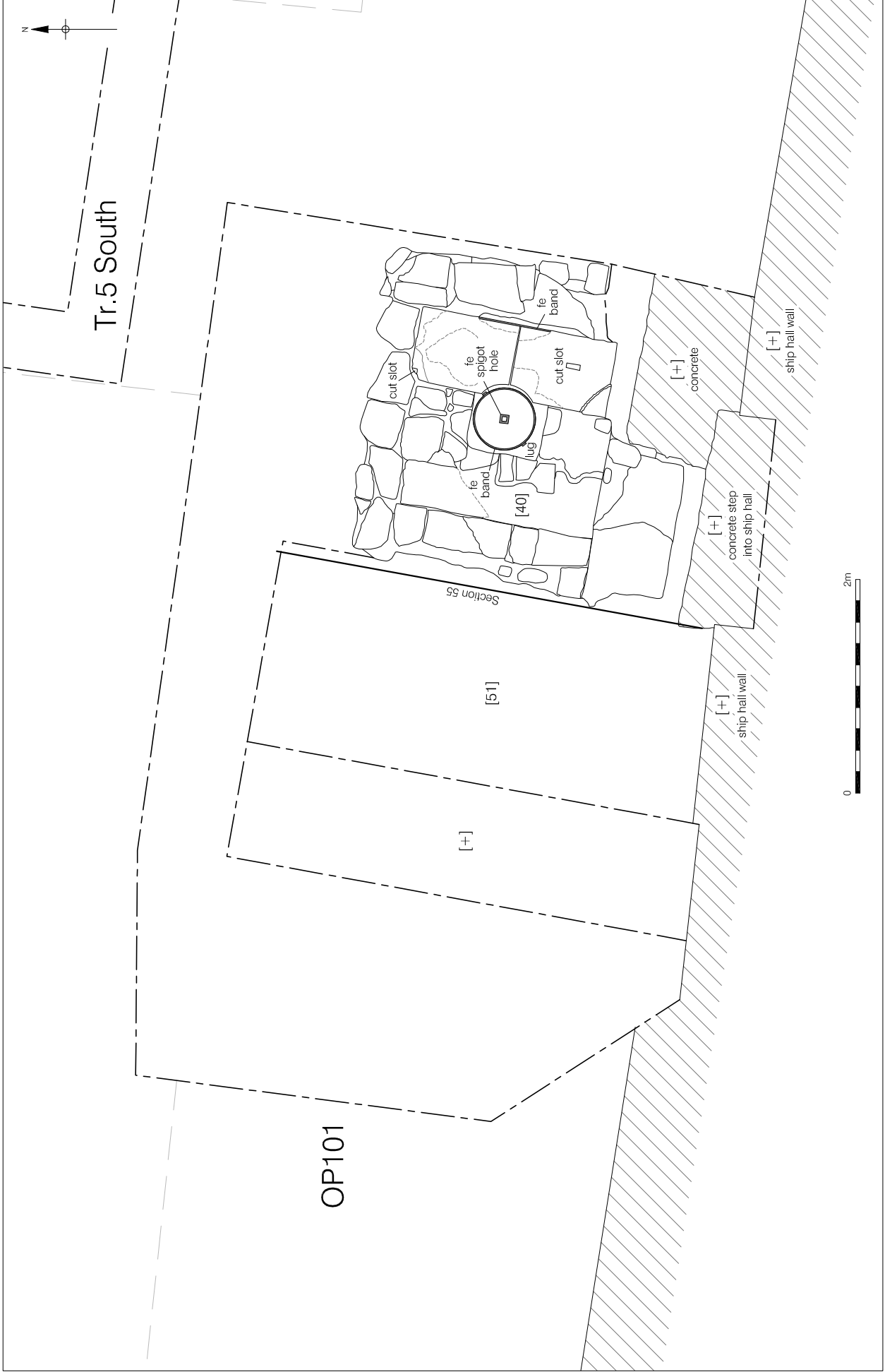
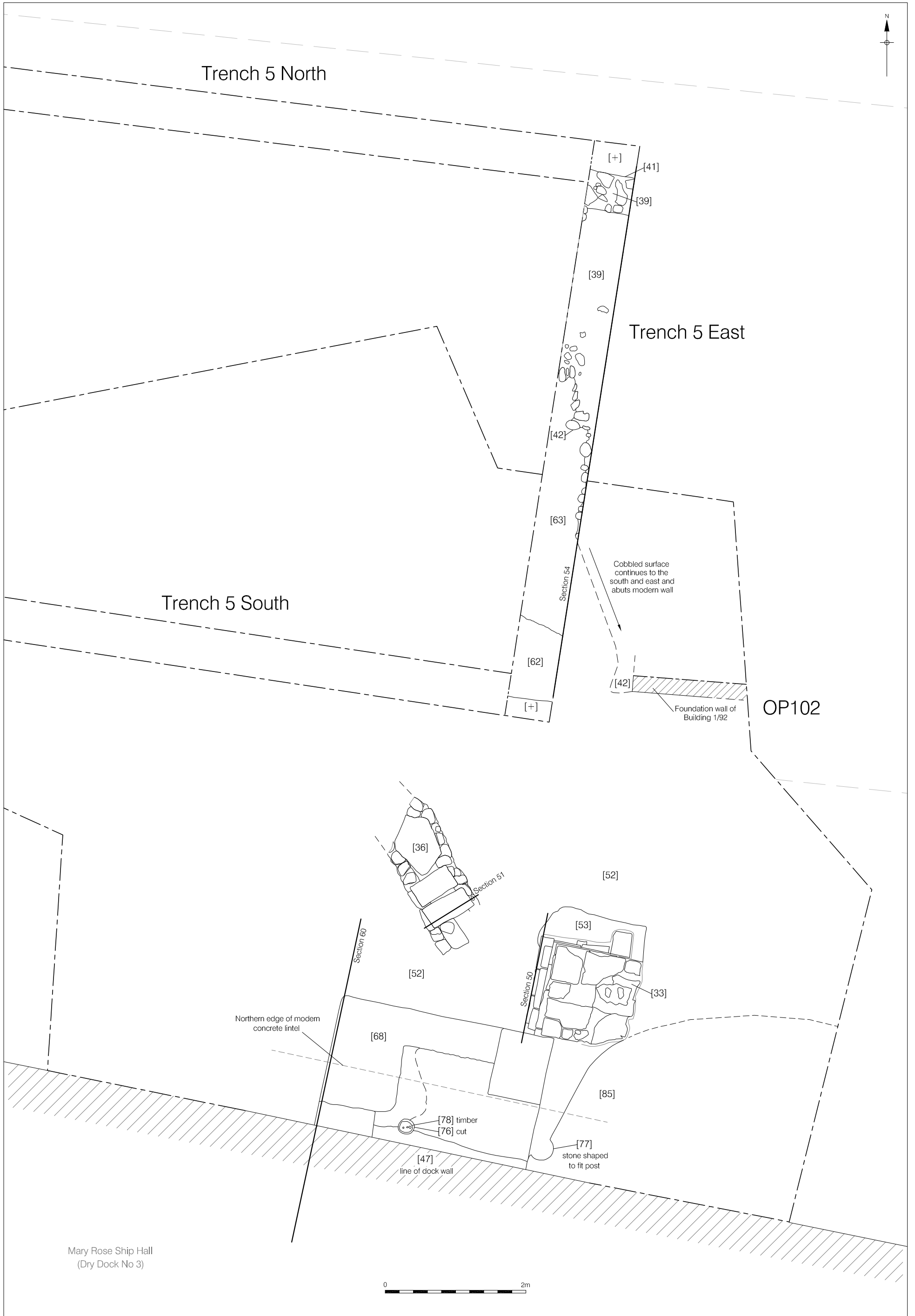
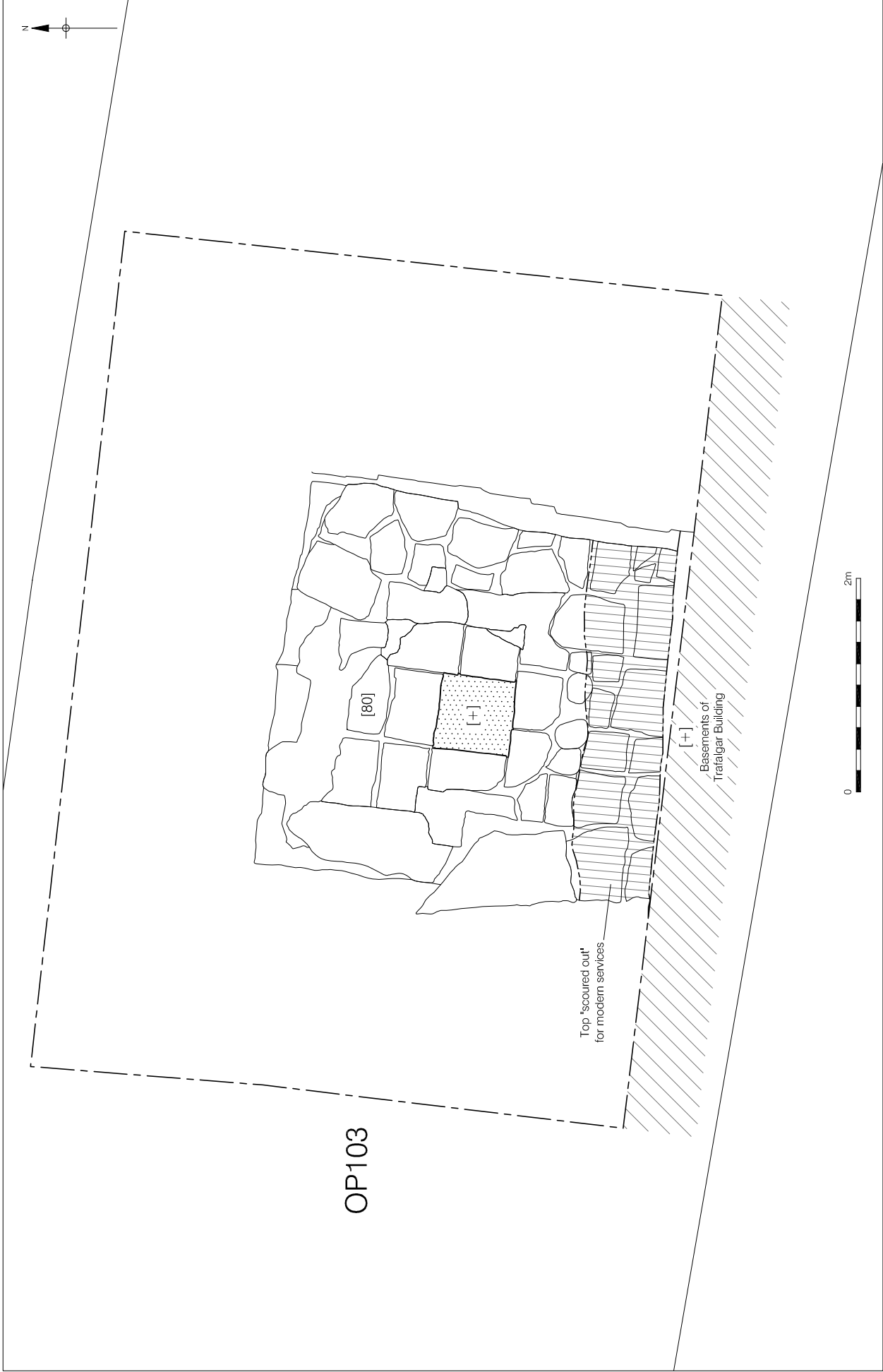


Figure 5
Plan of OP101
1:50 at A4

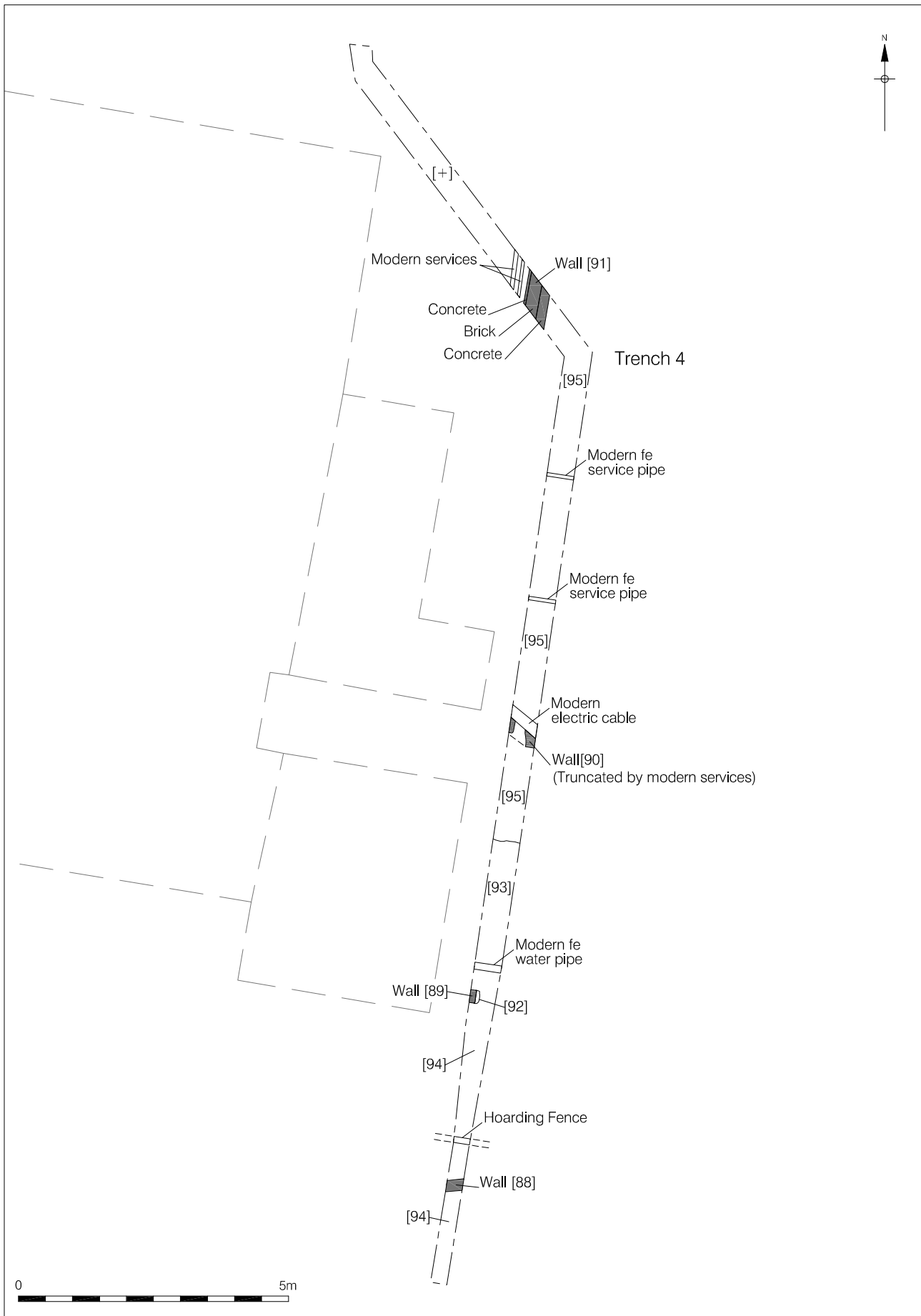




OP103

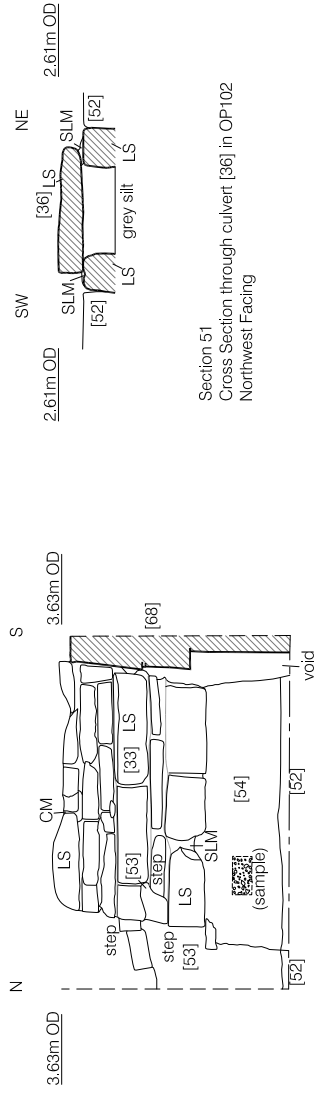
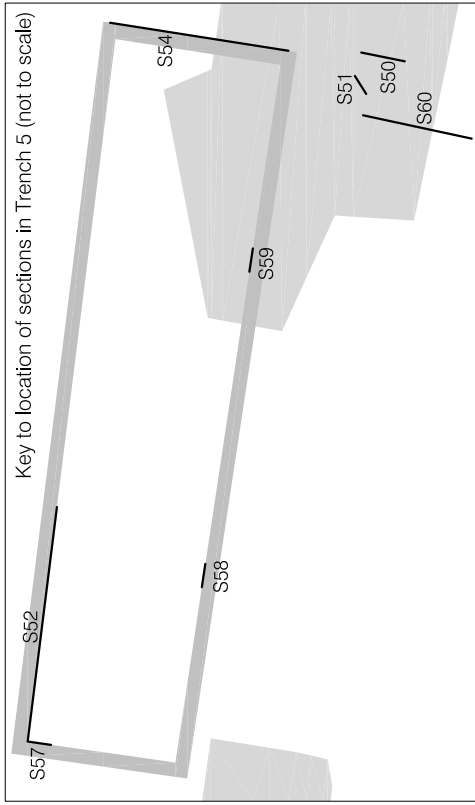
Figure 7
Plan of OP103
1:50 at A4



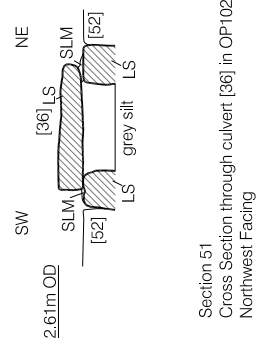


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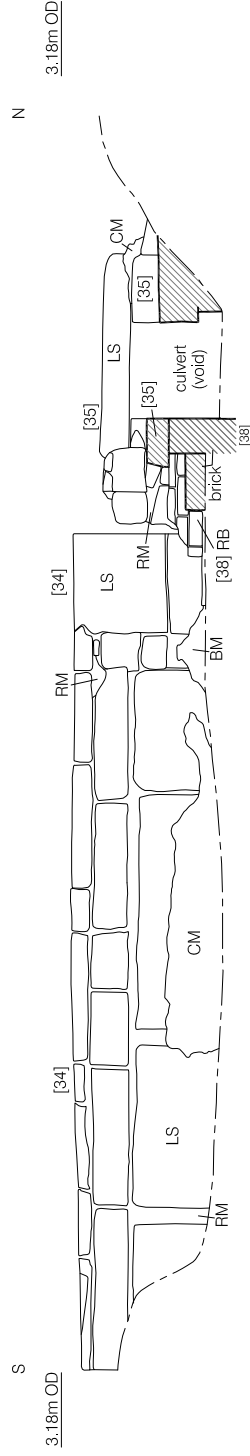
Figure 9
 Plan of Trench 4
 1:100 at A4



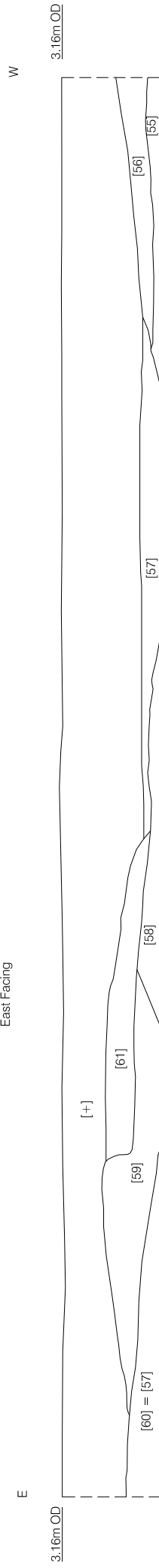
Section 50
Stone Foundation Pad [33] in OP102
West Facing



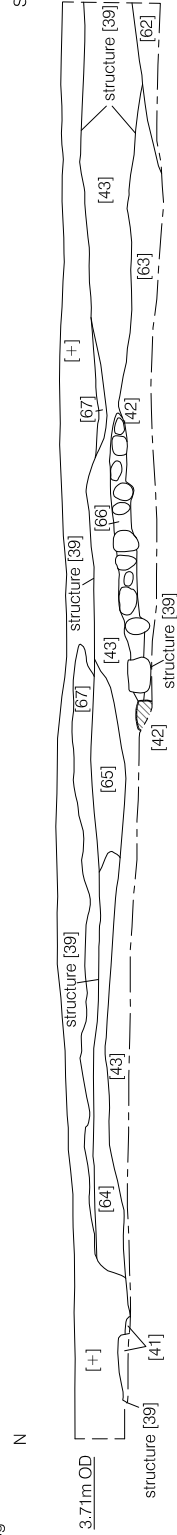
Section 51
Cross Section through culvert [36] in OP102
Northwest Facing



Section 53
Elevation of [37] in Area B
East Facing



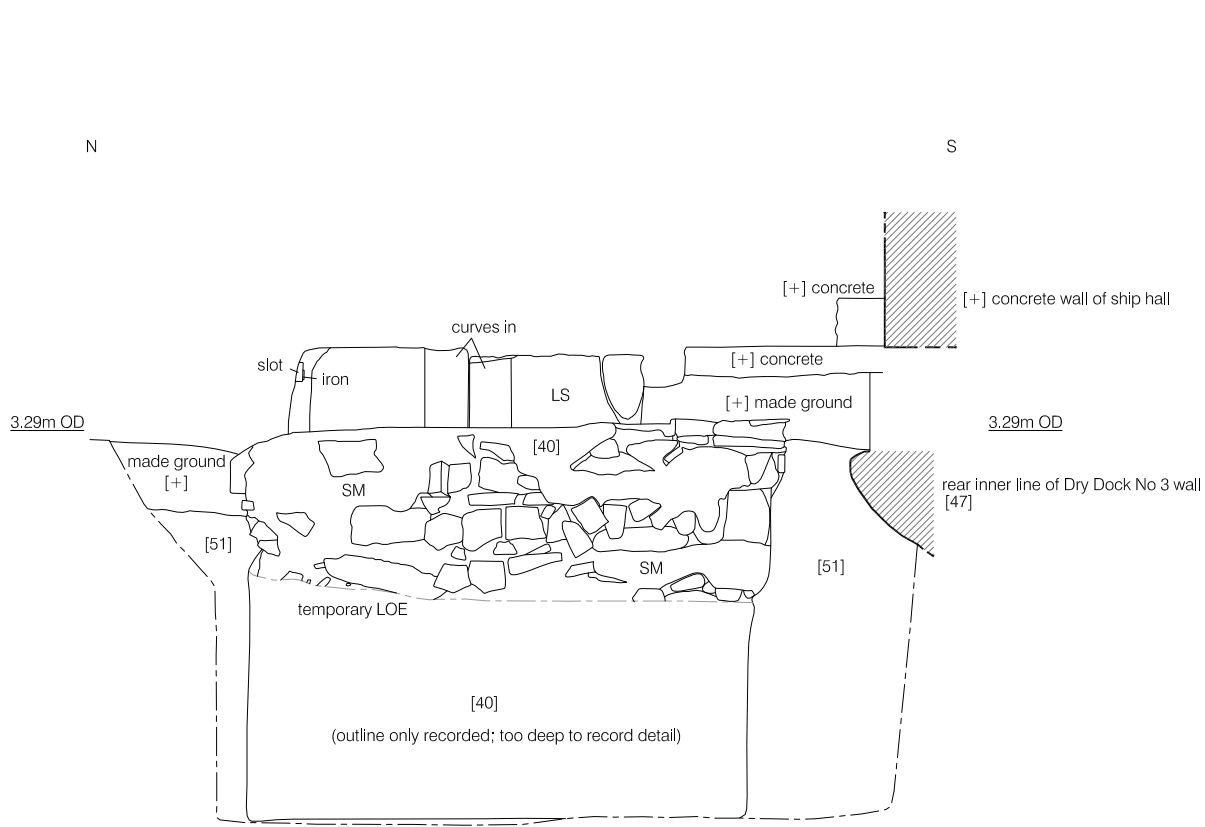
Section 52
Trench 5 North
North Facing



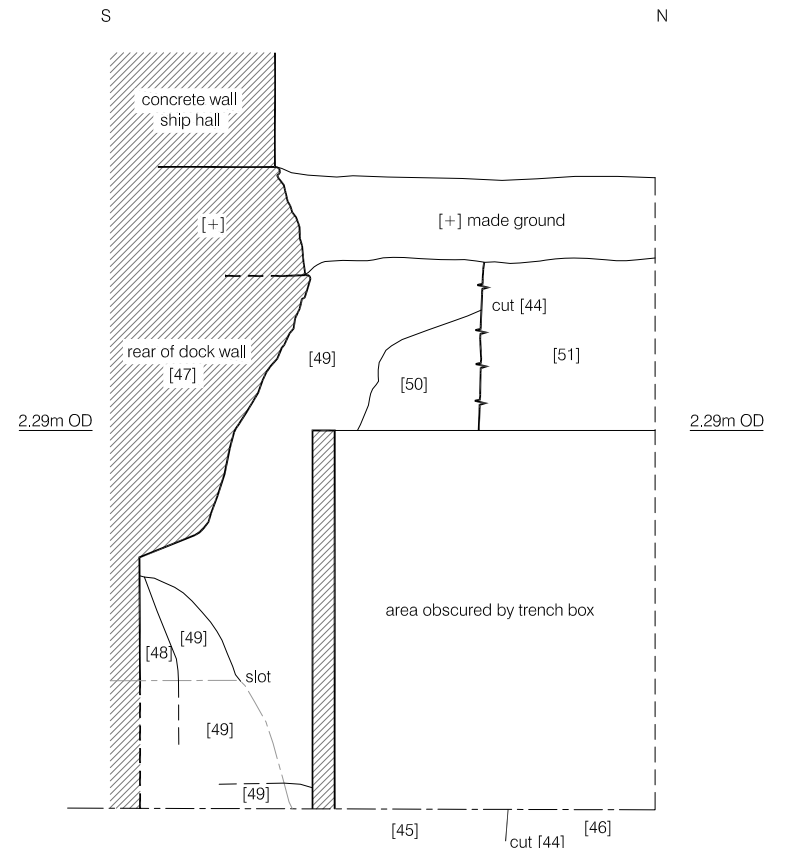
Section 54
Trench 5 East
West Facing



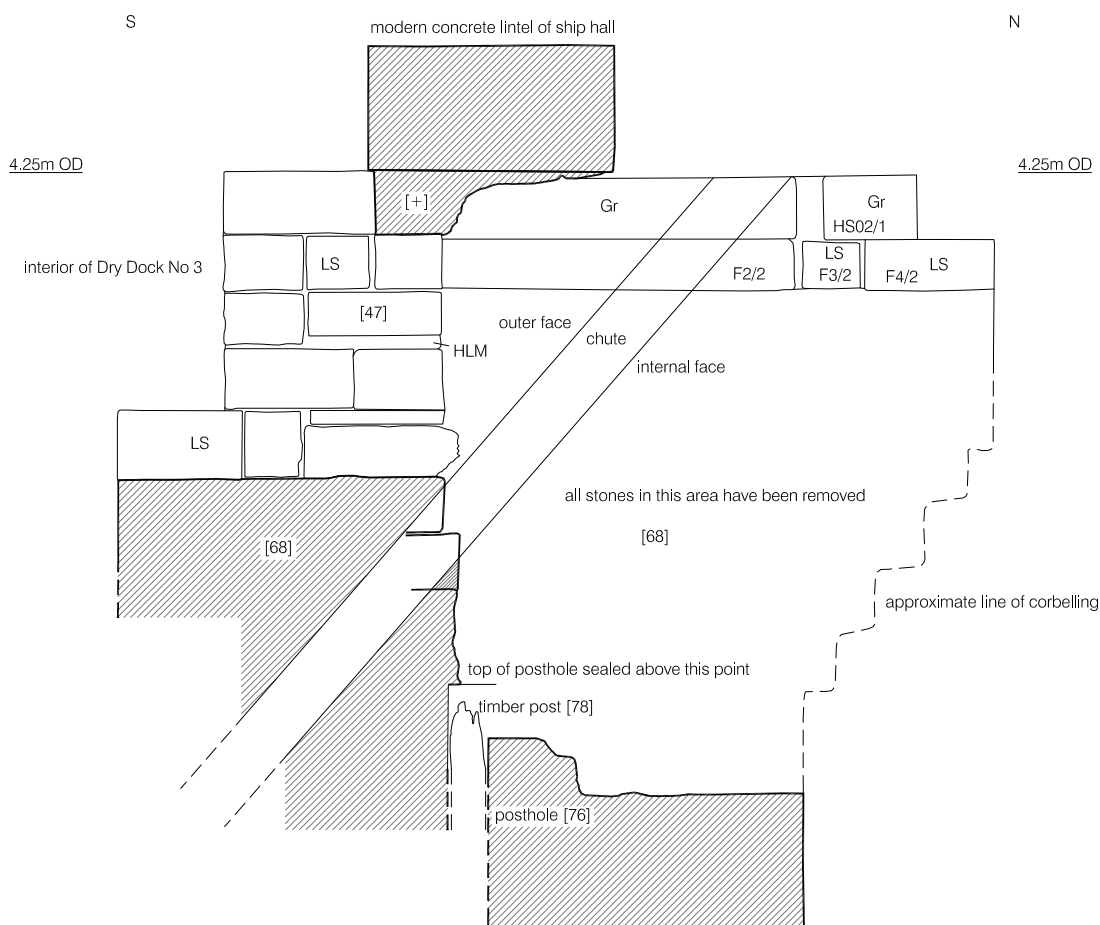
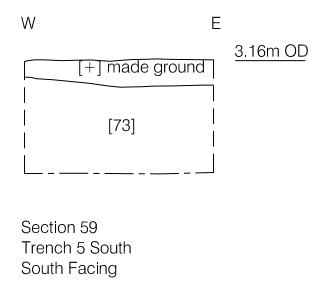
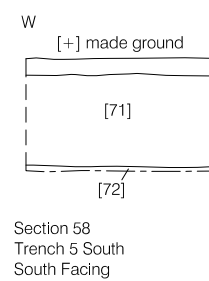
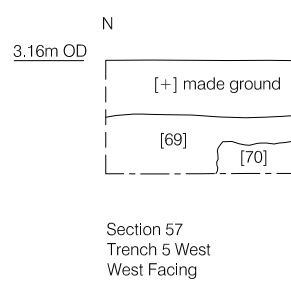
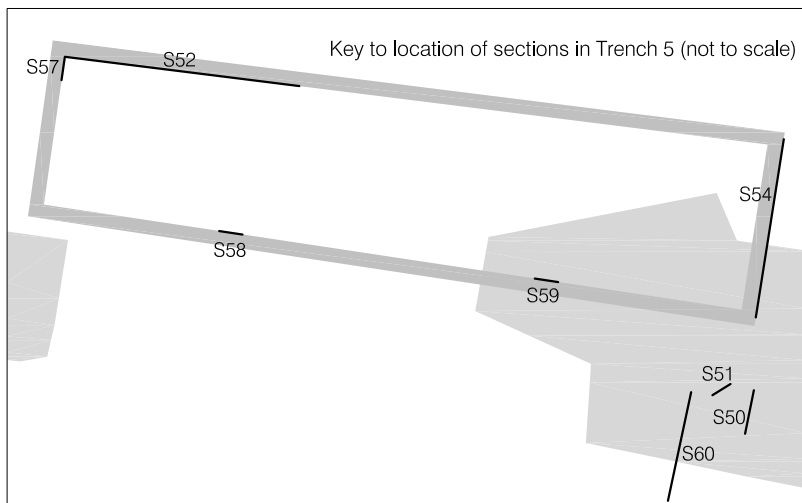
Figure 10
Sections 50 to 54
1:40 at A4



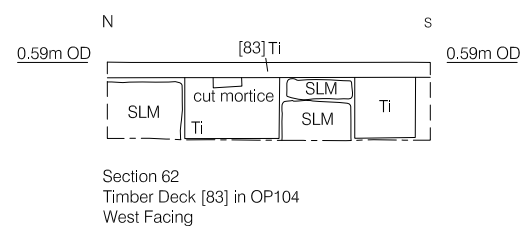
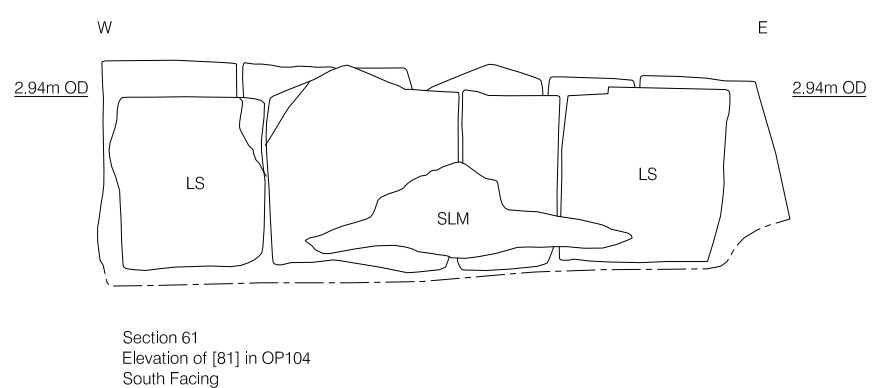
Section 55
Elevation of [40] in OP101
West Facing



Section 56
Cross Section Profile of Dry Dock No 3; Back Wall in OP101
East Facing



Section 60
Cross Section through dock wall [68] & chute [68] in OP102
East Facing

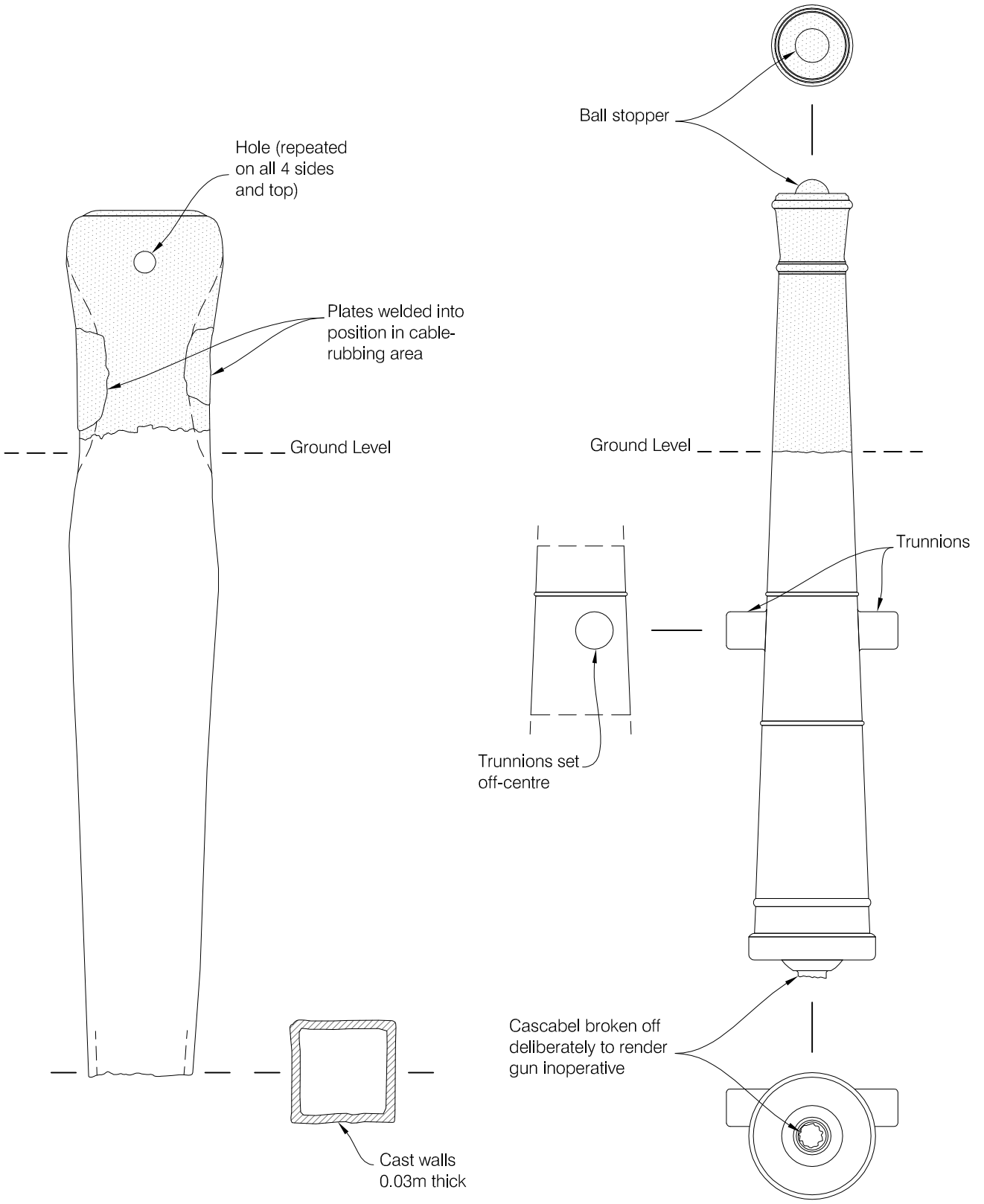


KEY:
LS = Limestone SM = Sandy Mortar
Gr = Granite HLM = Hard Lime Mortar
Ti = Timber SLM = Soft Lime Mortar

0 2m
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Bollard - 01/S/D4

Bollard - S/D3/3



Area of white paint



Figure 12
Bollards 01/S/D4 and S/D3/3
1:20 at A4



Plate 1. OP101. Capstan base [40]. Scale 1.0m, looking east.



Plate 2. OP101. Dock-wall [47] illustrating the overhang and puddled clay lining [48]
Looking south.



Plate 3. OP101. Natural deposit [46] to the left, cut by construction cut [44] for the Dry Dock. Scale 0.5m, looking south-east.



Plate 4. OP102. Chute/buttress structure [68] at an early stage of dismantling. The stone foundation [33] is to the top left. Scale 1.0m, looking south-east.



Plate 5. OP102. Culvert [36]. Scale 1.0m, looking south.



Plate 6. OP102. Culvert [36] in relation to [33] and [68]. Scale 1.0m, looking east.



Plate 7. OP102. Chute [68] with timber post [78] in foreground at a later stage of dismantling. Staircase [85] with post hole [77] is in background. Scale 1.00m, looking east.



Plate 8. OP103. Capstan base [80]. Scale 1.0m, looking east.



Plate 9. OP104. Vertical stone support slabs [79] edging southern side of chute/buttress [74]. Scale 1.0m, looking west.



Plate 10. OP104. Chute/buttress [74] with timber post [82] at a later stage of dismantling. Scale 0.5m, looking north.



Plate 11. OP104. Timber deck [83] to right of chute/butress [74]. Scale 0.5m, looking north.



Plate 12. OP104. Detail of timber deck [83]. Scale 0.5m, looking north.



Plate 13. OP104. Detail of timber joist from deck [83], after removal. The piece of cloth mentioned in paragraph 7.6.19 is to the top right. Scale is 10.0cm.



Plate 14. OP104. Cutting of staircase [86]. Looking south.



Plate 15. Area B. Structure number [37], presumed to be a 19th century hydraulic power system. The stone foundation [34] is in the background, the associated culvert system [35] is in foreground. Looking south-west.



Plate 16. Area B. Detail of stone foundation [34]. Scale 0.5m, looking north-east.



Plate 17. Area B. Detail of culvert [35], part of structure [37]. Scale 0.5m, looking west.



Plate 18. Trench 1 east. Structure [39] with cobbled floor surface [42]. Scale 1.0m, looking north.



Plate 19. Detail of cobbled floor [42] abutting foundation wall of building 1/92, south-east of Trench 5 east. Scale 0.5m, looking north.

8 ORIGINAL AND REVISED RESEARCH QUESTIONS

8.1 Original Research Objectives

8.1.1 The aims and objectives for the watching brief were set out in the Written Scheme of Investigation¹⁵ prepared for the site. The following section aims to answer the research objectives posed by that document:

8.2 To record comprehensively any archaeological remains that may be impacted by the enabling works for the new museum.

8.2.1 The site was subdivided into areas of impact from the enabling works of the proposed Mary Rose New Museum. The areas were excavated using the methodology set out in Section 6 and this recorded significant hard deposits that constituted foundation bases to various 19th century dockside features that post-date the construction of Dry Dock No. 3, as well as foundation features and a drainage culvert that may pre-date Dry Dock No. 3. Structural elements of the Dry Dock itself, along with its construction cut, were also recorded during the investigation. Soft deposits of 19th century made ground exposed during the excavations were also recorded.

8.2.2 The removal of the stone chutes located on either side of the dock was subject to a separate methodology outlined in Section 6 and was also subject to a separate written specification¹⁶. These works were monitored by the attendant archaeologist and where required scaled plans and sections were produced to record elements within the bulk structure of the chutes that were otherwise recorded by the main contractor Warings with a view to producing a 3D view of the exposed structure.

8.3 To survey the location of any archaeological features recorded within the areas affected by the works.

8.3.1 The location and OS datum heights of all significant archaeological features were surveyed by GPS equipment operated by PCA staff or by Total Station operated by Warings staff and tied in to the OS national grid. Other heights on certain features were recorded using a Dumpy level.

8.4 To understand more fully the construction of the Dry Docks and the use of this area both prior to, during and after the construction of the Docks. This will add

¹⁵ Bradley, T with Moore, H. 2009

¹⁶ Moore, H. 2009

to the understanding of early engineering techniques in Dry Dock construction and ground conditions and inform any future works that may take place around the Dry Docks.

- 8.4.1 One of the principal aims of the investigation was to try and understand more fully the construction of the Dry Dock. Earlier investigations at the same site¹⁷ had sought as a principal aim to establish whether stone or brick buttresses supported the dock and the results had proved to be inconclusive. During this current investigation the recording and dismantling of the stone chutes enabled a clearer understanding of the construction and role of these structures. It seems likely that the chutes (two on each side) acted as the main buttresses to the dock (see discussion below).
- 8.4.2 It was also during the dismantling of the chutes that various construction techniques employed by the original builders, specifically concerning the chutes/buttresses, began to be revealed. Other areas of the dock construction were also exposed and recorded, along with information on some of the challenges faced, and problems overcome, by the docks' builders. The results of these findings are discussed below. Information was also obtained on technical innovations on what, at the time, was the forefront of dock design. The results from this investigation have greatly increased our knowledge on the construction of this important Scheduled Ancient Monument, particularly as no records for Dry Dock No. 3 have survived.
- 8.4.3 In OP104, on the southern side of the dock a stone built foundation [81] was part exposed on the western boundary of OP104. It is not clear what function this structure served, as so little of it was exposed but its size (similar in dimensions to other capstan bases exposed in other locations) would suggest a possible foundation to a capstan base. This structure appears to mirror the position of a 19th century capstan base [33] on the northern side of the dock and it is tempting therefore to ascribe it the same function. However, dating obtained from the stone and mortar samples suggest a late 18th to early 19th century date, earlier than structure [33]. The structure abuts chute [74] in OP104, rather than being truncated by it, and is likely therefore to be contemporary with the docks construction. The exact function of this feature remains unclear.
- 8.4.4 The discovery of various 19th century dockside features was to be expected at the home port of the Royal Navy, but their survival at relatively shallow depths was perhaps less expected and this fact should be taken into account during any future works that may take place in the area.

8.5 To record any remains of earlier dockyard buildings that pre-date the construction of the 19th century Dry Dock.

8.5.1 The investigation had only limited success in uncovering earlier dockyard buildings. No evidence was found for any 18th century buildings that stood on this site, in particular no evidence of the 18th century saw-houses whose foundations, it was hoped, would survive on site. 19th century made ground deposits associated with the dry dock and indeed the original excavation for dock itself have evidently truncated away almost all earlier remains of buildings that pre-date the dock.

8.5.2 One feature that did pre-date the dock was encountered. A small stone drain culvert [36] exposed in the base of OP102, has been spot dated to 1750-1850. It is unclear exactly what function this culvert served, but is presumed to be part of a drainage system. It is also unclear to what building this feature related to. The southern end had been truncated by the construction of chute [68] on the northern side of the dock and is therefore likely to pre-date it, while spot dates of stone and mortar samples place it within the date range of the 18th century saw-houses. It was also in the right location to relate to the saw-houses, as indicated on a historic map of 1774, but that is as far as the available evidence can take us and further work would be needed to clarify this situation.

8.6 To determine the extent, condition, nature, character, quality and date of any archaeological remains present, and to establish the ecofactual and environmental potential of archaeological deposits and features.

8.6.1 As demonstrated by the results of this investigation, and insofar as the scope of the watching brief would allow, the extent, condition, nature, character, quality and date of the archaeological remains uncovered was successfully established.

8.7 Revised Research Questions

8.7.1 The following additional research questions were suggested by the results of the investigation.

8.8 What is the evidence for the assertion that the chutes dismantled in OP102 and OP104 are in fact the buttresses to Dry Dock No. 3?

8.8.1 The two stone chutes removed from both the north and south sides of Dry Dock No. 3, [68] in OP102 and [74] in OP104 has provided strong evidence for the assertion

¹⁷ Sayer, K. 2009

that these are in fact buttresses to Dry Dock No. 3. The plan to remove them stone by stone to the base of the pile cap trench (c 3.50m below the current ground surface) and retain the stone for later reinstatement was an achievable goal at the start of the process. However, as the dismantling of the stonework progressed it became apparent that these structures were substantially more extensive than first assumed. When the contractors reached the formation level of 3.50m below ground level to accommodate the pile cap, the stonework was observed to be continuing vertically downwards, possibly to the depth of the dock floor, 10.0m below ground level. The exposed structures are deep and extensive, and consequently it seems likely that the 19th century engineers of the Dry Dock had designed these structures to provide a supporting foundation for the Dry Dock itself as well as to the chutes.; These structures are likely to be the main supporting buttresses to the dry dock wall. However, definitive proof would require further excavation or survey work to be undertaken.

8.9 What evidence is there to show a variation in the construction methods employed in the building of the dry dock?

- 8.9.1 The excavation of Observation Pits OP102 and OP104, while essentially revealing structures that were mirror images of themselves, also uncovered certain differences in construction methods. It seems likely that a mistake was made during the construction of chute [74] in OP104. To accommodate the chute the upper five courses needed to corbel out from the main shaft of the buttress to allow sufficient room to build in the width of the chute. While this seems to have been successfully achieved for chute [68] in OP102, this appeared not to be the case in chute [74] in OP104; the main shaft had been built too high at the narrower dimension resulting in an abrupt overhang of approximately 1.00m. Left as it was, the weight of the chute would have been too unstable in the upper courses of the chute. The apparent solution employed by the dock builders was to pack the front of the overhang with seven rows of large vertically placed limestone slabs [79] as support. It may be surmised that chute/buttress [74] was built first, as the mistakes made here were not repeated in chute/buttress [68] in OP102; lessons had been learned. There were other variations in the method of construction. Timber chocks were used in [74] to support the slide stones during construction, which were not present in [68]. This again may represent a difficulty in construction that had been solved by the time [68] was built.
- 8.9.2 The curved staircase [86] in OP104 was built onto a timber deck, a feature not present in staircase [85] in OP102. It seems likely that the ground conditions in the

area of OP104 were more unstable, possibly from ground water seepage (during these current works the ground conditions were noticeably wetter on this side of the dock). The solution appears to have been to build the staircase onto a temporary supporting deck, made from re-used ships timbers (easily available in a dockyard) which would provide support until the completed structure could bear its own weight.

- 8.9.3 The problem of ground water seepage into the Dry Dock appears to have been an issue. The solution appears to have been the application of a thick band of very plastic pinkish red clay [48] as a puddling layer or waterproofing membrane around the lower parts of the dock. The use of puddle clay from other docks is well attested: at the West India Docks in London, built at approximately the same time (1801–2), albeit as wet docks, puddle clay was used to back the walls and covered the dock floor, to prevent water escaping through the gravel¹⁸. In the case of the dry docks at Portsmouth it was used to keep water out.

8.10 Was there any evidence of technical innovation in the construction of the dock?

- 8.10.1 Dry Dock No. 3 is one of a series of late 18th /early 19th century docks at Portsmouth that incorporated technical innovations in dock design instigated by Brigadier-General Sir Samuel Bentham, the Inspector General of Naval Works from 1795 to 1812.

- 8.10.2 An example of technical innovation was observed in the mortar technology being used in both of the chutes/butresses on either side of the dock. The bulk of the construction material used was Portland limestone and this was bonded with a hard white Portland mortar. The normal dating of this type of mortar has a range of 1830-1950. However, as the dock is known to have been completed in 1803, the use of this type of mortar can be taken as evidence of an innovative early use of the material, a building technology known to have been pioneered by the military at this time¹⁹. The late 18th century is a period of innovation in cement, partly driven by the growing need for hydraulic cement, to build the Eddystone Lighthouse in 1790 for example, as well as the expansion of Britain's commercial and naval docks²⁰.

8.11 What is the nature of the large stone built structure [37] in Area B?

¹⁸ From: *The West India Docks: The docks*, Survey of London: volumes 43 and 44: Poplar, Blackwall and Isle of Dogs (1994), pp. 268-281. URL: <http://www.british-history.ac.uk/report.aspx?compid=46495> Date accessed: 20 April 2010.

¹⁹ Dr. K. Hayward, PCA stone and CBM specialist, pers. comm.

²⁰ Sutherland, J. 2001

8.11.1 At the north-western end of Dry Dock No. 3, a large stone built dockside feature was uncovered in an area subsequently allocated the designation 'Area B'. Given the overall structure number [37], this is a series of associated features consisting of a large stone-built foundation structure [34], surrounded by a stone-built culvert system [35] and a later brick-built drain culvert [38].

8.11.2 The exact function of this large structure remains unclear. Two possible interpretations suggest themselves. The first is that this is the foundation to part of the dry dock's gate opening assembly, but this is based purely on its location at the opening of the dock. The second and perhaps more plausible explanation is that it is part of a hydraulic power system serving the various cranes and capstans that would have been operating dockside, a common source of power in docks in the second half of the 19th century²¹. This theory is lent credence by the presence of the culvert system [35] that flanks the main body of the structure. The way the culverts were built; wide and from stone would suggest culverts for cables or ropes or possibly housing steam pipes (although no pipe work was observed), rather than as drainage culverts, which are more likely to be built from brick. It also appears that the culverts were heading in the direction of a large capstan assembly at the far western end of the dock, which may be connected to the system. This view is also reinforced by an inspection chamber set into the middle of [34], an obvious feature to a hydraulic system. Structure [37] had evidently become obsolete by the early 20th century as it was covered over by Building 1/95 at some time in the 1930s.

8.11.3 It is hoped that further work can take place in Area B to fully uncover this feature, which may succeed in clarifying its function.

8.12 Do the walls observed in Trench 4 relate to the Trafalgar Building or earlier 20th century buildings?

8.12.1 The brick walls observed in Trench 4 are constructed from bricks very similar in form to the bricks used in the foundations of the Trafalgar Building, the demolished remains of which are still visible in places on the surface. Wall [88], in the southern part of the trench, had previously been observed during an earlier phase of work in October 2009²² (designated as context [2]). The brickwork was described as 'very similar to those that from which the Trafalgar Building was made'.²³ Indeed all the brick from the walls in this trench were of similar fabric and are therefore dated to no earlier than the late 19th/ early 20th century. Cartographic evidence shows a building

²¹ D. Hawkins, pers. comm.

²² Humphrey, R. 2009

²³ Ibid, p.23, 7.3.3

known as a 'working shed' standing on the site from at least 1901. A smaller brick building is shown to the east of the working shed, which had been removed by 1910. The Trafalgar Building dates to c.1940 and it is unknown if the earlier working shed was incorporated into the Trafalgar Building²⁴. Walls [89], [90] and [91], are approximately on the same line as the eastern side of the Trafalgar building and therefore presumed be part of the basement construction. Wall [88] lies outside of the 1940s footprint of the building, and therefore, it is suggested that wall [88] may be the surviving remains of the 1901 or 1910 buildings.

²⁴ Moore, H and Wheeler, R. 2008. p32.

9 IMPORTANCE OF THE RESULTS, FURTHER WORK AND PUBLICATION OUTLINE

9.1 Importance of the results

- 9.1.1 This current investigation was afforded the unique opportunity to explore the construction of a Georgian naval dry dock. The results of this current phase of works has gone some way to help in the understanding of the methods employed in the building of Dry Dock No. 3, as well as offering an insight into the workings of the 19th century dockyard environment.
- 9.1.2 An earlier investigation during geotechnical works in 2008²⁵ revealed elements of the dock construction that are in some cases confirmed by this latest investigation. What the earlier investigation could not provide was any conclusive evidence for the use of buttresses in the construction of the dock. This current investigation has gone some way to resolve this issue.
- 9.1.3 No contemporary plans of the construction of Dry Dock No. 3 survive and prior to this investigation much has had to be assumed from plans of other docks, particularly Dry Dock No. 4. One of the principal aims of the investigation was to establish the existence or absence of a buttress system thought to be used to support the dock wall. It is likely that this investigation has identified some strong candidates in the two chutes dismantled on either side of the dock. The presence of such a substantial stone structure supporting the chutes is strongly suggestive of a buttress system, and their presence here may provide a pointer to other buttresses existing below the system of chutes and stairways that line the edges of the dock.
- 9.1.4 What was evident during the investigation was the engineering skill and monumental effort needed to build such a large structure over a relatively short period. The dock, begun in 1799, took four years to build and the accuracy and skill displayed by the stonemasons and the physical effort require to excavate enormous quantities of material would pose a serious challenge to modern construction methods. In dismantling the two chutes evidence was revealed of the construction methods used in one small part of the dock and this evidence offers an insight into the challenges the builders faced; the use of timber decking below one of the staircases to overcome adverse ground conditions; the use of timber as construction aids as well as the

²⁵ Sayer, K. 2009

evidence of remedial work to correct a building error, all present a picture of a challenging project.

- 9.1.5 The uncovering of various 19th century dockside structures such as capstan bases and a possible hydraulic system were not unexpected, but this investigation had the opportunity to identify and locate features that had been lost under 20th century buildings and give an insight into the life of the dock at its peak in the mid to late 19th century. The identification of one feature [33] as the possible foundation pad to a timber roof known to have been erected over the dock at sometime in the 1820s or 1830s, and their subsequent removal at the end of the 19th century²⁶ provides clues into the evolving use of the dock over time.
- 9.1.6 What was notable in the construction of the Dry Dock features was their sheer monumental size. The principal building material was Portland limestone and it was used extensively; the capstan bases for example were massively built, one could almost say over-engineered, but this is indicative of both military engineering and the Navy's access to the government Portland stone quarries and therefore a plentiful supply of affordable building material. It is known that the granite was obtained from Aberdeen. What was equally evident was the paucity of finds from the site, and this again is typical of military establishments where tidiness is part of the naval routine.

9.2 Further Work

- 9.2.1 The results of the archaeological investigation need to be placed in the context of the Naval Dockyard at Portsmouth, and an understanding of naval engineering and innovation at the turn of the 18th century. The methods of engineering design and construction used in the other dry docks in the naval base in Portsmouth and potentially elsewhere in Britain should be compared with those used in Dry Dock No. 3.
- 9.2.2 The use of hydraulic power in the dockyard during the 19th century should also be researched, in order to shed more light on the large structure [37] that has been postulated may be part of an hydraulic power system adjacent to the Dry Dock.
- 9.2.3 The building materials assemblage contains a number of items of interest that require further research and comparison and should be included at the publication stage.

²⁶ Moore , H and Wheeler , R. 2008. P.25

- As with the National Maritime Museum in Greenwich, (Hayward 2010) and Royal Clarence Victualling Yard in Gosport (Hayward 2008; 2009), Portsmouth Dockyard is another site where the innovative use of different waterproof concrete patents in large naval projects during the late 18th to early 19th century, has been identified. The development of these materials spurred on by the expansion of the dockyard due to the increase in size of warships and the need for more and larger Dry Docks with better methods of emptying them, both before and during the Napoleonic Wars for example, would suggest that further investigation and analysis. of these concrete and mud puddling clays is a valid research topic.
- The use of a standard group of stone types (granite; Purbeck limestone and Portland limestone) in these naval constructions also warrants further analysis.
- Material studies of in-house naval materials (mortar; stone; cbm) could be the subject of a stand alone paper in a scientific or Industrial Archaeological Journal or a future research topic.

9.3 Publication outline

- 9.3.1 The results of this investigation are intended to be published in a suitable journal. The extent of the publication and the intended journal will be determined following consultation with Gifford, English Heritage and the Mary Rose Trust.

10 CONTENTS OF THE ARCHIVE

10.1 PAPER AND PHOTOGRAPHIC ARCHIVE

Type	Media	Number
Records	Context sheets	59
	Plans	14
	Sections and elevations	17
	Scaled drawings	8
Photographs	Colour slides (35mm)	51
	Black and White prints (35mm)	50
	Hi-Res Digital shots	615

10.2 ARTEFACTS

Type	Number
Metal	6 bags
CTP	2 bags
Stone samples	2 bags
Mortar samples	7 bags
Stone and mortar samples	3 bags
Animal Bone	1 bag
CBM	1 bag
Fabric	1 bag

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APPENDIX 1: CONTEXT INDEX

* Note: Context nos. 1-32 relate to previous works on site

Context	Trench	Plan	Section	Type	Description	Date	Phase
*33	OP102	33	50	Masonry	Stone built foundation	19 th c	4
34	Area B	M/C Area B	53, drw 1	Masonry	Crane base/dock gate foundations	19 th c	4
35	Area B	M/C Area B	53	Masonry	Culvert system adjacent to [34]	19 th c	4
36	OP102	36	51	Masonry	Culvert adjacent to chute [68]	Pre-1803	2
37	Area B	M/C Area B	53	Structure	Inc. [34], [35], [38]	19 th c	4
38	Area B	M/C Area B	53	Masonry	Brick built drain-part of [37]	19 th c	4
39	TR 1 east	M/C TR1E	54	Structure	Floor, inc [41]to[43], [64]to[67]	19 th c	4
40	OP101	40, drw 4	55	Masonry	Poss. capstan base	19 th c	4
41	TR 1 east	M/C TR1E	54	Masonry	Stone wall-part of [39]	19 th c	4
42	TR 1 east	M/C TR1E	54	Masonry	Cobble floor-part of [39]	19 th c	4
43	TR 1 east	M/C TR1E	54	Layer	Mortar layer-part of [39]	19 th c	4
44	OP101	Trench Box OP101	56	Cut	C/cut of Dry Dock No. 3	1799-1803	3
45	OP101	Trench Box OP101	56	Fill	Back fill of [44]	1799-1803	3
46	OP101	Trench Box OP101	56	Natural	Nat sands in base of OP101	Natural	1
47	OP101	Trench Box OP101	56	Masonry	Back wall of Dry dock No. 3	1799-1803	3
48	OP101	Trench Box OP101	56	Layer	Pink clay abutting [47]	1799-1803	3
49	OP101	Trench Box OP101	56	Layer	Yellow/grey clay-re-deposited natural	1799-1803	3
50	OP101	n/a	56	Fill	Dump deposit as b/fill of [44]	1799-1803	3
51	OP101	n/a	56	Layer	Made ground	1799-1803	3

Context	Trench	Plan	Section	Type	Description	Date	Phase
52	OP102	36	51	Layer	Re-deposited yellow clay	Pre-1803	2
53	OP102	33	50	Layer	Made-ground-clinker deposits	19 th c	4
54	OP102	n/a	50	Layer	Dump layer- rubble; stone and mortar as sub-strata for [33]	19 th c	4
55	TR 1 north	n/a	52	Layer	Re-deposited nat. clay as ground make-up	19 th c	4
56	TR 1 north	n/a	52	Layer	Re-deposited blue/green clay as ground make-up	19 th c	4
57	TR 1 north	n/a	52	Layer	Dump layer-dark brown silty clay	19 th c	4
58	TR 1 north	n/a	52	Layer	Dump layer -yellow sandy silt	19 th c	4
59	TR 1 north	n/a	52	Layer	Sand dump layer	19 th c	4
60	TR 1 north	n/a	52	Layer	Same as [57]	19 th c	4
61	TR 1 north	n/a	52	Layer	Dump layer-mid brown sandy silt	19 th c	4
62	TR 1 east	M/C TR1E	54	Layer	Dump layer-very dark silty clay	19 th c	4
63	TR 1 east	M/C TR1E	54	Layer	Made ground	19 th c	4
64	TR 1 east	n/a	54	Layer	Mortar layers-part of [39]	19 th c	4
65	TR 1 east	n/a	54	Layer	Mortar layers-part of [39]	19 th c	4
66	TR 1 east	n/a	54	Layer	Dark red mortar layers-part of [39]	19 th c	4
67	TR 1 east	n/a	54	Layer	Dump layers of clinker-part of [39]	19 th c	4
68	OP102	Contractors TST	n/a	Masonry	Chute on NE of dock No. 3	1799-1803	3
69	TR1 west	n/a	57	Layer	Made ground	19 th c	4

Context	Trench	Plan	Section	Type	Description	Date	Phase
70	TR1 west	n/a	57	Layer	Clinker made ground	19 th c	4
71	TR1 south	n/a	58	Layer	Silt and clinker made ground	19 th c	4
72	TR1 south	n/a	58	Layer	Re-deposited nat. blue/grey clay as made ground	19 th c	4
73	TR1 south	n/a	59	Layer	Made ground	19 th c	4
74	OP104	75	n/a	Structure No.	Overall structure no for dockside chute; inc. [75] [79] [82] and [84]	1799-1803	3
75	OP104	75	n/a	Masonry	Granite upper layer and iron cover of [74]	1799-1803	3
76	OP102	76	60	Cut	Stone cut post hole in [68]	1799-1803	3
77	OP102	76	n/a	Cut	Stone cut post hole in staircase	1799-1803	3
78	OP102	76	60	Timber	Timber post in [76]	1799-1803	3
79	OP104	79	61	Masonry	Line of vertical slabs edging S side [74]	1799-1803	3
80	OP103	80	n/a	Masonry	Capstan base S side Dock No. 3	19 th c	4
81	OP104	81	n/a	Masonry	Stone foundations on SW corner of chute [74]	Pre-1803	2
82	OP104	83	n/a	Timber	Timber post within [84]	1799-1803	3
83	OP104	83	62, drw 7	Timber	Timber deck base of staircase E of chute [74]	1799-1803	3
84	OP104	83	n/a	Cut	Stone cut post hole for [82]	1799-1803	3
85	OP102	76	n/a	Masonry	Stone staircase abutting chute [68]	1799-1803	3
86	OP104	83	n/a	Masonry	Stone staircase abutting chute [74]	1799-1803	3
87	Site wide	n/a	n/n	Group No.	Bollards	19 th c	4
88	TR4	TR4	63	Masonry	Brick wall	20 th c	4

Context	Trench	Plan	Section	Type	Description	Date	Phase
89	TR4	TR4	64	Masonry	Brick wall	20 th c	4
90	TR4	TR4	n/a	Masonry	Truncated brick wall	20 th c	4
91	TR4	TR4	66	Masonry	Brick wall built onto concrete slab	20 th c	4
92	TR4	TR4	64	Layer	Clinker bedding layer for wall [89]	20 th c	4
93	TR4	TR4	64	Layer	Clayey silt levelling layer	19 th c	4
94	TR4	TR4	65, 66	Layer	Made ground	19 th c	4
95	TR4	TR4	65, 66	Layer	Gravelly sand, re-deposited nat. as levelling	19 th c	4

APPENDIX 2: BUILDING MATERIAL ASSESSMENT

By Dr Kevin Hayward

Introduction and Aims

Four shoe boxes of ceramic building material, stone and mortar were retained from the excavations at the site of the Mary Rose New Museum, Portsmouth Historic Dockyard SU 62850 00650.

This small sized assemblage (55 examples 9.6kg) was assessed in order to:

- Identify (under binocular microscope) the fabric of the mortar types used in the construction of the 1799-1803- Dry Dock No. 3.
- Identify (under binocular microscope) the fabric of the clay puddle sample used to waterproof line the base and sides of the 1799-1803 Dry Dock No. 3.
- Identify (under binocular microscope) whether there are any parallels in the innovative use of early waterproof cement/concrete with 1799-1803- Dry Dock No. 3.
- Identify (under binocular microscope) the fabric and (where possible the geological source) of the worked stone types used in the foundation, sides and stairwell of the Dry Dock. Are similar material types used at other naval sites e.g. Plymouth Dockyard and the Royal Clarence Victualling Yard at Gosport? And if so what may this tell us about material supply and the navy?
- Identify (under binocular microscope) the fabric and form of the brick used in the foundation and sides of the Dry Dock.
- Identify whether the fabric and the form of the worked stone, brick and mortar changes in the later 19th century modifications.
- Made recommendations for further study.

Methodology

The building material (mortar; brick; stone) was examined using the London system of classification with a fabric number allocated to each object. The application of a 1kg mason's hammer and sharp chisel to each example ensured that a small fresh fabric surface was exposed. The stone fabric was examined at x20 magnification using a long arm stereomicroscope or hand lens (Gowland x10) and compared with samples retained at the PCA building material reference collection to determine the geological source. This was not as straightforward with the ceramic building material fabrics as the reference collection is based on London clay/brickearth types rather than those from Hampshire. Similarly, mortar

samples were classified in to 5 categories (Types A-E) only two of which Type 'B' and Type 'E' were comparable with London mortars.

Ceramic Building Material

Brick Fabric 3033

The small (2 examples 3.3kg) ceramic building assemblage contained just post-medieval unfroged bricks of one fabric 3033. The preference for using stone in combination with waterproof cements over brick seems to be a feature of dockside structures, possibly because of the resilience of hard stone materials to salty water and the susceptibility of fired clay to marine action.

Bricks were only used in a later culvert [38] and the consolidation deposit beneath the dry dock [45]. Both are well made hand manufactured very compact red bricks. The example from the Culvert [38] is especially large (228mm x 120mm x 64mm), comparable somewhat to the red bricks manufactured in London 3033 between 1450 and 1700. The manufacture of red bricks outside London, however, continued unabated throughout the 18th and 19th centuries. This means they are not useful in dating these two features. The same problem was encountered from the brickwork used in the various structures of the nearby 18th/19th century Victualling Yard at Gosport (Hayward 2008; 2009).

Mortar

It is from the analysis of the associated mortar that we can begin to establish differences, some of which relate to technological changes in response to the need for waterproof cements.

A summary of mortar types and concrete as well as their period of use from excavations at PMRP 08 are summarised below. These help to provide a chronological framework, along with the stratigraphic evidence, for the different building phases of Dry Dock No. 3 at the Portsmouth Naval Dockyard.

Mortar/Concrete Type	Description	Use at PMRP08
<i>TYPE A White powdery mortar</i>	<i>White powdery mortar with moderate to frequent flecks of quartz (3-8mm) and chalk inclusions.</i>	Very common use of mortar in both the Phase 3 1799-1803 supporting buttress of dock 3 [68] foundation of capstan bases [33] [80] Phase 4 capstan base [81] Phase 4 Dockside feature [37] Area B stone culvert [35] brick culvert [38]
<i>TYPE B Hard dark yellow waterproof</i>	<i>Portland cement Very hard dark yellow brown fine cement with elongate shell slithers up to</i>	This type of Portland cement is only present in Phase 4 capstan base [80]

<i>cement</i>	<i>10mm long and 3mm across inclusions of dark grey/brown iron oxide 1mm across occasional red brick 0.5mm</i>	and dockside feature [34] Portland cement patented after 1830
<i>TYPE C Early Gravel and brick Mortar</i>	<i>A soft light-grey earthy mortar with lumps of angular flint 10-20mm across and red brick flecks (2-5mm).</i>	Phase 2 Mid-late 18 th century stone built culvert [36] beneath Dry Dock No. 3
<i>TYPE D Yellow Grey powdery mortar</i>	<i>Yellow/grey harder mortar than Type A with clinker inclusions</i>	Phase 3 chute on southern side of dock [74]
<i>TYPE E Hard Black mortar</i>	<i>Early waterproof cement black</i>	Phase 3 chute on southern side of dock [74]

The use of very loosely consolidated gravel cement with brick inclusions, TYPE C is of a type typical of 18th century construction and this period of use fits in with its identification in a late 18th century culvert [36] prior to the 1799-1803 construction of Dry Dock No. 3.

The building of the dry dock in stone including the supporting buttresses [68] and Capstan Bases [33] [81] is marked by the widespread use of a very white, pure quartz rich lime mortar (Type A) that is not particularly hard and cannot be classified as waterproof.

The first waterproof mortar is of a very hard black fabric (Type E) from a chute on the southern side of the 1799-1803 dry dock construction [74] and early patent prototype of later concrete. A similar fabric was identified in the concrete waterproofed lining of a 1830s swimming pool at Greenwich (Hayward 2010). The experimentation of concrete patent was widespread in dockyards at this time. For example, the dockyards at Chatham had waterproof concrete in 1834 patented by the 'contractor Ranger... using a 1:6 lime: gravel combination mixed with hot water and compressed between timber forms'. (Sutherland *et al.* 2004, 119) George Ledwell Taylor, architect for the government 'used Rangers patent in Chatham and Woolwich dockyards' (Sutherland *et al.* 2004, 119) from the late 18th century, so the use of one of these pioneering concrete types does not seem so surprising. Further analysis and research is required (see recommendations).

A later waterproof cement (Type B) such as the very hard, compact, dark yellow brown type with shelly fragments somewhat akin to Portland cement (patented after 1830) appear in Phase 4 capstan base [80] of the dry dock and associated dock feature [34].

Clay Puddling

Further waterproof innovations in use during the construction of Phase 3 (1799-1803) dry dock include a 0.2m band of reddish pink puddling clay [48] used as a sealant around its lower vertical section of wall [47] and abutting the lower parts of chutes and staircases. This very fine plastic pinkish red clay does have some occasional inclusions of flint and organic

matter which reduces the plasticity somewhat. The inclusions of flint would indicate that it derives from a local mudstone from around the Portsmouth Harbour area e.g. London Clay.

Parallels for contemporary use include the walls of the West India Import Dock, constructed between 1801 and 1802 where clay puddle backed the walls and covered the dock floor, to prevent water escaping through the gravel (Hobhouse 1994).

Stone 24 examples 4.1kg

3126 Purbeck Limestone, Portlandian, Upper Jurassic, Isle of Purbeck, Dorset

3125 Granite probably Permian, Cornwall/Devon/Aberdeen

3110 Portland Whit Bed – Portlandian, Upper Jurassic, Isle of Portland, Dorset

The preferential use of stone in the construction of the Phase 3 (1799-1803) and Phase 4 (19th century) dry dock and associated structures is a feature replicated at other 18th and 19th century naval sites. The types of stone material (Purbeck Limestone; Granite; Portland Limestone) being used are for example comparable to those from the Royal Naval Victualling Yard at Gosport (Hayward 2008; 2009).

Purbeck Limestone, Portlandian, Upper Jurassic, Isle of Purbeck, Dorset 3126

By far the most common stone type identified in retained samples (16 examples 3.1kg) from the earliest Phase 2 brick culvert [36] to the main Phase 3 (1799-1803) construction of the Dry Dock No. 3 including the stone built supporting buttress [68], vertical support slabs [79] and in the Phase 4 large stone built dockside construction feature [34] and culvert [35]. In addition, it was observed in the Phase 3 outer face of the dock wall [47] as regular coursed 300mm x 200mm blocks, beneath the granite headstones of the supporting buttress in large blocks of 900mm x 600mm x 270mm [68] [74] the regular blocks in curved built stairwells [85] [86].

This hard, unyielding light cream/grey banded oyster rich limestone is not an easy stone to dress and this is borne out by the rough and irregular coursing and finishing in many parts of the dock e.g. [68].

It has been identified elsewhere as *in-situ* blocks in an early 18th century cooling cellar floor of a naval brewery at the Royal Naval Victualling Yard at Gosport [212] (Hayward 2008) and quarries were opened up such as at Winspit on the Isle of Purbeck in 1673 to meet this demand (Stainier 2000).

Granite 3125

Although only one example of granite was retained from the Phase 4 stone culvert [35] within the large stone-built dockside feature [37], it was observed in large quantity elsewhere. In particular the Phase 3 (1799-1803) upper supporting buttresses of the dock [68] [75] where well dressed rectangular granite blocks, were used. It was also used in Phase 4 granite cobble setts surrounding the dock and in 1 cubic metre blocks of the foundation of a Phase 4 structure at the north-western end of the dry dock. This very robust coarse grained igneous rock would have been ideal material type to resist the strains and impacts of a dock yard area.

It is identified elsewhere at the Royal Naval Victualling Yard at Gosport in the construction of the 1782 Thomas Wyatt Naval Brewery (Hayward 2008).

Portland Whit Bed 3110

Although only tiny quantities of the finely oolitic Portland Whit Bed were recovered from the phase 4 stone built structure [40] adjoining the dry dock it is likely that at least some of the Purbeck limestone observed in the dock were made from this material. Like the Purbeck limestone, this coastal rock (Upper Jurassic – Isle of Portland) was quarried in enormous quantities in the 17th and 18th century. Here, it was more in response for demand of this stone for large houses, ecclesiastical structures and grave markers in London. Although a freestone²⁷ this material is exceptionally robust and would have been equally at home in large engineering projects.

Phase Summary

In the absence of reliable brick dating evidence, a summary of mortar types and concrete as well as their period of use from excavations at PMRP 08 are discussed below. These help to provide a chronological framework, along with the stratigraphic evidence, for the different building phases of Dry Dock No. 3 at the Portsmouth Naval Dockyard

Distribution

The use of very loosely consolidated gravel cement with brick inclusions, TYPE C is of a type typical of 18th century construction and this period of use fits in with its identification in a late 18th century culvert [36] prior to the 1799-1803 construction of Dry Dock No. 3.

The building of the dry dock in stone including the supporting buttresses [68] and Capstan Bases [33] [81] is marked by the widespread use of a very white, pure quartz rich lime mortar (Type A) that is not particularly hard and cannot be classified as waterproof.

²⁷ A soft, even-grained porous limestone that can be worked or carved in any direction (Stanier 2000)

The first waterproof mortar is of a very hard black fabric (Type E) from a chute on the southern side of the 1799-1803 dry dock construction [74] and early patent prototype of later concrete. A similar fabric was identified in the concrete waterproofed lining of a 1830s swimming pool at Greenwich (Hayward 2010). The experimentation of concrete patent was widespread in dockyards at this time. For example, the dockyards at Chatham had waterproof concrete in 1834 patented by the ‘contractor Ranger...using a 1:6 lime: gravel combination mixed with hot water and compressed between timber forms’. (Sutherland et al. 2004, 119) George Ledwell Taylor, architect for the government ‘used Rangers patent in Chatham and Woolwich dockyards’ (Sutherland et al. 2004, 119) from the late 18th century, so the use of one of these pioneering concrete types does not seem so surprising. Further analysis and research is required (see recommendations). It is also during this phase that clay puddling is introduced as another patent for sealant in the dry dock [84]

A later waterproof cement (Type B) such as the very hard, compact, dark yellow brown type with shelly fragments somewhat akin to Portland cement (patented after 1830) appear in Phase 4 capstan base [80] of the dry dock and associated dock feature [34].

Context	Fabric	Form	Size	Date range of material		Latest dated material		Spot date
33	3101 3126	TYPE A White soft quartz rich mortar Shelly Purbeck limestone	5	50	1900	1700	1900	1750-1850
34	3101 3126	TYPE B Very hard dark yellow brown fine mortar shell slither red iron oxide Shelly Purbeck limestone	3	50	1900	1790	1940	1790-1900
35	3101 3126 3125 3120 3110	TYPE A White soft quartz rich mortar Shelly Purbeck, limestone, Portland limestone type fragment, Cornish Granite,	7	50	1900	1700	1900	1750-1850
36	3101 3126	TYPE C Soft light grey earthy pebbly mortar lumps of	5	50	1900	50	1900	1750-1850

Context	Fabric	Form	Size	Date range of material		Latest dated material		Spot date
		angular flint 10-20mm and brick inclusions Shelly Purbeck limestone						
38	3033 3101	TYPE A White soft quartz rich mortar Red unfrogged brick	2	1450	1900	1700	1900	1750-1850
40	3126 3110 3101	TYPE A White soft quartz rich mortar Portland type and Purbeck shelly limestone	8	50	1900	1700	1900	1750-1850
45	3033 3101	TYPE A White soft quartz rich mortar Large red brick	2	1450	1900	1700	1900	1750-1850
48 Base Dock n03 OP102	3101	Waterproof Membrane Clay Puddling lump	1	1790	1950	1790	1950	1790-1900
68 Chute OP102	3101 3126	TYPE A White soft quartz rich mortar Slightly grey clinker version Purbeck Shelly Limestone	3	50	1900	1700	1900	1750-1850
74	3101	TYPE D Hard Portland and Type E very dark grey hard shelly Roman Mortar	2	1790	1950	1830	1950	1830-1900
79	3101 3126	TYPE A White soft quartz rich mortar Slightly grey clinker version Purbeck Shelly Limestone	7	50	1900	1700	1900	1750-1850
80	3101	TYPE A White soft quartz rich mortar	4	1700	1900	1790	1900	1790-1900

Context	Fabric	Form	Size	Date range of material		Latest dated material		Spot date
		Slightly grey clinker version TYPE B Very hard dark yellow brown fine mortar shell slither red iron oxide Shelly						
81	3101	TYPE A White soft quartz rich mortar Slightly grey clinker version	3	1700	1900	1700	1900	1750-1850

Recommendations

a) Retention

The importance of the mortar assemblage and clay puddling (see below) means retention and incorporation of samples into a mortar fabric reference collection is essential. Rock samples of the Purbeck limestone and granite have been retained.

b) Significance

This assemblage contains a number of items of interest that require further research and comparison and should be included at the publication stage.

- As with Greenwich, (Hayward 2010) and Gosport (Hayward 2008; 2009) here is another site where the innovative use of different waterproof concrete patents in large naval projects during the late 18th to early 19th century, has been identified. The need during the Napoleonic Wars for example of these concrete and mud puddling clays needs further investigation and analysis.
- The use of a standard group of stone types (granite; Purbeck limestone and Portland limestone) in these naval constructions also warrants further research and analysis.

- Material studies of in-house naval materials (mortar; stone; cbm) could be the subject of a stand alone paper in a scientific or Industrial Archaeological Journal or a future research topic.

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APPENDIX 3: METAL AND SMALL FINDS ASSESSMENT

By Dr Märit Gaimster

Around 40 metal objects, along with a piece of cloth, were retrieved from the Phase 3 watching brief; they are listed in the table below. The majority of the finds appear to date from the 19th and 20th centuries. With the exception of an unstratified cannonball, all metal finds consisted of structural fittings, in particular large iron pins. Two copper-alloy pins with domed heads were also recovered, along with a cache of 24 corresponding copper-alloy washers of three different sizes; these finds were all from a sample taken from within the hollow body of a late 19th century bollard (01/S/D4) after removal from its original location south of Dry Dock No. 4; the finds accumulated over time, discarded into the hollow bollard via holes in the top, are probably waste from episodes of ship repairs carried out during the working life of the docks, which were still in use up until the 1980s. A further iron object from here has a round-section handle or finial, flattened out into a rectangular-section strap; the function of this object is unclear, but it may represent a specific form of iron pin. A rectangular piece of tar-stained woollen cloth, from a re-used ship's timber, used as a joist for timber deck [83], appear to have been used as packing, and pre-dates the construction of Dry Dock No. 3 in 1803.

Recommendations

The metal finds from Portsmouth Historic Dockyard form an integral component of the material recovered during excavation and should, where relevant, be included in any further publication of the site. For this purpose, more precise functions and parallels for the structural fittings should be sought, and their date should be further established. The possible pin from Dock 4, discussed above, will require x-ray for further identification, while the piece of cloth will need conservation prior to deposition with Portsmouth City Museum.

context	description	date	action
0	complete iron cannonball; diam.c.110mm		
0	incomplete tapering iron pin with transverse perforation at top; L 340mm+; diam. at thickest end 30mm; from sample <1>	19 th /20 th century	
0	incomplete tapering iron ?pin/bolt; circular handle diam. 30mm; flattening out to rectangular-section bar; L 180mm+; from sample <1>	19 th /20 th century	x-ray
0	copper-alloy pins; two incomplete with slightly enlarged domed heads; diam. 20mm; L 100 and 110mm; one with circular copper-alloy washer diam. 45mm; from sample <1>	19 th /20 th century	
0	circular copper-alloy washers; 21 complete and 2 incomplete; 5 x 50mm diam.; 15 x 45mm diam.; 1 x 40mm diam.; one 45mm washer stamped '7/8'; from sample <1>	19 th /20 th century	
0	iron nails; a dozen incomplete and heavily corroded; one incomplete iron pin/bolt diam. 13mm; from sample <1>	19 th /20 th century	

39	copper-alloy nail; complete with small applied cylindrical head; L 77mm	19th century	
68	iron pin; incomplete; slightly enlarged circular head; L 380mm+; diam. 20mm	1799-1803	
68	iron nails; two complete but heavily corroded; L 105 and 145mm	1799-1803	
68	Cattle rib bone (id by K.Rielly)	1799-1803	
83	iron nail; complete square-section with square head; L 180mm	1799-1803	
83	iron pin; complete with traces of wood at end; diam. 25mm; flat circular head diam. 50mm; L 410mm	1799-1803	
83	rectangular piece of coarse tabby-woven woollen cloth; 100 x 310mm; patches of tar adhering to the edges	Pre-1803	

APPENDIX 4: CLAY TOBACCO PIPE ASSESSMENT

By Chris Jarrett

INTRODUCTION

A small sized assemblage of clay tobacco pipes was recovered from the site (1 box). Most fragments are in a fairly good condition, indicating that they had not been subjected to too much redeposition or were deposited soon after breakage. Clay tobacco pipes occur in two contexts as small groups (under 30 fragments).

All the clay tobacco pipes (ten fragments, of which none are unstratified) were recorded in an ACCESS 2007 database and classified by Atkinson and Oswald's (1969) typology (AO). The pipes are further coded by decoration and quantified by fragment count. The degree of milling has been noted and recorded in quarters, besides the quality of finish. The tobacco pipes are discussed by their types and distribution.

THE CLAY TOBACCO PIPE TYPES

The clay tobacco pipe assemblage from the site consists of three bowls, seven stems and one nib or mouthpart. The bowl types range in date to between c. 1680 and 1710.

1680-1710

AO22: one heeled bowl with straight sides. The front of the bowl is damaged, but the back has evidence for faint milling. The bowl has a poor quality of finish.

Undetermined types

From the same context as the AO22 bowl are two fragmentary bowls, one of which is comprised mostly of stem and the other survives as mainly a stem with a short spur. They are probably contemporary with the AO22 bowl.

DISTRIBUTION

Table 1 shows the distribution of the clay tobacco pipes, showing the number of fragments, the date range of the types and the latest bowl, the types of bowls present, together with a spot date for each context tobacco pipes occur in.

Context	Fragment count	Date range of bowl types	Latest dated bowl type	Bowl types (and makers)	Spot date
39	1			Stem	1580-1910
94	10	1680-1910	1680-1910	X1 AO19, x2 unidentified bowl types, 1680-1710 x1 nib, x6 stems	

Table 1. PMRP. Distribution of clay tobacco pipes. A spot date of 1580-1910 indicates that only stems were present in the context

SIGNIFICANCE OF THE COLLECTION

The clay tobacco pipes have a low level of significance at a local level. There is no evidence for clay tobacco pipe production amongst the assemblage.

POTENTIAL

The clay tobacco pipes have the potential to date the contexts they were found in. None of the bowls require illustration.

RESEARCH AIMS

No research aims are suggested.

RECOMMENDATIONS FOR FURTHER WORK

No further work is recommended on the clay tobacco pipes and further publication work should refer to this document.

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APPENDIX 5: OASIS FORM

OASIS ID: preconst1-77051

Project details

Project name Archaeological Watching Brief at the Mary Rose New Museum, Portsmouth Historic Dockyard, Hampshire

Short description of the project An archaeological watching brief was undertaken by PCA on the initial phase of enabling ground works prior to the construction of a new museum to house the Mary Rose, Henry VIII's ill-fated flagship. The investigation focused on Dry Dock No. 3, a Scheduled Ancient Monument and Grade 1 listed building, where the Mary Rose is housed. The investigation revealed previously unknown information on the construction of Dry Dock No. 3, including part of the buttress system that supports the dock walls as well as large stone built dockside structures that pre-date, are contemporary with, and post-date the dock.

Project dates Start: 04-01-2010 End: 22-07-2010

Previous/future work Yes / Yes

Any associated project reference codes PMRP08 - Sitecode

Type of project Recording project

Site status Scheduled Monument (SM)

Site status Listed Building

Current Land use	Community Service 2 - Leisure and recreational buildings
Monument type	FOUNDATIONS-HYDRAULIC SYSTEM Post Medieval
Monument type	FOUNDATIONS-CAPSTAN Post Medieval
Monument type	FOUNDATIONS-DOCK WALL Post Medieval
Monument type	FOUNDATIONS-DOCK BUTTRESS Post Medieval
Monument type	CULVERT Post Medieval
Significant Finds	WOOD Post Medieval
Significant Finds	METAL Post Medieval
Significant Finds	STONE AND MORTAR Post Medieval
Significant Finds	CBM Post Medieval
Significant Finds	CTP Post Medieval
Significant Finds	FABRIC Post Medieval
Significant Finds	ANIMAL BONE Post Medieval
Investigation type	'Watching Brief'
Prompt	Scheduled Monument Consent

Prompt Listed Building Consent

Prompt Direction from Local Planning Authority - PPG16

Project location

Country England

Site location HAMPSHIRE PORTSMOUTH PORTSMOUTH Mary Rose Museum, Historic Dockyard, H.M Naval base, Portsmouth, Hampshire

Study area 6750.60 Square metres

Site coordinates SU 62850 00650 50.8014316401 -1.108021656270 50 48 05 N 001 06 28 W Point

Height OD / Depth Min: 0.19m Max: 0.19m

Project creators

Name of Organisation Pre-Construct Archaeology Ltd

Project brief originator Gifford

Project design originator Helen Moore

Project director/manager Tim Bradley

Project supervisor Stuart Watson

Type of sponsor/funding body Trust

Name of sponsor/funding body The Mary Rose Trust

Project archives

Physical Archive recipient Hampshire County Council

Physical Contents 'Animal Bones','Ceramics','Industrial','Metal','Wood'

Digital Archive recipient Hampshire County Council

Digital Contents 'Industrial'

Digital Media available 'Survey'

Paper Archive recipient Hampshire County Council

Paper Contents 'Animal Bones','Ceramics','Industrial'

Paper Media available 'Context sheet', 'Drawing', 'Map', 'Matrices', 'Photograph', 'Plan', 'Report', 'Section', 'Survey', 'Unpublished Text'

Project bibliography 1

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Description A4 client report

Entered by Jon Butler (jbutler@pre-construct.com)

Entered on 10 August 2010

APPENDIX 6: DOCK FURNITURE REMOVED FOR STORAGE

The following items of Dock furniture were removed and stored prior to eventual reinstatement (Fig. 2):

Bollard	01/S/D4
Bollard	02/S/D4
Bollard	03/S/D4
Bollard	04/S/D4
Bollard	05/S/D4
Bollard	01/N/D3
Bollard	02/N/D3
Cannon Bollard	03/N/D3
Bollard	04/N/D3
Bollard	S/D3/1
Bollard	S/D3/2
Cannon Bollard	S/D3/3
Bollard	S/D3/4
Capstan	S/D3/5

PCA

PCA SOUTHERN

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