# HMS Colossus

# Stabilisation & Recording 2008


# Project Report

Kevin Camidge

| | |
|---|---|
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| Approval | - |

## Acknowledgements

This project was commissioned by English Heritage. I would like to thank the English Heritage project officer Mark Dunkley for his assistance with this project.

I would like to acknowledge the contribution made to the recording phase of the project by CISMAS members. They worked tirelessly for no pay, giving up a week of their valuable annual leave in order to take part – often working 12-14 hours per day. They were Sharon Austin, Bill Bowen, Peter Holt, Luke Randall, Phil Rees, Brendon Rowe and Janet Witheridge.

I would also like to extend thanks and gratitude to 3H Consulting Ltd. for providing a copy of Site Recorder which was used to record the planning frame survey and for generous technical assistance with Site Recorder.

Many thanks to David McBride, the charter boat operator for the recording phase of the project, for much additional help. Sean Lewis assisted in a number of ways and I am indebted to him for his contribution.

David Williams, Jolene Williams and Anna Cawthray of Scavenger Diving Services undertook the installation of the Terram and underwater sign and were helpful and cheerful throughout a strenuous diving operation.

Kevin Camidge
June 2008

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## List of Illustrations

## Project Name

Colossus Site Stabilisation and Recording 2008

## Summary Description

A small area at the stern of the designated wreck of *HMS Colossus* was protected with a geotextile covering of Terram 4000. The efficacy of this type of protection on this site was established in the stabilisation trials commissioned by English Heritage (2003-2005). Timber sample blocks were installed beneath the Terram mat and on the seabed. A small seabed sign was also installed to inform visiting divers of the function of the Terram protection. Before the Terram was installed the area to be covered was recorded in detail, along with a control area so that the long term effects of the stabilisation can be determined.

## Background

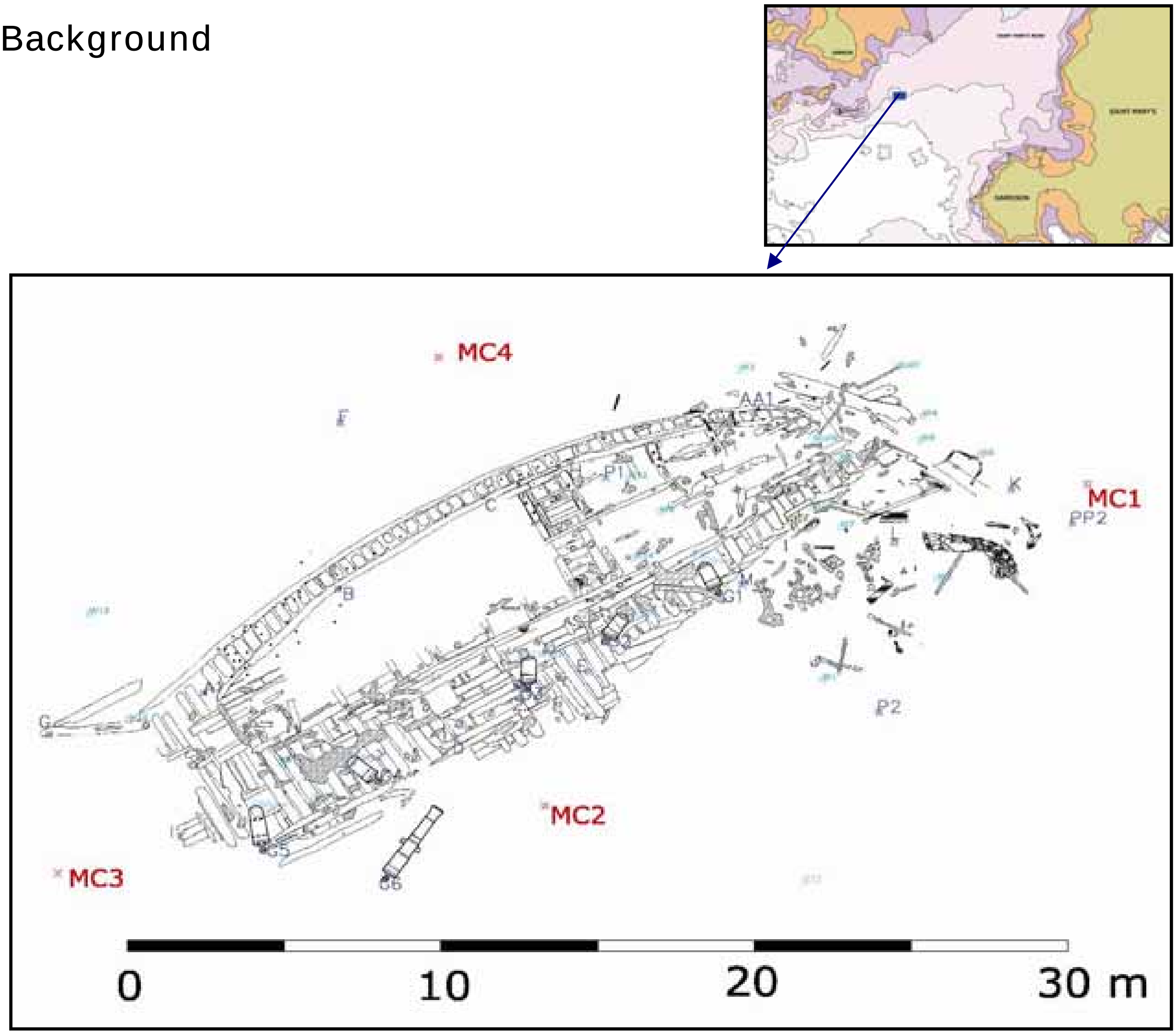



*Figure 1 The stern of Colossus as drawn in 2003. The inset shows the location within St Mary's Roads, Scilly.*

## The Ship

*HMS Colossus* was a 74 gun warship built in 1787 at Gravesend and wrecked off Samson in the Scillies in 1798. These 74 gun ships were one of the most successful types of the period. They were typically about 51m (170 feet) in length and had a crew of over 600. During her relatively short working life (eleven years) *Colossus* saw action at Toulon, Groix, Cape St Vincent and Cadiz. She also took part in the capture of two enemy ships in 1793[1]. She had nine different captains during her relatively short career. *Colossus* had a complete refit, which took six months, in 1796.

In December 1798 *Colossus* was on her way home to England with wounded from the battle of the Nile and with cargo including part of Sir William Hamilton's second collection of Etruscan pottery. She was sheltering from a gale in St Mary's Roads when the anchor cable parted and she was driven aground to the south of Samson. All but one member of the crew were taken off safely before *Colossus* turned onto her beam ends and proceeded to break up.

Vital Statistics[2], [3]

| | |
|---|---|
| Length (MGD) | 172' 3" (52.5m) |
| Breadth | 47' 9" (14.6m) |
| Tonnage | 1703 tons |
| Draught (hold) | 20' 9½" (6.3m) |
| | |
| Standard armament | 28 x 32lb main gun deck |
| | 28 x 18lb upper gun deck |
| | 14 x 9lb quarter deck |
| | 4 x 9lb forecastle |
| | |
| Ballast[4] | 110 tons of iron ballast and |
| | 250 tons of shingle |
| | |
| Ordered | 13th December 1781 |
| Laid down | October 1782 |
| Launched | 4th April 1787 |

## The Site

The wreck of *HMS Colossus* lies to the south of Samson in the Isles of Scilly. To date two main areas of wreckage have been identified, the bow and the stern. In 1975 part of the wreck (probably the bow) was designated under the Protection of Wrecks Act. This designation was revoked in 1984. The current site, the stern, was designated in 2001, and is located at Latitude 49° 55'.471N, Longitude 006° 20'.505W (260154.906E 5535593.077N UTM zone 30, WGS84[5]).

[1] *Le Vanneau*, a French 6-gun ship (ADM 52 3006 Masters log) and *Vrai Patriot* (NMM warships database)
[2] Warships database - National Maritime Museum.
[3] Brian Lavery, *Ship of the Line, Vol 1*.
[4] ADM 52 2808 Masters log *Colossus* to December 1797.
[5] The survey work undertaken in 2001-3 used positions and grid references in UTM coordinates using zone 30 based on the WGS84 datum. The designation under the Protection of Wrecks Act gives the position in latitude and longitude.

## Previous Work

Salvage work took place on *Colossus* from the time of her loss until the early part of last century. Work included Braithwaite and Tonkin 1803-1806, the Dean Brothers in the 1830s and possibly Western Marine Salvage in the early part of last century.

Roland Morris, a marine salver and proprietor of the Penzance Maritime Museum[6], began searching for the wreck of *Colossus* in 1967 using a small team of divers. In August 1974 they located material relating to *Colossus*. The site was designated in 1975 under the Protection of Wrecks Act 1973.[7] A large quantity of pottery, remains of Hamilton's second collection, was recovered and deposited in the British Museum – where at least one of these reconstructed pots is now on public display. Once Morris' team had finished their work, the site was de-designated in 1984.

Areas of exposed timber and iron guns were discovered by local divers in 2001. This material was some distance to the east of the area worked by Morris and turned out to be part of the stern of *Colossus*. This was designated in July 2001. Late in 2001 the Archaeological Diving Unit (ADU) excavated at the stern of *Colossus* as well as around a piece of carved timber, which was one of the stern quarter pieces of the vessel.

In 2002 the quarter-piece, part of the stern decoration of the vessel, was recovered from the site by the licensee Mac Mace. This is currently undergoing conservation at the Mary Rose Trust, it will eventually be displayed in the Abbey Gardens on Tresco, Isles of Scilly. Later in 2002 a small excavation was undertaken on the site to establish the nature and extent of the structural remains.

In 2003, a two year site stabilisation trial was commissioned by English Heritage. This trial was undertaken to determine the most effective method of slowing down the deterioration of the exposed timbers on the seabed.

In 2004 & 2005 the Cornwall and Isles of Scilly Maritime Archaeology Society (CISMAS) carried out a survey of the debris field surrounding the wreck of *Colossus*.

From 2002 to 2007 the author has monitored the sediment levels on the site. This work has demonstrated that despite seasonal variations, the sediment levels around the stern section of *Colossus* have continued to fall throughout this period.

[6] The museum closed in 2001 and the collection was auctioned in 2002.
[7] *HMS Colossus* DBA, Wessex Archaeology 2003.

# Objectives

## The Stabilisation Trials (2003-2005)

The broad aim of the stabilisation trial was to determine a suitable method of stabilising the timbers of *HMS Colossus* exposed on the seabed. These exposed timbers have deteriorated considerably since survey began in 2001. The most obvious damage to the timbers is from wood boring organisms. Various strategies exist for protecting sites. The specific aim of the trial was to establish the efficacy and economic viability of different protection strategies in the conditions prevailing on this site.

Three different methods of stabilisation were employed in the trials. These were installed on an area of seabed to the south of the exposed timber where there are no visible archaeological remains. The stabilisation materials used were a Terram 4000 mat, a synthetic mesh mat and an artificial frond mat system. Each trial mat covered an area 5 x 2.5m and was left in place on the seabed for a period of two years. The trial started in May 2003 and was concluded in May 2005.

To determine the relative performance of the three mats, eight timber sample blocks were installed under each mat. These were retrieved at intervals of 3, 6, 9 and 24 months and analysed to determine the amount of deterioration caused by wood boring organisms, bacteria and fungi. Timber sample blocks were also installed directly on the seabed to act as a control. The results from the analysis of these timber blocks demonstrated that the blocks from the Terram 4000 mat showed no signs of decay even after two years. The blocks from all the other trial areas showed some degree of deterioration.

The conditions under each of the test mats were monitored using a sub-sea data logger, deployed consecutively under each mat for a three month period. The data logger recorded dissolved oxygen, redox potential, pH, temperature and depth at one hour intervals. Results from the Terram and frond mats showed highly anoxic conditions (less than 0.02 mg/l of dissolved oxygen) within days

At the same time as the trial areas were monitored, the sediment levels around the wreck were also measured to establish the prevailing sediment variation at the time of the trial. To achieve this, fourteen sediment monitoring points were established around the site and the seabed levels were recorded throughout the trial. It became clear that there was a degree of sediment mobility on the site, the net result of which was a small diminution of seabed levels around the wreck over the two year trial. Seabed samples from around the wreck were analysed to establish the nature of these sediments.

The results of the stabilisation trial demonstrated that the Terram 4000 mat was clearly the most efficient and cost effective of the systems trialled on this site. The full report of the Stabilisation Trials can be downloaded from the CISMAS website at www.cismas.org.uk

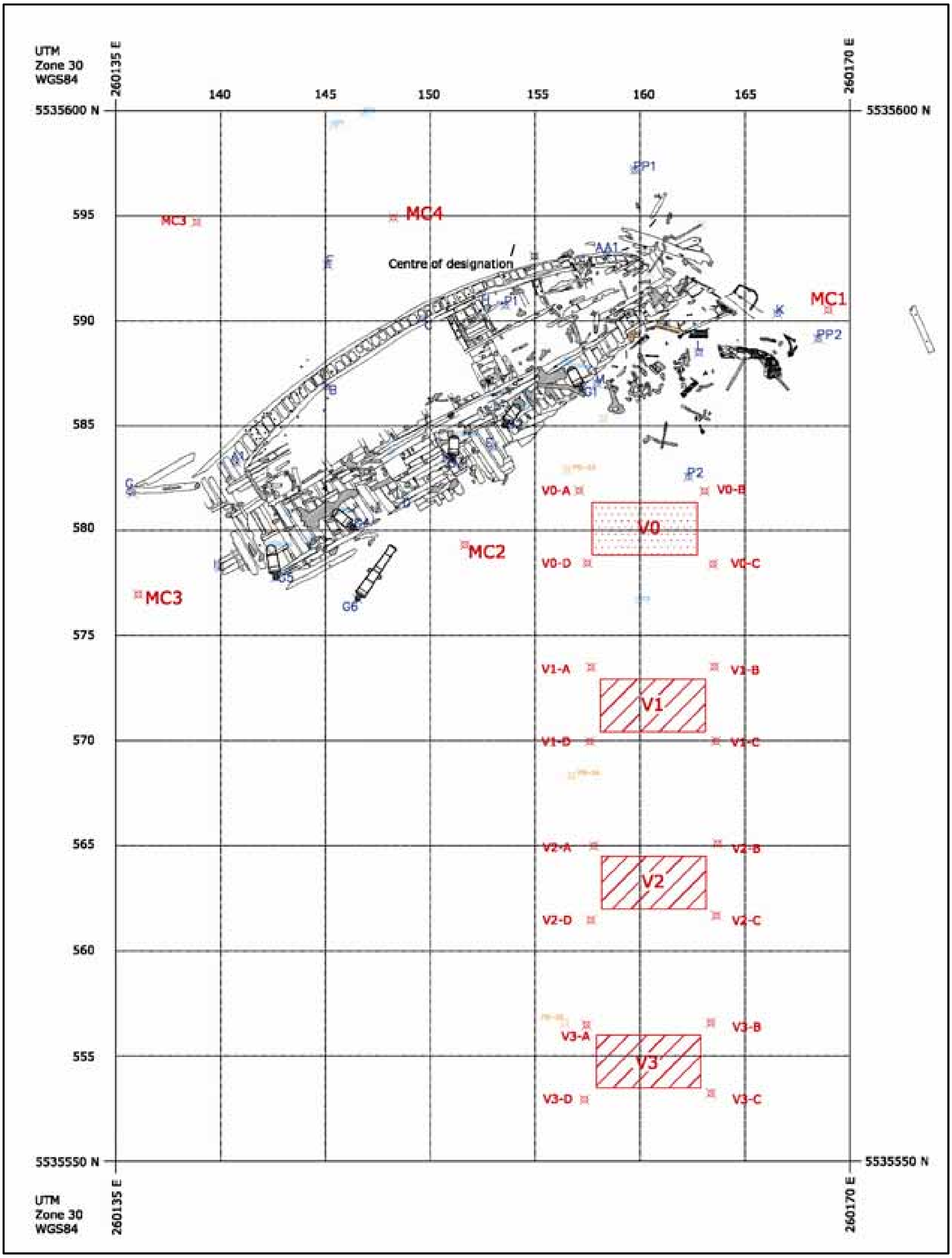



*Figure 2 Plan showing the location of the stabilisation trial areas. V0 control area, V1 Terram 4000, V2 synthetic mesh and V3 floating frond mat.*

## Site Stabilisation

It is clear from the stabilisation trials which of the trialled methods is the most effective way of stabilising the exposed timber of this wreck. However, as this trial was only over a two year period we need to understand the longer term effects of stabilisation on this site.

The plan was that a relatively small area (3.8 x 5.5m) at the stern of the vessel be protected using a Terram 4000 mat held in place with sand bags. The method and its efficacy were established in the stabilisation trials. The reason for choosing the small area at the stern of the vessel is twofold. Firstly, excavation at the stern of the vessel carried out by the ADU in 2001 demonstrated the high quality of the remains on this part of the wreck. The possibility of further carved material lying buried in this area is considerable. Secondly, this is a visually unappealing part of the wreck, so covering it with Terram will not detract from the appeal of the wreck to visiting divers. Currently the local dive charter boats in Scilly take divers to the wreck using visitor licences issued by DCMS.

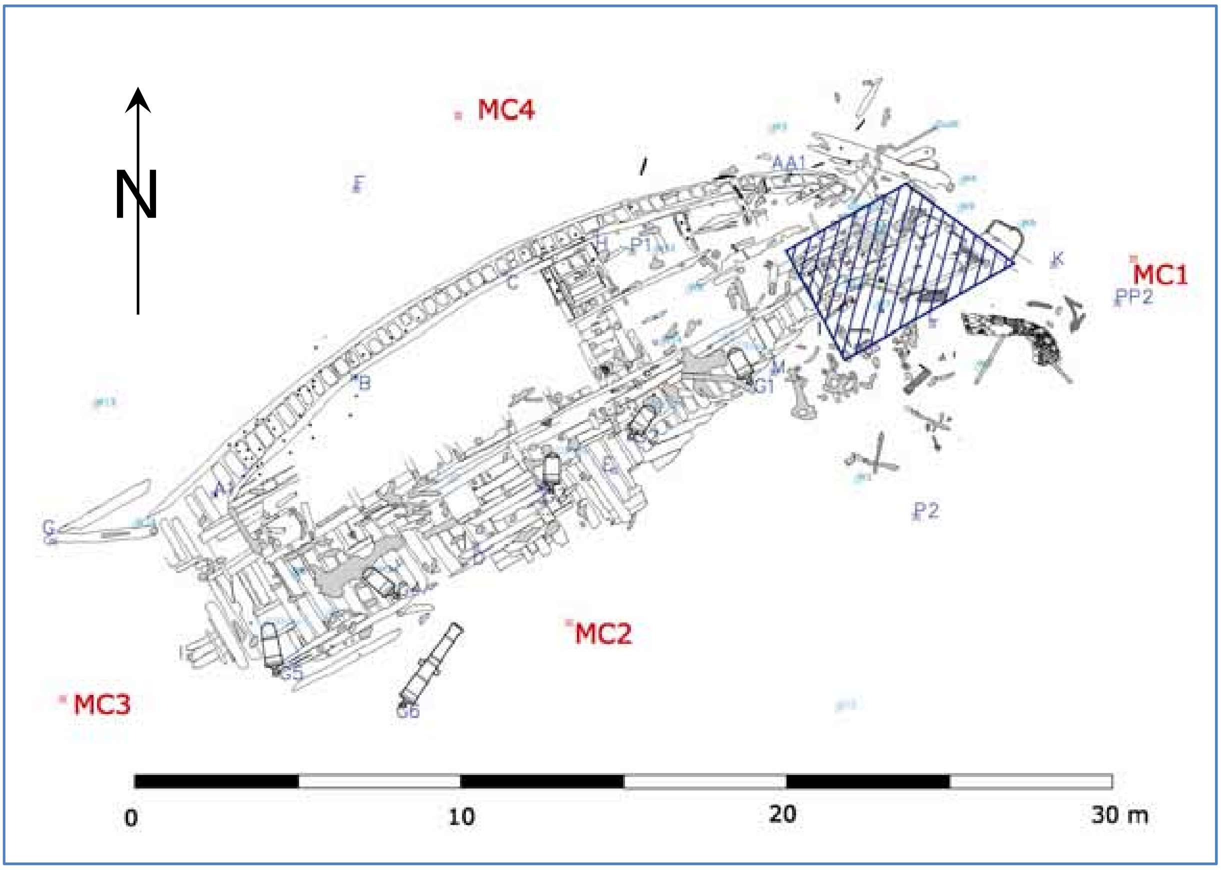



*Figure 3   The planned area of Terram 4000 is shown outlined and hatched.*

So that the long term effects of the stabilisation can be determined, the protected area was recorded in detail prior to protection. The project was undertaken in two parts. Firstly, the recording of the small area of timber to be protected, along with the associated control area. Secondly, once this work had been completed, the installation of the Terram protection and a small seabed sign explaining the function of the Terram mat.

## Recording

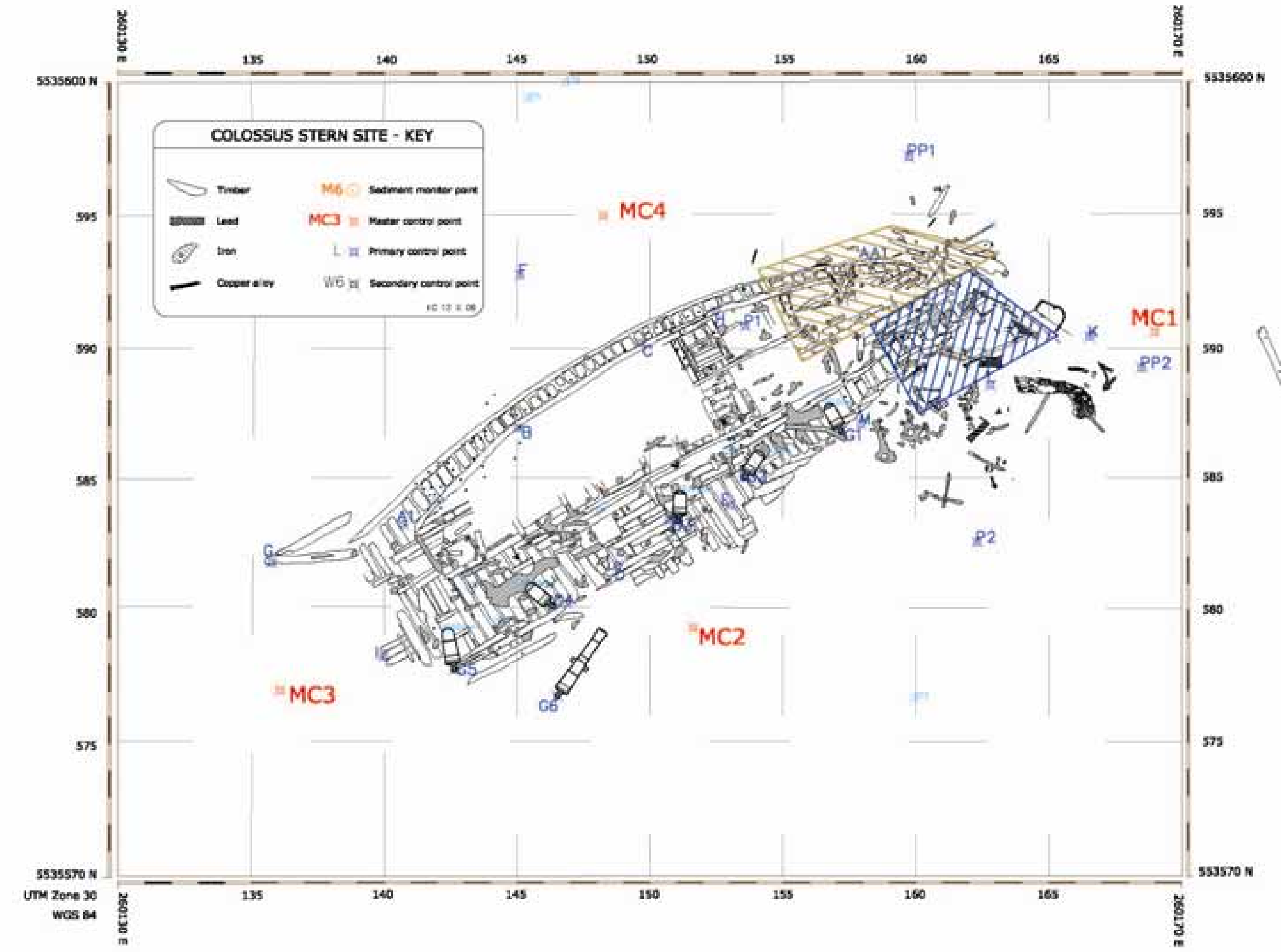



*Fig 4 The two areas which were recorded are shown outlined and hatched. The control area is shown in green and the Terram area in blue.*

### The planning frame survey

The areas shown outlined in fig 4 above were drawn at a scale of 1:5. This was achieved using 1m square planning frames consisting of standard steel reinforcing mesh with gridded-in 200 millimetre squares. The planning frames were positioned along tape baselines fixed to stainless steel pins driven into the seabed. The baselines were referenced to the existing survey control points (placed 2001-2005) using direct measurements and Site Recorder software.

The underwater drawings were made on plastic drafting film, one sheet (A4) per planning frame. These 'site sheets' were then scanned and imported into Site Recorder as JPEG files. These were then placed into the correct position, orientation and scale in Site Recorder. This drawing was then digitised by the same person who drew that 1m square on the seabed.

The principle advantage of drawing at a scale of 1:5 is that it is possible at this scale to record more detail. For example, at the more usual scale of 1:10, an average treenail (25mm diameter) is only 2.5mm on the drawing, making it very difficult to record details such as wedging of treenails.

*Figure 5 Planning frame survey*

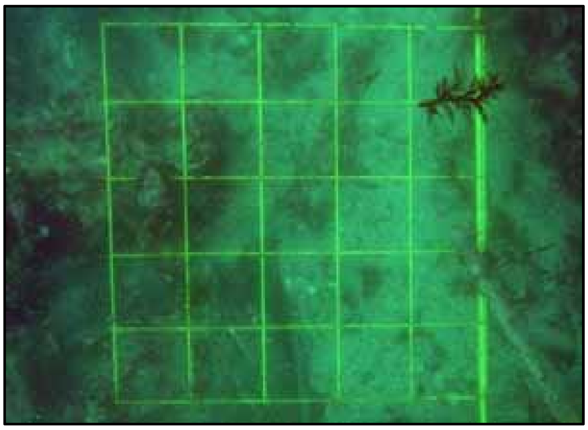


*Figure 6 Planning frame in position on its tape baseline*

A number of disadvantages of drawing at 1:5 were noticed. As anticipated, the drawing took slightly longer; in this case the 42 square metres were drawn by four divers in five days. Each draughtsman undertook two one-hour dives per day. This resulted in an average of one square metre drawn per hour (this includes all ancillary tasks such as establishing baselines and positioning planning frames). The actual speed achieved depended very much on how complex the drawing was. Surveying of baselines was undertaken by two separate divers who were not drawing. An unforeseen disadvantage of drawing at this scale was the amount of time it took to digitise the site drawings, about twice as long as it took to make the original drawing. This resulted in a long evening's work by the team after the day's diving was completed. Experience on previous projects has shown that it is essential to do this digitising as soon as possible to allow anomalies to be resolved on the ground. Past experience has also shown that digitising 1:10 drawings is considerably quicker.

Comparing the planning frame survey made this year with that previously drawn in 2003 gives a graphic illustration of how the timbers have deteriorated in the intervening five years. Figs 7 and 8 below show detail from the 2003 and 2008 surveys. Those timbers shown in pink on the 2003 survey no longer survive. Comparison of the two plans also shows many areas where timbers have decayed to a smaller size in the five years between the two drawings.

The complete 2008 planning frame survey is reproduced below in fig 19.

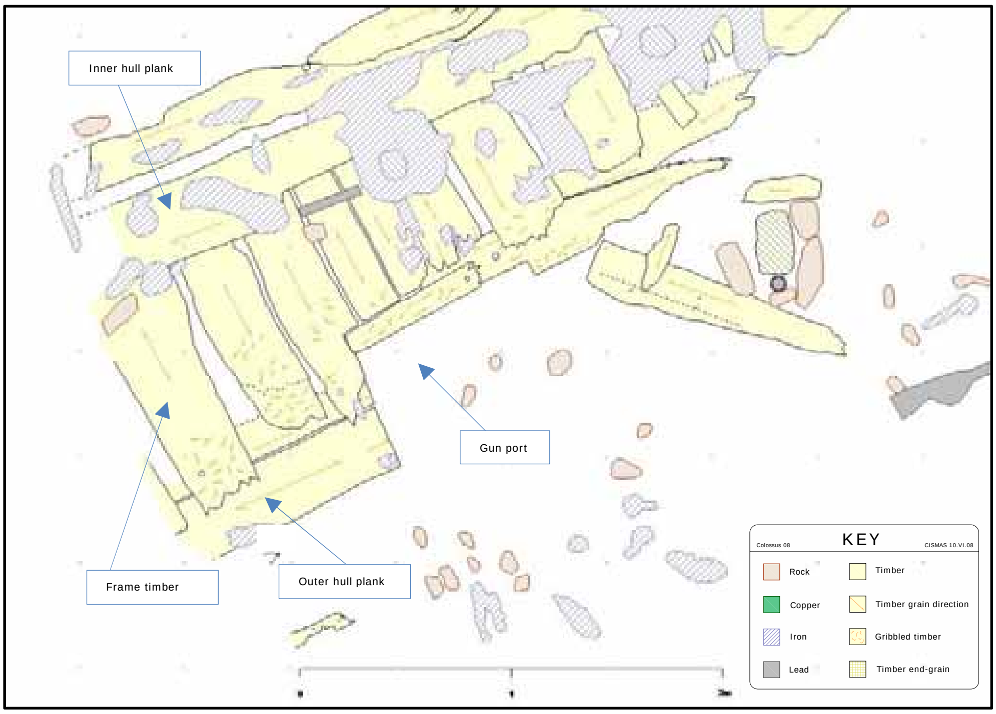



*Figure 7 Detail from the 2008 plan showing the area around the rearmost upper gun deck port.*

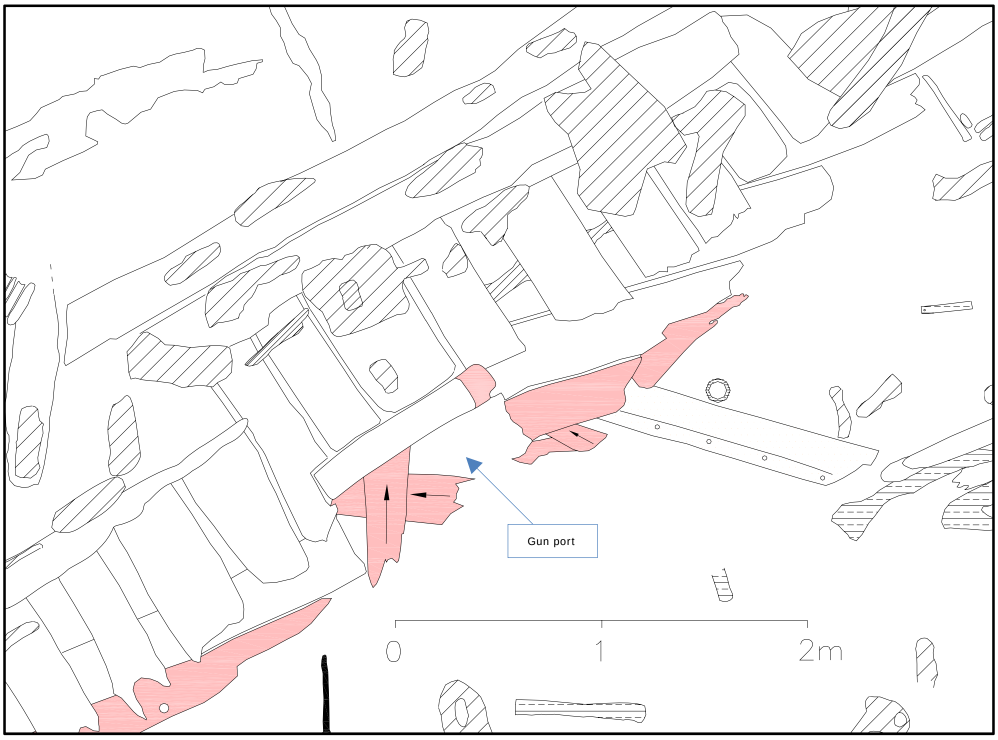



*Figure 8 Detail from the 2003 plan. Note how those timbers coloured pink are no longer present in 2008. Many other timbers are reduced in size due to decay.*

## Photography

*Figure 9 This photograph of a loose sheave demonstrates the amount of loose weed in the water column.*

The visibility during the recording phase of the project was fairly poor. At best it was no more than 3-4 metres. Moreover there were considerable amounts of material in the water column, mainly detached weed, amounting at times to a blizzard of weed.

Each of the one-metre planning frame areas used in the production of the 2008 drawing was also photographed, with and without the planning frame in place. Each of these planning frame areas was given a name in the Site Recorder file of the survey. This allowed the drawings to be visually checked using the photographs. The locations and names of the planning frames are shown in fig 10 below. The photographs are indexed to these planning frame names and appear on the CD ROM which accompanies this report.

These photographs confirm the author's opinion that photographs are not a substitute for proper underwater drawings. Similarly, drawings made directly from such photographs are rarely satisfactory. There are a number of reasons for this; principally that it is often not possible on the photographs to distinguish between iron concretion, rocks and timber in the final stages of decay. In addition artifactual material is often partly obscured by sediment in the photographs – when drawing these items they can be 'wafted' clear of sediment to show the real edges a small part at a time. Underwater photographs also suffer from a degree of distortion, often much worse towards the edges of the picture.

The photographs were taken using a pair of underwater digital compact cameras in underwater housings. Both cameras had zoom lenses and were always used at the widest zoom setting – in this case 5.1mm (equivalent in coverage to a 24mm lens on a 35mm camera). This relatively short focal length allowed reasonable coverage at close range – essential in the relatively poor visibility encountered during the survey. One problem encountered with these cameras was that of misting on the inside of the housing. This only occurred for about 15 minutes after entering the water, after which it cleared. This problem did not occur with the previous CISMAS cameras used. The cure to the problem was found to be placing bags of silica gel inside the housings and putting the camera in a bucket of cold water 20 minutes before the dive.

*Figure 10 Location of Planning frames*

## Sediment monitoring

The excellent preservation of the exposed timbers when discovered in 2001 and their subsequent rapid deterioration suggested that sediment levels over the wreck had recently diminished. Any attempt to stabilise the site must take into account the sediment levels surrounding the exposed wreckage. Consequently, in 2003 a programme of sediment level monitoring was inaugurated. Two types of monitoring were installed. Firstly, stainless steel pins M1-M8 were driven into the seabed around the outside of the exposed wreckage (M4 is in the middle of the wreck). These were all set so that exactly 100mm of pin was exposed above the seabed. Secondly, M10-M15 which are copper nails were driven into the timber of the wreck itself. These are used to monitor levels around the immediate edges of the exposed timber. All sediment monitoring points are labelled with yellow York Survey tags inscribed with the monitor point's number. The locations of the monitor points are shown in fig 11 below.

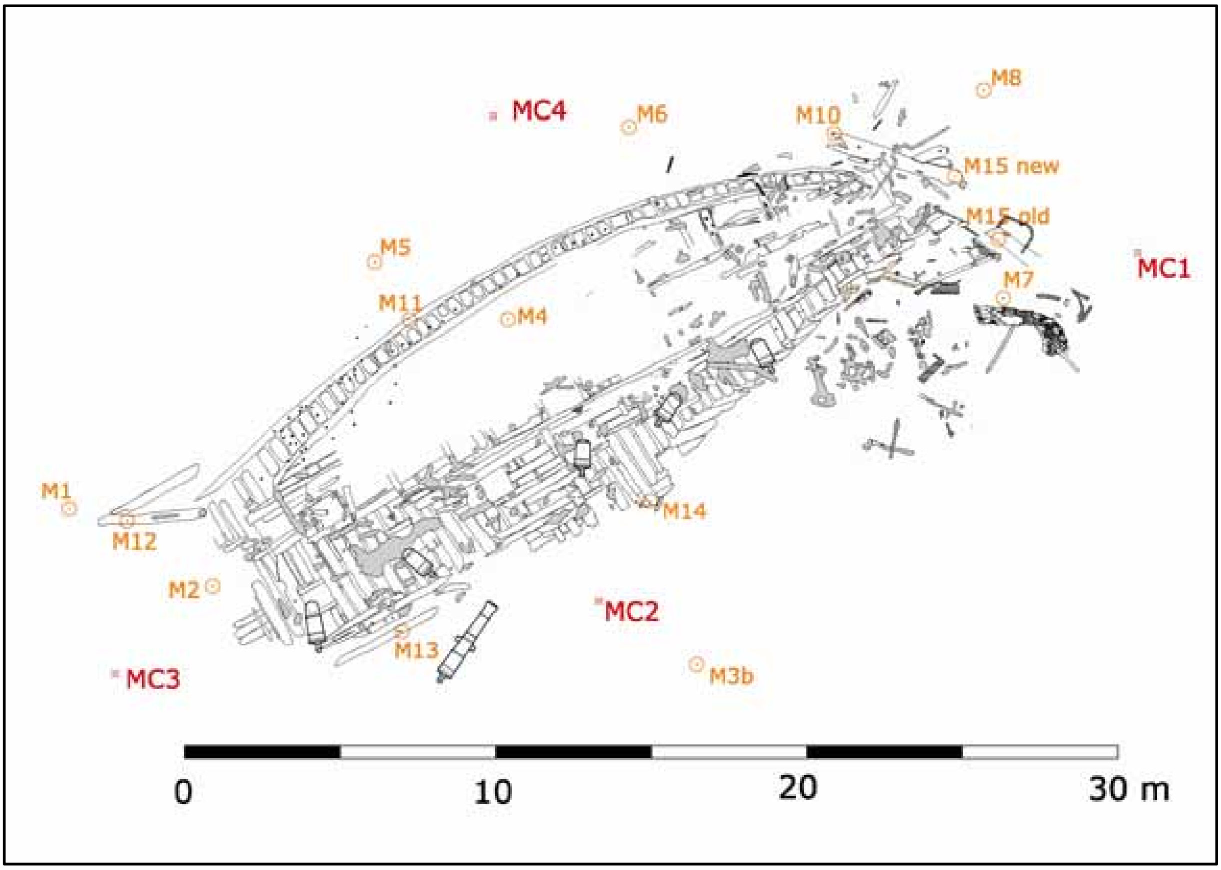



*Figure 11 Location of sediment monitoring points M1-M8 and M10-M15*

Last year (2007) saw the largest fluctuations in sediment levels on the site since recording of these levels began in 2003. This year (2008) the first measurements were taken as part of the recording phase of this project. These measurements demonstrated that the levels have fallen again, by a mean of 10mm relative to the levels in 2003. The mean change for all monitoring points is shown in fig 12 below. Note how the levels are generally lower at the beginning of the year and higher at the end of the year. This suggests that the sediment is removed from the site during the winter months and slowly returns throughout the calmer summer months. However, the trend is towards a net loss of sediment over the site.

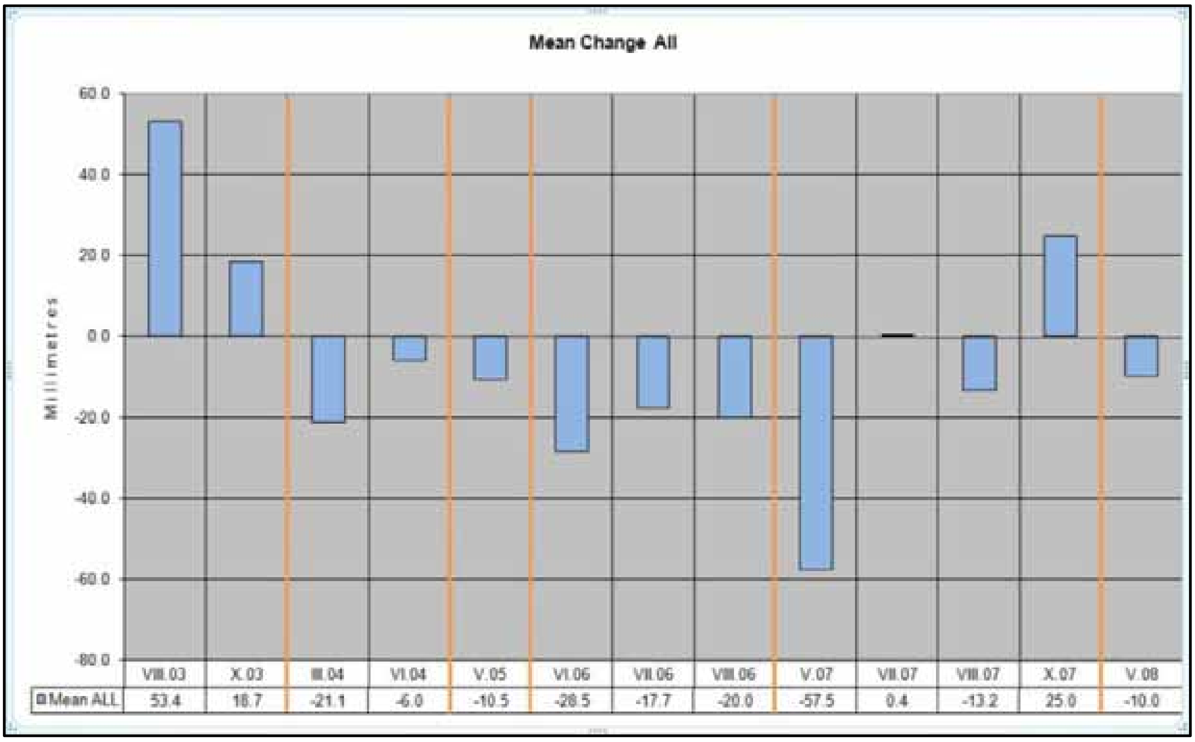



*Figure 12 Graph showing the mean change (in millimetres) since 2003 of all sediment monitoring points from August 2003 to May 2008. Positive numbers indicate a rise in sediment level, negative numbers a fall.*

*Figure 13 Exposed timber at the western end of the wreck in the final stages of decay. Note the weed growth and that the timber stands clear of the seabed in places. Experience suggests that this timber will have disappeared by next year.*

*Figure 14 Diver demonstrating the taking of sediment level measurements May 2008.*

# Stabilisation

## The Terram mat

The installation of the small area of Terram 4000 was undertaken in early June 2008 by Scavenger Diving Services (Jolene Williams nee Alsop). Terram 4000 is a thermally bonded geotextile made from 70% polypropylene and 30% polyethylene. The data sheet for Terram 4000 is reproduced in appendix I below. The corners of the area to be covered with Terram were marked on the seabed by four stainless steel pins: ST3, ST4, ST5 and ST6. These were measured relative to the existing survey control points on the site. The Terram mat was pre-cut to the required shape on land prior to deployment. A small hole was also cut in the mat to allow the upstanding lead pipe TD1 to poke through the mat.

On installation it became clear that several upstanding iron concretions were preventing the mat from sitting properly on the seabed. Consequently, it was decided to remove a small part of the mat on the northern edge to avoid these concretions and allow the mat to sit flat on the seabed. The most important elements of the stern wreckage were still protected by this modified mat shape. Fig 16 below shows the actual size and shape of the Terram mat.

*Figure 15 The Terram mat and seabed sign in place on the seabed*

The Terram mat was secured using 60 sandbags, each containing 25-35kg of clean builder’s sand. Two different types of sandbag were used. Green heavy-duty bags containing approximately 35kg of sand were used at the eastern and western ends of the mat – the ends subject to the greatest tidal flow. The rest of the sandbags were standard white polypropylene bags containing 25kg of sand. The sandbags were placed in a continuous line around the edge of the mat. Additional lines of standard sandbags were also placed in the centre of the mat and around the upstanding lead pipe TD1.

Work on the stabilisation trials suggests that this mat will quickly become colonised with weed and will accumulate a layer of sediment within a few months. The ultimate longevity of the Terram mat will depend to some extent on future sediment movements on the site. Indications are that the Terram itself will have a long lifespan. Experience has shown, however, that the sandbags will start to deteriorate within five to ten years. By then, there should be sufficient sediment accumulated on the mat to hold it securely in position. Careful inspection during the routine sediment monitoring of the site will document the condition of the Terram mat.

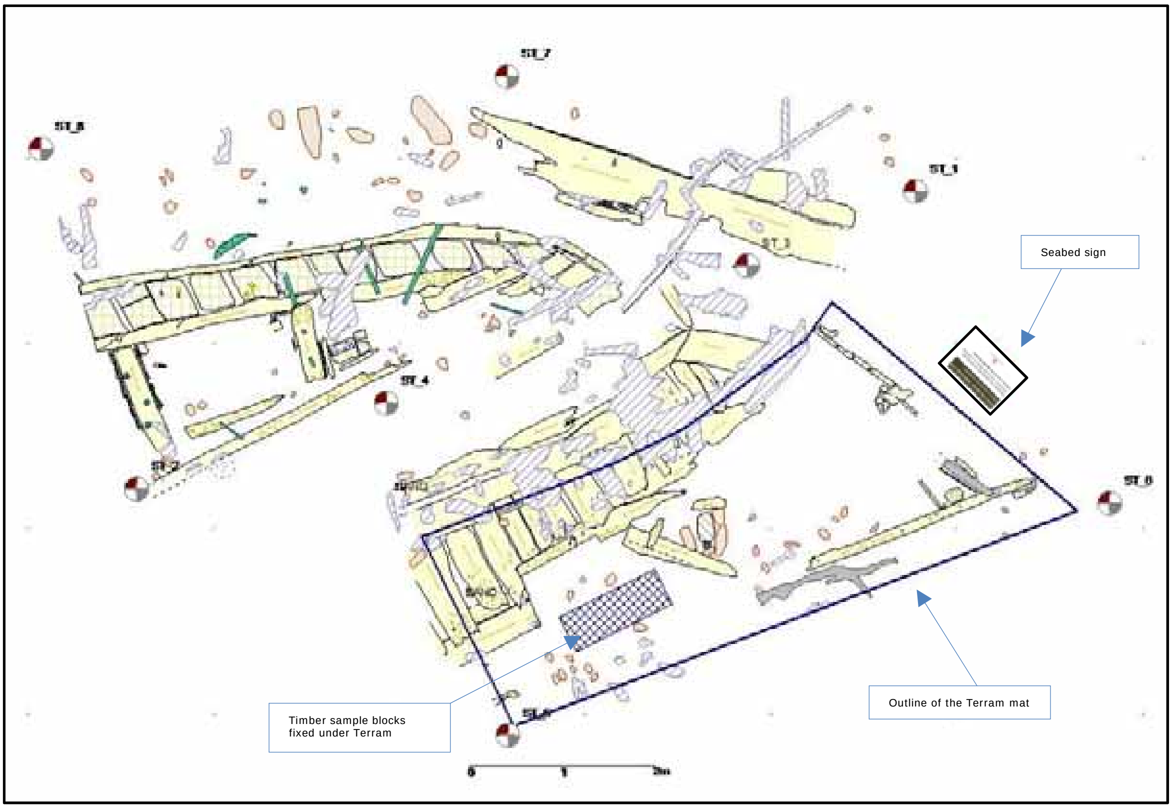



*Figure 16 Plan showing the location of the Terram mat, timber sample blocks and the seabed sign*

## Timber sample blocks

Eight timber sample blocks – four oak and four pine – were placed under the Terram mat in the position shown in fig 16. These blocks were secured to plastic pegs using heavy duty cable ties – the same method used in the stabilisation trials. Each block is identified by a plastic tag marked with the sample number, attached by cable ties to the block. There is no scheduled retrieval for these timber blocks, which were placed to facilitate assessment of the long term efficacy of the Terram protection on this site if required.

| Timber blocks – Under Terram - June 08 | | |
|---|---|---|
| Number | Type | Dry weight (grams) |
| 100 | Oak | 190.8 |
| 103 | Oak | 251.4 |
| 104 | Oak | 239.5 |
| 105 | Oak | 271.1 |
| 110 | Pine | 197.4 |
| 111 | Pine | 184.5 |
| 112 | Pine | 190.0 |
| 118 | pine | 197.8 |

A further four timber blocks were placed on the seabed to the south of Gun 2 in position 260154E 5535581N UTM zone 30 WGS84. These blocks, which were placed at the request of Paola Palma, lecturer in marine archaeology at Bournemouth University, were secured to stainless steel pins driven into the seabed. They will be recovered late 2008 or early 2009 during routine monitoring of the site. This work will provide further information on the species of wood boring organisms active on this site.

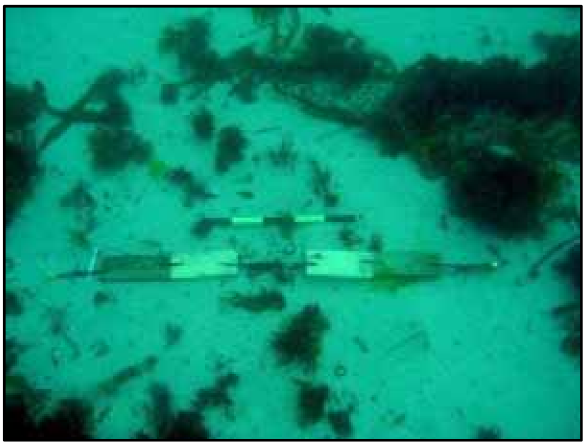


*Figure 17 Timber blocks secured to the seabed south of Gun 2*

| Timber blocks – Seabed - June 08 | | |
|---|---|---|
| Number | Type | Dry weight (grams) |
| 101 | Oak | 272.1 |
| 102 | Oak | 284.9 |
| 114 | Pine | 201.4 |
| 116 | Pine | 189.0 |

## Seabed sign

The seabed sign was manufactured by Island Signs of St Mary's, Isles of Scilly. The sign board consisted of an 'oversize' white A3 high density PVC board. CISMAS uses this material as underwater drawing boards and we have found them to be extremely durable. Computer-cut adhesive vinyl formed the text of the sign. The A3 board was then attached to a substantial, custom-cast concrete plinth using stainless steel screws and washers. The sign was relatively cheap to have manufactured. What we do not know is how long it will last underwater. However, a template of the holes used to fasten the board to the concrete plinth has been retained to allow replacement of the sign without the need to raise the plinth. The sign has been placed next to the Terram mat at the point where divers first encounter the site.

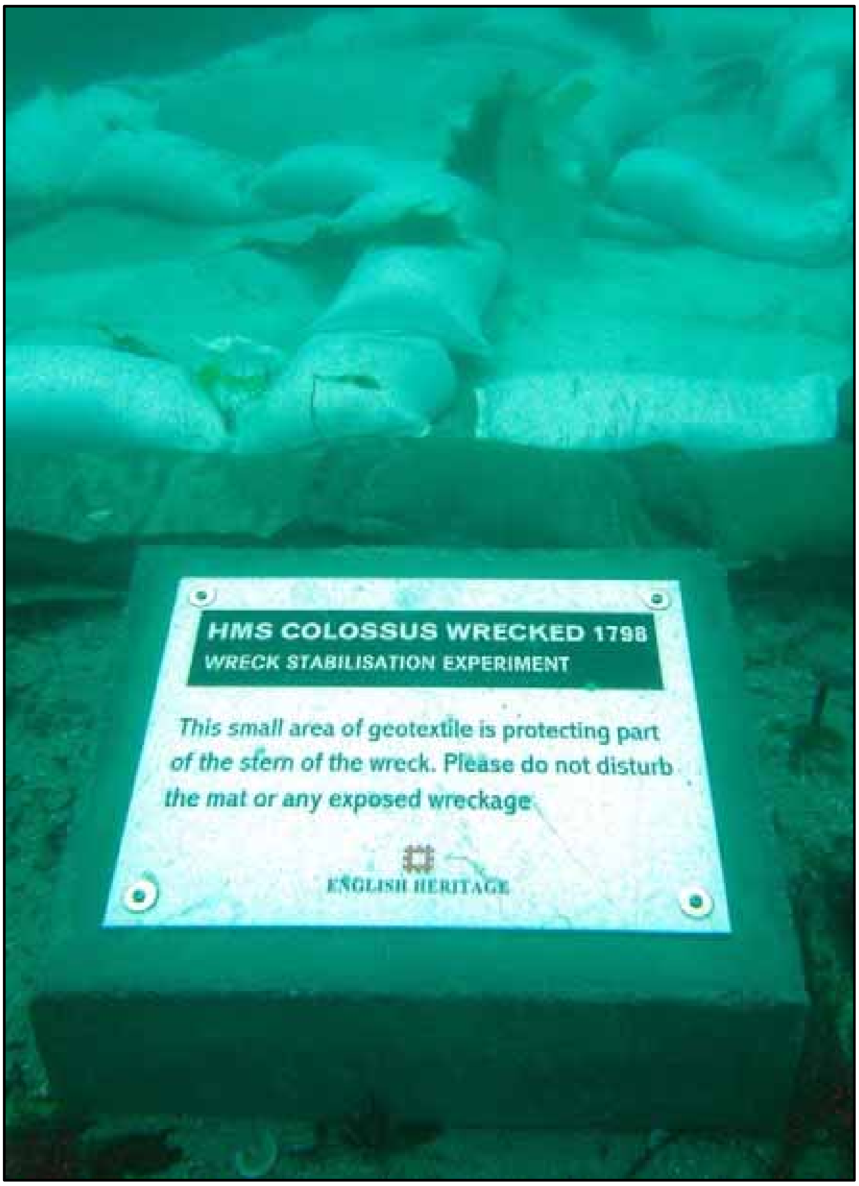
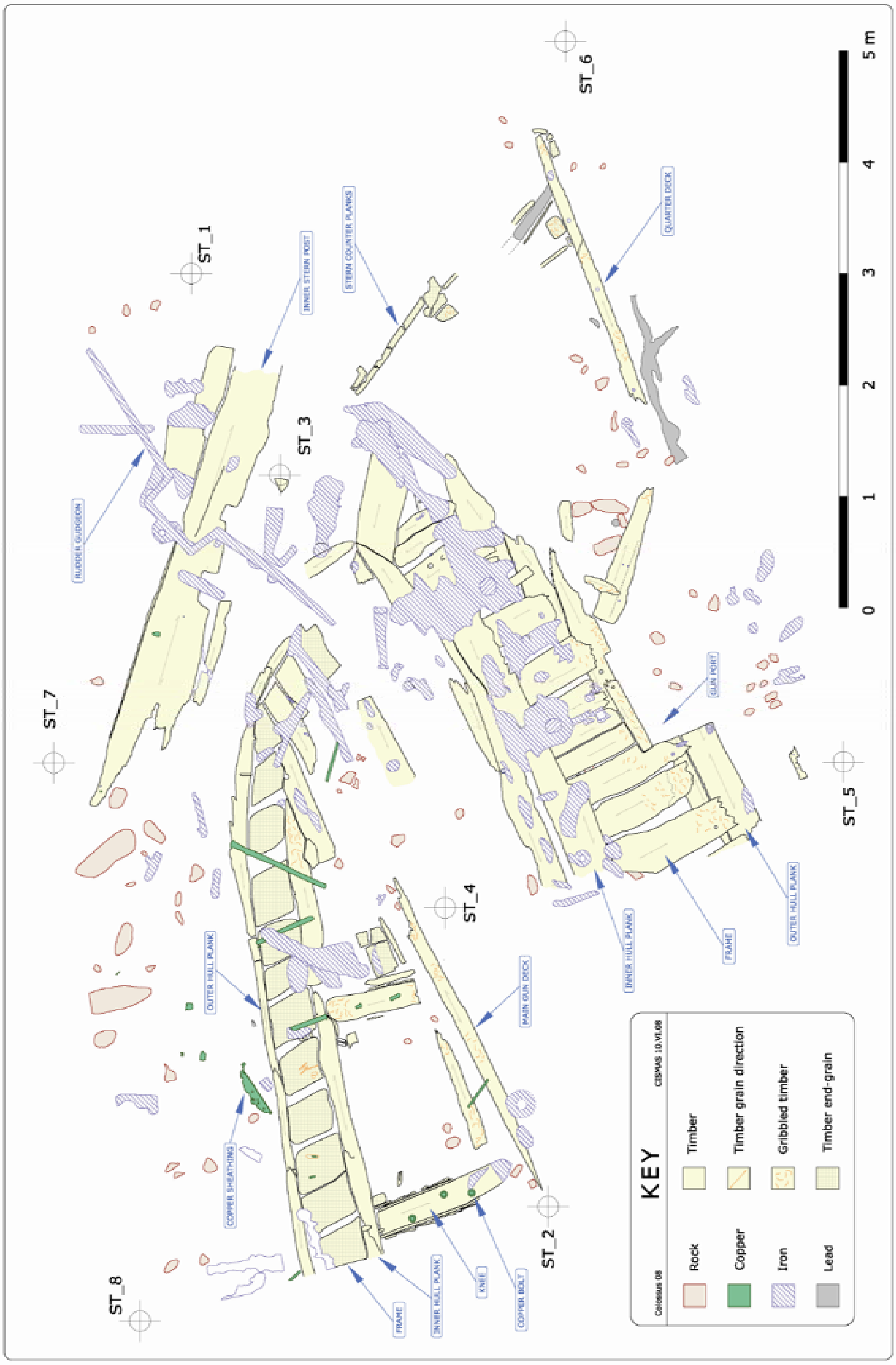



*Figure 18*
*Seabed sign in place on the seabed*

## 2008 planning frame survey



# Compact Disks

CD1 Contents

This report as an Adobe PDF file
Selected photographs as JPEG files
The site plan as an Adobe PDF file

CD2 Contents

The Site Recorder survey file
Containing the site plan, images and primary data in a self-installing file that can be viewed with the included Site reader program

## Previous Reports

There are now a considerable number of reports concerning the work already undertaken on *Colossus*. These have been produced by various authors and for this reason they are listed below. Those by the author and CISMAS are available to download as PDF files from the CISMAS web site at www.cismas.org.uk .

| | |
|---|---|
| *HMS Colossus* (Hutchinson 1979) | Roland Morris |
| *HMS Colossus* (IMAS Excavating Ships of War) | Ann Birchall |
| Finds from Scillonian Wrecks (IJNA 13.2 1984) | Roland Morris |
| Big Guns from the Seabed (IJNA 13.2 1984) | Roland Morris |
| More Finds from Scilly Islands Wrecks (IJNA 13.3) | Roland Morris |
| Vases & Volcanoes (BM 1996) | Ian Jenkins & Kim Sloan |
| *HMS Colossus* Project Design 2001 | Kevin Camidge |
| *HMS Colossus* Project Design 2002 | Kevin Camidge |
| Stabilisation Trial Project Design | Kevin Camidge et al |
| Stabilisation Trial Final Report | Kevin Camidge et al |
| *HMS Colossus* Survey Report 2001 | Kevin Camidge |
| *HMS Colossus* Survey Report 2002 | Kevin Camidge |
| *HMS Colossus* Survey Report 2003 | Kevin Camidge |
| *HMS Colossus* Desk-Based Assessment (2003) | Wessex Archaeology |
| Fragments from Sir William Hamilton's Second Collection of Vases Recovered from the Wreck of *HMS* Colossus (BM Fascicule 10 2003) | Valerie Smallwood & Susan Woodford |
| *HMS Colossus* Survey Report 2004 | Kevin Camidge |
| *Colossus* Revisited (Minerva Aug 2004) | Ann Birchall |
| *HMS Colossus* Debris Field Survey 2004 | CISMAS |
| *HMS Colossus* Debris Field Survey 2005 | CISMAS |
| *HMS Colossus* Designated Site Assessment (2005) | Wessex Archaeology |
| The Search for Colossus (2006) | CISMAS |
| *HMS Colossus* Survey Report 2006 | Kevin Camidge |
| *HMS Colossus* Designated Site Assessment (2007) | Wessex Archaeology |
| Wreck of Colossus – The Find of a Lifetime (2007) | Todd Stevens |
| *HMS Colossus* Conservation and Management Plan | |
| English Heritage (2007) | Mark Dunkley |
| *HMS Colossus* Survey Report 2007 | Kevin Camidge |

## Appendix I – Terram 4000 Data Sheet

# Terram – Thermally Bonded Nonwovens

TERRAM
Geosynthetics
**data**
P1 Data GB
03 May 2001 • 1 of 2

| Product Grades | | 500 | 700 | 900 | 1000 | 1300 | 1500 | 2000 | 3000 | 4000 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mechanical Properties – control** | | | | | | | | | | |
| Wide width strip tensile | | | | | | | | | | |
| EN ISO 10319 | | | | | | | | | | |
| - Mean peak strength | kN/m | 3.0 | 6.0 | 7.5 | 8.0 | 10.5 | 12.5 | 14.5 | 18.0 | 22.0 |
| - Elongation at peak strength | % | 35 | 25 | 28 | 28 | 28 | 30 | 30 | 33 | 33 |
| CBR puncture resistance | | | | | | | | | | |
| EN ISO 12236 | | | | | | | | | | |
| - Mean peak strength | N | 525 | 1050 | 1350 | 1500 | 2000 | 2250 | 2750 | 3250 | 4300 |
| Trapezoidal tear resistance | | | | | | | | | | |
| ASTM D4533 | | | | | | | | | | |
| - Mean peak strength | N | 175 | 225 | 275 | 300 | 425 | 475 | 575 | 700 | 900 |
| **Mechanical Properties - consequential** | | | | | | | | | | |
| Wide width strip tensile | | | | | | | | | | |
| EN ISO 10319 | | | | | | | | | | |
| - strength at 5% strain | kN/m | 1.3 | 2.6 | 3.2 | 3.4 | 4.3 | 4.7 | 5.5 | 6.3 | 7.5 |
| **Hydraulic Properties - consequential** | | | | | | | | | | |
| Pore size | | | | | | | | | | |
| EN ISO 12956 | | | | | | | | | | |
| - Mean AOS $O_{90}$ | μm | 300 | 180 | 160 | 150 | 130 | 125 | 110 | 100 | 85 |
| Permeability | | | | | | | | | | |
| EN ISO 11058 | | | | | | | | | | |
| - $VI_{H50}$ | | | | | | | | | | |
| - 5cm head | $10^{-3}m.s^{-1}(l/m^2.s)$ | 150 | 130 | 105 | 100 | 80 | 75 | 65 | 55 | 45 |
| **Physical Properties - typical** | | | | | | | | | | |
| Mass per unit area EN 965 | $g/m^2$ | 65 | 90 | 115 | 125 | 160 | 180 | 215 | 260 | 335 |
| Roll width | m | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 |
| Roll length | m | 200 | 150 | 150 | 100 | 100 | 100 | 100 | 100 | 50 |
| Roll weight | kg | 65 | 65 | 85 | 65 | 80 | 90 | 105 | 125 | 80 |

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Certificate No: FM 22730

# Property Description

TERRAM
Geosynthetics
data

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## Control Properties

Control properties are those properties that are statistically controlled during manufacture of the product. The results quoted are the family means of the appropriate tests derived over periods of time. Other statistical parameters are available on request.

## Consequential Properties

Consequential properties are those properties which arise as a consequence of the manufacturing process. Furthermore, the test methods used to evaluate these properties do not have the required level of reproducibility to be used as control tests. The result quoted are the family means of the appropriate tests derived over periods of time.

## Typical Properties

Typical properties are family means of the appropriate tests derived over periods of time.

## Composition and Environmental Behaviour

### Composition

70% polypropylene / 30% polyethylene.

### Chemical Resistance

Alkali - Resistant to all naturally occurring soil alkalis.
Acid - Resistant to all naturally occurring soil acids, (i.e. to acids of pH≥ 2).

### Biological Resistance

Terram is unaffected by bacteria, fungi, etc. Since it is not a source of nourishment, rats and termites will not eat the product as food.

### Reaction to Temperature

The tensile strength of Terram decreases with increase in temperature, but recovers fully when the geotextile is returned to normal ambient temperature.

### Exposure to Sunlight

Terram is delivered in coloured polyethylene wrappers to protect it from the harmful effects of ultra-violet rays: it is recommended that it remains wrapped until it is to be used.

In most applications geotextiles are exposed to direct sunlight for only short periods during installation; the degree to which they resist the effects of UV light is, therefore, of no significance.

For projects where prolonged exposure is inevitable Terram Ltd offers special Terram grades with UV resistance to match the requirement. In these grades the UV light resistance is enhanced by appropriate stabilisers in the polymers, so that they retain over 50% of their original strength after exposure to 70,000 Langleys of solar radiation. All other properties are identical to the corresponding standard series Terram presented in the data sheet. Terram products with enhanced UV resistance carry the suffix UV (e.g. Terram 1000 UV).

## Notes

1 The mean tensile strength and tear resistance values quoted are the mean values of either the length or cross directions, whichever is the lower.
2 For a full description of the test procedures quoted please refer to the specific methods of test.
3 Where widths or lengths greater than those supplied on one roll are required, jointing is normally effected by simple overlapping. However, depending upon application, subgrade conditions, material loading, convenience and cost, alternative methods (pegging, sewing, stapling or gluing) may be used. Please refer to the Terram Jointing Methods leaflet for more details.
4 As part of its continual improvement process Terram Ltd reserve the right to change the properties listed on this data sheet without prior notice.