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# London Gateway Clearance Programme: Wreck Site of 19th Century Paddle Steamer Sea Reach No. 1

Detailed Recording of the Maritime Material Stored at London Gateway





**London Gateway Clearance Programme:  
Wreck site of 19<sup>th</sup> century Paddle Steamer  
Sea Reach No. 1**

**Detailed Recording of the Maritime Material Stored at London Gateway**

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## Detailed Recording of the Maritime Material Stored at London Gateway

### Contents

Summary .....	ii
Acknowledgements.....	iii
<b>1 INTRODUCTION.....</b>	<b>4</b>
<b>2 BACKGROUND.....</b>	<b>4</b>
<b>3 METHODOLOGY.....</b>	<b>5</b>
<b>4 RESULTS .....</b>	<b>5</b>
4.2 Paddle wheel.....	6
4.3 Engine.....	6
4.4 Hull.....	8
4.5 Anchors and Machinery.....	8
<b>5 REFERENCES.....</b>	<b>9</b>
5.1 Published and grey literature sources.....	9
5.2 Online sources .....	10
5.3 Contemporary sources .....	11

### Figures

- Figure 1 Site Location  
Figure 2: Drawing of the cylinder and the engines assembled  
Figure 3: Plans of *Achilleus*' engines, built by Hepple in 1867  
Figure 4: Photograph of Eppleton Hall tug port wheel

### Plates

- Plate 1: Model of the paddle wheel  
Plate 2: Model of cylinder #1  
Plate 3: Model of engine bedplate  
Plate 4: Model of Hull section  
Plate 5: Model of Keel section  
Plate 6: Model of windlass  
Plate 7: Model of Anchor



# **London Gateway Clearance Programme: Wreck site of 19<sup>th</sup> century Paddle Steamer Sea Reach No. 1**

## **Detailed Recording of the Maritime Material Stored at London Gateway**

### **Summary**

This report presents the results of a survey commissioned by DP World London Gateway Port Limited to record the machinery and ship structure that was recovered during the removal of an obstruction on the seabed located close to the Sea Reach No. 1 Buoy (Zone 38), at the eastern limit of the Yantlet Channel (UKHO obstruction No. 81149) in 2014.

Due to the lack of storage and conservation facilities on site during the clearance, a number of potentially diagnostic large objects were retained in order to allow the retained archaeologist to carry out a detailed recording at a later stage. These objects were transported and stored at the facilities of DP World within the London Gateway Development and this report is the result of a detailed digital survey carried out on the 4<sup>th</sup> and 5<sup>th</sup> of August by Wessex Archaeology.

The clearance operation produced significant amount of the ship's structure, internal components and small finds, comprising at least the remains of one vessel along with other likely intrusive contemporary and later items. The variety and exceptional condition of the material provides an example of an assemblage belonging to a working vessel operating in the Thames during the mid to late 19<sup>th</sup> century.

The material removed from the seabed as part of this clearance was subject to detailed assessment and identified as having originated from an iron paddle steamer powered by feathering side-wheels and driven by twin grasshopper steam engines, possibly built by a Tyne and Wear shipyard.

The survey resulted in a 3D record of each of the objects by means of photogrammetry. Also traditional techniques such as hand drawing and tape measurements were used.



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## **Detailed Recording of the Maritime Material Stored at London Gateway**

### **Acknowledgements**

This assessment was commissioned by DP World London Gateway Port Limited. Wessex Archaeology would like to acknowledge the assistance of Chris Webb and Marcus Pearson of London Gateway Port Limited.

Wessex Archaeology would also like to thank George Dickinson, Volunteer at Markham Grange Steam Museum, Doncaster, where the Hepple port engine from the paddle tug "Old Trafford" / "Reliant", complete with feathering paddle wheel, was restored to working condition (by electric motor). The fieldwork was carried out by Croce Paolo who also compiled this report. Quality control was provided by Toby Gane. Kitty Foster prepared the illustrations and the project was managed for Wessex Archaeology by Toby Gane.



# London Gateway Clearance Programme: Wreck site of 19<sup>th</sup> century Paddle Steamer Sea Reach No. 1

## Detailed Recording of the Maritime Material Stored at London Gateway

### 1 INTRODUCTION

- 1.1.1 Wessex Archaeology (WA) was commissioned by DP World London Gateway Port Limited (hereafter London Gateway) to undertake an archaeological survey of the material stored at the facilities of London Gateway and recovered during planned obstruction clearance, by means of grab dredger, undertaken by the contractor Herbosch-Kiere on behalf of the Port of London Authority (PLA).
- 1.1.2 This report follows a report on the archaeological watching brief undertaken during the clearance of the obstruction and a post-clearance assessment report that were prepared in 2014 and 2015 (WA 2014, 2015b).

### 2 BACKGROUND

- 2.1.1 The material was recovered during clearance operations by grab by the clearance vessel *Atlantis* between the 31st March and the 4th April 2014 during the removal of an obstruction on the seabed located close to Sea Reach No. 1 Buoy.
- 2.1.2 These large artefacts selected for further recording were stored at Denton Wharf by the Port of London Authority (PLA) and then transported to the facilities at London Gateway where they are currently stored.
- 2.1.3 The evidence gathered during the watching brief and the post-clearance assessment suggests that the obstruction was a wreck that was propelled by feathering side-wheels and the machinery driven by twin grasshopper steam possibly built by a Tyne and Wear shipyard. The vessel was tentatively identified as the *Admiral*, an iron paddle tug built in 1870 and sank off the Nore in February 1872 after colliding with a steam collier, *Rajah*.
- 2.1.4 The *Admiral* was propelled by a Hepple tug engine and there are apparently very few drawings in existence of this type of tug engine and paddle wheels. Of the only two that Wessex Archaeology was able to find, one is contained in the publication "British Steam Tugs" (Thomas 1991), whilst the other is a drawing of the engine plans for another paddle steamer constructed by Hepple in 1876. However even though the drawing presents similar characteristics to the engines recovered, they fail to show all the arrangements and construction details that were observed in the recovered objects. Similarly, Wessex Archaeology was able to find only one photograph showing the arrangement of the feathering paddle of Hepple's wheels.
- 2.1.5 Further information on the watching brief operations together with an initial interpretation of the finds recovered during the clearance are presented in a previous WA report (WA 2014). A Clearance Mitigation Statement has also been produced that presents an overall history of the site since 2001 together with a summary of the clearance activities and proposed post-clearance mitigation (WA 2015).



### 3 METHODOLOGY

- 3.1.1 The assemblage of the recovered material was recorded with the use of multi-image photogrammetry as suggested in the post-clearance assessment (WA 2015). The use of this technique allowed to the creation of 3d models of each objects with sub-centimetre accuracy. The models were then used for producing high-quality elevations and measured line drawings of the artefacts.
- 3.1.2 Standard archaeological recording techniques such as taped measurements, measured drawings and still photography were also used.
- 3.1.3 The finds were cleaned of Thames sediment and searched for markings before starting the archaeological recording.
- 3.1.4 The images of engine plans for another paddle steamer constructed by Hepple in 1867, *Achilleus* that were taken from the Tyne and Wear Archives were used to compare with the recovered engine elements to aid identification of the different parts.
- 3.1.5 Photographs of the main part of the machinery were sent to Paddle Steamer expert George Dickinson who provided invaluable technical comments and helped with the identification of the machinery parts.
- 3.1.6 The photograph of the arrangement of the starboard wheel of the tug *Eppleton Hall* was used for comparison with the wheel.

### 4 RESULTS

- 4.1.1 A total of 13 large finds were recorded during the survey and the assemblage includes part of the machinery, sections of hull and two anchors. Of these the majority is clearly associated with the grass hopper engine of a paddle tug. Within the remaining objects one of the two hull section, the two anchors and the windlass may be not directly associated with the main wreck.
- 4.1.2 All the material stored at London Gateway has been recorded using photogrammetry and a 3D model produced for each of the artefacts.
- 4.1.3 The finds recorded at London Gateway at the time of the survey are:

WA ID	Find description	Plates
WA3022	Feathering paddle wheel	Plate 1
WA3079	Paddle wheel float	
WA3044	Cylinder #1	Plate 8
WA3046	Cylinder #2	Plate 9
WA3047	Vacuum pump	Plate 2
WA3210	Engine bedplate	Plate 3
WA3025	Section of coupling wheel with engine frame	Plate 6
WA3080	Hull section with 3 frames and reversed frames, floors, keel, wooden ceiling still attached, bitumen in the bilge	Plate 4



WA3216	Keel section	Plate 5
WA3144	Bow riveted	
WA3145	Windlass	Plate 6
WA3071	Admiralty pattern anchor	Plate 7
WA3068	Admiralty pattern anchor	

## 4.2 Paddle wheel

- 4.2.1 The paddle wheel (possible radius c. 1.920m, width 1.230m) is fitted with feathering gear. This feature allows the adjustment of the angle at which the paddles entered the water so that the paddles are aligned to be almost vertical and produce a more efficient thrust. The construction includes two large rings and two smaller ones and several radial smaller fixed spokes. At least one flat diagonal cross braces from the hub to spoke is visible within the entanglement and thin horizontal iron cross between corresponding spokes in the inner and the outer rings for rigidity. There are at least five floats in different but fragmented states still attached to their pivots. They all seem to be broadly the same size (1160 by 690mm). Each float is made from three wooden planks fixed together by two iron bands and fixed with four square headed bolts. On the other side a similar arrangement fits the brackets with a pin bearing to a corresponding pivot on a spoke. Feathering arms and brackets to support the floats are visible. Those of the *Reliant* were made of elm which seems to be the same wood species used in these floats. However no analysis has been carried out on the wood and the species of the wood used for the floats cannot be confirmed.
- 4.2.2 The paddle wheel is in a poor condition as result of the recovery by grab. Many key parts such as the feathering hub are missing and the rings are twisted as a consequence of the way it was recovered. A single and separated float was recorded and shows similar characteristics to those still attached to the wheel.
- 4.2.3 George Dickinson suggested that the feathering arrangement was not articulated by a separated hub as in *Reliant* but by an eccentric located on the shaft that rotated the wheel. This arrangement is suggested by the presence of a disc-like feature (eccentric<sup>1</sup>) in a mass of metal in the middle of the long shaft (**WA3012**). Unfortunately the shank has been lost during recovery but photographs taken at the time of the recovery shows the shaft having an eccentric and crank at one end and a disc that it is likely to be a bearing at the other extreme, and the possible eccentric for the feathering mechanism in the middle. The other eccentric, located near the crank arm, is also important as it is very likely to be the one for the starboard engine main valve.
- 4.2.4 The arrangement of the paddle construction is similar to the one shown in the photograph of the starboard wheel of *Eppleton Hall* during renovation and maintenance (**Figure 2**) albeit of much lighter construction (pers. Comm. Dickinson).

## 4.3 Engine

- 4.3.1 The vessel's propulsion system consisted of two feathering side paddle wheels propelled by two single cylinder 'grasshopper' beam engines. A total of sixteen constituent parts of the propulsion system were identified during the watching brief.

<sup>1</sup> An eccentric is a disc or a wheel mounted on a revolving shaft for converting rotary motion to reciprocating motion. Its centre is offset from that of the axle, hence the terminology.

- 4.3.2 Both the single cylinders of the two engines were recorded (c. 2090mm by 850mm by 860mm). The cylinders have a condenser close-coupled below it (diameter of the bore 650mm/25.5ins) and bolted with large square headed bolts. Only one of the cylinders still retains the grid on which the expansion valve is mounted although the valve is not present. Behind it the main slide valve is visible. The flat faces to which the upper valve operating platform was bolted are also visible. The large copper pipes on each side conveyed the exhaust steam from the valve chest to the condenser. The pipes (two for each engine) are in different states of preservation: one of the pipes of **WA3044** is truncated and the other missing whilst the pipes of **WA3046** are still complete and have only suffered light damage. From the shape of the condensers and the absence of tubes in them they are likely to be jet condensers. The function of the jet condenser is to spray sea, canal or river water into the exhaust steam to condense it. Flow control valves are present on the two condensers.
- 4.3.3 On the cylinders there seems to have been an expansion valve mounted on the grid as a remaining part is visible outside the main slide valve. It has been observed (G. Dickinson pers. Comm.) that this valves would require its own separate eccentrics to work, therefore the total of eccentrics needed to run the pair of engines was four: two for the main valves and two for the expansion valves. These valves would be coupled to the discs of the eccentrics via gabs and the whole arrangement balanced with weights. However, the arrangement of the links that drove the expansion valve is at the moment not clear. The drawing of side lever engine published in *British Steam Tugs* (Thomas 1991: 199) shows the expansion valve as being driven via a Gooch type link, whereas *Reliant* is described as having completely different arrangement (Dickinson 2007). In fact the location of the eccentrics seems to have similar order to the one of *Reliant* where *"the expansion valve eccentrics are between the engines (and only usable when the engines were coupled and going ahead), and the main valve slip-eccentrics are outboard"* (G. Dickinson pers. Comm.).
- 4.3.4 **WA3025** is the section containing the joining shaft between the two engines. It contains the remains of the dog-clutch-plate that enabled the two engines to run independently, the inner main bearing and part of the engine frame (possibly of the port engine), a loose fixture made of brass or bronze and interpreted as a possible eccentric, a rusty mass that has been provisionally identified with the remains of an iron eccentric, and a large thin circular disc which is also a possible eccentric. The space on the shaft that follows was probably the location for the starboard inner main bearing, and the crank arm of the starboard engine with the clamp with four bolts retaining the bronze insert in which the crankpin rested (now missing).
- 4.3.1 **WA3047** is a pump, very possibly an air pump. As the lower end it is broken it was possible to measure the internal bore (460mm/ 18ins). The height is 940mm/37ins.
- 4.3.2 The presence of two independent engines suggests that the machinery was likely to be a tug for river or in-shore use, because sea-going boats are unlikely to have had disconnectable double engines (Dickinson 2007).
- 4.3.3 In the drawing of the engine from the Tyne and Wear archives (**fig 2**) there seems to be two eccentrics between the engines, which are also apparently in **WA3025**. However the other two discs needed for the main valves are not shown and unfortunately the drawing does not show details of the valve arrangements. Hence it appears that the engine in the drawing is incomplete and only partially corresponding to the recovered engine because it shows no method of driving the engines' main valve and this connection is required for any pair of disconnectable engines (Dickinson pers. Comm.).
- 4.3.4 No manufacturer marks were evident on any section of the above material.

#### 4.4 Hull

4.4.1 Two sections of hull were surveyed were selected for detailed recording.

4.4.2 **WA3080** is a hull section (approximately 3 by 4.25 by 1m) and consists of three iron floors and four longitudinal elements assembled by rivets. The rivets are mostly pan headed rivets and the section of the hull is a single skin type of construction (Corlett 1990). Two planks (total width 420mm length 1.5m) of the original wooden ceiling are still in place retained on top of the floor by two longitudinal angles of unequal flanges (Stokoe 1996). The spacing between the floors is a maximum of 550mm and plate riveting was 150mm. Only single or chain riveting is present. The floors are solid riveted plate floors with no apparent manholes and two reverse frame (L bars) on the top and two bottom frames. The hull seems to be externally flush and the longitudinal strength is provided by several longitudinal bars between the floors. These are reinforced by the use of side girders. On the side of the section a bilge or side keelson formed by a longitudinal bar (single plate keelson) is connected to the floors with an angle bar. A plate with squared holes is riveted with an angle frame to the upper part of the side keelson. The maximum moulded dimension of the floors at the centre line was 330mm and sided dimensions were c. 140mm with each floor doubled meaning that two frames of c. 70mm were placed alongside each other. Another similar longitudinal angle is opposite on the portside of the midline suggesting more planking on that side. Drain hole spacing was c. 170mm. The maximum beam was 3.70m although difficult to measure due to the condition of the section. Traces of bitumen or another bituminous sealing substance is present over up to the bilge covering frames and rivets. Unfortunately no plating was found attached to the frames. The condition of the structure is poor and suffered from several impacts during the recovery.

4.4.3 **WA3216** is another and smaller (c. 3.4 by 2.4 by 0.7m) section of hull. It retains the keel bar, four plates in different states of preservation, and three floors (spacing 503mm). The arrangement of rivets on the garboard strake indicates that three floors are missing. The section is assembled with closely spaced pan head rivets and a layer of bitumen covers rivets, floors and plates at the level of the bilge. Circular bilge holes are visible and one still retains the wooden peg used as a plug. A butt strap with chain riveting runs on the garboard strake. The floors are made by solid V shaped beams attached to the plating with single angle frames riveted with a single line of rivets (rivet spacing 160mm - 140mm but closer as the strakes overlap). The plates (700mm) are in clinker fashion and fastened together by a single line of close spaced rivets (c. 65mm). This section of the hull does not retain any longitudinal elements apart from the keel. The keel (4m by 136mm) is made of a thick iron beam (25mm) attached to the turn of the two garboard strakes with rivets in a zig zag pattern. From the V shape of the frames it is very likely this section comes from one of the ends of the ship, possibly the bow. The section is very worn and the iron was brittle at the time of the survey.

4.4.4 Another section of hull includes the extent of the prow where the port and starboard stringers meet (**WA3156**). This section is quite small measuring less than 1.5m by 0.7m and presents a potential slot for a stanchion or a pole at the very end.

#### 4.5 Anchors and Machinery

4.5.1 Two admiralty pattern anchors were recovered during clearance works (**WA3068** and **WA3071**). The larger (**WA3068**) has one arm of the iron stock broken whilst the other arm is complete and still retains the ball. On the section of the broken arm of the stock hole for the retaining pin can be seen. The stock's eye diameter is c. 120mm and the remaining arm of the stock is c. 1.8m long. The shank is c. 3.2m long with diameter at the top measuring 150mm. The length of the fluke is 650mm (including bill) by a maximum width of 480mm. The distance between the bills is c. 1.75m.

- 4.5.2 The smaller one (**WA3071**) still retains the shackle and chain with studded links. The stock is complete with the retaining pin in place but an arm is bent. The shank length is c. 2.2m and diameter is 112mm. The length of the fluke is 420mm (including bill) by a maximum width of 330mm. The distance between the bills c. 1.3m.
- 4.5.3 **WA3145** is a wooden windlass. The overall length is 2.1m. The wooden barrel measures c. 1.6m and is octagonal in shape (side 120mm). Four of the iron whelps are still attached to one end of the wooden barrel. It is likely that there were eight whelps originally placed onto opposite faces of the barrel and divided in two groups of four at the two ends. At the centre an empty space (c. 140mm) suggests the location of the pawl rim.

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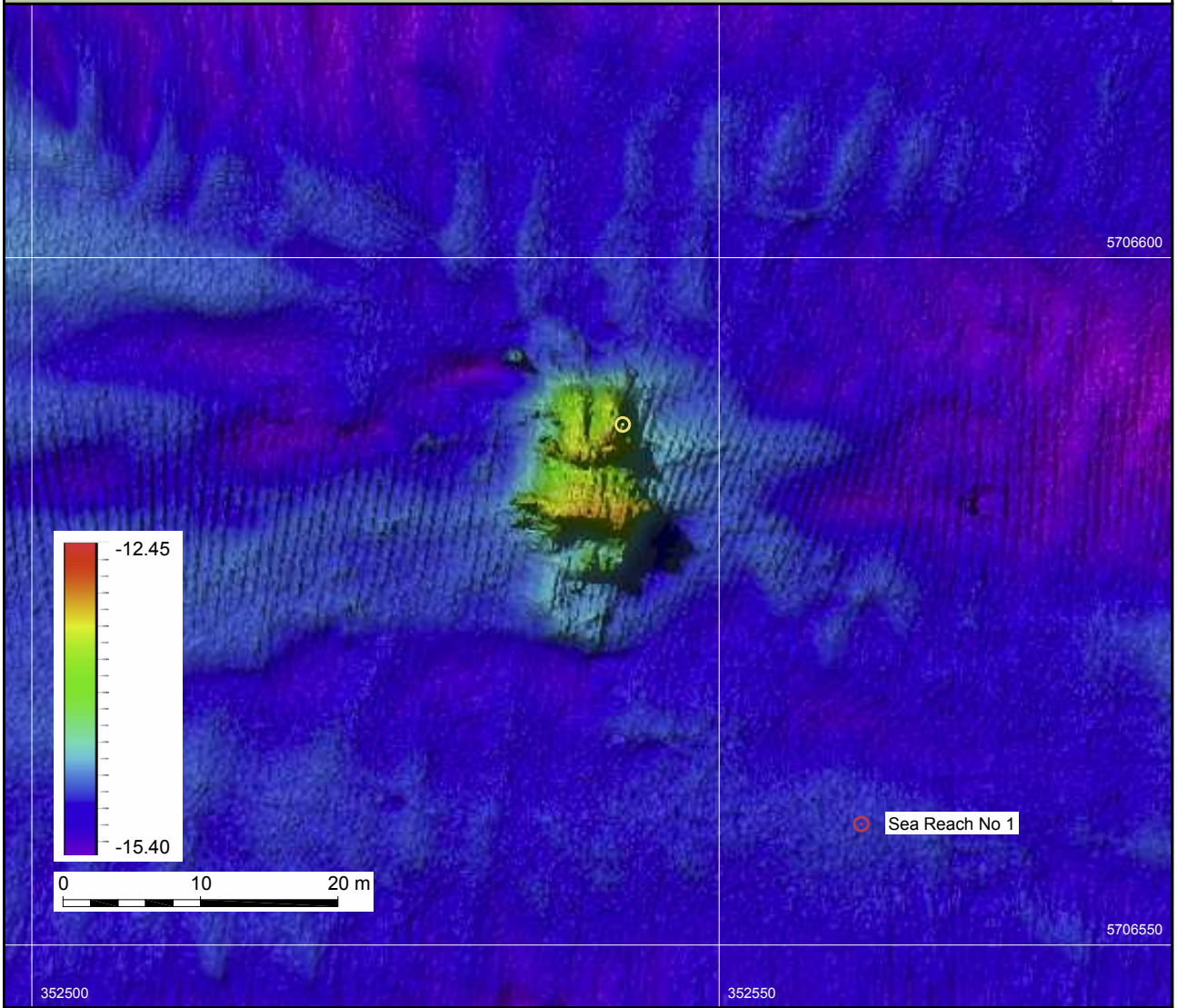





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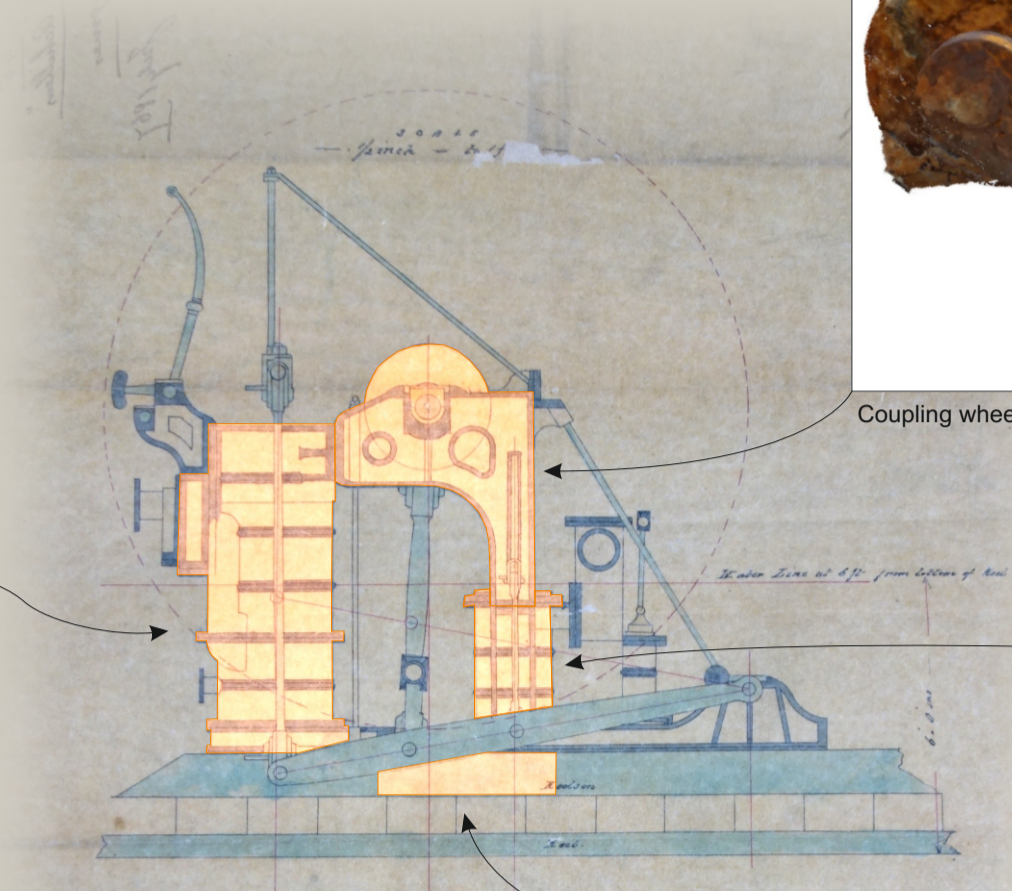
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Site location

Figure 1



Cylinder 2



Coupling wheel with engine frame



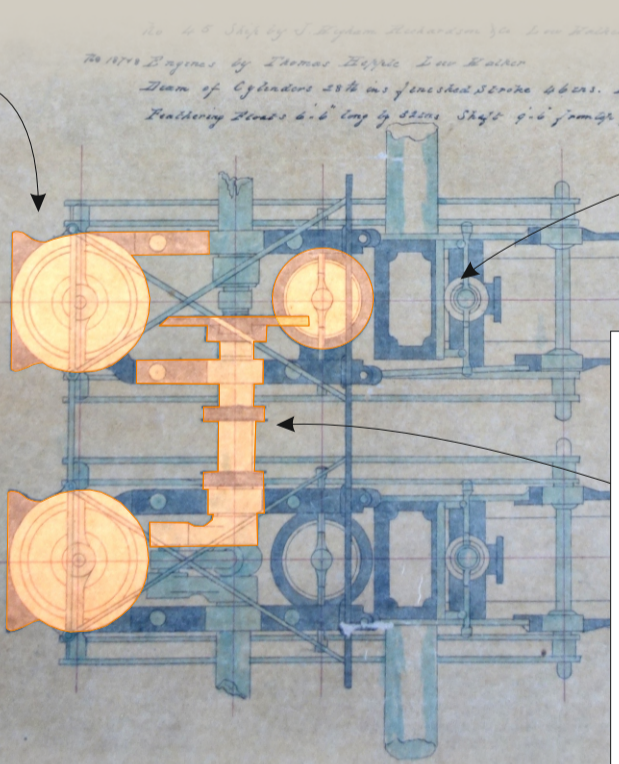
Air pump



Bedplate



Cylinder 1



Air pump



Cylinder 2



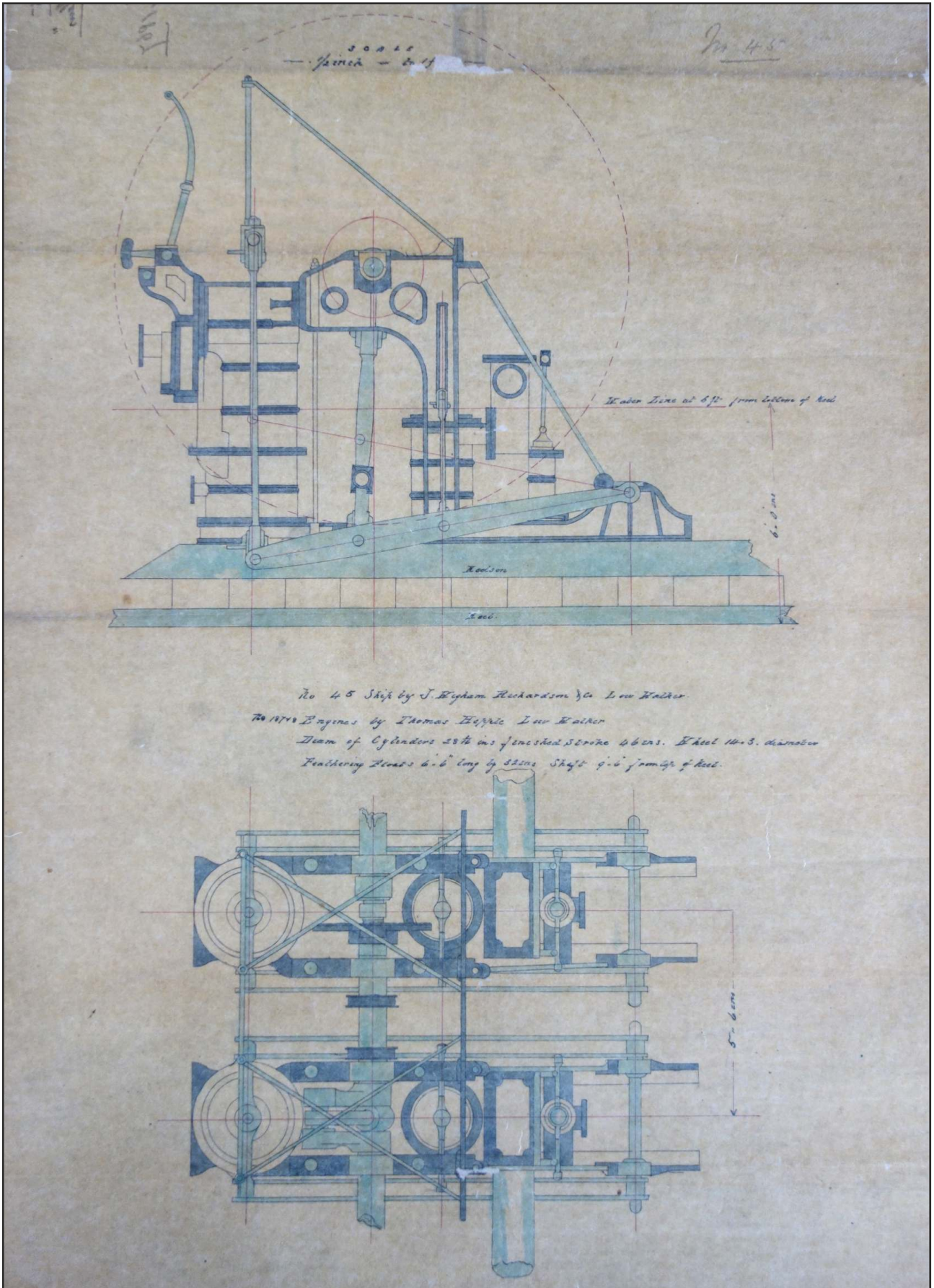
Coupling wheel with engine frame

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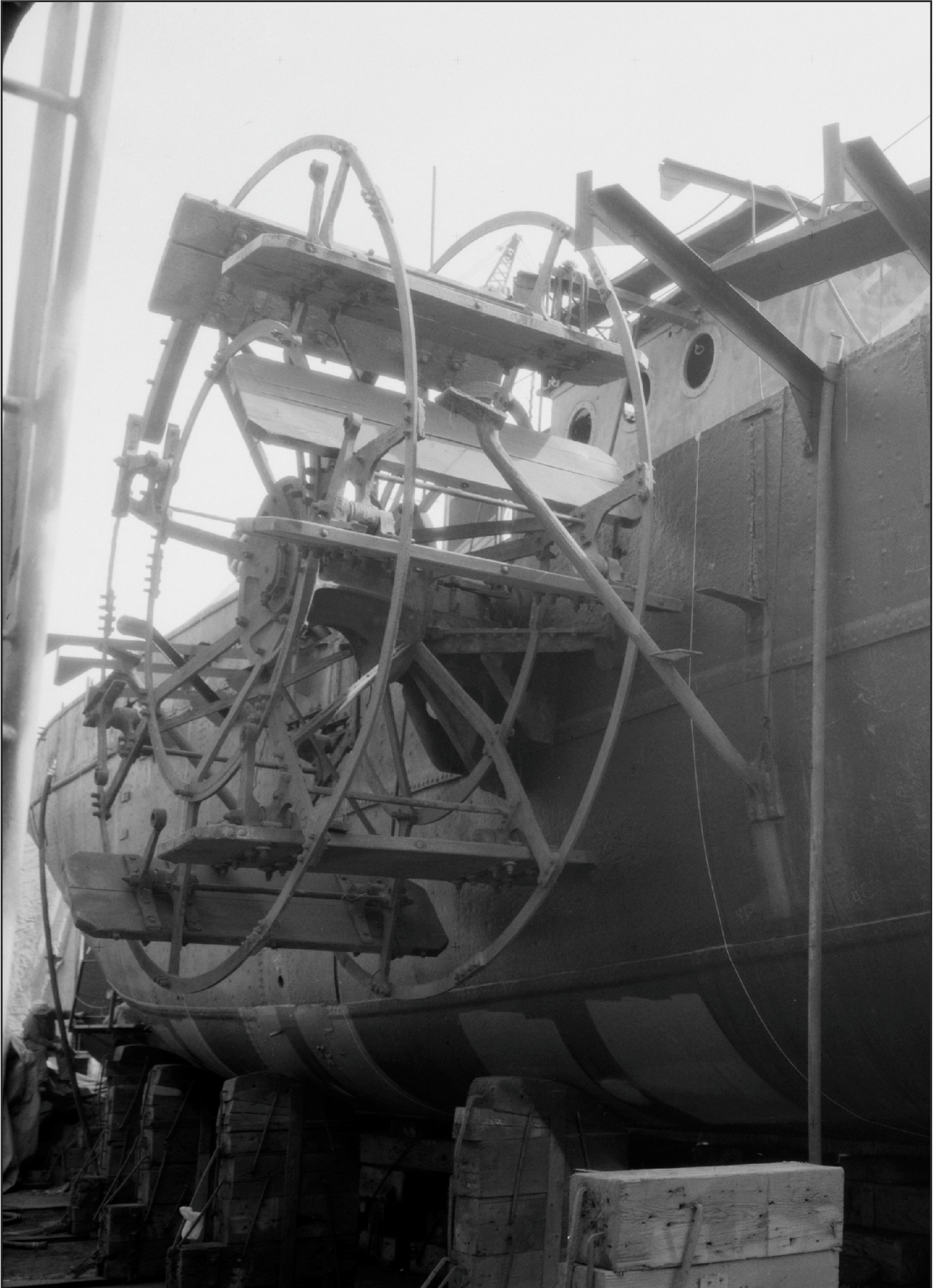
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Plans of *Achilleus'* engines, built by Hepple in 1867

Figure 3



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Photograph of Epbleton Hall tug port wheel

Figure 4



Plate 1: Paddle wheel


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Plate 2: Air pump



Plate 3: Baseplate



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Plate 4: Hull section

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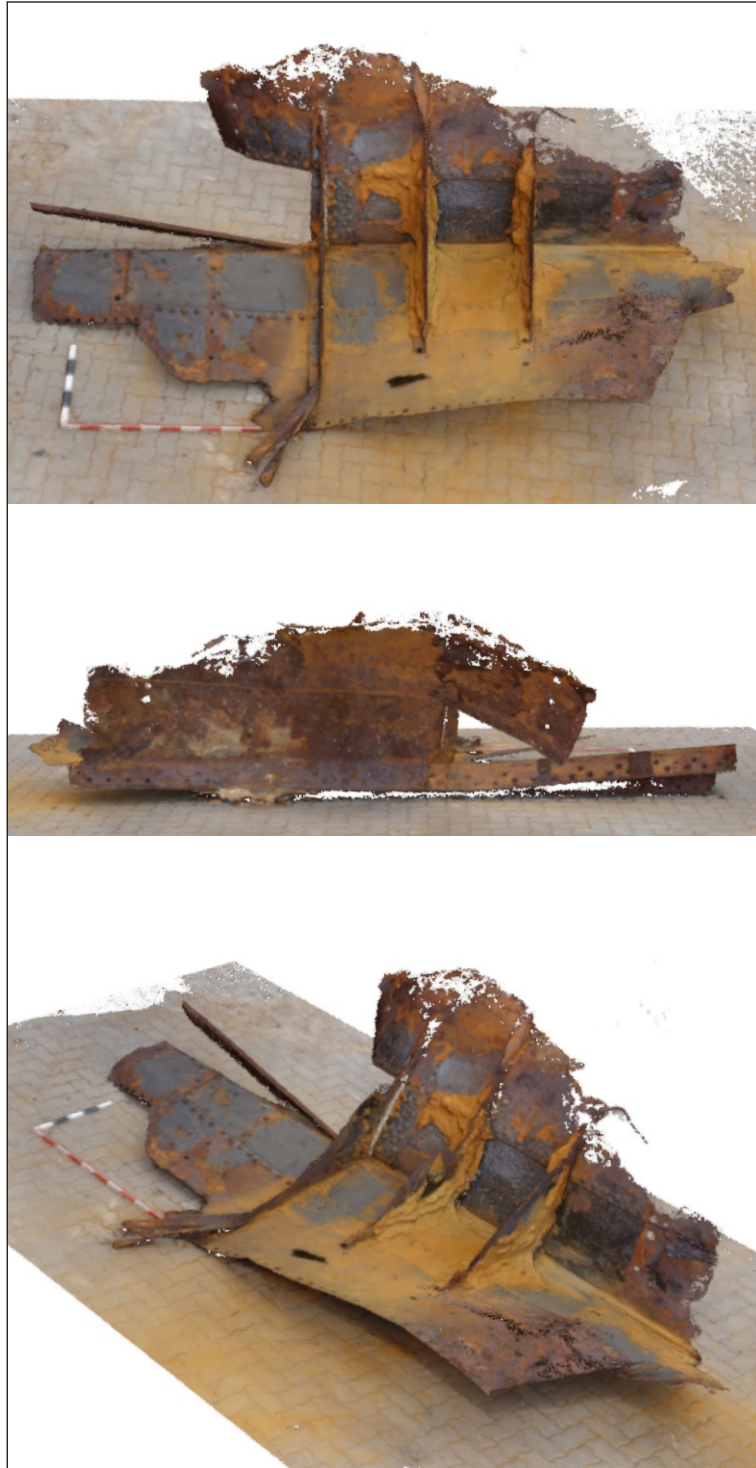


Plate 5: Keel section


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Plate 6: Windlass


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Plate 7: Anchor


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Plate 8: Cylinder 1



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Plate 9: Cylinder 2

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