Excavation and Recovery of the Carpow Logboat, Perth and Kinross.

Data Structure Report

Excavation and Recovery of the Carpow Logboat, Perth and Kinross.

Data Structure Report

David Strachan BA MIFA FSA Scot

with contributions by Mike Cressey, Theo Skinner, Anne Crone and Leeanne Whitelaw

February 2007

Perth and Kinross Heritage Trust,
4 York Place,
PERTH
PH2 8EP
T: 01738 477081
F: 01738 477089

www.pkht.org.uk

CONTENTS **page**

LIST OF ILLUSTRATIONS

1 NON TECHNICAL SUMMARY

This report documents the excavation and recovery of a prehistoric logboat from the inter-tidal zone of the Tay Estuary in July and August 2006. In addition it provides a summary of the discovery of the vessel and previous work carried out on the site; details the methodology and results of the excavation and recovery**;** gives an initial description of the vessel as uncovered during cleaning work in preparation for conservation; and outlines ongoing and planned recording and conservation work and plans for future study, publication, display and interpretation. The project was funded by Perth and Kinross Heritage Trust and Historic Scotland, with additional contributions from the National Museums of Scotland and Perth Museum and Art Gallery.

2 INTRODUCTION

2.1 Discovery

The discovery of a logboat, partially buried in inter-tidal mud-flats at Carpow Bank on the Tay estuary, was reported to Dundee Museum in August 2001 by Mr Scott McGuckin, an amateur metal-detectorist working out of Dundee (Strachan 2001). The discovery was then relayed to the Fife Council Archaeologist, who reported the find to Perth and Kinross Heritage Trust (PKHT) once it was realised that the site was located within the Perth and Kinross local authority area. In September of that year a site visit was made by staff from PKHT; Historic Scotland (HS); The Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS); the National Museum of Scotland (NMS) and Perth Museum and Art Gallery (PMAG). As a result, the find was confirmed to be logboat, with *c.*5m of the vessel exposed from the sands, gravels and estuarine mud. The exposed end, which was assumed to be the bow of the craft, was found pointing upstream, while the stern remained buried (Strachan 2004).

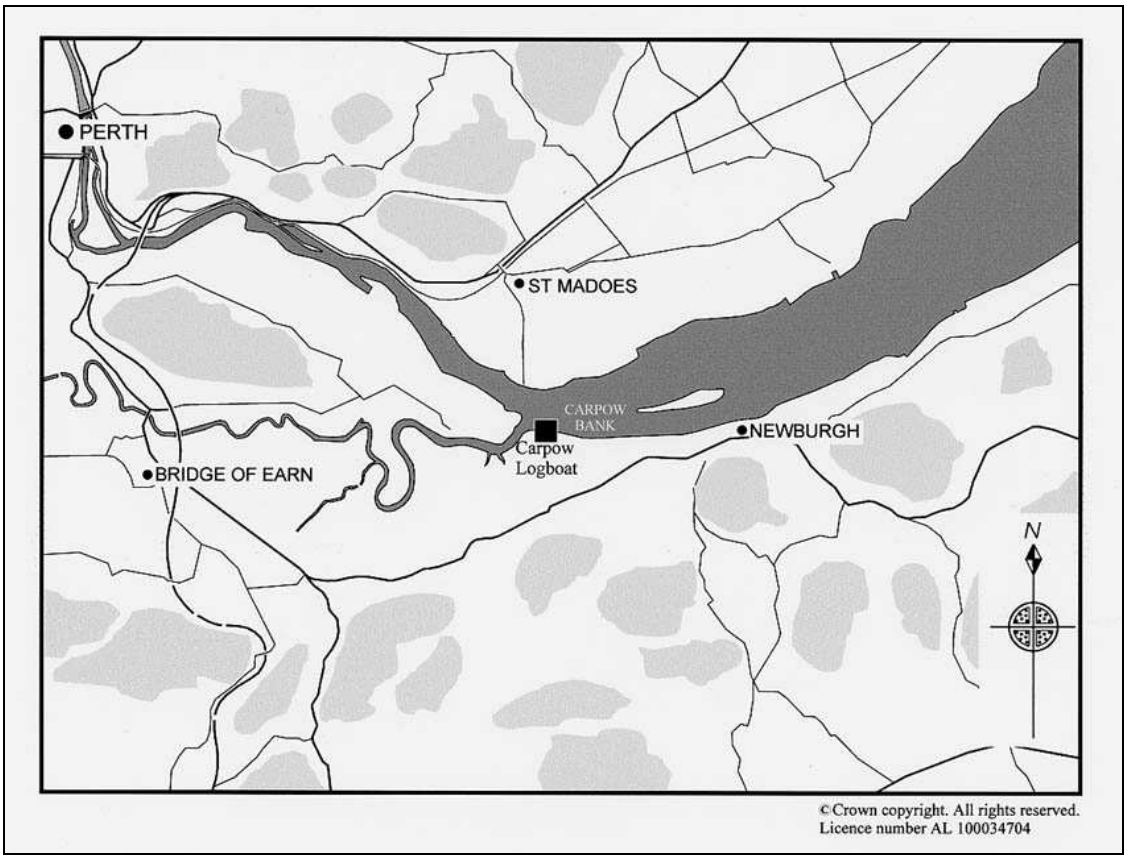
2.2 Location, Topography and Geology

The logboat (NMRS: NO21NW 161) was located on the lower inter-tidal zone of Carpow bank on the south side of the estuary at the confluence of the rivers Earn and Tay, the head of the estuary proper (Illus. 1 & 2). The site, which is in the parish of Abernethy, is within a number of environmental designations, including Site of Special Scientific Interest (SSSI) and Special Protection Area (SPA). The solid geology of the area is the Glenvale Sandstone formation which underlies most of the Tay estuary and the Carse of Gowrie. In terms of drift geology, the site is on the edge of the raised marine deposits (clay and silt) of Flandrian Age, which makes up most of the Carse of Gowrie and lower Strathearn.

The inter-tidal Carpow Bank is very low lying with the ground surface being at around -0.75m O.D. To the immediate south of the site, which is positioned at the very eastern edge of the low-lying river-valley of Strathearn, the land rises above the reed beds to around 10m O.D. Further to the south, above the modern Abernethy to Newburgh road the bottom of slope of the Ochil range begins at around 50 m O.D. rising to hills of between 200-300 m. To the west of the site, the River Earn oxbows along Strathearn which lies between 5-10m O.D. to the south of Moncrieffe Hill which rises from around 50m O.D. to a height of 223m O.D, with the river Tay running to the north. Directly north of the site, on the other side of the estuary, lies the

western edge of the Carse of Gowrie, an extensive low-lying area between 5-20m O.D. with the Sidlaw Hills to the north.

An initial NGR of NO 2001 1859 was collected with a hand-held Global Positioning System (GPS) during the evaluation work of 2003, giving an accurate location to within around 10m. This was found to be around 10m from the accurate location of the boat verified by DGPS (Illus. 3).



Illus 1: Location of the Carpow bank on the Tay estuary.

2.3 Inter-tidal Access

The tidal amplitude of the inter-tidal zone at Carpow Bank is seriously affected by the volume of water flowing downstream as result of rainfall and/or snow-melt carried by the River Tay and River Earn. Experience gained from site visits in 2002 showed that only low spring tides (with a predicted height of less than 1m O.D. at Dundee) preceded by a dry period of around one week ensured a workable tidal window of around 3-4 hours. In addition, however, wind direction and strength was found to effect the extent of tidal fluctuation at this part of the estuary, and as a result occasionally planned trips fulfilling the above conditions were aborted. In 2002, it was estimated that Carpow Bank was only exposed, with a workable tidal window, during the roughly twice-monthly spring-tides between June and August. On each of these occasions, the bank was revealed at each low tide for 4-5 days.

A familiarity with the tidal regimes, and the associated logistical problems, on this particular part of the estuary was developed during the evaluation work in 2002 and 2003. The nature of inter-tidal excavation can vary considerably from site to site according to a number of factors including the nature of the surviving archaeology and available tidal windows. The logistical implications of 3-4 hour inter-tidal

windows for archaeological excavation are significant. Water removal is required in the form of pumps and time required for pumping. In addition, the results of each window of excavation are largely disrupted by intervening tidal action and subsequent deposits.

Illus 2: Carpow bank at low tide showing the River Tay and River Earn on the left and the estuary, to the east, to the right.

3 PREVIOUS WORK (PRE 2006)

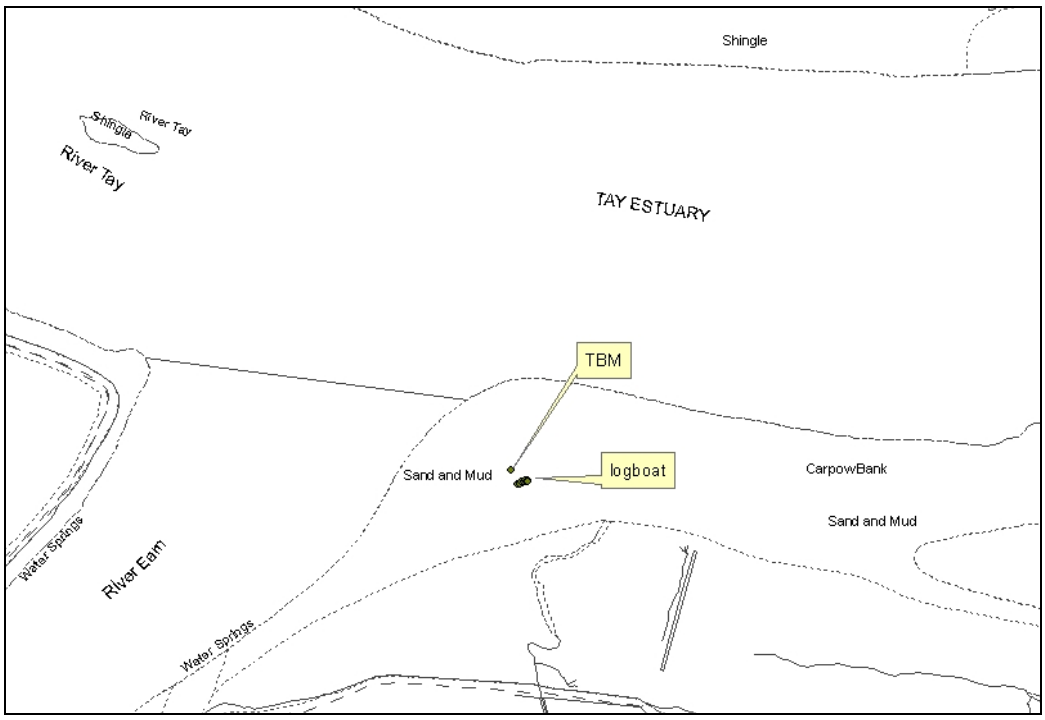
3.1 Aims of Previous Work

A strategy for initial recording, evaluation and *in situ* management were developed by PKHT, based on recommendations by HS, RCAHMS and the NMS further to the September 2001 meeting. As a result, a programme of evaluation was developed which had three main objectives:

- to establish the date of the vessel;
- to establish the condition of the buried portion of the vessel.
- to establish the full length of the vessel.

3.1.1 Dating (2001)

The first priority for evaluation was to establish the date of the vessel and so in October 2001, a sample was recovered from the bow of the vessel. This produced a single radiocarbon date (AA-45634 - GU-9597) with a radiocarbon age of 2885 ± 50 years BP, producing calibrated dates of cal 1130-970 BC (1 sigma) and cal 1220-910 BC (2 sigma). While it was ensured that the outer rings of the timber were used for dating, it was acknowledged that the sample came from the eroded bow of the vessel and that the outermost rings had been lost. Further to the evaluation work in 2003 it was recognised that a better sample could be recovered from the buried portion of the vessel where the timber was much better preserved.



Illus 3: Carpow bank showing the location of the logboat and the Temporary Bench-mark surveyed in using Differential GPS in 2006.

Early in January 2002, a sample of the eroded timber from the bow was identified as being of slow-grown oak, suitable for dendrochronology (Crone *pers comm*). Given the reductive nature of logboat manufacture, however, it was considered unlikely that dendrochronological study would be of value. It was recognised, however, that the accuracy afforded by a dendrochronological date would eradicate the old wood factor associated with radiocarbon dating (Fry 2000, 45-6). As result an assessment of suitability of the craft for dendrochronology was planned should the vessel be recovered.

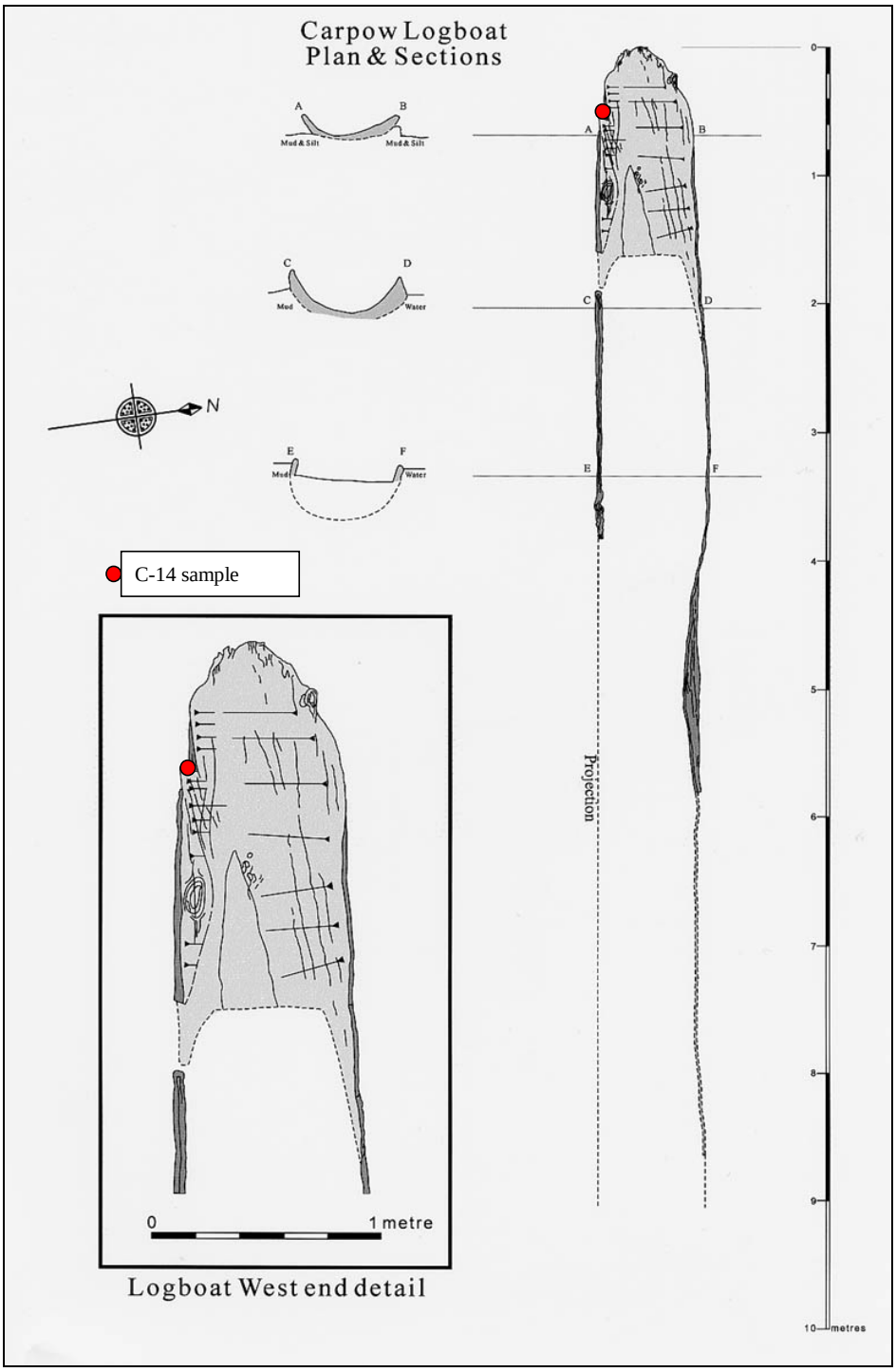
3.1.2 Condition of the Buried Portion at Bow (2002)

The first evaluation excavation was carried out in October 2002 (Strachan and Glendinning 2002) and aimed to assess the condition of the buried section of the vessel at the bow. It was recognised that the exposed portion of the vessel would be more eroded than the buried section as a result of relatively recent tidal action, presumably over a period of at least decades. As result, the aim of the exercise was to establish whether the buried section had been exposed for a significant period in the past, resulting in erosion across the entire vessel, or whether the condition of the buried portion suggested that the vessel had become buried prior to erosion as result of exposure over a significant period of time. The evaluation showed that the buried portion of the vessel at the bow was considerably better preserved that the exposed part suggesting that the boat had been remained *in situ* for a considerable period of time and had not suffered erosion across the entirety of the vessel before deposition.

Work in 2002 also identified that the vessel was buried largely in relatively fine estuarine gravels and indicated the extent of flooding likely to occur as the water-table beneath the exposed ground surface fluctuated over the tide. It was also clear that the vessel lay at a considerable angle within the inter-tidal deposits, with the bow much higher than the stern (Illus. 4). This indicated that excavation of the stern would be

likely to involve excavation of over 1m in depth and would require a water-removal strategy.

Further to evaluation of the bow, the vessel was sand-bagged for protection and monitored on a roughly monthly basis. Monitoring confirmed that the high-energy inter-tidal environment continued to scour and erode both the peat deposits and the vessel. Hessian sand-bagging was found to provide temporary protection for the vessel however it was estimated that these would require replacement on a quarterly basis to provide ongoing protection to the exposed bow.



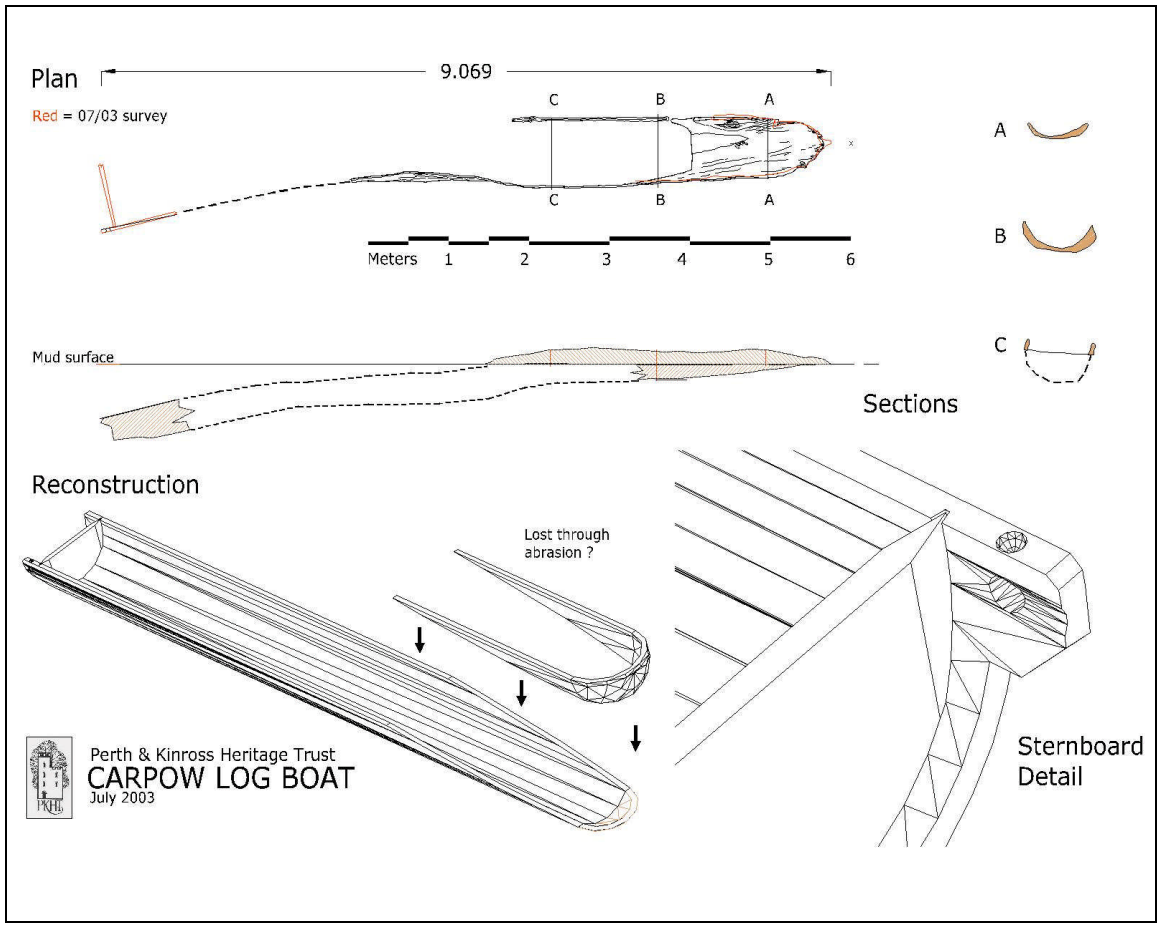
Illus 4: Plans and sections from the initial evaluation in October 2002 and showing the C-14 sample from 2001 (GU-9597).

3.1.3 Length of the Boat and Condition of Stern (2003)

In July 2003, a second phase of evaluation of the site was undertaken (Strachan and Glendinning 2003). The aim of this exercise was to establish the full length of the vessel and assess the depth and condition of the buried stern. The inter-tidal nature of the excavations placed serious limits on the extent of information recovered. A trench, approximately 2m by 3m was extended across the projected line of the vessel approximately 9m from the bow. Despite the use of a water-pump the excavation at the stern was hampered by persistent flooding, however the buried stern was eventually revealed for only a few minutes to allow photography and basic measurements to be taken.

The full length of the vessel was shown to be *c*.9.25m and the top of the buried stern was found to be *c*.0.75m below the ground surface. The width of the vessel was shown to be *c*.0.9-1m. The evaluation also revealed the condition of the stern, which was found to be excellent, having suffered little erosion from either tidal action or regular exposure to the air. In particular, the survival of an *in situ* transom board was confirmed (Strachan and Glendinning 2003, Strachan 2004).

The plans and sections (Illus. 5) suggested that the vessel may have been broken or warped in some way in the central section. In particular, in plan the vessel appeared to have a kink in the projected line. The middle section of the vessel was deliberately not investigated, however, as this could have resulted in the vessel becoming freed from the inter-tidal deposits and the possibility of transportation of the boat by the tide.



Illus 5: Plans and sections from the July 2003 evaluation with schematic detail of the buried stern.

3.1.4 Interim Management of Vessel after Evaluation.

Further to the excavations in 2002 and 2003, the vessel was sand-bagged as an interim measure of protection against further erosion, transportation or damage from objects carried by the tide (Illus. 6 and Strachan 2004). In addition, sand-bagging also minimised the negative effects of exposure of the water-logged timber to air and sunlight at low tides. As the site was a Special Site of Scientific Interest (SSSI), permission was obtained for excavation work by Scottish Natural Heritage (SNH), with the condition that only hessian sand-bags were used to protect the vessel and for site reinstatement subsequent to excavation.

Monitoring of this site was continued on a quarterly basis after the 2003 excavations. This work confirmed that while deposits would occasionally accrue around areas of sand-bagging during periods of minimal river flow from the Tay and the Earn, the deposits were later removed during periods of scouring resulting from heavier river flow. As a result, it was considered that long-term preservation *in situ* would be impracticable to achieve, as it would require re-sandbagging of the site on at least a quarterly basis.

Illus 6: Sand-bagging of the evaluation excavation of 2003.

3.2 Interim Publication.

An interim account of the evaluation work in 2002 and 2003 was published in the Tayside and Fife Archaeological Journal (TAFAJ) (Strachan 2004) along with a short discussion on the significance of the vessel, both in terms of other logboats from the area and in terms of the boat's later Bronze Age context. The drawing together of the paper highlighted the importance of the vessel and indicated that it is of national, if not international significance. The paper concluded with a statement that various options for preservation were being considered, including both *in situ* preservation and full excavation and recovery, followed by conservation and display.

3.3 Management Options; Project Planning and Fund-raising.

Given the results of monitoring of the site, outlined in above in section 3.1.4, by the time of publication of the TAFAJ paper in 2004, it had become clear that *in situ* preservation was not a long-term option and plans were developed for an excavation and recovery strategy. Once an agreed strategy for conservation had been developed with the National Museums of Scotland (NMS) and an agreement in principle had been made with Perth Museum and Art Gallery (PMAG) for initial display in Perth, a project design was developed to excavate and lift the vessel. A bid to Historic Scotland (HS) for 50% grant aid (with PKHT agreeing to fund the other 50%) was submitted in September 2004. As this bid to HS was unsuccessful, various other sources of funding were explored including the Crown Estate and local businesses, however these also proved unsuccessful and so in September 2005 a second bid was made to HS. The success of this bid led to the development of the project plan for the summer of 2006.

4 EXCAVATION AND RECOVERY 2006 METHODOLOGY

4.1 Partnership Structure and Project Team

The funding partners for the project were Perth and Kinross Heritage Trust (PKHT) and Historic Scotland (HS), both contributing 50% of the required funds for the project. Other partners made in kind contributions, such as the National Museums of Scotland (NMS) and Perth Museum and Art Gallery (PMAG) who have contributed staff time to the project. In addition, the NMS contributed the recording of the project with high resolution video, for use in interpretation and display. This recording work was carried out by Circa Media of Edinburgh. Other contracted partners were CFA Archaeology Ltd., who provided part of the excavation team and carried out the scale drawing of the vessel once in Granton, and Moorings & Marine Services, a marine engineering contractor based on the Tay estuary, who provided water removal on site, diving support and engineered the floating and lifting of the vessel under the supervision of the archaeological team. In addition to the above, a number of volunteers, including the logboat finder, were involved at various stages. Details of these can be found in the acknowledgments.

4.2 2006 Project Aims and Objectives

The aims and objectives of the 2006 project were as follows:

- Excavate the logboat and recover/record any artefacts associated with it.
- Record and study the archaeological/palaeoenvironmental context of the logboat.
- Recover the logboat from its location and transport it to the National Museums of Scotland, Granton, Edinburgh.
- Conserve the vessel.
- Discuss the vessel both in terms contemporary archaeology of the area, and in terms of its importance in relation to logboat studies.

4.3 Project Timetable (July–Aug. 2006).

The project was planned to take place over two tidal windows as outlined below. The latter included some of the lowest predicted tides of the year, maximising the

available low tide working window. The excavation and lift was carried out over the seven days shown:

Window	Date	Predicted tide Metres OD (Dundee)	Predicted tidal window (BST)	Project Event	Event time (BST)
1	**26/07/06**	1.00	1025-1300	Excavation	1100-1300
1	**27/07/06**	0.92	1100-1350	Excavation	1050-1340
1	**28/07/06**	0.90	1140-1420	Excavation	1120-1420
1	**29/07/06**	0.96	1210-1440	Excavation	1210-1440
2	**09/08/06**	0.69	0930-1220	Excavation	0910-1220
2	**10/08/06**	0.36	1010-1330	Excavation	1030-1220
				Excavation complete	1220
				Rigged to float	1230-1315
				Float	1325
				Move	1330-1430
				Reed-bed location	c.1430
2	**11/08/06**	0.18	1050-1420	Vessel exposed at Reed-bed location	0830-1100
				Photography	1100-1115
				Site reinstatement	1100-1400
				Mud-pack applied	1115-1130
				Re-rigged to float	1200-1430
				Float	1620
				Tow to Newburgh	1700-1810
				Rigged within frame	1810-1930
				Lift	1940-1942
				Leave Newburgh	2010
				Arrive Granton	2240
2	**12/08/06**	0.17	1140-	Unused	-
2	**13/08/06**	0.33	1230-	Unused	-
2	**14/08/06**	0.64	1310-	Unused	-

4.4 Background to Operation

The inter-tidal nature of the excavation, and the logistical challenges involved in the recovery and transportation of the vessel, required flexibility in the prepared method statement for the project (Strachan 2006). The most significant modification to the plan concerned transportation of the vessel from its original site to Newburgh harbour. The project design involved the logboat being inserted into the lifting frame on site, with the lifting frame being floated and towed to Newburgh. In the event, as a result of various factors which became apparent during the excavation, the logboat was floated and towed to meet the lifting frame at Newburgh. An important factor was the possibility that there was a break, or partial break, in the vessel as had been suggested by the 2003 evaluation (Illus. 5). Early in the excavations in July 2006, it became apparent that this was not the case and it was evident that the vessel was robust enough to float on its own, making the additional trouble of using the lifting frame for the initial tow unnecessary. In summary, the operation involved four stages:

1. Excavation and securing of the logboat *in situ* at low tide.
2. Floating of the vessel at high tide to a suitable lifting location
3. Lifting the logboat from water to suitable transport
4. Site Reinstatement

4.5 Excavation and Recovery Methodology

4.5.1 Low Tide Excavation

The aim of the excavation was to loosen deposits around the vessel prior to floating/lifting while allowing any associated deposits/finds within the vessel to be recovered/recorded archaeologically in the best conditions available. The excavation of the logboat was carried out in two stages: the excavation of the interior and exterior of the upper (bow) half of the boat, and subsequently of the lower (stern) half of the vessel.

Upper (bow) section: Excavation was carried out on the 26th and 27th July, with hand excavation to a depth of around 0.5m over an area approximately 1m around the vessel, along with excavation of the interior of the vessel. The upper section was well above the water-table and so did not require water removal. Once the vessel had been undercut and following recording of the deposits, the boat was underpinned with sandbags to support the boat.

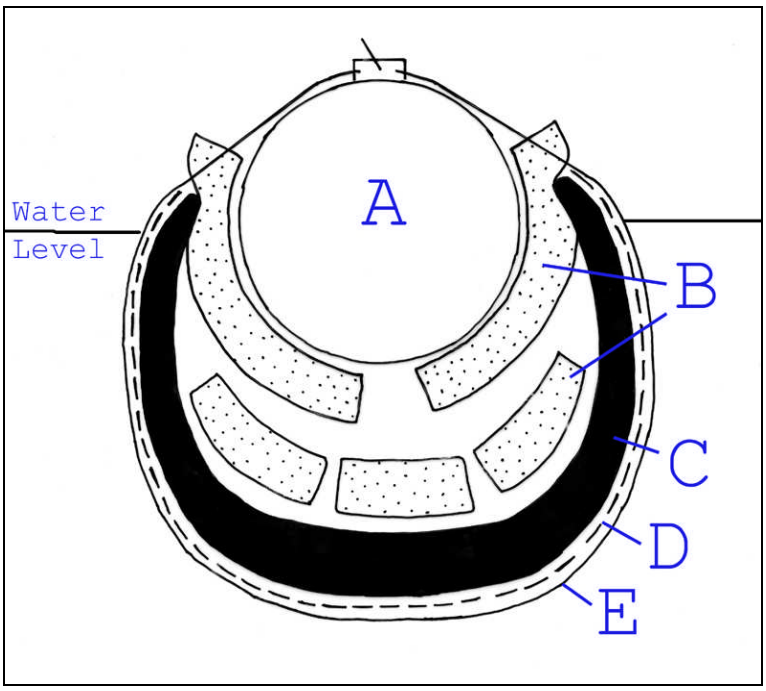
Lower (stern) section: Excavation of the stern area of the vessel began early in the project (26th July) and continued through until the excavation was complete on the 10th August. Stepped shoring of the excavation, using plastic scaffold planks and sand-bags was employed to prevent the trench filling with estuarine sands/gravels. A combination of water-pumps were employed to remove water during excavation as the top of the stern lay around 0.75m below the surface of the ground, and the bottom being some 1.75m below, which was around 0.75m below the water table during the low tide windows.

The fully excavated logboat (Illus. 10 and 8, B) lay supported on a layer of sandbags allowing final on site recording by photography, scale drawing and DPGS survey.

4.5.2 Recovery and Lift

Recovery:
Following full excavation, the vessel was rigged to float using three 200 litre plastic barrels positioned within the logboat supported by foam blocks to protect the surface of the boat. These barrels and protective foam blocks were secured within the vessel with load-bearing ratchet straps. The barrels could be partially filled with water to decrease buoyancy (Illus. 8, A-E).

The schematic diagram (Illus. 7) shows the method of lifting the vessel from its *in situ* location. After full excavation (Illus. 7 B), the vessel was supported almost entirely on sandbags and had been completely undercut. During the rigging process (Illus. 7 C) the air barrels were secured within the vessel, while the deposits beneath the bow were further undercut to allow a downward motion of the bow as the stern lifted during the incoming flood tide (Illus. 7 D). Once the tide had come in further and the vessel was clear of the excavation trench, the vessel could be guided to its new temporary location (Illus. 7 E).



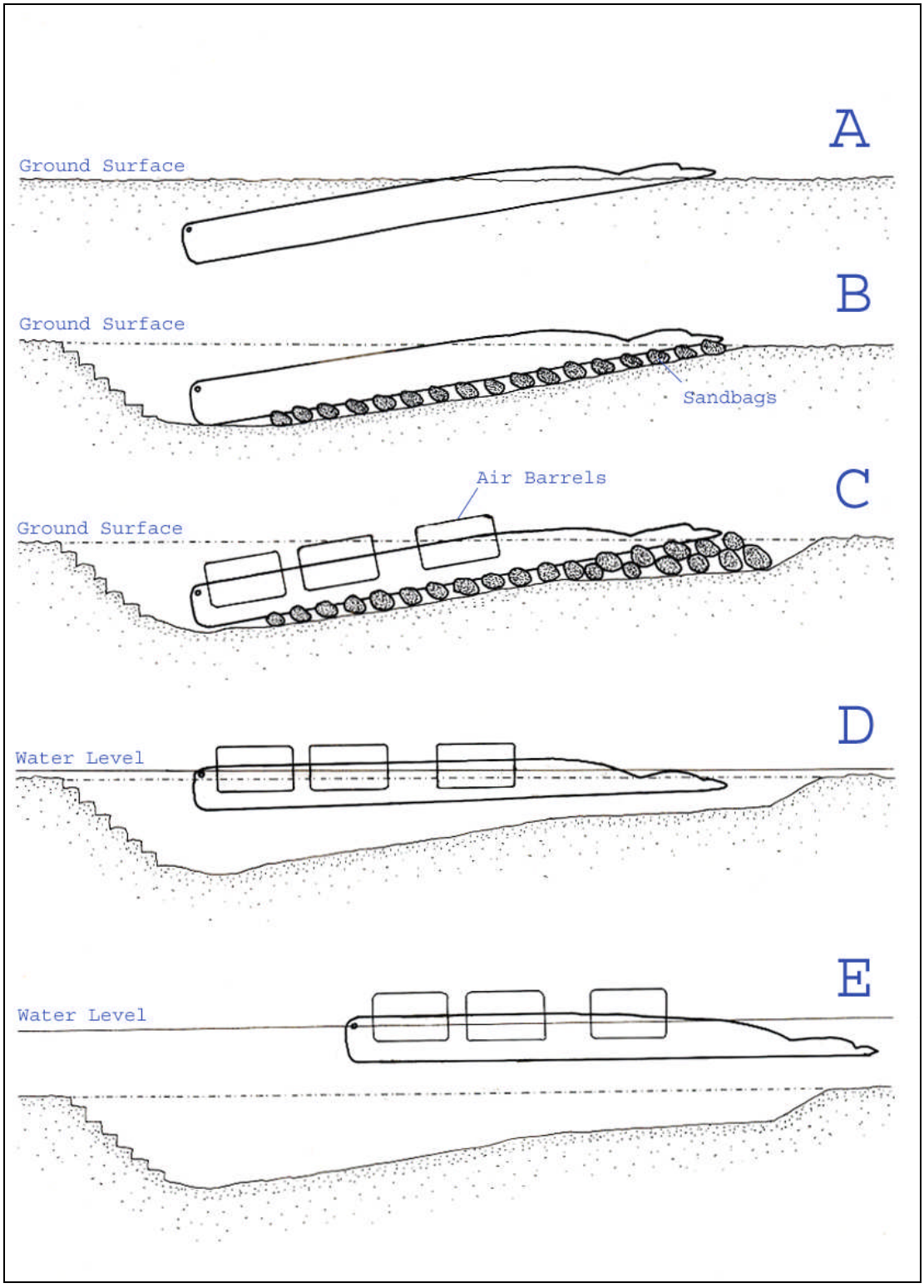
Illus 7: Schematic section showing the floating rig; air barrels (A), foam padding (B), logboat (C), plywood wrap (D) and load-bearing ratchet straps (E).

On the flood tide on the 10th August the vessel was floated and guided to soft mud, deposited along reed beds near the estuary shore, by a team of ten people. The vessel was then anchored in its temporary location, the soft mud minimising the risk of damage to the base of the vessel. The following morning the boat was fully revealed for the first time on the mudflats. The vessel was then de-rigged to allow a full photographic record to be made and subsequently a mud-pack to be applied to the vessel to prevent it from drying out over the next seven hours in the hot summer sun.

By late afternoon of the 11th August, the vessel had been re-rigged to float again (Illus. 11), this time with the additional measure of covering the whole with mesh netting to collect any fragments of the vessel which may have become dislodged during the tow from Carpow Bank to Newburgh. At the next flood tide the vessel was once again floated and this time towed by a small motored power craft the 3km to Newburgh. During the tow a diver accompanied the floating logboat to protect the stern (from which the tow was made) against the force of the oncoming water. The tow was done at a very slow speed in order to minimise this effect and care was taken to wait until slack water to ensure that no additional tidal force was added to this. After a journey of around 30 minutes the vessel arrived at Newburgh quay.

Lift

During the process of excavation of the vessel, a bespoke 9.3m long steel box lifting frame was constructed (Illus. 7, 11, 41& 43) to size to fit around the boat. This was located at Newburgh quay (NGR NO 234 185) and on arrival, during slack water of the evening of the 11th August, the vessel was floated into the lifting frame and secured onto the frame using load-bearing straps positioned underneath the vessel at closely spaced intervals and tied to the top of the frame, effectively suspending the logboat within the frame. This provided equal support along the structure of the vessel and minimised stress-loading during the lift. The lifting frame and vessel was then craned onto a flat-bed lorry. The lift from water level to the lorry took around 3 minutes (Illus. 45).



Illus 8: Stages of excavation and recovery; prior to excavation (A), fully excavated and supported on sandbags (B), floating rig in place (C); sandbags removed and vessel floating (D), and transportation during flood tide (E).

Illus 9: A general view of the excavation.

Illus 10: The fully excavated boat, supported by sandbags.

Illus 11: The boat if rigged for floating under the supervision of Dr Theo Skinner of the National Museums of Scotland.

4.5.3 Transportation to Granton

Once the lifting frame had been secured onto the flat-bed lorry, the logboat was lowered onto the base of the frame, though still secured by the load-bearing straps, and further cushioned with padding to minimise shock to the vessel by vibration. It was also covered in polythene sheeting to prevent drying during transportation. The logboat was then transported to the National Museums of Scotland accommodation at Granton, Edinburgh. The vessel was then lifted into the Granton laboratory within the lifting frame, again with suspension time being kept to a minimum.

4.5.4 Site Reinstatement

Further to recovery of the logboat, all lifting materials and aids were removed from the site and the excavation site was back-filled and consolidated again using hessian sand-bags in agreement with Scottish Natural Heritage.

4.6 Recording Strategy

4.6.1 On Site Survey

A temporary benchmark (TMB) was established on site around 10m NNW of the position of the logboat. All survey work, including the environmental work (section 6) and on site recording (4.6.2 below) were tied into this. The position of the TBM was later located using DGPS (4.6.3 below).

4.6.2 Scale Plans and Sections

A plan and sections were made of the vessel *in situ* and its context at a scale of 1:20 (Illus 12 and 16). This survey was tied into the TBM above, although verified by a total of 14 points by DGPS (below).

4.6.3 Differential Global Positioning System (DGPS) survey

A Differential Global Positioning System (DGPS) using Real Time Kinematic features was employed to provide centimetre accuracy in three dimensions to accurately locate the temporary bench mark (TBM). In addition, fourteen points were recorded in three dimensions across the vessel while in situ to be used to verify the site plans and sections (above). The value of DGPS technology on this inter-tidal site, where no control was available for conventional survey, cannot be cannot be over emphasised, particularly given the time pressures placed on the conventional recording team as a result of the short tidal windows.

4.6.4 Photographic Survey

The excavation process was fully recorded using high resolution digital photography.

4.6.5 High Resolution Video Recording

The excavation and lifting process were recorded using high resolution digital video, carried out by Circa Media of Edinburgh, with a view to using the material in future displays.

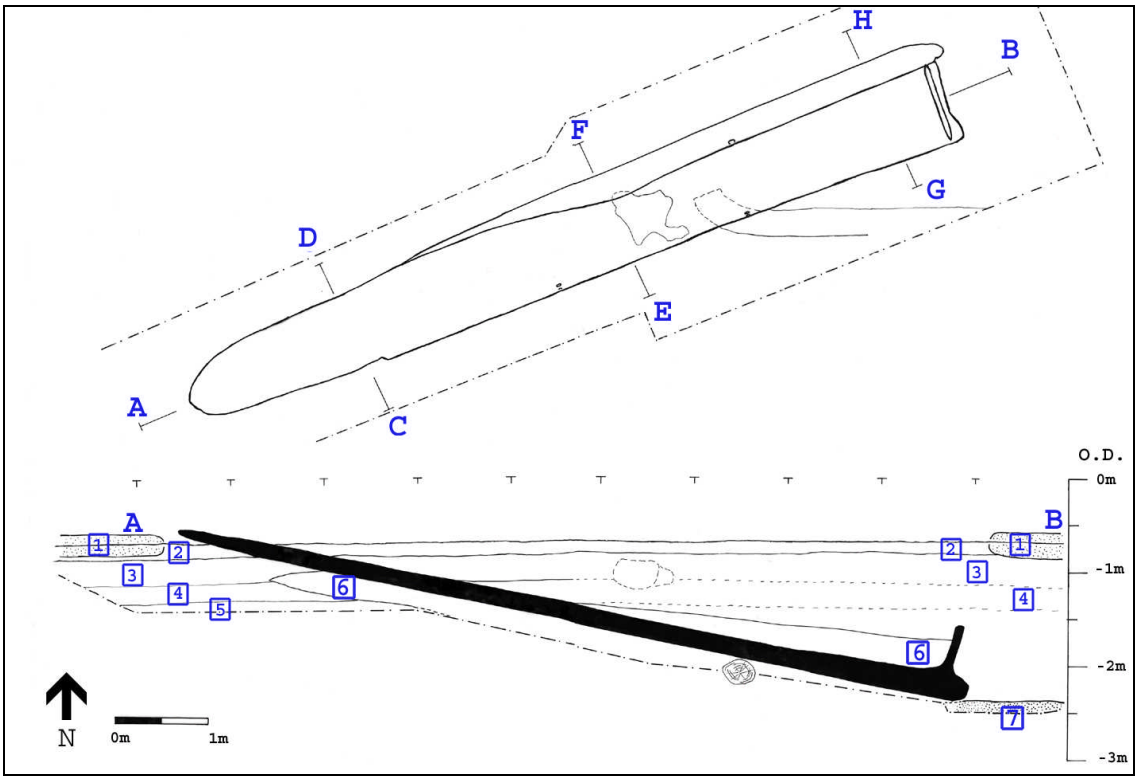
5 EXCAVATION AND RECOVERY RESULTS (2006)

5.1 The Stratigraphic Sequence

The sequence revealed by the excavation was very simple (Illus. 12 & 16) however the logistical problems of inter-tidal excavation have to be taken into account when considering the nature of the record made. It was possible to photograph and draw sections, as per a "dry" site on the upper (bow) section of the vessel. This was not possible, however, on the lower (stern) section where excavation was below the inter-tidal water-table and, despite shoring, sand and gravel continually flooded into the trench carried by water. It was not therefore possible to recognise stratigraphic changes in sands and gravels over the lower section, as it was on the upper section.

1	**Peat**:	the "upper" peat appears across Carpow bank as broken blocks of peat truncated in depth to around 10-30 cm.

2	**Recent tidal deposits**:	around 5-10cm deep, consisting of mixed sands, gravels and mud.
3	**Sand/gravel**:	orange sand/gravel (see Sample 3).
4	**Grey alluvial silt and sand/gravel**:	a gravel rich grey alluvial silt (see Sample 4).
5	**Alluvial sand and gravel**:	alluvial sands and gravels (see Sample 5).
6	**Alluvial silt**:	a black organic rich deposit which produced large quantities of small round-wood and twigs (including hazel and birch), fragments of peat, hazel nut shells (including rodent damage).
7	**Peat**:	a thick deposit of "lower" peat (see sample X?).



Illus 12: Plan and section of the logboat showing contexts (1-7) marked within squares on section A-B. Section A-B indicates the considerable angle at which the vessel lay with the base of the stern being 1.75m below the ground surface. The plan also indicates the location of sections C-D, E-F and G-H (see Illus. 16).

Illus 13: The sequence of deposits beneath the bow of the vessel, looking north (see Illus. 17).

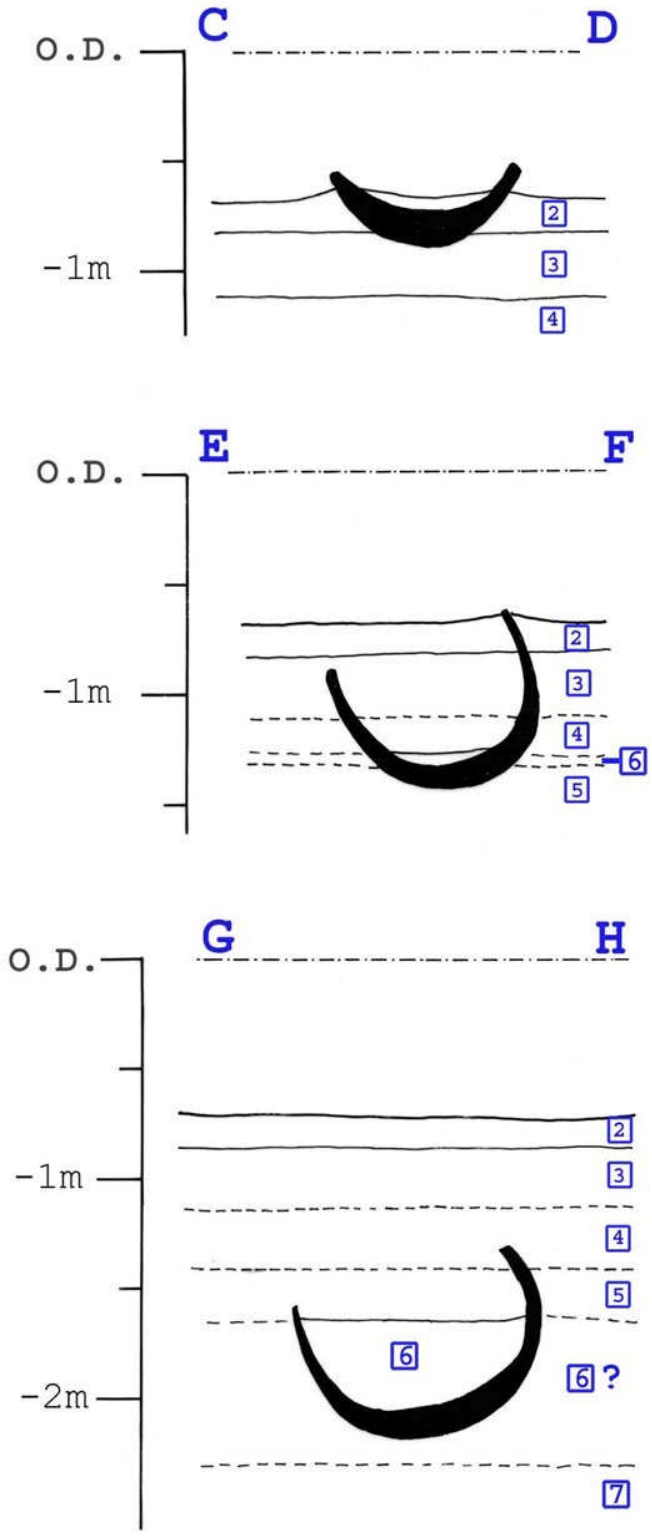
5.2 The logboat in Relation to the Sequence

The 3D position of the logboat within the stratigraphic sequence is somewhat enigmatic and must be considered in the light of the highly dynamic inter-tidal, where deposits are regularly transported and re-transported, and in terms of the problems of inter-tidal excavation discussed above. The orientation of the logboat is such that the bow of the vessel is pointed upstream towards the River Earn (Illus. 3 & 12). Notably the stern of the boat is considerably lower than the bow (Illus. 12 & 14) with the base of the stern being around 1.75m below ground surface while the bow of the vessel was truncated above ground level. This could be explained by the fact that the stern of the boat is considerably heavier than the bow, the hull being wider and thicker than the bow. It is possible to envisage the boat gradually sinking differentially into a soft deposit, such as a soft river/estuarine mud. The condition of the stern is an important consideration, as the survival of tool-marks on the transom board and the general condition of the buried portion would suggest that the vessel was not exposed for a long period allowing rotting of the timber to begin, but became buried fairly rapidly.

It is suggested that the logboat was originally deposited in an alluvial silt which survives as Context 6. This black/grey organic-rich deposit was found to survive both under the vessel and inside the vessel. Further from the vessel however, it appears to have been replaced by the ubiquitous inter-tidal sands and gravels. The survival of Context 6 as a lens shaped to a point upstream beneath the bow of the vessel may suggest that the deposit has been eroded away, and gradually replaced, by shifting sands and gravels on ebb tides (Illus. 12 & 13). As a result of continual flooding, the extent of Context 6 could not be adequately recorded at the stern, so it is not possible to suggest a similar process during flood tides.

Illus 14: The stern of the vessel during excavation showing the angle at which the boat was positioned with the port (south side) considerably lower than the starboard (north side).

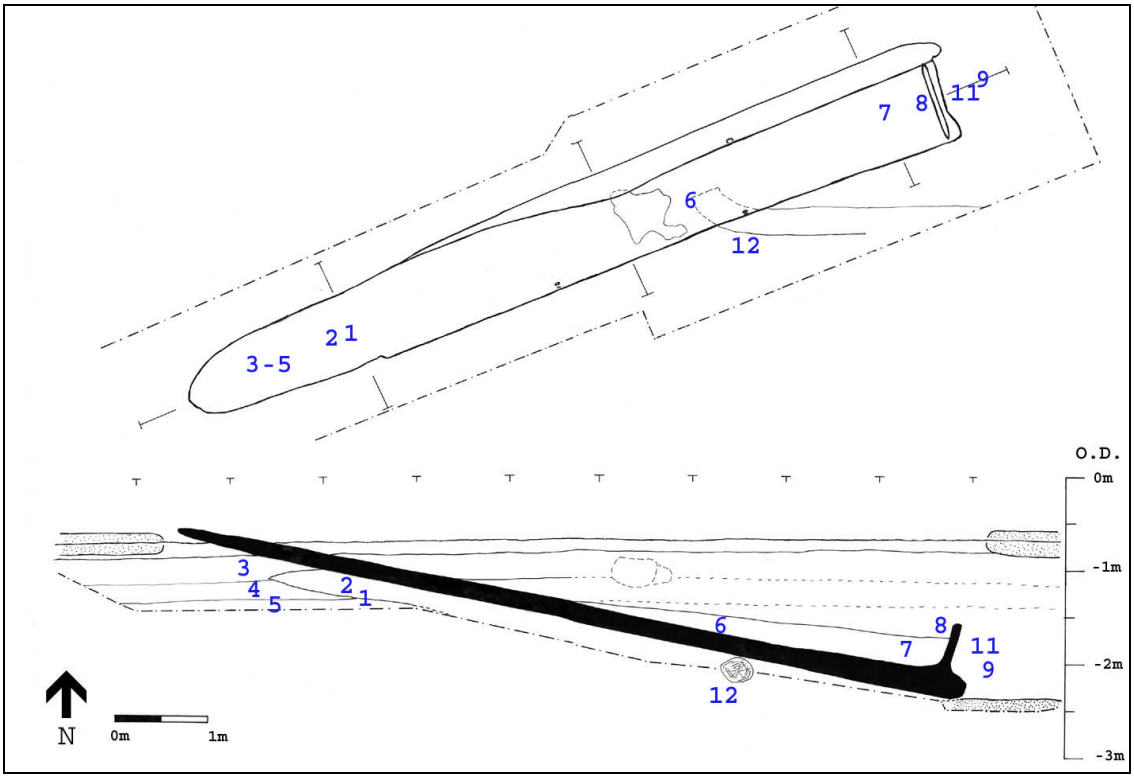
Illus 15: Detail of the trunk, identified as hazel, which the stern of the boat lay upon.



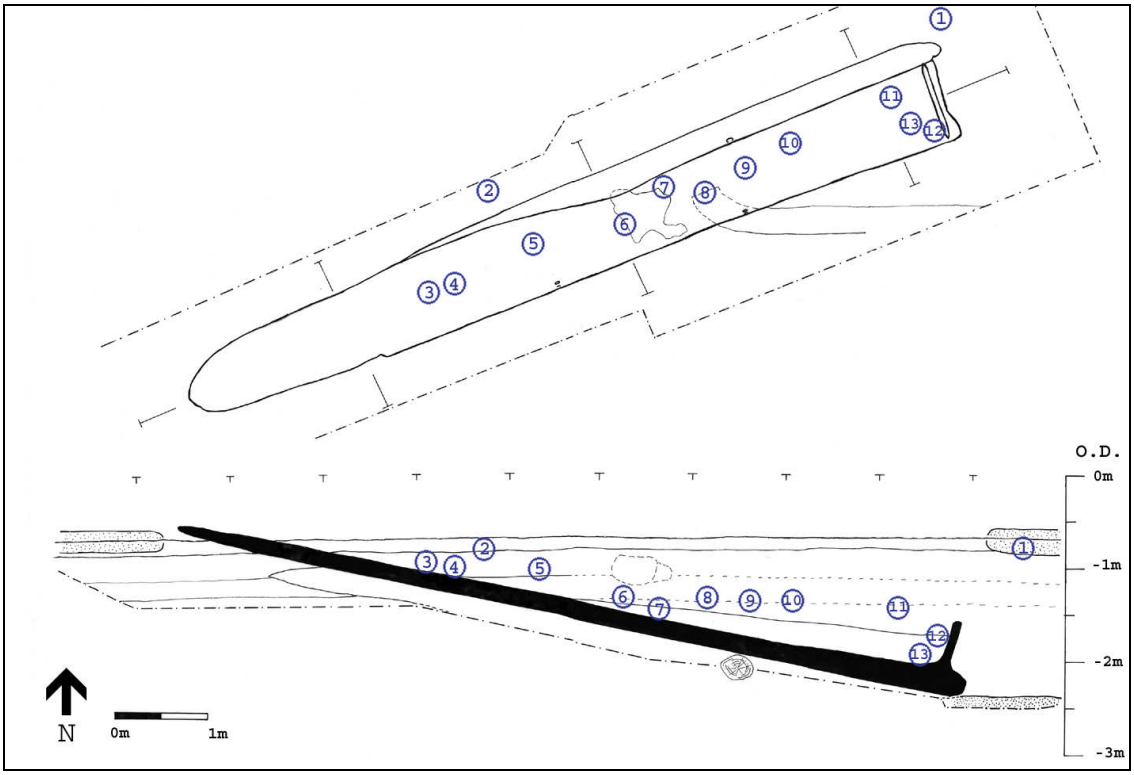
Illus 16: Sections C-D, E-F, G-H as shown in plan in Illus X. The sections show the angles at which the vessel was sitting, with the starboard (north) side of the vessel much higher than the port (south) side. C-D also illustrates how the exposed bow has been truncated by erosion.

5.3 Samples

A total of 15 grab samples from the above contexts were taken during the excavation in order to assess the nature and make-up of each identified context (Illus. 17). The samples were studied by Dr M. Cressey of CFA Archaeology Ltd (see Appendix 3).



Illus 17: Location of samples taken during the excavation.



Illus 18: Location of small finds recovered during the excavation.

5.4 Small Finds

A total of 16 small finds, all water-logged wood, were recovered on the basis that they appeared to have been possibly worked (Illus. 18). All but one of these could not be securely dated or shown to be contemporary with the logboat, and only SF001 (probably part of a small barrel lid); SF002 (a wooden peg); SF007 (a cut timber); SF014 (a cut timber) have clearly been worked. It is possible that the latter two were cut during the excavation process, however it is hoped to clarify this when a detailed study of the finds is made in the future. To date, the small finds have been initially studied by David Strachan (PKHT) and Theo Skinner (NMS) though will be further considered by Dr. Rob Sands of University College Dublin as part of his wider study of worked wood from the boat (section 8.3). The only find which is clearly contemporary with the vessel is SF015, a repair block, which is in two pieces, found in a cut repair at the stern. The repair involved cutting a section across the transom groove and inserting the block, which had a transom groove cut on one side. The transom board would fit against the repair block, serving to tighten the fit of the transom board into the overall transom groove. Indeed, a very similar repair was found on the Hasholme vessel, where a similar and better preserved block survives. It may be the case that the use of such blocks in the transom groove was not a repair but an integral part of the initial construction. Details of the small finds can be found in Appendix 4.

6 ENVIRONMENTAL STUDY
Dr M. Cressey, CFA Archaeology Ltd

6.1 Aims and Objectives

From an early stage in the project design it was acknowledged that the environmental context of the vessel would be critical for understanding both the taphonomy of the logboat itself and also environmental change over time in this part of the Tay estuary. The vessel was located partially buried in inter-tidal mud, sands and gravels on an eroding peat shelf (Illus. 19). The peat would have originally formed a continual bed across the flats, however in parts of the bank the peat has eroded into isolated blocks of variable thickness. In some cases the peat exposures have been undercut by erosion leaving fossil stumps exposed. Having provided an initial radiocarbon date of around 1,000 BC, the logboat offered an opportunity to study the wider environmental issues of this area and reassess work on the peat deposits of the area carried out in the late 1970s (Cullingford *et al* 1980).

6.2 Background

A programme of palaeoenvironmental sampling was carried out in conjunction with the excavation of the logboat. This included recovery of environmental samples from within and below the boat and from exposed outcrops of exposed inter-tidal peat and *in-situ* tree stumps. The abrasive effects of shifting alluvial sand and gravel were found to be eroding the inter-tidal peat and tree-trunks, both of which are an important local palaeoenvironmental resource which will certainly vanish within the next ten years.

Illus 19: The “upper peat” and one of the tree-stumps.

The Lower Strathearn region does have a robust relative sea-level curve that was constructed by Cullingford *et al* (1980) this was largely based on 1cm thick peat samples and not on single entity AMS dates (Ashmore 1999). Based on radiocarbon dated biostratigraphic profiles obtained at six locations within the Lower Strathearn, Cullingford was able to show that sea level rose to around 9m O.D. and finally culminated at around 6000BP. Radiocarbon determinations on marine shell recovered at a depth of –3m below the present flood plain surface at the Carse of Gowrie fitted well with Cullingfords Early Flandrian relative sea-level curve for the Lower Strathearn (Cressey 2001, Fig 2).

The aims of the ongoing palaeoenvironmental research are to address the following questions:

- What is the age of the inter-tidal peat and the in-situ tree-stumps?
- Is the inter-tidal peat contemporary with the Carpow Logboat?
- Can the inter-tidal remains further advance our knowledge of relative sea-level changes within the locality of the Carpow Logboat?
- Are the environmental samples recovered from below the log-boat contemporary or later than the log-boat?

The palaeoenvironmental significance of these remains cannot be assessed without radiocarbon dating.

6.3 Methodology

An assessment of the inter-tidal peat was carried out to determine suitable sample locations and to identify the position of in-situ tree stumps that were known to survive close to the Carpow log-boat. Following an assessment of the peat the mean High

Watermark Spring Tide (MHWST) and the Low Watermark Spring Tide was plotted using a Leica GS50 global positioning recorder. Three stumps (SP1-3) were found in-situ and their position was recorded following sub-sampling. The samples were recovered from two discrete locations including a) from the inter-tidal area around the Carpow logboat and below the logboat during its excavation.

A stratigraphic profile of the peat at SP1 was obtained using a series of Kubiana tins that were hammered into the peat below the tree-stump. The depth of peat below the stump was 0.35m. The biostraigraphy was examined back in the laboratory and is summarised below. SP2-3 stumps were found in-situ on inter-tidal peat but were severely eroded. SP1 peat is considered here to represent the rest of the visible surface peat deposits which is suffering from scouring in this highly dynamic environment.

6.4 Analytical results

6.4.1 Biostratigraphic Analysis of the Inter-Peat below the SP 1 Stump.

A biostratigraphic profile below the SP1 stump sample was constructed. This provides a summary description of the peat prior to radiocarbon sampling and can be found in Appendix 1.

6.4.2 **Tree-ring Identification**

Wood sub-samples were obtained from the SP1-3 stumps and frozen prior to thin sectioning for species identification. The species types are listed in Appendix 2. Two species of tree are represented and include *Quercus* (oak) and *Betula sp* (birch). Both are native to Scotland and well represented in the Prehistoric period. Birch is a light demanding pioneer that can tolerate acidic damp ground and normally lives no longer than 150-200 years. Oak is tolerant of a wider type of soil and is at the apex of woodland species and has a slow rate of growth living up to and beyond 500 years.

During the tree-ring study, grab-samples of branch-wood were identified from samples obtained from below the boat Appendix 3.

6.5 Recommendations for radiocarbon dating and diatom analysis

6.5.1 Wood and Peat

In order to address the question regarding the age of the inter-tidal peat it is proposed to obtain dates on all three tree stumps. The SP1 and SP3 stumps should have two replicate radiocarbon dates assessed so as to establish the age range between the two dates attained. SP2, the oak stump will require a single date. This stump was on its side as it fell, but is certainly in situ and was surrounded by eroding tabular inter-tidal peat. Historic Scotland (HS) have endorsed the submission of 14 environmental samples for radiocarbon dating and these are listed in Appendix 2.

6.5.2 Estuarine Silt, Unit 4

Radiocarbon dates derived from the humic acid fraction from samples obtained from the middle of Unit 2/3 and basal contact zone (Unit 1, see section 3 above) of the peat will establish its onset and development. It will also establish the terminus anti-quem for the deposition of an estuarine silt layer that rests below it. The significance of this layer lies in the fact that it represents one of several that were observed within the

locality by Cullingford *et al* (1980 *ibid*) and was proposed to represent one of several marine transgressions that occurred before 6000BP. A date relating to the period of marine regression which allowed the growth of peat would allow us to compare this event with Cullingford's sea-level model with greater precision.

6.5.3 Diatoms

A sample of the silt (Unit 4) has been submitted to Dr Susan Dawson at University of St Andrews for diatom analysis. The results will confirm conclusively if the silt was formed in marine or freshwater/brackish conditions.

6.5.4 Environmental Samples Obtained from below the Boat.

A sample of very compressed peat was recovered from the boat and was found to be in the region of 5cm thick. At the centre of the peat were two fragments of branch-wood which could be suitable candidates for further radiocarbon dating. All other materials such as branch-wood and hazel nut shells would not be reliable materials for dating given the highly dynamic nature of the depositional environment below the boat.

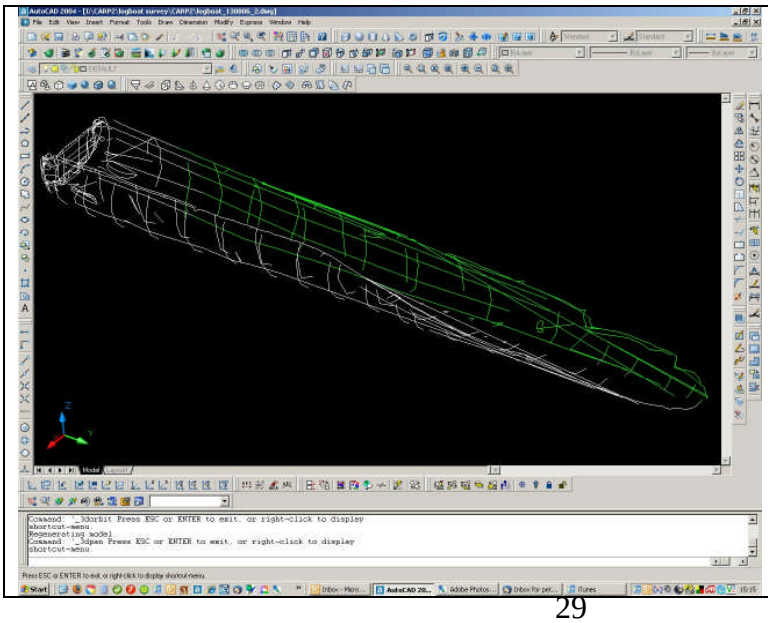
7 POST-EXCAVATION RECORDING AND STUDY 2006

7.1 Pre-treatment cleaning

Once positioned within the Granton workshop, the initial task involved cleaning the mud-pack which had been applied by the team on the morning of the lift and removing some of the mud, sand and gravel which had been left *in situ* at the stern of the vessel. The vessel has been kept wet by an arrangement of pierced piping running around the top of the vessel while recording of the vessel was carried out.

7.2 Recording of the vessel L. Whitelaw CFA Archaeology Ltd

Prior to the conservation process, the logboat was surveyed using a Leica Reflectorless Total Station [EDM] linked to PENMAP surveying software. This produced a highly accurate 3-Dimensional wire-frame model of the vessel that can be



Illus 20: The 3-D CAD model of the logboat created by survey of the vessel in the Granton laboratory.

viewed from all angles, elevations and scales (Illus. 20). High-resolution digital SLR photographs were also taken to capture the logboat in its entirety and then rectified using the metric survey wire-frames. Selected views were then extracted in order to form the basis of ink drawings (Illus. 21, 24 & 25). The ability to rotate the metric survey data in 3-Dimensional space allowed the team to obtain unique scaled three-dimensional isometric views of the boat, in particular the detail of the transom grooves, perspectives that traditional drawing techniques would have found difficult to capture in a short amount of time (Illus. 24 & 25).

7.3 Description of the vessel

7.3.1 The condition of the vessel

The upper third of the vessel is highly abraded with some signs of rot being evident, particularly on the tops of the sides. In addition, some splitting has occurred. The water-logged timber has been identified as oak (*Quercus sp*.) of reasonably high quality with only one major knot being apparent (Crone *pers comm*). Abrasion has removed any traces of tool-marks or faceting on bow, where the timber had been exposed. In addition, the regular exposure of this part of the craft to the air during low tides has resulted in some rotting of the wood, increasing the scouring effects of the tidal waters. The stern of the vessel is generally much better preserved having a leeched mineral conglomerate deposited over the timber which has served to further protect the surface.

7.3.2 The Parent Log of the Hull.

The hull of the boat is fashioned from an oak tree of at least 10m in length. As the bow of the boat has been truncated it is not possible to say how much of the bow has been lost, though by projecting the sides of the boat it is possible to suggest that the boat was originally no more than around 11-12m in length, as the bow would be too narrow if any longer. It is possible that the full length of the parent log was in the region of 13m, given that there is no sign of buttresses at the stern of the vessel (Sean McGrail *pers comm*). There are two knots at the bow end of the vessel, F2 and F4, the latter being a fairly large branch insertion which has rotted on the outside of the vessel to produce a fairly significant hole. There is no sign of sapwood on the sides of the vessel, however, this still has to be confirmed for the very underside of the boat. Almost every other early logboat and plank boat has provide to have some sapwood present, although this is often only recognised after dendrochronological study (McGrail *pers comm*). **Further comment on the nature of the parent log will result from the planned dendrochronological study (see 8.2).**

7.3.3 Shape.

The vessel is overall log-shaped and tapers towards the bow. It is considered probable that the boat is constructed from a whole log rather than a half a log split longitudinally, although a planned study of the section will confirm or refute this. The bow of the vessel has been lost to erosion and there is no indication, such as an upturn in the base of the bow, to suggest either where the bow began, or what form it took. The form of the boat can be described using the McGrail morphology code (McGrail 1978, 129-30) which describes the morphological characteristics of the stern, body and bow in terms of plan, elevation and transverse section. The Carpow boat can be described as 44B2:212:??2.

Illus 21: The initial draft of the pencil drawing of the boat. A number of sections through the craft will be added at a later stage.

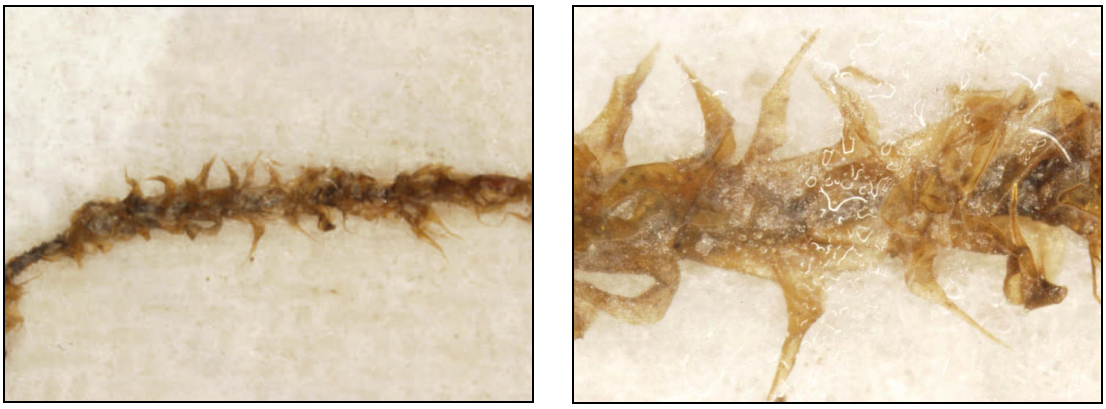
7.3.4 The Stern – Transom Grooves.

In profile and plan the stern is at right angles to the overall run of the boat. An unusual feature is that the stern has two transom grooves (F27 and F28), transverse groove cut into the bottom and sides to house a transom board. The inner of these (F28) had the transom board surviving *in situ* and is considered to be the original transom groove for a variety of reasons. Firstly, F28 is cut around 22cm from the stern, the usual sort of distance at which transom grooves are cut in logboats (McGrail *pers comm*). Secondly, unlike F27 the groove is cut from the base of the boat to the top of the sides allowing a full-sized transom board to be fitted. The outer transom groove (F27) is cut around 12cm from the stern, and is unusual in that it does not run up the internal sides of the boat, but stop short at the lower pair of holes (F23 – port; F25 starboard). It is suggested that the outer groove may be a repair, possibly relating to leakage through the smaller of the basal splits in the parent log (F26 A), which took the form of a one-third sized, or "dwarf" transom board which was added and has subsequently been lost.

7.3.5 The Stern –Transom Board.

Fitted transoms are relatively common in the larger prehistoric logboats, those over around 7m in length, in which the parent logs were older and more likely to have suffered from "brittle heart" rot (McGrail 1978A, 64-5). This rotting of the heart wood starts low down at the base of the tree, which almost always becomes the stern of the vessel. Such rotting often required a separate fitted transom as the wood was too damaged to allow the stern to be fashioned fro the parent log. Only the Hasholme vessel has previously produced a separate transom to survive in an almost complete state however (McGrail 1987, 112). The Carpow example was fashioned by cleaving a plank tangentially from the tree. The plank has then been cut to fit the internal section of the boat and, like the Hasholme example, is somewhat lense-shaped in section with the outer edge of the board being cut to a point. This outer edge was fitted within the transom groove which was packed with both thin oak wedges and moss caulking. Notably cleaning of the transom has revealed well-preserved tool-marks on the interior face. These are of a form and shape consistent with a Bronze Age date for the boat, being narrow and short (see section 8.1.1). **A detailed study of the tool-marks is planned (see section 8.3) to coincide with scale drawing.**

7.3.6 The Stern – Transom Board Caulking



Illus 22: Detail of the moss caulking from the inner transom grove.

The *in situ* moss caulking from the inner transom groove has been identified by Dr David G. Long, Bryology Section of the Royal Botanic Garden, Edinburgh, as *Rhytidiadelphus squarrosus* (Hedw.) Warnst, or 'Springy Turf-moss' (Illus. 22). It is a very common moss of disturbed grassland, heathland, upland woods and usually with an acid soil.

7.3.7 The Stern – Beam Ties Holes and Other Fittings.

While fitted transoms are caulked and wedged within a groove, their structural integrity and watertight-ness are generally further enhanced by two types of beam tie: a) one on top of the transom that forces the transom down onto the groove and/or b) one aft the transom (McGrail *pers comm*). Both beam ties would also serve to hold the sides of the boat together against the transom thus stabilising the structure and also decreasing leakage.

A notable characteristic of the stern of the vessel are three pair of symmetric cut features (F20/F21; F22/F24; and F23/F25). The up most pair of these (F20/F21) are relatively deep, vertically cut circular sockets, around 6cm in diameter and 7cm deep, cut into the top of the vessel aft side of the transom board (Illus. 24). The function of these is not known although it is suggested that they may relate to the fitting of a board over the stern, which would have acted to hold the transom board in place. A similar feature is known from the Hasholme vessel (McGrail 1987, Fig 24 and 25).

The second pair of features, roughly circular holes (F22 and F24) cut horizontally into through the sides of the vessel at the sheerline aft side of the transom, also have good parallels in the Hasholme vessel. Beam ties are timbers fitted athwartships and high-up in a boat with the function of pulling together the two sides of the craft. These are particularly important for logboats with fitted transoms where there could be a tendency for the sides of the parent log to splay out at the stern, releasing the transom board. In the Hasholme example, one of the beam ties also held the transom board in place by contacting from above with a u-shaped projection from the transom board (McGrail 1987, 113). The position of the beam tie holes on the Carpow vessel is similar to that of the Hasholme vessel, being on the aft of the transom board. There are no projections on the Carpow transom board, however, to suggest a similar dual function as found on the Hasholme vessel. While it is possible that the transom board and beam tie was not designed to function in this way on the Carpow vessel, it would appear to an opportunity to provide additional security in retaining the transom board that the boat builders would be unlikely to have missed, particularly given the configuration of the board in relation to the holes. It is also possible that the transom board is not an original, but a replacement, however, this should be confirmed or otherwise by the forthcoming dendrochronological study. Whatever the configuration in relation to the transom board, it is likely that the main beam tie on the Carpow vessel was a simple spar of circular, or sub-circular, cross-section. The diameter of the beam tie holes F22 and F24 are between 8-10cm and so, given visible erosion around the features, it is likely that the timber spar would have been in the region of 6-8cm in diameter.

The third pair of cut features (F23 and F25) may also be beam ties holes, but notably relating to the outer transom groove, the holes being positioned directly above the terminal of the outer transom groove (Illus. 24). As outlined above it is considered probable that the outer transom groove represents the position of a second, smaller and additional transom board, possibly added in response to leakage resulting from the basal splits F26 A and B. With the configuration of outer groove and beam tie

holes, the beam tie spar would have acted to retain the smaller transom board being secured directly above it. This also indicates the size of the outer transom board which could only have come as far up as the smaller beam tie holes, which are notably offset (Illus. 25). Given that the entirety of the outer transom board would have been submerged it is suggested that the outer board did not function as transom board usually does (i.e. by physically keeping water out of the open stern of a boat), but rather offered an important space between the transom boards into which additional caulking, such as moss or perhaps clay, could have been inserted in order to reduce leakage caused by the basal splits.

It has also been notes that a "dwarf" or "false" transom could have proved operationally useful in a boat of this size, where "three point turns" may have been required in river use. In such circumstances the boat would have to "make a sternboard" (i.e. be propelled stern-first) which would result in water flowing into the open stern aft of the transom. The second transom would have stemmed the force of such a flow and minimised leakage into the main hull (McGrail *pers comm*).

7.3.8 Stern – Shelves.

At a position just forward from the original transom groove, a matching pair of shelves have been fashioned in the solid on both internal sides (Illus. 23, F16 and F17). Similar features were found in the Hasholme logboat and noted in an earlier logboat from Brigg (McGrail 1987, 108). It is considered likely that such shelves either supported a raised deck or platform plank on which a helmsman may have stood. This would have afforded him view over the heads of the crew and a commanding position from which to steer.

7.3.9 Hull - Evidence of Repairs.

There are two significant basal splits in the hull (F26 A and F26 B) both originating at the stern (Illus. 23). In addition to the possible repairs to the stern discussed above, split F26 B has a total of seven repairs over the length of the hull, taking the form of small patches of tar-like material, possibly tree-sap, which has been applied to the split. Notably F5 to F9 are all roughly equally spaced, which may suggest that they were contemporary. Of these F9 is exceptional in its size and appears to have been made up of several patches applied over time.

7.3.10 Hull - Thickness Gauge Holes.

No thickness gauge holes have been recognised although it is possible that the repairs at F9 could be over a thickness gauge hole, being roughly half way along the hull it would be a useful place for a thickness gauge hole. It is plausible that the repeated repairs at F9 are in response to a failure in the caulking of the thickness gauge hole. The presence of thickness gauge holes will be confirmed once the underside of the vessel can be inspected. **The presence/absence of thickness gauge holes will be confirmed once the vessel is lifted into the PEG tanks**.

7.3.11 Hull - Sheerline Holes.

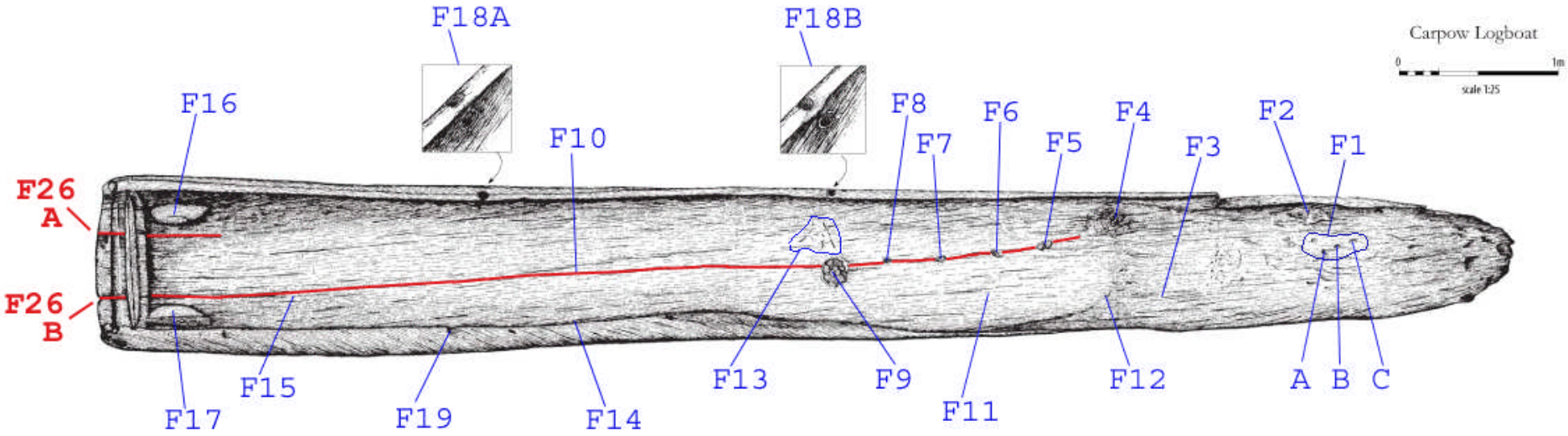
Three unusual L-shaped holes (F18 A, F18 B and F19) have been cut into the top of the sheerline of the boat (Illus. 23). They are fashioned in such a way as to be cut horizontally into the inboard face of the hull and more vertically on the outboard, leaving a thin rod of wood in place across the top of the hole.

McGrail notes that such holes are not uncommon on logboats although it is usually not possible to ascribe a function as a result of erosion and lack of associated fixtures (McGrail 1987, 110). As outlined by McGrail, such holes are usually related to one of three functions:

Constructional: either pushing the sides of the parent log apart following heat treatment, or holding them together, during the construction stage.
Structural: relating to fittings such as washstrakes, stabilisers or ribs.
Operational: for example paired oarports through which oars would be passed to allow the vessel to be lifted and carried, or as fastening points for hides to cover perishable goods (effectively a "spray deck").

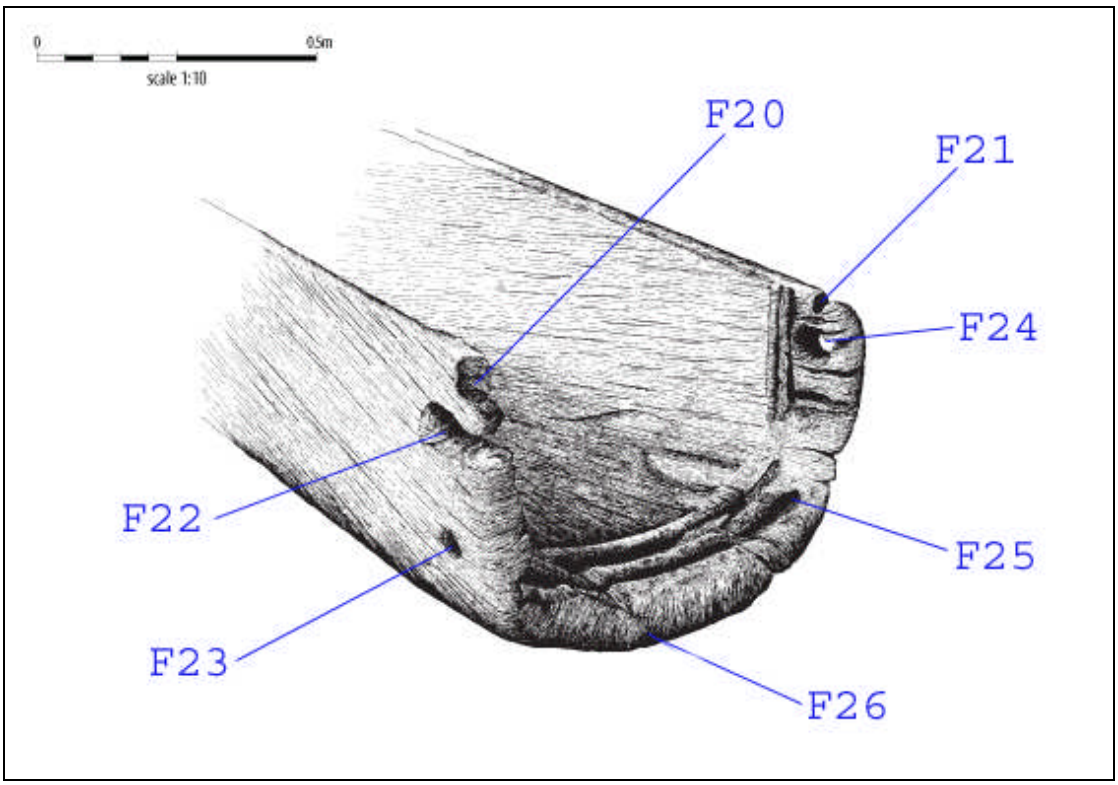
A series of seventeen sheerline holes in the Hasholme vessel were fairly regularly spaced and positioned around 8cm down from the top of the sheerline. They were also positioned directly opposite one (McGrail 1987, 110). The Carpow holes share none of these characteristics with F18 A and F19 being slightly off-set, there being only three that survive (and from projection probably only six in total) and also being cut directly into the top of the sheerline. In the Hasholme example, the most likely was considered to be either temporary beam lashings to hold together the parent log during construction, or operational by way of the spray deck model (McGrail 1987, 122-124).

In terms of the Carpow sheerline holes, many of the above theories can be discounted because the holes are offset. For example, oars could only be passed through the offset pair at an inconvenient angle. Further, the holes are cut in such a way (Illus. 25) as to leave only a thin piece of timber, less than 1 cm, in diameter. Such a delicate piece of wood could not withstand any pressure or weight caused by, for example, a rope being tied to it. Significantly, one of the holes, F18 A has probable signs of a fitting marking on the inboard of the hull which could suggest a "loose toggle" being straddled on the inboard of the boat, across the hole as a fastening for an external lashing. In this model, the holes would have served as fastening points for either a spray deck, or for wet hides to cover the hull in order to keep the vessel wet.



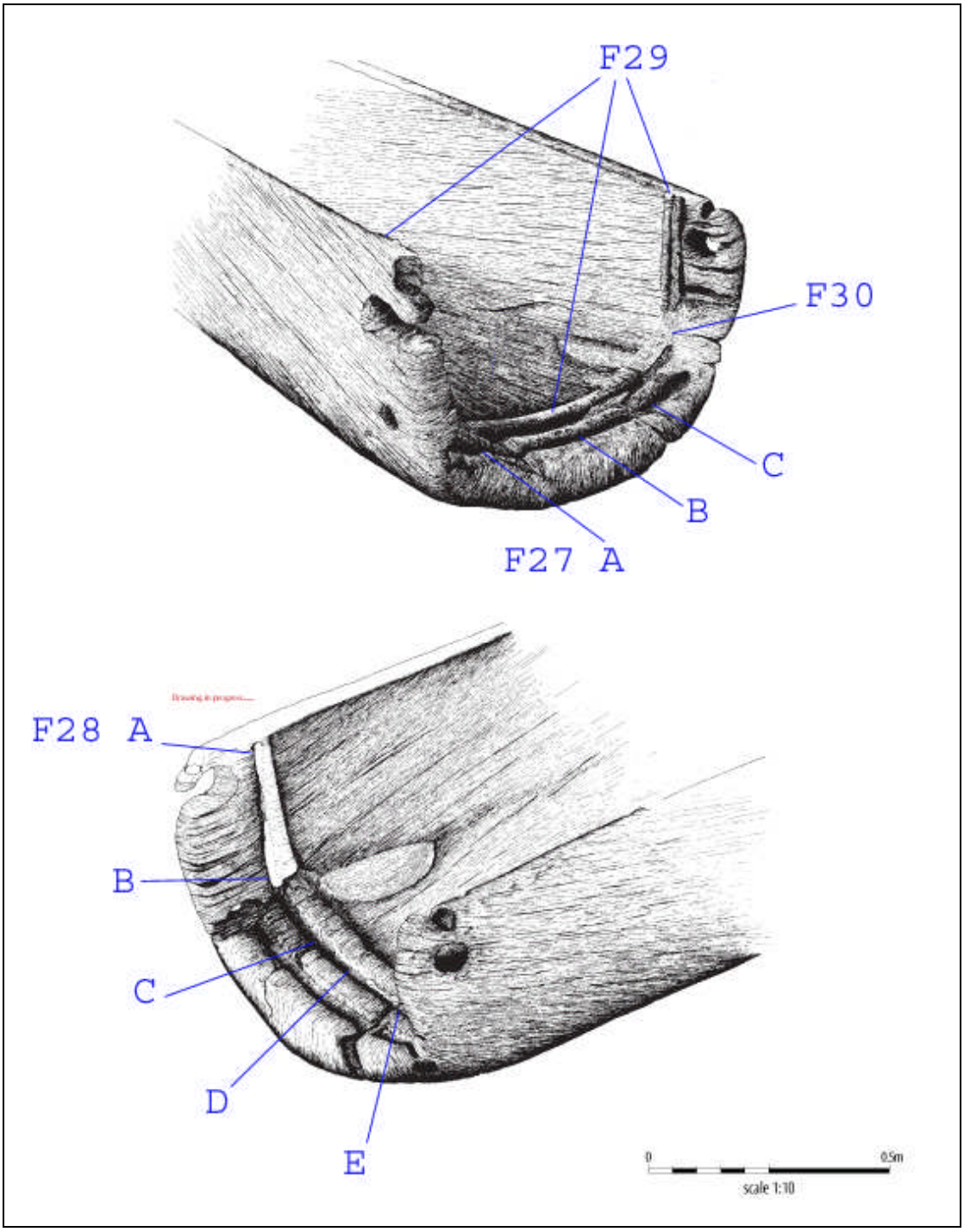
Illus 23: Above: Annotated Drawing 1 showing Features F1-F19 and F26 and 27. Below: Photo mosaic of the boat.

Feature No.	Description	Measurement
F1	group of three (?) dimples A-C. A is much more prominent.	A: 45mm diameter, 12mm deep B: 45mm diameter, 4mm deep C: 50mm diameter, 3mm deep
F2	knot with hairline crack running towards prow. Knot is evident on outside of the vessel.	350mm diameter
F3	possible raised feature. Darker in colour than surrounding wood. Trapezoidal in shape.	90mm (vertical) by 50mm and 70mm (horizontal)
F4	pronounced knot. Raised on inside of vessel, hollow on exterior.	170mm diameter, 30mm raised (interior) 120mm by 80mm, 50mm deep (exterior)
F5	resin repair (along basal split). Pronounced repair, sub rectangular in shape.	140mm by 70mm, 30mm raised (distance between F5 and F6: 240mm)
F6	resin repair (along basal split). Sub circular in shape.	60mm in diameter, 10mm raised (distance between F6 and F7: 250mm)
F7	resin repair (along basal split). Amorphous in shape.	80mm by 50mm, 15mm raised (distance between F7 and F8: 290mm)
F8	resin repair (along basal split). Sub circular in shape.	40mm in diameter, 4mm raised (distance between F8 and F9: 240mm)
F9	resin repair (along basal split). Large repair. Sub circular. Made up of smaller composite repairs.	230mm by 180mm, 30mm raised
F10	'plug' feature. Possible gauge hole. Circular in shape. Raised circumference and depressed centre.	50mm by 40mm
F11	resin repair. Sub circular in shape.	35mm by 20mm, 5mm raised
F12	resin repair. 'Figure of 8' in shape.	40mm by 30mm in shape
F13	various linear marks – possibly excavation damage	
F14	possible repair made up of accreted material on the inside of vessel.	40mm by 50mm, raised 7mm Position: 400mm down from top of strake
F15	resin repair on basal split.	40mm by 50mm, raised 5mm
F16	support/mount (?) feature at stern of vessel (port side)	390mm by 130mm, maximum height 90mm
F17	support/mount (?) feature at stern of vessel. (starboard side). Top of support has been sheared off.	380mm by 130mm, maximum height 80mm
F18 A	Sheer-line hole: port side	External: 40mm by 50mm (port to starboard, prow to stern) Internal: 40mm in diameter Depth: 25mm
F18 B	Sheer-line hole: port side	ditto
F19	Sheer-line hole: starboard	External: 40mm by 50mm (port to starboard, prow to stern) Internal: 40mm in diameter Depth: 25mm



Illus 24: Annotated isometric drawing of the stern showing features F20-F26 (beam tie holes and basal split).

Feature No.	Description	Measurement
F20	a vertically cut retaining feature (port side). It appears as a deep sub circular depression and is paired by F21.	65mm (port to starboard) by 40mm (stern to bow), 65mm deep
F21	a vertically cut retaining feature (starboard side). It appears as a deep sub circular depression eroded on the after side and is paired by F20.	65mm (port to starboard) by 60mm (stern to bow), 65mm deep
F22	a circular hole cut horizontally through the sheer-line aft the transom (port side). The afterside is missing and it is paired with F24 and together they are the larger and upper of four such holes (the others being F23 and F25).	80mm (top to bottom), 90mm (stern to bow), 100mm thick at base of hole.
F23	lower hole (port side). Triangular in shape. Angled downwards (exterior to interior)	50mm (top to bottom), 45mm (stern to bow), 110mm thick.
F24	upper hole (starboard side). Large circular feature.	80mm (top to bottom), 100mm (stern to bow), 90mm thick at base
F25	lower hole (starboard side). Circular feature. Angled downwards (exterior to interior)	60mm (top to bottom), 60mm (stern to bow).
F26 A	basal split at the stern.	The split runs for around 80cm
F26 B	basal split along the boat which appears to have been repaired several times (see F5-10 and F15).	The split is around 7m long



Illus 25: Annotated isometric drawing of the stern showing features F27–F30 (transom grooves, inner ridge and repair).

Feature No.	Description	Measurement
F27	outer transom groove. Rectangular shaped groove with vertical sides.	A: 45mm wide, 25mm deep B: 40mm wide, 25mm deep C: 20mm wide, 20mm deep
F28	inner transom groove. Flat bottomed groove with angled rather than vertical sides. Forward side of groove is higher than the after side.	A: 40mm wide, 25mm deep B: 40mm wide, aft side 20mm deep, forward side 40mm deep C: 45mm wide, aft side 40mm

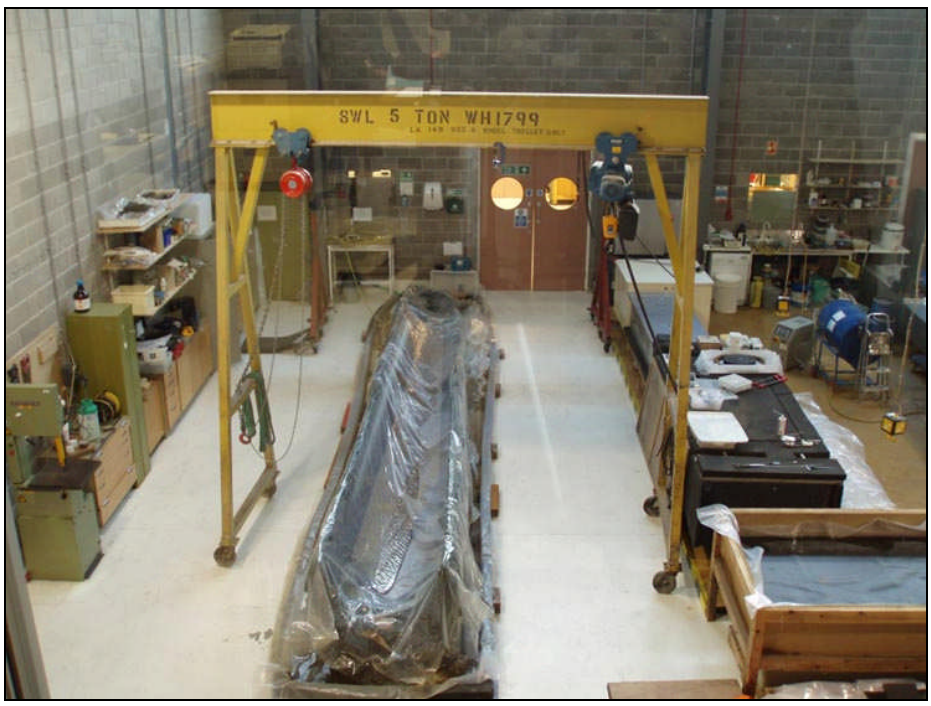
		deep, forward side 50mm deep D: 45mm wide, aft side 30mm deep, forward side 50mm deep E: 45mm wide, aft side 40mm deep, forward side 50mm deep
F29	inner transom 'ridge'. Large band of wood parallel to inner transom groove.	60mm thick at port side, 50mm thick at starboard side
F30	a section cut across the inner transom groove. During excavation, a an eroded timber block (SF015) would found *in situ* between the transom board and this slot. It is suggested as a repair - a similar feature having been found on the Hasholme vessel.	240mm of inner transom groove and ridge have been removed. Wedge: 10mm by 20mm head, 100mm tail

8 ONGOING/FUTURE WORK

8.1 Interim Conservation Report Dr T. Skinner, National Museums Scotland

8.1.1 Initial Treatment

The initial stages of conservation of the log-boat are now almost completed. The main emphasis of work over the past few months has been to facilitate the recording of the log-boat and to carry out the analytical work needed to assess its condition. This has meant keeping the log-boat accessible, and yet maintaining it in a wet state. This has been accomplished, very successfully, using "leaky" hoses and capillary matting to distribute tap-water over the whole surface of the boat. A small pump and float switch are used to pump out the tap-water from the bund housing the boat into the drain. This continuous washing will also effectively desalinate the wood (Illus. 26).



Illus 26: The logboat in the Granton laboratory.

A major problem that immediately became evident is the conglomerate concretion adhering to the surface (Illus. 27). This is composed of gravel overlying a layer of fine silt, bound, according to scanning electron microscope (SEM) analysis, with iron and sulfur compounds. It is worse on the outside of the boat, but is also present on the inside. While it is possible to soften the concretion with dilute hydrochloric acid, this can only be done with small pieces in a fume cupboard, as the process produces highly toxic and flammable hydrogen sulfide. The concretion has therefore been removed where necessary to reveal detail, mainly around the stern, by mechanical means. This is laborious and time-consuming, and it has not yet decided whether or not to treat the whole logboat in this way – it may be possible to do it gradually during the polyethylene glycol (PEG) impregnation phase of the treatment.

Illus 27: The stern of the vessel showing gravel concretion.

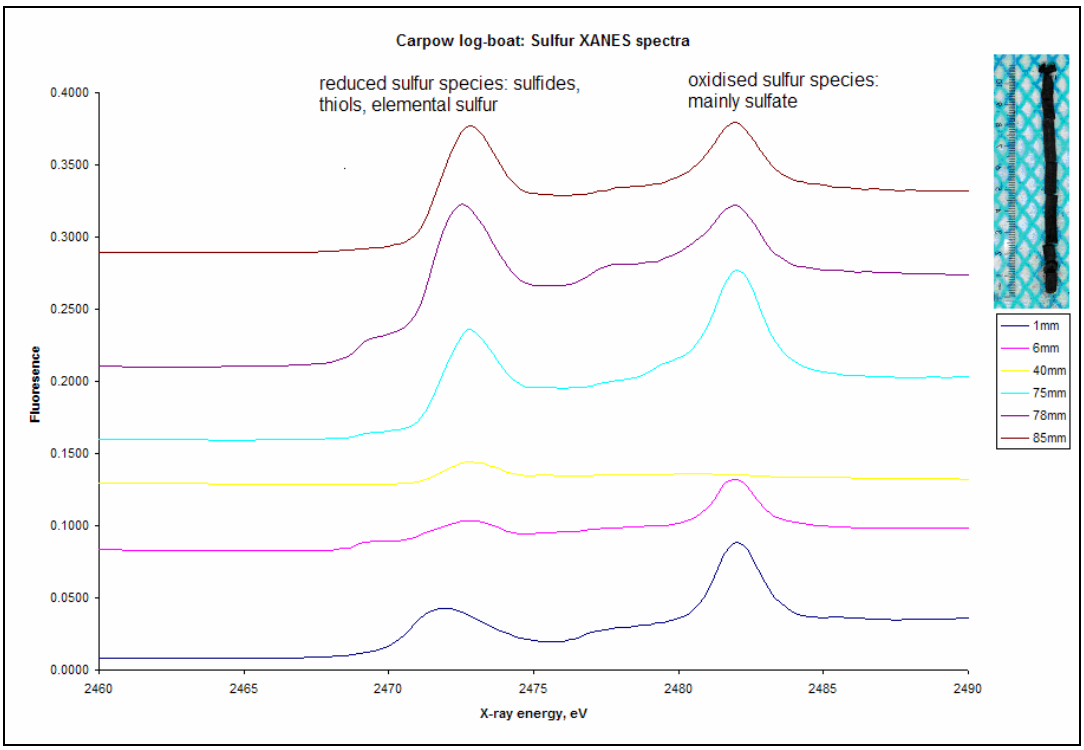
The cleaning has been successful in revealing well-preserved tool-marks on the transom board. These are of a form and shape consistent with a Bronze Age date for the boat, being narrow and short (Illus. 28). It also revealed quantities of moss in the gap between the transom and the hull, as well as details of the slot(s) into which the transom was fitted.

Illus 28: The removed transom showing wood-working detail.

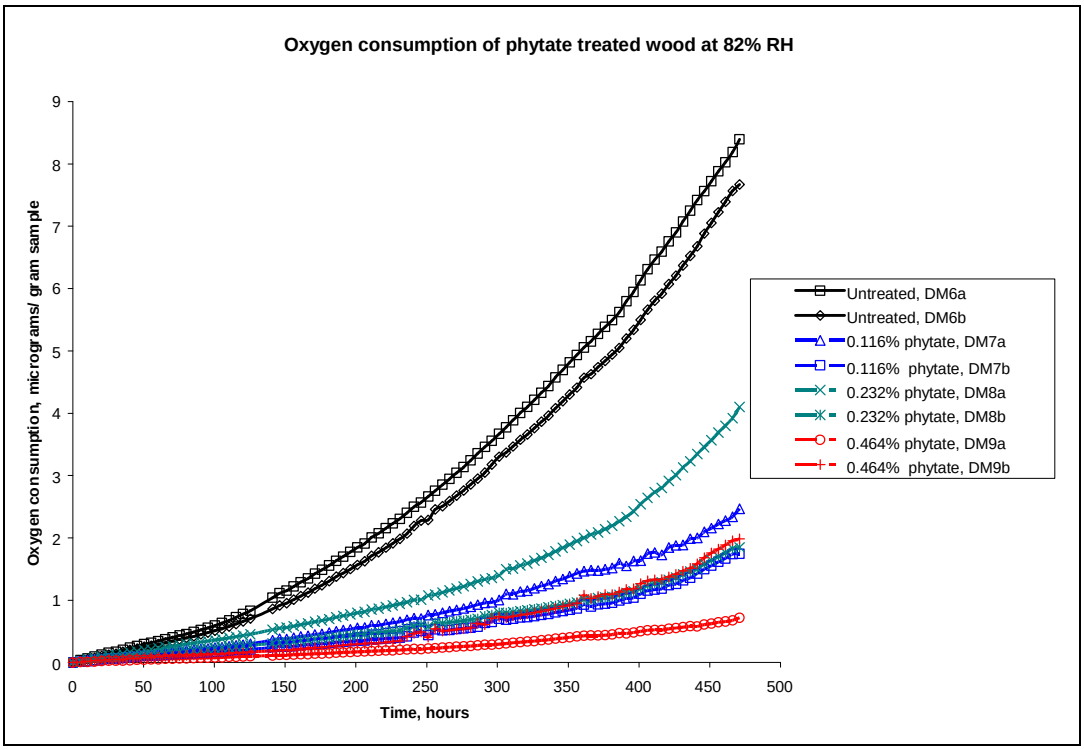
The SEM analysis of the concretion was carried out on a small sample removed from a damaged area of the side of the hull. The presence of sulfur and iron compounds in the concretion is of some concern: these can oxidise in air to produce sulfuric acid, and this is a matter of major international concern in marine conservation. It was important to determine the nature and distribution of these compounds within the wood itself. Core samples were taken with an increment borer and analysed at the Swiss Light Source using X-ray spectroscopy. This is a synchrotron-based technique which enables us to identify the type of sulfur compounds in the wood, and in a core sample, their distribution.

The spectra shown in Illus. 29 and 30 are for one core, and show the relative amounts of reduced and oxidised sulfur compounds at various depths. The relative height of the lines gives an indication of the total sulfur content. The results indicate that the reduced sulfur species are more prevalent on the outside of the boat, but there are some on the inside of the hull. The centre of the hull, at a depth of 40mm, shows very little sulfur compared to the near-surface sample spots.

There is a significant possibility that these compounds will oxidise into sulfuric acid once the conservation process is complete, although it may take several years for the problem to become apparent, as happened with the Swedish warship the Vasa. However, NMS have been working on this problem, in collaboration with the Mary Rose Trust, and have found at least one potential solution: treatment with calcium phytate. This is a compound found in seeds, and acts as an iron-chelating agent to prevent oxidation in the seeds, enabling them to remain dormant and viable for considerable periods of time. Results with a modern respirometer indicate that treatment of marine wood with low levels of calcium phytate dramatically reduce the oxidation rate, and should prevent acid generation. This treatment may be easily incorporated in the PEG impregnation phase.



Illus 29: X-ray absorption sulfur near-edge spectra of a core from the log-boat showing the types and relative amounts of sulfur compounds at various depths within the wood.



Illus 30: Respirometer data for the oxygen consumption of wood from a marine shipwreck showing the oxygen consumption of wood either untreated or treated with a solution of calcium phytate.

8.1.2 Future Work

The PEG impregnation stage will be carried out in three tanks. The log-boat will need to be cut into three pieces to fit into the freeze drier which will be used to carry out the final phase of treatment. A tree surgeon will carry out the necessary surgery using a relatively heavy diamond-bladed saw. This technique for cutting was used on the Dover boat. Three stainless steel lifting cradles are to be constructed to house the boat sections during these last stages of treatment, to keep them accessible and moveable, and stainless steel braces around the cuts to prevent sagging. Weighing will be used to monitor the impregnation process. The precise PEG impregnation schedule has yet to be determined, but it is expected the whole process to be completed within eighteen months.

8.2 Dendrochronological Assessment Dr A. Crone, AOC Archaeology Ltd

Both the logboat and transom are fashioned from oak. The thickest part of the logboat lies just in front of the innermost transom slot; the wood is 250mm thick at this point. It is planned that a sample would be removed using a Swedish incremental corer, which has already been used by to remove cores for sulphate tests. The existing cores indicate a reasonably fast growth rate of 6-7 rings per 10mm – which suggests that there may be as many as 170 rings present. The logboat is a hollowed out tree and there appears to have been no shaping to the outer surface so the curved outer surface is likely to be the heartwood/sapwood boundary, give or take a few growth rings that may have eroded away. The sapwood is no longer present; this may have been deliberately removed or simply eroded away with use. The presence of the heartwood/sapwood boundary means that a felling range can be estimated for the tree, if it is possible to absolutely date it.

The transom has been fashioned by cleaving a plank tangentially from the tree. The grain runs diagonally across the transom. The ring-pattern is visible around the curved edge of the transom where it has been trimmed flat to sit into the groove. The ring-pattern appears to be of a similar growth rate to that on the boat, ie 6-7 rings per 10mm. The maximum surviving radius from the original tree is 440mm so there could be between 250–300 rings present. The transom is too thin to core but the ring-pattern around the edge of the transom could be cleaned to enhance the ring-pattern by paring the surface as unobtrusively as possible with a razor blade. The ring-pattern would then be measured manually using an eyepiece with a graticule.

There are no tree-ring chronologies for Scotland which cover the Bronze Age and so a calendar date for the logboat chronology could not be guaranteed. However, even if the logboat could not be absolutely dated dendrochronological analysis should be able to determine the chronological relationship between the logboat and the transom, thereby addressing the question as to whether the transom is original or secondary. **The work is planned for late February/March 2007.**

8.3 Tool-mark Study

As outlined above, a study of tool-marks on the transom board is planned and Dr. R. Sands of University College Dublin, School of Archaeology, has been approached to carry out the study. **The work is planned for March 2007.**

8.4 Future Research Priorities

There are two identified areas for future research, the first being consideration of the logboat construction by comparison with other examples from the U.K. and Ireland. The second involves the consideration of the logboat in terms of contemporary archaeology of the area. It is hoped that both these strands would be developed via the conference and incorporated into the final publication (section 8.6 below).

8.6 Publication Plans

Interim notes have appeared in *Discovery and Excavation Scotland* (Strachan 2001, Strachan and Glenndinning 2002 and Strachan and Glenndinning 2003) and are planned for 2007 Strachan (*forthcoming*). In addition, an interim report presenting the results of the 2003 evaluation work was published in the *Tayside and Fife Archaeological Journal* (Strachan 2004). The current plans for final publication of the project are as a *Tayside and Fife Archaeological Journal* monograph, based on this Data Structure Report, any further planned study and possibly a one-day conference on the boat and its context.

8.7 Public Interpretation and Display Plans

8.7.1 Leaflets

The initial interpretation of the logboat will be through a series of leaflets, the first of which, on the discovery excavation and lift, has already been produced and distributed.

8.7.2 Photographic exhibition

A series of 40 A3 photographs of the excavation and lift have been produced and mounted on kappa board for display. To date the exhibition has been displayed at the Dover Boat conference, Dover, in October 2006; at Abernethy Museum, close to the excavation site, during Doors Open Days in September 2006; and in the Local Studies Department of the A.K. Bell public library, Perth, from January to February 2007.

8.7.3 Museum Display and Storage

Once the conservation has been completed there are currently two options for the future display of the logboat. The preferred option is dependent on the approval and completion of a major re-development project at Perth Museum & Art Gallery. This would result in significantly increased space available for displaying the collections, including the long-term display of the logboat as apart of the "permanent" archaeology gallery.

If this re-development does not take place, or is significantly delayed, then the contingency plan is for a 12-month temporary exhibition devoted to the logboat.

In the event of the re-development the long-term storage will be catered for by the re-development. Without the re-development there may be scope for long-term storage of the boat in pieces, though we also have a generous offer from the NMS to provide accommodation at Granton.

8.7.4 CAD graphics and interpretation

During the recording of the logboat at Granton (section 7.2) the CFA's graphic team recognised the potential of using the various recording techniques to produce a highly realistic 3-Dimensional interactive model of the logboat for teaching and exhibition purposes. Using a combination of CAD data and rectified photography they have begun to reconstruct the logboat in order to create a 'solid' 3-Dimensional model using the animation and modelling package 3dsMax 7. In the future it will be possible to use such graphics for museum displays, allowing the visitor to view the logboat digitally and interact with the structural design via an interactive kiosk. A similar experience can be offered through publishing the animations on the World Wide Web.

9 CONCLUSION

While little can be said of the find in relation to contemporary sites in the immediate area, the vessel was probably used to exploit the rich river and estuarine environments of the Earn and the Tay in a similar way as has been documented on other east coast estuaries (for example Van de Noort and Ellis 1995, and Wilkinson and Murphy 1995). Indeed it is worth noting that the topography of the lower Tay, and the Tay estuary, is in many ways reminiscent of Fenland or parts of the low-lying coast of East Anglia. Further it is likely that this comparison would have been far more noticeable prior to drainage, reclamation and conversion to arable land of low-lying areas where salt-marsh and coastal grasses would have existed. The sizable group of recorded logboats from the Tay estuary reflects the suitability of this type of craft to the shallow sheltered waters that exist there. Activities such as fishing and wild-fowling, in addition to the transportation of goods and people, are the most probable uses of the vessel, and it is likely that this formed part of a wider exploitation of the wetlands surrounding the estuary augmenting subsistence from agriculture.

The distribution of possible contemporary activity in lower Strathearn and the Tay Estuary is primarily represented by ritual and funerary monuments and an extensive scatter of Late Bronze Age metalwork (Cowie and Hall 2001, 6, Illus. 3). As a result, our understanding of settlement and economy of the area at this time is limited. The analysis of pollen remains from Moncrieffe suggests agricultural activity in the area in the late third millennium BC (Caseldine 1983). In addition, a later prehistoric origin is possible for a number of probable settlement sites recorded as crop marks on the Carse of Gowrie; at the foot of the Ochil hills between Newburgh and Abernethy; and at the foot of Moncrieffe Hill. While none of these are securely dated, it is possible that some may have had origins in the Late Bronze Age. Indeed, the latter sites around Moncrieffe Hill may be related to the ritual activity at Moncrieffe stone circle (Stewart *et al* 1986). Finally, it is conceivable that one or more of the hillforts in the area may have had origins in the Late Bronze Age, as has already been suggested again at Moncrieffe (Cowie and Hall 2001, 10).

The vessel is broadly comparable in date to Late Bronze Age metalwork possibly ritually deposited in the river Tay between Perth and Newburgh (Cowie and Hall, *ibid*, 8-11), and while no direct association can be made, a possible ritual association for the Carpow vessel should be considered. For example, at Fiskerton, Lincolnshire, a votive deposition has been interpreted for one of two logboats recently excavated at an Iron Age timber causeway. The vessel was apparently deposited in pristine condition and set between two clusters of posts and pegged into position. A large

assemblage of other artefacts interpreted as votive offerings were discovered, including a sword, an iron dagger, a spear, numerous pieces of bronze and a socketed axe, the latter a skeuomorph of Later Bronze Age examples (Field *et al* 2003). If the suggestion that this section of the Tay was the focus for ritual deposition activity, as suggested above, is accepted, then it is possible that such activity may have required the use of a logboat. Indeed, given the example of Fiskerton, then deliberate sinking of the vessel, at some point, cannot be ruled out.

Whatever the function of the Carpow vessel, it is likely that it was propelled by a combination of paddling in deeper waters and poling or punting in shallow water. The Canewdon paddle from the Essex coast (Wilkinson and Murphy 1995, 152-7) is contemporary with the Carpow logboat and may give some indication of the type of paddle employed. The paddle is of oak and is notable for its length (2.08m) and quality of workmanship, having a diamond-shaped blade and shaft of c50mm diameter. The issue of propulsion and steering will be given further consideration prior to final publication, with the use of scale models being used to determine number/position of paddlers, length of paddles required etc.

It is considered likely, given the orientation of the vessel and the angle at which it is partly buried, that it was deposited on the bank having been carried downstream from either the river Tay or the Earn. It is noticeable that the peat shelf of the bank currently acts as a weir, collecting items washed downstream during ebb tides.

In conclusion, the significance of the Carpow vessel is not only its early date and good state of preservation, but also the fact that it is one of a very few Scottish logboats to be recorded, and recovered and conserved using modern techniques of archaeology and conservation.

Acknowledgements

Historic Scotland funded the initial radiocarbon date in 2001 and part-funded both the evaluation work in 2003 and the excavation and lift in 2006. The National Museums of Scotland contributed staff time during both the excavation and conservation process, and funded the video recording by Circa Media. Perth Museum and Art Gallery have also contributed staff time throughout the project. Scottish Natural Heritage gave permission to excavate within the SSSI.

The author would like to thank the following individuals for their involvement with the project: the Millar brothers of Jamesfield Farm, who gave permission to access and excavate the boat. Theo Skinner and Alison Sheridan, assisted by Jane Clark and Colleen Healey of The National Museums of Scotland who worked along with the excavation team on site and have led the conservation programme. Robin MacKenzie (Perth and Kinross Council) and David Dawson of KOREC Group for their work with DGPS which was kindly provided free gratis. Professor Colin Martin and Bob Mowat (RCAHMS) kindly visited the excavations on a regular basis and provided useful guidance throughout as did Philip Robertson and Noel Fojut of Historic Scotland.

In particular thanks are due to the excavation and lift team. The project was challenging in many respects, working in short, intense bursts in often very difficult circumstances: Jim Ferguson, Donny Macleod and Scott Macleod (Moorings and Marine Services); Sarah Winlow, Lindsay Farquharson, Steve Timoney and Andrew

Driver (PKHT); Bruce Glendinning, Chris O'Connell and Alasdair Curtis (CFA Archaeology Ltd); Mark Hall and Fiona MacKenzie (Perth Museum and Art Gallery); and volunteers Scott McGuckin, Keith Emerson and Ricky Blake and student Jake Streatfield-James; Mike Cressey and Len McKinney (CFA Archaeology Ltd) who carried out the environmental study. Thanks are also due to Professor Seán McGrail for the invaluable discussions both at Granton and by mail on both early boat building and the process of studying the Carpow boat.

Illus 31: Part of the excavation team.

10 BIBLIOGRAPHY

Ashmore, P J	1999	'Radiocarbon dating: avoiding errors by avoiding mixed samples' *Antiquity* 73, 124–130.
Caseldine, C	1983	'Palynological evidence for early cereal cultivation in Strathearn', in *Proc Soc Antiq Scot* 112 (1982), 39-47.
Cowie, T and Hall, M A	2001	'Late Bronze Age metalwork from Scottish Rivers: a rediscovered sword from the River Forth at Cambus, Clackmannanshire, in its wider context', *Tayside and Fife Archaeol J* 7 (2001), 1-15
Cressey M, Rees, A and Dawson, S	2003	Radiocarbon determinations on marine shell from Inchture, Perth and Kinross. Tayside and Fife Archaeological Journal Volume 9, 3-5.
Crumlin-Pedersen, O. and McGrail, S	2006	'Some Principles for the Reconstruction of Ancient Boat Structures', *The International Journal of Nautical Archaeology* 35, 53-7.
Cullingford, R A, Caseldine, C J and Gotts, P E	1980	'Early Flandrian land and sea-level changes in Lower Strathearn', *Nature*, 284, 159-161.
Field, N Parker-Pearson, M and Rylatt, J	2003	'The Fiskerton causeway: research - past, present and future' in Catney, S and Start, D (eds) *Time and Tide: the archaeology of the Witham Valley*, Heckington, Witham Valley Archaeology Research Committee, 16-32.
Fry, M F	2000	*Coití Logboats from Northern Ireland.* Antrim (= Northern Ireland Archaeological Monographs No. 4).
Geikie, J	1880	'Discovery of an ancient Canoe in the old alluvium of the Tay at Perth', *The Scottish Naturalist: A Magazine of Natural History*, v, 1-7.
Hutcheson, A	1897	'Notice of Ancient Canoe found in the River Tay', *PSAS* 31 265-281.
Lanting, J N	2000	'Dates for Origin and Diffusion of the European Logboat', *Palaeohistoria* (1997-8) 39/40, 627-50.
Lanting, J N and Brindley A L	1996	'Irish Logboats and their European Context', *The Journal of Irish Archaeology* VII, 85-95.
McGrail, S	1978a	Logboats of England and Wales with comparative material from European and other countries. Part i: Discussions and Catalogue. Oxford (= British Archaeological Reports British series no. 51i).
McGrail, S	1978b	Logboats of England and Wales with comparative material

from European and other countries. Part ii: Drawings and Illustration. Oxford (= British Archaeological Reports British series no. 51ii).

McGrail, S 1987 *Ancient boats in N.W. Europe.* London and New York: Longman.

Millett, M and McGrail, S, 1987 'The Archaeology of the Hasholme Logboat', Archaeol. J. 144, 69-155.

Mowat, R J C 1996 *The Logboats of Scotland*. Oxford (= Oxbow Monograph 68).

Robinson, M E, Shimwell, D W and Cribbin, G 1999 'Re-assessing the logboat from Lurgan Townland, Co. Galway, Ireland', *Antiquity* 73 903-908.

Stewart, M et al 1986 'The excavation of a henge, stone circles and metal-working area at Moncrieffe, Perthshire', *Proc Soc Antiq Scot* 115 (1985), 125-50.

Strachan, D 2001 'Carpow Log Boat', *Discovery and Excav Scot* 2001, 74.

Strachan, D 2004 'A Late Bronze Age Logboat from the Tay estuary at Carpow, Perth and Kinross', *Tayside and Fife Archaeol J* 10 (2004), 58-63.

Strachan, D 2006 *The Carpow Logboat, Perth and Kinross. Method Statement for low tide survey, environmental sampling, excavation and lifting.* Unpublished method statement. Perth and Kinross Heritage Trust.

Strachan, D and Glenndinning, B 2002 'Carpow Log Boat', *Discovery and Excav Scot* 2002, 90.

Strachan, D and Glenndinning, B 2003 'Carpow Log Boat', *Discovery and Excav Scot* 2003.

Van de Noort, R and Ellis, S (eds) 1995 *Wetland Heritage of Holderness, an archaeological survey.* Kingston upon Hull.

Wilkinson, T J and Murphy, P L (eds) 1995 *Archaeology of the Essex Coast, Volume 1: The Hullbridge Survey.* Chelmsford (= East Anglian Archaeology Report No 71).

Weski, T 2005 'Unfinished and Paired Logboats from Bavaria', *The International Journal of Nautical Archaeology* 34, 269-281.

APPENDIX 1 Biostratigraphic analysis of the inter-peat below the SP 1 stump.

UNIT 1: 10YR 2/1 Black, very fibrous peat, with 90% organic remains, marsh reeds *(Fragmites communis).* The soil matrix is a clay with no clasts, it is highly compacted. Boundary is faint and merging.

UNIT 2: 10YR 2/1 Black main colour, 10YR 2/2 very dark brown subsidiary colour. Very fibrous compacted peat, 90% organic remains, marsh reeds, as with Unit 1, the matrix is clay with no clasts. Boundary is faint but identifiable.

UNIT 3: 10YR 2/1 Black main colour, 10YR 2/2 very dark brown subsidiary colour. Very fibropus compacted peat, 90% organic remains, marsh reeds, as with Unit 1 the matrix is again a clay with no clasts. Boundary is faint but identifiable.

UNIT 4: 10YR 3/1 Very dark grey. Silty clay loam, marine carse fluvial deposit underlying the peat. There is no mottling or banding within the unit itself. Boundary is sharp and well defined. There is one small piece of organic material at the base of the tin but this may be an artefact of the sampling process rather than a result of any geomorphic process.

APPENDIX 2 List of radiocarbon dating samples, type, species and weight.

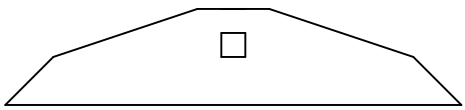
Sample No	Sample type	Species	C14 Dating	Wet weight
Sample 1	Log boat sample	Quercus sp	AMS	1-2g
Sample 2 (SP2)	Stump	Quercus	AMS	5.7g
Sample 3 (SP2)	Stump	Quercus	AMS	5g
Sample 4 (SP3)	Stump	Betula	AMS	6.8g
Sample 5 (SP3)	Stump	Betula	AMS	4.4g
Sample 6 (SP1)	Stump	Betula	AMS	4.7g
Sample 7 (SP1)	Stump	Betul	AMS	9.5g
Sample 8	Middle peat	n/a	AMS	4.2g
Sample 9	Basal peat	n/a	AMS	4g
Sample 10	Tooled roundwood	Betula	AMS	1g
Sample 11	Nut shell	Corylus av.	AMS	1g
Sample 12	Nut shell	Corulus av.	AMS	1g
Sample 13	Nut shell	Corylus av.	AMS	1g
Sample 14	Nut shell	Corylus av.	AMS	1g

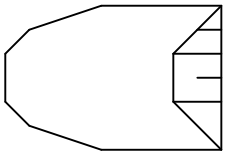
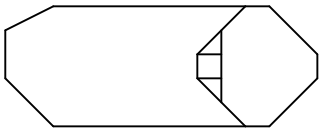
APPENDIX 3 List of samples examined during laboratory analysis.

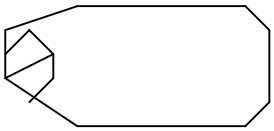
Sample No	Summary description	Sample Location
SAMPLE 1	Highly compressed peat containing	Beneath boat c. 2m from

	Phragmites stems. Two fragments of small diameter branch wood extracted from the centre. Compressed, probably Betula.	prow
SAMPLE 2	10 hazel nut shells, 4 have rodent damage. 1 stake with two oblique facets forming a point. Abundant small twigs	Beneath boat between 1 to 2m from prow
SAMPLE 3	Gravel rich sample containing small branch wood, 1 fir cone	Beneath boat between 1 to 2m from prow
SAMPLE 4	Grey alluvial silt and sand with pea-sized gravel	Beneath boat between 1 to 2m from prow
SAMPLE 5	Alluvial sand and gravel	Beneath boat between 1 to 2m from prow
SAMPLE 6	Fragments of roundwood and hazel nut shells	Inside boat mid section
SAMPLE 7	Twigs with some identified as hazel	Inside end section of boat
SAMPLE 8	Alluvial sand and gravel	Inside end section of boat
SAMPLE 9	Large fragment of wood, 360mm x220mm x80mm identified as birch	Beneath end of boat
SAMPLE 10	Missing	Beneath end of boat
SAMPLE 11	Grey estuarine clay	Beyond end of boat
SAMPLE 12	Trunk wood identified as hazel, 160mm diameter encrusted with gravel and iron ozide	Part of a larger log beneath the boat
SP1	Birch tree stump resting on inter-tidal peat	c. 25m north-east of boat
SP2	Large oak stump with eroded inter-tidal peat	c. 30m south-east of boat
SP3	Small birch stump resting on shallow inter-tidal peat	C 100m south

APPENDIX 4 List of small finds

SF001	**Wooden board / handle ? with hole**: A worked piece of wood consisting of a shaped plank, around 2-3cm thick, 29 cm in length and around 8 cm in height. It has a single straight edge and a curved edge (see drawing) and has a single hole (4x2 cm) cut through it. There is no reason to suggest that the find is contemporary to the logboat and it is possibly a section of a small barrel lid.	
SF002	**Wooden peg. Lost?**:	

SF003	**Worked (?) wood**: a section of timber (14 x 12 x 4 cm) which has been worked, apparently a single cut.	
SF004	**Worked (?) wood**: piece of possibly worked wood (23x15x6 cm)	
SF005	**Pieces of wood – worked?**: a) eroded and compressed round-wood, 7 cm in length and oval in section (2 x 1 cm); b) a roughly square section of thin wood, possibly bark (5 x 5 cm); a roughly square section of thin wood, possibly bark (7 x 6 cm);	
SF006	**Worked (?) wood**: a) x3 ?hazel nuts; b) 4x round-woods (less than 10 cm length); 2x small pieces of eroded wood.	
SF007	**Worked (?) wood**: a large piece of slightly compressed round-wood (18 x 12 x 10 cm) which appears to have been worked by a single cut.	
SF008	**Worked (?) wood**: a section of round-wood 11 cm in length and 5cm in diam.	
SF009	**Worked (?) wood**: a) round-wood (16 cm in length and 3am in diam.); b) triangular piece of wood (7 cm in length with each triangular length being 2 cm); c) compressed round-wood (11 cm in length, oval in section measuring 4m x 2cm) – Only b) may possibly be worked.	
SF010	**Wooden object**: compressed round-wood 10 cm in length, oval in section (4x3cm).	
SF011	**Worked (?) wood**: a) one piece of peat (13x9x4 cm); b) 2x small eroded wood (4-6 cm); and c) 1x triangular piece of wood (10 cm long, with each triangular length being around 3 cm). Only c) may be worked.	
SF012	**Worked (?) wood**: 8 fragments of	

	eroded wood (10-18 cm in length) – none appear worked.	
SF013	**Worked (?) wood**: 10 fragments of eroded wood (6-9cm in length), including 2 pieces of round-wood (c.1cm diam.) – none appear worked.	
SF014	**Worked (?) wood**: a sub-rectangular bloack of wood (20 x 14 x 6 cm) which appears to have been worked by a single cut.	
SF015	Worked wood: an eroded sub-rectangular block of wood, in two pieces, found *in situ* at the stern of the vessel on either side of the transom board and slotted into cut features F30.	
"Carpow 2006"	6x lengths of round-wood (less than 10 cm in length and between 3-4 cm in diam.).	

APPENDIX 5 List of drawings for archive

Drawing Number	**Year**	**Description**	
1	2006	1:20 plan and cross section of logboat. Pencil	SW
2	2006	1:20 plan and cross section of logboat. Pencil	SW/DS
3	2006	1:20 plan and cross section of logboat. Inked	SW/DS
4	2006	1:20 plan and cross section showing location of samples, contexts and finds. Inked	SW/DS
5	2006	1:20 sections at 2m, 5m and 8m from bow of logboat. Pencil	SW/DS
6	2006	1:20 sections at 2m, 5m and 8m from bow of logboat. Pencil	SW/DS
7	2006	Schematic section of floating rig. Inked	DS
8	2006	Stages of excavation and recovery of logboat. Inked	DS
9	2006	Photocopy of inked 1:10 drawing of logboat (in progress).	LW

10	2006	Reduced photocopy of inked 1:10 measured drawing of logboat (in progress).	LW
11	2006	Photo mosaic of the logboat	LW
12	2002	1:10 cross section of exposed bow of logboat. Pencil	RS
13	2002	1:10 exposed section of bow end of logboat in plan and section. Pencil	RS
14	2002	1:10 exposed section of logboat in plan	RS
15	2002	1:10 sections 0.70m, 2.03m and 3.35m from bow of logboat. Pencil	RS

DS- David Strachan (PKHT): SW- Sarah Winlow (PKHT); LW-Leeanne Whitelaw (CFA Archaeology Ltd); RS Ross White (SUAT Ltd).

APPENDIX 6 List of photography for archive

Archive No.	Date	Description
DSC_0005-DSC_0007	26/07/06	General shots of site
DSC_0008-DSC_0017	26/07/06	General working shots
DSC_0018-DSC_0025	26/07/06	Shot of c. 8
DSC_0026-DSC_0031	26/07/06	General working shots
DSC_0032-DSC_0033	26/07/06	General shot of the removal of deposits from the interior of logboat
DSC_0034	26/07/06	General working shot including film crew
DSC_0035	26/07/06	General shot showing the removal of water from the interior of the logboat using a pump
DSC_0036-DSC_0038	26/07/06	General shot of F18A
DSC_0039-DSC_0041	26/07/06	General shot of the removal of deposits from the interior of the boat
DSC_0042	26/07/06	General shot of the filling of sandbags
DSC_0043-DSC_0044	26/07/06	General shot of the removal of deposits from the interior of the boat
DSC_0045-DSC_0048	26/07/06	General working shots
DSC_0048-DSC_0054	26/07/06	General working shots taken from above

DSC_0055	26/07/06	General working shot
DSC_0056- DSC_0060	26/07/06	General shot showing the sandbagging of the logboat
DSC_0061- DSC_0063	27/07/06	General shot of tide going out. Taken form W
DSC_0065 DSC_0072	27/07/06	General shots showing the removal of water around the logboat and of shoring
DSC_0073 DSC_0080	27/07/06	General shots of the removal of deposits around the boat and of shoring
DSC_0082 DSC_0086	27/07/06	Record shots of c. 3, 4, 5. Taken from the S
DSC_0087 DSC_0089	27/07/06	General working shots
DSC_0090 DSC_0091	27/07/06	General shots showing the removal of water around the logboat and of shoring
DSC_0092 DSC_0093	27/07/06	Record shot of c. 1, 2,3,4,5. Taken from the S
DSC_0094 DSC_0096	27/07/06	Record shot of c. 5, 6. Taken form the South
DSC_0097 DSC_0099	27/07/06	Record shot of c. 1, 2,3,4,5. Taken from the S
DSC_0100	27/07/06	General shot showing the removal of samples from under logboat. Taken from the North
DSC_0101 DSC_0103	27/07/06	Record shot of c. 5, 6. Taken form N
DSC_0104	27/07/06	General shot showing the removal of deposits from under boat
DSC_0105 DSC_0116	27/07/06	General shot showing the sandbagging of logboat.
DSC_0117 DSC_0121	28/07/06	General shots of logboat as tide goes out. Taken from N
DSC_0122	28/07/06	General shot showing the drawing of the logboat
DSC_0123	28/07/06	General shot of logboat and director
DSC_0124 DSC_0125	28/07/06	General shot of logboat. Taken from W
DSC_0126 DSC_0127	28/07/06	General shot of logboat and director
DSC_0128 DSC_0130	28/07/06	General shot of logboat. Taken from W
DSC_0134 DSC_0136	28/07/06	General shot showing the surveying of the logboat
DSC_0134 DSC _0136	28/07/06	Record shot of F18B
DSC_0138 DSC_0139	28/07/06	General shot showing removal of interior deposits

DSC_0140 DSC_0149	28/07/06	General working shot showing the removal of water and deposits and shoring
DSC_0150 DSC_0153	28/07/06	Record shot of logboat. Taken from the North
DSC_0154	28/07/06	General shot of stern
DSC_0155	28/07/06	Record shot of logboat. Taken from the North
DSC_0156	28/07/06	Record shot of bow
DSC_0157 DSC_0158	28/07/06	Record shot of mid section of logboat
DSC_0159	28/07/06	General shot of stern
DSC_0160	28/07/06	General shot of F18A and F19
DSC_0161 DSC_0163	28/07/06	Genarel shot of the removal of water using pump
DSC_0164	28/07/06	General shot of F21 and F24
DSC_0165 DSC_0166	28/07/06	General of the removal of water using pump
DSC_0167	28/07/06	General shot of logboat with sandbags. Taken from NW
DSC_0168 DSC_0171	28/07/06	General shot of logboat. Taken from W
DSC_0172	28/07/06	Interior of boat with sandbags
DSC_0173 DSC_0180	28/07/06	General shot of logboat. Taken from W
DSC_0181 DSC_0185	28/07/06	General shots of tide coming in
DSC_0186 DSC_0187	29/07/06	General shots of the logboat. Taken from W
DSC_0189	29/07/06	General shot showing the removal of water from the logboat
DSC_0190 DSC_0203	29/07/06	General shots of the removal of water and sandbags from the logboat
DSC_0204 DSC_0216	29/07/06	General shot of the removal of deposits from the interior of the boat
DSC_0217	29/07/06	General shot of stern and transom
DSC_0218	29/07/06	General shot of the logboat from the E
DSC_0219	29/07/06	General shot of stern and transom
DSC_0220	29/07/06	General shot of the NE corner of stern
DSC_0221	29/07/06	General shot of the transom board

DSC_0222	29/07/06	General shot of F22
DSC_0223 DSC_0234	29/07/06	General working shots showing air barrels being secured in the logboat and subsequent sandbagging
DSC_0235 DSC_0249	29/07/06	General shots of the sandbagged logboat with tide coming in
DSC_0250	09/08/06	General shot showing the site before tide goes out. Taken from S
DSC_0251 DSC_0269	09/08/06	General working shot showing the removal of air barrels, sand bags and water from logboat
DSC_0270 DSC_0271	09/08/06	General shots showing the removal of deposits from under stern end of boat
DSC_0272 DSC_0273	09/08/06	General shots of the removal of water from around stern of boat using a pump
DSC_0274 DSC_0275	09/08/06	General working shots showing the removal of deposits and water
DSC_0276	09/08/06	General shot of shoring
DSC_0277 DSC_0282	09/08/06	General working shots
DSC_0283 DSC_0288	09/08/06	General shot showing the removal of deposits and water from stern end of boat
DSC_0289 DSC_0292	09/08/06	General working shots of sandbagging under the mid section of the boat
DSC_0293	09/08/06	General shot of the removal of deposits and water from stern end of the boat
DSC_0294	09/08/06	General working shot
DSC_0295 DSC_0310	09/08/06	General shots of the logboat and the tide coming in
DSC_0311 DSC_0313	10/08/06	General shots of the removal of water and deposits from stern end of the boat
DSC_0314	10/08/06	General shot showing the Korec Trimble DGPS
DSC_0315 DSC_0326	10/08/06	General shots of the removal of water and deposits from stern end of the boat
DSC_0327 DSC_0328	10/08/06	General Shot of conservation team spreading mud on exposed bow
DSC_0329 DSC_0358	10/08/06	General shots showing the removal of water and sandbags from around and under the boat and the strapping of the stern end of the boat
DSC_0358 DSC_0359	10/08/06	General working shots of the film crew
DSC_0360 DSC_0361	10/08/06	General working shots
DSC_0362 DSC_0365	10/08/06	General shot showing the removal of sandbags from the bow of boat

DSC_0366	10/08/06	General shot showing the straps being fixed to boat
DSC_0367 DSC_0376	10/08/06	General shots showing the removal of sandbags from the bow of boat
DSC_0377 DSC_0379	10/08/06	Record shot of the logboat with starps. Taken from N
DSC_0380 DSC_0382	10/08/06	Record shot of F22
DSC_0383 DSC_0385	10/08/06	Record shot of sample 12
DSC_0386 DSC_0388	10/08/06	Record shots of the stern end of the boat
DSC_0389 DSC_0393	10/08/06	Record shot of the logboat. Taken from the E
DSC_0394	10/08/06	Record shot of mid section of boat
DSC_0395 DSC_0400	10/08/06	Record shot of the boat. Taken from the S
DSC_0401 DSC_0406	10/08/06	Record shot of the boat. Taken from the W
DSC_0407 DSC_0412	10/08/06	Team photograph
DSC_0413 DSC_0414	10/08/06	General working shots
DSC_0415 DSC_0416	10/08/06	General shots of peat selves
DSC_0417 DSC_0420	10/08/06	General shot of straps being fixed to the bow end of boat
DSC_0421 DSC_0488	10/08/06	General shots of straps being attached to boat and air barrels being secured
DSC_0488 DSC_0498	10/08/06	General shots of logboat with straps and air barrels while tide begins to come in
DSC_0499 DSC_0504	10/08/06	General shot of the tide rising and stern end of the boat beginning to float
DSC_0506 DSC_0507	10/08/06	General shot showing the sandbags being removed from the bow of boat
DSC_0508 DSC_0537	10/08/06	General shots of the tide rising and log boat begging to float
DSC_0538 DSC_0552	10/08/06	General shots of boat being moved toward mud bank
DSC_0553 DSC_0559	11/08/06	General shots of logboat on mud bank with tide going out. Taken from NE
DSC_0560 DSC_0562	11/08/06	General shots of logboat on mud bank with tide going out. Taken from E

DSC_0563 DSC_0564	11/08/06	Shots showing gravel concretion on stern end of boat
DSC_0565	11/08/06	General shot of logboat on mudbank with tide going out. Taken from S
DSC_0566	11/08/06	General shots showing gravel concretion on stern end of boat
DSC_0567 DSC_0568	11/08/06	General shot of logboat. Taken from E
DSC_0569 DSC_0570	11/08/06	General shots of logboat. Taken from N
DSC_0571 DSC_0575	11/08/06	General shots showing gravel concretion on stern end of boat
DSC_0576	11/08/06	General shots of logboat. Taken from NE
DSC_0577	11/08/06	General shots of logboat. Taken from N
DSC_0578 DSC_0582	11/08/06	General shot of stern shown F22
DSC_0583 DSC_0586	11/08/06	General shot of transom board
DSC_0587 DSC_0588	11/08/06	General shot showing F22 and F24
DSC_0589	11/08/06	General shots of logboat. Taken from NE
DSC_0590 DSC_0591	11/08/06	General shots of logboat. Taken from W
DSC_0592	11/08/06	General shot of F24
DSC_0599 DSC_0600	11/08/06	General shots of logboat. Taken from N
DSC_0600 DSC_0602	11/08/06	Record shot of logboat. Taken from N
DSC_0603 DSC_0606	11/08/06	Record shot of bow. Taken from N
DSC_0608 DSC_0609	11/08/06	Record shot of mid section of boat. Taken from N
DSC_0610 DSC_0612	11/08/06	Record shot of stern. Taken from N
DSC_0613 DSC_0616	11/08/06	Record shot of transom
DSC_0617 DSC_0620	11/08/06	Record shot of F24
DSC_0621 DSC_0622	11/08/06	Record shot of F16
DSC_0623 DSC_0624	11/08/06	Record shot of F24
DSC_0625	11/08/06	Record shot of transom board
DSC_0626	11/08/06	Record shot of F22

DSC_0627 DSC_0630	11/08/06	Record shot of transom board
DSC_0631 DSC_0633	11/08/06	Record shot of boat taken from E
DSC_0634 DSC_0635	11/08/06	Record shot of F22. Also showing gravel concretion
DSC_0636 DSC_0638	11/08/06	Record shot of F24
DSC_0639	11/08/06	Record shot of boat. Taken from NE
DSC_0640	11/08/06	Record shot of logboat. Taken from E
DSC_0641 DSC_0642	11/08/06	Record shot of logboat. Taken from NE
DSC_0643	11/08/06	Record shot of logboat. Taken from W
DSC_0644 DSC_0648	11/08/06	General shots of conservation team putting mud on logboat
DSC_0649 DSC_0652	11/08/06	Record shots of tree trunk on peat shelf
DSC_0653	11/08/06	Record shot off peat
DSC_0657 DSC_0659	11/08/06	General working shots of the reinstatement of site
DSC_0670 DSC_0673	11/08/06	General shots of Tay Estuary
DSC_0674 DSC_0679	11/08/06	General shots of lifting frame at Newburgh Quay
DSC_0680 DSC_0694	11/08/06	General shots of air barrels being secured in boat and tide coming in
DSC_0695 DSC_0698	11/08/06	General shots of logboat being attached to boat
DSC_0699 DSC_0703	11/08/06	General shots of logboat being towed
DSC_0704 DSC_0706	11/08/06	General shots of Newburgh Quay
DSC_0707 DSC_0709	11/08/06	General shots of the lifting frame being lowered into the water
DSC_0710 DSC_0715	11/08/06	General shots of the logboat being manoeuvred into the lifting frame
DSC_0716 DSC_0717	11/08/06	General shots of the crowd at Newburgh Quay
DSC_0718 DSC_0756	11/08/06	General shots of the boat in the lifting frame being raised and secured on lorry
DSC_0757 DSC_0759	11/08/06	General shots of the boat being covered in polythene
DSC_0760 DSC_0772	11/08/06	General shots of the logboat arriving at NMS storage unit, Granton, Edinburgh

APPENDIX 7 Project Diary

26th July: interior of upper section of vessel excavated, which involved only sands/gravels, with occasional fragments of un-worked wood. The interior of the vessel was sandbagged overnight.

27th July: excavation at the north side of the stern, including initial shoring, and excavation at the south side of the exposed bow (with interior of vessel sand-bagged). Excavation and recording of deposits under the bow of the vessel (with interior sandbags removed from the bow section) followed by underpinning of undercut bow with sandbags. Continued excavation and shoring of the stern (with interior sandbags intact).

28th July: recording of the upper (bow) half of the vessel. Removal of the interior sandbags at the lower (stern) section followed by excavation of the interior and exterior of the stern. Excavation at stern completed to about last 3m. Interior partially sand-bagged for overnight protection.

29th July: Excavation of interior of stern. The interior of the vessel was packed with three air barrels, cushioned by sandbags, in order to minimise time in emptying the interior of the vessel at the start of the August phase of work (three air barrels being equivalent of around 35-40 sandbags). The remainder of the interior and the exterior of the vessel were then sandbagged and the air barrels with filled with water on the flood tide and a temporary buoy attached to the vessel as the site was moth-balled until the August work.

9th August: Emptying of the vessel of sandbags and air barrels was followed by re-shoring of the stern of the vessel, extending the shored are away from the stern to allow deeper excavation around the stern. Minimal sandbagging of the interior of the vessel offered support to the vessel overnight.

10th August: DGPS survey carried out across the site and on the vessel. Environmental study carried out. The stern of the vessel was under cut and initial rigging (straps) put around vessel. The deposits beneath the bow of the vessel were then undercut further to allow for downward movement as the stern rose in the flood tide. The fully excavated vessel photographed *in situ* and then rigged to float, with three air barrels within interior. On the flood tide the vessel was floated and towed by hand approximately 30m to the foot of the inter-tidal reed-beds and berthed on the soft-mud to avoid damage to the underside of the vessel. Towing, by hand the vessel, during the strong flood tide took a team of twelve people around half and hour.

11th August: The vessel was revealed early in the morning at the start of the ebb tide and completely revealed by around 1100 hrs, the floating rig from the previous day was removed allowing the first photographic record of the vessel in its entirely to be made. The vessel was then covered in a mud-pack to prevent it drying out in the hot summer sun, while backfilling of the excavation trench commenced. The vessel was then re-rigged to float in the same way as before, although mesh netting covered the vessel in order to collect any part of the vessel dislodged during the tow to Newburgh quay. The vessel was then secured in position during the flood tide until slack water when it was towed downstream approximately 1.5km to Newburgh quay. The vessel was then floated into the bespoke lifting frame which had been lowered to water level from the flatbed lorry crane on the quay. The straps which had held the air barrels in

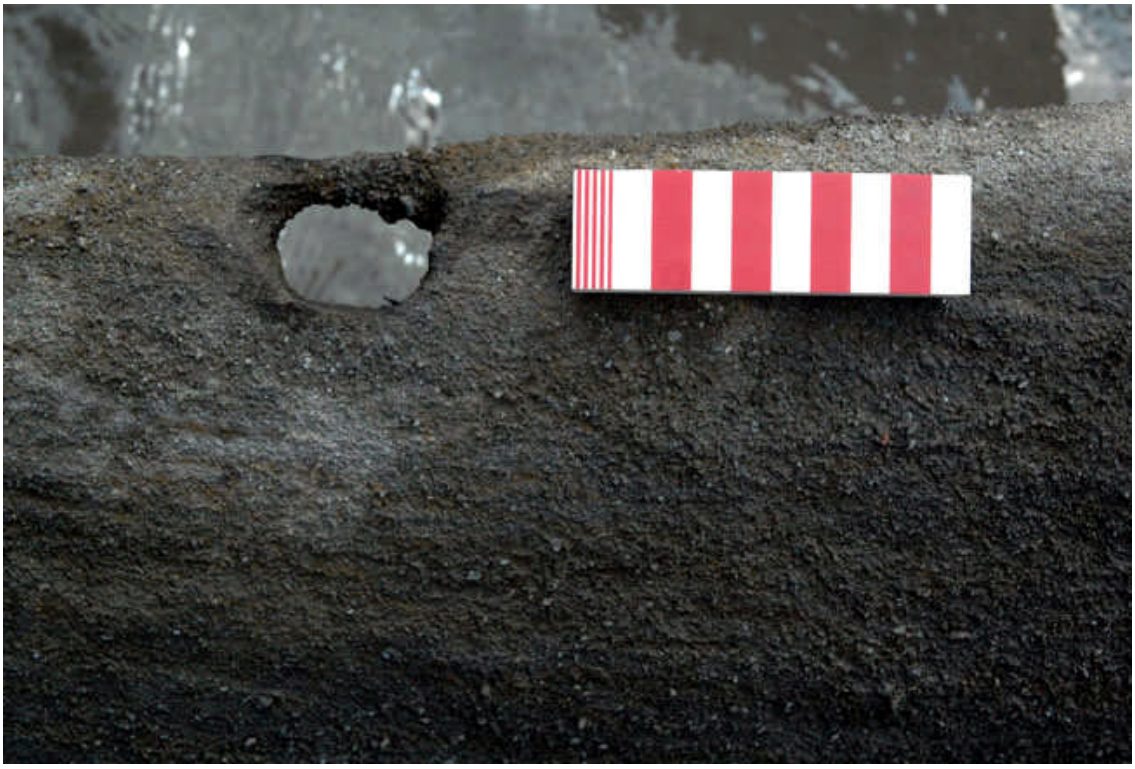
place were then secured around the top of the lifting frame, suspending the logboat within the frame, and the interior of the vessel was emptied. The lifting frame was then craned on to the flatbed lorry on the quayside, before the vessel was secured and covered in polythene sheeting to protect it during the drive to Edinburgh.

APPENDIX 7 Photographic Diary

Illus 32: Early stages of excavation showing inter-tidal environment.

Illus 33: Sandbagging of the interior of the boat for protection during excavation.

Illus 34: The excavation is submerged during the flood tide.



Illus35 : Detail of the F19.

Illus 36: DGPS survey of the boat and environs.

Illus 37: Excavation of context 6, the organic rich deposit found both inside and underneath the boat.

Illus 38: The excavated boat showing the angle at which the vessel sat within the sands and gravels.

Illus 39: Removal of the supporting sandbags from the underneath of the vessel prior to rigging of the vessel to float.

Illus 40: The rigged boat being floated for the first time on the flood tide.

Illus 41: The boat at its interim location on the soft mud of the estuary bank.

Illus 42: National Museums of Scotland staff apply the mud-pack prior to re-rigging of the boat.

Illus 43: The re-rigged vessel is re-floated on the flood tide prior to being towed to Newburgh quay.

Illus 44: The vessel is towed to Newburgh quay while being recorded by videoed by Circa Media.

Illus 45: The vessel within its frame being lifted onto the flatbed lorry at Newburgh quay.