Hampshire & Wight Trust for MARITIME Archaeology

LCT(A) 2428

An Assessment for Scheduling in the Marine Zone

Project Report

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LCT(A) 2428: An Assessment for Scheduling in the Marine Zone

Project Report

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On behalf of
English Heritage
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This report has been written by Julian Whitewright, with contributions from Stephen Fisher on the historical context of Operation Neptune and the use of LCTs in that operation. The sections on biological sampling were provided by Amy Dale and Jolyon Chesworth of the Hampshire and Isle of Wight Wildlife Trust. The project podcasts were conceived and created by Stephen Fisher. 3D site models were created by Gareth Owen. The Landing Craft Project has been managed by Virginia Dellino-Musgrave.

IV. COPYRIGHT STATEMENT

This report has been produced by the HWTMA with the assistance of funding provided by English Heritage, (Historic Environment Enabling Program). Additional funding for fieldwork was also derived from Interreg IVA through the Archaeological Atlas of the 2 Seas Project.[1] The HWTMA Heritage Lottery Funded Maritime Bus was utilised for Education and Outreach activities associated with the Project.

V. SUMMARY

On the night of the 5th/6th June 1944, LCT(A) 2428 broke down in the south-eastern approaches to the Solent while on route to the D-Day landings in Normandy. The vessel was taken under tow but subsequently capsized, spilling its cargo of tanks and armoured bulldozers, intended to support the landings, into the sea. Sometime afterwards the vessel was deliberately sunk by gunfire from its tug, several miles to the east.

Although known about for some years, the site of the Tanks and Bulldozers was not systematically evaluated until 2008, when divers from Southsea Sub-Aqua Club (SSAC) began investigating the site. They later extended their investigation to the site of LCT(A) 2428 and through historical research established the link between the remains of the landing craft and the vehicle assemblage several miles to the west.

The present project was conceived with the aim of facilitating further investigation of the two sites in conjunction with SSAC. This has allowed the position, extent, character and stability of both sites to be established and for plans of both sites to be created through archaeological survey. Provision for the future monitoring of both sites has been developed, this will be undertaken by SSAC.

Oral histories have helped discover otherwise unrecorded information relating to the use of such vessels and LCT(A) 2428 in particular. This element of the project has allowed the creation of a podcast designed to aid dissemination of the work and the sites to the general public.

Finally, the project was conducted to act as a case study for the application of the *Ancient Monuments and Archaeological Areas Act 1979* (AMAAA) to the marine zone for the purpose of scheduling and protecting ancient monuments. Thus far, no fully-submerged shipwreck sites have been scheduled in English waters. The threats facing each site were assessed to develop site risk assessments. Finally a discussion is provided relating to the application of the AMAAA to the marine zone of England and to its suitability for protecting the LCT and associated vehicle assemblage sites in particular.

[1] http://www.hwtma.org.uk/archaeological-atlas-of-the-2-seas

1. Introduction

1.1 Project Background

This report presents the results of a nine month project, undertaken by the Hampshire and Wight Trust for Maritime Archaeology (HWTMA), in collaboration with Southsea Sub-Aqua Club (SSAC), into the sunken remains of Landing Craft Tank (Armoured) 2428 and its former cargo of military vehicles. Work was primarily concerned with providing an archaeological assessment of the two sites in question, building upon archaeological fieldwork previously undertaken by SSAC. This fieldwork included the provision for the future monitoring of both sites by SSAC. Oral history work gathered further, potentially un-documented, material relating to the events surrounding the sinking of LCT(A) 2428. This information was disseminated through the creation of a freely available, downloadable podcast. Finally, the project acted as a pilot study for the application of the Ancient Monuments and Archaeological Areas Act (1979) to the marine zone, within English Territorial waters.

1.2 Project Study Area

The study area of the project comprises two sets of seabed remains located approximately 10km to the south of Selsey Bill (Figure 1.1). These can be classified as;

- Tanks and Bulldozers Site (050 38.540N, 000 51.586W (WGS84); 651324.12E, 5612237.98N (UTM Zone 30N); 480720.73E, 83143.87N (OSGB36). This site comprises the remains of a collection of military vehicles (two tanks, two armoured bulldozers and a jeep), military vessel fixtures, fitting and armament. The site covers c. 750m^2 (30m x 25m).
- Landing Craft Site (050 38.457N, 000 46.490W (WGS84); 657333.33E, 5612261.14N (UTM Zone 30N); 486728.52E, 83085.91N (OSGB36)). This site comprises the remains of Landing Craft Tank (Armoured) 2428, commonly abbreviated to LCT(A) 2428. The site covers c. 1200m^2 (40m x 30m).

1.3 Project Aims and Objectives

The broader aims and objectives of this project (English Heritage 2010) were to;

- Enable case-study assessment of the site(s) for designation as an Ancient Monument.
- Understand management patterns to determine how these can be influenced to ensure that the sites' interest is maintained and preserved for both present and future generations.
- Identify opportunities for local 'ownership' and involvement.
- Serve as a pilot study for assessing fully-submerged sites.

Additional specific objectives were;

- Liaison with SSAC, specifically with Alison Mayor.
- Confirmation of position, extent, form and type of the identified sites.
- Recording of the seabed disposition of the LCT(A) 2428 and associated vehicles, features and artefacts.
- Information retrieval from the Receiver of Wreck relating to material previously recovered from the site.
- Discussion of future monitoring of the site with SSAC.
- Identification of management patterns for both sites.
- Undertake a biological survey and liaison with local Sea Fisheries Committee to identify fishing patterns at the site.
- Undertake project with SSAC and explore opportunities for podcast.
- Provide direct project support to SSAC.
- Assess the site(s) against the criteria for determining the National Importance of Ancient Monuments (DCMS 2010).
- Undertake a Risk Assessment with reference to English Heritage's *Risk Management Handbook* (Dunkley 2008).
- Dissemination of project findings and products.

2. Historical Background

2.1. Operation Neptune

Operation Neptune was the assault phase of Operation Overlord, the Western Allies' plan to invade north-west Europe. This assault required a large scale amphibious landing in France in order to establish a sufficient foothold on the continent from which to advance through Europe and into Germany.

Planning for Operation Neptune began in 1942 and continued in detail right up until May 1944 (Belchem 1981: 51). Several landing areas were considered, but eventually Normandy was selected as the most suitable site. As late as January 1944, General Montgomery argued for the widening of the assault sector in order to prevent the allies being confined to a narrow beachhead. The expansion was approved, but it was the need to acquire more landing craft and train their crews that delayed the operation to June of that year (Belchem 1981: 44).

The invasion had two main elements; an overnight airborne landing to secure the two flanks of the invasion area, followed by a dawn amphibious assault along a 60 mile stretch of the Normandy coast. Most of the landings would take place along lightly defended beaches and would employ all manner of specially designed boats and ships in order to place men onto the shore as quickly as possible. These vessels were known as landing craft and landing ships, which were built to several different specifications depending on the task allocated to them.

2.2 Landing Craft

The inspiration for landing craft is occasionally attributed to Winston Churchill, who recognised the need for a shallow draught vessel capable of landing men directly onto beaches after the Gallipoli Campaign.[2] In fact, First Sea Lord John Fisher had asked Walter Pollock to design 200 motor landing craft in February 1915, for use in the Gallipoli landings.[3] These 'X' Lighters were the inspiration behind the first purpose built vehicle landing craft – the Motor Landing Craft (MLC), designed and built by J. Samuel Wight of Cowes in the 1920s. The MLC was capable of landing the British Army's medium tanks directly onto a beach and the concept was quickly replicated for infantry in the Landing Craft Assault (LCA). Throughout the inter-war years, the British, Americans and the Japanese began developing more and more landing vessels for a variety of tasks.

The MLC design evolved into the Landing Craft Mechanized (LCM), a vessel capable of carrying infantry or one vehicle onto a beach. It was early in the Second World War that Churchill pressed for a vessel capable of landing several tanks on a beach and being able to sustain itself at sea for a week or more.[4] [5] This led to the British Landing Craft Tank (LCT) Mk I, launched in November 1940, which was quickly followed by another three Mks in the following year. When the United States entered the war in 1941, having no LCT designs of their own, they were forced to consider British designs. One such design, already drawn up by Thornycroft, was modified by American designers and launched in 1942 as the LCT Mk V.[6] Approximately 470 of these were built during the war,[7] several hundred of which were provided to the British armed forces under the Lend-Lease programme.

In preparation for Operation Neptune, it was recognised that not only would hundreds of LCTs be required to land armour on the beaches, but that LCTs were the best craft to modify for gunfire support on the beaches. Large numbers of LCTs were modified to perform various tasks, including;

- LCT(R): Landing Craft Tank (Rocket)
- LCT(HE): Landing Craft Tank (High Explosive)
- LCT(HR): Landing Craft Tank (Hedgerow)
- LCT(CB): Landing Craft Tank (Concrete Buster)
- LCT(SP): Landing Craft Tank (Self-Propelled)
- LCT(A): Landing Craft Tank (Armoured)
- LCG(L): Landing Craft Gun (Large)

[2] http://www.globalsecurity.org/military/systems/ship/lct.htm
[3] http://www.xlighter.org/
[4] http://ww2lct.org/history/stories/tin_armada.htm
[5] http://www.navyhistory.org.au/british-landing-craft-of-world-war-ii/
[6] http://ww2lct.org/history/stories/tin_armada.htm
[7] http://ww2lct.org/history/stories/tin_armada.htm

- LCG(M): Landing Craft Gun (Medium)
- LCF: Landing Craft Flak

For several of the modifications, a large platform was built on the vehicle deck, allowing a tank or self-propelled gun to fire over the LCT's bow. This was the case with the LCT(CB) (which used a Sherman Firefly Tank armed with a 17-pounder gun to demolish concrete bunkers), the LCGs (armed with large artillery pieces), the LCT(SP)s (equipped with the 105 mm Self Propelled Gun, Priest) and the LCT(A), whose ramp allowed two tanks to be positioned side by side to fire over the bow (Figure 2-1).

The LCT(A) was designed to provide close support fire during the first assault wave. The two tanks would fire on designated targets on the run into shore and then disembark to provide cover for the infantry on the beaches. LCT Mk Vs were converted to fulfil this role, and each was reinforced with extra 2-inch armour plating around the wheelhouse and crew quarters and 1-inch armour around the bow. Forty-eight Mk Vs that had been loaned to Britain were so converted into LCT(A)s, twenty-six of which were reverse loaned back to the US for the invasion (Mayor 2008: 11). The craft were re-designated with a number 2 in front of the existing LCT number, thus LCT 428 became LCT(A) 2428.[8]

2.2.1 Tanks and Bulldozers Support at D-Day

The unit that primarily made use of the LCT(A) was the Royal Marines Armoured Support Group (RMASG), who would provide fire support in the first wave at Sword, Juno and Gold beaches using Centaur tanks. It was initially planned that the Centaurs would remain on the landing craft to provide fire support from the sea and so it was intended that they would have their engines removed and be manned by Royal Marines (as they would not be required to move anywhere). However, General Montgomery intervened after watching an exercise on the Dorset coast, and decided the tanks would be of more use if they could land to support the infantry on the beach and beyond. To this end, Royal Armoured Corps drivers were transferred to the Marines and the RMASG was formed in March 1944 (Fletcher and Harley 2006: 23). This unit was organised into two regiments (each consisting of two batteries) and one independent battery (Fletcher and Harley 2006: 23). Each battery consisted of four troops and each troop was made up of five tanks (totalling 100 tanks across the whole RMASG). The unit was not meant to fight as a single unit, but would be divided amongst the three British and Commonwealth beaches (Mayor 2008: 6).

The unit was equipped with Eighty Centaur CS IV cruiser tanks and Twenty Sherman tanks (four Centaurs and one Sherman per troop). The Centaur had a convoluted lineage that dated back to the British Army's request of 1940, to provide a new tank to replace the unsatisfactory A15 Crusader. Three designs were proposed, of which the Nuffield Mechanisation & Aero Company's 'A24' was considered the most promising (Fletcher and Harley 2006: 4). This design, which became known as the A24L Cavalier, used Nuffield's *Liberty* engine, but this was far from suitable for the task (Fletcher and Harley 2006: 7). Instead the tank's design was modified by Leyland who utilised the Rolls Royce *Meteor* engine to create the A27M Cromwell tank (Fletcher and Harley 2006: 10). Unfortunately, there were problems with the supply of the new engine and refining the tank's design to allow for more cooling ventilation meant that production fell behind schedule (Fletcher and Harley 2006: 11). While the Birmingham Railway Carriage & Wagon Company (BRCW) took over production of the Cromwell, Leyland further refined the tank's design to once again accept the *Liberty* engine. The tank had by now evolved somewhat from the original Cavalier and was named the A27L Centaur (Fletcher and Harley 2006: 12). Trials soon proved that the Centaur was not an ideal front line vehicle and early on it was declared that the first 300 to be produced would only ever be training vehicles (Fletcher and Harley 2006: 12). In spite of this, a grand total of 1821 Centaurs of various different marks were built (Fletcher and Harley 2006: 14). These included modified designs that removed the gun turret to make the vehicle a bulldozer or gun tractor, or replaced it with anti-aircraft guns (Fletcher and Harley 2006: 22). The Centaur typically had a riveted hull and bolted turret, 14 inch wide, 5-wheel tracks and 76mm of steel armour (this was often added to with 25mm plates in 1944) (Fletcher and Harley 2006: 15).

One model was the Centaur CS IV (Centaur Close Support Mk IV). One hundred and fourteen of these were produced by John Fowler & Co. Engineers (Fletcher and Harley 2006: 17). The tank was equipped with a 95mm howitzer capable of flinging High Explosive Anti-Tank (HEAT) rounds at targets over 2500m away (Fletcher and Harley 2006: 13) and the turrets of the tanks were painted with protractor markings so that an outside observer could direct their fire (Mayor 2008: 6). The 80 Centaur

[8] http://ww2lct.org/history/stories/lct_a.htm

CS IVs given to the RMASG were the only ones that would see combat – the rest were reserved for training purposes.

Once the infantry were on the beach, they would need support from all manner of vehicles to clear their advance. This would be provided by the 79th Armoured Division, which for the last year had been an experimental division equipped with numerous modified and elaborate armoured vehicles. These were more commonly known as Hobart's Funnies, taking their name from the division's commander, Major General Percy Hobart. The collection of vehicles that the 79th Division fielded included such famous designs as the DD tank (equipped with a propeller and watertight canvas floatation screen, enabling the tank to be launched offshore and 'swim' to the beach), the Sherman Crab (equipped with a flail to detonate mines in the tank's path) and the Churchill bridge laying tank.

Another vehicle that the 79th used was one that had been developed earlier in the war – the Armoured Bulldozer. Both the Caterpillar D7 and D8 bulldozers (first produced in early 1930s) were adapted by the British army for military service by Jack Olding Ltd of Hatfield.[9] The modifications centred on armouring the vehicle to protect the bulldozer and its driver from enemy fire when it was 'in the field'. Such armour will only have pushed up the weight of the bulldozer (which already weighed 23,910 lbs, plus a 5,600 lbs blade) (Mayor 2008: Part 3, pp 10). Such was the value of the armoured bulldozer that it was not limited to the 79th Division alone. The armoured D7 was also fielded by American and Canadian engineer units during Operation Neptune.[10]

2.2.2 Sinking of LCT(A) 2428

LCT(A) 2428 was assigned as 'Leader' of the 105th Flotilla of Assault Group J1 Support Squadron, assigned to Juno Beach in support of the 7th Infantry Brigade of the 3rd Canadian Division at Courseulles.[11] The loading tables for LCT(A) 2428 indicate that it was destined for Mike Green beach at H-Hour (ie. in the first wave), although the Operation Orders for the RMASG indicate that it would land at Mike Red beach at H-Hour (Mayor 2010: part 5, annex B, pp 2-3). However, subsequent after action reports from the RMASG indicate that LCT(A) 2428 was actually destined for the right (ie. green) beach. The landing craft was loaded with two Centaur CS IVs, two D7 Armoured Bulldozers and one 'Truck Airborne' (a typical British designation for a Willys Jeep). The Centaurs were of Q Troop of the 4th Battery of the 2nd Regiment RMASG and under the command of Lieutenant V.J. Syborn, Royal Armoured Corps. The bulldozers and jeep were of 3rd Canadian Infantry Division's 18 Canadian Field Company, Royal Canadian Engineers. There were also personnel of 'A' Company of the 8th Battalion the Kings (Liverpool Irish) Regiment. The 3rd Canadian Infantry Division was tasked with advancing inland towards Caen (Hastings 1984: 44), while the 8th Battalion the Kings would secure the beaches themselves.[12]

The RMASG war diary notes that the 2nd regiment embarked onto their LCT(A)s at Stokes Bay, Gosport on June 2nd 1944. The craft remained at anchor off Lee-on Solent until the evening of June 5th when, at 1905 hours they began their voyage (Mayor 2010: part 5, annex B, pp 5). The diary also notes that several craft were overloaded despite careful plans made by the 3rd Division (Mayor 2010: part 5, annex B, pp 5). Veteran Norman Vingoe of LCT(CB) 2041 (Figure 2.2), whose craft had been modified with the ramp for one tank, but was not weighed down with armour, noted that his craft was so low in the water that during the crossing to Normandy the sea nearly flooded the vehicle deck (Norman Vingoe pers.comm.). Erwin Kauffmann, the Officer-in-Charge of LCT(A) 2124 at Omaha Beach, noted that there was very little freeboard for the channel crossing once the tanks were loaded on board.[13]

An after action report from the destroyer HMS *Wrestler* suggests that LCT(A) 2428 broke down at 1724 hours on the 5th June (Mayor 2010: part 5, annex B, pp 11), although this seems unlikely given that the RMASG diary says they did not weigh anchor at Lee-On Solent until 1905 hours. More credible is the Admiralty Naval War Diary, which suggests that 'at 2140, LCT(A) 2428 broke down and anchored near the Nab Tower' (approximately five miles east of Bembridge on the Isle of Wight) (Mayor 2010: part 5, annex B, pp 10). A subsequent interview with Able Seaman Charles Hunt of the LCT(A)'s crew, indicates that the engines failed and the craft started taking on water as a result of

[9] http://www.hatfield-herts.co.uk/features/olding.html
[10] http://www.hatfield-herts.co.uk/features/olding.html
[11] Source: http://www.navsource.org/archives/10/18/180428.htm
[12] http://webarchive.nationalarchives.gov.uk/+/http://www.mod.uk/aboutus/dday60/beach_organisation.htm
[13] Source: http://ww2lct.org/history/stories/lct_a.htm

'damage sustained by weather to double bottoms on starboard side aft.' (Mayor 2010: part 5, annex B, pp 13), It has been suggested that the LCT(A)'s commander wanted to drive the two centaurs off the vessels bow and into the sea to reduce weight, but the RMASG commander refused to endanger his tank driver's lives (Alison Mayor, pers.comm.). The tug HMT *Jaunty* took off all the crew and army personnel and attempted to take the craft in tow, but this failed and the landing craft capsized (Mayor 2010: part 5, annex B, pp 13). LCT(A) 2428 subsequently floated in the water for a while before *Jaunty* fired on the upturned hull to sink it, presumably so it would not to pose a floating hazard to the remaining invasion fleet and other naval operations (Mayor 2008: part 3, pp 13). The tug subsequently returned the survivors to the shore establishment HMS *Vernon* (Mayor 2010: part 5, annex B, pp 13).

The RMASG after action reports indicate that the 105th Flotilla was split by a large ship company later in the voyage, and the LCT(A) carrying the remaining half of Q Troop (two centaurs and one Sherman) under the command of Captain Perrott, RM, became detached and was two hours late arriving at Normandy (Mayor 2010: part 5, annex B, pp 9). It eventually beached at some point between 0900 and 0945 hours (Mayor 2010: part 5, annex B, pp 8), but by this time fire support was not required. After spending the night near the coast it began advancing inland and engaged the enemy on June 7th (Mayor 2010: part 5, annex B, pp 8).

Although Max Hastings suggests that the Centaurs were unseaworthy on landing craft and that at Juno 'only six of forty intended to support the Canadians made it to shore' (Hastings 1984: 125). This is not supported by the RMASG war diary, which suggests that thirty Centaur tanks and all eight Sherman tanks of all eight troops of the 2nd regiment made it ashore (Figure 2.3) and that those lost on LCT(A) 2428 were the only ones missing (Mayor 2010: part 5, annex B, pp 8). Some of the Centaurs were still fighting two weeks later up to ten miles inland (Fletcher and Harley 2006: 23), but it was at this point that the RMASG was withdrawn, its task complete. Only forty-eight Centaurs are believed to have made it across the Channel on the 5/6th June and how many were left by the time the unit was withdrawn is unknown (Mayor 2008: part 3, pp 8). The tanks were subsequently made available to the Canadian and Free French forces and the RMASG was disbanded (Fletcher and Harley 2006: 23).

2.3 History of Investigation

2.3.1 Tanks and Bulldozers

The National Record of the Historic Environment (NRHE) entry (Monument No. 911191) for the Tanks and Bulldozers vehicle assemblage records an echosounder survey of the site in 1974 on behalf of UKHO (HOID 020008). This noted a general depth of 17m, a least depth of 15.8m and a scour depth of 18.6 m. A further survey in 1975 records the vehicle assemblage as lying in the scour. Another echosounder survey in 1988 recorded a general depth of 15.5-17m, a least depth of 15.2m and scour of 1.5m. UKHO records note the site as covering 22m by 15m in one report and 10m by 5m in another.

Enquiry with the Receiver of Wreck has indicated that no material has been recovered from the vehicle assemblage and subsequently declared.

In 2008, Southsea Sub-Aqua Club (SSAC) led by Alison Mayor investigated the remains of two tanks, two armoured bulldozers, a jeep and evidence of a military vessels' fixtures, fittings and armament (including High Explosive 95mm ammunition) about 10km south-west of Selsey Bill, West Sussex (Mayor 2008). In assessing the condition of the vehicle assemblage, Alison Mayor (2008) concluded that:

Whilst their strong construction has enabled these armoured fighting vehicles to remain relatively well preserved after almost 65 years on the seabed there is probable evidence that interference by divers and fishing activities has resulted in damage to the vehicles. The loss of the Bulldozer B plough and the tracks of Tank A being the most serious damage to the wrecks.

Care needs to be taken in the way boats anchor at the site, to either fish or dive. My opinion is that the majority of damage to the vehicles has been as a result of boats attempting to secure to the site for diving or fishing purposes.

The vehicle assemblage has been adopted by SSAC under the Nautical Archaeology Society's (NAS) Adopt-a-Wreck scheme. As a result of this, SSAC conducted five days of survey on the vehicle assemblage in order to survey and photograph the site and identify the type and origin of the vehicles present, as well as the other artefacts identified at the site. In 2009 the archaeological work of the club on the vehicle assemblage site was recognised when it won the Nautical Archaeology Society 'Adopt-a-Wreck' award.

The Tanks and Bulldozer vehicle assemblage is listed as a sports diver site in current sports diver handbooks for the area (eg. McDonald 1999: 40, site 40).

2.3.2 LCT(A) 2428

LCT(A) 2428 is included in the NRHE as Monument No. 1534450 (updated 2011). The site of LCT(A) 2428 is also listed in current sports diver handbooks for the area (eg. Macdonald 1999: 41, site 42). The vessel is noted as lying upside down on the seafloor and that the steel plate of the hull is holed in many places, the implication is that the vessel remains are relatively coherent. The description given by Macdonald is also cited in the NRHE entry.

The UKHO also contains a listing for the site (HOID 020004) and records the vessel as a barge or LCT, located on the 10th April 1975 and lying intact, inverted and almost buried at a depth of 21-24m. The site is described as being orientated 165°/345° and standing about four metres above the seabed. The NRHE and the UKHO both list the dimensions of the vessel as approximately 160ft x 30ft x 8ft. While the width and height correspond with a LCT MkV, the listed length is around 45ft too long. Diving on the site in 1976 recorded that the steel plate was thin with holes, three small propellers are recorded on the vessel. In June 2003, the orientation of the wreck was revised to 170°/350° and it was noted that there was no scour. The site was also wire swept clear to a depth of 21.9m.

Enquiry with the Receiver of Wreck indicates that some material has been recovered from LCT(A) 2428. A secure location is not given, but the site is referred to as the 'Patch' landing craft, a common name for the site with sports divers (Mayor 2010: Part 4, pp 7). The recovered, declared material (Droit A/4061) is a miscellaneous group of objects and includes; ten shell-heads, one weight, two valves, one hose, one switch box, six shell-cases, five name-plates, two caps, one ruler, one spoon, one filter, one trigger and one cable.

The continued interest and investigations of SSAC into the Tanks and Bulldozers site (above) led them to locate in 2009, the remains of a Landing Craft Tank (LCT) that could be strongly associated with the vehicle assemblage previously investigated (UKHO HOID 020004). The LCT site was some 6km east of the vehicle assemblage and SSAC concluded that the site was almost certainly LCT(A) 2428 and that consequently the vehicle assemblage comprises its former cargo lost in June 1944. This contrasts with the commonly reported view that the vehicle assemblage was lost from the deck of a Mulberry Harbour Whale bridge (see Macdonald 1999: 40, site 39). The historical research conducted by SSAC into the events surrounding the deposition of the vehicle assemblage confirmed the link with LCT(A)2428.

3. Methodology

3.1 Archaeological Fieldwork

Archaeological diving fieldwork was undertaken according to the following methodology:

3.1.1 Diving Practice

The HWTMA is registered as a diving contractor with the Health and Safety Executive (HSE). Diving undertaken by HWTMA for the project was therefore conducted in accordance with the HSE Scientific and Archaeological Approved Code of Practice. Diving was conducted using SCUBA and utilised through water communications to maintain contact between HWTMA divers and the dive supervisor.

Diving was organised around slack water in order to ensure that time on site was during the most favourable conditions. This period occurred approximately one hour before low water and one hour before high water.

3.1.2 Archaeological Survey

Survey work undertaken ensured that visible structure, fittings, features and artefacts are drawn *in situ*. Recording utilised the HWTMA pro-forma sheet system which is based on the Molas system, on which the HWTMA recording sheets have been based. The main adaptation of the Molas system for work in the underwater zone is the addition of a 'Dive Log Sheet' and an 'Archaeological Record Sheet', the former are used as the primary numbering system and are used for logging individual divers. Each diver filled in an Archaeological Record Sheet which provides details of specific work undertaken on each dive and will reference any numbers utilised (eg. context numbers, feature numbers and artefact numbers).

In summary the principal record sheet system includes:

- Dive Log Sheet
- Archaeological Record Sheet
- Context Log and Record Sheets
- Drawing Index
- Finds Index and Record Sheets
- Sample Index and Record Sheets
- Timber Index and Record Sheets
- Photo Index
- Video Index and Log Sheets

Survey was targeted at producing as complete a plan as possible of the seabed remains within the project timescale. A network of datums was established across both sites, upon which offset surveys of each site were based. The datums comprised steel stakes, driven into the seabed and topped with an ID tag. Securely placing these on the seafloor enabled them to be left *in-situ* for the benefit of future monitoring. Diver position on site was located and monitored through the use of an acoustic diver tracking system.[14] Application of this methodology allowed the production of;

- An overall plan to describe the extent, nature and relative seabed remains at each site.
- Recording of diagnostic features in specific areas of either site, this includes both photographic and video record to facilitate future monitoring.
- Written records of diver observations on the extent, apparent stability and character of the site.

No artefacts were raised as a result of the diving activity undertaken on the site during the present project. The results of the archaeological fieldwork are presented in Section 4.2.

3.2 Biological Site Profile Methodology

(Amy Dale & Jolyon Chesworth)

Wrecks often develop locally unique biological communities which make them of particular interest and conservation importance. HIWWT carried out surveys within the study area to construct a

[14] The diver tracking system utilised by the project was an Applied Acoustics Easytrak 2650 portable base-station, an ETM902C transducer and three transponders.

biological profile. Surveys were carried out both on the remains of the LCT and on vehicle assemblage. All dives were planned and supervised by HWTMA.

Two dives were scheduled to take place on each area. However, adverse weather conditions on the scheduled dive days resulted in only one dive taking place on each area. Data gathered by divers was done so in accordance with Seasearch[15] protocol in habitat and species identification. Seasearch Surveyor forms were used as a template to record data from the dives. Abundances were recorded using the SACFOR abundance scale, as developed by the Joint Nature Conservation Committee (Table 1). This is a widely accepted abundance scale used to ensure a systematic and consistent approach to recording habitats and species in biological surveys. Where an accurate SACFOR abundance scale category could not be assigned, the species was recorded as present. The results of the biological fieldwork are presented in Section 4.3.

	Encrusting & Turf Species *e.g. encrusting algae/sponge/bryozoans, jewel anemones, hydroids, barnacles, mussels, seaweeds* **% habitat covered by species**	**Small Animals (1-5cm)** *e.g. worms, small sponges, anemones, cup-corals, shells, solitary sea squirts* **Individuals per m^2**	**Large Animals (>5cm)** *e.g. large sponges, seafans, seapens, large anemones, crabs, lobsters, starfish, fish* **Individuals per m^2**
Superabundant	80-100	10,000	100
Abundant	40-80	1,000	10
Common	20-40	100	1
Frequent	10-20	10	1 per $10m^2$
Occasional	5-10	1	1 per $100m^2$
Rare	< 5%	< 1	1 per $1,000m^2$
Present	present	present	present

Table 1. SACFOR scale used to record species abundance. The definition of abundance depends on the type of plant or animal and its size.

3.3 Oral History Project

Oral history work was intended to uncover additional knowledge relating to the events surrounding the sinking of LCT(A) 2428 that were not already contained within the existing historical resource. The methodology utilised a combination of Public open days and targeted one-to-one interviews. It was envisaged that the oral history material would be utilised in a podcast that would help disseminate the results of the project.

Project Open Days

Recognising that there might be a reservoir of knowledge relating to the sinking of LCT(A) 2428 within the Portsmouth and Southsea area, two open-days were held at which the general public could share any memories that they might have about the event in question, or the use of landing craft in relation to the D-Day landings in general. The first open-day was funded by the HWTMA A2S project. Facilities were provided for the recording of oral memories and for the recording of any 'hard' memories, such as photographs, letters, etc. These facilities consisted of audio equipment and trained staff for recording oral memories, alongside photographic and scanning equipment to record any photos or letters that people might wish to offer. For ease of future access, all audio files produces by the project were stored as MP3 files and all documents stored as PDF. In addition, the use of the HWTMA maritime bus gave an added presence at the open-days (Figure 3.1).

A secondary purpose of the open-days was to provide a platform to disseminate the on-going project work to the general public, to make them aware of the existence of the sites and to gauge their feelings regarding the long-term protection and management of the sites.

Targeted Interviews

In conjunction with the open-days, it was recognised that specific individuals might have important information about the site, specifically landing craft veterans or D-Day veterans who may have memories about being transported upon landing craft. Veterans' organisations were contacted to

[15] Seasearch is a National programme that gathers information on seabed habitats and associated marine wildlife in Britain and Ireland through the participation of volunteer recreational divers. It is nationally co-ordinated by the Marine Conservation Society on behalf of a National Steering Group which includes statutory conservation bodies, NGOs, diver training associations and independent experts. Seasearch is delivered locally by a collection of co-ordinators, with The Wildlife Trusts taking on this role in several counties. The Hampshire and Isle of Wight Wildlife Trust's Marine Officer Dr Amy Dale is the co-ordinator for Seasearch activities in Hampshire and the Isle of Wight.

attempt to establish whether there were any individuals who might have such memories and be willing to share them. Additionally, as stated in the EH project brief, because of the desire to formulate a podcast to disseminate the project, interviews were conducted with key members of the current HWTMA project and members of the SSAC project to record their memories of working on the two sites, for posterity. Identified individuals were contacted and interviewed, either face-to-face or via a recorded telephone interview.

4. Results

4.1 Assessment of Sites Via South Coast Regional Environmental Characterisation

A desk-based assessment was conducted that utilised the geophysical and other data collected as part of the South Coast Regional Environmental Characterisation Survey (SCREC). The aim of the SCREC was to acquire data to enable subsequent broad scale characterisation of the seabed habitat, associated biological communities and potential historic environmental assets within the region (Gardline Geosurvey Limited 2008: v). The SCREC survey provides the basis of the information provided below relating to the wider context of the two archaeological sites associated with LCT(A) 2428.

4.1.1 Geological Context

The site of LCT(A) 2428 and the associated vehicle assemblage are both located in region two of the South Coast REC Area (East Wight and St Catherine's Deep), in an area of seabed with a noted depth of 10-19m below lowest astronomical tide (Figure 4.1). The general seabed character is of a course sediment in the vicinity of the vehicle assemblage with rock and thin sediment in the vicinity of the landing craft. The difference in underlying geology is probably due to the situation of the vehicle assemblage on the northern edge of the Eastern Solent palaeo-channel, the formation of which allowed significant erosion of the underlying bedrock and subsequent deposition of sediment layers. Current general sediment transport in the region of the sites is from West to East.

In both cases the sediment is characterised as Sandy Gravel (sG), by both the SCREC and the British Geological Survey (BGS) (Figure 4.2). Data from the latter is included in the SCREC as additional data. The sediment is considered to be poorly sorted across the vehicle assemblage and very poorly sorted across the landing craft site. Classification is of pebbles, with a mean diameter greater than 4mm (Figure 4.3). At either site, mud comprises less than 5% of the observed seabed (Figure 4.4). Some difference can be noted in the ratio of sand to gravel at each site. The vehicle assemblage is between 40-50% sand and 50-60% gravel, while the landing craft site is between 20-30% sand and 70-80% gravel (Figure 4.5 and 4.6).

4.1.2 Geophysical data

The SCREC provides high level geophysical bathymetry data for the entire South Coast region. However, two considerations prevent any conclusions about either the LCT site or vehicle assemblage being reached;

- The data is not of sufficient resolution for either site, or even site extent, to be ascertained.
- There is no comparable data, either previous or more recent, that might allow conclusions regarding general sediment movement to be drawn.

4.1.3 Biological Profile

The biological surveys conducted as part of the SCREC process do not sample any areas in the immediate vicinity of either LCT(A) 2428, or the vehicle assemblage. The SCREC biological profile is therefore not considered further. The biological profile of the site carried out as part of the project is presented in Section 4.3.

4.1.4 Fishing Activity

The SCREC provides a considerable amount of information relating to fishing activity within the South Coast region, drawn from CEFAS and the Sussex Sea Fishery Committee (Figure 4.7 to Figure 4.10). There is a potential threat to the future integrity of both sites from such activity, identified by SSAC's investigations of the sites (Section 2.3.1). Consequently, an assessment of the fishing practices in place across both sites was undertaken. Initially, the permitted fishing activities at the site were identified during analysis of the South Coast REC (summarised in Table 2), many of these have the potential to disrupt or damage the sites and the resulting threat is discussed further in Section 5.2. Two further avenues of investigation were identified in order to establish the actual fishing patterns across the site;

- Liaison with the Sussex Sea Fisheries Committee.
- Evidence for fishing activity type observed during diver survey.

Sussex Sea Fisheries have failed to respond to enquiries regarding the matter, however, it is thought unlikely that additional information over and above that contained in the SCREC would have been

forthcoming. Observations taken during diver surveys related to the type of fishing equipment that has been lost on the site during fishing activity and which remains *in-situ*. Fishing gear lost at either of the sites can, or has been, noted during previous and on-going diver surveys. The remains of such gear; lines, net, pots etc. obviously indicates that such activity is taking place on a site. It is recognised that the absence of a particular type of fishing equipment does indicate the absence of that fishing activity across a particular site. The two sites are discussed below and the fishing activities that are taking across the two sites are presented in Table 2

Fishing Activity		Vehicle Assemblage			Landing Craft		
		SCREC	SSFC	Diver	SCREC	SSFC	Diver
Fin Fishery	Line Fishing	Yes	N/A	Yes	Yes	N/A	Yes
	Drift Nets	No	N/A	No	No	N/A	No
	Fixed Nets	No	N/A	No	No	N/A	No
	Stern Trawling	Yes	N/A	No	Yes	N/A	No
	Pair Trawling	No	N/A	No	No	N/A	No
	Beam Trawling	Yes	N/A	No	Yes	N/A	No
Shell Fishery	Oyster Dredging	No	N/A	No	No	N/A	No
	Scallop Dredging	No	N/A	No	Yes	N/A	No
	Whelk Potting	Yes	N/A	No	Yes	N/A	No
	Crab & Lobster Potting	Yes	N/A	Yes	Yes	N/A	Yes
	Mussel Beds	Yes	N/A	No	Yes	N/A	No
	Cuttlefish Fishery	No	N/A	No	No	N/A	No
	Clam & Cockle Fishery	No	N/A	No	No	N/A	No

Table 2. Table illustrating all identified fishing activity across the site of the vehicle assemblage. Data is drawn from the South-Coast REC (SCREC), Sussex Sea Fisheries Committee (SSFC) and diver observations (Diver) during 2008, 2009 and 2010.

Fishing practices

Fishing practices relating to both the *fin fishery* and the *shell fishery* have the potential to be applied to both sites. Line-fishing, stern-trawling and beam-trawling relate to the former category and have the potential to occur at both sites. Meanwhile, whelk-potting, crab and lobster potting, and mussel-beds are associated with the shell fishery and also have the potential to occur at both sites. Additionally, scallop-dredging could potentially occur at the vehicle assemblage site. Diver observations at both sites indicated that currently, there is only evidence that line-fishing and crab and lobster potting are being actively pursued at both sites. The threats to the site posed by these activities are discussed in Section 5.2

4.2 Archaeological Fieldwork: Results Analysis and Interpretation

An initial day of fieldwork was conducted in June 2010 as part of the HWTMA A2S project (with the assistance of divers from SSAC).[16] This was followed up by a week of survey during September 2010 that combined divers from HWTMA, SSAC and HIWWT. Adverse weather meant that 1½ days of survey time were lost. This stage of the project had the following four main aims;

- Conducting further survey of the two sites to build on the initial survey conducted by SSAC.
- Documenting as much of the two sites as possible through video and photographs.
- Establishing some provision for future monitoring of the sites.
- Completion of a biological survey of the site, undertaken by HIWWT.

The project brief also established the following survey objectives to be achieved in the course of the fieldwork;

- Confirmation of the position, extent, stability and character of the sites.
- Positioning of visual archaeological material and
- Production of a site plan and further, more detailed survey of key features.

Despite the short period of fieldwork, it was felt that all of the aims were successfully completed. However, there is scope for further detailed survey work on the LCT remains, which, due to the complex nature of the site could not be undertaken in the timescale available. In general, the observations, interpretation and historical research conducted by SSAC in the course of its investigations were confirmed, as were the geographical locations of both sites (Section 1.2). The following section addresses each site in turn, providing an outline of the extent and character of the

[16] http://www.hwtma.org.uk/archaeological-atlas-of-the-2-seas

seabed remains. A summary section then provides an overview of both sites on the basis of the fieldwork including comment on the perceived stability of each site. Further analysis of the threats which may impact future site stability are discussed in Section 5.2.

4.2.1 LCT(A) 2428 Site

The site of LCT(A) 2428 has lost much of its structural integrity as the coherent remains of an LCT. As might be expected, given the capsize of the vessel prior to sinking, the remains lie upside down on the seafloor. The vessel remains lie along a general north/south axis and the site measures c. 40m (north/south) by c. 30m (east/west) giving an area of 1200m^2. The site can be considered to be contained within a circular area, radius of 25m. The vessel is broken into three areas (Figure 4.12);

- A northern section relating to the stern of the vessel, containing the engines.
- A southern section located at the forward end of the central body of the vessel. No debris or structure has been observed to the south of this structure.
- A small western area of steel plating that may relate to the deck of the vessel, or possibly the bow doors.

The most notable features are the two large structural elements noted by the SSAC survey which they termed the 'goalposts'. These stand between 1.6 and 1.7m clear of the seafloor and measure 9.8m in length. One set of goalposts is the primary feature of the southern section of remains (Figure 4.13) and another forms the southern edge of the northern section of remains. The length of the 'goalposts' corresponds closely with the breadth of an LCT MkV and the distance between them corresponds very closely to the length of the central section of a LCT MkV. It therefore seems highly likely that the 'goalposts' represent the main structural bulkheads, located at either end of the central hull where the bow and stern sections were attached, during assembly.

The upside-down orientation of the vessel noted by the UKHO (Section 2.3.2) was confirmed through the survey of the southern section of remains. Original plans of LCT MkV show the presence of an 8" pipe fender running along the outside of the vessel, just below the level of the deck. The remains of this were observed at either side of the southern section (Figure 4.14). The distance between this pipe fender and the top of the bulkhead corresponds with the distance shown in plans from the pipe fender to the bottom of the vessel. The steel plate visible on the seafloor underneath the southern bulkhead is therefore very likely to be the remains of the vessel's deck, seen from the underside. This also explains the structural elements that are visible in this area, between the deck, the bulkhead and the other steel framing elements (Figure 4.15).

Establishing the upside-down orientation of the vessel illustrates that virtually the entire hull of the vessel has been lost, with the exception of the small elements still attached to the bulkhead (Figure 4.16). The edge of the vessel's deck can be seen on both the north and south side of the southern section, suggesting that this section of the vessel has become totally detached from the northern section of remains. Mayor (2010: part 4, pp 7) notes that the wire sweep of the site in 2003 may have contributed to the overall broken-up nature of the site. This conclusion seems to be borne out by the observations made during the current survey and provides a striking contrast with the UKHO listing which describes the vessel as 'intact'. Figure 4.17 illustrates the extent of lost material by overlaying the current site-plan against the outline plan of an LCT MkV.

The northern section of remains is framed on the southern side by the second 'goalpost' with a short section of framing at the eastern end. To the north of the 'goalpost' lies the area of the vessel that would have contained the engines and crew accommodation. The upside down orientation of the vessel means that much of the latter must be buried in the seabed, with the engines, prop shafts, etc on top of them. Three engine blocks were observed, which are in a heavily concreted state (Figure 4.18). The visibility of the vessel's engines indicates that, like the southern section, the external steel hull of the vessel has largely been lost from the northern section of remains. One of the vessel's propeller and propeller shaft remains *in-situ* (Figure 4.19). There is no sign of the other two propellers recorded by divers in June 1976 (Section 2.3.2). To the north of the engines, in the vicinity of the propeller is a substantial and incoherently jumbled debris field, which includes some recognisable elements, such as a battery, gun turret mounts and one of the vessel's rudders. It seems likely that the aft superstructure of the vessel and the crew accommodation is buried in the seabed and lies below the northern jumble of debris and engines.

The additional western section comprises a section of steel plating. This measures 5.4m by 3.3m and is irregular in shape (Figure 4.12). The function of this is unclear, however, the size of this element corresponds closely to that of the sides of the vessel, either side of the bow ramp. This element may also have become displaced during the 2003 wire sweep of the site.

4.2.2 Tanks & Bulldozers Site

The vehicle assemblage that represents the remains of the tanks and bulldozers lost during the capsize of LCT(A) 2428 is a coherent, well-preserved site. The site measures c. 30m (north/south) by c. 25m (east/west) to give a total area of c. 750m^2, the entire site can be contained within a circular area with a radius of 20m. The main features of the site (Figure 4.20) are;

- Two Centaur CSIV tanks, lying slightly west of a north/south alignment, the tanks have been designated Tank A (Figure 4.21) and Tank B (Figure 4.22), moving from west to east respectively.
- Two D7 armoured bulldozers lying to the south of the tanks, on a similar general alignment and designated in the same way; Bulldozer A to the west (Figure 4.23) and Bulldozer B to the east (Figure 4.24). Bulldozer A lies 4m south of Tank A while Bulldozer B lies 8m south of Tank B.
- A kedge anchor, partially lying under Tank B, on its eastern side (Figure 4.25).
- Vehicle remains, possibly that of a jeep, heavily degraded, lying to the north of Tank A (Figure 4.26).
- Areas of 95mm ammunition, located to the north of both Tanks (Figure 4.27).
- Two objects originally thought to be Porpoise ammunition sleds, but now considered more likely to be bow door extensions, lying to the south of the bulldozers.
- A gun barrel, lying to the east of Bulldozer B.
- A propeller, lying to the east of Tank B.

With the exception of the jeep remains, the fabric of the vehicles is well-preserved. There are some holes in their structure, but this is unsurprising given the period of time spent on the seabed. Although the levels of preservation across the site are generally good, a number of specific further observations can be made;

- Tank A has lost the majority of its tracks.
- The blade of Bulldozer B is detached and is located immediately to the north of that vehicle.

SSAC surveys of the site recorded ropes wrapped around Tank A, which were gone by the time of the present surveys in 2010. The damage to the tracks of Tank A seem to have occurred in a single incident, indicated by the corrosion and concretion on all of the resulting exposed areas of wheels, which is uniform in nature. The disposition of the displaced track elements suggests that the vessel was struck from its western side, resulting in segments of track lying across the underside of the vehicle. The fact that these track section have stayed together, suggests a reasonable elapse of time between the deposition of the vehicle and the damage. At least long enough for the individual track pieces to become concreted together. The detachment and dislocation of the blade of Bulldozer B also seems likely to have occurred at a single point of time and provides a marked contrast with the coherent nature of Bulldozer A. The possible cause of these incidents of damage is discussed in Section 5.2.

Further comment can also be made on the disposition of the vehicles and associated artefacts across the site. Most notably, that the arrangement of the vehicles closely matches what would be expected to be seen when they were loaded; the two Centaur CSIV tanks towards the bow of the vessel, with the D7 armoured bulldozers behind them, towards the stern of the vessel. The ammunition field in front of the Tanks is also of a type consistent with that used by Centaur CSIVs. Finally, the anchor found underneath Tank B is the same size and type used on an LCT MkV. It is tempting to suggest that the absence of such an anchor from the LCT site indicates that the anchor present on the vehicle assemblage site was the LCT's main anchor that was lost from its housing when the vessel capsized. However, its location underneath Tank B makes this unlikely as the anchor was housed on the stern of the vessel, rather than towards the bow area. The anchor on the site is therefore more likely to be a spare anchor carried on board. Similarly, the propellers at the vehicle assemblage site are also probably spares, particularly as three propellers were observed on the LCT in 1976 and recorded in the UKHO entry for the site (HOID 020004).

4.2.3 Summary

In summary, the two sites under investigation may be characterised as the well-preserved remains of an assemblage of Second World War military vehicles, in association with the far less well-preserved remains of the landing craft that should have served to transport them to Normandy. The two sites have clearly been subject to contrasting fortunes in recent years. The remains of the vehicle assemblage have retained their structural integrity and coherence and are very recognisable as the vehicles deposited on the seafloor in June 1944. There has been some interference that has caused the dislocation of the blade of one of the bulldozers. This may have been cause by an anchoring vessel, or as a result of the entanglement of crab/lobster pots. However, on the whole the site can be considered to remain in a good state of preservation and in a seemingly stable condition.

This contrasts markedly with the site of LCT(A) 2428. In 1976 the site was considered to be intact, although with some holes in the exposed outer hull of the vessel. At least some of these are likely to have been caused by the gunfire directed at the vessel by HMS *Jaunty* as part of the attempts to sink the vessel following its capsize. Investigation by the present project and SSAC has indicated that the site is now heavily degraded and that it has lost much of the structural integrity and coherence that was obviously present until relatively recently. The cause of this is unclear, but while it is likely that on-going natural degradation has played a part, the wire sweep of the site in 2003 seems to have caused significant damage to the upstanding structural remains. Historical diver reports suggest that there may have been some diver interference on the LCT site; two of the three propellers that were noted by divers in 1976 are now missing from the site. They may have been removed by sports divers, or may have been disturbed in the 2003 wire sweep and lie in the jumble of debris at the northern end of the site. Assessing the long-term stability of the site is difficult because of the dramatic changes that seem to have taken place. The site may remain in its current condition, providing there is no further interference, for some time. Alternatively, the degradation to the site may continue to accelerate leading to the site being completely destroyed in the near future. Until proven otherwise, the site should probably be considered as unstable.

4.3 Biological Sampling and Analysis

(Amy Dale & Jolyon Chesworth)

Diving fieldwork was undertaken by the Hampshire and Isle of Wight Wildlife Trust (HIWWT) in order to establish a biological profile of the two sites under investigation.

4.3.1 LCT(A) 2428 Site

Divers descended down the shotline onto wreckage (bulkhead 2) and surveyed wreckage and surrounding substrate. The wreckage rose approximately 2.5 m above the seabed and consisted of several pieces of metal piled on top of each other as well as large vertical sheets of metal. Figure 4.28 illustrates the approximate route taken by divers during biological survey of the Landing Craft Tank site.

In total, 42 taxa were recorded (Table 3 – Species List), representing 8 phyla (1 algae, 2 annelids (Figure 4.29), 4 bryozoans, 7 cnidarians (Figure 4.30), 5 crustaceans, 1 mollusc, 14 chordata and 8 sponges). Wreckage provided both a hard substrate for attachment of sessile species, and crevices/overhangs for cryptic species. Wreckage was substantially encrusted with *Turbularia indivisa* (oaten pipe hydroids), barnacle species, and *Molgula* sea squirts. Fish were also seen regularly on this site with *Ctenolabrus rupestris* (goldskinny wrasse), *Gobiusculus flavescens* (two-spotted goby), *Parablennius gattorugine* (tompot blenny) and *Trisopterus luscus* (bib) all seen frequently. Some crevices were large enough to provide shelter for small shoals of *Trisopterus luscus* (bib) and *Pollachinus pollachius* (Pollock). Sediment consisted predominantly of chalk covered with sand, with several large mats of *Molgula* sp. (colonial sea squirt) and patches of *Flustra foliacea* (hornwrack).

4.3.2 Tanks & Bulldozers Site

Divers descended down the shot onto wreckage of Bulldozer A. The wreckage of Bulldozer A and surrounding substrate was surveyed before moving north to the wreckage of Tank B. The surveyed wreckage rose approximately 2.5m above the seabed and were both intact vehicles. Figure 4.31 illustrates the approximate route taken by divers during biological survey of the Armoured Vehicles site.

In total, 45 taxa were recorded (Table 4 – Species List), representing 8 phyla (1 annelid, 10 bryozoans, 10 cnidarians, 5 crustaceans, 1 echinoderm, 2 molluscs, 8 chordata and 8 sponges (Figure 4.32)). Both provided hard substrate for attachment of sessile species, and crevices/overhangs for cryptic species. All the wreckage surveyed was substantially encrusted with bryozoans and hydroid turf and *Parablennius gattorugine* (tompot blennies) were seen regularly (Figure 4.33). The wreckage of Tank B provided shelter for several large *Conger conger* (conger eels) and *Galathea strigosa* (squat lobsters). *Cancer pagurus* (edible crabs) and *Dysidia fragilis* (goosebump sponge) were also common on wreckage. Sediment consisted of gravel, pebbles and cobbles with empty *Crepidula fornicata* (slipper limpet) shells, and was generally fairly bare and flat, with the exception of *Nemertesia antennina* (antenna hydroids) and *Flustra foliacea* (hornwrack) attached to cobbles.

Scientific Species Name	Common Species Name	SACFOR Category	Observed on wreckage	Observed on sediment
Algae (seaweeds), Total Species: 1				
Palmaria palmate	dulse	R		yes
Annelida (segmented worms), Total Species: 2				
Bispira volutacornis	double spiral worm	O		yes
Salmacina sp./*Filograna* sp.*	coral worms	R	yes	
Bryozoa (sea mats & moss animals), Total species: 4				
Alcyonidium diaphanum	finger bryozoan	R		yes
Bugula sp.*	spiral bryozoan	R	yes	
*Flustra foliacea**	hornwrack	C		yes
Vesicularia spinosa	*a sea mat*	R		yes
Cnidaria (hydroids & anemones), Total species: 7				
*Actinothoe sphyrodeta**	white-striped/fried egg anemone	O	yes	yes
*Alcyonium digitatum**	dead man's fingers	O	yes	
Hydrallmania falcate	a hydroid	R	yes	
*Nemertesia antennina**	antenna hydroid	O		yes
*Sertularia argentea**	a hydroid	O	yes	
*Tubularia indivisa**	oaten pipe hydroid	C	yes	
Family *Plumulariidae* sp.*	a family of hydroids	R	yes	
Crustacea (Barnacles, amphipods, crabs, lobsters, prawns), Total species: 5				
Balanus crenatus (ID unconfirmed)	a barnacle	C	yes	
*Galathea strigosa**	spiny squat lobster	O	yes	
Homarus gammarus	common lobster	R	yes	
*Necora puber**	velvet swimming crab	F	yes	
Order Thoraciea sp.	barnacles	C	yes	
Mollusca (sea snails, sea slugs & clams), Total species: 1				
Callistoma zizyphinum	painted topshell	F	yes	
Chordata (sea squirts & fish), Total species: 14				
Aplidium punctum	a club sea squirt	R	yes	
*Ctenolabrus rupestris**	goldskinny wrasse	F	yes	
Dendrodoa grossularia	gooseberry sea squirt	O	yes	
Didenium maculosum	a sea squirt	O	yes	
Diplosoma sp.	a sea squirt	C	yes	
Gobiusculus flavescens	two-spotted goby	F		yes
Labrus mixus	cuckoo wrasse	O	yes	
Molgula socialis	a colonial sea squirt	C		
Molgula sp.*	a colonial sea squirt	C	yes	yes
*Parablennius gattorugine**	tompot blenny	F	yes	
Pollachinus pollachinus	Pollock	O	yes	
Scophthalmus rhomus	brill	R		yes
*Styela clava**	leathery sea squirt	R	yes	yes
*Trisopterus luscus**	bib	F		
Porifera (sponges), Total species: 8				
*Dysidea fragilis**	goosebump sponge	R	yes	
*Esperiopsis fucorum** (ID unconfirmed)	unidentified orange sponge	O	yes	
Halichondria panacea	a sponge	P		
*Hemimycale columella**	crator sponge	O		yes
Polymastia pencillis	chimney sponge	R		yes
Stelligera stuposa	a sponge	P		yes
*Suberites ficus**	sea orange	R		yes
Phylum Porifera sp.	unidentified white sponge	R		yes

*Table 3. Full taxa list from biological survey carried out on the Landing Craft Tank site. Note that * indicated taxa that were also found at the vehicle assemblage site.*

Scientific Species Name	Common Species Name	SACFOR Category	Observed on wreckage	Observed on sediment
Annelida (segmented worms), Total Species: 1				
Salmacina sp./*Filograna* sp.*	coral worms	R	yes	
Bryozoa (sea mats & moss animals), Total species: 10				
Amphiblestrum auritum	a sea mat	P	yes	
Bugula sp.*	spiral bryozoan	R	yes	
Callopora dumerilii	a sea mat	P		
Crisia aculeate	white claw sea moss	P		
Electra pilosa	a sea mat	P		
Escharella immerse	a sea mat	P		
*Flustra foliacea**	hornwrack	C		yes
Schizomavella auriculata	an encrusting bryozoan	O	yes	
Scrupocellaria scruposa	a sea mat	P		
Turbicellopora avicularis	an encrusting sea mat	P		
n/a	encrusting bryzoans	C	yes	
Cnidaria (hydroids & anemones), Total species: 10				
*Actinothoe sphyrodeta**	white-striped/fried egg anemone	O		yes
*Alcyonium digitatum**	dead man's fingers	O	yes	
Eudendrium sp.	a hydroid	R		
Halecium lankesteri	a hydroid	P		yes
*Nemertesia antennina**	antenna hydroid	R/O		yes
Plumularia setacea	a hydroid	R/O		yes
Sertularella gaudichaudi	a hydroid	P		
*Sertularia argentea**	a hydroid	R		
*Tubularia indivisa**	oaten pipe hydroid	R	yes	
Family *Plumulariidae* sp.*	a family of hydroids	P		
n/a	hydroid turf	F		
Crustacea (Barnacles, amphipods, crabs, lobsters, prawns), Total species: 5				
Cancer pagurus	edible crab	F	yes	
*Galathea strigosa**	spiny squat lobster	R	yes	
Macropodia sp.	a spindly crab	R	yes	
*Necora puber**	velvet swimming crab	O (x3)	yes	
Palemon serratus	common prawn	R	yes	
Echinodermata (sea stars & sea urchins), Total species: 1				
Ophiuroidea sp.	a brittlestar	R		yes
Mollusca (sea snails, sea slugs & clams), Total species: 2				
Crepidula fornicate	slipper limpet	F		yes
Ostrea edulis	European/native oyster	R	yes	
Chordata (sea squirts & fish), Total species: 8				
Conger conger	conger eel	F (x5)	yes	
*Ctenolabrus rupestris**	goldskinny wrasse	R (x1)	yes	
Diplosoma listerianum	an encrusting sea squirt	R/O		
Labrus bergylta	ballan wrasse	R (x2)	yes	
Molgula sp.*	a colonial sea squirt	O		yes
*Parablennius gattorugine**	tompot blenny	C	yes	
*Styela clava**	leathery sea squirt	O		yes
*Trisopterus luscus**	bib	F	yes	
Porifera (sponges), Total species: 8				
*Dysidea fragilis**	goosebump sponge	C	yes	
Esperiopsis fucorum	shredded carrot sponge	O		
*Esperiopsis fucorum** (ID unconfirmed)	unidentified orange sponge	O	yes	
Halichondria bowerbanki	a sponge	O/C		
*Hemimycale columella**	crator sponge	O/C	yes	
Antho inconstans	an encrusting sponge	O		
Antho involvens	an encrusting sponge	O	yes	
Myxilla rosacea	a sponge	P		
*Suberites ficus** aggregation	sea orange	O	yes	

*Table 4. Full taxa list from biological survey carried out on the Vehicle Assemblage site. Note that * indicated taxa that were also found at the Landing Craft Tank site.*

4.3.3 Discussion

A biological profile of the study area was constructed by surveying both sites using Seasearch biological recording methods. Both sites are biologically diverse with 69 taxa within 9 phyla recorded in total. Species richness was similar at both sites, 42 and 45 taxa for the Landing Craft and Tanks and Bulldozers site respectively. There was a dominance of sessile taxa, with 30 and 34 sessile taxa for the Landing Craft and Tanks and Bulldozers site respectively. Species richness was also higher on wreckage than surrounding sediment at both sites. This demonstrates that wreckage is an important complex feature providing both shelter and attachment points for a diverse suite of species in an otherwise fairly homogenous habitat.

There was not a high degree of overlap of taxa recorded between sites, with only 20 of the taxa recorded at the Landing Craft site, also recorded at the Tanks and Bulldozers site (taxa occurring at both sites are indicated with an asterisk in Table 3 and 4). The majority of the taxa common to both sites were sessile and recorded on wreckage rather than the surrounding sediment. Taxa richness at a phylum level was similar between the two sites, though there was notable difference in the number of bryozoan and chordate species found at each site (Table 5). In the case of chordates this was found to be a reflection of sea squirt (ascidian) species, which were much more abundant at the LCT site.

Phylum		Number of Taxa Recorded at Each Site	
		LCT	Vehicle Assemblage
Algae (seaweeds)		1	0
Annelida (segmented worms)		2	1
Bryozoa (sea mats & sea mosses)		4	10
Cnidaria (hydroids & anemones)		7	10
Chordata (sea squirts & fish)	- sea squirts	7	3
	- fish	7	5
Crustacea (barnacles, crabs, lobsters, prawns)		5	5
Echinodermata (sea stars & sea urchins)		0	1
Mollusca (sea snails, sea slugs & clams)		1	2
Porifera (sponges)		8	8
	Total	**42**	**45**

Table 5. Table showing distribution of species richness between phyla group at each site.

4.4 Oral History Project: Analysis and Interpretation

4.4.1 Targeted Interviews

Landing craft veterans were contacted via the Landing Craft Veterans Association and the D-Day Museum in Southsea. Only a very small number of surviving veterans had memories of landing craft tank operations and none could be identified with specific reference to the events surrounding the sinking of LCT(A) 2428. Interviews were therefore conducted to record the memories relating to the service of landing craft during D-Day in order to provide increased historical context to the project. This confirmed several of the existing pieces of information from other oral history gathering projects regarding the often unseaworthy nature of a fully laden landing craft. The majority of the surviving veterans are now elderly and often frail or in ill health, this prevented some targeted interviews from taking place. In some instances interviewees provided written accounts instead of/in addition to oral information. An abridged sample of one these relating to Landing Craft activity during Operation Neptune is provided in Appendix One.

In order to provide further contextualisation to the current project and the podcast, interviews were also conducted with core members of the current project team, including divers and with core members of the SSAC project team. All of the targeted interviews provided information or direct material for the podcast (below). The archive of interviews, both oral and written has been retained by HWTMA.

4.4.2 Open Day Workshops

The Open Day Workshop elements of the Oral History work aimed to establish the extent to which the local population had any residual memories of the events surrounding the sinking of LCT(A)2428, or of the general operation of Landing Craft during the D-Day operation. Three workshops were held, the first at Southsea High Street, the remaining two at the Royal Marines Museum, Southsea.

Taking account of the people who attended both Open Days, it is clear that there is little residual knowledge of either the sinking of LCT(A)2428 or of the presence of Landing Craft in the area as part of the D-Day operation. One veteran contacted HWTMA in response to an Open Day advert that he had seen, but he was too unwell to be able to attend the event at the Royal Marines Museum. He instead provided written memories of his time serving on Landing Craft during the Second World War. This also served to highlight the difficulty in gathering information from surviving veterans, many of whom are very elderly or unwell.

A secondary product of the Open Days was the opportunity to gauge the extent to which the general public valued heritage assets such as the LCT(A)2428 and vehicle assemblage, whether they were interested in their history and felt any desire to protect them. It was clear from the wide range of

people who viewed project related displays on the HWTMA Maritime Bus and who talked to project staff, that there was a real interest in the history of the two sites and how they came to be where they were. It was also clear that there was a desire among the general public for the sites to be offered some form of protection, if possible. This sentiment was of particular interest amongst the members of the public at the Southsea High Street event, where it was far less likely to encounter people with a direct interest in heritage, or D-Day history, as might be the case with members of the public at the Royal Marines Museum.

4.4.3 Podcast

The practicalities of producing a podcast to disseminate the project to the general public was explored. HWTMA experience in this form of dissemination has shown that podcasts are an easily accessible way for ordinary members of the public to engage with maritime archaeology. The creation of a podcast focused on the Landing Craft Project mixed elements of the history of the landing craft and the events surrounding its sinking, with a report of this project and the rationale behind it.[17] By blending the personal interviews with an over-arching commentary, the podcast tells the history of the LCT, the Centaur tanks, the sinking and finally the current project to record and preserve the remains on the seabed. The aim of this was to make the public aware of the history of the two sites, their inter-relationship and also of the different forms of legislative protection that could potentially be applied to them.

Interviews were conducted with core members of the dive team during the dives onto the LCT and the vehicle assemblage. Later interviews were also recorded with other key staff members and Alison Mayor of Southsea Sub Aqua Club. It was possible to conduct one oral history recording with a veteran of D-Day by telephone, and he kindly agreed to allow this interview to be used in the finished podcast.

As a result, there was a large amount of recorded material available, as well as a detailed history of the LCT, tanks and units involved in the sinking. Rather than limit the amount of information presentable, the decision was taken to create something more akin to a short radio programme. The finished podcast came to a considerable length and so was spilt into three parts. This enabled relatively small files sizes to be maintained for download on the website. It also gave those downloading the podcast the option to listen in three separate sessions, rather than a single longer one.

4.4.4 Summary

The oral history element of the project produced mixed results in terms of the information acquired relating to LCT(A) 2428. A very small number of veterans were identified during the period of the project as having useful information relating to LCTs and their use at D-Day. Their memories, collected both orally and in written form, provided further historical context to the study of the sites and were a valuable addition to the subsequent podcast. The limitations imposed by age and health both became clear during this phase of the project. The public open-days indicated that there was a virtually non-existent level of residual memory about LCT(A) 2428 within the local area. However, the open-days did serve to establish that there is a high-level of interest and concern within the general public about this aspect of maritime heritage and willingness for it to be protected. The overall success of the podcast will only be seen over the longer term, however, it must be considered to be an easily accessible way for such a project to be disseminated to the general public.

[17] The Landing Craft Project podcast can be downloaded from www.hwtma.org.uk/podcasts

5. Site Management & Monitoring

5.1 Provision for Future Monitoring

Provision for future monitoring of both sites by SSAC was addressed through the installation of monitoring points and the identification of monitoring features. Such an approach should allow the identification of changes to the overall nature of the site, in particular sediment levels, as well as changes/alterations to specific areas of the seabed structure. The former approach has been successfully adopted on a number of sites over the longer-term, most notably that of the *Hazardous* (HWTMA 2006/8) and *HMS Colossus* (Camidge 2009: 180-1) protected wreck sites, while the application of on-going formal structural monitoring has worked successfully on the site of the *Flower of Ugie* (HWTMA 2011: section 3.2). The following section addresses each site in turn and outlines the measures put in place.

5.1.1 Tanks and Bulldozers Site

A series of monitoring points were installed on the seabed around the vehicle assemblage (Figure 5.1) (Section 3.1.2), in the form of steel stakes driven into the seabed, surmounted by an ID tag. Measurements were taken from the top of these to the seafloor in order to provide a benchmark for the future monitoring of the seabed height over the site in relation to the monitoring point (Table 6). It should be noted that the nature of the seabed on the site (Section 4.1) and the presence of relatively small artefacts still *in-situ* on the surface, eg. ammunition, indicates that little change has taken place to the seabed since deposition and that little future change should be expected.

Monitoring Point	Distance to Seabed	Locational Notes
TB1	0.38m	North of Tank B
TB2	0.32m	North of Bulldozer A
TB3	0.28m	Between Tank A & Tank B
TB4	0.25m	East of Bulldozer B

Table 6. Monitoring points and seabed heights on the Vehicle Assemblage.

Additionally, the monitoring points are intended to serve as orientation points for the consistent inspection of specific areas of the vehicles in the future. The creation of a three-dimensional site plan (Figure 5.2) means that a view of the vehicles from each of the monitoring points can be created that is independent of visibility or lighting constraints both of which can be a problem at the site. These viewpoints can then be utilised by visiting divers to record, either through photographs, video, or written record (preferably all three) the condition of the remains visible from each monitoring point. An example of such a virtual viewpoint, along with a photograph taken from the same place. is included in Figure 5.3. A 'virtual dive' around the site stopping at each monitoring point will also be hosted on the HWTMA LCT project webpages in order to allow divers to orientate themselves prior to site visits.

Monitoring Point	Distance to Seabed	Locational Notes
M241		Top of the western end of bulkhead 2
M251		Base of the eastern end of bulkhead 2
M250		Northern end of western engine
A251		Southern end of central engine
A250		Northern end of eastern engine
M280		Propeller at north-east edge of site
A280		Probable rudder in north-centre of site
M283	1.56m	Upper end of western end of bulkhead 1
A282	1.73m	Central top of bulkhead 1
M281	1.70m	Upper end of eastern end of bulkhead 2
A281		Pipes to north of eastern end of bulkhead 2

Table 7. Monitoring points and seabed heights on the LCT site.

5.1.2 LCT(A) 2428

It was intended that a similar set of monitoring points would be installed in the seabed at the site of LCT(A) 2428 (steel stakes driven into the seabed). However, problems were encountered due to the seafloor being too hard to be able to securely locate the monitoring points. As a result, it was decided to attach the points directly to the surviving vessel structure at recorded locations (Figure 5.4 & Figure 5.5). Additional monitoring points were also located on potentially fragile/moveable elements such as the surviving propeller (eg. Figure 4.19) that were identified as features to be monitored. This should ensure that these features are visited as part of future monitoring schedules. Further complications

arose when the dive on which measurements from the monitoring points to the seafloor were scheduled to be taken had to be aborted, due to the weather conditions. However, some measurements are in place because of the previously recorded dimensions of elements such as the structural bulkheads (Table 7).

5.2 IDENTIFIED THREATS

The following section provides a focused assessment of the threats, both natural and socio-economic, that can be identified as having a potential impact on the site of LCT(A) 2428 and the associated vehicle assemblage site. The identified threats are derived from those listed by Dunkley (2008: list 12) in relation to the management of protected wreck sites, accordingly they are also listed in the appropriate section of the risk management for each site (Section 5.3). Assessment is based on existing observations of the sites and the likely activities already identified in this report (eg. Section 4.1), assessment is conducted on a scale ranging between LOW, MEDIUM, HIGH and VERY HIGH. The assessment of threat provided here attempts to consider both the potential long-term and short-term threat to each site. Consideration is also given to the present condition of remains (Section 4.2) and the implications of this when assessing the threat levels. For example it was noted that the vehicle assemblage exhibited much higher levels of preservation, coherence and structural integrity than the remains of LCT(A) 2428. The relative impact on the former site resulting from any of the identified threats is therefore likely to be much higher than on the latter site. Because of the relative geographical proximity and over-riding environmental conditions, there is a certain amount of repetition in the threats to each site. However, because of the difference in the preservation of remains, it is seen as desirable to maintain a separate threat assessment for each site, despite the repetition of material presented below.

5.2.1 Tanks and Bulldozers Site

Fishing Activity

A range of fishing activity was identified in Section 4.1 as being permitted in the area of the vehicle assemblage site. This includes line fishing, stern trawling, beam trawling, potting for whelks, crabs and lobsters and the presence of mussel beds. While trawling activity may be considered a potentially damaging activity, in reality, fisherman are aware of known seabed obstructions and make an effort to avoid them in order to avoid damage to their equipment. More serious consideration should be given to line fishing and potting activity. The potential for damage from anchoring line fishing vessels is discussed below. It must be considered likely that such line fishing will take place at the site because of the abundance of marine life noted in Section 4.3. Potting also has the potential to cause damage via the tangling of strings of pots around the seabed remains, and subsequent efforts to free them, leading to sections of the seabed remains being disturbed or displaced. This kind of activity may have resulted in the dislocation of the plough of Bulldozers B and the damage to the tracks of Tank A (Section 4.2.2) and indicates the potential for further damage in the future.
Threat from Fishing Activity: MEDIUM-to-HIGH

Natural Processes

It is clear that the vehicle assemblage is naturally declining as a result of its submergence for nearly sixty-seven years. Some of this is undoubtedly associated with on-going biological decay and chemical processes resulting from the immersion of steel in seawater. The site must also be subject to some mechanical degradation from sediment suspended in the water column, although energy levels across the site are generally low. The thickness of the vehicles armour plating seems to have afforded them a measure of protection over the years, this contrasts with the remains of the military jeep, which has almost totally degraded. Such natural processes of decay, currently witnessed by small holes in the vehicle's structure will inevitably continue over the coming years and will ultimately lead to their destruction, however, there is no reason to expect the rate of decay to increase. There seems to be little in the way of seabed mobility at the site, the seabed is comprised of gravel and sand and there is little or no evidence of scour forming around any of the vehicle remains during the past sixty-seven years. Furthermore, the presence of relatively small artefacts, in the form of ammunition, on the seabed, in the position in which they were deposited also attests to the stability of the seabed at the site. On-going monitoring of the seabed (Section 5.1) will confirm/refute these observations.
Threat from Natural Processes: MEDIUM

Socio-Economic Activity

The likelihood of vessels anchoring at the site can be considered to occur for two reasons. Firstly for the purpose of line fishing (above) and secondly for the purpose of recreational diving. Whatever the

reason, damage from anchoring vessels may be considered to present a serious threat to the structural integrity (currently very high) of the vehicle assemblage. The damage to Tank A and Bulldozer B discussed above could potentially have resulted from an anchoring vessel. Interlinked with the threat from anchoring vessels is the threat from casual sports divers who have the intention to remove elements of the site as 'souvenirs'. This kind of activity has recently occurred on the remains of the *Holland 5* submarine site,[18] itself a Protected Wreck in the eastern Solent and on the remains of a Second World War German Dornier 17 bomber on the Goodwin Sands in Kent.[19] As publicity of the site increases it is likely that higher levels of divers will be attracted to it because of the combined high levels of preservation and its unique nature.
Threat from Socio-Economic Activity: HIGH

5.2.2 LCT(A) 2428

Fishing Activity
A range of fishing activity was identified in Section 4.1 as being permitted across the site of LCT(A) 2428. In general this was similar to the range identified at the vehicle assemblage site (above), which includes line fishing, stern trawling, beam trawling, potting for whelks, crabs and lobsters, scallop dredging and the presence of mussel beds. The trawling activity related to some of these activities may be considered a potentially damaging activity, in reality, fisherman are aware of known seabed obstructions and make an effort to avoid them in order to avoid damage to their equipment. As with the vehicle assemblage site, more serious consideration should be given to the danger posed by line fishing and potting activity. The potential for damage from anchoring line fishing vessels is discussed below. It must be considered likely that such line fishing will take place at the site because of the abundance of marine life noted in Section 4.3. Potting also has the potential to cause damage via the tangling of strings of pots around the seabed remains, and subsequent efforts to free them, leading to sections of the seabed remains being disturbed or displaced. Against the likelihood of such damage must be set the fact that the extant remains of LCT(A) 2428 are already extremely degraded and incoherent. Further damage is unlikely to actually damage the integrity of the site, in relative terms, any further.
Threat from Fishing Activity: LOW

Natural Processes
It is clear that the vehicle assemblage is naturally declining as a result of its submergence for nearly sixty-seven years. Some of this is undoubtedly associated with on-going biological decay and chemical processes resulting from the immersion of steel in seawater. The site must also be subject to some mechanical degradation from sediment suspended in the water column, although energy levels across the site are generally low. As noted in Section 4.2, the remains of the landing craft are severely degraded and lie in at least three main pieces, possibly the result of the sinking process in combination with a subsequent wire-sweep of the site. It is therefore doubtful whether continuing degradation will have any relative impact on the physical remains of the vessel, over and above continuing natural decline. The seabed surrounding the site is comprised primarily of gravel, with some sand and appears to be stable. There is little or no evidence for the development of scour around the seabed remains since their deposition sixty-seven years earlier. On-going monitoring of the seabed (Section 5.1) will confirm/refute these observations.
Threat from Natural Processes: LOW

Socio-Economic Activity
The likelihood of vessels anchoring at the site of LCT(A) 2428 can be considered to occur for two reasons. Firstly for the purpose of line fishing (above) and secondly for the purpose of recreational diving. Whatever the reason, damage from anchoring vessels may be considered to present a serious threat to the structural integrity of the site, although this is currently relatively low due to the highly dispersed nature of the remains. Interlinked with the threat from anchoring vessels is the threat from casual sports divers who have the intention to remove elements of the site as 'souvenirs'. Precedents for this are discussed above. Material has been removed from the site during the past thirty years and has been declared to the Receiver of Wreck (Section 2.3.2). Although this complies with current legislation, the material has still been removed from its archaeological context and its potential contribution to our understanding of the vessel has been lost. There is also potential reason to believe that other material has been recovered, notably two propellers, that has not been declared.

[18] http://www.bbc.co.uk/news/uk-england-11154558
[19] http://www.bbc.co.uk/news/uk-12997528

Threat from Socio-Economic Activity: HIGH (N.B. potential impact on surviving remains is MEDIUM)

5.2.3 Threat Summary

The vehicle assemblage site and the remains of LCT(A) 2428 can be seen to be under threat from the same general forms of activity. Threats arise from fishing, natural processes and socio-economic activity (Sports Diving) at both sites. The latter in particular has the potential to occur within an entirely legal framework, while still damaging the overall archaeological context of the seabed remains. Natural processes affecting the sites appear to be low/normal levels of degradation resulting from long-term submergence. The seabed/sediment regime at both sites appears to be stable and should not be considered as a threat to future stability. In general, the level of threat to either site from each identified threat is broadly similar. However, the great difference in the levels of preservation (at the current time) dictates that the potential impact of these threats at either site is very different. In general terms the remains of LCT(A) 2428 can be considered to be under a LOW-to-MEDIUM level of threat, while the remains of the vehicle assemblage may be considered to under MEDIUM-to-HIGH levels of threat.

5.3 Site Risk Assessment

This risk assessment has been completed according to the guidelines set out by English Heritage (Dunkley 2008). A separate risk assessment has been completed for each site, to reflect their differing conditions and assessed significance.

Wreck/Site Name														
Tanks & Bulldozers														
NRHE / UKHO No.	***EH Region***													
NRHE 911191	South East													
Latitude (WGS84)	050 38.540N													
Longitude	000 51.586W													
Class Listing	***Period***													
Landing Craft Tank	Modern (WW2)													
Licensee	***Nominated Archaeologist***													
N/A	N/A													
Seabed Owner	***Navigational Administrative Responsibility***													
The Crown Estate	Nil													
Environmental Designations														
G: None														
Seabed Sediment	***Energy***													
Sandy Gravel	Low													
Survival														
Good														
Overall Condition	***Condition Trend***													
B: Generally satisfactory but with minor localised issues	C: Stable													
Amenity Value: visibility														
A: Substantial above bed structural remains that are highly visible and legible without further information.														
Amenity Value: physical accessibility	***Amenity Value: intellectual accessibility***													
A: Full	C: None													
Management Action	D: Legal protection should be sought to preserve integrity of site													
Management Prescription	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**
														X
Notes														
Site comprises the remains of two Centaur CSIV tanks and two D7 armoured bulldozers lost following the capsize of LCT(A)2428 while en-route to the D-Day landings. All the vehicles lie in a well-preserved state on the seabed, in a variety of positions; either upside down or on one side. In all cases they lie proud of the seabed. The site is seemingly stable with little excessive degradation to the vehicles, other than what would be expected after 67 years on the seafloor. Limited damage has been caused to one of the bulldozers, probably from an anchoring vessel or from entanglement with crab/lobster pots. Threats to the site have been identified as arising from fishing activity, natural processes and human interference, the latter in particular has the potential to remove items of contextual significance from the site through the action of divers. The highly significant nature of the site means that it would benefit from some form of legal protection. Provision has been made														

for the on-going monitoring of the site by Southsea Sub-aqua Club.

Overall Risk Assessment: MEDIUM-to-HIGH

Wreck/Site Name			***SI Number***											
LCT(A) 2428														
NRHE / UKHO No.	***EH Region***		***Restricted Area***		***Principal Land Use***									
	South East				Coastland 1									
Latitude (WGS84)	050 38.457N													
Longitude	000 46.490W													
Class Listing	***Period***		***Status***											
Landing Craft Tank	Modern (WW2)		Non-Designated Wreck Site											
Licensee	***Nominated Archaeologist***		***Principal Ownership Category***											
N/A	N/A		E: Crown/MOD											
Seabed Owner	***Navigational Administrative Responsibility***													
The Crown Estate	Nil													
Environmental Designations														
G: None														
Seabed Sediment	***Energy***													
Sandy Gravel	Low													
Survival														
Poor														
Overall Condition	***Condition Trend***		***Principal Vulnerability***											
E: Extensive Significant Problems	B: Declining		ANGL, FISH, POT, SHELL, TRAWL, BIO, MECH, NAT, ANCH, DIVE,											
Amenity Value: visibility														
B: Limited above bed structural remains and finds scatter with limited visibility and only legible with further interpretative information														
Amenity Value: physical accessibility	***Amenity Value: intellectual accessibility***													
A: Full	C: None													
Management Action	D: Legal protection should be sought to preserve integrity of site													
Management Prescription	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**
														X
Notes														
The site comprises the broken up remains of Landing Craft Tank (Armoured) 2428. The remains of the vessel are in three pieces in a highly incoherent state. The vessel is extremely badly degraded and the current evidence indicates that the exposed remains will continue to degrade rapidly in the near future. It is likely that buried elements of the vessel, possibly including superstructure at the stern of the vessel will be in a better state of preservation It seems likely that the physical degradation of the site is irreversible at this point in time and has been primarily caused by the sinking process and subsequent biological and natural decay of the materials concerned, in conjunction with a wire-sweep of the site in 2003. Material has been raised from the site and declared to the Receiver of Wreck, additional material may have been raised and not declared, however, this is unclear. Threats to the site have been identified as arising from fishing activity, natural processes and human interference, the latter in particular has the potential to witness the further removal of items of contextual significance from the site through the action of divers. The dispersed nature of the material on the site means that such casual removal is relatively simply. Although the remains of LCT(A) 2428 are not in good condition, seabed remains of Mark V Landing Craft are relatively rare. Further significance of the site lies in its historical association with the vehicle assemblage remains. Because of this association, the site would benefit from some form of legal protection. Provision has been made for the on-going monitoring of the site by Southsea Sub-aqua Club. Overall Risk Assessment: LOW-to-MEDIUM													

5.4 THE APPLICATION OF THE AMAAA (1979) TO THE MARINE ZONE

5.4.1 Background

The Ancient Monuments and Archaeological Areas Act 1979 (AMAAA), is the primary legislative mechanism for the protection of the UK's archaeological assets. The Act specifically includes monuments located within UK territorial waters (Section 45(4) and 53). However, until the passing of the *National Heritage Act* in 2002, English Heritage did not have responsibility for the management of historic assets within England's territorial sea (Roberts and Trow 2002: 2), despite the fact that it is the agency responsible for such management within the terrestrial zone. Additionally, the development of the *Protection of Wrecks Act* 1973 (PWA), a distinctive piece of legislation to enable the protection of historic shipwrecks, has contributed to a continuing separation between the protection and scheduling of terrestrial sites in England and those lying within England's territorial waters.

It has been a long-term aim of terrestrial and maritime archaeological legislation and management within England, primarily through English Heritage, to achieve a 'seamless' approach to the protection of archaeological sites both above, below and within the inter-tidal zone (Williams *et al* 2005: 12 & 137). In their review of the position of heritage legislation relating to the marine zone, Roberts and Trow (2002: 16) note that any new arrangements must 'have as wide a common basis with terrestrial legislation as possible'. Such an approach has been increasingly possible within the devolved administrations of the UK. Scotland in particular now has legislative tools to allow a completely seamless approach through the provision of *Historic Marine Protection Areas* as part of the *Marine (Scotland) Act* 2010. Such areas replace the protection afforded via the *Protection of Wrecks Act* and may be extended from the marine zone to the terrestrial zone in a seamless fashion. Reform to the legislation that underpins heritage protection within England (including that appertaining to the marine zone) was contained within the proposed *Draft Heritage Protection Bill* (2008) but has failed to progress through parliament and now appears to have been abandoned.

An effort is therefore being made to utilise the extension granted to EH to manage the heritage assets contained within England's territorial waters, in conjunction with the ability of the AMAAA to be applied to the marine zone. The current project is acting as a pilot study to establish the suitability of the application of the AMAAA to the marine zone.

5.4.2 Precedent and Considerations

It is the policy of Historic Scotland to utilise the AMAAA in preference to the PWA where the sites are established diver attractions or where the PWA may be counter-productive in the long-term (Roberts and Trow 2002: 13). There are two groups of marine heritage assets in Scotland that are protected under the AMAAA, these are

- The remains of seven vessels of the German High Seas Fleet, scuttled in Scapa Flow in 1919, comprising four light cruisers and three battleships.
- Eight hulks representing 19th-early 20th century *Fifie* fishing vessels and Kilspindy, Aberlady Bay, Lothian.

Additionally, in Wales, the remains of the seagoing merchant vessel *Louisa*, in Grangetown, Cardiff are also scheduled under the AMAAA.

Of these examples, the most significant precedent to the present study of the vessels located at Scapa Flow. Not only are they relatively modern, but they also represent shipwreck remains lying fully submerged in the marine zone, rather than in the inter-tidal zone. Scheduling under the AMAAA rather than the PWA has allowed these vessels to be afforded protection, while maintaining public access to this popular dive location.

Application of the AMAAA for the legal protection of a site would afford the site much the same level of protection as is offered by the PWA. For example, the AMAAA states (Section 2) that it is illegal to carry out, cause or permit 'works' that demolish, destroy, damage, remove, repair, alter or add to the monument without consent. This is comparable with Section 1(3) of the PWA which notes that it is an offence to 'tamper with, damage or remove' any part of the protected site, conduct salvage operations on the site with the intention of exploring the site or removing objects from it. A potential strength of the PWA is the automatic provision of a restricted area around the site (Section 1(2)), within this area it is an offence to dive on the site for the purpose of exploration or to use diving equipment (Section 1(3)(b)). This effectively means that access to the site is prohibited, unless granted by the Secretary of

State under the system of licenses managed by English Heritage. Such restricted access can also be achieved under the AMAAA as provision for this is made in Section 19(2) of the act which allows for the public access to be limited to certain times, or for the public to be totally excluded from the site if this is deemed necessary. It is worth noting at this point that the restricted areas that can be established by the PWA specifically excludes any area of the site that lies above the high water mark of ordinary spring tides (Section 1(2)(b)). In contrast, use of the AMAAA would allow a defined site to straddle the high water mark and would provide a seamless approach to the scheduling of heritage assets at the interface between the marine and terrestrial zones.

Finally, consideration must be given to the on-going management and monitoring of the site following any designation. Clearly, such activity requires financial provision to fund such activity, including formal site visits. In the case of sites located in the marine zone, these could be more expensive than sites located in terrestrial or inter-tidal contexts. Financial provision for sites designated under the PWA is provided by EH under Section 6 of the *National Heritage Act 2002*. Similar powers are granted to EH under Section 33(2)(c) of the *National Heritage Act 1983* for the purpose of defraying or contributing towards the costs of research in relation to ancient monuments situated within England (which includes those located in England's territorial sea).

5.4.3 LCT(A) 2428, Vehicle Assemblage and the AMAAA (1979)

On the basis of the precedents and considerations outlined in Section 5.4.2, there seems to be no reason why sites of national importance situated within England's territorial sea should not be scheduled under the AMAAA. Scheduling under this act has been successfully applied to fully submerged sites within the Scottish territorial sea. As with the PWA, it is possible for public access to such a site to be restricted or denied, if this is deemed to be in the best interest of the site. However, the default position of the AMAAA is for a site to be publically accessible. With this in mind, Roberts and Trow (2002: 13) note that a shortcoming of the PWA is that is constrains public access to sites that are in reality robust enough to accommodate conscientious visitors. On the basis of the underwater remains it seems likely that both the vehicle assemblage and the remains of LCT(A) 2428 are robust enough to accommodate visiting divers on a 'look but don't touch' basis.

Clearly, scheduled ancient monuments need some form of on-going monitoring to allow management strategies to be developed and updated. This is particularly the case where public access to the site is popular or commonplace. The AMAAA allows for the costs incurred in carrying out research relating to ancient monuments to be either fully or partially defrayed. For sites located in the marine zone, the involvement of suitably experienced, local, avocational organisations, such as SSAC in the case of the LCT and vehicle assemblage, may facilitate a route to increased local involvement and awareness coupled with a reduction in the financial outlay associated with the contracting of fully professional services.

Having established that the AMAAA represents a potentially viable means to apply legal protection to the remains of LCT(A) 2428 and its associated vehicle assemblage, attention can now focus on whether or not these two sites should be afforded protection. In the case of the vehicle assemblage it is clear that the site is a site of considerable rarity, preserved in good condition and of high significance as a means to illustrate its period of origin. The schedule of England's ancient monuments would be enhanced and broadened by the inclusion of this site. By contrast, LCT(A) 2428 is a site of equal rarity, that is currently preserved in a poor condition, probably as a result of recent human interference. However, despite this it provides a clear characterisation of its period of origin. Furthermore, knowledge of LCT(A) 2428 is essential in understanding the story surrounding the deposition of the vehicle assemblage. If LCT(A) 2428 had capsized and sank in a single event, leading to the deposition of vessel and vehicles in the same place, both would be scheduled as a single site. The dislocation of LCT(A) 2428 from its vehicle cargo due to the wrecking process should not diminish its significance. Accordingly, LCT(A) 2428 should also be considered, along with the vehicle assemblage site, for scheduling under the AMAAA. In the first instance it also seems desirable to maintain unrestricted public access to both sites.

6. Conclusions

This report has set out the findings of a project dedicated to the archaeological investigation of the submerged remains of LCT(A) 2428 and its associated vehicle assemblage. Diving fieldwork was carried out jointly between the Hampshire and Wight Trust for Maritime Archaeology and Southsea Sub-Aqua Club. This fieldwork established the extent, character and condition of the seabed remains at both sites. In the case of the vehicle assemblage site, the seabed remains were found to be in a good state of preservation, historical research also established that surviving examples of Centaur CSIV tanks of the type found at the site are very rare. The remains of LCT(A) 2428 were found to be far less well preserved. The site of the LCT seems to have suffered from extensive, recent human disturbance, including the removal or artefacts from the site.

The fieldwork undertaken during the project enabled the creation of an overall plan of each site. This provided information on the extent of the site and will also serve to aid future monitoring of the structural remains present on both sites. In the case of the remains of LCT(A) 2428, the site plan produced during the project should serve as the baseline information for future survey work on the stern of the vessel, where the complex nature of the remains did not permit a full survey to be conducted during the course of the project. Monitoring points were also installed at specific locations across both sites as a means to monitor any changes to the sediment regime on the sites and to provide points of reference for on-going changes to the structural make-up of the two sites. Biological profiling was also undertaken to establish the character of the natural resource present at either site.

In conjunction with the archaeological fieldwork, an oral history project was undertaken to attempt to unearth local memories relating to the events that surrounded the sinking of LCT(A) 2428. Open day workshops were held in the Southsea area and suitable veterans groups were contacted in order to ascertain the extent of surviving memories of this event. This element of the project revealed little specific information relating to LCT(A) 2428, but did uncover useful personal recollections relating to the wider events of Operation Neptune and D-Day itself. The open day workshops also indicated a strong interest within members of the general public regarding the seabed remains and a desire that such elements of England's heritage should receive adequate legal protection.

It was clear from liaison with D-Day/Landing Craft Veterans' Association that there is still a significant corpus of information relating to the maritime element of the Normandy landings available. This project uncovered a small quantity of this. Future research, focused on the systematic, large-scale collection, documentation and analysis of the surviving oral history relating to D-Day would doubtless shed even more light on the events of June 1944 and increase presence of the personal, human element in our historical understanding of those events.

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8. Appendix

8.1 Selected recollections of Andrew Marchant, 2nd in Command, LCT(A) 2455.

'All down the Southampton water to Calshot the craft were moored in trots on the buoys. Transport to and from Southampton was in Motor Boats manned by the Wrens. The atmosphere was electric. The big day was coming and we wondered where we were going. We only knew about three or four days beforehand... I suppose the majority of all personnel had never actually been in battle. The atmosphere is well described by Nevil Shute in "Requiem for a Wren". We went ashore regularly and the dance halls and bars did a roaring trade. The Civic centre at Southampton put on dances to really big bands most nights. The local girls were pretty and the Americans were teaching us to Jitter Bug.

The whole of the South Coast was packed with troops, vehicles and tanks of every description. On 2nd June we were at Southampton New Docks. All shore leave was stopped. At 1515 we went down Southampton water and round to Stokes Bay where the loading "hards" were. We loaded three tanks (two Centaur and one Sherman) and thirty-two men, also one armoured bull dozer. The tanks were Royal Marine Armoured Support and we had a Beach party from the Berkshires...

On the 5th June we singled up and warmed up the engines. At 0735 we slipped and went down Southampton Water. By 0830 we had joined up with the rest of the Flotilla. Twenty minutes later we experienced difficulty in steering. Wind was Force 3-4 from the SW when still in the Solent. Plenty for these sort of craft. At 1135 we passed through the anti-submarine net gate at Spithead on a course S30 E. The flag signal was ORDER 2 GEORGE 6 meaning two columns ahead at 6 knots. We were off. I was nineteen years of age as were thousands of others, many only eighteen... To all horizons was every sort of Landing Craft, escorting warships and the peculiar things for the Mulberry Harbour... The fleet wallowed about in the c. Force 4 wind at 5 knots which was the top speed for us and therefore for everybody else.

The marine Major in charge of the tanks was in our 'wardroom' and fed with us. The rest of the troops existed on the tank deck somehow. They must have been bloody uncomfortable and there was only one lavatory for them with our crew. They had been on board two days and one of the reasons why Eisenhower decided to go was the fact that there was a limit to the length of time the troops could be kept and fed and watered in these confined spaces.

The troops all felt a bit sick. The Major was unable to eat his rather fat pork chops for lunch so I finished them up for him.

On the 6th at 0200 we again experienced difficulties in steering. The engines were overheating, the starboard one in particular. Eventually when we dried out on the beach it was discovered that the sea suction chamber on the port side was full of bundles of electrodes used by welders... We fell out of line and drifted eastwards and dropped our kedge anchor. The stokers worked and got centre and port engines going but we could not keep on course without starboard.

When daylight came we could just see some high ground, I suppose about ten miles away near Le Havre. The fleet on the horizon was heading in a steady stream for the beaches. I flashed up one or two with the Aldis lamp (we were not on any wireless system) "Broken down send tow". The marines were in touch with their squadron and could hear the battle going on. "Can't you get this bloody thing going" they said.

At 1315 the weather was moderating slightly and we tried again but could not hold a course with just two engines.

At 2200 a US tug arrived. The skipper was no ship handler and it took him until 0045 to get us connected in the prevailing weather. We went very slowly otherwise he would have pulled us under and arrived at Bernieres where we anchored. At 1500 our "oppos" LCT 2009 commanded by Lt Stead came and towed us alongside and put us on the beach (Nan White) and we put our load ashore a day and half late. The rest of the Flotilla (103) were lying on the beach where they had landed.'

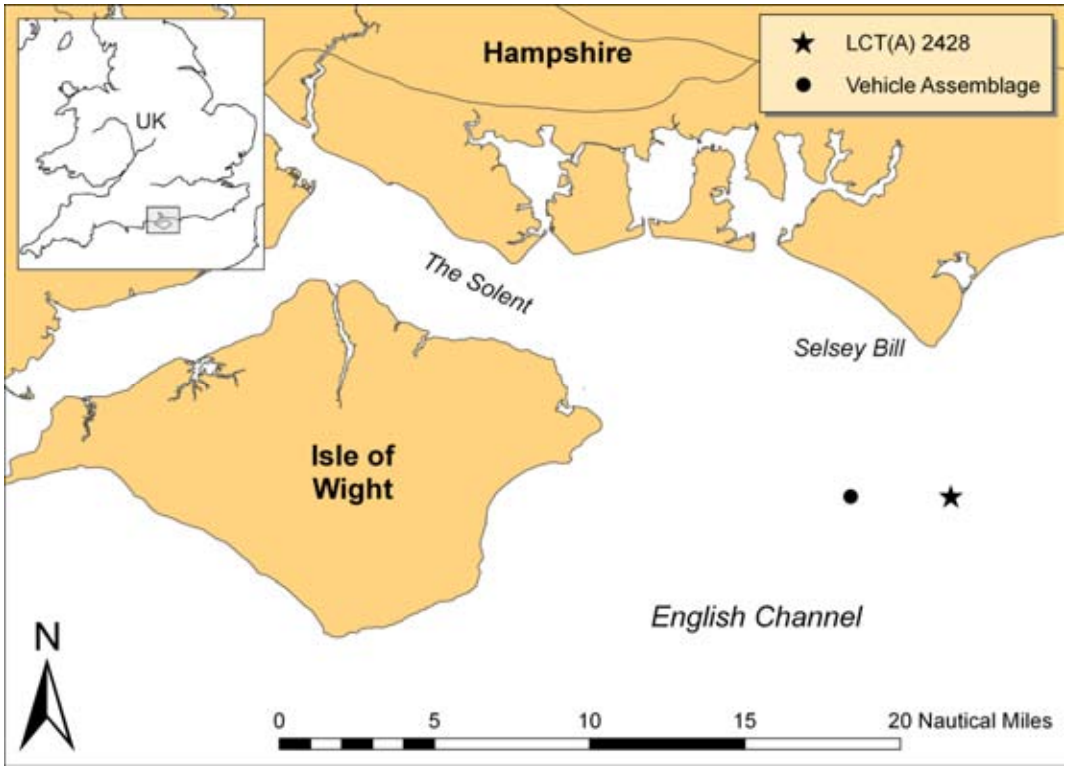

Figure 1.1. Location of LCT(A) 2428 and associated vehicle assemblage.

Figure 2.1. LCT(A) 2237 of the US Gunfire Support Group off Omaha Beach on D-Day, the vessel is carrying two Sherman tanks in the firing position with a tank-bulldozer behind them (Source: Robert Hurst, via www.navsource.org).

Figure 2.2. LCT(CB) 2041 ashore, Norman Vingoe can be seen on the right hand side of the bow ramp (Source: Landing Craft Veterans' Association).

Figure 2.3. Canadian Centaur CSIV Tank on the beach at Courseulles, Normandy, towing a porpoise ammunition sled (Source: Conseil Régional de Basse-Normandie/National Archives of Canada).

Figure 3.1. Open day workshops held at the Royal Marines Museum utilised the HWTMA maritime bus in addition to facilities provided by the Museum.

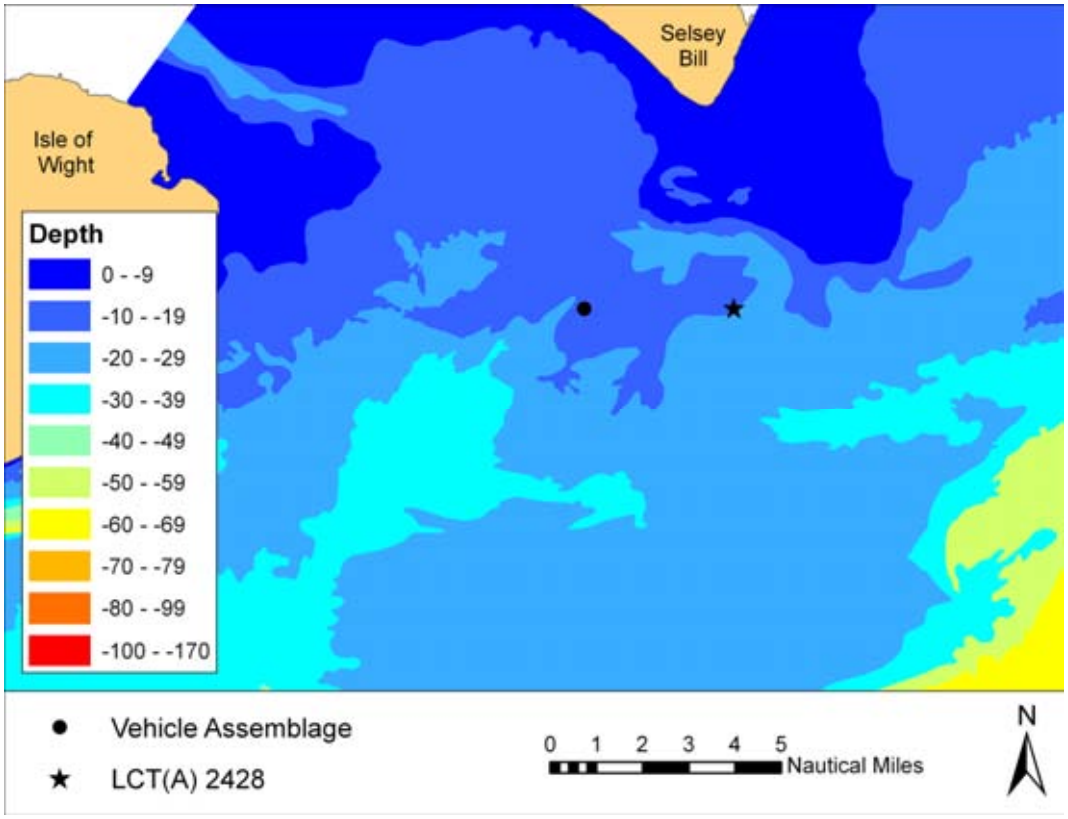

Figure 4.1. Seabed bathymetry for the area surrounding the vehicle assemblage and LCT(A) 2428. Data derived from the British Geological Survey via the South Coast REC.

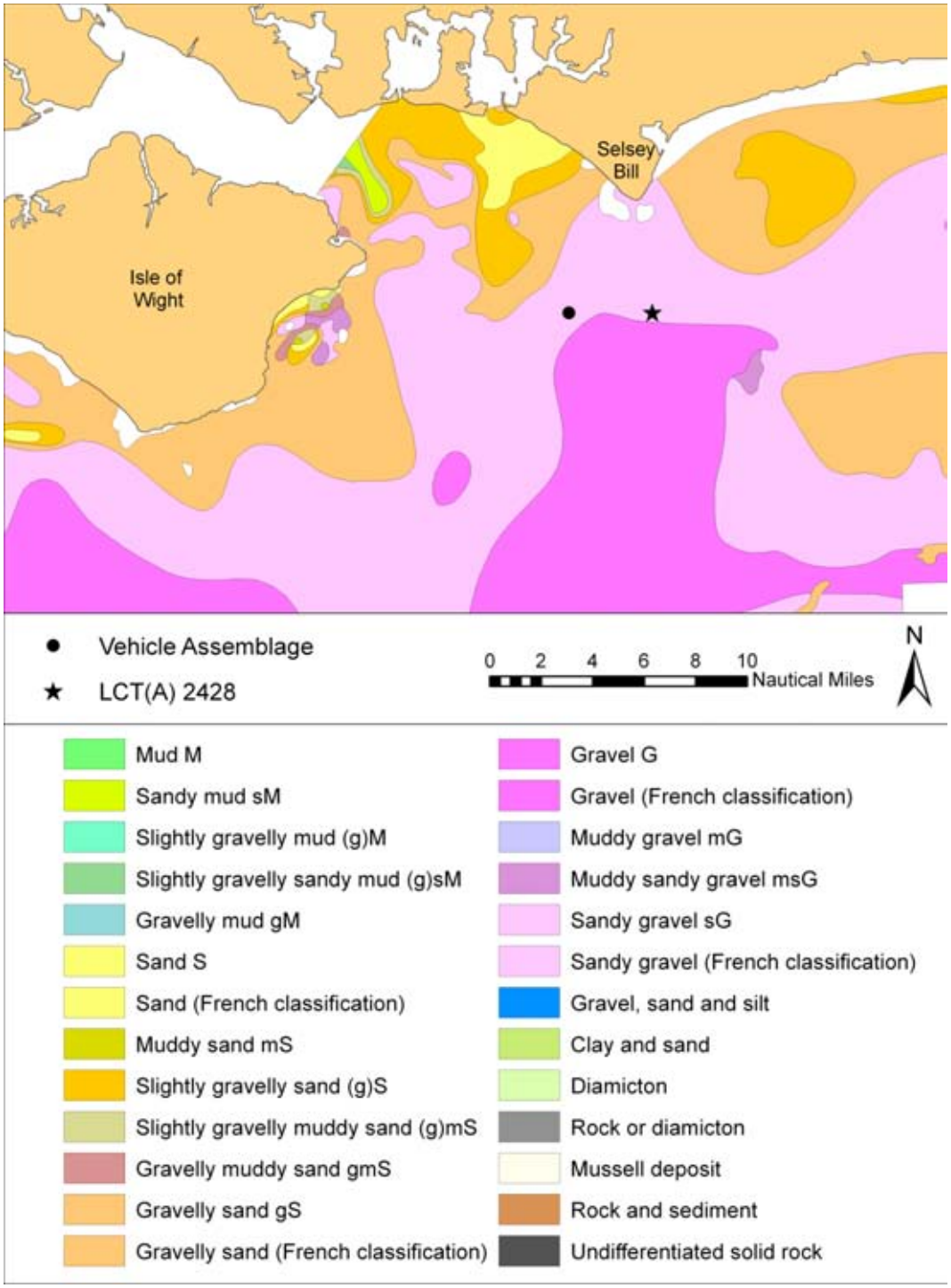

Figure 4.2. Seabed sediment for the area surrounding the vehicle assemblage and LCT(A) 2428. Data derived from the British Geological Survey via the South Coast REC.

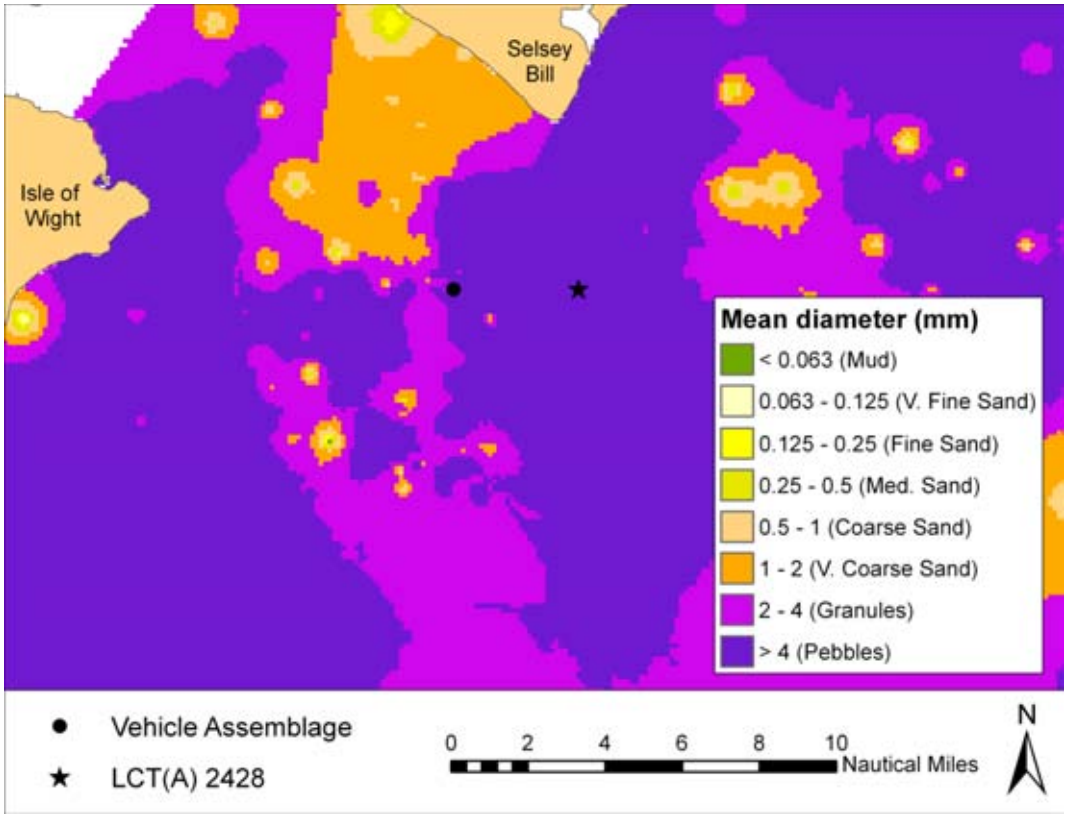

Figure 4.3. Seabed sediment sorting for the area surrounding the vehicle assemblage and LCT(A) 2428. Data derived from the South Coast REC.

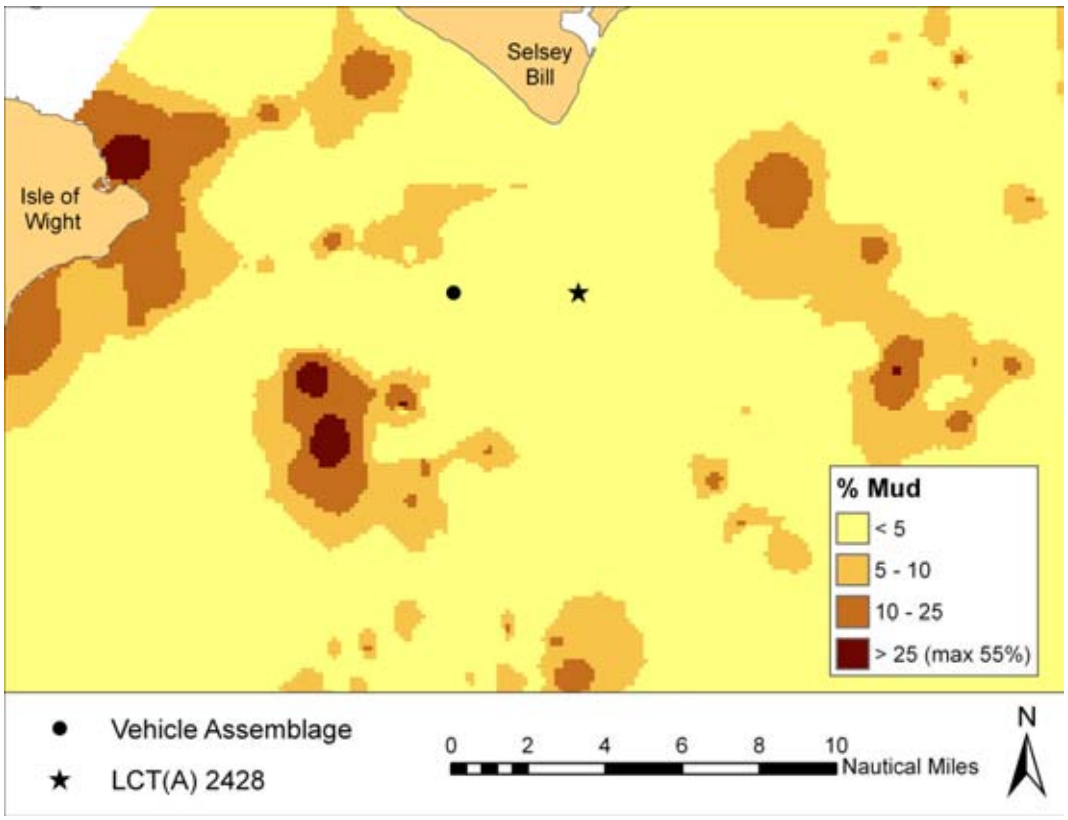

Figure 4.4. Percentage of mud as seabed sediment for the area surrounding the vehicle assemblage and LCT(A) 2428. Data derived from the South Coast REC.

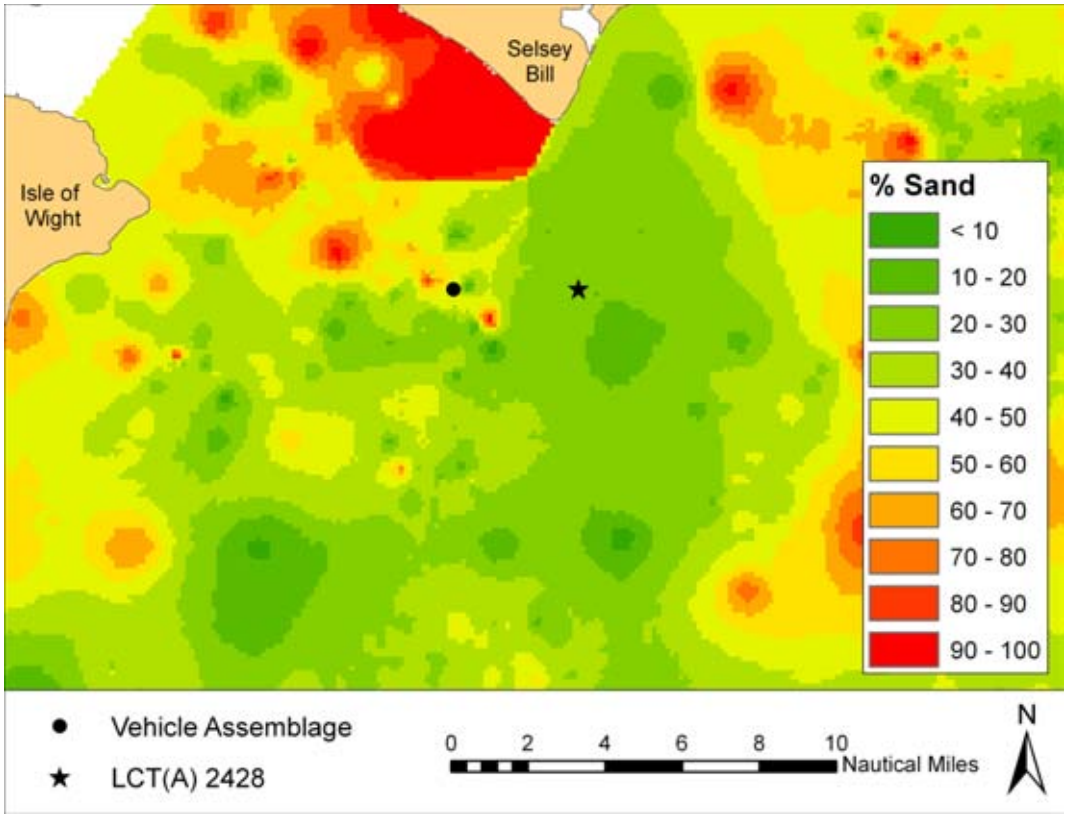

Figure 4.5. Percentage of sand as seabed sediment for the area surrounding the vehicle assemblage and LCT(A) 2428. Data derived from the South Coast REC.

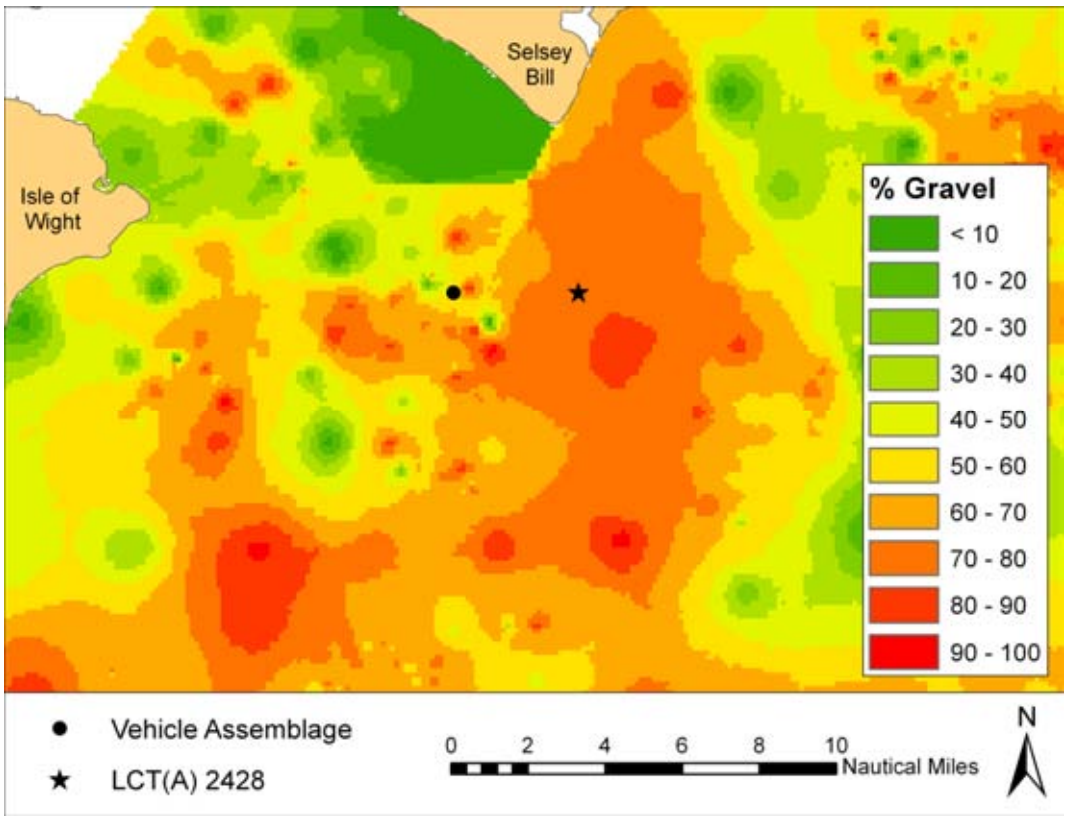

Figure 4.6. Percentage of gravel as seabed sediment for the area surrounding the vehicle assemblage and LCT(A) 2428. Data derived from the South Coast REC.

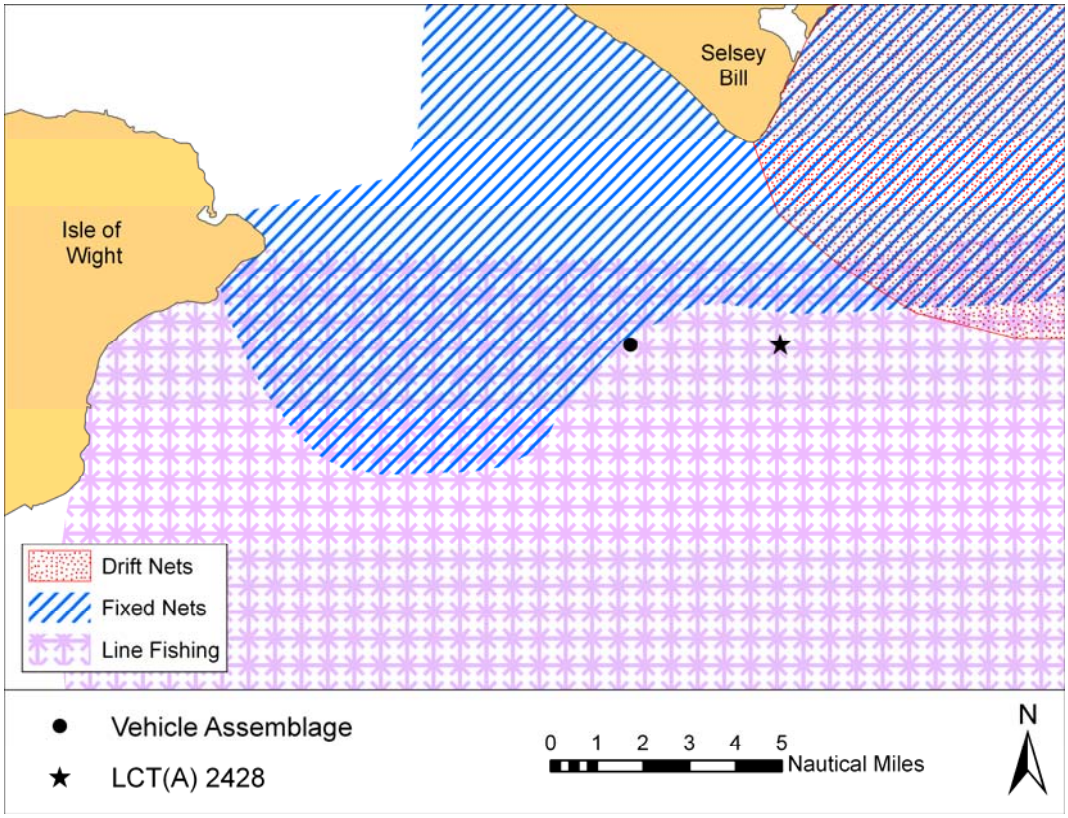

Figure 4.7. Potential areas of Net or Line fishing for the waters surrounding the vehicle assemblage and LCT(A) 2428. Data derived from CEFAS via the South Coast REC.

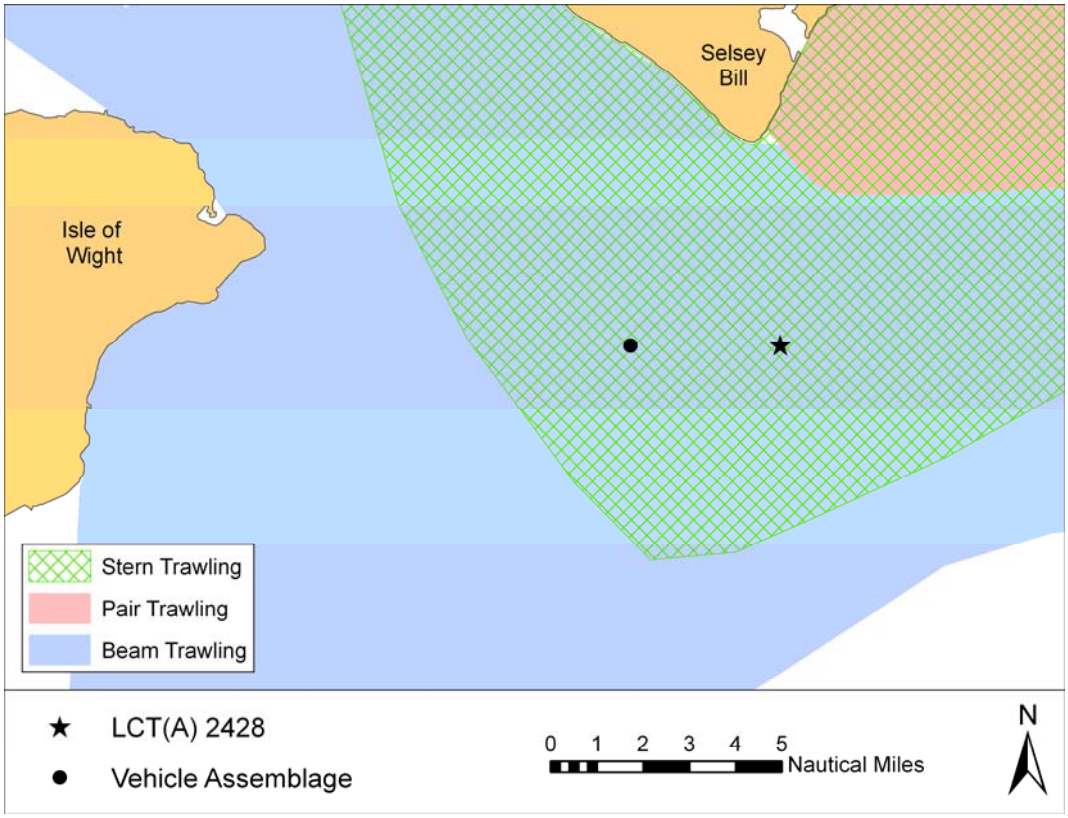

Figure 4.8. Potential areas of Trawling for the waters surrounding the vehicle assemblage and LCT(A) 2428. Data derived from CEFAS via the South Coast REC.

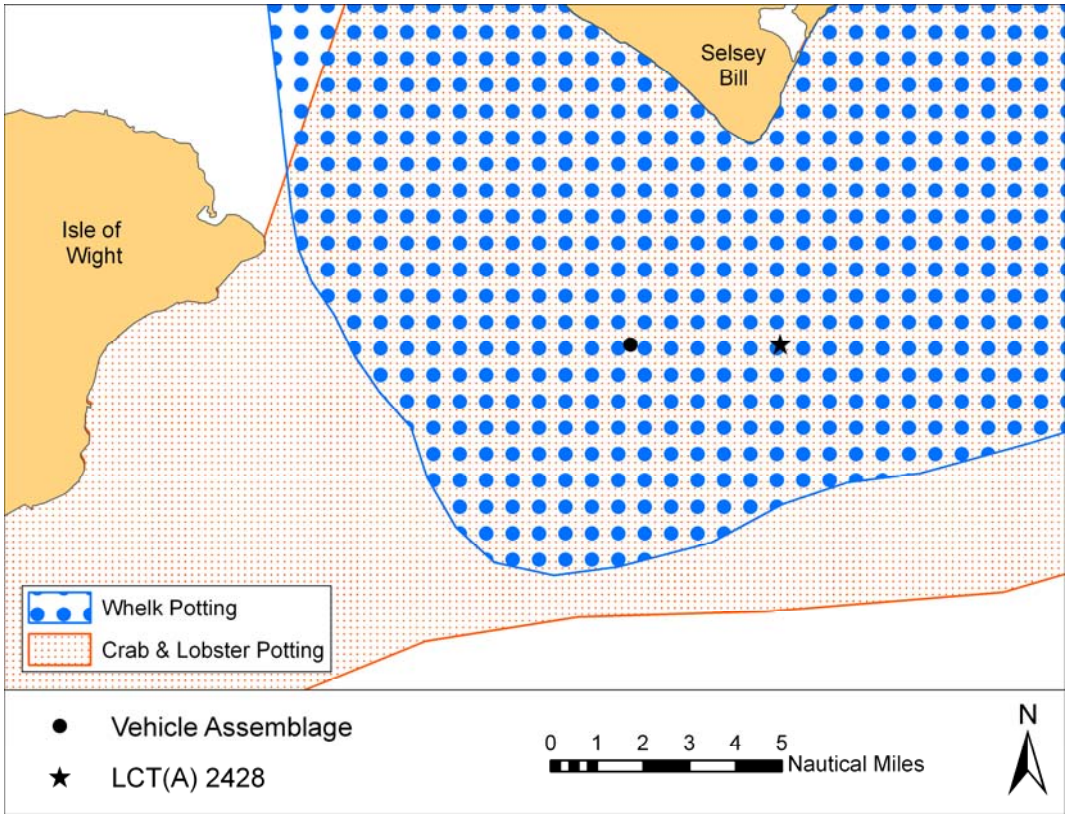

Figure 4.9. Potential areas of Potting for the waters surrounding the vehicle assemblage and LCT(A) 2428. Data derived from CEFAS via the South Coast REC.

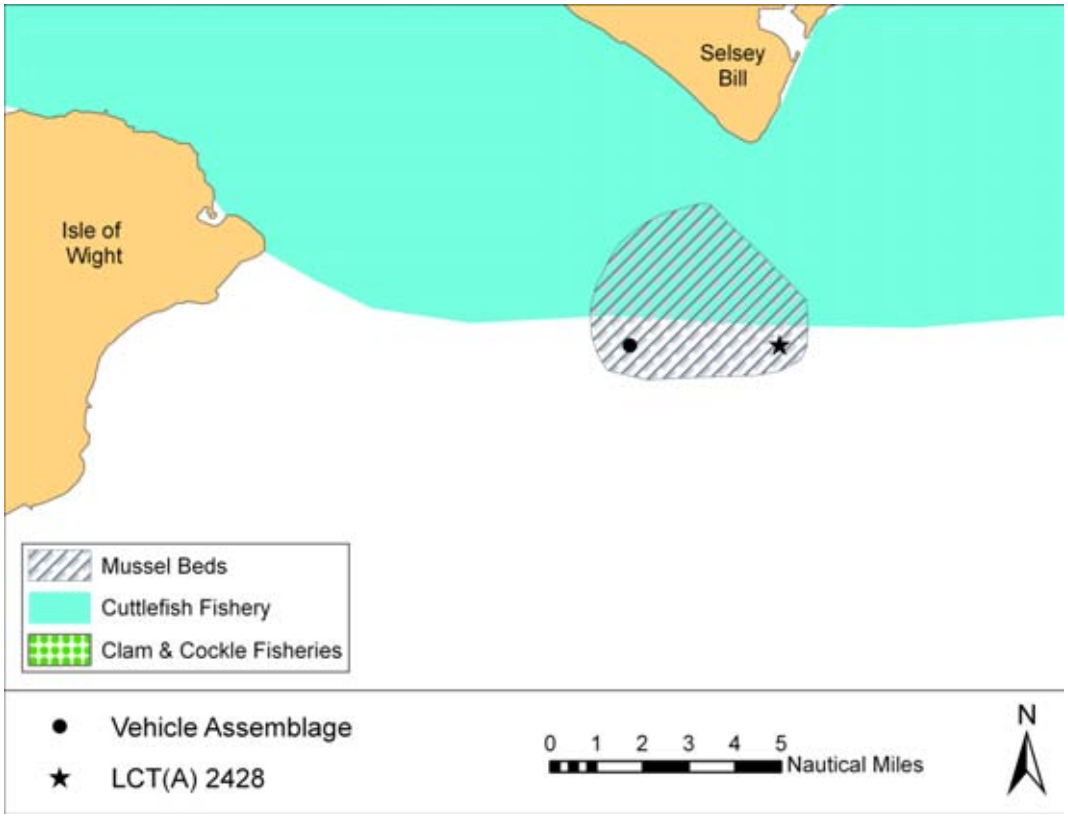

Figure 4.10. Potential areas of Shell Fisheries for the waters surrounding the vehicle assemblage and LCT(A) 2428. Data derived from CEFAS via the South Coast REC.

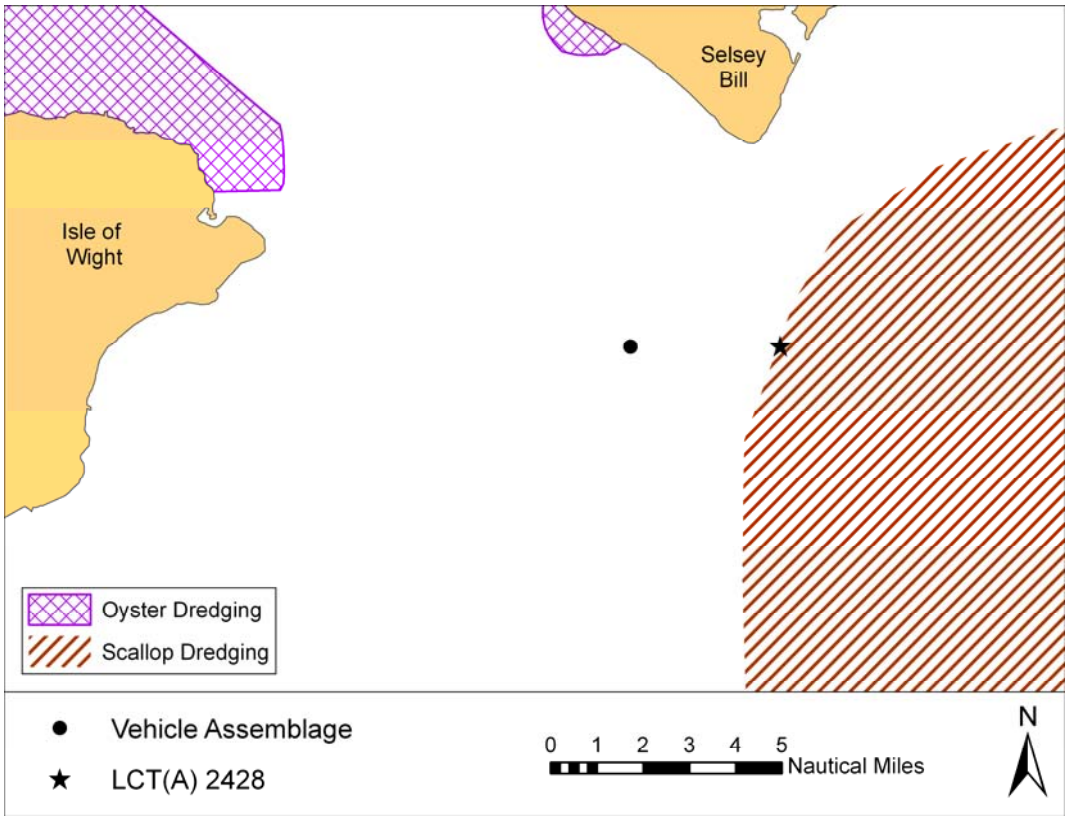

Figure 4.11. Potential areas of Shellfish dredging for the waters surrounding the vehicle assemblage and LCT(A) 2428. Data derived from CEFAS via the South Coast REC.

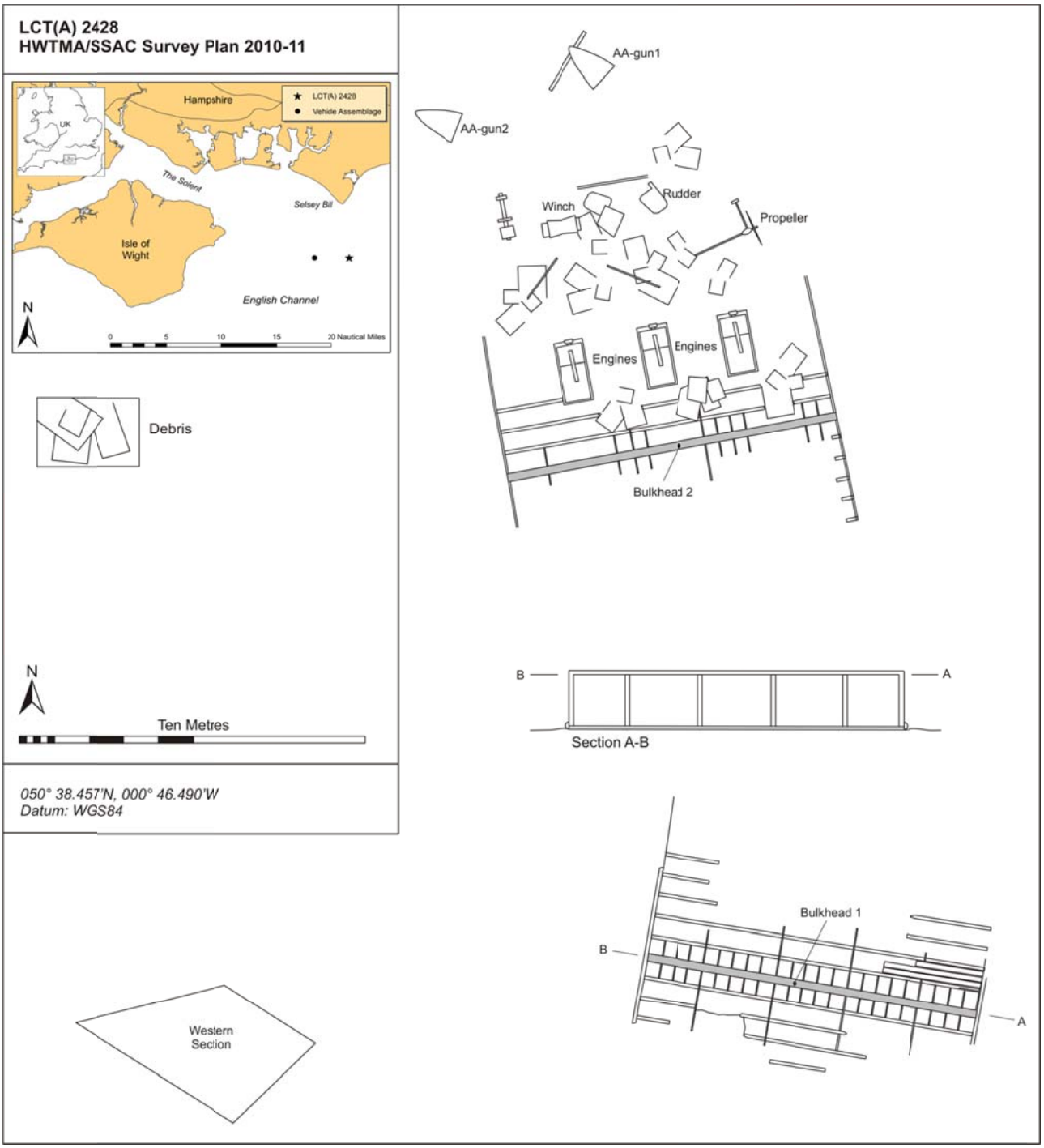

Figure 4.12. Overall site plan of LCT(A) 2428.

Figure 4.13. General view of the southern section of remains and bulkhead 1, further framing, originally on the underside of the deck is visible in the foreground (Source: HWTMA).

Figure 4.14. Pipe fender running along the side of the vessel at bulkhead 1 (Source: HWTMA).

Figure 4.15. The southern extent of the vessel remains, including the broken edge of the vessel's deck, seen from the underside (Source: HWTMA).

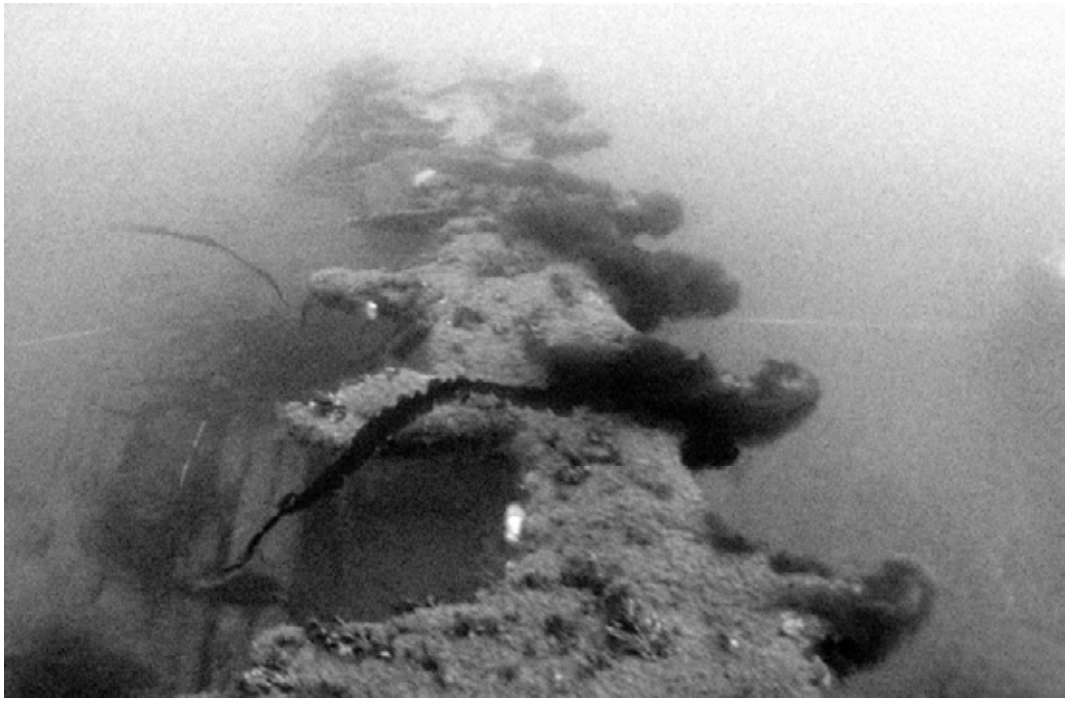

Figure 4.16. The upper face of bulkhead 1, with remnants of what was formerly the bottom of the landing craft (Source: HWTMA).

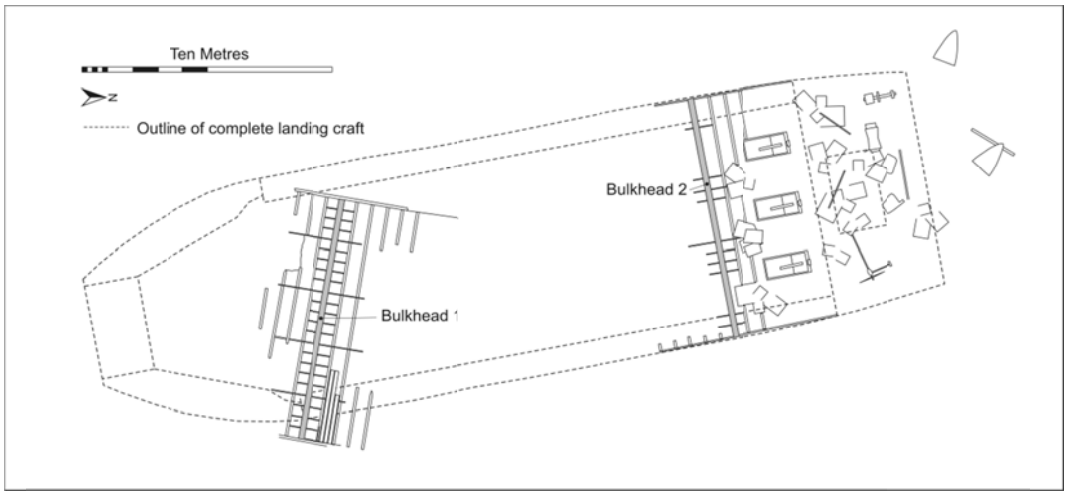

Figure 4.17. Current site extent/remains, overlaid on the outline of an LCT MkV, to illustrate the extent of lost structure.

Figure 4.18. Concreted remains of an engine block, scale: 50cm (Photo: Jim Fuller, SSAC).

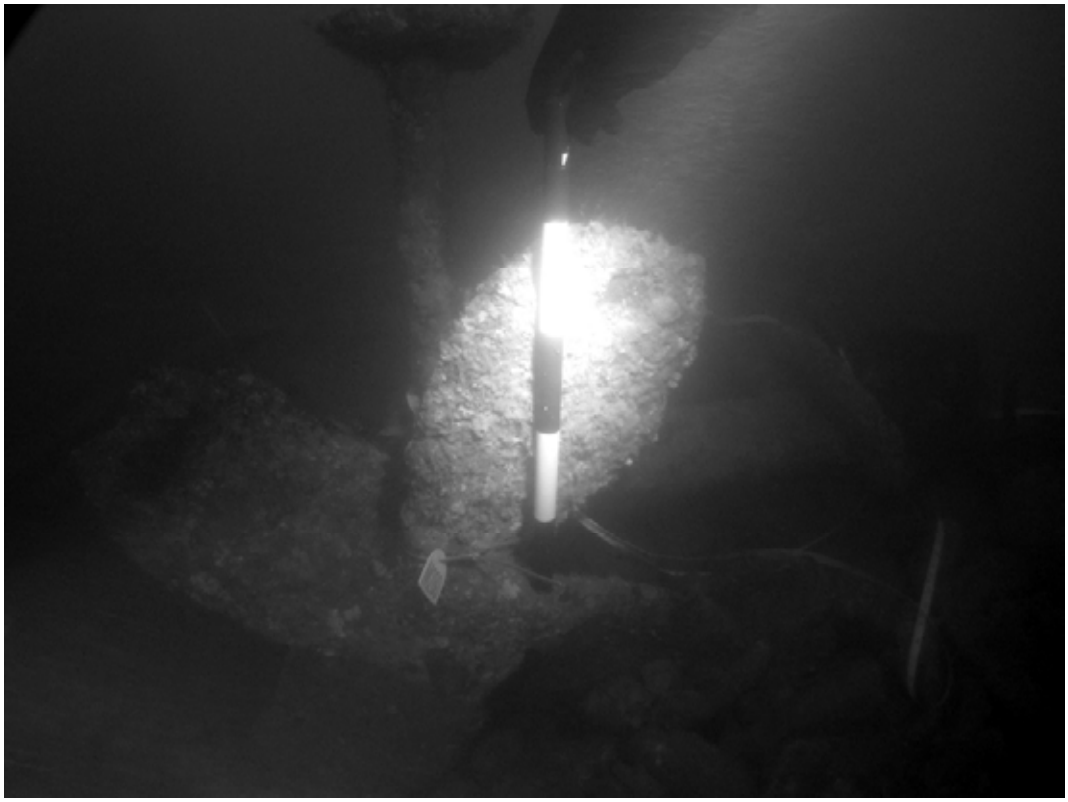

Figure 4.19. Surviving propeller in-situ, monitoring tag M280 is visible attached to the centre of the propeller, scale: 50cm (Photo: Jim Fuller, SSAC).

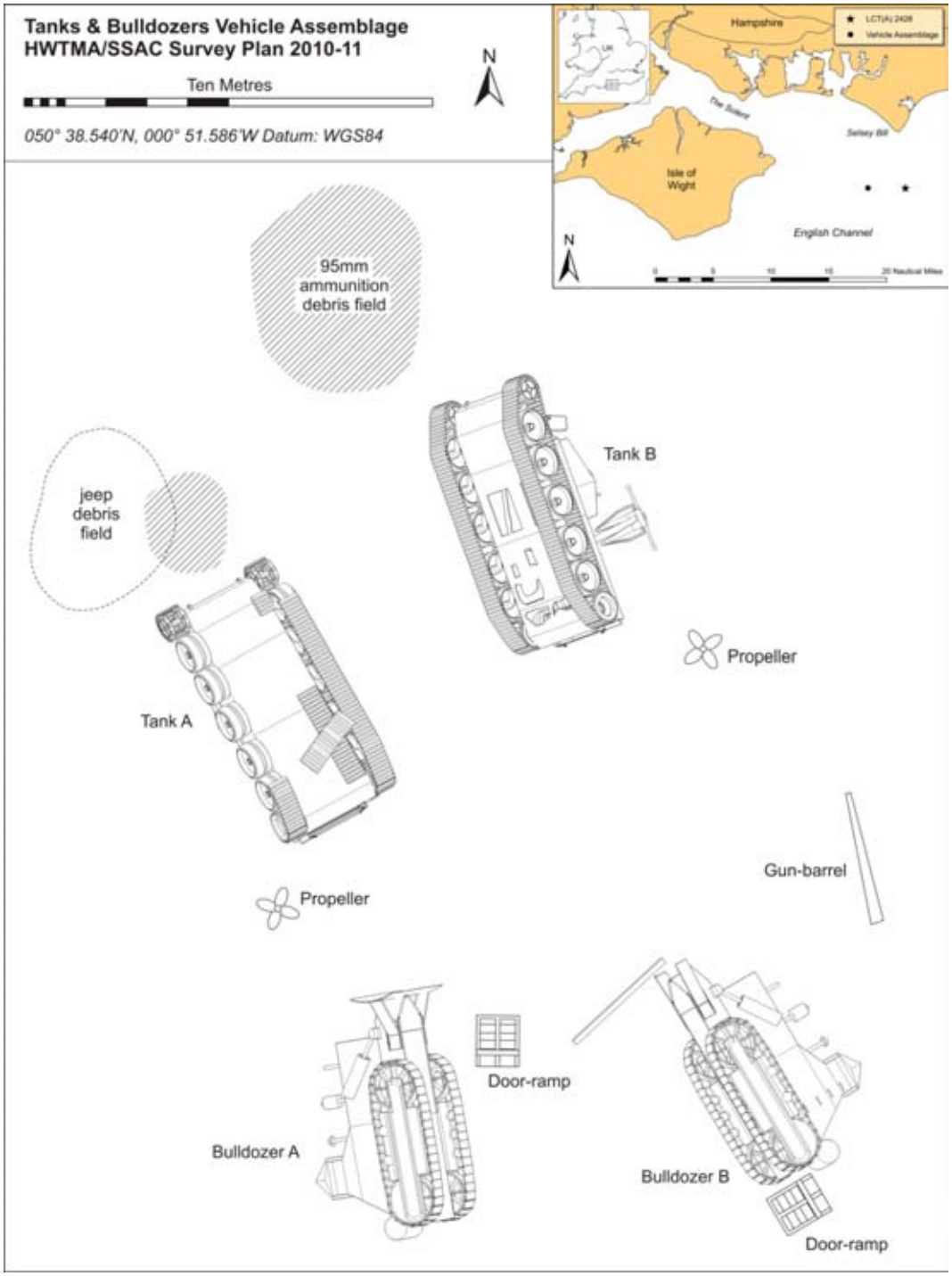

Figure 4.20. Overall site plan of the Tanks and Bulldozer vehicle assemblage.

Figure 4.21. Tank A, viewed from the north (Image: Martin Davies, SSAC).

Figure 4.22. Tank B, viewed from the north-east (Image: Alison Mayor, SSAC).

Figure 4.23. Bulldozer A, viewed from the west (Image: Martin Davies).

Figure 4.24. Bulldozer B, viewed from the north (Image: Alison Mayor, SSAC).

Figure 4.25. Kedge anchor lying underneath the eastern side of Tank B (Image: Martin Davies, SSAC).

Figure 4.26. Heavily degraded remains of a jeep.

Figure 4.27. Remains of 95mm ammunition, located to the north of the tanks.

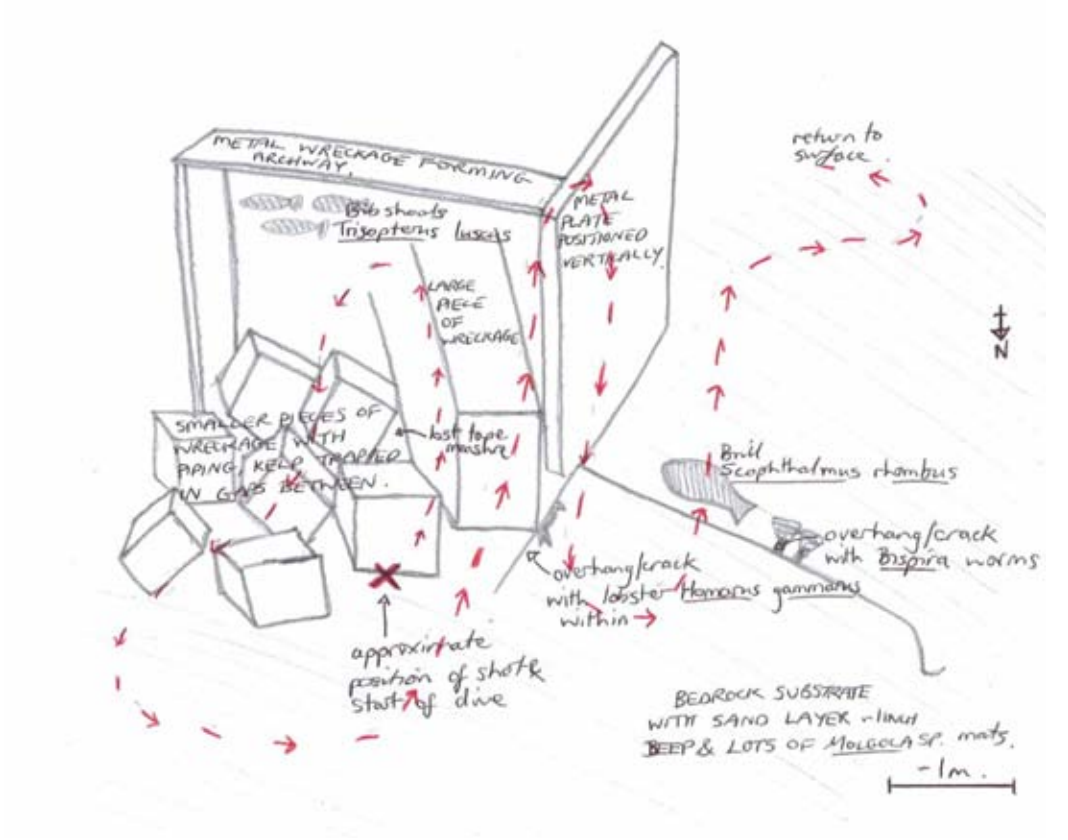

Figure 4.28. Sketch diagram showing the approximate route taken by divers during biological survey of the Landing Craft Tank site (Courtesy HIWWT).

Figure 4.29. Bispira volutacornis, *double spiral worm (Image: HIWWT).*

Figure 4.30. Actinothoe sphyrodeta*, white-striped/fried egg anemone (Image: HIWWT).*

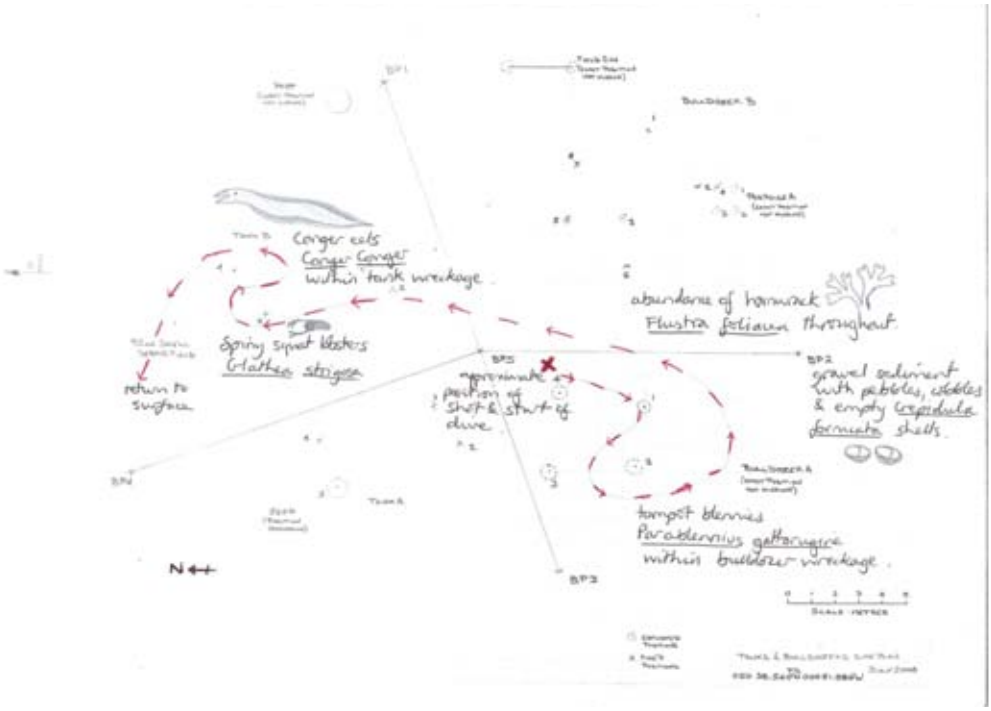

Figure 4.31. Sketch diagram showing the approximate route taken by divers during biological surveys of the collection of armoured vehicles (Courtesy HIWWT).

Figure 4.32. Hemimycale columella*, crator sponge* (Image: HIWWT)

Figure 4.33. Parablennius gattorugine, *tompot blenny (Image: HIWWT).*

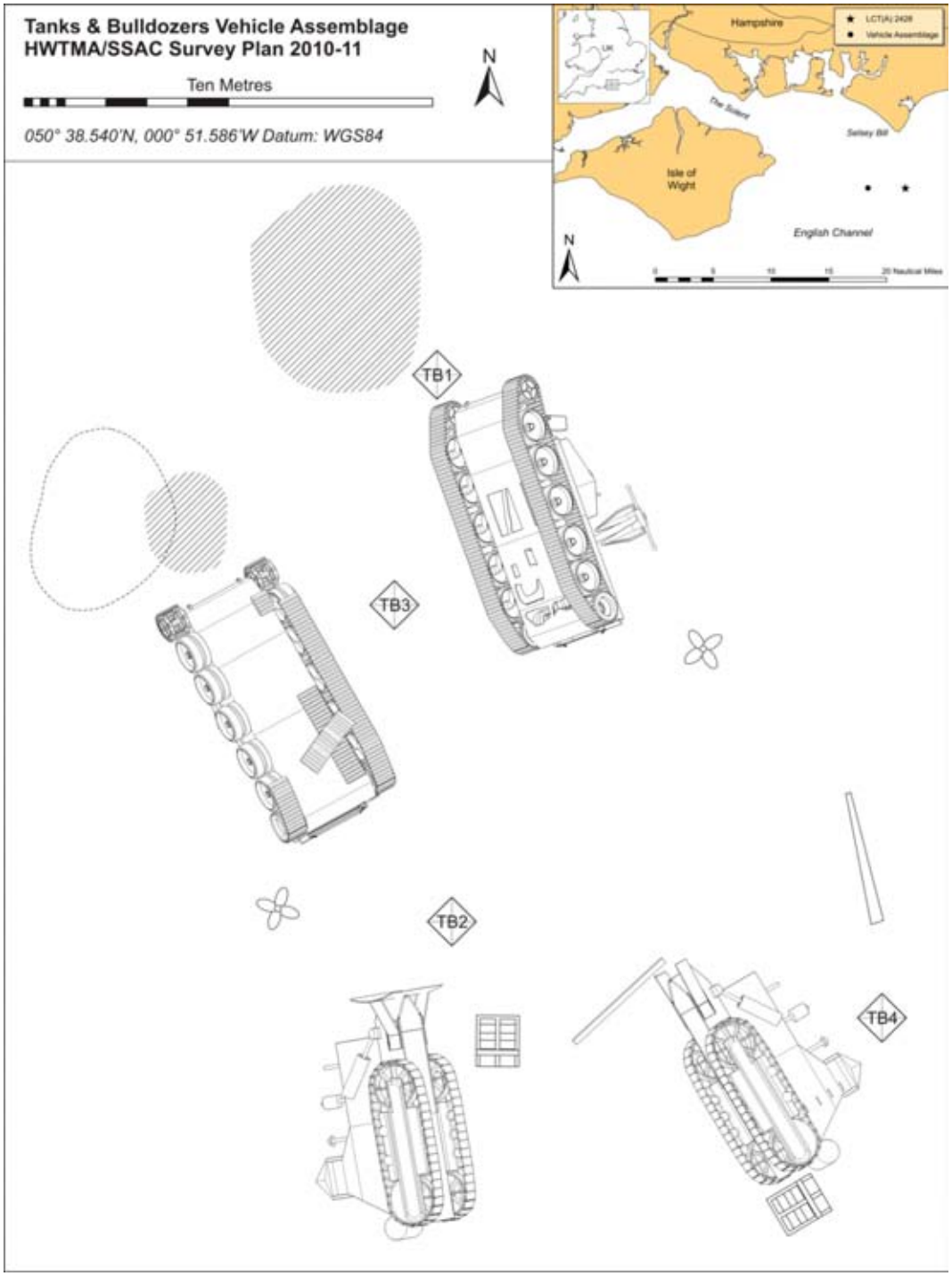

Figure 5.1. Location of monitoring points on the Tanks and Bulldozer vehicle assemblage.

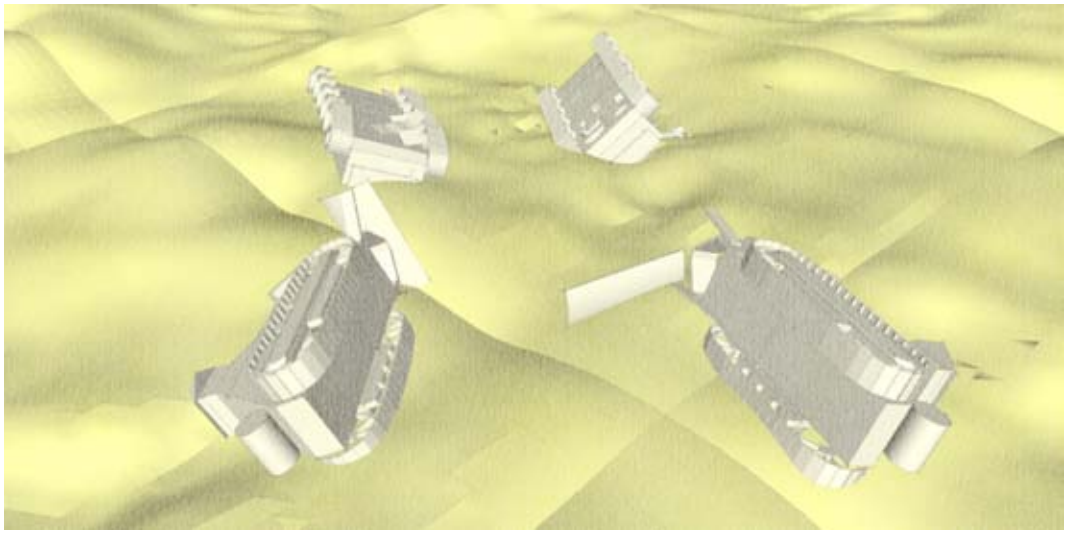

Figure 5.2. Isometric view of the vehicle assemblage site, resulting from creation of 3D site plan.

Figure 5.3. Example of virtual viewpoint on the vehicle assemblage site. Top: Tank B seen from monitoring point TB01. Bottom: Diver viewpoint from comparable position in average visibility.

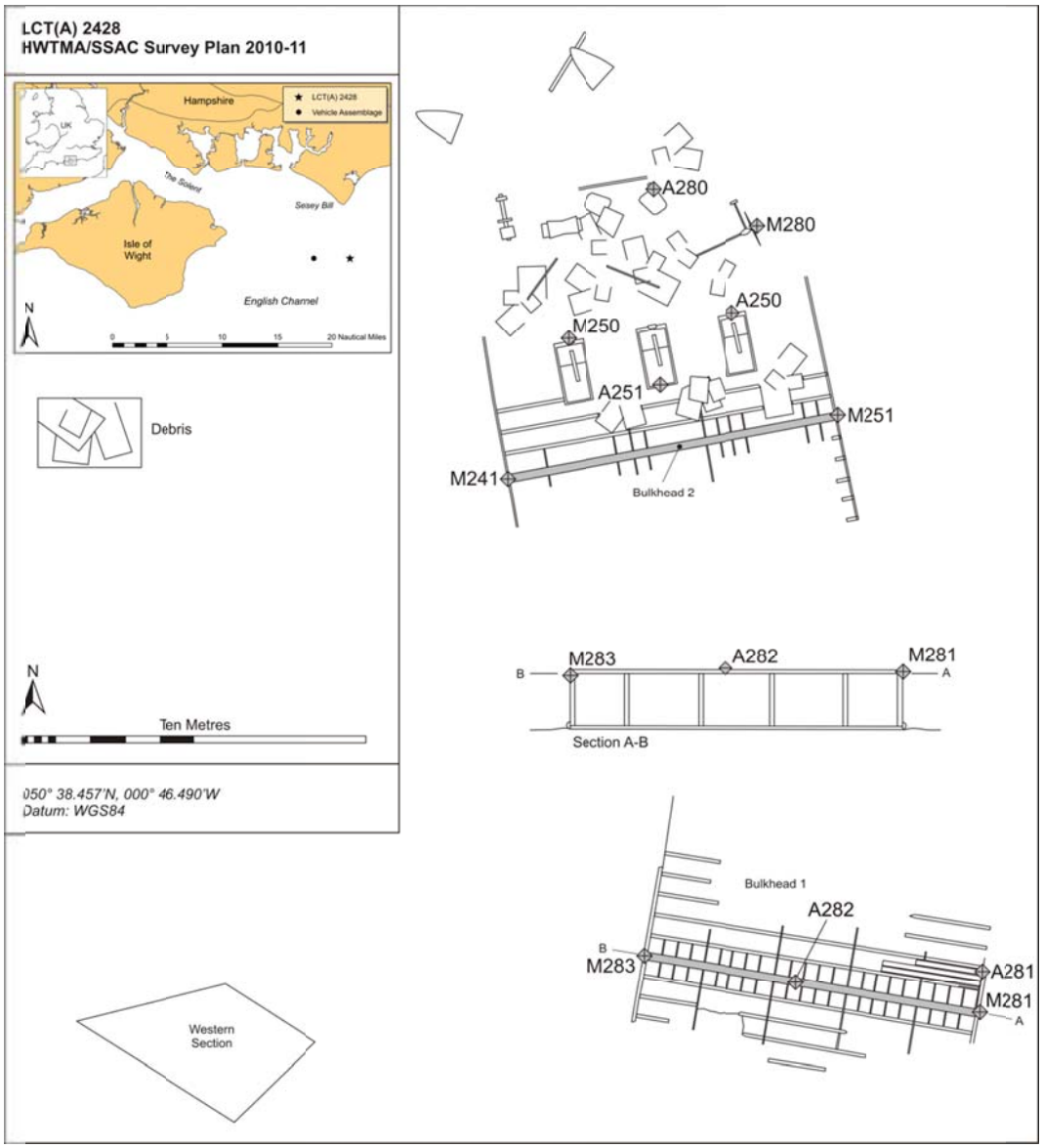

Figure 5.4. Location of monitoring points on the LCT site.

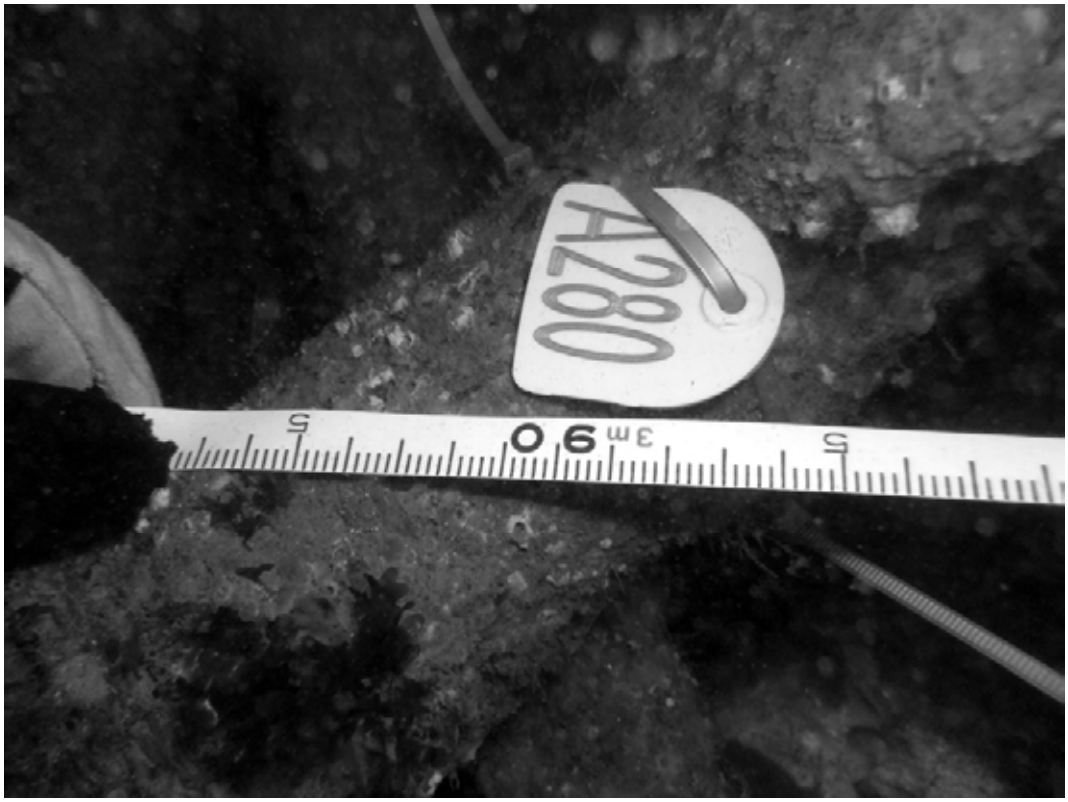

Figure 5.5. Monitoring point A280, one of the probable rudders of the vessel (photo: Alison Mayor, SSAC).