

The Maritime Archaeology of Duplex Drive Tanks in the United Kingdom

Thomas Cousins

Bournemouth University, UK
tcousins@bournemouth.ac.uk

Thomas Harrison

MSDS Marine, UK
tom@msdsmarine.co.uk

Dave Parham

Bournemouth University, UK
DParham@bournemouth.ac.uk

Abstract

The catastrophe at Dieppe in 1942, where unsupported infantry attempted to capture a fortified beachhead, showed the allied forces how difficult such a venture was. As part of the invasion plan for what became Operation NEPTUNE or the Normandy landings, the allied staff saw the need for armoured support for the first waves of troops ashore. This need evolved into the concept of 'swimming tanks' that would land a few minutes ahead of the first infantry waves. The development of such a weapon was undertaken in conditions of absolute secrecy in the UK from late 1942 onwards. This secrecy led to the destruction of much of the historical records that relate to these armoured vehicles, leaving a confused and largely unknown record of what was an important aspect of WWII.

This project sets out to record the known examples of such vehicles on the coast of the UK including a group lost as part of 'Exercise SMASH', the largest live ammunition exercise of the war, a full scale beach assault training exercise with all supporting arms including amphibious tanks. Though six tanks were lost during the exercise in conditions, which are not fully understood, the loss led to the changing of the operational plans for D-Day.

Using archaeological and historic data, this project offers an alternative interpretation for these losses and provides a better understanding of their subsequent impact on Operation NEPTUNE.

Keywords

World War II, D-Day, Duplex Drive Tanks, Exercise SMASH

Introduction

In late 1941, following the Japanese attacks on Pearl Harbour, Hitler and Mussolini declared war on the United States (Belcham 1981: 10; Doherty 2011); in response, under Prime Minister Churchill and President Roosevelt, the American and British forces formed an alliance. Although differences arose in their ideas, their defining decision was the large scaled assault of Europe to defeat Germany, launched from the British coast when the time was right (Belcham 1981: 10; Doherty 2011). The British Combined Services Committee (BCSC) was formed to study methods of gaining access to Europe, as by 1942 Nazi Germany had control over much of Europe. During the Nazi occupancy of France, Hitler had also ordered the construction of the 'Atlantic Wall'. This series of coastal defences running along the Channel coastline were constructed between 1942 and 1945, for the purpose of preventing amphibious invasions (Anderson 2010: 61–63). With France being a

short distance across the Channel, the allied forces also needed to pre-empt an invasion of mainland Europe to meet the now advancing Soviet army to the east of Germany. Furthermore, Stalin was keen for the allied forces to create a western front, relieving some of the pressure Germany was putting on the Soviet armies.

In response, Churchill and Roosevelt devised the largest and most complex invasion ever to take place, Operation OVERLORD. The plan was to land forces on the northern French coasts, liberate France, then push towards Germany. The invasion, which was to take place on the Normandy beaches, was named Operation NEPTUNE and was described by Churchill as 'the most difficult and complicated operation that has ever taken place' (Winter 2014: 2).

During the planning of the landings on what became known as 'D-Day', the vast scale of the task at hand meant that invaluable cooperation was needed from

all of the armed forces including resources and specialist equipment. Armoured units were needed to eliminate the German defences along the Normandy beaches, otherwise high casualties among the infantry would prove unacceptable. During the earlier landing at Dieppe in August 1942, a force of c. 6000 British, Canadian and US infantry was landed suffering heavy casualties (Thompson 2011: 38). There, the infantry was supposed to be supported by the Canadian 14th Army Tank Regiment with their new Churchill tanks; these were late arriving, leaving some of the infantry unsupported and exposed to German machine gun fire (Poolton 1998: 38). Driving the landing craft loaded with tanks up to the beach resulted in the Churchill tanks getting stuck in the shingle beach, with two landing craft reported to have sunk as a consequence of this. Those tanks that made it over the sea wall were prevented from progressing further due to a mass of anti-tank obstacles. The losses were very high, with 60% of infantry being either killed or captured (Thompson 2011).

The failed raid at Dieppe in 1942 led to the formation of the 79th Armoured Division, later known as the 'Hobart Funnies,' in October 1942 under the command of Major-General P.C.S. Hobart. At this time the Duplex Drive (DD) units consisted of the 27th armoured brigade, which itself consisted of the 13th/18th Hussars, 4th/7th Dragoon Guards and the East Riding Yeomanry, and the infantry of 285th brigade. In April 1943, Hobart's division was reformed as the only division in the British army made up of just specialised armoured units (Anon 1945: 9). A series of vehicles designed for specific roles during the invasion, including Bridge laying, minesweeping, flamethrowers and swimming tanks were all developed and extensively tested (Anderson 2010: 223; Anon 1945: 31). A key feature was the Duplex Drive system (DD) i.e. having a transfer box within the gears that switch power from the tracks to a single three blade propeller. The novel idea of these inventions was that they were armoured engineering machines, able to assist troops and other vehicles across and off the beaches as quickly as possible. To ensure their success the special vehicles had to be kept under extreme secrecy, for example the DD tank does not appear in the normal A.F.V. schedules (AVIA22/456). Additionally, the destruction of records was ordered in some cases, 'All papers concerning Exercise SMASH will be destroyed after the final conference' (WO199/2320). This high level of secrecy was maintained throughout the build-up to D-Day (Anon 1945).

Development

Nicholas Straussler was a boat builder specialising in floatation devices. He began working for Vickers-Armstrong designing tank accessories. The idea of

amphibious tanks had been studied by several nations prior to the war (Fletcher 2006: 3). Many concepts were devised but Straussler eventually broached the idea of Duplex Drive swimming tank. The Duplex Drive tank works by having a transfer box within the gears that switch power from the tracks to a single three-blade propeller (two propellers on the later Sherman tanks) (Anderson 2010: 23). Flotation being provided by a canvas screen erected using compressed air filled tubes, given shape by a series of tubular supports running around the circumference of the tank (Doherty 2011: 51; WO185/66). Once the tank has 'swum' ashore after leaving its transport the Landing Craft Tank (LCT) at sea, the drive reverts to the tracks and the screen is lowered and propeller(s) raised (Fletcher 2006; WO185/66).

The British took on the idea of Duplex Drive (DD) tanks and Straussler was provided with an 8-ton Tetrarch Mk VII from the 1st Armoured Division in July 1940 to begin work on his prototype (WO185/66; AVIA22/1522). The Tetrarch prototype was fitted with an outboard motor for propulsion, technically making it not a DD tank. The resulting prototype was trialled around the Brent Reservoir in June 1941, and in September the Tank Board agreed Straussler's design would be applied to the Vickers-Armstrong Valentine and later the Sherman tank (Fletcher 2006: 6-7; WO185/66; AVIA22/1522).

On 6 July 1942, the first order for 450 sets of DD equipment was made prior to the seaworthiness trials due to the equipment being a 'matter of great urgency' (WO185/66). The DD tanks were all placed under the command of Hobart's division (Anon 1945: 9). Hobart began his career in 1904, a Royal Engineer throughout the First World War, his career continued through to the end of the Second World War. He was described as a determined leader who the war office received countless comments about as being 'impossible to work with' (Macksey 1967: 12). Nonetheless he was a devoted patriot with high expectations and a sense of urgency, an inspiration and irritation (Duncan 1972: 1). After transferring to the Royal Tank Corps in 1923 he was responsible for the training of some of the best known and most successful armoured divisions of the Second World War including the 7th Armoured Division, better known as the Desert Rats, the 11th Armoured Division, acknowledged as the best British armoured unit in Europe and the creation of one of the most important aspects of success on D-Day, the 79th Armoured Division (Macksey 1967).

While the DD tanks would not directly operate under the 79th Armoured Division, Hobart would be responsible for the training (Doherty 2011: 51). Most training in Britain took place using Valentine tanks and Hobart eventually trained ten regiments from Britain, Canada and the United States (Anon 1945: 9; Fletcher 1984: 23).

By the time D-Day was approaching the light Valentine tank had become out-dated compared to other allied and German tanks, both in terms of firepower and armour (Fletcher 1984: 23). The Sherman tank had become the main battle tank of the allied forces during 1943 and was the most obvious choice for conversion. While both vehicles could be made to float, the most notable difference was the additional propeller found of the Sherman DD thus increasing its power. The canvas screen on the Valentine was double thickness for support and to help prevent puncturing although once the DD equipment was adapted for the Sherman tank, the lower section was increased to triple thickness to help maintaining seaworthiness (Doherty 2011: 56). The forward position of the turret on the Valentine meant that the gun had to face the rear to raise the screen; the Sherman tank turret could remain facing forward while the screen was raised, allowing it to come into action much quicker.

Training

Extensive testing and training was conducted in the development of the equipment in the build-up to D-Day at sites around Great Britain, including Castle Toward and Moray Firth, Linney Head, Gosport, Westward Ho!, Bridlington, Slapton Sands, and Studland Bay. Freshwater training was also conducted including Fritton Lake in Norfolk (Doherty 2011; Fletcher 2006; Hills 2003). Trials involved launching and landing practice, live firing landings, seaworthiness, and exposure to small arms fire.

The first stage of DD tank training took place at Fritton Lake (also known as Decoy Lake) which was owned by an admiral who gave the army permission to turn it into the freshwater DD training school known as 'A' wing (Delaforce 1988: 66; WO166/10710). Tank parks and workshops were rapidly built—one of the earliest installations being dummy landing craft ramps to practice deployment from, swimming in offensive lines, along with the varying steepness of the lake's banks providing exiting practice (Macksey 1967: 250). The 79th Armoured Brigade started their freshwater training wing at Fritton Lake on 8 June 1943 upon the closing of Narford Lake where initial trials occurred (WO166/1096; WO166/10710).

The main saltwater training school was 'B' wing at Gosport. Upon the opening of 'B' wing on 1 November 1943, the 79th specialist saltwater training school for the use of DD tanks, under the command of Colonel Nigel Duncan was based here. Based at Stokes Bay, the Solent offered many different landing beaches within near reach, and there are several mentioned during training and exercise. There is evidence to suggest landings at Osborne Bay and Barton Head on the Isle of

Wight, as well as further landing sites at Hayling Island, Bracklesham Bay and Littlehampton during Operation FABIUS. FABIUS was the final and largest rehearsal for D-Day, taking place over several days at the end of April and beginning of May 1944 (WO199/1396).

Hobart and his team of instructors successfully put ten Divisions through the saltwater school prior to the D-Day landings. The training was intense and covered all possible eventualities and is what made Hobart and his 79th division so well known. While at 'B' wing the tank crews would practice vehicle maintenance, launching and swimming practice at all times of day and night. During the operation of 'B' wing over 30,000 launches were conducted with the known loss of only one tank (Anon 1945: 15; Daniels 2003: 25; Delaforce 1998: 67; Doherty 2003: 57).

Full-scale exercises took place to prepare for the complex coordination required to make the D-Day landing a success. Rehearsal exercises were high risk in terms of German intelligence, the rehearsals involving the army infantry, navy bombardment and the air force. Exercises such as Operation FABIUS, SMASH and the American rehearsal Operation TIGER at Slapton Sands ended in huge loss of life after a German E-boat attack prior to the exercise (Manousos 2014; Zaloga 2012: 18).

Studland Bay

Studland Bay was used on occasion as opposed to the B wing training school further along the coast in the Solent. There the 4th/7th Dragoon Guards gave a full demonstration of LCT loading procedures on 11 and 12 December 1943 in front of Hobart upon completion of their training at B wing (WO166/11070). This was the first time that a complete unit of DD tanks was launched from LCT at once (WO205/750). During this trial the tanks were launched from 1500 yards (c. 1400m) instead of the planned 3,000 yards but it reads that all tanks landed with two minor mechanical breakdowns (WO205/750). The memo goes on to say that 'from a technical point of view this exercise proves conclusively that the DD tank is a very formidable new weapon' (WO205/750). The main lesson learnt here was that the most dangerous period for the DD tank is its launch from the LCT (WO205/750). Studland Bay also had several other functions in relation to the DD tanks. By 20 December 1943, three 'hards' (ramps used for the loading of LCT's and other landing craft types) had been constructed for the 3rd Canadian Division to carry out exercises (WO205/749). Further trials to take place at Studland included driving a DD Sherman through a simulated flame barrage attack known as Project FOUGASSE (Petroleum Warfare Material 1943) This involved setting fire to oil on the sea, then the DD drove through the flames unharmed using a device called a

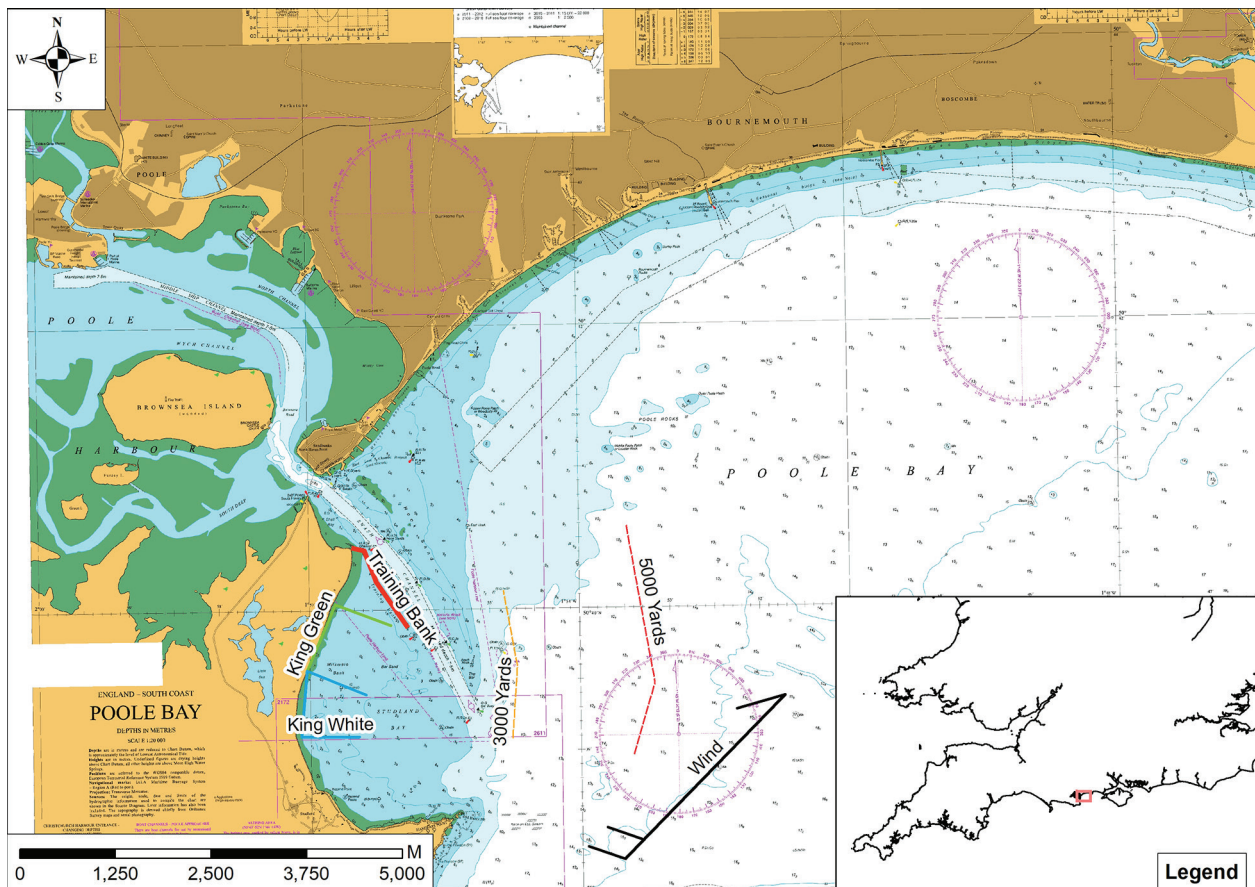


Figure 1. The positions and headings of the tanks in relation to the landing beaches of King White and Green (© Crown Copyright/SeaZone Solutions). All Rights Reserved. Licence No. 052006.001 31st July 2011. Not to be used for Navigation.

Belch that would suck up seawater and then squirt it over the canvas skirt (Doherty 2011: 54; Fletcher 2006: 24, 34; Fletcher 1984: 21). Studland Bay then became best known for exercise SMASH—one of the biggest live firing rehearsals of the Second World War.

Exercise SMASH I

Exercise SMASH was the code name given to a series of live fire beach assault training exercises taking place between 3 and 23 April 1944 in preparation for the Normandy landings on 6 June 1944. The first of these exercises was codenamed SMASH I.

Like D-Day itself 'SMASH I' was postponed by 24 hours due to the weather, eventually taking place at dawn on 4 April. The aim of 'SMASH I' was to assault the beaches of Studland and establish a beachhead, observed by a number of 'Class A' (VIPs such as senior officers, commanders and government officials) in Fort Henry, (WO199/2321) a purpose-built bunker overlooking the beach, which included King George VI, Winston Churchill and General Dwight D. Eisenhower. In addition, 400 'Class B' officers watched the exercises from Ballard Down. The assault was planned to take

place on two sections of the beach designated 'King Green' and 'King White' but due to the presence of the training bank, a human-made breakwater which covers at high water alongside the main shipping channel into Poole, the approach to 'King Green' would be restricted (WO199/2321) (Figure 1).

As part of this exercise two squadrons of DD tanks from the 4th/7th Royal Dragoon Guards were launched from ten LCT 3s, each with 5 Valentines to support the infantry landings of the 50th Northumbrian Division and securing a series of objectives on land. The official war diary states that the loss of the 'special craft' was due to 'the wind getting up with a strong sea' (Bovington Tank Museum 2014) and the deaths of 6 men: 'Lt. C.R. Gould, Sgt. Hartley, Cpl. Park 84, Tpr. Kirby and Tpr. Petty all of C Squadron, and Cpl. Townson of B Squadron'. In addition, a 7th DD ran aground, probably on the training bank. This DD maintained its buoyancy floating off in the next tide, drifting off more than 5km before being sunk by naval gun fire to prevent the vessel falling into the wrong hands (Stirling 1946: 43–44). After the exercise was concluded the relevant officers held a conference after which all documents concerning Exercise SMASH were destroyed. One outcome of the

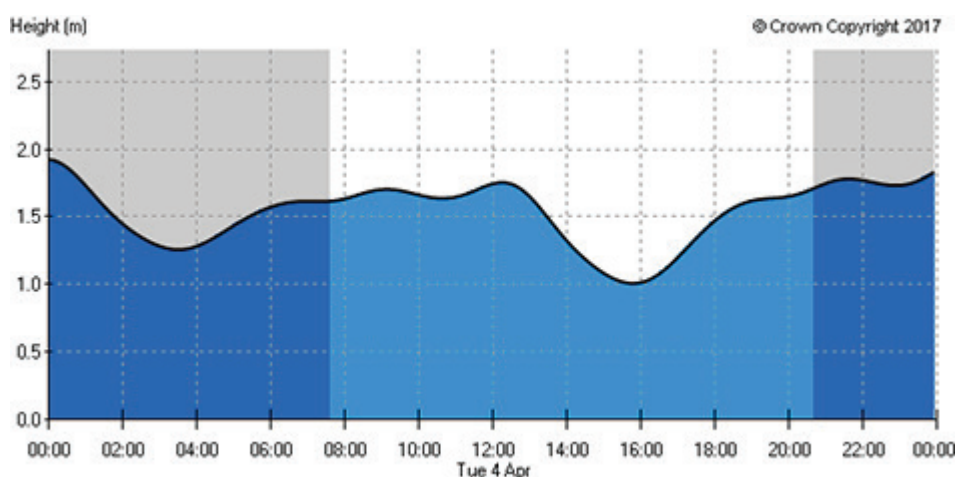


Figure 2. Tidal graph for the 4th April 1944 showing little tidal movement at the time of the exercise 07:40 after UKHO (2014) ' (© Crown Copyright and/or database rights). Reproduced by permission of the Controller of Her Majesty's Stationery Office and the UK Hydrographic Office (www.GOV.uk/UKHO).'

losses was the appointment of a Regimental Officer as an advisor to Naval HQ on whether conditions were suitable to launch DD tanks (Doherty 2003: 54).

Circumstances of the losses

With the official records apparently destroyed details of the operation are based on eyewitness statements and the archaeological record. The official accounts give weather as the primary reason for the loss of six tanks. The weather report for Portland shows the wind on 4 April 1944 to be a steady force 4 from the south-west all day (Meteorological Office, 1944), and out in the bay waves of up to 1m could be expected. Further, the exercise took place over the high-water slacks with the tide at c. 1.6m above chart datum and at this state of the tide the training bank that usually sheltered the training exercises would be completely covered.

Lt (subsequently General Sir) Robert Ford later said of the incidents:

...We were on the surface of the water after coming off the landing craft and becoming increasingly apprehensive. The water was coming in very fast and although we had small pumps, they were just not effective. The weight of the water against the canvas was just too great. We knew we weren't going to make it. We were still floating and all four of us were standing on the top of the tank. Then a great wave crashed over the top and we sank to the bottom ... (*Bournemouth Daily Echo* 2005).

The suggestion that the tank sank almost immediately after coming off the landing craft is correlated by another trooper of the 4th/7th Royal Dragoon Guards,

R.W. Mole (1993), who describes waves 'slopping in' as the tank exited the landing craft leading to it being front heavy and going straight down, with some others drifting off before sinking.

Major J.D.P Stirling states the DDs were 'launched in a very heavy swell but one which was adjudged to be fit for launching' (Stirling 1946: 43). He continues that shortly after launching the tanks the weather changed for the worse, 'the wind increased, the waves grew bigger, and the tanks began to get into difficulties' (Stirling 1946: 43). As the weather reports for the day showed no sign of changing it is likely that the DDs turned into the wind giving the impression of increased swell.

These eyewitness accounts attribute the heavy sea conditions as a cause for the loss but it is known from previous trials of DD tanks that they only had a freeboard of 12" (c. 35cm) in Force 1-3 winds with a calm sea state (ADM1/13246). This meant that even in moderate seas it could be expected that the tanks would take on water. Given the fact that the majority of the DD tanks launched at SMASH I reached the beach, other factors may have played a role in the loss of the six tanks.

While the DDs at SMASH I were launched from modified LCT 3s, prior to 1944 most launches were off LCT 4s and a letter (WO205/747: 9411) dated 24 December 1943 raises doubts that sufficient training and trials had taken place; and, whether under 'operational conditions' that DDs could be successfully launched from LCT 3s. In addition to this many of the DD training schools had not received the newly modified LCT 3s suggesting that the LCT 3 and DD crews had little experience in launching at sea especially if conditions

were not ideal. This contrasts with the large amount of training in deploying from LCT 4s. Given the weight of a Valentine, c. 16 tonnes, each time the LCT unloaded a tank its displacement and distribution of weight would have changed—in combination with the bad weather this could have led to the tank sinking directly after leaving the landing craft.

The positions given for the remains of the seven Valentine tanks lost in Exercise SMASH varies greatly. In 2014, Bournemouth University undertook a study to accurately position the tanks and assess their rate of survival (Manosous 2014). This study successfully located all seven DDs using geophysical survey techniques and showed that the five tanks listed in the National Historic List for England (then the NMR) were over 100m out from the beach.

The plot of the DDs (Figure 1) revealed that Tanks 1 and 2 are close to the 5000 yard line (c. 4500m) from the beach on a westerly heading and within 100m of each other suggesting that these tanks are either from the same squadron launching close by or from the same LCT.

The other tanks present somewhat more of a mystery. These tanks appear to be running in two lines in a south-south-west direction heading far to the north of the landing beach. Given the slack state of the tide (0.3kts in an northerly direction) (Figure 2) (UKHO 2017) and their low freeboard, and therefore windage on the vessels, it is unlikely that they drifted any distance from their disembarkation point suggesting that they were launched parallel to the shore and had to head south into the wind to avoid running aground on the training bank as Tank 7 did, as this would expose the blunt bow of the vessel to the full force of the wind and tide possibly leading to their sinking.

Significance and lack of protection of the tanks

Their operational successes

The importance of the DD tanks and other specially developed vehicles aiding the infantry making progress off the beaches on D-Day is highlighted by Omaha beach. The beach head, codenamed Omaha, was the responsibility of the First US Army led by 1 US and followed up by 29 US divisions. The 741st Division consisted of 32 DD tanks, 29 of these were launched at 5000 yards into a choppy, tidal sea (Belcham 1981: 86; Fletcher 2006: 22). The result of this involved 27 of the tanks being swept off course and swamped. Two of the DDs made it onto the beach and a further three were not launched and landed straight onto the beach (Belcham 1981: 86; Fletcher 2006: 23). When this lack of armoured support is combined with the lack of other specialised equipment such as flails, the difficult terrain of a rising

beach and Hitler's formidable Atlantic wall, casualties ran high. The clearance of beach defences was slowed by the requirement of infantry engineers, with infantry progressing only a few hundred yards by nightfall (Anon 1945: 53). Whereas on Sword Beach for example, the infantry was supported by a full complement of specialised armour and successful landings (33 tanks landing), made quick progress, advancing approximately a mile and a half by 0930 (Belcham 1981: 108). The combined British and Canadian casualties over the course of D-Day are estimated to be around 4200 across the three landing beaches. The American's casualties were about 6000 on two beaches with around half of these casualties being during the Omaha Beach assault (Anon 1945: 53; Belcham 1981: 118; Duncan 1972: 25; Fletcher 2006: 23).

The success of the specialised armour on D-Day is shown in their use during later operations. The crossing of the Rhine—Operation PLUNDER—was undertaken by the Staffordshire Yeomanry (Saunders 2006: 87) occurring under the cover of darkness on 23 March 1945. For the Rhine crossing, initial training took place on Fritton Lake with further training undertaken at Burton-on-Sather where the Staffordshire Yeomanry trained specifically in the crossing of rivers (Fletcher 2006: 36). Further training wings were opened on the River Mass and the Waal (Doherty 2011: 164; Fletcher 2006: 37). Prior to Operation PLUNDER, landings took place at Beveland, the river Elbe and the river Po (Doherty 2011; Fletcher 2006: 38). The US army utilised the DD tanks successfully for Operation DRAGOON, the amphibious invasion of southern France on 15 August 1944. Twenty DD tanks were launched from their LCTs, and 16 successfully made the beach (Zaloga 2012: 28). At least one Sherman DD was lost off Italy by the 753rd battalion during the training for Operation DRAGOON in July 1944 (Duncan 2017). DD Valentines also being shipped out to north Africa and the Middle East (WO32/10523). The memoir of John Leyin of the 25th Dragoons (Leyin 2003) recalls his training in India for the amphibious landings in Japanese occupied Malaya. The success of the DD tanks was clear. Clearly they are of considerable military significance.

The protection of the submerged DD tanks

Historic England recognise the significance of the exercise as seen in their listing of Fort Henry, the Bunker built for the VIPs to observe the exercise, as a Grade II Listed Building (List entry Number: 1411809). As one of the key parts of the exercise and D-Day itself the tanks played a vital role in the history of Europe with only a handful of DD Valentines known to have survived. Of the Poole Bay Tanks, all have been heavily salvaged with four of the six lost off Studland having been partially destroyed by the Navy in 1987 to prevent salvage of munitions by sports divers. Tank

2, which had the turret blown off, was salvaged by sports divers in 1989, the material recovered showed a remarkable level of preservation with material such as cardboard and personal items such as shaving kits and leather belts surviving (pers. comm. Nigel Bryant). With Tank 1 still intact the archaeological potential of the tank and, therefore, its significance is greatly increased; however, there is no desire from Historic England to protect the tanks under the *Protection of the Wrecks Act 1973* (Protection of Wreck Act 1973) as although they were travelling under their own power they are not recognised as 'wrecks'. Historic England has also changed their policy specifically so as to not designate the vessels under the *Ancient Monuments and Archaeological Areas Act 1979* (Ancient Monuments and Archaeological Areas Act 1979), which defines monument to include 'any vehicle, vessel, aircraft or other movable structure'. Even though they recognise the tanks as being of 'national importance' it is Historic England's policy not to use the 1979 Act to schedule below the Mean Low Water mark (Historic England 2015). It should be noted that Historic England has designated protection to at least one vessel, a WW2 Phoenix Caisson, which lies 660m beyond the low water mark in 2013 (List entry Number: 1415588), as well as several wrecks in the Intertidal Zone between high and low water marks. Historic Scotland and Cadw have also used the 1979 Act to protect shipwrecks below the low water mark such as the German High Seas Fleet at Scapa Flow.

Under the current UK legislation only the 1979 Act can be used to protect underwater cultural heritage (UCH), which cannot be identified as wreck. The failure to schedule these vehicles, despite their acknowledged national importance, especially when compared to the scheduling of surface monuments, would appear to show a 'sea blindness' on the part of the heritage authorities in dealing with UCH.

Conclusion

The intended use for the tanks was the Normandy Landings during D-Day, and much attention is drawn to Omaha Beach where the DD tanks failed to make the beaches due to bad weather. The units on the other beaches successfully deployed the tanks and experienced much lower casualties. The DD tanks therefore, played an important role in the Normandy Landings despite the high number of casualties on Omaha Beach. The success of the DD tank on D-Day led to further successful amphibious landings, including Italy, providing vital support in multiple operations during the allied advance, such as Operation PLUNDER, the crossing of the Rhine (Fletcher 2006: 37). Without the DD tanks and the other specialised armour of the 79th Division the Normandy Invasion may not have gone as planned with many historians believing that

the Soviets would have continued their push beyond Germany and could have even led to atomic war in Europe (BBC 2014).

Little work has gone into the investigation of the known DD tanks, beyond that being conducted by Bournemouth University (2014). The only known work to be carried out is on locating and recording of those lost during exercise SMASH and the one at Bracklesham Bay, with Manousos' (2014) concluding remarks on the tanks being that they are actively decaying and being actively salvaged, thus highlighting the importance of recording these vehicles while still possible. No other DD tanks are recognised to be within English waters; a Sherman DD lost in Exercise TIGER was raised in 1984 and is now on permanent display on Slapton Sands as a memorial to the lives lost during Exercise TIGER.

The extensive development of such a new idea shows the importance of the equipment, as authorities strived to maintain secrecy while developing and trialling at an extensive list of locations, combined with the struggle to produce the numbers needed for training and operational use. While the deliberately fragmented records and widespread coverage of the use of DD's makes this difficult, the significance and potential presence of these vehicles within the archaeological records is limited due to their secret nature.

The topic, therefore, should be studied to its fullest potential, such fragmented records being deliberately discrete over the nature of the equipment due to their success relying on secrecy. With very limited archaeological investigation being undertaken to locate, record and learn from those tanks within the archaeological records, further work must be undertaken to fully appreciate the role that these tanks played throughout the war. Many features of the war are well remembered, and deservedly so, with many protected structures, ships and aircraft within the archaeological records and the public eye. Many elements of D-Day have already received deserved recognition and protection, either through the *Protection of Military Remains Act*, as scheduled monuments or listed buildings. While features of the operation SMASH have already been listed (Fort Henry), the tanks have been noted for national importance but not offered any form of protection. The DD tanks were an important aspect of D-Day and one with such little archaeological presence should represent an ideal candidate for protection. The DD tanks are yet to receive the appreciation they deserved for their role in the Normandy landings, attention being drawn to their great losses at Omaha Beach. Little attention has previously been paid to the extensive investment that the War Office put into these tanks and their successful role in the penetrating of 'fortress Europe'.

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