MICRONESIAN
JOURNAL OF THE HUMANITIES AND SOCIAL SCIENCES

Vol. 5, nº 1/2 Combined Issue November 2006

MANAGING UNEXPLODED AMMUNITION AT AND NEAR CULTURAL HERITAGE SITES
Issues for Micronesian Historic Preservation

Dirk HR Spennemann
Institute for Land, Water and Society, Charles Sturt University

Unexploded ammunition is a common hazard among heritage sites that have been the focus of military action. As the unpredictable nature of such ammunition threatens the wellbeing of management staff and visitors alike, unexploded items are normally removed and destroyed. That action, on the other hand, contravenes the principle that heritage sites should be preserved in place and unchanged to the extent feasible. This paper sets out the historical conditions that rise to the problem, discussed the nature and extent of the problem and strives to find an balanced approach that safeguards human life and health, while at the same time reduces the impact to the heritage places thus managed.

.

The ethics of cultural heritage management stipulate that heritage places, if deemed culturally or historically significant, should be maintained in place and unchanged lest their significance be impaired. Any conservation management must be respectful to the historic fabric of the site and should contemplate irreversible methods of conservation intervention only as the last resort (US Secretary of the Interior Standards). Usually cultural heritage sites do not pose an unreasonable risk to the heritage manager and/or visitor, recent developments in the public liability field not withstanding. There are items, however, that had been designed to maim or kill, that survived by circumstance the period of their initial application, and that now pose a serious threat to cultural resource managers, visitors and the sites alike: unexploded ammunition.

Unexploded ammunition is a common problem on all battlefield locations, ranging from small caliber ammunition to large shells and unexploded aerial bombs. This paper excludes, on purpose, the question of land mines and their management. Given the remit of the journal, the paper focuses on unexploded ammunition of World War Ii vintage in Micronesia and the Pacific. Heritage managers dealing with the management and protection of heritage places are faced with the question how to deal with the contrasting demands of public safety to visitors and management staff on the one hand, and the need to preserve the heritage sites in place and unchanged.

There is very little literature on the interrelationship of unexploded ammunition and heritage sites. In the majority, papers and reports may mention the presence of unexploded ammunition in passing, or may comment on the impact of previous ordnance removal activities on the preservation of the heritage resource (cf. Adams *et al* 1997, p. 85-86). To the knowledge of the author, only two papers make specific reference to the subject matter. In 1998 the

This is a peer reviewed contribution. *Received:* 26 May 2006; *Revised:* ###; *Accepted:* ##
 ISSN 1449-7336
HeritageFutures™ International, PO Box 3440, Albury NSW 2640, Australia

Persistent identifier: http://www.nla.gov.au/nla.arc-65664

author set out some of the issues in a paper for the US National Park Service journal *CRM* (Spennemann 1998), while in 2001 Linck & Vann (2001) discussed the approaches taken by the explosive ordnance disposal teams when carrying out archaeological fieldwork on former military training areas.

The issue of legal title to and thus ownership of unexploded ammunition, and the concomitant responsibility for its safe management or removal, is outside the scope of the present paper. This has been addressed elsewhere (Spennemann 2005).

THE ORIGIN OF THE PROBLEM

The Pacific War (1941-1945) has seen the development of several permanent and temporary military bases on several islands and atolls in the central and western Pacific by both Japanese and Allied forces. Vast quantities of ammunition, ranging from small arms to large coastal defense and naval guns, as well as aerial bombs were moved to the bases and stored in concrete bunkers or open bomb dumps. Small quantities were stored in ammunition ready magazines at the gun emplacements, where they were needed. Most of this ammunition was either expended during military action or was removed after the war. Some however remains. In addition, enemy action brought substantial quantities of ammunition onto a base. Whilst most of the bombs and shells exploded, some did not. A US intelligence report following the US capture of Kwajalein Atoll, Marshall Islands, indicates that approximately 50% of the naval shells failed to detonate on impact, an observation reinforced by a statement by the commander of the Japanese garrison made after surrender of Taroa (Kamada 1947). Several of these were buried into the soft sand. Despite initial clean up and a number of subsequent ordnance removal missions there is still an abundance of ammunition located on the islands. Scrap metal drives of 1970s as well as utilization of explosives for bomb fishing have further scattered the ordnance. Much of the ammunition is found during normal vegetation clearing in the course of agriculture/gardening and during conservation management actions.

Table 1. Types and distribution of Japanese military installations in the Marshall Islands.

Atoll	Islet	Air-field	Sea-plane base	Naval base	Sub-marine base	Piers, Jetties	Ancho-rage	Lookout/ weather station
Jaluit	Emidj	■					■	
	Jabor		■	■	■	■	■	
Mile	Mile	■				■	■	
	Tokowa							■
	Port Rhin		■					
Maloelap	Taroa	■				■	■	
Wotje	Otdia	■	■	■		■	■	
Kwajalein	Roi-Namur	■				■	■	
	Ebeye		■				■	
	Kwajalein	+		■	■	■	■	
	Bigej			■		■	■	
	Guegue			■		■	■	
Enewetak	Engebi	■	**?**				■	
	?							■
Majuro	Djarrit		■				■	
	Telap	**?**						
Bikini								■
Ebon								■
Bikar								■
Taongi				**?**				■
Rongelap		+			+			■

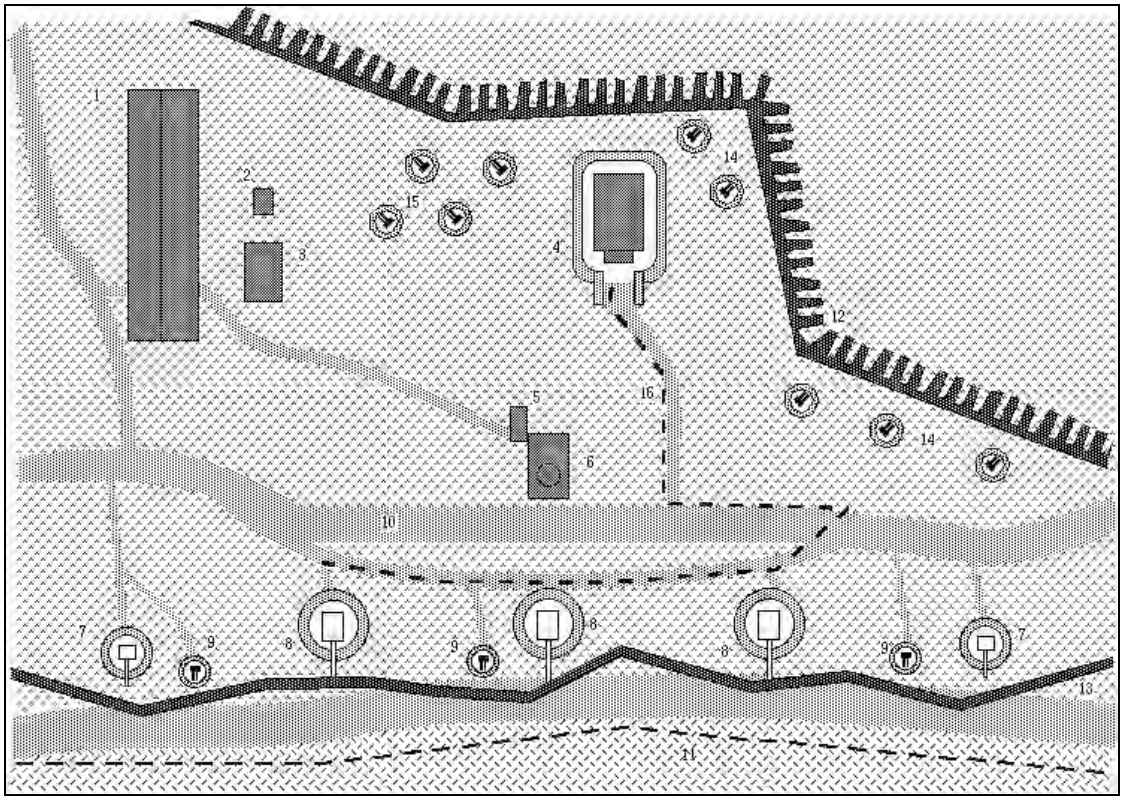

Fig. 1. Schematic lay-out of a 150mm coastal defence battery. 1—Barracks building for gun crews; 2—Bath building for gun crews; 3—Toilet building for gun crews; 4—Ammunition magazine in earth revetment; 5—Auxiliary Building (generator building?); 6—Fire control center; 7—Anti-aircraft gun (medium) in emplacement; 8—Six inch coastal defence gun in emplacement; 9—Heavy machine gun (anti-aircraft); 10—Access road system; 11—Barbed wire entanglement and obstacles for beach defence; 12— Slotted personnel trench to guard against attacks from the landward side; 13—Personnel trench to guard against attacks from the seaward side; 14— Heavy machine gun emplacements to ward off attacks from the landward side; 15—Heavy machine gun battery (anti-aircraft); 16—Narrow gauge railroad to deliver shells to the coastal defence guns

Left: Fig. 2. Unexpended Japanese ammunition in place shortly after the invasion, Kwajalein Island
(Photo: US National Archives 80-G-3400964

Fig. 3. Japanese Weaponry and ammunition lined up for removal after capitulation, Wake Island
(Photo: US National Archives 80-G-346844)

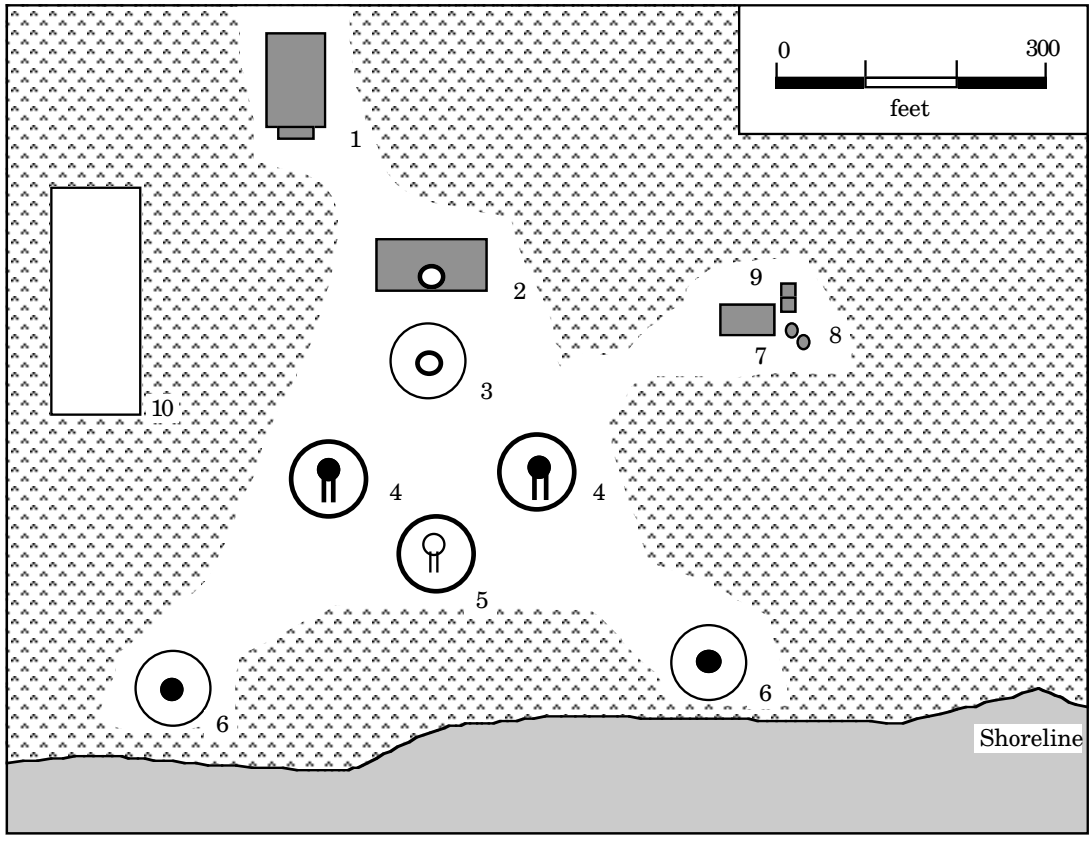

Fig. 4. Schematic lay-out of a 127mm dual purpose gun battery. 1—Ammunition storage building; 2—Fire Control Center; 3—Range Finder (Director); 4—127mm double-barrel dual purpose gun emplacement and ammunition storage; 5 —dummy gun emplacement; 6—searchlight; 7 —generator station; 8—cooling water tanks; 9—fuel storage tanks; 10—barracks building for gun crews (no longer in existence) (after USSBS 1947a: 272).

The live ammunition encountered in Micronesia stems from two sources: (i) unexpended Japanese ordnance left over from the war and (ii) unexploded US ordnance ("duds") sent into the bases.

Japanese ordnance

We are ill informed about the total amount of Japanese ammunition initially stored on the bases in the Marshall Islands. The US Strategic Bombing Survey (1947) lists the kind of defence systems installed on Mile (table 1) and, to some extent, the amount of ammunition placed there (table 2). It is quite unclear how much of the ammunition was destroyed during the war and how much of it has been removed after surrender (see below). On the whole, direct hits on major bomb magazines as known from Taroa, Maloelap Atoll, are not in evidence.

US ordnance

We are far better informed about the scale of the US ordnance.

The U.S. attack strategy on the Japanese defences in the Marshall Islands was to eliminate Japanese air power and then to take one or two key bases and to bypass the others. By that time it was not clear how long the U.S. construction battalion would need to create a serviceable airfield from scratch. Thus it was decided to take the undefended Majuro Atoll first and use it as a fleet anchorage. In addition, an airfield was to be built as it could be anticipated that none of the airfields on any of the Japanese bases would be operational for quite some time after the base had been taken by assault. However, rather than taking the Japanese bases one by one, it was decided by CINCPAC

to take the central atoll, Kwajalein, and the north-western base, but to leave the other bases in Japanese hands (Morrison 1951, p. 205-107). Kwajalein had an unfinished bomber strip, which could be used after capture as the backbone of a base.

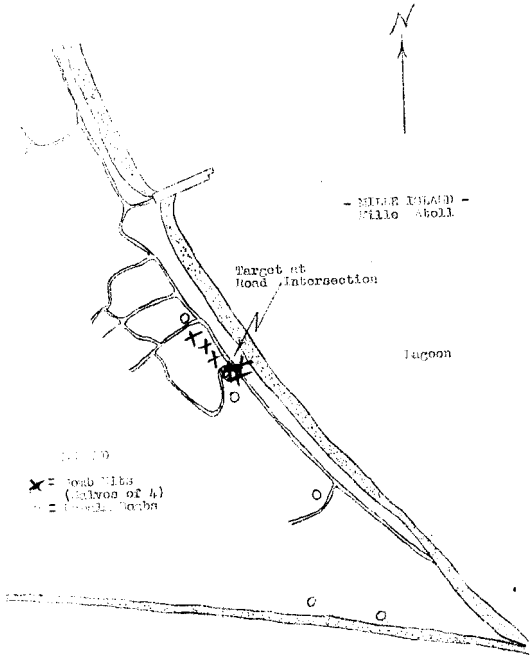

Fig. 5. Mile Island. Target drawing (C-3 target, Officers area) after a successful bombing mission of the VMSB-231 on 14 May 1945 using depth bombs (in clusters of four) (x) and napalm (o).
(U.S. National Archives, Washington. Record Group 243 II C Air Action Report No. 5)

The following description of the attacks on Mile is representative of the effects on the main bases, ie. Wotje, Taroa, Kwajalein, Jaluit and Mile. Concentrated carrier raids conducted by USS *Compens* (CVL-25 29 sorties), USS *Lexington* (CV-16 188 sorties) and USS *Yorktown* (CV-10 194 sorties) during the period of 19-22 November 1943 increased the pressure on the Mile garrison. The damage incurred was limited, although one of the two hangars was set alight and gutted. Another attack damaged numerous barracks. In addition, some aircraft were destroyed on the ground. A photograph taken by a Douglas Dauntless from USS *Lexington* (CV-16) shows two twin-engine bomber planes, most likely Bettys, lying destroyed on the southern turning circle. During the main attack on the Marshalls end of January and early February 1944, none of the carrier groups attacked Mile, apparently because Mile no longer was seen to play an important role in the defense of the Marshalls.

Initial concentrated bombing started prior to the landings in Kiribati (Craven & Cate 1950, p. 300). Bombing preparatory to the landings in the Marshalls commenced in end of November 1943 and intensified after January 15, 1944, accompanied by intensified submarine activity from mid-January and naval shelling from January 29 (Dyer 1972, p. 767). During December 1943 and January 1944 Mile received 415 tons of bombs from land-based bombers operating from Kiribati (Morrison 1951, p. 212). Mile as attacked nearly every day during January. In mid-January two Japanese 4 engine bombers were shot down on Mile airfield whole landing after this incident apparently all Japanese aircraft were withdrawn from Mile (Craven & Cate 1950, p. 300-31; Morison 1951, p. 207, Shaw *et al.* 1966, p. 137).

During the weeks prior to the U.S. landings in the Marshall Islands, the 7th Army Air Force sent B-24's and B-25's to bomb the Japanese installations. Apart from their obvious targets Jaluit, Wotje, Mile, Taroa and Kwajalein (Wake and Enewetak being outside the range), the atolls of Arno, Ailinglaplap, Aur, Bikini, Ebon, Majuro Utirik, Ujelang, and Rongelap were also bombed (USSBS 1947d, p. 4; 6; 18; Cockrum 1970, p. 216). Of these, only Bikini, Ebon and Rongelap had a look-out station and Majuro had a — deserted — seaplane base. The bombardment of the other atolls, however, was on a very limited scale only. It is of interest to note, however, that even after the fall of Kwajalein and Enewetak Rongelap (twice) and Ujelang (once) were bombed (USSBS 1947c, p. 6), highlighting the state of intelligence of from which the U.S. forces operated. To discourage shipping and inter-atoll contact the passes in and out of the atolls of Maloelap, Jaluit, Mile, and Wotje had been mined, Kwajalein had been mined with dummy mines so as not to attract attention to the fact that Kwajalein had been chosen as the main target.

EXTENT OF THE PROBLEM

Given that history, it is not surprising that large quantities of ammunition were used. Although accounting of ordnance was quite good during World War II, the overall records are not as good as could be hoped for. Nonetheless and image emerges that a vast tonnage of ammunition was dropped on the Japanese bases in the Marshall Islands.

How much ammunition was used?

A very heavy and destructive raid occurred on 20 November 1943, when Mile was attacked by about 300 fighters and bombers from a U.S. taskforce (Tokuno 1947; CinCPac-CinCPOA 1944a). Destroyed were three landing craft, 10 barracks, the main radio communications shack, most of the signal equipment (in houses) and a few automobiles and water tanks. The runway was damaged (repaired soon after). One soldier was killed and two were wounded. During the attack a large amount of ammunition was expended. According to the official Japanese account, 794 rounds of 127mm DP ammunition, 521 rounds of 25mm Machine guns, 20,300 rounds of 13 mm and 33,000 rounds of 7.7 mm machine gun (CinCPac-CinCPOA 1944a).

By December 1943 Mile had received a greater tonnage of bombs than any other target in World War II to that date, including Berlin and Monte Cassino (Howard & Whitley 1946, p. 178).

After the U.S. landings in the Marshalls

During the main all-out attack on the Japanese bases in February 1944, Mile was no longer perceived to be a serious threat and major target worth risking the lives of experienced carrier pilots. Thus TF 58 attacking all other bases and engaging the Japanese air strength in the Marshall Islands by-passed Mile.

Carrier raids

A carrier and bombardment raid was carried out in March 1944 by USS *Lexington* (CV-16) whose air wing flew 120 sorties against Mile mainly attacking the airfield. The battleships USS *Iowa* (BB-61) and USS *New Jersey* (BB-62) escorted by destroyers USS *Hull* (DD-350) and USS *Dewey* (DD-349) shelled the island.

The Japanese had about 150 serviceable aircraft on January 27th, 1944 (Morrison 1951, p. 212), most of which were destroyed during the initial attacks launched from the carrier task forces. Many aircraft were destroyed on the ground. The few remaining aircraft, including the surviving crew, were evacuated from Jaluit, Mile and Wotje before D-day (31 January), and those from Taroa on 2 February. The last pilots were transferred to Truk on 6 February 1944. Having stripped the Japanese defenders of their air power in the first days of the attacks on the Marshall Islands, the U.S. forces took Kwajalein and Enewetak by force (

Wotje was attacked on 29 January and 30 January by the carrier task force TG 58.4, Adm. Ginder, consisting of carriers U.S.S. *Saratoga*, U.S.S. *Princetown*, and U.S.S. *Langley*, and heavy cruisers U.S.S. *Boston* and U.S.S. *Baltimore*, as well as a screen of destroyers. Wotje was shelled by Rear Adm Northern Attack Force (CTG 58.5) consisting of one heavy and three light cruisers and a screen of six destroyers, one of which was hit midships. The bombardment group, served by spotting planes, shelled the island with 250 rounds of 8-inch, 1813 round of 6-inch and 4567 rounds of 5-inch ammunition, rendering the airfield useless for the time being (Dyer 1972, p. 775-780; Morrison 1951, p. 220). Naval shelling continued for considerable period of time from various naval units.

Similar to the Japanese bases on Maleolap, Jaluit (Jaluit) and Wotje (Wotje) Atolls, the base on Mile Atoll was leapfrogged by the U.S. forces attacking and taking the Marshall Islands. All four bases, once stripped of their airpower, were in no way capable of hindering either the U.S. advance in the Marshalls, nor the U.S. occupation of the atoll other than these bases. Largely cut off from supplies, due to a constant vigilant air search for submarines and surface shipping, the bases were slowly starved to death and proved in fact a drain on the Japanese resources as attempts were undertaken to supply them with food.

Operations from the U.S. bases in the Marshall Islands
After the bloodless fall of Majuro Atoll on January 29th, 1944, the island of Delap was developed as an airfield with a 5800 foot runway, from which attacks were flown against the Japanese bases in the Marshall Islands (Morrison 1951 Sherrod 1952). The Fourth Marine Aircraft Wing, comprising Squadrons VMSB-231, VMSB-331, VMSB-245, VMO-155, VMF-111, VMF-113, VMF-224, VMF-311, VMF-441, VMB-613, operated out of Majuro.

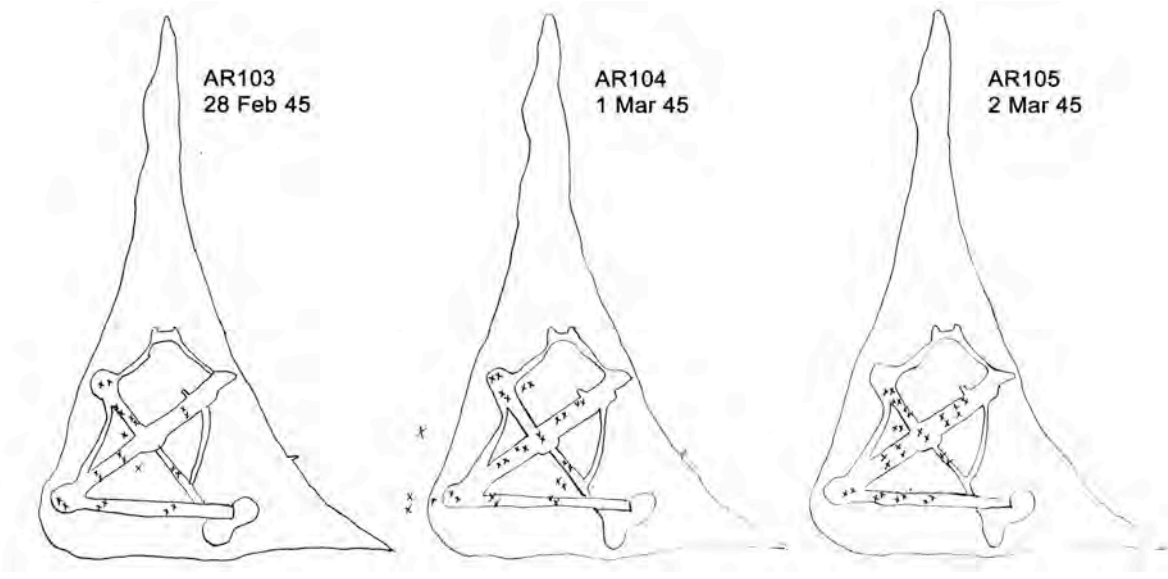

Fig. 6. Mile Island. Target drawings of three successive bombings runs by VMF-155.
(U.S. National Archives, Washington. Record Group 243 II C Air Action Report No. 103–105)

Table 2. Tonnage of high explosive bombs, naval shells, napalm and rockets directed by U.S. Army, Navy and Marine units against targets in the Marshall Islands, February 1942-August 1945, ranked by tonnage delivered against targets. (Compiled from: USSBS 1947a; SCU1945)

	7th AAF	USN carrier		USN land	Fourth Marine Air Wing			Naval	
Atoll	Bombs	Bombs	Napalm	Bombs	Bombs	Napalm	Rockets	Gunfire	Total
Wotje	1236.10	166.10		213.10	1861.20	10.60	5.07	1016.53	4508.70
Mile	786.10	239.35		97.50	2236.41	150.27	3.81	453.00	3996.44
Maloelap	1128.00	227.77	29.00	219.00	1119.46	41.85	4.77	864.88	3634.73
Jaluit	1374.00	49.50		232.20	1425.38	54.20	7.32	6.00	3148.60
Enewetak									
Kwajalein	315.20								
Majuro	15.00								15.0
Rongelap	11.40								11.4
Aur	8.50								8.5
Arno	5.90								5.9
Likiep	3.00								3.0
Ujelang	3.00								3.0
Bokak **)									
Bikini									
Ebon									
Enemy shipping	36.30								36.3

Table 3. Tonnage of high explosive bombs, naval shells, napalm and rockets directed by U.S. Army, Navy and Marine units against targets on Wotje Atoll, February 1942-August 1945.

Month	7th AAF	Navy carrier	Navy land	Fourth Marine Air Wing			Naval gunfire	Total
				Bombs	Napalm	Rockets		
February 1942		11.0					129.84	140.84
November 1943								0.00
December 1943	152.0	11.0						163.00
January 1944	214.60	129.00					170.00	513.60
February 1944	261.2	15.1	17.0				701.00	994.30
March 1944	68.2		41.5	120.8				230.50
April 1944	172.5		62.7	272.5				507.70
May 1944	332.8		51.5	252.2			15.69	652.19
June 1944	2.0		11.2	61.2				74.30
July 1944	19.6			234.5				254.10
August 1944	4.2			90.80				95.00
September 1944	9.0		12.7	299.60			321.30	642.60
October 1944			11.75	89.8				101.55
November 1944			2.75	89.7				92.45
December 1944			2.0	146.90			148.00	296.90
January 1945				62.50				62.50
February 1945				0.00				0.00
March 1945				22.00				22.00
April 1945				22.3	1.2	1.44		24.94
May 1945				42.6	3.8			46.40
June 1945				9.5				9.5
July 1945				38.9		2.67		41.57
August 1945				5.5	5.6	0.96		12.06
Total	1236.10	166.10	213.10	1861.20	10.6	5.07	1016.53	4508.70

Table 4.Weaponry at Mile (USSBS 1947)

Type	Number installed	Claimed as destroyed	damaged	Surveyed
15 cm coastal defence gun	8	8	0	6
14 cm coastal defence gun	3	3	0	3
12.7 cm twin dual purpose guns	4	4	0	4
10 cm mortars	2	0	0	0
8 cm dual purpose	4	4	0	2
75 mm anti-aircraft	9	1	0	0
37 mm anti tank	2	1	0	0
25 mm twin mount anti-craft	6	1	0	0
13.2 mm twin mount anti-craft	4	3	0	0
7.7 mm anti-craft (heavy)	10	0	?	0
7.7 mm anti-craft (light)	70	3	?	0
Total	122	28	0	15

Table 5. Wotje I., Wotje Atoll, summary of military installations (excl. guns). Abbreviations: B—Bombs; F—Fire by Napalm; N—Naval shelling S—Strafing.[1]

Installation	Original	Destroyed	Damaged	Weapon
Command posts				
Atoll Commander headquarters	1		1	B
Navy headquarters	3		3	B
Army headquarters	1		1	B
Fire control stations	3	3		B
Observation posts	5	3		2B 1N
Ammunition magazines				
150-millimeter	6	6		B
127-millimeter	2		2	B
120-millimeter	2	2		B
25-millimeter	5	2		B
20-millimeter	26	6		B
13.2-milimeter 1)				
7.7-millimeter 2)				
6.5-millimeter 3)				
Utilities				
Warehouses (surface)	10	10		B
Food storage (surface)	30	30		B
Food storage (underground)	25	12		B
Water tanks	30	3		B
Power plants	4	2	2	B
Gasoline storage dumps (underground)	5	3		B
Communications				
Radar installations	2	2		B
Radio stations	3	3		B
Aviation				
Torpedo Planes	20	10	?	B,S
Flying boats	10	4	S	B,S
Concrete revetments	5	5		B
Air operations bldg.	1		1	B
Repair shops (surface)	1	1		B
Underground Operations buildings	10	5		B

1) 1,500 rounds of 4,500 destroyed by bombing; 2) 1,000 rounds of 3,000 destroyed by bombing; 3) 6,000 rounds of 12,000 destroyed by bombing; Source: USSBS 1947.

Table 6.Mile I., Mile Atoll, summary of ammunition magazines.

Ammunition magazine	Original No.	No. destroyed	No. damaged	by weapon
15-centimeter	4	4		Bombs
12.7-centimeter	2	2		Bombs
8-centimeter	4	4		Bombs
75-milimeter	—	—	—	Bombs
37-milimeter	—	—	—	Bombs
25-milimeter	3	3		Bombs
13.2-milimeter	2	2		Bombs
7.7-milimeter	—	—	—	Bombs

Table 7.Tonnage of bombs and naval shells dropped on Mile (November 1943 to August 1945) (Sources: USSBS 1947a; SCU 194, p.5.).

Month	7th Army Air Force	4th Marine Aircraft Wing	Navy carrier-based	Navy land-based	Naval gunfire	Total
November 1943	64.7	—	190.6	—	—	255.3
December 1943	202.6	—	—	—	—	202.6
January 1944	180.0	—	—	2.5	—	182.5
February 1944	157.4	—	—	16.8	—	174.2
March 1944	127.5	41.0	47.6	31.5	438.0	685.6
April 1944	34.1	69.5	—	27.8	—	131.4
May 1944	16.0	72.0	—	2.5	12.0	102.5
June 1944	—	92.3	—	13.5	—	105.8
July 1944	—	107.0	—	—	—	107.0
August 1944	3.8	1017.2	—	—	—	1021.0
September 1944		243.4	—	—	—	243.4
October 1944	—	61.1	—	—	3.0	64.1
November 1944	—	75.9	—	—	—	75.9
December 1944	—	100.8	—	—	—	100.8
January 1945	—	75.1	—	3.0	—	78.1
February 1945	—	11.0	—	—	—	11.0
March 1945	—	53.6	—	—	—	53.6
April 1945	—	15.3	—	—	—	15.3
May 1945	—	1.8	—	—	—	1.8
June 1945	—	69.0	—	—	—	69.0
July 1945	—	111.7	—	—	—	111.7
August 1945	—	—	—	—	—	—
Total	786.1	2217.7	238.2	97.7	453.0	3792.6

The U.S. Marine Corps, Marine Scout-Bombing Squadrons 231 and 331, task group 57.4 and 59.4, arrived on Majuro on February 3rd and operated out of Majuro from 21 February 1944, and was fully combat operational from 23 February onwards. Apart from almost daily conducted bombing raids (see Appendix A) flown against the Japanese installations, the squadron undertook a regular daily search operation at dawn, flying over Mile, Jaluit, Wotje and Maloelap Atolls (U.S. Marine Corps 1944a).

The objectives of the U.S. bombing and aerial patrols were two fold:

- to keep the runways inoperational to prevent their use in the event of a counter attack of the Japanese and
- to prevent any supplies coming through to the garrisons.[2]

In addition, the standardized nature of Japanese gun emplacements and other installations, facilitated the use of the by-passed Japanese bases as training grounds for new pilots on their way to other theatres of the war as well as testing grounds for the effectiveness of new types of ammunition and warfare. For example, the later so successful fighter-bomber was first developed in attacks on the by-passed garrisons. Likewise, the effectiveness of Napalm was tested from late 1944 onwards.

All bombing attacks on Mile were accompanied by a flying boat to pick up the crew of aircraft downed by Japanese AA. The bombing missions against the by-passed bases were commonly given derogatory terms, mainly due to the relative ease with which they could be conducted: to the pilots they were known as the "milk route" (Moore 1945, p. 325). Apart from aerial bombardment, which was the most destructive force, there was some shelling of the by-passed bases by U.S. naval units stationed off the ocean side of the atolls. As far as can be ascertained, until surrender, U.S. naval units never ventured inside the lagoons.

Although most bomb raids were undertaken during daytime, some night harassments took place, when bombs were dropped over the target without any intention of precise

bombing. These night harassments had the following objective:

> "These attacks are each to be made by two plane sections who are to go over the traget without escort, release their bombs on separate single runs, strafe, drop flares, and generally make the Japs miserable" (U.S. Marine Corps 1944d).

Lieutenant Tomita, IJN, under interrogation by the U.S. Strategic Bombing Survey, mentioned that the U.S. night raids on Mile were rather ineffective in term of destruction installations, but were mentally very strainful and "nerve-wrecking" for the garrison. (Tomita 1947, p. 224). Although commonly dive-bombers were used, one harassment was carried out by a PBY-5A ("Catalina") Flying boat of VPB-24 on 2-3-1945 at 21:00 hrs.[3]

Fig. 7. US bomb storage dump on Kwajalein Island soon after invasion
(Photo: US Navy Historical Center K-14581)

Fig. 8. US Artillery personnel land ammunition during the invasion of Kwajalein Island
(Photo: Department of Defence Photo (Army) 324729)

Of four the by-passed atolls, Mile, Wotje, Jaluit and Maloelap, Wotje took the heaviest pounding. Of the total 15288.7 of bombs and naval shells delivered against targets on these bases, Wotje received 4508.70t or 29.50% By comparison, Mile received 3996.44t or 26.12%.

Wotje Atoll

Of four the by-passed atolls, Mile, Wotje, Jaluit and Maloelap, Wotje took the heaviest pounding. Of the total 15288.7 of bombs and naval shells delivered against targets on these bases, Wotje received 4508.70t or 29.50%. By comparison, Mile, the southernmost Japanese base in the Marshall Islands, and in easier range for the medium range B-25 bombers operating out Kiribati and later for the dive bombers operating out of Majuro received 3996.44t or 26.12%.

Mile Atoll

Mile has been the target of considerable bombing by Navy, Army and Marine aircraft but also of some naval shelling by battleships, cruisers and destroyers. The total airborne bombing campaign carried 3,359.4 tons of bombs, 150.25 tons of napalm and 3.81 tons of rockets into Mile (table 2). It appears that only relatively few of the bombs were duds and did not detonate.

This is a quite a difference from the results of the naval shelling. In interviews conducted after the war by the US Strategic Bombing Survey, the Japanese base commander of Taroa, Maloelap Atoll alleged that about 50% of all naval shells fired upon that island failed to detonate. We can assume that the failure rate of the shells fired on Mile Atoll was in the same order of magnitude. Mile received 438 tons of naval shells in March 1944, twelve tons in May 1944 and another 3 tons in October 1944 (total 453 tons). It is a figure of anyone's guess to what extent these shells have been removed in the meantime and to what extent they are still present.

A 50% failure rate is therefore equivalent of 219 tons of unexploded shells. Even if we assume that the 50% rate is an overestimation given by the Japanese commander, and only assume a dud rate of 25%, of which, say, 90% were removed after the war (see below), and

furthermore assume that 10% of shell fired fell short of Mile (that is into the ocean), then we are still dealing with almost 10 tons of unexploded shells.

Most bombing missions flown against the targets on the four by-passed atolls were accompanied by photographic planes. These planes commonly took one set of pictures at the end of the day, regardless of how many bombing raids from different squadrons had been flown (U.S. Marine Corps 1944i). Thus, ideally, a large amount of bombing raid documentation photographs should be present. According to a report by the U.S. Marine Corps (1944i) many of the photographs taken were either too dark or too small for assessment. It is also unclear what happened to those negatives which were useful for interpretation. Given the problems in locating such photographs in the National Archives, no such information was available to the author at the time this report was written.

Based on the information supplied by the PoW taken off Mile Atoll on 18 March 1945,[4] the U.S. Forces targeted specifically those islands where either dispersed habitation of troops or where food gardens were reported. A particularly heavy raid occurred on June 13, 1945. In three consecutive raids, bivuac areas and gardens on the following islands were fire-bombed and strafed: Alu, Buruon, Enesetto (three times), Garu (twice), Jobenor, Lukuonor (three times), Naarupu, Rebiyon, Tokowa. Another spell of such action was carried out on June 28, 1945, when the following islands were fire-bombed and strafed during three raids: Alu (twice), Arbar, Chirubon (twice), Ejowa, Garu, Inewa (twice), Lukuonor (twice) and Naamakke. Two weeks later, on July 12, 1945, another such raid was carried out, this time targetting Arbar, Dowagain, Kannatangan, Namoyen, Supein and Mile itself.[5]

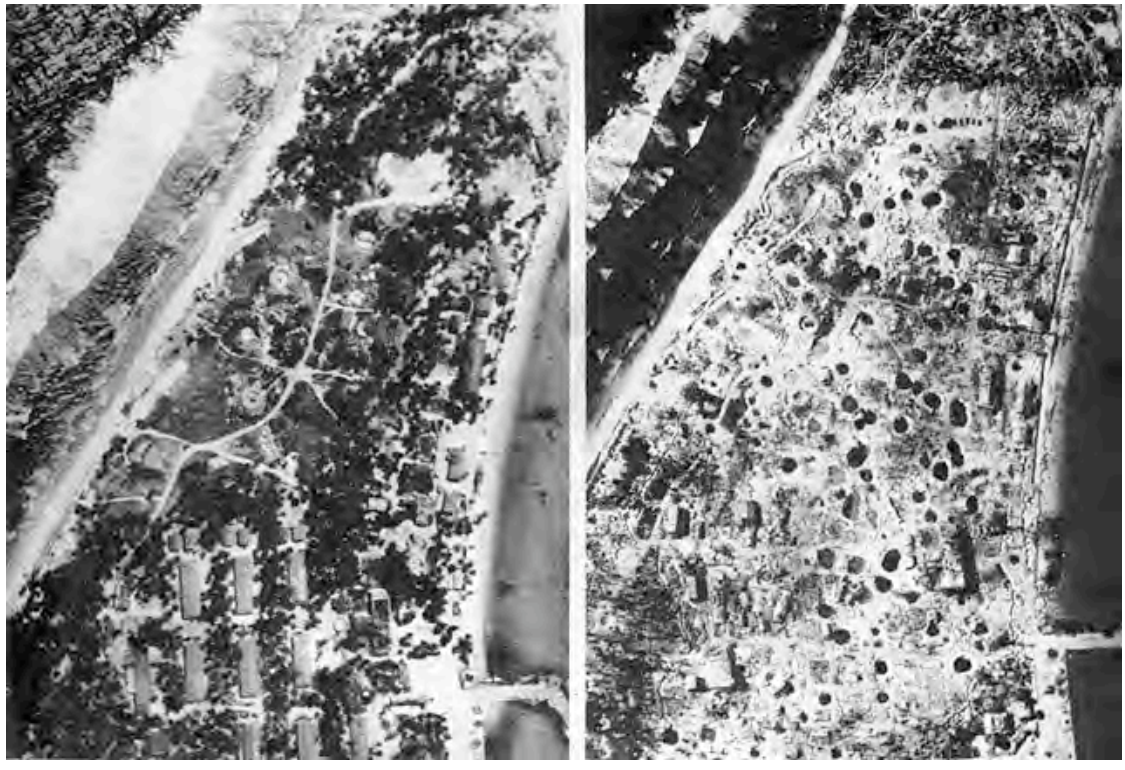

Fig. 9. Impact of prolonged aerial bombardment on by-passed atolls. The northern tip of Emidj Islet, Jaluit Atoll. The photo at the left was taken in November 1943 prior to the commencement of long-distance bombardment, the photo on the right six months later in May 1944
(Photo: Heinl & Crown 1954, p.156)

Fig. 10. Mile Island. Approximate location of some unexploded ammunition encountered in 1992.

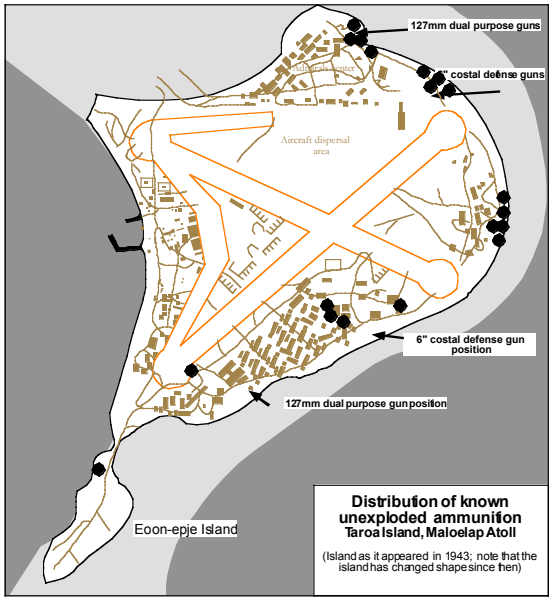

Fig. 11. Taroa Island. Approximate location of some unexploded ammunition encountered in 1992.

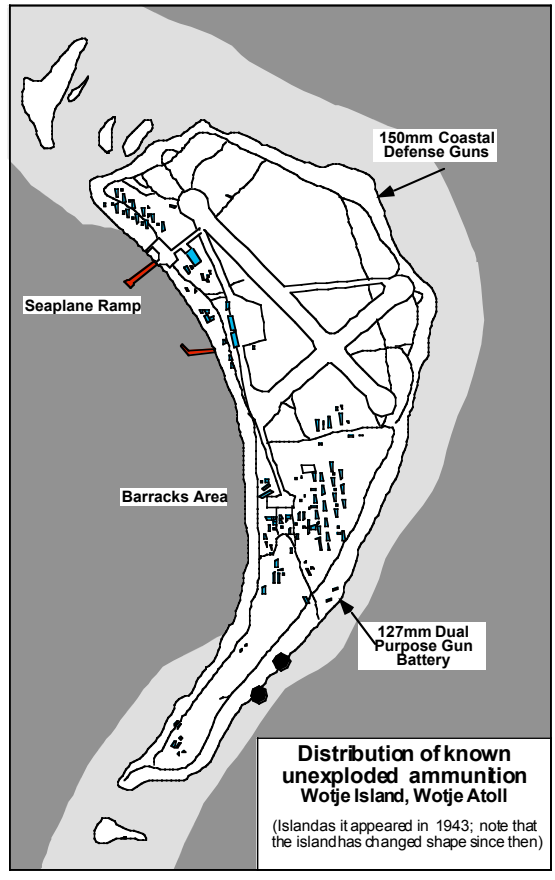

Fig. 12. Wotje Island. Approximate location of some unexploded ammunition encountered in 1992.

The Pacific theatre of World War II saw the development of extensive fortifications on various Micronesian Islands by the Japanese forces. While Chuuk was developed into a major naval base, several atolls of the Marshall Islands were transformed into large-scale airbases for fighter, bomber and seaplane operations.

While unexploded ammunition is prevalent on those islands that saw military action, the presence of ammunitions on other islands cannot be discounted. Fig. 15 shows fragments of (exploded) aerial bombs on the islet of Aelon-Eo on uninhabited Nadikdik Atoll. The bombs are either remains of Japanese practice bombs, dropped by Japanese aircraft operating from the Mile airbase, or they are the remains of US bombs either prematurely released on a bombing run against one of the passes into Mile atoll, or jettisoned while returning from one of the bombing runs on Mile.

Irrespective of their origin, these harmless fragments flag the possibility that unexploded ammunition in form on duds can also occur on the island in particular, and highlight the possibility that unexploded ammunition can occur away from the main foci of action.

Figure 13. Various shells and ammunition left behind after the Japanese positions on Kwajalein had been captured (Photo: US National Archives 80G-400976)

TYPES OF UNEXPLODED AMMUNITION

Let us now look at some of unexploded ammunition that has been encountered during the course of standard archaeological survey work on the former Japanese bases. All of the examples have been documented and photographed between 1989 and 1992 in the Marshall Islands and on Pohnpei. Of the three Japanese bases surveyed, Mile, Taroa and Wotje, the greatest amount of unexploded ammunition was encountered on Mile, so much so that it raised concern at the time (Spennemann *et al* 1990).

Japanese 127mm shells

The most common type of unexploded projectile found On Mile Atoll are the 127mm shells belonging to the two 127mm dual purpose gun batteries at the northern (Fig. 25) and the southwestern point. These shells are present either in a complete state together with the propellant casings (Fig. 21) or as projectiles only (cf. Fig. 20). A fair number of these projectiles, among them some still in their casings, was encountered at the western gun emplacement of the northern 127mm DP gun battery (Fig. 22, Fig. 26). A single projectile was found south of the eastern searchlight position of the same battery, possibly stemming from one of the ammunition magazines (Fig. 20). Some projectiles were encountered at the southwestern 127mm dual purpose gun battery, both at the shore (Fig. 18) and in the eastern gun emplacement (Fig. 33).

Figure 14. Fixed 127mm rounds left behind after the Japanese positions on Kwajalein had been captured (Photo: US National Archives 80G-400976)

Japanese 75 mm shells

A handful of projectiles of 75mm anti-aircraft shells were found at a sniper position and small ammunition bunker next to the northern 127mm dual purpose gun battery (Fig. 30).

Japanese 225mm (9 inch) shell

In 1991, a large 225mm (9 inch) naval projectile could be seen on the surface next to the underground ammunition storage or command structure of the northern 127mm dual purpose gun position on Mile I. (Spennemann *et al* 1990).

Japanese Aerial bombs

Unlike US aerial bombs, which were dropped liberally on the atolls, the presence of Japanese aerial bombs is limited. During the war they

would have been stored in ammunition bunkers on Taroa and Wotje, while on Mile they would have been stored in open revetments and ammunition dumps. After surrender these major dumps would have been emptied. The bombs that remain are those that had been moved to other locations for various reasons. We know from Wotje that aerial bombs had been buried vertically, fuse upwards, to serve as an anti-tank barrier in the case of a landing.

Again on Mile, close to the southern coastal defense battery (140mm) a large, apparently unexploded air bomb was found half buried in the wash zone of the beach (Spennemann *et al* 1990).

A 1000lb bomb is reported next to the Japanese war cemetery on Eoon-epje Island, Wotje.

Japanese Torpedoes

The Japanese bases in the Marshall Islands were equipped with flying boats (Wotje, Kwajalein) as well as squadrons of dive bombers and torpedo planes (Jaluit, Taroa and Mile). Torpedoes formed part of the ammunition stores on these bases. Torpedoes comprise in essence three discrete parts: the warhead, a cylinder for compressed air, and the motor. During a survey of Mile Island four compressed air cylinder of Japanese torpedoes were encountered (Fig. 27, Fig. 28) which were blown but unexploded removal teams even though perfectly harmless (Fig. 29).

Mine and buried depth charges

Close to the southwestern turning circle of runways A and B of the Mile airbase the lid of a disarmed depth charge or air mine was encountered. Although perfectly harmless, its existence may indicate the presence of other unexploded buried mines/depth charges. Indeed, according to the land owner, there are several other depth charges, at least three in number, still buried in the area, which form a health hazard of the first order.

Sea mines have been salvaged, made safe and turned into water catchments (Fig. 38).

Japanese Rifle and small arms ammunition

There is a considerable amount of rifle and small arms ammunition scattered about all island. In many cases the casings have been squashed. It is assumed that most it will be perfectly harmless unless battered with a stone or hammer. Other ammunition has been stripped of the copper-alloy casings, leaving the bullets behind (Fig. 37).

US Naval shells

In addition to the Japanese ammunition some US shells were also encountered, some of which were still live (Fig. 31) and others already made safe (Fig. 32). It can be surmised that a large quantity of unexploded naval shells is buried at shallow depth in the sand of the islands.

Napalm and Rockets

Napalm was trialed in October 1944 by fourth Marine aircraft wing, squadron VMF-441 (USSBS 1947a, p. 360) and heavily used against all four by-passed bases from April 1945 onwards (data in USSBS 1947a, p. 132; 206; 274; 360). While no napalm canisters have so far been recorded on the Japanese bases thus surveyed, it is quite likely that some may have not detonated and thus may still exist, possibly buried at a shallow depth.

Similar to Napalm, rockets were trialed in mid 1945 against the various targets (data in USSBS 1947a, p. 132; 206; 274; 360). As both applications were live-fire trials, it is possible that some may have gone wrong and not performed as expected.

UXO AS A HAZARD

The foremost danger inherent in the live ammunition is that its volatility has increased manifold as the years passed by. It is now over fifty years since the surrender of Japan. In the meantime the casings have corroded and the charges have undergone chemical changes. It can be foreseen that it is simply a question of time until someone will be hurt by an exploding shell.

Let us consider one of the common ammunition types: the 127 mm fixed rounds. The iron used for the shell's mantle and the copper

alloys used for the casings are of very inferior metal quality. If we consider the shell shown in Fig. 26, for example, we also note that that the fuse of the shell is still extended and seems to show no corrosion due to galvanic corrosion of the shell body. That galvanic corrosion differential can be observed among all 127 mm shells which have the cupro-alloy fuse and an iron-based shell mantle (see Fig. 20, Fig. 33). The accelerated corrosion, combined with the nature of the explosives contained in the shell make such ammunition particular unpredictable and thus dangerous. While some shells may well be perfectly harmless others may well be extremely volatile. From a management perspective such unpredictability pauses severe occupational health and safety issues.

An inherent danger in the management of the ammunition is that its danger and unpredictability can be underestimated. In the past the ammunition was 'safe' to handle as long a certain safety precautions were met. Thus the communities of Mile and other islands formerly serving as Japanese bases have found a large variety of secondary uses for World War II artifacts (Spennemann 2006). One of them utilizes the casings of shells a boundary markers for house platforms (in lieu of coral limestone boulders) and as pig bells (Fig. 43). The former clearly have not been fired and the projectiles have been pulled out at some stage. It is also quite possible that the powder charge in the casing has been used for bomb fishing. Some of the isolated projectiles may have also been stripped of their casings by scrap metal hunters. There are, for example, piles of small arms bullets that are fully formed and have not been fired—rather, it seems that the copper alloy casings were pulled off for the metal (Fig. 37). The location of these bullets at the beach indicates that whoever removed the casings either thought that beach was safer place for doing so, or may well have used the cordite to make bombs for bomb fishing.

As the volatility of the shells has increased considerably, such behavior, which may have been relatively safe ten years ago, has become a high health risk. It needs to be noted that a number of projectiles are to be found right in the middle of inhabited areas and that children not only come near to them but also play with them. In addition, given the limited size of Mile I., for example, it is obvious that children will chance to encounter a projectile, which may potentially go off if handled improperly.

Apart from intentionally handling these shells and projectiles, several are located in areas overgrown with vegetation, and it is possible that any gardening activities will cause the shells or projectiles to go off. In this context the presence of depth charges or mines at the southwestern part of Mile needs to be noted.

Transport of live ammunition from the bases to other islands

Dangers inherent from ammunition stemming from World War II sites, however, is not restricted to the atoll where the site is located. Completely apart from tourism-related removal of live ammunition to be dealt with below, ammunition has been moved for other purposes.

In early June 1989 a mortar shell destroyed part of the copra grinder of the Tobolar Copra processing plant in Majuro, Republic of the Marshall Islands. Fortunately, the mortar shell did not explode and the only–though costly–damage to the grinder was caused by the metal. The shell had been placed in a copra bag to increase its weight and hence the earnings. It is likely that the shell came from either Wotje or Maloelap.[6]

Dangers inherent in plant cover

Since many of the sites assessed are gun emplacements or other military installations they were shelled by U.S. forces. The around these sites abound with unexploded U.S. naval ammunition (even after 20 years of explosive ordnance removal) and unexploded Japanese Ordnance left on site. Documentation or vegetation clearing of such sites exposes the cultural resource manager to hazards of hidden explosives, such as Japanese 127mm shells which have not been fired and U.S. naval shells . This ammunition is deemed so unpredictable by explosive ordnance disposal specialists that the ammunition is exploded on sites, to the detriment of the cultural resource.

Fig. 15. Fragments of aerial bombs. (Aelon-Eo I., Nadikdik Atoll, RMI).

Fig. 16. Deactivated Japanese aerial bomb in the scrub. (Mile I., Mile Atoll, RMI).

Fig. 17. Unexploded aerial bomb. Note that the tail fins of the bomb (at left) are missing, while the fuse is still undamaged. (Wotje I., Wotje Atoll, RMI).

Fig. 18.Four 127mm DP projectiles on the beach just off the south-western 127mm gun battery. (Mile I., Mile Atoll, RMI).

Fig. 19. The burning of the vegetation in this 127mm dual purpose emplacement also exposed some unexploded 127mm shells. While this shell did not explode, other fires of the same (Mile I., Mile Atoll, RMI).

Fig. 20. 127mm shell in the grass in a 127mm gun emplacement (Mile I., Mile Atoll, RMI).

Fig. 21. Complete, but heavily corroded 127mmm round in a damaged gun emplacement. (Mile I., Mile Atoll, RMI).

Fig. 22. Inherent dangers of vegetation removal. Japanese 127mm shell partially covered by vegetation and discovered before vegetation clearing commenced (Mile I).

Fig. 23. Vegetation cleared around a Japanese 150mm gun (Wotje I., Wotje Atoll, RMI).

Fig. 24. Unexploded ordnance fully covered by vegetation accumulate leaf litter, discovered during vegetation clearing around the gun shown at left.

Fig. 25. A 127mm dual purpose gun emplacement . (Mile I., Mile Atoll, RMI).

Fig. 26. Live fixed round for a Japanese 127mm dual purpose gun. (Mile I., Mile Atoll, RMI).

Fig. 27. Disturbance of the heritage record by modern activities. The search for coconut crabs disturbs of the original arrangement of these compressed air cylinders of Japanese torpedoes (Mile I., Mile Atoll, RMI..

Fig. 28. Compressed air cylinders of Japanese torpedoes before disturbance (Mile I., Mile Atoll, RMI).

Fig. 29. Even though perfectly harmless, the compressed air cylinders were blown up by an overactive UXO team (Mile I., Mile Atoll, RMI).
(Photo Matt Holly late 1990).

Fig. 30. Mile Island. Unexploded 75 mm anti-aircraft gun projectile found in a sniper post and small ammunition magazine at the northern 127mm dual purpose gun battery (Mile I., Mile Atoll, RMI).

Fig. 31. US Naval shell among coconut (Mile I., Mile Atoll, RMI).

Fig. 32. 155 mm round at a house site on Tokowa Islet. This particular shell is harmless as it is open at the back. (Tokowa I., Mile Atoll, RMI).

Fig. 33. Cache of unexploded 127mm projectiles at the southern 127mm DP gun battery. v

Fig. 34. Impact damage to the bourrelet ring of the 150mm shell shown in Fig. 41. (Madelonimwh Harbour, Temwen I., Pohnpei, FSM)

Fig. 35. Several 127mm casings (shells removed) accumulated on Wotje I. (Wotje Atoll, RMI).

Fig. 36. Several 127mm casings (shells removed) accumulated on Wotje I. (Wotje Atoll, RMI).

Fig. 37. Small arms projectiles on the beach at Wotje. The brass casings have been removed for scrap metal. (Wotje I., Wotje Atoll, RMI).

Fig. 38. Deactivated sea-mine used as water catchment (Mile I., Mile Atoll, RMI).

Fig. 39.Disarmed naval projectile and cylinder of an aerial bomb used as a border of a living platform. (Tokowa I., Mile Atoll, RMI).

Fig. 40. Compressed air cylinders for use in Mitsubishi A6M 'Zero' fighter aircraft, piled up in a corner of the aircraft hangar or Mile Airbase. While perfectly harmless, uninitiated visitors might mistake these for unexploded ammunition.. (Mile I., Mile Atoll, RMI).

Fig. 41. The position of unexploded ammunition can pose substantial problems. In this case a past visitor placed a shell partly into the into the muzzle of a 150mm coastal defense gun and left it there. (Madelonimwh Harbor, Temwen I., Pohnpei State, FSM)

Fig. 42. The same gun barrel photographed in July 2006, showing the effects of ordnance detonation in place.

Fig. 43. Casing of a Japanese 127mm round serving as a pig bell (Mile I., Mile Atoll, RMI) (1991).

Tourism

If tourism is to be promoted, then the volatile ammunition needs to be removed from the sites or determined to be perfectly harmless. Otherwise the tour operators and/or the airline transporting the visitors to these destinations may be found liable in case of accidents. And any accident for that matter could potentially tarnish to reputation of the islands as a holiday destination.

Fig. 44 shows a visitor examining a 127mm dual purpose gun emplacement with unexploded ammunition in the immediate vicinity.

If the former Japanese bases are to be promoted a tourist installation catering for the war buffs it can be foreseen that there will be people collecting and attempting war materiel de-

spite regulation and law enforcement to the contrary. If someone collects a naval shell and carries it on the plane, the drop in air pressure at altitude may cause the shell to go off. The results of such a mid-air accident need no further explanation. Apart from the domestic flight, this is of even greater concern for the international airlines.

Fig. 44. A visitor examining a 127 mm dual purpose gun on Mile Islands. The arrow indicates the position of unexploded 127mm shells.

That visitors happily handle unexploded ammunition is evident from the example of the 150mm gun battery on Temwen Island, Madelonmwh Harbor, Pohnpei. A visitor picker picked up a shell and stuck in backwards into the muzzle of one of the guns (Fig. 41). The shell, left in place subsequently rusted in the muzzle through crevice corrosion, now forming a quite solid bond. Other visitors took a blunt instrument, possibly a stone, and battered the shell, presumably with the object of removing it. The impact damage to the bourrelet ring is quite obvious (Fig. 34). It is testament to the strength of the shell at the time that it does explode. The state of preservation of the fuse to shell-mantle joint inside the gun's muzzle can be speculated at., but is not likely to be very stable.

But harm to visitors may also come from an unexpected corner. Fig. 40 shows a pile of compressed air cylinders, which had been used in Mitsubishi A6M 'Zero' fighter aircraft.

Even though these cylinders are perfectly harmless, uninitiated visitors may mistaken then for unexploded ammunition their corroded condition and overall 'bomb shape.' Unless this has been managed, it may cause distress among some visitors were they to stumble upon the items unexpectedly during a visit.

Usage of live ammunition

So far, it appears, bomb fishing relying on unexploded ordnance no longer frequently occurs in the Marshalls. This is in contrast to the practice on Chuuk to dive to the sunken ships and retrieve unexploded ammunition (Hezel & Graham 1989).

The changes to the security situation following 11 September 2001 meant that real or perceived access to ammunition, especially to explosives, has been more curtailed that before. Thus the abundance of unexploded ammunition that is readily accessible and to which access is comparatively uncontrolled raises potential security concerns.

ISSUES OF HERITAGE PRESERVATION

Historic Preservation is based on the premise that cultural heritage sites should be preserved to the extent feasible unchanged and in place and that all preservation management actions should follow the Secretary of the Interior Standards for preservation—at least as applicable in the USA (*i.e.* Guam) and the US-influenced countries of Micronesia. The Standards stipulate that any conservation management must be respectful to the historic fabric of the site, should engage in minimal intervention and should contemplate irreversible methods of conservation intervention only as the last resort (US Secretary of the Interior Standards).

The Japanese and American World War II airbases on the Microensian islands are time

capsules of the Pacific War and in their complexity, and integrity, form prime cultural resources of significance to the two combatant countries (USA and Japan) as well as to the Micronesian communities own whose land the war was fought (Spennemann 1992c). From a heritage management perspective the ammunition lying around a given sites forms an integral part of the appearance of that site at war's end. On Japanese bases, such as those discussed earlier in the paper, unexploded Japanese ammunition forms part of the original fabric, while any unexploded American ammunition is now part of the site as it tells the story of the American attacks. In the strict heritage management sense, these items should be regarded as artefacts that are integral to the site and thus should not be removed from their original location. While is acknowledged that some of the items have been moved or interfered with some time in the past , but after the war (for example as part of scrap metal collections), they too now form part of the historic narrative embedded in the site. For example, the 127mm projectiles in the gun emplacements (cf. Fig. 19, Fig. 33) would have been part of complete fixed rounds (cf. Fig. 26). Some time in the past villagers removed the copper ally casing (presumably for scrap metal sales) and left the shells behind. Even though the immediate post-War (*ie* post September 1945) integrity of the site is impaired, the remaining elements of the ammunition still demonstrate the surrender and incomplete clean-up after the war, *and* they demonstrate the post World War II usage of ammunition in scrap metal drives.

From a heritage management perspective it is of importance that any unexploded ammunition stays *in situ*. If that cannot be ensured then the ammunition should be made safe or removed, but, to the extent feasible, any removal should not occur to the detriment of the heritage resource in question.

UXO and Managing Risk

As unexploded ammunition forms a hazard, its ethical management should follow the risk management approach. Risk is anthropocentric concept that considers the nature and extent of the hazard impact, the recurrence interval or probability of the impact actually occurring, and the extent to which the level of damage caused by the event is deemed acceptable (Spennemann 2005b).

Unexploded ammunition is different from other human and natural hazards as it does not have a standard measure of recurrence interval or probability of occurrence. *Any* area that has been the local of enemy action during World War II has a likelihood of unexploded ammunition, with the vicinity of the actual targets having a higher probability. Because bombing runs and naval shelling were not always accurate, and because on occasion bombing runs had to be aborted and the bomb load jettisoned, unexploded ammunition can occur on any part of an island that once hosted a Japanese base, and even on islands in the immediate vicinity of such a base that are located in the flight path in or out from that target to the base from which the US aircraft originated. The probability of occurrence increases on the islands that held Japanese garrisons or defense installations. On these islands the probability increases even further in the vicinity of specific strategic targets, such as defense gun emplacements (coastal or anti-aircraft), airfields, piers, truck and tank revetments, power stations, fuel dumps and command buildings.

When considering the potential impact of the ammunition, at the Japanese (or US) bases, we need to differentiate between unexpended Japanese (US) ammunition that is in association with the gun emplacement and ammunition storage, and the US (Japanese) ordnance that had been targeted at these emplacements but had failed to detonate on impact.[7]

The former is normally in a 'safe' condition with fuses not set or activated, while that latter had been activated but the systems/mechanics malfunctioned. Irrespective of this distinction, however, the passage of time has rendered *both* kinds of ordnance dangerous to the unwary. While *all* unexploded ammunition has the potential to severely injure or kill due to shrapnel scattering on explosion, napalm bombs have the added potential or burning the victims.

From a risk management perspective we need to acknowledge that i) the potential of unexploded ammunition hazards exists, ii) po-

tential impact on human health and even human life is unpredictable, and iii) that there is an understandable reluctance to wantonly expose fellow human beings to bodily harm. Thus the risk posed by unexploded ammunition cannot be accepted but must be mitigated.

"Traditional" Ordnance management

In the closing months of 1945 the US forces removed all remaining and easily accessible Japanese ordnance from the ammunition dumps on Wotje, Mile, Taroa and Jaluit. Most of these dumps were still substantial the time of surrender (USSBS 1947a). Although the US apparently took great care of the removal of Japanese ordinance from the major stores, there is still a fair amount of ordinance lying about which is definitely of Japanese origin.

The information about previous ordnance removal operations, concerning themselves with scattered ammunition, however, is very limited. Two years after the war, the US Army sent an ordnance removal team to the islands formerly held by Japanese garrison troops. This team, consisting of one ensign, two qualified enlisted men and a local interpreter, worked on Wotje, Jaluit, Taroa, Maloelap, and Mile (Richard 1957, p. II24). Mile was not visited until spring 1947, and Wotje was not visited until later, when the vegetation had largely recovered and a great deal of ammunition may have become hidden under scrub.

Following further reports of unexploded ammunition, a third ordnance removal mission was dispatched in September 1958 from the U.S. Navy Station Kwajalein to 'sanitize' Wotje and Mile.[8]

Yet another major ordnance removal mission took place in early 1969, covering Wotje (completed 13 April 1969), Jaluit [Akmann, Bok-en and Bijet islands] (1 May 1969), Mile [Mile & Tokowa Islands] (16 May 1969) and Maloelap [Taroa, Ollot & Tian Islands] (1 June 1969).[9]

Wotje Atoll clean-up in the early 1970s

Between 1971 and 1974 a succession of U.S. Army Civic Action Detachment Teams (CAD) had been active on Wotje clearing war debris and improving living conditions. While this was of definite benefit for the people of Wotje, a fair number of World War II sites was bulldozed.

These actions had the following effects on the archaeological sites on Wotje:

- a number of bomb craters was filled in; at one point the Civic Action Detachment Teams proposed and actually began filling in bomb craters with soil and stocking others with freshwater fish in order to combat the mosquito problem. Neither solution, it seems was well received by the Marshallese (Porter 1972a, p. 4-1). In another mission the CAD teams filled in bomb craters with scrap metal found on the surface. See also Porter 1973a, p.5-3
- a large number of personnel trenches were filled in during the construction of a road network: Porter 1972b, p.5-1
- a Japanese laundry building was converted into a 150,000 gallon water catchment (Porter 1972, p.5-1; figure 14);
- conversion of a bunker to act as water catchment (Porter 1972a, figure 15);
- general war debris, until then largely in situ was removed (Porter 1972b, p.5-3 quotes a figure of 2.5 tons for the period from 19 February to 27 July 1971 alone)
- As the clearance of land required was always achieved with heavy bulldozing equipment, a fair number of pre-Japanese archaeological surface sites, which may have survived the war, will have been destroyed.
- On the beneficial side, the following Japanese installations were completely or partially restored to serve their function:
- the main dock (Porter 1972a, p. 5-1; figure 17);
- the seaplane ramp (Porter 1972b, p. 5-3; figures 28-35; 1973a, p. 5-1; figures 6-9);
- a series of water catchments (Porter 1972a, p. 5-1);
- a 15,000 gallon steel tank with numerous shrapnel holes was rehabilitated and used for the runway construction (Porter 1972b, p. 5-3);
- the main runway, running NNW-SSW (runway A) was cleared of vegetation and rehabilitated for use by the inter-island air services; The runway was cleared to a length

of 4600 feet (of the former 4800 feet) and to a width of 220 feet (formerly 266). On the runway, 72 major bomb craters had to be filled in (Porter 1972a, p. 5-1 and figures 6 7, 9; 1972b, p. 5-1, figures 37-39)
- the main Japanese ammunition bunker was found by CAD team members, serviced with an access road and access ramp and rehabilitated as a warehouse and gear storage area of the CAD team (Porter 1972b, p. 5-3).

Ordnance situation on Mile

Mile, Mile as well as Bikenen Island, Mile Atoll, were uninhabited in early 1952, as the ammunition scattered on the island posed to great a danger to human life.[10]

Following reports of unexploded ammunition, a third ordnance removal mission was ordered by the U.S. Navy in 1954, covering Taroa, Maloelap Atoll, and Mile Island, Mile Atoll.[11]

An assessment of the situation on Mile Atoll in 1955 revealed that most of the islands need clearing of unexploded ordnance and replanting, since people are still unable to return there for settlement and live on other islands of Mile Atoll.[12]

On Mile 613 "known" pieces (as shown to the team by some islanders and the Peace Corps volunteers) and 2594 other pieces of ordnance were destroyed during the 1969 mission.

The co-operation with the locals during this removal mission was not the best, it appears. During a survey of Mile Island the EOD team found 11½ 55 gal. drums of picric acid, some of which already in a crystallized form. On returning the following day in order to remove and destroy these drums, only ten drums were present. The missing 1½ drums could not be located and none of the locals would be of assistance. The report mentions that bomb fishing was of great importance to the locals and that they would not volunteer the whereabouts of unexploded ammunition.[13]

Ordnance situation on Taroa, Maloelap

Ordnance removal mission to Taroa seem to have occurred soon after the war in the closing months of 1945), where the majority of the readily accessible Japanese ordnance was removed (USSBS 1947a), with another mission on 1947 (Richard 1957, p. II24) and a third major ordnance removal mission in June 1969.[14] Local informants during the 1989 fieldwork also mentioned that another ordnance and site clearing mission arrived on Taroa in the mid-1980s, possibly in 1985, during which time part of the island was cleared of ammunition as well as war debris using a bulldozer (Adams *et al* 1997, p. 86). The archaeological survey of Taroa in 1989 indeed encountered abundant evidence of sites damaged during the previous ordnance removal activities (Adams *et al* 1997,p. 86).

Fig. 45. Stockpiled unexploded ammunition collected for future disposal in a non-secure environment. While some of the pieces are safe others are volatile. (Saipan, CNMI)(2003).

Some general comments

Even though Japanese base islands in the Marshall Islands are comparatively small, it will be impossible to remove all unexploded ammunition, unless an island is removed to the reef platform and rebuilt—a wholly unrealistic concept. The soft substrate of the islands, coral sand, means that the ammunition can be embedded at various depths. Ammunition detection using metal detectors is virtually made impossible given the massive amount of bomb and shell fragments and shrapnel that is scattered there. Thus despite all good efforts, *some* unexploded ammunition will remain and will eventually be unearthed.

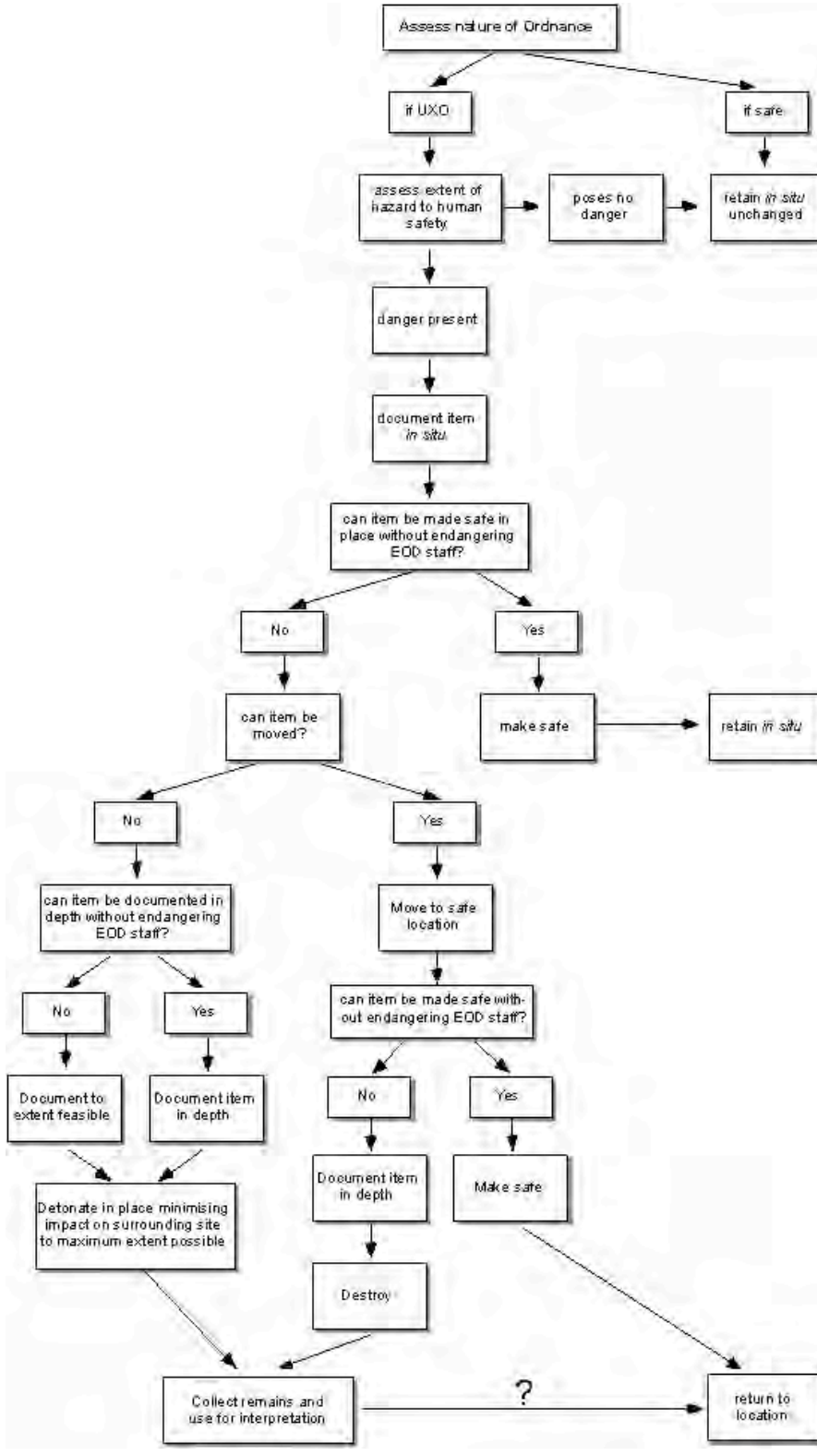

Fig. 46. Suggested decision tree for the management of ammunition encountered at heritage sites

Status of the unexploded ammunition

Elsewhere in Micronesia unexploded ammunition removal follows the same principles. Where possible ammunition is collected, stockpiled and eventually exploded. Some of these collection dumps are not the most secure locations despite the potential security risk posed (Fig. 45, Fig. 47).

Fig. 47. Stockpiled unexploded ammunition collected for future disposal in a non-secure environment (Saipan, CNMI)(2003).

TOWARDS A RESPONSIBLE APPROACH

In he period immediately after the war all unexpended ammunition was essentially safe to handle, provided that standard precautions of handling ammunition were followed. The unexploded at the time was a more problematic matter, but could still be dealt with comparatively safely. The passage of time and the concomitant corrosion has now added another level of complexity and, above all, unpredictability. And is this unpredictability that needs to be paramount in heritage management decisions.

It must be stressed that unexploded ammunition is dangerous, and that it should only be handled by explosive ordnance removal personnel. The main problem is that cultural heritage management staff may underestimate the risk unexploded ammunition presents. Essentially, no unexploded ammunition situation is identical, and no piece of unexploded ammunition can be assumed to behave in the same fashion as the last. Not only are there micro-environmental variations that contribute to differential decay of the fabric of the unexploded ammunition, but there are also variations in the make up of the alloys used or shell casings and other elements of the original ordnance. Thus it would be dangerous to rely on 'experience' and take unexploded ammunition lightly. With regard to unexploded ammunition, the premise should always be that your first wrong assumption may be your last.

However, explosive ordnance removal personnel do not generally understand the principle of cultural heritage management and are thus prone to destroy heritage sites or their constituent materials. Fig. 46 provides a decision flow chart on how to deal with unexploded ammunition in heritage situations. That decision tree should be discussed with explosive ordnance removal personnel prior to actions being taken. Wherever possible, unexploded ammunition should be made safe and remain *in situ* as part of the site. Any action that cannot guarantee *in situ* preservation, should be preceded by in-depth documentation of the unexploded ammunition *in situ* (being mindful of the risk posed) and then once removed, documented again as a single object—Always under the proviso that human life and health must not be endangered. It is important that unexploded ammunition removal personnel are appraised of and appreciative of cultural heritage management needs.

The best case scenario is that the ammunition is deemed safe and can remain *in situ*. The worst case scenario is that the ammunition is deemed highly unstable and requires a controlled detonation in place. That scenario will pose the greatest risk to an associated site(s) as the blast may cause collateral damage. Given that many sites are already damaged by the impact of the war, and almost all have suffered from environmental decay since en, such controlled detonations of unexploded ammunition may increase the level of damage to unpredictable levels. The responsible approach will be to sand bag the ammunition in such a way that the surrounding fabric is well protected and that the force of the explosion is directed upwards.

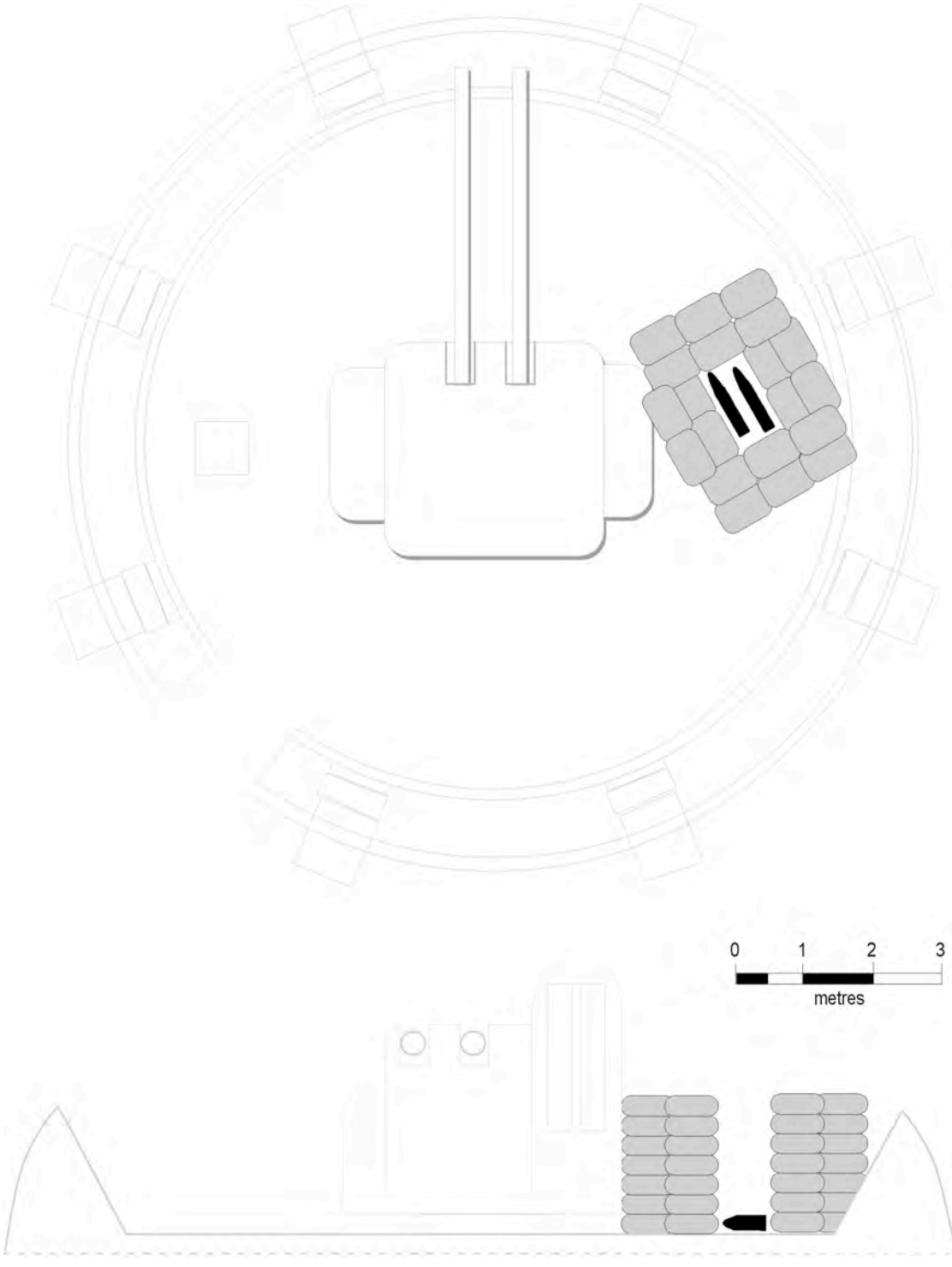

Figure 48. Schematic sand bagging of unexploded ammunition in a 127mm dual purpose gun emplacement, if in situ *detonation is required*

Unexploded ammunition will always be a problem for cultural heritage management—but there is no reason whatsoever, that explosive ordnance removal has to be carried out in fashion that is detrimental to the preservation of a heritage site. The solution rest in the full understanding of options and the careful and well considered planning of ordnance removal.

ENDNOTES

1. Source: USSBS 1947a:134; 1) two magazines remained at the end of the war; 2) 15000 rounds of 3224,250 destroyed by bombing; 3) 2,000 rounds of 38,520 destroyed by bombing; 4) 27 of the tanks were torn down and the material used for new construction.
2. *Cf.* Operations Plan No. 3-1944 for TF 57, Serial 00330, dated 16 April 1944. File A4-3(1)/FF12/25-dch, Group A8 Intelligence, general. U.S. National Archives. RG 313 Red Series Entry 353 Box 7067.
3. U.S. National Archives, Washington. Record Group 243 II C (59). Air Action Report No.1 of the VPB-24.
4. U.S. National Archives, Washington. Record Group 243 II C (21). Air Action Report No.116 of the VMF-155.
5. June 13, 1945: U.S. National Archives, Washington. Record Group 243 II C (15). Air Action Report Nos. 251, 252, 253 of the VMF-11;—June 28, 1945: Record Group 243 II C (21). Air Action Report Nos. 143, 144, 145 of the VMF-155.—July 12, 1945: Air Action Report No.149 of the VMF-155
6. But see the debate in the media (Johnson 1989; Steege 1989; Reeder 1989). The Ship which brought the copra, MV *MicroChief*, stopped and loaded copra at Likiep, Ailuk, Utirik, Mejit, Wotje and Maloelap. The only islands which had Japanese military bases were Taroa, Maloelap, and Wotje. Of the other islands only Utirik had been bombed (in November 1943) by B-24s of the VII Army Air Force operating from Makin and later Tarawa in Kiribati. However, the only atolls which had permanent Japanese military bases were Taroa Island, Maloelap Atoll, and Wotje Island, Wotje Atoll. Of the other islands only Utirik and Mejit Island ever had any Japanese military forces stationed on them both operated by the was operated by the Imperial Japanese Navy (IJN). Based on comparison with identification drawings in TM9-1985-5, both fragments belong to a Imperial Japanese Army (IJA) Type 100 81mm high-explosive mortar shell (TM9-1985-5 page 381) for use in the Army Type 97 or Type 99 81mm mortars. Missing from the complete round are – apart from the explosives (1.18 lb of TNT) – the fuse cap and the little tail-fins. Since the IJN had its own set of ammunition, including mortars (Type 3 81-mm high-explosive mortar: TM9-1985-6 Page 517) it is highly unlikely that the shell could have come from a location other than Taroa, Maloelap Atoll (368 IJA personnel) or Wotje, Wotje Atoll where IJA units had been stationed (429 IJA personnel USSBS 1947). Both atolls had seen a reinforcement of IJA garrison troops in the final days before the American Invasion in end of January/early February 1944. The majority of these troops was moved to Wotje. Unfortunately we are ill informed about the equipment these troops brought with them. The U.S. Strategic Bombing Survey (1947), which lists all stationary and semi-stationary guns, does not contain any data on the IJA weaponry on these atolls.
7. Excluded here are the booby traps that had been set by retreating Japanese soldiers on the islands that saw combat fighting (eg Guadalcanal, Kwajalein, Saipan, Peleliu etc). As these areas had been sanitised by conquering US/Allied forces, we can assume that these booby traps no longer exist—an exception may occur on Peleliu where some Japanese positions in caves had been closed US by bulldozers trapping personnel inside.
8. Memorandum from Explosive Ordnance Disposal Officer U.S. Navy Station Kwajalein to District Administrator Marshall Islands District, dated 23 September 1958. Archives of the TTPI Microfilm Roll Nº 545, Group 0058.
9. Message Commander Naval Ordnance Systems Command to headquarters Washington. ORD S-434, COMEODGRUPAC/JWI:rc 800C Serial Nº 159, dated 2 May 1969; Summary report and letter from Commander Explosive Ordnance Disposal Group Pacific to Commander Hawaiian Sea Frontier COMEODGRUPAC/JWI:rc 800C Serial Nº 350, dated 4 September 1969. Archives of the TTPI Microfilm Roll Nº 545, Group 0058.
10. Report by District Administrator Marshall Islands, April 3, 1952. Archives of the Trust Territory of the Pacific Islands, Microfilm Nº 545, Group 0058.
11. Commander U.S.Pacific Fleet Task Group 32.2 and Commander Hawaiian Sea Frontier 30A:WJM FF 14-5/A4-3 Serial Nº 11916. Op-

eration Order HSF 10-54. Archives of the TTPI Microfilm Roll Nº 545, Group 0058.

12 Memorandum from H.M. Majo, Staff Agriculturist to Deputy High Commissioner, Trust Territory of the Pacific Islands, Saipan, dated 1 April 1955. Archives of the TTPI Microfilm Nº442.

13 Message Commander Naval Ordnance Systems Command to headquarters Washington. ORD S-434, COMEODGRUPAC/JWI:rc 800C Serial Nº 159, dated 2 May 1969; Summary report and letter from Commander Explosive Ordnance Disposal Group Pacific to Commander Hawaiian Sea Frontier COMEODGRUPAC/JWI:rc 800C Serial Nº 350, dated 4 September 1969. Archives of the TTPI Microfilm Roll Nº 545, Group 0058.

14 Message Commander Naval Ordnance Systems Command to headquarters Washington. ORD S-434, COMEODGRUPAC/JWI:rc 800C Serial Nº 159, dated 2 May 1969; Summary report and letter from Commander Explosive Ordnance Disposal Group Pacific to Commander Hawaiian Sea Frontier COMEODGRUPAC/JWI:rc 800C Serial Nº 350, dated 4 September 1969. Archives of the TTPI Microfilm Roll Nº 545, Group 0058.

BIBLIOGRAPHY

Adams, William, H., Ross, Richard, E., Krause, Elisabeth, L. and Spennemann, Dirk H.R. (1997), *Micronesian Resources Study, Marshall Islands Archaeology. The Japanese Airbase on Taroa Island, Republic of the Marshall Islands, 1937-1945: an evaluation of World War II Remains*., San Francisco, Calif. : Micronesian Endowment for Historic Preservation, US National Park Service.

Compact of Free Association between the the Government of the United States and the Government of the Republic of the Marshall Islands (1982)

CNMI (1982) *An act to promote the preservation of the historic and cultural heritage of the Northern Mariana Islands, to prohibit the taking of historic properties and artifacts from the Northern Mariana Islands, to repeal Chapter 3.28 of the Mariana Islands District Code and Chapter 11, sections 251 through 256 of title 67 of the Trust Territory Code, and for other purposes.* Third Northern Marianas Commonwealth Legislature. First regular Session, 1982. Public law 3-39, Senate Bill No. 3-49, S.D.2, H.D.1.

Bartsch, W.H. (1986) Wreck Discovery: Unknown Maloelap. *After the Battle*, 54. London: Battle of Britain Prints International Ltd. Pp. 28-41.

Carrell, T. (1991) Submerged Cultural Resources Assessment of Micronesia. *Southwestern Cultural Resources Center Professional Papers* Nº 36. Santa Fé, New Mexico: Southwestern Cultural Resources Center.

Carter, K.C & R.Mueller (1973) *The Army Air Force in World War II. Combat Chronology 1941-1945.* Washington: Albert Simpson Historical Center, Air University & Office of Air Force History, Headquarters USAF.

Christiansen, Henrik (1994a) The Archaeology of World War II in the Marshall Islands. Volume I: Tõrwa. Republic of the Marshall Islands: Historic Preservation Office.

Christiansen, Henrik (1994b) The Archaeology of World War II in the Marshall Islands. Volume II: Wõjjã. Republic of the Marshall Islands: Historic Preservation Office.

Christiansen, Henrik (1994c) The Archaeology of World War II in the Marshall Islands. Volume III: Jãlwõj. Republic of the Marshall Islands: Historic Preservation Office.

Christiansen, Henrik (1994d) The Archaeology of World War II in the Marshall Islands. Volume IV: Mile. Republic of the Marshall Islands: Historic Preservation Office.

CinCPac-CinCPOA (1944a) CinCPac-CinCPOA Transalations Item #10,018. Summary of the American Army counter-attack in the Gilberts Area of November 1943. Imperial Army Headquarters, Army Department. January 1944. CinCPac-CinCPOA Transalations 12, Pp.43-71

CINPAC-CINCPOA (1945d) Japanese Artillery weapons. *CinCPac-CinCPOA Bulletin* 152-45. 1 July 1945. Commander in Chief U.S. Pacific Fleet and Pacific Ocean Areas.

CINPAC-CINCPOA (1945e) Landbased anti-aircraft gunnery manual. Special Translation 61. *CinCPac-CinCPOA Bulletin* 104-45. 18 May 1945. Commander in Chief U.S. Pacific Fleet and Pacific Ocean Areas. Page 97.

Craib, J. (1989) *Archaeology reconnaissance survey and sampling, U.S.Army Kwajalein Atoll facility (USAKA), Kwajalein Atoll, Republic of the Marshall Islands, Micronesia.* Report prepared by J.Craib with contributions by T.Bonhomme, Joyce Clevenger, Nancy Farrell, Orrin Sage Report submitted to U.S.Army Engineer District, Honolulu, Fort Shafter, Hawaii.

Crowl, P.A. & Lowe, E.G. (1955) *Seizure of the Gilberts and the Marshalls. The War in the Pacific. United States Army in World War II.* Washington: Office of the Chief of Military History, Department of the Army.

Delgado, J.P., Lenihan, D.J. and Murphy, L.E. (1991) Archaeology of the Atomic Bomb: A submerged Cultural Resources Assessment of the sunken fleet of Operation Crossroads at Bi-

kini and Kwajalein Atoll lagoons, Republic of the Marshall Islands. *Southwestern Cultural Resources Center Professional Papers* N° 37. Santa Fé, New Mexico: Southwestern Cultural Resources Center.

Denfeld, D.C. (1979a) Field Survey of Ponape: World War II Features. *Micronesian Archaeological Survey Report* No. 2. Saipan: Historic Preservation Office, Trust Territory of the Pacific Islands.

Denfeld, D.C. (1979b) Field Survey of Truk: World War II Features. *Micronesian Archaeological Survey Report* No. 6. Saipan: Historic Preservation Office, Trust Territory of the Pacific Islands.

Denfeld, D.C. (1980) *An Historic site survey of Kwajalein Missile Range, Kwajalein Atoll, Marshall Islands.* Pacific Studies Institute, Agana, Guam. Contract No. DACW-79-C-0028, P00005. (not seen).

Denfeld, D.C. (1981) Japanese fortifications and other military structures in the Central Pacific. *Micronesian Archaeological Survey Report* No. 9. Saipan: Historic Preservation Office, Trust Territory of the Pacific Islands.

Denfeld, D.C. (1988) Peleliu revisited. An historical and archaeological survey of World War II sites on Peleliu Island. *Micronesian Archaeological Survey Report* No. 24. Saipan: Historic Preservation Office, Commonwealth of the Northern Mariana Islands.

Department of the Interior (1992) *Secretary of the Interior's Standards for Rehabilitation and guidelines for rehabilitating Historic Buildings.* Washington, D.C.: US. Department of the Interior, National Park Service.

Heine, C. (1974) *Micronesia at the Crossroads. A reappraisal of the Micronesian Political Dilemma.* [Honolulu: East-West Center, University Press of Hawaii.

Hezel, F.X & Graham, C. (1997) *Micronesian Resources Study. Truk Underwater Archaeology. Truk's Underwater Museum:A report on the sunken Japanese ships, Federated States of Micronesia.* San Francisco, CA: Micronesian Endowment for Historic Preservation.

Hezel, F.X. & C.Graham (1989) *Truk's Underwater Museum. A Report on the Sunken Japanese Ships.* A project sponsored by the Micronesian Endowment of Historic Preservation. Report prepared for the Micronesian Resource Study, Micronesian Endowment of Historic Preservation.

Hickey, L.J. (1986) *Warpath across the Pacific.* 2nd edition. Boulder, Co.: International Research and Publishing Company.

Howard, C. & Whitley, J. (1946) *One damned island after another.* Chapel Hill: University of North Carolina Press.

JICPOA (1943a) Joint Intelligence Center, Pacific Ocean Areas. Information Bulletin Maloelap. *JIPCOA Bulletin* 52-43, November 25 (1943.

JICPOA (1943b) Joint Intelligence Center, Pacific Ocean Areas. Air Target Map and Photos Maloelap. *ATF 28-A*, November 25, 1943.

JICPOA (1943c) Joint Intelligence Center, Pacific Ocean Areas. Air Target Map and Photos Jaluit. *ATF 28-A*, December 10, 1943.

JICPOA (1943d) Joint Intelligence Center, Pacific Ocean Areas. Air Target Map and Photos Lesser Marshalls. *ATF 28-A*, December 20, 1943.

JICPOA (1944) Japanese Military Installations. Joint Intelligence Center Pacific Ocean Areas. *JICPOA Bulletin* 71-44, June 15, 1944.

JICPOA (1944a) Study of Japanese Installations on Butaritari Island—Makin Atoll. Part I: Fortifications and defence installations 14 January 1944. *JICPOA Bulletin* 4 -44.

JICPOA, 1944b) Study of Japanese Installations on Butaritari Island—Makin Atoll. Part II: Radar, communications and power plants. 14 January 1944. *JICPOA Bulletin* 4 -44.

JICPOA (1944c) Study of Japanese Installations on Butaritari Island—Makin Atoll. Part III: Base installations and miscellaneous information. 14 January 1944. *JICPOA Bulletin* 4 -44.

JICPOA (1944d) Japanese Military Installations. Joint Intelligence Center Pacific Ocean Areas. *JICPOA Bulletin* 71-44, June 15, 1944.

JICPOA (1944e) Joint Intelligence Center Pacific Ocean Areas, Air Target and Photos ATF No. 23-A Wake. February 20, 1944. 64th Engr. Top. Co. U.S.AFICPA No. 596-3.

JICPOA (1944f) Ground Photos and Analysis. Base installations Roi, Namur and Enubirr Islands, Kwajalein Atoll. *JICPOA Bulletin* 46-44. 15 April 1944.

JICPOA (1944g) Kwajalein Atoll, Kwajalein Island, Ebeye, Roi-Namur. Fortifications and Defence installations. *JICPOA Bulletin* 48-44. 10 April 1944.

JICPOA (1945a) Heavy dual purpose gun emplacements. Special Translation No. 59. Serial No. DIS-261400. *CinCPac-CinCPOA Bulletin* 97-45, 7 May 1945. Commander in Chief U.S. Pacific Fleet and Pacific Ocean Areas.

JICPOA (1945c) Air attack of Japanese coastal defence batteries. Target Analysis. Serial DIS-021340. *CinCPac-CinCPOA Bulletin 17-45* 15 February 1945.

JICPOA (1945d) Air attack of Japanese coastal defence batteries. Target Analysis. Serial DIS-021340. CinCPac-CinCPOA Bulletin 17-45 15 February 1945

JICPOA,1945b) Anti-aircraft defence fortifications. Special Translations No. 62. *CinCPac-CinCPOA Bulletin* 110-45. 17 May 1945. Commander in Chief U.S. Pacific Fleet and Pacific Ocean Areas.

Johnson, G. (198) "Bomb" takes toll at Tobolar. *Marshall Islands Journal* 20(27) June 9.

Kamada, S. (1947) Evidence given during interrogation. In: United States Strategic Bombing Survey, *The American campaign against Wotje, Maloelap, Mille and Jaluit*. Washington: Naval Analysis Section, United States Strategic Bombing Survey. Pp. 136-141.

Kerr, J. (1995) *The conservation plan. A guide to the preparation of conservation plans for places of European cultural significance*. Sydney: National Trust.

Linck, Dana C. & Vann, Joe W. (2001) Dig Fast, Die Young: Unexploded Ordnance and Archaeology. In: Kenneth L. Feder & David A. Piorier (eds), *Dangerous Places. Health, Safety and Archaeology* Westport, Conn.: Bergin & Garvey. Pp. 169-188.

Look, D. and Spennemann, Dirk H.R. (1993a) *For future use. A management conservation plan for the World War II sites in the Republic of the Marshgall Islands*. San Francisco and Albury: US National Park Service and Johnstone Centre of Parks, Recreartion and Heritage.

Look, D. and Spennemann, Dirk H.R. (1993b) Saving WWII Historic Sites. Metals Conservation Course in the Marshall Islands. *Cultural Resource Management Bulletin* [U.S. National Park Service] 16 (5), 22-24.

Marshall, S.L.A. (1945) *Island Victory, The battle of Kwajalein Atoll*. Washington: The Infantry Journal.

MEIU (1945c) *Japanese Explosive Ordnance*. Revised edition. U.S.Navy, Mobile Explosives Investigation Unit N° 1. FPO San Francisco. (AWM 623. 452. J35 1945).

Morison, S.E. (1948) History of U.S. Naval Operations in World War II. Vol. III: The rising sun in the Pacific. 1931-April 1942. Boston: Little, Brown & Co.

Morrison, S.E. (1951) *History of United States Naval Operations in World War II. Vol VII: Aleutians, Gilberts & Marshalls.June 1942-April 1944*. Boston: Little, Brown & Co.

Murphy, G. (1990) Majuro: Gateway to Coral Paradise. *Skin Diver* 39 (3), March 1990, 128-134.

National Park Service(1992) Guidelines for evaluating and registering historic archaeological sites and districts. *National Register Bulletin 36*. Washington, D.C.: US. Department of the Interior, National Park Service.

Porter, M.D. (1972a) CINCPACREP GUAM/TTPI CAD-GUAM, Civic Action Team Marshalls Deployment Completion Report for the period 24 August 1971 to 19 February 1972. Commander-in-Chief Pacific Representative Guam and Trust Territory of the Pacific Islands Civic Action Team Guam.

Porter, M.D. (1972b) CINCPACREP GUAM/TTPI CAD-GUAM, Civic Action Team Marshalls Deployment Completion Report for the period 19 February 1972 to 27 July 1972. Commander-in-Chief Pacific Representative Guam and Trust Territory of the Pacific Islands Civic Action Team Guam.

Porter, M.D. (1973) CINCPACREP GUAM/TTPI CAD-GUAM, Civic Action Team Marshalls Deployment Completion Report for the period 24 July 1972 to 15 January 1973. Commander-in-Chief Pacific Representative Guam and Trust Territory of the Pacific Islands Civic Action Team Guam.

Reeder, D. (1989) Tobolar regrets offending Maloelap. *Marshall Islands Journal* 20(28) July 14, 1989. Page. 16.

Richard, D.E. (1957) *United States Naval Administration of the Trust Territory of the Pacific Islands*. 2 vols. Washington, D.C.: US General Printing Office.

Rust, K.C. (1979) *Seventh Air Force Story in World War II*. Temple City, CA.: Historical Aviation Album.

SCU (1945) Operations of Seventh Air Force in Pacific Ocean Areas, November 1943-April 1945. Prepared by 9th Statistical Control Unit, Oversea, Special APO 331. Page 5.

Spennemann, Dirk H.R. (1990) The ownership of cultural resources in the Marshall Islands an essay in pertinent juridsprudence and legal history. Report OTIA-TAG-MAR-42-8/90. Majuro, Republic of the Marshall Islands: Alele Corporation

Spennemann, Dirk H.R. (1990a) *Cultural Resource Managment Plan for Majuro Atoll, Republic of the Marshall Islands*. 2 Vols. Report prepared in fulfillment of U.S.Department of Interior, Office of Territorial and International Affairs Technical Assistance Grant MAR-42. Report submitted to the Historic Preservation Office, Majuro, Republic of the Marshall Islands. August 1990.

Spennemann, Dirk H.R. (1990b) *Identification of a World War II shell found in the Copra-grinder of Tobo-*

lar. HPO Report N°4 1990. Ms. on file. Division of Archaeology, History and Traditional Material Culture, Alele Inc. P.O.Box 629, Majuro 969690, Republic of the Marshall Islands

Spennemann, Dirk H.R. (1991a) *Mile, Mile Atoll. Air Marshall Islands Sunday Escape. Folded tour brochure*, 2pp. Majuro Atoll: Air Marshall Islands.

Spennemann, Dirk H.R. (1991b) *Taroa, Maloelap Atoll. Air Marshall Islands Sunday Escape*. Folded tour brochure, 2pp. Majuro Atoll: Air Marshall Islands.

Spennemann, Dirk H.R. (1991c) Historical Sites on Taroa Island, Maloelap Atoll. *Ennaanin Etto—News from the Past* 1(1), 5-6.

Spennemann, Dirk H.R. (1991d) *Submerged Cultural Resources of Wotje Atoll. Identification and Resource Management*. Report in partial fulfillment of a South Pacific Cultures Fund Grant. HPO-Report 1991/7. Majuro Atoll, Republic of the Marshall Islands: Historic Preservation Office.

Spennemann, Dirk H.R. (1992a) *Wotje, Wotje Atoll. Air Marshall Islands Sunday Escape*. Folded tour brochure, 2pp. Majuro Atoll: Air Marshall Islands.

Spennemann, Dirk H.R. (1992b) Know your Past: Historical Sites on Mile Island, Mile Atoll. *Ennaanin Etto -News from the Past* 2(1), 1992, 8-10

Spennemann, Dirk H.R. (1992c) World War II Remains on Central Pacific Islands: Perceptions of Heritage versus Priorities of Preservation. *The Pacific Review* 5 (3), pp. 278-290.

Spennemann, Dirk H.R. (1992d) Investigations of a Consolidated B-24 "Liberator" aircraft of Jabu Island, Arno Atoll. HPO-Report 1992/1. Majuro Atoll, Republic of the Marshall Islands: Historic Preservation Office.

Spennemann, Dirk H.R. (1992e) Apocalypse now?—the fate of World War II sites on the Central Pacific Islands. *Cultural Resources Management Bulletin*. 15(2), pp. 15-16, 22.

Spennemann, Dirk H.R. (1998) Cultural heritage management of unexploded ammunition. *CRM Bulletin* 21(8), 48-51.

Spennemann, Dirk H.R. (2005). Is unexploded World War II ammunition abandoned property? A case of ethics and the law in Micronesia. *Journal of South Pacific Law* vol.9 (2), December 2005 http://law.vanuatu.usp.ac.fj/jspl

Spennemann, Dirk HR (2005b) Heritage Site Management Module 4: Disaster Management Plans. Wagga Wagga: Charles Sturt University

Spennemann, Dirk H.R. and Look, David W. (1994) Impact of tropical vegetation on historical cultural resources. A photographic case study from the Marshall Islands. The Johnstone Centre for Parks, Recreation and Heritage Report N° 18— The Johnstone Centre for Parks, Recreation and Heritage, Charles Sturt University, Albury, NSW., 1994.

Spennemann, Dirk HR. (2006) Examples of Adaptive re-Use of World War II Artefacts in Micronesia. *Micronesian Journal of the Humanities and Social Sciences* vol. 5 nº 1, pp. 268-284.

Spennemann, Dirk H.R., Holly, Matt and Lajuan, Newton (1990) Report on the occurrence of live ammunition on Mile Island, Mile Atoll. Report prepared for the Historic Preservation Office, Majuro, the Mile Atoll Local Government, Mile, Mile Atoll, and the Hon.Senator for Mile, Mr. Alee Alik. Republic of the Marshall Islands. Report OTIA-TAG-MAR-42-5/90. Majuro Atoll: Alele Museum.

Steege, S.H. (1989) Accusation against Maloelap unjustified. *Marshall Islands Journal* 20(28) July 14, 1989. Page. 16.

U.S. War Office (1953a) *Japanese Explosive Ordnance. (Army Ammunition, Navy Ammunition,*. TM 9-1985-5/TO 39B1A-12. Washington, DC.: U.S. Government Printing Office.

U.S. War Office (1953b) *Japanese Explosive Ordnance. (Bombs, Bomb fuzes, Land mines, Grenades, Firing devices and Sabotage devices,*. TM 9-1985-4/TO 39B1A-11. Washington, DC.: U.S. Government Printing Office.

US Marine Corps (1944) United States Marine Corps, Division of Aviation, Intelligence Section, *Bombing of gun emplacements by SBD-5's*. Copy of Ms. on file, Alele Museum, Majuro, Republic of the Marshall Islands.

USSBS (1946b) *Japanese Naval Ordnance. Military Supplies Division. Dates of Survey: October-November 1945*. United States Strategic Bombing Survey, Washington, DC.

USSBS (1947a) United States Strategic Bombing Survey, The American campaign against Wotje, Maloelap, Mille and Jaluit. Washington: Naval Analysis Section, United States Strategic Bombing Survey.

USSBS (1946a) United States Strategic Bombing Survey, *The Campaigns of the Pacific War*. Washington: Naval Analysis Division, United States Strategic Bombing Survey.

USSBS (1947a) United States Strategic Bombing Survey, *The American campaign against Wotje, Maloelap, Mille and Jaluit*. Washington: Naval Analysis Section, United States Strategic Bombing Survey.

USSBS (1947d) United States Strategic Bombing Survey, *The 7th and 11th Air Force in the war*

against Japan. Report 70. Washington: Naval Intelligence Center.

AUTHOR BIOGRAPHY AND CONTACT

Dirk HR Spennemann is Associate Professor in Cultural Heritage Management at Charles Sturt University, Albury, Australia. His main research interests are German colonial heritage in Oceania, in particular Micronesia, and historic preservation issues in Micronesia in general. His second focus are issues of heritage futures, including the threats to heritage posed by natural and human hazards and threats posed by managers in their efforts to counter these hazards. Ethical Heritage Planning and Policy are the cornerstones that need to be understood and addressed if our past is to have a meaningful future.

CONTACT: A/Professor Dirk H.R. Spennemann, Charles Sturt University, P.O.Box 789, Albury NSW 2640, Australia e-mail dspennemann@csu.edu.au