APPENDIX 6

Unexploded Ordnance
Management Plan

Gibson Nominees Pty. Ltd.

One-stop Seamless Strategic Support

A.C.N. 008 434 222

For

Umwelt (Australia) Pty Ltd
Environmental Consultants
Post Office Box 838
Toronto NSW 2283

UNEXPLODED ORDNANCE MANAGEMENT PLAN FOR THE EXTRACTION OF WIND-BLOWN SAND FROM LOT 218 IN DEPOSITED PLAN 1044608 AT WILLIAMTOWN NSW

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2930 Nelson Bay Road, Salt Ash N.S.W. 2318 Australia
Telephone: +61 2 4982 6205 Mobile Service: 0427 680 685
E-Mail: dthomas@wix.com.au

PREFACE

The Department of Defence (Defence) has established and sponsors the Defence Unexploded Ordnance Panel (DUXOP), to which a group of specially trained and skilled commercial ammunition search and technical contractors and consultants have been accredited (see http://www.defence.gov.au/uxo/duxop.asp). The primary role of the DUXOP is to provide UXO assessment, search and clearance services to Defence and to other Commonwealth departments. Accreditation to the DUXOP is frequently seen as a pre-requisite for the provision of such services outside Defence, including by some State Government Departments and by some commercial entities.

This Plan has been prepared by Gibson Nominees Pty Ltd. The company is not a member of the DUXOP. It does, however, provide an extensive range of strategic-level UXO-related services to Defence and, on occasions, other State and Territory departments.

A principal service provided by Gibson Nominees is assistance with establishment and maintenance of the DUXOP. This has involved assessment of proposals from companies aspiring to DUXOP membership. Having been privy to the confidential technical, commercial and financial details of each DUXOP tenderer, a significant conflict of interest were to arise if Gibson Nominees were to be accredited and permitted to commercially compete with other DUXOP members. Consequently, the company, although otherwise qualified, has not applied for DUXOP accreditation.

Gibson Nominees continues to provide a wide range of UXO-related consultancy services to Defence and other departments under a provision which allows the Commonwealth to engage a UXO consultant ex-Panel when it is in the interests of the Commonwealth to do so.

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1. Thomas, D.G. and Edwards, L.D. (2005): A Qualitative Screening Risk Assessment of Unexploded Ordnance-Affected Sites in Australia. Department of Defence, Canberra (unpub.).

EXECUTIVE SUMMARY

Mackas Sand Pty Ltd proposes to extract commercial grade windblown sand from Lot 218 in DP 1044608 on Stockton Beach near Williamtown NSW. Land within that title has been assessed by Department of Defence as potentially contaminated by unexploded ordnance (UXO), a legacy of World War II operational and training activities.

This paper summarises the military land use history of Lot 218 and adjacent properties. Gibson Nominees Pty Ltd has drawn on a number of sources of expert advice in the preparation of this plan.

The military land use summary identifies many of the types and natures of ammunition that were fired on the beach, malfunctioned items of which may be remnant on the land. Pictorial examples of these items are provided, both in new condition and in a condition following extensive exposure to the elements. It also examines the morphology of the site, especially in respect to the effect of mobile sand on UXO items that are potentially present.

The paper applies a qualitative screening risk assessment model, which has been developed by Department of Defence, to the site which indicates that the potential for UXO to be present in part of a former impact area on the land is substantial (although this impact area does not fall within the approved sand extraction area). Potential in other areas in the title vary between moderate and slight. However, the Macka's Sand proposal asserts that only windblown sand deposits laid down since the mid 1950's would be extracted. On that basis, the potential for hazardous items to be remnant within those levels in the approved extraction area has been assessed as slight.

The paper also suggests a plan to manage the potential UXO incidence. Pre-extraction search and clearance is not recommended and the plan details a number of precautionary measures to be observed by management and staff. These include a requirement for UXO search and clearance in any location in the former range danger area where excavation is necessary below the 1950's wind-blown sand deposition level. The plan also provides recommended action in the event that either a UXO item or evidence of an impact area is discovered.

The paper containing the Department of Defence Risk Assessment model is provided as an appendix.

1.0 INTRODUCTION

Macka's Sand Pty Limited, a company experienced in the extraction of commercial grade sands, proposes to extract windblown sand from the mobile beach dune area within Lot 218 in Deposited Plan 1044608, Parish of Stowell, County of Gloucester at Williamtown, NSW. The company is aware that the subject area is potentially contaminated by unexploded ordnance (UXO) which may pose a hazard to personnel and equipment engaged in extractive and processing procedures.

This paper summarises the military land use history of the Macka's Sand and adjacent properties. It outlines the factors which may have resulted in the legacy which may present hazards to the proposed operation. It provides an assessment on the nature and the possible effects of the hazard and on resultant risk magnitude and proposes a management plan designed to minimise the potential risk.

Gibson Nominees Pty Ltd has drawn on a number of sources of expert advice in the preparation of this plan[1]. The expert ammunition technical opinions provided, based on the assessment of the historical research undertaken, indicates that given the inception of some simple safe working practices, the hazard posed by UXO is insufficient to prevent the proposed project.

2.0 SITE HISTORY – The Background Setting

By mid-1942, the Australian Government was forced to accept that for the first time in the history of white settlement, it may be about to become committed to a land battle on the Australian mainland. Japanese assets had bombed Darwin and on June 7 of that year, Newcastle was shelled by a Japanese submarine surface armament from Stockton Bight.

At this time, Australia was committed to denying Japanese access to the mainland by halting the latter's advance in New Guinea. Already hampered by losses associated with the fall of Singapore, the build-up of assets in the south-west Pacific was not yet complete. It was doubted that any Japanese incursion onto Australia's north-eastern coast line and a subsequent southern advance in strength could be contained well to the north and even more doubtful that it could be repulsed. The Australian strategy was to establish a series of delaying positions forward of a number of major defence lines with the intention of not only denying the enemy access to the developed centres but also to force him to expend valuable resources which were not easily resupplied from Japan's domestic support base over the distance involved. One such major defence line ran east-west through and south of Brisbane. A second such line was immediately north of Newcastle. An assessment had been made that any land force invasion would aim for the rapid acquisition of Australia's industrial centres in order to support further operations. Newcastle and Wollongong were assessed as priority objectives.

[11] The site history review and the identification of the natures and types of UXO which are possibly remnant has been drawn from a report by David Thomas, who as Staff Officer Grade 2 (UXO) at Headquarters 2nd Military District in 1988, completed a site assessment of those areas on Stockton Beach known or suspected to be UXO-affected.

The possibility that the more northerly defensive lines may fall, but more particularly be by-passed in a marine-borne operation was well realised. Likely landing sites were identified, with Stockton Beach being assessed as a suitable point of entry. On the establishment of a beach head toward the northern end (local defence and sea conditions being more favourable) an invading force would advance in strength parallel to the coast. It would be constrained by the sea on the left flank and Port Stephens and the Hunter River estuary on the right and would be confronted by delaying positions firstly on a line Tilligerry Creek to the sea in the vicinity of Salt Ash and a major defensive line from Fullerton Cove to the sea north of Fern Bay. The proposed sand extraction site lies between these two lines.

Both the Salt Ash and the Fern Bay lines were in range of a coastal battery of three 9.2 inch guns at Fort Wallace and at least one 6 inch gun at Fort Scratchley could bear on targets in the vicinity. Defensive targets on the Stockton and Tilligerry Peninsulas were probably registered by these batteries. In addition to these fixed batteries and given the likelihood that any incursive attempt would be supported by air assets, the north-eastern approaches to Newcastle were also defended by at least three mobile heavy (3.7 inch) anti-aircraft batteries.[2]

The Newcastle Defence Line was manned principally by infantry elements, but supported by other arms, including field artillery (18 and 25 pounder [pdr]) and both heavy (3.7 inch) and light (40mm Bofors) anti-aircraft artillery. It is likely that had these defences ever been operationally tested, armour and anti-armour assets (mounting principally 37mm, 2 pdr and 6 pdr weapons] would have deployed to augment the defence. Department of Defence records do not indicate, however, that these calibres were ever fired in other than a proof (testing and calibration) capacity. 20 Garrison Battalion, which was the principal infantry unit manning the line, is believed to have had a considerable mobile (truck mounted) capability. This suggestion is supported by the road construction and improvements (some of which are still evident today) through the vegetated dune system. It is reasonable to assume that a number of alternate delaying positions well forward of the defence line proper were established with a view to a planned fighting withdrawal to the main line if necessary. The pertinent factors in this observation include the likely support of not only the delaying actions by the battalion's mortar platoon (4.2 inch and possibly 3 inch mortars) and the battalion's lighter 2 inch mortars, but also their covering any planned withdrawal. Given that these scenarios were rehearsed, some ammunition of these calibres must be assumed to have impacted in the vicinity of the extraction site.

2.1 Proofing Activities

In 1942, prior to the inception of the Newcastle Defence Line, an ammunition and armour plate proof facility was established between what became the defence line and the former Stockton Rifle Range. The proof range proper was used up until the 1960's, primarily for the proof of armour plate and armour piercing kinetic attack

[2] Australian War Memorial (AWM) file 54-243/18/15 – Operational log books – Newcastle fortress (6 vols) from 12 March 1942 to 14 May 1944. However, the Newcastle Fortress Logbooks, which recorded all large calibre live fire activities in the Newcastle area, show no evidence that the land targets registered form Forts Wallace and Scratchley were ever engaged with high explosive ammunition. Similarly, all practices fired by the 3.7 inch anti-aircraft batteries were directed seawards.

(free from explosive) projectiles which were usually caught in massive sand traps and concrete butts behind the target[3]. The potential for explosive-filled projectiles originating from within the armour plate proof range to terminate in Lot 218 is consequently considered negligible.

One such proof activity which is pertinent, however, concerns the firing of high explosive (HE) artillery projectiles from locations east and north of the former rifle range along Stockton Beach in conjunction with proof and experimental trials. Proof rounds were fired to test or calibrate weapons, propellants or projectiles and/or components. When proofing involved weapons or propellant, it was not usual for HE-filled projectiles to be used. At Fern Bay, proof projectiles, filled with an HE substitute (HES - sand or pitch) and fitted with empty fuze bodies (or plugs that represented fuzes) were made up in order that their ballistic characteristics could be expected to be similar to HE-filled projectiles. Many of those projectiles which have been found over time have, therefore, given every external appearance of being HE-filled items and should be treated as such. Only when explosive demolition or intrusive measures were attempted the inert HES filling was discovered. At other times, however, it was necessary to use HE-filled projectiles for proof. During the period late 1943 to early 1946, proof of fuzes No 117 using 25 pdr filled HE as the proof vehicle was carried out on Stockton Beach[4]. Defence records indicate that a number of these projectiles failed to function as designed[5].

In addition, some otherwise inert projectiles are believed to have been fitted with red phosphorous smoke boxes. This marking device gave off a puff of white smoke when the projectile impacted, thus assisting observation and plotting of the fall of shot. The smoke box is capable of inflicting burns if such a projectile is interfered with.

2.2 Mortar Firings (Macs Track)

It is known that other firings took place in the Stockton area, not associated with proofing, and that some mortar firings onto the beach took place from the Macs track area[6]. The suspected impact area may have included Lot 218.

2.3 Firing from Williamtown Area

Interviews with local inhabitants at the time have revealed definite recollection of 25pdr artillery firing from Williamtown onto the beach. A resident (now deceased) interviewed claimed to remember watching shells impact into the sand dunes on the beach[7]. This information is corroborated by an entry in the Newcastle Fortress

[3] Sinclair, Knight and Partners (SKP) for the Housing Commission of New South Wales, September 1983: 'Investigation of the presence of unexploded ordnance and feasibility of detection and clearance – site 4600 Fern Bay'.
[4] Thomas, D.G. for Department of Defence (Army) May 1988: 'Unexploded ordnance site assessment – Stockton Rifle Range, Fern Bay Armour Plate Proof Range, Stockton Beach artillery proof range and Morna Point air weapons range.'
[5] Letter, Deputy Master-General of Ordnance Eastern Command to Quartermaster General's Branch (E259/1/186), January 1962.
[6] Deputy Master General of the Ordnance (DMGO) B259/1/186 of 12 January 1962.
[7] Thomas, 1988. *Ibid*.

Logbooks of 28 January 1943[8]. It is possible that at least some of these projectiles terminated within Lot 218.

2.4 Newcastle Fortress Logbook Records

The logbook records of the Newcastle coastal defence system provide valuable insight to many aspects of military activity from Port Stephens to the central coast from March 1942 to May 1944 (by which time the Japanese threat to Newcastle had passed). It appears that while the Fortress Headquarters may not have been the approving authority for many of these activities, it played a key role in their coordination. As a result, outlines of many activities were recorded by fortress staff. Of relevance is the indication that impact areas for those coastal defence and training tasks which were fired were bounded, in part, by the high water mark. Consequently it would appear that Stockton Beach was not engaged by HE-filled ammunition from either Fort Wallace or Fort Scratchley. There are, however, records of proof firings and it is possible that as part of these, projectiles may have needed to be recovered. In this case, it is possible (but no-where has it been found to be confirmed) that they impacted on Stockton Beach. In this unlikely event, while any finds should be treated with due caution, it is likely that any hazard would be minimal from these sources.

2.5 3.7 inch Heavy Anti-Aircraft (HAA) Batteries

Newcastle was defended against air attack by wheeled 3.7 inch HAA weapons in a number of locations including the former Stockton rifle range, Cox's Track and Fern Bay. The 3.7 inch gun could traverse through 36 degrees horizontally and in excess of 180 degrees in the vertical plane. The danger areas for practices using these weapons were generally 22,000 yards (20km). Ammunition was fitted with a fuze which was designed to function the projectile (mainly HE or illumination) after a pre-set time of flight or, in later versions, on reaching a particular altitude. Non-operational procedures for the firing of these weapons imposed a left and right of arc (described as bearings) with all practices logged by the Newcastle Fortress as firing seaward. Consequently, unless these weapons engaged targets in anger (of which there is no record) any projectile that failed to function would have fallen into the sea. Some fragmentation which may have been from 3.7 inch projectiles which did function in the air over the beach has, however, been recovered in the past. However, from the records available, it would appear that negligible hazard is remnant from this source.

3.0 MORPHOLOGY

The effect of landform frequently contributes strongly to the characterisation of UXO-contaminated sites. However, it is probable that the dynamic effects of the landform in the dunal area proposed for sand extraction in this instance are difficult to equal. Firstly, many of the military activities which occurred on Stockton beach probably had little or no effect on the subject site. Those items which may have impacted on the land and failed to function as designed (principally 25 pdr and infantry support weapons such as 4.2 inch and 3 inch mortars and possibly hand grenades) have a

[8] AWM File 54-243/18/15. *Ibid*.

maximum ballistic penetration depth of not more than two metres in sand[9], which in most locations is insufficient to reach or penetrate the harder sedimentary 'core' of the dunes.

Due to the potential for the incidence of aboriginal heritage material being present on the land, the Environmental Management Strategy for this project[10] indicates that sand will only be extracted from the post 1950's level of windblown sand deposits with extraction not occurring below the underlying relict soil profile unless further archaeological investigation is undertaken. It is intended that a depth buffer of not less than 50cm of windblown sand from the mobile dune be maintained over the relict soil surface. In the event that a stabilised soil surface is exposed during extractive activities, works will cease in that location. At first appearance, these measures would seem to offer concurrent protection from the hazards of UXO. The rationale is that as the windblown deposits were laid down after the cessation of World War II hostilities, it is not possible for the material to be mined to contain UXO. However, this is not necessarily the case.

The effect of sand mobility in the high dunes at Stockton extends to many times the ballistic penetration depth of ordnance likely to be remnant. In 1989, a 3-metre long survey marker was placed in the summit of a dune to a depth at which the top 10cm protruded. The sand mobility was such that three weeks later, it had fallen over[11]. This drifting effect results in complete items being covered by considerable (and unpredictable) depths of sand for long periods. With sand movement, some eventually become uncovered and a few may be discovered and disposed of. More importantly, however, those which become uncovered on a slope (such as the face of a wind-exposed relict dune) are likely to gravitate downslope once sand support around it is eroded. It is likely that such an item will then terminate in wind-blown deposits at the base of the relict dune as was in and prior to the 1950's and at a level where it will once again become buried.

Consequently, there is some potential for hazardous material to be remnant in windblown sand deposits, particularly in the vicinity of the feet of relict dunes.

The Environmental Management Strategy for the project advises, however, that the windblown dunes are advancing inland at an approximate rate of 5 metres per year. In locations that are well away from 1950's relict dunes, our assessment is that the potential for hazardous material resulting from World War II activities to be remnant is negligible.

4.0 OBSERVATIONS AND DEDUCTIONS

In 1995, all available Department of Defence Explosive Ordnance Incidence reports outlining finds on the southern end of Stockton Beach over the previous twenty years were reviewed as part of a study by ADI Limited[12] as part of planning by Mineral

[9] Adaption of US Army Corps of Engineers data.
[10] Umwelt (Australia) Pty Ltd (2009): Environmental management strategy for sand extraction at lot 218 and lot 220, Salt Ash, NSW. December.
[11] Thomas, D.G. (1989) for Department of Defence (Army): Post Operation Report – Operation 'Sandsifter'.
[12] ADI Limited (1995): Site history review – hazard identification and assessment within proposed mineral sand extraction area in Crown reserve at Fern Bay, NSW.

Deposits Ltd to mine mineral sands at the southern end of Stockton Beach. They showed that incidental discoveries had become more frequent in the years immediately prior to 1995. From April 1974 until September 1983, ten reports were filed while from then until May 1994, 23 such reports were recorded[13]. The review noted that it was not considered that more items were becoming uncovered with time, but that increased public usage, awareness and possibly increased emotive sentiment in respect to the UXO issue may have been contributing factors. Two matters were, however, worthy of note. Firstly, of the 55 finds recorded, only 17 were assessed as *possibly having the potential* to have explosive fill or pyrotechnic (i.e., such as tracer or smoke box) components[14]. Of this 17, 11 must be assumed to have been filled, two of which (primer and fuze) are minor components in terms of fill quantity. The second matter is that of all of the 3.7 inch anti-aircraft projectiles reported by the Newcastle Fortress log books to have been fired, not one malfunctioned item has come to light, no doubt due to the primary danger areas being seaward.

Further examination of the nature of finds and the narratives provided with the reports established that at least 75% of the items reported had been recovered from, or in the vicinity of, the former armour plate proof range. Finds of some larger calibre (principally 25 pdr) ordnance must be assumed to have resulted from proofing activities on the beach artillery range.

Finally, in the years after 1995, extensive parts of the southern area of Stockton Beach were mined for mineral sand. The UXO management plan implemented for those operations was such that any ordnance-related material of greater than 75mm diameter was screened from extraction plant and deposited at the bottom of a dredge pond. The progressive re-filling of the dredge pond saw this material buried at depths from which they are never likely to re-surface.

As a likely consequence of this mining activity, a review of post 2000 Explosive Ordnance Disposal Reports held by Department of Defence indicates that significantly less finds are being made on the southern parts of Stockton Beach.

It should be noted, however, that Lot 218 does not fall within that area from which mineral sands were previously extracted. Consequently, any remedial action co-incidental to the mineral sands extraction activity does not include the land title of interest.

4.1 Likely Incidence Levels, Natures and Types

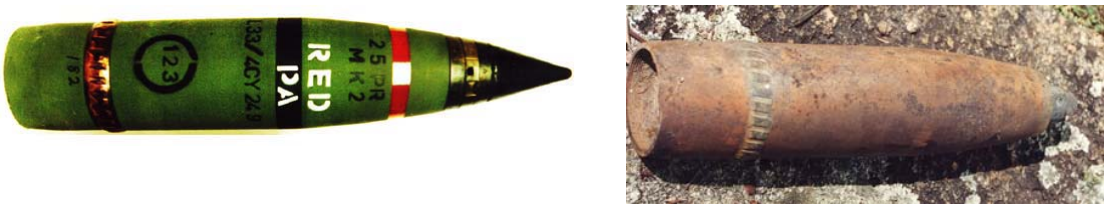
From the data to hand, it appears that only a minor part of Lot 218 falls within a former impact area and that area is outside the proposed extraction area (see Figure 1.). Approximately half of the land is within a former ‘danger area’ (i.e., a buffer area into which projectiles that overshot or otherwise failed to terminate in the impact area could be expected to impact). In the absence of any firm evidence of previous recoveries from Lot 218, the likelihood of encountering hazardous items in the proposed sand extraction area can only be assessed as moderate to slight with a low incidence of items likely to be remnant.

[13] Explosive Ordnance Disposal Reports, Regional Explosive Ordnance Services (East), Department of Defence.
[14] Ammunition technical advice at the time.

Incidental (i.e., single items rather than concentrations) of the following types and natures of ordnance are assessed as possibly being within Lot 218:

- Projectile, 25 pdr HE,HES, smoke and proof.
- Projectile, mortar, 4.2 inch, HE, white phosphorous, illumination and smoke.
- Projectile, mortar, 3 inch, HE, white phosphorous, illumination and smoke.
- Projectile, infantry, anti-tank, HE anti-tank.
- Grenade, fragmentation, 36M.
- Grenade, hand, No 69.

In order that these items can be recognised if encountered, photographs of new objects and, where available, of their likely appearance due to the effects of the ravages of time and decomposition, are provided below.



25 pdr smoke base ejection fuzed point detonating (PD) No 221 (left) and UXO (partial function (right).

25 pdr HE fuzed PD No 119 (left) and UXO fuzed PD No 117 (right).

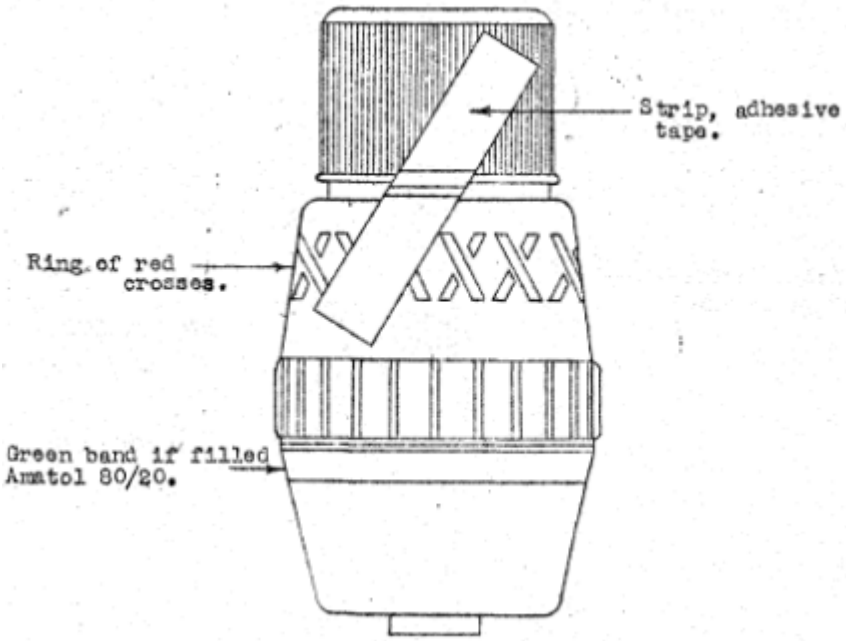
4.2 in mortar HE Mk 2 fuzed No 162.

3 inch mortar HE Mk2 fuzed No 150 Mk1 (right) and UXO (left).

3 in mortar smoke.

Projectile, infantry, anti-tank

Grenade, fragmentation, 36M.



Grenade, hand, No 69 Mk 1. Note, the case of this weapon is bakelite.

Mortar 2 inch HE

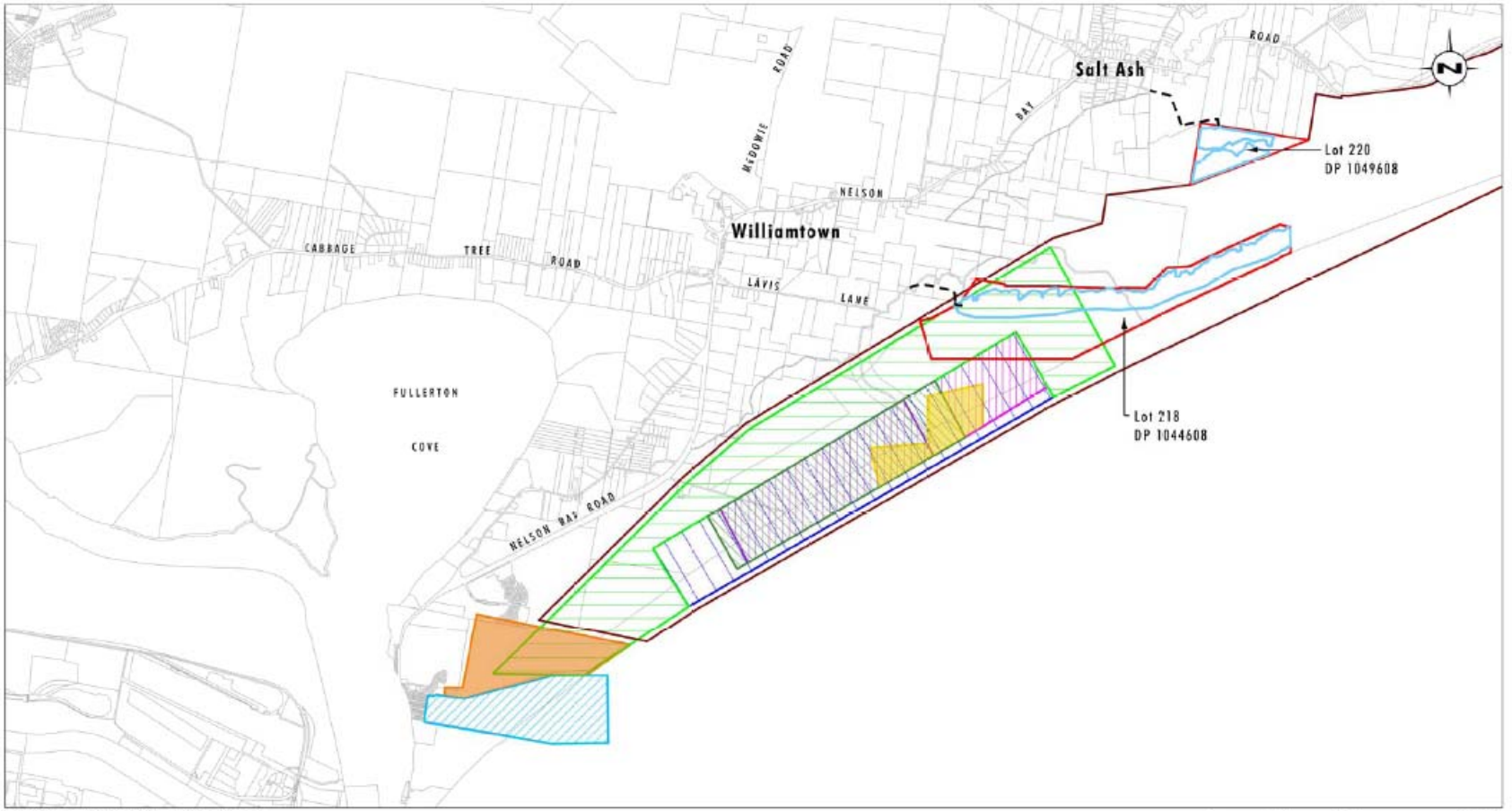


FIGURE 1

Unexploded Ordnance Plan
Mackas Sand

5. RISK ASSESSMENT

In 2005, Department of Defence (Defence) devised a rapid screening qualitative risk assessment model that produced a nominal value in order to rank the degree of risk presented by potentially UXO-affected land against current or likely future land uses. The paper describing the model in detail is provided at Appendix 1.
The model takes into account four factors and within each factor allocates a value. These are:

- Likelihood, from site history, of UXO on-site (H) – scores 1 – 10.
- Ammunition Contamination Category (A) – scores 1-10
- Magnitude of Usage (M) – scores 0.1-5
- Exposure Likelihood Against Varying Proposed (or actual) Land Use Intensities – (E) – scores 2-10

In order to obtain a nominal value by which the risk presented by a range of potentially UXO-affected sites can be ranked (Defence has ranked each known site in each State and Territory) a formula has been devised using the values that are applicable to each site. That formula is:

$$\text{Risk (R)} = \frac{HA}{100} \times \frac{M}{5} \times \frac{E}{10}$$

5.1 Likelihood, from site history, of UXO on-site

The site history for Lot 218 indicates that various areas within the land have been:

- Use as a demolition range, land service impact area or an air or naval weapons range (impact area shown at Figure 1.). Extremely high likelihood – score 10. (Highest Possible Score [HPS] – 10).
- Use as a live firing range (not including an impact area) ammunition depot or former operational area (danger area shown at Figure 1.). Very high likelihood – Score 8. (HPS – 10).
- Use as a field training area or in close proximity to a live firing range (Other areas shown at Figure 1.). High likelihood – score 6. (HPS – 10).

5.2 Ammunition Contamination Category

The history of the site demonstrates that UXO in the category of 'UXO2 - Blast/fragmentation potential (mortar, artillery, aircraft bomb) chemical and natures and types exhibiting high initiation sensitivity, attractiveness or portability potential' either was known to have, or was likely to have, impacted the site – Hazard level is Extremely High – score 10. (HPS – 10)

5.3 Magnitude of Usage

The Defence rating for this factor for Stockton Beach Artillery Range is that it 'Acquired for use as a demolition range, land service impact area or an air or naval weapons range' and that usage was light – score 2.5. (HPS – 5). The score outside the known range impact area reflects that it was 'Acquired for use as a field training area or in close proximity to a live firing range' and that the magnitude of use was light – score 2.

5.4 Exposure Likelihood against varying proposed or actual Land Use Intensities

The proposed land use for Lot 218, as described in the model is 'High density housing, heavy commercial and industrial, roads, railways, bridges, mining, other intrusive activities and extractive industries' or Very High exposure likelihood - score 10. (HPS – 10).

5.5 Risk Values

Using the formula $R = \frac{HA}{100} \times \frac{M}{5} \times \frac{E}{10}$

The value established for the impact area (see Figure 1.) is:

$R = \frac{10x10}{100} \times \frac{2.5}{5} \times \frac{10}{10}$

$= 0.5$

Similarly, the risk value established for the artillery range danger area is:

$R = \frac{8 \times 10}{100} \times \frac{2}{5} \times \frac{10}{10}$

$= 0.32$

And the risk value established for the remaining area outside the artillery range danger area is:

$R = \frac{6 \times 10}{100} \times \frac{2}{5} \times \frac{10}{10}$

$= 0.24$

5.6 Likely level of Risk as indicated by Model Scores

Because the Commonwealth of Australia is not considered responsible for the ongoing effects of UXO on land in which it has never had, or has disposed of, a legal interest[15], the risk ranking of sites provided from the model do not dictate priorities for site remediation. Under the Commonwealth Policy, that is seen as the responsibility of the landowner/occupier. However, Defence will undertake field assessment of potentially UXO-affected sites where it is seen as appropriate to do so. In addition, Defence will render safe or remove any item of UXO once it has been found and reported (there is no charge for this service). For Defence purposes, the risk value can be used to determine the priorities for such assessment. The following values are used as a guide:

Low priority:	< 0.25
Moderate priority:	0.25 to 0.4
High priority:	> 0.4

These priority category scores do, however, reflect the potential type, nature and incidence of UXO as measured against actual or potential land use. Scores of less than 0.25 reflect a slight risk, those of between 0.25 and 0.4 reflect moderate risk and those above 0.4 reflect significant risk.

In these terms, then the risk levels in terms of the model for Lot 218 appear to be:

- Area outside the Stockton Beach Artillery Range danger area: Slight risk (0.24)
- Area within the danger area but outside the impact area: Moderate risk (0.32)
- Area within the impact area: Significant risk (0.5).

The risk scores generated by the Defence model do not and cannot take into account any mitigating measures intended for the proposed land use. In Lot 218, measures outlined in the Environmental Management Strategy[16] will have some effect on reducing the *prima facie* risk.

5.7 Mitigating Measures

The proposal is to where possible during sand extraction to maintain a 50 cm buffer of windblown sand over the stabilized soil surface in order to preserve any indigenous significant sites and artifacts. It is understood that this measure will see sand removed from only post mid-1950's deposits. While this measure will not eliminate any potential for UXO to be encountered or disturbed (see paragraph 3 [Morphology] above) it could be expected to reduce the likely levels of incidence. On that basis, it is appropriate that the risk descriptions within the former impact area be reduced to Moderate and elsewhere to Slight. It is noted, however, that the approved sand extraction area does not fall within the known former impact area.

[15] Commonwealth Policy on the Management of Land Affected by Unexploded Ordnance (See http://www.defence.gov.au/uxo/what_is_defence_doing/what_is_defence_doing_policy.asp)
[16] Umwelt (2009) *ibid.* Page 25.

6.0 UNEXPLODED ORDANCE MANAGEMENT PLAN

Unexploded Ordnance is defined as explosive ordnance (EO) that has been primed, fused, armed or otherwise prepared for action and which has been fired, dropped, launched, projected or placed in such a manner as to constitute a hazard to operations, installations, personnel or material but remains unexploded either by malfunction or design or for any cause. UXO includes items of military ammunition or explosives removed from their original resting-place for any reason, including souveniring by members of the public.

By design, unfired EO is inherently stable. The design is such that an item will not function if subjected to shock or many other forms of mistreatment. However, EO which has been fired and which has failed to function as designed can be expected to have had many of the safety features that make unfired EO safe, disengaged or damaged. Safety devices may be disengaged by such influences as set-back (i.e., inertial effects), spin (such as induced by the rifling in a barrel) time of flight of the projectile, changes in atmospheric pressure as a projectile gains height or even proximity to a target. For this reason UXO may be significantly more sensitive to shock, movement or tampering than unfired ammunition. Deterioration over time as a result of exposure to the elements will frequently exacerbate sensitivity in fuze chemicals and explosive or pyrotechnic filling. However, there is no record in Australia of a civilian having been killed or injured by an item of UXO other than it having been mistreated, tampered with or inappropriately handled. In such cases, the effects of an item of UXO functioning can be expected to be fatal or at best, inflict serious injury.

Depending on the type and nature of EO being fired, Defence statistics indicate that historically, between 2% and 5% of items failed to function as designed and become, by definition, UXO. By way of example, if an artillery regiment of, say, 50 field guns fires a fire mission of 6 rounds per gun, 300 projectiles will terminate in the impact area. If the malfunction rate is, say, 2%, the result will be six projectiles that failed to initiate.

Locations that have been subjected to HE EO impact can usually be readily identified by commercial UXO search and clearance specialists[17]. Designed functioning effects of HE-filled EO are both blast and fragmentation. The fragmentation effect of EO results in the disintegration of the casing (and other components) of the projectile and its spread under explosive force over considerable (but varying) distances, dependent upon the type and nature of the items being fired. Consequently, particles of fragmentation, which may be on or close to the surface (but in the case of Lot 218 may be at considerable depth due to the deposition of wind-blown sand to varying levels) is indicative of an impact area in which UXO is potentially present.

The essential elements, therefore, of an effective UXO management plan must be based on awareness, vigilance and appropriate response. There are two principal factors in implementing such a plan:

[17] See http://www.defence.gov.au/uxo/duxop.asp for details of Department of Defence-accredited UXO consultants and contractors in Australia.

- Preparation, awareness and vigilance; and
- Action on discovery potential impact and of suspect item/s.

6.1 Preparation

The Site Operator (i.e., facility manager) must have a basic understanding of the likelihood of incidence of hazardous items and become familiar with the likely appearance of not only UXO items, but fragmentation and explosive ordnance waste that may be indicative of an impact area in which UXO may be remnant.

The facility manager should consider retaining a professional UXO consultant or contractor periodically (annually is suggested as appropriate) to brief management and employees on likely on-going hazards that may potentially result from the presence of UXO, its likely appearance after more than 50 years exposure to the elements and the appropriate action to take on discovery of UXO or suspected evidence of impact.

Access road and haul way construction works may require excavation in limited areas below the level of the 1950's deposits and possibly into relict dune strata. Prior to excavation at these levels search and clearance by a specialist UXO clearance contractor is warranted in conjunction with the required archaeological examination. In the event that relict dune strata are inadvertently broken into, further excavation should cease at that location until the required UXO and archaeological assessments have been completed. Wherever practical, unless UXO clearance is undertaken, a buffer of not less than 50cm of post-1950's deposit material should be maintained above the relict dune strata, in order to minimise the potential for a hazardous item to be struck or disturbed.

The responsibilities of employees in respect to UXO should be included in site inductions for new workers. This should include the need to be vigilant and watch for unfamiliar items during all stages of extraction and processing works and awareness of the action to be taken on discovery of a potentially hazardous item. The following preliminary briefing is appropriate:

"If you should find a suspicious item that may be a UXO, do not touch or disturb it. It has been there for many years, it won't hurt you if you don't disturb it. Tell your site supervisor who will contact Police - they will arrange for military experts to attend and dispose of it.

"Unless the UXO was deliberately disturbed (picked up, played with, kicked, thrown, etc.) there are no known instances, in Australia, where a UXO has injured a member of the public".

The Occupational Health and Safety Plan for the site should incorporate the appropriate parts of this UXO Management Plan.

6.2 Action on Discovery

In the event that an item suspected to be UXO is found:

- Works should cease in the immediate area.
- DO NOT TOUCH, DISTURB OR TAMPER WITH THE ITEM. This includes making any attempt to move the item to a 'safe' location.
- Mark the location so that it can be found later. Coloured tape or paint make easily recognised marker material. In placing marking material DO NOT TOUCH the item. Note the best route or access to it.
- Keep people away from the item
- Inform the site supervisor of the find.
- The site supervisor should inform the police that a possible ammunition item has been found. They will attend and will request Defence attendance. Specially trained Defence personnel will attend and dispose of the item or render it safe. There is no charge for this service.

Prior to resumption of works in the area from which the item originated, a search - trained ammunition contractor should be engaged to ensure that there are no more potentially hazardous items in the vicinity of the find (see footnote to paragraph 5 for access to contact details for Defence-accredited UXO contractors/consultants).

In the event that concentrations of fragmentation and other items of explosive ordnance waste (such as fuze bodies or fuze fragments are encountered, they could be indicative of an impact area. In that event, works should be suspended in the immediate area and its surrounds and a search -trained ammunition contractor engaged to ensure that there are no potentially hazardous items in the vicinity.

7.0 CONCLUSION

The potential for UXO incidence in the extraction area of Lot 218 has been assessed as Slight. This level of potential is insufficient to require search and clearance of the sand deposits approved for extraction prior to the commencement of works. The implementation of the Management Plan detailed above will provide adequate precautions in the unlikely event that any hazardous items are encountered.

The Commonwealth Policy on the Management of Land Affected by UXO[18] extends, on a case by case basis, an indemnity to landowners and occupiers. The Policy, in this respect, states:

[18] See http://www.defence.gov.au/uxo/what_is_defence_doing/what_is_defence_doing_policy.asp

'Although the Commonwealth is not considered legally liable to do so, the Commonwealth will indemnify landowners/occupiers for:

a. claims made against them in respect of personal injury and/or damage to property arising from detonation of UXO which is present on their land as a result of Commonwealth or allied military activities; or

b. such injury or damage suffered by themselves;

unless the circumstances of a particular case render it inappropriate for the Commonwealth to give such an indemnity. Circumstances where an indemnity would be inappropriate include irresponsible conduct on the part of a landowner/occupier, prior knowledge and acceptance of a UXO risk, or the existence of an effective claim by the landowner/occupier against another party.

Each application for an indemnity will be individually assessed. Should a landowner/occupier wish to apply for an indemnity from the Commonwealth in respect of a personal injury or property damage which has arisen from detonation of UXO, the landowner/occupier should apply to the Department of Defence outlining all the relevant circumstances.'

While indemnity for any potential UXO incident within Lot 218 (however unlikely) would be adjudged by the Commonwealth on the merits of the particular case, it is suggested that the adherence to the Plan provided herein may constitute appropriate precautions in the terms of the Commonwealth indemnity provisions.

APPENDIX 1

A QUALITATIVE SCREENING RISK ASSESSMENT OF UNEXPLODED ORDNANCE-AFFECTED SITES IN AUSTRALIA

A QUALITATIVE SCREENING RISK ASSESSMENT OF UNEXPLODED ORDNANCE-AFFECTED SITES IN AUSTRALIA

Authors:

David Thomas, Gibson Nominees Pty Ltd. Telephone: (02) 4982 6205 / 0427 680 685, e-mail: davidthomas45@bigpond.com and

Leigh Edwards, Project Director Strategic Acquisitions, Department of Defence. Telephone (02) 6266 8404 / 0416 266 456, e-mail Leigh.Edwards@defence.gov.au

Abstract

Responsibility for implementation of the Commonwealth Policy on the Management of Land Affected by Unexploded Ordnance (UXO) has devolved to the Directorate of Property Services, National Operations Division in respect to land in which the Commonwealth no longer has (or has never had) a legal interest and which is potentially (or actually) contaminated by UXO.

As part of its responsibilities under the Policy, Defence must undertake field assessment of such land and provide advice to State and Territory administrations on the management of any residual hazard to ensure that exposure to persons can be minimized.

In order to prioritise sites for assessment and in order to give appropriate advice in the face of residual hazard, Defence needed a preliminary risk assessment protocol as a basis on which to base risk magnitude. Two risk assessment models were considered, but which did not suit the Defence purpose. Using a number of elements inherent in these models, Defence then developed a protocol which takes into account history of military usage of the land, the types and natures of ordnance used on the land and the magnitude of that usage. It also takes into account the actual or proposed use of the land in terms of intensity of human usage. Numerical values are attached to each dimension of the model. A risk score is determined from the product of the values allocated in the case of each site. The methodology employed is fully explained.

In addition, by use of a risk score threshold, land which is potentially significantly affected and land which is potentially affected to a minor degree is determined. The threshold determination allows appropriate advices to be attached to each land area based broadly on risk magnitude.

Introduction

Under the provisions of the Commonwealth Policy, the implementation of management measures to protect the public from the hazards of Unexploded Ordnance (UXO) has devolved to Department of Defence[19]. In order to provide advice to State and Territory Governments and local authorities on appropriate management measures, Defence has agreed to review the priority and resources allocated to assessing UXO contamination of non-Commonwealth land. Following

[19] Commonwealth Policy on the Management of Land Affected by Unexploded Ordnance dated 19 May 1999 (Paragraph 5).

this review, Defence will develop strategic and operational plans for the UXO site assessment program[20]. For Defence to constructively participate in consultation with stakeholders, a procedure for allocating resources to site assessment studies on non-Commonwealth land is required. It would appear that the most appropriate manner in which to determine priorities for such site assessments is the application of a rapid, qualitative screening risk assessment to each potentially UXO-affected area[21].

In Australia, most State and Territory Governments do not perceive UXO to be a contaminant of a similar nature to those that are usually the subject of environmental protection legislation and policy. In fact, most environmental protection authorities are unable to provide any meaningful guidelines on the management of UXO. Consequently, the development of disciplined assessment procedures has fallen to a few narrow, albeit very focused, interest groups. These have principally comprised specialist environmental consultancies (including EPA-accredited auditors) and contracting and consulting firms with a business interest in the provision of UXO assessment and remediation services.

Overseas, the development of UXO-risk assessment protocols has fallen mainly to defence agencies. A model produced by the United States Army Corps of Engineers is extremely complex and is considered to be too detailed to apply to a site-by-site Australia-wide risk assessment. In addition, it applies values to some cultural and topographical factors that are probably inappropriate to the Australian demographic and physical environments. The UK Ministry of Defence retained Enviros Aspinwalls PLC (a leading environmental engineering consultancy) to develop what the company calls a five-dimensional probability-based quantitative model that enabled explosive ordnance contamination to be considered similarly to standard land quality assurance procedures. However, this model is, in fact, a qualitative approach using judgment and qualitative data to present risks numerically. In Australia, Greg Guthrie (then with ADI Limited) has proposed a screening level risk assessment for Australian UXO sites[22]. Whilst the UK model also appears to have some cultural features that are diverse from some Australian scenarios (probably as the result of comparative population densities), both the UK and the Australian (Guthrie) examples would appear to offer some potential for Defence use.

This paper briefly reviews the qualities of both models and draws on each of them to produce a mechanism that can provide a rational basis for the preparation of a prioritised risk-based site assessment strategy.

[20] Australian National Audit Office Performance Audit - Environmental Management of Commonwealth land – Follow-up Audit dated July 2000.
[21] Which may range from individual real property titles to hundreds of such land parcels, depending upon contamination characteristics.
[22] Guthrie, Greg. G. (1997): Screening level risk assessment for UXO contamination in Australia. Parari '97 Conference, Canberra, November.

Part 1: Review

The MOD UK (Aspinwalls) Model

The model examines the circumstances under which a person may encounter an item of UXO and links the probability of contact with human behaviour. The method closely pursues the source - pathway - receptor continuum, which depends on the probability of the receptor making contact with the source. Five event descriptions are used:

1. UXO exists on site.

2. Persons have access to the site.

3. Persons have access to ordnance.

4. Item is capable of detonating or deflagrating under applied stimulus.

5. The explosive event is capable of causing significant harm to human health.

The probability of each event is rated from 0-3 on the bases that it is impossible, unlikely, likely, or certain to occur. Each assessed rating becomes a multiplier. The following, a former ammunition depot planned for residential redevelopment, is an example:

The example makes the following assumptions:

a. The processing of ammunition would have been closely controlled, but its presence is still likely.

b. The ordnance is likely to be in a condition under which it is safe for storage and transport within the depot.

c. The depot would have been subjected to at least a careful search prior to closure and it is consequently unlikely that ordnance is easily accessible.

Consequently, each event was assessed as follows:

Event 1: Unexploded ordnance exists on site

The example steers away from assessing this factor as ‘certain’ but there is a low probability that some such items remain on the site. Hence this factor is scored as ‘likely’ and given a value of 2.

Event 2. Persons have access to the site

The proposed site use defines that public will access the site and a ‘certain’ rating and a value of 3 is allotted.

Event 3. Persons have access to ordnance.

Due to proposed construction and land use, potential for contact with ordnance items is likely – score 2.

Event 4. Item is capable of detonating or deflagrating under applied stimulus

Ammunition was stored in a safe condition; however, deterioration may result in increased sensitivity. Consequently, the functioning of an item under some form of applied stimulus is considered likely – score 2.

Event 5. The explosive event is capable of causing significant harm to human health.

The degree of hazard resulting from this event depends on the types and natures of ordnance handled in the former depot. The model assumes that the larger the item, the more probable the potential for harm. In this instance, likely harm is assumed – score 2.

This then led to the following Total Risk Score: 2x3x2x2x2 = 48

Comment:

1. The model does not allow for concurrent activity. In the example above, ammunition depots are also typically used for ordnance disposal by means of burial, burning or explosive demolition. The likelihood for incidence of UXO (or abandoned ordnance items) as a result of any of these activities may be greater than that appreciated in the example, which deals only with the core business of a former ammunition depot. As a consequence, the resultant real risk may be greater than appreciated and assessed.

2. Further to the above comment, the model was developed by environmental consultants who had little experience in either the hazards presented by the different types and natures of ordnance or by the potential increase in hazard presented by those items failing to function when used (or, in the more likely event in respect to an ammunition depot, failing to function when subjected to explosive demolition action). Consequently, in presenting such factors for risk assessment, it is essential that the full range of activities that potentially (or actually) occurred and the effects (actual and potential) that have resulted be identified by an expert assessor.

3. It is likely that some peculiar topographical and demographic limitations are built into the UK model that would not necessarily apply to Australian scenarios, particularly, for example, where formerly used Defence sites that were still under control of the Commonwealth or where remote sites in which the Commonwealth has no longer any legal interest are concerned. In fact, the model scores the risk of a former small arms firing range at 72 in comparison with the above example at 48. The comparative scores associated with potential for access to both the site and ordnance are questionable. No allowance is made for the comparative degrees of hazard presented by small arms ammunition and (say) high-explosive-filled artillery projectiles.

The Guthrie Model

The model produced by Greg Guthrie in November 1997 initially concentrates on hazard identification and the consequent exposure potential. In hazard identification, the model precepts go further than the Aspinwalls model in that the employment of particular types of ordnance and the manner in which they were used is acknowledged. The exposure potential component assesses the probability of human interaction with hazardous items.

Hazard is identified as explosion, fragmentation, burning or chemical toxicity. Five ammunition-related categories are employed. These are:

- UXO(S) - Small arms ammunition and pyrotechnics;
- UXO – UXO other than UXO(S);
- EO – Explosive ordnance that has not been fired or used or subjected to other than normal handling or storage;
- EOW – Explosive ordnance waste that is free from explosive or pyrotechnic compounds; and
- EOP – Explosive ordnance packaging.

The model allows for the consideration of the likelihood of these categories being present through historical research of military land-use. Multiple land-use combinations are allowed for, either concurrently or chronologically. At this dimension, nine specific classifications were selected as follows:

- no history of military use;
- history of military occupancy;
- use as a close training area;
- use as a field training area;
- use as a live firing weapons range;
- use as an air or naval weapons range;
- use as a demolition range;
- use as an EO storage area; and
- in close proximity to a range.

By allotting a subjective quality reflecting the degree of probability of encountering each of the ammunition-related categories against each of the forms of military land-use, a two dimensional matrix is constructed as follows:

Table 1: Qualitative Ammunition Contamination Probability

Site Classification	**Ammunition Contamination Category**				
	UXO(S)	**UXO**	**EO**	**EOW**	**EOP**
No History of Military Usage	Very Low	Very Low	Very Low	Very Low	Low
History of Military Occupancy	Very Low	Very Low	Very Low	Very Low	Low
Use as a Close Training Area	Very High	Low	Medium	Very High	Very High
Use as a Field Training Area	High	High	High	Very High	Very High
Use as a Live Firing Range	High	Very High	High	Very High	Very High
Use as an Air/Naval Weapons Range	Low	Very High	Low	Very High	Very Low
Use as a Demolition Range	Very Low	Very High	Very High	Very High	Very High
Use as an EO Storage Area	Very Low	Very Low	High	Very High	Very High
In Close Proximity to a Range	Medium	Low	Medium	High	High

An innovative quality, dealing with the level of risk potentially generated by the range of UXO items that could normally be encountered, is the consideration of the UN classification system of specific items according to their primary hazard. For explosive ordnance, these generally comprise mass explosion (hazard division 1.1) or projection (hazard division 1.2). The hazard thus presented is then related to each of the five ammunition contamination categories by assessment of the probability of major injury being caused to a human receptor that is in contact with a functioning item from within each category:

- UXO(S) Moderate Risk of Injury
- UXO Serious[23] Risk of Injury
- EO Major Risk of Injury
- EOW Minor Risk of Injury
- EOP Minimal Risk of Injury

The second axis of the process is to assess the probability of human receptors coming into contact with the hazard most likely to be on the site. Guthrie identifies a number of additional factors that could be expected to emerge from a study of the site history:

- period of usage of the site
- volume of ordnance used within the site
- previous UXO incidents on the site
- nature of ordnance used within the site
- the natural features of the site, including climate, terrain, geology, flora and fauna
- current and anticipated land uses

The first four of these are seen as modifiers to the initial probability assessments. The final two modify exposure probability between any UXO remnant on the site and human receptors.

Probable UXO density, nature and location of UXO represent one end of the exposure pathway. The intensity and nature of human interaction completes the pathway. Guthrie uses 14 types of land-use, each of increasing intensity in this regard. Against each he scales three levels of UXO location probability: at the surface, near surface and sub-surface.

The final product is the qualitative result of combined consideration of worst case contamination probability, item risk and exposure potential. He states that this function can be expressed mathematically as:

UXO risk = (contamination probability x item risk) + exposure potential

where each end of the exposure pathway is of equal value, for without either, risk does not exist. (See comment 2 below).

[23] The inbuilt mechanisms that make unfired EO inherently safe may become disengaged when an item is fired. Consequently, UXO is likely to be more unstable than EO. Thus risk from UXO is assessed as greater than from EO.

Comment

1. Guthrie has produced two versions of this risk assessment methodology. In this version, each value is a description, usually between ‘very low’ and ‘very high’. A former version attached a numerical value rather than a description, between zero and, typically, 5. It is suggested that the method employing numerical expression goes some way to reducing the subjectivity of the assessment, but also allows a response, or a number of alternative responses to be triggered when certain end values result from a mathematical expression.

2. The mathematical expression produces a value for probability and risk that is a product of those two factors. However, the final risk value is arrived at by the addition to, rather than a further multiplication by, an exposure potential value. Consequently, it is possible to produce a risk value even if the ‘contamination probability’ and/or ‘item risk’ do not exist. To make the expression valid, it would be necessary to have ‘exposure potential’ as a multiplication factor rather than an added value. Further, it is suggested that the addition method overly decreases the significance of the equally important receptor end of the pathway.

3. The site classification area allows for former use as a live firing range, but makes no further distinction in respect to a dedicated impact area within such a range. Experience (and logic) indicates that the incidence of hazardous items is comparatively much greater under the latter form of use and that it offers similar potential for incidence as does an air or naval weapons range. Similarly, the model does not allow for EO resulting from disposal by burial. Again, experience has shown that this is a necessary factor to be addressed in former ammunition depots and probably on field firing ranges where EOW and EOP could realistically be mixed with UXO or hazardous EO components.

Part 2: The Defence Assessment Application

The construction of a model that is suitable for the development of a risk-based site assessment program by which the comparative levels of human exposure can be determined cannot be over simplistic; concurrently, it should be able to be used by any member of the Defence UXO Panel[24] to produce a consistent result i.e. reach the same conclusion at different sites that have similar characteristics. Further, it should ideally be able to assess varying degrees of risk within single sites as a result of different hazard properties and/or varying proposed (or current) land-use patterns within that site. The desired outcome is a tool that can rank risk in such a manner that assessment resources can be allocated according to priorities that are objectively determined. For this reason the allocation of factor values rather than descriptors is considered to be appropriate.

It is also desirable for such a model to fit neatly within wider environmental assessment processes. To this end, it is proposed to follow the source-pathway-receptor linkage used in the two models discussed above. The Aspinwalls model demonstrates where the process fits within such a scenario.

Precepts

Although derelict, unfired ordnance is not UXO within the terms of the popular definition, it is often accepted as such. However, unfired ammunition that poses a blast hazard is often inherently safer than UXO, regardless of age and deterioration in both explosive fill and, where ammunition is fuzed, safety mechanisms. This distinction is drawn as part of the risk assessment process (Table 3, column 6) where explosive ordnance (EO) is represented in an Ammunition Contamination Category that falls between category SAA 2 (Large quantities of concentrated small arms ammunition and pyrotechnics) and category UXO 1 (Blast/fragmentation potential posed by such types as fired practice ammunition).

In Australia, the most significant sites on the national UXO register, both by incidence and area, are former field firing ranges and ammunition depots. Regionally, operational World War II areas are also significant. Whilst the comparative hazard generally posed by all of these is a function of human interaction, the potential incidence of UXO within impact areas and demolition ranges compared with other locations is such that the resultant variation in consequent hazard levels should be acknowledged.

Consequently, the following model, which incorporates a number of factors devised by Guthrie, is suggested. It should be noted that most of the factors considered in the Aspinwalls model are inherent in the suggested application.

UXO / EO Contamination Likelihood

This dimension considers military land use against the likelihood of incidence of various UXO/EO being remnant and allocates a value for each.

[24] Ie, a panel of UXO-specialist contractors that retain persons with an expert knowledge of the input factors and the relative hazard potential of each.

Table 2: Likelihood of UXO on Site

Site History Description	Likelihood of UXO from this military land use	Score
No history of military land use	Very low	0.5
History of military occupancy as an administrative or non-EO-related logistic facility	Low	1
Use as military training area, but no recorded history of live firing	Moderate	2
Use as a field training area or in close proximity to a live firing range	High	6
Use as a live firing range (not including an impact area) ammunition depot or former operational area	Very high	8
Use as a demolition range, land service impact area or an air or naval weapons range	Extremely high	10

Ammunition Contamination Category

This factor allows consideration of the level of hazard to people posed by various contamination categories. It is probably appropriate to qualitatively reflect hazard on a continuum of potential to cause minor injury to potential to cause immediately fatal injury. Seven ammunition categories that present increasing levels of hazard are proposed:

Table 3: Ammunition Contamination Category

Ammunition Category	Hazard Level	Score
EOP	Extremely low	1
EOW	Very low	2
SAA1 (Small quantities of dispersed small arms ammunition.)	Low	3
SAA2 (Large quantities of concentrated small arms ammunition and pyrotechnics).	Moderate	5
Unfired EO other than SAA that may or may not have been prepared for action (i.e., fuzed and primed).	High	7
UXO 1 - Blast/fragmentation potential – (practice ammunition such as bomb dummy units).	Very high	8
UXO2 - Blast/fragmentation potential (mortar, artillery, aircraft bomb) chemical and natures and types exhibiting high initiation sensitivity, attractiveness or portability potential.	Extremely high	10

EOP allows consideration of the possible failure to remove any hazardous items when ammunition was unpacked or repacked. The likely incidence of such items being present at a site and the likelihood of such a hazard occurrence is usually minor against most military land uses. However, it may become moderate in locations where large amounts of ammunition were processed or used (ammunition depots, firing ranges and former operational areas).

The likelihood of incidence of explosive ordnance of a particular ammunition contamination category against historical military land use to can now be considered. The result termed ‘Ammunition Contamination Likelihood’ is derived indicatively by the product of the ammunition category probability score and the site history score.

A matrix can be constructed as follows (see Table 4):

Table 4: Preliminary Qualitative Ammunition Contamination Hazard Likely to Result from Former Land Use Categories

Site History Description (score)	**Ammunition Contamination Category** (score)						
	EOP (1)	**EOW** (2)	**SAA 1** (3)	**SAA 2** (5)	**EO** (7)	**UXO 1** (8)	**UXO 2** (10)
No history of military land use (0.5)	0.5	1	1.5	2.5	3.5	4.0	5.0
History of military occupancy as an administrative or non-EO-related logistic facility (1)	1	2	3	5	7	8	10
Use as military training area, but no recorded history of live firing (2)	2	4	6	10	14	16	20
Use as a field training area or in close proximity to a live firing range (6)	6	12	18	30	42	48	60
(8)	8	16	24	40	56	64	80
Use as a demolition range, land service impact area or an air or naval weapons range (10)	10	20	30	50	70	80	100

The indicative contamination hazard as a result of previous site usage falls into one of six usage categories and seven ammunition categories. By multiplying both factors we can see, for example, that the comparative likely hazard of large calibre artillery projectiles being remnant in an impact area is 10 x 10 = 100 (against a highest possible score [HPS] of 100). Similarly, the comparative likely hazard of large calibre UXO being remnant on a live firing range (other than in an impact area), in an ammunition depot or in a former operational area is 8 x 10 = 80 (again against a HPS of 100).

This exercise ties together the likelihood of ordnance being present on a particular site together with a comparative hazard/consequence/impact characteristic of the ordnance.

Magnitude of Usage

Magnitude of usage considers the likely (or possible) incidence of UXO as a result of the level of use to which the site was put. For example, a field firing range that was continually used over a number of years could expect to exhibit a greater incidence of UXO than would, say, a local Volunteer Defence Corps range that was used infrequently. In fact, some ranges have been identified for which there is no evidence of usage at all of a nature that could be expected to result in UXO incidence. Where site research prior to field assessment indicates that some areas were lightly used, if used at all, it would be inappropriate for this factor not to be acknowledged and reflected in the risk assessment process. One mechanism that may assist in identifying lightly used areas is the reflection of UXO incidence indicated by the number of Explosive Ordnance Reports (EORs) originating at a given site and the types and natures of UXO dealt with. However, this mechanism should not be considered solely. A number of areas that were formerly quite heavily used were subsequently subjected to minimal human activity, as a result of which UXO that may have been remnant was not discovered.[25] The values for Magnitude of Usage are reflected at Table 5.

Table 5: Magnitude of Usage

Site History Description	Indications of Use (score)		
	Indications of Extensive Use	Evidence of Light Use	No Evidence of Use
Acquired for military occupancy as an administrative or non-EO-related logistic facility	0.5	0.25	0.1
Acquired for use as military training area, but no recorded history of live firing	1	0.5	0.2
Acquired for use as a field training area or in close proximity to a live firing range	3	2	0.6
Acquired for use as a live firing range (not including an impact area) ammunition depot or former operational area	4	1.5	0.8
Acquired for use as a demolition range, land service impact area or an air or naval weapons range	5	2.5	1.0

[25] An example is Yarrabandi in Central Western NSW. A small parcel of Crown Land was acquired shortly after WW2 where large-scale demolitions of a range of natures and types of EO (including large calibre artillery ammunition) were undertaken in what can only be described as a questionable manner up until 1963. The area acquired was of insufficient size to contain the effects of the demolitions and EO and fragments were projected up to 2,500 metres into surrounding private land in which the Commonwealth had never had any legal interest. The incidence of EO on the private land did not start to become apparent until a subsequent land owner began a cultivation program in 1980.

Exposure Likelihood

This factor deals with UXO Exposure Likelihood related to various proposed or actual site uses. The potential has been scaled from Low to High. Values represent the level of likely human exposure and thus risk of injury if an item of UXO is present. Because proposed land use reflects likely human exposure, which is seen as a critical risk assessment component, values allocated are between 1 and 10 (see below). Proposed land use categories are comprised as follows:

Low level – dry land grazing, isolated areas and non-intrusive activities.

Medium level – agriculture (cropping), improved pasture grazing, shallow (300mm) intrusive activities, camping grounds, parkland, State and National parks, fire / 4WD trails.

High level – medium density housing, rural residential, single dwelling housing, light commercial, light industrial.

Very high level - High density housing, heavy commercial and industrial, roads, railways, bridges, mining, other intrusive activities and extractive industries

Table 6: Exposure Likelihood against Varying Proposed (or Actual) Land Use Intensities

Proposed (or actual) Land Use Category	**Exposure Likelihood** (score)
Low level	2
Medium level	5
High level	8
Very high level	10

All factors can now be formulated into a risk function:

$$R = \frac{HA}{100} \times \frac{M}{5} \times \frac{E}{10}$$

Where:

R = UXO–related risk;
H = Likelihood that, from the site history, UXO exists on the site (Table 2);
A = Ammunition contamination category (Table 3).
(The product of H and A results in a qualitative ammunition contamination hazard resulting from former land use Categories (Table 4));
M = Magnitude of Usage (Table 5).
E = Exposure resulting from Proposed (or actual) land use (Table 6).

As an example: A former heavily used WWII artillery field firing range (other than a known impact area) proposed for rural residential and light commercial development and open access parkland.

H = 8 (from Table 3, line 5)
A = 10 (from Table 4, column 8)
M = 4 (from Table 5, column 2)
E = 8 (from Table 6, column 2, line 3)

$$R = \frac{8x10}{100} \times \frac{4}{5} \times \frac{8}{10}$$

$$= 0.512$$

However, this progression reflects only the risk factor for rural residential land. That for supporting services, such as roads and buried services due to intrusive activity could have an 'E' factor of 10, resulting in a final risk factor of 0.64.

A further example could be a Volunteer Defence Corps temporary mortar range that was used on two occasions only. The proposed land use is rural residential:

H = 10 (within the known impact area) or 8 (elsewhere on the former range)
A = 10
M = 2.5 (within the known impact area) or 1.5 (elsewhere on the former range)
E = 8

$$R = \frac{(10 \times 10) \times 2.5 \times 8}{5{,}000}$$

$$= 0.4$$

and

$$R = \frac{(8 \times 10) \times 1.5 \times 8}{5{,}000}$$

$$= 0.192$$

By comparison, consider a heavily used grenade range. The proposed land use is medium density residential.

H = 10
A = 8
M = 5
E = 8

Then:

$$R = \frac{(10 \times 8) \times 5 \times 8}{5{,}000}$$

$$= 0.64$$

As a mid-line example, take an area used in 1992 for a combined arms live fire and manoeuvre exercise (such as one of the 'Kangaroo' activities) in which the impact area boundaries are known and where the proposed land use is cultivation for improved pasture.

Then, within the impact area:

H = 10
A = 10
M = 2.5
E = 5

$$R = \frac{(10 \times 10) \times 2.5 \times 5}{5{,}000}$$

$$= 0.25$$

Elsewhere in the manoeuvre area:

H = 8
A = 10
M = 1.5
E = 5

$$R = \frac{(8 \times 10) \times 1.5 \times 5}{5{,}000}$$

$$= 0.12$$

As an extreme example, take the scenario of a heavily used former air to surface bombing range proposed for high density residential use:

H = 10
A = 10
M = 5
E = 10

$$R = \frac{(10 \times 10) \times 5 \times 10}{5{,}000}$$

$$= 1.0$$

All of the examples above pre-suppose that each site has been used, to some extent, for purposes that may have resulted in a UXO contamination legacy. Consider, however, the effect on the resultant values when there is no evidence that land acquired for such purposes was, in fact, ever used.

Going back to the first example,

A former WWII artillery field firing range (other than a known impact area) proposed for rural residential and light commercial development and open access parkland.

H = 8
A = 10
M = 0.8
E = 8

$$R = \frac{8x10}{5000} \times \frac{0.8}{1} \times \frac{8}{1}$$

$$= 0.1024$$

It is worthy of note that in such a scenario, there would be no known 'impact area' and consequently, the 6th usage category in Table 4 would be inapplicable in many cases. But imagine that land had been acquired for an artillery range, a siting board convened and an intended impact area identified. If there were no evidence of subsequent range use, the following values would then apply against the scenario outlined above:

H = 8
A = 10
M = 1
E = 8

$$R = \frac{8x10}{100} \times \frac{1}{5} \times \frac{8}{10}$$

$$= 0.128$$

The inclusion of this factor, then, has a marked effect on the product. The process weighs sites for which there is no evidence of use in an appropriate manner. This perhaps raises the question 'if there is no evidence of use, why is the site being assessed at all; in fact, why is it on the UXO register?' The response must lie in the inability to give a 100% guarantee that no activity occurred on the site at any time that was likely to have resulted in a UXO legacy. It is suggested that where sites have been identified for such use, but no evidence of actual usage has (to date) been identified, such a guarantee would be, at best, imprudent. The process (and the product) adequately reflects the unlikelihood of such a legacy, and that is appropriate within this assessment process.

Site Assessment Prioritisation

In developing a strategic risk-based assessment strategy, priorities will need to be established in consultation with State and Territory authorities. Three priority levels are suggested as appropriate. This model, in addition to providing a rapid screening assessment tool, can be equally as well applied to determining the priority in which Defence site assessment resources are allocated. The following provisional priority values are suggested:

Low priority: < 0.25
Moderate priority: 0.25 to 0.4
High priority: >0.4

The priority threshold should be reconsidered following the assessment of a significant proportion of affected sites using this methodology.

Defence Advice – General Caution

The Commonwealth has a responsibility to advise private and non-Commonwealth public landowners and managers through State and Territory-Government agencies on appropriate action to be taken in the face of UXO hazard. Defence has developed a standard advice in the event that an item suspected of being ordnance-related is found. The advice is as follows:

"Actions on finding a suspicious item:

"If you should find a suspicious item that may be a UXO, do not touch or disturb it. It has been there for many years, it won't hurt you if you don't disturb it. Contact Police -they will arrange for military experts to attend and dispose of it.

"Unless the UXO was deliberately disturbed (picked up, played with, kicked, thrown, etc) there are no known instances, in Australia, where a UXO has injured a member of the public".

Whilst more definitive advice can often not be given until after a field UXO assessment has been completed, there may be some correlation between 'priority triggers' suggested above and the appropriate detailed assessment and remediation action required to be taken. This correlation may relate to a relationship between assessment priority and advice to be provided if (and only if) the input to the risk assessment model is found, from field assessment, to be valid.

There are three levels of advice that have been accepted, by convention rather than by any direction, as appropriate for Defence to provide in accordance with the Commonwealth Policy. These are:

Advice 1 – Substantial Potential for UXO Incidence

This advice applies to those sites that present a known moderate to significant hazard based on incidence and UXO type/nature. Development and/or land usage re-zoning proposals for land parcels considered to be subject to a substantial UXO potential should only proceed following the conduct of UXO investigation and remediation. The advice states "The land within this title has been used for purposes that may have resulted in an unexploded ordnance hazard. Department of Defence advise that prior to any change in land use that is likely to increase human exposure to the hazard, the land should be subjected to a detailed assessment and, where required, remediation. A list of Department of Defence-accredited unexploded ordnance consultants and contractors is at http://www.defence.gov.au/uxo

Advice 2 – Slight Potential for UXO Incidence

This advice reflects potential low incidence and applies in areas with a confirmed history of military activities that may have resulted in residual UXO but Defence considers it inappropriate to assess as substantial and the Defence UXO site assessment recommended against a hazard reduction operation (HRO) being undertaken. The advice states: "All land usage within these areas may continue without specific UXO search or remediation." However, the general caution remains applicable.

Advice 3 - Other

This advice relates to land in which Defence may or may not, at some time, have had a legal interest, but there is no evidence to suggest that it was used for a purpose that was likely to result in an ordnance-related legacy. The advice states: "Defence records do not confirm that the site was used for live firing. UXO or explosive ordnance fragments/components have not been recovered from that site. These sites have been included for general information purposes only. Defence makes no recommendations in regards to this category."

Conclusion

The above model is as objective as believed possible. There is no requirement for 'educated guesses' to be made; consequently, rankings should be standard regardless of who is applying the assessment. The model can be applied to particular locations where certain types of military activity occurred within a more general land use (such as a demolition range within a field firing range) or where particular types of land use and hence differing human exposure risks are proposed. Consequently, the detailed application of the model would allow for risk contours to be drawn on planning maps, thus assisting the design and scoping of, initially, more detailed assessment and, where required, remediation strategies.

The qualitative screening risk assessment model has been developed for application by Defence to a national program of UXO site assessments. The model may also assist State and Territory land authorities in their management of UXO-affected sites.

References:

Enviros Aspinwalls PLC (2001): The application of a risk assessment to the remediation of explosive ordnance. For UK Ministry of Defence (unpub).

Australian Government (1999): Commonwealth policy on the management of land affected by unexploded ordnance. Department of Defence. May.

Guthrie, G.G. (1997): Screening level risk assessment for UXO contaminated sites in Australia. Parari '97 Symposium, Canberra. November.

Standards Association of Australia (1999): AS4360-1999 Risk management. Homebush, Sydney.

United Nations Economic Commission for Europe (2001): UN recommendations for transport of dangerous goods. http://www.unec.org/trans/danger/publi/unrec/12_e.html

United States Department of Defense (1993): Mil-Std-882, Systems Safety Program Requirements 19 January 1993. AMSC, F6869.

Umwelt (Australia) Pty Limited
PO Box 3024
75 York Street
Teralba NSW 2284

Ph. 02 4950 5322

www.umwelt.com.au