EXPLOSIVES CONTAMINATED SITES

Identification, Investigation and Remediation
Military Training, esp. during WW2 has left many sites contaminated through the use and storage of ammunition and explosives

Most of these sites are unidentified and the presence of contamination discovered accidentally
ACCIDENTAL DISCOVERIES

**LIVE SHELL INJURES LOCAL GIRL**

A young girl who was injured when a shell exploded in a bonfire at Rerewhakaaitu, was admitted to the Ruatoria Hospital yesterday afternooon with a fractured leg.

She is Wendy Girling-Butcher, aged 10, daughter of Mr and Mrs W. Girling-Butcher, of Ruatoria.

Wendy was one of a group of children playing on what was formerly a United States Army battle training ground. They lit a bonfire and it is thought that the shell, a .55 m.m. armour-piercing type, was under the fire.

Shortly after the fire was lit there was an explosion, and the girl was caught in the blast.

Police from Ruatoria made a preliminary investigation of the area last night, and a further search was made this morning.

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**Deadly “Dud” Shells Often Found At Rerewhakaaitu**

An Army spokesman said this morning that in the last few months, between 40 and 50 explosive shells have been destroyed at Rerewhakaaitu, which was a wartime U.S. Army battle range.

Recently a call was received to detonate a high explosive shell, and while the work was being done, the Army noticed a farmer who had been tending to a farm, who had been carrying an unexploded shell on his tractor for months without taking any action about it.

"It cannot stress the danger too highly," said the spokesman. "There are a number of so-called dud shells around which are more dangerous than live weapons."

He said the shells were caused by a defect in the firing mechanism, and sometimes it required only a slight tap to set them off.

"If we are advised immediately of the presence of any shell, steps will be taken to destroy them," he added.

"It is very dangerous for any member of the public to touch them."
<table>
<thead>
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</tr>
<tr>
<td>4</td>
<td>Airports – fuel storage, workshops, washdown areas, stormwater runoff from hardstanding.</td>
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</table>

+ Many current airports were previously used as military airfields - potential ammunition storage and disposal areas

Hamilton Airport – post WW2
EXPLOSIVE CONTAMINATED SITES
RIFLE RANGES

- Miniature
- 25 metre/yard
- Classification
RIFLE RANGES

PLAN OF RANGE
Scale: 100 ft. to 1 in.

Revolving targets.
Ring mounds formed up to 300 yds.

Compiled from
Field Survey
17 Jan. 1944.

Mounds
Butts
GRENADE RANGES

- For the throwing and projection of live hand grenades
- Often collocated with Rifle Ranges
- Potential Contamination
  + UXO
LIVE FIRING AND BOMBING RANGES

- Firing of Military Weapons
  + High Explosives, Smoke (including White Phosphorous) and Illuminating ammunition
- Potential Contamination
  + UXO
  + Dumpsites
AMMUNITION DEPOTS

- Storage of Ammunition and Explosives
- Demolition Ranges
- Burning Sites
- Dumping and Burials
- Potential Contamination
  - Burials – EO, heavy metals
  - Burials - asbestos
  - UXO
DEFENSIVE SITES

- Coastal Guns
- Anti-Aircraft Guns
- Potential Contamination
  - Ammunition Storage Area
  - Target Area – UXO/EOW
SEA DUMPING GROUNDS

- For disposal of surplus ammunition stockpiles
- Dump sites often misplaced in “shallow” water
- EO accidentally recovered by fishing trawlers or dredging, or by recreational divers
HISTORICAL OVERVIEW
HISTORICAL OVERVIEW – NZ MILITARY

- 19th – early 20th century – primarily firing of small arms. Rifle Ranges near bases and regional town
- Coastal forts and guns established late 19th Century
- First World War introduced new weapon systems – artillery, mortars, grenades
- Second World War resulted in major expansion of military forces
- Home Guard units in almost every small town or locality
HISTORICAL OVERVIEW – NZ MILITARY

- After Second World War most facilities disestablished or handed over to civilian control
- Many sites remained active for Compulsory Military Training in the 1950’s
- Latter 20th century many defence bases closed and sold
- Crown Land formerly used as ranges developed into farms
HISTORICAL OVERVIEW – US FORCES

- US Forces based in New Zealand 1942-1944
- Primarily US Army and US Marine Corps
- Based in Auckland and Wellington Regions
- Training Areas
  + Northland
  + Auckland
  + Waikato
  + Bay of Plenty
  + Wellington/Horowhenua
**HISTORICAL OVERVIEW - MANUFACTURING**

- New Zealand Munitions Manufacturing during WW2
  - Small Arms Ammunition
  - Mortar Bombs
  - Grenades
  - Fuzes
WAIKATO REGIONAL COUNCIL PROJECT
Aim; To identify explosive contaminated sites in the Waikato Region

Method; Conduct desktop review using readily available and accessible archival material
INFORMATION SOURCES

- NZ Archives – Auckland and Wellington
  - NZ Army Records
    - Works Branch
    - Range Inspection Records
  - Public Works Records

- Records primarily;
  - Legal matters – acquisition and disposal of property
  - Leasing and Grazing of property
  - Construction and maintenance
  - Inspections of facilities
INFORMATION SOURCES

- NZDF Property Branch
- Waikato Regional Council
- Historic Maps
- NZ Police -
- Public Libraries – war and local histories
- Internet
LIMITATIONS

- Legal descriptions only identifiable for Defence or Crown owned lands
- Limited information for sites on private property
- Gaps in records
- Lack of operational records
- Records destroyed
- Files missing key documents esp. maps/diagrams
- NZ Police only maintain records of active Pistol Clubs
FINDINGS

- Over 100 potentially contaminated sites identified
  + 3 Ammunition Depots
  + 3 Artillery and Live Fire Training Areas
  + 1 Bombing Range
  + 22 Grenade Ranges (often collocated with Rifle Ranges)
  + 1 Ammunition Manufacturing Plant
  + 75 military 25 yard or Classification Ranges
  + 24 Miniature Ranges
  + 22 Active Shooting Clubs
FUTURE OPTIONS – SITE SPECIFIC REVIEW

- Review of historic aerial photography,
- Interviews with former staff members and users,
- Consultation with local historians, historical societies and libraries,
- Consultation with local councils,
- For those sites where US forces have been present, research at US National Archives using a contracted researcher.
FUTURE OPTIONS – FIELD SURVEY

- Percentage Sample to determine
  - If contamination is present,
  - Degree and type of contamination,
  - Depth of Targets,
  - Highly contaminated areas within the site – i.e. the areas requiring targeting for remediation.
FUTURE OPTIONS - REMEDIATION

- Detection.

Detection technology and equipment is determined by various factors, including:
+ geological conditions,
+ size of target,
+ depth of target,
+ targets construction materials.
Removal or Destruction. All items that have been detected are excavated and identified. UXO will be destroyed in situ. Mechanical means would be used for excavation of deeper targets or for the removal and sieving of burial pits.
CONCLUSION

- Large number of sites reflects the level of activity in the past especially during the Second World War
- There is potential for a greater number of sites in close proximity to major cities
- The historical review forms a start point for the identification and remediation of explosives contaminated sites
ACKNOWLEDGEMENT

- Waikato Regional Council
  + Contaminated Lands Group
    - Michelle Begbie
    - Dominique Noiton
    - Rachael O’Donnell
EXPLOSIVES CONTAMINATED SITES
IDENTIFICATION, INVESTIGATION AND REMEDIATION

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INTRODUCTION

Background
Extensive military training, particularly during World War 2 (WW2), including that of United States visiting forces, together with subsequent peacetime training activities, has left a legacy of numerous sites that have been contaminated through the use of explosives and ammunition\(^1\). At many of the sites the contamination has remained unidentified, until unintentionally unearthed during ploughing, development earthworks, or erosion. With the development and expansion of residential property, expansion of national highways and power generation facilities, the likelihood of encountering UXO sites is increased. This includes Unexploded Ordnance (UXO) on former grenade training areas and live firing ranges, thrown out munitions from burning grounds and burial sites on former ammunition depots and the residues of munition production facilities.

Rifle and pistol shooting ranges proliferated in the lead up to World War 1 (WW1) and saw extensive use during WW2. Heavy metal contamination\(^2\) from the residues of training with small arms\(^3\) is another potential military legacy problem. UXO and Small Arms Ammunition (SAA) contaminants are little understood problems in New Zealand and although such sites are listed on the Hazardous Activities and Industries Listing (HAIL), few are actually documented or delineated.

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\(^1\) Some 2%-3% of all WW2 high explosive filled munitions fail to function on impact as intended and remain on or below the ground surface as unexploded ordnance (UXO). Thus any target area where high explosive filled munitions have been employed should be regarded as containing a proportion of UXO, i.e., those areas should be regarded as being potentially UXO contaminated.

\(^2\) Lead, antimony, copper and nickel are the predominant problems, arising from spent bullets and bullet particulates contained largely within and behind range stop-butts.

\(^3\) All ammunition smaller in calibre than 20mm is generally regarded as small arms ammunition.
Milsearch has recently completed a desktop study and historical review for the Waikato Regional Council and identified over 100 previously unlisted potentially contaminated sites. This study is the first stage of a hazard assessment and provides a basis for defining and treating such sites.

The review, the first of its type in New Zealand, benefits from a similar experience in Australia, where a systematic process for the identification of UXO contaminated sites on a national basis was commenced in the mid 1980’s. Undertaken by the Australian Defence Department, this process has so far identified over 1800 sites throughout Australia, largely comprising formerly used Defence sites and to a lesser extent, existing active Defence sites. This site information is publically available on an Australian Department of Defence website, where it serves as a public notification of the existence of hazardous ground and facilitates the due diligence process during property transfer and re-zoning applications. No similar listing of formerly used defence sites exists in New Zealand.

**Objective**

This paper provides an overview of the types of military contaminated sites and describes the process for identifying and treating them. This paper describes the conduct of a recent desktop study completed for Waikato Regional Council, which may form a precedent for other regions, leading over time to the de facto development of a national UXO sites register.

**POTENTIALLY CONTAMINATED SITES**

**Hazardous Activities Industries Listing**

The Ministry of the Environment HAIL identifies three key areas directly relating to sites potentially contaminated through the use or storage of ammunition and explosives as listed at Table 1 below.

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**Table 1: HAIL Extract**
Sites currently in use are already identified. Very few formerly used military sites are identified as potential contaminated sites.

Other types of facilities on the HAIL may also be contaminated by the presence of explosives, for example; Serial 4 Airports. A rain storm (May 2010) at Ardmore airfield exposed a cache of formerly buried aerial practice bombs\(^4\) dating from the airfields usage as a RNZAF training field during the 1940’s\(^5\).

TYPES OF SITES

Small Arms Ranges

Small arms ranges were for the primary purpose of firing rifles, pistols or machine guns. These ranges can be grouped as follows;

- **Miniature – Indoor or Outdoor.** These are also known as “Miniature Cartridge” ranges in reference to the .22in calibre ammunition primarily fired on these ranges. Miniature ranges were generally of short length, up to 25 yards or metres and have a stop-butt, either manmade or natural to capture the projectiles immediately behind the targets. These ranges generally did not have a recognised formal safety template (exclusion zone) extending beyond the stop butts. Miniature ranges were primarily located on schools grounds or army drill halls, or in the vicinity of these sites.

- **25 yard/metre ranges.** These ranges would be used for most calibres of small arms. The range would consist of a single firing point and a stop butt. These ranges were often sited with a safety template extending past the stop butts.

- **Classification Ranges.** These ranges were designed for the firing of small arms on ranges up to 1000 yards in length. These ranges would have multiple firing points, usually every 100 yards as well as a stop butt. Sometimes a protected gallery was provided for personnel to raise/lower targets and score hits behind shelter. These ranges always included a safety template frequently extending

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\(^4\) Most aerial practice bombs contain a small propellant charge and pyrotechnic, designed to explode on impact and give of a flash or smoke puff. A percentage of these fail during impact and remain as an UXO hazard, capable of blinding or injuring if tampered with

\(^5\) NZ Herald 26 May 2010
some 4000 yards beyond. Classification ranges were always sited with considerable attention to down range safety.

**Military Live Firing and Bombing Ranges**

These ranges are designed for the firing of mortars, grenades, rockets, artillery and aircraft bombing. The natures of ammunition include High Explosives, smoke including white phosphorous, illuminating and practice ammunition. Contamination at these sites includes Unexploded Ordnance (UXO) as well as dump sites where packaging, Explosive Ordnance Waste (EOW)\(^6\) and sometimes UXO were collected and disposed of by burial. It should be noted that many of the Defence Forces current ranges and training areas, such as the Army Training Area at Waiouru, were not formally established until the 1940’s. Prior to that time and elsewhere extending well into the 1970’s, high explosive training activities were conducted on Crown Land, Forest Service land, beaches, or other land that was uninhabited at that time.

**Ammunition Depots**

Ammunition depots for the storage and maintenance of ammunition\(^7\) were established in most cases near military bases. Temporary facilities were established near sites where US forces were based during the Second World War such as at the Mangere Domain. In addition to the storage of ammunition, these sites would contain grounds for the disposal of ammunition by detonation, burning or burial as well as domestic dumping facilities. Proof grounds were sometimes established within the storage depots, where ammunition would be test fired on controlled proof ranges.

**Defensive Positions: Anti Aircraft and Coastal Guns**

Vulnerable and critical facilities or population centres often had defensive sites established, including anti aircraft guns and coastal guns at major harbours. These sites had ammunition storage facilities on site. In the cases of the fixed coastal guns, these would be fired out to sea (or harbour). There have been many occurrences

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\(^6\) EOW describes the metallic residues remaining from the detonation of projectiles, bombs and the like. EOW includes steel fragments, brass or aluminium fuze portions, copper driving bands, tail fins for mortar and aerial bombs, rocket motor bodies etc. Large quantities of EOW build up in impact/target areas during use.

\(^7\) Also note that stocks of Chemical Weapons such as mustard gas were stored in New Zealand during the Second World War
where projectiles fired by coastal gun batteries have been brought to the surface during harbour dredging operations.

**Sea Dumping Grounds**

Sea dumping was the preferred method for disposing of surplus ammunition stockpiles, mostly those built up during the Second World War. Dumping grounds were intended to be in locations, such as deep underwater trenches, so that the ammunition was not able to be accessed or recovered. This however has not always been successful with many occurrences of ammunition being recovered by recreational divers or accidentally caught in nets by fishing trawlers.

**HISTORICAL OVERVIEW**

**NZ Military Activities**

During the 19th and early 20th centuries, military activities predominantly consisted of the firing of small arms. Small Arms Ranges were established at military bases, or near towns where non-regular territorial units were based. Coastal gun sites were first established near major harbours during the late 19th Century.

During and after WW1, weapons systems such as artillery, mortars and grenades were used and trained on more widely. At this time artillery ranges were established at various locations, often not on Defence controlled land.

During WW2, the mass expansion of the Army, Home Guard and the RNZAF necessitated the development of military bases, defensive sites, ranges and ammunition depots in most parts of the country.

Most small towns with a Home Guard or Territorial8 unit would have had at least a 25 yard rifle range and possibly a grenade range. Major centres had multiple small arms ranges of varying types as well as grenade ranges. Home Guard/Territorial battalion regions would have at least one live firing range for mortars. Many of the temporary ranges established during the Second World War were on private property under permissive occupancy arrangements, not owned or leased for the purpose.

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8 The Territorial Force is the part time component of the Army. The Headquarters of such units are based within major regional centres (eg Tauranga, Napier). Sub-units being based in regional towns (Whakatane, Whangarei)
Following WW2 many of the facilities established for the Home Guard were disestablished or transferred to the control of civilian rifle clubs. Compensation claims or remediation works were completed for private lands. Many sites did remain active to support Compulsory Military Training in the 1950’s.

During the latter 20th century, many Defence facilities were shut down and sold off. Also Crown and Forest land that had been used by Defence were developed into farms, in some cases as rural urban developments.

**United States Forces in NZ**

United States forces were based in New Zealand from 1942 – 1944. These forces were primarily US Army and US Marine Corps units based in the Auckland and Wellington regions. At its peak there were approximately 40,000 United States service personnel based in New Zealand9. Major United States units included camp and administrative facilities such as hospitals and ammunition depots within the areas in which they were based. However, these units also travelled more widely to where they used numerous sites for live firing training ranges in the Northland, Auckland, Waikato, Bay of Plenty and Wellington/Horowhenua regions.

**Munitions Manufacturing**

The Munitions Controller appointed by the Ministry of Supply controlled and coordinated munitions manufacturing within New Zealand during the Second World War. Munitions manufacturing and explosives filling plants produced small arms ammunition, mortar bombs, grenades and fuzes. Such plants would typically include nearby storage, maintenance and proofing (quality testing) facilities. For example, an explosives filling factory at the Lower Hutt Ford Motor Company plant established a nearby storage tunnel in the Wainui Hill in which 600 tons of explosives were stored10.

9 McKinnon, 1997, New Zealand Historical Atlas, David Bateman, plate 81
10 Cook, 2000, Defending New Zealand Volume 2, Defence of New Zealand Study Group, page 679
WAIKATO REGIONAL COUNCIL STUDY

Background

In early 2011, the Waikato Regional Council contracted Milsearch to complete a desktop study with the purpose of identifying sites contaminated through the use and storage and use of ammunition and explosives. Wherever possible, a legal description of the affected property was to be identified.

The study was to be completed through the research of readily accessible and publically available material.

Research

The research was primarily conducted through the review of NZ Archives records in Auckland and Wellington. The files reviewed were primarily NZ Army Works or Engineering Branch records or Public Works files. These files provided detail of the following;

- Legal issues; acquisition and disposal of property
- Leasing and grazing of property.
- Construction and Maintenance of facilities.
- Inspection of range facilities.

Few files were located in NZ archives which actually detailed the operations conducted on the sites. Regrettably, many of the files within the archival records were incomplete, with large gaps evident in the timescale of a site’s coverage, or containing covering letters referring to maps or drawing, which were themselves inevitably missing.

Other resources were consulted including:

- NZDF Property Branch;
- Waikato Regional Council - Site Land Use Register and Terralink;
- Historic Maps;
• NZ Police Arms Officers – however NZ Police only hold records (the address) of active Pistol Ranges;

• Public Libraries; and

• The Internet.

Findings

Over 100 potentially contaminated sites were identified during this study, with sufficient verifiable information to enable the development of a data sheet detailing the site history and in many cases the legal description of 29 sites.

These sites comprised the following:

• Three ammunition depots (two Army, one Colonial Ammunition Company);

• Three artillery and live fire training areas with several other sites potentially used by US Forces identified;

• One aircraft bombing and rocket range (collocated with a live firing range);

• One ammunition manufacturing plant – Colonial Ammunition Company;

• 22 Grenade Ranges (many collocated with rifle ranges);

• 75 military 25 yard or classification ranges;

• 24 Miniature Ranges; and

• 23 Active shooting clubs and ranges.

A definitive legal description however could not be determined for many of the sites sited on private property. The only aid for identification of the affected property would be a locality and an owner’s name, usually derived from records of related compensation or works. However, those sites on Defence or Crown Lands were easier to track, as the land usage was usually recorded with the legal description in the NZ Gazette.

Future Options

To further progress the identification and assessment of the explosives contaminated sites, the following brief overview describes the processes that are available:
Site Specific Historical Review. This process targets a specific site and includes the following;

- Review of historic aerial photography;
- Interviews with former staff members and users;
- Consultation with local historians, historical societies and libraries;
- Consultation with local councils; and
- For those sites where US forces have been present, research at US National Archives

UXO Safeguarding. Performed by former military ammunition or explosive demolition technicians in areas known or thought likely to be contaminated, safeguarding may be a process of conducting limited point searching where a safe work space must be created for other data capture, such as the conduct of invasive investigations for soil or groundwater contaminants, or geotechnical investigations. A safe access route is cleared to the invasive site then the site is progressively searched until the maximum depth at which UXO is likely to be present has been exceeded. Alternatively, if an UXO contaminated site is encountered, then it can be avoided by locating an alternative invasive site without metallic content. The safeguarding process also provides a technically competent presence on site who can take control in the event that a UXO is encountered.

Field Assessment Survey. A disciplined and documented instrument sampling of a given percentage of the site by UXO remediation specialists, usually conducted along nominally parallel transects. This seeks to identify:

- If contamination is present through the detection of residual EOW;
- An indication of quantities and type of munitions fired;
- The location of targets, direction of firing and the firing points; and;
- The extent of accessible UXO hazards remaining on the surface and an indication of public accessibility to these hazards; and
- A delineation of impact areas within the site – i.e. the areas likely to be candidates for remediation.
This procedure will determine if remediation is required and if so provide information on which to base the development of a remediation plan.

- **Remediation.** The process of locating and removing or disposing of all UXO contaminants.
  
  - **Detection.** Detection technology and equipment is determined by various factors, including geological conditions, calibre of UXO, depth of UXO and the UXO’s metallic composition.
  
  - **Removal or Destruction.** All items that have been detected are excavated and identified. UXO will generally be handed over to Defence personnel for explosive destruction in situ. Mechanical plant would be used for excavation of deeper UXO, or for the removal and sieving of burial pit content.

**CONCLUSION**

With over 100 SAA and potential UXO sites identified during this study of the Waikato region, it is a reflection of the significant military activity there during WW2. It is interesting to note that this large number of sites was identified within a region that did not contain an operational RNZAF or RNZN base, no fixed defensives sites, nor were US forces actually based in static facilities within the region. Clearly there is an even greater potential for other regions where more numerous and static bases existed, for these regions to be host to an even greater number of potential sites, many in close proximity to major cities.

The Waikato review forms a starting point for a wider identification and assessment of formerly used military sites.

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Bevan, 1992, United States Forces in New Zealand 1942 – 1945, MacPherson Publishing

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