NSW GOVERNMENT | Office of Sport

Southern Highlands Regional Shooting Complex

Water Cycle Management Plan

Operational Phase

June 2016

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1 Introduction

1.1 General Purpose and Objective

The purpose of this Water Cycle Management Plan (WCMP) is to provide guidance during the operational phase of the Southern Highlands Regional Shooting Complex (SHRSC, 'the Site') to minimise the risk to human health or the environment by reducing the potential for sediment, metal (and other) contamination migrating to nearby sensitive receptors. The management plan includes details on:

- Aspects of range design associated with pollution control and minimisation;
- Stormwater and wastewater management structures;
- Erosion control measures;
- The application of soil amendments to reduce the risk of metal mobilisation and transport;
- A long term environmental monitoring program and evaluation process;
- A clean up and recycling program for spent munitions; and
- Contaminated soil remediation and/or disposal.

This plan is prepared in accordance with US EPA (June 2005) Best management practices for lead outdoor shooting ranges, EPA-902-B-01-001.

Construction phase activities for soil and water management have been detailed in the Soil and Water Management Plan (SWMP) attached in Appendix B. These plans have been prepared in accordance with Landcom's Soils and Construction: Managing Urban Stormwater (2004) manual (the "Blue Book").

This plan should be read in conjunction with the Soil and Water Management Plan (SWMP) and Operational Environmental Management Plan (OEMP) also prepared for the SHRSC.

1.2 WCMP Requirements

This management plan addresses particular issues contained within the Minister's Determination for the SHRSC, as listed in Table 1.

Table 1 Minister's Requirements

Requirement	Relevant Section
A detailed water cycle management plan (WCMP) for the operation of the complex prepared by a person with knowledge and experience in the preparation of such plans which is to incorporate the elements of Appendix E of the Environmental Assessment.	All and Appendix B
The design capacity of the amended soil wastewater treatment and disposal system for the proposed shooting complex, including upgrade or transfer of the wastewater system at the existing Hill Top rifle range, must be based on average and peak wastewater loads expected to be generated at the site.	Section 4.2.4

Requirement	Relevant Section
The amended soil mound must be located at least 100 metres from the Rocky Waterholes Creek or any other perennial or intermittent creek or watercourse, and at least 40 metres from any drainage depression and dam.	Section 4.2.4
A detailed water cycle management plan (WCMP) for the operation of the complex prepared by a person with knowledge and experience in the preparation of such plans which is to incorporate the elements of Appendix E of the Environmental Assessment.	All
Plans and procedures for the remediation of any contaminated soils on the site.	Sections 4.2.5 and 4.2.6 and SHRSC OEMP
Emergency procedures for spill management of any contaminants including diesel.	Section 3.1.4
Ongoing monitoring plan, including monitoring of vegetation health, solids within and around all ranges, stopbutt material, sedimentation ponds, groundwater monitoring, rainwater and the pre and post construction water quality of Rock Waterholes Creek for the key contaminants associated with the development. This plan must incorporate exception reporting as well as annual reporting of outcomes to the Sydney Catchment Authority, with the reporting identifying appropriate mechanisms to modify management practices and procedure where deleterious impacts on vegetation and water quality are demonstrated. *Note: Preliminary sampling exercises have confirmed that routine sampling of Rocky Waterholes Creek is too remote from the facility to readily identify contamination issues or allow practical management response. Rocky Waterholes Creek and other nominated off site sample locations are unable to be routinely accessed in a practicable and safe manner.*	Section 5
Methods for achieving neutral or beneficial impact on water quality.	Section 1.4

1.3 Integrated Water Cycle Management

This management plan incorporates the principles of integrated water cycle management (IWCM). IWCM involves the integration of all aspects of the water cycle, including the supply of water, sewerage and stormwater to deliver sustainable development. The integration of all aspects of the water cycles incorporates urban planning and design via Water Sensitive Urban Design (WSUD).

The objectives of WSUD is to maintain or replicate (as practically as possible) the pre-development water cycle of the site being developed through design techniques and implementation of measures that manage the impact of the change in the physical characteristics of the site in a sustainable manner.

1.4 NorBE Principles

Due to the nature of the Southern Highlands Regional Shooting Complex (SHRSC), a Neutral or Beneficial Effect (NorBE) analysis on water quality is not feasible to be modelled using commercially available water quality modelling software. The SHRSC's major pollutant generator (metal contaminants) cannot be modelled using the MUSIC program and the remaining site generated pollutants are minimal due to the operational management of the site. Nonetheless, consideration has been given to the NorBE principles.

The following operational management measures ensure a neutral effect on water quality:

- Water quality controls to divert clear water around the SHRSC location;
- Devices (trenches and sediment control ponds) to capture water from cleared areas to ensure heavy metals and sediments do not leave the proposed location;
- Stopbutts designed in accordance with the US EPA (June 2005) Best management practices for lead outdoor shooting ranges, EPA-902-B-01-001; and
- An implemented maintenance management program.

The following measures ensure a beneficial effect on water quality:

- The septic system at the existing club house has been upgraded;
- The existing stopbutt will be rebuilt to the same standard as the new stopbutts; and
- Areas of erosion around the existing firing mounds have been rehabilitated.

1.5 Management Principles

The intent of water cycle management at the SHRSC is to mitigate potential for operation of the facility having adverse impact on the surrounding environment.

Physical and managerial mitigation measures are provided to control:

- The volume of water leaving the site to natural waterways;
- Erosion hazards and sediment generation; and
- Potential for operational contaminates to travel beyond defined areas.

These mitigation measures are detailed in Section 1.6.

A monitoring program designed to confirm the efficacy of the mitigation measures is detailed within Section 5.

1.6 Mitigation Measures

The following mitigation measures (in general) will be implemented to combat the potential environmental impacts from the proposal to develop the SHRSC:

- The existing 800m range stopbutt at the SHRSC will be remediated in accordance with NSW EPA requirements so that it meets health and ecological investigation levels suitable for recreational open spaces. A Site Audit Statement prepared by a qualified site auditor to assess the existing stopbutt and confirm that it has been remediated and is suitable for its intended use;

- Engineering controls isolate areas routinely contaminated by bullet strike (primary and secondary impact) from the surrounding catchment.
- Future remediation of soils if monitoring indicates exceedance of relevant contamination assessment criteria based on the land use;
- Five (5) sediment control ponds with a combined storage volume of 5,400m3 established at the commencement of construction have been retained for operational use of the SHRSC. Future development of the site will include another sediment control pond with a storage volume of 1,230m3;
- New stopbutts and target mounds are designed to reduce erosion, including the construction of a 3(h):1(v) slope to improve stability, to promote low-velocity sheet flow, and to assist with vegetation establishment. Note the angle of the forward slope is specified by NSW Police range guidelines as being at least 30o but ideally 35o in relation to the range fairway;
- New stopbutts have been constructed from suitable clean site soils and imported clean fill with all rocks and other debris removed to minimise the potential for ricochet;
- New stopbutts are designed to minimise contact between water and projectiles to reduce the rate of projectile deterioration and metal leaching; and
- The SHRSC Operational Environmental Management Plan includes the following measures:
  - The usage of firing lanes at rifle and pistol ranges would be staggered to minimise effects on stopbutt stability;
  - Surface Soils within Shot Fall zones (primary and secondary impacts) are monitored and treated as required to maintain Soil pH within the range of 6.5-8.5 to reduce the leaching and mobility of metals.
  - Grass cover is maintained over all areas other than primary impact zones as an erosion control. Vegetation cover also acts to mitigate movement of sediment in run off and migration of contaminants attached to sediments.
  - Fertiliser application and soil ameliorants are used where required to promote the maintenance of the protective grass cover. Regular soil testing is used to inform and confirm correct fertiliser application and avoid potential excessive application and offsite impacts.
  - Where feasible the use of less toxic projectiles (i.e. non lead) would be promoted by the Office of Sport; and
- An operational monitoring program for the SHRSC is in place to monitor possible metal accumulation and migration in and around the site. The monitoring program is outlined in Section 5 of this Water Cycle Management Plan.

2 SHRSC Description

The SHRSC is a regional recreational shooting complex incorporating the existing 800 metre Hill Top Rifle Range (which continues to operate), and includes:

- A (500 metres by 100 metres) shooting range;
- A (50 metres by 115 metres) shooting range;
- Supporting facilities and infrastructure, including:
  - Range control and Toilet facilities;
  - Access roads (designed for two-wheel drive vehicle access) connecting to Wattle Ridge Road and between the ranges;
  - Diesel generator, solar panels, water supply tanks and septic system;
  - Informal parking for 160 cars; and
  - Ponds to contain water for water quality control purposes.
- Future facilities include:
  - A (200 metres by 85 metres) shooting range;
  - A shotgun range;
  - An indoor air range (21 metres by 17 metres by 6.5 metres); and
  - A Clubhouse

2.1 Site Location and Detail

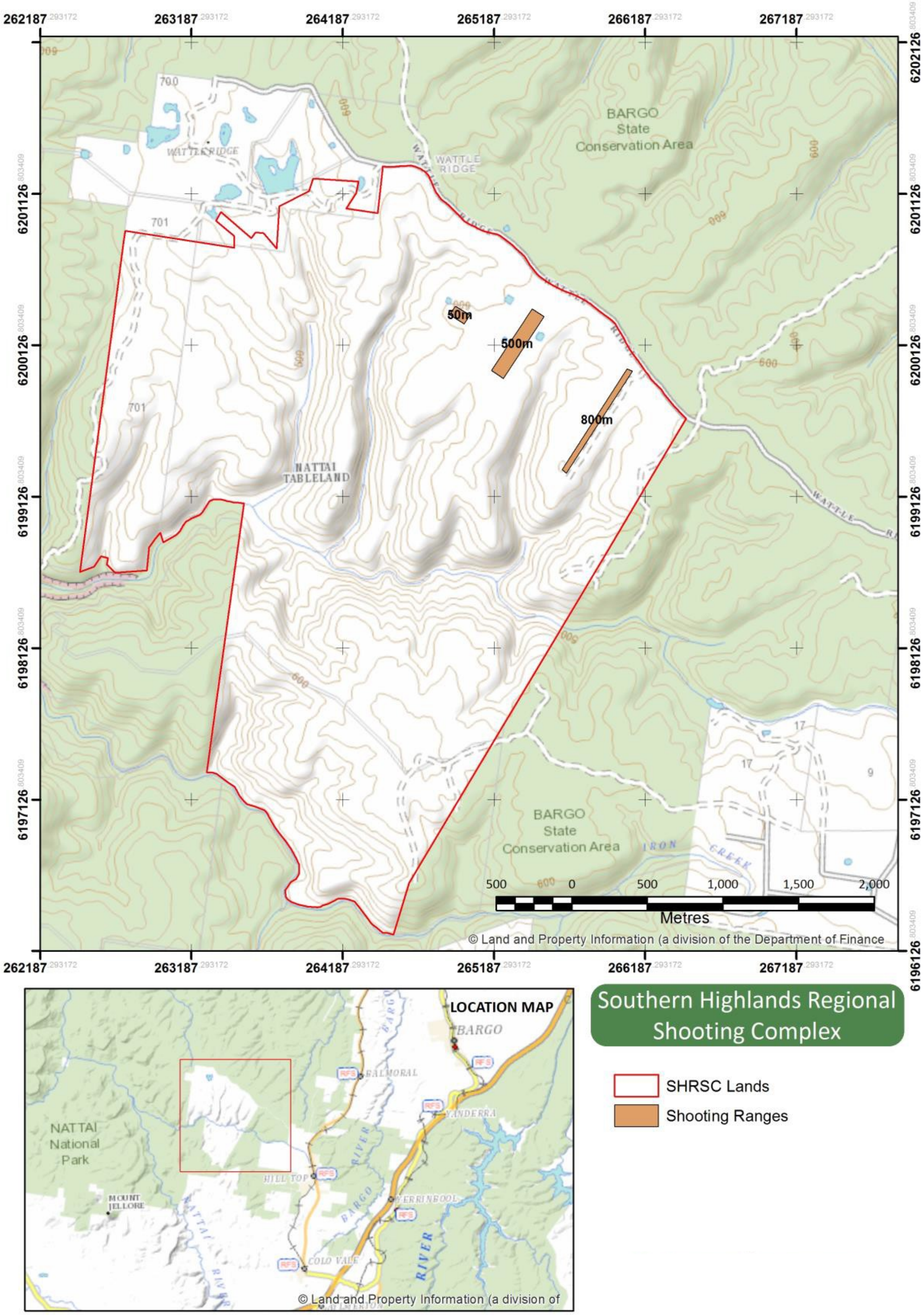
The SHRSC is located in the Wingecarribee LGA on Wattle Ridge Road, approximately 5.5 km northwest of the centre of the village of Hill Top in the southern highlands of New South Wales, approximately 11 km north of Mittagong. Mittagong is located at the south-western end of the Sydney Basin between the upper reaches of the Nepean River and other rivers such as the Wollondilly, Nattai, Bargo and Wingecarribee. These rivers flow into the Nepean River further to the north. See Figure 1 – Site Location.

The Wingecarribee Local Environmental Plan 1989 (the LEP) applies to the site.

The site is currently the location of the Hill Top Rifle Range. The Southern Highlands Rifle Club licensed land on which the range is located, from the National Parks and Wildlife Service, on 3 June 1993. The existing Hilltop Rifle Range consists of a seven-target rifle range 800 m long, with firing mounds at 100 m intervals. A small clubhouse, toilet facilities and informal car parking are also located on site.

1,036 hectares (ha) of land has been excised from the Bargo State Conservation Area by means of the National Parks and Wildlife (Adjustment of Areas) Act 2006. The SHRSC occupies an area of approximately 16 ha within this land. The area occupied by the range and associated facilities was cleared as per the Conditions of Approval. The remainder of the land on the site (approximately 1,000 ha) has been retained in its existing condition as a vegetation buffer zone. This area acts as a safety zone for the SHRSC.

Figure 1 Site Location



2.2 Surrounding Land Uses and Sensitive Receptors

The site is bounded by:

- Wattle Ridge – a grazing property/residence which adjoins the site to the northwest (located approximately 2.5 km north of the existing range);
- Bargo State Conservation Area to the southwest;
- A 330 kV cleared electricity easement (Transgrid) to the southeast; and
- Wattle Ridge Road to the northeast.

Bargo State Conservation Area is located further southwest, southeast and northeast. Nattai National Park is located further to the northwest, on the opposite site of the Wattle Ridge property. Nattai National Park is accessible from the end of Wattle Ridge Road approximately 3 km away.

Sensitive receptors include Rocky Waterholes Creek, located approximately 1.5 km south of the site. The creek is a tributary of the Nattai River. The Nattai River is located approximately 7.5 km west of the site.

2.3 Geology, Soils and Topography

Topographically and geologically the area is transitional between the Cumberland Plain of the Sydney Basin, and the southern uplands.

The underlying geology of the site comprises the Hawkesbury Sandstone of the Mittagong Formation (Herbert and Helby, 1980). The site lies within an outcrop of the Narrabeen group, which comprises sandstone, claystone and siltstone. The Hawkesbury sandstone overlies a Triassic shale unit, the Wianamatta Group.

The site is characterised by relatively flat topography, being situated on a spurline that trends to the north from the Wattle Ridge Range. This spurline occupies a position between two tributaries of the Rocky Waterholes Creek. All watercourses are upper tributaries of the Nattai River.

The three main groups of soils that occur within the region are (NPWS, 2001):

- Sandstone tableland soils;
- Valley soils (sandstone derived); and
- Soils associated with nutrient rich shales and igneous rocks.

Land surfaces in the site do not appear to have been significantly transformed. These soil landscape types are unstable when disturbed. They are highly susceptible to mass movement, such as slides and rock falls, as well as wind and water erosion (Hazelton and Tille, 1990). A major cause of erosion in an area of this type is fire. After a fire in which the crowns are consumed, the loose sandy soils remain bare for a long period. If rain then shortly follows a fire, there is a resulting increase in surface run-off, causing increased erosion, and a reduction in plant propagation and animal habitats.

2.4 Hydrogeology

The site is located within the Hawkesbury Sandstone – southeast groundwater flow system, which consists of a layered aquifer system with yields ranging from less than one to 50 ML/day. Basalt caps are expected to occur in some areas of the Mittagong Ranges, with groundwater from this horizon discharging into seeps, springs and rivers (Sydney Catchment Authority, 2006).

According to the Department of Natural Resources Groundwater Licence database, groundwater within the Hilltop area was found to be present at depths of approximately 20 metres in the sandstone aquifer. The depths to groundwater within the aquifers are expected to be dependent on rainfall and therefore are likely to vary seasonally. A borehole on site near the proposed clubhouse was terminated at 50 m depth with no water detection.

2.5 Hydrology

The nearest pluviograph station to the site is located at Moss Vale, which is considered too distant to provide representative hydrology data for the study area. A number of daily rainfall stations are located in close proximity to the study area. Table 2 summarises these stations, providing station number, name and recording start and end years.

Table 2 BOM Daily Rainfall Data

Station Number	Station Name	Start Date	End Date	Max mean monthly rainfall (mm)	Min mean monthly rainfall (mm)
068044	Mittagong (Beatrice St)	1886	2015	93.5	52.6
068052	Picton Council Depot	1880	2015	90.7	44.0

An analysis undertaken on this data indicated that there is some variability in the rainfall with the maximum mean monthly rainfall of 93.5 mm in March, while the minimum mean monthly rainfall recorded is about 44.0 mm in September. The annual average of the rainfall gauges is 857.45 mm. The mild seasonal variability would indicate that rainwater collection via rainwater tanks is viable.

Mean monthly evaporation data for the region ranges from 40-50 mm in June to 200-250 mm in December, with an annual evaporation rate of approximately 1600 mm. The annual evaporation rate exceeds the average annual rainfall for the region; however, the existing erosion control ponds still contained water during a site inspection in December 2006 despite a prolonged period with only limited rainfall.

The SHRSC only requires water for potable purposes and for construction dust suppression and vegetation establishment, so the low level of annual rainfall does not impact upon the SHRSC.

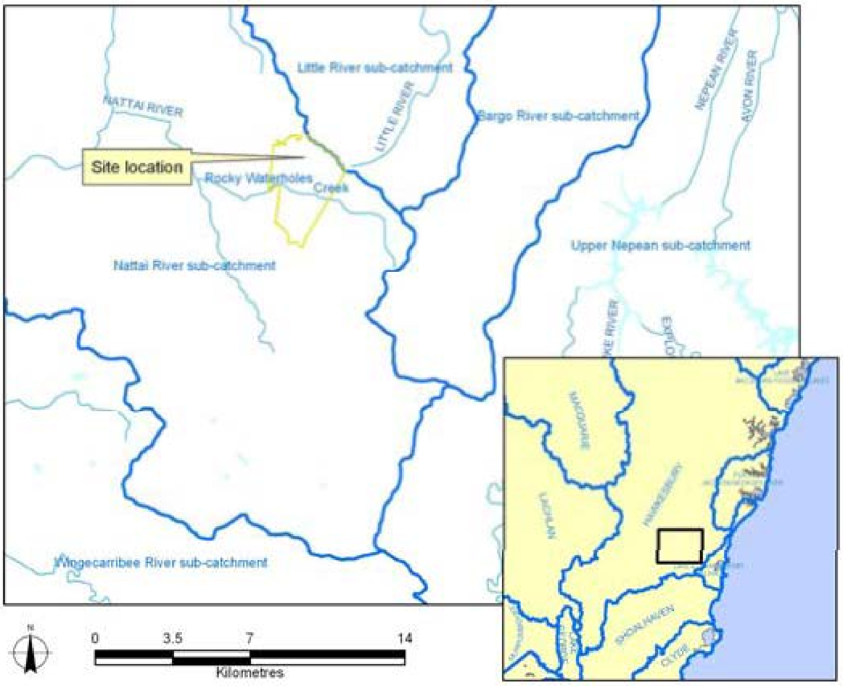
2.5.1 Waterways

Rocky Waterholes Creek, which is immediately south of the SHRSC drains directly to the Nattai River approximately 6 km to the west of the existing Hilltop Rifle Range. The Nattai River drains north to Lake Burragorang. The catchment of Rocky Waterholes Creek is approximately 23.5 square kilometres, while the catchment of the Nattai River upstream of the junction with Rocky Waterholes Creek is some 240 square kilometres. The total catchment area of the Nattai River upstream of Lake Burragorang is 480 square kilometres. Figure 2 below illustrates the major regional catchments within the vicinity of the site.

2.5.2 Onsite Creeks

As the site sits on the top of a spurline that runs from north to south, the natural fall is from the centre of the spurline to the east and to the west into steep gullies. The gullies drop from the level of Rocky Waterholes Creek Road down to Rocky Waterholes Creek, a fall of approximately 100 metres over a distance of less than 1 km. As a result of the topography, the site is not subjected to flooding.

Figure 2 Water Catchment



2.6 Water Quality

The Hawkesbury Nepean Catchment Management Authority has classified 98% of the Nattai River as being ‘Near Intact’. The Draft Hawkesbury Nepean Catchment Action Plan (2007) identifies a strategy for managing the entire catchment and sets out procedures for looking after the near intact systems such as the Nattai River.

3 Environmental Impact

This section outlines the potential contaminants that may affect the area as a consequence of the operation of the SHRSC.

3.1 Potential Contaminants of Concern

Projectiles (or shot) are primarily composed of lead (i.e. greater than 90% of projectile) therefore lead is considered to present the greatest contamination risk.

Other metals, including antimony, arsenic, cadmium, copper, nickel, tin and zinc, are often also present but make up less than 7% of the projectile. Each of these metals has the potential to be toxic to humans, aquatic and terrestrial organisms, and some vegetation under certain environmental conditions.

3.1.1 Lead

Lead contamination at shooting ranges is normally limited to surface and near-surface soil. Lead from the shot is likely to become mobile more quickly in surface soils where it can be oxidised and leached by rainfall or runoff than in sediments accumulating within water bodies under anaerobic conditions.

The longer lead is in contact with rainwater, the greater the amount of dissolved lead that will be present in stormwater runoff. Additionally, lead weathers faster for higher annual precipitation rates. Lead dissolves through the progressive weathering of the surface layer of projectiles. The accumulated lead corrosion compounds that form can dissolve rapidly in rainfall and can be easily transported through infiltration and runoff.

Lead is generally most mobile in acid environments below pH 6. Increases in pH will cause dissolved lead to precipitate out of solution, with only small concentrations of dissolved lead present at pH levels above 7.5. However increased lead mobility has been observed at pH levels above 7 in soils with moderate to high organic matter contents. The majority of rainwater in Australia is mildly acidic, and has the potential to leach lead from contaminated soils and corroding ammunition.

3.1.2 Other Metals

A broader suite of possible contaminants (metals other than lead) are included in the monitoring program. Metals of concern included in the analysis suite are those which are common bullet composition. The full suite of potential contaminates is provided within the tables in Section 5 Monitoring Program.

3.1.3 Clay targets

Clay targets used at shotgun ranges may also contribute contaminants to the environment.

In general, one clay target is launched for every shot made, and at busy ranges mounds of target fragments can rapidly accumulate. Clay targets are typically composed of 70% limestone bound with 30% tar pitch, bitumen, or other organic material. The contaminants typically found in clay targets include:

- Polycyclic aromatic hydrocarbons (PAH); and
- Heavy metals (lead, cadmium, chromium, copper, nickel, mercury and zinc).

Studies suggest that PAHs in both new and aged targets are tightly bound in a petroleum pitch and limestone matrix and are unlikely to be bioavailable in this form.

Polycyclic Aromatic Hydrocarbons (PAH) are included in the suite of contaminants within the Monitoring Program Section 5.

3.1.4 Other Contaminants

Other contaminant sources include stored substances such as domestic chemicals, and oil and fuel from vehicles visiting the site.

Containment and isolation of any spills of these substances should be first priority, should a spill occur. Containment measures would include bunded storage areas for large volume stored chemicals such as diesel so that any spills can be contained and disposed of appropriately, prior to any discharge to the environment.

In instances where chemical substances are discharged into the environment, procedures are to be in place for clean-up of the spill through the use of chemical spill kits. Due to the relatively small volumes of chemical substances that are expected to be stored at the site, the use of personal spill kits should be sufficient. Otherwise, emergency procedures for chemical spill should include the need to contact Emergency Services during spill incidents which are considered to be a potential environmental or health concern by a site management representative or a suitably qualified person.

Any chemicals which cannot be removed following clean up would be subjected to the water cycle management processes implemented.

3.1.5 Distribution of contaminants

From a contamination perspective, the major difference between shooting ranges and shotgun ranges relates to the physical distribution of the lead projectiles.

SHRSC shooting ranges each have a stopbutt, which helps concentrate lead in a small area of the stopbutt behind the targets. Projectiles may occasionally strike the foreground between the firing line and the targets, but here lead is usually sparsely distributed when compared to the concentrations found in the stopbutt.

Ricochets can increase the distribution of lead to other areas. As projectiles impact with targets or stopbutts located behind targets, they have the potential to produce lead dust and fragments. Recovery of lead projectiles may also generate dust at shotgun and shooting ranges.

It is considered that almost all projectiles will be captured by the stopbutts or other capture systems. Whilst no exact figures are available, discussions with the Australian Army NSW Range Inspector indicated that at least 95% of all projectiles are intercepted by the stopbutts.

3.2 Operational Impacts

No physical works are proposed that would alter stream characteristics, flows or creek morphology, therefore long term physical impacts to Rocky Water Holes Creek and its tributaries are unlikely.

Potential impacts are likely to be associated with:

- Migration of contaminants from the cleared areas to Rocky Water Holes Creek and its tributaries;
- Increase in surface water runoff from impervious surfaces; and
- Effluent water discharges.

3.2.1 Post Development Runoff

The clearing and development of bushland leads to an increase in the volume and rate of runoff as a result of pervious surfaces being replaced with surfaces that allow less infiltration. Whilst development results in increased runoff, the increase in runoff is expected to be low as most of the changes to the site would only result in a change of the vegetation type from woodland to grass.

Engineering controls minimise the potential for runoff to affect downstream water quality and include sediment control ponds and permanent erosion control. Ponds allow sediment to settle before the water is discharged at the runoff discharge locations for each range. The minimum storage volume provided in the existing sediment control ponds is 5,400m^3, which equates to a storage volume of 337.5m^3/hectare. In addition to the sediment control ponds, roof water is captured in rainwater tanks for general use around the site.

3.2.2 Wastewater

The SHRSC is not served by a centralised sewerage system.

The existing clubhouse facilities are connected to a new on-site treatment system. The new system was designed to meet current best practice standards.

The 50m and 500m ranges when complete will each be connected to an on-site treatment system designed to meet current best practice standards.

4 Mitigation and Control

4.1 Construction Phase

Proposed controls and mitigation measures to be implemented during the construction phase are detailed in the Soil and Water Management Plan included in Appendix B.

Controls and mitigation measures to be implemented during the construction phase include:

- Stormwater management - Specific strategies include the provision of treatment practices, promotion of sheet flow across the range surface, prevention of stormwater from impacting the berms and areas that have the highest potential for erosion, construction of sediment control ponds and locating the stopbutts away from existing water courses;
- Waste water management - Portable toilets will be utilised during the construction phase. These toilets will be removed following construction;
- Erosion control - Stopbutts and target mounds designed to reduce erosion, promote low-velocity sheet flow and to assist with vegetation establishment;
- Application of soil amendments - It is proposed that fine agricultural grade lime be raked into the soils within the range, stopbutts and collection trenches to reduce the mobility of metals by increasing soil pH to within the range of 6.5 to 8.5; and
- Rapid stabilisation of cleared areas to minimise potential for erosion.

4.2 Operational Phase

4.2.1 Containment and Management

Containment and Management strategies have been based on a best practice management approach in accordance with the US EPA (June 2005) Best management practices for lead outdoor shooting ranges, EPA-902-B-01-001.

Surface waters from all areas external to the range (fairway and stop butt) will be diverted or otherwise made to drain away from potentially contaminated areas.

Metal migration at the ranges is managed primarily by positioning bullet stopbutts behind the targets and bullet traps to collect/contain projectiles to facilitate their recovery and recycling.

Stopbutts are constructed from suitable clean site soils and imported clean fill and all rocks and other debris removed to minimise the potential for ricochet.

The stopbutts are designed to minimise contact between water and projectiles to reduce the rate of deterioration and metal leaching.

To reduce lead migration within the stopbutt, a layer of crushed limestone is located in the base of the stopbutt to reduce capillary rise and contact between low pH water and lead projectiles. The limestone increases the pH of waters leaving the media to further limit migration of contaminants.

Seepage is directed to lime treatment trenches and pits, where any lead or contaminants would drop out.

Within the range fairways, additional lime filled trenches are provided at low points to ensure that any potential overland flow containing lead is intercepted. These trenches drain directly to sediment control ponds.

Surface soils within the fairway will be monitored and treated with agricultural lime as required to maintain a pH range of 6.5-8.5.

4.2.2 Stormwater Management

In the context of Water Sensitive Urban Design (WSUD), the planning and design sets out to minimise the hydrological impacts of development on the surrounding environment. The management of stormwater encompasses:

- Water quality management;
- Flood management;
- Flow management; and
- Flow attenuation.

Key planning and design objectives are:

- Protect and enhance natural water systems following development;
- Integrate stormwater treatment into the landscape by incorporating multiple-use corridors, that maximise the visual and recreational amenity of the development;
- Protect water quality draining from development areas;
- Reduce runoff and peak flows from developments by employing local detention measures, minimising impervious areas and maximising re-use (for example through rain water tanks).

Stormwater management for the SHRSC is designed to prevent an increase in the amount of stormwater leaving the site, maintaining the water balance, and to slow the transmission of stormwater to receiving waters to match the existing predevelopment conditions.

Additionally, the stormwater management system prevents the transportation of gross and sediment-born pollutants as much as possible.

Specific strategies include:

- Provision of stormwater infrastructure in a ‘treatment train’ approach which provides controls which successively reduces erosion and sediment transport, mitigates leaching and transport of contaminants and final basins to manage water quality.

- Promotion of sheet flow of runoff water over the range surface. Sheet flow lowers the water velocity, which will lower the water's sediment load–carrying capacity. It avoids potential point source discharge issues and monitoring requirements that may occur with channeled flow. Promoting sheet flow is accomplished by regrading and flattening out the slope of the land surfaces and by creating broad, very shallow drainage pathways to replace ditches or deep, narrow channels;
- Prevention of storm water from impacting on berms or other engineering elements.
- Construction of sedimentation/water quality ponds which serve as a final containment measure for water leaving the ranges. The ponds are designed and sized properly to effectively slow the water and allow the suspended solids to settle out.
- The drainage area that the pond will serve is well defined, and the calculated volume of water the pond must handle is accurate; otherwise, the pond's effectiveness will be minimal. It is proposed that when complete the SHRSC will have six ponds, three located at the 500 m / future 200 m range, one each at the future shotgun and 50 m pistol range and one at the future clubhouse. The ponds have been sized in accordance with the requirements of Landcom Soils and Construction Volume 1 (Landcom; 2004). The sizes of the ponds are as follows:
    - Pond 1 at future 200 m range – 2,000 m^3;
    - Pond 2 at 500 m range – 660 m^3;
    - Pond 3 at 500 m range – 1,380 m^3;
    - Pond 4 at 50 m range – 270 m^3;
    - Pond 5 at future Shotgun range – 1,090 m^3; and
    - Pond 6 at the future carpark and clubhouse (existing pond to be retained to act as erosion control pond during construction) – 1,230 m^3;

  The capacity of the ponds to contain all runoff expected has been designed based on the 5-day 85th percentile storm depth and for type D/F soils.

  The ponds would be utilised for the life of the SHRSC and the water quality monitored as set out in Section 5 – Monitoring Programs.

  Dewatering of ponds can occur following sampling to confirm the water complies with the limits set in Table 4 by a National Association of Testing Authorities (NATA) Accredited Laboratory. The waters then may be discharged at the spillway or used for irrigation of range areas.
- Stopbutts and target mounds are designed to reduce erosion, including the construction of a 3(h):1(v) slope to improve stability, to promote low-velocity sheet flow, and to assist with vegetation establishment.

- In an effort to minimise impact to stopbutt stability usage of range firing lanes are staggered.
- Grass is maintained over the ranges and stopbutts for erosion control.
- Stopbutt maintenance between lead recovery and recycling operations involves:
  - Replacement of eroded areas, reseeding bare areas, maintaining vegetation.
  - Placement of temporary erosion controls measures as required to promote stabilization.
- The stopbutt is routinely inspected and filling undertaken to repair areas of concentrated impact points.

4.2.3 Post Development Runoff

The clearing and development of bushland leads to an increase in the volume and rate of runoff as a result of pervious surfaces being replaced with surfaces that allow less infiltration. Whilst development results in increased runoff, the increase in runoff is expected to be low as most of the changes to the site would only result in a change of the vegetation type from woodland to grass.

Engineering controls minimise the potential for runoff to affect downstream water quality and include sediment control ponds and permanent erosion control. Ponds allow sediment to settle before the water is discharged at the runoff discharge locations for each range. The minimum storage volume provided in the existing sediment control ponds is 5,400m3, which equates to a storage volume of 337.5m3/hectare. In addition to the sediment control ponds, roof water is captured in rainwater tanks for general use around the site.

4.2.4 Wastewater Management System

The SHRSC when complete will have an Ecomax Septic System or equivalent at all locations where wastewater is generated. The SHRSC currently only involves the construction of the 500m and 50m ranges, with the other ranges developed at a later date.

The design capacity of the amended soil wastewater treatment and disposal system for the SHRSC has been calculated based on average and peak wastewater loads expected to be generated at the site.

Wastewater Flows and Loads

As per AS/NZS 1547:2012 the design wastewater flow allowance for restroom facilities (toilets and hand basins only) is 15 L / equivalent population (EP) / day (roof water supply) in this instance as the proposed facility will be a used for members attending the shooting range between 10.00am to 5.00pm with an expected maximum occupancy of 220 EP per day –15 L per p / day has been applied in the design calculations.

Land Application Design Parameters and Sizing

Data has been selected from the SCA data from Bureau of Meteorology, rainfall calculation station Mittagong, Evaporation Station SCA Zone 4. The total land disposal area of 387.04 m² is required to dispose a maximum 3,300 L / day and provides a zero overflow. The delineated land application area requires a minimum area of 23.6m x 16.4m, the internal cell dimensions are 11.6m L x 4.4m W x 1 plus a perimeter sand bed of 6.0m.

Tertiary Treatment –Amended Soil Mound (ECOMAX)

The Ecomax in this design allows for an inflow of up to 3,300L / day. The Ecomax process is best described as "solid matrix filtration" with effluent renovation by processes which include sorption, oxidation/reduction, volatilization, filtration, biological uptake and detention. Each system consists of a NSW Health Approved septic tank and one Ecomax cell fed from the septic tank.

Each Ecomax system consists of one amended soil mound located within the cleared range areas remote from the Rocky Waterholes Creek or any other perennial or intermittent creek or watercourse, and at least 40 metres from any drainage depression and dam.

The Amended Soil Mound (cell) contains an Ecomax storage drain (tunnel) and amended soil medium contained within an area, between the amended soil medium and impervious layer. The above ground construction provides a large surface area exposure both vertically and laterally, and insulated internal temperature

The treatment processes which are applied to the effluent as it is driven through the amended soil include: filtration, PH adjustment, on exchange, volatilization, biological water and nutrient uptake, oxidation and reduction, absorption, chemical precipitation, detention and evaporation or dilution depending on rainfall/evaporation balance.

The treated effluent is clear, colourless and effectively. Phosphorus removal by Ecomax septic systems, at 99%, is substantially higher than can be achieved by any other practical domestic treatment process. Nitrogen removal is generally very high. High ammonia removal is also a key feature as this contaminant is undesirable in aquatic ecosystems, even at low concentrations. Biological oxygen removal is very high and final effluent concentrations will generally meet drinking water standards. In terms of faecal bacteria, Ecomax effluent meets the national health and medical research council guidelines for "reclaimed effluent" but it is not potable.

4.2.5 Application of Soil Amendments

Based on preliminary assessment, the risk of groundwater contamination from site use is considered likely to be minimal given the considerable depth to groundwater on the site, the shallow depth at which natural bedrock is encountered and the general elevation and topography of the site.

Migration of surface contamination may occur through dissolution of heavy metals via rainfall and transport through surface water runoff. To mitigate contaminant migration, fine agricultural grade lime would be applied to soils within the range, shot fall zones, stopbutts and collection trenches to reduce the mobility of metals by increasing soil pH to within the range of 6.5 to 8.5. The dose of lime required would be determined by laboratory testing and specifications provided for individual lime products.

Re-application of lime would be undertaken when the pH of soils is found to drop below pH 6.5.

4.2.6 Projectile Clean-Up and Contaminated Soil Remediation

Projectiles are regularly recovered and recycled from fall zones and stopbutts through raking, sifting and screening methods.

The removal of projectiles from the stopbutts is focused primarily around the bullet pocket/toe of the berm.

The regularity of projectile recovery is dependent upon the level of activity at the shooting complex (Office of Sport keep records of the amount of projectiles fired), but as a minimum is undertaken annually.

Inspections of the complex and buffer zones is undertaken annually to identify any additional zones that may require clean-up.

The quantity of projectiles recovered from the complex is compared with firing records to monitor the effectiveness of range operational and engineering controls.

Appropriate personal protective equipment, including gloves, eye protection, and respiratory protection, will be worn by those handling the projectiles during collection to minimise exposure risks. Office of Sport will confirm a safe work method statement is provided by any contractor engaged in activities to remove or retrieve munitions at the ranges.

The collected projectiles are to be held in appropriately labelled covered storage containers prior to recycling to prevent leaching and migration of contaminants. Projectiles would be stored on site for no longer than one month before being moved to a licensed recycling facility.

Soil testing and monitoring is undertaken in accordance with the monitoring program detailed in Section 5. Exceedance of the any assessment criteria indicated in the program is not necessarily intended to indicate when remediation is required but rather when a management response (such as further sampling, remediation planning or remediation works) should occur.

5 Monitoring Programs

5.1 Construction Phase Monitoring

Details of the construction phase monitoring have been detailed in the Soil and Water Management Plan included in Appendix B. Areas to be monitored during construction includes surface water and inspections of engineering controls.

5.2 Operational Monitoring Program

An operational monitoring program has been initiated at the site to:

Monitor possible metal accumulation and migration from the site during operation. Monitoring includes:

- Soil monitoring;
- Sediment monitoring;
- Surface water monitoring;

Monitor the function of engineered structures as well as other factors relevant to erosion risk. Monitoring includes:

- Inspection of stop butts, shot fall zones and erosion control structures; and
- Inspection of vegetation health and density.

Note: Preliminary sampling exercises have confirmed that routine sampling of Rocky Waterholes Creek is too remote from the facility to readily identify contamination issues or allow practical management response. Rocky Waterholes Creek and other nominated off site sample locations are unable to be routinely accessed in a practicable and safe manner.

Descriptions and requirements for the monitoring program are summarised in Tables 3 – 5:

- Table 3 - Monitoring program for Soils and Sediments
- Table 4 - Monitoring program for Surface Waters
- Table 5 - Monitoring program inspections of infrastructure/engineering controls and evidence of ricochet.

Analytes presented within the monitoring program are those metals common in the composition of projectiles.

A sampling plan example is presented in Appendix A for the various ranges at the SHRSC. This is a guide to sampling requirements location and number and should be confirmed within the plan for each sampling exercise.

Table 3 Monitoring Program – Soils & Sediments

Soils & Sediments			Assessment Criteria (mg/kg)	
Analytes/Suite	**Frequency**	**Sample Locations**	**Site Specific EILs relevant to land use**	**NEPM HIL(C) Recreational**
PAH	As required	Only when suggested by external factors or observations		
Cadmium	Annually	Primary shot zones Secondary shot zones Shot fall areas Note: Metals are offered by laboratories as a suite and as such a broader suite is not cost prohibitive.	-	90
Arsenic			100	300
Chromium			414	300
Copper			132	17000
Mercury			-	13
Nickel			34	1200
Antimony			-	25
Tin			Observations only	
Lead			1113	600
Zinc			190	30000
Iron			Observations only	
TCLP		Apply to samples which return high values for key contaminants to confirm suitability for disposal as required.		
CeC		Apply to selection of samples to monitor change and also assist in planning fertiliser response		
pH	6 monthly Plus quarterly field sampling of pH in primary & secondary impact areas	For areas outside the primary and secondary impact zones. Values should statistically correspond with the values observed and detailed within Section 6.3. Discussion of observed values and possible management issues will be raised as part of the reporting of operational monitoring. For areas within shot fall zones, observed pH values should reflect the objectives of the management of those areas and be discussed in relation to the potential for pH to effect the mobility of target analytes. Generally, this will result in target pH to be pH 7or above.		
Clay Content	As required	Only when suggested by external factors or observations		

Table 4 Monitoring Program – Surface Waters

Water			Assessment Criteria	
Analytes/Suite	**When**	**Where**	**ANZECC 2000 PFWS/NEPM GIL**	**ANZECC 2000 RWQG**
Total N			Observations especially following commencement of fertiliser applications	
Ammonia as N			0.9 mg/L	10mg/L
Phosphate as P			0.15mg/L	-
Dissolved Oxygen			Observations especially following commencement of fertiliser applications	
Phosphorous		All basin inlets and below outlets Creek areas accessible off range when available	Observations especially following commencement of fertiliser applications	
Nickel			11 µg/L	100 µg/L
Arsenic			24 µg/L	50 µg/L
Chromium			1 µg/L	50 µg/L
Lead	Six Monthly		3.4 µg/L	50 µg/L
Copper			1.4 µg/L	1000 µg/L
Zinc			8 µg/L	5000 µg/L
Antimony			9 µg/L	-
pH		pH should reflect the operational objectives of the treatment train for the surface water sampled. Waters from areas at or below the outlet from water quality structures should generally be consistent with the range observed in sampling to date. Extreme values either high or low should be discussed and responded to as part of reporting on sampling exercises. For areas within treatment trains of surface water quality measures. pH should reflect the objectives of that stage of the treatment train as it directly effects mobility target contaminants.		

Table 5 Monitoring Program – Visual Inspections

Visual Inspections		
Location	**Inspect**	**Frequency**
Water Quality Pond Outlets, inlets and Surrounds	Evidence of scour/ failure of structure	Six monthly and after any severe storm events
Engineering controls including berms, drains, channels, stopbutts, access tracks and culverts	Evidence of damage, erosion, sediment outside controlled areas.	Six Monthly and after any severe storm events
Range perimeter	Evidence of loss and/or damage from stray projectiles	Annually

5.3 Assessment Criteria

5.3.1 Relevant Guidelines

The guidelines used to assess site contaminants are based primarily on guidelines 'Made or Approved' by the DECC under Section 105 of the Contaminated Land Management Act 1997. These guidelines include:

- NSW DECC (2006) 'Guidelines for the NSW Site Auditor Scheme';
- ANZECC (2000) 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality' including Sediment Quality Guidelines Volume 1 Section 3.5;
- ANZECC / NHIVIRC (1992) 'Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites'; and
- NECP (1999 Amended 2013) 'National Environmental Protection (Assessment of Site Contamination) Measure 1999', (NEPM).

Reference is also made to the US EPA (U.S. Environmental Protection Agency) (2005) 'Best Management Practices for Lead at Outdoor Shooting Ranges' EPA-902-B-01-001', which provides guidance with particular relevance to the site use as a shooting range.

5.3.2 Assessment Criteria Adopted

The criteria used to assess levels of contamination include:

Soil/Sediment:

- NEPM National Environment Protection (Assessment of Site contamination) Measure (1999 Amended 2013) Health investigation level (HILs)
  - C – Developed Open Space such as parks, playgrounds, playing fields (Includes public recreational facilities such as SHRSC.)

- NEPM National Environment Protection (Assessment of Site contamination) Measure (2013) Ecological Investigation Levels(EILs) for urban residential and public open space land use

Water (sediment basins):

- ANZECC PFWS Protection of fresh water species - 95% trigger value (Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council, 2000) (note the ANZECC PFWS guidelines adopt the NEPM GILs for Freshwater)
- ANZECC RWCG Recreational Water Quality Guidelines (Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council, 2000)
- NEPM National Environment Protection (Assessment of Site contamination) Measure (2013) Ground Water Investigation Levels (GILs) for Freshwater. Note: As GILs for Antimony (Sb) are not available due to insufficient data, a Low Reliability Trigger Value is adopted from Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 2. Aquatic Ecosystems — Rationale and Background Information (Chapter 8) 2000.

5.4 Responsibilities

The operational monitoring of the SHRSC shall be undertaken by Office of Sport.

5.5 Reporting

As required, contamination assessment/remediation reports should be compiled in accordance with the NSW EPA (2011) Guidelines for Consultants Reporting on Contaminated Sites by a suitably qualified person.

The results of the monitoring are to be incorporated into an annual report to be prepared by Office of Sport and submitted to Water New South Wales.

The report will highlight any failed tests or issues that may have arisen during monitoring and will identify remedial actions or modified management practices to prevent recurrence of any failures. The report as a minimum is to contain the following sections:

- Summary, highlighting any test failures and site observations;
- Map and summary of testing locations;
- Analysis of testing results including trend analysis i.e. changes over the monitoring period;
- Recommendations for remedial work, and modifications to management procedures; and
- Recommendations to change the monitoring program i.e. additional testing, change of frequency etc.
- SHRSC remedial or management works undertaken including removal of lead projectiles from stop butts, volume retrieved and method of disposal.

Appendix A

Sampling Plan – Examples

1. 800m Sampling Plan

800m range – Sample number and location

Table 1 provides the Sampling Rationale Matrix for the 800m range.

The suite of analytes for each sample type is given in tables 2A-C following.

TABLE 1 - SAMPLING RATIONALE MATRIX 800M RANGE			
Sample Location	**Sample type**	**Context (in landscape) of Sample location**	**Rationale for selection**
Stop butt impact area (bullet catcher) (800mm range)	Soil	Face of stop- butt behind targets – impact area and adjacent to impact area	Confirm levels in area of expected contamination
Rear of stop butt	Soil	Possible shot fall area	Identify contamination
Bench in front of stop butt	Soil	Down gradient of stop butt impact area	Confirm levels in expected area of contamination. Identify contamination
Galley	Soil	Shot fall area	Confirm levels in expected area of contamination. Identify migration of contamination
Target Mound/Mantlet and associated drainage	Soil	Mound in front of galley – potential impact area	Confirm levels in expected area of contamination. Identify migration of contamination
Area in front of Mantlet	Soil	Outside drainage to impact areas	Identify migration of contamination
Drain from stop butt	Soil	Down gradient of stop butt impact area	Confirm levels in expected area of contamination. Confirm/characterise migration of contamination

SAMPLING RATIONALE MATRIX 800M RANGE - Cont			
Sample Location	**Sample type**	**Context (in landscape) of Sample location**	**Rationale for selection**
Mulched area behind stop butt	Soil	Down gradient of impact area– water quality area for stop butt	Confirm levels in expected area of contamination. Confirm migration of contamination
Outlet from mulched area	Soil, water, sediment	Discharge point for surface water	Assess for contamination from local catchment
Pond: East of 800m range	Surface, water sediment	Surface water from road and part range areas	Assess for contamination from local catchment

Tables 2A -C provide the planned location and numbers of samples at the 800m range. as prepared for the SAQP

Metals of concern included in the analysis suite are those to be common in the composition of bullets.

TABLE 2A: SOILS		
Analytes/Suite	Locations	Number (SAQP)
PAH	Stop butt (impact area behind targets)	2
Cadmium	Stop butt (impact area behind targets) 25cm	2
Arsenic	Stop butt (impact area behind targets) 50cm	2
Chromium	Stop butt (impact area behind targets) 100cm	2
Mercury	Stop but non-shot area	2
Nickel	Stop butt (non-shot area) 25cm	2
Tin	Stop butt (non-shot area) 50cm	2
pH	Stop butt (non-shot area) 100cm	2
Lead	Gallery area	3
Copper	Bench at front of butt/foot of stop butt	3
Zinc	Target mound/mantlet	3
Antimony	In front of target mound/mantlet and associated drainage	3
Iron	Stop butt –rear	1
CeC	Up gradient of butt	1
Clay Content	Down gradient towards mulched sump	2
	Invert of mulched sump	3

TCLP **(for samples with elevated levels only)**	Perimeter/banks of sump Exit channel from sump to offsite- to flow line over escarpment **Duplicate samples** **Triplicate samples**	4 3 **2** **2**

TABEL 2B: WATER		
Analytes/Suite	Locations	Number
Nickel Arsenic Chromium Total Phosphorus (TP) Total Nitrogen (TN) Ammonia (NH3) Dissolved Oxygen (DO) pH 1 Lead Copper Zinc Antimony Phosphate	Pond adjacent to 800m range Pond at rear of 800m range Channel at rear of 800m range	1 1

TABLE 2C: SEDIMENT		
Analytes/Suite	Locations	Number
PAH Cadmium Arsenic Chromium Mercury Nickel Tin Clay Content pH	Pond adjacent to 800m range Pond at rear of 800m range – at inlet to pond Channel at rear of 800m range	1 1 1

Lead Copper Zinc Antimony Iron CeC TCLP **(for samples with elevated levels only)**		

2. 50 & 500m Sampling Plan

50 & 500m Ranges – Sample number and location

Table 3 below gives the Sampling Rationale Matrix for the 50 and 500m Ranges.

TABLE 3: SAMPLING RATIONALE MATRIX: 50M & 500M RANGES			
Sample Location	**Sample Type**	**Context (in landscape) of Sample location**	**Rationale for selection**
On range	Soil	Main body of range / fairway/shot zone	Identify contamination – confirm no migration of contamination
Face of stop butt (SHRSC)	Soil	Impact area of range	Confirm levels of expected contamination
Area immediately in front of toe of stop butt associated drainage	Soil	Outside drainage to impact area	Confirm no migration of contamination
Ponds/basins	Water, sediment	Ponds receive water from range areas	Confirm no migration of contamination Confirm water quality parameters
Rear of stop butt	Soil	Possible shot fall area	Confirm no contamination
Creek water off range	Water, sediment	Separate from range run off	Confirm no migration of contamination. Confirm water quality parameters

Tables 4A- C provide to planned location and numbers of samples at the 50 & 500m Ranges.

TABLE 4A: SOILS			
Analytes/Suite	Range	Locations	Number
pH Lead Copper Zinc Antimony Iron CeC	500	On range Off range / bush land Face of stop butt Within 10m in-front of toe of Stop-butt and associated drainage	3 3 3 3
	50	On range Off range / bushland	3 3

		Face of stop butt Within 10m in-front of toe of Stop-butt and associated drainage	3 3
	50m/500m range	**Duplicate sample** **Triplicate sample**	1 1

TABLE 4B: WATER		
Analytes/Suite	Locations	Number
pH 1 Lead Copper Zinc Antimony Phosphate	Pond at car park (Basin 4)	1
	50m (Basin 5)	1
	500m East (Basin 3) 500m West (Basin 2)	1 1
	200m (Basin 1)	1
	Creek waters off range (if available)	2
	Duplicate sample Triplicate sample	1 1

TABLE 4C: SEDIMENT		
Analytes/Suite	Locations	Number
pH Lead Copper Zinc Antimony Iron CeC	Pond at car park (Basin 4)	1
	50m (Basin 5)	1
	500m East (Basin 3) 500m West (Basin 2)	1 1
	200m (Basin 1)	1
	Creek waters off range (if available)	2

Appendix B

Soil and Water Management Plan

Provided separately