Adaptive Environmental Management Plan

287 Tuhirangi Road

Makarau

Submitted to:

Raymond O'Brien and Victoria Pichler
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Appendices (at the rear of this report)

ENGEO Document Control:

Report Title	Adaptive Environmental Management Plan - 287 Tuhirangi Road, Makarau, Auckland		
Project No.	13704.000.000	Doc ID	05
Client	Raymond O'Brien and Victoria Pichler	Client Contact	Gary Clarke, Terra Group NZ Limited
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Date	Revision Details/Status	WP	Author	Reviewer
21/04/17	Draft	-	EM	DR
18/07/17	Final	BK	EM	DR
19/05/2023	Updates to address completed and planned development activities	DF	CD	EM

1 Record of changes and amendments

Date	Sections amended	Author	Authorisation
18/07/17	NA – Original Document	ENGEO Ltd	-
19/05/2023	Updates throughout to address current site conditions	ENGEO Ltd	Corné Roelofse, Terra Group NZ Limited

2 Introduction

ENGEO Ltd was requested by Raymond O'Brien and Victoria Pichler to prepare an Adaptive Environmental Management Plan (EMP) for a firearm shooting range at 287 Tuhirangi Road Makarau, Auckland ("the site"). This EMP has been prepared to address potential environmental issues associated with operation of the shooting range. This document will be updated, as required, to address any changed conditions from those stated or assumed herein.

Note that this EMP does not address health and safety issues associated with shooting range activities. Also not addressed herein is an assessment of whether the EMP has been implemented since operation of the shooting range began, or effectiveness of the control measures in the EMP – this assessment is outside of the scope of our services.

The contents of this EMP related to the existing shooting range design and construction are based on information provided by the project team, rather than assessments or observations made by ENGEO.

2.1 Location

The site is located approximately 40 km northwest of Auckland City. The shooting range is located on the eastern portion of the property.

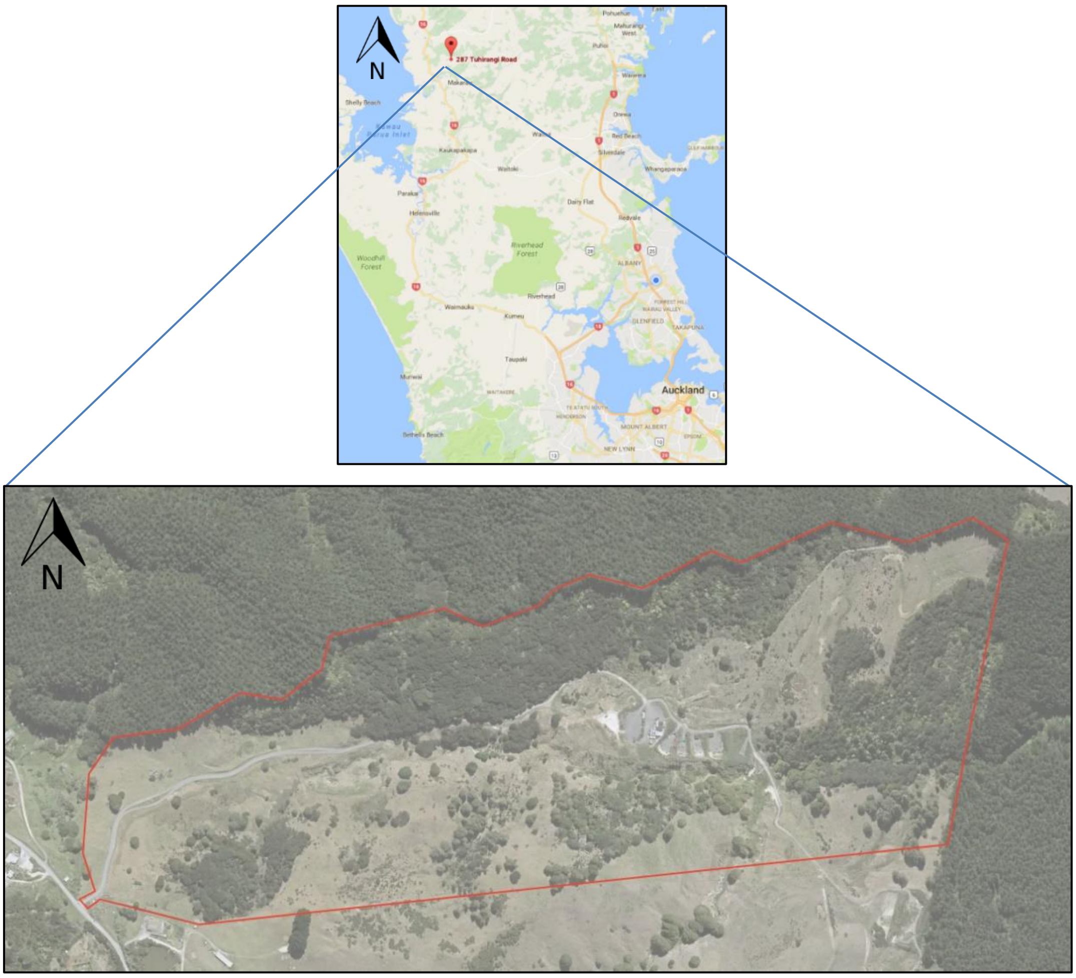

Figure 1: Site Location (sources: GoogleMaps and LINZ)

2.2 Objectives

The objectives of this EMP are to:

- Identify issues of potential environmental concern at the range;
- Identify environmental best management practices (BMPs) to manage these issues;
- Assign roles and responsibilities for implementation of this EMP and associated BMPs;
- Establish a monitoring programme to assess BMP performance; and
- Identify additional BMPs to be considered, if required, based on the results of the monitoring programme.

3 Range Description

3.1 Type and Use

The development is intended to provide a high quality, high capacity, world class shooting range for competitive events. A variety of firearms are allowed to be discharged on-site (pistols, rifles and shotguns). However, site activities are limited to meet noise performance standards for the Rural Production Zone. These standards state that the noise level measured inside the notional boundary shall not exceed 50 dB L_{Aeq} between the hours of 6am and 6pm Monday to Saturday and 45 dB L_{Aeq} between the hours of 6am and 6pm Sundays and public holidays.

Noise modelling has been performed by Marshall Day Consultants (Marshall Day; MDC, 2023). However, field testing could not be performed until the range was fully licensed and in operation. Based on modelling data performed by Marshall Day, the following noise limits have been adopted:

- 45 dB L_{Aeq} and 55 dB L_{Amax} between 0700 – 2200 Monday to Saturday, and 0900 – 1800 Sunday; and
- 50 dB L_{Aeq} and 60 dB L_{amax} on special event days.

Marshall Day recommends noise surveys be undertaken at regular intervals to confirm compliance; and are *to be measured and assessed in accordance with NZS 6801:2008 "Acoustics – Measurement of Environmental Sound" and NZS6802:2008 "Acoustics – Environmental Noise", except Section 6.3 shall not apply*.

3.2 Design

Targets (approximately 1.5 metres [m] in height) within shooting bays 1 to 4 have been constructed in compliance with the safety regulations of Pistol New Zealand and the New Zealand Police. The ranges are separated by a mixture of trapezoid shaped earth berms and fences constructed to meet the safety criteria set out by the New Zealand Police. The height and width of the berms vary in size from approximately 15 to 20 m in length, with a base width of 3.5 m and top dimension of 0.8 m. The earth berms have a minimum height of 3 m. Proposed new Bay 5 will be constructed in a similar manner to Bay 1 to 4; however, the length and height of the berm will be 30 m and 3.5 m, respectively.

There is no existing wastewater treatment or disposal system on-site, and at this stage is not proposed. Two portable toilets are present on-site, and are externally serviced. Drinking water is provided via two 25,000 L rainwater tanks.

3.3 Drainage

The proposed new drainage design is described in the Infrastructure Assessment Report, Revision A, dated May 2023 by Terra Consultants and shown on drawings prepared by Terra Consultants, which are included in Appendix 1.

Following the proposed drainage works, stormwater runoff from the shooting bays will be directed to a new stormwater discharge culvert via a contamination treatment device.

3.4 Vegetation

The shooting bays do not include significant planting. The base of the bays comprise compacted natural ground and / or gravel, with the sidewalls being earthen berms.

4 Range Setting

4.1 Topography

The base of the existing and proposed shooting bays are relatively level, with surface water runoff directed to a proposed stormwater discharge culvert via a contamination treatment device.

4.2 Surface water

Prior to development, the site encompassed a number of overland flow paths and two gullies, which converged in the southeast portion of the site. Just upstream of the convergence, a dam has been constructed on the southern-most gully. As part of the redevelopment works, a portion of the overland flow path leading to the northern creek on-site was piped underneath the road.

4.3 Groundwater

Based on historical (2017) site observations of surface water locations and the excavation taking place to reach design levels, it was considered possible that the depth to groundwater beneath the ranges is relatively shallow (i.e. less than 5 metres). Additionally, the soil was considered likely to be highly permeable.

Water seepage was observed in a number of test pits between 3.25 m and 4.5 m below ground level (bgl) during a geotechnical site investigation (ENGEO, 2017b); however, it was not determined whether this was groundwater or perched water.

The direction of groundwater flow beneath the site is not known. Shallow groundwater may be hydraulically connected to surface water on or near the site, and therefore flow to the east (within on-site gullies) or south (toward the Makarau River approximately 1.8 km from the site).

5 Environmental Issues

5.1 Shooting Range Contaminants and Contamination Pathways

Shooting ranges are included as item C2 of the Ministry for the Environment's (MfE's) Hazardous Activities and Industries List (HAIL; MfE, 2011a); namely "Gun clubs or rife ranges, including clay targets clubs that use lead munitions outdoors." MfE identifies the following hazardous substances typically associated with this activity: lead, antimony, copper, zinc, tin and nickel.

Lead is typically the primary contaminant of concern at shooting ranges due to the majority of projectiles fired being composed primarily of lead (ITRC, 2003). Therefore, the contamination pathways and associated controls discussed herein are focused on lead.[1]

Lead can be introduced into the environment at shooting ranges in the following ways:

- Lead oxidising when exposed to air and dissolving when exposed to acidic water or soil;
- Lead bullets, bullet particles or dissolved lead migration in stormwater runoff; and
- Dissolved lead migration through soils to underlying groundwater.

The presence and extent of each potential source of lead contamination is dependent on factors specific to the range, as summarised in Table 1 (USEPA, 2005).

Table 1: Lead Contamination Sources at Shooting Ranges

Source	Factors Associated with an Increase in Lead from Each Potential Source
Oxidation and Dissolution	• High annual precipitation rates • Low pH of water contacting soil (rain water, surface water and groundwater) • Greater contact time with water • Low organic material content in soil
Migration in Stormwater Runoff	• Greater rainfall intensity • Steeper slopes • Lower soil infiltration rates • Increasing stormwater runoff velocity • Less vegetative cover and man-made structures

[1] Note that many of the controls discussed would mitigate risks associated with the other hazardous substances typically associated with shooting ranges.

Source	Factors Associated with an Increase in Lead from Each Potential Source
Leaching to Groundwater	• High annual precipitation rates • High soil permeability • Low soil pH • Shallow depth to groundwater • Low groundwater pH

It is also acknowledged herein that not all lead in the environment is bioavailable to organisms.

5.2 Baseline conditions

As part of an environmental Preliminary Site Investigation (PSI) prepared for the site, soil, surface water and sediment samples were collected to assess baseline concentrations of metals at the site (ENGEO, 2017a). The organic content and pH were also tested as these parameters can be used to assess the leaching potential of metals in soil. The sample locations and laboratory reports are included in Appendix 2 for reference. The soil, surface water and sediment samples are identified with an “SS”, “SED” and “SW”, respectively.

No dissolved metals were detected above the laboratory report limits in the two surface water samples collected. Metals concentrations in soil and sediment are presented below in Table 2 and Table 3, respectively, alongside adopted comparison criteria.

Table 2: Criteria Comparison to Soil Metals Concentrations

Sample Name	SS01 – 0.0	SS01 – 1.0	SS02 – 0.0	SS02 – 1.0	Human Health Criteria for Recreational Land Use[1]	Permitted Activity Criteria[2]	Background Criteria for Inorganic Elements (non-volcanic)[3]
Material Type	Weathered Sandstone / Siltstone	Limestone	Weathered Sandstone / Siltstone	Weathered Sandstone / Siltstone			
Sample Depth, m	0.0	1.0	0.0	1.0			
Metals / Metalloids (mg / kg)							
Antimony	<0.4	<0.4	<0.4	<0.4	20[6]	-	-
Arsenic	3	2	2	3	80	100	12
Cadmium[4]	0.1	0.28	0.25	< 0.10	400	7.5	0.65
Chromium[5]	13	8	11	11	2,700	400	55
Copper	42	44	17	17	> 10,000	325	45
Lead	9.4	4.6	8	7.9	880	250	65
Mercury	< 0.10	< 0.10	< 0.10	< 0.10	1,800	0.75	0.45
Nickel	18	**109**	9	8	1,200[7]	105	35
Tin	<1.0	<1.0	<1.0	<1.0	50[6]	-	4
Zinc	45	34	42	33	30,000[7]	400	180

Table 3: Criteria Comparison to Sediment Metals Concentrations

Sample Name	SED01	SED02	ISQG-Low (Trigger Value)[8]	Background Criteria for Inorganic Elements (non-volcanic)[3]
Material Type	Sediment	Sediment		
Sample Depth, m	0.0	0.0		
Metals / Metalloids (mg / kg)				
Antimony	<0.4	<0.4	2	-
Arsenic	3	6	20	12
Cadmium[4]	**0.70**	0.12	1.5	0.65
Chromium[5]	8	7	**80**	**55**
Copper	24	21	65	45
Lead	5.2	5.6	50	65
Mercury	< 0.10	< 0.10	0.15	0.45
Nickel	18	20	21	35
Tin	<1.0	<1.0	-	4
Zinc	52	41	200	180

Notes:

[1] Human Health Criteria from the NES (NES, 2011), except where noted. No exceedances detected.

[2] Environmental discharge criteria from the AUP (AC, 2023). Exceedances are underlined.

[3] Background Concentrations of Inorganic Elements in Soils from the Auckland Region (AC, 2001). Exceedances are in **bold**.

[4] Assumes soil pH of 5.

[5] Criteria for Chromium VI were conservatively selected.

[6] Criteria sourced from the Canadian Environmental Quality Guidelines, update 2002 (CEQG, 2002).

[7] Criteria sourced from National Environment Protection (Assessment of Site Contamination) Measure (NEPM, 2013).

[8] Criteria sourced from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, updated 2019 (ANZECC, 2018).

As discussed in the PSI, the elevated nickel detection at SS01 – 1.0 is considered anomalous; however, it was recommended that the material be resampled as part of redevelopment earthworks to confirm baseline nickel concentrations in site soil. At the time of updating this EMP, we understand that this testing was not performed. As such, the baseline conditions in this EMP were not updated.

5.3 Leaching risk assessment

To assist in assessing the risk of lead leaching from site soils into underlying groundwater, a leaching risk assessment was performed. The methodology used to estimate the concentration of lead in soil leachate is based on the Freundlich equation, which was developed to model sorption from liquids to solids (USEPA, 1996). The equation, inputs and assumptions are included in Appendix 3 and discussed below.

Applicability

Using this methodology to predict lead leachate concentrations for the site is conservative as it assumes lead-contaminated soil is in direct contact with groundwater, ignoring the re-sorbing of lead to soil particulates that is likely to occur as stormwater infiltrates through the soil profile and migrates to underlying groundwater. However, the depth to groundwater from the final base elevation of the proposed pistol range is unknown at this stage.

Estimating the lead concentration in soil

A starting lead concentration in soil is difficult to estimate for shooting ranges because the elevated lead is generally localised around where bullets enter earthen berms, resulting in areas of very high lead concentrations with other soil within the range containing lead at or near regional background levels. Weathering of the bullets can also result in a protective coating being formed that significantly reduces the potential for lead to continue leaching from the bullet (Scheinost, 2004).

For the purposes of this assessment, the soil lead concentration assumed for estimating leachate concentrations was 250 milligrams per kilogram (mg/kg), which is the Auckland Council permitted activity criterion for discharges to the environment (AC, 2023).

Target leachate concentration

The estimated leachate concentrations were compared to a target leachate concentration calculated based on meeting the quality of groundwater required at a site's boundary under the Auckland Council Unitary Plan (AC, 2023 and ANZECC, 2018). This value is the aquatic ecological criterion in the ANZECC Water Quality Guidelines based on an 80% species protection level. The 80% ANZECC criterion for *freshwater* species was considered most relevant given the site's location.

The 80% ANZECC criterion for freshwater species was also multiplied by a dilution-attenuation factor (DAF) of 20. The United States Environmental Protection Agency (USEPA) has adopted a DAF of 20 based on modeling results and data for 300 groundwater sites across the United States (USEPA, 1996). In New Zealand, Environment Canterbury has also adopted a DAF of 20 based on the USEPA work.

Soil water partition coefficient

A wide range of soil water partition coefficients (“Kd values”) are available for lead. USEPA has published a range of Kd values based on soil pH and equilibrium lead concentrations. The pH of site soil has been measured, but the equilibrium lead concentration for site-specific conditions during range operation is not known.

For the site-measured pH, the Kd values for lead published by USEPA range from 710 to 23,270 L/kg, depending on the equilibrium lead concentration (USEPA, 1999). The estimated leachate concentrations for the site were calculated using these minimum and maximum published values, the average of these two values, as well as the average minimum and maximum Kd values for each of the four equilibrium concentration ranges.

Results

As shown in Appendix 3, the estimated leachate concentrations based on a site soil concentration of 250 mg/kg were below the target leachate concentration using the maximum Kd value, average of the minimum and maximum Kd values, as well as the average of the minimum and maximum Kd values published by USEPA for each of the four equilibrium concentration ranges. The estimated leachate concentration only exceeded the target leachate concentration using the minimum Kd value published by USEPA of 710 L/kg.

Based on this assessment, leaching of lead from the site is considered to be relatively low risk. However, there is potential for localised highly elevated concentrations of lead to contribute more significant concentrations of lead to underlying groundwater; therefore, shooting range best management practices (BMPs) shall be implemented and their performance monitored. If required, based on monitoring results, BMPs shall be upgraded to mitigate discharges of contaminants to the environment.

6 Environmental Management Overview

Region 2 of the USEPA has published a document summarising BMPs for lead at outdoor shooting ranges (USEPA, 2005).

The USEPA BMP document acknowledges that the range’s physical and operational characteristics will affect the type of BMPs most applicable to the site and how they should be implemented. The typical characteristics to consider for a pistol range are summarised in Table 4.

Table 4: Physical and Operational Characteristics to Consider when Selecting BMPs for Shooting Ranges

Characteristics	Considerations
Physical	
Soil pH	The ideal soil pH for shooting ranges is 6.5 to 8.5 (minimises lead leaching from spent bullets).
Physical Soil Characteristics	Dense soils (e.g. clay) will limit the leaching to groundwater pathway; however, dense soils may increase surface water runoff volume and are more difficult to mine for spent ammunition (e.g. for lead reclamation).
Annual Precipitation	Increases potential for lead migration off-site (via stormwater runoff and leaching to groundwater).
Topography	Steeper terrain increases the potential for lead migration off-site via stormwater runoff and makes lead reclamation more difficult.
Leaching to Groundwater	Shallow groundwater increases the potential for dissolved lead contamination to impact groundwater.
Vegetation	Vegetative ground cover reduces lead mobility.
Accessibility	Accessibility to shotfall zones and backstops is important for lead reclamation activities.
Operational	
Lead volume	Recording the number of rounds fired provides an estimate of the quantity of lead available for reclamation and assists in determining when reclamation may be needed to prevent an excess accumulation of lead in site soils.
Size of bullets	Can inform the screening techniques used during lead reclamation, maximising yield.
Shooting direction and patterns	Informs size / placement / number of bullet containment devices

To operate an outdoor shooting range that is environmentally protective, the USEPA BMP document recommends implementing an integrated lead management program that incorporates a variety of relevant BMPs. The BMPs are divided into a four-step approach to lead management; these four steps and the associated BMPs relevant to the proposed new pistol range are summarised in Table 5.

Table 5: Four-Step Approach to Lead Management

Characteristics	Considerations
Step 1. Control and Contain	• Bullet containment via earthen backstops, sand traps, steel traps, lamella or rubber granule traps or shock absorbing concrete
Step 2. Prevent Migration	• Monitor and adjust soil pH (e.g. lime spreading) • Immobilise lead (e.g. phosphate spreading) • Control runoff via planting vegetation, utilising organic ground cover and/or implementing engineered runoff controls
Step 3. Remove and Recycle	• Removing spent bullets via hand raking and sifting, screening, vacuuming, soil washing, working with a reclaimer • Recycle removed spent bullets
Step 4. Documenting Activities and Record Keeping	• Document number of rounds fired and bullet size • Document BMPs used • Document date and provider of BMP-related services • Evaluate the effectiveness of BMPs used • Keep records for the life of the range and at least 10 years after closing

7 Site-Specific Environmental Management

7.1 BMPs

The following site-specific BMPs shall be adopted for the range operation.

Table 6: Site-Specific BMPs

Characteristics	Considerations
Bullet Containment	• Construct earth berms around each shooting bay with a minimum height of 3 metres • Install bullet catchers in each shooting bay (e.g. plastic barrels filled with rubber chips)
Range Floor Drainage	• Direct stormwater runoff from shooting ranges to contamination treatment device
Water Quality Monitoring	• Sample discharge from contamination treatment device • Sample groundwater down-gradient of shooting range
Record Keeping	• Document number of rounds fired and bullet size • Document BMPs used • Document date and provider of BMP-related services • Document water quality monitoring results over time and use to assess BMP effectiveness • Keep records for the life of the range and at least 10 years after closing

7.2 Roles and Responsibilities

The roles and responsibilities associated with implementation of this EMP are summarised in Table 7.

Table 7: Roles and Responsibilities

Role	Responsibility
Range owner	• Maintain up to date copy of this EMP on-site • Train site workers in contents of this EMP • Ensure site records are maintained • Annual review of EMP applicability and associated updates
Range operator	• Implement this EMP • Monitor and Maintain BMPs
Contaminant Land Specialist	• Perform water quality monitoring and interpret results • Advise range owner on BMP performance based on water quality monitoring results

7.3 Monitoring and Maintenance Programme

The monitoring and maintenance programme for site BMPs is summarised in Table 8.

Table 8: BMP Monitoring and Maintenance Programme

BMP	Task	Frequency
Bullet catchers	• Maintain integrity of catchers to minimise rainwater infiltration and leaching of lead	• Inspect monthly • Replace, as required
Earth berms	• Maintain integrity of earth berms to capture bullets fired within range not captured by bullet catchers	• Inspect monthly • Refurbish, as required
Drainage	• Ensure surface water in shooting bays drains to contamination treatment device	• Inspect and document surface water flow from shooting bays during a minimum of two rain events each year
Surface water monitoring	• Monitor concentrations of lead, antimony, copper, zinc, tin and nickel in surface water discharging from raingarden	• Biannually during rain events, one at the beginning of winter (April/May) and one at the beginning of summer (October/November)
Groundwater monitoring	• Monitor concentrations of lead, antimony, copper, zinc, tin and nickel in groundwater at a minimum of one location down-gradient of the shooting range	• Biannually, one at the beginning of winter (April / May) and one at the beginning of summer (October / November)
EMP Applicability	• Review applicability of this EMP based on site operations and any updates to international best practice for shooting range operations	• Annually

8 Upgrading of BMPs

The following triggers will be used to consider an upgrade to site BMPs:

- An increasing trend of monitored contaminant concentrations in surface water or groundwater results over a minimum of three monitoring events; or
- Within any two year period of monitoring, two exceedances of the 80% ANZECC criterion in surface water exiting the raingardens or groundwater down-gradient of the range.

The BMP upgrade(s) shall be targeted to address the potential source / reason for surface water or groundwater contamination. Upgrades to consider include:

- Removing spent bullets from ranges via hand raking and sifting, screening, vacuuming or soil washing; or
- Increasing surface water and / or groundwater monitoring frequency.

9 References

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USEPA (1999). Understanding Variation in Partition Coefficient, Kd, Values, United States Environmental Protection Agency, Office of Air and Radiation, August 1999 (ref: EPA 402-R-99-004B)

USEPA (2005). Best Management Practices for Lead at Outdoor Shooting Ranges, United States Environmental Protection Agency, Region 2, Revised June 2005 (ref: EPA-902-B-01-001)

10 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Raymond O'Brien and Victoria Pichler, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground conditions indicated from published sources, site assessments and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific financial and technical requirements of the client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.

iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

iv. This Limitation should be read in conjunction with the IPENZ/ACENZ Standard Terms of Engagement.

v. This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (09) 972 2205 if you require any further information.

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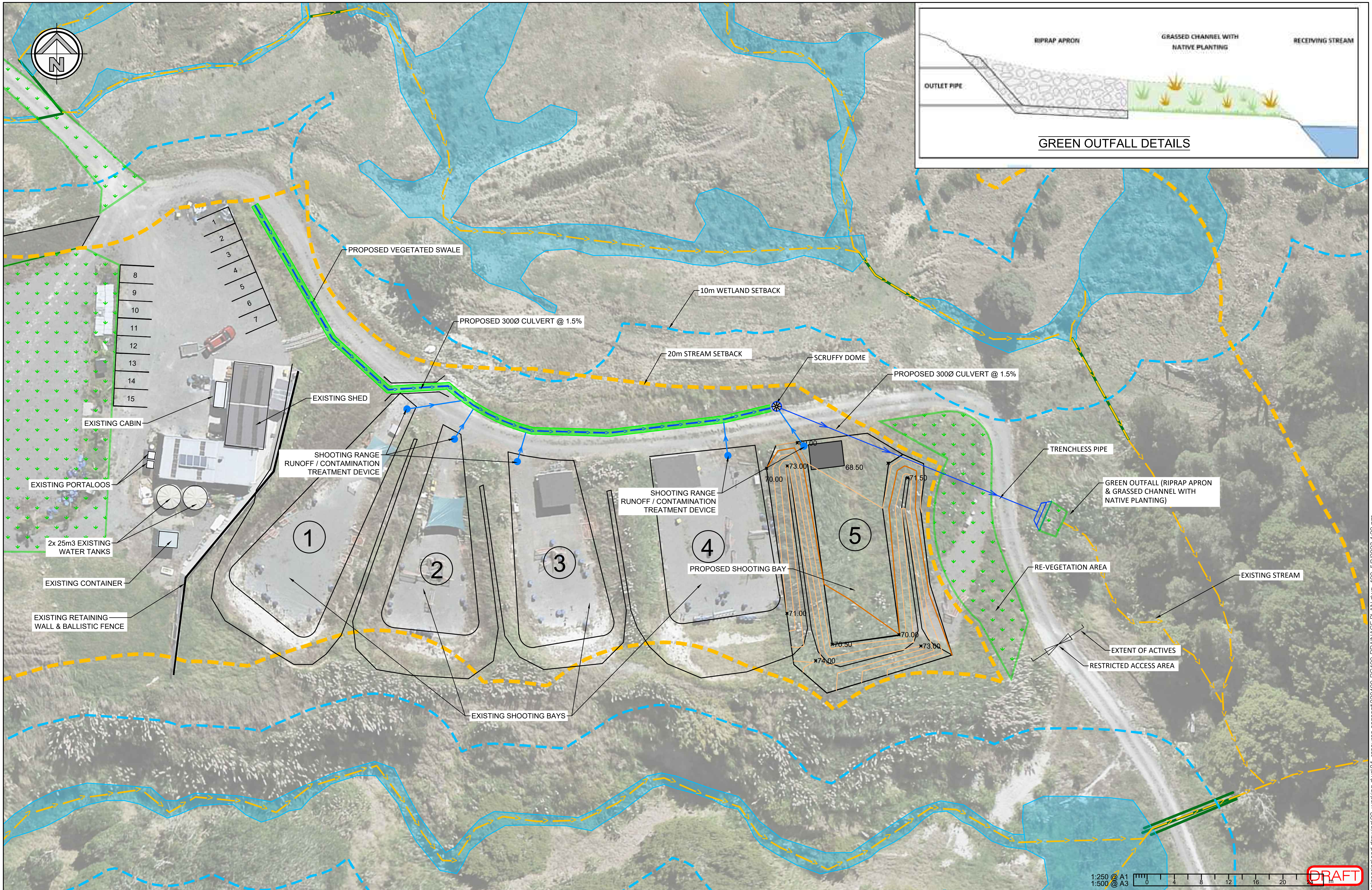
APPENDIX 1:

Drainage Drawings



ISSUE	DATE	REVISION	CHKD	DRWN		NAME	DATE
A	03/05/23	FOR RESOURCE CONSENT	GC	GCAI	SURVEYED	TERRA	01/03/23
					DESIGNED		
					DRAWN		
					TRACED		
					CHECKED		

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CLIENT
AUCKLAND SHOOTING CLUB INCORPORATED

PROJECT / LOCATION
287 TUHIRANGI ROAD, MAKARAU, AUCKLAND

DRAWING TITLE
DRAINAGE LAYOUT PLAN

STAGE	FOR RESOURCE CONSENT		
PROJECT NUMBER 230400	SCALE	A1	1:250
		A3	1:500
DWG NUMBER RC- 400	REVISION A		

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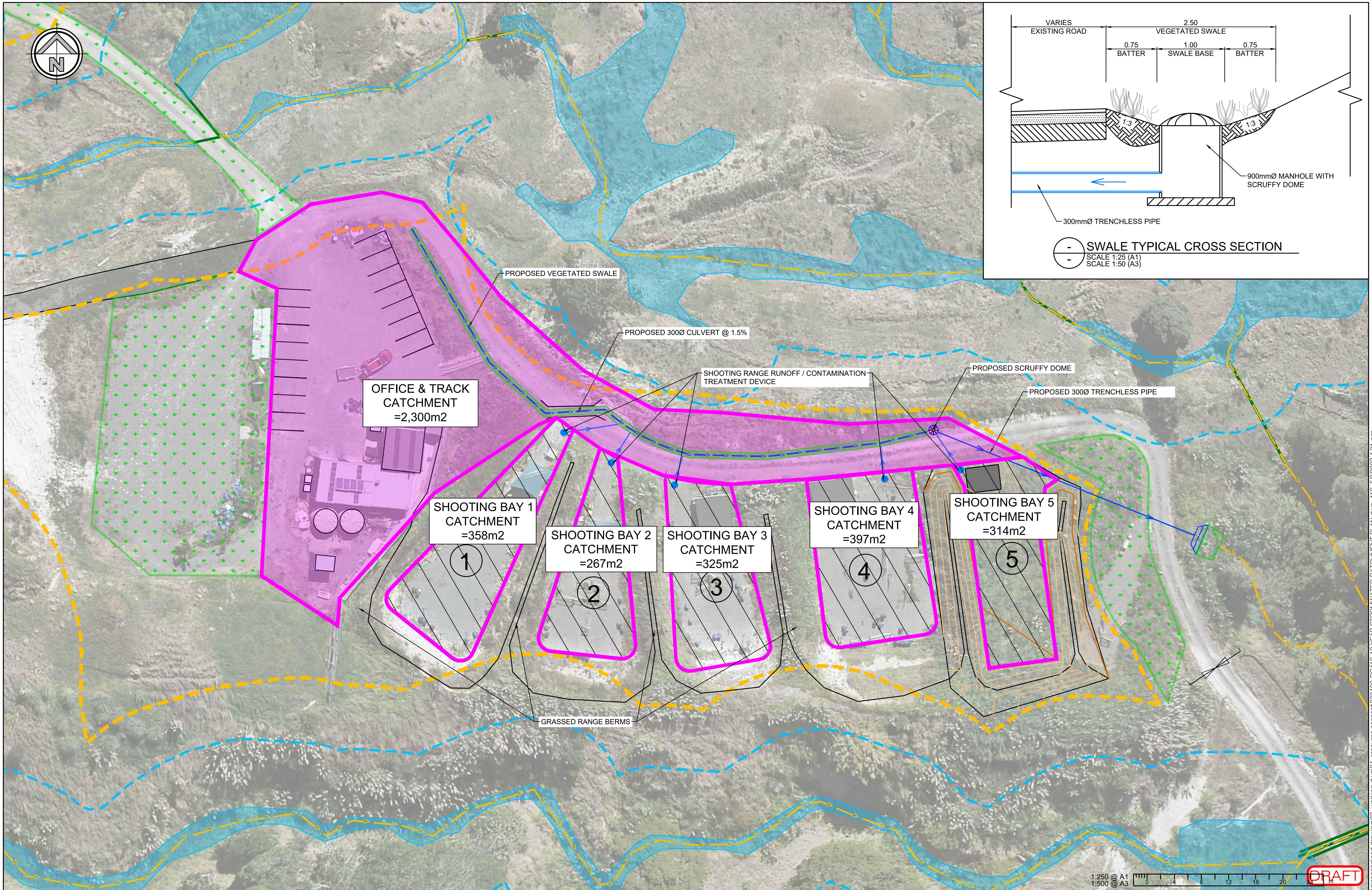

SWALE TYPICAL CROSS SECTION
SCALE 1:25 (A1)
SCALE 1:50 (A3)

ISSUE	DATE	REVISION	CHKD	DRWN		NAME	DATE
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					DESIGNED		
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					TRACED		
					CHECKED		

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CLIENT
AUCKLAND SHOOTING CLUB INCORPORATED

PROJECT / LOCATION
287 TUHIRANGI ROAD, MAKARAU, AUCKLAND

DRAWING TITLE
10 YEAR STORMWATER CATCHMENT PLAN

STAGE
FOR RESOURCE CONSENT

PROJECT NUMBER	SCALE	
230400	A1 1:250 A3 1:500	
DWG NUMBER	REVISION	
RC- 410	A	

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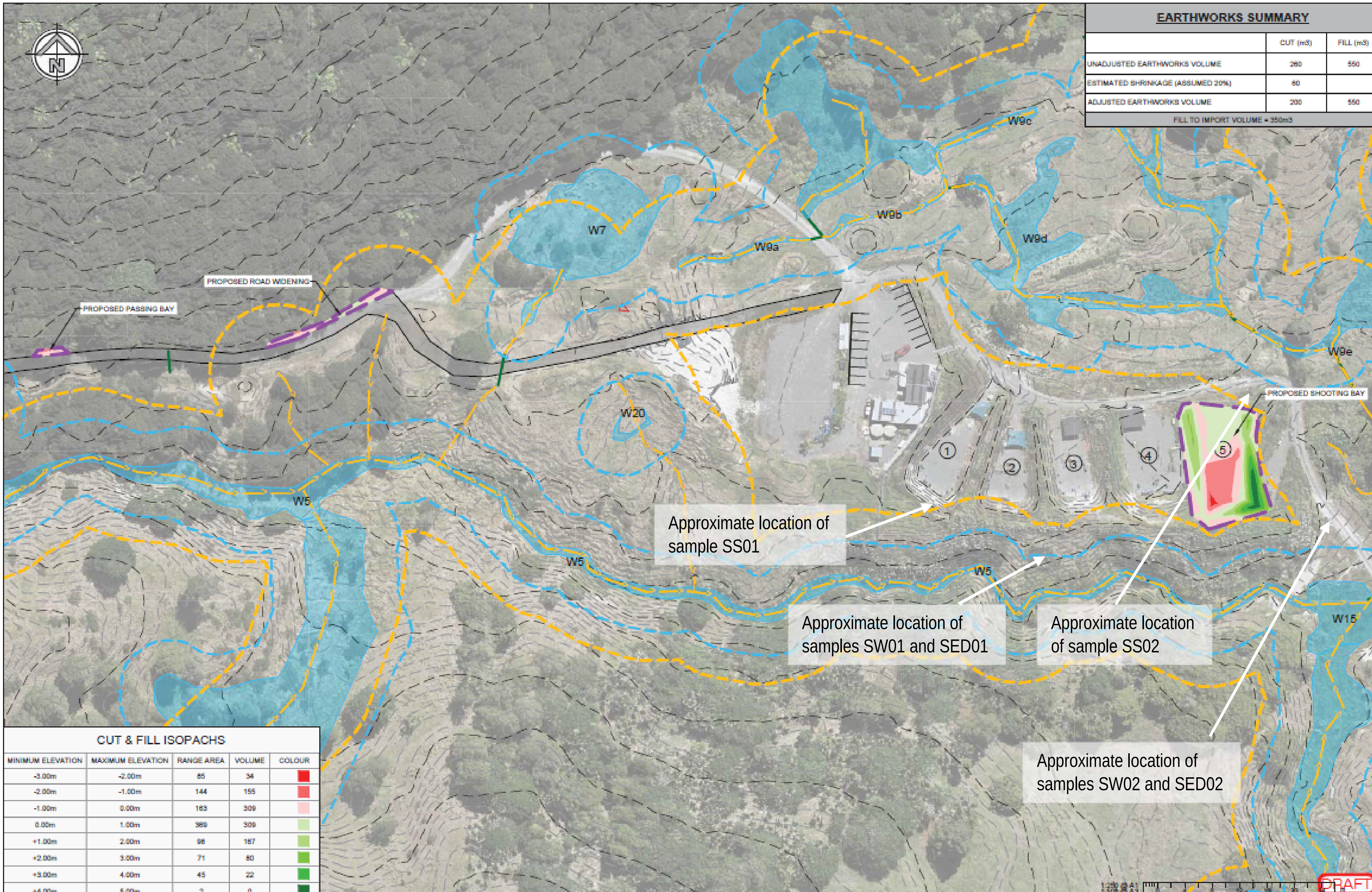
APPENDIX 2:

Baseline Sample Locations and Results



EARTHWORKS SUMMARY

	CUT (m3)	FILL (m3)
UNADJUSTED EARTHWORKS VOLUME	260	550
ESTIMATED SHRINKAGE (ASSUMED 20%)	60	
ADJUSTED EARTHWORKS VOLUME	200	550
FILL TO IMPORT VOLUME = 350m3		

CUT & FILL ISOPACHS

MINIMUM ELEVATION	MAXIMUM ELEVATION	RANGE AREA	VOLUME	COLOUR
-3.00m	-2.00m	85	34	
-2.00m	-1.00m	144	155	
-1.00m	0.00m	163	309	
0.00m	1.00m	369	309	
+1.00m	2.00m	98	167	
+2.00m	3.00m	71	80	
+3.00m	4.00m	45	22	
+4.00m	5.00m	2	0	

ISSUE	DATE	REVISION	CHKD	DRWN		NAME	DATE
A	13/04/23	FOR RESOURCE CONSENT	GC	GCAI	SURVEYED	TERRA	01/03/23
					DESIGNED		
					DRAWN		
					TRACED		
					CHECKED		

CONSULTANT
terra
CONSULTANTS
PO BOX 13058, Penrose, New Zealand
Auckland: (09) 357 3557
Northland: (09) 431 4444
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CLIENT
AUCKLAND SHOOTING CLUB INCORPORATED

PROJECT / LOCATION
287 TUHIRANGI ROAD, MAKARAU, AUCKLAND

DRAWING TITLE
OVERALL EARTHWORKS PLAN

STAGE	FOR RESOURCE CONSENT		
PROJECT NUMBER	230400	SCALE	A1 1:250 / A3 1:500
DWG NUMBER	RC- 200	REVISION	A

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TRIED, TESTED AND TRUSTED

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ANALYSIS REPORT

Client:	Engeo Limited	**Lab No:**	1720485 SPv2
Contact:	Erika McDonald	**Date Received:**	09-Feb-2017
	C/- Engeo Limited	**Date Reported:**	24-Feb-2017 **(Amended)**
	PO Box 305136	**Quote No:**	83353
	Triton Plaza	**Order No:**	
	Auckland 0757	**Client Reference:**	13704.000.000
		Submitted By:	Erika McDonald

Sample Type: Soil

Sample Name:		SS01-0.0 08-Feb-2017 11:00 am	SS01-1.0 08-Feb-2017 11:00 am	SS02-0.0 08-Feb-2017 11:50 am	SS02-1.0 08-Feb-2017 11:50 am	
Lab Number:		1720485.1	1720485.2	1720485.3	1720485.4	
Individual Tests						
Organic Matter*	g/100g dry wt	9.9	2.3	12.0	6.9	-
Ash*	g/100g dry wt	90	98	88	93	-
Total Recoverable Antimony	mg/kg dry wt	< 0.4	< 0.4	< 0.4	< 0.4	-
Total Recoverable Tin	mg/kg dry wt	< 1.0	< 1.0	< 1.0	< 1.0	-
pH*	pH Units	6.4	8.4	6.3	6.3	-
Heavy Metals with Mercury, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	3	2	2	3	-
Total Recoverable Cadmium	mg/kg dry wt	0.10	0.28	0.25	< 0.10	-
Total Recoverable Chromium	mg/kg dry wt	13	8	11	11	-
Total Recoverable Copper	mg/kg dry wt	42	44	17	17	-
Total Recoverable Lead	mg/kg dry wt	9.4	4.6	8.0	7.9	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	-
Total Recoverable Nickel	mg/kg dry wt	18	109	9	8	-
Total Recoverable Zinc	mg/kg dry wt	45	34	42	33	-

Sample Type: Sediment

Sample Name:		SED01 08-Feb-2017 11:25 am	SED02 08-Feb-2017 11:45 am			
Lab Number:		1720485.6	1720485.8			
Individual Tests						
Total Recoverable Antimony	mg/kg dry wt	< 0.4	< 0.4	-	-	-
Total Recoverable Tin	mg/kg dry wt	< 1.0	< 1.0	-	-	-
pH*	pH Units	8.2	8.4	-	-	-
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	3	6	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.70	0.12	-	-	-
Total Recoverable Chromium	mg/kg dry wt	8	7	-	-	-
Total Recoverable Copper	mg/kg dry wt	24	21	-	-	-
Total Recoverable Lead	mg/kg dry wt	5.2	5.6	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	< 0.10	-	-	-
Total Recoverable Nickel	mg/kg dry wt	18	20	-	-	-
Total Recoverable Zinc	mg/kg dry wt	52	41	-	-	-

Sample Type: Aqueous

Sample Type: Aqueous						
	Sample Name:	SW01 08-Feb-2017 11:25 am	SW02 08-Feb-2017 11:45 am			
	Lab Number:	1720485.5	1720485.7			
Individual Tests						
pH	pH Units	7.3	8.1	-	-	-
Dissolved Antimony	g/m³	< 0.004	< 0.004	-	-	-
Dissolved Mercury	g/m³	< 0.002	< 0.002	-	-	-
Dissolved Tin	g/m³	< 0.010	< 0.010	-	-	-
Heavy metals, dissolved, screen As,Cd,Cr,Cu,Ni,Pb,Zn						
Dissolved Arsenic	g/m³	< 0.02	< 0.02	-	-	-
Dissolved Cadmium	g/m³	< 0.0010	< 0.0010	-	-	-
Dissolved Chromium	g/m³	< 0.010	< 0.010	-	-	-
Dissolved Copper	g/m³	< 0.010	< 0.010	-	-	-
Dissolved Lead	g/m³	< 0.002	< 0.002	-	-	-
Dissolved Nickel	g/m³	< 0.010	< 0.010	-	-	-
Dissolved Zinc	g/m³	< 0.02	< 0.02	-	-	-

Analyst's Comments

Amended Report: This report replaces an earlier report issued on 14 Feb 2017 at 3:19 pm
Reason for amendment: At the client's request, organic matter results have been added.

Appendix No.1 - Chain of Custody

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Organic Matter*	Calculation: 100 - Ash (dry wt).	0.04 g/100g dry wt	1-4
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	1-4, 6, 8
Heavy Metals with Mercury, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	1-4
Ash*	Ignition in muffle furnace 550°C, 6hr, gravimetric. APHA 2540 G 22nd ed. 2012.	0.04 g/100g dry wt	1-4
Total Recoverable Antimony	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.4 mg/kg dry wt	1-4, 6, 8
Total Recoverable Tin	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	1.0 mg/kg dry wt	1-4, 6, 8
pH*	1:2 (v/v) soil : water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-4, 6, 8

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	6, 8
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	6, 8
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	6, 8

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals, dissolved, screen As,Cd,Cr,Cu,Ni,Pb,Zn	0.45µm filtration, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.0010 - 0.02 g/m³	5, 7
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field.	0.1 pH Units	5, 7
Filtration for dissolved metals analysis	Sample filtration through 0.45µm membrane filter and preservation with nitric acid. APHA 3030 B 22nd ed. 2012.	-	5, 7

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Dissolved Antimony	Filtered sample, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.004 g/m^3	5, 7
Dissolved Mercury	Filtered sample, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.002 g/m^3	5, 7
Dissolved Tin	Filtered sample, ICP-MS, screen level. APHA 3125 B 22nd ed. 2012.	0.010 g/m^3	5, 7

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

Job No: **172 0485** Date Recv: 09-Feb-17 05:32

Received by: Kris Workman

3117204857

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ANALYSIS REQUEST

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Office use only (Job No)

Quote No	83353	
Primary Contact	Erika McDonald	214286
Submitted By	Erika McDonald	214286
Client Name	Engeo Limited	192617
Address	PO Box 305136, Triton Plaza, Auckland 0757	
Phone	09 972 2205	*Mobile* 021628764
Email	emcdonald@engeo.co.nz	
Charge To	Engeo Limited	160117
Client Reference	13704.000.000	
Order No		

Results To *Reports will be emailed to Primary Contact by default. Additional Reports will be sent as specified below.*

- [x] *Email Primary Contact*
- [ ] *Email Submitter*
- [ ] *Email Client*
- [ ] *Email Other*
- [ ] *Other*

ADDITIONAL INFORMATION

CHAIN OF CUSTODY RECORD

Sent to Hill Laboratories
- [x] *Tick if you require COC to be emailed back*

Date & Time: 8/2/17, 2pm
Name: E. McDonald
Signature: E McDonald

Received at Hill Laboratories
Date & Time: 9/2/17 16:46
Name: [illegible]
Signature: [illegible]

Condition
- [ ] *Room Temp*
- [ ] *Chilled*
- [ ] *Frozen*

Temp: 2.4

- [ ] Sample & Analysis details checked

Signature:

Priority [ ] Low [ ] Normal [x] High

[ ] **Urgent** (ASAP, extra charge applies, please contact lab first)

NOTE: The estimated turnaround time for the types and number of samples and analyses specified on this quote is by 4:30 pm, 5 working days following the day of receipt of the samples at the laboratory.

Requested Reporting Date:

Quoted Sample Types

Soil (Soil), Surface Water (SW)

No.	Sample Name	Sample Date/Time	Sample Type	Tests Required
1	SS01-0.0	8/2/17 11:00am	Soil	HM8, Antimony, Tin, pH
2	SS01-1.0	"	Soil	HM8, Antimony, Tin, pH
3	SS02-0.0	8/2/17 11:50am	Soil	HM8, Antimony, Tin, pH
4	SS02-1.0	"	Soil	HM8, Antimony, Tin, pH
5	SW01	8/2/17 11:25am	Water (x2)	Dissolved [HM8, Antimony, Tin], pH
6	SED01	"	Sediment	HM8, Antimony, Tin, pH
7	SW02	8/2/17 11:45am	Water (x2)	Dissolved [HM8, Antimony, Tin], pH
8	SED02	"	Sediment	HM8, Antimony, Tin, pH
9	SS03-0.0	8/2/17	Soil	COLD HOLD
10				

APPENDIX 3:

Leaching Calculations

EQUATIONS

Soil Water Partition Coeficient

Kd = Cs/Cw^n

Adjusting sorbed to total concentration in soil

Mt = Ms + Mw + Ma

Mt = Ct*Pb*Vsp

Ms = Cs*Pb*Vsp

Mw = Cw*theta(w)*Vsp

Ma = Ca*theta(a)*Vsp

Ct = [(Cs*Pb) + (Cw*theta(w))]/Pb

INPUTS

Kd	Freundlich soil/water partition coefficient	L/kg	710	USEPA, 1999 (minimum of full range provided)
			23270	USEPA, 1999 (maximum of range provided)
			4360	USEPA, 1999 (minimum of 0.1-0.9ug/L equilibrium concentration range)
			23270	USEPA, 1999 (maximum of 0.1-0.9ug/L equilibrium concentration range)
			1950	USEPA, 1999 (minimum of 1.0-9.9ug/L equilibrium concentration range)
			10760	USEPA, 1999 (maximum of 1.0-9.9ug/L equilibrium concentration range)
			900	USEPA, 1999 (minimum of 10-99.9ug/L equilibrium concentration range)
			4970	USEPA, 1999 (maximum of 10-99.9ug/L equilibrium concentration range)
			710	USEPA, 1999 (minimum of 100-200ug/L equilibrium concentration range)
			2300	USEPA, 1999 (maximum of 100-200ug/L equilibrium concentration range)
Cs	Concentration sorbed on soil	mg/kg		
Cw	Solution concentrations	mg/L		
n	Freundlich exponent	-	** = 1 Assuming that adsorption is linear with respect to concentration	
Mt	total contaminant mass in sample	mg		
Ms	contaminant mass sorbed on soil	mg		
Mw	contaminant mass in soil water	mg		
Ma	contaminant mass in soil air	mg	** = 0 for lead	
Pb	dry soil bulk density	kg/L	1.5	USEPA, 1991
Vsp	sample volume	L		
theta(w)	water-filled porosity	L(water)/L(soil)	0.3	USEPA, 1996
Ca	concentration on soil pore air	mg/L(soil)		
theta(a)	air-filled soil proosity	L(air)/L(soil)		
Ct	screening level or expected level in soil	mg/kg	250	
Cw	target soil leachate concentration	mg/L	0.0094	ANZECC, 2000
			0.188	20 x ANZECC criterion

RESULTS

Soil Water Partition Equation for Migration to Groundwater Pathway: Inorganic Contaminants

Ct = Cw[Kd+(theta(w)/Pb)]

Cw = Ct/[Kd+(theta(w)/Pb)]

Cw =	0.352014	mg/L	Ct = 250, Kd = USEPA, 1999 overall min
Cw =	0.010743	mg/L	Ct = 250, Kd = USEPA, 1999 overall max
Cw =	0.02085	mg/L	Ct = 250, Kd = USEPA, 1999 average of overall min and max (710 L/kg and 23270 L/kg)
Cw =	0.018096	mg/L	Ct = 250, Kd = USEPA, 1999 average of min and max in 0.1-0.9ug/L equilibrium concentration range (4360 L/kg and 23270 L/kg)
Cw =	0.039338	mg/L	Ct = 250, Kd = USEPA, 1999 average of min and max in 1.0-9.9ug/L equilibrium concentration range (1950 L/kg and 10760 L/kg)
Cw =	0.085173	mg/L	Ct = 250, Kd = USEPA, 1999 average of min and max in 10-99.9ug/L equilibrium concentration range (900 L/kg and 4970 L/kg)
Cw =	0.166091	mg/L	Ct = 250, Kd = USEPA, 1999 average of min and max in 100-200ug/L equilibrium concentration range (710 L/kg and 2300 L/kg)

KEY	Hightlited result	= exceeds adopted target leachate concentration of 20 x the ANZECC criterion (0.188 mg/L)
	kg	kilogram
	L	litre
	mg	milligram