SITE MONITORING & MANAGEMENT PLAN
ATAWHAI CLOSED LANDFILL
NELSON

For the Attention of:

Nelson City Council

Reference: FES 0708.003 (R3) September 2019

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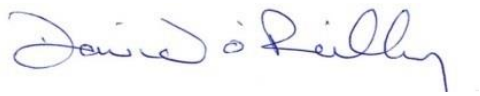

David O'Reilly
Principal Environmental Consultant

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Executive Summary

Focus Environmental Services Limited was contracted by Nelson City Council to prepare a Site Monitoring & Management Plan (SMMP) for the Atawhai Closed Landfill in Nelson.

This Site-Specific Management Plan (SSMP) has been prepared in general accordance with the requirements of the Contaminated Land Management Guidelines: No. 1, Reporting on Contaminated Sites in New Zealand, Ministry for the Environment, 2011. In addition, the monitoring procedures referred to are generally in accordance with the report titled 'A guide for the Management of Closing and Closed Landfills in New Zealand, Ministry for the Environment, 2001.

The history of the site has been described in detail in the report titled '*Preliminary Site Investigation, Atawhai Closed Landfill, Nelson*' dated October 2016 and prepared by Focus Environmental Services Limited (henceforth referred to as the PSI). In brief, the site has been subject to reclamation/landfilling since before 1942, ending with the opening of the York Valley Landfill in 1987.

The Atawhai Closed Landfill site is considered to be the area bound by Queen Elizabeth II Drive to the north west, Atawhai Drive to the east, Weka Street to the south and Sovereign Street to the west.

Due to the potential for discharges from the Atawhai Closed Landfill an investigation of the potential for landfill gas and leachate was recommended.

The report titled '*Site Investigation Report, Stage 1, Atawhai Closed Landfill, Nelson (R1)*' dated November 2017 and prepared by Focus Environmental Services Limited presents the results of the intrusive investigation carried out at the site. Based on the results of the intrusive investigation, the Atawhai Closed Landfill is producing quantities of landfill gas and leachate that, without suitable monitoring and management, have the potential to impact site buildings, human health and the environment.

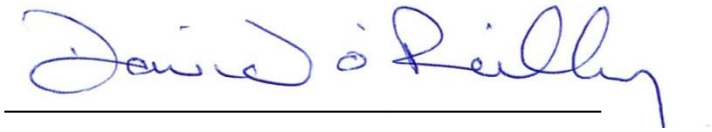
This Site Monitoring & Management Plan (SMMP) is therefore intended to provide the landowners/asset owners and their contractors with details of the site-specific management procedures required to mitigate the potential effects of settlement, exposure to contaminated soils and/or refuse, landfill gas and leachate during service maintenance, soil disturbance and site development activities at the Atawhai Closed Landfill site. This SMMP also provides recommendations for onsite residents and for the establishment of vegetation.

In addition, the outlined visual inspections, instantaneous surface monitoring (ISM) gas emission surveys, landfill gas well monitoring and groundwater monitoring will allow for the establishment of a baseline for the site, and the identification and management of onsite risks at the Atawhai Closed Landfill site.

Furthermore, the report titled '*Addendum Letter Report, Atawhai Closed Landfill, Nelson* dated September 2019 and prepared by Focus Environmental Services Limited presents the results of the statistical analysis used to derive the trigger level values for the Atawhai Closed Landfill.

These trigger level values are considered relevant and will be adopted for future monitoring events and will provide warnings of possible non-compliance issues within the landfill which may require further management or remedial works.

Submitted By,



David O'Reilly
Principal Environmental Consultant
Focus Environmental Services Limited

1.0 Scope

1.1 This report has been prepared at the request of Nelson City Council ("the Client") in terms of the Focus Environmental Services Limited Agreement ("Agreement").

1.2 The following report is based on:

- *Information provided by the client; and*
- *The report titled 'Preliminary Site Investigation, Atawhai Closed Landfill, Nelson' dated October 2016 and prepared by Focus Environmental Services Limited.*
- *The report titled 'Site Investigation Report, Stage 1, Atawhai Closed Landfill, Nelson 'dated November 2017 and prepared by Focus Environmental Services Limited.*
- *The report titled 'Addendum Letter Report, Atawhai Closed Landfill, Nelson 'dated September 2019 and prepared by Focus Environmental Services Limited.*

1.3 We have not independently verified the information provided to us by the Client or its completeness. We do not express an opinion on the accuracy or the reliability of such information.

1.4 No warranties are given, intended or implied.

1.5 Opinion, inferences, assumptions and interpretations made in this report should not be construed as legal opinion.

1.6 Where an assessment is given in this report, the Client must also rely upon their own judgement, knowledge and assessment of the subject of this report before undertaking any action.

1.7 This report must not be used in any other context or for any other purpose other than that for which it has been prepared without the prior written consent of Focus Environmental Services Limited.

1.8 This report is strictly confidential and intended for the use of Nelson City Council.

2.0 Site Identification

The Atawhai Closed Landfill site is considered to be the area bound by Queen Elizabeth II Drive to the north west, Atawhai Drive to the east, Weka Street to the south and Sovereign Street to the west as shown in Figure 1 attached. The site is located at latitude - 41.260850 and longitude 173.296022.

The site encompasses 182 land parcels forming Neale Park, Founders Park, The Whakatu Marae, a nursery, Miyazu Gardens the public road North Road a number of private roads located on Founders Park, Komatua housing and private residential dwellings with an area of approximately 496,026 m^2.

3.0 Geology and Hydrology

Published geological maps[1] indicate the site is underlain by anthropic deposits (landfill). Landfill materials are likely to be underlain by Port Hills Gravel in the north and Holocene river deposits in the south. A description of the underlying geologies is presented in Table 1 below.

Table 1: Geology of Atawhai Closed Landfill

Key name	OIS1 (Holocene) landfill and reclaimed land
Simple name	Holocene human-made deposits
Main rock name	Boulders
Stratigraphic age	Q1
Description	Reclaimed land with fill consisting of wood domestic waste sand and boulders
Subsidiary rocks	Gravel sand
Key group	Holocene anthropic deposits
Absolute age (min)	0.0 million years
Absolute age (max)	0.014 million years
Rock group	Fill
Rock class	Clastic sediment
QMAP sheet name	Nelson

Limited geotechnical information available for the site reports that the site is covered with a surficial layer of topsoil (typically 0.2-0.3 m) underlain with refuse materials, subsequently underlain with alluvial deposits, primarily gravels and gravelly silts.

Groundwater has previously been measured at the site at approximately 2.5 m below ground level (bgl) and is anticipated to flow in a north easterly direction, towards the Nelson Haven.

The nearest surface water bodies to the site are the onsite ponds located at Founders Park and the Miyazu Gardens, and the Nelson Haven to the immediate north west of the site.

[1] Geology of the Nelson Area (Institute of Geological & Nuclear Sciences 1:25,000 geological map 9, 1998)

4.0 Background

The history of the site has been described in detail in the report titled '*Preliminary Site Investigation, Atawhai Closed Landfill, Nelson*' dated October 2016 and prepared by Focus Environmental Services Limited (henceforth referred to as the PSI).

In brief, the site has been subject to reclamation/landfilling since before 1942, ending with the opening of the York Valley Landfill in 1987.

The Atawhai Closed Landfill site is considered to be the area bound by Queen Elizabeth II Drive to the north west, Atawhai Drive to the east, Weka Street to the south and Sovereign Street to the west.

Based on the information available, Atawhai Closed Landfill appears to have been formed without an underlying barrier and is contained by an earth bund on the seaward side, which has been widened to form Queen Elizabeth II Drive.

During the PSI, an initial assessment of the potential for landfill gas discharges at the Atawhai Closed Landfill was provided (SCS – Wetherhill Environmental, 2000). In brief, no landfill gas was detected above the 500ppm limit from across the monitored grid, however exceedances were observed at 12 targeted locations across the site, with two exceedances being elevated above 5,000 ppm.

The report recommended remedial actions to control surface emissions at the site, which included sealing site features and passive extraction vents, along with ongoing surface emission monitoring.

No further information on the potential for landfill discharges from the Atawhai Closed Landfill was available during the PSI.

Based on the duration following the completion of landfilling activities and the information gaps identified, the PSI concluded that there was potential for discharges from the Atawhai Closed Landfill to impact on site workers, site users, residents and the neighbouring environment.

Due to the potential for landfill discharges from the Atawhai Closed Landfill and due to the information gaps identified, an investigation of the potential for landfill gas and leachate discharges was recommended.

The report titled '*Site Investigation Report, Stage 1, Atawhai Closed Landfill, Nelson (R1)*' dated November 2017 and prepared by Focus Environmental Services Limited presents the results of the Stage 1 intrusive investigation carried out at Atawhai Closed Landfill.

In brief, based on the results of the intrusive investigation, the Atawhai Closed Landfill is producing quantities of landfill gas and leachate that, without suitable monitoring and management, have the potential to impact site buildings, human health and the environment.

This Site Monitoring & Management Plan (SMMP) is therefore intended to provide the landowners/asset owners and their contractors with details of the site management procedures required to mitigate the potential effects of settlement, exposure to contaminated soils and/or refuse, landfill gas and leachate during service maintenance, soil disturbance and site development activities at the Atawhai Closed Landfill site.

In addition, the outlined visual inspections, instantaneous surface monitoring (ISM) gas emission surveys, landfill gas well monitoring and groundwater monitoring will allow for the establishment of a baseline for the site, and the identification and management of onsite risks at the Atawhai Closed Landfill site.

Furthermore, the report titled '*Addendum Letter Report, Atawhai Closed Landfill, Nelson* dated September 2019 and prepared by Focus Environmental Services Limited presents the results of the statistical anlaysis used to derive the trigger level values for the Atawhai Closed Landfill.

These trigger level values are considered relevant and will be adopted for future monitoring events and will provide warnings of possible non-compliance issues within the landfill which may require further management or remedial works.

5.0 Roles & Responsibilities

5.1 General

This Site Monitoring & Management Plan (SMMP) has been prepared to document the Site Management and Monitoring requirements relating to the Atawhai Closed Landfill site.

The landowner/asset owner will be responsible for the on-going monitoring, maintenance and management of the site and supervising any remedial works identified as a result of the monitoring carried out.

In addition, this SMMP provides a framework for the management of future development and provides recommendations for private property owners.

5.2 Distribution

It is the responsibility of Nelson City Council to record this plan against, and place on the property files of, all affected properties within the Atawhai Closed Landfill site.

A copy of the SMMP shall be kept onsite at all times during site works. It is the responsibility of the landowner/asset owner to distribute the plan to all staff, contractors and network operators carrying out maintenance works, soil disturbance works or development.

In addition, a fact sheet for private property owners, attached as Appendix A, provides advice and recommendations for any soil disturbance activities on private property at the Atawhai Closed Landfill site.

5.3 Review & Update

The SMMP shall be reviewed at a minimum of every two years; following any significant changes identified in the monitoring results; and within 30 days of any alarm or evacuation due to the presence of landfill gas.

Any variations to the SMMP proposed by the contractor must be approved by Nelson City Council prior to the works commencing, or before the variation is implemented if the works have already commenced. It is the responsibility of the appointed contractor to distribute any changes to the SMMP to the relevant parties and to update the site copy.

5.4 Implementation

The responsibility for the implementation of the SMMP lies with the landowner/asset owner's appointed contractor/s.

The landowner/asset owner shall engage a contaminated land specialist to carry out inspection and provide advice as required during the works.

The contaminated land specialist must be sufficiently experienced to comply with the "suitably qualified and experienced practitioner" as required by the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NES).

6.0 Summary of Ground Conditions

6.1 Landfill Gas

Landfill Gas is generated by the biological decomposition, volatilisation or chemical reaction of waste, the composition, quantity and rate of which depends on the waste type, composition and density, environmental factors and the age of the landfill.

Typically Landfill Gas production peaks around the landfill's closure and declines exponentially over time. Under aerobic conditions (in free oxygen) decomposition products are predominantly carbon dioxide and water vapour, with decomposition products under anaerobic conditions (absence of free oxygen) predominantly being methane and carbon dioxide.

The migration of Landfill Gas is driven by the pressure differential between the gas within the landfill and the receiving environment and is affected by the presence of sufficient landfill cap/cover, the presence of any preferential flowpaths and the local geology and groundwater.

Landfill Gas has the potential to cause an explosion or fire, can cause asphyxiation, and is potentially toxic and odorous.

Based on the data available, elevated concentrations of methane were detected within underground services and in areas of the site where visual cracking could be observed, primarily in the northern area of the site.

In addition, landfill gas was identified during monitoring of the landfill gas monitoring wells installed at the Aawhai Closed Landfill, with concentrations of methane being detected at a number of locations at levels elevated above the lower explosive limit (LEL) and the perimeter probe limit, concentrations of carbon dioxide (CO_2) at levels exceeding the short-term exposure limit (STEL), concentrations of carbon monoxide (CO) exceeding the 8-hour time weighted average (TWA) at monitoring wells and concentrations of hydrogen sulphide (H_2S) at levels elevated above the STEL and TWA at a single monitoring well (MW03).

A number of passive ventilation towers have been connected to underlying services in the area of the Miyazu Gardens and the onsite nursery. However, there is currently no other known ventilation system installed on the landfill. Therefore, landfill gas being produced at the Atawhai Closed Landfill is likely being passively discharged to the atmosphere through the cap/cover materials.

It is therefore considered that on-going site management and monitoring will be required to prevent the creation of preferential flowpaths during ground disturbance activities and to prevent Landfill Gas from entering structures, underground services and confined spaces, and building up to dangerous levels.

6.2 Landfill Leachate

Landfill Leachate is generated by dissolving soluble contaminants and the mobilisation of insoluble liquids, suspended solids and biodegradation products, the composition, quantity and rate of which depends on the waste type, composition and density, environmental factors, the age of the landfill and the degree of surface infiltration.

Typically Landfill Leachate declines following the closure of the landfill, however elevated levels of contaminants may persist in the Leachate for several decades.

The migration of Landfill Leachate is driven by the geology of the underlying and surrounding soils and the degree of infiltration through the landfill cap, and is affected by the presence of any preferential flow paths and groundwater.

Landfill Leachate has the potential to degrade water quality and affect the health of ecosystems and is potentially toxic and odorous.

Based on the data available, elevated concentrations of leachate parameters were detected in the shallow groundwater at the site, with concentrations of specific contaminants being detected at concentrations elevated above the Australian and New Zealand Environment Conservation Council (ANZECC) Guidelines for the protection of 80% of marine water species.

In addition, during the visual inspection undertaken of the shoreline immediately adjacent to the Atawhai Closed Landfill, a number of potential preferential conduits were identified, along evidence of potential leachate seeps.

Groundwater has previously been measured at the site at approximately 2.5 m below ground level (bgl) and is therefore unlikely to be encountered by site users. However, in the event that excavations at the site extend below the groundwater table, it is considered that site management procedures will be required.

6.3 Landfill Cover

Landfill Cover plays an integral role in mitigating the effects of buried contaminated soils and/or refuse and in the mitigation and production of Landfill Gas and Leachate.

In accordance with the Ministry for the Environment (MfE) guidance[2] the recommended final cap should consist of the following:

- 150 mm topsoil layer for vegetation
- 600 mm compacted barrier layer
- 300 mm compacted subgrade or foundation layer.

A low permeability and suitably contoured cap provides a barrier to the underlying refuse materials, prevents uncontrolled discharge of Landfill Gas and reduces surface infiltration leading to the production of Leachate.

Without appropriate Landfill Cover, the potential exists for site users and site workers to come in contact with refuse materials, Landfill Gas to migrate into structures and confined spaces, and increased leachate production.

Based on the data available, boreholes completed across the site typically revealed a clay capping layer of variable thickness, subsequently underlain with gravel and refuse materials.

In addition, elevated concentrations of contaminants were detected in the surface soils across the Atawhai Closed Landfill. However, with the exception to two samples collected within the residential zone, the concentrations of soil contaminants detected across the Atawhai Closed Landfill were below the relevant soil guideline values.

It is therefore considered that on-going site management and monitoring of the Landfill Cover will be required to prevent the exposure of site users to potentially contaminated soils, underlying refuse materials, to prevent the creation of preferential flowpaths and to prevent surface infiltration.

In addition, due to the elevated concentrations of contaminants detected in the surface soils, it is considered that all properties located within the Atawhai Closed Landfill site, as defined in Section 2, have been subject to the importation and use of materials containing concentrations of contaminants at levels elevated above the natural background levels (HAIL category I). Any development on the Atawhai Closed Landfill will therefore be subject to the requirements of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES).

[2] A guide for the management of closing and closed landfills in New Zealand, Ministry for the Environment, 2001.

7.0 Site Management

During site works the quality of soils exposed may vary from soils containing natural background levels, to soils where visible contamination may be present. In addition, during site works the potential for Landfill Gas, Landfill Leachate, contaminated soils and refuse materials to be encountered exists.

Therefore, in order to mitigate the potential effects to human health and the environment, specific mitigation measures are required to be implemented prior to any service maintenance, soil disturbance or site development activities being carried out at the site.

7.1 Service Maintenance

Prior to the maintenance of any services located beneath the ground, or within confined spaces, where Landfill Gas has the potential to accumulate, at the Atawhai Closed Landfill, monitoring for Landfill Gas shall be undertaken by a competent person (as determined by Nelson City Councils Health and Safety Policy), using a gas monitor capable of measuring oxygen, methane and carbon dioxide.

In the event that monitoring exceeds 2% LEL (0.1% v/v) for methane, further investigation into the source of methane identified shall be carried out as soon as practicable and the requirement for active ventilation should be assessed by a competent person.

In the event that concentrations of Landfill Gas exceed 20% LEL (1% v/v) for methane or 1.5% v/v carbon dioxide, the service should not be entered or worked on, all ignition sources (including electricity) switched off, and remedial work carried out as soon as possible under an approved health and safety plan.

Service access covers shall be fitted with signage detailing the potential for Landfill Gas, no smoking shall be permitted during any maintenance works and the use of naked flames, or equipment/tools with the potential to create sparks shall be controlled by way of a Landfill Gas specific 'Hot Works' permit through Nelson City Council.

7.2 Soil Disturbance

Prior to any soil disturbance activities at the Atawhai Closed Landfill site, a Works-Specific Management Plan, prepared by a suitably qualified and experienced contaminated land specialist, shall be submitted to Nelson City Council for approval.

It should be noted that no smoking shall be permitted during any soil disturbance works and the use of naked flames, or equipment/tools with the potential to create sparks shall be controlled by way of permit.

In addition, continuous monitoring for Landfill Gas shall be undertaken during any soil disturbance activities by a competent person using a gas monitor capable of measuring oxygen, methane and carbon dioxide.

The works-specific site management plan should contain, but shall not be limited to, the following:

- Health and Safety Procedures
- Landfill Gas Monitoring Procedures
- Excavation and Disposal Procedures
- Confined Space/Excavation Entry Procedures

- Reinstatement Procedures
- Contingency Procedures

It should be noted that the works-specific site management plan shall be implemented in addition to, and not instead of, the standard health and safety procedures and any regulatory requirements, such as permit or resource consent, and in accordance with the requirements of the Health and Safety at Work Act (MBIE, 2015).

As previously stated, due to the elevated concentrations of contaminants detected in the surface soils, any soil disturbance works at the Atawhai Closed Landfill will likely be subject to the requirements of the NES.

It should be noted that due to the elevated concentrations of contaminants identified across the site, the site soils are not suitable for classification as cleanfill and materials removed from the site will required disposal to a suitably licensed disposal facility unless further sampling and analysis demonstrate otherwise.

7.3 Site Development

Prior to any development of the site, a Landfill Impact Assessment report, prepared by a suitably qualified and experienced contaminated land specialist, shall be submitted to Nelson City Council for approval.

The Landfill Impact Assessment will ensure that any future development at the site does not adversely affect the landfill and the landfill processes; that preferential flowpaths are not created during the development and that suitable landfill gas mitigation measures are installed in buildings, structures and services.

The Landfill Impact Assessment report should contain, but shall not be limited to, the following:

- An assessment of the potential for the existing landfill cap to be penetrated or otherwise damaged;
- An assessment of the potential increased landfill gas or landfill leachate discharge following compaction and/or the removal of impermeable materials;
- An assessment of the potential for landfill gas to migrate and accumulate in buildings, structures and services;
- An assessment of the risk posed by landfill gas on site buildings, prepared in accordance with CIRIA C665 (or similar), including details of any gas mitigation measures to be installed.

As previously stated, due to the elevated concentrations of contaminants detected in the surface soils, any development at the Atawhai Closed Landfill will likely be subject to the requirements of the NES, which may require the prevision of a Site Management Plan

7.4 Private Residences

Based on available data, the site soils contain concentrations of contaminants at levels elevated above relevant guideline values for the residential (10% produce) land use scenario and therefore present a potential risk to the health of site residents.

In the absence of further sampling and analysis and/or remediation of the affected soils, in order to prevent exposure to the identified contamination at the site, the following is recommended:

- Informing residents of the contamination status of the soils;
- Restricting access to exposed soils;
- Observing good hygiene practices, such as thoroughly washing hands after contact with any exposed soils and avoiding the tracking of soil into living spaces; and
- Restricting any produce grown at the site to raised beds comprising of imported certified clean materials.

7.5 Establishment of Vegetation

Vegetation at the Atawhai Closed Landfill shall be limited to grass and shallow rooting vegetation.

Where it has been demonstrated that deeper rooting vegetation, including vegetation which has the potential to penetrate the cap, is unlikely to present a significant risk, the establishment of which shall be controlled by way of permit through Nelson City Council.

Existing deep rooting vegetation will be monitored to ensure the potential effects are adequately mitigated.

7.6 Accidental Discovery Protocol

If any unexpected materials are identified during site works the contractor shall immediately contact the contaminated land specialist to inspect the material and provide advice for the safe handling and disposal of the material.

Visual and olfactory indicators of contamination include the following:

- Asbestos containing materials (ACM) (board, pipe, free fibres or fragments)
- Demolition debris (polystyrene, steel and timber)
- Refuse materials (other than concrete or brick)
- Odour (petroleum, oil, creosote, solvent, sulphur, landfill gas)
- Discoloured soil (black/green staining is most common)
- Incinerator ash (black course sand)
- Gasworks wastes (clinker – black gravel, blue billy, black tar)
- Harmful non Cleanfill materials

If any potential ACM or unexpected materials are identified during site works, the area shall immediately be fenced off (barrier tape) with a 2.0m buffer zone, photographs taken and the Contaminated Land Specialist contacted. The Contaminated Land Specialist will then inspect the material and provide advice for the sampling and analysis, safe handling and disposal of the material

Following the discovery of any unexpected materials any environmental investigation is to be carried out in general accordance with the Contaminated Land Management Guidelines No. 1 and No.5 (MfE, 2011).

In the event that soils are found to contain concentrations of contaminants elevated above the relevant site acceptance criteria, the site soils will require remediation and subsequent validation.

All contaminated materials removed from site will require disposal at a suitably licensed disposal facility and site validation sampling is to be completed at a frequency sufficient to meet the requirements of the Contaminated Land Management Guidelines No.5 (MfE, 2011).

In the event that asbestos containing materials are identified at the site, its removal from the site shall be conducted in accordance with the Health and Safety at Work (Asbestos) Regulations (MBIE, 2016) and the Approved Code of Practice for the Management and Removal of Asbestos (WorkSafe New Zealand, 2016).

Following the removal of any ACM, a certificate of clearance is to be produced by a suitably licensed asbestos assessor.

In the event that unexpected materials are encountered, Nelson City Council are to be notified of the nature and extent of the contamination along and provided with details of the management procedures undertaken at the site.

7.7 Reporting

Following site works, a site closure report shall be submitted to Nelson City Council for their record. The site closure report should contain sufficient detail to address the following matters:

- A summary of the works undertaken including volume of soil removed from site and details of the reinstatement process;
- A summary of the landfill gas monitoring completed during the works, including any remedial actions undertaken;
- A summary of any testing and landfill gas monitoring completed, including tabulated results;
- Details of any unexpected materials encountered and contingency procedures implemented during the works;
- Certified as-built drawings showing the detailed design and specification of any gas mitigation measures installed within the site buildings; and
- Copies of the disposal dockets for the material removed from the site.

8.0 Monitoring

Monitoring of the Atawhai Closed Landfill will allow for the establishment of a baseline for the site and the identification and management of onsite risks. In addition, the monitoring will allow for the correct activity assessment as part of any resource consent application for the site.

The monitoring will comprise of six-monthly visual inspections, instantaneous surface monitoring (ISM) gas emission surveys, landfill gas and groundwater monitoring as outlined in Appendix B.

All equipment utilised for monitoring of the Atawhai Closed Landfill shall be calibrated and maintained in accordance with the manufacture's specifications.

8.1 Visual Inspections

Surface Cover

In order to identify any potential preferential flowpaths, potential areas of significant infiltration or areas of subsidence/settlement, a visual inspection of the surface cover across the footprint of the Atawhai Closed Landfill shall be undertaken six-monthly, representing summer and winter conditions.

During the inspection the integrity of the surface cover of the Atawhai Closed Landfill shall be inspected in a systematic pattern, approximate 30 m grid, for evidence of vegetation distress, cracking, uneven/hummocky ground, surface pooling and seeps/leachate.

In the event that evidence of subsidence or potential preferential flowpaths are identified, further investigation into the potential for Landfill Gas in these areas shall be carried out as soon as practicable and remedial actions shall be undertaken.

The surface cover monitoring area of the Atawhai Closed Landfill is shown in Figure 2.

Shoreline

In order to identify any potential preferential conduits or connections between the Atawhai Closed Landfill and the Nelson Haven a visual inspection of the shoreline immediately adjacent to the Atawhai Closed Landfill will be undertaken six-monthly, representing summer and winter conditions, within two hours of mean low-tide.

During the inspection of the adjacent shoreline any potential conduits or evidence of potential leachate seeps will be recorded.

In the event that evidence of leachate discharges, or evidence of significant seeps are identified along the adjacent shoreline, further investigation into the potential for Landfill leachate discharge in these areas shall be carried out as soon as practicable and remedial actions shall be undertaken.

The shoreline monitoring area of the Atawhai Closed Landfill is shown in Figure 3.

Ventilation Structures

In order to ensure the passive ventilation towers are operating effectively, an inspection of the passive ventilation towers for evidence of surface pooling, damage to the ventilation structures and that the ventilation cowls are free to rotate will be undertaken six-monthly.

In the event that evidence of surface pooling, damage, or inefficient operation of the ventilation structures are identified, the potential for Landfill Gas discharge shall be assessed and remedial actions shall be undertaken as soon as practicable.

The ventilation tower location plan is presented as Figure 4.

8.2 Landfill Gas

Surface Gas Monitoring

In order to identify surface landfill gas discharges, instantaneous surface monitoring (ISM) gas emission shall be undertaken six monthly across the footprint of the Atawhai Closed Landfill (Figure 2).

The ISM gas emission survey shall be carried out over an approximate 30 m grid pattern, targeting any buried services, site buildings, fences, deep rooting vegetation, ventilation towers and any areas of subsidence, cracking and vegetation distress.

The ISM survey is to be completed using a RKI Instruments Eagle portable gas detector (or similar) in accordance with the Ministry for the Environment (MfE) procedures[3], ideally during periods of low and/or falling barometric pressure, light winds and following at least 48 hours of fine weather.

The level of methane shall be continuously monitored, with the instrument range being from 0 ppm to 50,000 ppm (5%). At all locations, the gas detector wand will be held 50-100 mm above the ground surface and readings in excess of 100 ppm are to be recorded.

The concentrations of methane detected during the ISM surveys and the Landfill Gas Well monitoring will be compared to the Landfill Guidelines[4].

The surface emission limit adopted at the Atawhai Closed Landfill is 0.5% (5,000 ppm), which corresponds to 10% of the lower explosive limit (LEL) for methane.

In the event that surface emissions exceed 5,000 ppm (10% LEL) for methane, investigation into the source of methane identified shall be carried out as soon as practicable and the requirement for remedial work shall be assessed by a suitably qualified contaminated land professional.

In the event that surface emissions exceed 10,000 ppm (20% LEL) for methane, investigation into the source of methane identified and remedial work shall be carried out as soon as possible.

[3] A guide for the management of closing and closed landfills in New Zealand, Ministry for the Environment, 2001.

[4] Landfill Guidelines, Centre for Advanced Engineering, University of Canterbury, 2000.

Building/Enclosed Spaces Monitoring

In order to identify any landfill gas discharges in the vicinity of the site buildings/enclosed spaces, an ISM survey will be undertaken around the perimeter of the site buildings and, where open access is available, enclosed spaces (i.e. stormwater sumps etc.) across the Atawhai Closed Landfill (Figure 2).

The ISM survey is to be completed using a RKI Instruments Eagle portable gas detector (or similar) in accordance with the Ministry for the Environment (MfE) procedures, ideally during periods of low and/or falling barometric pressure, light winds and following at least 48 hours of fine weather.

The level of methane shall be continuously monitored, with the instrument range being from 0 ppm to 50,000 ppm (5%). At all locations, the gas detector wand will be held 50-100 mm above the ground surface and readings in excess of 100 ppm are to be recorded.

The emission limit adopted for in and around the site buildings, and the corresponding contingency action, is presented in Table 2 below.

Table 2: Landfill Gas Guidelines (Buildings): Atawhai Closed Landfill

Methane Concentration	Action
<0.5% (< 5,000 ppm)	No immediate action required.
0.5% to 1.0% (5,000 to 10,000 ppm)	Implement gas control measures and undertake further monitoring.
>1.0% (> 10,000 ppm)	Evacuate building, switch off all ignition sources and carry out remedial work as soon as possible prior to re-occupation.

Landfill Gas Well Monitoring

In order to determine the potential for landfill gas to be discharged from the Atawhai Closed Landfill site the ten wells installed (MW01 – MW10) shall be monitored six-monthly, representing summer and winter conditions.

The landfill gas monitoring wells will be measured for levels of methane (CH_4), carbon dioxide (CO_2), carbon monoxide (CO), hydrogen sulphide (H_2S) and oxygen (O_2) using a Telegan GA5000 infrared gas analyser (or similar).

Gas pressures in each well along with flow measurements will be also made using an integrated flow gauge.

In the absence of buildings within 250 metres of the landfill boundary, the USEPA guidance value, above which gas control is required, is 5% methane in a boundary probe. Based on the proximity of the site to residential properties, a perimeter limit of 1.25% methane, which corresponds to 25% of the LEL for methane, has been adopted at the Atawhai Closed Landfill site.

In addition, the concentrations of carbon dioxide (CO_2), carbon monoxide (CO) and hydrogen sulphide (H_2S) will be compared to the New Zealand Workplace Exposure Standards[5], both for the short-term exposure limit (STEL) and the 8-hour time weighted average (TWA) as outlined in Table 3 below.

[5] Workplace Exposure Standards and Biological Exposure Indices, Worksafe New Zealand, 2017.

Table 3: New Zealand Workplace Exposure Standards for Landfill Gas.

Sample	STEL	8-hour TWA
CO_2	3% v/v	0.5% v/v
CO	200 ppm	25 ppm
H_2S	15 ppm	10 ppm

Following four consecutive rounds of monitoring, landfill gas trigger levels will be derived for the site and will be provided in an updated SMMP.

The landfill gas monitoring wells installed at the Atawhai Closed Landfill are displayed on Figure 5.

8.3 Landfill Leachate

In order to determine the potential for landfill leachate to be discharged from the Atawhai Closed Landfill site, four of the monitoring wells installed at the site (MW02, MW03, MW04 and MW07) shall be monitored six-monthly, representing summer and winter conditions.

Prior to purging, the depth to groundwater will be measured from the top of the well casings and recorded.

Following purging, representative groundwater samples will be collected using dedicated bailers and will be sent under full chain of custody documentation to an IANZ accredited laboratory and analysed for:

- Soluble arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury, calcium, iron, boron, magnesium, manganese, potassium and sodium;
- pH and electrical conductivity;
- Total alkalinity, total hardness and total phosphorus;
- Chloride;
- Total ammoniacal-N;
- Chemical Oxygen Demand (COD); and
- Carbonaceous Biological Oxygen Demand (cBOD).

The trigger values of the Australian and New Zealand Environment Conservation Council (ANZECC) Guidelines for Fresh and Marine Water Quality (2000) for the protection of 95% and 80% of marine water species are considered relevant and have been adopted as the site assessment criteria.

In addition, Groundwater parameters were chosen in reference to the Landfill Guidelines[6] and the Ministry for the Environment (MfE) guidance[7]. The relevant values of these guidelines have been reproduced in Table 4 below.

[6] Landfill Guidelines, Centre for Advanced Engineering, University of Canterbury, 2000.

[7] A guide for the management of closing and closed landfills in New Zealand, Ministry for the Environment, 2001.

Table 4: Site Assessment Criteria (Groundwater) – Atawhai Closed Landfill (mg/L)

Parameter	ANZECC 95%	ANZECC 80%	Trigger Level Values (%)
Arsenic	0.0045[1]	0.0045[1]	0.642
Cadmium	0.0055	0.036	0.0003
Chromium	0.0044	0.085	0.019
Copper	0.0013	0.008	0.016
Lead	0.0044	0.012	0.003
Nickel	0.07	0.56	0.058
Zinc	0.015	0.043	0.315
Mercury	0.0004	0.0014	2.613
Boron	5.1[1]	5.1[1]	45.8
Iron	0.3[1]	0.3[1]	5.562
Manganese	0.08[1]	0.08[1]	115.6
Ammoniacal Nitrogen	0.9	2.3	0.033
Nitrate-N	7.2[2]	12[2]	701.7
Chemical Oxygen Demand	-	-	1260.4
Chloride	-	100[3]	0.642

Note: 1 = Low reliability trigger value, ANZECC (2000); 2 = No ANZECC guidelines available, value obtained from "Nitrate guideline values in ANZECC 2000 – correction", NIWA, 2002; 3 = No ANZECC guidelines available, value obtained from "Soil Remediation Circular 2009, Ministry of Infrastructure and the Environment".

The trigger level values were derived from the statistical analysis results complied from the data obtained over the four monitoring periods at the Atawhai Closed Landfill.

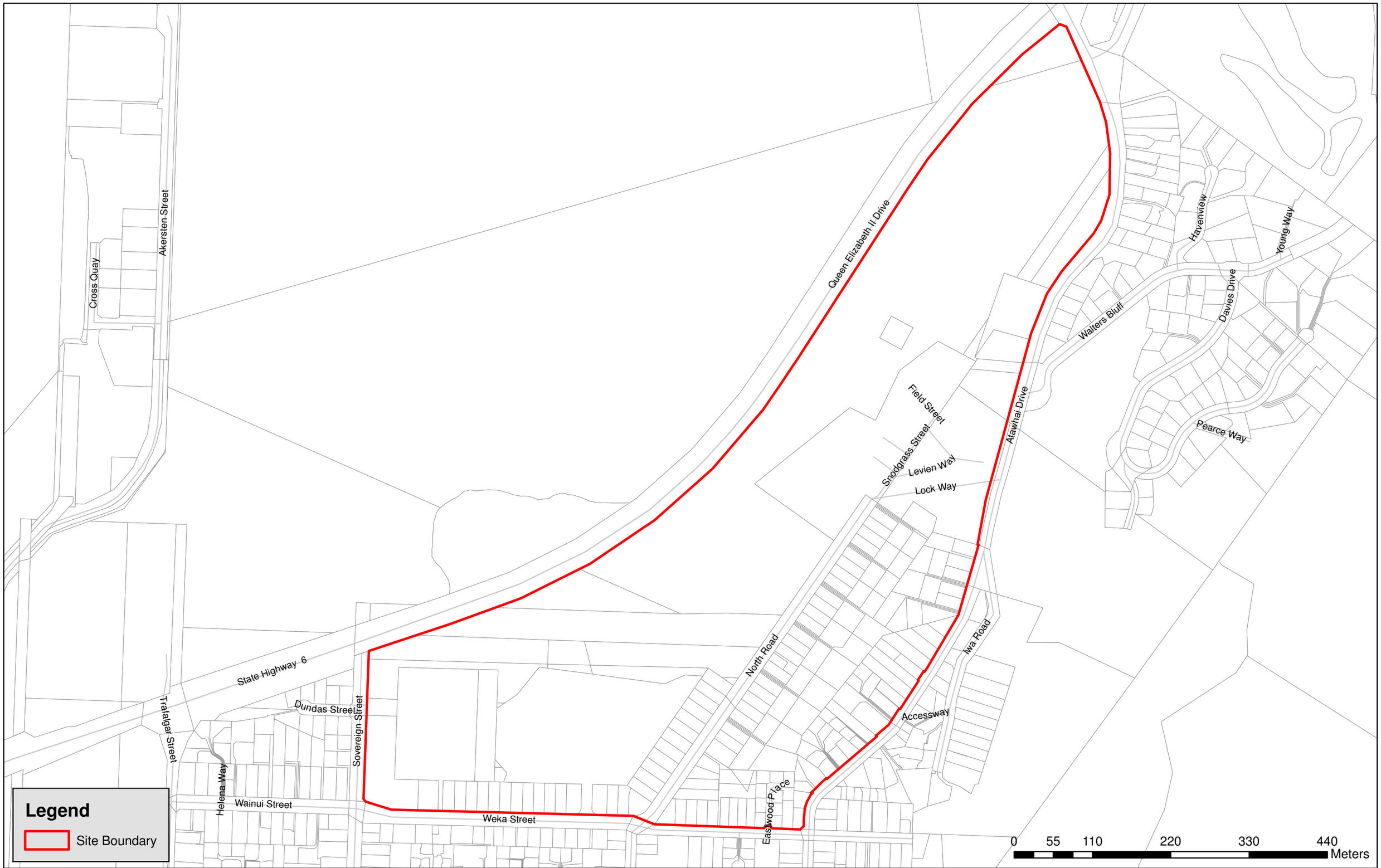
The location of the leachate monitoring wells are displayed on Figure 5.

8.4 Reporting

Continued bi-annual monitoring reports, along with annual summary reports, are recommended to be completed for the Atawhai Closed Landfill as done previously. The site monitoring report should contain sufficient detail to address the following matters:

- A summary of the monitoring undertaken including results;
- Details of any additional investigation and/or remedial work carried out as a result of the monitoring undertaken; and
- Any recommendations in relation to future monitoring, investigative and remedial work at site.

Figures



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Atawhai Closed Landfill
Nelson

Figure 1: Site Location Plan

Site Monitoring & Management Plan

0708.003

Drawing Number: 0708.003.01
Drawn By: SW
Checked By: DO'R
Date: 01/02/2018

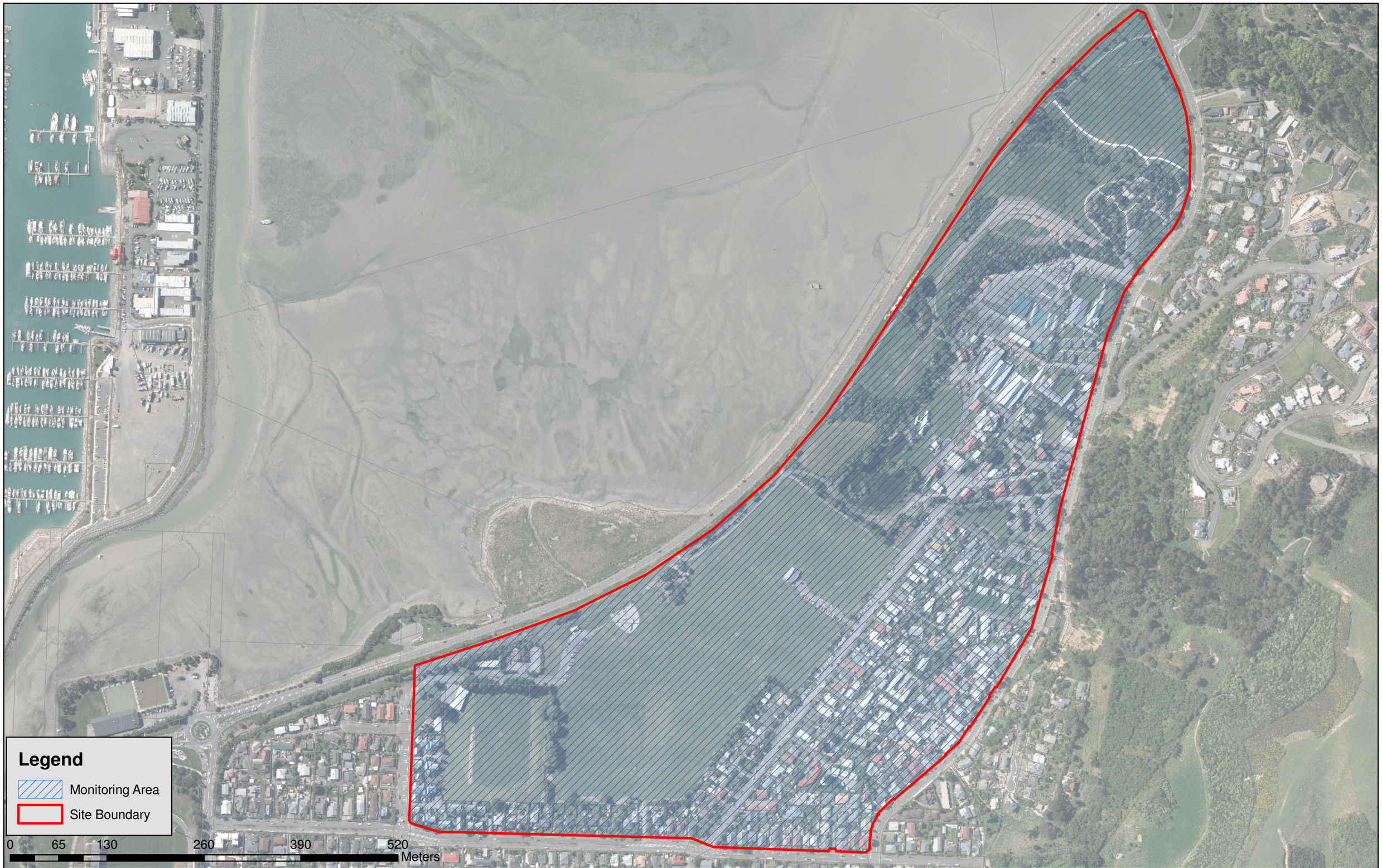

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Figure 2: Surface Cover Monitoring Plan

Site Monitoring & Management Plan

0708.003

Drawing Number: 0708.003.02
Drawn By: SW
Checked By: DO'R
Date: 22/03/2018

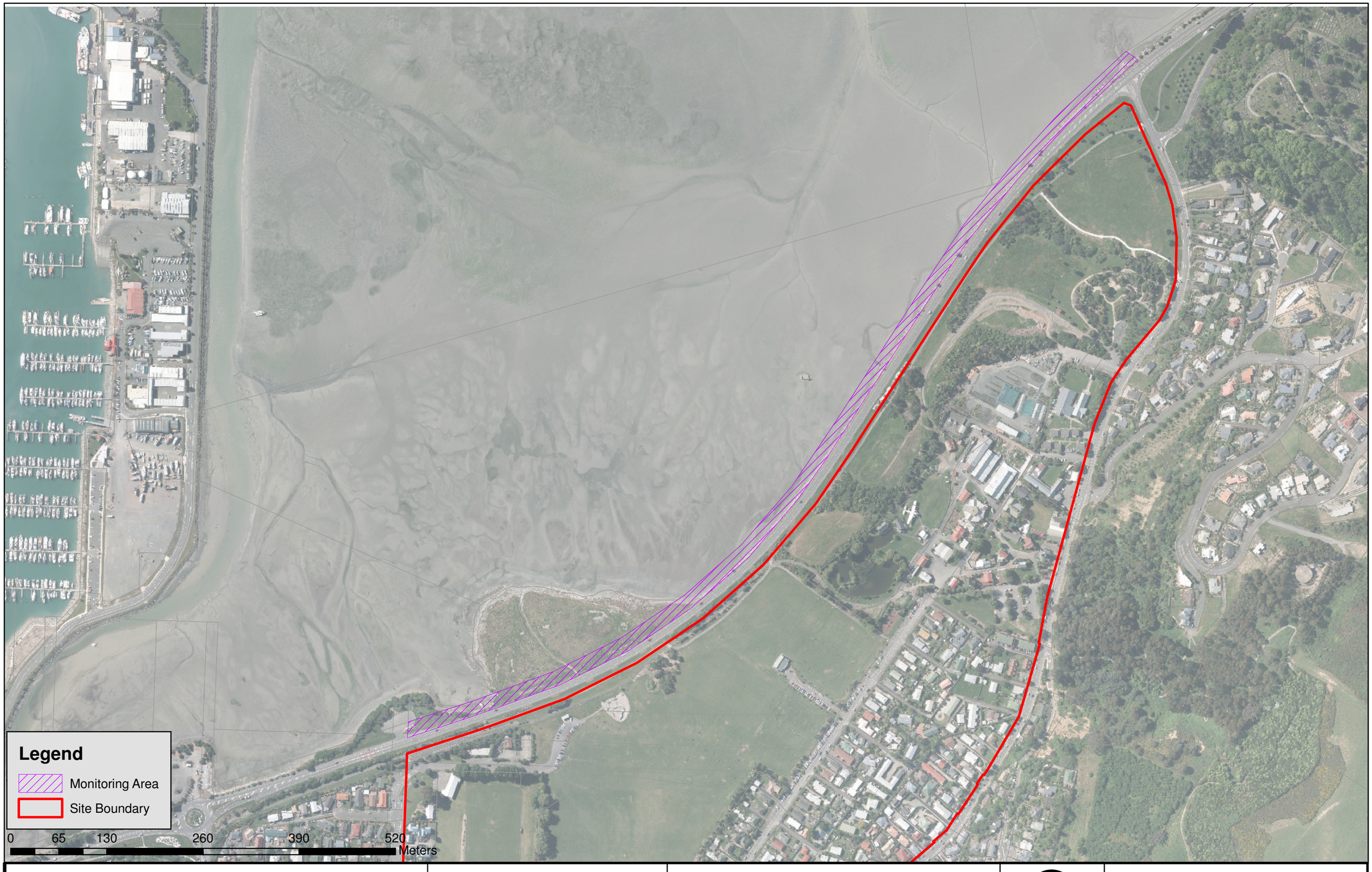

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Figure 3: Shoreline Monitoring Plan

Site Monitoring & Management Plan

	Drawing Number: 0708.003.03
	Drawn By: SW
0708.003	Checked By: DO'R
	Date: 01/02/2018

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Figure 4: Ventilation Tower Location Plan

Site Monitoring & Management Plan

0708.003

Drawing Number: 0708.003.04
Drawn By: SW
Checked By: DO'R
Date: 01/02/2018

FOCUS ENVIRONMENTAL SERVICES LTD	Focus Environmental Services Limited PO Box 11455 Ellerslie Auckland 1542 Ph: +64 9 579 4155 www.focusenvironmental.co.nz	**Nelson City Council** Atawhai Closed Landfill Nelson	**Figure 5: Well Location Plan** Site Monitoring & Management Plan	N 0708.003	Drawing Number: 0708.003.05 Drawn By: SW Checked By: DO'R Date: 01/02/2018

Appendices

Appendix A – Fact Sheet for Property Owners

17 April 2018

Re: Advice Note to Residents - Atawhai Closed Landfill, Nelson

Dear Resident,

As you will be aware from previous communications, your property is sited on, or immediately adjacent to, the old Atawhai Landfill site.

The old Atawhai Landfill covered the area between Queen Elizabeth II Drive, Atawhai Drive, Weka Street and Sovereign Street and operated from the 1940's for over 40 years before being closed in 1987 when the York Valley landfill was opened.

In line with standard practice at the time, when the landfill was closed, the area was capped with cover material.

Based on the investigations completed to date, the Atawhai Closed Landfill is producing quantities of landfill gas and leachate that, without suitable monitoring and management, have the potential to impact site buildings, human health and the environment.

Any proposed development, including soil disturbance, will therefore be subject to the requirements of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES).

As part of Nelson City Council's long-term management plan for the Atawhai Closed Landfill site, this letter provides information for the resident to prevent exposure to contaminated soils and/or refuse and to manage exposure to any landfill gas and leachate.

Based on available data, the soils on your property may contain concentrations of contaminants at levels elevated above relevant guideline values for the residential (10% produce) land use scenario and therefore have the potential to present a risk to the health of site residents.

In the absence of further sampling and analysis and/or remediation of the affected soils, in order to prevent exposure to the identified contamination at the site, the following is recommended:

- Informing residents/tenants of the contamination status of the soils;
- Restricting access to exposed soils;
- Observing good hygiene practices, such as thoroughly washing hands after contact with any exposed soils and avoiding the tracking of soil into living spaces; and
- Restricting any produce grown at the site to raised beds comprising of imported certified clean materials.

In addition, during excavations that extend beyond the topsoil layer the potential for refuse, Landfill Gas and Landfill Leachate to be encountered exists.

Therefore, prior to any soil disturbance activities that extend beneath the topsoil layer (~ 250 mm), a Works-Specific Management Plan, prepared by a suitably qualified and experienced contaminated land specialist, shall be submitted to Nelson City Council for approval.

It should be noted that no smoking shall be permitted during any soil disturbance works that extend beyond the topsoil layer and the use of naked flames, or equipment/tools with the potential to create sparks beneath the ground shall be avoided.

The works-specific site management plan should contain, but shall not be limited to, the following:

- Health and Safety Procedures
- Landfill Gas Monitoring Procedures
- Excavation and Disposal Procedures
- Reinstatement Procedures
- Contingency Procedures

It is recommended that due to the potential for Landfill Gas to be encountered continuous monitoring for Landfill Gas shall, completed by a competent person (as determined by Nelson City Councils Health and Safety Policy), is recommended during any soil disturbance activities that extend beneath the topsoil layer

It should be noted that the works-specific site management plan shall be implemented in addition to, and not instead of, the standard health and safety procedures and any regulatory requirements, such as permit or resource consent, and in accordance with the requirements of the Health and Safety at Work Act (MBIE, 2015).

Appendix B – Atawhai Closed Landfill Monitoring Plan

CLOSED LANDFILL MONITORING PLAN

Focus Environmental Services Limited
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PROJECT DESCRIPTION

SITE	PROJECT DETAILS
Atawhai Closed Landfill	**Project: 0708.003**
	Address: Atawhai Drive, Nelson, New Zealand

MONITORING PLAN

PARAMETER	FREQUENCY	ITEMS	ADDITIONAL PPE
Visual Inspection - Surface Cover	Six-monthly, representing summer and winter conditions	• Vegetation distress • Cracking, • Uneven/hummocky ground - subsidence • Surface pooling • Seeps/leachate	N/A
Visual Inspection - Shoreline	Six-monthly, representing summer and winter conditions	• Potential conduits • Evidence of potential seeps	N/A

CLOSED LANDFILL MONITORING PLAN

Focus Environmental Services Limited
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Email: mail@focusenvironmental.co.nz

PARAMETER	FREQUENCY	ITEMS	ADDITIONAL PPE
Visual Inspection - Ventilation Structures	Six-monthly, representing summer and winter conditions	• Surface pooling • Damage • Inefficient operation	N/A
Landfill Gas – Surface Gas	Six-monthly, representing summer and winter conditions	• ISM survey over 30 m grid • Target buried services, site buildings, fences, deep rooting vegetation, ventilation towers and any areas of subsidence, cracking and vegetation distress	N/A
Landfill Gas – Building/Enclosed Spaces	Six-monthly, representing summer and winter conditions	• ISM survey of building perimeters • ISM survey of open access enclosed spaces	N/A
Landfill Gas – Well Monitoring	Six-monthly, representing summer and winter conditions	• Monitoring of ten landfill gas monitoring wells (MW01-MW10)	N/A
Leachate – Well Monitoring	Six-monthly, representing summer and winter conditions	• Monitoring of four leachate monitoring wells (MW02, MW03, MW04 & MW07)	N/A