REPORT

For a comprehensive understanding of this report, please also refer to the relevant s92 responses

Auckland Regional Landfill

Waste Acceptance Criteria

Prepared for
Waste Management NZ Ltd

Prepared by
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1 Introduction

1.1 Scope of this report

Tonkin & Taylor Ltd (T+T) has been commissioned by Waste Management NZ Ltd (WMNZ) to prepare a technical assessment of proposed Waste Acceptance Criteria (WAC) for the proposed Auckland Regional Landfill. This assessment is intended to accompany resource consent applications.

This report covers the following matters:

- Site description and elements of context that are relevant to the WAC;
- An overview of the waste degradation process, which informs the WAC;
- Overall approach to WAC;
- The WAC, which comprise requirements for:
  - Waste type (relating to sources of waste);
  - Physical characteristics;
  - Leachability limits on contaminants that could leach from the waste, based on the Toxicity Characteristic Leaching Procedure (TCLP Limits);
- Total Concentration Values, which are not WAC, but can be used as an alternative means of confirming that the leachability limits are met;
- Other waste controls to minimise effects.

1.2 Project description and context

Particular aspects of the project that relate to the assessment of WAC described in this report are:

- The operating landfill will receive non-hazardous municipal solid waste and will not accept any hazardous municipal solid waste;
- The landfill will be designed and constructed to meet the definition of a Class 1 Landfill, as defined in the Technical Guidelines for Disposal to Land (WasteMINZ Guidelines, April 2016, amended August 2018). This design includes provision of a composite geosynthetic lining system which provides a level of leachate containment over and above the clay liner prescribed in the original, lower-spec USEPA Subtitle D regulations upon which the TCLP leachability limits by USEPA are based, i.e. the TCLP limits are conservatively low for modern lining systems. The USEPA limits are consistent with those used by WasteMINZ which are proposed for the WAC at this landfill;
- The landfill will be constructed with a leachate collection system, consistent with a Class 1 landfill. Leachate will be collected and treated on site using evaporation technology proven at Redvale Landfill in combination with recirculation into the landfill, except that leachate will be transported off site for disposal in the early years of the landfill's life until there is sufficient gas generation to power an on-site leachate treatment plant;
- Management controls will be implemented to enforce WAC;
- Materials generated during site clearance (e.g., soil strippings, tree stumps, and post-harvest wood slash) will be stockpiled in permanent stockpiles, which will be managed in accordance with the requirements of a Class 4 landfill, as defined in the WasteMINZ Guidelines.

The concept design report and hydrogeological assessment confirm that site conditions are consistent with assumptions for WAC in the WasteMINZ Guidelines for this site. In particular, the WAC in the WasteMINZ guidelines are designed to consider and have no harmful effect on downgradient surface water as close as 100 m from the site, whereas in this case, the distance to the nearest downgradient surface water body, or groundwater drinking well, is much greater than 100 m. This means the WAC are conservative.

1.3 Waste degradation, leachate, and WAC

1.3.1 Stages and phases of waste degradation

WAC reflect the fact that waste placed in a landfill degrades over time, generating leachate and landfill gas (LFG). The fate of contaminants in the waste depends not only on the type of waste deposited but also the stage of degradation. There are three distinct stages of waste degradation, sometimes expressed as the "five phases of waste stabilisation" (see Figure 1.1):

- **Aerobic Stage**. Phase I (aerobic) starts soon after waste placement. Aerobic organisms decompose the readily degradable organic material, producing simpler organic compounds, carbon dioxide and water;
- **Anaerobic Stage**.
  - Phase II (acedogenic; non-methanogenic) starts when the oxygen in the waste is either consumed or displaced by carbon dioxide. Aerobic organisms that thrived in Phase I die off, and organisms that thrive either with or without oxygen take over;
  - Phase III (acetogenic; acid formation) is when the waste is broken down into simpler compounds including ammonia, water, carbon dioxide, and organic acids. The organic acids are soluble and biodegradable, so the leachate has the highest biological and chemical oxygen demand (BOD and COD) in this phase;
  - Phase IV (methanogenic) is when methanogenic bacteria convert organic acids into methane and carbon dioxide, the principal components of landfill gas. Sulphates and nitrates are reduced to sulphides and ammonia. The pH of leachate increases, and heavy metals are removed from leachate by complexation and precipitation. Organic acid concentrations decrease, which decreases the COD and BOD of leachate;
- **Maturation Stage**. Phase V is when nutrients and available substrate limit the biological activity. Gas production drops dramatically and leachate strength stays steady at much lower concentrations than in Phases II to IV.

Controlling the by-products of the waste degradation stages is a primary consideration in landfill design, and drives both the fate of contaminants within the landfill and selection of WAC.

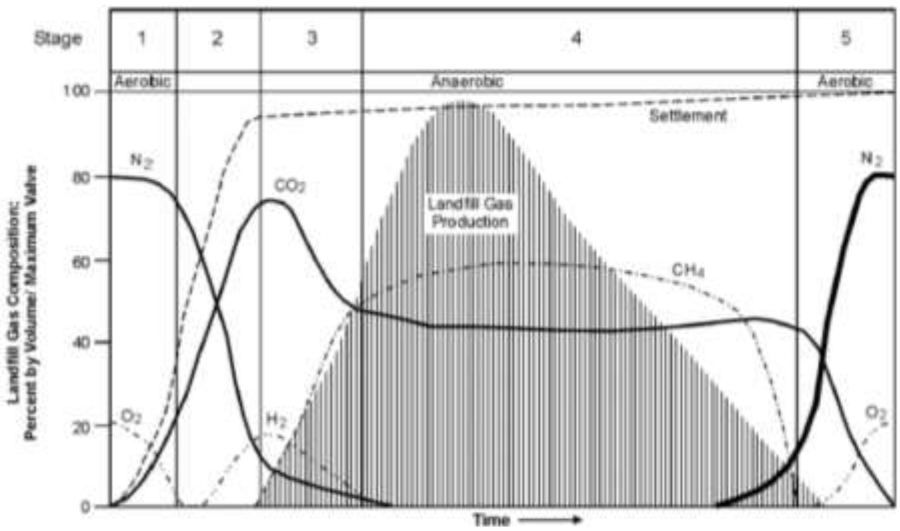

Figure 1.1: stages of waste decomposition in a landfill (Source: Technical Guidelines for Disposal to Land, WasteMINZ, 2018)

1.3.2 Leachate

Water is present in a landfill due to rainwater infiltrating through the surface and from the waste itself. Percolating water extracts (i.e., leaches) the soluble components out of the waste, and is termed leachate. The composition of the leachate depends on the type and age of the waste, the physical, chemical and microbiological conditions in the landfill, and the water balance in the landfill. Landfill leachate contains:

- "Major ions" such as calcium, magnesium, sodium, potassium, iron, ammonia, carbonate or bicarbonate, sulphate and chloride;
- Trace metals such as zinc, manganese, chromium, nickel, lead, and cadmium;
- Organic compounds, usually measured as total organic carbon (TOC), COD or BOD, volatile organic carbon (VOC) or semi-volatile organic carbon (SVOC);
- Microbiological components.

1.3.3 Landfill gas

Decomposition of organic waste materials by methanogenic bacteria produces landfill gas (LFG), which is mainly methane and carbon dioxide, with smaller amounts of odorous reduced sulphur compounds (including hydrogen sulphide). Other contaminants can be present in LFG due to volatilisation from the waste or chemical reactions. Normally, less than 1% (by volume) of LFG are non-methane organic compounds (NMOCs). Methane is highly flammable. This risk is controlled by capturing and destroying the methane by combustion, which also minimises the risk of offsite odour effects. Methane is generally not of concern from the point of view of toxicity. However, some of the trace constituents in LFG could have toxic effects if people are exposed at high enough concentrations.

1.3.4 Fate of contaminants in waste

Several processes decrease the leaching of metal contaminants in a municipal solid waste landfill. In the later stages of waste decomposition, the higher pH decreases metal solubility, and relatively insoluble metal precipitates form in the presence of sulphide, carbonate, and hydroxide ions. Some metals are strongly adsorbed by the waste mass, for example, lead and mercury bind strongly to organic matter. This means that a significant proportion of the metals disposed into a landfill as part of the waste stream remain within the landfill. However, trace quantities of metals are still found in leachate. Mercury, which is more volatile than other metals, can also be found in LFG.

Similarly, many organic compounds are attenuated and / or assimilated within a modern municipal solid waste landfill. However, highly volatile organic compounds are likely to be released into LFG. LFG management by controlled combustion plays an important part in minimising emissions of volatile compounds.

Leachate recirculation can increase the retention of contaminants within the waste mass. It redistributes contaminants within the landfill and extends the opportunity for biodegradation or reaction and sorption to occur.

2 Method: approach to developing WAC

2.1 Approach to WAC for Class 1 landfill

The proposed WAC for the Class 1 landfill are consistent with the WasteMINZ Guidelines for Class 1 municipal landfills. The approach to applying the WAC includes the option of using total concentrations as a possible way of demonstrating that the WAC are met.

The approach to developing the WAC for the landfill comprises:

- Identifying a list of waste types accepted, which is broadly defined as Municipal Solid Waste (MSW). MSW includes mixed municipal waste from residential, commercial and industrial sources, as well as: soils, rocks, gravel, sand, clay, road sweepings, asbestos (disposed in accordance with the Asbestos Regulations 1998 and the NZ Health and Safety and Work (Asbestos) Regulations 2016) (refer Table 6-1 of the WasteMINZ Guidelines) and other industry guidelines;
- Identifying a list of prohibited wastes;
- Specifying that hazardous waste is not acceptable. To identify waste that is hazardous due to toxicity, maximum contaminant leachability limits (TCLP Limits) are set, which are maximum values that should not be exceeded. The TCLP Limits represent the minimum treatment specification for waste[1];
- As a screening tool in lieu of leachability testing (TCLP), screening levels for total concentrations have been developed. The Total Concentration Values are values below which we can be confident that the TCLP Limits will be met. They are based on either:
  - The Total Concentration Values provided in MfE 2004, which are based on the assumption that 100% of the contaminant is leached out of the sample in the TCLP. This is the operationally defined ratio of **TCLP result (in mg/L) : total result (in mg/kg) = 1:20**; or
  - Deviations from the WasteMINZ Guidelines, based on **long-term TCLP and total concentration data collected by WMNZ**. The proposed deviations from the WasteMINZ Guidelines are based on real data from actual waste samples for the percentage of contaminant extracted in the TCLP. They reflect the fact that the TCLP rarely extracts 100% of the contaminant from the sample;
- Identifying additional limits set to address potential effects of odour (e.g., sulphur content, Volatile Organic Compounds), or physical characteristics of waste (e.g., sloppiness, dustiness) or other operational considerations;
- Proposed waste control measures (refer Section 5.2) are based on actions and historical performance at other landfills;
- A process for the development of WAC for new or emerging contaminants (refer Section 3.3.5), which will sit in the Landfill Management Plan, to future-proof the consent conditions and allow new WAC to be developed and implemented if new contaminants emerge.

Domestic waste may contain residual household hazardous waste, for example, containers with residual amounts of cleaning agents which are a very small proportion of the total waste going to landfill. It is not possible to remove all such items at the landfill, and WAC do not prohibit domestic waste which ordinarily may contain traces of hazardous waste.

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[1] The proposed TCLP Limits are drawn from the WasteMINZ Guidelines, which are based on the Ministry for the Environment's Module 2 Hazardous Waste Guidelines – Class A (MfE 2004), which are based on USEPA TCLP limits concept (albeit for a somewhat different chemical parameter list) to define the toxicity characteristic of hazardous waste, which in turn is based on USEPA Subtitle D regulations with prescribed landfill design features.

2.2 Approach to WAC for stockpiles

For the **permanent stockpiles** of Class 4 type materials (e.g., soil strippings, tree stumps and post-harvest wood slash), the WAC are taken directly from the WasteMINZ Guidelines.

3 Analysis

3.1 Basis for applying the TCLP Limits in the WasteMINZ Guidelines

The landfill will have engineered leachate management controls, therefore leachability criteria are appropriate. WMNZ proposes to use the TCLP limits from the WasteMINZ Guidelines. The TCLP limits in the WasteMINZ Guidelines are considered conservatively protective for this site, as outlined below

The WasteMINZ WAC are based on a Conceptual Site Model (CSM) for a Class 1 landfill, which considered potentially complete and incomplete pathways. The pathways assessed to be incomplete in the CSM, due to standard engineered controls and operational/institutional controls expected at a Class 1 landfill, will be incomplete at the proposed landfill. In particular controls for erosion and sediment management mean there will be no direct runoff to the environment and operating procedures (including PPE, daily cover, closed-cab machinery) mean there is no direct contact with waste by people onsite or offsite.

For the complete pathways (inhalation, seepage to groundwater, migration to surface water, ingestion of groundwater and surface water), a dilution attenuation factor (DAF) was estimated. The limiting pathway was used to derive an overall DAF of 100.

The WasteMINZ Guidelines highlight that the drinking water standards (DWS) used by USEPA were in some cases less stringent than New Zealand DWS. However, DWS are only relevant for the pathways in which there is seepage to groundwater and migration to surface water. The seepage to groundwater pathway is more highly mitigated in New Zealand Class 1 landfills than in landfills that meet the USEPA Subtitle D regulations. In particular, New Zealand Class 1 landfills have a composite geosynthetic lining system, which is a higher level of containment than assumed in the USEPA regulations.

The site meets all the factors that are critical to making a DAF of 100 conservatively protective (refer Table 3.1). This confirms that the method followed in the WasteMINZ Guidelines is appropriate for this landfill.

Table 3.1: Assumptions in TCLP limits (DAF = 100) and comparison with this landfill

Parameter	USEPA applicable range	Expected range on this landfill	Comment
Landfill cover permeability	10^{-9} to 10^{-6} m/s	10^{-7} m/s	Specified in design
Leachate discharge (liner leakage) to ground	10 to 5,000 L/ha/d	0.137 L/ha/d	
Distance to receiving environment or sensitive receptor	< 100 m	> 100 m	Because actual distance at this site exceeds 100 m, a higher (less conservative) DAF could be appropriate but is not considered here.
Hydraulic conductivity of primary pathways for leachate migration	> 10^{-5} m/s	< 10^{-5} m/s	If there were a sustained inward hydraulic gradient, a higher DAF could be appropriate

3.2 Basis for deviations from the TCLP Limits in the WasteMINZ Guidelines

The TCLP Limits in the WasteMINZ guidelines are operationally defined limits based on the Toxicity Characteristic Leaching Procedure (TCLP) that define the characteristic of *toxicity* in hazardous waste. The TLCP test simulates the scenario in which waste is placed in an unlined landfill, and infiltrating rain reacts with waste producing a weak acid solution, which then leaches contaminants from the waste. TCLP Limits were set by USEPA at levels that would prevent the groundwater under the unlined landfill from posing a threat to human health and the environment. All of the Class 1 TCLP Limits in the WasteMINZ Guidelines are proposed to be used in the WAC for the site.

3.3 Total Concentration Values

3.3.1 Context for Total Concentration Values

The WasteMINZ Guidelines do not include Total Concentration Values as an alternative method of demonstrating compliance with the TCLP Limits for Class 1 Landfills. This is a change from the MfE 2004 guidelines for Class A landfills.

The test for total concentrations is considerably quicker and less expensive than the TCLP. Therefore, if a Total Concentration Value can be set, below which we are confident the TCLP Limit will be met, then it makes sense to include a total concentration threshold as a preliminary screening step. The WAC is still the TCLP Limit. An exceedance of a Total Concentration Value doesn't mean the waste exceeds the WAC; it merely triggers TCLP testing for that particular waste.

Total Concentration Values were included in the Class A guidelines (MfE 2004). For some contaminants, the Total Concentration Values we propose here are deviations from the approach used in MfE 2004, based on long-term monitoring data collected by WMNZ. We have reviewed these data and are satisfied that there is a scientifically robust and technically sound basis for the proposed deviations. For some organic contaminants, we have proposed higher Total Concentration Values because the contaminants are typically tightly bound to most solids (wastes) and therefore the proportion that leaches as described in 3.1 is substantially less than the default of 100%.

3.3.2 Relationship between TCLP and total concentrations

The Class A guidelines (MfE 2004) included a total concentration screening value which was 20 times the TCLP Limit. The factor of 20 used in the Class A guidelines (i.e., Total Concentration in mg/kg = 20 x TCLP limit in mg/L) is based on the conservative assumption that the TCLP leaches 100% of the contaminant from the sample. Effectively, the Class A guidelines are saying that if the Total Concentration is less than 20 times the TCLP Limit, then it is impossible for the TCLP Limit to be exceeded. However, if the Total Concentration is greater than 20 times the TLCP limit, it is possible the TCLP Limit could be exceeded, so the TCLP result should be checked. The TCLP test method means there is no justification for a Total Concentration limit value that is less than 20 times the TCLP Limit.

The Total Concentration is measured by boiling a sample up in strong acids (nitric acid and hydrochloric acid) and measuring what is extracted. The TCLP is measured by shaking a sample in weak acid (dilute acetic acid), and measuring the amount of contaminant that leaches out of the sample. The TCLP method is an approximation of the effect of organic acids in leachate on the leachability of the waste. The amount that is leached out of the sample in the TCLP depends on how tightly the contaminant is bound to the waste, which depends on both the solubility of the contaminant and the type of waste material. For most contaminants and most waste types, only a small fraction (usually much less than 10%) of the contaminant is released (leached out) by the acetic acid in the TCLP test.

3.3.3 Metals

WMNZ has maintained a long-term database of test results for metals where both TCLP and total contaminant concentrations have been measured on wastes disposed at its landfills. Those data show that for most soluble metals, less than 20% of the contaminant is leached from the sample in the TCLP test. This would mean a Total Concentration Value factor of 100 x TCLP Limit would work just as effectively in triggering the need for a TCLP test as the factor of 20 used in the Class A guidelines. WMNZ's data provide a robust basis for choosing a higher Total Concentration Value (in mg/kg), below which we can be confident that a TCLP on the same sample would not exceed the TCLP limit. We also note that the TCLP test gives conservatively high estimates of several metals for municipal solid waste leachate, particularly later in the waste degradation process, because the test is run at pH 2-3, whereas the leachate in the anaerobic phase typically has higher pH.

WMNZ's data show a factor of 100 times the TCLP limit is appropriate and conservative for most metals. Notable exceptions are barium, mercury, selenium, silver, sulphides and cyanides for which there are few data available. For these metals, we propose the minimum Total Concentration Values are used (i.e., factor of 20).

The Totals vs TCLP data held by WMNZ are considered commercially sensitive, but an illustrative example is provided for lead and chromium (refer Figure 3.1). The absence of points falling in the upper left quadrant of these graphs supports the use of a factor of 100 x TCLP Limit.

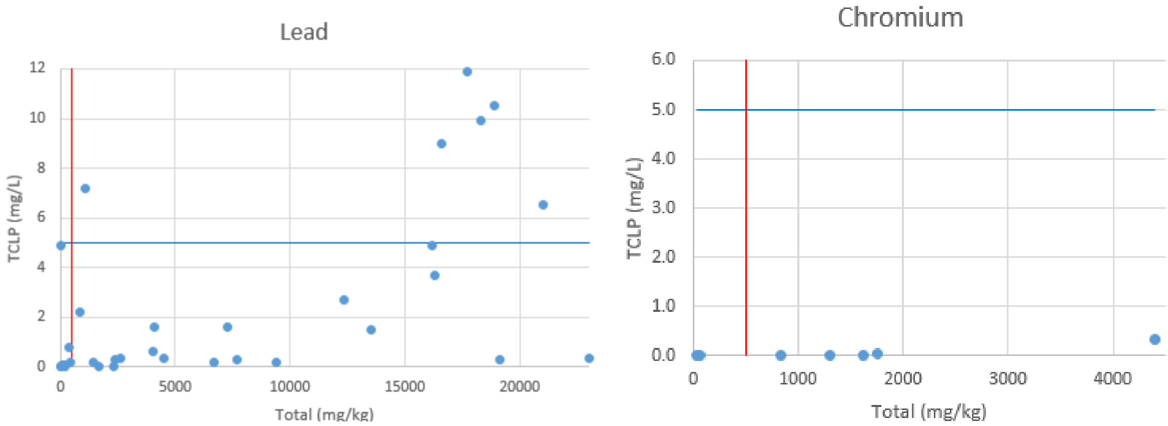

Figure 3.1: WMNZ data for TCLP and total concentrations, lead and chromium. Blue line is TCLP Limit from WasteMINZ Guidelines, red line is proposed Total Concentration Value, based on a factor of 100 x TCLP Limit

3.3.4 Organic contaminants

WMNZ does not have a database of Total vs. TCLP data pairs for organic compounds in waste, because they are less frequently tested in wastes. For most organic contaminants, including soluble and mobile compounds such as methyl ethyl ketone and 2-chlorophenol, a factor of 20 x TCLP is appropriate.

However, some common organic contaminants, such as organochlorine pesticides and polycyclic aromatic hydrocarbons (PAH), are tightly bound to organic matter in waste. For these compounds, only a small fraction will enter leachate, and so a higher Total Concentration Value factor is appropriate before a TCLP needs to be carried out. We have used partition coefficients to select which contaminants can confidently be assigned a higher factor before the TCLP test is required:

- K_{oc}, the soil adsorption coefficient, which describes the mobility in soil. A high value means the chemical sticks to organic matter in the soil.
- K_{ow}, the octanol-water coefficient, which describes the tendency of a chemical to dissolve in water; a high value means the chemical is not likely to dissolve in water.

K_{oc} and K_{ow} are chemical-specific (refer Table Table 3.2). For compounds with K_{ow} greater than 10,000 (i.e., log K_{ow} > 4) and K_{oc} greater than 300 (i.e., log K_{oc} > 2.5), only a very small proportion of contaminant is expected to be leached out of the waste, for most waste types. For these compounds, we propose a factor of 100 is applied. This represents 20% of the total contaminant concentration in the sample. The actual amount leached is expected to be much smaller. For these contaminants, if the total concentration exceeds 100 times the TCLP Limit, the TCLP test will still need to be carried out. However, if the total concentration is less than 100 times the TCLP Limit, the TCLP Limit can be assumed to be met.

WMNZ's data show that for some wastes, e.g., PCB-containing waste, the Total Concentrations are typically much higher than 100 times the proposed TCLP Limit. This means that WMNZ will always be seeking TCLP for PCB-containing waste.

Table 3.2: Partition coefficients for organic compounds

Chemical	log K_{oc}	log K_{ow}	Chemical	log K_{oc}	log K_{ow}
Benzene	1.82	1.99	Carbon tetrachloride	2.27	2.44
m-cresol	1.94	2.06	Chloroform	1.67	1.52
o-cresol	1.99	2.06	Tetrachloroethene	2.19	2.97
p-cresol	1.91	2.06	Trichloroethene	1.97	2.47
Chlordane	**5.08**	**6.60**	1,2-dichloroethane	1.24	1.83
Endrin	**3.97**	**5.45**	1,1-dichloroethene	1.81	2.12
Heptachlor	**4.07**	**6.21**	Vinyl chloride	1.04	1.62
Methoxychlor	**4.89**	**5.67**	Chlorobenzene	2.33	2.64
Pentachlorophenol	**2.61**	**4.74**	1,4-dichlorobenzene	2.81	3.28
Toxaphene	**4.98**	**6.79**	**Hexachloro-1,3-butadiene**	**3.84**	**4.71**
2,4-dichlorophenoxyacetic acid	2.95	2.62	**Hexachlorobenzene**	**4.45**	**5.86**
2,4,5-trichlorophenoxypropionic acid	1.72	3.26	**Hexachloroethane**	**3.26**	**4.03**
2,4-dinitrotoluene	1.71	2.18	**Polychlorinated biphenyls**	**5.72**	**6.3**
Nitrobenzene	2.12	1.81	2,4,5-trichlorophenol	2.47	3.45
Methylethyl ketone	0.28	0.26	2,4,6-trichlorophenol	2.12	3.45
Pyridine	0.64	0.8			

Units of K_{oc} and K_{ow} L/kg. Source of data is Texas Risk Reduction Programme RG-366 TRRP-19 Toxicity Factors and Chemical Physical Parameters June 2001, as collated in the Chemical Database within USEPA's *RBCA Tool Kit.* Chemicals in **bold** have K_{oc} > 2.5 and K_{ow} > 4.

3.3.5 Process to develop new WAC for new contaminants

It is possible that within the life of the consent, additional WAC may be needed, for example, if new contaminants become a concern. The process for developing new WAC will be set out in the Landfill Management Plan, and will comprise the following steps:

- Review New Zealand and international regulations and good practice guidelines, to identify whether there are pre-existing WAC for other sites and jurisdictions;
- If there are pre-existing WAC, compare the conditions under which the pre-existing WAC were developed with ARL conditions. If the assumptions made in developing the pre-existing WAC are conservative for ARL, the WAC can be adopted as is. In some cases, it may be more appropriate to develop ARL-specific criteria;

- If there are no pre-existing criteria, or if the assumptions underlying the pre-existing criteria are not appropriate for ARL, develop ARL-specific criteria; and
- Document the criteria and assumptions and update the Landfill Management Plan.

4 Proposed WAC

4.1 Prohibited wastes

The list of prohibited wastes (refer Table 4.1) is taken directly from Appendix H of the WasteMINZ Guidelines.

Table 4.1: Characteristics of prohibited wastes

Class	Characteristic
H1	Explosives
H2	Gases
H3	Flammable liquids
H4.1	Flammable solids
H4.2	Substances or wastes liable to spontaneous combustion
H5.1	Oxidising substances
H6.2	Infectious substances
H7	Radioactive materials
H8	Corrosives
H10	Liberation of toxic gases in contact with air or water
H13	Capable, by any means after disposal, of yielding another material (i.e., leachate which possesses any of the above characteristics).

4.2 WAC for landfill

4.2.1 Acceptable waste types

The acceptable waste types are (refer Table 6-1 of the WasteMINZ Guidelines):

- Clean fill material;
- Managed fill material;
- Construction and demolition (C&D) waste;
- Municipal solid waste;
- Household waste;
- Commercial waste;
- Industrial waste;
- Treated hazardous waste (i.e., waste that has been treated so it is no longer hazardous, for example, cement-stabilised soil that no longer has the characteristic of toxicity);
- Contaminated soil.

4.2.2 Physical nature of wastes

In accordance with the WasteMINZ Guidelines, the following physical requirements apply:

- All wastes should have an angle of repose of greater than 5 degrees (i.e., "spadeable") (typically applicable to biosolids); and
- All wastes shall have no free liquid component, which is to be assessed at the point of loading into the truck that delivers it to the tip face.

Additional controls that WMNZ will apply on an as-required basis at WMNZ's discretion, to meet operational requirements include the following which may be confirmed by inclusion in the Landfill Management Plan:

- Packaged goods originally intended for domestic use but would be regarded as hazardous if in bulk are acceptable provided that the quantity is less than 0.1% of the daily waste tonnage;
- Odorous waste will not be accepted if it will cause objectionable odour at the site boundary. Controls for managing odorous waste are set out in Section 5.2.6;
- Some large volume wastes may be monofilled or encapsulated within the waste mass to avoid particular mixing that leads to adverse effects like release of odour or suppression of decomposition, e.g., high sulphate and sulphur wastes;
- Oversize items (e.g., moulds for fibreglass yachts, tree logs, monster truck tyres) will be accepted provided they do not compromise the ability to apply daily cover. For example, WMNZ may choose to apply a time of day restriction to delivery of such wastes;
- Dusty materials will be accepted subject to additional controls to manage safety at the tip face (visibility, dust sticking to compactor windows, inhalation). These controls may include pre-bagging, load covering, dampening at source, or restricting delivery to low-wind days.

4.2.3 Soil from HAIL sites

The landfill will accept certain types of soil from contaminated sites. Soil from sites that have been used for activities on the Ministry for the Environment's Hazardous Activities and Industries List (HAIL sites[2]) is potentially contaminated. The evaluation of acceptance will be based on the bulk concentration of material received from a HAIL site. The material must meet the leachability limits in Section 4.2.4.

Land that has been used for horticultural purposes is considered a HAIL site, due to potential presence of organochlorine pesticides (OCP). While OCP are highly toxic and persistent, they are also strongly bound to soil particles. If not handled appropriately, there can be risks to human health via contact with the soil at these sites, and it is appropriate that development of these sites is carefully managed to minimise risk to human health. However, when soil from these sites is placed in a landfill, there is very low risk to human health or the environment. TCLP testing for OCP to characterise small quantities of soil for disposal can be disproportionate, and only at the most highly contaminated sites would soil ever exceed TCLP Limits. We propose it would be appropriate to accept up to 100 m^3 of soil from the development of a broad-acre horticultural HAIL site without testing, provided the only reason the site is a HAIL site is broad-acre pesticide application (i.e., this exemption from testing does not apply to soil from HAIL sites where there was intensive pesticide use). The proposed volume is expected to cover most single-house developments. For larger quantities of soil, testing is required.

4.2.4 Potentially toxic waste: TCLP Limits and total concentration values

Waste that is hazardous by the characteristic of toxicity is not acceptable. The proposed TCLP Limits (mg/L) to define toxicity are in Table 4.2. The TCLP Limits are all from the WasteMINZ Guidelines for Class 1 landfills, and all TCLP Limits identified in the WasteMINZ Guidelines are proposed to be used.

The Total Concentration Screen Levels (mg/kg) in Table 4.2 are concentrations below which the TCLP Limits are highly unlikely to be exceeded (refer Section 3.3).

[2] http://www.mfe.govt.nz/land/hazardous-activities-and-industries-list-hail

Table 4.2: Leachability limits (TCLP limit) and screening total concentrations (Screen level)

	Contaminant	TCLP Limit[1] (mg/L)	Screen level (mg/kg)
Metals	Arsenic	5	500 [2]
	Barium	100	2,000
	Cadmium	1	100 [2]
	Chromium	5	500 [2]
	Lead	5	500 [2]
	Mercury	0.2	4
	Selenium	1	20
	Silver	5	100
Other inorganics	Cyanides (reactive)	50	1,000
	Sulphides (reactive)	50	1,000
Aromatic hydrocarbons	Benzene	0.5	10
	m-cresol	200	4,000
	o-cresol	200	4,000
	p-cresol	200	4,000
	Total cresol	200	4,000
Pesticides and herbicides	Chlordane	0.03	3 [2]
	Endrin	0.02	2 [2]
	Heptachlor	0.008	0.8 [2]
	Lindane	0.4	8
	Methoxychlor	10	1,000 [2]
	Pentachlorophenol	100	10,000
	Toxaphene	0.5	50 [2]
	2,4-dichlorophenoxyacetic acid	10	200
	2,4,5-trichlorophenoxypropionic acid	1	20
Other organics	2,4-dinitrotoluene	0.13	2.6
	Nitrobenzene	2	40
	Methylethyl ketone	200	4,000
	Pyridine	5	100
Chlorinated organics	Carbon tetrachloride	0.5	10
	Chloroform	6	120
	Tetrachlorethene	0.7	14
	Trichloroethene	0.7	14
	1,2-dichloroethane	0.5	10
	1,1-dichloroethene	0.7	14
	Vinyl chloride	0.2	20
	Chlorobenzene	100	2,000
	1,4-dichlorobenzene	7.5	150
	Hexachloro-1,3-butadiene	0.5	50 [2]
	Hexachlorobenzene	0.13	13 [2]
	Hexachloroethane	3	300 [2]
	Polychlorinated biphenyls	50	5,000 [2]
	2,4,5-trichlorophenol	400	8,000
	2,4,6-trichlorophenol	2	40

[1] All TCLP Limits are from WasteMINZ Guidelines Table D-1 Class 1 Waste Acceptance Criteria

[2] for these contaminants, the screening value is 100 x TCLP, based on WMNZ data for metals, or K_{ow} > 10,000 and K_{oc} > 300 for organics. All other screening limits are 20 x TCLP, based on MfE 2004 Class A guidelines and definition of TCLP test

4.3 WAC for permanent stockpiles

For the permanent stockpiles, WMNZ proposes to use the WAC for Class 4 permanent stockpiles that are consistent with the WasteMINZ Guidelines. As provided in the WasteMINZ Guidelines, they are:

- Virgin excavated natural materials (VENM), including soil, clay, gravel and rock;
- Maximum incidental inert manufactured materials (e.g. concrete, brick, tiles) to be no more than 5% by volume per load;
- Maximum incidental or attached biodegradable materials (e.g. vegetation) to be no more than 2% by volume per load; and
- Maximum chemical contaminant limits are local natural background soil concentrations.

Incidental items or materials are those present in small quantities that cannot practically be separated from the materials intended for disposal.

The WAC for Class 4 landfills are based on the local background concentrations for metals, and provide for trace concentrations of a limited range of organic compounds. The proposed WAC for the permanent stockpiles are provided in Table 4.3.

Table 4.3: WAC for permanent stockpiles (WasteMINZ Class 4)

Contaminant	Background concentration (mg/kg)	Contaminant	Maximum allowable concentration (mg/kg)
Arsenic	12	TPH C7-C9	120
Cadmium	0.65	TPH C10-C14	58
Chromium	55	Benzene	0.0054
Copper	45	Ethylbenzene	1.1
Lead	65	Toluene	1.0
Mercury	0.45	Total xylene	0.61
Nickel	35	Benzo(a)pyrene eq.	2
Zinc	180	Total DDT	0.7

Benzo(a)pyrene eq. is the potency-weighted sum of nine carcinogenic PAHs, as follows: benzo(a)pyrene + dibenzo(a,h)anthracene + 0.1 x [benzo(a)anthracene + benzo(b)fluoranthene + benzo(j)fluoranthene + benzo(k)fluoranthene + indeno(1,2,3-cd) pyrene] + 0.01 x [chrysene + fluoranthene].

5 Mitigation and monitoring

5.1 Decision tree for waste evaluation process

The intention of a waste evaluation decision tree is to deliver a waste evaluation process prior to acceptance that is clear, simple to use, minimises risk of inappropriate wastes being accepted, and effectively addresses the types of complex wastes WMNZ expects to receive.

The flow chart in Figure 5.1 illustrates the overall waste application evaluation process.

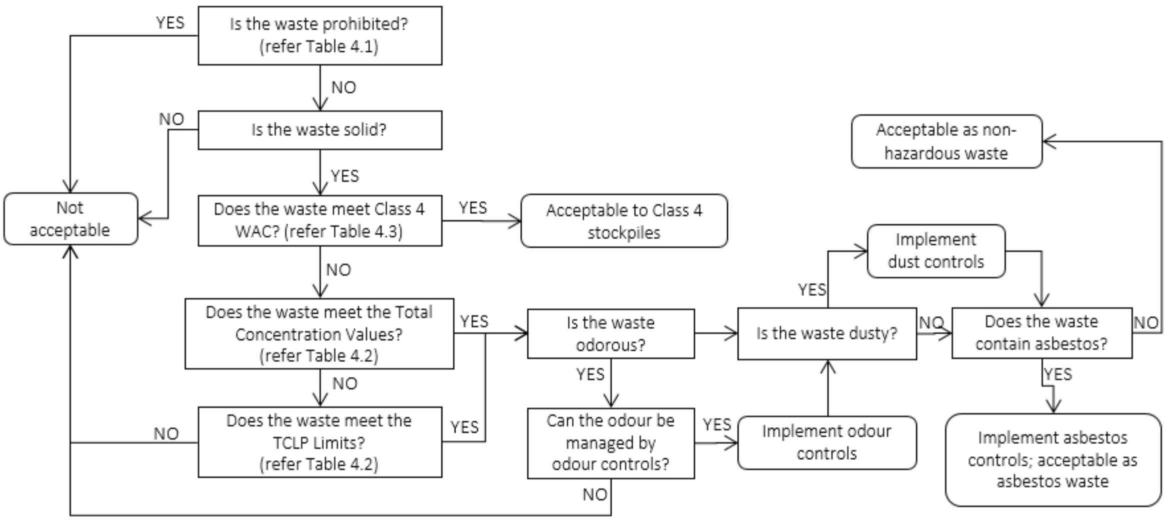

Figure 5.1: Waste pre-acceptance evaluation process

5.2 Elements of waste control

Waste control measures are based on actions and historical performance at other modern landfills. The main elements are:

- Pre-acceptance testing;
- Pre-acceptance agreement;
- Gatehouse controls;
- On-site screen testing;
- Regulatory reporting.

5.2.1 Pre-acceptance testing

Pre-acceptance testing is required for all special wastes and soils whose contaminant concentrations cannot otherwise be fairly assessed e.g. by observation, relevant historical records, or good knowledge of the source.

The landfill must keep sufficient records to show that the waste is not hazardous.

In the case of any new special waste with potential ecotoxicity, the landfill will ask the customer to provide test results that show that the waste meets the TLCP limits or the total concentration limits, prior to accepting the application.

The requirements for testing are:

- The testing must be done by an accredited laboratory;
- The sample size must be sufficient to effectively characterise the material;
- The sampling will typically include worst-case and average concentrations, but this is disposer-specific.

In addition to limits set in the contaminant list (Table 4.2), the landfill operator would use discretion and experience to impose limits on any other contaminants or apply customised disposal methods that they deem necessary.

5.2.2 Evaluation of odorous waste

In the case of a new special waste stream that is odorous, especially waste from a new source or process, the landfill will ask the customer to provide information that allows the landfill to assess the odour potential of the waste. Potentially odorous waste will be evaluated on a case-by-case basis, by consideration of:

- The odour potential;
- The total volume, rate of delivery, and timing of delivery, and how this ties in with operations at the landfill at the proposed time of delivery;
- Whether any pre-treatment has been done (e.g., mixing with lime). Potentially malodorous waste, such as egg wastes or wool scourings, must be pre-treated by the waste generator to reduce odour before delivery (e.g., mixing with lime).

A precautionary approach will be taken when accepting any new potentially malodorous waste streams, including trial disposal of small quantities before entering into longer term contracts.

Where waste is assessed as being excessively odorous, or has been identified as excessively odorous on-site, future loads will not be accepted unless the waste can be pre-treated to reduce odour to acceptable levels.

5.2.3 Pre-acceptance agreement

For the landfill, the customer's application must include:

- Description of the waste and waste generator contact information;
- For potentially hazardous waste, results of any testing on the waste;
- For potentially malodorous waste, information to allow the landfill to assess whether the waste is acceptable (i.e., odour potential, rate of delivery, timing of delivery, any pre-treatment carried out on the waste); and
- For malodorous waste that requires pre-treatment, confirmation that pre-treatment has occurred.

For Class 4 stockpiles, the application must include:

- Source of the waste;
- Evidence provided by the customer and accepted by the landfill that the source has not been contaminated. This may be confirmation that the site is not a Hazardous Activities and Industries List (HAIL) site, or test results that show the material is not contaminated;
- Copies of any resource consents authorising the land disturbance at the source site;
- Results of any testing required at the discretion of the landfill operator to demonstrate compliance with Class 4 WAC.

5.2.4 Gatehouse

Every load of special waste must be accompanied by a manifest corresponding to an approved waste application.

All loads of odorous waste must be covered for transport to the landfill and remain covered as far as the working face or a dedicated de-tarping area. The gatehouse must notify operators by site radio when the load has arrived at the site. Odorous wastes shall be rejected at the gate if unacceptable.

5.2.5 On-site screen testing

For both the landfill and the stockpiles, random load inspections will be carried out at a frequency of approximately 1 in 50 loads. The frequency may be revised (up or down) depending on previous inspection results.

For the stockpiles, samples will be collected at a frequency of 1 per 500 m^3 but no less often than annually.

- The random samples (~1/500 m^3) will be tested for metals and PAH;
- Annual samples will be tested for metals and organic compounds listed in Table 4.3.

5.2.6 Odorous waste management

Odorous waste must be buried as soon as possible. Excavations in preparation for rapid burial must consider odour potential from the excavation as well as timing of delivery of the waste.

Hours for delivery of odorous waste may be restricted to middle hours of the day when the working face operations and climatic conditions are most favourable for odorous waste management.

Operators must ensure loads are adequately tipped out of truck. The site truck wash and/or tray wash must be used before the truck leaves the site if there is residual waste odour from the truck after tipping.

5.2.7 Regulatory reporting

If any waste load is rejected at the gatehouse or removed because it is hazardous, Auckland Council is to be notified within 48 hours.

Waste tonnage tallies will also be reported to Council in accordance with bylaws.

5.3 Leachate quality monitoring

After waste has been buried under daily cover, the next opportunity to find out information about the nature of the waste and effectiveness of waste control is to examine the leachate. Leachate chemistry provides an indicator of non-hazardous waste compliance, proper decomposition and good landfill management practices relating to stormwater and gas.

Leachate should be tested quarterly for the first three years of operation, and no less often than annually after that. A sample of combined leachate should be tested.

The quarterly test suite will focus on common and soluble contaminants, as indicators of excessive leachability of special waste. Additional parameters for which there are no toxicity-related waste acceptance criteria (e.g., ammonia, conductivity, pH) will also be measured to assess leachate quality.

A broader suite of potential contaminants should be tested annually. The proposed suite of contaminants for the quarterly and annual monitoring is set out in Table 5.1. This recommendation has been reflected in the draft consent conditions.

If groundwater monitoring finds any contaminant that has not already been measured in leachate then the leachate would also be tested as part of any investigation or clarification. The process for this additional leachate testing would be:

- Carry out routine groundwater monitoring for leachate indicator parameters;
- If the results show that there is potential for leachate to be present in the groundwater, compare downgradient results with upgradient groundwater quality;
- If the upgradient/downgradient comparison confirms that leachate could be present in groundwater (e.g., elevated boron, conductivity, ammonia), then also check for other contaminants that may be present. This means testing leachate and groundwater for VOC, SVOC, and PFAS; and
- If groundwater contamination is confirmed, then develop a response plan with reference to the groundwater monitoring and contingency plan, site emergency management plan and liaison with Auckland Council.

Table 5.1: Leachate monitoring

Quarterly (including annual)	Annual only
Metals for which there are leachability limits: • Arsenic • Cadmium • Copper • Chromium • Lead • Nickel • Mercury • Selenium • Silver • Zinc	Volatile organic compounds, including: • Benzene • Chlorinated solvents • Organochlorine pesticides, including DDT-compounds
Other leachate quality parameters: • pH • Ammonia • Conductivity • Potassium • Chloride • Total petroleum hydrocarbons (TPH)	

6 Conclusions

The WasteMINZ Technical Guidelines for Disposal to Land (WasteMINZ Guidelines, April 2016, amended August 2018) include recommended waste acceptance criteria (WAC) for different classes of landfills. Two classes of landfill (Class 1 - landfill, and Class 4 - stockpile) are proposed at this site.

WMNZ proposes to develop the site as a municipal solid waste landfill. Design of the landfill, including lining, leachate collection, and operation, will be in accordance with the requirements for Class 1 landfills specified in the WasteMINZ Guidelines. The proposed WAC for the Class 1 landfill are taken from the WasteMINZ Guidelines. This is appropriate for this landfill, because the landfill is designed in accordance with the requirements for a Class 1 landfill as specified in the WasteMINZ Guidelines. Of particular note with regard to WAC, the landfill will be lined and leachate will be collected for management, either by reinjection into the landfill or treatment and disposal offsite. The WAC from the WasteMINZ Guidelines are conservatively protective for this landfill because Class 1 landfills have a composite geosynthetic lining system which provides a level of leachate containment over and above what was prescribed in the USEPA Subtitle D regulations from which the TCLP-based WAC by WasteMINZ were derived.

WMNZ also proposes Total Concentration Values as a means of assessing potential toxicity a proxy for TCLP limits. If the Total Concentration Values are exceeded, TCLP testing is required to check if the WAC are met. The Total Concentration Values are based on data gathered by WMNZ at other landfill sites in the region, the inherent leachability of organic compounds, and the operational definition of the TCLP test.

WMNZ proposes to implement specific controls to manage potentially odorous waste, including rigorous pre-acceptance approval, requirements for pre-treatment of some waste streams, control on timing and rate of delivery to ensure the waste can be accommodated at the time of delivery, and trial periods for new, potentially odorous wastes.

The proposed waste management controls comply with the WasteMINZ Guidelines, and the WAC in the WasteMINZ Guidelines for Class 1 landfills are considered conservatively protective for this particular site.

WMNZ proposes a process to develop new WAC for new contaminants, in the event this becomes necessary within the life of the landfill. WMNZ proposes the process should sit in the Landfill Management Plan, so that new WAC can be added as needed without triggering the need for a change of consent condition.

WMNZ also proposes to develop permanent stockpiles of cleanfill type material generated during site preparation. For the permanent stockpiles, the WAC proposed are taken directly from the WasteMINZ Guidelines for Class 4 landfills.

7 Applicability

This report has been prepared for the exclusive use of our client Waste Management NZ Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

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