

# Auckland Regional Landfill

## Risk Management Assessment

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

## Auckland Regional Landfill

### Risk Management Assessment

Client: Waste Management New Zealand Limited

ABN: N/A

#### Prepared by

**AECOM New Zealand Limited**

8 Mahuhu Crescent, Auckland 1010, PO Box 4241, Auckland 1140, New Zealand  
T +64 9 967 9200 F +64 9 967 9201 www.aecom.com

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## 1.0 Introduction

AECOM New Zealand (AECOM) has been engaged by Waste Management New Zealand Limited (WMNZ) to assist with the identification of risks associated the development, operation, closure and aftercare of the proposed Auckland Regional Landfill (the landfill) located in the Dome Valley approximately 10 km north of Warkworth, New Zealand. This will be achieved through the following:

- The review of available information relating to the proposed design construction, operation, closure and aftercare of the landfill.
- The classification of key risks associated with the design, construction, operation, closure and aftercare of the landfill.

## 2.0 Risk Assessment Framework

### 2.1 Context

WMNZ will be responsible for the design, construction, operation, closure and aftercare of the landfill. WMNZ seeks to ensure that the landfill is designed and operated in such way that any potential adverse human health and environmental effects are avoided, managed or mitigated. The following presents the context for the risk management assessment:

- Significant risks to the community, landowners and the environment are identified and analysed to understand them in terms of likelihood and consequence.
- This risk identification and analysis provides the basis for evaluating the risks qualitatively.
- The mitigation measures that are proposed as part of good engineering design, construction, operational management and closure are considered to derive the mitigated risk.
- The risks with the highest risk post mitigation will be further assessed quantitatively for development of the bond.

### 2.2 Risk Identification and Categories

The risk identification process involves finding, recognising and describing the risks. This includes identification of sources of risk, the events and circumstances that could affect the event occurring along with the potential consequences of the event occurring as well as the receptors. **Table 1** presents a summary of the risk categories nominated for the landfill. **Table 2** presents a summary of receptors.

### 2.3 Risk Consequences

A single event can generate a range of consequences which can have both positive and negative effects. Initial consequences can also escalate through knock-on effects. For each of the risk categories nominated above we have outlined potential risk consequence guidelines for consideration, with these outlined in **Table 3**.

### 2.4 Risk Likelihood

Likelihood is the chance that the event might happen. Likelihood can be defined, determined, or measured objectively or subjectively and can be expressed either qualitatively or quantitatively outlined in **Table 4**.

Table 1 Summary of Risk Categories and Definitions

Risk Category	Definition
<b>Environment and Human Health</b>	<p>The nature and extent of potential adverse effects to the environment and/or human health of a discharge to soil, air, surface water or groundwater from the landfill. Aspects to be considered include:</p> <ul style="list-style-type: none"> <li>• Site specific conditions.</li> <li>• Source pathway-receptor linkages.</li> <li>• Sensitivity of environmental receptors.</li> <li>• Sensitivity of human health receptors.</li> </ul>
<b>Financial</b>	<p>Compliance with statutory or common law, delegations, regulations, and contractual requirements; including the potential financial consequences for not complying. This risk category includes the requirement to comply with the Resource Management Act (1991). Aspects to be considered include:</p> <ul style="list-style-type: none"> <li>• Potential resource consent conditions.</li> <li>• Non-compliance with regulatory or contractual requirements with respect to the potential for legislative action to be taken against WMNZ i.e. fines, prosecution, legal action etc.</li> <li>• Business interruption and damage to customer relationships.</li> </ul>
<b>Social</b>	<p>Public or cultural sensitivity to a discharge or perceived discharge and the potential for adverse comment or media coverage. Aspects to be considered include:</p> <ul style="list-style-type: none"> <li>• Site specific conditions.</li> <li>• Sensitivity of environmental receptors.</li> <li>• Sensitivity of human health receptors.</li> <li>• Current or intended land-use.</li> <li>• Cultural practices.</li> <li>• Loss of amenity. E.g. noise or nuisance.</li> </ul>

Table 2 Summary of Receptors

Receptor	Description
<b>Surface Water/Aquatic Ecosystems</b>	<ul style="list-style-type: none"> <li>• Tributaries of the Hotoe River.</li> <li>• Hotoe River.</li> <li>• Kaipara Harbour.</li> <li>• Significant Ecological Areas and Wetlands.</li> <li>• Aquatic organisms including fish, macro-invertebrates and frogs.</li> </ul>
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>• Groundwater extracted for drinking.</li> <li>• Groundwater extracted for non-potable purposes, i.e. irrigation, dust suppression, and firefighting.</li> <li>• Groundwater that discharges into surface water via springs and seeps.</li> <li>• Groundwater that is not extracted or discharged but is legacy groundwater for future users and generations.</li> </ul>
<b>Terrestrial Ecosystems</b>	<ul style="list-style-type: none"> <li>• All flora including native vegetation, exotic forest, and pasture areas.</li> <li>• Natural management areas.</li> <li>• Terrestrial fauna.</li> </ul>
<b>Air</b>	<ul style="list-style-type: none"> <li>• Dust.</li> <li>• Landfill gas.</li> <li>• Thermal discharges and emissions from combustion.</li> <li>• Odour.</li> </ul>
<b>Human Health – Workers</b>	<ul style="list-style-type: none"> <li>• Dermal contact.</li> <li>• Ingestion.</li> <li>• Inhalation.</li> <li>• Noise and vibration</li> </ul>
<b>Human Health - Public</b>	<ul style="list-style-type: none"> <li>• Ingestion.</li> <li>• Inhalation.</li> <li>• Noise and vibration.</li> </ul>

Receptor	Description
<b>Cultural and Social Values</b>	<ul style="list-style-type: none"><li>• Loss of amenity (e.g. increase in ambient noise, increase in traffic).</li><li>• Visual effects.</li><li>• Cultural values.</li></ul>

Table 3 Summary of Risk Consequences

Consequence	Negligible	Minor	Moderate	Major	Catastrophic
Score	<1	1 - <10	10 – <100	100 - <1000	≥1000
Environmental	No measurable/detectable adverse environmental effects.	Minor environmental damage. Transient effects.	Environmental impact requiring treatment inside or outside of the landfill. Persistent adverse effect.	Serious environmental harm requiring restoration and/or remediation inside or outside of the landfill with possible regulatory intervention.	Permanent/material damage to environment requiring ongoing remediation and monitoring with regulatory involvement and possible further enforcement action.
Human Health	No measurable/detectable adverse human health effects.	Easily preventable, non-permanent health effects on humans.	Easily preventable, permanent health effects on humans.	Medium/long-term (chronic) effect to human health.	One or more fatalities (public or workers).
Social and Cultural	No significant community or cultural issues; and/or no significant adverse comment or media coverage; and/or no complaint to management.	Local community or cultural concerns; and/or adverse comment on local media.	Significant community or cultural concerns causing delays and modifications to planned use of the landfill.	Widespread significant community or cultural concerns causing delays and modifications to planned use of the landfill.	Major community or cultural concerns causing major re-think of complete failure of planned use of the landfill.
Financial	<\$10K.	\$10K to <\$100K.	\$100K to <\$1M	\$1M to <\$10M	≥\$10M.

Table 4 Summary of Risk Likelihood

Likelihood	Inconceivable	Rare	Unlikely	Possible	Likely
Probability	≤0.0001	>0.0001 - 0.001	>0.001 - 0.01	>0.01 - 0.1	>0.1 - 1
Description	Circumstances are such that events will not occur even in the long term (unlikely to occur).	Circumstances are such that it is improbable that an event would occur even in the very long-term. (may occur in the next 1000 years).	Circumstances are such that it is by no means certain that an event would occur even over a longer period (may occur in the next 100 years).	Circumstances are such that such an event is not inevitable and is possible in the short-term and is likely over the long-term (may arise once in a ten year period).	Circumstances are such that an event appears very likely in the short-term or almost inevitable in the long-term; or there is already evidence that such an event has occurred (may arise once per year or more).



## 2.5 Risk Analysis

A semi-quantitative approach has been applied to this risk assessment. This approach attributes values or multipliers to the likelihood and consequence groupings described above (refer **Table 5**). The consequence will be multiplied by the likelihood for each risk category. The calculated product will fit into a range described by a qualitative risk score (refer **Table 6**).

**Table 5 Summary of the Risk Rating Matrix**

Consequence	≥1000	Catastrophic	≤1	>1 to 10	>10 to 100	≥100	≥100
	100 to <1000	Major	≤1	≤1	>1 to 10	>10 to 100	≥100
	10 to <100	Moderate	≤1	≤1	≤1	>1 to 10	>10 to 100
	1 to <10	Minor	≤1	≤1	≤1	≤1	>1 to 10
	≤1	Negligible	≤1	≤1	≤1	≤1	≤1
Likelihood			Inconceivable	Rare	Unlikely	Possible	Likely
			≤0.0001	>0.0001 - 0.001	>0.001 - 0.01	>0.01 - 0.1	>0.1 - 1

**Table 6 Summary of Risk Acceptability**

Risk Score		Definition of Risk Acceptability	Likely Actions Required
Extreme	>100	Intolerable (active management).	Severe harm to a defined receptor is very likely or has already occurred. The risk is likely to result in a substantial liability. Urgent investigation (if not already undertaken) is likely to be required. Urgent action or remediation is likely to be required.
Major	>10 to 100	Tolerate with active management to reduce risk to as low as reasonably practicable.	Harm to a defined receptor is likely, but severe harm is unlikely. The risk is likely to result in a major liability. Investigation (if not already undertaken) is required to clarify the level of potential liability and risk. Remediation is likely to be required.
Moderate	>1 to 10	Tolerate with active management to reduce risk to as low as reasonably practicable.	Potential harm to a defined receptor is possible, but severe harm is very unlikely. The risk is likely to result in a moderate liability. Investigation (if not already undertaken) maybe be required to clarify the level of potential liability and risk. Some remediation may be required in the longer term.
Low	≤1	Tolerate risk.	Harm to a defined receptor is possible but is likely to be moderate at worst. Liabilities could theoretically arise but are unlikely. Further investigation is not required at this stage. Remediation is unlikely to be required.

## 3.0 Risks Register

### 3.1 Overall Summary

The full risk register is included in **Appendix A**. In summary:

A total of 75 risks are presented in the risk register which have been divided into five categories:

- Uncontrolled contaminant and or sediment release.
- Uncontrolled leachate release to surface water and or groundwater.
- Uncontrolled gas or odour release.
- Uncontrolled dust release.
- Landfill construction and operations nuisance.

Of the 75 risks identified:

- No risks are identified with a risk score of extreme (after mitigation).
- No risks are identified with a risk score of major (after mitigation).
- There were 20 risks identified with a risk score of moderate (after mitigation) and these are listed in Section 3.2 below with further details provided in Appendix A.
- There were 55 risks identified with a risk score (after mitigation) of low.

### 3.2 Moderate Residual Risks (after Mitigation)

As outlined in Table 6, a moderate risk is considered tolerable on the basis that active risk management is in place to ensure that the risk is mitigated to as low as reasonably practicable.

Tables 7 – 10 below list the moderate risks (after mitigation) identified. As shown in Appendix A mitigation measures specific to each of these risks have been identified.

**Table 7 Moderate residual risks resulting in potential contaminant and/or sediment release**

Item	Event
1.5 -1.8	Treatment standard not met (suspended solids) in the discharges from sediment retention ponds associated with treating runoff from disturbed earthworks areas.
1.9	Treatment standard not met (suspended solids) in the discharge from the Access Road filter strips.
1.10	Discharge of sediment from upstream forestry activities in the Eastern Block.
1.15	Water Quality criteria not met in the discharge from Pond 1, Pond 2 or Pond 3. Located in Valley 1.
1.17	Tracking of mud and dirt onto public roads.

**Table 8 Moderate residual risks resulting in potential leachate release to surface water and/or groundwater**

Item	Event
2.8	Lining system settlement and failure.
2.11	Liner interface failure.
2.17	Stormwater pipe or swales fail/block and up catchment stormwater can't discharge through or past the landfill.
2.16	Landfill instability.

**Table 9 Moderate residual risks resulting in potential for uncontrolled gas or odour release**

Item	Event
3.7	Odour from landfill gas emissions through cover.

**Table 10 Moderate residual risks resulting directly from construction or operation.**

Item	Event
5.2	Subsurface landfill fire.
5.4	Landfill fire migrating to adjacent forestry and bush areas.
5.7	Bird strike of an airplane.
5.11	Onsite traffic accident.
5.12	Traffic accident at the main intersection of site with SH1.
5.13	Traffic accident at the intersection between Crowther Road and SH1.
5.16	Waste acceptance criteria not met and hazardous waste received.

## 4.0 Summary

The outputs of this risk assessment are used as the basis for identifying the key potential risks posed by the landfill that should be actively managed or mitigated. This semi quantitative approach is also used to screen risks that should be considered in the derivation of a bond for the landfill. A separate report is provided that covers the derivation of the bond based on this risk assessment.

## 5.0 References

Information regarding the development, operation, closure and aftercare of the proposed Auckland Regional Landfill has been sourced from the Specialist Working Area of Project Orbit, a web-based SharePoint platform set up for document management for collating the consent applications.

## 6.0 Limitations

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It is prepared in accordance with the scope of work and for the purpose outlined in the contract dated 23 August 2018

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It is the responsibility of third parties to independently make inquiries or seek advice in relation to their particular requirements and proposed use of the landfill.

# Appendix A

## Risk Register

ID	Block Location	EVENT	DESCRIPTION	RECEPTOR	UNMITIGATED LIKELIHOOD	UNMITIGATED CONSEQUENCE	UNMITIGATED RISK SCORE	POTENTIAL CONSEQUENCE	MITIGATION	MITIGATED LIKELIHOOD	MITIGATED CONSEQUENCE	MITIGATED RISK SCORE
<p><b>Uncontrolled Contaminant/Sediment Release</b></p> <p>The construction of the landfill and associated sealed access road requires large scale earthworks including approximately 6 Mm<sup>3</sup> of cut and 1 Mm<sup>3</sup> of fill. The landfill footprint area is 58.5 ha. Stormwater treatment pond/s are proposed to treat runoff from exposed areas prior to discharge offsite. The catchment characteristics will vary over the life of the landfill, but will include steep forestry areas, clay and topsoil stockpiles, completed areas of landfill cover, landfill liner areas while under construction, temporary access road and the unsealed perimeter road. Runoff from uncapped waste areas will be treated as leachate. The receiving environment for stormwater discharges from the site are all tributaries of the Hotoe River which flows to the Kaipara Harbour. Separate stormwater treatment ponds will be constructed for each of the proposed stockpile areas.</p>												
1.1	Eastern Block	Stormwater treatment pond embankment failure (Pond 1, Pond 2 or Pond 3). Located in Valley 1.	The pond embankment is compromised, leading to failure and direct loss of sediment and/or failure to treat subsequent runoff.	Un-named tributary of the Hotoe River	Possible	Major	100	Sedimentation of downstream environment. Failure to treat subsequent flows until reinstated.	Design to be undertaken by a Chartered Professional Engineer. Design to be peer reviewed. Specification and quality assurance programme for pond embankment construction (QA/QC). Overflow/spillway design including armouring. Ability to temporarily pump water to alternative ponds for treatment.	Rare	Major	1
1.2	Western Block	Stormwater treatment pond embankment failure (Pond 6 or Pond 7). Stockpile 1 and Clay Borrow and Stockpile.	The pond embankment is compromised, leading to failure and direct loss of sediment and/or failure to treat subsequent runoff.	Un-named tributary of the Hotoe River	Possible	Major	100	Sedimentation of downstream environment. Failure to treat subsequent flows until reinstated.	Design to be undertaken by a Chartered Professional Engineer. Design to be peer reviewed. Specification and quality assurance programme for pond embankment construction (QA/QC). Overflow/spillway design including armouring. Ability to temporarily pump water to alternative ponds for treatment.	Rare	Major	1
1.3	Waiteira Tributary Block	Stormwater treatment pond embankment failure (Pond 8). Stockpile 2.	The pond embankment is compromised, leading to failure and direct loss of sediment and/or failure to treat subsequent runoff.	Waiteira Stream (which includes a SEA)	Possible	Major	100	Sedimentation of downstream environment which includes a Significant Ecological Area. Failure to treat subsequent flows until reinstated.	Design to be undertaken by a Chartered Professional Engineer. Design to be peer reviewed. Specification and quality assurance programme for pond embankment construction (QA/QC). Overflow/spillway design including armouring. Ability to temporarily pump water to alternative ponds for treatment.	Rare	Major	1
1.4	Western Block	Stormwater treatment pond embankment failure (Pond 9). Topsoil Stockpile.	The pond embankment is compromised, leading to failure and direct loss of sediment and/or failure to treat subsequent runoff.	Un-named tributary of the Hotoe River (which includes a SEA and significant wetland)	Possible	Moderate	10	Sedimentation of downstream environment which includes a Significant Ecological Area. Failure to treat subsequent flows until reinstated.	Design to be undertaken by a Chartered Professional Engineer. Design to be peer reviewed. Specification and quality assurance programme for pond embankment construction (QA/QC). Overflow/spillway design including armouring. Ability to temporarily pump water to alternative ponds for treatment.	Rare	Moderate	0.1
1.5	Eastern Block	Treatment standard not met (suspended solids) in the discharge from Pond 1, Pond 2 or Pond 3. Located in Valley 1.	There is not enough settling time provided within the pond to achieve consented suspended solids and/or contaminant limits. This could be due to a number of different events including: flood event, catchment area increased beyond pond capacity, sediment does not settle readily. The design is such that large runoff events receive a low level of treatment with smaller runoff events receiving a high level of treatment.	Un-named tributary of the Hotoe River	Likely	Moderate	100	Partial treatment of runoff leads to short term increase in suspended solids being discharged to surface water.	Pond to be designed (volume, shape and depth) to achieve sediment removal. Pond to be designed to a minimum volume 3% of the exposed area. Real time monitoring of turbidity at the outlet. Progressive stabilisation of exposed areas. Chemical treatment to speed up settlement time if required. Diversion of clean water around exposed areas. Pre-treatment by additional silt traps before water reaches the pond system. Pond to be designed to convey a 100 year flood event.	Likely	Minor	10
1.6	Western Block	Treatment standard not met (suspended solids) in the discharge from Pond 6 or Pond 7. Stockpile 1 and Clay Borrow and Stockpile. Located in the Western Block.	There is not enough settling time provided within the pond to achieve consented suspended solids and/or contaminant limits. This could be due to a number of different events including: flood event, catchment area increased beyond pond capacity, sediment does not settle readily. The design is such that large runoff events receive a low level of treatment with smaller runoff events receiving a high level of treatment.	Un-named tributary of the Hotoe River	Likely	Moderate	100	Partial treatment of runoff leads to short term increase in suspended solids being discharged to surface water.	Pond to be designed (volume, shape and depth) to achieve sediment removal. Pond to be designed to a minimum volume 3% of the exposed area. Pond to be designed to convey a 100 year flood event. Diversion of clean water around exposed areas. Chemical treatment used to speed up settlement time if required. Progressive stabilisation of exposed areas. Pre-treatment by additional silt traps before water reaches the pond system.	Likely	Minor	10
1.7	Waiteira Tributary Block	Treatment standard not met (suspended solids) in the discharge from Pond 8.	There is not enough settling time provided within the pond to achieve consented suspended solids and/or contaminant limits. This could be due to a number of different events including: flood event, catchment area increased beyond pond capacity, sediment does not settle readily. The design is such that large runoff events receive a low level of treatment with smaller runoff events receiving a high level of treatment.	Waiteira Stream (which includes a SEA)	Likely	Moderate	100	Partial treatment of runoff leads to short term increase in suspended solids being discharged to surface water. The receiving environment includes a SEA.	Pond to be designed (volume, shape and depth) to achieve sediment removal. Pond to be designed to a minimum volume 3% of the exposed area. Pond to be designed to convey a 100 year flood event. Pre-treatment by additional silt traps before water reaches the pond system. Diversion of clean water around exposed areas. Chemical treatment used to speed up settlement time if required. Progressive stabilisation of exposed areas.	Likely	Minor	10
1.8	Western Block	Treatment standard not met (suspended solids) in the discharge from Pond 9.	There is not enough settling time provided within the pond to achieve consented suspended solids and/or contaminant limits. This could be due to a number of different events including: flood event, catchment area increased beyond pond capacity, sediment does not settle readily. The design is such that large runoff events receive a low level of treatment with smaller runoff events receiving a high level of treatment.	Un-named tributary of the Hotoe River (which includes a SEA and significant wetland)	Likely	Moderate	100	Partial treatment of runoff leads to short term increase in suspended solids being discharged to surface water. The receiving environment includes a SEA.	Pond to be designed (volume, shape and depth) to achieve sediment removal. Pond to be designed to a minimum volume 3% of the exposed area. Pond to be designed to convey a 100 year flood event. Pre-treatment by additional silt traps before water reaches the pond system. Diversion of clean water around exposed areas. Chemical treatment used to speed up settlement time if required. Progressive stabilisation of exposed areas.	Possible	Moderate	10

ID	Block Location	EVENT	DESCRIPTION	RECEPTOR	UNMITIGATED LIKELIHOOD	UNMITIGATED CONSEQUENCE	UNMITIGATED RISK SCORE	POTENTIAL CONSEQUENCE	MITIGATION	MITIGATED LIKELIHOOD	MITIGATED CONSEQUENCE	MITIGATED RISK SCORE
1.9	Southern Block	Treatment standard not met (suspended solids) in the discharge from the Access Road filter strips.	The filter strips do not provide sufficient treatment to achieve consented suspended solids and/or contaminant limits. This could be due to a number of difference events including: rain event in exceedance of the design storm, increased sediment generated by mud tracked onto the road surface, leachate leaking from vehicles carrying waste to the landfill. The design is such that large runoff events receive a low level of treatment with smaller runoff events receiving a high level of treatment. Large run-off events would only occur during high stream flow so the relative effect is less.	Waiteira Stream (which includes a Natural Management Area)	Likely	Moderate	100	Partial treatment of runoff leads to short term increase in suspended solids being discharged to surface water.	Filter strips designed for a 2-year ARI storm event.	Possible	Moderate	10
1.10	Eastern Block	Discharge of sediment from upstream forestry activities in the Eastern Block.	Forestry activities in the catchment above the landfill lead to an increase in sediment load which is unable to be treated by the combined stormwater treatment ponds 1, 2, 3, 4 & 5. The forestry works will be undertaken on the WMNZ land holding but will be contracted out. The forestry works will be undertaken upstream of the landfill works, but the runoff will discharge through Pond 1.	Un-named tributary of the Hotoe River	Possible	Moderate	10	Partial treatment of runoff leads to short term increase in suspended solids being discharged to surface water.	The design of Ponds to accommodate the potential for sediment laden runoff from the forestry catchment upstream. Upstream (from the discharge of Pond 1) monitoring to differentiate the effects of the forestry activities and the landfill activities. Specialist forestry management and contractors to be engaged. Construction of landfill ponds as early as possible to provide additional protection for forestry in Valley 1.	Possible	Moderate	10
1.11	Waiteira Tributary Block	Discharge of sediment from upstream forestry areas in the Waiteira Tributary Block within the WMNZ landholding.	Forestry activities in the catchment lead to sediment laden runoff being discharged from the site without treatment. This would occur prior to the establishment of Stockpile 2. The forestry works will be undertaken on the WMNZ landholding.	Waiteira Stream (which includes a SEA)	Likely	Moderate	100	Partial treatment of runoff leads to short term increase in suspended solids being discharged to surface water. The receiving environment includes a SEA.	Specialist forestry management and contractors to be engaged until post-harvest handover to WMNZ. Liaison with forestry management to ensure controls are implemented prior to handover.	Rare	Moderate	0.1
1.12	Eastern Block	Discharge of debris from forestry areas up catchment of the landfill, but within the WMNZ landholding.	The nature of forestry activities often results in debris/slash being mobilised during large runoff events. This could result in drains/culverts becoming blocked and water discharging from the site in an uncontrolled manner and not receiving treatment prior to discharge.	Un-named tributary of the Hotoe River	Possible	Moderate	10	Stormwater conveyance and treatment system not able to operate as intended. Potential for water to bypass treatment system until reinstated.	Specialist forestry management and contractors to be engaged until post-harvest handover to WMNZ. Tree felling away from waterways as per the National Environmental Standards for Plantation Forestry. Liaison with forestry management to ensure controls are implemented prior to handover. Inlet screens.	Unlikely	Moderate	1
1.13	Waiteira Tributary Block	Discharge of debris from forestry areas left after harvest within the Waiteira Tributary Block, but within the WMNZ landholding.	The nature of forestry activities often results in debris/slash being mobilised during large runoff events.	Waiteira Stream (which includes a SEA)	Possible	Moderate	10	Property damage and/or blockage of downstream stormwater infrastructure until reinstated	Specialist forestry management and contractors to be engaged until post-harvest handover to WMNZ. Tree felling away from waterways as per the National Environmental Standards for Plantation Forestry. Liaison with forestry management to ensure controls are implemented prior to handover. Construction of stockpile pond(s) as early as possible to provide additional protection for forestry activities.	Unlikely	Moderate	1
1.14	All Blocks	A slip occurs, outside of the areas of the landfill development that are captured by sediment treatment ponds.	A slip in the steep catchment areas lead to increased sediment release without treatment.	Surface Water/Aquatic Ecosystems	Possible	Moderate	10	Discharge of untreated sediment laden runoff to downstream environments which could potentially include Significant Ecological Areas (depending on the slip location).	Geotechnical assessments undertaken to identify high risk areas with stability measures installed for high risk areas identified, i.e. retaining walls, maximum batter slopes.	Unlikely	Moderate	1
1.15	Eastern Block	Water Quality criteria not met in the discharge from Pond 1, Pond 2 or Pond 3. Located in Valley 1.	Runoff impacted by contaminants from refuse enters stormwater ponds and discharges without being isolated.	Un-named tributary of the Hotoe River	Possible	Moderate	10	Aquatic organisms downstream impacted.	Operational management of site to ensure water contacting refuse is not discharged. This water will be treated as leachate. Continuous electrical conductivity monitoring at the inlet of Pond 1. Scheduling and internal approval process for earthworks (within the refuse) to avoid exposure and manage cover placement.	Possible	Moderate	10
1.16	All Blocks	Earthworks are undertaken prior to the implementation of erosion and sediment control measures.	Sediment laden runoff from exposed catchment areas discharge into waterways without treatment.	Surface Water/Aquatic Ecosystems	Possible	Moderate	10	Discharge of untreated sediment laden runoff to downstream environments which could potentially include Significant Ecological Areas (depending on the earthworks location).	Erosion and sediment control plans for all earthworks to be implemented prior to soil disturbance. The majority of the earthworks will be undertaken in the summer months.	Unlikely	Moderate	1
1.17	Southern Block	Tracking of mud and dirt onto public roads.	Wet conditions and unsealed sections of road, cause mud to stick to the wheels and undercarriage of vehicles which could then be tracked onto SH1.	Waiteira Stream (which includes a SEA)	Likely	Moderate	100	Mud on the road could create unsafe road conditions by reducing traction. Mud on the road, when dried, could create dust. Any mud tracked onto SH1 will runoff to waterways during rain events without receiving treatment.	All vehicles leaving the landfill (working face and any bare earthworks areas) will pass through a wheelwash and travel along 2 km of sealed road prior to exiting on to a public road. Runoff from the access road will receive treatment in filter strips prior to discharge.	Possible	Moderate	10
1.20	All Blocks	Increased flooding risk caused by site development.	Filling in floodplain areas (bin exchange area only) and/or changing of the catchment runoff properties.	Human Health – Public Surface Water/Aquatic Ecosystems	Unlikely	Negligible	0.01	An assessment of the pre and post development volumes for a 100 year storm event has been made with a calculated additional volume of 4,771 m³, this represents an increase in height to the existing flood plain of 1 mm.	All activities proposed are located above the identified flood plain level, and therefore there are not expected to be any effects on the proposed landfill and associated works from on-site flooding.	Rare	Negligible	0.001

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<b>Uncontrolled Leachate Release to Surface Water/Groundwater</b> An engineering lining system is to be constructed to contain leachate within the landfill where it is collected for treatment and disposal. It is proposed to collect leachate in a series of collector drains on the liner. Leachate will then be pumped up to storage tanks from where (initially), tankers will remove the leachate for offsite disposal. In the longer term it is proposed that there will be an onsite treatment/disposal facility. A portion of the leachate will be recirculated through the waste. A 1,350 mm diameter HDPE pipe will be installed under the liner and designed to convey a 10 year ARI storm event under the landfill from the upstream catchment areas with larger flows attenuated in an upstream storage pond (noting that this is only operational during Phase 1 of the landfill before being backfilled). Intermediate and final cover will be installed to control seepage of water into the underlying waste materials, minimise landfill gas escape, leachate generation, provide a barrier to the underlying waste and to provide a growth medium for cover vegetation.												
2.1	Eastern Block	Leachate disposal system compromised.	Onsite leachate storage capacity within the tanks is exceeded following: A flood or slip event blocks/damages access road leading to the leachate storage tanks not being emptied. Issues with leachate acceptance at the disposal facility meaning there is nowhere to accept the leachate for disposal.	Stormwater	Unlikely	Minor	0.1	Leachate head within the landfill will temporarily increase while the leachate disposal system is restored. Implement recirculation to the working face.	Leachate Monitoring and Management Plan including maintenance requirements. The design includes a contingency storage volume.	Rare	Minor	0.01
2.2	Eastern Block	Unforeseen leachate production.	Prolonged high rainfall leads to a large increase in leachate generation (2.15 Related event)	Groundwater	Unlikely	Negligible	0.01	Leachate head and within the landfill will temporarily increase while the extra leachate volume is treated/disposed of. Cover unlikely to fail on a scale that would present issues for leachate management.	Prompt daily, intermediate and final cover installation. Clean water diversions with freeboard allowance.	Rare	Negligible	0.001
2.3	Eastern Block	Leachate pumping and disposal system compromised.	Tanks and/or pipework compromised, leading to direct loss of leachate to surface water.	Un-named tributary of the Hotoe River	Unlikely	Major	10	Leachate release to surface water.	Tank design, installation and maintenance. Tank level alarms, monitoring. Secondary containment/bunding. Perimeter bollards. Any leachate loss would need to pass through at least one stormwater treatment pond, where the inlet is monitored for electrical conductivity.	Rare	Major	1
2.4	Eastern Block	Stormwater conveyance pipe under the landfill liner fails (noting that this pipe is only operational for Phase 1 before being backfilled)	The stormwater pipe (located under the liner) is crushed by the weight of waste, leading to liner failure and a direct path for leachate release to the stormwater system.	Un-named tributary of the Hotoe River Groundwater	Unlikely	Catastrophic	100	Liner failure leading to leachate release to surface water and groundwater.	Liner designed to allow for some displacement. The pipe is to be designed to allow for the weight of refuse. Specification and quality assurance programme for construction (QA/QC). Monitoring of water through pipeline/groundwater drains for leachate indicators. Closure of pipe at earliest practical time.	Rare	Major	1
2.5	Eastern Block	Leachate collection pipework failure within landfill.	The leachate collection pipes (within the landfill) become blocked leading to a reduced ability to remove leachate from within the landfill.	Groundwater	Unlikely	Minor	0.1	Increased head on the liner.	Cleanout risers installed to flush leachate collection pipework. Leachate pipes are drilled and installed within a gravel drainage layer. Flow through surrounding drainage layer will prevent significant head increase.	Unlikely	Negligible	0.01
2.6	Eastern Block & Southern Block	Leachate disposal tanker accident.	The leachate disposal tanker responsible for removing leachate from the site is involved in an access road incident where the tanker containment is compromised and leachate released to surface water.	Un-named tributary of the Hotoe River or Wateraire Stream (including a Natural Management Area)	Rare	Minor	0.01	Leachate release to surface water.	Access road and intersection designed for safety. Onsite speed restrictions. Contingency plan preparedness for temporary damming of affected drains and pumping to other tankers.	Rare	Minor	0.01
2.7	Eastern Block	Toe bund failure.	The structural bund at the toe of the landfill fails and leachate is no longer contained within the liner system.	Un-named tributary of the Hotoe River Groundwater	Rare	Catastrophic	10	Leachate is released to the groundwater and surface water resulting contamination until remediated.	Design review, conservative specification and certification of constructed works.	Rare	Major	1
2.8	Eastern Block	Lining system settlement and failure.	The lining system fails due to differential settlement or failure due to an earthquake.	Groundwater	Unlikely	Catastrophic	100	Leachate is released to the groundwater resulting in long term contamination.	Robustness in site selection and geotechnical investigation prior to works commencement. Factor of safety provided for lining system design, including seismic design factor of safety. Lining system design comprises multiple layers as back-up if one layer/liner element fails. Strict specification and quality assurance programme for liner placement (testing, independent review). Regular monitoring for leachate indicators in the groundwater from a series of bores around the landfill. Monitoring for leachate indicators in the subsoil drains beneath the liner and management as appropriate.	Rare	Catastrophic	10



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2.9	Eastern Block	Liner materials failure.	The liner fails due to poor quality materials, contamination of liner materials with trees or debris from forestry, and/or installation errors.	Groundwater	Rare	Catastrophic	10	Leachate is released to the groundwater resulting in long term contamination.	Strict specification and independent quality assurance programme for liner placement. Independent Peer Review Panel to review as-built construction, testing and independent reports on the lining system prior to waste placement. Lining system comprises three constructed layers/elements to provide back-up if a location suffered a failure.	Inconceivable	Catastrophic	1
2.10	Eastern Block	Liner materials failure.	The liner materials are damaged during operations or construction activities (e.g., early fill placement, liner tie in).	Groundwater	Unlikely	Major	10	Leachate is released to the groundwater over a prolonged period resulting in contamination.	Geotextile layer and drainage blanket act as mechanical protection to liner. Selection of appropriate waste materials for initial (fluff) waste layers, which is not compacted. Provision of as-built plans to allow for continuity in future works programmes (liner tie-in).	Rare	Moderate	0.1
2.11	Eastern Block	Liner interface failure.	There is a slip at the interface between the different liner components.	Groundwater	Rare	Catastrophic	10	Leachate is released to the groundwater over a prolonged period resulting in contamination.	Material specific lab shear testing to be undertaken to input into design. Floor is designed at flat grade. Side walls have anchor trenches on each bench. As waste is placed the vertical load increases the friction between the layers, reducing the likelihood.	Rare	Catastrophic	10
2.12	Eastern Block	Lining system failure.	Groundwater pressure from beneath the lining system compromises the integrity leading to failure and an increase in leachate volume.	Groundwater	Rare	Moderate	0.1	Leachate is released to the groundwater over a prolonged period resulting in contamination, groundwater enters the landfill resulting in increased leachate volume generated.	Subsoil drains to be installed prior to lining system installation. Underlying ground has low permeability. Waste pile increases vertical load and downward pressure to above any vertical groundwater pressure.	Rare	Moderate	0.1
2.13	Eastern Block	Cover failure.	The cover is below permeability specification leading to increased leachate generation breakout and leachate production.	Groundwater & stormwater	Rare	Moderate	0.1	The cover is unlikely to fail on a scale that would present issues for leachate management.	Design specification for cover. Construction QA and weekly cover inspections.	Rare	Moderate	0.1
2.14	Eastern Block	Cover failure.	The cover is cracked or damaged leading to increased leachate generation. This could be caused by operational activities, dry weather leading to cracking or surface water eroding the cover.	Groundwater & stormwater	Possible	Minor	1	The cover is unlikely to be compromised on a scale that would present issues for leachate management.	Weekly cover inspections and maintenance. Exclusion of stock from the cover.	Unlikely	Minor	0.1
2.15	Eastern Block	Leachate surface breakouts.	Leachate breakouts through the cover and discharges into stormwater system.	Un-named tributary of the Hotoe River	Possible	Minor	1	Discharge of leachate to the stormwater system.	Minimising leachate head within the landfill by the installation of leachate drainage and extraction. Real time continuous monitoring of the stormwater collection system for leachate indicators. Operation of the landfill to avoid barriers to downward percolation of leachate. Monitoring to include regular inspections of landfill cover and procedures for prompt corrective actions.	Possible	Minor	1
2.16	Eastern Block	Landfill instability	Slope movement within placed waste leads to waste outside liner containment or a tear in the liner beneath placed waste.	Groundwater	Unlikely	Major	10	Leachate from the waste outside of the liner extent discharges to groundwater.	Design criteria with factor of safety for all interim slopes. Compaction of waste and density testing. Option always available to recover slipped material and place it in the unaffected landfill.	Unlikely	Major	10
2.17	Eastern Block	Stormwater pipe or swales fail/block and up catchment stormwater can't discharge.	Up-catchment surface water cannot be discharged, and dammed water accumulates resulting in interaction with waste.	Un-named tributary of the Hotoe River	Possible	Major	100	Increased leachate production. Reduced stability of the waste materials.	Inlet screens, maintenance, redundancy in design. Risk Management to develop timely mitigation. Landfill stages to be designed for stormwater diversion around the landfill after approximately 15 years, at which point the pipe will become redundant.	Unlikely	Major	10

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2.18	Eastern Block	Subsoil drain failure.	The network of subsoil drains beneath the lining system become blocked or are crushed and are no longer able to drain the groundwater from beneath the liner.	Groundwater	Unlikely	Major	10	Increased groundwater pressure on the liner and potential seepage into the fill mass increasing leachate volume.	Subsoil drains designed to exclude sediment from entering the pipe or accumulating within the pipe. Design provisions for cleanout of pipe work.	Rare	Moderate	0.1
2.19	Eastern Block	Cover failure.	The cover is not placed in accordance with the design and consent conditions. It might not be continuous, might not be tracked and graded correctly or it might be too thin (leaving areas of exposed refuse)	Stormwater	Possible	Minor	1	The additional leachate volume (which will only arise if this occurs during a rain event) will not have a detectable impact on the environment. It will merely increase the volume of leachate that has to be treated.	Design specification for cover. Construction QA and weekly cover inspections.	Possible	Minor	1
2.20	Eastern Block	Leachate enters stormwater from recirculation.	Method of recirculation results in leachate running into the stormwater system.	Un-named tributary of the Hotoe River	Possible	Moderate	10	Discharge of leachate to the stormwater system.	Management plan, procedures, monitoring. Real time continuous monitoring of the stormwater collection system for leachate indicators.	Unlikely	Moderate	1

#### Uncontrolled Gas/Odour Release

The discharges to air comprise the following: odour from waste materials, odour from landfill gas emissions, combustion products generated by the burning of landfill gas in a flare or generator, the release of landfill gas directly to the atmosphere.

3.1	Eastern Block	Cover material failure.	The cover is below the permeability required, cover is insufficient, or cover dries out and cracks, leading to uncontrolled gas discharge and the creation of a potentially explosive/asphyxiating atmosphere.	Air Human Health - Workers	Possible	Minor	1	Discharge of landfill gases directly to the atmosphere.	Adequate cover thickness and permeability. Management of ignition sources. Comprehensive reach of horizontal and vertical gas collectors laid in the waste as the refuse pile is built up. Cover maintenance. Weekly visual inspection of the cover. Exclusion of stock from the cover. Prompt topsoil and vegetation cover to retard drying out.	Unlikely	Minor	0.1
3.2	Eastern Block	Gas capture ineffective.	The gas capture is ineffective leading to uncontrolled gas discharge and the creation of a potentially explosive/asphyxiating atmosphere.	Air Human Health - Workers	Possible	Minor	1	Discharge of landfill gases directly to the atmosphere.	Gas vacuum maintenance to optimise extraction. Procedures to be developed for times where wells are not connected to the extraction system (i.e. maintenance, extensions). Stand-by gen-set on site to provide power for continued gas extraction during a power outage.	Possible	Minor	1
3.3	Eastern Block	Damage to gas extraction pipework.	Pipework is damaged (machines, settlement) leading to oxygen being drawn into the landfill. Or system becomes blocked and gas unable to be extracted. Can lead to increased risk of subsurface landfill fire or ineffective gas capture.	Air Human Health - Workers Human Health - Public	Likely	Minor	10	Discharge of landfill gases directly to the atmosphere.	Continuous monitoring of gas composition at the blower. Weekly visual inspection of the cover and wells. Dedicated and trained landfill gas team to install, maintain and monitor the gas extraction network. Permanent standby gas extraction and destruction systems.	Possible	Minor	1
3.4	Eastern Block	Power outage results in flare/blower failing to operate.	Gas flare capacity is exceeded leading to landfill gas being discharged to air without destruction.	Air	Possible	Minor	1	Discharge of landfill gases directly to the atmosphere.	Provision of a standby flare. Flame out auto-dial. Auto slam shut valve upon flame out. Multiple blowers (standby) and alternative gas destruction capability (flares and generation). Auto flame recognition. Permanent standby power generator to run gas extraction.	Possible	Minor	1

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3.5	Eastern Block	Extreme weather event.	The flare is damaged. Leads to discharge of undestroyed landfill gas being released to air. This could lead to the creation of a potentially explosive or asphyxiating atmosphere.	Air Human Health - Workers	Rare	Moderate	0.1	Discharge of landfill gases to the atmosphere and failure to treat subsequent flows.	Provision of a standby flare and generators. Flame out auto-dial. Auto slam shut valve upon flame out. Auto flame-out recognition and re-ignition.	Rare	Moderate	0.1
3.6	Eastern Block	Odour from the working face.	Odour release through general waste placement, inadequate cover or special waste placement.	Air Human Health – Public Human Health - Workers	Likely	Minor	10	Discharge of odour beyond site boundary. Minimum distance of 1km to sensitive receptors.	Restricted hours of acceptance. Overly odorous waste not accepted without pre-treatment. Prompt placement of waste in its' final place. Mixing with other wastes. Special burial for known odorous wastes as per waste acceptance criteria and disposal procedure outlined in Operational Management Plan. Minimise size of the working face. Prompt burial with cover materials and equipment available for burial at all times. Mobile odour neutralising spray units. Daily cover and end of day sign off. Early placement of intermediate and final cover materials. Early planning and installation of gas extraction systems. Buffer distance.	Possible	Minor	1
3.7	Eastern Block	Odour from landfill gas emissions through cover.	Landfill gas discharges.	Air Human Health – Public Human Health - Workers	Likely	Minor	10	Discharge of odour beyond site boundary.	Cover materials. Thickening of cover (intermediate) where waste will not be placed for several months. Prevent trees growing in the cover, especially ones with deep roots and weeds that prevent mowing and surface monitoring like gorse and pampas. Active (continuous vacuum) gas extraction. Odour neutralising spray units to be mobilised for any excavation into waste areas. Buffer distance.	Likely	Minor	10

#### Uncontrolled Dust Release

Large scale earthworks, vehicle movements on unsealed roads have the potential to generate dust. A groundwater bore is proposed on the site to provide water for dust suppression.

4.1	Eastern Block	Dust release from vehicle movements and earthworks areas in Valley 1 during the operation and construction within the landfill footprint.	Heavy vehicle movements generate unacceptable dust nuisance.	Air Terrestrial Ecosystem Human Health - Workers Human Health - Public	Possible	Minor	1	Discharge of dust onto property, trees and roads.	Buffer distance. Limiting working face and exposed earthworks areas during construction. Permanent and high use roads are to be sealed. Restriction of vehicle speeds. Dust suppression including provision of an on-site water source. Full time availability of water cart with sprayers.	Unlikely	Negligible	0.01
4.2	Western Block	Dust release from vehicle movements and stockpiling at Stockpile 1.	Heavy vehicle movements and earthworks activities generate unacceptable dust nuisance.	Air Terrestrial Ecosystem Human Health - Workers Human Health - Public	Possible	Minor	1	Discharge of dust onto property, trees and roads.	Buffer distance. Rapid stabilisation of completed stockpile areas. Restriction of vehicle speeds. Dust suppression including provision of an on-site water source and water cart.	Unlikely	Negligible	0.01
4.3	Southern Block	Dust release from vehicle movements and stockpiling at Stockpile 2.	Heavy vehicle movements and earthworks activities generate unacceptable dust nuisance.	Air Terrestrial Ecosystem Human Health - Workers Human Health - Public	Possible	Minor	1	Discharge of dust onto property, trees and roads.	Buffer Distance. Rapid stabilisation of completed stockpile areas. Restriction of vehicle speeds. Dust suppression including provision of an on-site water source.	Unlikely	Negligible	0.01
4.4	Western Block	Dust release from vehicle movements and topsoil stockpiling.	Heavy vehicle movements and earthworks activities generate unacceptable dust nuisance.	Air Terrestrial Ecosystem Human Health - Workers Human Health - Public	Possible	Minor	1	Discharge of dust onto property, trees and roads.	Rapid stabilisation of completed stockpile areas. Restriction of vehicle speeds. Dust suppression including provision of an on-site water source and water cart.	Unlikely	Negligible	0.01
4.5	Eastern Block	Dust release from contaminated soil disposal operations.	Contaminants movement offsite.	Air Terrestrial Ecosystem Human Health - Workers Human Health - Public	Possible	Negligible	0.1	Discharge of dust onto property, trees and roads.	Buffer distance. Waste acceptance criteria. Load inspections. Cover materials (daily, intermediate, final). Wetting of soils to prevent dust generation. Appropriate re-use of any contaminated soils. Permanent and high-use roads to be sealed.	Unlikely	Negligible	0.01
4.6	Eastern Block	Onsite water supply is insufficient to provide for sufficient dust suppression. Especially during long dry periods.	Dust generated by heavy vehicle movements and earthworks activities is unable to be sufficiently controlled.	Air Terrestrial Ecosystem Human Health - Workers Human Health - Public	Possible	Major	100	Discharge of dust onto property, trees and roads. Reduced visibility.	Current proposed bore to provide 50 m <sup>3</sup> /day. Pond level management system to allow for stormwater runoff to be stored for use as dust suppression.	Unlikely	Negligible	0.01

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<b>Landfill Construction/Operations/Nuisance</b>												
5.1	Eastern Block	Subsurface landfill fire	A buried heat source, resulting from biological decomposition or oxidation, spontaneous combustion if aerobic conditions remain for a long time, mixing of incompatible wastes that may react, elevated oxygen levels from ingress into the waste due to strong vacuum in the gas collection pipes, or inadvertent burial of a heat source.	Air Un-named tributary of the Hotoe River Terrestrial Ecosystem Groundwater	Possible	Major	100	Landfill containment infrastructure is damaged. Leachate collection system, liner, gas extraction system and cover could all be impacted. Smoke and gas emissions rising through the landfill cover.	Continuous monitoring of gas composition and temperature at the blower and regular monitoring and throttling of gas well heads. Good use of cover to minimize oxygen ingress. Pre-acceptance of all waste materials. All wastes accepted under manifest so non-compatible wastes are identified prior to acceptance. Separation of incompatible waste materials at the working face. A permanent on-site water truck. Earthworks machinery available on-site at all times to enable rapid cover placement (soil smothering).	Unlikely	Major	10
5.2	Eastern Block	Surface landfill fire	Heat source at the surface, hot wastes, lightning, incompatible waste mixing or arson.	Air Terrestrial Ecosystem Human Health - Workers	Possible	Major	100	Short term surface fire. Discharge of smoke.	Pre-acceptance of all waste materials. All wastes accepted under manifest so non-compatible wastes are identified prior to acceptance. Separation of incompatible waste materials at the working face. Load inspectors prior to disposal. Prompt placement of cover materials (daily, intermediate, final) and readily available source of cover materials available at all times. Small working face area. Firefighting training, skills and resources (including a water supply) available on site.	Possible	Minor	1
5.3	All blocks	Forest fire migrating to landfill.	Dry and windy conditions. Arson. Accidental fire starting (i.e. lightning, camping fires, cigarette butts).	Air Terrestrial Ecosystem Human Health - Public Human Health - Workers	Possible	Major	100	Landfill infrastructure could be damaged. Landfill surface fire could trigger a subsurface fire. Impacts on terrestrial and aquatic animals. Loss of habitat.	Fire breaks and adequate separation of waste pile from forest. Firefighting reserve, training, skills and resources (including a water supply) available on site. Gas header pipes are buried, and grass is maintained (short). No smoking allowed anywhere on site by staff or 3rd parties. Water source on site. Prompt placement of daily, intermediate and final cover.	Rare	Major	1
5.4	Eastern Block	Landfill fire migrating to adjacent forestry and bush areas.	Dry and windy conditions. Subsurface or surface landfill fire (as described above) spreading in windy conditions.	Air Human Health - Public Human Health - Workers	Possible	Major	100	Risk to offsite 3 <sup>rd</sup> party infrastructure. Impacts on terrestrial and aquatic animals. Loss of habitat.	Fire breaks and adequate separation of waste pile from the surrounding forest areas. Firefighting reserve, training, skills and resources (including a water supply) available on site. Gas header pipes are buried and grass is maintained (short). No smoking allowed anywhere on site by staff or 3rd parties. Prompt placement of daily, intermediate and final cover.	Unlikely	Major	10
5.5	All blocks	Windblown litter.	Windy conditions lead to litter release beyond site boundary. Litter could originate from within the landfill footprint, blown from trucks travelling through the site or from the bin exchange area.	Terrestrial Ecosystem	Likely	Minor	10	Unsanitary, can enter streams where the litter can be transported large distances, effect of wildlife (both aquatic and terrestrial).	Prompt placement of daily, intermediate and final cover. Small working face area. Waste trucks to be covered or enclosed. Mobile and semi-permanent litter fences. Litter patrols around the landfill footprint, bin area and entrance.	Possible	Minor	1
5.6	All blocks	Windblown litter that is washed offsite down waterways.	Windblown litter is washed into waterways and carried downstream from the site.	Terrestrial Ecosystem Tributaries of the Hotoe River	Likely	Minor	10	The majority of the litter generated on the site will be captured in the screens installed around the working face.	Inlet screens, outlet screens to prevent litter leaving the site. Regular inspections and litter picking as required.	Possible	Minor	1
5.7	All blocks	Bird strike of airplane.	The site is located 2 km from an air field. The presence of birds associated with landfill activities presents a risk to aircraft.	Human Health - Public	Rare	Catastrophic	10	Airplane could crash resulting in multiple fatalities.	Prompt placement of daily, intermediate and final cover. Small working face area. Pest control plan to be implemented including control measures such as trapping, poisoning and shooting. The site is located outside of flight approach path.	Rare	Catastrophic	10
5.8	Eastern Block	Vermin on site.	The presence of waste might attract rats, birds, feral cats and other vermin.	Terrestrial Ecosystem	Likely	Moderate	100	Increase in vermin may negatively impact terrestrial ecology adjacent to the site. Vermin can act as vectors for waste depositing on neighbouring properties.	Prompt placement of daily, intermediate and final cover. Small working face area. Pest control plan to be implemented.	Possible	Minor	1
5.9	All blocks.	Members of the public entering the site (unauthorised).	Public access is provided to adjacent forestry areas for recreation. Protesters. Adjacent forestry operations staff. Curious members of the public.	Human Health - Public Human Health - Workers	Possible	Minor	1	Persons could encounter waste operations and come into contact with waste or operating plant.	Signage, locked gates, and a staffed weighbridge at landfill entrance. The landfill operations area will be fenced (stock fencing).	Possible	Minor	1

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5.10	Eastern Block	Oil or fuel spills.	Diesel, petrol and oil storage on site for fuelling and maintaining plant items.	Groundwater Un-named tributary of the Hotoe River Terrestrial Ecosystem	Possible	Moderate	10	Hydrocarbon discharge to ground or water.	Secondary containment of all fuel storage areas. Spill response materials and provision of training to staff. Prompt removal and disposal of contaminated soils associated with contaminated materials. Refuelling area to be bunded to contain any spills. Any runoff directed to a sump and interceptor before being pumped to the wheel wash pond for reuse.	Unlikely	Moderate	1
5.11	All blocks	Onsite traffic accident.	Vehicle accident within the site.	Human Health - Workers	Unlikely	Catastrophic	100	Vehicle collision, accident resulting in injury or possibility of a serious injury and/or property damage.	Speed restrictions within the site. Clear road signage. Roads and intersections to be designed for safety.	Unlikely	Major	10
5.12	n/a	Traffic accident at the main intersection of site with SH1.	Vehicle accident at the intersection between SH1 and the access road.	Human Health – Public Human Health - Workers	Unlikely	Catastrophic	100	Vehicle collision, accident resulting in serious injury and/or property damage.	Intersection design to NZTA satisfaction. Visual screening to prevent driver distraction. Clear road signage.	Unlikely	Major	10
5.13	n/a	Traffic accident at the intersection between Crowther Road and SH1.	This intersection is to be used for approximately two years while the main access road and intersection is constructed.	Human Health – Public Human Health - Workers	Possible	Catastrophic	1000	Vehicle collision, accident resulting in serious injury and/or property damage.	Temporary traffic management plans - safety improvements on SH, increased median for right turn and traffic controls to meet increased NZTA safety requirements	Unlikely	Major	10
5.14	All blocks	Noise beyond the site boundary.	Noise associated with general landfill operations (including bin exchange) and construction activities.	Human Health - Public	Unlikely	Minor	0.1	Ongoing nuisance and disruption to the public.	Site location and topography. Buffer distance of over >1 km to neighbouring residents. Vehicle and machine specifications that disallow excessive noise. Noise monitoring programme.	Rare	Minor	0.01
5.15	Waiteira Tributary Block	Noise beyond the site boundary.	Noise associated with the temporary (approximately 2 years) use of Crowther Road during the construction phase of the landfill.	Human Health - Public	Possible	Moderate	10	Temporary nuisance and disruption to nearby residents.	Speed restrictions. Limits on daily activity hours.	Possible	Minor	1
5.16	Eastern Block	Waste acceptance criteria not met and hazardous waste received.	Leachate contaminants at levels greater than expected. Human health effects - workers. Incompatible waste mixing.	Human Health – Workers Air Discharge	Possible	Major	100	The waste reacts with other wastes, the leachate compounds generated are unable to be destroyed through the treatment and disposal process.	Waste declaration and manifest system. Pre-approval for waste to be received with agreement system in place. Approved customers only, no access to the public. Load inspections at weighbridge.	Unlikely	Major	10
5.17	All Blocks	Landfill and ancillary operations have a visual impact on the community.	At different stages, portions of the landfill development will be visible from publicly accessible areas.	Human Health - Public	Possible	Negligible	0.1	waste placement area is largely shielded from residential properties. Some earthworks and ancillary operations will be visible for periods of time.	Site location and topography. Buffer distance of over >1 km to neighbouring residents. Stockpile management and revegetation. Final finished contours to be planted in pasture.	Unlikely	Negligible	0.01
5.18	Eastern Block	Wastewater discharge from ancillary facilities such as the site office.	Discharge of wastewater to ground or waterway.	Groundwater Un-named tributary of the Hotoe River	Unlikely	Moderate	1	Discharge of wastewater to groundwater or waterway.	Onsite treatment and disposal. Operation and management plan which provides for regular monitoring and maintenance of the system.	Rare	Moderate	0.1

ID	Block Location	EVENT	DESCRIPTION	RECEPTOR	UNMITIGATED LIKELIHOOD	UNMITIGATED CONSEQUENCE	UNMITIGATED RISK SCORE	POTENTIAL CONSEQUENCE	MITIGATION	MITIGATED LIKELIHOOD	MITIGATED CONSEQUENCE	MITIGATED RISK SCORE
5.19	Southern Block	Site access blocked.	If the access road becomes blocked (i.e. slips, flooding etc) then there is no alternative access to the landfill for heavy vehicles. As a consequence, waste stored at the bin exchange area is unable to be placed at the tip face, resulting in odour generation.	Human Health - Public	Unlikely	Minor	0.1	Leachate and waste cannot be disposed of.	Likely availability of alternative disposal sites. Bins stored within the bin exchange area will be transferred off site to alternative site.	Unlikely	Negligible	0.01
5.20	All Blocks	Light spill from site operations (e.g., tip face or bin park including vehicles using the access road) to neighbouring properties.	Works undertaken at night, or in the early morning or early evening will require lighting. This light may be visible to nearby residents (nuisance).	Human Health - Public	Unlikely	Negligible	0.01	Lights are visible from a distance to nearby residents.	Site location and topography. Buffer distance of over >1 km to neighbouring residents. Operations at night limited to tip face and bin exchange areas only, with no work on stockpiles.	Rare	Negligible	0.001
5.21	Eastern Block	Light spill from site operations (e.g., tip face or bin park including vehicles using the access road) to adjacent properties.	Works undertaken at night, or in the early morning or early evening will require lighting. This light may disrupt the activities of nocturnal fauna.	Terrestrial Ecosystem	Unlikely	Moderate	1	Temporary adverse effect on bat communities.	Shrouded lighting. Smart lighting (motion detector, auto dimmers).	Unlikely	Moderate	1
5.22	Eastern Block	Increased biosecurity risk.	Waste disposed of could introduce new species or insects or plant species to the area.	Terrestrial Ecosystem Surface Water/Aquatic Ecosystem	Unlikely	Moderate	1	Pests and disease are introduced to the area via waste disposed at the site.	Waste handling practices (e.g. daily cover, covered bins) to control environment release of seed and vectors. Pest control programme including regular inspections around the landfill footprint and mandatory eradication response provided in Landfill Management Plan.	Rare	Moderate	0.1
5.23	Eastern Block	Asbestos discharged from site (air or water).	Asbestos fragments from onsite disposal are washed or blown from the landfill footprint.	Human Health - Public Human Health - Workers	Unlikely	Moderate	1	Highly unlikely for asbestos material dust to be blown beyond the site boundary given the mitigation measures.	Handling of asbestos in accordance with regulations. Operational practices to minimise dispersion of dust from waste areas. Implementation of a waste acceptance policy that avoids friable asbestos becoming exposed. Prompt burial. Buffer.	Rare	Moderate	0.1
5.24	Eastern Block	Blasting during construction	Blasting may be required during the construction phase as part of basegrade excavation.	Human Health - Public	Unlikely	Minor	0.1	Vibration effects beyond site boundary.	Vibrations standards within the unitary plan will be met for any blasting undertaken at the site. Buffer distance between the proposed excavations and the residents.	Unlikely	Minor	0.1