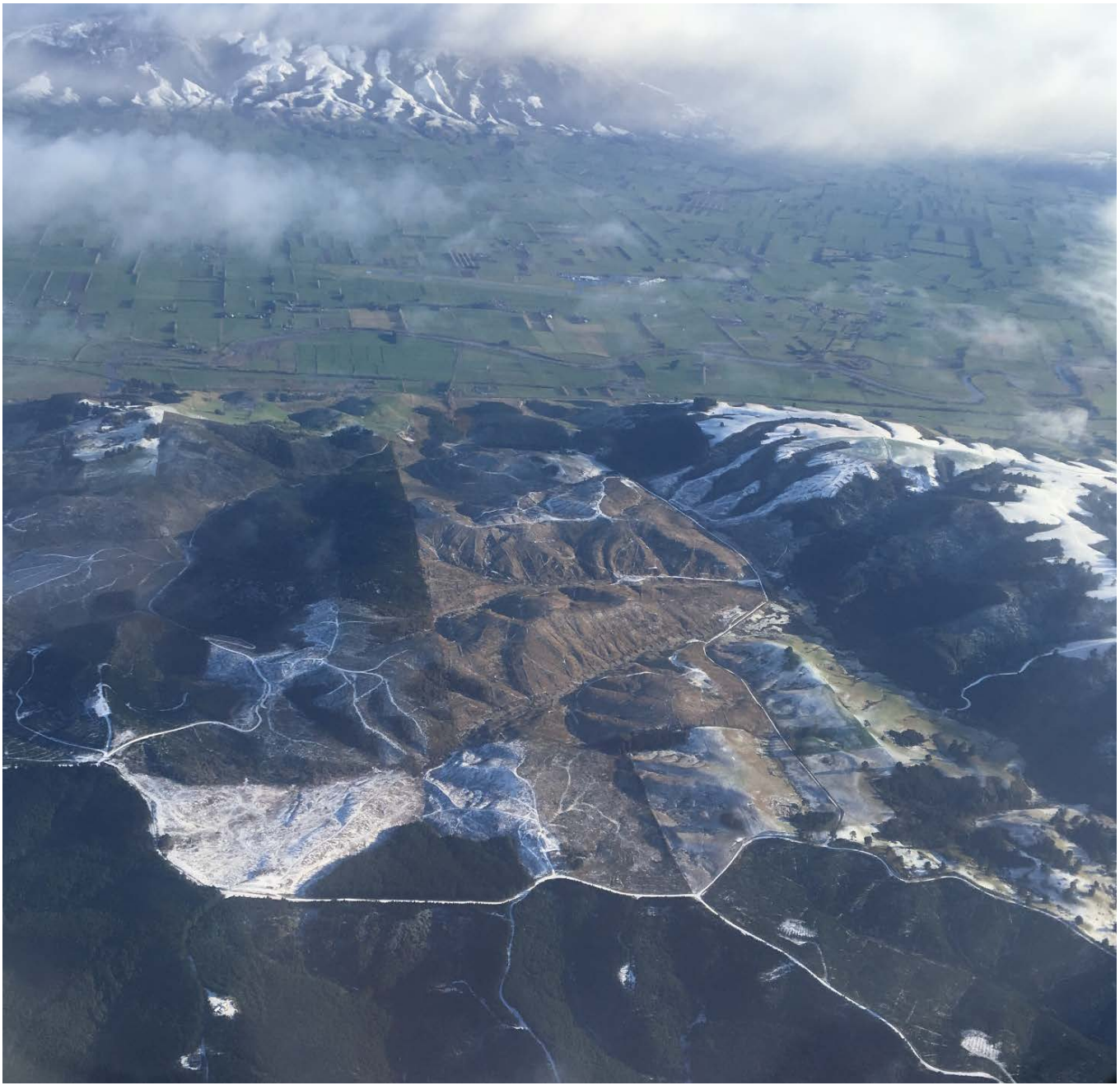
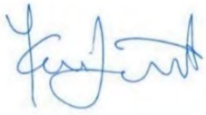
Smooth Hill Landfill

DRAFT Landfill Management Plan
Prepared for Dunedin City Council

4 June 2021



Document Quality Assurance

Bibliographic reference for citation: Boffa Miskell Limited 2021. *Smooth Hill Landfill: DRAFT Landfill Management Plan*. Report prepared by Boffa Miskell Limited for Dunedin City Council.		
Prepared by:	Deborah Rowe Principal / Planner Boffa Miskell Limited Maurice Dale Principal / Planner Boffa Miskell Limited	
Reviewed by:	Rachael Eaton Senior Principal Boffa Miskell Limited Nick Eldred Principal GHD Ltd	
Approved by:	Ken Gimblett Partner / Planner Boffa Miskell Limited	
Status: FINAL	Revision / version: 1	Issue date: 4 June 2021

Template revision: 20190509 0000

File ref: BM200252_FINAL_Smooth_Hill_LMP_20210604.docx

CONTENTS

1.0 Introduction 1

1.1 Purpose 1
1.2 LMP Requirements 1
1.3 LMP Structure 1
1.4 Resource Consents and Designation 2
1.5 Related Documents 3
1.6 Best Practice Guidelines 3
1.7 LMP Review 4
1.8 Document History 4

2.0 Site Management 4

2.1 Site Description 4
2.2 Roles and Responsibilities 8
2.3 Staffing and Training 8
2.4 Health and Safety 9
2.5 Communication and Complaints 10

3.0 Landfill Development 12

3.1 General Description of Design 12
3.2 Landfill Formation 14
3.3 Leachate Containment and Management 14
3.4 Landfill Gas Collection and Management 15
3.5 Stormwater Management and Sediment and Erosion Control 16
3.6 Groundwater Management 17
3.7 Landfill Access 18
3.8 Construction Management 19
3.9 Ecological Management 23
3.10 Landscape Management 24

4.0 Landfill Operation 25

4.1 Access Control 25
4.2 Waste Acceptance 25
4.3 Placing of Refuse 26
4.4 Leachate Management 28

4.5 Landfill Gas Management 29
4.6 Stormwater Management and Sediment and Erosion Control 30
4.7 Groundwater Management 31
4.8 Site Internal Roading 32
4.9 Landfill Facilities 32
4.10 General Amenity Management 33
4.11 Odour Management 33
4.12 Dust Management 35
4.13 Noise Management 35
4.14 Bird Management 35
4.15 Pest Management 36
4.16 Hazardous Substances 37
4.17 Ecological Management 37
4.18 Landscape Management 37
4.19 Incident Management 38

5.0 Landfill Closure and Aftercare 38

6.0 Monitoring, Records and Reporting 39

6.1 General Requirements 42
6.2 Groundwater and Surface Water Monitoring 42
6.3 Landfill Gas Monitoring 42
6.4 Bird and Ecological Monitoring 42
6.5 Odour Monitoring 42
6.6 Noise Monitoring 42
6.7 Waste Acceptance and Placement Monitoring 42
6.8 Emergency Management 42
6.9 Annual Reporting 42

Appendices

Appendix 1: Bird Management Plan

Appendix 2: Vegetation Restoration Plan

Appendix 3: Landscape Mitigation Plan

Appendix 4: Lizard Management Plan

Appendix 5: Falcon Management Plan

Appendix 6: Glossary of Terms

Appendix 7: Resource Consents

1.0 Introduction

1.1 Purpose

This draft Landfill Management Plan (LMP) framework has been prepared to support the construction, operation, closure, and aftercare of the Smooth Hill Landfill. The LMP documents the site-specific procedures including monitoring and contingency actions to be implemented ensure the landfill achieves the operational and environmental objectives and conditions set out in the resource consents, to ensure the potential for adverse environmental effects is minimised.

1.2 LMP Requirements

The resource consents issued by ORC require that the detailed design, construction, and operation of the landfill shall be in accordance with the provisions of a LMP, developed in consultation with Te Rūnanga o Ōtākou. The LMP is required to be provided to ORC for approval at least three months prior to construction commencing.

The LMP is required to include procedures, including monitoring and contingency actions, to ensure the detailed design, construction, operation, and aftercare of the landfill achieves the operational and environmental objectives and conditions set out in the resource consents.

The LMP objectives are set out in the resource consents issued for the construction and operation of the Smooth Hill Landfill and are incorporated in the relevant management sections of this LMP. The objectives guide the development of the procedures of the plan and provide the basis against which the success of the plan in minimising environmental effects is to be measured.

The landfill is to be operated at all times in accordance with the provisions of the current LMP.

The LMP is required to be reviewed annually in consultation with Te Rūnanga o Ōtākou to ensure that management practices result in compliance with the conditions of these consents, however, may also be revised at other times if required. Any proposed revisions are to be provided to the ORC for prior approval.

1.3 LMP Structure

This LMP has been structured as follows:

- **Section 1.0 – Introduction (this section)** – The plan purpose; requirements, structure; schedule of resource consents held and designation; relevant documents and guidelines; and procedures for plan review.

1. **Section 2 – Site Management** – Description of the site; landfill management roles and responsibilities; training requirements for specialist roles; health and safety requirements; and procedures for communication with the community and receiving and responding to complaints.
2. **Section 3 – Landfill Development** – General description of the design; and the parameters and procedures for detailed design and construction of the landfill that achieves the LMP objectives, and resource consent conditions. This section applies to

both initial site establishment/enabling works and to the progressive extension of landfill stages 1- 4.

3. **Section 4 – Landfill Operation** – Daily procedures for operation of the landfill, including for waste acceptance, that achieves the LMP objectives, and resource consent conditions.
4. **Section 5 – Landfill Closure and Aftercare –** Procedures for site closure, rehabilitation and ongoing aftercare, that achieves the LMP objectives, and resource consent conditions.
5. **Section 6 – Monitoring and Reporting** – Details of the monitoring and reporting requirements that will be undertaken.

Sections 3 – 5 reference and incorporate elements of more detailed bird management, ecological, and landscape management plans attached as appendices to the LMP. Those plans form part of the overall suite of procedures for the management of landfill in this LMP.

Standard terms used in this LMP are defined in the glossary in **Appendix 6**.

1.4 Resource Consents and Designation

The construction, operation, closure, and aftercare of the Smooth Hill Landfill is authorised under the Resource Management Act 1991, by way of resource consents issued by ORC and DCC, and the site's designation in the Proposed Second Generation Dunedin City District Plan (2GP).

Dunedin City Council holds the resource consents from ORC and DCC set out in **Table 1** for the landfill and road upgrades supporting the landfill operation. The resource consents for the landfill, and road upgrades were granted by ORC on the [insert date] and expire on [insert date]. The resource consent for the road upgrade was granted by DCC on the [insert date]. Copies of all the resource consents are included in **Appendix 7**.

Table 1 – Smooth Hill Resource Consents

[Content to be included following issuing of consents]

Consent Type	Consent Reference	Description

The Smooth Hill Landfill site is designated (reference D659) for *'Proposed landfilling and associated refuse processing operations and activities'* in the 2GP. The designation has a lapse date of 2058 (unless given effect to prior to that date). The extent of the designation is shown in **Figure 1**. The designation, is subject to the following three conditions:

1. *This designation shall lapse on the 40th anniversary of the date on which this designation becomes operative.*

2. *A landscape plan showing proposed initial planting, final landform and final planting shall be prepared by the Requiring Authority under the direction of a qualified landscape architect prior to the commencement of landfilling operations. Development of the site shall be in accordance with this landscape plan.*

3. *Noise generated by any activity on the site shall comply with the following standards within 50 metres of the nearest house existing at the date on which the designation becomes operative - 55Dt/40Nt dBA. (NB These levels are subject to an adjustment of minus 5dBA for noise emissions having special audible characteristics).*

The designation of the land means that, development and operation of the underlying land for a landfill is therefore enabled, subject to the requirement under section 176A of the RMA to submit an outline plan of works to the DCC, as consenting authority.

1.5 Related Documents

In addition to this LMP, the documents set out in **Table 2** below include other requirements for the development and operation of the Smooth Hill Landfill.

Table 1 – Related Documents

[Content to be finalised following issuing of consents]

Title	Author	Date	Comments
Resource consents	ORC	[insert date]	
Health and safety plan	DCC	[insert date]	

1.6 Best Practice Guidelines

The best practice guidelines set out in **Table 3** below have been used in preparing this LMP.

Table 3 – Best Practice Guidelines

[Content to be finalised following issuing of consents and as part of detailed design]

Guideline	Author	Date
Technical Guidelines for Disposal to Land	Waste Management Institute of New Zealand (WasteMINZ)	August 2018.
Module 2 – Hazardous Waste Guidelines: Landfill Waste Acceptance Criteria and Landfill Classification.	Ministry for the Environment	May 2004.
GD05 – Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region	Auckland Council	June 2016

Erosion and Sediment Control Toolbox	Environment Canterbury	
Erosion and Sediment Control Guideline, R12/14.	Environment Canterbury	2007

1.7 LMP Review

The LMP is a living document and is required to be reviewed annually in consultation with Te Rūnanga o Ōtākou to ensure that management practices result in compliance with the conditions of these consents. The LMP may also be revised at other times outside of annual reviews, if required.

The reviews will also respond as necessary to changes in waste demands, best practice design and management, regulatory requirements, and any environmental changes.

DCC, as consent holder, is the owner of the master copy of the LMP and shall be responsible for reviews and updates to the plan.

1.8 Document History

The version history of the LMP is set out in in **Table 4** below.

Table 4 – Document Version History

[Content to be finalised following issuing of consents]

Revision	Prepared by	Date Approved by ORC	Copies of LMP held by
Rev 1, dated [insert date]	Boffa Miskell Ltd and GHD Ltd	[insert date]	ORC, DCC

2.0 Site Management

2.1 Site Description

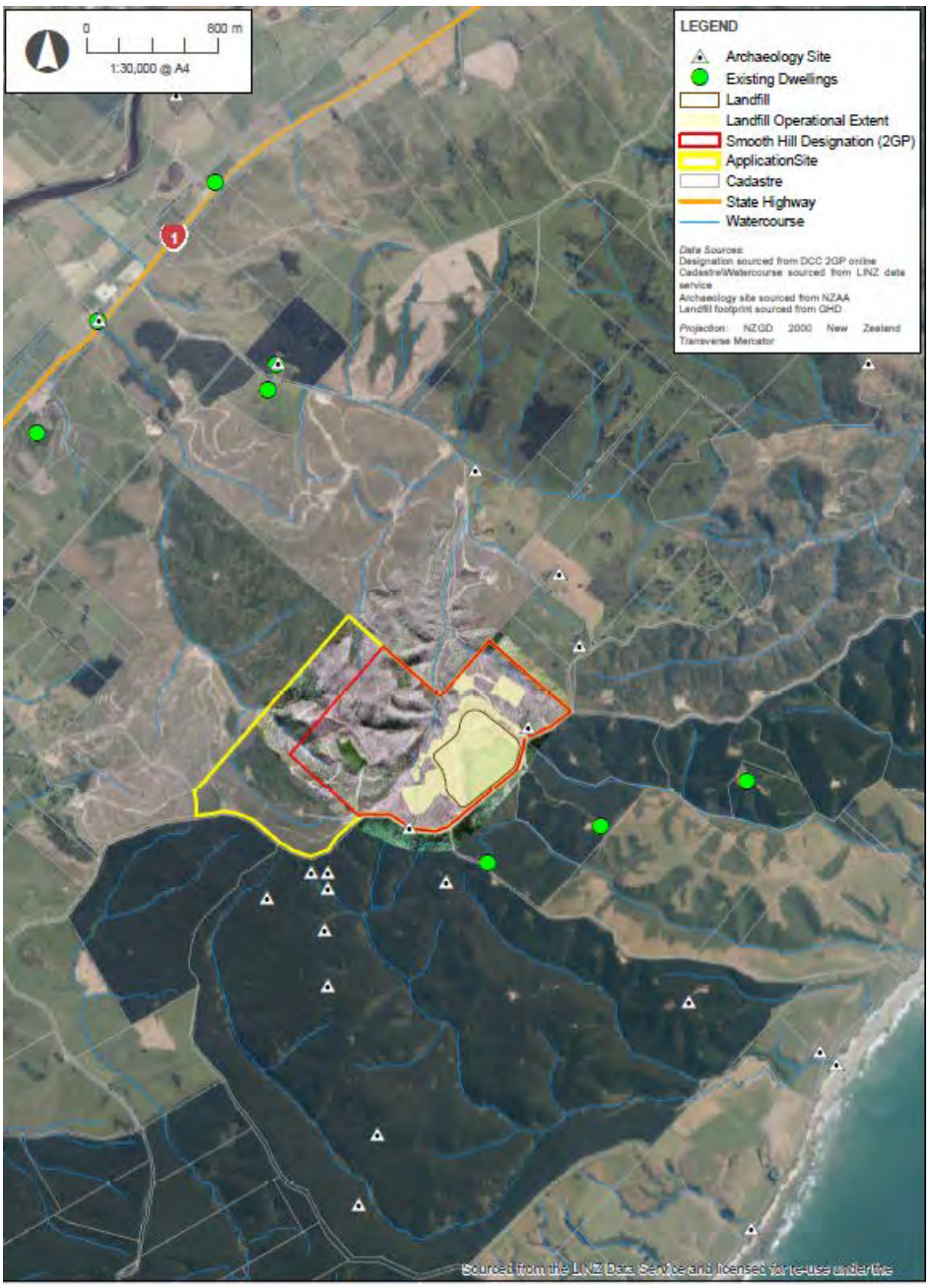
The Smooth Hill Landfill site is located approximately 28 km southwest of Dunedin in the hills between the Taieri Basin and the South Island east coast. Access to the site is primarily from State Highway 1 (SH1), McLaren Gully Road and Big Stone Road to a vehicle entrance located on the south eastern boundary of the site.

The site is legally described in **Table 5** and outlined in **Figure 1** below. This also shows the extent of the 2GP designation (reference D659) over the site.

Table 5 – Smooth Hill Landfill Site Legal Description

Address	Legal Description	Area	Owner
750 Big Stone Road	Part Lot 1 DP 457417, and Section 1 – 2 SO Plan 547235 (RT 971405)	118.8517 ha	Dunedin City Council
700 Big Stone Road	Lot 2 DP 457417 (RT 598006)	58.9603 ha	

Figure 1 – Smooth Hill Landfill Site



The site contains the following key environmental features, which are further described in the sections of the LMP where they relate to management of the development and operation of the landfill.

2.1.1 Surface Freshwater Systems

The landfill is situated within the McColl Creek catchment. A branch of the Ōtokia Creek originates within the landfill site, that ultimately flows to the coast near Brighton, approximately 10 km north-east of the landfill site. A series of south to north ephemeral watercourses pass through the site, that contain flowing water after persistent rainfall. The watercourses merge at the northern edge of the site forming a swamp wetland habitat.

The swamp wetland connects via a defined channel to a tributary of the Ōtokia Creek beyond the northern boundary of the site that is perennial or likely to have surface water present all or most of the year. During dry periods, surface water flow ceases as far downstream as at least the culvert, and surface water retreats to occasional isolated pools where water is impounded. The tributary flows approximately 1km downstream where it ultimately reaches a culvert beneath McLaren Gully Road. The tributary and valley floor forms part of a valley floor marsh wetland system. Beyond McLaren Gully Road, the tributary ultimately joins the main stem of the Ōtokia Creek.

2.1.2 Water Quality

Existing ground and surface water quality downstream of the landfill site is influenced by landform, soils vegetation cover, and cycles of forestry land use. During the harvest/replanting cycle of the forestry land use, the removal of the vegetative cover and the associated soil disturbance results in increased runoff and erosion of the surface soils with associated impacts on water quality downstream. As a result, there can be a significant variation in the water quality and runoff volumes from the catchment over time as forestry is cleared, replanted, and grows to maturity.

Baseline sampling of groundwater and surface water quality has been undertaken in accordance with the ORC resource consent conditions, for the purposes of setting trigger levels for monitoring to detect leachate leakage effects on groundwater, and leachate, suspended solids and turbidity on surface water quality.

[Content to be finalised following issuing of consents and completion of baseline water quality monitoring as per consent conditions].

2.1.3 Groundwater Systems

The landfill site is underlain by shallow and deep groundwater systems separated by an intermittent fine-grained low permeability layer within the Henley Breccia formation. The system receives recharge directly from rainfall, as well as from surface runoff and seepage from surface soil layers.

The shallow groundwater system is located within the bottom of the gullies of the site. Groundwater flows in the shallow system follow topography north towards the valley floor. Shallow groundwater levels are near the surface in the valley bottom, and the shallow system contributes baseflow to the perennial valley floor marsh wetland system and downstream Ōtokia Creek.

The deep groundwater system is located within the Henley Breccia. Some minor rainfall recharge, and seepage from the shallow system occurs, however it is constrained by low permeability materials. The deep groundwater system has very low permeability due to the presence of unweathered to slightly weathered breccia and conglomerate units. Horizontal groundwater gradients are relatively flat, with an inferred flow direction towards the coast southeast of the site.

2.1.4 Terrestrial and Freshwater Ecology

Vegetation types within the landfill site range from highly modified plantation forestry areas of negligible ecological value, to degraded wetland habitats of moderate ecological value and regenerating / secondary indigenous forest habitat of high ecological value. With the exception of kānuka, no *at-risk*, *threatened*, or locally uncommon or important plant species have been found on the landfill site.

The site provides habitat for a range of avifauna, including 14 native and 8 exotic bird species. Overall, the avifauna community assemblage at the site is characterised by an abundance and diversity of passerines and occasional harrier hawks, black-backed gulls, magpies and ducks. The most abundant native birds are tui and harrier hawk. Eastern falcon which have an *at-risk* classification have been recorded on the site. No *threatened* species have been recorded.

The site consists of variable, low to high quality habitat for native lizards, and a potential population of southern grass skinks is likely to be present. No *threatened* lizard species have been recorded on the landfill site.

The tributary of the Ōtokia Creek beyond the northern boundary of the landfill site contains habitat suitable for fish species. The New Zealand Freshwater Fish Database records show the Ōtokia Creek supports indigenous fish species including koaro, banded kokopu, longfin eel, and giant kokopu and inanga in the lower catchment. However, it is likely that the tributary between the designation site and McLaren Gully Road provides limited habitat for freshwater fish species other than eels.

2.1.5 Cultural and Historic Values

Kāi Tahu whānui, represented by Kā Papatipu Rūnaka and Te Rūnanga o Ngāi Tahu, comprise people of Kāi Tahu, Ngāti Māmoe and Waitaha descent, who hold mana whenua over an area that includes the entire Otago region. Te Rūnanga o Ōtākou have mana in the project area.

Smooth Hill is part of a wider cultural landscape which is imbued with the lived experiences of mana whenua tūpuna. These experiences and the values passed down through the generations inform mana whenua and Kāi Tahu Whānui identity, cultural practices and approaches to environmental management. Mana, mauri and whakapapa are core values which underpin the Kāi Tahu worldview with respect to this project. These values are interconnected and the degradation of one value can affect other values.

Two archaeological sites (NZAA references I45/71 and 145/72) that contain the remains of two European pre-1900 buildings exist along the Big Stone Road frontage of the landfill site.

2.16 Surrounding Land Use

The land use surrounding the landfill site predominately consists of commercial plantation forestry on large landholdings. Some localised areas of pastoral farming exist, notably adjacent to the sites north eastern boundary, and land at the bottom end of McLaren Gully Road.

Two houses are located along McLaren Gully, approximately 1km from the SH1 intersection, and approximately 1.7km from the landfill site.

Two further houses are located in the hills between Big Stone Road and the coast, approximately 380m and 605m southeast of the landfill site respectively. Other houses are located at distances beyond 1km along Big Stone Road in the direction of Brighton.

Dunedin International Airport is situated 4.5km to the northwest of the landfill site on the Taieri Plain.

2.2 Roles and Responsibilities

DCC is both the owner of the Smooth Hill Landfill site, and the holder of all associated resource consents. DCC has responsibility for compliance with the resource consents, and designation requirements.

Specific roles and responsibilities that will be held for the construction and operation of the landfill are as follows:

- Landfill manager
- Landfill site supervisor
- Environmental manager
- Bird control officer
- Landfill gas systems manager
- Waste acceptance and compliance manager
- Communication/complaints manager

The organisational structure is shown in **Figure 2**.

Figure 2 – Organisational Structure

[Content will be finalised following the issuing of consents and as part of detailed design, and in collaboration with future landfill operator]

2.3 Staffing and Training

Objective:

1. Appropriately trained staff are retained to operate the landfill in a safe and effective manner.

Procedures

The following staff and training procedures will be implemented during the construction and operation of the landfill:

a. Responsibilities are to be assigned for the training of staff on the contents of this LMP together with regular compliance monitoring.

b. Staff who inspect or direct the placement of incoming wastes are to be trained to identify wastes that are unacceptable or require special handling procedures (including, for example, identifying potentially odorous or unexpected highly odorous deliveries). These staff include weighbridge attendants, tip face supervisors, and equipment operators.

c. Environmental staff are to be familiar with the procedures and monitoring requirements relating to surface water, groundwater, air emissions, vegetation restoration, bird management, falcon / kārearea management, lizard management, plant and animal pest management, and emergency responses should there be any breaches.

d. Operators of plant and equipment are to be trained to undertake the tasks required of them and to operate the machinery assigned to them. A summary of training of operators it be maintained to readily identify what staff can use what machinery.

e. All staff are to be familiar with the landfill facilities, operational procedures, site hazards, health and safety procedures, and environmental requirements.

f. All staff are to be familiar with site emergency procedures.

[Content will be finalised following the issuing of consents and as part of detailed design, and in collaboration with future landfill operator]

2.4 Health and Safety

Objectives

1. The landfill is constructed and operated in way that prevents harm to self, other workers and the public and meets obligations under Health and Safety regulations.

Procedures

The following health and safety procedures will be implemented during the construction and operation of the landfill:

a. A site-specific Health and Safety Plan will be prepared and implemented to meet obligations under the Health and Safety at Work Act 2015.

b. All site and operational hazards and risks are to be identified, assessed and eliminated where possible.

c. Responsibilities are to be assigned for the management of health and safety and training of staff together with regular compliance monitoring.

d. All site staff are to be aware of all the risks and be trained to manage those risks or be prohibited from entering the risk zone.

e. Staff that may be in contact with hazardous chemicals, dust or biological contaminants are to be provided with appropriate PPE and inoculations.

f. All staff, contractors, and visitors are to be inducted to advise the hazards on site and where they may or may not have access. All contractors and visitors are to be accompanied unless trained to manage the identified risks.

[Content will be finalised following the issuing of consents and as part of detailed design, and in collaboration with future landfill operator]

2.5 Communication and Complaints

2.5.1 Communications

Objective

1. Members of the public can contact the landfill operator at all times in relation to the construction and operation of the landfill, and in the case of emergency.

Procedures

The following communications procedures will be implemented during the construction and operation of the landfill:

a. The [Landfill Operator Role 1] will be the primary point of contact for all emergencies.

b. The [Landfill Operator Role 2] will be the primary point of contact for all enquiries. In the event that [Landfill Operator Role 2] is not available, the [Landfill Operator Role 3] shall be the point of contact.

c. [Landfill Operator Name] will ensure that contact details for [Landfill Operator Roles 1, 2 & 3] are made available on the Dunedin City Council, and [Landfill Operator Name] websites, and posted on signage at the site entrance to the landfill.

[Content will be finalised following the issuing of consents and as part of detailed design, and in collaboration with future landfill operator]

2.5.2 Complaints Management

Overview

Complaints may be received from customers, neighbours, the DCC service desk, or the wider community. Issues that could lead to complaints include:

a. Dust, noise, odour, litter and visual impacts.

b. Traffic impacts.

c. Birds, vermin, rabbits, wild cats, rodents and flies.

[Landfill Operator Name] will seek to manage and operate the landfill in a manner that ensures that the facility is a good neighbour.

Objective

1. All complaints received in relation to the landfill are investigated and responded to promptly, including investigations into whether any improvements to the operations of the landfill should be made.

Procedures

The following complaints management procedures will be implemented during the construction and operation of the landfill.

Complaints will be managed in the following way:

a. A complaints management system will be established prior to the commencement of construction of the landfill. This shall include the preparation of a Complaints Log that captures the following information:
    i. Type, date, and time of complaint.
    ii. Name and address of complainant (if available).
    iii. Location from which the complaint arose.
    iv. Wind direction and general weather conditions at the time of complaint (if relevant)
    v. The likely cause of the complaint.
    vi. The action taken as a result of the complaint.
    vii. The feedback to the complainant.
b. If a complaint is received, the landfill operator shall ensure that it is recorded in the Complaints Log.
c. Complaints will be forwarded to the [Landfill Operator Role 1] for prompt attention, or to the [Landfill Operator Role 2] in the absence of the [Landfill Operator Role 1].
d. Each complaint shall be investigated as soon as possible and shall take the form of a telephone conversation with the complainant in the first instance.
e. If appropriate, a visit to the complainant's location shall be made as soon as possible after the complaint is received so that an assessment of the conditions to which the complaint relates can be made.
f. In the case of complaints that relate to odour, investigations shall:
    i. Determine the contributing factors to the issue; and
    ii. Identify improvements to odour control procedures.
g. All dealings with the complainant shall be undertaken in a courteous and professional manner.
h. Corrective actions are implemented as required and the LMP is updated to accommodate such corrective actions.
i. The complaints management system outlined above shall be maintained for the duration of the life of the landfill (subject to any improvements that may arise as a result of the annual review of the LMP).

[Content will be finalised following the issuing of consents and as part of detailed design, and in collaboration with future landfill operator]

3.0 Landfill Development

[This section of the LMP will ultimately set out parameters that will guide detailed design, and construction management procedures. The section will be finalised during the detailed design phase.

This section applies to both initial site establishment/enabling works and to the progressive extension of landfill stages. The information presented below is consistent with the design intent and principles of the conceptual landfill design.

Whilst the conceptual design describes the overall landfill development to a reasonable degree of detail (sufficient to support resource consent applications), fuller details of construction management requirements and procedures will only be defined during and following detailed design phases of the project.

At the current concept design level, it is important to maintain the opportunity to incorporate the widest available range of future design improvements and innovations]

3.1 General Description of Design

[This section of the LMP will provide a brief description of the detailed design of the landfill. It will provide details about the landfill's capacity, its projected life and staging. A schedule of approved concept design drawings and documents will also be included].

[The following placeholder content is based on the concept design used to support the resource consent application. Content will be finalised following the issuing of consents and as part of detailed design, and in collaboration with future landfill operator]

The Smooth Hill landfill has been designed as a Class 1 landfill for the disposal of municipal solid waste and hazardous wastes. The general arrangement of the landfill design is shown in **Figure 1** below**.**

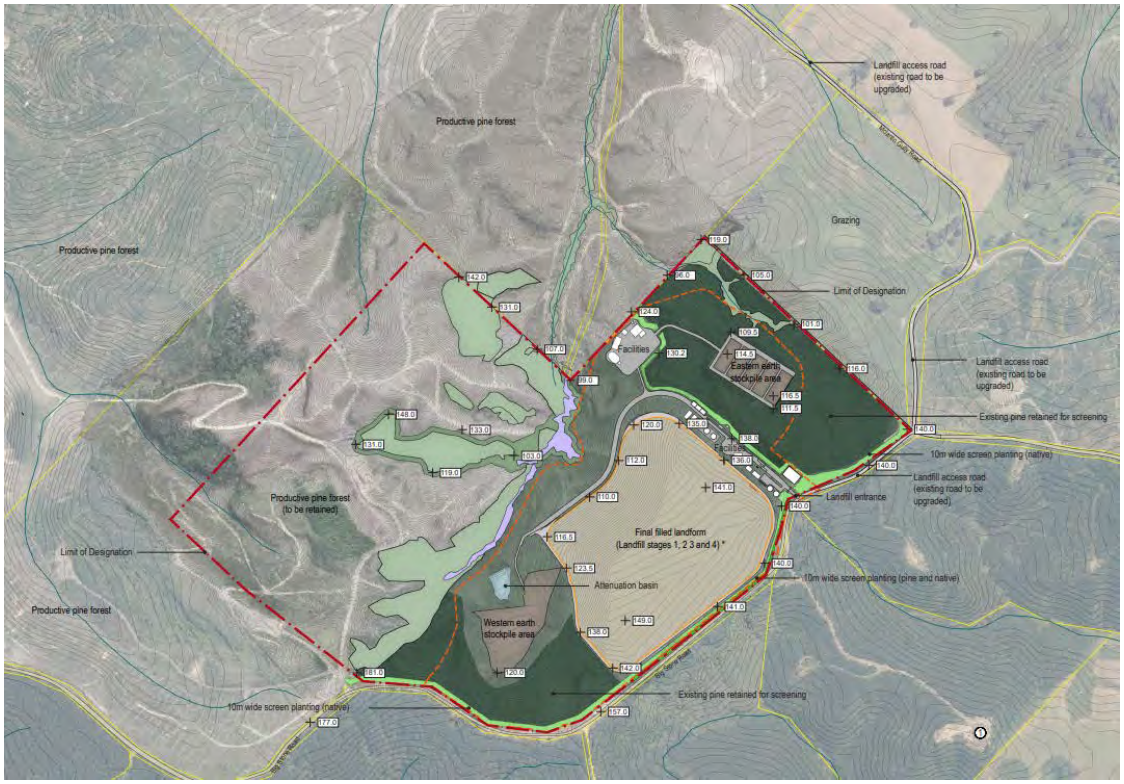
Construction, filling, and final capping of the completed landfill will occur progressively in four stages supported by a 10m high toe embankment. Stage 1 involves filling behind the toe embankment. Stages 2 to 4 will then progress in a clockwise fashion from northeast, the south and then west filling over Stage 1 and buttressed against the surrounding gully.

Each stage will in turn be developed and filled sequentially in a number of sub-stages. As filling of each stage progresses, incoming waste will first be covered with daily cover, followed by placement of intermediate cover, and then the final cap.

The landfill will have a total waste volume of approximately 2.94 M cubic metres, which is equivalent to approximately 2.35 M tonnes of refuse.

Initial construction activities occur prior to the landfill accepting its first waste. It is anticipated that these activities will take place over at least two construction seasons prior to the landfill accepting waste.

Figure 1 – Smooth Hill Landfill General Arrangement



Initial construction activities will include:

- Upgrades to McLaren Gully Road, including its intersection with State Highway 1, and Big Stone Road.
- Initial site clearance.
- Construction of landfill site access and access between the facilities areas and soil stockpile areas, and the perimeter access track.
- Landfill facilities.
- Landfill toe embankment, stormwater attenuation basin, and the sediment control measures and the section of the landfill perimeter drain serving the upper facilities area, and stage 1.
- Formation of the base grade, groundwater collection, low permeability liner system, and leachate collection systems for stage 1.
- Perimeter planting for all stages and required ecological mitigation/offset planting.
- Landfill environmental monitoring systems, including groundwater/LFG wells.
- LFG collection and destruction system to coincide with the timing for placement of 200,000 tonnes of waste in the landfill – approximately 3 – 4 years after commencement of landfilling.

3.2 Landfill Formation

Objectives

1. Optimally utilise the designated land for the disposal of waste.
2. Seismic risks and risks of slope failure for the landfill are minimised.
3. The landfill base grade, toe embankment, and completed surface slopes are stable during landfill development and in the long-term.

Procedures

The following landfill formation procedures will be implemented during the detailed design and construction of the landfill. “Landfill formation” in the context of this section relates to all matters relating to construction of the landfill to ensure its short- and long-term stability.

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator. All procedures will reflect the relevant land stability requirements of the final conditions of consent]

3.3 Leachate Containment and Management

Overview

Leachate is the liquid produced through waste degradation and rainwater that percolates through the waste to the landfill liner, collecting dissolved and/or suspended matter from the waste as it passes through.

Objectives

1. Leachate is managed and contained within the landfill footprint through the use of a high-performance landfill liner, and provision of an on-site leachate collection and storage system, to limit/reduce any risk of migration into the underlying soil, groundwater, and surface water.
2. Safe disposal of leachate off-site.
3. The risks of excessive liner hydration are minimised.
4. The ingress of stormwater into open and closed sections of the landfill are minimised to avoid excessive leachate generation.

Procedures

The following leachate containment and management procedures will be implemented during the detailed design and construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures the reflect the relevant leachate containment and management requirements of the final conditions of consent.

b. A low permeability liner system placed on the landfill base grade will be constructed progressively as the landfill stages are developed to contain leachate within the landfill

and prevent it from entering the underlying soils or groundwater. In accordance with WasteMINZ guidelines, the liner will meet Type 1 or Type 2 as required for Class 1 landfills.

c. A stormwater management system that enables monitoring of stormwater from areas of intermediate cover or final cover and provides the ability to redirect any contaminated surface water to the leachate system if found to be contaminated.

d. A leachate collection system at the base of the landfill from where it will be removed off site for treatment and disposal.

e. Design and installation of an appropriate groundwater and surface water monitoring network to confirm the effectiveness of the system, including monitoring wells outside the waste boundary]

3.4 Landfill Gas Collection and Management

Overview

LFG is a complex mixture of different gases produced predominantly from anaerobic degradation of biodegradable waste materials deposited within landfill sites. The emission rate and chemical composition of LFG varies depending on many factors including waste type, time, moisture content, temperature, etc. Fugitive or pathway specific LFG emissions can occur and can pose safety and environmental risks if not adequately managed.

LFG collection and destruction is required by the National Environmental Standards for Air Quality (Air Quality NES) Regulations 2004 for landfills designed to contain more than 1,000,000 tonnes of waste, in which the systems must be in operation before 200,000 tonnes of waste is placed. Based on the predicted waste stream of 60,000 tonnes per annum, it is anticipated that the gas collection and flaring system will need to be operable in the fourth year of waste disposal to meet these standards.

Objectives

1. Contain, capture, and control LFG through the progressive installation and operation of a landfill gas collection system in the active landfill areas and destruction of gas captured.
2. Comply with the LFG related requirements of the Air Quality NES and recommendations of the WasteMINZ Guidelines and the Ambient Air Quality Guidelines.
3. Ensure the health and safety of people on and beyond the site who may be at risk of being exposed to LFG emissions by addressing the prioritised risks identified by the preliminary LFG Risk Assessment.

Procedures

The following landfill gas procedures will be implemented during the detailed design and construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures that reflect the relevant landfill gas containment and management requirements of the final conditions of consent.

b. Progressive installation and appropriate construction quality assurance (CQA) of a low permeability basal and sidewall lining system which will reduce the likelihood of subsurface LFG emissions beyond the landfill liner system (either on site or off site).

c. Progressive installation of an active LFG collection, treatment and destruction system (i.e. gas extraction wells, pipework, manifolds, flares and/or engines) that is suitable for the quantity and quality of LFG emitted by the site as landfill development progresses.

d. Installation of a destruction system using flaring (with the possible future generation of electricity once LFG quantities are sufficient).

e. Design and installation of an appropriate LFG monitoring network to confirm the effectiveness of the system, including LFG monitoring boreholes/wells outside the waste boundary.

f. Buildings and structures on-site (but outside the landfill footprint) will be designed and constructed to minimise the risk of LFG entry and accumulation.

g. Subsurface services on-site will be designed and constructed in accordance with relevant standards in relation to LFG as applicable (e.g. AS/NZS 2381.1.1:2005).

3.5 Stormwater Management and Sediment and Erosion Control

Objectives

1. Land disturbance activities are to be undertaken in a manner that minimises sediment generation.
2. Sediment runoff from the site is effectively controlled so that the site does not contribute a disproportionate sediment load downstream in comparison to the catchment above McLaren Gully Road.
3. Infrastructure failure or damage, including that caused by extreme events such as weather and earthquakes, are promptly detected and remedied to ensure its operation, and to protect the receiving environment.

Stormwater and Erosion and Sediment Control Procedures

The following stormwater and erosion and sediment control procedures will be implemented during the detailed design and construction of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however, is expected to include:

a. Procedures which reflect the relevant stormwater and erosion and sediment control requirements of the final conditions of consent.

b. Preparation of a site-specific Water Management Plan (WMP) for the entire landfill catchment, and includes:

   i. Early attenuation basin and perimeter swale drain development, to ensure these principal runoff diversion features are installed from the outset.

   ii. Installation of Sediment Retention Ponds (SRPs), specifically designed to serve specific areas of the development (such as temporary stockpiling areas).

iii. Toe bund construction methods that ensure runoff predominantly occurs into the site and into stormwater control features and prevents uncontrolled runoff to the downstream receiving environment.

iv. Appropriate diversion of stormwater runoff is achieved around active earthworks and construction areas (during enabling/establishment phases).

v. Exposed soil surfaces will be minimised and will be protected by diversion/cut-off drains to reduce runoff over them, including temporary measures where practicable to minimise the transport of sediment from earthworks areas. Disturbed areas shall be stabilised with vegetation cover or by other means as soon as practicable.

vi. Suitable conveyance systems (channels, pipes, culverts) are in place to carry the stormwater to suitable treatment devices to remove any entrained sediment. These systems may comprise permanent systems (e.g. perimeter channels) or temporary systems as each stage is developed.

a. Adequate treatment systems are in place to remove sediment from stormwater at all stages of development and operation of the landfill.

b. Preparation of site-specific erosion and sediment control plan (ESCP) for each construction catchment which sit under the WMP and includes -

i. design and construction of surface water drainage channels and discharge structures that ensure sufficient sediment settlement capacity and scour protection.

ii. use of best practice soil stabilisation and sediment control measures to control discharges at source, such as silt fences, temporary diversion/contour swales, grassing, hydroseeding, protective matting etc.

iii. Stage area limitation: Excavation will be carried out on an “as required” basis to limit the footprint of soil disturbance at any one time and following excavation, surfaces will be protected as soon as possible.

iv. Localised control measures such as the use of filter socks or temporary silt dams in channels while works are under construction and there is potential for elevated sediment concentrations in runoff.

v. Regular surface water monitoring will be undertaken during construction to confirm and optimise sediment management efficacy.

3.6 Groundwater Management

Objectives

1. Control groundwater beneath the landfill liner through the installation and operation of a groundwater collection system.

Procedures

The following groundwater management procedures will be implemented during the detailed design and construction of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however, is expected to include:

a. Procedures which reflect the relevant groundwater management requirements of the final conditions of consent.

b. Design and installation of a network of subsoil drains beneath the lining system to alleviate groundwater pressures and provide sub-liner drainage protection for all stages of the landfill development.

c. Installation of a collection manhole fitted with a submersible pump to extract water for storage at the non-potable water supply reservoir located at the facilities area. The groundwater collection manhole will be otherwise be designed to discharge groundwater to the Ōtokia Creek catchment. In the event that unacceptable changes in groundwater quality are identified the pump will allow groundwater to be redirected for treatment as leachate.

d. Design and installation of an appropriate groundwater monitoring system]

3.7 Landfill Access

Objectives

1. Provide safe all weather access to the site.
2. Prevent unauthorised site access.
3. Traffic impacts and disruption to surrounding residents, neighbours, landowners, and road users are minimised.

Procedures

The following landfill access procedures will be implemented during the detailed design and construction of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however us expected to include:

a. Procedures which reflect the relevant access requirements of the final conditions of consent.

b. The site entrance and internal site access/haul roads linking the critical enabling works platforms (attenuation basin, toe embankment, stockpile areas and support facilities) will be formed in a logical sequence and as a site establishment priority.

c. An access track will be constructed around the landfill perimeter to provide 4-wheel drive access to the perimeter of the landfill for fence and swale drain construction and monitoring and maintenance purposes.

d. Perimeter security fencing, security gate controls and signage will be installed as a component of site establishment.

3.8 Construction Management

3.8.1 Supervision

Objectives

1. The construction of the landfill is supervised by a suitably qualified chartered professional engineer (CPE).

Procedures

The following supervision procedures will be implemented during the detailed design and construction of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator. All procedures will reflect the relevant supervision requirements of the final conditions of consent]

3.8.2 Construction Standards and Quality Assurance

Objectives

1. Landfill design and construction activities are undertaken in accordance with applicable New Zealand Standards relating to landfill construction (including geotechnical, lining system and drainage standards).
2. Earthwork materials will be placed as controlled engineered fill placed in accordance with good earthworks practices and under strict quality construction control and assurance procedures.
3. Landfill elements (liner, cover, leachate, and LFG systems) will be designed and constructed to at least the minimum thicknesses and standards recommended in WasteMINZ guidance for a Class 1 landfill facility.

Procedures

The following construction standards and quality control procedures will be implemented during the detailed design and construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with future landfill operator. All procedures will reflect the relevant construction standard and quality assurance requirements of the final conditions of consent]

3.8.3 Construction Hours

Objectives

1. Hours of construction of the landfill are managed to minimise the level and duration of disruption to neighbours in the surrounding area.

Procedures

The following construction hours procedures will be implemented during the construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Working hours during construction are to be limited to between 7:00 AM and 7:00 PM]

3.8.4 Archaeology

Objective

1. The construction of the landfill is managed to ensure that known and unknown archaeological values are retained where possible, or otherwise appropriately recorded.

Procedures

The following archaeology procedures will be implemented during the construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures which reflect the archaeology requirements of the final conditions of consent

b. Undertaking a baseline survey and periodic monitoring of archaeological sites I45/71 and I45/72 prior to the commencement of construction.

c. Constructing temporary site fencing around the standing structures at archaeological sites I45/71 and I45/72 to prevent inadvertent collisions with the standing structures, and to prevent unnecessary access.

d. Preservation of the standing structures at archaeological sites I45/71 and I45/72 as ruins.

e. An archaeological authority under Section 44 of the HNZPTA 2014 is obtained from the HNZPT prior to any modification of an archaeological site]

3.8.5 Dust Management

Objectives

1. Dust is controlled during the construction of the landfill to minimise the potential for off-site dust emissions as far as practicable.

2. Control dust so that there is no particulate matter that causes an objectionable effect at any building used for residential activity in existence at the date consent is granted.

3. Adequate water supply for dust suppression is maintained.

Procedures

The main activities that can lead to the generation of dust during the construction phase are:

- Earthworks for construction of the facilities areas, vehicle access, toe embankment, attenuation basin, and perimeter drainage.
- Earthworks associated with the construction of landfill cells.
- Vehicle movements on unpaved surfaces.
- Stockpiling of fill or aggregate.

Further construction will occur periodically during the operation of the site as project stages are developed with most of the activities outlined immediately above being undertaken within the landfill operational area.

The following dust management procedures will be implemented during construction of the landfill:

a. Visual dust inspections will be carried out on a regular basis throughout the day.

b. Watercarts or fixed sprinklers will be used to control dust generated from haul roads.

c. Where visual inspections find instances of dust leaving the boundary of the site, the intensity of dust control measures should be increased, including increasing dust suppression (watering) rate.

d. During high-wind speeds (wind speeds above 5 m/s) delay/reduce rate of works and/or further increase the rate of watering. Data collected by the on-site AWS will be used to inform site staff if wind speeds are above 5 m/s.

e. Establish vehicle speed limits (typically less than 15 km/hour) to reduce wheel generated dust emissions.

f. Where practicable, those parts of the site that are paved should be kept clean and free from waste and dust through regular sweeping and/or hosing down.

g. Controlling dust from any excavation by placing material directly into trucks where possible.

h. If material being excavated is very dry, using water sprays to increase surface moisture.

i. Where material is placed in temporary stockpiles, use water in dry windy conditions to control the dust potential or cover, if practicable, prior to re-use or long-term storage.

j. Limit the height of uncovered stockpiles to reduce wind entrainment. Stockpiles exceeding 3 m in height have a higher risk of discharging dust.

k. Long term stockpiles should be grassed or covered using other appropriate measures to avoid dust generation.

l. Take account of daily weather forecast wind speed, wind direction and spoil conditions before commencing dust generating activities.

m. Installation of appropriate temporary wheel wash facilities in advance of the permanent wheel wash being available to reduce impacts to local roads.

Content to be finalised following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator]

3.8.6 Traffic Management

Objectives

1. Traffic to, from, and within the landfill site is managed during construction to minimise the level and duration of disruption on the surrounding transport network, residents, neighbours, landowners and road users as much as practicable.

Procedures

The following traffic management procedures will be implemented during the construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, an in collaboration with a future landfill operator, however, will include:

a. Procedures which reflect the traffic management requirements of the final conditions of consent.

b. Preparation of a Construction Traffic Management Plan (CTMP)]

3.8.7 Noise Management

Objectives

1. Manage noise arising from activities on site to minimise disruption to property owners, neighbours and/or occupiers in the surrounding area.

Procedures

The following noise management procedures will be implemented during construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures which reflect the noise management requirements of the final conditions of consent

b. Working hours during construction are to be limited to between 7:00 AM and 7:00 PM

c. Construction activities are to be in compliance with condition 3 of the designation.

d. Equipment is to be selected, maintained and operated to minimise noise emissions and prevent noise sources that could potentially lead to annoyance.

e. Movable equipment involved with the construction of the landfill that typically stays on site for longer period(s) of time are to be fitted with broad band reversing alarms. Note: this provision does not strictly apply to equipment that arrives and departs site on a daily basis (e.g. delivery vehicles), although installation of broad-band reversing sirens on such visiting equipment is to be encouraged whenever practical as good acoustics practice.

f. Noise minimisation training is to form part of the site-induction program and include procedures for managing noise e.g. prevention of tailgates banging.

g. Implementation of a noise monitoring programme which includes specification of noise measuring equipment, measurement duration, recommended weather conditions, required schedule of measurements (e.g. periodic and at the commencement of an activity), location(s) requiring measurement and reporting requirements]

3.8.8 Hazardous Substances

Objectives

1. Ensure best practice management for the handling, storage and disposal of waste and hazardous materials.
2. Any spills of fuels, hazardous substances, or other contaminants are promptly contained and remediated.

Procedures

The following hazardous substances procedures will be implemented during construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures which reflect the hazardous substances management requirements of the final conditions of consent.

b. Undertake regular maintenance and systematic inspections of plant and equipment, with particular attention to hydrocarbon and other hazardous material storage areas to reduce the likelihood of equipment failure, spills and leaks.

c. In the event of a spill of fuel, hydraulic fluid, or any other potential contaminants, take immediate steps to contain and remove the spilt contaminant. The spilt contaminants and any material used to contain are to be disposed of in an authorised manner]

3.9 Ecological Management

Objectives

1. Adverse effects on vegetation, birds, lizards, and aquatic ecological values from construction are minimised.
2. Prevent clearance of indigenous vegetation and wetlands, and vehicle and machinery movements in areas of indigenous vegetation and wetlands outside the landfill operational footprint.
3. Disturbance of nesting eastern falcons are avoided or minimised.
4. Areas of suitable lizard habitat within the site are maintained.

Procedures

The following ecological procedures will be implemented during the construction of the landfill:

Terrestrial vegetation and wetlands

a. There is to no clearance of indigenous vegetation, earthworks, or landfill operations in West Gullies 1, 2, 3 and 4 as identified in the *Smooth Hill Ecological Impact Assessment Report, Boffa Miskell, May 2021*.

b. Construction operations are to be undertaken in accordance with the Vegetation Restoration Management Plan (see **Appendix 2**)

c. There is to be no vegetation clearance, earthworks, road widening and vehicle or machinery movements in areas of indigenous vegetation and wetland outside the ultimate footprint of the construction and landfill operation works.

d. Construction equipment is to be clean when entering and leaving the site to prevent the spread and introduction of weeds.

Birds

e. Enabling and construction works (tree felling; vegetation clearance, earthworks and the construction of roads and other infrastructure) within areas identified as potential falcon / kārearea habitat are to be undertaken in accordance with the management actions set out in the Falcon Management Plan (see **Appendix 5**).[1]

Lizards

f. Enabling and construction works shall be undertaken in accordance with the management actions set out in the Lizard Management Plan (see Appendix 4). The Lizard Management Plan:

   i. describes the key lizard habitats within the site;

   ii. The potential effects on lizards that may arise; and

   iii. The ways in which the effects can be managed (including the need for lizard salvage and release).

[Content to be finalised following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator]

3.10 Landscape Management

Objectives

1. Landscape and visual amenity effects from the landfill are minimised through perimeter planting of appropriate species.

Procedures

The following landscape procedures will be implemented during the construction of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures which reflect the landscape requirements of the final conditions of consent.

b. Perimeter landscape planting is to be implemented in accordance with the landscape mitigation plan in **Appendix 3]**

[1] Areas of potential falcon / karearea habitat are identified in Appendix 2 to the Falcon Management Plan (Appendix 5 to this LMP)

4.0 Landfill Operation

4.1 Access Control

Objectives

1. The landfill site is securely fenced, and gates closed outside of opening hours.
2. Allow only authorised and appropriately site-inducted (or supervised) workers, inspectors or visitors onto the landfill site.
3. Provide site security to ensure the safety of all persons on site and all procedural environmental safeguards are maintained.

Procedures

The following access control procedures will be implemented during the operation of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

1. Implementation of hours of operation.
2. Monitoring and maintenance of security fencing, security gate controls and signage.
3. Prevention of after-hours access via a locked gate at the site entrance.
4. During the hours of operation, access to landfill areas beyond the site entrance is to be via a controlled gate and/or barrier]

4.2 Waste Acceptance

Objectives

1. All landfill users are aware of the Waste Acceptance Criteria and acceptance procedures.
2. All waste received complies with the Waste Acceptance Criteria specified in the consent conditions.
3. Prevent the disposal of hazardous waste that does not comply with the Waste Acceptance Criteria specified in the consent conditions.
4. Accurate records of all waste accepted at the landfill, load inspections, and disposal locations are maintained.
5. All waste being transported to the landfill is securely contained to prevent the escape of solid material or liquid from the vehicle.

Procedures

The following waste acceptance procedures will be implemented during the operation of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

Waste Acceptance Criteria

a. Waste acceptance criteria which reflect the relevant requirements of the final conditions of consent.

Pre-approval of waste disposers

b. Waste disposers to complete a formal Waste Disposal Application and submit it to the landfill operator prior to becoming a user of the landfill; or before there is a change to the nature or the mass of the waste being disposed of at the landfill.

c. The landfill operator evaluating Waste Disposal Applications (including pre-assessment testing supplied by the disposer) to determine whether the waste meets the Waste Acceptance Criteria.

d. If a Waste Disposal Application is accepted, confirmation of a Waste Acceptance Agreement by the landfill operator and the disposer of the waste. The agreement will set out the requirements of the disposer in terms of any pre-treatment and landfill access restrictions and rights of the landfill operator to inspect, challenge, sample, test and, if necessary reject waste.

e. Waste will only be accepted at the landfill from disposers who hold a valid Waste Acceptance Agreement confirming the material in the disposer's load meets the waste acceptance criteria for the landfill.

f. Waste disposers will be required to provide evidence of their Waste Acceptance Agreement to the landfill operator at the weighbridge.

Acceptance procedure

g. Trucks arriving at the landfill will be directed to the weighbridge. The landfill operator will check the disposer's Waste Acceptance Agreement and weigh the waste.

h. Any disposer who does not hold a valid Waste Acceptance Agreement will be turned away.

i. Disposers who are transporting loads of dust generating wastes will be required to dampen down these loads prior to delivery to the landfill.

j. Random inspections of incoming loads for the presence of hazardous waste will be undertaken, and records of these inspections will be kept.

k. If a random inspection of a load of incoming waste identifies any unacceptable wastes, the landfill operator shall turn the delivery away, make a record of the waste collection operator; the date; and the type(s) of unacceptable wastes present in the load; and notify the ORC]

4.3 Placing of Refuse

Objectives

1. Ensure that the life of the landfill is maximised.
2. Placement of waste in the landfill ensures waste and landfill stability.
3. Protection of the landfill liner from waste tipping and compaction activity.
4. A small as practicable working landfill face is maintained.

5. Minimise odour, birds, pests and litter.
6. All waste is covered with appropriate daily and intermediate cover material.

Procedures

The following refuse placing procedures will be implemented during the operation of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures which reflect the relevant refuse placement requirements of the final conditions of consent.

Staging, cells and the tipping face

b. Operating cells within each stage will be limited to avoid excessive percentages of cover soils to waste.
c. Alternative tipping cells should be available in case of high winds.
d. The landfill operator shall minimise the width of the tipping face.

Placement of waste

e. Waste shall only be placed within the landfill liner extent.
f. Tipping of all waste shall be supervised.
g. If inappropriate loads are identified once they have been tipped from the vehicle, immediate steps will be taken to separate and secure the waste. Contingency plans for identification of the waste and special handling procedures will be implemented immediately.
h. The placement of waste will be managed to ensure that operations do not damage the landfill liner and leachate system
i. Potentially odorous loads will be covered as soon as possible.
j. Dust generating waste will be treated as a special waste. The customer will be required to dampen down the load prior to delivery to site, and specific controls to be implemented at the disposal point e.g. water sprays, waste pit.
k. Waste which has significantly different compressibility properties from the surrounding waste will not be placed within close proximity of the final cover layer to avoid sharp differential settlement which could affect the integrity of the cap.
l. Special waste which has implications for health and safety (such as asbestos) will not be placed within close proximity of the underneath of the final cover to prevent accidental disturbance during capping and underground services works.
m. Where placement of waste occurs over an area of intermediate cover the cover will be adequately penetrated or removed to render the surface permeable to gas and leachate.

Special and/or Hazardous Waste

n. Requirements set out in section 4.2 for medical waste, asbestos and hazardous wastes that meet the Ministry for the Environment Module 2: Hazardous Waste Guidelines – Class A.

Compaction

o. Compaction is undertaken using specialised heavy mobile equipment to minimise voids in the waste mass and ensure efficient use of the landfill volume available.

p. Waste will be placed and compacted to ensure that unconfined faces are stable and capable of retaining cover material.

Cover

q. Daily cover of a depth consistent with the consent conditions, will be placed to ensure that waste is not exposed outside of operating hours (and will not remain exposed overnight).

r. Intermediate cover of a depth consistent with the consent conditions will be placed over areas of the landfill where there will not be any waste placement for a period of at least three months.

s. When each stage of the landfill is completed, a final cover layer will be placed over that part of the landfill, consistent with the consent conditions]

4.4 Leachate Management

Objectives

1. Minimise the volume of leachate that is produced.
2. Leachate is managed and contained within the landfill footprint through the use of a high-performance landfill liner, and provision of an on-site leachate collection and storage system, to limit/reduce any risk of migration into the underlying soil, groundwater, and surface water.
3. The risks of excessive liner hydration are minimised.
4. Safe disposal of leachate off-site.
5. Leachate transport occurs with an incident contingency plan which meets the Ministry of the Environment Code of Practice for Transport of Hazardous and Liquid Waste.
6. Infrastructure failure or damage, including that caused by extreme events such as weather and earthquakes, are promptly detected and remedied to ensure its operation, and to protect the receiving environment.

Procedures

The following leachate management procedures will be implemented during the operation of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures which reflect the relevant leachate management requirements of the final conditions of consent.

b. Redirecting upslope surface water from entering the leachate collection system.

c. Minimising the size of the active filling area where waste is exposed to rainfall.

d. Covering areas with intermediate or final cover as soon as is practicable so that as much water as possible is shed into a stormwater collection system and minimising percolation of water through these layers into the underlying waste

e. Providing well managed stormwater systems to separate all stormwater flow from areas where waste is placed and ensuring all site stormwater is diverted away from waste.

f. Removal of leachate off site for treatment and disposal].

g. Implementation of an appropriate groundwater and surface water monitoring program to confirm the effectiveness of the system.

4.5 Landfill Gas Management

Objectives

1. Contain, capture, and control LFG through the progressive installation and operation of a landfill gas collection system in the active landfill areas.
2. Optimise the overall quantity of LFG collected from the deposited waste to minimise fugitive emissions and LFG related odour.
3. Comply with the LFG related requirements of the Air Quality NES and recommendations of the WasteMINZ Guidelines and the Ambient Air Quality Guidelines.
4. Ensure the health and safety of people on and beyond the site who may be at risk of being exposed to LFG emissions by addressing the prioritised risks identified by the preliminary LFG Risk Assessment.
5. The destruction of recovered LFG by combustion or electricity generation.
6. Erosion and damage of the landfill cap is minimised.
7. Infrastructure failure or damage, including that caused by extreme events such as weather and earthquakes, are promptly detected and remedied to ensure its operation, and to protect the receiving environment.

Procedures

The following landfill gas management procedures will be implemented during the operation of the landfill:

[Content to be included following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator, however, will include:

a. Procedures which reflect the relevant landfill gas management requirements of the final conditions of consent.

b. Operation and monitoring of an active LFG collection, treatment and destruction system (i.e. gas extraction wells, pipework, manifolds, flares and/or engines) as landfill development progresses.

c. Operation of a destruction system using flaring (with the possible future generation of electricity once LFG quantities are sufficient).

d. Implementation of an appropriate LFG monitoring program to confirm the effectiveness of the system, including from LFG monitoring boreholes/wells outside the waste boundary and regular surface monitoring of methane emissions from the completed cap.

e. Appropriate work, health and safety procedures will be developed and implemented in relation to situations where workers/site users may be at risk of being exposed to LFG emissions]

4.6 Stormwater Management and Sediment and Erosion Control

[Operational Stormwater management will be performed as an extension of the systems and procedures implemented in the construction and enabling works phases of the development]

Objectives

1. The ingress of stormwater into open and closed sections of the landfill is minimised.
2. Stormwater that comes into contact with waste is directed to the leachate collection system.
3. Land disturbance activities are to be undertaken in a manner that minimises sediment generation.
4. Sediment runoff from the site is effectively controlled so that that site does not contribute a disproportionate sediment load downstream in comparison to the catchment above McLaren Gully Road.
5. Erosion and damage of the landfill cap is minimised.
6. Infrastructure failure or damage, including that caused by extreme events such as weather and earthquakes, are promptly detected and remedied to ensure its operation, and to protect the receiving environment.

Stormwater and Erosion and Sediment Control Procedures

The following stormwater and erosion and sediment control procedures will be implemented during the operation of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however is expected to include:

a. Procedures which reflect the relevant stormwater and erosion and sediment control requirements of the final conditions of consent.

b. Preparation of a site-specific Water Management Plan (WMP) for the entire landfill catchment, and includes:

   i. Appropriate diversion of stormwater runoff is achieved around active landfill development and filling areas. Any stormwater that interacts with landfill wastes shall be captured and treated as leachate.

   ii. Exposed soil surfaces will be minimised and will be protected by diversion/cut-off drains to reduce runoff over them, including temporary measures where practicable to minimise the transport of sediment from operational areas.

iii. Suitable conveyance systems (channels, pipes, culverts) are in place to carry the stormwater to suitable treatment devices to remove any entrained sediment. These systems may comprise permanent systems (e.g. perimeter channels) or temporary systems as each stage is developed.

iv. Adequate treatment systems are in place to remove sediment from stormwater at all stages of development and operation of the landfill.

v. Regular inspections of the stormwater system to ensure separation of clean and leachate or sediment contaminated stormwater, before and after significant rainfall events.

c. The stormwater collection system shall incorporate practicable measures to re-direct contaminated stormwater to the leachate system to reduce risks of surface water contamination. Preparation of site-specific erosion and sediment control plan (ESCP) for each construction catchment which sit under the WMP and includes -

i. design and construction of surface water drainage channels and discharge structures that ensure sufficient sediment settlement capacity and scour protection.

ii. use of best practice soil stabilisation and sediment control measures to control discharges at source, such as silt fences, temporary diversion/contour swales, grassing, hydroseeding, protective matting etc.

iii. Regular surface water monitoring will be undertaken during operational phases to confirm and optimise sediment management efficacy and to confirm the absence of leachate impacts in surface water discharges]

4.7 Groundwater Management

Objectives

1. Control groundwater beneath the landfill liner through the installation and operation of a groundwater collection system.

Procedures

The following groundwater management procedures will be implemented during the operation of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however is expected to include:

a. Procedures which reflect the relevant groundwater management requirements of the final conditions of consent.

b. Implementation of an appropriate groundwater monitoring program to confirm the effectiveness of the system.

c. Regular inspections of the groundwater collection system.

d. Where monitoring of groundwater indicates unacceptable changes in groundwater quality, the groundwater will be intercepted and re-directed as leachate]

4.8 Site Internal Roading

Objectives

1. Provide safe all-weather access to the landfill for placement of waste.

Procedures

The following internal roading procedures will be implemented during the operation of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however is expected to include:

a. Procedures which reflect the relevant internal roading management requirements of the final conditions of consent.

b. Temporary aggregate access roads will be constructed on the landfill to provide passage of the waste delivery trucks. These temporary access roads will be amended regularly as the waste is placed and the level of the waste increased as the cell is progressively filled]

4.9 Landfill Facilities

Objectives

1. Landfill facilities are provided and maintained that provide for the effective functioning of the site.

Procedures

The following facilities will be provided for the operation of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however is expected to include:

a. Procedures which reflect the relevant facilities requirements of the final conditions of consent.

b. Installation and operation of the necessary facilities at the landfill including:

   i. Site Office and Staff Amenities

   ii. Potable and non-potable (including fire-fighting) water storage

   iii. Maintenance workshops

   iv. Weighbridge facilities

   v. Wheel Wash facilities

   vi. Leachate storage tanks, odour suppression beds and tanker loading bay

   vii. LFG Flare, and possible future Energy Generation

c. Operation and maintenance of the site facilities]

4.10 General Amenity Management

Objectives

1. Prevent windblown litter outside the site boundaries.
2. Maintain a clean and tidy site.

Procedures

The following general amenity procedures will be implemented during the operation of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however is expected to include:

a. Procedures which reflect the relevant requirements of the final conditions of consent.

b. Procedures for keeping the site neat and ensuring that no litter is allowed to blow off the site, including maintaining screen fencing at the tip face as required to reduce windblown litter over and around the site]

4.11 Odour Management

Objectives

a. Minimise and control odours so that there is no odour that causes an objectionable effect at any building used for residential activity in existence at the date consent is granted.

b. As small as practicable working landfill face is maintained to minimise odour.

c. Potentially highly odorous waste deliveries are identified prior to disposal.

d. All waste is covered with appropriate daily and intermediate cover material to minimise odour.

Procedures

The following odour procedures will be implemented during the operation of the landfill:

Waste Acceptance

a. Implementing protocols to forewarn of the arrival of odorous wastes so that preparations can be made to cover waste as soon as its placed.

b. Transporting refuse to the site in sealed truck and trailer units or bins.

c. Treating wastewater biosolids (stabilised with lime or equivalent treatment) prior to arriving at the site.

d. Training weighbridge staff to identify and hold unexpected highly odorous deliveries until such time as measures are in place to enable acceptance and cover of the waste immediately.

Waste Handling and Landfill Management

e. Implementing and maintaining good housekeeping standards on the site.

f. Keeping the size of the landfill working face to a minimum.

g. Locating the refuse tip head close to the refuse placement area to avoid pushing the refuse a long distance that would increase odour potential.

h. Landfill cells will be filled from the base of the valley.

i. Covering waste at the end of each working day so no refuse is exposed overnight.

j. Mowing landfill surfaces that are grassed to allow effective surface emission monitoring, prior to times when that monitoring is being undertaken.

k. Undertaking instantaneous surface monitoring (ISM) on a regular basis to identify any areas of capping that need to be remediated.

l. Scheduling activities such as extensive excavations into old waste (only undertaken under exceptional circumstances) to days when wind direction is away from sensitive receptors.

m. Conducting regular walk-over inspections of the landfill to identify any damage to the cover system and to monitor the effectiveness of the mitigation measures employed.

Highly odorous waste disposal control procedures (e.g. biosolids or offal)

n. Arranging deliveries so that trucks are not waiting outside the gate prior to the landfill opening for the day.

o. Arranging deliveries of highly odorous waste to arrive during the middle part of the day, as this time of day generally provides better odour dispersion conditions.

p. Prioritising deliveries of highly odorous waste directly to the tip-head.

q. Locating placement areas as far as practicable from the nearest sensitive receptors.

r. Locating a stockpile of suitable cover material near to the disposal area to allow the waste to be immediately covered.

s. Completely emptying bins as far as practicable to minimise the amount of residual material retained in the bin which can cause odour nuisance as the truck leaves the site.

t. Investigation of odour complaints to determine the contributing factors and identification of improvements to odour control procedures. Potential odour sources include:

    i. Refuse odours from tipped waste or material awaiting tipping;

    ii. Storage of leachate;

    iii. Odour from highly malodorous specific wastes,

    iv. Excavation activities into previously placed waste; and;

    v. Landfill gas.

u. If it is determined that all odour mitigation measures were being implemented effectively at the time of the complaint and that the complaint is directly attributed to the placement of highly odorous waste, then waste from this customer will no longer be accepted until it can be demonstrated that the level of odour from the waste has reduced to acceptable levels.

Measures to identify and control excessive abnormal odour.

Should excessive odour be generated by the landfill from abnormal operation, implementing a staged approach to identifying and remediating the cause of odour, including:

v. Identifying and covering odorous waste.

w. Stop further deliveries from any identified source of the odorous waste.

x. Redistribute odour sprayers.

y. Alter the odour spray chemical dose rate.

z. Repair obvious leaks in gas system.

aa. Repair obvious deficiencies in the landfill cover.

bb. Move the tipping to a remote area until wind is favourable.

cc. Undertake surface emissions survey.

[Content to be finalised following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator]

4.12 Dust Management

[Operational dust management will be performed as an extension of the systems and procedures implemented in the construction and enabling works phases of the development – refer Section 3 for further details]

4.13 Noise Management

[Operational noise management will be performed as an extension of the systems and procedures implemented in the construction and enabling works phases of the development – refer Section 3 for further details]

4.14 Bird Management

Objective

1. The attractiveness of the landfill to birds is reduced, and bird numbers are kept to very low levels in accordance with a Bird Management Plan.

Procedures

The following procedures will be implemented during operation of the landfill to manage birds:

a. Operation of the Smooth Hill Landfill will be undertaken in accordance with the procedures set out in the Bird Management Plan (see **Appendix 1**). The Bird Management Plan:

   i. Sets out key roles and responsibilities for managing birds at the Smooth Hill Landfill;

ii. Describes operational procedures that should be followed to avoid the establishment of bird populations at the Smooth Hill Landfill (e.g. requirements around daily cover of placed waste; minimising areas of pooled water etc.);

iii. Sets out a sequence of deterrence and control methods that should be employed if specified bird population thresholds at the Smooth Hill Landfill are exceeded (e.g. anti-roosting strips, shooting birds, colony control);

iv. Record keeping requirements; and

v. Monitoring requirements.

[Content to be finalised following issuing of consents and as part of detailed design, and in collaboration with a future landfill operator]

4.15 Pest Management

Overview

The operation of the landfill has the potential to result in the following issues relating to pests:

1. An increase in fly numbers during the summer months, particularly when there are delays between the collection and deposition of waste. Eggs laid in putrescible waste may hatch over this period.
2. An increase in rodent populations due to the increase in food supplies at the landfill; which can also lead to impacts on native species and neighbouring land occupiers.
3. Uncontrolled weeds across the wider site may pose a risk to newly developed plantings and existing areas of biodiversity, as well as posing a potential source of seed that may create issues for neighbouring properties.
4. Predatory animals (rodents, mustelids (stoats, ferrets and weasels), and possums) may be attracted to the site, leading to impacts on native species, particularly lizards.
5. Browsing and grazing animals (ungulates (hoofed animals e.g. pigs and goats), rabbits and possums) may impact existing biodiversity, damage new plantings and pose a risk of immigration to neighbouring properties.

Objectives

1. Ensure the landfill meets its obligations under the Regional Pest Management Plan for Otago (**RPMP**), including its obligations to abide by the Good Neighbour Rules.
2. Minimise pest populations at the landfill.
3. Control pests to enhance existing biodiversity across the wider Smooth Hill Site.
4. Protect new plantings and restoration areas from the impacts of animal pests and weed infestations.

Procedures

The following pest management procedures will be implemented during the operation of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however is expected to include:

a. Procedures which reflect the relevant requirements of the final conditions of consent.

b. Undertaking monitoring of rodent and mustelid populations (stoats, ferrets and weasels) to inform the most appropriate pest control methods for these populations and establish a baseline.

c. Fencing the high value biodiversity sites within the designation boundary to exclude large pest animals (e.g. pigs and goats) from these areas.

d. Preparation and implementation of a detailed Pest Control Programme which -

    i. Establish a rodent control network around the landfill site which reflect industry best practice.

    ii. Establish a predator (mustelids, possum and rat) trapping network across the wider site to protect native species.

    iii. Control weeds as needed to enhance existing areas of biodiversity and allow new plantings to establish free of competition. Prompt compaction of waste and application of cover soil.

    iv. Weed control in all plantings and high value habitats, and control of any weeds as required by the RPMP.

    v. Control of the pig and goat population if needed to ensure there is no unacceptable damage to the site, high value habitats or new plantings. Also, ensure that these pests do not impact on neighbouring properties.

    vi. Control of the rabbit population to ensure that the population remains at or below Level 3 on the Modified Mclean Scale.

    vii. In particularly severe cases of fly infestations, application of insecticides]

4.16 Hazardous Substances

[Operational hazardous substances management will be performed as an extension of the systems and procedures implemented in the construction and enabling works phases of the development – refer section 3 for details]

4.17 Ecological Management

[Operational ecological management will be performed as an extension of the systems and procedures implemented in the construction and enabling works phases of the development – refer section 3 for details]

4.18 Landscape Management

[Operational landscape management will be performed as an extension of the systems and procedures implemented in the construction and enabling works phases of the development – refer section 3 for details]

4.19 Incident Management

Objectives

1. Ensure landfill incidents including any escape of leachate or other contaminants, release of hazardous substances, fire, or other event that may adversely affect the receiving environment and surrounding properties are rapidly responded to and managed.
2. Ensure infrastructure failure or damage, including that caused by extreme events such as weather and earthquakes, are promptly detected and remedied to ensure its operation, and to protect the receiving environment.
3. Prevent landfill fires from occurring.
4. Adequate water storage for fire-fighting is maintained.
5. Ensure that adequate fire control equipment is present on site and operable at all times.
6. Maintain a Fire Plan in conjunction with Fire and Emergency New Zealand (FENZ).

Procedures

The following incident management procedures will be implemented during the operation of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however is expected to include:

a. procedures which reflect the relevant requirements of the final conditions of consent].
b. Procedures for fire prevention, including keeping and maintaining appropriate fire-fighting equipment on site in serviceable order.
c. Providing on site storage of water for fire fighting purposes]

5.0 Landfill Closure and Aftercare

Prior to the end of the life of the landfill a Landfill Closure and Aftercare Plan will be prepared to detail the activities required for closure of the landfill and the aftercare period. In general terms, the following issues will be addressed.

Objectives:

1. The landfill site is reinstated to a final form and end use compatible with the surrounding environment.
2. Effective ongoing operation and maintenance of the landfill cap, groundwater and leachate collection, stormwater, and landfill gas management systems.
3. Ensure ongoing environmental monitoring in accordance with resource consent requirements.

Procedures:

The following procedures will be implemented during the closure and aftercare of the landfill:

[Content to be drafted following issuing of consents, as part of detailed design and in collaboration with future landfill operator, however is expected to include:

a. Procedures which reflect the relevant requirements of the final conditions of consent.

b. Preparation of a Landfill Closure Plan and Aftercare Plan.

c. Progressive construction of the final capping system following completion of filling in any area.

d. Grading the completed stockpile sites to conform to the adjacent topography, revegetated, and any stormwater systems disestablished.

e. Establishment of final permanent stormwater features, including contoured swales on the landfill cap draining to the perimeter drain and attenuation basin.

f. Removal of all facilities not required during the landfill aftercare period.

g. Ongoing provision of aftercare activities comprising:

    i. Ongoing operation and maintenance of the LFG collection and treatment system

    ii. Ongoing operation and maintenance of the leachate collection, treatment and disposal system.

    iii. Maintenance of the site stormwater systems

    iv. Maintenance of the landfill cap, including filling any areas that may have been subject to differential settlement, and repair of any surface erosion and maintenance of vegetation as required

    v. Maintenance of any remaining site infrastructure, including fences.

    vi. Ongoing environmental monitoring as required by consents.

    vii. Any reporting required by consents.

    viii. Responding to contingent events as set out in the Landfill Closure Plan]

6.0 Monitoring, Records and Reporting

[This section of the LMP will set out the various monitoring, record-keeping and reporting requirements for various aspects associated with the pre-construction, construction, operation, and closure and aftercare phases of the landfill.

Monitoring of landfills is necessary to confirm that they are performing as expected, in accordance with the design, operational practices and regulatory requirements; and that discharges are not resulting in, or likely to result in, adverse effects on the environment.

The primary areas of focus for the landfill monitoring programme will:

– Leachate

– Stormwater

– Groundwater

– Surface water

- Landfill gas
- Landfill stability
- Landfill cap integrity; and
- Waste Acceptance

In addition to these areas of focus, monitoring at the landfill will also include:

- Birds
- Lizards
- Pests
- Odour
- Noise
- Waste acceptance

The section is expected to include procedures which reflect the relevant monitoring requirements of the final conditions of consent. This includes, but is not limited to procedures for the monitoring, recording, and reporting set out in the following table:

Component	**Proposed Monitoring**	**Reporting**
Weather	Baseline and operational monitoring of wind speed and direction, temperature, relative humidity, and rainfall.	
Groundwater	Rate and volume of water taken from groundwater collection system, and volume of water conveyed to non-potable water storage.	Annually to ORC.
	Baseline and operational monitoring of groundwater quality from monitoring bores GW1 – GW6 to detect for leachate.	Baseline as part of approval of monitoring trigger levels. Operational annually to ORC, and within 2 weeks of any exceedance of trigger levels.
	Operational monitoring of water from groundwater collection system prior to discharge to the Ōtokia Creek or abstraction for non-potable supply to detect for leachate.	Operational annually to ORC, and within 2 weeks of any exceedance of trigger levels.
Surface Water	Baseline and operational monitoring of surface water quality at monitoring points SW1 – SW7 to detect for leachate, suspended solids, and turbidity.	Baseline as part of approval of monitoring trigger levels. Operational annually to ORC, and within 2 weeks of any exceedance of trigger levels.
	Operational monitoring of water from the stage 1 sediment retention pond prior to	Operational annually to ORC, and within 2 weeks of any exceedance of trigger levels.

	discharge to the Ōtokia Creek to detect for leachate, suspended solids, and turbidity.	
Landfill Gas	Baseline and operational monitoring of landfill gas monitoring bore network and surface of the final landfill cap.	Baseline as part of approval of monitoring trigger levels. Operational annually to ORC and within 2 weeks of any exceedance of trigger levels.
Landfill Stability	Regular engineering inspections.	Annually to ORC.
Landfill Cap Integrity	Regular walkover inspections.	Annually to ORC.
Odour	Operational monitoring for objectionable odour.	Annually to ORC.
Dust	Construction and operational monitoring for objectionable odour.	Annually to ORC.
Noise	Construction and operational monitoring for exceedance of relevant noise standards.	Annually to ORC.
Waste	Quantities and types of wastes accepted. Load inspections Location of special wastes deposited in landfill.	Annually to ORC.
Birds	As set out in the Bird Management Plan.	Annually to ORC.
Terrestrial Vegetation	As set out in the Vegetation Restoration Management Plan.	Annually to ORC.
Falcons	As set out in the Falcon Management Plan.	Annually to ORC.
Lizards	As set out in the Lizard Management Plan.	Annually to ORC.
Incidents	Events or incidents, including their nature, response, and follow up actions implemented.	Following event to ORC.
Complaints	Complaint's log.	On request to ORC.

The following sections will be completed in detail following the issuing of consents, and as part of detailed design and in collaboration with future landfill operator]

6.1 General Requirements

6.2 Groundwater and Surface Water Monitoring

6.3 Landfill Gas Monitoring

6.4 Bird and Ecological Monitoring

6.5 Odour Monitoring

6.6 Noise Monitoring

6.7 Waste Acceptance and Placement Monitoring

6.8 Emergency Management

6.9 Annual Reporting

[Section will capture annual reporting requirements set out in the consent conditions]

Appendix 1: Bird Management Plan

AVISURE
safety | aviation | wildlife

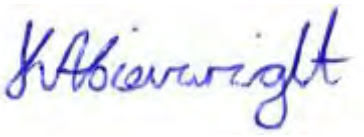
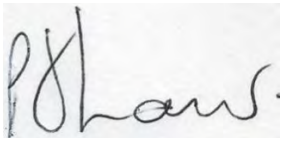
Boffa Miskell

Smooth Hill Landfill – Bird Management

Draft Management Plan
Prepared for Dunedin City Council

4 June 2021

Document Quality Assurance

<table>
<tr><td colspan="3">Bibliographic reference for citation:
Boffa Miskell Limited and Avisure 2021. Smooth Hill Landfill – Bird Management: Draft Management Plan. Report prepared by Boffa Miskell Limited and Avisure for Dunedin City Council.</td></tr>
<tr><td rowspan="2">Prepared by:</td><td>Karin Sievwright
Ecologist / Professional
Boffa Miskell Limited and Avisure</td><td>  </td></tr>
<tr><td>Kylie Patrick
Principal Consultant
Avisure</td><td>  </td></tr>
<tr><td rowspan="2">Reviewed by:</td><td>Phil Shaw
Principal Aviation Ecologist | Managing Director
Avisure</td><td>  </td></tr>
<tr><td>Tanya Blakely
Senior Ecologist | Senior Principal
Boffa Miskell Limited</td><td>  </td></tr>
<tr><td>Status: DRAFT</td><td>Revision / version: A</td><td>Issue date: 4 June 2021</td></tr>
<tr><td colspan="3">Use and Reliance
This report has been prepared by Boffa Miskell Limited on the specific instructions of our Client. It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Boffa Miskell does not accept any liability or responsibility in relation to the use of this report contrary to the above, or to any person other than the Client. Any use or reliance by a third party is at that party's own risk. Where information has been supplied by the Client or obtained from other external sources, it has been assumed that it is accurate, without independent verification, unless otherwise indicated. No liability or responsibility is accepted by Boffa Miskell Limited for any errors or omissions to the extent that they arise from inaccurate information provided by the Client or any external source.</td></tr>
</table>

Template revision: 20180621 0000

File ref: BM19099C_005_Smooth_Hill_Interim_Bird_Management_Plan_Updates_20210525_KS_Avisure.docx

File ref:
U:\2020\BM200252_REa_Smooth_Hill_landfill-post_lodgement\Documents\Ecology\BM200252_009a_Smooth_Hill_Falcon_Management_Plan_20210604.docx

Cover photograph: Proposed Smooth Hill landfill location, © BML, 2019

Contents

1.0 Introduction 3

1.1 Background Information 4

1.1.1 Attraction of birds to landfills and bird strike risk with aircraft 4

1.1.2 Importance of this plan 5

2.0 Operational Procedures 6

2.1 Reducing putrescible / organic waste 6

2.2 Good daily cover 7

2.3 Minimising the extent of the active tip face 7

2.4 Minimising open earthworks and pools of water 8

2.5 Reducing barren areas 8

3.0 Bird Deterrence and Control Methods 8

3.1 Bird Number Threshold Levels 9

3.2 Deterrence methods 9

3.2.1 Disperse birds from the active tip face 9

3.2.2 Anti-roosting strips on structures 9

3.3 Lethal methods 9

3.3.1 Shooting 10

3.3.2 Poisoning 11

3.3.3 Colony control 11

3.4 Further Bird Management Options 12

3.4.1 Installation of wires above the landfill 12

3.4.2 Baling waste 12

3.4.3 Installation of a net over the landfill 12

4.0 Bird Management and Control Registers 13

5.0 Bird Monitoring 13

5.1 Monitoring regime 14

5.1.1 On-airport surveys 14

5.1.2 Off-airport surveys 14

5.1.3 Green Island landfill surveys 15

5.1.4 Smooth Hill landfill surveys 15

5.1.5 Monitoring records and analysis 16

5.2 Training 16

6.0 Risk Assessment 16

7.0 Managing Black-Backed Gulls in the Dunedin Area 17

8.0 Review and Updating of the Plan 17

9.0 Communication with Dunedin Airport 18

10.0 Summary of Key Messages 18

11.0 References 20

1.0 Introduction

This draft Bird Management Plan (BMP) describes the bird management for operation of the Smooth Hill Landfill, located 4.5 km southeast of Dunedin Airport. It is a draft plan, given that some details about the components of the waste stream, delivery and operation of Smooth Hill landfill are yet to be finalised. Prior to operation of the landfill, this plan will be updated to reflect finalised details and procedures. It will also be updated to include action plans on how to manage different bird species at the landfill, standard operating procedures for the different deterrence and control methods included in this plan, key performance indicators, and roles and responsibilities. Examples of the latter two components are provided in Appendix 1.

This BMP is one of a suite of ecological management plans and is to be read in conjunction with the draft Landfill Management Plan (LMP), which has been prepared as part of the consent application documents for the construction, operation, closure and aftercare of the Smooth Hill Landfill.

The BMP is based on information provided in scientific (and unpublished) literature, landfill best practise documentation, a Smooth Hill preliminary bird hazard assessment prepared by Avisure (Avisure, 2021), and communications had with personnel involved with other landfills in New Zealand. Adaptive management will be applied as necessary. For example, if a better way of undertaking a bird control technique is found, or learned through conversations had with other landfill personnel, then this will be applied so that bird deterrence and control is maximised and conducted in the most effective manner.

Prior to the commencement of operation, the following will be arranged:

- A “Bird Control Officer” will be assigned who is responsible for overseeing bird management at the site and is the “go to” person for people to report black-backed gull sightings and other bird-related observations.
- A marksman / shooter will be on-site for when black-backed gulls are observed (black-backed gulls are Not Threatened and are not protected under the Wildlife Act). This person will be trained in bird identification, have a gun license and be registered with the Department of Conservation (DOC; among other things outlined in Section 3.3.1).
- A dedicated small team of personnel will be trained in techniques to deter birds from the active tip face. This component of the plan could be provided in-house or contracted out.
- Suitable netting and support material for enclosing the landfill (if bird control escalation is required) will be identified and a plan will be put in place for installation, detailing the supplier, installer, cost, etc.
- A suitably qualified and experienced ecologist / ornithologist will be engaged to complete and analyse bird monitoring data and assess risk.
- Health and safety documentation for specific activities that relate to bird control on site (e.g. shooting gulls, poison use, etc).

1.1 Background Information

1.1.1 Attraction of birds to landfills and bird strike risk with aircraft

A number of bird species are attracted to landfill sites, particularly scavenging species such as gulls. This is because landfills can provide a foraging opportunity for birds if putrescible (organic) waste is exposed and not managed well. Birds may also use landfill grounds for roosting and breeding (Centre for Advanced Engineering, 2000; ISWA Working Group for Landfill, 2010; Queensland Department of Environment and Resource Management, 2010; Ryder Environmental Limited, 2019; Stantec, 2019; Waste Management NZ Ltd, 2018). It is important that these bird foraging, roosting and breeding opportunities are reduced as much as possible at landfill sites. Birds can be a nuisance to people in neighbouring properties (e.g. noise, fouling), can present a potential health risk (via the transfer of pathogens and contaminants) (Cook et al., 2008; Ryder Environmental Limited, 2019; Waste Management Institute New Zealand, 2018), and can increase bird strike risk with aircraft if the landfill is located near an airport (Belant et al., 1995; Cook et al., 2008; Ryder Environmental Limited, 2019).

Given the isolated, rural location of the Smooth Hill Landfill, public nuisance and contamination effects are not a major concern[1]. However, the risk of bird strike with aircraft is of concern, given that the landfill is approximately 4.5 km from Dunedin Airport and is within the Airport's flight fan (see Figure 1). The consequences of wildlife strike with aircraft can be very serious. In the extreme, wildlife strikes can cause human fatalities, injuries, aircraft loss and damage. The New Zealand Civil Aviation Authority (NZ CAA) and International Civil Aviation Organisation (ICAO) '…recommends that refuse dump sites be located no closer than 13 km from the airport property" (Civil Aviation Authority of New Zealand, 2008). These statements are guidance only and not regulated. The guidance applies to all Part 139 aerodromes, including Dunedin Airport[2]. Consequently, it is of the utmost importance that landfills within 13 km of airports (i.e. Smooth Hill) are carefully planned, monitored and operated appropriately to mitigate bird strike risk and manage this risk to acceptably low levels.

The species of most concern at the Smooth Hill Landfill is black-backed gull. This is because they are large, common, flocking birds that fly to and from the coast and Taieri Plains, including over and in the vicinity of the landfill site and around Dunedin Airport. Black-backed gulls are also the species most attracted to landfills with putrescible (organic) waste[3] and are at risk from strike with aircraft. There is a large local population of black-backed gulls in Dunedin, including at least 3,000 birds at Green Island Landfill, which is proposed to close in the next few years. These birds will be seeking an alternative food source when Green Island Landfill closes and thereby may be attracted to Smooth Hill Landfill if food is readily available and accessible. If black-backed gulls establish a population at Smooth Hill Landfill, this would increase aviation strike risk.

Other species that may use the landfill, and / or associated infrastructure (e.g. water retention basins) that have been identified as posing a low to moderate aviation strike risk are mallard ducks, red-billed gulls, harrier hawks and starling (Avisure, 2021).

[1] This is because there are few houses in close proximity to the landfill as a result of the rural context of the area, and bird control management and methods will minimise attractiveness of the landfill to birds and thereby further minimise potential nuisance and contamination effects.

[2] Additional information on requirements and recommendations for managing land use near airports is provided in Appendix 2.

[3] Putrescible waste is a solid waste that contains organic matter capable of being decomposed by microorganisms and is capable of providing food for birds and other vectors.

Without mitigation, the preliminary bird hazard assessment concluded that there is a very high risk to aviation from the landfill (Avisure, 2021). However, the risk can be managed to an acceptably low level with mitigation, involving multiple actions and based on an escalating response if initial mitigation actions are not successful (Avisure, 2021). It is therefore very important to implement mitigation measures to keep bird numbers to very low levels at the landfill.

This BMP, therefore, focuses on black-backed gulls and procedures / control methods to manage them at the site (refer to Appendix 3 for a species identification guide). With the implementation of good landfill operational techniques, bird management, monitoring, deterrence and control methods, black-backed gulls can be kept to very low numbers (as well as mallard duck, red-billed gulls, harrier hawk and starling numbers)[4] and, therefore, aviation strike risk will be managed to an acceptably low level.

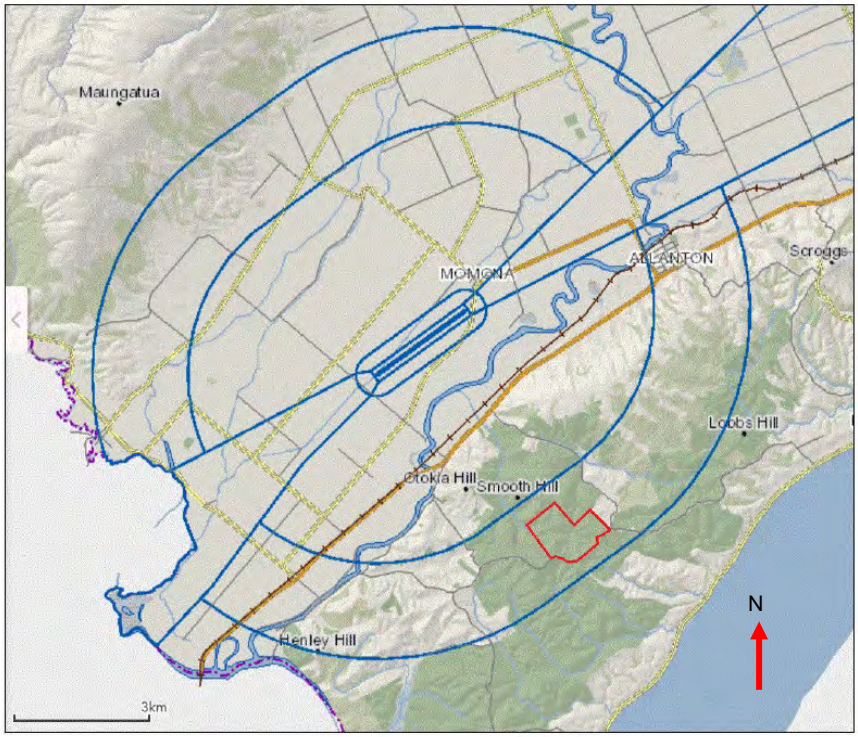


Figure 1. Dunedin Airport's flight fan (blue ovals) in relation to Smooth Hill landfill (red polygon). The two outer ovals are approximately 4 km and 6.2 km from the outer edge of the Airport's runway (blue rectangle).

1.1.2 Importance of this plan

It is critical that the operational procedures, bird deterrence and bird control measures are applied well so that bird numbers are kept very low at the landfill (i.e. below threshold levels, refer to Section 3.1). This will require a high standard of operation, bird management, discipline and vigilance that needs to be maintained throughout the lifespan of the landfill. These standards will be applied by all people working on site and it is everyone's responsibility to keep

[4] Operational measures to reduce and manage black-backed gull numbers at the landfill will also be effective for other bird species that are attracted to landfills. Likewise some of the bird deterrence and control methods will also be effective for controlling these species, noting however that red-billed gulls and harrier hawks are protected under the Wildlife Act therefore cannot be killed (i.e. poisoning, colony control or shooting are prohibited control options).

an eye out for gulls at and around the landfill, and to report observations to the Bird Control Officer. This unified and disciplined approach will reduce the attractiveness of the Smooth Hill Landfill to birds and, therefore, keep bird numbers and associated aviation strike risk low. Furthermore, there will be regular communication with Dunedin Airport to discuss bird numbers and coordinate management methods.

2.0 Operational Procedures

It is very important to establish and maintain effective operational procedures at Smooth Hill Landfill. If operational procedures are not conducted adequately, birds may become resident at the landfill and once birds are established and resident at a landfill, they are very difficult to disperse. Therefore, the procedures outlined below must be executed to a high standard from the outset of operation of the landfill and sustained throughout operation of the landfill.

2.1 Reducing putrescible / organic waste

Putrescible (organic) waste at landfills is an attractive food source for many bird species. Even with kerbside collections including a “food waste bin” and an optional “garden waste bin”, it is anticipated that some organic waste will still enter the general waste stream. It is critical that this is minimised as much as is reasonably possible. The landfill will also receive “special wastes” that have a high putrescible content (e.g. waste from food manufacturing or as part of clean up during emergency response).

Details have not been finalised on how much putrescible waste will be present in the waste stream at Smooth Hill Landfill (although it will be greatly reduced, relative to levels at the current Green Island Landfill

Based on observations made at Kate Valley Landfill (a modern landfill where very few birds are present), the following is recommended:

- Reducing putrescible waste as much as possible (at Kate Valley Landfill it is estimated that over the past five years organics comprised 3-16% of all waste)
- Separating putrescible and general waste streams.
- Transporting the waste to the landfill in sealed containerised trucks.
- Unloading special waste with a high putrescible content into a ‘V’ pit formed by the parallel lines of general waste, which is then covered and compacted with general waste as placed This pit makes access to special waste with a high putrescible content difficult for birds as they would need to go into the pit, which is unsettling for them to enter.
- Applying daily cover at the end of operation each day to all waste placed in that day (including the putrescible waste V pits) to ensure putrescible (organic) waste is well covered and not exposed (see Section 2.2).

2.2 Good daily cover

Providing good daily cover of the active tip face is a very important operational procedure to reduce the attractiveness of the landfill to birds as a food supply. Good cover results in no food being left exposed at the end of each day, thereby denying birds a food source and minimising bird numbers at the site (Centre for Advanced Engineering, 2000; Environmental Protection Agency, 1997; ISWA Working Group on Landfill 2019, 2019; Queensland Department of Environment and Resource Management, 2010; Waste Management NZ Ltd, 2018).

The guidelines for daily cover provided in the draft Smooth Hill Landfill Management Plan will be adhered to. In brief, daily cover will involve spreading / grading and thorough compaction of waste at the tip face (including the putrescible waste V pits) at the end of operation each day (Environmental Protection Agency, 1997; ISWA Working Group on Landfill 2019, 2019; Waste Management NZ Ltd, 2018). The entire active tip face will be covered with daily cover consisting of either at least a 150 mm layer of soil or a suitable artificial cover that is compacted to seal and stabilise it (Waste Management NZ Ltd, 2018)[5]. The guidelines in the draft Landfill Management Plan for intermediate and final cover will also be adhered to in order to reduce bird numbers at the landfill.

In addition to waste compaction and cover at the end of the day, if possible, all waste that could provide a food source to birds will be compacted and covered immediately with general waste and then daily cover (soil or artificial cover) applied throughout the day if possible, particularly in areas where no more waste will be received that day (ISWA Working Group on Landfill 2019, 2019; Waste Management NZ Ltd, 2018). This will reduce the amount of time food is exposed to birds.

If black-backed gulls are observed at the landfill, extra vigilance and care will be taken when covering the tip face to make sure that it is thoroughly and evenly covered and is also well compacted. Bird deterrence and / or control methods must also be employed as described in Section 3.1.

If black-backed gulls persist at the site, cover thickness will be increased (WasteMINZ Technical Guidelines for Disposal to Land) and observations of the tip face will be made to see if / where birds are foraging. These areas will then be targeted for additional compaction and soil coverage. Bird deterrence and control methods will also be implemented to deter the birds from the landfill and to avoid birds increasing above acceptable thresholds, as outlined in Section 3.1.

The landfill's soil cover plan will be abided by to ensure that an adequate supply of soil cover is always available and accessible on site (Waste Management NZ Ltd, 2018). Personnel involved in applying daily cover will be made aware of the importance of this task, with respect to bird management and reducing strike risk with aircraft.

2.3 Minimising the extent of the active tip face

The active tip face will be kept as small as is practicable to reduce the area where food may be available to birds (Centre for Advanced Engineering, 2000; Waste Management NZ Ltd, 2018). At Kate Valley Landfill, the active tip face is moved daily so that waste does not have to be

[5] Thorough waste compaction is very important as it makes the process of covering the waste quicker and is a more conservative use of soil as it reduces the total area over which soil needs to be spread. Grading the waste is also important because it reduces the number of ruts and depressions in the tip face and therefore also reduces the amount of soil required for daily cover and the time required for this task.

pushed very far (R. Ward, pers. comm., February 24, 2020)[6]. This minimises open exposure to waste material and thereby reduces foraging opportunities for birds. If practicable, this practise will be employed at the Smooth Hill Landfill.

2.4 Minimising open earthworks and pools of water

It is important to minimise open areas of earthworks around the landfill and to make sure that there are no hollows or depressions where water can pool as birds will use these areas to drink and clean themselves (ISWA Working Group on Landfill 2019, 2019; Waste Management NZ Ltd, 2018). The stormwater attenuation basin on site will be dry most of the time, however, some water may pool. Pooling should not exceed 100 m^2 of open water for more than a continuous 48-hour period; if this occurs and birds are attracted to the site above acceptable thresholds (see Section 3.1) then Council should investigate the installation of wires, permeable membranes or nets over the basin or other such method to discourage birds being attracted to the attenuation pond.

Restored and non-operational areas of the landfill will be checked regularly to make sure that there are no areas of exposed waste, or areas where water can pool. If detected, there areas will be graded, covered with soil, compacted and grassed.

Underground drains and water storage will be used where possible to reduce availability to birds.

2.5 Reducing barren areas

Barren areas around the landfill will be minimised by planting grass. The grass will be maintained at a minimum sward length of 200 mm, but preferably at approximately 300 mm. This will reduce the attractiveness of the area to birds for roosting and nesting and make it more difficult for birds to land and take off. Birds may also be fearful of predators where long grass is present (ISWA Working Group on Landfill 2019, 2019).

3.0 Bird Deterrence and Control Methods

Birds cannot be allowed to establish at the site, as once resident at a site it can be very difficult to disperse them (R. Ward, pers. comm., February 24, 2020; P. Withers, pers. comm., February 19, 2020). Therefore, the key to bird deterrence and control is being vigilant, disciplined and proactive, so that appropriate deterrence and control actions can be implemented or changed in response to changes in bird numbers. Vigilance is particularly important during the egg laying stage of the black-backed gull breeding season (egg laying broadly occurs between the start of October and end of January) as this is the time when they are looking for nesting sites and laying eggs. If nests are found, eggs will be removed, and the nests will be oiled. Bird control responsibility will be assigned to someone on site (i.e. a “Bird Control Officer” who has some personnel trained in deterring birds from the active tip face) and it will be their responsibility to manage the control response. However, everyone on site will work as a team and immediately

[6] Some landfills only have one tip for up to one to two years. This results in waste being pushed large distances and increases exposure to birds.

alert the Bird Control Officer when black-backed gulls (as well as red-billed gulls, mallard ducks, harrier hawks and starlings) are observed on site and if observations are made of birds becoming habituated to a deterrence or control technique.

3.1 Bird Number Threshold Levels

There will be zero tolerance for birds greater than 50 g in size feeding at the landfill or accessing waterbodies. This size class includes species from the size of a starling and above. Occasional use by small birds (such as house sparrows) in low numbers will be tolerated.

An escalation procedure will be implemented to deter and control bird numbers at the landfill (these methods are additional to operational control procedures that will always be implemented). In the first instance bird management will involve bird deterrence and lethal methods (as discussed in Sections 3.2 and 3.3, below). If this is unsuccessful, i.e. **if at any time more than 20 individuals from a species greater than 50 g, or combined numbers of these species exceeds 100 individuals, then management actions will be elevated to also include lethal control methods**. If lethal control methods are unsuccessful, other escalation procedures will include trialling wires above the landfill and baling waste. **If more than 12 breaches of these thresholds occur in any 12-month period, the final step in the escalation procedure will be to position a net over the landfill** to ensure no further bird activity is possible, unless an aviation risk assessment indicates that the risk can otherwise be managed to an acceptable level.

3.2 Deterrence methods

3.2.1 Disperse birds from the active tip face

To prevent birds from accessing waste at the active tip face, a team of landfill staff or contractors will be responsible for dispersing birds from the tip face during daylight operational hours (until end-of-day cover is applied). Dispersal methods will include using stockwhips, pyrotechnics, starters pistols and portable distress callers. These personnel will be trained by a suitably qualified and experienced person.

3.2.2 Anti-roosting strips on structures

To prevent birds landing and roosting on structures at the landfill, anti-roosting strips / bird spikes will be fixed to the rooves of the buildings, signs and other built structures prior to the commencement of operation of the landfill (Queensland Department of Environment and Resource Management, 2010; Waste Management NZ Ltd, 2018). Appropriately sized spikes will be installed to deter gulls[7].

3.3 Lethal methods

Based on scientific literature and conversations had with personnel involved with other landfills in New Zealand, the two most effective bird control measures are shooting / scaring birds and

[7] The following website has an example of anti-roosting strips that are appropriate to deter gulls, https://www.pestrol.co.nz/buy-online/pestrol-bird-spikes/.

setting out poison (Centre for Advanced Engineering, 2000; ISWA Working Group on Landfill 2019, 2019; Waste Management NZ Ltd, 2018)[8]. These methods may be used if bird deterrence methods (Section 3.2) are unsuccessful and bird numbers on site breach threshold levels (refer to Section 3.1). Shooting should be conducted first (if dispersal methods are unsuccessful) and then potentially poisoning as a last resort before netting (refer to Section 3.6). Lethal control will be used randomly and sparingly so that birds are continually unsure of the type of danger they are being exposed to and may react by relocating away from the area (Cook et al., 2008; ISWA Working Group for Landfill, 2010; Waste Management Institute New Zealand, 2018). This will increase the effectiveness of the lethal control methods as they will present a more novel danger to birds in the area and should increase the chance of birds leaving the area and seeking safer foraging sites. The longer a technique is used the less successful it generally becomes because birds can become habituated to it.

3.3.1 Shooting

Shooting is an effective measure to scare birds from landfills (Centre for Advanced Engineering, 2000; ISWA Working Group on Landfill 2019, 2019; Waste Management NZ Ltd, 2018). If bird numbers breach threshold levels on site (refer to Section 3.0), then a shooting operation will be conducted as instructed by the Bird Control Officer. The landfill's designated shooter / marksman will be contacted to undertake the shooting operation at the earliest opportunity it is safe to do so. It is recommended that a high-powered .22 gun is used during these operations (R. Ward, pers. comm., February 24, 2020).

Prior to a shooting operation commencing, the Bird Control Officer will confirm that the shooter can correctly identify black-billed gulls[9], red-billed gulls, harrier hawks, eastern falcon and paradise ducks. These are protected native species that may be present at, or near the landfill, and must not be shot. A species identification guide is provided in Appendix 3.

During a shooting operation, bird strike rates are likely to be low, but nonetheless the shots fired should scare birds away from the area. If birds are killed, the number shot (and date of kill) will be recorded in a register of birds killed (see Section 4.0). Dunedin Airport should also be contacted prior to a shooting operation to inform them that this activity will be occurring so they can implement bird deterrence methods at the Airport if required.

Although black-backed gulls (a native species) are not protected under the Wildlife Act, before commencement of operation of the landfill, conversations will be had with the Department of Conservation about the intention to shoot black-backed gulls observed at the site. People who own properties in the vicinity of the Smooth Hill Landfill will also be informed that shooting may occur from time to time at the landfill, so they are not alarmed when they hear shots.

A comprehensive health and safety plan will be prepared and abided by that documents the procedure to follow when undertaking shooting operations during operational hours. There will also be appropriate documentation about gun security, transport, maintenance and safe use of firearms. The shooter will have a valid firearms licence and must also be a licensed shooter registered with the Department of Conservation.

[8] This method was also endorsed by a conversation had with the regional manager of Canterbury Waste Services (R. Lord, pers. comm., February 24, 2020).

[9] It is highly unlikely that black-billed gulls will be present, however they are a Threatened species so positive identification is necessary.

3.3.2 Poisoning

If bird numbers still breach threshold levels (refer to Section 3.1) following a shooting operation, or birds are too far away to shoot, then poison will be set but only as a last resort before installation of a net (refer to Section 3.6). Poisoning will involve putting out plain (unbaited / without poison) bread where the birds are observed for three to four days to allow time for the birds to recognise this as a food source. After three to four days, an appropriate bird poison will be added to the bread (R. Ward, pers. comm., February 24, 2020). The baited bread will not be set by water and it will only be laid during calm weather, as windy conditions may blow poisoned gulls away from the area into neighbouring properties (Bell & Harborne, 2018).

Pestoff Bird Control Paste will be used (it is also known as Alpha Bird Paste)[10]. This product is supplied by Animal Control Products Ltd and can be bought from rural merchants. The paste will be liberally applied to the bread and then set in the areas frequented by the gulls. The poison is more effective at lower temperatures, therefore, the baited bread will be laid out as close to dusk as possible (particularly in summer; this is less important in winter) (Bell & Harborne, 2018). For birds the LD_{50} (lethal dose) is 32-56 mg / kg B/W[11]. This poison does not kill the birds but renders them incapacitated, therefore, following a poisoning operation regular checks will be made for incapacitated birds and they will be humanely dispatched.

Poison will only be set if no black-billed gulls and red-billed gulls have been observed at the landfill for the past three to four days. If poison is set at dusk and left overnight, the Bird Control Officer, and / or a small team of trained personnel, will monitor for and deter non-target species (e.g. red-billed gulls, harrier hawks) until dark and again from first light until the bread has been consumed; this is to prevent potential poisoning of these non-target species.

The paste is a harmful substance, therefore, a health and safety plan will be prepared and abided by when using this substance. The chemical safety datasheet for this product is provided in Appendix 4.

Alphachloralose, the active ingredient of Pestoff Bird Control Paste, can persist in the tissue of poisoned birds, which can result in secondary poisoning of scavenging birds such as hawks. Therefore, after a poisoning exercise, dispatched birds will be collected and appropriately disposed of.

Prior to operation of the landfill, discussions will be had with the Department of Conservation regarding this control method as well as adjacent landowners in case any poisoned birds end up on their properties. Appropriate signage will also be installed on site and will remain in place until toxic baits and poisoned gulls are retrieved. Appropriate approvals and Approved Handler Test Certificates will also be gained for the operation and poison handling (Bell & Harborne, 2018).

3.3.3 Colony control

Black-backed gull colony control is occasionally conducted at some airports and by the Department of Conservation to manage bird populations. If black-backed gull numbers at Smooth Hill Landfill are increasing, despite the implementation of operational and control procedures, then colony control is something that may be investigated and potentially implemented.

[10] This poison is used at Kate Valley Landfill. If another poison proves effective at bird control, based on the literature and / or on the ground use elsewhere, then alternative/s may be used.

[11] The average weight of a black-backed gull is approximately 1 kg, therefore, to be conservative, 56 mg should be used per piece of bread to achieve the LD_{50}.

Prior to closure of Green Island Landfill this may be conducted during the breeding season to reduce bird recruitment and thereby help minimise a significant scattering of birds across the landscape during and following closure. Implementation of this method may reduce the population of gulls subsequently attracted to Smooth Hill Landfill (managing black-backed gulls in Dunedin is discussed further in Section 7.0).

Colony control would involve culling birds and / or breaking or pricking eggs at nesting colonies (as identified during the off-airport bird monitoring regime described in Section 5.1.2). Prior to this occurring, discussions will be had with the Department of Conservation, and possibly the Otago branch of the Ornithological Society of New Zealand. The objectives of these discussions are to determine their receptiveness to this activity and potentially for help locating colonies not identified during the monitoring regime and assisting in undertaking this control. It must be noted that culling black-backed gulls may not be perceived favourably by some members of the public, however, it is an effective control method. Note that culling is only appropriate for black-backed gulls; it is not appropriate for the protected red-billed gulls or black-billed gulls that are At Risk and Threatened species, respectively. These species, particularly black-billed gulls, however, are unlikely to utilise the Smooth Hill Landfill.

3.4 Further Bird Management Options

Below are further options that the Council should investigate if the other bird management methods outlined above were unsuccessful.

3.4.1 Installation of wires above the landfill

If bird deterrence and lethal control methods are unsuccessful it may be necessary to escalate management efforts. Trialling the installation of wires above the landfill may be an option, although this is unproven in New Zealand. The type of wire used, spacing and height of installation will be dependent on operations (i.e. the level of the tip face, the reach of vehicles / equipment used, etc) and will be advised by the a suitably qualified ecologist or ornithologist.

3.4.2 Baling waste

Another escalation procedure if bird thresholds are breached will be to bale waste. This does not eliminate the food (putrescibles) but compresses it and makes access for birds very difficult. Waste will first be unloaded into a bird-proofed building to prevent access at the unloading stage.

3.4.3 Installation of a net over the landfill

If more than 12 breaches of the bird thresholds occur in any 12-month period, the final escalation procedure to be implemented will be installation of a net over the landfill. This is an expensive but tested solution to prevent birds from accessing food waste. Dunedin City Council will establish the cost of this installation (as well as net maintenance) and where to source the materials from prior to operation of the landfill so that the Council is prepared to implement this management action if required. Nets tear easily so good maintenance regimes will be essential to maintain the integrity of the enclosure.

4.0 Bird Management and Control Registers

During operation, a number of registers will be kept updated regarding the use of bird deterrence and bird control measures and their effectiveness. Black-backed gull observations at the landfill will be recorded as well as the numbers shot and poisoned. Records will also be kept of red-billed gulls, black-billed gulls (although their presence is highly unlikely), harrier hawks, starlings and mallard ducks observed at the landfill, as well as any bird threshold trigger breaches. The following registers will be kept:

- The number of black-backed gulls observed at the landfill;
- The number of black-backed gulls killed by shooting;
- The number of black-backed gulls killed by poison;
- The number of red-billed gulls, harrier hawks, starlings and mallard ducks observed at the landfill;
- The number and date of bird threshold trigger breaches;
- The date/s bird control measures are implemented and the duration of implementation;
- A success register that documents how effective bird control measures are / were; and
- Sightings of falcon at or near the landfill (this will help inform if it is appropriate to use falcon decoys as a potential bird control option).

These registers, which will be combined into one spreadsheet, will help keep track of what bird deterrence and control methods have been used at the site (including their frequency) and how successful they have been. This information will be used to inform what techniques to use at the site to maximise the effectiveness of bird control and keep bird numbers, and thereby strike risk, to very low levels.

5.0 Bird Monitoring

A monitoring regime will be established prior to the closure of Green Island Landfill and establishment of Smooth Hill Landfill. Monitoring will commence as soon as possible and will occur for at least a 12-month period. Following this period, discussions will be had with a suitably qualified ecologist / ornithologist and Dunedin Airport to determine if the monitoring frequency can be scaled back to seasonal monitoring (i.e. once each in summer, autumn, winter and spring). The purpose of this monitoring regime is to:

- Determine the year-round behaviour patterns of key bird species and their populations in the Dunedin area, especially black-backed gulls.
- Determine how black-backed gulls and other species, respond to management initiatives at Green Island Landfill leading up to, during and after its closure to organic waste.
- Establish a baseline estimate of risk at and around Dunedin Airport through structured regular surveys that allow risk assessment models to be updated.

- Enable comparisons to be made between baseline (pre-operation) and operational bird data to assess aviation strike risk and success of bird management at Smooth Hill Landfill.

Information obtained from monitoring will be used to inform risk assessments to determine the impact of the landfill's operation on aviation safety. It will be used to demonstrate that risks are being managed to an acceptable level, or if not, then indicate further mitigation is required.

5.1 Monitoring regime

The following monitoring regime will be conducted by a suitably trained bird observer (training is discussed in Section 5.2). Binoculars will be used during these surveys to enhance vision and aid species identification.

Refer to Appendix 5 (Smooth Hill Preliminary Bird Hazard Assessment) for more information and previous survey results (Avisure, 2021).

5.1.1 On-airport surveys

Monthly on-airport bird surveys will be conducted at Dunedin Airport (noting that this requires Dunedin International Airport Ltd to give consent to access these sites) using the following methodology (which was established during the survey conducted for the Smooth Hill Preliminary Bird Hazard Assessment; (Avisure, 2021)).

Three surveys will be conducted at Dunedin Airport over one day: early morning, middle of the day, and late afternoon. Each survey will include observations at assigned observation points within the seven sectors that cover the area inside the fence at Dunedin Airport (Appendix 6).

The observer will travel from one observation point to the next following the established anti-clockwise route through each sector making observations while en route. The observer will spend five minutes at each observation point, recording all birds observed within the sector during this time. Birds observed in transit or thermalling within the aerodrome boundary or on aircraft flight paths should be recorded regardless of whether they are in the current sector or not. Information recorded will include: time, species, number sighted, location, estimated height above ground level, heading and activity (breeding, chasing, foraging, perching, sheltering, thermalling or transiting). Survey records will also include ambient conditions (first and last light, rainfall, temperature, air pressure, wind speed and direction).

Prior to commencing each survey, the Dunedin Airport Operations Manager will be contacted, and appropriate arrangements will be made to facilitate the survey (e.g. health and safety requirements, having an appropriate escort while on site, etc).

5.1.2 Off-airport surveys

Monthly off-airport surveys will be conducted at three locations in close proximity to Dunedin Airport as identified (and surveyed) in the Preliminary Bird Hazard Assessment (Avisure, 2021). These sites include Dam 3, Landside Paddock and Drain West of Carpark (Appendix 7). At each location, all bird species present upon arrival will be identified, and their numbers recorded (no specified time period for the count, just until all species present have been counted).

Additionally, seasonal counts (i.e. summer, autumn, winter, spring counts) will be conducted at the same locations surveyed in the Smooth Hill Preliminary Bird Hazard Assessment (Avisure, 2021) (Appendix 7). Each location will be visited once per season. All bird species present upon arrival will be identified, and their numbers recorded (no specified time period for the count, just until all species present have been counted). Black-backed gulls departing Green Island Landfill at closing (just before 5 pm) will also be followed once per season to observe where they roost at night.

5.1.3 Green Island landfill surveys

Monthly counts of gulls arriving at Green Island Landfill will be conducted by a suitably trained bird observer. The surveys should be conducted at first light and approximately 100 m north of the landfill admission booths. All gulls arriving at site should be identified to species, counted using a clicker (one continuous count rather than recording numbers in flocks) and the direction of approach should be noted. Approximate numbers of birds departing the site should also be recorded.

5.1.4 Smooth Hill landfill surveys

Prior to and during operation, monthly bird counts will be conducted from one vantage point overlooking the Smooth Hill Landfill site, concurrently with the off-airport surveys and using the same methods as the off-airport surveys. These counts will be conducted by a suitably trained bird observer.

Once Smooth Hill Landfill is operational, counts will be undertaken on the days the landfill is operating and completed by suitably trained operational staff using binoculars. Just prior to the commencement of operation, a standard survey route will be established around the designated site. The route will not include every single structure / location at the landfill but will target key sites. Stopping points will be designated where areas are scanned for birds. During the surveys, data will be collected for each bird, or flock of birds observed, and will include the following:

- Date;
- Time;
- Species;
- Number of birds;
- Bird behaviour (e.g. foraging, perching, transiting, etc);
- Bird habitat usage (e.g. grass, building, drain, tank, etc); and
- Any other observations of interest (e.g. nesting activity, unusual bird activity, effectiveness of mitigation devices).

Weather conditions will also be noted at the start and end of each survey and will include:

- Visibility (e.g. sunny, partly cloudy, overcast, etc);
- Cloud cover (as a percentage of the sky);
- Precipitation (e.g. none, drizzle, light, heavy etc);
- Temperature (°C);

- Wind strength; and
- Wind direction.

5.1.5 Monitoring records and analysis

Information collected during this monitoring will be entered into an electronic database (e.g. Excel, Fulcrum) and a suitably qualified and experienced ecologist / ornithologist will be engaged to analyse the data and assess risks. This engagement will occur prior to the commencement of monitoring.

5.2 Training

The bird observer and Smooth Hill Bird Control Officer conducting the surveys will be trained by a suitably qualified and experienced person prior to commencing monitoring to make sure the correct survey methods are implemented. This training will either be in person or via phone / email communications.

All staff at the landfill will also be trained by a suitably qualified and experienced person on:

- Bird identification
- Bird dispersal
- Bird counts
- Hazard assessment and reporting
- Firearm use

All staff will be familiar with the contents of this plan, their responsibilities with regards to reporting bird sightings and undertaking good operational procedures.

6.0 Risk Assessment

An annual risk assessment will be conducted by a suitably qualified expert in bird strike risk assessments to determine the contribution to bird strike risk. This will be conducted using a method that considers:

- Species (behaviour, mass, tendency to flock or roost communally)
- Land use / activity type
- Location relative to Dunedin Airport and the approach / departure paths
- Location relative to nearby land uses that attract, or have the potential to attract, birds
- Species strike risk based on Dunedin Airport strike data.

7.0 Managing Black-Backed Gulls in the Dunedin Area

To avoid a significant scattering of birds across the landscape during and following the closure of Green Island Landfill, and to reduce the population of black-backed gulls likely to be attracted to Smooth Hill Landfill, a management plan should be prepared for black-backed gulls in the Dunedin area.

This management plan will be prepared prior to the closure of Green Island Landfill to putrescible waste and:

1. In collaboration with Dunedin Airport, the Department of Conservation and Dunedin City Council, to establish a breeding season control program at key black-backed gull breeding sites.

2. In consultation with Dunedin Airport to commence a staged dispersal program for black-backed gulls at Green Island Landfill. It will be necessary to have excellent communications between bird controllers and Dunedin Airport staff to ensure that aviation risks are well managed. This program should commence prior to the next black-backed gull breeding season, as populations deprived of food at this critical time are less likely to build nests and lay eggs. They are also more likely to disperse away from the region more rapidly. Dispersal will involve a trained and equipped bird control officer positioned at the landfill to prevent birds from feeding on the active tip face for all daylight hours. Over time, the hours required on site can be scaled back based on the success of the program and / or the impact on the aviation risk as assessed in consultation with Dunedin Airport.

8.0 Review and Updating of the Plan

This Bird Management Plan is a dynamic document that will be prepared and reviewed biannually (halfway through the year and at the end of the year) for the first three years of operation of Smooth Hill Landfill. If, after 3 years, birds have been successfully kept at low numbers, then the plan will be reviewed on an annual basis.

The plan will be reviewed and updated by the Smooth Hill Landfill Bird Control Officer in collaboration with an external expert in aviation safeguarding. Communications will also be had with an external expert in aviation safeguarding or a suitably qualified and experienced ecologist / ornithologist each time a bird threshold level is triggered; based on these discussions a review and update of the plan may be required.

The Bird Management Plan will be updated based on lessons learned on site, bird numbers at the site, risk assessments, and new information available in landfill bird management literature. There will also be regular communication with other landfills to get up-to-date information about what techniques they are using and which bird control techniques they are having most success with.

During operation, this Bird Management Plan will include a section on bird monitoring results, the number of black-backed gulls observed on site, bird threshold breaches, control methods employed, and how successful controls employed have been. These aspects will be updated during each plan review so that it can be determined which control methods are the best at reducing bird numbers; these methods will then be employed thereafter to maximise control.

9.0 Communication with Dunedin Airport

Regular communication will be had with the Wildlife Officer (or equivalent person) at Dunedin Airport to remain informed on bird numbers and trends at the Airport and what bird deterrence and control mechanisms are most effective.

It is recommended that a Wildlife Hazard Management Committee is established or the Dunedin Airport Wildlife Hazard Management Committee (if established) is joined to provide a forum to discuss wildlife hazard management with relevant stakeholders and local authorities. Regular meetings will help with:

- Ongoing exchange of information between stakeholders to improve wildlife management.
- Ensuring stakeholders are aware of their responsibilities.
- Encouraging stakeholders to adopt a proactive approach to wildlife management.
- Improving communication between stakeholders.
- Reducing the economic impact on aircraft operators and improving operational safety.

Information collated from these communications should be incorporated into the bird management plan during the biannual reviews.

10.0 Summary of Key Messages

- A Bird Control Officer will be appointed by the landfill operator to oversee bird management at the landfill.
- Putrescible waste should be removed from the waste stream, or if not possible, reduced as much as possible to reduce the attractiveness of the landfill to birds by denying them a food source.
- Good operational procedures, bird deterrence and control measures will be used during operation of the Smooth Hill Landfill (right from the onset of operation) to reduce the attractiveness of the site to birds. Applying good daily cover at the tip face (including the putrescible waste V pits) at the end of operation each day is a key control to ensure putrescible (organic) waste is well covered and not exposed to reduce attractiveness to scavenging birds.

- An escalation approach will be followed whereby, if operational and bird deterrence methods do not deter birds and bird numbers exceed thresholds, then lethal control methods will be employed. If lethal control is unsuccessful and thresholds are still exceeded, then the Council should investigate the other bird management methods outlined in Section 3.4.
- Bird control measures, and some bird deterrence methods, will be implemented randomly and occasionally to maximise effectiveness of the bird control strategy.
- Regular communication with Dunedin Airport will be had to discuss bird numbers and the coordination of bird management methods.
- All staff on site will undergo bird training and will be familiar with the contents of this Bird Management Plan, their responsibilities with regards to reporting bird sightings and undertaking good operational procedures.
- It is crucial that birds are not allowed to become resident at the site. To prevent this from occurring, the operational procedures outlined in this plan will be executed to a high standard. This requires discipline and vigilance throughout the lifespan of the landfill. Furthermore, when implementing bird control methods, a proactive and responsive approach will be conducted so that appropriate and effective methods are employed if, and when, needed.
- Bird management and control registers will be maintained that document observations of gulls at the site, bird control methods used and their success at reducing bird numbers.
- Formal, standardised bird surveys will be conducted at various locations in Dunedin prior to construction of the landfill as well as during operation of the landfill. Comparisons will then be made between baseline (pre-operation) and operational bird data to assess aviation strike risk and success of bird management at the landfill.
- Black-backed gull deterrence should be conducted at Green Island Landfill prior to closure in conjunction with colony control in Dunedin to reduce bird numbers in the area prior to operation of Smooth Hill Landfill.
- This plan will be reviewed and updated biannually (and after bird threshold trigger breaches if required) so that it remains current and has the most up-to-date information about bird control options, and their relative effectiveness, so that the best bird management approach can be applied at the landfill.
- With implementation of the operational procedures, bird deterrence and control methods outlined in this plan, black-backed gulls can be kept to very low numbers at the landfill and aviation risk can be managed to an acceptably low level.

11.0 References

Avisure. (2021). *Smooth Hill landfill preliminary bird hazard assessment - draft* (pp. 1–50). Avisure.

Belant, J. L., Seamans, T. W., Gabrey, S. W., & Dolbeer, R. A. (1995). Abundance of gulls and other birds at landfills in Northern Ohio. *American Midland Naturalist*, *134*, 30–40.

Bell, M., & Harborne, P. (2018). *Canterbury southern black-backed gull/Karoro strategy* (pp. 1–43). Prepared by Wildlife Management International Ltd for Environment Canterbury. https://www.timaru.govt.nz/__data/assets/pdf_file/0020/260174/Draft-SBBG-Strategy_Oct.pdf

Civil Aviation Authority of New Zealand. (2008). *Guidance material for land use at or near aerodromes* (pp. 1–8). CAA of NZ.

Cook, A., Rushton, S., Allan, J., & Baxter, A. (2008). An evaluation of techniques to control problem bird species on landfill sites. *Environmental Management*, *41*(6), 834–843.

Environmental Protection Agency. (1997). *Landfill manuals: Landfill operational practices*. Environmental Protection Agency.

International Civil Aviation Organisation. (2013). *International standards and recommended practises: Annex 14 to the convention on international civial aviation - aerodromes* (Volume 1; International Standards and Recommended Practises, pp. 1–336). International Civil Aviation Organisation.

International Civil Aviation Organisation. (2020). *Airport services manual part 3 - wildlife hazard management* (ICAO 9137 part 3; pp. 1–72). International Civil Aviation Organisation.

ISWA Working Group for Landfill. (2010). *Landfill operational guidelines* (2nd ed.). International Solid Waste Association.

ISWA Working Group on Landfill 2019. (2019). *Landfill operational guidelines* (3rd ed.). International Solid Waste Association.

Queensland Department of Environment and Resource Management. (2010). *Guideline ERA 60 - waste disposal* (pp. 1–43). Queensland Government.

Ryder Environmental Limited. (2019). *Smooth Hill landfill bird hazard assessment*. Prepared by Ryder Environmental Ltd for Dunedin City Council.

Stantec. (2019). *DCC waste futures 2003 landfill feasibility workstream* (pp. 1–56). Stantec.

Waste Management Institute New Zealand. (2018). *Technical guidelines for disposal to land* (pp. 1–162). Waste Management Institute New Zealand.

Waste Management NZ Ltd. (2018). *Green Island Landfill - landfill management plan* (pp. 1–85). Waste Management NZ Ltd.

Appendix 1: Key Performance Indicators, Roles and Responsibilities

Examples of Key Performance Indicators and Roles and Responsibilities Sections to be Incorporated into this Plan Prior to Operation

Key Performance Indicators example. These indicators could include the landfill's compliance conditions as set out by Dunedin City Council.

Legislation and Regulatory Requirements		
To develop, implement and maintain procedures and systems to ensure operations at comply with applicable legislation, regulations, standards and industry best practice.		
Target	**Performance Indicator**	**Evidence**
Continual improvement to meeting legislative compliance.	Compliance to legal requirements is conducted at least annually.	Record of BMP review

Roles and Responsibilities example to be tailored to the landfill and updated.

Position	**Responsibilities**
[add]	Endorse the final BMP.
	Provide resources for implementing the BMP.
	Attend the annual WHMC meetings or delegate a representative.
[add]	Oversee the implementation and review of the BMP.
	Ensure wildlife control staff are trained and competent in the functions required for wildlife hazard management, including inspections, bird counts, bird and animal identification, bird harassment and reporting techniques.
	Issue the BMP and procedures to relevant staff and ensure implementation.
	Ensure wildlife control staff and other relevant staff adhere to the procedures and actions detailed in the BMP.
	Liaise with airport operators, local government and other stakeholders to assist in identifying and managing wildlife issues
	Provide information regarding wildlife hazards and their management to regulatory authorities

Position	Responsibilities
	Coordinate interactions with WHMC stakeholders for the management of land use surrounding the airport.
	Attend WHMC meetings or delegate a representative.
[add]	Ensure that all Procedures contained in the BMP are implemented.
	Review of the BMP at least annually, particularly the Operations Procedures and Firearms Policy. Forward any recommended modifications to the [position].
	Ensure wildlife management staff monitor, inspect, assess, record and report as described in the BMP.
	Ensure that the wildlife management staff are trained and competent in the functions required for wildlife hazard management, including wildlife surveys, wildlife identification, and wildlife dispersal and reporting techniques.
	Provide technical presentations and advice to wildlife hazard management meetings.
	Coordinate training for personnel assigned to conduct wildlife harassment with appropriate firearms certification.
	Attend WHMC meetings or delegate a representative.
Wildlife Control staff	Manage wildlife and their habitats as described in the relevant sections in the BMP and adhere to wildlife management procedures.
	Attend wildlife hazard management training as required.
	Use, store and maintain firearms and ammunition as required by the ’s firearms policy and procedures.
	Record management actions as per wildlife management procedures.
	Report wildlife hazards.
	Maintain the database detailing species and number of wildlife culled as part of airfield management.
	Collect and maintain dispersal data, including ammunition use.
	Provide input in the revision of the BMP and associated procedures.
	Attend the WHMC meetings.
[consultant name]	Undertake standardised wildlife surveys.
	Provide advice regarding environmental matters.

Position	Responsibilities
Environment Manager	Prepare wildlife strike data and depredation data and monitor species risk and hazards.
	Ensure that the principles BMP are consistent with the Environmental Management System.
	Maintain the necessary permits for culling lethal control, egg and nest removal, and relocation of birds and other wildlife.
	Ensure compliance with permit conditions.
	Regularly review waste management practices at the airport to secure food and waste attractants for birds and other wildlife.

Appendix 2: Requirement and Recommendations for Managing Land Use Near Airports

There are a number of national and international requirements and guidance documents that indicate land use in the vicinity of an airport can contribute significantly to the wildlife hazard levels and safety of aircraft operations.

The following NZCAA documents provide guidance and/or advice primarily for aerodromes that hold a 139-aerodrome operating certificate, however, the principles are relevant for good risk management.

Table 1. Sections of the NZ CAA Part 139 and AC relevant to the proposed Smooth Hill Landfill.

Document	Requirement
NZ CAA Part 139, CAA Consolidation, Aerodromes – Certification, Operation and Use, March 2017	Subpart B, Section 139.71 states: "An applicant for the grant of an aerodrome operator certificate must, if any wildlife presents a hazard to aircraft operations at the aerodrome, establish an environmental management programme for minimising or eliminating the wildlife hazard." DUD has a documented Wildlife Management Program.
NZ CAA Guidance material for land use at or near aerodromes, June 2008	The document states: "It is important that land use changes are monitored and reviewed by the aerodrome operator in areas outside their immediate control to ensure that these land use changes do not increase wildlife hazards for the aerodrome. Garbage disposal dumps and other sources that may attract wildlife activity on, or in the vicinity of, an aerodrome, need to be assessed as a potential source of wildlife hazard. It is an International Civil Aviation Organization requirement that such activities are closely managed by the controlling authority. If necessary, an aeronautical study may need to be undertaken to assess the potential wildlife activity hazard".
NZ CAA Advisory Circular AC139-16, Wildlife Management at Aerodromes, Revision 0, October 2011.	This advisory circular (AC) is applicable for certificated and non-certificated aerodromes. It lists landfills as a potentially hazardous land use practice.

ICAO defines aerodrome standards for wildlife hazard management at civilian airports. Tables 2 and 3 summarise the standards relevant to the proposed landfill.

Table 2. Sections of ICAO Annex 14 Vol 1. 6th Ed. 2013 relevant to the proposed Smooth Hill Landfill (International Civil Aviation Organisation, 2013).

Section	Requirement
9.4.3	Action shall be taken to decrease the risk to aircraft operations by adopting measures to minimize the likelihood of collisions between wildlife and aircraft.
9.4.4	The appropriate authority shall take action to eliminate or to prevent the establishment of garbage disposal dumps or any other source which may attract wildlife to the aerodrome, or its vicinity, unless an appropriate wildlife assessment indicates that they are unlikely to create conditions conducive to a wildlife hazard problem. Where the elimination of existing sites is not possible, the appropriate authority shall ensure that any risk to aircraft posed by these sites is assessed and reduced to as low as reasonably practicable.
9.4.5	States should give due consideration to aviation safety concerns related to land developments in the vicinity of the aerodrome that may attract wildlife.

Table 3. Sections of ICAO Airport Services Manual Doc 9137 5th Ed. 2020 relevant to the Smooth Hill Landfill (International Civil Aviation Organisation, 2020).

Section	Recommendation/Guidance
4.2.1.5	Landfills and garbage dumps are a significant source of food for wildlife. Certain species will travel several tens of kilometres to reach a dump. Birds flying to and from these sites may cross over an aerodrome or aircraft flight paths. It is not uncommon to observe hazardous birds, for example gulls, kites and vultures, soaring over dump sites in the thermals created by composting garbage. The greater presence of birds may give rise to problems for approaching aircraft.
4.4.1	The concept of compatible land use planning is the environmental relationship between airports and their community neighbours. Its implementation requires careful study and coordinated planning. Land use around airports can influence restrictions on aircraft flights and affect aircraft safety
4.4.2	A 13-km circle centred on the aerodrome reference point is recognised where land use should be assessed with regard to wildlife hazard management. However, the circle may be extended or reduced based on a wildlife evaluation of the aerodrome vicinity. States should consider all aviation safety concerns related to land development in the vicinity of the aerodrome to minimize the attraction of wildlife. Aerodrome operators are encouraged to communicate their safety concerns with the local authority in order to raise awareness Prior planning is necessary to ensure that incompatible land use is not allowed to become established. Such developments should be subjected to a risk assessment process … and changes sought, or the proposal opposed, if a significant increase in the wildlife strike risk is likely to result
4.4.3	In order to successfully deal with land use issues, a comprehensive WHMP including coordination among the aviation regulatory authority, aerodrome operator, aircraft operators and the surrounding communities should be implemented

Section	Recommendation/Guidance
4.2.1.5	Landfills and garbage dumps are a significant source of food for wildlife. Certain species will travel several tens of kilometres to reach a dump. Birds flying to and from these sites may cross over an aerodrome or aircraft flight paths. It is not uncommon to observe hazardous birds, for example gulls, kites and vultures, soaring over dump sites in the thermals created by composting garbage. The greater presence of birds may give rise to problems for approaching aircraft.
4.4.4	A monitoring process of sites where hazardous wildlife is to be found should be instigated, at least seasonally. The survey of the land use around aerodromes should be reviewed at a period determined by the safety risk assessment. In general, it is desirable to carry out a new comprehensive land use survey assessment every five years
4.4.7	The appropriate authority should encourage prohibiting or restricting the establishment of new or existing organic waste sites near aerodromes. If a waste management site in the vicinity of an aerodrome cannot be closed, it may be necessary to provide control measures at the site to reduce its attractiveness to hazardous wildlife

Appendix 3: Species Identification Guide

Black-backed gull (*Larus dominicanus*)

Adult

Juvenile

The black-backed gull is a native, Not Threatened species.

They are large gulls that are c.60 cm in length and weigh c.1 kg.

Adults are black and white with a white head and underparts, a yellow bill and a distinctive black back.

Juveniles look different to adults. They are a mottled dull brown colour with dark brown eyes and bill.

Red-billed gull *(Larus novaehollandiae)*

The red-billed gull is a native species that has a threat status of At Risk, Declining.

They are medium sized gulls with a pale grey mantle, back and wing coverts. They have a red bill, red legs (adults) and a white iris with a red eye-ring. Their main flight feathers are black with white tips.

The main way to distinguish them from black-backed gulls is their much smaller size. Red-billed gulls are c.37 cm in length, whereas black-backed gulls are c.60 cm in length. Red-billed gulls weigh c.240-320 g, whereas black-backed gulls are much heavier and weigh c.1000 g.

Black-billed gull (*Larus bulleri*)	
	The black-billed gull is a native species that has a threat status of Threatened, Nationally Critical. They are medium sized gulls with a pale back and grey wings, black legs and a black beak. Their flight feathers have white-tipped black margins and they have a white iris with a red eye-ring. They can be identified from black-backed gulls by their much smaller size. Black-billed gulls are c.35-38 cm in length, whereas black-backed gulls are c.60 cm in length. Black-billed gulls weigh c.230g, whereas black-backed gulls are much heavier and weigh c.1000 g.
Harrier hawk (*Circus approximans*)	
	The harrier hawk is a native species that has a threat status of Not Threatened. They are a large (c.50-60 cm in length), long-legged harrier with long taloned toes, long pointed wings, prominent facial discs and a strongly hooked bill. Adults have a tawny-brown back, pale cream streaked breast, yellow eyes and a creamy white rump visible in flight. Juvenile and immature birds are uniformly dark chocolate brown.
Eastern falcon (*Falco novaeseelandiae "eastern"*)	
	The eastern falcon is an endemic species with a threat status of At Risk, Recovering. They are a robust falcon, c.40-50 cm in length with broad wings, long tail, long yellow legs and toes, yellow eye ring, dark eyes and a distinct moustache striped from the base of the strongly hooked bill down the face. Adults are brown-backed with a streaked cream breast and a red- brown under tail and thighs. Fledglings and juveniles are dark brown, lack cream streaking, with blue-grey legs and eye ring.

Paradise shelduck (*Tadorna variegata*)	
	The paradise shelduck is a native species with a threat status of Not Threatened. They are large ducks c.63-70 cm in length. Males weigh c.1.7 kg and females weigh c.1.4 kg. Both sexes have a chestnut undertail, black primary and green secondary wing feathers, and a white upper wing surface. Males have a dark grey or black body and head (bird on the right in the image) while females are rich chestnut brown with a white head and upper neck (bird on the left in the image).

Appendix 4: Chemical Safety Datasheet for Pestoff Bird Control Paste

Animal Control Products Ltd

Bird Paste

orillion

SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name:	**PESTOFF BIRD CONTROL PASTE**
Synonyms:	Alpha Bird Paste
Supplier 1:	Animal Control Products Ltd
Street Address:	408 Heads Road Whanganui 4501 New Zealand
Telephone:	64 (0) 6 344 5302
Web site:	www.pestoff.co.nz
Emergency Telephone No:	021 919 624
National Poisons Centre:	0800 764 766

2. COMPOSITION / INFORMATION ON INGREDIENTS

Active Ingredient:	Alphachloralose 2.5% w/w
Other Ingredients:	Icing sugar, red fleck, oil, petrolatum
Active constituent:	2.5% (R)-1,2-O-(2,2,2,-Trichloroethylidene)-α-D-glucofuranose
Active Cas Number:	15879-93-3
Molecular Weight:	309.5
Molecular Formula:	$C_8H_{11}Cl_30_6$
Recommended use:	For the control of birds
Appearance:	A thick white paste with red aluminium fleck

3. HAZARDS IDENTIFICATION

This product is classified as a **HARMFUL SUBSTANCE.**

HSNO Approval Code: HSR001600

HAZARD IDENTIFIERS:	**Priority Identifiers** - Harmful. Keep out of reach of children. Ecotoxic. **Secondary Identifiers** - Warning. May be harmful if swallowed, inhaled or absorbed through the skin. When handling open containers or baits, wear protective gloves and overalls. Harmful to terrestrial vertebrates. Ensure domestic birds and animals and cannot be exposed to the toxin either through eating baits or through eating the carcasses of poisoned birds.
DANGEROUS GOODS CLASS:	Not classified as dangerous goods.
GENERAL REQUIREMENTS:	No special requirements. The product may be used only in accordance with label directions.

NOT CLASSIFIED AS DANGEROUS GOODS FOR TRANSPORT PURPOSES

4. FIRST AID MEASURES

Ingestion: If eaten, call a doctor. Keep patient awake and warm. Give patient stimulants if possible. Large doses may reduce body temperature to a fatal level.

Appendix 5: Preliminary Smooth Hill Bird Hazard Assessment

Smooth Hill Landfill

Preliminary Bird Hazard Assessment – Final

Boffa Miskell

May 2021

AVISURE
aviation | wildlife | safety

Summary

Dunedin City Council engaged Boffa Miskell Ltd and subcontractor Avisure to prepare this Smooth Hill Preliminary Bird Hazard Assessment. This was in response to concerns the proposed facility could increase the bird hazard for air traffic at and around Dunedin International Airport which is adjudged to already have a high bird strike risk. The proposed Smooth Hill Landfill is located approximately 4.5 km from the airport and regulatory guidance suggests that putrescible waste landfills are not located within 13 km of an airport. At this stage it has not been decided if the proposed landfill will accept organic waste, or if it will, how it will be handled and in what quantity. This will be critical for the likely attraction of birds to the new landfill.

The assessment was based on non-breeding season surveys in May 2021 and a review of Dunedin International Airport data. A modern Landfill in Kate Valley north of Christchurch was also visited to explore why that landfill is relatively unattractive to birds.

The assessment was limited by a range of factors; accordingly, it is considered preliminary. More surveys across all seasons, updated information on what the waste stream will consist of and how it will be handled at Smooth Hill, and a review of key factors contributing to the low bird numbers at Kate Valley are necessary to update this risk assessment.

Without appropriate mitigation, the assessment indicates that there is a very high risk to aviation from the proposed Smooth Hill Landfill. Mitigation involving multiple actions and based on an escalating response requirement depending on the success of initial mitigation, will manage the risk to an acceptably low level. If monitoring finds population targets are not met at the new site and this proves to increase the risk at the airport, then as a last resort it would be necessary for operators to net the landfill to prevent bird entry to the site.

Southern Black-backed Gulls present the greatest aviation risk owing to their size, flocking nature, current local population size, utilisation of the existing Green Island Landfill, preference for putrescible waste, ability to soar, opportunistic response to food from farm paddocks, and their ability for population growth based on artificial food supply leading to spill over into the general environment.

A series of recommendations to manage the risk has been provided:

1. Limiting organics in the waste stream.

2. Updating the Draft Smooth Hill Bird Management Plan to include:

    a) a detailed monitoring regime prior to its operations to establish baseline population data and risk levels, and to assess populations around the Dunedin area, including at Dunedin International Airport and Green Island Landfill. Monitoring should start immediately, and frequency reassessed annually

    b) monitoring protocols during operations

    c) acceptable thresholds for bird numbers at the new landfill

    d) details of actions taken on site to mitigate risks

    e) training requirements for people involved in the bird control program

    f) Standard Operating Procedures for bird control activities.

3. Developing a bird management plan for Southern Black-backed Gulls around Dunedin at their breeding sites and at the Green Island Landfill prior to its closure. This will assist with managing the number of gulls that could be attracted to the new site and minimise the risk that gulls scatter around the landscape, including on or around the Dunedin International Airport upon the landfills closure.

Glossary

Aerodrome/Airfield	Any location where aircraft take off, land and are stored and maintained. An airfield consists of at least one runway for an aircraft to take off and land, and may contain a helipad, buildings such as control towers, hangars, and terminal buildings.
Bird Strike	A collision between bird(s) and an aircraft.
Consequence	The outcome of an event affecting objectives.
Critical Area	Areas within or in proximity to the runway strip, approach and landing paths, and movement areas of an aerodrome.
Foraging	When animals search for and obtain food.
Hazard	A source of potential harm.
Incident	An occurrence, other than an emergency/disaster, associated with the operation of an aircraft that impacts on the safety of operations.
Loafing	When animals rest.
Probability	The extent to which an event is likely to occur (also referred to as 'likelihood').
Putrescible waste	A solid waste that contains organic matter capable of being decomposed by microorganisms and is capable of providing food for birds and other vectors.
Risk	The effect of uncertainty on objectives.
Roosting	When birds repeatedly return to a particular place in numbers to loaf or spend the night.
Runway	A defined area on an aerodrome prepared for the take-off and landing of aircraft.
Transit	When birds fly from one place to another.
Wildlife Strike	A collision between wildlife and an aircraft.

Abbreviations

AGL	Above Ground Level
ASRI	Airport Survey Risk Index
BBG	Southern Black-backed Gull
CEMP	Construction Environment Management Plan
DIAL	Dunedin International Airport Ltd
DUD	Dunedin International Airport
ICAO	International Civil Aviation Organization
NZCAA	New Zealand Civil Aviation Authority
SOP	Standard Operating Procedure
SRI	Species Risk Index

Table of Contents

Summary i
Glossary iii
Abbreviations iv
Table of Contents v
1. Introduction 1
1.1. The Wildlife Strike Issue 1
1.2. Bird Strikes and Land Use Around Airports 2
1.2.1. Birds and Landfills 2
1.3. Dunedin Airport 4
1.4. Smooth Hill Landfill Project Description 4
1.5. Scope of this Report 5
2. Methods 7
2.1. Review of Existing Data 7
2.2. Stakeholder Meeting 7
2.3. Bird Surveys 7
2.3.1. On Airport 7
2.3.2. Smooth Hill 8
2.3.3. Green Island Landfill 8
2.3.4. Dunedin city, Coastline and wetlands and surrounds 9
2.3.5. Kate Valley Landfill 9
2.4. Risk Assessment 12
2.5. Limitations 13
3. Results 15
3.1. Review of Existing Data 15
3.2. Bird Surveys 15
3.2.1. Overview 15
3.2.2. On Airport 19
3.2.3. Smooth Hill 19
3.2.4. Green Island Landfill 20
3.2.5. BBG Roost Sites 20
3.2.6. Kate Valley 20
4. Risk Evaluation 22
4.1. Existing Risk at DUD 22
4.2. Airport Species Risk Assessment 22
4.3. Smooth Hill Hazard Assessment 23
4.3.1. Assessment of risk by species 23
4.3.2. Assessment of BBG risk 25
5. Conclusion 26

6. Recommendations 27
6.1. Limit Organics from the Waste Stream 27
6.2. Update the Draft Smooth Hill Bird Management Plan 27
6.2.1. Monitoring 27
6.2.2. Establishing acceptable thresholds of bird numbers 28
6.2.3. Mitigation at Smooth Hill 28
6.3. Managing BBG in the Dunedin area 37
References 39
Appendix A: On Airport Survey Risk Assessment 40
Survey Risk Assessment (Shaw, 2004) 40
Appendix B: Southern Black-backed Gull (*Larus dominicanus*) eBird Records 41

1. Introduction

1.1. The Wildlife Strike Issue

The consequence of wildlife strikes[1] with aircraft can be very serious. Wildlife strikes have caused 532 human fatalities and 614 aircraft losses since the beginning of aviation (Shaw et al, 2019[2]). Wildlife strikes cost the commercial civil aviation industry an estimated US$1.2 billion per annum (Allan, 2002) and involve more than just the repair of damaged engines and airframes. Even apparently minor strikes which result in no obvious damage can reduce engine performance, cause concern among aircrew and add to airline operating costs.

Strike risk depends on the probability of colliding with birds and the consequence to the aircraft if collision occurs. The probability of a bird strike occurring increases as the number of birds and aircraft operating in the same airspace increases. Strike probability also increases with airspeed. In practice, this means that the likelihood of colliding with a bird inflight increases when operating at high speed below 5000 feet above ground level (AGL), which is where the majority of birds operate. Bird density, and therefore strike probability, increases with decreasing height above the ground. Operating at low altitudes over, or near, known bird hazards will significantly increase strike probability.

The main factors determining the consequences of a strike are the number and size of animals struck, the combined closing speed at which the strike occurred, the phase of flight when struck and the part of the aircraft hit. Generally, the larger the animal, the greater the damage. Large animals can destroy engines and windshields and cause significant damage to airframe components and leading edges. Strikes involving more than one animal (i.e., a multiple strike) can be serious, even with relatively small birds, potentially disabling engines and/or resulting in major accidents. While total mass struck and impact site on the aircraft are important considerations, final impact speed is the most significant determinant as impact force varies exponentially with the square of closing speed[3].

[1] As birds are considered the main threat for this project, bird strikes are referred to here, rather than the broader wildlife strike terminology which includes collisions with mammals and other terrestrial animals.

[2] A database that lists more details about significant and fatal wildlife strike events is available at https://avisure.com/about-us/fatalities-and-destroyed-aircraft-due-to-wildlife-strikes-1912-to-present/

[3] The energy of the impact is proportional to the mass of the bird multiplied by the square of the speed of impact (impact energy = 1/2 x mass x velocity^2).

1.2. Bird Strikes and Land Use Around Airports

In civil aviation around 93% of strikes occur at below 3500 feet AGL (Dolbeer 2011). Consequently, management focusses largely on terminal airspace and management responsibility has typically resided with aerodrome operators. However, aircrew and air traffic controllers should be engaged in strike risk and mitigation processes, and that high-risk operations consider predicted or observed bird movement patterns.

It is also critical that external stakeholders, including wildlife authorities, local planning authorities and land users, are engaged to monitor and mitigate bird hazards, and that both on- and off-aerodrome hazards are critically assessed. It is particularly pertinent for land use planning to consider bird strikes where new land uses in the surrounding areas are being proposed. Because they are the only sizable flying vertebrate in New Zealand, birds are the main concern when attracted to off-airport land uses.

1.2.1. Birds and Landfills

Putrescible waste is attractive as a food resource to several bird species, as it is generally abundant, easily obtained, and is nutritionally adequate for many species. Long-life putrescible waste landfills that allow regular access to the waste can significantly influence local bird populations. Once the site is established as a reliable and primary foraging site, breeding activity increases, populations increase, and behaviours can become increasingly urbanised (i.e., more use of, and reliance on, urban areas). When this occurs close to airports, the strike risk can increase, and aviation safety is compromised. Landfills sometimes offer waterbodies, trees and other landscape features that may also attract birds.

The New Zealand Civil Aviation Authority (NZ CAA) and International Civil Aviation Organization (ICAO) "…. recommends that refuse dump sites be located no closer that 13km from the airport property" (NZ CAA, 2008). These statements are guidance only and not regulated. The guidance applies to all Part 139 aerodromes, including Dunedin Airport (DUD). Therefore, landfills within 13km of airports require careful planning, monitoring, and operating to mitigate potential bird strike risks. In some situations, landfill projects have been rejected by local planning authorities because the risk was assessed as unacceptable.

There are three main ways that landfills near airports can affect bird strike risk:

1. **Site Risk:** Aircraft overfly the landfill and birds soaring above can conflict with aircraft.
2. **Flight Path Risk:** Birds traverse aircraft flight paths to and from the landfill (Figure 1).

3. **Spill Over Risk:** Significant population growth of species receiving abundant food results in 'spill over' onto areas around or on the airport. This can be highly influenced by certain events, such as heavy rainfall, calving season, or ploughing activity.

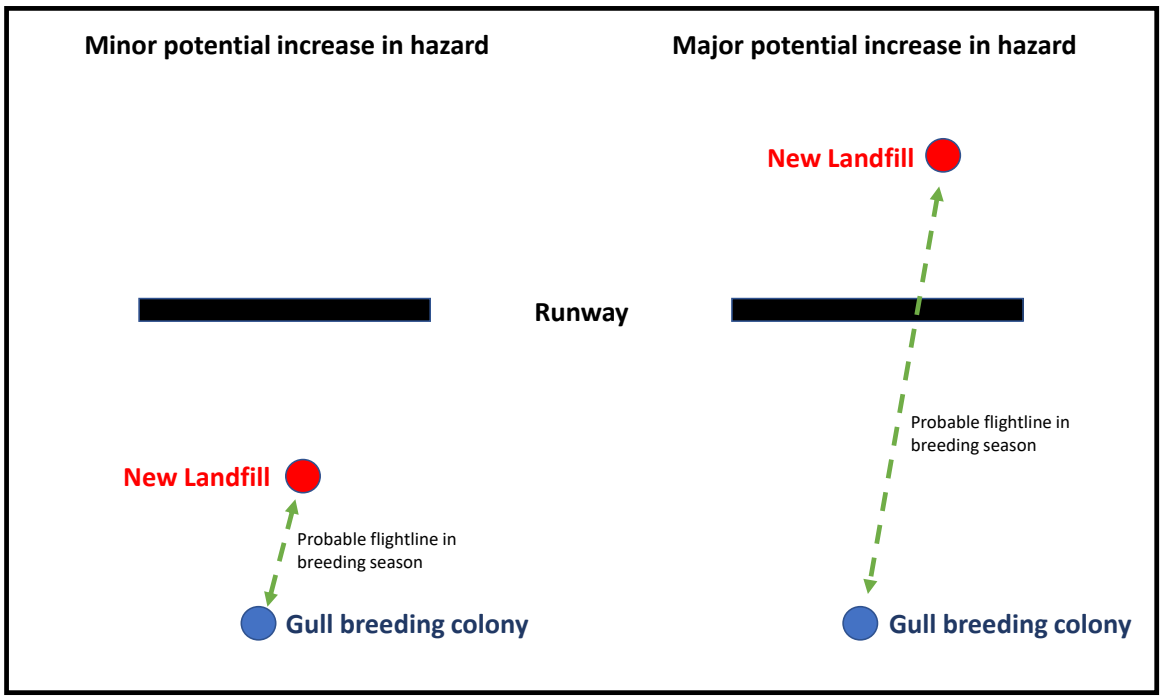


Figure 1. Position of new landfill in relation to the runway and other bird habitats can impact risk (adapted from UK, CAA CAP 680). *Note: A highly attractive habitat that has a complementary habitat on the other side of the aerodrome, significantly impacts strike risk because birds are likely to transit though critical airspace.*

In New Zealand, the main bird species attracted to landfills include: the Southern Black-backed Gull (*Larus Dominicanus* [BBG]), Red-billed Gull (*Larus novaehollandiae*), Rock Dove/Pigeon (*Columba livia*), Common Starling (*Sturnus vulgaris*), House Sparrow (*Passer domesticus*), various finch species, along with ducks and shags that can be attracted to landfill waterbodies such as retention ponds.

By far the most significant hazard to aviation in New Zealand are gulls, particularly the BBG. They are predators and scavengers and are attracted to food scraps and organic waste. BBG prey on a range of terrestrial and marine insects and animals, as well as small mammals and other birds. As scavengers, they exploit organic food sources at landfills, farms, parks, piggeries, fishing areas, food processing factories etc.

They are also common in coastal environment (harbours, estuaries, rocky and sandy shores), and usually breed in large colonial groups on braided rivers, cliffs/steep headlands, islands, sand, or shingle spits.

Figure 2. Black-backed Gull (*Larus dominicanus*)

1.3. Dunedin Airport

DUD, comprising 110ha, is located approximately 22km south-west of Dunedin City and operates with more than 20,000 aircraft movements per annum (pre-COVID19) on its single runway. Flights are primarily domestic, but there are also scheduled flights to Australia.

DUD management have raised concerns about the proposed Smooth Hill Landfill.

1.4. Smooth Hill Landfill Project Description

A putrescible waste landfill is proposed at Smooth Hill, 4.5km south-east of DUD. The landfill is expected to operate for up to 55 years. Details are yet to be finalised on aspects that could influence bird attraction to the site, such as:

1. The amount of organic material in the waste stream and if that will be separated from the general waste.
2. How waste will be transported to the site.
3. How the waste will be unloaded at the site.

1.5. Scope of this Report

The resource consent application has addressed the bird strike issue in various documents that generally indicate that with good bird management at the landfill, low bird numbers will be maintained and there will be a negligible change to strike risk for aircraft operating at DUD.

In November 2020, Dunedin City Council engaged Avisure to provide expert advice on the suitability of the proposed approaches to manage the risk to aviation that could arise from bird activity created by the new landfill. The review determined that the initial documentation relevant to managing birds at the proposed landfill, primarily Smooth Hill Landfill Bird Hazard Assessment (Ryder 2019) and Draft Bird Management Plan (Boffa Miskell 2020), did not adequately address the issue or how to best manage the risk. The Avisure report (2020) recommended:

1. That the Smooth Hill Landfill will need to be carefully planned and managed because landfills are generally not recommended within 13 km of an airport in various aviation regulation and guidance material.

2. The removal of putrescible waste from the waste stream should be considered as it would significantly alter the site's risk profile.

3. Updating the Hazard Assessment and the Draft Bird Management Plan to provide a more informed and robust understanding of the issues and more comprehensive risk management.

Dunedin City Council engaged Boffa Miskell Limited to complete the requirements of item 3 above, who subcontracted Avisure to prepare this hazard assessment and assist with updating the Draft Bird Management Plan. This risk assessment was based on a 3.5 day site visit in May 2021 which included:

1. A meeting with council staff and key staff of the Dunedin International Airport Limited (DIAL) to discuss council's approach to this issue.

2. A visit to the proposed site of the new landfill.

3. Reviewing, where available, background data on bird populations from ornithological groups and eBird.

4. Bird surveys on and around DUD to assess the current bird strike risk.

5. Bird surveys in and around Dunedin City, including the proposed Smooth Hill site, Green Island Landfill, the Otago Peninsula, the Dunedin coastline, Lake Waihola, Lake Waipori and the Sinclair wetlands to better understand populations of the bird species of interest (primarily BBG), their relative population size and behaviour.

6. A visit to a modern landfill operation at Kate Valley north of Christchurch to allow comparison with the proposed site.

2. Methods

2.1. Review of Existing Data

A desktop review of eBird provided information on bird populations around Dunedin and provided guidance on locations for surveys. The focus was on locations likely to support BBGs but also Red-billed Gulls, waterbirds, and other species of interest. Previous bird data from DUD and surrounds was also available from the draft DUD Wildlife Hazard Management Plan (Avisure 2018).

2.2. Stakeholder Meeting

A meeting was held on 6th May 2021 in DIAL offices involving Richard Roberts, Glen Pleasants, Jesse Gibbs, Bruce Smail, Chris Henderson (Dunedin City Council), Rachael Eaton (Boffa Miskell), Karin Sievwright (Boffa Miskell) and Phil Shaw (Avisure). There was no set agenda, nor were minutes taken. The meeting offered an opportunity for DIAL to express any concerns and for Council to explain the processes in place to manage aviation risks.

2.3. Bird Surveys

Principal Aviation Ecologist Phil Shaw (Avisure) and Ornithologist Karin Sievwright (Boffa Miskell) completed the following bird surveys between 4 and 7 May 2021. Binoculars were used to assist with identification of birds.

2.3.1. On Airport

Three surveys were completed: early morning, middle of the day, and late afternoon. Each survey consisted of seven sectors that covered the area inside the fence at DUD with assigned observation points that overlooked each sector.

The observer travelled from one observation point to the next following a set route through each sector making observations while en-route. The observer spent five minutes at each observation point, recording all birds observed within the sector during this time. Birds observed in transit or thermalling within the aerodrome boundary or on aircraft flight paths were recorded regardless of whether they are in the current sector or not. Information recorded included: time, species, number sighted, and position, estimated height above ground level, heading and activity (breeding, chasing, foraging, perching, sheltering, thermalling or

transiting). Survey records also included ambient conditions (first and last light, rainfall, temperature, air pressure, wind speed and direction).

2.3.2. Smooth Hill

On 5 May the site of the proposed Smooth Hill Landfill was visited to assess the habitat and consider the current and future attraction for bird species that could be a risk to air traffic.

2.3.3. Green Island Landfill

The Green Island Landfill surveys estimated the numbers of birds (gulls in particular) using the landfill and determined night-time roosts by tracking gulls leaving the landfill. Surveys occurred on 4 May 2021 (0715 to 0845 hrs) and 7 May 2021 (0715 to 0905 hrs), commencing at first light until the majority of the birds had arrived and only occasional individual birds were still arriving.

The two observers were positioned approximately 100 m north of the landfill admission booths. Each surveyor had a designated survey sector to avoid double counting birds. All gulls arriving at the site were identified to species, counted (one continuous count rather than recording numbers in flocks) and the direction of approach was noted. Approximate numbers of birds departing the site were also recorded.

Incidental observations of other bird species seen and heard at the site during the survey were noted. Abundances were not recorded.

Discussions with the Waste Management Operations Manager (Paul Withers) and Dunedin City Council landfill engineer (Lincoln Coe) provided information on landfill operations, bird numbers and management. A walkover of the landfill allowed the observers to view the site, surrounding areas (e.g., Kaikorai estuary) and gull behaviours.

On 4 May 2021, the observers completed an additional count at 1600 hrs to observe the direction the gulls departed the landfill for their roosting site. As soon as the birds began departing, the observers followed in a vehicle to determine the location of roosting sites. Counts were then made from vantage points overlooking the roost sites to determine the number of roosting birds (See 2.3.4 Dunedin City).

2.3.4. Dunedin city, Coastline and wetlands and surrounds

Between 4 and 7 May 2021, off-airport bird surveys were completed at several locations of interest within 13 km of DUD, and at locations along Otago Peninsula, the Dunedin coastline, Sinclair Wetland, Lake Waihola and Lake Waipori (**Error! Reference source not found.**, Figure 3). At each site, all bird species were identified, and numbers recorded. These surveys helped to:

- Understand bird communities and abundances around DUD and the wider area.
- Determine likely feeding, roosting and nesting sites of BBG.
- Determine likely bird flight paths and how they might interact with aircraft flight patterns.

On 6 May 2021 evening roosting observations were made from two vantage points, one off Sunshine Lane and the other from Ocean View Beach. Counts were made to determine the number of roosting gulls and their locations.

2.3.5. Kate Valley Landfill

On 7 May 2021, Phil Shaw visited Kate Valley landfill in Teviotdale (approximately one hour north of Christchurch) to observe the landfill and to talk to the Environmental Engineer from Canterbury Waste Services (Ajay Krishna). The purpose of this site visit was to understand how they are able to manage bird populations to very low levels.

Table 1. The locations of off-airport surveys conducted between 4-7 May 2021 in Dunedin.

Survey Date	Survey Location
4 May 2021	Kaikorai Estuary - Top (from Green Island Landfill)
	Green waste
	Keep It Clean
	Dunedin Harbour road transect– western shore southern half
	Otago Peninsula – Harwood tidal flat
	North of Harwood
	Otago Peninsula north-eastern sand bank
	Taiaroa Head
5 May 2021	Dam 3 off Kirks Drain Road
	Drainage channel to west of Dunedin airport carpark
	Dunedin airport landside paddock
	Taieri River bridge (Allanton)

Survey Date	Survey Location
6 May 2021	Tomahawk Lagoon 1
	Tomahawk Lagoon 2
	Smails Beach
	Maori Head
	Bird Island
	St Kilda Beach
	Lawyers Head
	White Island
	Kaikorai Estuary – Top (from landfill)
	Kaikorai Estuary - Mid
	Kaikorai Estuary - East
	Green Island (offshore island)
	Ocean View beach
	Brighton
	Beach on Taieri Mouth Road
	Rock outcrop on Taieri Mouth Road
	South of Kuri Bush
	Moturata Island
	Moturata Island Reserve
	Taieri River mouth
	Lake Waihola site 1
	Lake Waihola site 2
	Sinclair Wetlands Information Centre
	Sinclair wetlands
7 May 2021	Watson Beach north
	Kaikorai Estuary – Top (from Walton Park)
	Lake Waipori

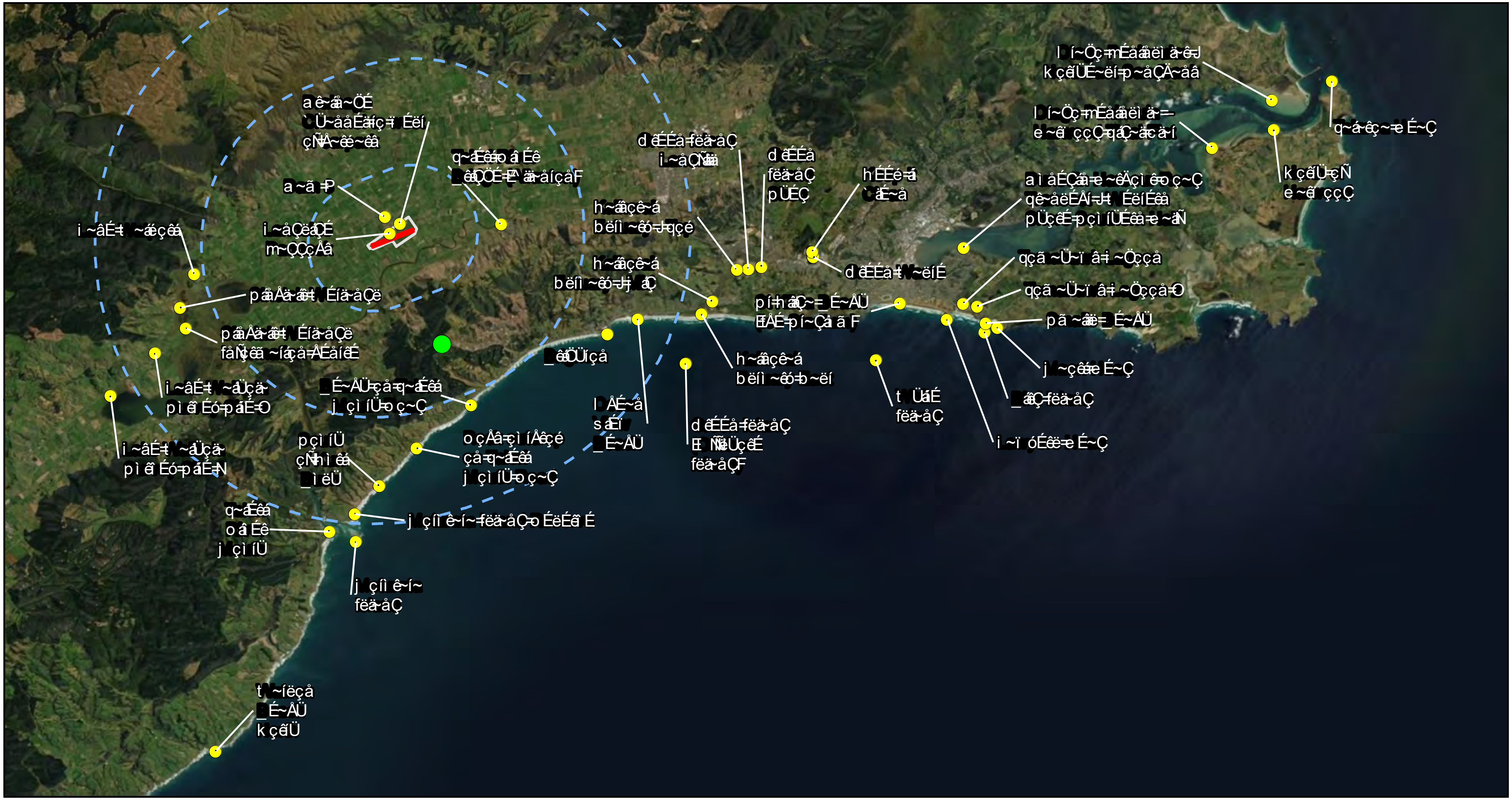


Figure 3: Location of survey sites, 4 to 7 May 2021

safety | aviation | wildlife

Data Sources:

2.4. Risk Assessment

We reviewed the species identified as a risk in the DUD Draft Wildlife Hazard Management Plan (Avisure 2018) and updated the risk assessment based on the May 2021 airside surveys (Appendix A). The key species of concern to the airport were considered in the context of species that could be attracted to the Smooth Hill Landfill and then become a threat to aviation.

The off-airport surveys were analysed for:

1. The size and nature of bird populations in Dunedin and surrounds.
2. How the closure of the Green Hill Landfill and opening of the proposed Smooth Hill Landfill could influence these populations, both in size and behaviour, and how that could impact aircraft flight paths.

The above assessment was then appraised for risk levels by species under the following categories:

1. **The existing risk at DUD**. This was based on assessments completed in 2018 and 2021. Where a species had not been classified as a risk due to an absence from surveys or strikes, it was assumed to be a very low risk.
2. **Existing population size in the Dunedin Survey Area.** Species were classified according to numbers observed during surveys: > 5000 = Very Large; 1000 to 4999 = Large; 100 to 999 = Moderate; 10 to 99 = Low to moderate; < 10 = Low. If a species had not been recorded at DUD and was observed in numbers fewer than 10 elsewhere, it was left out of the analysis as its impact on risk was deemed to be negligible.
3. **Existing population size at Green Island Landfill.** Species were classified according to numbers observed during surveys: as categorised above.
4. **Likely attraction to a new putrescible waste landfill.** Observations from various New Zealand landfills including three around Wellington, the former Burwood Landfill in Christchurch, and Green Island Landfill, informed a qualitative assessment of this category for each species.
5. **Likely impact on Site Risk.** (see Section 1.2.1). The ability for a bird species to soar and to do so in flocks was appraised to determine the classification of risk. Soaring and flocking birds scored higher.

6. **Likely impact on Flight Path Risk.** (see Section 1.2.1). The availability of complimentary habitats in positions that could encourage birds to move to and from the proposed site and through flight paths was considered for this category. Species with complimentary habitat around and across the airport scored higher.

7. **Likely impact on Spill Over Risk.** (see Section 1.2.1). The availability of a food supply from a putrescible waste landfill that supports significant population growth was considered for this category. Bird species that benefit from the artificial food supply from a landfill score higher.

8. **Likely unmitigated risk to aviation.** This was assessed based on an amalgamation of the seven factors listed above. High scores in multiple categories resulted in a higher score in this category.

9. **Residual risk to aviation after mitigation.** This assumed the successful implementation of mitigating actions recommended in Section 6 of this report.

2.5. Limitations

This Bird Hazard Assessment is considered 'preliminary' due to the following limitations:

1. A single site visit. Survey and risk assessment results are a snapshot of bird populations and do not account for climatic and seasonal fluctuations. Surveys were completed in May, so information on breeding activities and locations is based on eBird records alone.

2. Several of the sites recorded on eBird as supporting BBG, including some breeding sites, were inaccessible and would require private landholder permission to access.

3. Surveying across multiple days increases the chances that birds move between sites and it is possible we many have over or under counted birds as a result.

4. One-off risk assessment. The risk assessment cannot accurately quantify changes in local bird populations. It identifies attributes that currently attract hazardous species and the likely hazards presented by those species for the proposed landfill to contribute.

5. Details on the how the waste stream will be managed, including organic content, the transportation and unloading of the waste at the proposed Smooth Hill Landfill are yet to be decided. These will significantly influence the site's bird attraction.

6. The DUD Wildlife Hazard Management Plan has not been finalised and requires updating. Risk assessments have been based on strike data that are not recent.

7. A considerable risk to aviation will arise upon the closure of the Green Island Landfill with the redistribution of birds that currently forage there. This will be irrespective of what happens at Smooth Hill. This risk has not been assessed in this report, although it is considered in the recommendations (Section 6).

8. Details on the organic proportion of waste dumped at Green Island was not available for comparison with Kate Valley Landfill.

As a result of these limitations, there is some uncertainty around the risk outcome from the project and a precautionary approach has been recommended. As further information becomes available, the assessment should be updated.

3. Results

3.1. Review of Existing Data

eBird information on BBG indicates a significant population Dunedin and surrounds (Appendix B). Kaikorai Estuary – Top supported the highest recorded numbers of 2800 at any one site, adjacent to the Green Island Landfill. Nesting has been recorded at Blackhead, Tunnel Beach, Sandymount Seacave, Hooper's Inlet, Penguin Place, Heyward Point Blueskin Bay, Goat Island, Taieri Mouth, Taieri Island, Akatore Coast Head, and Watson Beach North.

In surveys completed at DUD in March 2018 (Avisure 2018), Common Starling was most abundant with 131 observed across three daytime surveys. Unidentified ducks and Grey Duck (collectively, most likely to be Grey Duck-Mallard Hybrids, *Anas spp.*) were the next most populous with 67 observed. Six BBG were observed.

In March 2018 (Avisure 2018), Lake Waihola recorded 150 BBG, the site with the highest number across a limited number of off-airport sites visited.

3.2. Bird Surveys

3.2.1. Overview

BBGs were by far the most abundant species recorded across all survey locations. Daytime totals for this species across all sites exceeded 6000 (Table 2 and Figure 4). The Green Island Landfill was the site with the most birds recorded, accounting for nearly half of all daytime observations of this species.

The second most populous area was the western flank and northeast sandflat of Dunedin Harbour. This area supported 1478 BBG (mostly loafing during the day) and a range of other bird species. Of the 246 Red-billed Gulls recorded across all sites, more than 200 were recorded in this area, and it supported 272 of the overall 411 Grey Duck-Mallard Hybrids recorded across all sites. Areas near the DUD were attractive to this species, including the Landside Paddock (45), the Drainage Channel to west of the carpark (20) and Dam 3 (10). Surveys also recorded the Grey Duck-Mallard Hybrid at Tomahawk Lagoon 2 (49) and the mid-section of the Kaikorai Estuary (15).

Large numbers of BBG (>1300) were observed in the Kaikorai Estuary, along with other species. This estuary is close to the Green Island Landfill and it is highly likely that birds

interchange between these sites. Smails Beach (178) and the roof of the Dunedin Ice Stadium (134 observed from St Kilda Beach) also support significant numbers of BBG during the day.

To the south of the survey area, Moturata Island Reserve (250) and Watson's Beach North (83) also recorded BBG and would be important complementary sites if Green Island Landfill populations were allowed to relocate to the proposed Smooth Hill site.

Table 2. Maximum daytime BBG counts across all survey sites. *The Kaikorai Estuary – Top count was excluded from the total count, as birds observed here were likely to have been counted during fly-in to the Green Island Landfill.

Survey Location	Maximum Count
Green Island Landfill	3002
Otago Peninsula – Harwood tidal flat	594
Sand bank - northeast	550
Kaikorai Estuary East	510
Kaikorai Estuary Mid	500
Kaikorai Estuary Top	300*
Moturata Island Reserve	250
North of Harwood	220
Smails Beach	178
Dunedin Ice Stadium (St Kilda Beach)	134
Dunedin Harbour road transect	114
Watson Beach North	83
Keep it Clean	60
Ocean View Beach	40
Bird Island	29
Lawyers Head	28
Lake Waipori	20
Tomahawk Lagoon 2	15
Taiaroa Head	15
Taieri River mouth	10
Green waste	10
Brighton	7
Moturata Island	4
White island	4
Beach on Taieri Mouth Road	4
Maori Head	4

Survey Location	Maximum Count
Landside Paddock	2
Tomahawk Lagoon 1	2
Lake Waihola Survey Site 1	1
Total	**6390**

Figure 4: Location and number of Southern Black-backed Gull observations, 4 to 7 May 2021

Boffa Miskell Limited

Smooth Hill Landfill Preliminary Bird Hazard Assessment

3, 8 & 13km buffers from runway
Dunedin Airport runway boundary
Dunedin Airport boundary

1 to 40 Gulls
41 to 134 Gulls
135 to 300 Gulls

301 to 594 Gulls
595 to 3,002 Gulls

AVISURE safety | aviation | wildlife

Job number: PR6386
Revision: 1
Author: AS
Date: 21/05/2021

0 1 2 4
Kilometers

NZGD 2000 New Zealand Transverse Mercator
Projection: Transverse Mercator
Datum: NZGD 2000
Units: Meter

PR6386_MPX_Black-backedGullLocations_Landscape A4

3.2.2. On Airport

Surveys completed at DUD in May 2021 reflected similar abundance and species diversity to surveys completed in March 2018 (Figure 3). Common Starling were the most abundant with 290 counted across the three surveys. Unidentified Small Bird (202) and Grey Duck-Mallard Hybrid (99) were other species observed in significant numbers. BBG were observed in the morning (13) and afternoon (6). Red-billed Gull were not recorded.

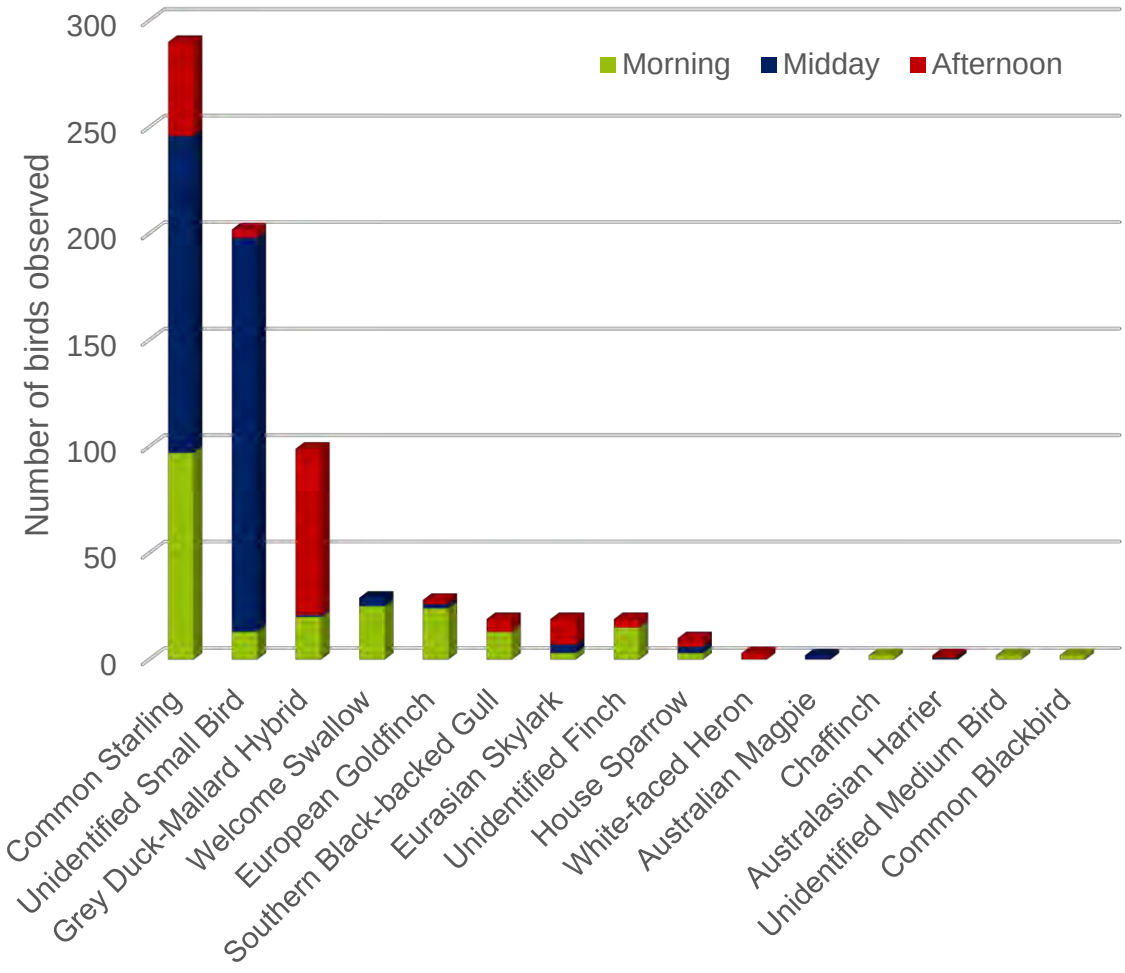


Figure 5. Bird numbers observed during surveys at DUD, May 2021

3.2.3. Smooth Hill

Bird activity was very low and a detailed bird survey was not completed.

3.2.4. Green Island Landfill

On the morning of 4 May, 3002 BBG were recorded flying into the site, mainly from the north and north west. During that period approximately 300 left the site but did not appear to return. On 7 May 2600 BBG were observed entering the landfill from the same directions. Time constraints did not allow us to remain counting until all birds were on site. It is reasonable to estimate that more than 3000 BBG use the site daily to forage. It is highly likely that this is the main food source for the majority of BBG in the Dunedin area.

Approximately 550 BBG were observed roosting during the day on the large flat roof of a shed located at the landfill. It is unknown if they use this roof to roost overnight.

Only three Red-billed Gull were recorded. Other species recorded included Australasian Harrier (*Circus approximans*), Common Blackbird (*Turdus merula*), Chaffinch (*Fringilla coelebs*), Pukeko (*Porphyrio melanotus*), House Sparrow, Songthrush (*Turdus philomelos*), Spur-winged Plover (*Vanellus miles*), Common Starling, Tui (*Prosthemandera novaeseelandiae*), and duck species.

3.2.5. BBG Roost Sites

Of an evening, BBG return to the north and most appear to roost at night on various flat roofed buildings around the city. Some drop into the southern part of Dunedin Harbour to bathe prior to relocating to the roofs. We observed different roofs being used on different nights, so it is possible that several other flat roofed buildings could be used. BBG roosted on the following building during our observations: Mainfreight transport, Bunnings Warehouse, Mico Plumbing and the Dunedin Ice Stadium. It is possible that these same buildings are used during the breeding season for nesting, although this needs to be confirmed.

3.2.6. Kate Valley

Observations at the Kate Valley Landfill indicated very low bird use which is consistent with previous anecdotal reports. One BBG was observed flying over the site, apparently not interested in what the site had to offer. Approximately 20 small unidentified birds (probably House Sparrow, but distance did not allow accurate identification) were observed around the tip face and were likely to be obtaining food.

Kate Valley is a very modern and ’clean‘ landfill with two main waste streams (Ajay Krishna, Pers comm, May 2021):

1. General waste - which consists of curb side collection of red-lidded bins taken to transfer stations and then transported in sealed containerised trucks to Kate Valley where it is unloaded, bulldozed, compacted by a 55-tonne compactor, and covered at the end of each day. There appeared to be very little organics mixed in with this general waste, hence the compactor was not exposing much food for birds.

2. Special waste - which includes a concentration of animal by-products and a range of other organics unloaded into the 'V' pit formed by the parallel lines of general waste, compacted with an excavator bucket, and covered at the end of the day. The placement of organic material into the 'V' would make accessing the organic material difficult as birds would need to go into a 'pit' which would be unsettling for them to enter.

It was estimated that that over the past 5 years, organics comprised 3-16% of all waste.

The reason for the low bird use may be due to:

1. The relatively low organic content of waste material.

2. The delivery of most organic material into a 'V' pit that would be difficult for birds to access.

3. The landfill was opened in 2005 and a bird population has never been allowed to establish.

4. The landfill is approximately 50km from the Burwood Landfill (Christchurch's main landfill prior to closing in 2005) where significant gull populations foraged, and a similar distance from the braided Waimakariri River where gulls (especially BBG) have traditionally nested. This distance could be an impediment for bird populations to have shifted.

The Kate Valley Landfill is a good example of how waste facilities can operate without attracting large populations of birds that could be hazardous to aviation.

4. Risk Evaluation

4.1. Existing Risk at DUD

DUD had a strike rate of 2.1 strikes per 10,000 aircraft movements in 2017 which was lower than each of the previous three years. However, nine strikes in the first 10 weeks of 2018 indicated that the strike rate is likely to increase in 2018 (Avisure 2018). Strike rate is a poor estimation of risk. Damaging strikes and strikes resulting in an adverse effect are better indicators of risk, as is the mass struck per 10,000 aircraft movements. In the absence of recent strike data, these analyses have not been completed as part of this hazard assessment.

Between 2014 and 17 March 2018, the most frequently struck species was House Sparrow with 14 strikes. BBG along with Unknown Species reported six strikes each, followed by five Spur-winged Plover strikes. Other bird species struck for the same period include Unidentified Finch (2), Welcome Swallow (2), Unidentified Duck (1), South Island Pied Oystercatcher (1), and Australasian Harrier (1).

It is reasonable to estimate DUD's strike risk to be significant. The implication for the Smooth Hill Landfill project is that from a risk management perspective, the project should not elevate the strike risk.

4.2. Airport Species Risk Assessment

Survey data from 2021 provided very similar results in the species risk assessment from March 2018. Grey Duck-Mallard Hybrids were assessed as a very high risk, BBG as a high risk and Common Starling, Australasian Harrier, Australian Magpie (*Cracticus tibicen*), White-faced Heron (*Egretta novaehollandiae*), Welcome Swallow (*Hirundo neoxena*), and Skylark (*Alauda arvensis*) as moderate risk (Figure 6). Other species observed including European Goldfinch (*Carduelis carduelis*), House Sparrow, Common Blackbird and Chaffinch were assessed as low risk.

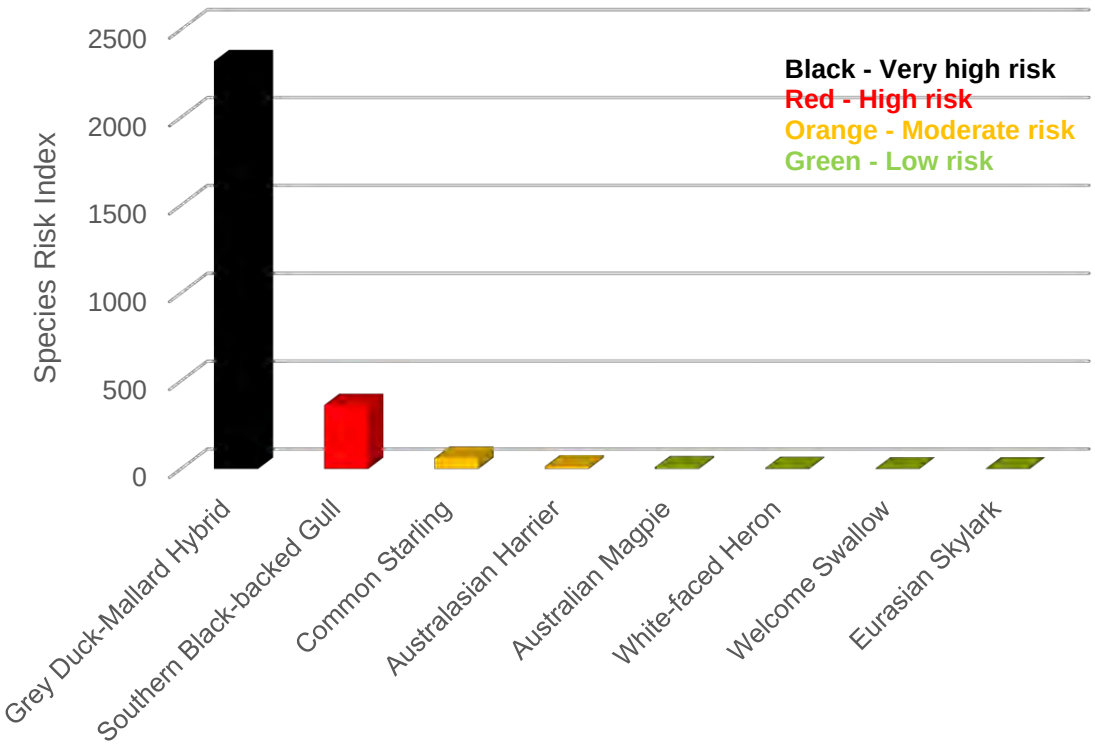


Figure 6. Species Risk Index, DUD, May 2021.

4.3. Smooth Hill Hazard Assessment

4.3.1. Assessment of risk by species

The species assessment for the proposed Smooth Hill Landfill indicates that the risk (Table 3) can be managed to an acceptable level if mitigating actions recommended in Section 6 are successfully implemented. By far the most significant contributor to risk is the BBG and managing their populations will be critical in managing the overall risk.

Grey Duck-Mallard Hybrid could add a low to moderate risk to the existing very high risk this species currently presents at the airport. This would occur if populations were allowed to build in any retention basins and other waterbodies proposed for the landfill site.

The other species that could present a low to moderate additional risk are Red-billed Gulls, Australasian Harrier and Common Starling, all of which can be effectively managed by the actions applied to mitigate the BBG risk.

Table 3. Assessment of risk from the proposed Smooth Hill Landfill

Species	Risk at DUD	Existing population size in Dunedin Survey Area	Existing population size at Green Island Landfill	Likely Attraction to a new putrescible waste landfill	Likely impact on Site Risk	Likely impact on Flight Path Risk	Likely impact on Spill Over Risk	Likely unmitigated risk to Aviation	Residual risk to aviation after mitigation
Southern Black-backed Gull	High	Very Large	Large	High	Moderate	Moderate	High	Very High	Low
Grey Duck-Mallard Hybrid	Very High	Large	Low	Low to moderate	Very Low	High	Low	Moderate	Very Low
Common Starling	Moderate	Low	Low to moderate	Moderate	Low	Low	High	Low to moderate	Very Low
Australasian Harrier	Moderate	Low	Low	Moderate	Low to moderate	Moderate	Moderate	Low to moderate	Very Low
White-faced Heron	Moderate	Low	Not recorded	Very Low	Low	Moderate	Low	Low	Very Low
Australian Magpie	Moderate	Very Low	Not recorded	Low	Low	Moderate	Low	Low	Very Low
Welcome Swallow	Moderate	Very Low	Not recorded	Low	Low	Low	Low	Low	Very Low
Striated Heron	Moderate	Very Low	Not recorded	Very Low	Very Low	Low	Low	Low	Very Low
South Island Pied Oystercatcher	Low	Moderate	Not recorded	Low	Very Low	Low	Low	Low	Very Low
Spur-winged Plover	Low	Moderate	Low	Moderate	Low	Low	Low	Low	Very Low
Pukeko	Low	Low	Low	Low	Low	Low	Low	Low	Very Low
Red-billed Gull	Very Low	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Low to moderate	Very Low
Canada Goose	Very Low	Moderate	Not recorded	Very Low	Moderate	Moderate	Low	Low	Very Low
Black Swan	Very Low	Large	Not recorded	Low	High	Moderate	Low	Low	Very Low
New Zealand Scaup	Very Low	Moderate	Not recorded	Very Low	Low	Low	Low	Low	Very Low
Black -winged Stilt	Very Low	Moderate	Not recorded	Very Low	Low	Low	Low	Low	Very Low
Shags (all species)	Very Low	Moderate	Not recorded	Very Low	Low	Low	Low	Low	Very Low
Variable Oystercatcher	Very Low	Low to moderate	Not recorded	Very Low	Low	Low	Low	Low	Very Low
White-fronted Tern	Very Low	Low to moderate	Not recorded	Very Low	Low	Low	Low	Low	Very Low
Paradise Shelduck	Very Low	Low to moderate	Not recorded	Very Low	Low	Low	Low	Low	Very Low
Common Blackbird	Very Low	Low	Low	Very Low	Low	Low	Low	Low	Very Low
Rock Pigeon	Very Low	Low	Not recorded	Moderate	Moderate	Low	Moderate	Low	Very Low
Grey Teal	Very Low	Low	Not recorded	Low	Low	Low	Low	Low	Very Low
House Sparrow	Very Low	Very Low	Low	Moderate	Low	Low	Moderate	Low	Very Low
Chaffinch	Very Low	Very Low	Low	Low	Low	Low	Low	Low	Very Low
European Goldfinch	Very Low	Very Low	Not recorded	Low	Low	Low	Low	Low	Very Low
Overall risk								**Very High**	**Low**

4.3.2. Assessment of BBG risk

Without appropriate mitigation, the BBG presents a very high risk for the proposed Smooth Hill Landfill. The reasons for this include:

1. Their current high risk at DUD. They are a large flocking bird species with a body mass of 850-1150g. Surveys recorded them on the airport, and they have been reported in six strikes between January 2014 and 17 March 2018. When flocks are moving through aircraft airspace a multiple strike (i.e., where more than one bird is struck in a single incident) is more likely.

2. There is a large existing population of more than 6000 in the Dunedin region.

3. Around half of the known population appear to feed at the existing Green Island Landfill.

4. Transition to a new landfill at Smooth Hill is likely when Green Island is closed unless major modification is made to the composition of the waste stream and/or how it is handled.

5. Aircraft flight paths occasionally pass over the proposed Smooth Hill site and as BBG are known to soar to considerable heights, the Site Risk is considered moderate.

6. The Flight Path Risk was assessed as moderate. There are no known roosting and or breeding colonies to the southwest, west or northwest of the airport and the habitat is not ideal for such colonies to develop. It is likely that populations would generally move in a southward direction along the coast from their current preferred locations. However, there are many farm paddocks and dams to the southwest, west or northwest of the airport and, during certain conditions (such as during calving or lambing, during or following high rainfall conditions), some BBG could move from Smooth Hill across aircraft flight paths to these habitats to feed.

7. The Spill Over Risk was assessed as high because a population of BBG using the proposed Smooth Hill Landfill would continue to obtain artificial food resources and fuel population growth.

5. Conclusion

This preliminary bird hazard assessment based on non-breeding season surveys and a review of DUD data indicates that there is a very high risk to aviation from the proposed Smooth Hill Landfill. Mitigation involving multiple actions and based on an escalating response requirement depending on the success of initial mitigation, indicates that the risk can be managed to an acceptably low level.

BBG present the greatest aviation risk owing to their size, flocking nature, current local population size, utilisation of the existing Green Island Landfill, preference for putrescible waste, ability to soar, opportunistic response to food from farm paddocks, and their ability for population growth based on artificial food supply leading to spill over into the general environment.

Guidance material from the NZ CAA and ICAO indicates that putrescible waste landfills should ideally be situated at least 13km from airports. As the bird strike risk is already high at DUD then the risk assessment and the Bird Management Plan must detail how the landfill will not exacerbate the risk.

Dunedin City Council will decide by the end of May 2021 if it intends to proceed with separating organics at the curb side. This will be a critical factor influencing if birds will relocate from Green Island to Smooth Hill. In any event, the closure of the Green Island facility is likely to scatter BBG populations across the landscape and a heightened risk to aviation can be expected at that time. This will be irrespective of what happens at Smooth Hill and is a risk that must be managed.

This assessment was limited by a range of factors (Section 2.5), accordingly it is considered a preliminary assessment. More surveys across all seasons, updated information on what the waste stream will consist of and how it will be handled at Smooth Hill, and a review of key factors contributing to the low bird numbers at Kate Valley are necessary to update this risk assessment.

6. Recommendations

6.1. Limit Organics from the Waste Stream

Key to managing the attraction of birds to waste landfills is eliminating organic materials. Where elimination is impossible, reducing the organic content to as low as possible is likely to provide the best results. The way organics are processed is important for bird attraction, as evidenced by the Kate Valley Landfill. A more detailed understanding of why birds are not attracted to Kate Valley is advised to see if a similar process can be established at Smooth Hill.

6.2. Update the Draft Smooth Hill Bird Management Plan

The Draft Smooth Hill Bird Management Plan requires updating. Apart from detailing the acceptable amount of organic material to be unloaded at the landfill and how that is to occur in a manner that restricts access, there are a number of initiatives that need to be included:

6.2.1. Monitoring

A monitoring regime should be established prior to the closure of Green Island and establishment of Smooth Hill. This should be designed to:

1. Determine the year-round behaviour patterns of key bird species and their populations in the Dunedin area, especially the BBG.

2. Determine how BBG and other species respond to management initiatives at Green Island leading up to, during and after its closure to organic waste.

3. Establish a baseline estimate of risk at and around DUD through structured regular surveys that allow risk assessment models to be updated.

Commencing immediately and reassessed annually, the following monitoring frequency is suggested by a suitably trained and qualified bird observer:

Monthly

- On airport surveys – morning, middle of day, afternoon.

- Off airport surveys – Dam 3, Landside paddock, drain west of carpark, Smooth Hill.

- Green Island fly in count at first light.

Seasonally

As above plus:

- Repeat surveys completed in May 2021.

Monitoring at Smooth Hill, once operational, should be more frequent. Daily counts should be completed by trained onsite staff using binoculars. Monthly counts should be completed by a suitably trained and qualified bird observer. Detailed procedures and survey data sheets should be included in the management plan.

6.2.2. Establishing acceptable thresholds of bird numbers

There should be zero tolerance for birds greater than 50g in size feeding at the Smooth Hill Landfill or accessing waterbodies. This size class includes species from the size of a Common Starling and above. Occasional use by small birds in numbers fewer than 100 such as House Sparrows can be tolerated.

If at any time more than 20 individuals from a species greater than 50g, or combined numbers of these species exceeds 100, then management actions should be elevated. If more than 12 breaches of these thresholds occur in any 12-month period, a net should be positioned over the landfill to ensure no further bird activity is possible, unless an aviation risk assessment indicates that the risk can otherwise be managed to an acceptable level.

6.2.3. Mitigation at Smooth Hill

In addition to the above, the following key elements should be added to the Draft Bird Management Plan:

1. Ponds as attraction for waterbirds. The Plan indicates that there will be a detention basin that will usually be dry. If this is the case, there is unlikely to be a significant attraction to birds. However, if monitoring indicates that numbers increase above acceptable thresholds and that pond(s) are contributing to that increase, then measures that may need to be retrospectively installed, such as wires or nets. The Plan should highlight these measures.

2. Training. Add detail on the level or type of training required for people involved in implementing the Plan.

3. Standard Operation Procedures (SOP). SOPs for each main activity related to the Plan should be included.

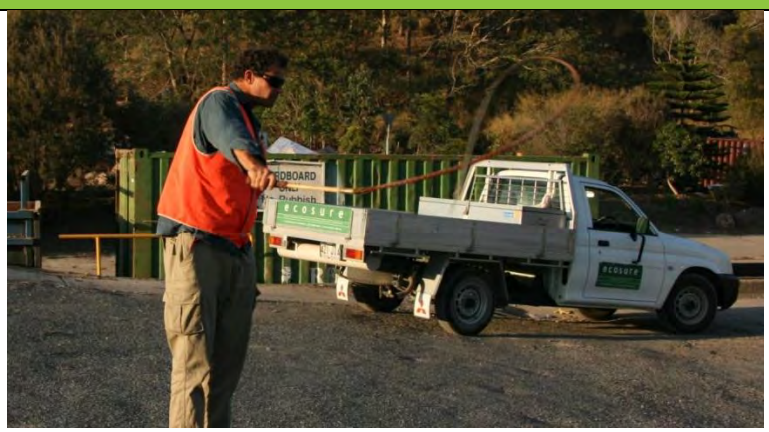
The Bird Hazard Assessment and Draft Management Plan should be updated to accommodate the concepts outlined in Table 4 which lists recommendations to mitigate the potential strike risk at DUD associated with birds using Smooth Hill Landfill.

Table 4. Bird hazard management recommendations for Smooth Hill Landfill.

Area	Recommendation
Risk Assessment	Determine the contribution to bird strike risk using a method that considers: • species (behaviour, mass, tendency to flock or roost communally) • land use/activity type • location relative to DUD and the approach/departure paths • location relative to nearby land uses that attract, or have the potential to attract, birds • species strike risk based on DUD strike data. This would include a detailed assessment of the current bird population at Green Island Landfill and the areas they roost and nest.
Bird Management Plan	Should include: • regular monitoring surveys • bird hazard assessments by qualified ornithologists or biologists • details of bird awareness and bird management training for relevant staff, including syllabus • establishment of bird population triggers • implementation of activities to reduce hazardous bird populations • adoption of bird deterrent technologies to reduce hazardous bird populations • performance indicators to evaluate implementation and compliance to consent conditions • a review process to regularly assess implementation against performance indicators, identify gaps, and ensure currency • allocation of roles and responsibilities for plan implementation and review. • regular reassessment of the risk • escalation of measures to reduce bird attraction if bird population triggers are met.
Bird Management Plan	Standard operating procedures should include: • bird dispersal • bird counts

Area	Recommendation
	• maintaining a small single tip-face • Lethal control.
Monitoring	Commence a monitoring program prior to construction to obtain a baseline of bird activity and habitat use on the landfill site and in the vicinity.
Monitoring	Ensure the monitoring program is regular and standardised so that it: • determines the level of bird attraction • identifies temporal variation of bird activity (i.e., how birds use the site at different times of the day, year, or climatic phase) • identifies current, emerging and potential risks • monitors the presence and behaviour of birds • identifies attractants (e.g., water, food).
Monitoring	Monitoring procedures should: • Establish a standard survey route around the designated site. This does not have to include every single structure/location but should include key ones. • Designate stopping points where areas are scanned for birds. • Record bird data on a standardised form (electronic or paper) that has been created to capture at least the following data: - date - time - observer - weather - bird name - bird number - bird behaviour (e.g., perching, foraging, transiting, etc.) - bird habitat usage (e.g., grass, building, drain, tank, etc.). Monitoring should also note any nesting activity, unusual bird activity, effectiveness of mitigation devices.
Landfill construction	Include bird hazard management as part of Construction Environment Management Plans (CEMP). This will assist with identifying potential bird attractions and identify ways to mitigate any risks. It can also help deter birds becoming attracted, and habituated, to the site who may

Area	Recommendation
	contribute the DUD strike risk. The CEMP can include options for managing bird hazards associated with: • earthworks • soil and other material stockpiles • temporary infrastructure • water retention area.
Landfill construction	Level the ground during clearing and construction. Grading the ground effectively on commencement of construction will reduce the number and extent of low-lying areas and ground depressions.
Tip face management	Maintain the tip face area to as small as possible.
Tip face management	Cover exposed waste at the end of each day.
Tip face management	Disperse birds from the tip face.
Dispersal	Dedicate trained personnel to disperse birds from the tip face during daylight operational hours (until end-of-day cover is applied).
Dispersal	Tools: stockwhip, pyrotechnics, starters pistol, portable distress caller.  

Area	Recommendation
	 
Nesting/ Roosting	If birds establish nests or roosts on site, arrange to restrict breeding success (e.g., by removing eggs and nests or egg oiling) and/or roost dispersal. If applicable, acquire necessary permits.
Waste management	If the initial actions do not manage the risk, it may be necessary to escalate management efforts. Trialling wires above the landfill maybe an option, although is unproven in New Zealand.
Waste management	Consider baling waste as an escalating action if thresholds are breached. This does not eliminate the food but compresses it and makes access for the birds very difficult. Waste should first be unloaded into a bird-proofed building to prevent access at the unloading stage.

Area	Recommendation
	
Waste management	An expensive but tested solution to prevent bird access to food waste is netting. This may be considered as the final escalating action and Dunedin City Council should establish the costs of installation and maintenance. Nets tear easily so good maintenance regimes are essential to maintain the integrity of the enclosure. 
Grass management	Maintain grass height at 200-300mm to deter ground foragers. 
Water management	Use underground drains and water storage where possible to reduce water availability to birds.

Area	Recommendation
Water management	Ensure any water detention ponds fully drain with 24-48 hrs (where this does not occur, apply the same management as retention areas).
Water management	Ponding should not exceed 100m^2 of open water, for more than a continuous 48-hour period.
Water management	The continuous water surface area of detention and retention basins should not exceed 100m^2.
Water management	Net detention and retention basins (or other permanent water) if surface area exceeds 100m^2. Bird hazard assessments should consider this within the context of distance from the airport and location relative to other off-airport hazards. Consider replacing open water areas with underground storage. 
Water management	If netting is not feasible, cover retention basins and other permanent water sources with exclusion devices such as wires or permeable membranes. 

Area	Recommendation
	
Water management	Water depth between 0.5m and 1.18m is less likely to attract hazardous flocking bird such as swans, and cormorants or upending ducks.
Water management	Bank slopes for retention and detention areas and stormwater drains should not exceed 4V:1H. Narrow-sided retention and detention ponds are very effective at deterring birds from accessing water from the banks. Use of gabion or other edging treatment (see images below) can assist with maintaining steep banks and minimising erosion.  
Buildings and other infrastructure	Where perching, roosting or nesting activity is detected on structures, install exclusionary devices such as netting or anti-perching spikes. Carefully evaluate any retrospective installation of exclusionary devices to ensure they are effective.

Area	Recommendation
	
Buildings and other infrastructure	At the design stage, assess and evaluate building and infrastructure design to identify ways to proactively reduce the bird attraction. Minimise any retrospective efforts required to reduce the attraction by installing exclusionary devices or retrofitting structures.
Stakeholder committee	Establish a Wildlife Hazard Management Committee or join the DUD Wildlife Hazard Management Committee (if established) to provide a forum to discuss wildlife hazard management with relevant stakeholders and local authorities. Regular meetings will assist with: • The ongoing exchange of information between stakeholders to improve wildlife management. • Ensuring stakeholders are aware of their responsibilities. • Encouraging stakeholders to adopt a proactive approach to wildlife management. • Improving communication between stakeholders. • Reducing the economic impact on aircraft operators and improving operational safety.

6.3. Managing BBG in the Dunedin area

To avoid a significant scattering of birds across the landscape during and following the closure of Green Island Landfill and to reduce the population of BBG likely to be attracted to the new landfill, prepare a management plan for BBG in the Dunedin area.

Prior to the closure of Green Island Landfill to putrescible waste:

1. Collaborate with DIAL, the Department of Conservation and Dunedin Council, to establish a breeding season control program at key BBG breeding sites.

2. Consult with DIAL to commence a staged dispersal program for BBG at Green Island Landfill. It will be necessary to have excellent communications between bird controllers and DIAL staff to ensure that aviation risks are well managed. This program should commence prior to the next BBG breeding season, as populations deprived of food at this critical time are less likely to build nests and lay eggs. They are also more likely to disperse away from the region more rapidly. Dispersal will involve a trained and equipped bird control officer positioned at the landfill and preventing birds from feeding on the active tip face for all daylight hours. Over time, the hours required on site can be scaled back based on the success of the program and/or the impact on the aviation risk as assessed in consultation with DIAL.

References

Allan, J. (2002) *The Costs of Birdstrikes and Birdstrike Prevention. in Clarke L (ed.)* Human Conflicts with Wildlife: Economic Considerations pp 147-153. US Department of Agriculture, Fort Collins.

Avisure (2018) Dunedin International Airport Draft Wildlife Hazard Management Plan, October 2018.

Avisure (2020) Smooth Hill Landfill Wildlife Strike Hazard Review – Draft, Report to Dunedin City Council November 2020.

Boffa Miskall (2020) *Smooth Hill Landfill Assessment of Environmental Effects*. Report prepared for Dunedin City Council.

Dolbeer, A (2011) *Increasing Trend of Damaging Bird Strikes with Aircraft Outside the Airport Boundary: Implications for Mitigation Measures*. Human-Wildlife Interactions 5(2):235-248, Fall 2011.

eBird https://ebird.org/map/kelgul?neg=true&env.minX=169.6163700525194&env.minY=-46.25109877665183&env.maxX=171.041044984433&env.maxY=-45.63396623883648&zh=true&gp=true&ev=Z&mr=1-12&bmo=1&emo=12&yr=all&byr=1900&eyr=2021

New Zealand Civil Aviation Authority (2008) *Guidance Material for Land Use at or near Aerodromes*.

Ryder (2019) *Smooth Hill Landfill Bird Hazard Assessment.* Report prepared for Dunedin City Council.

Shaw, PP 2004, *A Model for Determining Risk Categories for Birds at Airports Using Bird Survey Data*. Bird Strike Conference 2004, Baltimore, USA.

Shaw P., Dolbeer R., & McKee J. (2019) *Human Fatalities and Destroyed Civil Aircraft Due to Wildlife Strikes, 1912 to Present*. In Proceedings of the 2019 North American Bird Strike Conference, Halifax Nova Scotia, Canada.

Appendix A: On Airport Survey Risk Assessment

Survey Risk Assessment (Shaw, 2004)

Avisure has developed a model for determining risk categories using professional bird survey data. The survey data is used to derive probability factors (population size, position on airport, time spent in air and the species ability to avoid) and consequence factors (bird mass and flock size) for all species recorded. The combination of these probability and consequence factors give a numerical risk index, the Species Risk Index (SRI). This provides a real-time method of risk assessment as it is able to react to observed changes in airside bird assemblages and movement patterns.

Table A1 outline the risk rating for wildlife species according to calculated SRI, and the risk ranking of an airport.

Table A1. Species Risk Index and Airport Survey Risk Index for determining risk categories based on survey data.

SRI ranges used to rate risk for each species		ASRI ranges used to rate risk of an airport	
SRI	Risk rating	ASRI	Risk rating
>1000	Very high	>10000	Very high
100 to 999.9	High	1000 to 9999.9	High
10 to 99.9	Moderate	100 to 999.9	Moderate
1 to 9.9	Low	10 to 99.9	Low
< 1	Very low	< 10	Very low

The process intends to provide a transparent, logical and systematic approach to the identification and treatment of wildlife related risks at the airport. The risk assessment identifies high risk species, which allows suitable management practices to be targeted in areas where the maximum reduction in risk may be achieved.

Appendix B: Southern Black-backed Gull (*Larus dominicanus*) eBird Records

High counts of kelp gulls (black-backed gulls) around Dunedin, accessed 27 April 2021.

https://ebird.org/map/kelgul?neg=true&env.minX=169.6163700525194&env.minY=-46.25109877665183&env.maxX=171.041044984433&env.maxY=-45.63396623883648&zh=true&gp=true&ev=Z&mr=1-12&bmo=1&emo=12&yr=all&byr=1900&eyr=2021

Location	Notes	Count	Date	GPS Coordinates
Dunedin Airport		200	4 Feb 2021	45.9226771,170.199573
School Road South		689	10 Aug 2017	45.8659869,170.2784729
Henley farmland	Paddock	500	29 Apr 2018	45.96896,170.1688886
Green Island (offshore island)		200	13 Jun 2020	45.9531796,170.3870487
Kaikorai Reserve		800	20 Mar 2021	45.9263191,170.3910828
Kaikorai Estuary		410	18 Feb 1990	45.9282076,170.3917265
Kaikorai Estuary		900	22 Jun 2012	45.9263191,170.3910828
Kaikorai Estuary		1033	14 Apr 2018	45.9263191,170.3910828
Kaikorai Estuary		2265	19 May 2001	45.9077266,170.4065752
Kaikorai Estuary		2800	19 May 1991	45.9059349,170.41224
Blackhead	Chicks in creche, near flying. Boulder beach east side of Blackhead	200	31 Dec 2020	45.92652, 170.43486
Tunnel Beach	Fresh juveniles and some adults still at nest sites on stack to east	40	7 Jan 2020	45.9212143,170.4580736
Bird Island	Roosting	>200	26 Jul 2015	45.9117199,170.5593967
Sandymount Seacave	Nests	20 nests	22 Nov 2017	45.8923978,170.6861687
Hooper's Inlet	On nests	108	29 Nov 2020	45.861564,170.6691742

Location	Notes	Count	Date	GPS Coordinates
Hooper's Inlet		399	3 Mar 2021	45.8691666,170.6692757
Papanui Inlet		506	17 Jun 1989	45.847456,170.6938934
Victory Beach		600	20 Sep 2009	45.8463611,170.7301111
Penguin Beach		300	20 Feb 2021	45.8037942,170.7440293
Penguin Place	Numerous nests (not quantified)	80	4 Dec 2019	45.7967932,170.7303071
Aramoana Mole/Harbour Entrance		300	29 May 2020	45.7709955,170.719471
Heyward Point	About even numbers of adults and fledglings. Westside of the main headland is a large colony	50	22 Jan 2021	45.767,170.708
Blueskin Bay	Colony of ~30 nests – eggs or small young	91	10 Nov 2010	45.734643,170.5831718
Otago Harbour		300	5 Jan 2020	
Otago Peninsula – Harwood tidal flat		500	16 Feb 2020	45.8170758,170.6688309
Otago Peninsula – Portobello & adjacent bays		700	7 Jun 2020	45.8381284,170.6537247
Goat Island	Nesting on Goat Island cliffs	20	21 Dec 2015	45.8245349,170.6257979
Dunedin Harbour		400	11 Mar 2018	45.8750708,170.5393982
Taieri Mouth	Nesting colony	2500	10 Sep 2008	46.0505992,170.199852
Taieri Island	Nesting with chicks	150	9 Dec 2013	46.0578798,170.2165461
Taieri Beach		350	1 Aug 2020	46.0556331,170.1950717
Akatore Coast Head	Indictive of colony site	70	8 Jul 2018	46.1294514,170.1856041

Location	Notes	Count	Date	GPS Coordinates
Watson Beach North	Indicative of colony site	60	8 Jul 2018	46.1576789,170.1620865
Nugget Point		300	16 Feb 2011	46.448107,169.817058
Nugget Point		580	25 Jan 2016	46.447575,169.816596

NB: 6 nests noted at Kaikorai estuary for one survey conducted and 4 nests on island 400m east of Tunnel Beach; 6 nests at Christinas Rock Stack; 16 juveniles and 6 immature birds on Bird Island; breeding colony on offshore rocks - 30 immature birds seen from Tomahawk lookout; 20 juveniles on Bird Island; some nesting at Nugget Point.

NB: Kaikorai Estuary is near Green Island landfill – numerous counts at the estuary have recorded very high numbers of black-backed/kelp gulls around this area.

Revision History

Rev. No.	Rev. Date	Details	Prepared by	Reviewed by	Approved by
0	19/05/2021	Preliminary Smooth Hill Landfill Bird Hazard Assessment (Draft)	Phil Shaw Principal Aviation Ecologist	Kylie Patrick Principal Consultant	Phil Shaw Principal Aviation Ecologist
1	2**5**/05/2021	Preliminary Smooth Hill Landfill Bird Hazard Assessment (F**inal**)	Phil Shaw Principal Aviation Ecologist	Phil Shaw Principal Aviation Ecologist	Phil Shaw Principal Aviation Ecologist

Distribution List

Copy No.	Date	Format	Issued to	Name
1	2**5**/05/2021	E-copy (Word)	Boffa Miskell	Karin Sievwright
2	25/05/2021	E-copy (Word)	Boffa Miskell	Rachael Eaton
3	20/05/2021	E-copy (Word)	Avisure	Administration

BoffaMiskell-RE.SmoothHillPreliminaryBirdHazardAssessment.Final

contact@avisure.com | www.avisure.com

GOLD COAST – AUS
Head Quarters
Level 4 McDonald House
10/37 Connor Street
Burleigh Heads QLD 4220

PO Box 404
West Burleigh QLD 4219
Australia

P +61 7 5508 2046
F +61 7 5508 2544

ABN 26 131 545 054

ADELAIDE - AUS
36A/11-13 Parkway
Mawson Lakes SA 5095

PO Box 145
Pooraka SA 5095

P+61 1300 112 021

MELBOURNE -AUS
Point Cook Rd
Point Cook VIC 3030

P+61 1300 112 021

SEATTLE - USA
17801 International Blvd
Seattle, Washington 98158

P +1 907 625 1027

SYDNEY - AUS
PO Box 880
Surry Hills NSW 2010

P+61 1300 112 021

VANCOUVER - CAN
PO Box 32372
YVR Domestic Terminal RPO
Richmond BC V7B1W2

P +1 855 758 5830

Appendix 6: Dunedin Airport On-Airport Bird Monitoring Locations

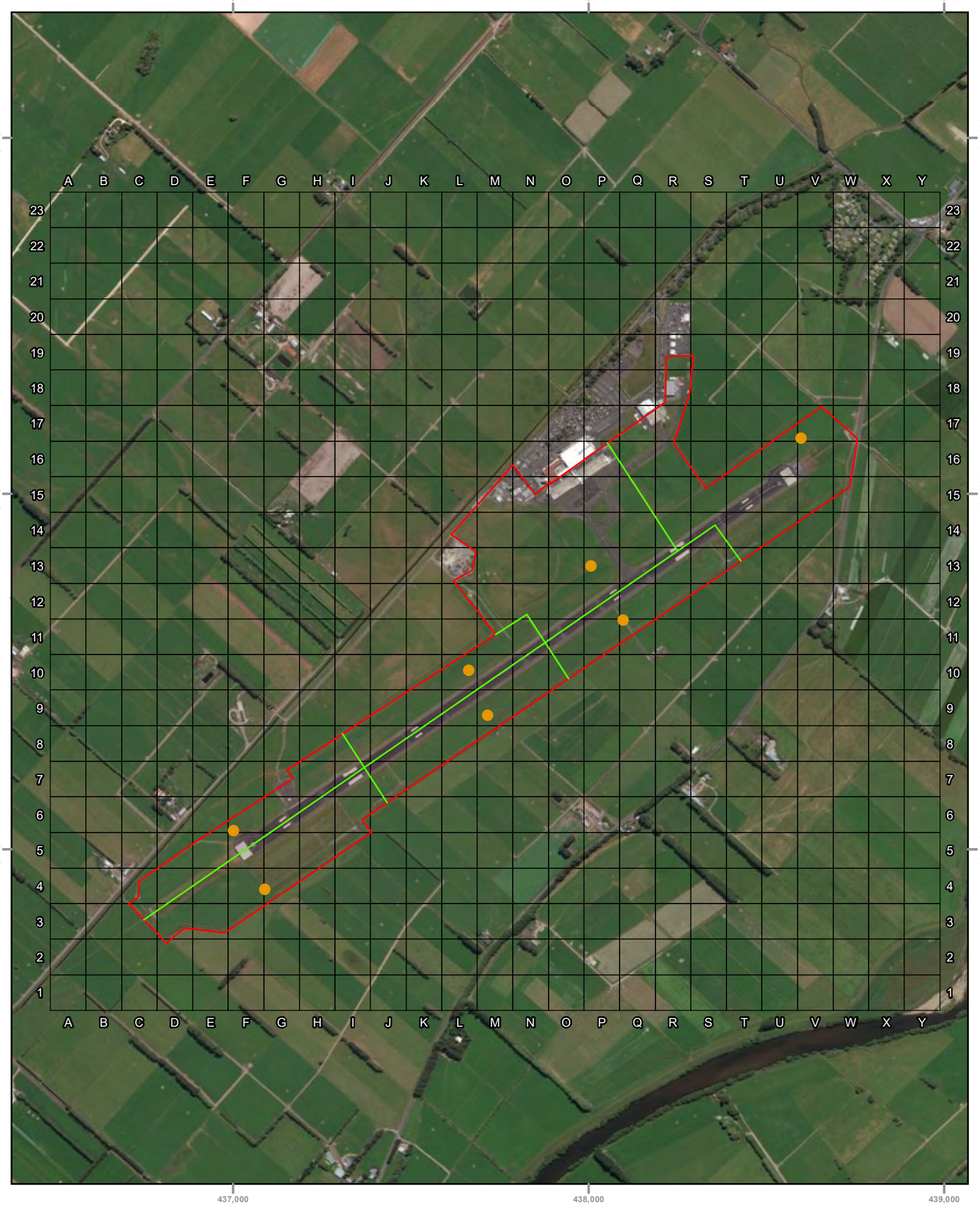


Figure A1 : On-airport Survey

Dunedin Airport

Wildlife hazard assessment and management plan

- On-airport Survey Points
- On-airport Survey Points
- Airport Boundary

AVISURE safety | aviation | wildlife

Job number: PR2189
Revision: 2
Author: DB, AS
Date: 28/03/2018

0 100 200 400
Meters

NZGD 2000 UTM Zone 59S
Projection: Transverse Mercator
Datum: NZGD 2000
Units: Meter

Appendix 7: Off-Airport Bird Monitoring Sites

Figure 3: Location of survey sites, 4 to 7 May 2021

Boffa Miskell Limited

Smooth Hill Landfill Preliminary Bird Hazard Assessment

Smooth Hill Landfill proposed site

Off-airport sites

3, 8 & 13km buffers from runway

Dunedin Airport runway boundary

Dunedin Airport boundary

AVISURE safety | aviation | wildlife

Job number: PR6386
Revision: 1
Author: AS
Date: 21/05/2021

0 1 2 4
Kilometers

NZGD 2000 New Zealand Transverse Mercator
Projection: Transverse Mercator
Datum: NZGD 2000
Units: Meter

PR6386_MPX_OffairportLocations_Landscape
A4

About Boffa Miskell

Boffa Miskell is a leading New Zealand professional services consultancy with offices in Auckland, Hamilton, Tauranga, Wellington, Christchurch, Dunedin and Queenstown. We work with a wide range of local and international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, cultural heritage, graphics and mapping. Over the past four decades we have built a reputation for professionalism, innovation and excellence. During this time we have been associated with a significant number of projects that have shaped New Zealand's environment.

---

www.boffamiskell.co.nz

Auckland	**Hamilton**	**Tauranga**	**Wellington**	**Christchurch**	**Queenstown**	**Dunedin**
+64 9 358 2526	+64 7 960 0006	+65 7 571 5511	+64 4 385 9315	+64 3 366 8891	+64 3 441 1670	+64 3 470 0460

Appendix 2: Vegetation Restoration Plan

Boffa Miskell

Smooth Hill Landfill – Vegetation Restoration

Draft Management Plan
Prepared for Dunedin City Council

4 June 2021

Document Quality Assurance

Bibliographic reference for citation: Boffa Miskell Limited 2021. *Smooth Hill Landfill – Vegetation Restoration: Draft Management Plan*. Report prepared by Boffa Miskell Limited for Dunedin City Council.		
Prepared by:	Jaz Morris Ecologist Boffa Miskell Limited	
Reviewed by:	Tanya Blakely Senior Principal | Senior Ecologist Boffa Miskell Limited	
Status: DRAFT	Revision / version: [A]	Issue date: 4 June 2021

Template revision: 20180621 0000

File ref: BM200252_004b_Smooth_Hill_Vegetation_Restoration_Management_Plan_20210604.docx

Cover photograph: Gorse, pūkio, harakeke and creeping buttercup in the Smooth Hill swamp wetland

CONTENTS

1.0 Introduction 3

1.1 Background 3
1.2 Purpose of Plan 4
1.3 Restoration Objectives 6
1.4 Restoration Principles 6

2.0 Existing Ecological Values 9

2.1 Wetland Vegetation 9
2.2 Forest / Scrub Vegetation 10
2.3 Fauna 10

3.0 Restoration Process 12

3.1 Overall Measures 12
3.2 Restoration Zones 16
3.3 Timing of Works 25

4.0 Monitoring and Plan Review 27

4.1 Overall Monitoring 27
4.2 Wetland Areas 28
4.3 Plan Review 28

5.0 References 29

Appendices

Appendix 1: Map of Location Names (Fig. 2 from EcIA)

Appendix 2: Site and Vegetation Photographs

Figures

Figure 1. Existing Habitats in Forest and Wetland Restoration Area 8

Figure 2. Forest and Wetland Restoration Overview.....11

Figure 3. Forest and Wetland Restoration Zones - 'Smooth Hill Reserve' Area 17

Figure 4. Forest and Wetland Restoration Zones - Wetland Offset Area 18

Figure 5. Restoration target for the Smooth Hill swamp wetland, depicting some of the **target outcomes** for vegetation pattern in the proposed restoration zones (from left to right) B, A.2, and A.1. 21

Figure 6. Restoration target for West Gully 3 and northern lizard habitat planting buffer, depicting some of the target outcomes for vegetation pattern in the proposed restoration zones (from left to right) C.1 and D. 23

Tables

Table 1. Pest plant species to be controlled within the Smooth Hill Reserve and wetland offset area. 13

Table 2. Indigenous plant species recommended for Zone A.1 restoration planting. 19

Table 3. Indigenous plant species recommended for Zone A.2 restoration planting. 19

Table 4. Indigenous plant species recommended for Zone B restoration planting. 20

Table 5. Indigenous plant species recommended for Zone C.1 restoration planting. 21

Table 6. Indigenous plant species recommended for Zone C.2 restoration planting. 22

Table 7. Indigenous plant species recommended for Zone D restoration planting. 23

Table 8. Indigenous plant species recommended for Zone E restoration planting. 24

Table 9. Indigenous plant species recommended for Zone O restoration infill planting. 25

Table 10. Additional indigenous plant species recommended for Zone O restoration planting. 25

1.0 Introduction

This Vegetation Restoration Management Plan (VRMP) describes the enhancement and ongoing protection of a small regenerating forest area and degraded natural wetland adjacent to the site of a Dunedin City Council (DCC) landfill at Smooth Hill, south-east of Dunedin.

This VRMP is one of a suite of ecological management plans and is to be read in conjunction with the draft Landfill Management Plan (LMP, Boffa Miskell 2021a), which has been prepared to support the construction, operation, closure and aftercare of the Smooth Hill Landfill. This plan should also be read in conjunction with the Smooth Hill Lizard Management Plan (Boffa Miskell 2021b).

This plan will provide sufficient detail for evaluation of the project by Dunedin City Council (DCC) and Otago Regional Council (ORC) for resource consents for the Smooth Hill Landfill and associated upgrade to McLaren Gully and Big Stone roads.

The landfill's designation site (originally designated in the 1990s) is currently dominated by radiata pine plantation forestry but includes several small bush gullies that are connected to areas of 'valley floor marsh' and 'swamp wetland' habitat[1]. These habitats are outside the footprint of the landfill but are in its immediate vicinity. Boffa Miskell Limited was engaged by DCC to undertake an ecological impact assessment to describe the potential impacts of the landfill, and associated upgrades of McLaren Gully Road and Big Stone Road.

The ecological impact assessment (Boffa Miskell 2021b) identified that several wetland areas immediately fringe McLaren Gully Road and that widening of the road would result in a small loss (16.5 m^2 or 0.0017 ha) of wetland habitat. In addition, the landfill development may potentially affect the water supply to a 'swamp wetland'[1] located within the designation site and immediately below the landfill footprint, potentially causing shifts in species composition favouring facultative wetland species or an increase in dryland weeds. Further, the landfill development will result in the loss of habitat for indigenous lizards (skinks) alongside the access roads and in areas of existing plantation forestry that may be cleared. These adverse effects require ecological mitigation / offset measures.

1.1 Background

1.1.1 Site location and context

The landfill site is situated in the hill country between the Taieri River plains and the coastline, 28 km south of Dunedin, seven kilometres from the sea-side township of Brighton and eleven kilometres from Waihola. The site is accessed off McLaren Gully Road and Big Stone Road, from State Highway 1. The designation site sits within the Tokomairiro Ecological District.

A range of vegetation types are present within the Smooth Hill landfill footprint, the designation site, downstream areas, and areas adjacent to roads that may be widened. These range from highly modified plantation forestry areas of negligible ecological value, to grassland and wetland habitats of moderate ecological value, and regenerating / secondary indigenous forest habitat of

[1] See Figure A1.1, Appendix 1 for a map of location names.

high ecological value (see Section 2.0). Regenerating forest gullies at the designation site (outside the landfill footprint) contributes to a local mosaic of forest fragment habitats in the wider area. A range of widespread and common indigenous bird species are present, including eastern falcon[2]. Most areas of the designation site, and rank grassland areas in particular, are likely to provide habitat for indigenous lizards[3].

1.1.2 Protection of wetland habitats

Wetland areas that may be impacted by the landfill proposal are bordered largely by plantation forestry or agricultural farmland but qualify as ecologically significant under the Operative and Proposed Dunedin District Plans and the Partially Operative Otago Regional Policy Statement. These areas are 'natural inland wetlands' for the purposes of the National Policy Statement for Freshwater Management 2020 (NPS-FM 2020). Regional and district rules both require proposals to achieve 'no net loss' or preferably a 'net gain' in the indigenous biodiversity values[4] of significant areas.

The area of wetland habitat that may be lost alongside McLaren Gully Road is exceedingly small, and the areas that will be lost have limited species diversity and are typically dominated by facultative[8] and / or facultative wetland[8] taxa that are either exotic (e.g. creeping buttercup, jointed rush) or indigenous and extremely common (rautahi). However, the 0.47 ha swamp wetland within the designation site (which may be affected due to changes to the water supply to the wetland) is more representative and supports a greater range of indigenous plant species including both obligate[8] and facultative wetland[8] species (Boffa Miskell 2021b).

1.1.3 Protection of lizards and lizard habitat

Indigenous lizard species are absolutely protected by the Wildlife Act 1953, and their presence in an area of habitat (even if that habitat would otherwise not meet significance criteria) may render an area significant under regional and district rules. It is likely that southern grass skink (classified as nationally At Risk – Declining) and potentially other lizard species are present within the designation site, including within the landfill footprint, and in habitat immediately adjacent to McLaren Gully and Big Stone roads (see Boffa Miskell 2021b, 2021c). As a result, areas of exotic grassland and plantation forestry that may be cleared as a result of the landfill proposal are considered significant, and no net loss, and preferably a net gain, rules also apply to these areas (i.e. similar or better lizard habitat must be created or enhanced elsewhere). Any lizards that may be present, being protected, are to be salvaged and translocated to a suitable release site in accordance with the Smooth Hill Landfill Lizard Management Plan (Boffa Miskell 2021b).

1.2 Purpose of Plan

The purpose of the information provided in this plan is to guide the permanent restoration of an area of indigenous wetland, and of shrubland and forest habitat, to mitigate and offset the adverse ecological effects of the Smooth Hill Landfill.

This VRMP outlines the process for the enhancement of two connected. The areas are:

[2] Classified as nationally At Risk – Recovering.

[3] Including at least one At Risk – Declining species.

[4] In the Proposed Dunedin District Plan (2GP), no net loss is "measured by type, amount or condition".

- A 'Smooth Hill Reserve[5]' where:
    - potential changes in vegetation composition, due to changes to water supply, that may degrade an area of 'swamp wetland' located below the landfill will be mitigated by weeding, planting, and ongoing protection, within the swamp wetland[1]; and
    - the loss of indigenous lizard habitat, due to the landfill development and road upgrade, will be mitigated by enhancement and protection of existing habitat outside the landfill footprint (at 'West Gully 3'); and
- A 'wetland offset area' where:
    - the loss of 16.5 m^2 or 0.0017 ha wetland habitat along McLaren Gully Road is offset by the enhancement of 0.49 ha area of similar wetland habitat that sits within the designation site referred to as 'West Gully 3' and 'West Gully 4'[1]; noting that
    - The wetland offset area is partially within the Smooth Hill Reserve (0.17 ha) and part (0.32 ha) is adjacent to it[6].

Overall, implementation of this plan as part of the landfill development would see weeding and planting activities occur across the newly protected and fenced 5.8 ha Smooth Hill Reserve (of which 1.7 ha of indigenous habitat would be created by conversion from existing production forestry land use), and enhancement at the wetland offset area of additional connected wetland adjacent to the Smooth Hill Reserve area.

The aim of this management plan is to enhance biodiversity values to the extent that the restored Smooth Hill Reserve represents a net gain for wetland and lizard values in the area. These gains will also have associated benefits for forest habitats and bird species at the site. The areas of wetlands and areas of regenerating forest in the Smooth Hill Reserve area are further connected to a moderately sized 'valley floor marsh wetland' (see Boffa Miskell 2021b) downstream. The enhanced Smooth Hill Reserve would, therefore, provide (while not on a large scale) for connectivity, buffering of runoff, and a sequence of relatively representative and indigenous habitats at the head of the Otokia Creek catchment. Whereas, as described above (and see Boffa Miskell 2021b), the existing habitats that would be modified or lost during the landfill development are degraded and largely fragmented areas set against a backdrop of highly modified land uses.

The below information should be considered a **guide** to restoring the Smooth Hill Reserve. The final design of the restoration areas will occur in accordance with the requirements of the finalised versions of the draft Lizard Management Plan (Boffa Miskell 2021b) and the draft

[5] This name is a **placeholder** for the purposes of this draft plan. Ideally an alternative name bestowed via the project's stakeholders, including manawhenua, would be used.

[6] There are specific weeds (crack willow) in the 0.32 ha wetland area at the base of West Gully 4 and elimination of these threats will have substantial benefits for the Smooth Hill Reserve proposal. Accordingly, this area has been included in the wetland offset area and would receive weed control. We also considered the inclusion of the regenerating bush in West Gully 4 and this 0.32 ha section of the wetland offset area within the Smooth Hill Reserve proposal. Including this wider area (and / or other additional areas, such as 'West Gully 2' and / or 'West Gully 1', and intervening areas) would be of ecological benefit. However, this may add substantial costs in terms of additional fencing, loss of revenue (loss of forestry), and potentially in terms of new plantings. We consider that the benefits of the existing proposal more than outweigh the impacts of the landfill proposal that they are intended to address.

This proposal also takes advantage of natural breaks in the existing vegetation due to existing site boundaries and the effects of earthworks during a recent episode of forestry harvest, which have led to a break (due to a skid track) in the wetland vegetation between the Smooth Hill Reserve boundary and the 0.32 ha wetland offset area (see Appendix 2, Figure A2.5). Other proposals may require vegetation clearance to construct fences and / or would have more convoluted site boundaries.

Landfill Management Plan (Boffa Miskell 2021a), in conjunction with contractors and the project's expert herpetologist and wetland ecologist.

1.3 Restoration Objectives

The primary objective of the restoration is to improve biodiversity values at the site by creating a representative sequence of indigenous wetland and forest habitat. Remnant areas of the Ecological District include small pockets of kahikatea swamp forest, and drier Halls totara, rimu, miro and Mataī forest on hill slopes (Allen 1977, McEwan 1985). The wetland and forest surrounds should reflect these habitats prior to historic forest clearance to rebuild the native biodiversity.

1.4 Restoration Principles

1.4.1 Wetland Restoration

The enhancement of the existing wetland is intended to reflect existing habitat patterns and processes rather than use major earthworks or manipulation of water flows or water retention. Enhancement will be through removing weed and forestry slash, and then planting with selected indigenous species. Early stages of the enhancement may result in some parts of the area appearing rudimentary and with less total vegetation cover. However, these gaps will be filled by new plantings over time (within 2-5 years) and the habitat complexity and quality will improve rapidly.

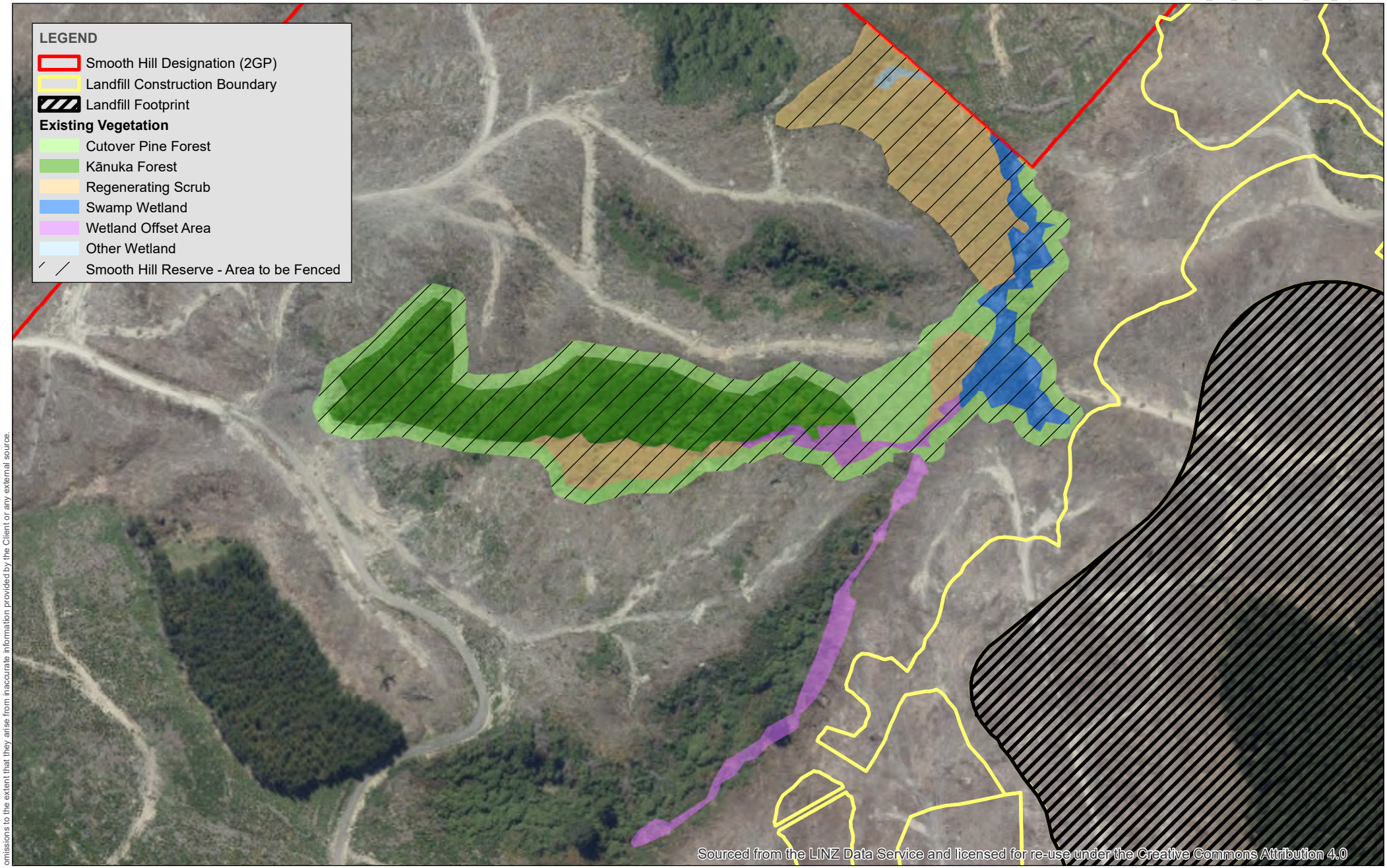
Plantings will reflect the existing variation in water levels / inundation regime. For example, obligate wetland species will surround a natural meander channel, surrounded in turn by facultative wetland species, and indigenous terrestrial (upland species) plantings buffering the wetland edge. The restoration relies on existing flow paths and hydrological inputs (almost entirely surface runoff) and does not increase the level of water retention (e.g. via bunding). The habitat, including surrounding native forest fragments, is intended to develop to a state as natural as possible, rather than be a replacement of the existing wetland habitat (vegetation surrounding small channels with periodic standing water) with a new habitat type (e.g. a pond).

It is acknowledged that the landfill proposal is expected to intercept c.20% of overland surface flows (runoff) from the swamp wetland's catchment, meaning a long-term reduction in water supply. Existing wetland species are already largely facultative wetland species (rautahi, harakeke) that are not reliant on permanent inundation. The current extent of these species beyond existing well-defined flow paths suggests that the vegetation present is likely highly resilient to periodic drought. Further, much of the existing wetland area to be protected receives all or the vast bulk of its water supply from areas of the catchment unaffected by the landfill proposal. Removal of rapidly growing existing weeds (largely facultative upland species such as gorse, exotic grasses and bittersweet, which are establishing often on raised areas or piles of forestry slash) may somewhat reduce competition for water among indigenous plant species and maintain appropriately wet conditions.

Soil drainage at the site is likely highly impeded (i.e. the area retains water) due at least in part to ongoing land modification and accumulated runoff of loess fines (e.g. during previous episodes of plantation forest harvest). Historic aerial imagery suggests wetland formation in the area has been induced in recent decades. Therefore, an ultimate outcome of a fairly limited extent of obligate wetland species surrounded by facultative wetland species and thence upland shrubland and forest species is likely to best reflect the pre-human state.

1.4.1 Forest Restoration

Across much of the Smooth Hill Reserve site, natural regeneration of indigenous forest and wetland species, through a nursery of gorse, would be expected to improve the terrestrial biodiversity values over time (>25 years), to some extent, without intervention. The recommendations throughout this VRMP are intended to speed this process. In this context, gorse clearance is only necessary to facilitate plantings, to aid plant establishment by minimising competition, and to eliminate or exclude other weeds that would not naturally diminish over time. Dense planting areas are intended to buffer higher quality existing indigenous vegetation against ongoing weed reinvasion, and in one area is intended to create a somewhat new habitat type (high quality lizard habitat). Other plantings are intended to reintroduce, at a low density, species that would naturally have been present at the site in the past but which do not appear to be regenerating naturally (e.g. native podocarps) due to insufficient local seed source.



Boffa Miskell

www.boffamiskell.co.nz

0 100 m

1:3,500 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

Existing Habitats in Forest and Wetland Restoration Area

Date: 17 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: JMo | Checked: TBI

Figure 1

2.0 Existing Ecological Values

Existing habitats in the restoration area are summarised in Figure 1. The vegetation types[7] within these overall habitats are described below and in Boffa Miskell (2021b).

2.1 Wetland Vegetation

The existing swamp wetland and upstream wetlands in West Gully 3 and 4 comprises two broad wetland vegetation types. These are described below.

2.1.1 Harakeke – gorse / (pūrei – rautahi) flaxland

A flaxland that is dominated by harakeke (FACW[8]) and gorse (FACU[8]) forms the central area of the swamp wetland (in terms of wetland type, this vegetation occurs in a palustrine swamp, with areas of marsh). It extends from the base of a nearby gully with native kānuka forest, and sits at the confluence of several minor gully systems. This vegetation type in likely receives year-round seepage and periodic overland flows and has areas of standing water with frequent pūrei (OBL[8]). In parts of the Swamp Wetland these wet areas may contain exotic sweetgrass (OBL), monkey musk (OBL), and watercress (OBL). Frequent rautahi (*Carex geminata*, FACW) and occasional pūkio (OBL) sedges and wīwī (*Juncus edgariae*, FACW) rushes are present on the edge of the flaxland. Indigenous mikimiki (*Coprosma dumosa*) shrubs (FAC[8]) and prickly shield fern (FACU) and are present within the flaxland, along with a host of exotic grass (OBL, FAC, and FACU species) and weedy herb species including creeping buttercup (FAC), bittersweet (FACU), and climbing ivy in elevated areas (UPL[8]).

2.1.2 (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland

A sedgeland dominated by rautahi with abundant pūrei, Yorkshire fog (FAC), and cocksfoot (FACU) occupies low-lying areas with permanently or intermittently saturated soils. In terms of wetland type, this vegetation occurs in a palustrine marsh, with areas of swamp. This vegetation type also dominates the valley floor marsh wetland that drains the Smooth Hill designation site. Excluding rautahi and purei, indigenous species in this overall vegetation type are scattered or patchy individuals of widespread and common species adapted to, or tolerant of, wet conditions, such as wīwī, harakeke, and prickly shield fern, and annual weedy species such as willowherbs (*Epilobium* spp., FAC), fireweed and groundsel (both *Senecio* spp., FACU). Exotic weeds such as gorse, browntop (FACU), creeping buttercup, California thistle (FACW), bittersweet and curled dock (FAC) are overall occasional but may be locally abundant in places within this vegetation community. Areas of standing water in small channels may have patchy exotic sweetgrass, monkey musk, and watercress, and very infrequent indigenous sharp spike sedge (OBL). At the base of West Gully 4, several large crack willow (FACW) are present, but the area has a relatively high density of rautahi and small areas of swampy ground including harakeke and little hard fern (FAC).

[7] Vegetation types are named using the classification system of Atkinson (1985).

[8] Wetland indicator status rankings are derived from Clarkson et al. (2013). These rankings assess fidelity of plant species to wetland habitats: obligate wetland (OBL: occurs almost always in wetlands); facultative wetland (FACW: occurs usually in wetlands); facultative (FAC: equally likely in wetlands or non-wetlands); facultative upland (FACU: usually in non-wetlands); or obligate upland (UPL: almost always in non-wetlands).

2.2 Forest / Scrub Vegetation

2.2.1 Kānuka forest

West Gully 3 contains an area of regenerating kānuka forest that is likely to have been present and largely unmodified for many decades, and potentially longer, as evidenced by the reasonably mature stands of kānuka (c.10 m in height) and mature individuals of other indigenous tree species (e.g. horoeka / lancewood). It supports a host of tree species typical of regenerating indigenous forest, such as tī kōuka, kōtukutuku, māhoe, makomako, and putaputaweta, along with diverse indigenous understory shrubs (e.g. *Coprosma* spp. and horopito) and ferns (e.g. *Asplenium* spp. and ferns in the family Blechnaceae). Bush lawyer (*Rubus cissoides*) and large-leaved pohuehue are occasional, extending to the forest canopy and frequently smothering the forest edge. The interior of the forest is almost entirely composed of indigenous plant species, but forest gaps and edges are weedy, with occasionally dense patches of Himalayan honeysuckle, as well as scotch broom and gorse. Areas of rautahi with prickly shield fern form a narrow strip at the base of the gully, and juvenile indigenous trees appear to be spreading beyond their current south-facing gully extent.

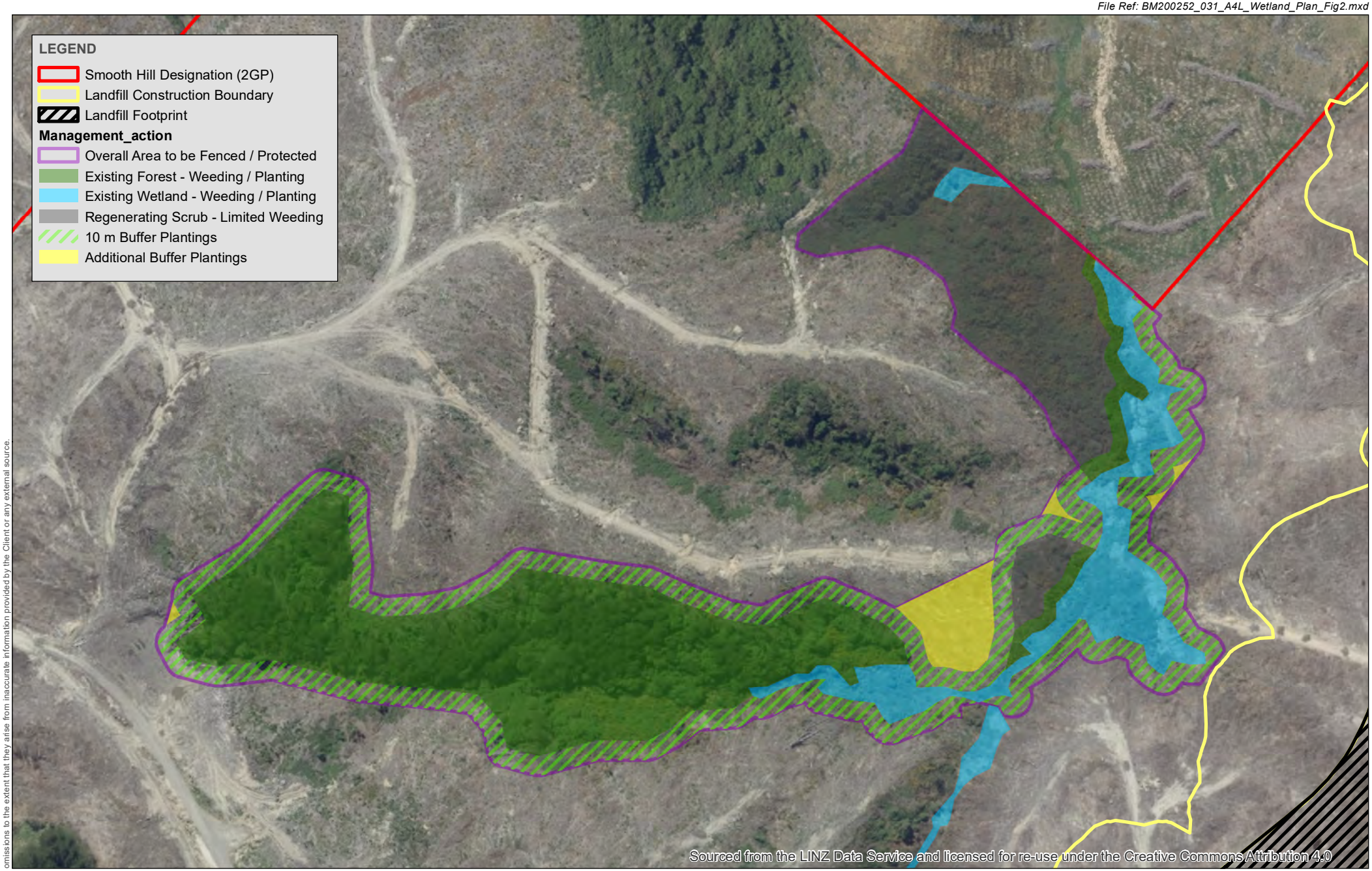
2.2.2 Other / surrounding areas

To the east and south, the swamp wetland is bordered by recently cutover plantation pine forestry and the vegetation in the immediate vicinity of the wetland is young pines with intervening exotic grass, gorse, and other weeds. Between the kānuka forest in West Gully 3 and the downstream end of the swamp wetland (to the west) is exotic scrub dominated by gorse and Himalayan honeysuckle (the vegetation type is [large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub). The areas surrounding the wetland, with the exception of the kānuka forest, have negligible ecological values and are extremely weedy. It is likely that these areas would regenerate over several decades into indigenous secondary forest, as there is sufficient seed source nearby and some evidence of regeneration already occurring. West Gully 4 contains regenerating indigenous forest with frequent makomako and kōtukutuku (the vegetation type is [large-leaved pohuehue) / kōtukutuku – makomako] / Himalayan honeysuckle treeland).

2.3 Fauna

The swamp wetland provides fairly poor-quality habitat for a small range of indigenous bird species including grey warbler, fantail, and kingfisher. It likely provides seasonal feeding habitat for tui and bellbird. West Gully 3 and West Gully 4 supports a reasonable diversity of indigenous forest birds including eastern falcon (*Falco novaeseelandiae* “eastern”, At Risk – Recovering). West Gully 3 may also support lizard species such as southern grass skink and possibly jewelled gecko (both At Risk – Declining). The full range of bird and lizard species that may use the designation site and landfill footprint is described in Boffa Miskell (2021b).

File Ref: BM200252_031_A4L_Wetland_Plan_Fig2.mxd



Boffa Miskell

www.boffamiskell.co.nz

0 75 m

1:2,500 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

Forest and Wetland Restoration Overview

Date: 17 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: JMo | Checked: TBl

Figure 2

3.0 Restoration Process

3.1 Overall Measures

3.1.1 Pest plant control

Pest plant management across the landfill site is described in the Landfill Management Plan (Boffa Miskell 2021a). Relevant objectives and methods for forest and wetland restoration are included below. General locations of pest plant management areas in the Smooth Hill Reserve area are shown in Figure 2.

The Smooth Hill designation site has been highly modified over many decades and extensive populations of pest plants have established in the area. Exotic gorse is prevalent within parts of many wetland areas and surrounding the kānuka forest. Gorse and Himalayan honeysuckle dominate hillsides above the swamp wetland within the Smooth Hill Reserve area and West Gully 4. Upstream, in the wetland offset area below West Gully 4, mature crack willow trees form a canopy over an area of the wetland, along with a large radiata pine tree. Other pest plant species are found in the understory and margins of the Smooth Hill Reserve and wetland offset area.

Extensive initial control of pest plants will be required within wetland areas, kānuka forest and buffer areas to control / manage pest plant species. A large seed source of pest plants will remain *in situ* (in scrub areas of the Smooth Hill Reserve) but weed control across this area would be highly inefficient, and the area will likely regenerate over time to native bush. Instead, herbicide spraying of a 5 m buffer of scrub adjacent to the wetland will minimise seed throw from mature gorse in this area, reducing gorse reinvasion. The surrounding plantation forestry area and the operational landfill itself may also be a source of weeds. Any weeds (most likely gorse and Himalayan honeysuckle) that reinvade from this area will be controlled within the wetland, forest, and buffer areas. Regular pest plant control will be required to reduce the cover of pest plant species and remove competition with planted indigenous species. The approach for pest plant control is described in the Landfill Management Plan.

The relevant objectives are to:

- remove / kill all crack willow trees within the wetland offset area and Smooth Hill Reserve; and
- manage other exotic pest plants over the wetland offset area and Smooth Hill Reserve to enable the restoration of indigenous wetland vegetation and habitats.

3.1.1.1 Pest plant species to be controlled

Pest plant species know to occur either within or near the wetland area and Smooth Hill Reserve area; in the wider landscape; and as defined in the Otago Regional Council's Regional Plan are listed in Table 1.

Table 1. Pest plant species to be controlled within the Smooth Hill Reserve and wetland offset area.

Scientific name	Common name	Life form	Control method(s)	Zones
Acer pseudoplantanus	Sycamore	Tree	Cut and paint stumps or drill and fill larger trees	ALL Zones
Cytisus scoparius	Scotch broom	Shrub	Cut and paint stumps	A.1, A.2, C.1, C.2, D, E
			Spray with herbicide	F.1, F.2
Hedera helix	Ivy	Vine	Hand pull infestations	A.1, A.2, C.1, C.2, D, E
			Spray with herbicide	F.1, F.2
Leycesteria formosa	Himalayan honeysuckle	Shrub	Cut and paint stumps or dig out and leave onsite to rot down	A.1, A.2, C.1, C.2, D, E
Pinus radiata	Radiata pine	Tree	Drill and fill, hand-pull seedlings	ALL Zones
Rubus fruticosus agg.	Blackberry	Vine	Dig out small patches, or stem scrape and paint with glyphosate, or cut and paint stumps	ALL Zones
Salix x fragilis	Crack willow	Tree	Drill and fill with undiluted glyphosate and cut and paint stumps of smaller saplings	ALL Zones (currently present only in Zone O)
Sambucus nigra	Elder	Tree	Dig out seedlings and small plants, cut stems near ground level and paint	A.1, A.2, B, C.1, C.2, D, E
			Spray with herbicide	F.1, F.2
Solanum dulcamara	Bittersweet	Vine	Hand pull infestations	A.1, A.2, C.1, C.2, D, E
Ulex europaeus	Gorse	Shrub	Where sparse, cut and paint stumps	A.1, A.2, C.1, C.2, D, E
			Spray dense areas with herbicide	Zone A.1, A.2, C.1, C.2, D, E, F.2

Monitoring for and controlling any incursions of other weed species not currently present in the immediate area is also of importance. Threats include tree lupin, banana passionfruit, Chilean flame creeper, common alder, and grey willow.

3.1.1.2 Control methods

Control methods for pest plant species is described within the Landfill Management Plan; control methods relevant to the VRMP are also provided below.

Crack willow control

If possible, willow control will be undertaken when the trees are actively growing and in leaf.

Crack willow trees will be drilled and poisoned using undiluted glyphosate. Saplings that are too small to drill and poison will be cut, and their stumps will be painted with glyphosate. All cut material will be removed from the site and disposed of appropriately (i.e. mulched or disposed of appropriately) to prevent it from regrowing. Follow-up ground control will be required to ensure that all willow trees are killed.

Mechanically clearing willows, or limbing-up branches, should be avoided as this often results in mass germination and growth of weeds as a result of increased light and can also lead to physical damage to indigenous understory vegetation during removal.

As dead crack willow trees will be left standing until they decompose, restoration activities (e.g. planting, pest plant control) must take into account the risks associated with falling trees and limbs. This potential risk will need to be managed appropriately while restoration activities are being planned and undertaken.

Other pest plant species

Other exotic trees, shrubs and climbers (including seedlings) will be either hand pulled, dug out, cut and painted with herbicide or sprayed as appropriate (refer to Table 1, above).

Follow up control of pest plants and exotic plants within the wetland is to be undertaken as required.

Methods to ensure pest plant species are not introduced into the restoration area

Any machinery and equipment used within the Smooth Hill Reserve and wetland offset area will be cleaned and cleared of seeds and plant fragments before being brought onto the site to prevent the introduction of pest plant species. Indigenous plants proposed for use in the restoration plantings (from nursery stock) will also be checked for pest plant species before being planted.

Minimising damage to existing indigenous plants

It is important that regenerating indigenous plants are not damaged or killed during weed control operations, and that appropriate methods are used to minimise risk of by-kill (e.g. cut and paste instead of herbicide spraying) in the vicinity of regenerating indigenous plants.

3.1.2 Pest animal control

General pest animal control (targeting feral ungulates, pigs, possums, mustelids and rodents is to occur across the designation site (see Boffa Miskell 2021a). The priorities for the Smooth Hill Reserve area are:

- exclusion of pigs and deer from wetlands and regenerating forest;
- very low density possums;
- very low density mice in West Gully 3 and buffer habitat (as these are potent predators of indigenous lizards and invertebrates).

3.1.3 Planting

3.1.3.1 Objectives

The objective of planting indigenous species is to increase indigenous vegetation cover, decrease the cover of exotic species (including pest plants), improve habitat for indigenous fauna and generally improve indigenous biodiversity. General locations of planting areas in the Smooth Hill Reserve area are shown in Figure 2.

Planting will be required in areas with limited indigenous wetland vegetation cover and in any unvegetated areas created through pest plant control. Most planting will be undertaken during the initial stages of the restoration programme, but additional planting will likely be required during the maintenance period.

Plant species chosen have been selected based on their presence in the area already, or else their presence in nearby areas in the Ecological District (e.g. Allen 1977, McEwan 1985), their suitability for the habitat type, and their likely success in restoration plantings.

3.1.3.2 Planting Methods

Planting can be undertaken during spring, summer and autumn, although spring and early summer is preferable (when ground conditions are warmer). Planting during times of drought or flooding should be avoided.

Within the Smooth Hill Reserve area and wetland offset area, planting should follow the methods for each restoration zone as described in Section 3.2. During planting, onsite decisions will be important to ensure that plants are planted in appropriate locations that account for variations in micro-topography to maximise their survival. Plants should not be planted within any narrow wetland channel areas where they are likely to be washed away or damaged during flood events.

Protective sleeves should be placed around plantings, especially in open and wetland areas. These **must be biodegradable (**e.g. 'FiberGuard,' 'NaturGuard' or similar), and wooden (or other biodegradable) stakes should be used in wetland areas to prevent plant / sleeve removal by pūkeko or other species (pūkeko have not been observed on site, but are likely present at times (Boffa Miskell 2021b).

Nursery sourced plants should be at least RX90 /1L grade or larger (10L for large trees) and grown from seed sourced from the Tokomairiro Ecological District. If plant species of the required numbers are not able to be sourced from the Tokomairiro Ecological District, then the remaining numbers should be sourced from the Otago Coast Ecological Region. The planting area must be cleared of exotic weeds before planting (excluding dead / dying crack willow and large radiata pine) and it is recommended that planting be undertaken at least two weeks after any weed spraying.

Plant spacings are described per zone in Section 3.2 below.

Supplementary planting to replace all dead or sickly specimens may need to be undertaken over the first three years of planting. The species used in these supplementary plantings should be exact replacements (i.e. the same species as those that have died) unless a group of this species die in the same place. If this occurs, a different species should be planted. In the first 3 years following planting, inspection or monitoring will be required on at least an annual basis to establish how many of which species, if any, need to be replaced, and in which locations.

3.1.4 Fencing

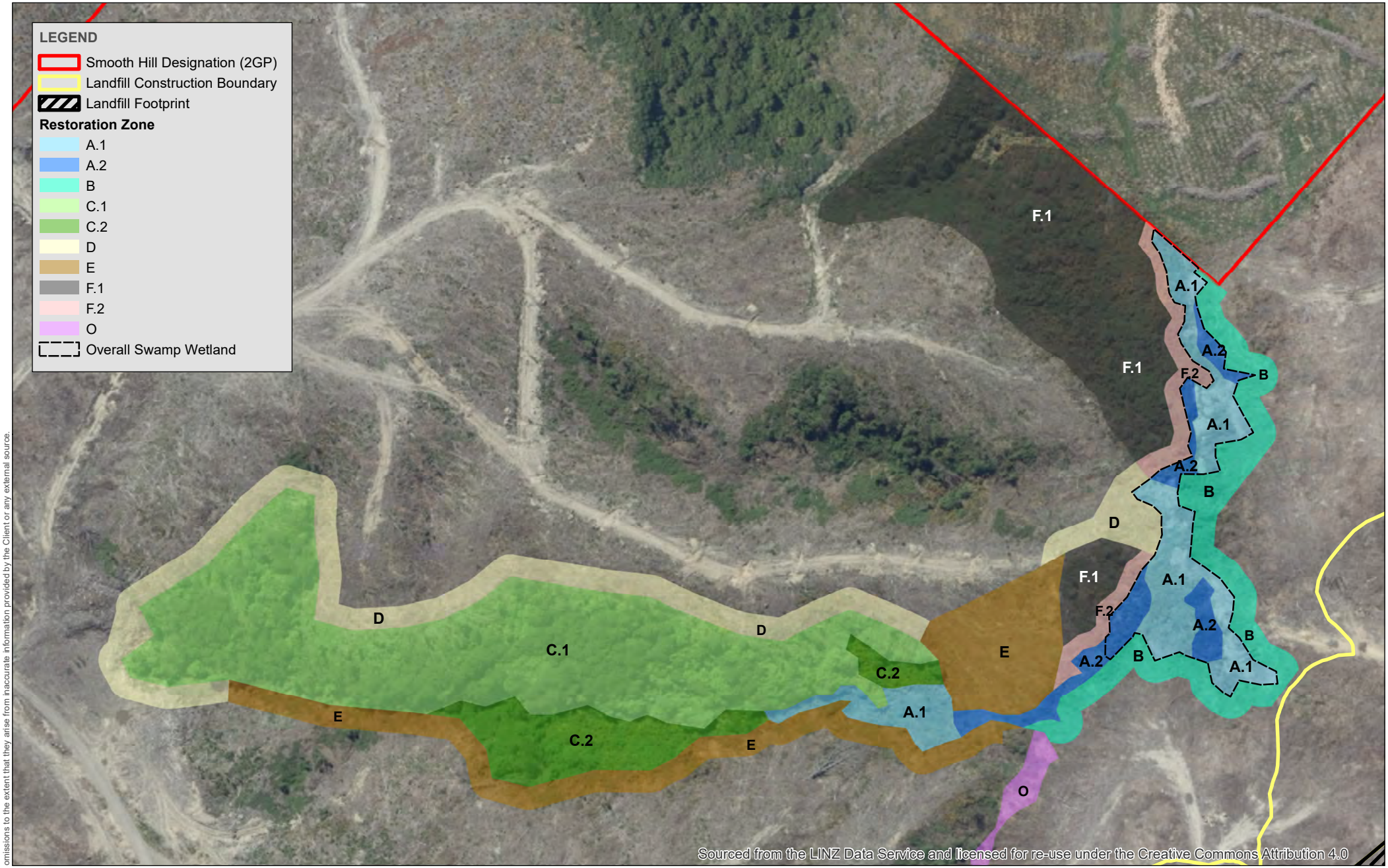
The entire of the Smooth Hill Reserve area should be fenced to a high standard to exclude pigs, reduce predator movements, to contain translocated lizards (see Boffa Miskell 2021b) to appropriate habitat areas, and to provide safe habitat for lizards. An exterior barbed or electric wire near ground level is required to exclude pigs, and additional temporary fencing requirements are needed surrounding lizard buffer plantings areas as described in the Lizard Management Plan (Boffa Miskell, 2021b).

3.2 Restoration Zones

The Smooth Hill Reserve area and wetland offset area have been divided into zones reflecting the restoration measures that are recommended (see Figure 3). The following zones are described in detail, including planting lists and planting density, in Sections 3.2.1-3.2.10. Restoration zones are mapped in Figure 3 for the Smooth Hill Reserve area and in Figure 4 for the wetland offset area.

- Zone A.1 – existing wetland – weed removal
- Zone A.2 – existing wetland, degraded area – weed removal and planting
- Zone B – wetland buffer – weed removal and planting
- Zone C.1 – existing regenerating forest – weed removal, minor planting
- Zone C.2 - existing regenerating forest, degraded area – weed removal, planting
- Zone D – forest buffer – weeding and planting of lizard friendly species
- Zone E – additional plantings area – removal of pines, minor planting
- Zone F.1 – weedy regenerating scrub – leave to regenerate
- Zone F.2 – weedy regenerating scrub – weed spraying buffer
- Zone O – additional wetland offset area – weed removal and planting

Indicative illustrations depicting the general restoration objectives, in terms of plant species and pattern, are shown in Figure 5 (for the Swamp Wetland, zones A.1, A.2, and B) and Figure 6 (kānuka forest in West Gully 3 and lizard buffer area, zones C.1 and D).



Boffa Miskell

www.boffamiskell.co.nz

0 75 m

1:2,250 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

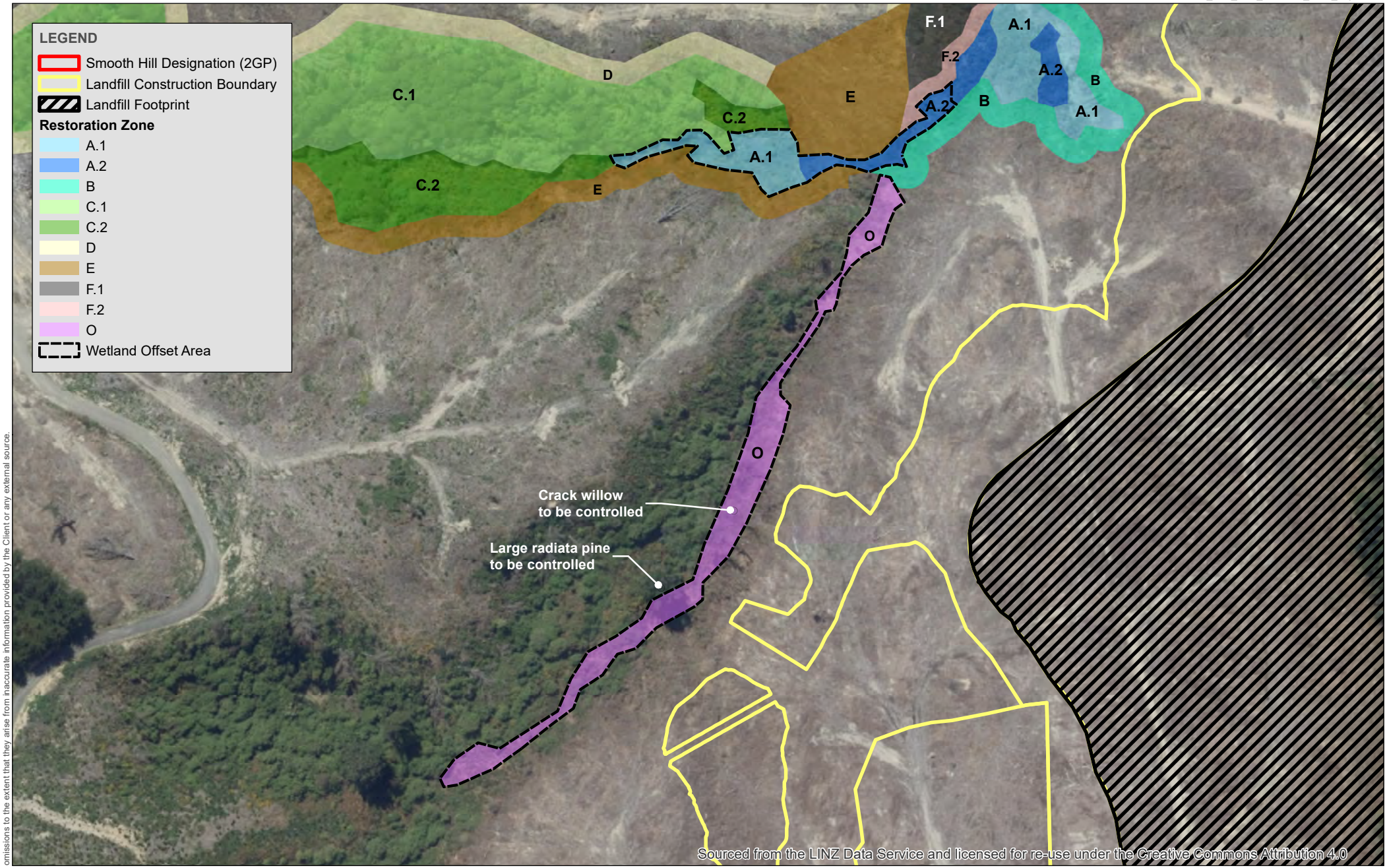
Forest and Wetland Restoration Zones - 'Smooth Hill Reserve' Area

Date: 17 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: JMo | Checked: TBI

Figure 3



Boffa Miskell

www.boffamiskell.co.nz

0 75 m

1:2,250 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

Forest and Wetland Restoration Zones - Wetland Offset Area

Date: 17 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: JMo | Checked: TBI

Figure 4

3.2.1 Zone A.1 – existing wetland – weed removal

Weed control: Control of gorse, broom, blackberry, bittersweet, and ivy are the main priorities in this area. Cutting and removal of cut weed material is required.

Planting site preparation: Where possible, scrape topsoil by hand from areas where dense gorse is removed, and remove forestry slash from planting areas.

Planting: Zone A.1 is generally densely vegetated with indigenous species (harakeke, pūrei, pūkio) and minimal plantings are likely to be required. Where >2 m^2 gaps are created by weed control, the following species should be planted to achieve plantings with overall 0.5 m to 0.75 m spacings (Table 2).

Total area: 0.45 ha.

Table 2. Indigenous plant species recommended for Zone A.1 restoration planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
Austroderia richardii	Toetoe	Grass	Saturated or moist	0.75 m
Carex secta	Pūrei	Sedge	Saturated or moist	0.5 m
Carex virgata	Pūkio	Sedge	Saturated or moist	0.5 m
Cordyline australis	Tī kōuka/ cabbage tree	Small tree	Saturated or moist	2 m
*Dacrycarpus dacrydioides**	Kahikatea	Large tree	Moist	7.5 m
Juncus edgariae	Wīwī	Rush	Saturated or moist	0.75 m
Parablechnum minus	Swamp kiokio	Fern	Saturated or moist	1 m
Phormium tenax	Harakeke	Grass	Saturated or moist	1 m

*Not recorded on site but present in similar habitats nearby. Reintroduction to the area would be of benefit.

3.2.2 Zone A.2 – existing wetland, degraded area – weed removal and planting

Weed control: Control of gorse, broom, blackberry, bittersweet, and ivy are the main priorities in this area. Cutting and removal of cut weed material is required.

Planting site preparation: Where possible, scrape topsoil from areas where dense gorse was removed (especially raised areas), and remove forestry slash. A small mechanical digger may be employed where areas can be accessed without damage to indigenous plants.

Planting: Zone A.2 contains denser weed areas than Zone A.1 and many areas will be bare following weed control. Plantings with overall 1 m spacings of the following species should be used (Table 3).

Total area: 0.19 ha.

Table 3. Indigenous plant species recommended for Zone A.2 restoration planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
Austroderia richardii	Toetoe	Grass	Saturated or moist	1 m
Carex secta	Pūrei	Sedge	Saturated	0.75 m
Carex geminata	Rautahi	Sedge	Saturated or moist	0.5 m
Carex virgata	Pūkio	Sedge	Saturated	0.75 m
Coprosma dumosa	Mikimiki	Shrub	Moist / dry	5 m
Coprosma propinqua	Mikimiki	Shrub	Moist	5 m
Cordyline australis	Tī kōuka/ cabbage tree	Small tree	Moist	2 m

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
*Dacrycarpus dacrydioides**	Kahikatea	Large tree	Moist	7.5 m
Parablechnum minus	Swamp kiokio	Fern	Saturated or moist	1 m
Phormium tenax	Harakeke	Grass	Saturated or moist	1 m

*Not recorded on site but present in similar habitats nearby. Reintroduction to the area would be of benefit.

3.2.3 Zone B – wetland buffer – weed removal and planting

Weed control: Removal of pine seedlings, and control of gorse, broom, and blackberry are the main priorities in this area. Spray dense weed infestations prior to planting. Retain any regenerating native species.

Planting site preparation: Clearance of small areas to allow planting.

Planting: Most of the area will be bare following weed control. Species suggested reflect the existing regenerating species, but also add diversity. Plantings with overall 1 m spacings of the following species should be used (Table 4).

Total area: 0.41 ha.

Table 4. Indigenous plant species recommended for Zone B restoration planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
Aristotelia serrata	Makomako / wineberry	Tree	Moist / dry	1 m
Carpodetus serratus	Putaputaweta / marbleleaf	Tree	Moist / dry	1 m
Coprosma dumosa	Mikimiki	Shrub	Moist / dry	1 m
Coprosma propinqua	Mikimiki	Shrub	Moist	1 m
Coprosma robusta	Karamu	Shrub	Moist / dry	1 m
Cordyline australis	Tī kōuka / cabbage tree	Small tree	Moist	2 m
*Dacrydium cupressinum**	Rimu	Large tree	Moist / dry	10 m
*Dacrycarpus dacrydioides**	Kahikatea	Large tree	Moist	10 m
*Eleaocarpus hookerianus**	Pōkākā	Large tree	Moist / dry	10 m
*Myrsine divaricata**	Weeping māpou	Shrub	Moist / dry	2 m
*Pennantia corymbosa**	Kaikomako		Moist / dry	5 m
Pittosporum tenuifolium	Kōhūhū / Black matipo	Tree	Moist / dry	2 m
Pseudopanax arboreus	Whauwhaupaku / five-finger	Tree	Moist / dry	2 m
Pseudopanax crassifolius	Horoeka / lancewood	Tree	Moist / dry	5 m
*Sophora microphylla**	Kowhai	Tree	Moist / dry	5 m
Veronica salicifolia	Koromiko	Shrub	Moist / dry	2 m

*Not recorded on site but present in similar habitats nearby. Reintroduction to the area would be of benefit.

The restoration target for the Smooth Hill swamp wetland to be achieved by the weed control, planting site preparation and planting of zones A.1, A.2, and B is shown in Figure 5.

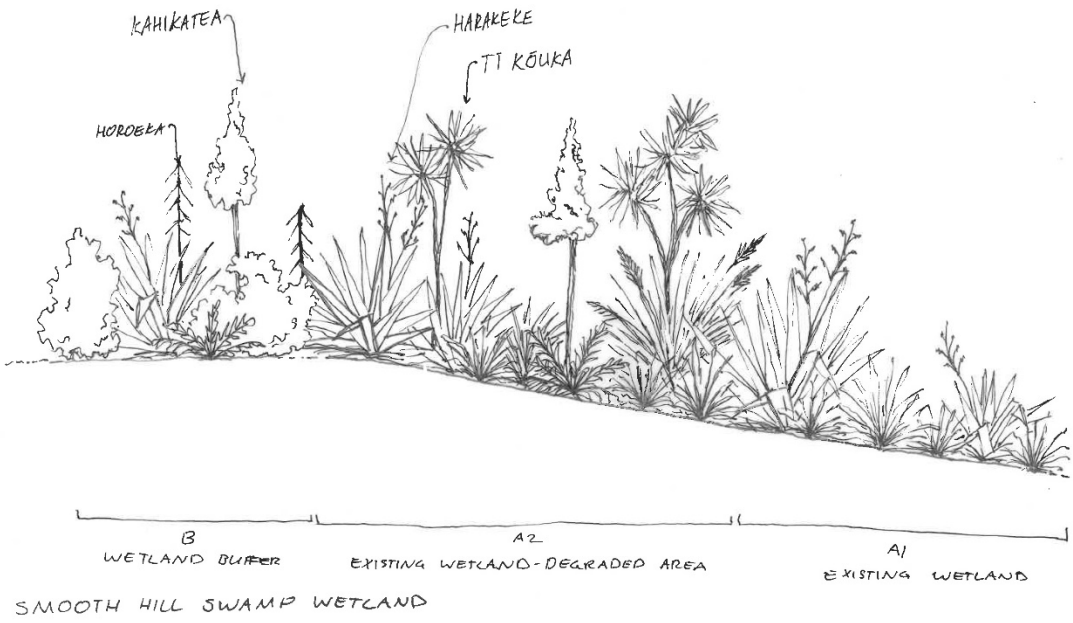


Figure 5. Restoration target for the Smooth Hill swamp wetland, depicting some of the **target outcomes** for vegetation pattern in the proposed restoration zones (from left to right) B, A.2, and A.1.

3.2.4 Zone C.1 – existing regenerating forest – weed removal, minor planting

Weed control: Removal of Himalayan honeysuckle, elder (if any) and blackberry within the forest are the main priorities in this area.

Planting site preparation: General measures applied.

Planting: Zone C.1 generally has a complete canopy and minimal plantings are required. To introduce slow-growing podocarp species into the kānuka forest (forming a new canopy over the coming decades / centuries), the following species could be planted at a very wide spacing (10 m or more) (Table 5).

Total area: 1.64 ha.

Table 5. Indigenous plant species recommended for Zone C.1 restoration planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
*Dacrydium cupressinum**	Rimu	Large tree	Moist / dry	10 m
*Podocarpus laetus**	Hall's tōtara	Large tree	Moist / dry	10 m
*Pectinopitys ferruginea**	Miro	Large tree	Moist / dry	10 m
*Prumnopitys taxifolia**	Matai	Large tree	Moist / dry	10 m

*Not recorded on site but present in similar habitats nearby. Reintroduction to the area would be of benefit.

3.2.5 Zone C.2 – existing regenerating forest, degraded area – weed removal, planting

Weed control: Removal of dense gorse, Himalayan honeysuckle, scotch broom, elder (if any) and blackberry are the main priorities in this area.

Planting site preparation: General measures applied.

Planting: Zone C.2 contains denser weed areas than zone C.1 and many areas will be bare following weed control. Species suggested reflect the existing regenerating species, but also add diversity. Plantings with overall 1 m spacings of the following species should be used (Table 6).

Total area: 0.32 ha.

Table 6. Indigenous plant species recommended for Zone C.2 restoration planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
Aristotelia serrata	Makomako / wineberry	Tree	Moist / dry	1 m
Carpodetus serratus	Putaputaweta / marbleleaf	Tree	Moist / dry	1 m
Coprosma robusta	Karamu	Shrub	Moist / dry	1 m
Cordyline australis	Tī kōuka / cabbage tree	Small tree	Moist	2 m
*Dacrydium cupressinum**	Rimu	Large tree	Moist / dry	10 m
*Dacrycarpus dacrydioides**	Kahikatea	Large tree	Moist	10 m
Fuchsia excorticata	Kotukutuku	Tree	Moist / dry	2 m
Griselinia littoralis	Kāpuka / broadleaf	Tree	Moist / dry	5 m
Myrsine australis	Red māpou	Tree	Dry	5 m
*Myrsine divaricata**	Weeping māpou	Shrub	Moist / dry	2 m
*Pennantia corymbosa**	Kaikomako	Tree	Moist / dry	5 m
Pseudopanax arboreus	Whauwhaupaku / five-finger	Tree	Moist / dry	2 m
Veronica salicifolia	Koromiko	Shrub	Moist / dry	2 m

*Not recorded on site but present in similar habitats nearby. Reintroduction to the area would be of benefit.

3.2.6 Zone D – forest buffer – weeding and planting of lizard friendly species

Weed control: Removal of pine seedlings, and control of gorse, broom, and blackberry are the main priorities in this area. Spray dense weed infestations prior to planting. Retain regenerating native species.

Planting site preparation: Leave forestry slash piles *in situ*. Introduce additional large logs or rocks if available.

Planting: Most of the area will be bare following weed control. Plantings with overall 1 m spacings (including existing native species) of the following species should be used (Table 7).

Total area: 0.66 ha.

Table 7. Indigenous plant species recommended for Zone D restoration planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
Austroderia richardii	Toetoe	Grass	Moist / dry	1 m
Astelia fragrans	Bush flax	Grass	Moist / dry	2 m
Coprosma dumosa	Mikimiki	Shrub	Moist / dry	1 m
Coprosma propinqua	Mikimiki	Shrub	Moist	1 m
Coprosma robusta	Karamu	Shrub	Moist / dry	1 m
Coprosma rhamnoides	Twiggy coprosma	Shrub	Moist / dry	1 m
Cordyline australis	Tī kōuka / cabbage tree	Small tree	Moist	2 m
*Gaultheria antipoda**	Tāwiniwini / bush snowberry	Shrub	Moist / dry	2 m
Kunzea robusta	Kānuka	Tree	Dry	2 m
*Leptospermum scoparium**	Mānuka	Shrub / Tree	Moist / dry	2 m
Muehlenbeckia complexa	Shrub pohuehue	Vine / shrub	Moist / dry	5 m
*Myrsine divaricata**	Weeping māpou	Shrub	Moist / dry	2 m
Pittosporum tenuifolium	Kōhūhū / black matipo	Tree	Moist / dry	2 m
Pseudopanax arboreus	Whauwhaupaku / five-finger	Tree	Moist / dry	2 m

*Not recorded on site but present in similar habitats nearby. Reintroduction to the area would be of benefit.

The restoration target for West Gully 3 and lizard habitat planting buffer to be achieved by the weed control, planting site preparation and planting zones C.1, C.2 and D is shown in Figure 6.

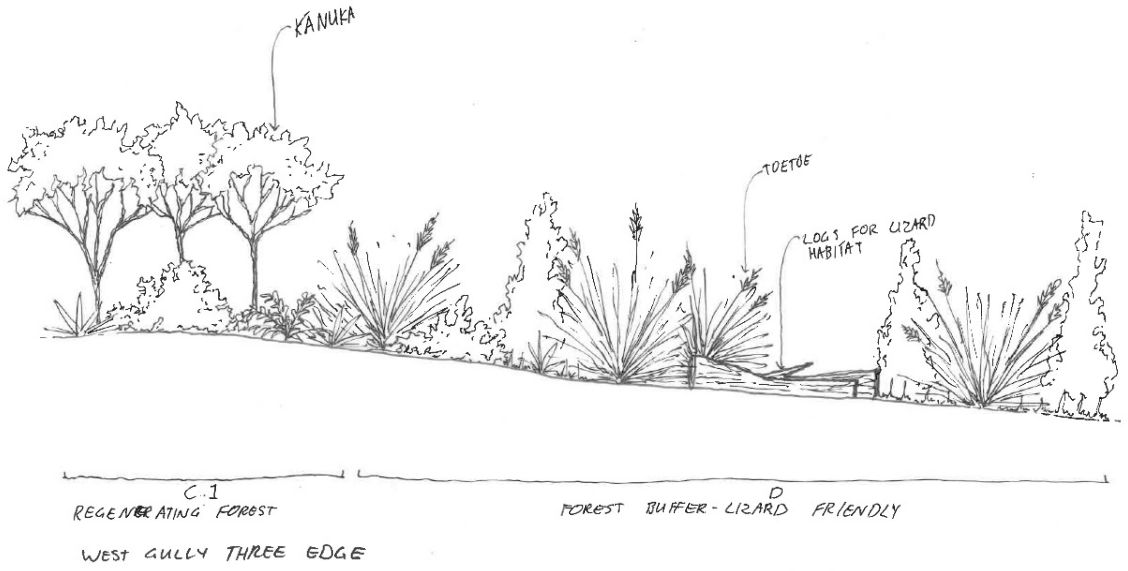


Figure 6. Restoration target for West Gully 3 and northern lizard habitat planting buffer, depicting some of the target outcomes for vegetation pattern in the proposed restoration zones (from left to right) C.1 and D.

3.2.7 Zone E – additional plantings area – removal of pines, minor planting

Weed control: Removal of scotch broom, Himalayan honeysuckle, elder (if any) and blackberry are the main priorities in this area. Gorse can generally be left as a nursery plant.

Planting site preparation: Clearance of small areas to allow planting.

Planting: Species chosen are well suited to regeneration through gorse. Plantings into gorse with overall 3 m spacings of the following species should be used (Table 8).

Total area: 0.70 ha.

Table 8. Indigenous plant species recommended for Zone E restoration planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
Aristotelia serrata	Makomako / wineberry	Tree	Moist / dry	3 m
Carpodetus serratus	Putaputaweta / marbleleaf	Tree	Moist / dry	3 m
Coprosma robusta	Karamu	Shrub	Moist / dry	3 m
Cordyline australis	Tī kōuka / cabbage tree	Small tree	Moist	3 m
Fuchsia excorticata	Kotukutuku	Tree	Moist / dry	3 m
Kunzea robusta	Kānuka	Tree	Dry	3 m
Pseudopanax arboreus	Five-finger	Tree	Moist / dry	3 m

3.2.8 Zone F.1 – weedy regenerating scrub – leave to regenerate

Weed control: Limited weed control as per Table 1.

Planting site preparation: n/a.

Planting: None.

3.2.9 Zone F.2 – weedy regenerating scrub – weed spraying buffer.

Weed control: Herbicide spray scrub to form 5 m buffer from the edge of wetland areas. Avoid indigenous shrubs and cut and paste around these as appropriate. Repeat every 1-3 years as gorse and other weeds reinvade until year 10. From year 10, cease control and allow to regenerate (except for 'All Zones' weeds as per Table 1).

Planting site preparation: n/a.

Planting: None.

3.2.10 Zone O – additional wetland offset area – weed removal and planting

Weed control: Elimination of crack willow and control of gorse, broom, and blackberry are the main priorities in this area. Cutting and removal of weed material is required, except large crack willow, which should be drilled and filled and left in situ. Any large radiata pine should be drilled

and filled or felled prior to planting. The locations of crack willow and large radiata pine are shown in Figure 4.

Planting site preparation: Where possible, scrape topsoil from areas where dense gorse is removed (especially raised areas), and remove forestry slash. A small mechanical digger may be employed where areas can be accessed without damage to indigenous plants.

Planting: Zone O generally has a good cover of indigenous wetland plants and minimal plantings are likely to be required to fill gaps. However, additional plantings to boost the habitat complexity and quality are required as part of offset measures (Boffa Miskell 2021b).

Replacement plantings: Where >2 m^2 gaps are created by weed control, infill plantings with overall 0.5 m to 0.75 m spacings should be undertaken (Table 9).

Total area: 0.32 ha.

Table 9. Indigenous plant species recommended for Zone O restoration infill planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
Austroderia richardii	Toetoe	Grass	Saturated or moist	1 m
Carex secta	Pūrei	Sedge	Saturated	0.75 m
Carex geminata	Rautahi	Sedge	Saturated or moist	0.5 m
Carex virgata	Pūkio	Sedge	Saturated	0.75 m
Coprosma dumosa	Mikimiki	Shrub	Moist / dry	5 m
Coprosma propinqua	Mikimiki	Shrub	Moist	5 m
Cordyline australis	Tī kōuka / cabbage tree	Small tree	Moist	2 m
Phormium tenax	Harakeke	Grass	Saturated or moist	1 m

Additional plantings: Plantings with overall 10 m spacings of the following species should be used (Table 10).

Table 10. Additional indigenous plant species recommended for Zone O restoration planting.

Scientific name	Common name	Life form	Habitat requirements	Plant spacing
*Dacrycarpus dacrydioides**	Kahikatea	Large tree	Moist	10 m

*Not recorded on site but present in similar habitats nearby. Reintroduction to the area would be of benefit.

3.3 Timing of Works

Year 1

- Control willows and elder when trees are actively growing.
- Control other exotic plant species.
- Plant indigenous species at least two weeks after any pest plant control (ideally spring and / or summer when ground is warmer).

Year 2 – 5

- As required, annual follow-up control of pest plants and exotic plants.
- Release indigenous plantings from rank grass and other exotic plants (annually at a minimum).

- Carry out infill planting of indigenous plant species into bare areas / gaps preferably two weeks after any plant pest control to replace any dead or sickly indigenous plant species from the previous planting round as per planting plan.
- Pest animal control / plant protection measures as and when required.

Year 5 – 10

- As required, annual follow-up control of pest plants and exotic plants.
- Pest animal control / plant protection measures as and when required.

Year 10 – landfill closure (or indefinite)

- As required, annual follow-up control of pest plants and exotic plants.
- Cease spraying of Zone F.2.
- Pest animal control / plant protection measures as and when required.

4.0 Monitoring and Plan Review

4.1 Overall Monitoring

To ensure success of this plan, and compliance with resource consent conditions for the landfill, monitoring is required. This is to be undertaken by an independent expert / expert engaged by the landfill operator, with information provided to the landfill operator and local authorities as mandated by the LMP / consent conditions.

The restoration works may, as part of or in addition to this process, be inspected from time to time by accredited representatives of the local authorities in relation to consent conditions. Should such representatives request information in connection to planting, planting maintenance, pest plant and animal control, the landfill operator / Dunedin City Council shall provide the information to them willingly, to the details of their knowledge.

The aim of the monitoring is to provide quantitative data to compare against the objectives of the mitigation described in Section 1.3 as well as provide a basis for ongoing management (e.g. if / where further weed control and / or indigenous planting is required). Monitoring should be undertaken by a suitably qualified ecologist and will include:

- baseline monitoring will be undertaken before restoration works commence.
- a minimum of six permanent photopoints will be set up at appropriate locations to visually monitor the restoration site over time.
- in all areas, visual observations will also be undertaken to collect qualitative data on:
    - indigenous planting success;
    - natural regeneration and canopy closure weed in forest areas;
    - fauna observed; and
    - weed species present and any weed “hotspots” to inform pest plant control.
- checks of fence integrity around the Smooth Hill Reserve, undertaken during pest animal control operations or every 3 months, whichever is more frequent. Repairs to any fence breaks should be made immediately.
- visual observations and retaking of photopoints will be undertaken 6 months after the initial planting has been completed. Monitoring and retaking of photopoints will then be undertaken within 2, 5, and 8 years of initial works (or until such time as Dunedin City Council / the landfill operator and the Otago Regional Council agree that, based on the monitoring results, restoration has been successful and no further monitoring is required).

A brief report will be prepared after each monitoring occasion detailing results, outlining conclusions and providing recommendations as necessary.

4.2 Wetland Areas

4.2.1 Site-wide wetland monitoring

Monitoring of wetland areas will be undertaken by a suitably qualified and experienced wetland ecologist engaged by the landfill operator / local authority. Monitoring in wetland areas (zones A and O) will consist of five 5 m by 5 m monitoring plots based on the methodology described in 'A Handbook for Monitoring Wetland Condition' (Clarkson et al., 2004), where vegetation cover is estimated over different wetland tiers (i.e. canopy, groundcover and sub-canopy tiers, depending on complexity). The location of the plots will be selected at random using a random point generator in ArcGIS software. Discretion will be used on site during monitoring to shift monitoring plots should they be located over or adjacent to a feature which will provide data bias.

Monitoring will exclude the wetland condition indices that are used to assess wetland pressures and changes to specific different wetland components over time. The monitoring will also exclude some field measurements (specifically water table depth, water conductivity, water pH and von Post peat decomposition index), soil core laboratory analysis and foliage laboratory analysis).

Baseline monitoring will be undertaken before restoration works commence.

A Wetland Condition Assessment, including completion of the Wetland Record Sheet and Wetland Plot Sheets in accordance with a Handbook for Monitoring Wetland Condition (Clarkson et al., 2004).

4.2.1 Determining offset success

During each episode of wetland monitoring, the project manager and wetland ecologist should inspect the offset area to establish if weeding has been successful in meeting the plan objectives, that additional plantings have established, and that the vegetation cover is sufficient to persist and resist weed invasion. The targets for a successful offset are 70% cover of indigenous plant species in the wetland offset area and successful establishment of kahikatea in this area[9]. At such a time as monitoring demonstrates that these targets have been met, this shall be reported to the relevant Regional / District Council compliance officer(s) and the offset shall be deemed a success.

4.3 Plan Review

This plan will be reviewed and revised within 6 months, and between four and five years after the commencement of landfill construction works at the designation site.

[9] Meeting these targets would represent a substantial net gain (se Boffa Miskell 2021a). Achieving close to these targets (>60 % indigenous cover) would still equate to no net loss and a net gain for the wetland offset.

5.0 References

Allen, R.B. (1977). *Report on botanical survey, Taieri Mouth*. Botany Division, DSIR, unpublished report. 12 p.

Atkinson, I.A. E. (1985). Derivation of vegetation mapping units for an ecological survey of Tongariro National Park North Island, New Zealand. *New Zealand Journal of Botany*, 23: 361–378.

Boffa Miskell (2021a.) *Smooth Hill Landfill: Draft Landfill Management Plan June 2021*. Report prepared by Boffa Miskell Limited for Dunedin City Council.

Boffa Miskell (2021b). *Smooth Hill Landfill: Ecological Impact Assessmen*t *June 2021*. Report prepared by Boffa Miskell Limited for Dunedin City Council.

Boffa Miskell (2021c). *Smooth Hill Landfill: Lizard Management. Draft Management Plan June 2021*. Report prepared by Boffa Miskell Limited for Dunedin City Council.

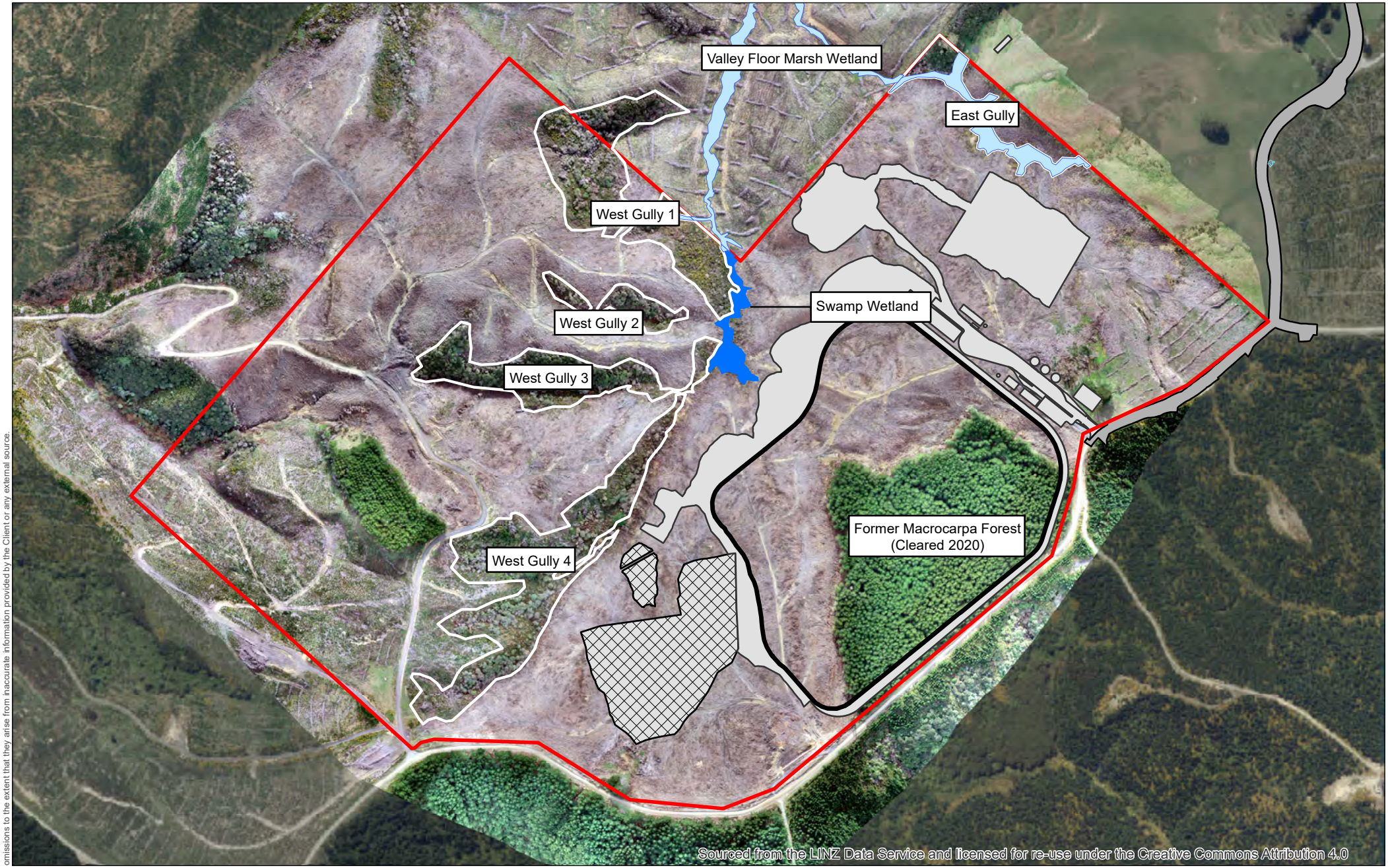
Clarkson, B.R., Sorrell B.K., Reeves P.N., Champion P.D., Partridge T.R., Clarkson B.D. (2003). *Handbook for Monitoring Wetland Condition*. Revised edition 2004. Landcare Research. Hamilton, New Zealand.

Clarkson, B.R. (2013). *A vegetation tool for wetland delineation in New Zealand*. Landcare Research Contract Report: LC1793 prepared for Meridian Energy Limited. 70 p.

McEwan, W.M. (1987). *Ecological Regions and Districts of New Zealand (Part 4)*. New Zealand Biological Resources Centre, Publication Number 5. Department of Conservation, Wellington. 161 p.

Appendix 1: Map of Location Names (Fig. 2 from EcIA)

File Ref: BM200252_022_A4L_ECO_Fig2_SiteNames.mxd



Boffa Miskell

www.boffamiskell.co.nz

0 200 m

1:7,500 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Smooth Hill Designation (2GP)
- Operations Area
- Access Road
- Landfill Footprint
- Stockpile

SMOOTH HILL LANDFILL

Location Names Used in this Report

Date: 20 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: JMo

Figure A1.1

Appendix 2: Site and Vegetation Photographs

Figure A2.1. Smooth Hill Reserve central area. Wetland offset area at the base of West Gully 4 at left, and in the base of West Gully 3 top right, swamp wetland at centre.

Figure A2.2. (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland bordering harakeke – gorse / (pūrei – rautahi) flaxland in the swamp wetland (Zone A.1).

Figure A2.3. (Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub on hill slopes above the swamp wetland (zones A.1, A.2 foreground, F.1, F.2 at rear).

Figure A2.4. Harakeke – gorse / (pūrei – rautahi) flaxland in the swamp wetland (Zone A.1).

Figure A2.5. Recent (2019) forestry works created a break between the wetland habitat at the base of West Gully 4 (not visible, left of frame) and the connected wetland habitat that includes the swamp wetland (upper areas visible at far right) and similar habitat at the base of West Gully 3 (centre of photo). Kānuka forest in West Gully 3 centre rear, and a large planting area (Zone E) visible at right.

Figure A2.6. (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland in the wetland offset area below West Gully 4 (Zone O).

Figure A2.7. Willows and large radiata pine in the wetland offset area below West Gully 4 (Zone O).

Figure A2.8. Kānuka forest at the west end of West Gully 3 (Zone E in foreground, Zone C.1 at rear).

Figure A2.9. Diverse understory species in the kānuka forest in West Gully 3 (Zone C.1).

About Boffa Miskell

Boffa Miskell is a leading New Zealand professional services consultancy with offices in Auckland, Hamilton, Tauranga, Wellington, Christchurch, Dunedin and Queenstown. We work with a wide range of local and international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, cultural heritage, graphics and mapping. Over the past four decades we have built a reputation for professionalism, innovation and excellence. During this time we have been associated with a significant number of projects that have shaped New Zealand's environment.

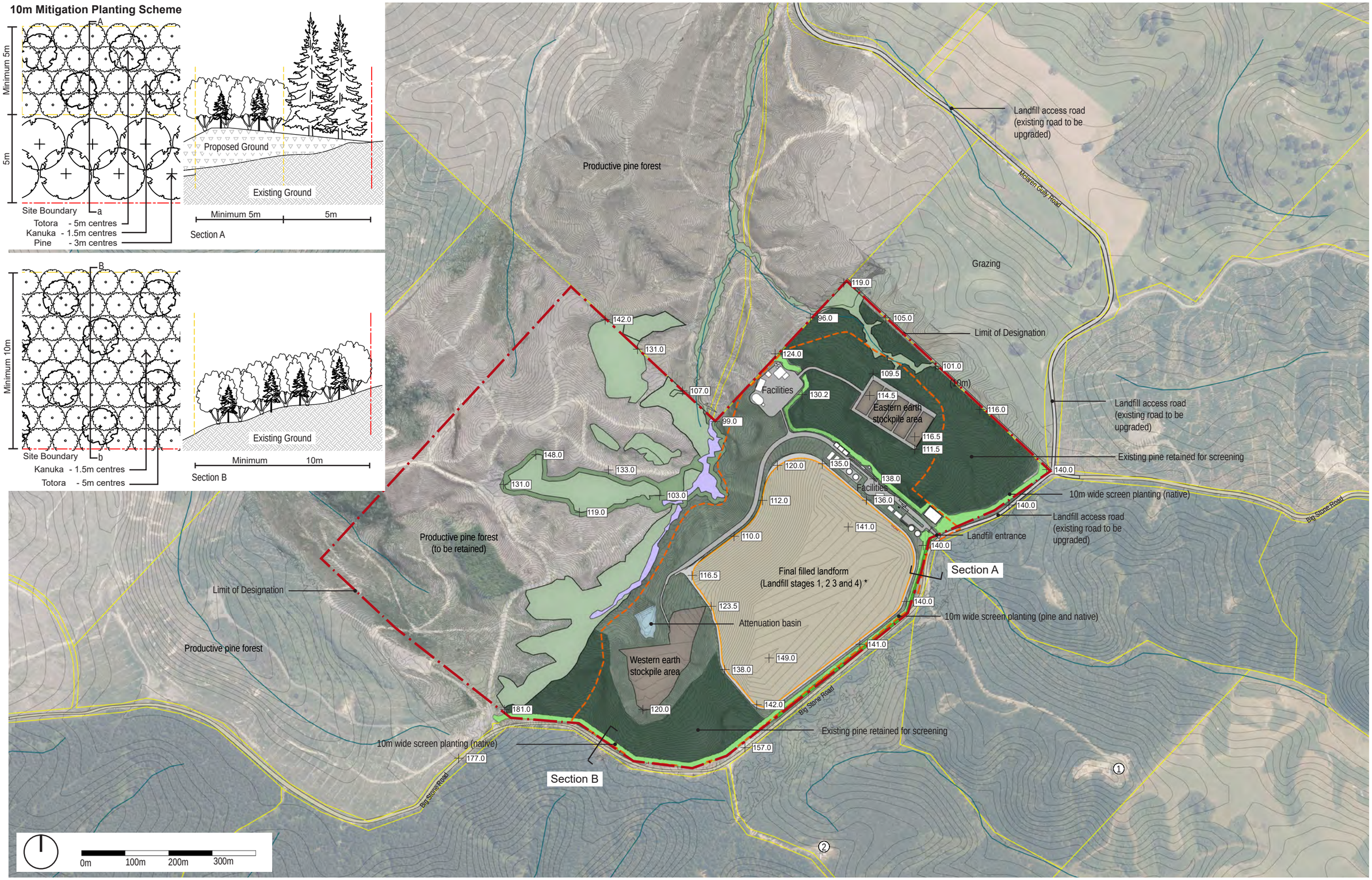
---

www.boffamiskell.co.nz

Auckland	Hamilton	Tauranga	Wellington	Christchurch	Queenstown	Dunedin
+64 9 358 2526	+64 7 960 0006	+65 7 571 5511	+64 4 385 9315	+64 3 366 8891	+64 3 441 1670	+64 3 470 0460

Appendix 3: Landscape Mitigation Plan

10m Mitigation Planting Scheme



LEGEND

- Cadastre boundary
- Designation Boundary (Incorporating stopped road)
- Landfill - operational extent
- Landfill - final cap extent Stages 1-4 (~40 year life)*

* Refer to GHD Drawings C210-C214 for staging plans

- Water Courses
- Existing wetlands (to be retained)
- Existing native vegetation (to be retained)
- Proposed native revegetation/enhancements

- Screen planting - native (planted at Stage 1)
- Screen planting - pine (planted at Stage 1)
- Existing pine retained for screening
- ①-② Rural- Residential Neighbours

SMOOTH HILL LANDSCAPE AND VISUAL ASSESSMENT

Landscape Mitigation Plan

Date: August 2020 (Updated May 2021)

Plan prepared for Dunedin City Council by Boffa Miskell Limited

Project Manager: rhys.girvan@boffamiskell.co.nz | Drawn: ETa | Checked: RGi

Figure 8

Appendix 4: Lizard Management Plan

Boffa Miskell

Smooth Hill Landfill - Lizard Management

Draft Management Plan
Prepared for Dunedin City Council

4 June 2021

Document Quality Assurance

Bibliographic reference for citation: Boffa Miskell Limited 2021. *Smooth Hill Landfill - Lizard Management: Draft Management Plan*. Report prepared by Boffa Miskell Limited for Dunedin City Council.		
Prepared by:	Samantha King Ecologist Boffa Miskell Limited	
Reviewed by:	Tanya Blakely Senior Ecologist | Senior Principal Boffa Miskell Limited	
Status: DRAFT	Revision / version: A	Issue date: 4 June 2021

Template revision: 20180621 0000

File ref: BM200252_007b_Smooth_Hill_Lizard_Management_Plan_20210604.docx

Cover photograph: Smooth Hill designation site © Boffa Miskell, 2020

Executive Summary

This Lizard Management Plan has been prepared for the Dunedin City Council. It is one of a suite of ecological management plans and is to be read in conjunction with the draft Landfill Management Plan (LMP, Boffa Miskell 2021a), which has been prepared to support the construction, operation, closure and aftercare of the Smooth Hill Landfill. This plan should also be read in conjunction with the Smooth Hill Vegetation Restoration Management Plan (Boffa Miskell 2021b), which details the enhancement and ongoing protection of a small regenerating forest area and degraded natural wetland, including lizard specific habitat enhancement and creation.

This plan will provide sufficient detail for evaluation of the project by Dunedin City Council (DCC) and Otago Regional Council (ORC) for resource consents for the Smooth Hill Landfill and associated upgrade to McLaren Gully and Big Stone roads; and the Department of Conservation (DOC) and their mandate under the Wildlife Act (1953). This plan is designed to explicitly address the 'Nine Principles for lizard salvage' (DOC 2019). This plan describes the primary tool of lizard management as lizard salvage (i.e. a mitigation-driven translocation) and describes how and why this approach was chosen.

This Lizard Management Plan addresses:

- the lizard values of the designation site and along McLaren Gully and Big Stone roads (habitat and species present, or likely present);
- actual and potential effects of the development on lizard habitat and lizards;
- evaluation of alternatives to salvaging lizards;
- methodology for lizard salvage, transfer and release;
- lizard release site characteristics;
- on-going lizard monitoring;
- reporting requirements; and
- contingency actions for lizard release.

CONTENTS

Executive Summary i

1.0 Introduction 1

1.1 Background 1
1.2 Draft Conditions 2
1.3 Lizard management approach 3

2.0 Lizard values 3

2.1 Literature review 3
2.2 Lizard survey results 5
2.3 Lizard habitats 7
2.4 Lizard values summary 13

3.0 Effects on lizards 14

3.1 Actual and Potential effects 14
3.2 Significance of effects 16
3.3 Management of effects 17

4.0 Lizard salvage, transfer and release 21

4.1 Lizard salvage methods 21
4.2 Risk associated with proposed management 24

5.0 Lizard release site assessment 25

5.1 Release site options 25
5.2 Predator control at the release site 29
5.3 Release methods 29

6.0 Contingency Actions 30

7.0 Post release monitoring and reporting 33

7.1 Post-release monitoring 33
7.2 Reporting 33

8.0 References 34

Tables

Table 1: Lizard species potentially present within the site, according to the DOC Bioweb Herpetofauna Database (Accessed May 2021). Threat classification based on Hitchmough et al. (2016), which is under review as of May 2021. 4

Table 2: Lizard survey effort and weather conditions. 5

Table 3. Summary of habitat types, extent, area to be lost and species present within the designation site and adjacent to McLaren Gully and Big Stone roads. 10

Table 4: Ecological values of lizards potentially present within the designation site and adjacent to McLaren Gully and Big Stone roads (ecological value is based on the criteria in Table 5 of Roper-Lindsay et al. (2018)). 13

Table 5: Potential significance of ecological effects on native lizards (ecological value, magnitude of effect, level of effect are based on the criteria in Table 5 of Roper-Lindsay et al. (2018)). 16

Table 6. Summary of survey methods, stages and areas to be surveyed and/or salvaged. TT = tracking tunnel 22

Table 7: Assessment of lizard release site options based on Principle 6 of the Lizard Salvage Guidelines (DOC 2019). Both options are tabled and are in bold where management of the release site may differ. 26

Table 8. Proposed lizard mitigation and compensation measures for the Landfill and road widening. 30

Figures

Figure 1. Location of artificial cover objects. 6

Figure 2. Location names used in this management plan and potential lizard habitats found within the Smooth Hill Designation. 9

Figure 3. Potential lizard habitat along McLaren Gully and Big Stone roads 11

Figure 4. Rank grass habitat within the landfill extent. 12

Figure 5. Potential buffer planting between landfill footprint and Big Stone Road. 19

Figure 6. Lizard survey and/or salvage staging adaptive management along McLaren Gully Rd and Big Stone Rd. 23

Figure 7. Habitat along the marginal strip at Brighton Beach. 27

Figure 8. Detailed restoration plan for West Gully 3 - proposed lizard release area (see also Boffa Miskell 2021b). 28

Figure 9. Further area to be enhanced based on accidental discovery of cryptic skink. 32

1.0 Introduction

This Lizard Management Plan is designed to explicitly address the 'Nine Principles for lizard salvage' (Department of Conservation, 2019). This plan describes the primary tool of lizard management as lizard salvage (i.e. a mitigation-driven translocation) and describes how and why this approach was chosen.

This Lizard Management Plan is one of a suite of ecological management plans and is to be read in conjunction with the Landfill Management Plan (Boffa Miskell 2021a), which has been prepared to support the construction, operation, closure and aftercare of the Smooth Hill Landfill.

This plan should also be read in conjunction with the Smooth Hill Vegetation Restoration Management Plan (Boffa Miskell 2021b), which details the enhancement and ongoing protection of a small regenerating forest area and degraded natural wetland, including lizard specific habitat enhancement and creation.

1.1 Background

1.1.1 Site location and context

The Smooth Hill Landfill site is situated in the hill country between the Taieri River plains and the coastline, 28 km south of Dunedin, seven kilometres from the sea-side township of Brighton and eleven kilometres from Waihola. The site is accessed off McLaren Gully Road and Big Stone Road, from State Highway 1. The designation site sits within the Tokomairiro Ecological District.

A range of vegetation types are present within the Smooth Hill Landfill footprint, the designation site, downstream areas, and areas adjacent to McLaren Gully and Big Stone roads that may be widened. These include highly modified plantation forestry areas, with areas of exotic grassland and plantation forestry that may be cleared as a result of the landfill, wetland habitats, and regenerating / secondary indigenous forest habitat. Regenerating forest gullies at the designation site (outside the landfill footprint) contributes to a local mosaic of forest fragment habitats in the wider area.

1.1.2 Statutory framework

All native lizard species are 'absolutely protected' under the Wildlife Act (1953, s63 (1) (c)), and lizard habitats are protected by the Resource Management Act (1991), administered by the Department of Conservation (DOC) and local authority Dunedin City Council, respectively.

This Lizard Management Plan has been developed to follow the principles provided in "Key principles for lizard salvage and transfer in New Zealand" (hereafter "Lizard Salvage Guidelines", (Department of Conservation, 2019). These guidelines outline the requirements that enable the outcome of a successful lizard salvage. These include a thorough assessment of the lizard values and site significance both at the site of impact and potential release sites, the actual and potential effects of the construction impact.

Further, this Lizard Management Plan addresses the potential impact on threatened species and the options of using salvage as mitigation tool. Following the Lizard Salvage Guidelines, the release sites have been assessed, and monitoring and reporting will be undertaken.

1.2 Draft Conditions

This Lizard Management Plan follows the draft consent conditions[1] drafted at lodgement of consent, as below:

- A Lizard Management Plan (based on this Draft Smooth Hill Lizard Management Plan prepared by Boffa Miskell Ltd, dated May 2021) shall be prepared by a suitably qualified ecologist prior to the commencement of construction, to ensure effects on any lizards during the construction of stages 1 – 4 of the landfill are avoided or minimised. The plan shall be developed in consultation with Te Rūnanga o Ōtākou. As a minimum the plan shall include:

  a. Background information on the lizards that may be present.

  b. Responsibilities for lizard management.

  c. Mitigation measures.

  d. Enhancement of lizard habitat for translocated lizards.

  e. Monitoring.

  f. Review and updating of the plan.

  The plan shall be provided to ORC for approval that it addresses the requirements in this condition prior to construction commencing. The plan is to be implemented for the duration of any landfill construction works.

- A Plant and Animal Pest Control Programme shall be prepared prior to the commencement of construction, to ensure adverse effects on vegetation, avifauna, and herpetofauna from exotic pest plant species, and mammalian pests (rodents and mustelids) due to construction and operation of the landfill operation are minimised. The plan shall be developed in consultation with Te Rūnanga o Ōtākou. The programme shall be provided to ORC prior to construction and shall be implemented during construction and operation of the landfill.

This Lizard Management Plan has been developed by herpetologist Samantha King (Boffa Miskell Limited) based on field work completed by herself and lizard survey work completed by Mandy Tocher (Ryder Environmental Limited) under Wildlife Act Authority (WAA) [81987 - FAU].

Any lizard salvage and future surveys will be conducted under a lizard salvage permit (WAA), following the conditions set out in this plan. All lizard surveys and salvage will be implemented by a suitably qualified herpetologist.

[1] Draft consent conditions to be finalised following issuing of consents

1.2.1 Conditions of Lizard Management Plan implementation

This Lizard Management Plan is considered a draft until timeframes for construction of the landfill and road widening have been confirmed. Lizard survey and salvage methods, knowledge, and the extent of works may change over this time and will require a thorough review prior to implementation.

The following details the matters that must be considered when finalising this plan in order for the Lizard Management Plan to be submitted to DOC as part of the WAA application.

1. Consult with Te Rūnanga o Ōtākou on the revised plan;
2. Consult with DOC on confirmed release site;
3. Review the herpetofauna database and update desktop review, as required;
4. Review potential lizard habitats within the landfill footprint and road widening;
5. Review survey methods to be undertaken, including any salvage methods, to ensure these meet DOC best practice guidelines;
6. Review extent of disturbance and construction.

1.3 Lizard management approach

Any lizard management must be carried out in consultation with Te Rūnanga o Ōtākou, DOC, ORC and DCC. At present, we consider mitigation including translocation, habitat enhancement and pest control a viable option for this site given the surrounding landscape, likelihood of lizards persisting / thriving and long-term management. This Lizard Management Plan has been developed to follow the principles provided in the Lizard Salvage Guidelines, (Department of Conservation, 2019)).

2.0 Lizard values

2.1 Literature review

The DOC online database for herpetofauna (DOC Bioweb Herpetofauna Database) was accessed in May 2021, along with iNaturalist records, to determine if there were any records of herpetofauna within a 20 km radius of the designation site. Data older than 20 years was excluded from analysis because they are not considered representative of the likely lizard fauna within the Landfill Designation.

In addition to this interrogation of the database records, the known distributions of indigenous lizards were analysed to determine if these distributions overlapped with the designation site.

Based on the Bioweb records (Table 1), lizards potentially present within the designation site and in habitats adjacent to McLaren Gully and Big Stone roads include four At Risk – Declining species (two geckos: korero and jewelled; and two skinks: cryptic and southern grass skink), and one Not Threatened species (McCann's skink). There are several records from undetermined *Oligosoma* skinks within the 20 km radius. A northern grass skink was also

recorded 7.5 km from the designation site; we consider that this species was misidentified and was in fact a southern grass skink (the distribution of northern grass skink does not extend south-east beyond the Nelson region).

Of the species that may be present within the designation site and in habitats adjacent to McLaren Gully and Big Stone roads, the following information is a summary of the types of habitats they are likely to occur. Jewelled gecko are typically confined to scrub and forest and may occupy the remnant patches of kānuka forest within the Smooth Hill Landfill designation site. McCanns skink and korero gecko, if present, are likely to use rock and scrub habitat within the area. Cryptic skink may occupy gully systems, wetlands and scrubland within the designation, but this species has not previously been recorded from this area. Southern grass skink may occupy all of these habitats mentioned above, but this species is likely to be more abundant within rank grassland, weedy areas of cutover pine forest, and regenerating scrub areas of the designation site, and along McLaren Gully and Big Stone roads. Southern grass skinks, McCann's and cryptic skinks are all similar species in terms of morphology and may be easily confused.

Table 1: Lizard species potentially present within the site, according to the DOC Bioweb Herpetofauna Database (Accessed May 2021). Threat classification based on Hitchmough et al. (2016), which is under review as of May 2021.

Common name	**Species**	**Threat classification**	**Nearest record**	**Preferred habitats**
Southern grass skink	*Oligosoma* aff. *polychroma* Clade 5	At Risk – Declining (Taxonomically Indeterminate)	7.5 km	Rank grassland, weedy areas of cutover pine forest, marginal habitats
McCann's skink	*Oligosoma maccannii*	Not Threatened	None recorded	Rank grassland, weedy areas of cutover pine forest, cobble / rock outcrops
Jewelled gecko	*Naultinus gemmeus*	At Risk - Declining	15 km	Scrub, forest
Cryptic skink	*Oligosoma inconspicuum*	At Risk - Declining	None recorded	Scrub, rock outcrops
Korero gecko	*Woodworthia* "Otago/Southland large"	At Risk – Declining (Taxonomically Indeterminate)	7 km	Rock outcrops, schist, scrub

2.2 Lizard survey results

Samantha King (Ecologist, Boffa Miskell), Tanya Blakely (Senior Ecologist | Senior Principal, Boffa Miskell) and Alex Gault (Ecologist, Boffa Miskell) carried out a site visit on 8 October 2019. Weather conditions on site were cool and drizzly (Table 2). The objective of this first site visit was to assess the quality of potential lizard habitat within the designation site. Habitat quality varied across the site. The main potential lizard habitat noted was rank grassland found both within the harvested pine forest and along road margins.

145 double layer onduline Artificial Cover Objects (ACO) were deployed within this potential lizard habitat in the designation site (Figure 1), on 8 October 2019.

The ACOs were left in place and checked once and collected on the same day on 24 & 25 March 2020. The ACOs were checked and collected by herpetologist, Mandy Tocher (Ryder Environmental), Tanya Blakely and Jaz Morris (Ecologist, Boffa Miskell) on 24-25 March 2020. At the time, New Zealand was in COVID-19 Alert Level 3 restrictions and about to move to Level 4 restrictions, which meant that inter-regional travel was not allowed and the project's Auckland-based herpetologist, Samantha King, was unable to be on site when the ACOs were checked.

Samantha King revisited the designation site and walked the alignment of the proposed upgrade of McLaren Gully and Big Stone roads on 7 May 2021. During this time, Samantha gathered general information on habitat condition within the designation site and adjacent to the road and carried out limited hand searching for lizards within road-side vegetation.

Weather conditions on 24 March were poor, with a cold southerly wind bringing occasional showers. On 25 March, conditions were cool with little wind or cloud cover. Weather conditions on 7 May 2021 were sunny and warm (20 degrees Celsius) (Table 2).

No lizards were found during ACO checks, however, the weather conditions were not ideal for surveys, consisting of overcast cool, and drizzly conditions (Table 2).

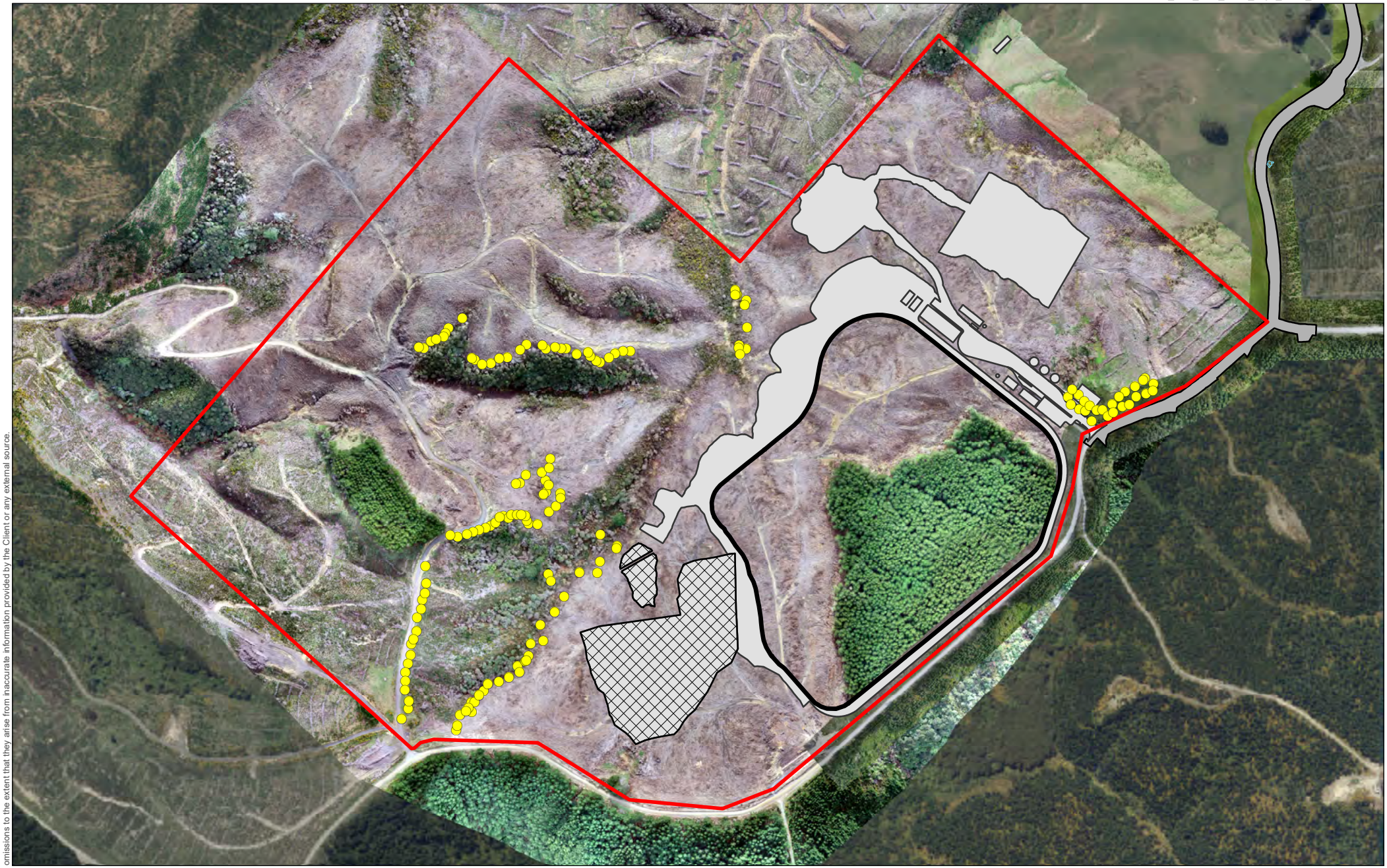
Table 2: Lizard survey effort and weather conditions.

Date	Weather	Activity & effort	Species detected
8 October 2019	Overcast, light drizzle	ACO set up	n/a
24-25 March 2020	Overcast, drizzle (>13 degrees)	ACO checks	Scat, lizard sign
7 May 2021	Sunny, warm (20 degrees)	Manual searches	none

Acknowledgement of the limitations of lizard survey methods

Lizard survey methods currently available may have poor detection rates because of typically low population densities, species' cryptic colouration, difficulty in surveying preferred habitats and behaviour / activity patterns. As such, even intensive lizard surveys are unlikely to detect all individuals in the population or, possibly, all species present.

File Ref: BM200252_025_A4L_ECO_Fig5_ACO_Locations.mxd



Boffa Miskell

www.boffamiskell.co.nz

0 200 m

1:7,500 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Artifical Cover Object
- Smooth Hill Designation (2GP)
- Access Road
- Landfill Footprint
- Operations Area
- Stockpile

SMOOTH HILL LANDFILL

Location of Artificial Cover Objects

Date: **04 June** 2021 | Revision: **1**

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: TBl

Figure 1

2.3 Lizard habitats

2.3.1 Key habitats within the site

The native southern grass skink (*Oligosoma* aff. *polychroma* Clade 5), which has been observed within eight kilometres of the proposed site within the past 20 years (Table 1), may be within the designation site, particularly in rank grassland habitats, along grass margins and in wood and debris piles scattered throughout the site, as well as in grasslands along McLaren Gully and Big Stone roads. The habitat types of particular interest for this species are (Yorkshire fog) - cocksfoot grassland (within the designation site, and along roads), [large leaved pohuehue] / (Himalayan honeysuckle) – gorse scrub and kānuka forest habitats found within West Gully 2 and 3 (Figure 2). The southern grass skink is classified as At Risk – Declining.

The korero gecko (*Woodworthia* "Otago/Southland Large") have been observed more recently (2019), along Taieri Ferry Road, and may be within the designation site, particularly in habitats where there is woody debris scattered throughout the site, however this species prefer rocky substrates end scrub environments. The habitat types of particular interest for this species are (Yorkshire fog) - cocksfoot grassland (within the designation site, and along roads), [large leaved pohuehue] / (Himalayan honeysuckle) – gorse scrub and kānuka forest habitats found within West Gully 2 and 3 (Figure 2). Korero gecko is classified as At Risk – Declining.

Based on species distribution in the wider area, McCann's skink (*Oligosoma maccannii*) might also be present and, if so, would be found along grass margins and in wood and debris piles scattered throughout the site. However, McCann's skink habitat preference is rockier substrate than what is found in the site, so is less likely to be present than the southern grass skink. The habitat type of particular interest for this species is radiata pine - gorse / cocksfoot - Yorkshire fog shrubland / treeland (Figure 2). McCann's skink is classified as Not Threatened.

The jewelled gecko (*Naultinus gemmeus*), which may have been recorded within 16 km of the site, might be present on site. Although considered less likely, the presence of this species is still possible and remnant populations of a small number of individuals could be persisting within the remnant native scrublands within the designation site. The habitat type of particular interest for this species is kānuka forest (specifically West Gully 3) (Figure 2). The jewelled gecko is classified as At Risk – Declining and is not locally abundant within the south Dunedin area.

Based on species distribution, there is a very low likelihood that cryptic skink (*Oligosoma inconspicuum*) could be present within the designation, preferring damper habitats, scrub and rock outcrops (which are not present within the designation site). However, although a low likelihood, this species could be present and should not be ruled out. Cryptic skink is classified as At Risk – Declining.

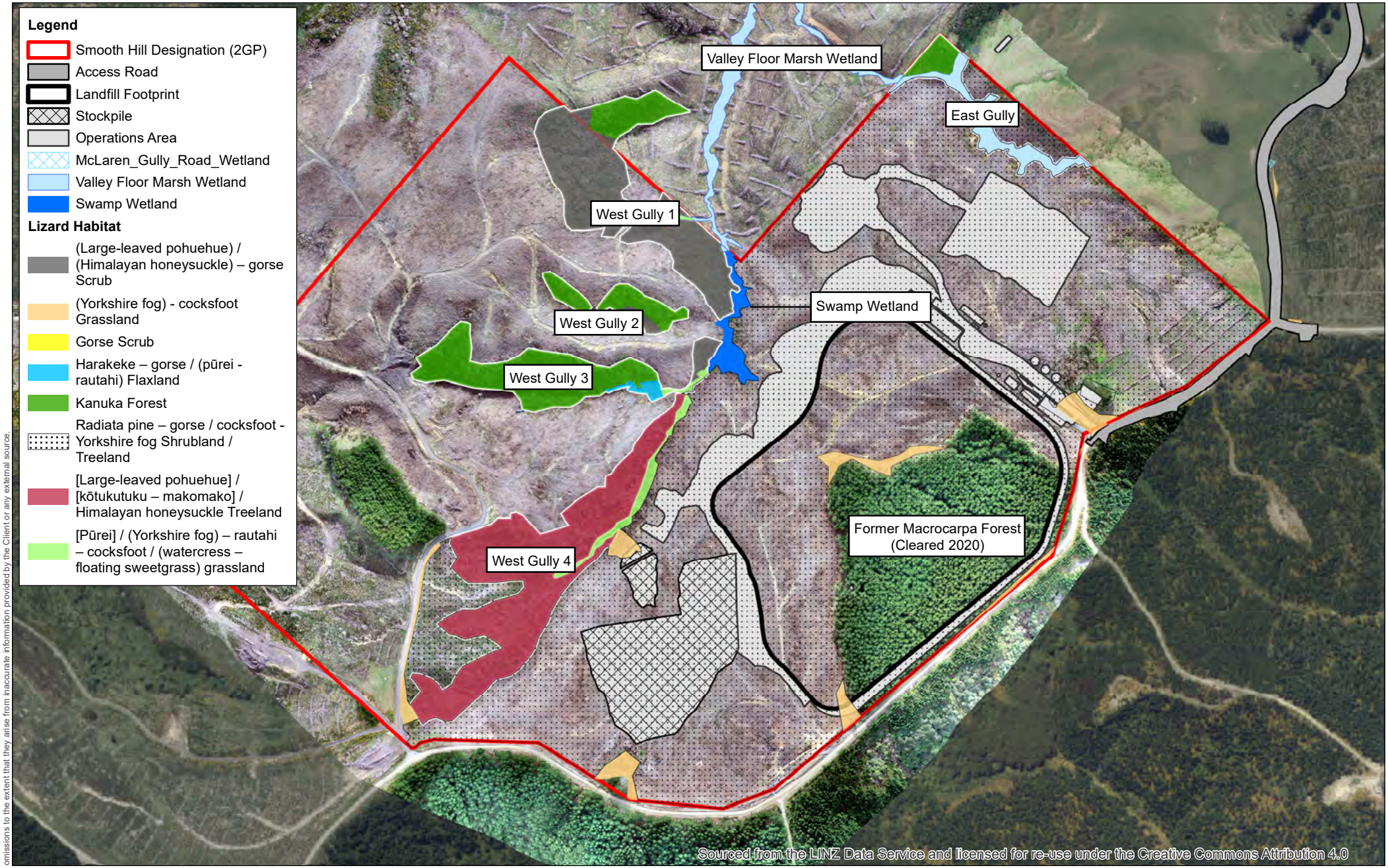
2.3.2 Extent of lizard habitats within the development site

For the purposes of this plan, lizard habitat has been identified by vegetation type and zone within the designation. With respect to impact type, this is regarding permanent loss, or potential ongoing degradation. Habitat type pertains to the vegetation type found within the area to be impacted. For example, the habitat surrounding West Gully 3 is comprised of kanuka forest with some areas bordered by regenerating treeland, scrub, grassland and wetland. These habitats are not going to be permanently altered, are found outside of the landfill site, and are to be enhanced as described in the Vegetation Restoration Management Plan (Boffa Miskell 2021b).

Without implementation of the Vegetation Restoration Management Plan, these areas are likely to be impacted by long term disturbance and edge effects during plantation forestry cycles.

Much of the cutover pine / forestry area is likely to be retained but some will be impacted, which provides low quality habitat for southern grass skinks (especially in weedy areas). In addition, a small amount of grassland will be permanently lost through the creation of the landfill. The larger sections of grassland will be lost where McLaren Gully Road and Big Stone Road are to be widened.

Table 3 summarises this below.



Boffa Miskell

www.boffamiskell.co.nz

0 200 m

1:7,500 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

Location names and potential lizard habitats found within the Smooth Hill Designation.

Date: 04 June 2021 | Revision: 1

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: SKi

Figure 2

Table 3. Summary of habitat types, extent, area to be lost and species present within the designation site and adjacent to McLaren Gully and Big Stone roads.

Habitat type	Location	Approximate extent of habitat	Amount of habitat lost	Species likely to be present	Management required
Cutover pine and macrocarpa forest area (Radiata pine / gorse / cocksfoot – Yorkshire fog treeland) **(within landfill construction footprint)**	Designation site, McLaren Gully and Big Stone roads, Landfill footprint (impact site)	> 90 ha (within designation site)	33.88 ha	Southern grass skink, McCanns skink	Progressive salvage in identified likely locations, habitat clearance
Kānuka forest, and surrounding regenerating scrub and treeland in West Gully 1, 2, 3 and 4, and surrounding [large-leaved pohuehue] / [kōtukutuku–makomako] / Himalayan honeysuckle tree land, sedgeland and flaxland in swamp wetland **(outside landfill, within designation site)**	Designation site	2.5 ha kānuka forest, 3.48 ha regenerating scrub, 4.6 ha regenerating treeland, 1.7 ha wetland (within designation site)	0 ha (within designation site). 0.0017 ha sedgeland / rushland cleared during road upgrade)	Jewelled gecko, McCanns skink, cryptic skink, southern grass skink and korero gecko	Protection from disturbance / sedimentation.
Rank grassland area (Yorkshire fog) - cocksfoot grassland **(along roads)**	Designation site, McLaren Gully and Big Stone roads, Landfill footprint (impact site)	1.06 ha (within designation site), >4 ha (along roads)	3.15 ha	Southern grass skink	Progressive salvage, habitat clearance

2.3.3 McLaren Gully and Big Stone roads

Access to the designation site is from State Highway 1 via the existing McLaren Gully Road to the junction with Big Stone Road (4.3 km approx.). Traffic then turns right onto the existing Big Stone Road for 350 m to a proposed landfill access road junction. A new access will be constructed from the junction to the site facilities and landfill (200 m approx.). McLaren Gully and Big Stone roads will be widened resulting in a direct loss of vegetation including potential

lizard habitat (rank grassland – Figure 4). It is understood that the road will be sealed, resulting in a reduction of dust accumulation along the road edge.

	
Rank grass along the roadside edge (Big Stone Road)	Rank grass along either side McLaren Gully Road
	
Rank grass along McLaren Gully Road	State Highway 1 road intersection with rank grass

Figure 3. Potential lizard habitat along McLaren Gully and Big Stone roads

2.3.4 Smooth Hill Landfill

The landfill will be 18.6 ha in area, with a construction footprint of c.34 ha, within the wider c.113 ha designation and affect potential lizard habitat (rank grassland and generally weed infested areas of the cutover pine forest) both within this landfill footprint and along the margins of McLaren Gully and Big Stone roads (Table 3).

The landfill area is currently under forestry management, which changes the vegetation composition and habitat type and quality every forestry harvest cycle (25-30 years). We consider that lizards may occupy the rank grass edges of these plantations, and potentially occupy the forest when it is at an early stage of growth (Figure 5). It is assumed that the plantation forestry cycle will continue with / after the construction of the landfill. Given the time scale of pine plantation, it is feasible that lizards make use of these habitats as they change if lizards are present in low populations.

Rank grassland within the landfill footprint

Rank grassland below the landfill extent

Figure 4. Rank grass habitat within the landfill extent.

2.3.5 Smooth Hill designation

Within the wider designation, kanuka scrub vegetation is found within several gully fragments. This vegetation has the potential to be affected by residual effects of the landfill such as pest / predator influxes and increased sedimentation or dust deposition over time.

Lizards are more likely to be persisting within these native remnants as they are large fragments of vegetation with potentially higher loads of resource and more complex vegetation with a

variety of refugia, compared to marginal habitats such as rank grass. As such, they are likely to contain a wider variety of species.

2.4 Lizard values summary

Although no specific lizard species were confirmed to be present within the site, scat was confirmed additional to the potential habitat for the following species to be present. We consider that there is a very low likelihood that cryptic skink (M. Tocher pers. comm. 2020), korero gecko and jewelled gecko are present within the designation. However, we cannot rule out that they are present, given limited surveys and the cryptic nature of these lizard species. A summary of the species possibly present within the designation site and adjacent to McLaren Gully and Big Stone roads and their ecological values is provided in Table 4.

This ecological values assessment takes into account the limited probability of cryptic skink, korero gecko and jewelled gecko presence within the designation site and habitat adjacent to McLaren Gully and Big Stone roads. However, it is more likely given the modified nature of the habitat that the southern grass skink and, less likely, the McCann's skink are the only lizard species likely to be present within the designation site and along the roads.

The potential lizard habitats within the designation site and adjacent to McLaren Gully and Big Stone roads are of generally low quality and are expected to have low abundance of lizards as a result.

Table 4: Ecological values of lizards potentially present within the designation site and adjacent to McLaren Gully and Big Stone roads (ecological value is based on the criteria in Table 5 of Roper-Lindsay et al. (2018)).

Common name	**Species**	**Threat class**	**Ecological Value**
McCann's skink	*Oligosoma mccannii*	Not Threatened	Low
Southern grass skink	*Oligosoma* aff. *polychroma* Clade 5	At Risk - Declining	High
Korero gecko	*Woodworthia* "Otago/Southland Large"	At Risk - Declining	High
Jewelled gecko	*Naultinus gemmeus*	At Risk - Declining	High
Cryptic skink	*Oligosoma inconspicuum*	At Risk - Declining	High

3.0 Effects on lizards

3.1 Actual and Potential effects

Effects on lizards have been assessed at a **local population scale**, although we note that where species have limited distributions, loss of animals will have national population scale effects. Actual and potential effects on lizards resulting from the proposed development are detailed below.

The landfill and associated works (excluding road widening) is likely to be permanent in nature and 18.6 ha in size. Therefore, lizards are likely to have habitat connectivity reduced and fragmented in nature, permanently. The vegetation within the landfill footprint and wider designation site is highly modified and not high quality habitat for native lizards, therefore, populations that may be present within the designation site and along the road edge are likely to be reduced to sparse or less than reproductively viable.

Based on a **High** ecological value and with an appropriate management plan and habitat enhancement, the magnitude of effect on the wider populations is likely to be **Low** (*having a minor effect on the known population or range of the element / feature*) and, therefore, a **Low** level of ecological effect.

3.1.1 Injury/death

Lizard fauna are mobile over short distances but may not be able to escape during site preparation and construction, particularly if carried out during colder months when lizards are less active. Activities that may result in injury or death to lizards include vegetation clearance and earthworks. Lizards are particularly susceptible to injury and mortality during vegetation clearance because they are visually and behaviourally cryptic (hiding under cover when disturbed), have low mobility and are inactive for parts of the year.

Effects of injury or death will be minimised as much as possible with salvage and translocation.

3.1.2 Disturbance

Disturbance and sub-lethal stress to lizards is difficult to quantify, but is likely that noise, dust and vibrations during construction may impact lizards that are vocal (i.e. some green gecko species) and / or predominantly ground-dwelling species (i.e. southern grass skink). The increase in both vehicle movements, and increased lighting will increase the potential for disturbance to nocturnal lizards (such as korero gecko).

3.1.3 Habitat loss and displacement

The majority of the landfill development is located away from indigenous vegetation and habitats likely to be occupied by native lizards. Where lizards are present, works associated with the development will result in direct, permanent habitat loss within the construction footprint and temporary occupation areas (e.g. lay down areas).

Unmanaged clearance of vegetation and other lizard habitat (including feeding and refuge habitats, such as debris piles) may result in significant sub-lethal effects to lizards by the following mechanisms:

- displacement into unsuitable neighbouring habitat;
- increased competition for resources and consequent reduction in breeding success;
- loss of mature food and refugia (i.e. vegetation with suitable crevices); and
- high stress resulting from the loss of refuge habitats and increased exposure to predators.

We consider that the existing lizard population size is likely constrained by predation pressure and availability of suitable refuges and food. As such, displacement of lizards into surrounding habitat, if present, may have a moderate adverse population-level effect where lizards are unable to survive or breed.

3.1.4 Habitat fragmentation

Habitat fragmentation disproportionately affects animals with low dispersal ability by effectively constraining the extent of available habitat. This may result in breeding suppression as a result of limited habitat and reduced mate choice.

Key areas where habitat fragmentation may result from the proposed development include existing native scrub remnants, separation from these with uninhabitable areas, encroachment of plant and animal pests into the fragmented habitats.

3.1.5 Increased predation

Increased levels of activity at the Site have the potential to create additional interest and visitation of mammalian pests and predators, especially rodents. Increased predation may have population level effects on native lizards. The creation of the landfill will also increase the residual effects of predators within the habitat. There is currently no pest control within the site, which may be keeping lizards supressed. Predator control will aim to reduce the risk of increased predation within the habitats to remain at the site (see predator control section in the Landfill Management Plan, Boffa Miskell 2021a).

3.1.6 Habitat quality reduction / dust sediment deposition

Habitat remnants within the site are particularly vulnerable to encroachment from dust deposition, sediment runoff and debris deposition. These remnants could likely hold higher numbers of lizards within them compared to the site that is to be modified, due to their higher quality habitat. These effects would likely reduce populations further and leave the remnant populations at risk of predation and reduction of food resource.

Given the habitat along McLaren Gully and Big Stone roads is already affected by dust deposition, we consider that the proposed sealing of these roads[2] will significantly reduce and potentially eliminate the effects of dust in these areas, which will be a **positive effect.**

[2] We understand that access roads are to be sealed.

3.1.7 Translocation

Potential effects on lizards resulting from salvage and subsequent translocation may include injury, death, competition, displacement, overheating and overcrowding. These effects will be minimised by using experienced handlers. An evaluation of the risk of these effects is provided in Section 4.2.

3.2 Significance of effects

At Risk - Declining species (*Oligosoma* aff *polychroma "*Clade 5*"*) have high conservation value meaning that any predicted impact of moderate or higher magnitude on these species defaults to a High level of effect. For this assessment, effects are considered at a local population scale. Not threatened species such as McCann's skink have a **Low** level of effect (Table 5).

Table 5: Potential significance of ecological effects on native lizards (ecological value, magnitude of effect, level of effect are based on the criteria in Table 5 of Roper-Lindsay et al. (2018)).

Adverse effect	**Threat class**	**Ecological Value**	**Magnitude of Effect**	**Level of Effect**
Accidental injury / death	Not Threatened	Low	Low	**Very Low**
	At Risk - Declining	High	Moderate	**High**
Habitat loss / displacement	Not Threatened	Low	Low	**Very Low**
	At Risk - Declining	High	Moderate	**High**
Disturbance during construction	Not Threatened	Low	Moderate	**Low**
	At Risk - Declining	High	Moderate	**High**
Habitat fragmentation	Not Threatened	Low	Low	**Very Low**
	At Risk - Declining	High	Moderate	**High**
Breeding failure / avoidance	Not Threatened	Low	Negligible	**Very Low**
	At Risk - Declining	High	Low	**Low**
Habitat quality reduction / Dust sediment deposition	Not Threatened	Low	Negligible	**Very Low**
	At Risk - Declining	High	Low	**Low**

Although the level of effect is high in some instances, given the expected low densities of some of the potential species (e.g., southern grass skink), there is a chance of only encountering a few animals per hectare. As such, the level of effect may be high, but the likelihood of that effect being realised with the proposed management in place, is **low**.

3.3 Management of effects

3.3.1 Avoidance

At Risk lizard species may be present within the site and all native lizards are protected under the Wildlife Act. As such, where practicable, clearance of areas of lizard habitat (particularly regenerating native treeland (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub community); and areas of (Yorkshire fog) - cocksfoot grassland (within or surrounding radiata pine / gorse / cocksfoot – Yorkshire fog treeland) will be avoided.

Where the removal of lizard habitat cannot be avoided, measures are recommended to avoid and minimise the potential effects on resident lizard populations.

3.3.2 Remediation

Because some areas of habitat will be lost, rather than temporarily impacted, it is unlikely that lizard habitats directly impacted by landfill construction and road widening can be practically remediated.

3.3.3 Minimisation: Lizard salvage as a management action

We recognise that there are inherent risks associated with lizard capture and salvage as a management tool for mitigation purposes. In particular, there is high risk of poor capture rates for lizards during pre-survey capture and salvage activities. This will be managed by maximising lead-in time for pre-clearance capture and using a range of tools suitable to the species in question. We further recognise that communication with machinery contractors is key to ensuring that lizard salvage is carried out in such a way as to minimise risk to lizards (i.e. gradual habitat clearance, using appropriate machinery).

3.3.4 Mitigation

As a requirement of consent conditions[3,4], we consider that buffer planting of the potential release site, stock fencing (at a minimum) of vegetation remnant West Gully 3 (see Section 3.1.4 of the Vegetation Restoration Management Plan, Boffa Miskell, 2021b) and landscape scale predator control will mitigate for adverse effects of the landfill and road widening.

As landfill activities and disturbance will be ongoing for many years, salvaged lizards will need to be relocated to prepared areas well outside of the landfill footprint. Site preparation includes habitat enhancement (e.g. plantings of native grasses and shrubs) prior to release of salvaged lizards.

The DCC Landfill Concept Design Report5 states that landfill perimeter tree planting is proposed to provide visual screening along the exterior of the landfill footprint and will also intercept dust generated from site operations. A minimum 10 m wide vegetation buffer strip has been proposed, including a mixture of exotic and indigenous tree species along the site

[3] Draft consent conditions to be finalised upon lodgement of consent

[4] Areas of suitable lizard habitat within the site are maintained in accordance with a Lizard Management Plan.

[5] Dunedin City Council Waste Futures Phase 2 - Workstream 3 Smooth Hill Landfill. Landfill Concept Design Report (2021)

boundary with Big Stone Road and along the north eastern ridge within the site (see the Vegetation Restoration Management Plan, Boffa Miskell 2021b).

All sections of the proposed vegetation screen can be planted at (or prior to) the commencement of the landfill development project. The planting will consist of double staggered rows of pine adjoining the site boundary combined with a mixture of kānuka and totara within the site.

These plantings will assist in the reduction of dust deposition for native fauna that may be inhabiting the wider vegetation, and assist with habitat enhancement for the rank grassland corridors that are present along the edge of Big Stone Road (Figure 5).

File Ref: BM200252_035_A4L_ECO_LIZ_Mitigation.mxd

Boffa Miskell

www.boffamiskell.co.nz

0 100 m

1:4,000 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Smooth Hill Designation (2GP)
- Access Road
- Landfill Footprint
- Stockpile
- Operations Area
- Mitigation Planting

SMOOTH HILL LANDFILL

Potential buffer planting

Date: 26 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: SKi

Figure 5

Native plants have been chosen based on plants that may have been in the area historically, which provide ideal lizard habitat including a variety of shrubs, trees and low growing ground cover plants (see Vegetation Restoration Management Plan, Boffa Miskell 2021b).

Areas to be cleared, which surround indigenous vegetation and potential lizard habitats, should be temporarily fenced with silt-fence material to prevent the dispersal of lizards out of these areas into the construction footprint.

An appropriate predator control programme is to be designed and implemented within the designation site to prevent large scale influx of rodents and mustelids prior to the construction on site, which includes focusing on areas which are likely to remain, such as West Gully 2 and 3. Lizards are acutely threatened by mice and rats, as well as mustelids such as weasels and stoats. We recommend that ongoing trapping is implemented in these areas (as detailed in the plant and animal pest control detailed in the draft Landfill Management Plan, Boffa Miskell 2021a).

3.3.5 Residual effects

Creation of predator corridors and increased edge effects: increased edge effects and predator corridors are likely to form around the edges of the landfill footprint. In turn, without buffered planting between the landfill and any remnant of native scrub, there will be increased edge effects, including but not limited to soil / sedimentation run off; dust suppression; predator influx.

Ongoing disturbance through increased traffic: there will be increased traffic and people as a result of the landfill and road upgrade. This will negatively affect lizards by disturbance, with potential for harm / injury or death.

Increased dust deposition through dust from landfill: traffic into the landfill and trucks dumping waste may expose the remaining indigenous vegetation and lizard habitat to increased dust deposition.

Inability to salvage all lizards within the footprint: we acknowledge that the methods of survey and capture of lizards are imperfect and, as a result, it may not be possible to salvage every lizard within the construction footprint. It is likely that some lizards may not be detected during salvage and will be injured or killed as a result.

4.0 Lizard salvage, transfer and release

All surveys and salvage must be undertaken no more than 2 weeks prior to commencement of road widening (including associated works such as vegetation clearance).

All lizard salvage and surveys must be carried out between October and March inclusive (weather dependent).

Surveys must be undertaken in mild, fine conditions with preferably little wind, with daytime temperatures ranging between 15 and 25 degrees (lizards are most detectable within this temperature range).

Any lizard habitat will be clearly demarcated. Any disturbance outside of this area must be avoided. The demarcation will be communicated during an osite meeting with the contractor two weeks prior to clearance.

4.1 Lizard salvage methods

4.1.1 Before habitat clearance

If the habitats are still present within the landfill footprint and road edges:

Methods for skinks and geckos

Tracking tunnels (as of May 2021) have not yet been accepted as an approved standard method for surveying lizards, however, they are currently used in a range of situations to determine lizard presence (M. Lettink pers. Comm. May 2021). Tracking tunnels do not determine species present but do indicate presence of lizards.

Tracking tunnels will be installed within the rank grassland vegetation within the landfill footprint, and any habitat identified by the project herpetologist. Tracking tunnels will be installed at a spacing of 10 m, and baited with pear. These can be set up and left in place for ideally 2-3 months prior to construction. Tracking tunnels will be checked and refreshed every 10 days to ensure ink does not dry out, and bait is fresh.

If lizards are found to be present:

A combination of pitfall trapping and funnel trapping of McLaren Gully and Big Stone roads will be carried out in stages in order to adequately salvage the area with enough time consideration given for each stage. Traps will be placed at 10 m spacings in habitat deemed suitable for lizards and baited with tinned pear and checked once daily.

All traps will be left for a minimum of four trap days (three nights). After the fourth night, if no lizards are caught then salvage will cease. If more than 20% of the traps are still catching lizards, then salvage will continue until less than 20% of traps capture lizards.

Each stage of the road will be treated as an individual salvage event. For example, the start of McLaren Gully Road at the intersection of State Highway 1 will be the first stage of salvage (Table 6, Figure 6).

Table 6. Summary of survey methods, stages and areas to be surveyed and/or salvaged. TT = tracking tunnel

Area	Stage / Section	Approx. No. of TTs and / or Traps required	Size / Length of habitat	Road Side
SH1 intersection – McLaren Gully Road	One	100	500m	Northern and Southern
McLaren Gully Road – First Forestry Road to Northern pine block	Two	80	400 m	Northern and Southern
McLaren Gully Road End of northern pines to Forestry Road	Three	120	600 m	Northern and Southern
McLaren Gully Road - Forestry Road sweeping bend	Four	25	250 m	South western side
McLaren Gully Road – Forestry road to end of toitoi beyond eucalyptus	Five	65	650 m	Mostly Northern side
Big Stone Road intersection to Landfill	Six	35	350 m	On Landfill side of the road

4.1.2 Road widening Stage One – Stage Six

It is impractical to consider salvage for all stages if skinks are not found. The following is an adaptive management approach to address this.

- If no lizards - move on to next stage.
- If only one or two skinks detected in tracking tunnels salvage may be avoided **ONLY IF** West Gully 3 is protected from residual effects (see Section 5.0).
- If one or two species of skink or gecko is recorded (i.e. prints differ enough to determine species difference) but less than 20% tracking tunnels within a stage have lizard presence, salvage must be carried out.
- If more than 20% of tracking tunnels within a stage have lizard presence, salvage must be carried out in this stage, and release site must be enhanced.

File Ref: BM200252_036_A4L_ECO_LIZ_Staging.mxd

Boffa Miskell

www.boffamiskell.co.nz

0 400 m

1:20,000 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Smooth Hill Designation (2GP)
- Access Road
- Landfill Footprint

SMOOTH HILL LANDFILL

Lizard Survey and/or Salvage Staging

Date: **04 June** 2021 | Revision: **1**

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: SKi

Figure 6

4.1.3 Salvage Review Prior to construction of Road and landfill

This plan is written using best practice approved methods at the time of writing and methods may change or adapt based on new research and development of new tools. We consider that species composition may also change prior to the construction of the landfill and road widening.

Further, the effects, remediation, mitigation (including the choice of salvage as a mitigation tool) may change over time, and must be reviewed prior to the construction of the landfill and road widening.

4.1.4 Data collection

Lizard capture data will include species identity, sex, length, tail regeneration, notes on scale / lamellae / feet / mouth / pattern colouration (if there is any doubt about species identification), GPS coordinates and a habitat description for the capture location, date and time. Weather conditions will be recorded during and at the beginning and end of each salvage or survey event.

If possible – depending on the species caught – the weight, reproductive condition, photos suitable for individual identification, scale counts / macro photographs of feet / head scales for species identification and tail tips will be collected. Tail tips will be taken following the DOC standard operating procedure for sampling avian and reptile tissue. This is especially necessary in cases where skinks are caught but not able to be identified to species level.

4.1.5 Transportation

Lizards will be held individually in cloth bags in a secure, vented container out of the sun. Lizards will be transported to the release site within 12 hours of capture.

4.2 Risk associated with proposed management

Potential risks to lizards as a result of the proposed salvage include:

- Overheating: lizards will be placed in individual containers and kept in a cool place until released. Handling will be minimised to ensure they do not become stressed. All traps will be checked daily in the morning.
- Overcrowding: it is likely that any population of lizard within habitat within the proposed release area is under pressure from predation and is therefore not at carrying capacity, and as a result overcrowding is not likely to be a risk.
- Competition: it is likely that any population of lizard within habitat within the release site is already under extreme pressure from predation and is therefore not at carrying capacity, and as a result competition is not likely to be a risk. A lizard survey will be required to be carried out within the release area prior to release to determine species presence and abundance.
- Displacement: any lizards are likely to be released within habitat similar to where they were captured and within the same geographic range, however the effects of displacement can only be minimised and not eliminated.

- Injury / death: all lizards will be captured or supervised by an appropriately qualified herpetologist, following best practice and full hygiene protocols, minimising the risk of injury, death and disease transmission through inappropriate handling and capture.

5.0 Lizard release site assessment

5.1 Release site options

If salvage and release is deemed the best lizard management option, we propose two options for releasing lizards: Smooth Hill Reserve (West Gully 3 – within the designation) or Brighton Beach (Brighton / Taieri Mouth Marginal Strip) (Figure 7). Table 7 addresses the criteria for consideration of a site for lizard release.

West Gully 3 comprises tall kanuka treeland, surrounded by pine plantation. West Gully 3 is east facing and has some low growing vegetation, which is suitable for lizards (Figure 8, also see Boffa Miskell, 2021b). ACOs placed along the edge of the habitat may have had skink presence with scat recorded within these during surveys.

The Brighton / Taieri Mouth Marginal Strip comprises remnant coastal vegetation, including flax, cabbage tree, gorse, hebe, bracken, rank grass, marram, and mapou (Figure 7). The marginal strip has not been surveyed for lizards.

These two options have been considered based on the potential for lizards to be present within the designation site and in habitat adjacent to McLaren Gully and Big Stone roads. West Gully 3 is the preferred option but will require buffering from forestry and residual landfill effects. The rationale is provided below, considering the mitigation of the effects from landfill:

- West Gully 3 must be protected from adverse effects (including felling, removal of scrub, pest plant species encroachment, and sediment deposition).
- appropriate and long-term predator control including rodent and mustelids.
- fencing (at least mesh, ideally UV stable woven material) of the surrounding West Gully 3 with a 10 m buffer around the edge.
- removal of pine plantation and associated pest plant species from within the 10 m buffer.
- in addition, a lizard survey of the release site must be carried out prior to release to determine its suitability – this may include DOC approved methods and any new methods that have been approved since this plan draft.
- prior to construction of the landfill and road widening, if the project herpetologist does not deem this release site suitable, we propose Brighton / Taieri Mouth Marginal Strip the next suitable release site.

The release site has been selected based on its ability to accommodate lizards within habitats similar to those from which they were captured. Further considerations included Principles 6, 7 and 9 of the Lizard Salvage Guidelines (Department of Conservation, 2019).

Table 7: Assessment of lizard release site options based on Principle 6 of the Lizard Salvage Guidelines (DOC 2019). Both options are tabled and are in bold where management of the release site may differ.

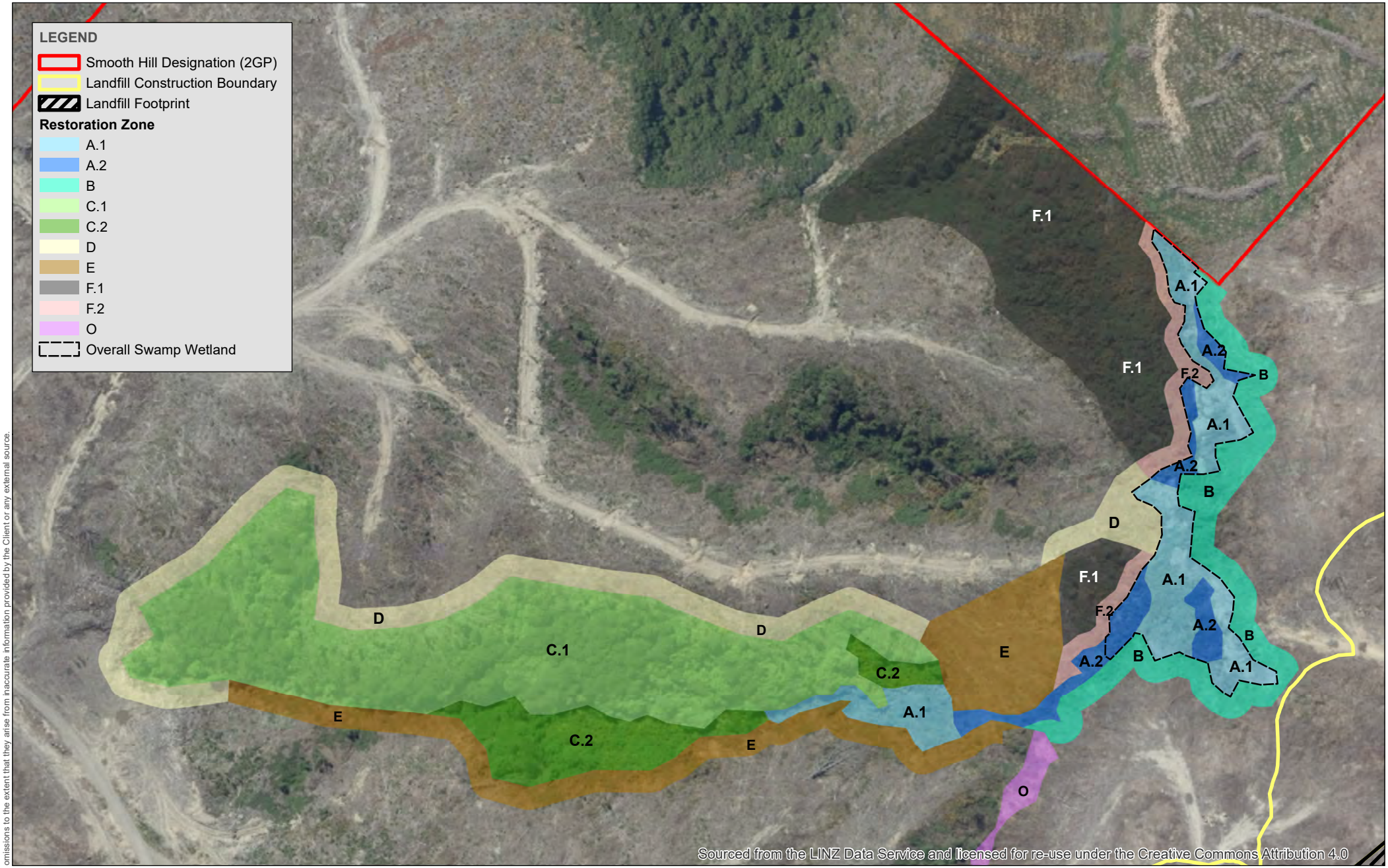
Principle relating to salvage and release	Description	Detail/Activity
1. The site must be ecologically appropriate and have long-term security	**Resident lizard communities must be understood** *Will released lizards increase viability of population, or be released in high enough numbers to start new population?*	A lizard survey of the proposed release site to be undertaken prior to construction.
	The release site must be an appropriate distance from the impact site to prevent lizard homing, but close enough that it provides similar habitat	The release site has similar habitat – consisting of rank grassland, low scrub and *Muehlenbeckia* and would be an improvement on the habitat available in the impact site.
	The location must be within the species natural geographic range. *Ensure no mixing of potentially genetically structured populations.*	The location of the release site is within the geographic range of the southern grass skink, cryptic skink and korero gecko.
2. The habitat at the site must be suitable for the salvaged species	**Vegetation composition and size:** predominantly indigenous vegetation and sufficiently large and continuous for residents, release lizards and allowing for population growth.	The habitat in both proposed release sites is similar to the impact site, comprising rank grass, regenerating scrub, low *Muehlenbeckia* species. The habitat is continuous and provides habitat along a 2 km marginal strip.
	Must contain sufficient resources for potential population. e.g., food, cover, retreats. What enhancements are proposed for expanded population?	The habitat may contain low numbers of lizards so food cover and retreats are already sufficient, however planting of lizard friendly plants is proposed for the buffer of **West Gully 3**
	Habitat enhancement – must be ongoing in an ecologically relevant timeframe	**West Gully 3** Planted along edges with lizard friendly habitat and pine trees and gorse / broom will be removed
	Edge effects – The release site must be buffered from intermittent climatic extremes, such as drought.	**West Gully 3:** Must be buffered from edge effects by fencing at least a buffer of 10 m, planted with lizard friendly plants including *Muehlenbeckia, Gaultheria* and *Coprosma spp.* **Brighton Marginal Strip:** Not buffered from climatic extremes such as sea level rise / storm surge however this is not considered a high risk given the proximity of the Pacific Ocean. (Dunedin City Council, 2014)
3. The site must provide protection from predators	*Habitat must protect from predators, or effective pest control must be in place. Must include full suite of predators including trapping for mice*	See plant and animal pest control as detailed in the draft Landfill Management Plan (Boffa Miskell 2021a)
4. The site must be protected from future human disturbance	*Land tenure must ensure long term protection from disturbance*	**West Gully 3**: will be protected in the long term from disturbance following the conditions above (restoration planting, fencing and predator control) **Brighton Marginal Strip:** is a DOC reserve but under different rules than general DOC conservation areas.

Figure 7. Habitat along the marginal strip at Brighton Beach.

5.1.1 Restoration of the buffer around West Gully 3

The Smooth Hill Vegetation Restoration Management Plan (Boffa Miskell, 2021) describes the vegetation restoration required for the restoration of West Gully 3 and surrounding area.

- Zone A.1 – existing wetland – weed removal
- Zone A.2 – existing wetland, degraded area – weed removal and planting
- Zone B – wetland buffer – weed removal and planting
- Zone C.1 – existing regenerating forest – weed removal, minor planting
- Zone C.2 - existing regenerating forest, degraded area – weed removal, planting
- Zone D – forest buffer – weeding and planting of lizard friendly species
- Zone E – additional plantings area – removal of pines, minor planting
- Zone F.1 – weedy regenerating scrub – leave to regenerate
- Zone F.2 – weedy regenerating scrub – weed spraying buffer
- Zone O – additional wetland offset area – weed removal and planting



Boffa Miskell

www.boffamiskell.co.nz

0 75 m

1:2,250 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

Detailed restoration plan for West Gully 3 - proposed lizard release area (reproduced from Boffa Miskell 2021b)

Date: **04 June** 2021 | Revision: **1**

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: JMo | Checked: TBI

Figure 8

5.2 Predator control at the release site

The Landfill Management Plan (Boffa Miskell, 2021a) details predator control at the release site:

Initial Work

Subject to the preparation of a detailed Pest Control Programme prior to the construction of the landfill, it is anticipated that the following procedures will be employed at the Smooth Hill Landfill to manage plant and animal pests.

5. *Establish a rodent control network around the landfill site using bait station and/or traps which reflect industry best practice.*
6. *Reduce the possum population to 30% Waxtag Index to enable the ease of ongoing population maintenance.*
7. *Establish a predator (mustelids, possum and rat) trapping network across the wider site to protect native species.*
8. *Establish a network of devices to control mice in West Gully 3 to protect lizards*

Further, predator control will be set up in the release site with a pre-control monitor, including using tracking tunnels within a small area of the release site. Tracking tunnels are an appropriate method for monitoring predators within the release site as they monitor for both rats and mice.

We consider that mouse and rat control should be undertaken in the release site in the form of bait stations and traps for the life of the landfill (traps will be a mixture of A24 self-resetting and manual traps). Bait stations and traps will be set out across the chosen lizard release area in a grid at 20 x 20 m spacings, checked and refilled quarterly. The original post-release tracking tunnels will be monitored before and after a bait pulse to adapt bait levels accordingly to ensure that baiting is sufficient for the site. Suitably experienced contractors will administer the bait stations and monitoring at the site.

Predator control at the release site must be approved and reviewed by the project herpetologist and by DOC prior to implementation.

5.3 Release methods

Any lizards caught will be released into habitat within the lizard release site where there is appropriate ground cover. The baseline lizard survey will determine the distribution of lizards resident in the site. Any korero gecko will be released into rock piles in aggregations (if more than one is found at any time).

6.0 Contingency Actions

The purpose of contingency actions is to ensure that there is no net loss of lizards and lizard habitat post development, or in the event that lizard salvage and transfer fail or be only partly successful.

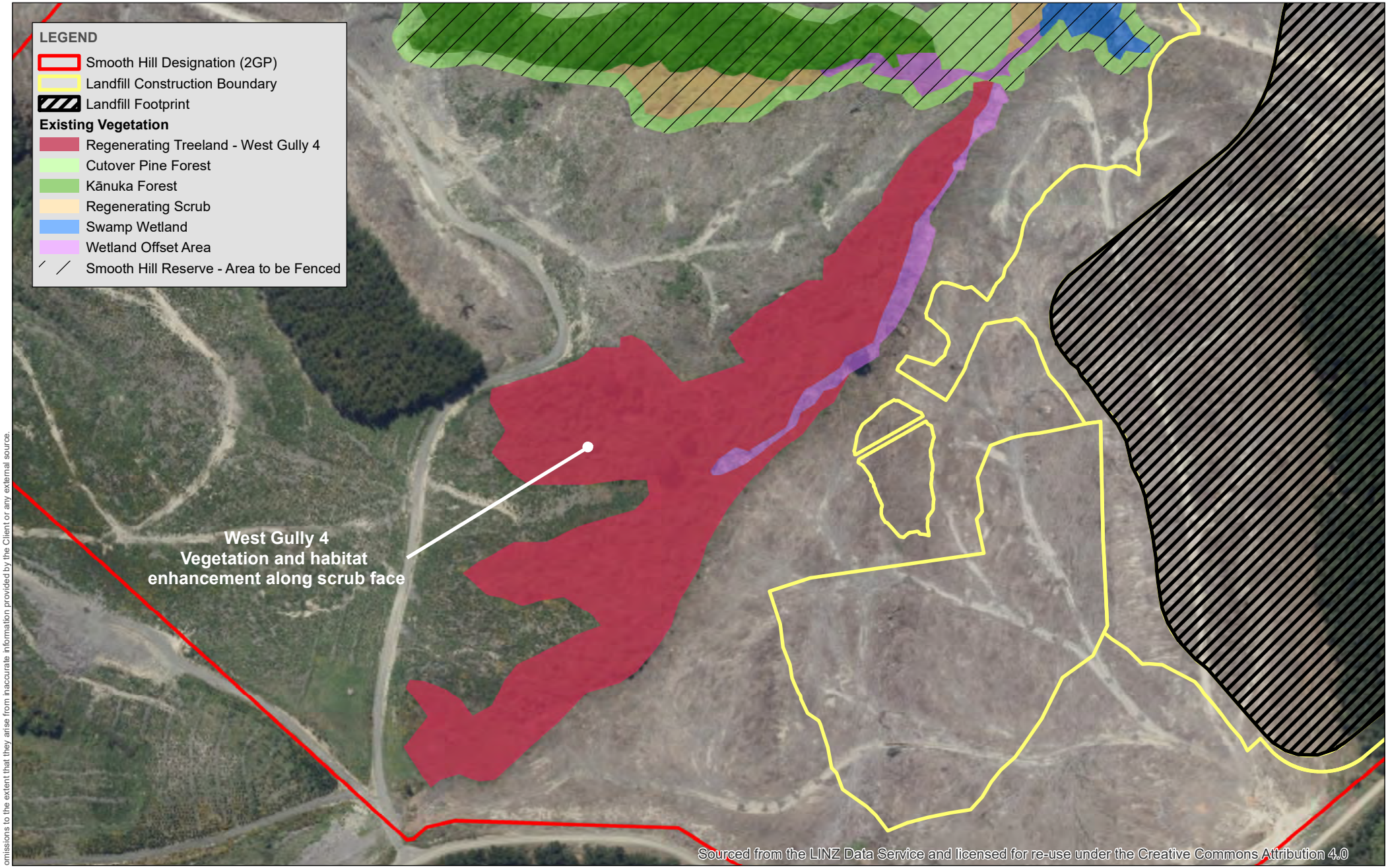
Proposed contingency measures are detailed in Table 8.

Table 8. Proposed lizard mitigation and compensation measures for the Landfill and road widening.

Measure	**Contingency Action(s)**	**Frequency / timing**
Salvage and transfer of lizards (mitigation)	Capture and relocate lizards from the affected area prior to the start of construction to reduce mortality. Skinks will be captured in funnel and/or pitfall traps using best-practice methods. Skinks will be released into a 1.9 Ha release site (West Gully 3).	Salvage dependent on timing of construction. Report lizard salvage results to DOC, including submission of ARDS (Amphibian & Reptile Distribution Scheme) records.
Cryptic skink discovery	If **cryptic skinks** are discovered during salvage, we recommend fencing the regenerating treeland and wetland offset area at West Gully 4 this area and incorporating it into the Smooth Hill Reserve Area (Figure 8; Boffa Miskell 2021b).	Dependent on the outcome of salvage
Release site	A contingency approach if more than 150 lizards are salvaged from the project, was recommended but has since been incorporated into Boffa Miskell (2021b) (enhancement to be carried out along the scrub face (see Figure 9, also Boffa Miskell 2021b), to allow for extra habitat.	Dependent on the outcome of salvage
Post-release monitoring	Post-release monitoring will be carried out.	Annually for three years in late spring / early summer. Report results to DOC on conclusion of the monitoring (see Section 7.0 below)
Predator control	If < 20 skinks are salvaged, mouse and rat control will be undertaken at the release site	Bait stations will be baited, traps checked and refilled

Measure	Contingency Action(s)	Frequency / timing
	in the form of bait stations set out across the lizard release site.	quarterly for the life of the landfill.
Restoration planting	If lizards are recorded during pre-clearance lizard surveys of the development site, contingency actions include: • Buffer revegetation around the edge of the West Gully 3 release site, if chosen.	To be determined if lizard salvage is required.

File Ref: BM200252_037_A4L_ECO_LIZ_Contingency_Restoration.mxd



Boffa Miskell

www.boffamiskell.co.nz

0 100 m

1:3,500 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

Further area to be enhanced based on accidental discovery of cryptic skink

Date: 04 June 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: JMo | Checked: TBI

Figure 9

7.0 Post release monitoring and reporting

7.1 Post-release monitoring

The following post-release monitoring must be followed if:

- >20 individuals of the most abundant 'Not Threatened' species = 3-year monitoring programme.
- >20 individuals of the most abundant 'At Risk' species = 5-year monitoring programme.

If ≥20 individuals are salvaged, monitor lizards in the chosen release site for a period of 3 years following their release to determine population persistence. This will be assessed using footprint tracking tunnels. Post-release monitoring will be carried out annually for three years in late spring / early summer.

7.2 Reporting

Post-release monitoring will be reported to DCC and DOC at the conclusion of the monitoring, unless changes occur such as a population crash, the condition of the release site deteriorates, or high predator influx occurs. If any of these scenarios occur, consultation with DOC will be undertaken to determine the best solution.

8.0 References

Boffa Miskell (2021a.) *Smooth Hill Landfill: Draft Landfill Management Plan. June 2021.* Report prepared by Boffa Miskell Limited for Dunedin City Council.

Boffa Miskell (2021b). *Smooth Hill Landfill: Vegetation Restoration. Draft Management Plan. June 2021.* Report prepared by Boffa Miskell Limited for Dunedin City Council.

Dunedin City Council (2014). *Coastal hazards of the Dunedin City District. Review of Dunedin City District Plan – Natural Hazards.* Prepared by Otago Regional Council.

Hitchmough, R.; Barr, B.; Lettink,M.; Monks, J.; Reardon, J.; Tocher, M.; van Winkel, D.; Rolfe, J. (2016). *Conservation status of New Zealand reptiles, 2015. New Zealand Threat Classification Series 17*. Department of Conservation, Wellington. 14 p.

About Boffa Miskell

Boffa Miskell is a leading New Zealand professional services consultancy with offices in Auckland, Hamilton, Tauranga, Wellington, Christchurch, Dunedin and Queenstown. We work with a wide range of local and international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, cultural heritage, graphics and mapping. Over the past four decades we have built a reputation for professionalism, innovation and excellence. During this time we have been associated with a significant number of projects that have shaped New Zealand's environment.

---

www.boffamiskell.co.nz

Auckland	**Hamilton**	**Tauranga**	**Wellington**	**Christchurch**	**Queenstown**	**Dunedin**
+64 9 358 2526	+64 7 960 0006	+65 7 571 5511	+64 4 385 9315	+64 3 366 8891	+64 3 441 1670	+64 3 470 0460

Appendix 5: Falcon Management Plan

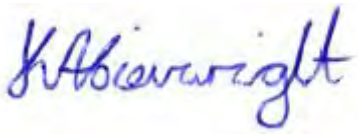
Boffa Miskell

Smooth Hill Landfill

Draft Falcon / Kārearea Management Plan
Prepared for Dunedin City Council

4 June 2021

Document Quality Assurance

Bibliographic reference for citation: Boffa Miskell Limited 2021. *Smooth Hill Landfill: Draft Falcon / Kārearea Management Plan.* Report prepared by Boffa Miskell Limited for Dunedin City Council.		
Prepared by:	Karin Sievwright Ecologist / Professional Boffa Miskell Limited	
Reviewed by:	Dr Leigh Bull Senior Ecologist / Partner Boffa Miskell Limited	
Status: DRAFT	Revision / version: A	Issue date: 4 June 2021

Template revision: 20180621 0000

File ref:
U:\2020\BM200252_REa_Smooth_Hill_landfill-post_lodgement\Documents\Ecology\BM200252_009a_Smooth_Hill_Falcon_Management_Plan_20210604.docx

Cover photograph: Proposed Smooth Hill landfill location, © BML, 2019

Contents

1.0 Introduction 2

2.0 Background Information on Eastern Falcon / Kārearea 3

2.1 Ecology and Identification 3

2.2 Habitat Surrounding and Within the Project Area 5

3.0 Management and Mitigation During Enabling & Construction Works 6

3.1 Conduct Enabling and Construction Works Outside of the Breeding Season 6

3.2 Enabling and Construction Works Within the Breeding Season 6

3.2.1 Pre-Construction Falcon / Kārearea Surveys 6

3.2.2 Establishing Buffer/Exclusion Zones 7

3.2.3 Staff Training and Responsibilities for Falcon / Kārearea Management 8

4.0 Review and Updating of the Plan 8

5.0 References 9

1.0 Introduction

This Falcon / Kārearea Management Plan has been prepared for the Dunedin City Council (DCC). It is one of a suite of ecological management plans and is to be read in conjunction with the draft Landfill Management Plan (Boffa Miskell 2021a), which has been prepared to support the construction, operation, closure and aftercare of the Smooth Hill Landfill

This document is a plan to manage potential effects on eastern falcon / kārearea (*Falco novaeseelandiae* "eastern") during construction of the landfill. This species was identified in the Ecological Impact Assessment for the project (Boffa Miskell Ltd, 2020) as an At Risk (Recovering) species (Robertson et al., 2017), which utilises habitat within the project footprint and that may require management during enabling and construction works to reduce potential adverse effects on them.

The resource consent application for this project has been lodged with the DCC and the Otago Regional Council (ORC) and draft consent conditions have been formed as part of the application package. These will be finalised through the consenting process.

This Falcon Management Plan follows the draft consent conditions[1] drafted at lodgement of consent, as below.

> A Falcon Management Plan shall be prepared by a suitably qualified ecologist prior to the commencement of construction, to ensure effects on any eastern falcons nesting at the site during construction of stages 1 – 4 of the landfill are avoided or minimised. The plan shall be developed in consultation with Te Rūnanga o Ōtākou. As a minimum the plan shall include:
>
> a. Background information on falcons.
>
> b. Responsibilities for falcon management.
>
> c. Mitigation measures.
>
> d. Monitoring.
>
> e. Review and updating of the plan.

The plan shall be provided to ORC for approval that it meets the requirements in this condition prior to construction commencing. The plan shall be implemented for the duration of any landfill construction works.

[1] Draft consent conditions to be finalised following issuing of consents

2.0 Background Information on Eastern Falcon / Kārearea

2.1 Ecology and Identification

The eastern falcon / kārearea (Photo 1, Photo 2, Photo 3) is one of three forms of the New Zealand falcon species. It is the largest and lightest form and is found from eastern and central South Island. Habitats utilised by eastern falcon / kārearea include pine plantation, pine slash, farmland, native scrub and forest, and coastal areas (Bell, 2017). They are highly mobile and have large home ranges; 9 km^2 has been reported at Kaingaroa Forest (Seaton, 2007; Seaton et al., 2013) and up to 75 km^2 has been reported in indigenous forest (Fox, 1977).

Falcon / kārearea are raptors that pre-dominantly feed on live prey such as small to medium-sized birds, rodents and lagomorphs (rabbits and hares). They have relatively short, deep rounded wings and a long tail, which makes them highly manoeuvrable when hunting (Photo 3). They often hunt from an elevated perch but may also hunt along habitat edges or surprise prey by contour-flying close to the ground.

Their breeding season is broadly between August and May[2], with peak egg laying occurring from August to January. They lay between one and four eggs in a simple scrape on the ground (Photo 5) with varying amounts of cover, on a ledge, or within an epiphyte in a tree. They are territorial birds, particularly during the breeding season, and often use their distinctive 'kek kek kek' alarm call when defending their territory / nest. They are also prone to dive bombing people if they come too close to their nest.

Falcon / kārearea look somewhat similar to harrier hawk / kahu (*Circus approximans*), which is a Not Threatened species found throughout New Zealand. Falcon and harrier hawk occur in similar habitats. Key identification features to distinguish between these two species are listed in Table 1 and shown in Photo 1, Photo 2, Photo 3 and Photo 4.

Key threats to falcon / kārearea include habitat loss, degradation and modification, electrocution from uninsulated powerlines, and predation.

Table 1. Key differences between New Zealand falcon / kārearea and harrier hawk / kahu.

Characteristic	**Species**	
	Falcon / Kārearea	**Harrier hawk / Kahu**
Size	Smaller (40-50 cm)	Larger (50-60 cm)
Foraging behaviour	Aerial hunter that feeds on live prey (rarely feeds on carrion[3])	Often scavenges and feeds on carrion (e.g. roadkill)
Flight behaviour	Active chasing flight and when gliding has flat wings	Lazy, looped flights in thermals and when gliding has its wings in a shallow V-shape
Rump colour	Brown	Cream / pale

[2] Seaton, R.; Hyde, N. 2013 [updated 2017]. New Zealand falcon. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

[3] Carrion is the decaying flesh of dead animals.

Photo 1. Adult New Zealand falcon / kārearea (photo by Les Feasey).

Photo 2. Adult harrier hawk / kahu (photo by Marie-Louise Myburgh).

Photo 3. New Zealand falcon / kārearea gliding with flat wings (photo by Craig McKenzie).

Photo 4. Harrier hawk / kahu gliding with its wings in a shallow v-shape (photo by Imogen Warren).

Photo 5. Falcon / kārearea nest (shallow scrape) with eggs (photo by Andrew Thomas).

Photo 6. Falcon / kārearea chick (photo by Steve Attwood).

2.2 Habitat Surrounding and Within the Project Area

Exotic production pine forest is prevalent in the northwest and south of Dunedin. These plantations provide good habitat for eastern falcon / kārearea for approximately four years post-felling (Seaton, 2014). This is because the open areas created attract many small birds that provide prey for falcon / kārearea. The piles of pine slash also provide good nesting sites for falcon / kārearea, as do young re-planted pine adjacent to mature pine stands. As scrub regenerates and newly planted seedlings grow, these areas become less suitable for falcon / kārearea.

Surveys conducted in October 2015 in pine forest blocks northwest and south of Dunedin, identified falcon / kārearea at seven locations and included six single birds and one pair (Parker Conservation, 2015). A more recent survey (2016 / 2017 falcon / kārearea breeding season), conducted northwest to south of Dunedin in an approximately 150,000 ha area of plantation pine and native forests surrounding the Taieri Plain, detected a minimum of 16 breeding falcon pairs (Parker Conservation, 2017). Areas of production pine forestry around Dunedin and the Smooth Hill site are shown in Appendix 1.

Most of the Smooth Hill site provides potential falcon habitat. The key habitats include regenerating native scrub, treeland and forest (gully areas), macrocarpa forest and radiata pine treeland (including re-planted areas and piles of pine slash). These habitats are shown in Appendix 2.

During surveys conducted at the Smooth Hill site, two observations of an individual falcon / kārearea were made. One was recorded during the May 2019 survey, the other during the July 2019 survey. On both occasions the falcon / kārearea was heard calling. During the May observation the falcon / kārearea was observed interacting with a harrier hawk / kahu above a stand of exotic conifers to the west of the site. During the July observation the falcon / kārearea flew south-east over the site into an adjacent pine forest block. Two falcons / kārearea were also incidentally observed on the proposed landfill site in October 2019 outside of the formal survey period. They flew over the site, landed briefly on a pine stump on the proposed landfill site, then flew off together over an adjacent pine forest block to the south. The locations of these falcon observations are shown in Appendix 2.

Falcon / kārearea were also heard, but not seen, in the wider area (not within the project site) during other fauna surveys conducted on site in spring. No nesting falcon / kārearea were detected on site during the breeding season survey conducted. A falcon / kārearea pair, however, did nest on site the previous breeding season (Fulton Hogan, *pers. comm.* 2019) and four falcon / kārearea pairs have been recorded at, and / or in, the vicinity of the Smooth Hill area (Graham Parker, *pers. comm*. 2020). Falcon / kārearea were heard in native forest to the north of McLaren Gully Road in June 2020.

3.0 Management and Mitigation During Enabling & Construction Works

Outlined below are the management actions to reduce potential enabling and construction work impacts on falcon / kārearea using habitat within the project footprint.

3.1 Conduct Enabling and Construction Works Outside of the Breeding Season

If timing allows, in areas identified as potential falcon / kārearea habitat on site (see Appendix 2), enabling and construction works will be conducted outside of the falcon / kārearea breeding season (i.e. will take place between 1 June and 31 July). Enabling and construction works include tree felling / vegetation clearance, earthworks, and constructing roads and other infrastructure.

3.2 Enabling and Construction Works Within the Breeding Season

If enabling and construction works in areas identified as potential falcon / kārearea habitat on site (see Appendix 2) cannot take place outside of the falcon / kārearea breeding season (i.e. where the breeding season is broadly between 1 August and 31 May, inclusive), then the following management actions will be implemented to manage potential effects on falcon:

- Pre-construction falcon / kārearea surveys (Section 3.2.1);
- Establishing buffer / exclusion zones (Section 3.2.2); and
- Staff training and assignment of responsibilities for falcon / kārearea management (Section 3.2.3).

3.2.1 Pre-Construction Falcon / Kārearea Surveys

If enabling and construction works are to occur during the falcon / kārearea breeding season in areas identified as potential breeding habitat on site (shown in Appendix 2), a suitably qualified and experienced ecologist will check for the presence of breeding birds (including nests and chicks) within a week before the commencement of enabling and construction works.

This check will involve:

- surveying the area of proposed works with binoculars to look for any falcon in the area;
- walking through the area of proposed works and looking for nests; and
- conducting 60-second playback surveys of taped falcon calls using an appropriate device (e.g. an iPod, mobile phone or iPad with speakers) at 200 m intervals within the area of proposed works, each followed by a three-minute period of and listening and looking for falcon.

If no nesting birds are identified, works can commence.

If nesting birds are identified, an exclusion zone will be established immediately around the nest/s as described in Section 3.2.2 below.

3.2.2 Establishing Buffer/Exclusion Zones

If an active nest is detected during the pre-construction falcon / kārearea survey, or during construction works, works where the nest is located will stop immediately and will not re-commence until nesting activities are complete (i.e. nest is empty) as determined by a suitably qualified and experienced ecologist (refer to Section 3.2.2.1).

The construction manager will be informed and a 200 m area (radius) around the nest will be cordoned off with flagging or fencing with appropriate signage informing people that this is a "No Go Zone". The falcon / kārearea, or nest contents, will not be handled at any time. The establishment of the exclusion zone will be conducted under the guidance and supervision of a suitably qualified and experienced ecologist.

A hard hat and protective eye wear should be worn while establishing the exclusion zone/s as falcon are very territorial and may potentially be aggressive / protective of their nest when people approach (dive-bombing strike behaviour is common).

3.2.2.1 Monitoring

Active falcon / kārearea nests within exclusion zones will be monitored weekly by a suitably qualified and experienced ecologist. Observations of the nest will be made with binoculars outside of the exclusion zone. If an adverse effect is identified (i.e. the nest is abandoned, or frequent dive-bombing behaviour is observed, which is indicative of disturbance), mitigation measures will be implemented, as advised by the ecologist. This may include increasing the size of the buffer zone if frequent dive-bombing is observed (or if nest abandonment is observed, increasing the size of the buffer zone in future nests that are detected) and / or conducting pest control around the exclusion zone to reduce predation risk.

3.2.2.2 Reporting

Records of all pre-clearance falcon / kārearea pre-construction surveys will be kept as well as records of all falcon / kārearea nests detected on site. The following nest detection / monitoring information will be recorded:

- location / habitat type;
- detection date / date of exclusion zone establishment;
- if the bird/s are banded[4];
- nest contents upon detection (i.e. adult, eggs, chicks);
- nest contents during weekly observations;
- behaviour of the falcon / kārearea; and
- any other notes of interest (e.g. if the exclusion zone is increased as a result of birds being disturbed by construction activities)

[4] If banded, the coloured bands would be present on a leg. Note which leg and the colour of the band/s.

This information will be entered into an Excel spreadsheet and appended to this management plan during the annual update of the plan (as discussed in Section 4.0). These results will be provided to the Department of Conservation (DOC) on request.

If any banded birds are observed, this should be reported to Parker Conservation[5] (a local ecological consultancy) as they are monitoring falcon / kārearea in the wider area.

3.2.3 Staff Training and Responsibilities for Falcon / Kārearea Management

Construction workers will be trained annually to identify falcon / kārearea (including identifying their call as well as their characteristic falcon / kārearea dive-bombing behaviour during the breeding season), their nests and to distinguish between falcon / kārearea and harrier hawks / kahu. Observations will be reported to the construction manager so that appropriate records can be kept, and management actions implemented as required. It is the responsibility of all people working on site to report falcon / kārearea observations during the breeding season (broadly 1 August – 31 May) to the construction manager and to follow adhere and abide by the requirements of this management plan.

4.0 Review and Updating of the Plan

This falcon / kārearea management plan is a dynamic document that is to be updated annually during construction (at the end of the falcon / kārearea breeding season) by the construction manager, or other appointed person, on site. The plan is to be updated with the reporting information listed in Section 3.2.2.2. Following this, the plan will be reviewed by a suitably qualified and experienced ecologist to determine if the current management actions are sufficient and effective in managing falcon, and if necessary, additional adaptive management actions will be recommended and incorporated into the plan. Subsequently, the management plan will be provided to local iwi (Te Rūnanga o Ōtākou) and a Biodiversity Officer at Dunedin City Council for review and comment.

[5] parkerconservation@parkerconservation.co.nz

5.0 References

Bell, D. (2017). Distribution of New Zealand falcon (Falco novaeseelandiae): Results of a 10-year survey 2006-2016. *Notornis*, *64*, 234–238.

Boffa Miskell Ltd. (2020). *Smooth Hill landfill ecological impact assessment* (Report No. BM19099; pp. 1–148). Prepared by Boffa Miskell Ltd for Dunedin City Council.

Fox, N. C. (1977). *The biology of the New Zealand falcon (*Falco novaeseelandiae*Gmelin 1788).* [Unpublished PhD thesis]. University of Canterbury.

Parker Conservation. (2015). *Surveys for rare, threatened and endangered avian species in Wenita Forest Products plantation estate*. Prepared by Parker Conservation for Wenita Forest Products.

Parker Conservation. (2017). *Research to inform the management of Karearea / NZ falcon in Eastern Otago*. Parker Conservation.

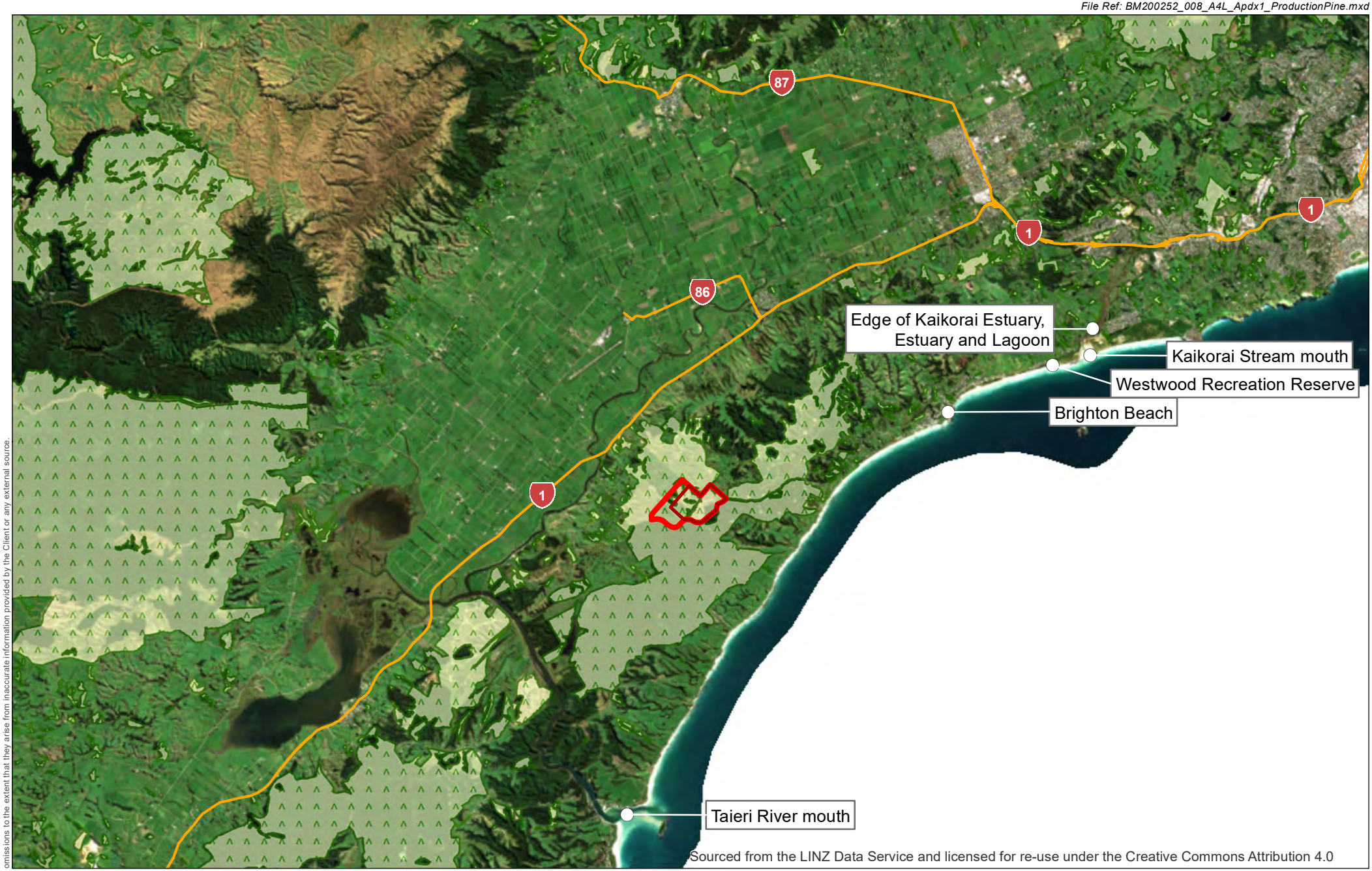
Robertson, H. A., Baird, K., Dowding, J. E., Elliott, G. P., Hitchmough, R. A., Miskelly, C. M., McArthur, N., O'Donnell, C. F. J., Sagar, P. M., Scofield, R. P., & Taylor, G. A. (2017). *Conservation status of New Zealand birds, 2016* (New Zealand Threat Classification Series No. 19). Department of Conservation.

Seaton, R. (2007). *The ecological requirements of the New Zealand falcon (*Falco novaeseelandiae*) in plantation forestry* [Unpublished Doctor of Philosophy in Zoology thesis]. Massey University.

Seaton, R. (2014). *NZ falcon identification and managment summary - New Zealand falcon identification* (pp. 1–2). Prepared for Ernslaw One Ltd.

Seaton, R., Minot, E. O., & Holland, J. D. (2013). Home range and habitat use of New Zealand falcons (*Falco novaeseelandiae*) in an exotic plantation forest during the breeding season. *Journal of Raptor Research*, *47*(3), 223–233.

File Ref: BM200252_008_A4L_Apdx1_ProductionPine.mxd



Boffa Miskell

www.boffamiskell.co.nz

0 4 km

1:150,000 @ A4

Data Sources:
Designation sourced from DCC data service
Forestry sourced from LCDB5

Projection: NZGD 2000 NZTM

LEGEND

- Production Pine Forestry
- Designation
- Application Site
- State Highway

SMOOTH HILL LANDFILL

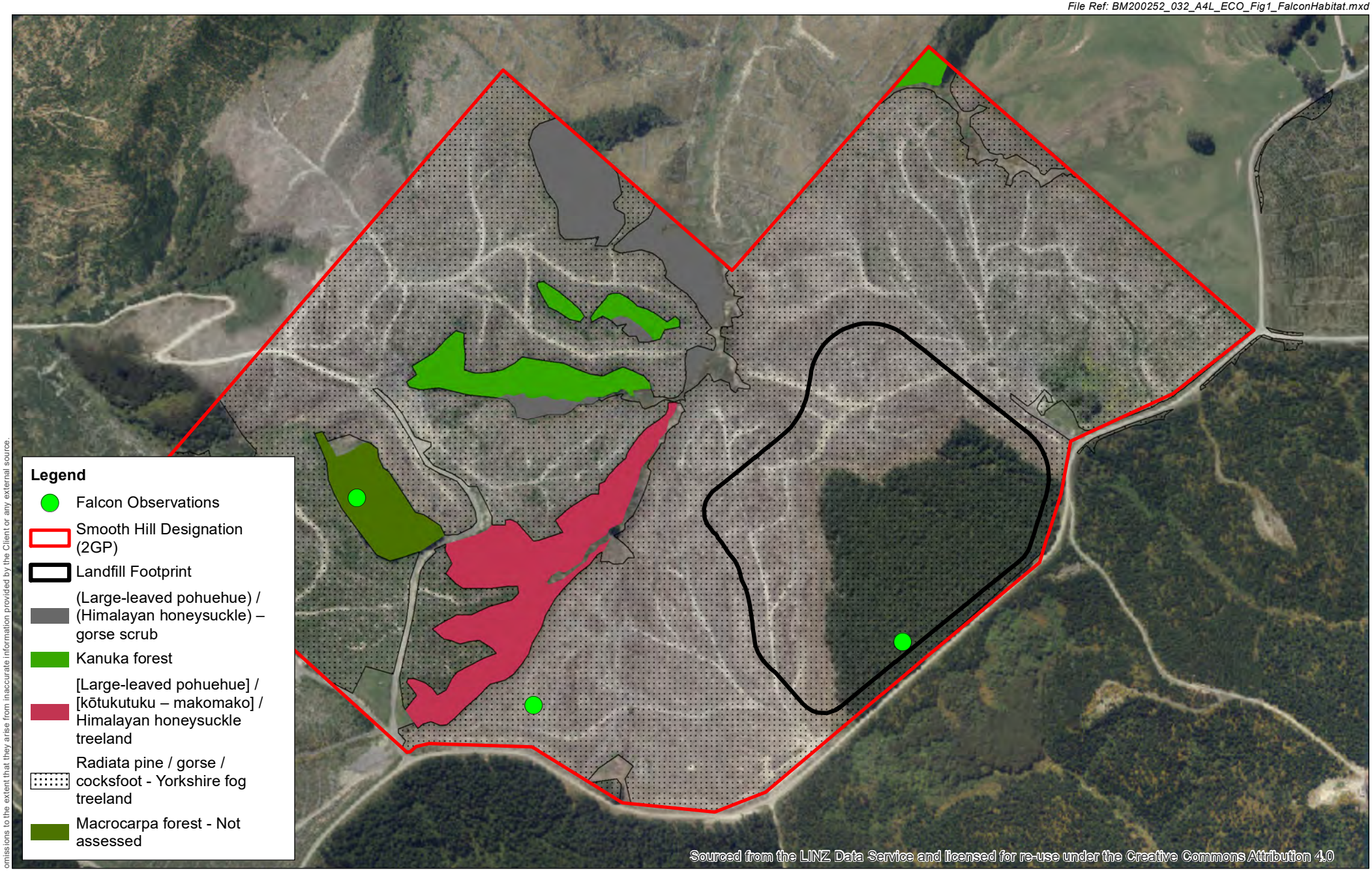
Areas of production pine forest near Smooth Hill

Date: 04 June 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: KSi

Appendix 1



Boffa Miskell

www.boffamiskell.co.nz

0 200 m

1:7,500 @ A4

Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

Falcon Habitat Overview

Date: 04 June 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: KSi

Appendix 2

About Boffa Miskell

Boffa Miskell is a leading New Zealand professional services consultancy with offices in Auckland, Hamilton, Tauranga, Wellington, Christchurch, Dunedin and Queenstown. We work with a wide range of local and international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, cultural heritage, graphics and mapping. Over the past four decades we have built a reputation for professionalism, innovation and excellence. During this time we have been associated with a significant number of projects that have shaped New Zealand's environment.

---

www.boffamiskell.co.nz

Auckland	**Hamilton**	**Tauranga**	**Wellington**	**Christchurch**	**Queenstown**	**Dunedin**
+64 9 358 2526	+64 7 960 0006	+65 7 571 5511	+64 4 385 9315	+64 3 366 8891	+64 3 441 1670	+64 3 470 0460

Appendix 6: Glossary of Terms

Appendix 7: Resource Consents