Appendix 11: Ecological Impact Assessment Report

Boffa Miskell

Smooth Hill Landfill

Ecological Impact Assessment
Prepared for Dunedin City Council

19 August 2020 (updated 28 May 2021)

Document Quality Assurance

Bibliographic reference for citation: Boffa Miskell Limited 2021. *Smooth Hill Landfill: Ecological Impact Assessment*. Report prepared by Boffa Miskell Limited for Dunedin City Council.		
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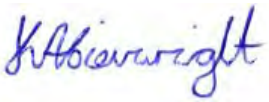
	Karin Sievwright (Avifauna) Ecologist Boffa Miskell Limited	
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Status: FINAL	Revision / version: 3	Issue date: 19 August 2020 (updated 28 May 2021)

Template revision: 20180621 0000

File ref: BM200252_001b_Smooth_Hill_Ecological_Impact_Assessment_Report_20210528.docx

Cover photograph: Smooth Hill designation site, Boffa Miskell 2020

Executive Summary

Dunedin City Council (DCC) is currently working on an overall Waste Futures programme to identify and procure the best solid waste solution for Dunedin City, to enable it to move towards a zero-waste future and a more circular economy. Part of this programme includes consenting and development of a new landfill at Smooth Hill. The Smooth Hill site was designated as a future landfill in 1996.

Boffa Miskell Limited has been engaged by DCC to undertake an Ecological Impact Assessment for the proposed landfill at Smooth Hill, south-east of Dunedin. This report presents the findings of this assessment, with the scope of the report limited to assessing effects on ecological values within the landfill designation site, areas of road which are to be widened, and effects on a wetland / stream that forms part of the Ōtokia Creek catchment immediately downstream of the designation site (the receiving environment).

The ecological effects of the proposal were investigated by on-site studies of the existing environment in terms of vegetation communities, avifauna, herpetofauna and freshwater ecology. This report describes the existing environment, the ecological significance of habitats at the site in terms of the local and regional planning framework under the Resource Management Act (1991), summarises the landfill proposal, and assesses the level of ecological effect of the proposal on the ecological values present. The key findings of this report are:

Existing environment:

- A range of vegetation types are present within the designation site at the Smooth Hill landfill site. These 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 were found on site. No such species were found in the proposed landfill and road upgrade construction footprint.
- Vegetation types in the designation site contribute to a local mosaic of forest fragment habitats in the wider area, and a range of widespread and common indigenous bird species are present, as well as introduced species. The At-Risk – Recovering species eastern falcon (of moderate ecological value) is present, and an area of kānuka forest is of importance to this species at the site and has been used for breeding.
- Vegetation types present at the site are also likely to provide habitat for indigenous herpetofauna, including southern grass skink (At Risk – Declining; high ecological value).
- An interconnected area of gully forest / treeland / scrub habitats and flaxland / grassland wetland habitats is of ecological significance as significant vegetation and significant habitat of indigenous

biodiversity in terms of the proposed Otago RPS and proposed Dunedin 2GP.

- No ecological values relating to freshwater habitats such as streams or lakes are present within the designation site (excepting wetland vegetation) as these habitat types are not found in this area. Some wetland habitats receive ephemeral overland flows, but do not provide habitat for indigenous fish or aquatic invertebrates.
- The freshwater habitats downstream of the designation site, including a tributary of the Ōtokia Creek catchment, had suboptimal habitat and a macroinvertebrate community commonly found in soft-bottomed and slow-flowing waterways. Shortfin and longfin eels were found within a large pond that forms part of the downstream receiving environment and is approx. 200-300 m downstream of the designation site.

Effects of landfill construction and road upgrade

- Clearance of vegetation associated with landfill construction, including road upgrading works, represents negligible or very low magnitudes of ecological effect, as the areas cleared are relatively minor in comparison to the extent of these vegetation types in the wider area and at the level of the ED. They are of a low or very low overall level of ecological effect.
- However, some of the vegetation types and habitats are significant under the RPS and 2GP, and the rules require 'no net loss' or 'net gain' of the significant ecological values of these habitats.
- Preparation of a Vegetation Restoration Management Plan by an ecologist, and implementation of these plans, is required to mitigate the adverse effects of landfill construction and vegetation clearance in significant areas to effect 'no net loss' or 'net gain.' These effects can be managed on site through such plans by expansion and enhancement of similar habitats to those impacted. Areas outside the landfill footprint but within the land to be acquired by the DCC have been identified.
- In order to: mitigate adverse effects on vegetation, avifauna, and herpetofauna due to landfill construction; to enhance these ecological values; and to avert future losses associated with a potential influx in mammalian pests due to landfill operation, preparation and implementation of plant and animal pest control (as detailed in the Landfill Management Plan) is required.
- As the proposed landfill is located close to the Dunedin International Airport, a separate report has been prepared pertaining to requirements for managing the risk of aircraft bird strike from avifauna attracted to the site by landfill operation.
- Construction during the breeding period, or direct impacts to important areas of eastern falcon habitat may have adverse effects on this species at the site. Preparation and implementation of a

Falcon Management Plan outlining best practices to minimise these effects should lead to negligible effects to eastern falcon at the site.

- Clearance of vegetation and lizard habitats may have adverse effects on southern grass skink, which are likely to be present in rank grassland habitats, along grass margins and in wood and debris piles scattered throughout the site. Preparation and implementation of a Lizard Management Plan outlining best practices to minimise these effects should lead to low effects on southern grass skink on this site.

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1.0 Introduction

Dunedin City Council (DCC) is currently working on an overall Waste Futures programme to identify and procure the best solid waste solution for Dunedin City, to enable it to move towards a zero-waste future and a more circular economy. Part of this programme includes consenting and development of a new landfill at Smooth Hill. The Smooth Hill site was designated as a future landfill in 1996.

This ecological assessment is one of a suite of technical assessments that provided input into the concept design of the landfill. This assessment considers the potential effects of the proposed landfill on the ecological values of the site to support applications for resource consent and notice of requirement.

1.1 Scope

Boffa Miskell Limited (BML) was engaged by DCC to undertake an Ecological Impact Assessment (EcIA) for the proposed landfill at Smooth Hill, south-east of Dunedin. The objective was to assess the effects of the construction and operation of the proposed landfill, road upgrade and access on terrestrial and aquatic ecology, and assess the potential for increased risk of aircraft bird strike.

The EcIA is limited to assessing the potential ecological effects of the proposed:

- landfill construction and operation on the ecological values within the designation site, including associated infrastructure;
- widening of McLaren Gully and Big Stone Roads to access the landfill site on the ecological values along these roads; and
- landfill construction and operation on a wetland and stream system immediately downstream of the designation site (the receiving environment), which forms part of the Ōtokia Creek catchment.

'Designation site' refers to the designated area (from the District Plan) (Figure 1).

1.2 Report Revisions

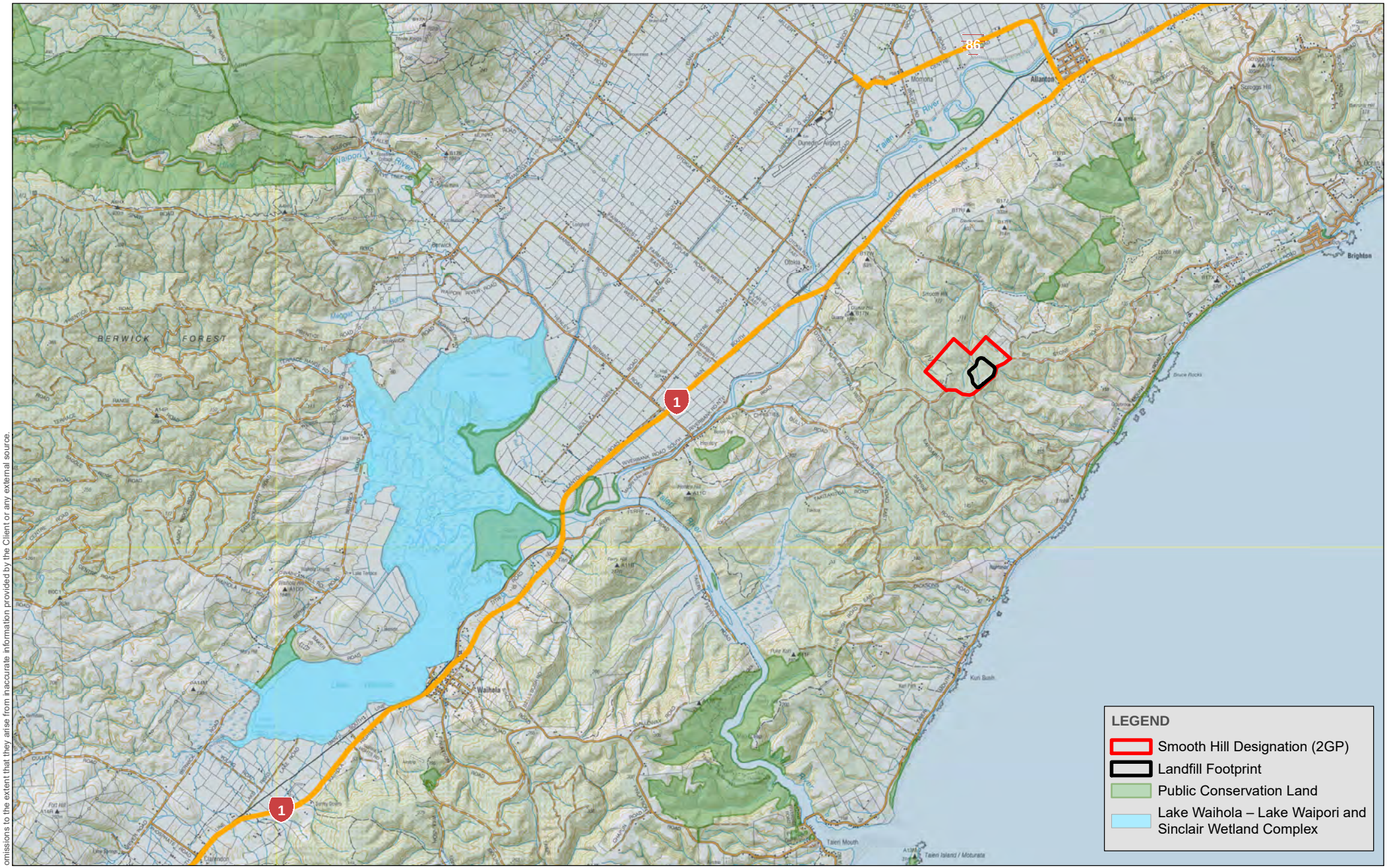
The Council lodged applications with the Otago Regional Council (ORC) and DCC for resource consents for the construction and operation of Smooth Hill landfill, including upgrades to McLaren Gully Road in August 2020. The lodged application included an earlier version of this EcIA (as Appendix 11). Following lodgement, the ORC and DCC considered the application and requested further information relating to the proposal under Section 92 (s92) of the Resource Management Act.

This EcIA has subsequently been updated to respond to these s92 requests and subsequent updates to other technical assessments and to the lodged landfill design (supporting information is discussed in Section 2.1).

1.3 Report Structure

This ecological assessment has been divided into the following sections to:

- outline the methodology used to undertake the assessment (Section 2.0);
- describe the existing environment, assess the significance of the vegetation, habitats and ecosystems, and assess the ecological values (Section 3.0);
- provide a summary of the proposed works (Section 4.0);
- assess the ecological effects of the project (Section 5.0);
- provide recommendations to avoid, remedy, mitigate or offset effects (Section 6.0);
- summarise the predicted effects and proposed mitigation (Section 7.0); and
- provide conclusions (Section 8.0).



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Data Sources:
Designation sourced from DCC 2GP
Landfill design sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

SMOOTH HILL LANDFILL

Location of Smooth Hill designation site and proposed landfill footprint

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 1

2.0 Methodology

A combination of desktop assessments (including of relevant databases, published and unpublished reports) and field investigations were undertaken to obtain information regarding the ecology values associated with the designation site.

For each area of ecology (vegetation and wetlands, avifauna, herpetofauna and freshwater) the following sections (Sections 2.4-2.7) describe the existing information relied on for the desktop assessments, and detail the methodologies used in field investigations.

The extent of the field investigations was limited to the designation site within which the landfill footprint is contained, the vegetation immediately adjacent to McLaren Gully and Big Stone Roads, and the wetland and stream system immediately downstream of the designation site (the receiving environment) that forms part of the Ōtokia Creek catchment (also see Section 2.2).

Figure 2 provides information on the naming of ecological features within the designation site, which are referred to throughout the remainder of this report.

We then describe the methodology used to assess the effects on ecological values and the effects management hierarchy approach we have used (Section 2.8-2.9).

2.1 Supporting Information

In addition to the information collected through the desktop and ecological field investigations, this assessment has been based on the information provided to us by GHD in the following supporting documents and plans:

- Landfill Concept Design Report, updated May 2021;
- Surface Water Assessment, updated May 2021; and
- Assessment of Effects to Groundwater, updated May 2021.

2.2 Limitations and Assumptions

- Not all areas of the designation site were surveyed. Vegetation present in an area referred to in Section 3.2.1 as West Gully 1 (see Figure 2) and in areas west of a secondary forestry access road (to the west of the designation site) that fell well outside the proposed landfill footprint (and are located within the Palmer Stream (Taeri River) catchment, rather than the Ōtokia Creek catchment) were not subject to survey.
- At the time of preparing an early draft of this report, we had not been granted permission to access private properties outside of the Smooth Hill site (i.e. properties adjacent to / downstream of, or required for accessing, the designation area), so the EcIA was initially limited to assessing the potential ecological effects of the proposed regional landfill construction and operation on the ecological values within the designation site.

- Access to the downstream receiving environment, through the Wenita Forest Products Limited property, was granted on 6 May 2020. This access agreement allowed for the assessment of the potential ecological effects due to the widening of McLaren Gully and Big Stone Roads, and the potential ecological effects on the downstream receiving environment (the wetland / stream that forms part of the Ōtokia Creek catchment immediately downstream of the designation site).
- The main terrestrial ecology surveys conducted as part of this report were carried out in late autumn and early winter conditions, when some annual plant species had died back, or when identifying features such as flowers or seed heads were absent or had degraded.
- In addition, some vegetation types present on site were essentially inaccessible due to their density (e.g. gorse scrub). The implication of this is that some plant species present within the designation site, such as annual species or interior / understory species occurring in dense scrub, may not have been observed and subsequently recorded.
- Avifauna surveys around Dunedin Airport were restricted to areas of public access due to safety factors. Consequently, some survey sites were up to one kilometre away from the airport.
- Herpetofauna surveys were conducted in late autumn immediately prior to the Alert Level 4 lockdown in response to the COVID-19 pandemic. As a result, the weather conditions on the days of surveying were not ideal for herpetofauna surveys and manual searches were not completed. A walkover, habitat condition assessment, and limited hand searching for lizards within the road-side vegetation along McLaren Gully or Big Stone Roads was carried out on 7 May 2021.
- Freshwater surveys of the downstream tributary of Ōtokia Creek was unable to occur until the land access agreement was in place in May 2020. As a result, surveys for freshwater fish and other fauna were conducted in winter months and outside of the period recommended by the national protocol of Joy et al. (2013). Surveying of freshwater fauna (particularly fish) should be undertaken between November and April, inclusive, as fish become less active (and, therefore, less susceptible to being caught) during cooler conditions. To remedy this and in response to s92 requests for further information, we conducted additional surveys on 12 & 13 April 2021. However, surveying was limited to the pond located approximately 200-300 m downstream of the designation site; the waterway up- and downstream of this pond was dry at the time due to prolonged dry conditions over the summer and autumn.

2.3 Experience and Qualifications of Report Authors

This report has been prepared by suitably qualified experts who declare their relevant qualifications and experience as follows:

Jaz Morris holds a Bachelor of Science with Honours and a Doctor of Philosophy, both in the field of botany, from the University of Otago. He has over a decade's experience in vegetation and ecological surveying and has been an ecologist at Boffa Miskell since early 2019. He has published a range of peer-reviewed papers in scientific journals, held Tutor and Teaching Fellow roles in Botany and Ecology at the University of Otago, is a full member of the Environmental Institute of Australia and New Zealand. He is a member of the New Zealand Botanical Society and New Zealand Plant Conservation Network.

Karin Sievwright is an ornithologist and holds a Bachelor of Science degree and a Master of Science degree in Conservation Biology from Massey University. She has five years of ecological experience working at Boffa Miskell and has conducted bird monitoring and consulted on ornithological aspects for a variety of projects. She has co-authored several scientific articles and is currently involved in avifauna volunteer work including little blue penguin monitoring on Matiu / Somes Island and conducting coastal bird surveys around Wellington Harbour with the Wellington branch of the Ornithological Society of New Zealand.

Samantha King holds a Bachelor of Science in Environmental Studies from Victoria University Wellington, a Postgraduate Diploma in environmental management from University of Auckland and a Master of Science in conservation biology from Massey University. Samantha is a Certified Environmental Practitioner with the Environment Institute of Australia and New Zealand. She has over 8 years' experience as an ecologist and herpetologist and has been an ecologist at Boffa Miskell since October 2018. She is a member of the Society for Research on Amphibians and Reptiles in New Zealand, and regional representative for the NZ Herpetological Society.

Tanya Blakely is an expert freshwater ecologist and Senior Principal at Boffa Miskell, with 18 years' experience as a research and consultant ecologist. Tanya holds a Bachelor of Science with Honours in Zoology and a Doctor of Philosophy in Ecology. She is a Certified Environmental Practitioner – Ecology Specialist – with the Environment Institute of Australia and New Zealand. She has published eleven peer-reviewed scientific papers, a guidebook on aquatic insects, and numerous technical ecological reports, ecological impact assessments, and other publications in her areas of expertise. Tanya is a full member of the Environment Institute of Australia and New Zealand, the New Zealand Freshwater Sciences Society and the New Zealand Entomological Society; she is the Chair of the New Zealand Fish Passage Advisory Group.

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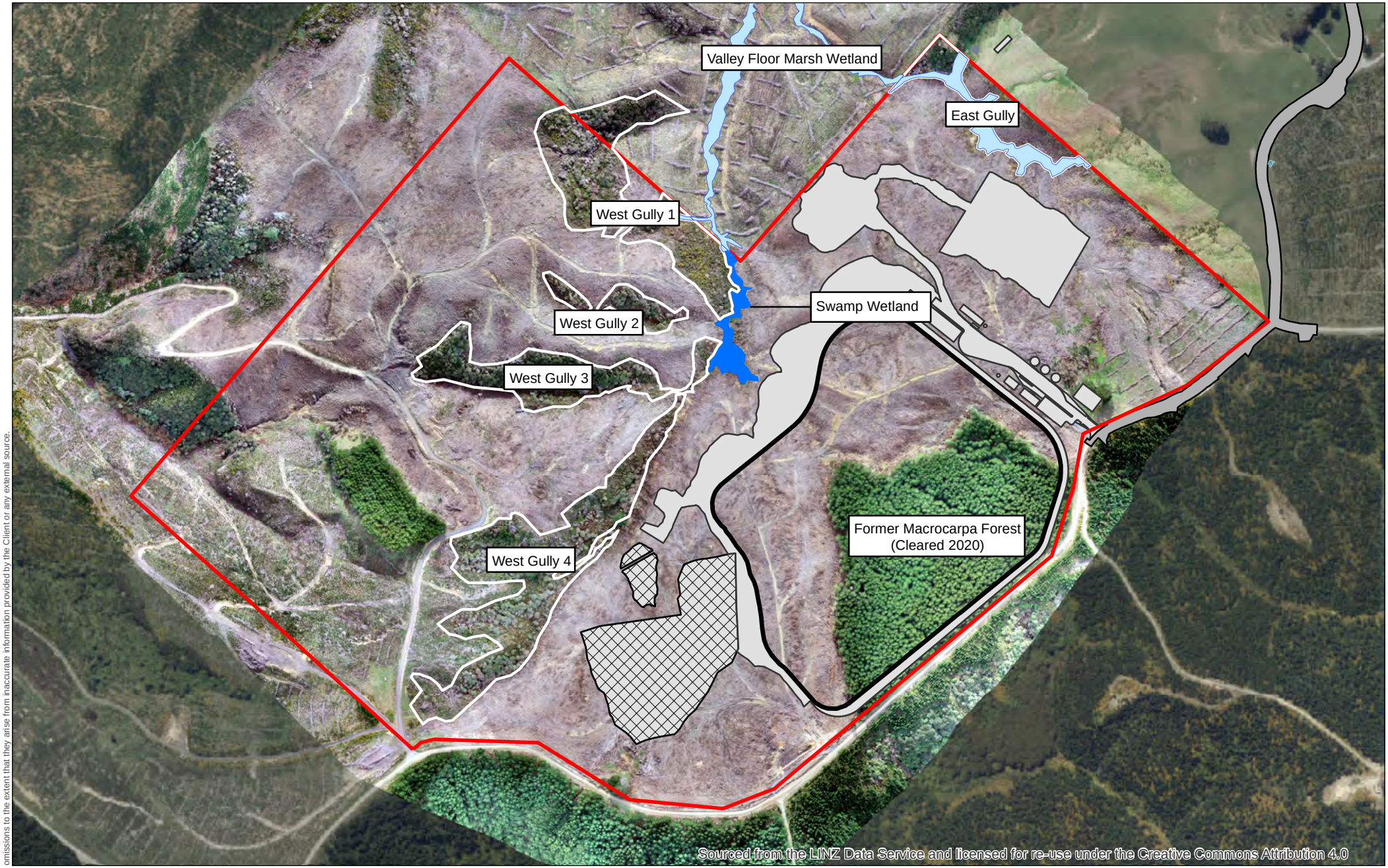

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Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

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 2

2.4 Vegetation and Wetlands

2.4.1 Desktop Review

Existing information on vegetation and wetlands within the designation site were gathered from the following sources:

- GIS (Geographic Information System) databases and aerial imagery:
  - Threatened Environment Classification (Walker et al. 2015); and
  - Ecological region and ecological district GIS layer.
- Background reports about nearby locations:
  - Allen, R. B. (1991) Forest and scrub vegetation, East Branch Tokomairiro River. *Conservation Advisory Science Notes* No. 4, Department of Conservation, Wellington. 8p.
  - Allen, R.B. (1993). Gorse and Wilding Pine Management, Maungatua Scientific Reserve. Conservation Advisory Science Notes No. 8, Department of Conservation, Wellington. 22p.
  - Allen, R.B. (1994). Native plants of Dunedin and its environs. Otago Heritage Books. 80p.
  - Johnson, P. (2004). Otago Peninsula Plants; An annotated list of vascular plants growing in wild places. Published by Save the Otago Peninsula (STOP) Inc. 94p.

2.4.2 Site Investigations

Initial site investigations of terrestrial (vegetation) ecology were carried out by Katherine Dixon (Ecologist, Boffa Miskell[1]), who visited the designation site on 30 May and 6 June 2019. On 30 May 2019 the weather was poor with rain and cold temperatures. On 6 June 2019 conditions were mild and calm with no precipitation.

Jaz Morris (Ecologist, Boffa Miskell) subsequently visited the designation site on 24-25 March 2020, 10-11 June 2020, and again on 12-13 April 2021. The site visit on 24-25 March 2020 was to familiarise himself with the vegetation of the designation site and to capture any information additional to that already gathered by Katherine Dixon. An additional terrestrial ecology survey of habitats immediately adjacent to McLaren Gully and Big Stone Roads (which would be widened by this proposal) and a vegetation survey of the wetland / stream below the designation site was undertaken on 10 and 11 June 2020, respectively. A follow-up visit on 12-13 April 2021 was made to assess each location where the proposed upgrades to McLaren Gully and Big Stone roads apparently overlapped with mapped wetland habitats. Weather conditions on 24 March 2020 were poor, with a cold southerly wind bringing occasional showers. On 25 March 2020, conditions were cool with little wind or cloud cover. Conditions on 10-11 June 2020 and 12-13 April 2021 were fine with mild temperatures.

Field assessments and surveys were carried out as below.

[1] Katherine Dixon no longer worked for Boffa Miskell at the time this report was prepared.

2.4.2.1 Terrestrial and Wetland Ecosystems and Habitats

A walk-through survey was conducted of the vegetation and habitats within the designation site that could potentially be affected by the proposed landfill.

During the vegetation surveys:

- The vegetation communities were classified using the classification system and naming conventions developed by Atkinson (1985) and adapted by Johnson and Gerbeaux (2004) for wetlands. A handheld Global Positioning System (GPS) was also used to mark vegetation community boundaries where necessary.
- Plant species were recorded in each of the vegetation communities[2] (a list of the plant species recorded during the site visit is provided in Appendix 1).
- General notes were made on the condition of the vegetation communities and habitats present.
- Katherine Dixon prepared plant species lists, described the vegetation communities and visited all areas within the designation site described in Section 3.2.1, except for areas referred to as ~~'Macrocarpa forest' and~~ 'West Gully 1' and 'West Gully 2', which she viewed from a distance using binoculars[3].
- Jaz Morris prepared plant species lists and described the vegetation communities adjacent to McLaren Gully and Big Stone roads and in an area referred to in Section 3.2.1 as the 'valley floor marsh wetland' downstream of the designation site. He also briefly visited areas referred to in Section 3.2.1 as 'West Gully 3', 'West Gully 4', the 'swamp wetland,' the 'cutover pine forest' and briefly observed 'West Gully 2' and 'West Gully 1' from a distance[3]. Within the designation site, brief notes and photos were recorded to confirm the location and extent of vegetation community types recorded by Katherine Dixon and to assist with vegetation community mapping. Some additional plant species that were incidentally observed were recorded to supplement existing plant species lists, but no deliberate searches or detailed survey methods were used in this area.
- GHD provided us with an updated design for the proposed upgrade of McLaren Gully and Big Stone roads on 06 April 2021. The redesign work undertaken by GHD intended to avoid wetlands along the road alignment, based on our advice to GHD on 02 February 2021, where we identified a number of locations where (based on geospatial mapping, see Section 2.4.2.2 below) the then-road design extent overlapped with the apparent roadside margins of nearby wetland features (the overlaps ranged in size from 0.0002 m^2 to 47.4 m^2, with a total of 74.3 m^2 wetland habitat overlap). While the wetland mapping undertaken up to this date was detailed, it was also somewhat conservative. As a result, Jaz Morris re-visited each site where there was overlap in mapped wetland vegetation and the road design extent on 12-13 April 2021 and confirmed the wetland mapping. This assessment of the natural variation in fine-scale topography and vegetation composition on site revealed that seven of the apparent overlap areas did not comprise wetland vegetation / habitat (i.e. these seven areas did not meet relevant

[2] Not all exotic herb and grass species present were recorded.

[3] West Gully 1 and West Gully 2 are dominated by and / or bordered by extremely dense (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub, making access impractical. These areas are within the designation site but are well outside the proposed footprint of works associated with landfill construction and operation and would not have been affected by any of the landfill design iterations to date. See Section 2.7 for further details on limitations and assumptions.

Resource Management Act 1991 / National Policy Statement for Freshwater Management 2020 wetland definitions. These seven areas ranged in size from 0.02 m^2 to 5.4 m^2, comprising a total of 10.4 m^2) [4].

2.4.2.2 Vegetation Community Mapping

The vegetation communities recorded on site, their location within the designation site, and their boundaries, were mapped using ArcGIS. Geo-referenced aerial photography of the designation site provided to Boffa Miskell was used in conjunction with field notes, photographs, and GPS records made during the field surveys.

Wetlands in the vicinity of McLaren Gully and Big Stone roads were initially mapped using publicly available aerial imagery. A subsequent aerial survey of the road was undertaken, and very-high resolution ortho-rectified imagery was provided to Boffa Miskell by GHD on 21 January 2021. This imagery, in conjunction with detailed site notes, GPS records, and georeferenced photos, was used by Jaz Morris to re-map all wetland extents within the extent of the road aerial survey imagery. This mapping was provided to GHD in a spatial format on 02 February 2021 and was used by GHD to refine an initial road design to avoid, as much as practicable, all mapped wetland areas (also, refer to final bullet point in Section 2.4.2.1).

2.5 Avifauna

An avifauna desktop review and a site investigation (surveys) were required to provide a base list of bird species at the proposed landfill site against which potential construction and operational effects of the proposal can be assessed. The base list also provides a pre-operational baseline to which bird abundances and species diversity can be compared to during operation. This will help assess the effectiveness of different bird management techniques used during operation of the landfill[5] and help dictate what additional control / management techniques are required.

An additional consideration of this project is the risk of aircraft bird strike associated with the landfill, given that the designation site is approximately 4.5 km from Dunedin Airport and is within the Airport's flight fan. Some bird species are both attracted to landfills and are susceptible to bird strike; furthermore, these species are also highly mobile. As such, a desktop review and field investigations were also conducted in the wider landscape (which is varied and has some extensive areas of avifauna habitat) to provide context as to what species, and in what abundances, are already present in surrounding areas. This information was used to help inform the risk of aircraft strike associated with the proposed landfill.

The methods employed during these investigations are described below.

2.5.1 Desktop Review

Data from the Ornithological Society of New Zealand's (OSNZ) atlas (Robertson et al., 2007) was collated from the three 10 x 10 km grid square (228, 546; 229, 546; 229, 547), which encompass the project area and surrounds (including Dunedin Airport, the Taieri Plains and the Lake Waihola-Waipori and Sinclair wetland complex; Figure 3).

[4] A final road design issued to Boffa Miskell on 13 May 2021 avoided the 47.4 m^2 wetland overlap area, and 11 small overlap areas remained. Therefore, the total amount of wetland habitat impacted by this finalised proposal is 16.5 m^2 / 0.0017 ha. See Section 5.1.1 for discussion of potential impacts to wetlands arising from the finalised proposal.

[5] Bird management is standard practise at landfills and is conducted to reduce the number of nuisance birds attracted to and present at the site.

The primary and secondary habitats[6] for each of the species recorded within the three grid squares was obtained from Heather & Robertson (2005), along with each species' threat status according to the current New Zealand Threat Classification for avifauna (Robertson et al., 2017). The species list obtained from the OSNZ atlas data served as a base list of avifauna species recorded in the wider Smooth Hill and Taieri Plains area and therefore potentially present at or near the project site.

Further literature (published and unpublished) and website searches were undertaken to obtain additional information regarding bird species known to occur within the surrounding habitats. Information was also gathered on bird species attracted to landfills, bird management at landfills, bird strike and bird strike management. Conversations were had with staff at Green Island landfill in Dunedin and Kate Valley landfill in Teviotdale, north of Christchurch, to understand bird numbers and problem species at these sites and what bird management and control methods are employed.

2.5.2 Site Investigations

To get an understanding of the avifauna community on site, as well as communities present in the wider landscape, Karin Sievwright (Ecologist, Boffa Miskell) conducted 30-minute point count surveys over four seasons (autumn, winter, spring and summer[7]) at a total of six locations (two locations at the proposed landfill site and at four locations around Dunedin Airport; Figure 4). The surveys were conducted between May 2019 and February 2020. The sites chosen provided good encompassing views of either the landfill or airport. However, the airport sites were restricted to areas of public access due to safety factors and as such some survey sites were up to one kilometre away from the airport.

Each survey was conducted over two consecutive days and each site was surveyed twice (once in the morning and once in the afternoon). During the surveys, data was collected on each bird, or flock of birds, observed. The data collected included: species; number of birds; distance observed from the observer (m); direction of bird movement; maximum flight height (m); average flight height (m); minimum flight height (m); behaviour displayed (e.g. traversing, feeding, resting, etc); the time of observation; location (e.g. pine forest, native forest, etc); and any other observations of interest. Approximate flight paths were also drawn for each bird/flock observed to obtain an understanding of how the birds were using each survey location and wider landscape. Weather conditions were also noted at the start and end of each survey, and included: visibility, cloud cover (as a percentage of the sky), precipitation, temperature (°C), wind strength and wind direction (Table A2-1, Appendix 2).

A survey for nesting falcon was also conducted on site on 30 October 2019 (within the falcon breeding season which broadly spans between 1 August and 31 May[8] (i.e. spring - autumn)). This involved playing playbacks of falcon calls at different locations around the site and looking and listening for any responses.

[6] For the purpose of this report, primary habitat refers to the habitat that the species spends most of its time. Secondary habitats are other habitat types that the species may also utilise.

[7] The autumn survey was conducted on 23-24 May 2019. The winter survey was conducted on 17-18 July 2019. The spring survey was conducted on 31 October and 1 November 2019. The summer survey was conducted on 10-11 February 2020.

[8] Seaton, R.; Hyde, N. 2013 [updated 2017]. New Zealand falcon. *In* Miskelly, C.M. (ed.) *New Zealand Birds Online*. www.nzbirdsonline.org.nz

Two 20-minute water bird count surveys were also conducted at Lake Waihola in spring and summer[9] to obtain an understanding of the bird assemblage at this location (Figure 4). Each survey was conducted over two consecutive days and each site was surveyed twice, once in the morning and once in the afternoon. During these surveys data was collected on each bird, or flock of birds, observed. The data collected included: species; number of birds; direction observed from the observer; direction of bird movement; behaviour; location; time; and any other observations of interest. Weather conditions were also noted as described above (Table A2-1, Appendix 2).

Incidental observations of other birds observed at each survey site between formal survey times were also recorded.

Additional surveys specific to managing the risk of bird strike to aircraft of Dunedin airport have been undertaken as part of this EcIA review process and in response to s92 requests for further information. This work has been done in collaboration with Avisure – aviation, wildlife and safety experts. We have not included methods and results from these additional surveys in the EcIA[10], as these do not alter our finding of potential impacts of the landfill on avifauna values. Instead, the additional information has been used to inform and revise the Smooth Hill Bird Strike Management Plan.

[9] The spring survey was conducted on 31-October-1 November 2019 and the summer survey was conducted on 10-11 February 2020.

[10] These data from additional surveys are documented in a separate Smooth Hill Landfill Preliminary Bird Hazard Assessment (Avisure, 2021).

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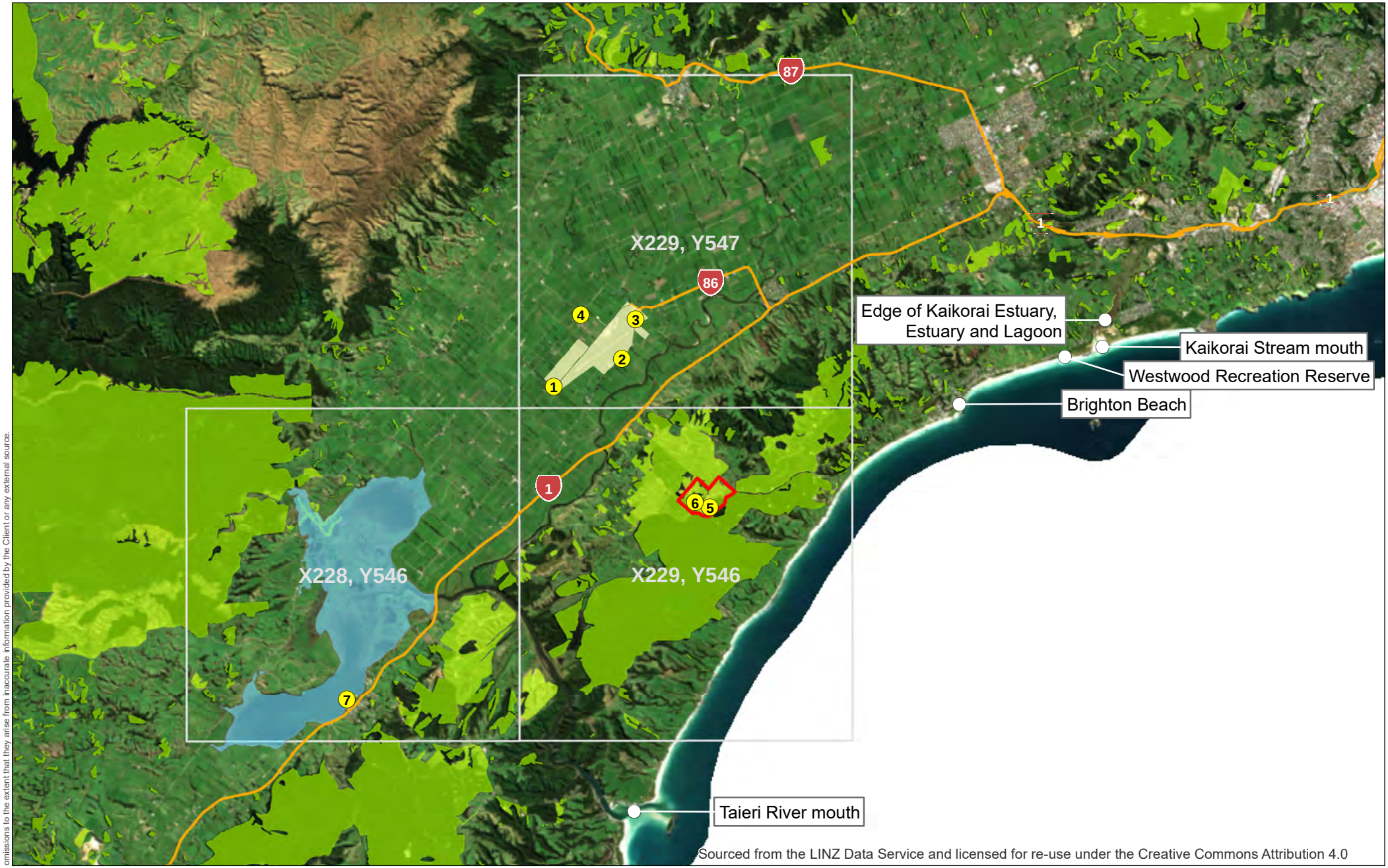

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Data Sources:
Wetlands sourced from ORC data service
Designation sourced from DCC data service
Forestry sourced from LCDB5
Projection: NZGD 2000 NZTM

LEGEND

- Bird Survey Locations
- Ornithological Society of NZ Grid
- Dunedin International Airport Ltd
- Lake Waihola – Lake Waipori and Sinclair Wetland Complex
- Smooth Hill Designation (2GP)
- Production Pine Forestry
- State Highway

SMOOTH HILL LANDFILL

OSNZ Bird Atlas Grid Squares

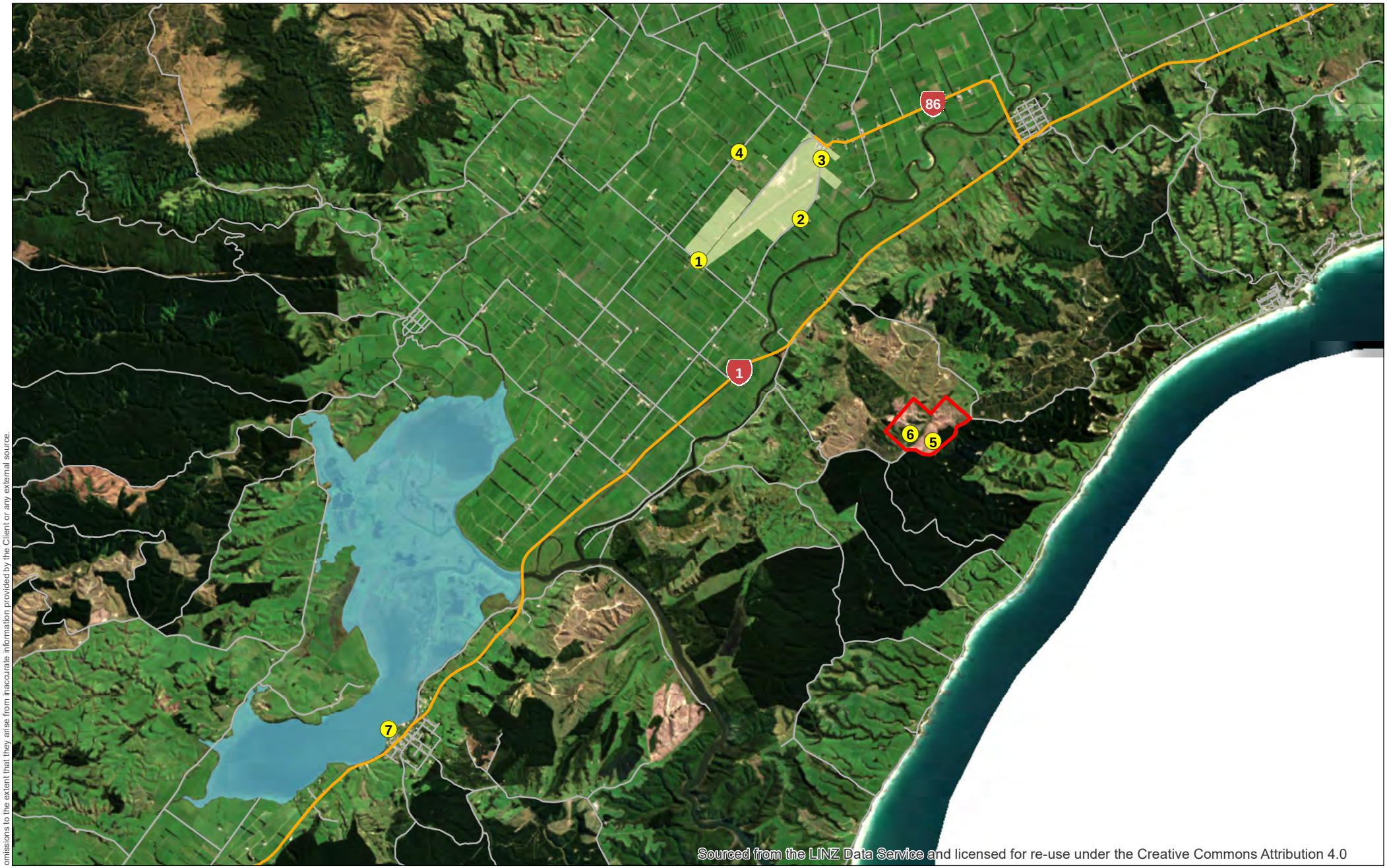
Date: 20 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: KSi

Figure 3

File Ref: BM200252_024_A4L_ECO_Fig4_BirdSurveyLocations.mxd



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Data Sources:
Wetlands sourced from ORC data service
Designation sourced from DCC data service
Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Bird Survey Locations
- Dunedin International Airport Ltd
- Lake Waihola – Lake Waipori and Sinclair Wetland Complex
- Smooth Hill Designation (2GP)
- State Highway
- Road

SMOOTH HILL LANDFILL

Bird Survey Locations

Date: 20 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: KSi

Figure 4

2.6 Herpetofauna

2.6.1 Desktop Review

The Department of Conservation 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. 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.

2.6.2 Site Investigations

Samantha King (Ecologist, Boffa Miskell), Tanya Blakely (Senior Principal / Senior Ecologist, 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. 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.

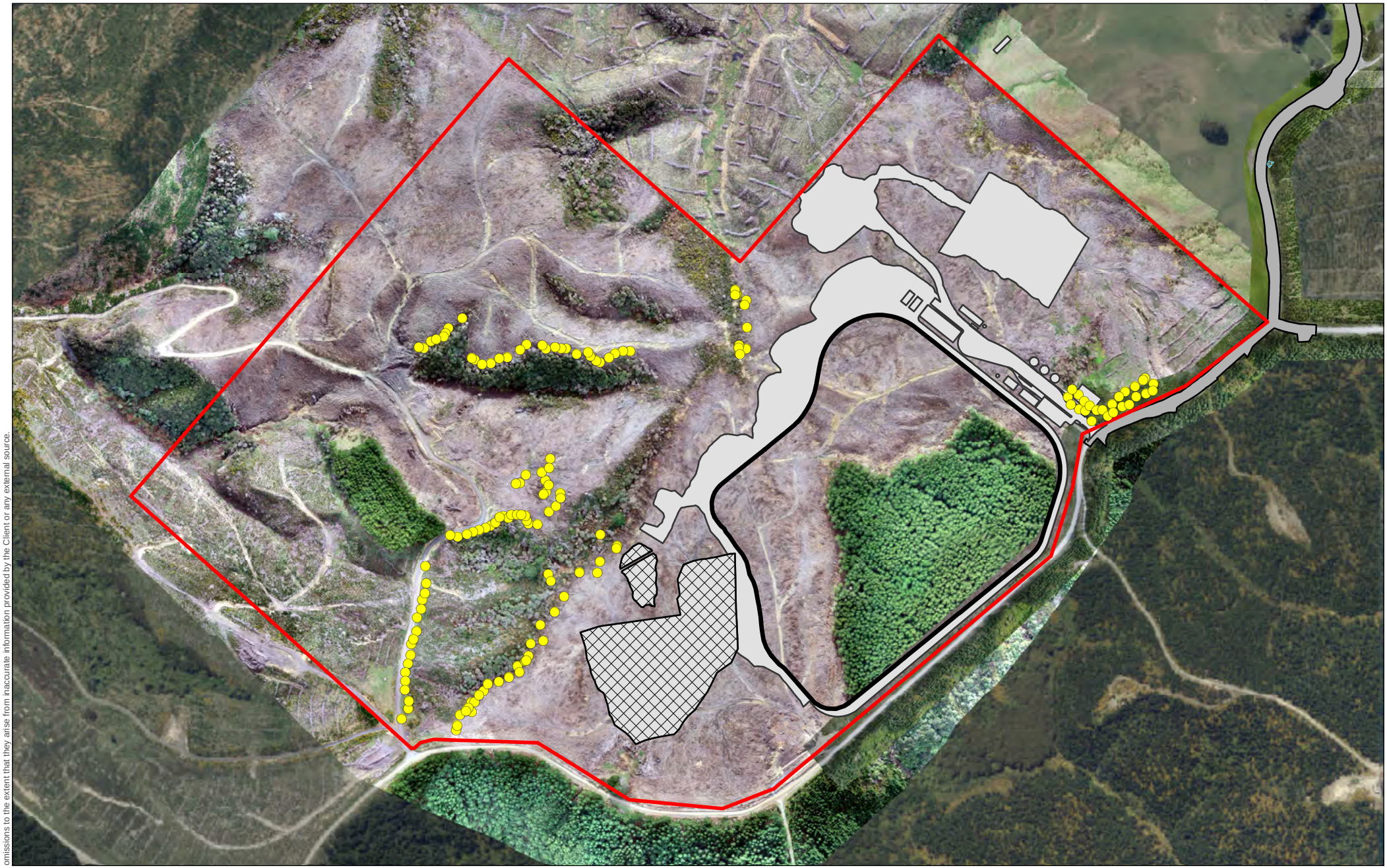
145 Artificial Cover Objects (ACO) were deployed within this potential lizard habitat in the designation site (Figure 5). The ACOs were left in place for at least 8 weeks, then checked once in March 2020 before being retrieved from the site (as per Wildlife Act Authorisation (WAA) requirements).

The ACOs were checked and collected by Tanya Blakely and Jaz Morris on 24-25 March 2020. At the time, New Zealand was in COVID-19 Alert Level 3 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. To ensure we were working within the conditions of the WAA, Mandy Tocher (Herpetologist, Ryder Environmental Ltd.) assisted Tanya Blakely and Jaz Morris on site on 24 March 2020.

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, clear and mild (approximately 20 degrees throughout the day).

File Ref: BM200252_025_A4L_ECO_Fig5_ACO_Locations.mxd



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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: 17 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: TBl

Figure 5

2.7 Freshwater Ecology

2.7.1 Desktop Review

Existing information on freshwater habitats and fauna within the designation site were gathered from the following sources:

- GIS (Geographic Information System) databases and aerial imagery
- The NIWA-administered New Zealand Freshwater Fish database (NZFFD)
    - this database holds records of freshwater fish occurrences and distributions based on previous surveys.

2.7.2 Site Investigations

Tanya Blakely (Senior Principal | Ecologist, Boffa Miskell) visited the site 30 May and 7-8 October 2019, 24-25 March and 10-11 June 2020 and again on 12-13 April 2021.

The site visit on 30 May 2019 was for project and site familiarisation with the wider project team and involved a walkover within the designation site.

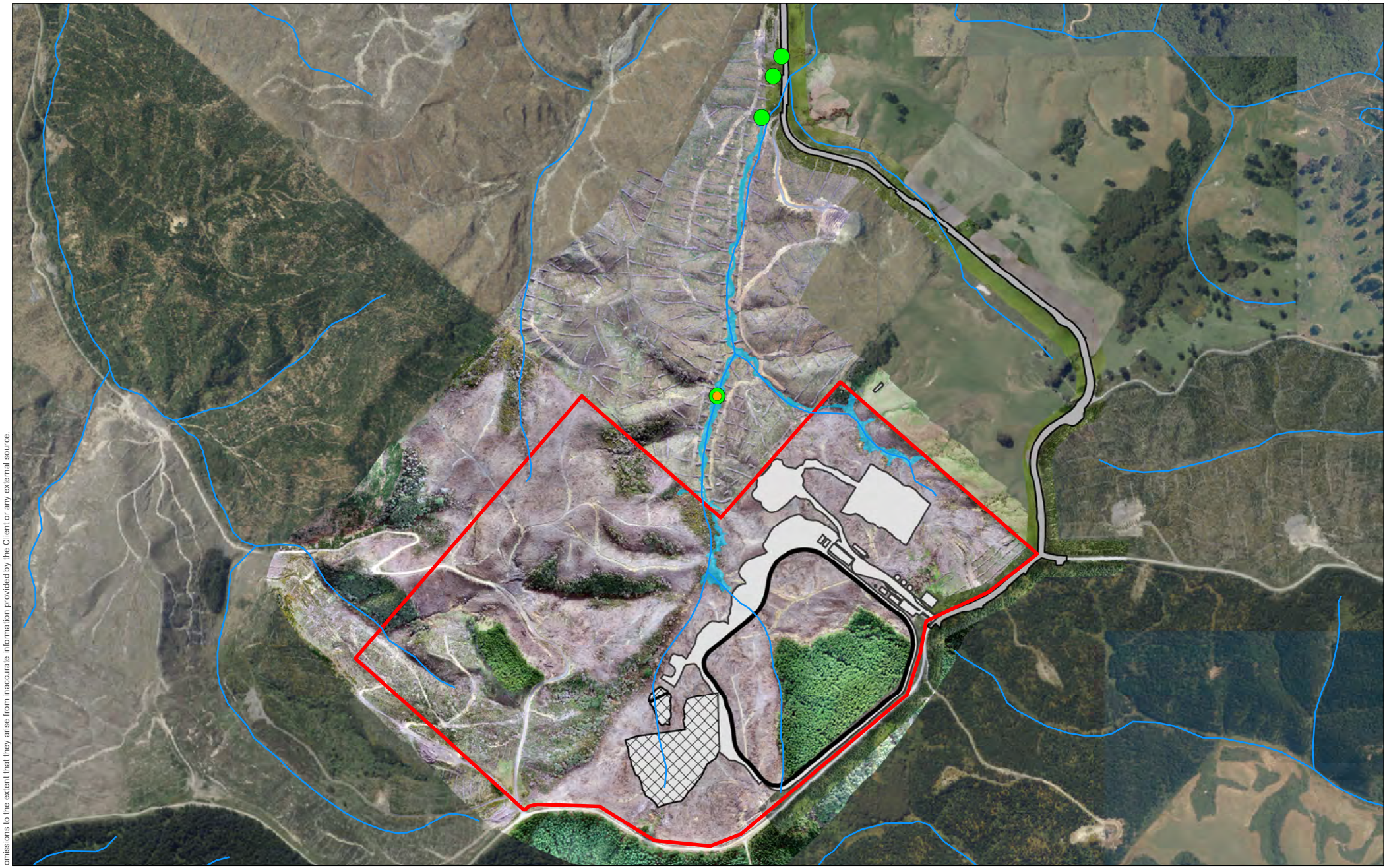
On 7-8 October 2019 and 24-25 March 2020, Tanya walked over the designation site, to assess if waterways were present and, if present, whether these were permanent or ephemeral watercourses. The designation site was walked, noting gullies where streams (river centre lines) were shown on New Zealand Topographical Maps (Figure 6). No waterways were found within the designation site, with gullies having only ephemeral flow paths to convey overland surface flows during rain fall events.

Site investigations of the downstream receiving environment (the wetland and stream systems downstream of the designation site, and a tributary of Ōtokia Creek) between the designation site and McLaren Gully Road (Figure 6) were conducted on 10-11 June 2020 and 12-13 April 2021. Field assessments were not able to commence prior to this as access through the Wenita Forest Products Limited property was not granted until 6 May 2020.

The site visit on 10-11 June 2020 included a walkover of the downstream receiving environment, from the swamp wetland down to McLaren Gully Road. In addition, the freshwater ecology was investigated by Tanya Blakely at four sites along this extent. At each site, basic habitat conditions (Rapid Habitat Assessment; Clapcott 2015), macroinvertebrate and fish communities were assessed. The fish community was also assessed at a variety of locations along the downstream tributary, wherever sufficient habitat was found (i.e. flowing water, depth >10 cm, pools and presence of undercut banks).As discussed in Section 2.2, conducting fish surveys outside of the months November to April (inclusive) brings a risk of not detecting fish even when present due to cooler water temperatures and fish inactivity.

Tanya Blakely revisited the downstream tributary on 12 and 13 April 2021, to further survey the fish community during a season in line with recommendations of Joy et al. (2013) national protocol. However, surveying was limited to the pond located approximately 200-300 m downstream of the designation site as the waterway up- and downstream of this pond was dry due to prolonged dry conditions over the summer and autumn (also see Section 2.2).

Freshwater ecology assessments were carried out as detailed below.



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Data Sources:
Designation sourced from DCC 2GP online
Landfill design / road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Valley Floor Marsh Wetland
- Fish survey – April 2021
- Survey locations – June 2020
- Smooth Hill Designation (2GP)
- Access Road
- Landfill Footprint
- Stockpile
- Operations Area

SMOOTH HILL LANDFILL

Waterways and Sampling Sites

Date: 20 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: TBI

Figure 6

2.7.2.1 Habitat Conditions

Rapid Habitat Assessment (RHA), involves ranking the following parameters between 0 and 10[11] for each site:

- Deposited sediment;
- Invertebrate habitat diversity;
- Invertebrate habitat abundance;
- Fish cover diversity;
- Fish cover abundance;
- Hydraulic heterogeneity;
- Bank erosion;
- Bank vegetation;
- Riparian width; and
- Riparian shade.

2.7.2.2 Macroinvertebrate community

Macroinvertebrates (e.g., insects, snails and worms that live on the stream bed) can be extremely abundant in streams and are an important part of aquatic food webs and stream functioning. Macroinvertebrates vary widely in their tolerances to both physical and chemical conditions, and are therefore used regularly in biomonitoring, providing a long-term picture of the health of a waterway.

The macroinvertebrate community was assessed on 11 June 2020. A single kick-net (500 µm mesh) sample was collected from each site in accordance with protocol C2 of Stark et al. (2001). Each kick net sampled approximately 0.3m^2 of stream bed, including sampling the variety of microhabitats present, to maximise the likelihood of collecting all macroinvertebrate taxa present at a site, including rare and habitat-specific taxa.

Macroinvertebrate samples were preserved, separately, in 70% clear methylated spirits prior to sending to Boffa Miskell's taxonomy laboratory for identification and counting in accordance with protocol P1 (coded-abundance method) of Stark et al (2001).

The macroinvertebrate communities present were used to provide an indication of stream health. A range of commonly used biotic metrics, including the Macroinvertebrate Community Index (MCI) and its semi-quantitative variant (SQMCI), were calculated.

The MCI index is based on tolerance scores for individual macroinvertebrate taxa found in soft-bottomed streams (Stark 1985, Stark and Maxted 2007). These tolerance scores, which indicate a taxon's sensitivity to in-stream environmental conditions, are summed for the taxa present in a sample, and multiplied by 20 to give MCI values ranging from 0 – 200.

The SQMCI is a variant of the MCI, which instead uses abundance data and provides additional information about the dominance of pollution-sensitive species in soft-bottomed streams.

Table 1 provides a summary of how MCI and SQMCI scores were used to evaluate stream health.

[11] An RHA of 0 indicates poor condition, and 10 indicates optimal condition.

Table 1. Interpretation of MCI and QMCI scores for soft-bottomed streams (Stark & Maxted 2007).

Stream health	Water quality descriptions	MCI	QMCI
Excellent	Clean water	>119	>5.99
Good	Doubtful quality or possible mild enrichment	100-119	5.00-5.99
Fair	Probable moderate enrichment	80-99	4.00-4.99
Poor	Probable severe enrichment	<80	<4.00

Note, the MCI and QMCI (hard-bottom scores) were developed primarily to assess the health of streams impacted by agricultural activities (e.g. organic enrichment) and should be interpreted with caution in relation to other systems.

2.7.2.3 Fish community

The fish community was surveyed[12] on 11 June 2020 at each site, incorporating the reaches where the macroinvertebrate community and habitat assessments were made. The fish community was assessed using a single pass with a Kainga EFM 300 backpack mounted electro-fishing machine (NIWA Instrument Systems, Christchurch). Methods were in line with those recommended by Joy et al. (2013) with the exception that the survey was conducted in June 2020, which is outside of the November to April timeframes recommended for fish surveys.

The fish community within the large pond approx. 200-300 m downstream of the designation site was surveyed using two fyke nets, baited with tinned cat meat. The fyke nets were set in the late afternoon of 12 April 2021 and left overnight. The nets were checked early on the morning of 13 April 2021. All fish captured were identified and size estimated, before being returned alive to where they were caught.

Collecting eDNA samples was considered and we planned to do this in April 2021. However, the stream habitat was dry at the time of surveying, and the pond was difficult to sample and it was not possible to get a sufficient and uncontaminated sample[13].

2.7.3 Other

Where possible, common names for plants have been used in this report. Where a species does not have a common name, or its common name cannot be used to identify the species without ambiguity, scientific names have been used. The common and scientific names of the plants mentioned in this report, or recorded near the landfill footprint, are listed in Appendix 1.

Common names, with scientific names on first mention in text, have been used for avifauna, herpetofauna and freshwater fauna.

The conservation status of nationally Threatened and At-Risk indigenous species used in this report (on first mention of that species in text) are from the most current versions of their respective New Zealand Conservation status lists:

- Plants: de Lange et al. (2018);
- Birds: Robertson et al. (2017);
- Reptiles: Hitchmough et al. (2016); and
- Freshwater fish: Dunn et al. (2018).

[12] Boffa Miskell holds: a Special Permit to *take* fish issued by the Ministry for Primary Industries pursuant to Section 97(1) of the Fisheries Act 1996; and approvals from the Department of Conservation and Fish and Game pursuant to regulations 4A.(1)(a) of the Freshwater Fisheries Regulations 1983 and 48A(1)(l)(i) of the Conservation Act 1987.

[13] Collecting eDNA is a straightforward process, however, given the sensitivity of the laboratory analyses, samples can easily be contaminated and give false positives. For example, the person collecting the sample must avoid being in the water as waders, gumboots etc can carry eDNA and easily contaminate samples.

2.8 Assessing Ecological Significance

Section 6(c) of the RMA requires identification of sites of significant vegetation and significant habitats of flora and fauna. Ecological significance was assessed following Schedule 4 of the Partially Operative Otago Regional Policy Statement (RPS)[14], and the site was significant if it met one or more of the criteria. Sites were also considered against the proposed Dunedin 'Second-Generation' District Plan (Dunedin 2GP) significance criteria in Policy 2.2.3.2, which are substantially similar[15].

Under the significance criteria in Schedule 4, and Policy 2.2.3.2, indigenous vegetation and habitats of indigenous fauna are either significant or not.

2.9 Assessing Ecological Value and Effects

This ecological impact assessment follows the Environmental Institute of Australia and New Zealand's (EIANZ) Ecological Impact Assessment (EcIA) guidelines (Roper-Lindsay et al., 2018).

In summary, the EcIA method requires **ecological values** to be assigned (Table 2 to Table 5) and the **magnitude of effects** identified (Table 6) in order to determine the overall **level of effect** of the proposal (Table 7).

The EIANZ guidelines (Roper-Lindsay et al., 2018) note that the level of effect can then be used as a guide to the extent and nature of the ecological management response required (including the need for biodiversity offsetting). For example:

- **'Very high'** represents a level of effect that is unlikely to be acceptable on ecological grounds alone (even with compensation proposals). Activities having very high adverse effects should be avoided.
- **'High' and 'Moderate'** represents a level of effect that requires careful assessment and analysis of the individual case. Such an effect could be managed through avoidance, design, or extensive offset or compensation actions.
- **'Low'** and **'Very low'** should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking impact management measures developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure low or very low-level effects.
- **'Very low'** level effects can generally be classed as 'not more than minor' effects.

[14] At the time of drafting this report, Schedule 4 had been recently confirmed by consent order on 24 June 2020. Other potentially relevant definitions and provisions of the proposed RPS that may be applicable to this project were considered based upon an appeals version of the proposed RPS (dated 17/5/2019).

[15] There are two criteria for significance in the proposed 2GP that do not have an equivalent in the proposed RPS; these criteria were also considered in this assessment.

Table 2. Attributes to be considered when assigning ecological value or importance to a site or area of vegetation / habitat / community for terrestrial ecosystems (Roper-Lindsay et al., 2018).

MATTERS	ATTRIBUTES TO BE CONSIDERED
Representativeness	Criteria for representative vegetation and aquatic habitats: - Typical structure and composition - Indigenous species dominate - Expected species and tiers are present - Thresholds may need to be lowered where all examples of a type are strongly modified Criteria for representative species and species assemblages: - Species assemblages that are typical of the habitat - Indigenous species that occur in most of the guilds expected for the habitat type
Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats: - Naturally uncommon, or induced scarcity - Amount of habitat or vegetation remaining - Distinctive ecological features - National priority for protection Criteria for rare/distinctive species or species assemblages: - Habitat supporting nationally Threatened or At Risk species, or locally uncommon species - Regional or national distribution limits of species or communities - Unusual species or assemblages - Endemism
Diversity and pattern	- Level of natural diversity, abundance and distribution - Biodiversity reflecting underlying diversity - Biogeographical considerations – pattern, complexity - Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation
Ecological context	- Site history, and local environmental conditions which have influenced the development of habitats and communities - The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) - Size, shape and buffering - Condition and sensitivity to change - Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material - Species role in ecosystem functioning – high level, key species identification, habitat as proxy

Table 3. Attributes to be considered when assigning ecological value or importance to a freshwater site or area (Roper-Lindsay et al., 2018).

MATTERS	ATTRIBUTES TO BE ASSESSED
Representativeness	- Extent to which site / catchment is typical or characteristic - Stream order - Permanent, intermittent, or ephemeral waterway - Catchment size - Standing water characteristics
Rarity/distinctiveness	- Supporting nationally or locally[16] Threatened, At Risk or uncommon species - National distribution limits - Endemism - Distinctive ecological features - Type of lake / pond / wetland / spring
Diversity and pattern	- Level of natural diversity - Diversity metrics - Complexity of community - Biogeographical considerations – pattern, complexity, size, shape
Ecological context	- Stream order - Instream habitat - Riparian habitat - Local environmental conditions and influences, site history and development - Intactness, health and resilience of populations and communities - Contribution to ecological networks, linkages, pathways - Role in ecosystem functioning – high level, proxies

Table 4. Scoring for sites or areas combining values for four matters in Table 2 and Table 3 (Roper-Lindsay et al., 2018).

VALUE	DESCRIPTION
Very High	Area rates High for 3 or all of the four assessment matters listed in Table 2 and Table 3. Likely to be nationally important and recognised as such.
High	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder; or Area rates High for 1 of the assessment maters, Moderate for the remainder. Likely to be regionally important and recognised as such.
Moderate	Area rates High for one matter, Moderate and Low for the remainder; or Area rates Moderate for 2 or more assessment matters Low or Very Low for the remainder. Likely to be important at the level of the Ecological District.
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

[16] Locally – defined as within the relevant Ecological District

Table 5. Factors to consider in assigning value to species for EcIA (Roper-Lindsay et al., 2018). ZOI: zone of impact.

DETERMINING FACTORS	
Nationally Threatened species found in the ZOI either permanently or seasonally	Very High
Species listed as At Risk – Declining, found in the ZOI, either permanently or seasonally	High
Species listed as any other category of At Risk, found in the ZOI either permanently or seasonally	Moderate
Locally uncommon (in ED) or distinctive species	Moderate
Nationally and locally common indigenous species	Low
Exotic species, including pests, species having recreational value	Negligible

Table 6. Criteria for describing magnitude of effect (Roper-Lindsay et al., 2018).

MAGNITUDE	DESCRIPTION
Very High	Total loss of, or very major alteration to, key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature
Low	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature

Table 7. Criteria for describing level of effects (Roper-Lindsay et al., 2018).

		ECOLOGICAL VALUE				
		Very High	**High**	**Moderate**	**Low**	**Negligible**
MAGNITUDE	**Very High**	Very High	Very High	High	Moderate	Low
	High	Very High	Very High	Moderate	Low	Very low
	Moderate	High	High	Moderate	Low	Very low
	Low	Moderate	Low	Low	Very Low	Very low
	Negligible	Low	Very Low	Very Low	Very Low	Very low
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain

3.0 Existing Ecological Environment

3.1 Ecological Context

The proposed 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 (ED). In terms of the Threatened Environment Classification[17], the area is entirely within a Category 2 (previously called 'Chronically Threatened') land environment (Q4.3c), where 10-20% indigenous vegetation remains on this land environment, nationally (Walker et al. 2015). Some valley floor areas adjacent to McLaren Gully Road immediately below Gledknowe Hill are within a Category 3 land environment (Q4.3a), where 20-30% indigenous vegetation remains nationally.

The original and existing vegetation of the ED is described below (paraphrased from McEwan 1987 and Allan 1991).

The original vegetation of the Tokomairiro ED (in the area including and surrounding the proposed landfill site) prior to the arrival of humans was comprised of kahikatea, matai, tōtara, narrow-leaved lacebark, cabbage tree and kowhai forest on the hills of East Otago. These vegetation communities are now present only as remnants in deep gullies that survived fire, logging, and clearance for farming.

Existing vegetation types in the ED and near the designation site are mainly improved pastures on the Taieri plain, with extensive areas of harakeke flax-crack willow dominated swamps around Lakes Waipori and Waihola and some highly modified swamps elsewhere on the plains. In the hills from Taieri Mouth to Saddle Hill dividing the plain from the sea, there are extensive areas of pasture and plantation forests (mostly radiata pine). Remnant or secondary indigenous forest or scrub / shrublands is occasionally present in gullies not managed as pasture or plantation forestry. Remnant coastal podocarp / hardwood forest includes species such as rimu, miro, Hall's tōtara, māhoe, broadleaf, and kōhūhū. Secondary forest types include kanuka forest of varying stature, usually with an understory dominated by *Coprosma* spp. shrubs. In addition, mixed broadleaved forests of kōhūhū, marbleleaf and fuchsia occur, with frequent wineberry and lancewood in the canopy. The understory includes species such as red māpou, weeping matipo, kaikomako, horopito and *Coprosma* spp. scrub or shrublands are common in areas affected by recent disturbance or forest clearance; in these areas, bracken fern along with exotic weeds such as broom, gorse and Himalayan honeysuckle are typical.

Although there is a large protected area in the west of the Tokomairiro ED[18], there is little protection of indigenous forest types of the sort that occur, or would have formerly occurred, within the designation site. Nearby protected areas include Hope Hill Scenic Reserve (approx. 170 ha), which is managed by the Department of Conservation and is accessed from McLaren Gully Road around 1.5 km to the north-east of the designation site; Taieri River Scenic Reserve (approx. 500 ha) to the south; and scattered, small areas of covenanted private land, the

[17] The Threatened Environment Classification is a combination of three national databases: Land Environments of New Zealand, Land Cover Database (Version 2) and the Protected Areas Network. The Threatened Environment Classification shows how much indigenous vegetation remains within land environments, how much is legally protected, and how the past vegetation loss and legal protection are distributed across New Zealand's landscape.

[18] A >3500 ha area including Waipori Falls Conservation Area and Scenic Reserve, Mill Creek Scenic Reserve and Maukaatua Scenic Reserve. The bulk of this area is tussock grassland habitats.

nearest of which is immediately to the north of McLaren Gully Road around 1.5 km north of the designation site. There are two wetlands within the wider vicinity of the proposed landfill site that have been scheduled on ORC maps (2019) as being regionally significant wetlands; Ōtokia Swamp, located approximately 3.4 km north west of the site adjacent to the Taieri River; and Lower Ōtokia Creek Marsh, adjacent to McColl Creek approximately 7.6 km northeast of the site at Brighton. Ōtokia Swamp is a highly modified and partially drained crack willow, harakeke, grass and sedge swamp. Lower Ōtokia Creek Marsh is a modified and partially drained brackish / estuarine saltmarsh.

3.2 Terrestrial Vegetation and Wetlands

3.2.1 Vegetation Communities

Geographical approach: the vegetation communities within the designation site and immediately downstream are listed in Table 8 below. Vegetation communities are described in an approximately north-to-south order; that is, their appearance to an observer walking up-valley from where a tributary of Ōtokia Creek draining the designation site meets McLaren Gully Road. Species lists for these vegetation communities are provided in Appendix 1. The location and extent of these vegetation communities within the landfill footprint / designation site is shown in Figure 7 and further detail is provided in Appendix 4. Photographs of the vegetation communities are in Appendix 3.

Additional vegetation communities impacted by the expansion of McLaren Gully Road and Big Stone Road are also included in Table 8 below. Complete species lists are not available for these vegetation communities as they sit largely on private land and were observed from the road. Some vegetation communities affected by road widening are substantially similar to vegetation communities in the designation site; these are described together for conciseness.

Note: Some vegetation communities that are outside the proposed landfill footprint (and that would not be affected by landfill construction in any way) are also included in Table 8 below (indicated by a '*'). These communities were assessed for an initial landfill design; the redesigned proposal assessed in this EcIA avoids impact to these communities. For the purposes of fully describing all vegetation types within the designation site that are within the landfill catchment (and wider Ōtokia Creek catchment), these descriptions have been retained.

Table 8. Vegetation communities within the landfill site and along McLaren Gully and Big Stone Roads, described using the classification system of Atkinson (1985). Also see Figure 2 for location of the vegetation communities listed below. * indicates vegetation communities that are within the designation site (and Ōtokia Creek catchment) but are outside the proposed landfill footprint.

Vegetation communities	Location within designation site
(Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland*	Valley Floor Marsh Wetland, East Gully, Swamp Wetland, West Gully 2, West Gully 4, areas alongside Big Stone Road and McLaren Gully Road
[Large-leaved pohuehue] / (Himalayan honeysuckle) – gorse scrub*	West Gully 1, hill slope near West Gully 2, Swamp Wetland
Harakeke – gorse / (pūrei – rautahi) flaxland*	Swamp Wetland, West Gully 3
Kānuka forest*	West Gully 1, West Gully 2, West Gully 3, East Gully
[Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland*	West Gully 4

Vegetation communities	Location within designation site
Radiata pine / gorse / cocksfoot – Yorkshire fog treeland	Recently cutover pine and macrocarpa forest (main designation site), other forestry areas adjacent to Big Stone Road and McLaren Gully Road
(Yorkshire fog) – cocksfoot grassland	Recently cutover pine forest (main designation site), forest edges, roadsides verges along McLaren Gully Road
~~Macrocarpa forest~~	~~Block adjacent to Big Stone Road~~
Additional vegetation communities along roadsides	**Location**
[Pūrei] – wīwī / rautahi – exotic grass rushland	Areas alongside McLaren Gully Road
Gorse scrub	Areas alongside McLaren Gully Road
Exotic grass grassland / fodder crops	Working farmland paddocks alongside McLaren Gully Road

Structure of this section: vegetation communities are described in general terms (Section 3.2.1), followed by an assessment of whether, or not, they meet the 2GP definition of 'indigenous vegetation[19]', an assessment of their ecological significance[20] (Section 3.2.2), and an assessment of their ecological value[21] (Section 3.2.3).

Wetlands: the 0.47 ha 'swamp wetland' at the north end of the designation site, and the c.2 ha 'valley floor marsh wetland' form part of a connected wetland sequence. There is also wetland habitat upstream of the swamp wetland at the base of West Gully 3 and in a narrow strip at the base of West Gully 4 (these areas, which comprise a total 0.49 ha, are essentially connected to the adjacent swamp wetland, but recent forestry works have cleared a narrow strip between them). All these wetland areas meet the Resource Management Act definition of wetland and meet the National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) definition of 'natural inland wetland.' The wetland boundaries are the outer boundaries of the (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland and / or harakeke – gorse / (pūrei – rautahi) flaxland vegetation types as mapped in Figure 7 and Appendix 4.

Areas of (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland and [pūrei] – wīwī / rautahi – exotic grass rushland along McLaren Gully Road are likewise natural inland wetlands that have formed at the base of tributary gullies and valleys of Ōtokia Creek and in the vicinity of road culverts.

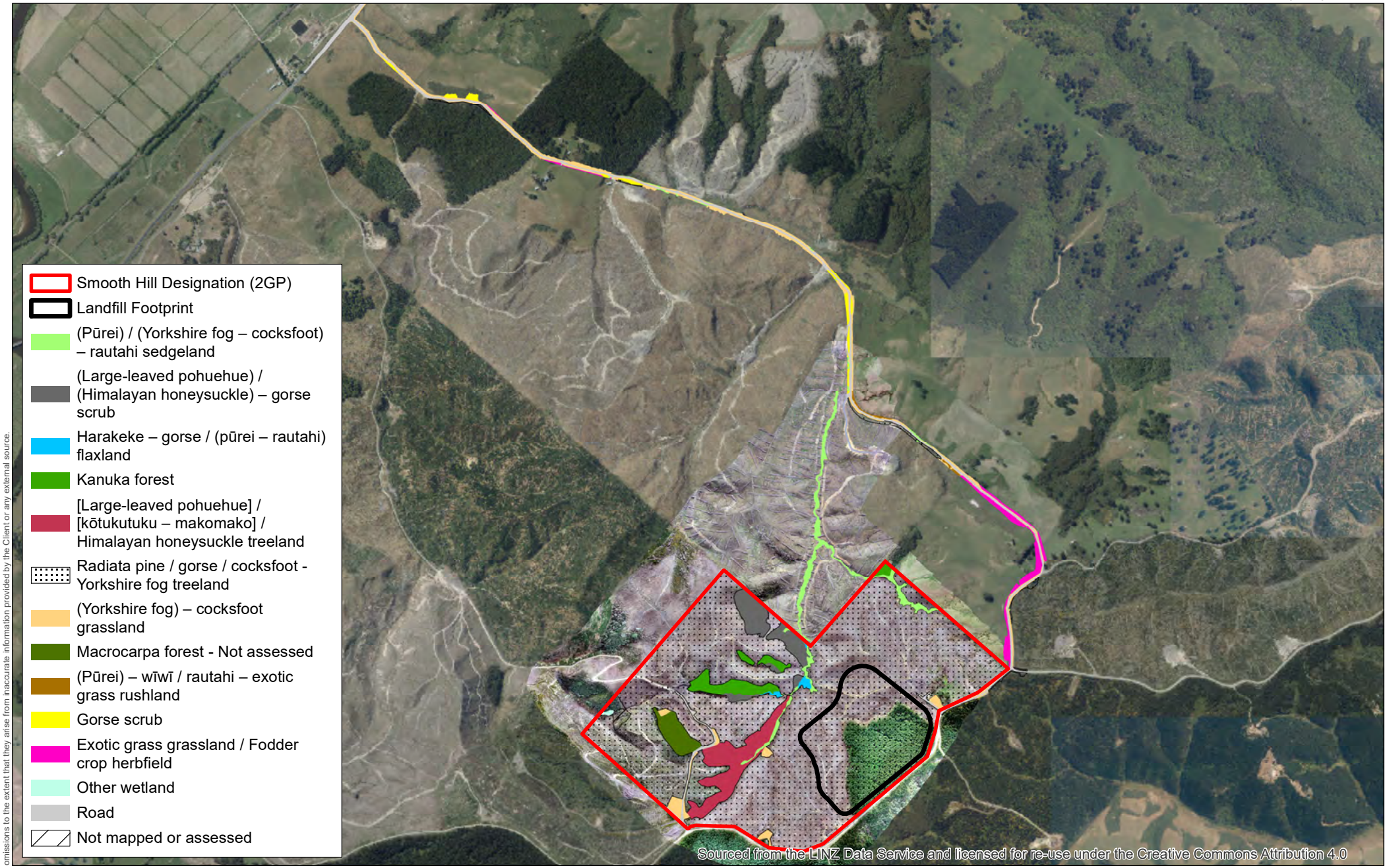
Habitat: avifauna and herpetofauna that inhabit these vegetation types are mentioned briefly within this section of the report, but are dealt with substantially in Sections 3.3 and 3.4, respectively. Other fauna that may be present are introduced mammalian pests. Browsing

[19] In the proposed 2GP, 'indigenous vegetation' is defined as*: a plant or lichen community in which species indigenous to that part of New Zealand are dominant, where dominance is measured as either: indigenous species comprising at least 30% coverage by area or 30% of the total number of specimens present; or indigenous species comprising at least 20% coverage, in plant or lichen communities where indigenous species make up the tallest stratum or are visually conspicuous.* It is noted that the word 'specimen' is an ambiguous term in this context and is not itself defined. In this report, 'specimen' has been interpreted to mean either 'species' or 'plant,' i.e. indigenous vegetation includes areas where indigenous species represent >30% of the total plant taxa, or where indigenous plants represent >30% of the total number of total plants in an area (noting that the latter parameter would likely be extremely impractical to assess).

[20] Vegetation types are assessed as being either significant or not, as described in section 2.6. Habitats were assessed against the Partially Operative Otago RPS (ORC 2019) matters contained in *Schedule 4: Criteria for the identification of areas of significant indigenous vegetation and habitat of indigenous fauna* (note that this is subject to appeal) and the Dunedin 2GP Policy 2.2.3.2. For reference, the text of any proposed RPS criteria met is included in footnotes, but for conciseness the 2GP criteria are identified but not included in footnotes.

[21] Ecological value was determined using the EIANZ methodology (Roper-Lindsay et al. 2018).

animals observed and / or likely to be present on site and in the surrounding area include deer, goats and pigs. Possums, mustelids, and rodents are likely to be present, along with feral cats, throughout the designation site and in the wider area.



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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

Vegetation Types Overview

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 7

3.2.1.1 (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland

A sedgeland dominated by rautahi (*Carex geminata*) and with abundant pūrei, Yorkshire fog and cocksfoot occupies low-lying areas of the designation site with permanently or intermittently saturated soils and in adjacent valley floors (East Gully, and the valley floor marsh wetland that drains the designation site – see Figure 2 for location and context). Within this overall vegetation type, a species association featuring locally abundant or dominant watercress and sweetgrass occurs in localised (often faintly channelised) zones of standing water or active water seeps (this feature does not occur in all locations of this overall vegetation type). Where rautahi is less abundant, the vegetation type is a grassland[22]. The areas where this overall vegetation type occurs are:

- the valley floor marsh wetland, which forms the drainage of the designation site, and extends to McLaren Gully Road;
- the lowest lying areas of the 'East Gully' (also a marsh wetland, which ultimately connects to the valley floor marsh wetland);
- the base of 'West Gully 2', where it occurs as a seepage area feeding into a wider swamp wetland, providing groundwater;
- patches within a wider swamp wetland where it fringes harakeke – gorse / (pūrei – rautahi) flaxland (described below) at the base of 'West Gully 3';
- the valley floor immediately below 'West Gully 4', where several large crack willows are present and visually prominent (vehicle tracks associated with forestry harvest have essentially isolated this wetland from the swamp wetland); and
- alongside McLaren Gully Road.

Excluding rautahi and purei, indigenous species in this overall vegetation type were scattered or patchy individuals of widespread and common species adapted to or tolerant of wet conditions, such as wiwi, harakeke, and prickly shield fern (the latter was only recorded in the swamp wetland and West Gully 4), and annual weedy species such as willowherbs (*Epilobium* spp.), fireweed and groundsel (both *Senecio* spp.). Exotic weeds such as gorse, browntop, creeping buttercup, California thistle, monkey musk, bittersweet and curled dock are overall occasional but may be locally abundant in places within this vegetation community.

A deep pool downstream from the designation site is surrounded by essentially similar vegetation that supports a relatively much higher density of pūrei; for simplicity this area is included in this overall vegetation type. Elsewhere, in some areas, the vegetation present in this community consists of small patches that are essentially a monoculture of rautahi; these are again included in this overall type.

3.2.1.2 [Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub

In northern parts of the designation site, scrub dominated by gorse contains frequent Himalayan honeysuckle and is in places smothered by large-leaved pohuehue. This vegetation type is located in:

- hill slopes in West Gully 1, where scattered indigenous trees are present;

[22] In an earlier version of this EcIA, this vegetation type was referred to as a (pūrei - rautahi – Yorkshire fog) - cocksfoot / floating sweetgrass – watercress grassland. This most accurately describes the vegetation in the valley floor marsh wetland (the downstream receiving environment) but is a less appropriate classification for this overall vegetation type especially where it occurs in the designation site and along McLaren Gully and Big Stone roads.

- an area between that extends south from West Gully 1 along a hill face towards West Gully 2, where very few indigenous trees are present; and
- an area above harakeke – gorse / (pūrei – rautahi) flaxland in the swamp wetland described below, where very few indigenous trees are present.

The scrub is extremely dense and generally supports little indigenous vegetation (apart from large-leaved pohuehue). Occasional bracken fern and very sparse tī kōuka (cabbage tree), māhoe (whiteywood) and makomako (wineberry) were the only other indigenous species recorded in this habitat type. This vegetation type may provide habitat for indigenous lizard species including southern grass skink (At Risk – Declining).

3.2.1.3 Harakeke – gorse / (pūrei – rautahi) flaxland

In the centre of the designation site a flaxland that is dominated by gorse and harakeke forms the central area of a swamp wetland (in places, gorse is more prevalent than flax, and it is a shrubland). It extends from the base of West Gully 3 to the base of West Gully 2, and sits at the confluence of several minor gully systems. It likely receives year-round seepage and / or periodic overland flows and has areas of standing water with frequent pūrei. Rautahi is present on the edge of the flaxland, which is surrounded by (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland (described above). Prickly shield fern and shrubs of indigenous mikimiki (*Coprosma dumosa*) are present within the flaxland, along with a host of exotic grass and weedy herb species including climbing ivy, bittersweet, and creeping buttercup.

3.2.1.4 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. 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 *Carex geminata* 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.

West Gully 3 supports a reasonable diversity of indigenous forest birds including eastern falcon (*Falco novaeseelandiae* "eastern", At Risk – Recovering). It may also support lizard species such as southern grass skink and possibly jewelled gecko (also At Risk – Declining; see Section 3.4 for details about lizard species at the site).

Patches of the same overall vegetation type occur in West Gully 2 and West Gully 1, with similar fringing regenerating indigenous trees but relatively greater issues of weediness and smothering by large-leaved pohuehue. It appears that kānuka trees in West Gully 1 may have been recently sprayed and trees at the edge of the forest patch are dead.

3.2.1.5 [Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland

West Gully 4 is the largest gully within the designation site that has not been planted in forestry and contains an area of regenerating treeland. The treeland is composed of immature (3-5 m) indigenous trees (makomako and kōtukutuku are frequent, with māhoe, kānuka and tī kōuka

rare or occasional) interspersed among dense Himalayan honeysuckle. Gorse and bracken fern are also patchy, and large-leaved pohuehue is frequent throughout, smothering trees particularly on the edges of the treeland. Underneath indigenous trees, understory species similar to those found in kānuka forest in West Gully 3 are present, including *Coprosma* spp. shrubs and indigenous fern species. However, canopy cover of indigenous trees is discontinuous, and trees typically form small patches among lower-stature weedy exotic species. A small number of very large radiata pine have not been felled and are within the treeland.

West Gully 4 supports a reasonable diversity of widespread and common indigenous bird species, and because of the abundance of species such as makomako and kōtukutuku is likely to offer seasonal feeding habitat for frugivorous and nectivorous bird species. Sparse areas of treeland where weeds or vines are not smothering offer habitat for insectivorous avifauna, but in general this treeland offers lower quality feeding habitat compared to nearby kānuka forest and similar vegetation types.

3.2.1.6 Radiata pine / gorse / cocksfoot – Yorkshire fog treeland

The majority of the designation site comprises recently cutover (in the past c.7 years) and re-planted radiata pine (and a small area of macrocarpa harvested in 2020-2021). Where radiata pine has been replanted, there is extensive and dominant gorse in between pine saplings (generally 1-3 m at the time of preparing this report). Exotic grasses such as cocksfoot and Yorkshire fog are present throughout, and form patches in places where gorse is less frequent. Native species present in this area are weedy, fast-establishing indigenous species such as poroporo, fireweed and groundsel. Where macrocarpa forest has very recently been harvested, there is very little vegetation. Other areas of plantation forestry adjacent to McLaren Gully and Big Stone roads are included in this vegetation type – where pines are more mature, the vegetation type could be described as a radiata pine forest.

3.2.1.7 (Yorkshire fog) – cocksfoot grassland

Rank exotic grassland occurs in some places within the main cutover area, such as:

- areas that did not have mature pine trees during the recent forestry harvest;
- along fence lines and roadsides; and
- on the upper and lower edges of the treeland in West Gully 4.

This vegetation type is composed of exotic rank grasses such as cocksfoot and Yorkshire fog and weed species with occasional gorse and broom. Native species present in this area are weedy, fast-establishing indigenous species such as poroporo, fireweed and groundsel. Particularly in the areas bordering West Gully 4, this vegetation type may provide habitat for indigenous lizard species (southern grass skink).

This vegetation type is also the predominant vegetation type alongside McLaren Gully Road and areas of Big Stone Road adjacent to the designation site. Indigenous bracken and toetoe occur in scattered patches within the grassland in some parts of the roadside, but other indigenous species are generally scarce individuals (e.g. wīwī, kānuka, blue tussock, mosses). Particularly in north-facing roadside areas, this vegetation type may also provide habitat for southern grass skink.

3.2.1.8 Macrocarpa forest

~~Near Big Stone Road an upper area of immature plantation forestry comprises a near-monoculture of macrocarpa, with sparse understory species, and edge species including weedy species such as gorse, exotic grasses and poroporo.~~

3.2.1.8 Additional vegetation types along roadsides

An area bordered by seasonally wet pasture in paddocks bordering McLaren Gully Road contains [pūrei] – wīwī / rautahi – exotic grass rushland. This vegetation type contains exotic grasses (largely cocksfoot), dominant wīwī rushes, occasional or patchy pūrei, and a small number of tī kōuka trees; this area is best described as a marsh wetland with some minor areas of swamp.

Beside McLaren Gully Road, especially near State Highway 1, areas of essentially pure gorse scrub occur near the roadside. These areas were not subject to detailed survey but are not part of plantation forestry and do not contain more than extremely scarce native tree or shrub species, unlike gorse scrub habitats in the designation site (e.g. in West Gully 2).

While much of the land bordering McLaren Gully Road is plantation forestry, some areas contain exotic grass grassland (improved pastures; which appear to be dominated by cocksfoot and browntop) and rotational fodder crop herbfield (seasonally cultivated brassicas).

These areas occur on private land and were not subject to detailed survey. They are described because they may be affected by widening of McLaren Gully Road (see Section 5.1).

3.2.1.9 Threatened, At Risk Plants or Locally Uncommon Plants

Threatened, At Risk or locally uncommon plants identified within the designation site during the study were limited to kānuka (Threatened – Nationally Vulnerable)[23]. No species considered locally 'threatened' or locally 'important' (i.e. those listed in Schedule 16 A and 16 B respectively in the Operative (2006) Dunedin City District Plan) were observed on site.

3.2.2 Ecological Significance

The operative Dunedin District Plan or 2GP does not identify any area within the designation site as a site of significant biodiversity value or an outstanding natural area. However, an area of south-facing hill slopes below Gledknowe Hill and adjacent to McLaren Gully Road is designated as an Area of Significant Conservation Value in the 2GP (McLarens Gully Covenant, Site Number C075).

Ecological significance of sites within and adjacent to the potential project footprint is assessed against the RPS and 2GP criteria described in Section 2.7.

We have chosen to assess the significance of sites, where 'site' "include[s] the significant features, connecting habitat and key ecological processes that help to maintain the significant features" including exotic vegetation "within a significant site where they occur within a mosaic of indigenous vegetation" following the guidance of Davis et al. (2016) and Wildlands Consultants (2013).

Four sites are assessed: an area of connected forested gullies and wetlands that supply water to Ōtokia Creek; plantation forestry areas (~~macrocarpa forest,~~ the main cutover area of the designation site, and similar areas adjacent to McLaren Gully Road and Big Stone Road); areas of rank grassland that fringe the cutover area and roadsides; and working farmland areas adjacent to McLaren Gully Road.

Indigenous vegetation (under the 2GP definition) types within the designation site are (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland, harakeke – gorse / rautahi – pūrei flaxland, kānuka forest, and [large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan

[23] Kānuka are extremely common and widespread in habitats such as these. However, due to the threat posed to kānuka by myrtle rust, the species is precautionarily considered to be nationally Threatened (de Lange et al. 2018).

honeysuckle treeland. Other vegetation types present in the designation site and described in Section 3.2.1 are not indigenous, because indigenous plant or lichen species do not comprise 30% of the taxa present, 30% of the plants present, or 30% of the cover, or do not or comprise 20% cover where indigenous species are the tallest stratum or are visually conspicuous. Indigenous vegetation along roadsides are (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland and [pūrei] – wiwi / exotic grass rushland.

3.2.2.1 Connected Gullies and Wetlands

An interconnected area of gullies and wetland habitat comprised largely of indigenous vegetation types is present within the designation site and the valley floor marsh wetland to the north. This overall area supplies water to (forms part of the catchment of) Ōtokia Creek and includes other connected tributary wetlands that are well outside the designation site but are potentially affected by the widening of McLaren Gully Road. This area includes:

- the valley floor marsh wetland comprising (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland;
- the swamp wetland, comprising harakeke – gorse / rautahi – pūrei flaxland and (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland;
- wetland habitats well outside the designation site but which are also tributaries of Ōtokia Creek and are connected to the above wetlands. This includes (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland, and [pūrei] – wīwī / rautahi – exotic grass rushland;
- West Gully 1, comprising kānuka forest;
- exotic (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub that fringes the swamp wetland and connects it to West Gully 1, 2, and 3[24];
- West Gully 2 and areas that connect it to the swamp wetland; comprising patches of kānuka forest, (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland; and small areas of exotic radiata pine / gorse / cocksfoot – Yorkshire fog treeland with occasional indigenous trees;
- West Gully 3, containing kānuka forest and harakeke – gorse / rautahi – pūrei flaxland;
- West Gully 4, comprising [large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland, comprising (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland, and immediately fringing (Yorkshire fog) - cocksfoot grassland; and
- East Gully, where it includes (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland in the gully base, and a small kānuka forest remnant.

These habitats are connected and form an area of significant indigenous vegetation and significant habitat of indigenous fauna, whether assessed as a whole unit, or (in most cases) as individual habitats.

Representativeness: The flaxland vegetation type and kānuka forest are considered representative, because they support a range of typical indigenous species and have

[24] Large-leaved pohuehue prevalent in this scrub may provide habitat for an At-Risk declining lizard species (southern grass skink), but West Gully 1 was not subject to detailed survey as it is not proposed to be affected by landfill construction. Its estimated ecological values and significance indicated in this report are uncertain.

characteristic structurally dominant taxa for these habitat types locally; they are significant in terms of RPS criterion 1[25] (2GP criterion 2.2.3.2 c).

Rarity: Habitats that support At Risk fauna (forest, scrub, and fringing (Yorkshire fog) - cocksfoot grassland that probably support southern grass skink, and forest that supports eastern falcon and possibly jewelled gecko) are significant in terms of RPS criterion 2a[26] (2GP criterion 2.2.3.2 b.i).

The entire designation site occurs on a land environment where only 10-20% indigenous vegetation remains on this land environment, nationally (Walker et al. 2015). In this context, all indigenous vegetation types present (grassland, flaxland, forest, and treeland) meet RPS criterion 2b[27] (2GP criterion 2.2.3.2 b.ii). Additionally, the sedgeland and flaxland are wetland habitats, which are a national priority for protection on private land (MFE, 2007), and which have been reduced to less than 20% of their former extent nationwide. Wetland habitats outside the designation site, even though not all occur on threatened land environments (Walker et al. 2015), are also significant under this criterion.

Diversity: The overall diversity of these habitat types, with forest or treeland on drier hillslopes and wetlands in connected gully / valley floors, and the overall diversity of indigenous taxa that these habitats support is significant in terms of RPS criterion 3[28] (2GP criterion 2.2.3.2 f). However, no individual vegetation types contain a notably high level of diversity compared to similar vegetation types elsewhere in the ED.

Distinctiveness: Neither the overall area nor any individual habitat components are distinctive.

Ecological context: The mosaic of individual small forest habitats in this area are in turn part of a network of forest patches in the wider area that allow dispersal of mobile indigenous fauna and spread of indigenous flora. The forest offers breeding habitat for indigenous bird species, and the presence of breeding eastern falcon makes this habitat of importance. Scrub, forest, treeland and grassland likely provide habitat of local importance for indigenous lizard species. The sedgeland and flaxland wetland areas also have an important buffering effect by moderating the water supply to downstream wetland habitats and the Ōtokia Creek. This area is therefore significant in terms of RPS criteria 5a, 5b, and 5c[29] (2GP criteria 2.2.3.2 e.i-iii).

Other criteria: No vegetation types meet the additional criteria for significance in the proposed 2GP criteria (2.2.3.2 a. Protected Areas, or 2.2.3.2 g., Size) that do not have an equivalent criterion in the proposed RPS.

[25] RPS criteria 1, Representativeness: *An area that is an example of an indigenous vegetation type or habitat that is typical or characteristic of the natural diversity of the relevant ecological district*

[26] RPS criteria 2, Rarity: a. *An indigenous species that is threatened, at risk, or uncommon, nationally or within an ecological district or coastal marine biogeographic region*.

[27] RPS criteria 2, Rarity: *An area that supports:* […] *b. Indigenous vegetation or habitat of indigenous fauna that has been reduced to less than 20% of its former extent nationally, regionally or within a relevant land environment, ecological district, coastal marine biogeographic region or freshwater environment including wetlands.*

[28] RPS criteria 3, Diversity: *Areas that support a high diversity of indigenous ecosystem types, indigenous taxa or have changes in species composition reflecting the existence of diverse natural features or gradients.*

[29] RPS criteria 5, Ecological Context: *The relationship of the area with its surroundings, including: a. An area that has important connectivity value allowing dispersal of indigenous vegetation and fauna between different areas; b. An important buffering function that helps to protect the values of an adjacent area or feature;* c*. An area that is important for indigenous fauna during some part of their life cycle, either regularly or on an irregular basis, e.g. for feeding, nesting, breeding, or refuges from predation.*

3.2.2.2 Plantation Forestry

This area, which includes the main cutover area (radiata pine / gorse / cocksfoot – Yorkshire fog treeland) type does not include indigenous[30] vegetation types. However, this area is significant as a habitat for indigenous fauna under the proposed RPS and 2GP criteria as it supports an At Risk – Recovering bird species (eastern falcon), and provides breeding, refuge, feeding or resting habitat for that species. It is therefore significant in terms of RPS criterion 2a and 5c (2GP criterion 2.2.3.2 b.i and 2.2.3.2 e.iii).

3.2.2.3 Rank Grasslands

Although the overall rank grassland areas that fringe the cutover area and roads ((Yorkshire fog) – cocksfoot grassland) are not indigenous[30], this area is likely to be significant as a habitat for indigenous fauna under the proposed RPS and 2GP criteria as it probably supports an At Risk – Declining lizard species (southern grass skink) and is therefore significant in terms of RPS criterion 2a (2GP criterion 2.2.3.2 b.i). It may, therefore, also be significant in that it likely offers feeding habitat for that lizard species (RPS criterion 5c, 2GP criterion 2.2.3.2 e.iii).

3.2.2.4 Working Farmland

This area, which comprises stock-grazed exotic grass grasslands / fodder crop herbfields and gorse scrub on private land adjacent to McLaren Gully Road, is not significant under RPS or 2GP criteria.

3.2.3 Ecological Value

An assessment of ecological value in conjunction with an assessment of an activity's possible magnitude of effect allows an overall level of ecological effect of a proposal to be determined; this is discussed using the methodology of Roper-Lindsay et al. (2018).

3.2.3.1 (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland

In terms of ecological value, this vegetation type is slightly to moderately representative of intact or remnant valley floor wetland habitats in the Tokomairiro ED, where rautahi-dominated sedgelands naturally occur in frosty, intermittently or permanently wet valley basins. However, this sedgeland is highly modified and degraded by the presence of extensive exotic weed species (particularly grasses), and it supports only a handful of the sorts of indigenous plant species that would be expected in intact rautahi-dominated sedgelands.

In terms of rarity / distinctiveness, it is highly rare, in that it is a naturally occurring wetland feature with areas in which indigenous species are abundant or dominant. Within the designation site and valley floor marsh wetland it occurs on a Category 2 land environment (Walker et al. 2015). Some very small areas of seepage wetland are present (seepages are a naturally rare ecosystem type; Williams et al. 2007), but this is likely an induced wetland type resulting from historical forest clearance. However, the species present within this vegetation

[30] The possible ambiguity of the definition of 'indigenous vegetation' is discussed in Section 3.2.1. Over 30% of vascular species included in the species list for this vegetation type are indigenous, but we do not consider it appropriate to describe this vegetation type as 'indigenous' because of the overwhelming dominance of exotic species in terms of structure, coverage, and number of individual plants. The apparently large number of indigenous species recorded is largely an artefact arising because this vegetation type occurs in numerous discrete areas of the designation site and on roadsides that fringe other vegetation types. Subsequently, many indigenous species are present as only isolated or scattered patches / individuals that have spread from nearby wetland, forest, and scrub vegetation types. These happen to have established in the grassland but do not contribute to the overall character of the grassland. In any case, the vegetation type likely meets regional / district significance criteria, and thus the requirements in terms of no-net-loss, and avoidance / mitigation (etc.) of effects are essentially the same, whether the vegetation is 'indigenous' or not.

type are not rare (indigenous species present are widespread and common), and the vegetation type is not distinct. It has a low level of species diversity and habitat pattern. It is of moderate importance in terms of ecological context, in that it buffers downstream wetland and stream habitats, although it provides poor habitat for indigenous avifauna and freshwater species.

It is overall of moderate ecological value.

3.2.3.2 (Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub

In terms of ecological value, this vegetation type is dominated by exotic weed species, and is not representative. As a vegetation community it is neither rare, nor distinct, and has a very low level of species diversity and habitat pattern, and strictly as vegetation has negligible ecological values. However, it is considered likely to provide habitat for an At Risk – Declining skink species. This habitat is therefore of some rarity and importance in terms of ecological context; it also provides habitat of low quality for widespread and common indigenous bird species.

It is overall of moderate ecological value. Ecological values of, and potential effects on, specific indigenous lizard species are discussed in Section 3.4 and 5.3 respectively.

3.2.3.3 Harakeke – gorse / (pūrei – rautahi) flaxland

In terms of ecological value, this vegetation type is moderately representative of intact valley floor wetland habitats in the Tokomairiro ED but is modified and degraded by the presence of extensive gorse and other exotic weed species. In terms of rarity / distinctiveness, it is highly rare, in that it is a naturally occurring wetland feature (as above), although the species present within it are not rare (indigenous species present are widespread and common), and the vegetation type is not distinct. Within the designation site, it has a low level of species diversity and habitat pattern. It is of moderate importance in terms of ecological context, in that it buffers downstream wetland and stream habitats, and likely provides seasonal feeding and breeding habitat for small numbers of widespread and common indigenous avifauna.

It is overall of moderate ecological value.

3.2.3.4 Kānuka forest

In terms of ecological value, this vegetation type is moderately representative of secondary forest types in the ED. Although the patches are small and modified by 'edge effects' such as weed invasion, they contain a range of typical indigenous canopy, mid-canopy and understory plant species. In terms of rarity / distinctiveness, it is moderately to highly rare, in that it supports an At Risk – Recovering bird species and may support one or two At Risk – Declining lizard species, although the plant species present within it are not rare (indigenous plant species present are widespread and common species), and the vegetation type is not distinct. In West Gully 3, it has a moderate to high level of species diversity and some habitat pattern; species diversity in the understory of West Gully 1 and East Gully kānuka forests was not assessed. It is of moderate to high importance in terms of ecological context, in that it provides seasonal feeding and breeding habitat for indigenous avifauna (and probably herpetofauna) and contributes to a network of indigenous forest fragments in the area.

It is overall of high ecological value.

3.2.3.5 [Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland

In terms of ecological value, this vegetation type is not representative of intact forest types in the ED. It is small and highly modified by 'edge effects' such as extensive weed invasion. The vegetation type is not rare or distinct. It has a low level of species diversity and habitat pattern. It

is of low to moderate importance in terms of ecological context, in that it provides some seasonal feeding and breeding habitat for indigenous avifauna and contributes to a network of indigenous forest fragments in the area.

It is overall of low ecological value.

3.2.3.6 Radiata pine / gorse / cocksfoot – Yorkshire fog treeland

Overall, this vegetation type is not representative, is not rare, and has a very low level of indigenous species diversity. It is of moderate importance in terms of its ecological context as habitat for falcon, but the quality of this habitat will lessen over time as the radiata pine mature (see Section 3.3.1.3 for further details).

It has negligible ecological value.

3.2.3.7 (Yorkshire fog) – cocksfoot grassland

This vegetation type is not representative and as vegetation has negligible ecological values, despite the presence of occasional individuals or patches of widespread and common indigenous plant species throughout the overall grassland area. However, it is likely to provide habitat for an At Risk – Declining skink species and therefore has a moderate level of rarity. While there is very low diversity and habitat pattern, this habitat is of some importance in terms of ecological context by likely providing skink foraging habitat fringing areas of denser vegetation that provide refugia. It may also to some extent provide a corridor for the dispersal of skinks, especially where it connects other habitats along roadsides.

It is overall of moderate ecological value as habitat. Ecological values of and potential effects on specific indigenous lizard species are discussed in Section 3.4 and 5.3 respectively.

~~3.2.1.8 Macrocarpa forest~~

~~This vegetation type is not representative, is not rare, has a very low level of indigenous species diversity and is of very low importance in terms of ecological context. It is of moderate importance in terms of its ecological context as habitat for falcon, but the quality of this habitat will lessen over time as the radiata pine mature (see Section 3.3.1.3 for further details).~~

~~It has negligible ecological value.~~

3.2.3.8 Other vegetation types

Areas of wetland with ~~(pūrei) – wiwi / cocksfoot rushland~~ [pūrei] – wīwī / rautahi – exotic grass rushland are likely to be an induced vegetation type that has arisen through grazing in historically wet areas. While this vegetation type is not representative, it is highly rare, in that it is a naturally occurring wetland feature (as above), although the species present within it are not rare (indigenous species present are widespread and common), and the vegetation type is not distinct. Habitat diversity and pattern is very low and although this vegetation type likely has some downstream buffering effect its location within farmland paddocks renders it of low importance in terms of ecological context.

It is of moderate ecological value.

Dense gorse scrub bordering McLaren Gully Road is not representative, is not rare, has a very low level of indigenous species diversity and is of very low importance in terms of ecological context.

It has negligible ecological value.

Exotic grass grassland and fodder crop herbfield vegetation types bordering McLaren Gully and Big Stone Roads are not representative, are not rare, have a very low level of indigenous species diversity and are of very low importance in terms of ecological context.

They are of negligible ecological value.

3.2.3.9 Threatened, At Risk Plants or Locally Uncommon Plants

Kānuka has a threat status of 'Threatened – Nationally Vulnerable' (de Lange et al. 2018). This threat status has been precautionarily assigned due to the possible and, as yet, poorly understood threat of myrtle rust to indigenous myrtle species (which includes kānuka).

Ordinarily, threatened species would be considered of very high ecological value according to the methodology of Roper-Lindsay et al. (2018). However, we do not consider this is the case for kānuka because of the circumstances above. Kānuka is an extremely common species at the level of the ED and nationwide and is not assigned a specific ecological value in this report nor is it assessed specifically in terms of magnitude / level of effect. Further, while it is probable that a small number of seedlings or low stature kānuka occur in areas affected by the proposal, this species largely or exclusively occurs in areas of the designation site that are outside the landfill footprint.

3.3 Avifauna

3.3.1 Wider Landscape

The proposed landfill, and designation site that the landfill sits within, is part of a wider landscape providing habitat for avifauna. This includes: Taieri Plain (pre-dominantly agricultural land and includes Dunedin Airport); Lake Waihola – Lake Waipori and Sinclair wetland complex; production pine forestry; and coastline (a section of the Otago coast is east of the proposed site). Data from the three OSNZ squares recorded 69 bird species across this wider landscape, including 21 introduced and 48 native species. Details of these areas are provided in the following sections; and Table A4-1, Appendix 5 summarises the species known from these areas (as well as those at the proposed landfill site as described below in Section 3.3.2).

3.3.1.1 Taieri Plain

The Taieri Plain is a low-lying, gently sloping basin, approximately 210 km^2 in size, located to the southwest of Dunedin. It is fertile land mainly used for agriculture (pre-dominantly dairy and sheep farming) and is the floodplain of Taieri River, Silver Stream and Waipori River. Dunedin Airport is situated on the Plains. The Plains are bordered by Mosgiel and the Silver Peaks to the northwest, coastal hills to the east, Lakes Waipori and Waihola to the southwest and Maungatua to the west (O'Sullivan et al., 2013). The area provides foraging, breeding and roosting habitat (including around the Airport) for a range of native and exotic bird species including gulls, passerines and waterfowl (Ryder Environmental Limited, 2019). South Island pied oystercatchers also sometimes forage in inundated pasture on the Plains.

Twenty-two bird species were recorded during the current surveys conducted around Dunedin Airport (refer to Figure 4 for survey locations and Table 9 for species list). Two additional species were also observed incidentally, increasing the overall total to 24 species. This included 11 native species and 13 exotic species. One At-Risk species, South Island pied oystercatcher, was recorded (two birds were observed foraging in a paddock). With respect to abundances, 324 native birds were recorded during the surveys and 774 exotic birds. However, these abundances, particularly that of exotic birds, underestimate the number of small passerines

(e.g. finches, starlings, blackbirds, sparrows) present in the area utilising roadside vegetation and the paddocks that are within the airport property (including directly adjacent to the runway) and surrounding farmland. These birds are small and very abundant, which made counts difficult. The counts of larger species, however, are accurate as they were easier to detect and identify. Of these larger species, black-backed gulls were the most abundant species (n=173), followed by mallard ducks (n=153) and rock pigeons (n=89) (Table 9). Overall, the Taieri Plain avifauna community assemblage was characterised by a diversity and abundance of small passerines as well as high numbers of ducks and black-backed gulls.

The flight patterns of the passerines observed were sporadic and largely comprised short, low flights across the paddocks to forage, or as a result of disturbance from planes, vehicles or farm work. Waterfowl were observed traversing the airport and looping around and landing in the paddocks. Dominant flight directions were north and south (i.e. presumably to and from the wetland complex described below). The average flight height of ducks (all species combined) ranged between 3 and 30 m and the maximum flight height recorded was approximately 50 m. North and south movements were also the dominant directions of flight for black-backed gulls. The average flight height of black-backed gulls ranged between 10 and 100 m and the maximum flight height recorded was approximately 150 m. Many of the birds recorded during the surveys were observed flying across the runway and directly over Dunedin Airport.

Table 9. Birds observed around Dunedin Airport during baseline point count surveys conducted between May 2019 and February 2020. Species observed incidentally are not included as their abundance was not recorded.

Species	Introduced / Native	Abundance	Proportion of observations (%)
Starling	Introduced	280	25.5
Black-backed gull	Native	173	15.8
Mallard duck	Introduced	153	13.9
Goldfinch	Introduced	126	11.5
Rock pigeon	Introduced	89	8.1
Spur-winged plover	Native	49	4.5
Harrier hawk	Native	42	3.8
Australian magpie	Introduced	37	3.4
Unidentified finch sp.	Introduced	27	2.5
Paradise shelduck	Native	23	2.1
Unidentified passerine	Introduced	20	1.8
Welcome swallow	Native	20	1.8
Song thrush	Introduced	10	0.9
Blackbird	Introduced	9	0.8
House sparrow	Introduced	9	0.8
Greenfinch	Introduced	8	0.7
Pukeko	Native	6	0.5
White-faced heron	Native	5	0.5
Redpoll	Introduced	5	0.5
South Island pied oystercatcher	Native	3	0.3
Bellbird	Native	1	0.1

Species	Introduced / Native	Abundance	Proportion of observations (%)
South Island fantail	Native	1	0.1
Grey warbler	Native	1	0.1
Skylark	Introduced	1	0.1
Total		**1098**	**100%**

3.3.1.2 Lake Waihola – Lake Waipori and Sinclair Wetland Complex

Lakes Waihola and Waipori and the Sinclair wetlands make up a large lake-wetland complex (approximately 2000 ha in total) located 6 km southwest of Dunedin Airport and approximately 8 km west of the proposed landfill site. This complex is one of the largest and most significant wetland systems remaining in New Zealand and it is recognised in Schedule 9 of the Otago Regional Plan as a Regionally Significant Wetland (Otago Regional Council, 2015; Ryder Environmental Limited, 2019). The wetland complex supports a high number of bird species that are resident or regular visitors to the area (Ryder Environmental Limited, 2019); 41 species were recorded during a survey in 2002 (Department of Conservation, N.D.) and a total of 61 species are listed in eBird[31]. It is recognised as a significant bird habitat that supports large numbers of waterfowl; up to approximately 10,000 birds have been recorded during surveys conducted (Otago Fish and Game, 2019[32]). High numbers of black-backed gulls (180), starlings (200) and lesser redpolls (320) have also been recorded in this area[33]. The area also supports At Risk and Threatened wetland bird species including a moderate population of South Island fernbird and low numbers of Australasian bittern and marsh crake.

During the surveys conducted at Lake Waihola as part of this assessment, 14 bird species were recorded (refer to Figure 4 for survey locations and Table 10 for the species list). Three additional species were also observed incidentally, increasing the overall total to 17 species (comprising 10 native and seven exotic species). One Threatened species (black-billed gull) and two At Risk species (black shag and red-billed gull) were observed. With respect to abundances, 189 native birds were recorded during the surveys and 30 exotic birds. More small passerines were observed in the wider area than were recorded as the focus was on larger, more mobile birds in the area.

The most abundant species observed were black-billed gull (n=129), black swan (n=25) and Canada goose (n=20) (Table 10). There were no distinct flight patterns as most birds were observed on land or resting on the lake, given the windy and choppy conditions during both surveys.

[31] Data accessed 6 December 2019 from https://ebird.org/newzealand/hotspot/L1082293.

[32] An eBird list accessed 6 December 2019 from https://ebird.org/newzealand/hotspot/L1082293 also reports observations of thousands of waterfowl.

[33] Data accessed 29 November 2019 from https://ebird.org/newzealand/hotspot/L1645480.

Table 10. Birds observed at Lake Waihola during baseline point count surveys conducted between May 2019 and February 2020. Species observed incidentally are not included as their abundance was not recorded.

Species	Introduced / Native	Abundance	Proportion of observations (%)
Black-billed gull	Native	129	58.9
Black swan	Native	25	11.4
Canada goose	Introduced	20	9.1
Black-backed gull	Native	10	4.6
New Zealand scaup	Native	8	3.7
Welcome swallow	Native	6	2.7
Mallard duck	Introduced	5	2.3
Grey teal	Native	4	1.8
House sparrow	Introduced	3	1.4
Red-billed gull	Native	3	1.4
Redpoll	Introduced	2	0.9
Australasian shoveler	Native	2	0.9
Black shag	Native	1	0.5
Harrier hawk	Native	1	0.5
Total		**219**	**100%**

3.3.1.3 Pine Forest

Exotic production pine forest is prevalent northwest and south of Dunedin. These plantations provide good habitat for eastern falcon (an At Risk species) for up to approximately four years post-felling (Seaton, 2014). This is because the open areas created attract many small birds that provide prey for falcon. The piles of pine slash also provide good nesting sites for falcon, 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.

Surveys conducted in October 2015 in 10 pine forest blocks northwest and south of Dunedin identified falcon at seven sampling points (Hope Hill, Cuttance (Moeraki), Popham's (below the summit of Ferry Hill), Morrison's, Akatore and Berwick), and included six single birds and one pair (Parker Conservation, 2015). A more recent survey (2016/17 falcon 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). During these surveys, falcon was the only At Risk or Threatened species detected using the exotic forest habitats.

3.3.1.4 Otago Coast

A section of the Otago coast borders the eastern/north-eastern extent of the wider landfill site and includes the Taieri River mouth/estuary, the Kaikorai Stream mouths/estuary and Brighton Beach. This area includes two Areas of Significant Biodiversity Value: Westwood Recreation Reserve (C037) and Edge of Kaikorai Estuary, Estuary and Lagoon (C106). Westwood Recreation Reserve is an important site of pingao and the Kaikorai area is described as containing an estuary mudflat, salt marsh and reed swamp and succulent herb swamp (Dunedin City Council, 2006). The wider coastal area supports a diverse number of bird species including native coastal and oceanic species such as gulls, terns, swans, ducks, shags, stilt and oystercatchers (Miller, 1993). High numbers of black-backed gulls have been recorded at Taieri

Rivermouth and Kaikorai Rivermouth (respectively 2500 and 1033; these are the highest counts of this species recorded on eBird[34]).

3.3.2 Proposed Landfill Site and Immediate Surrounds

The habitats available for avifauna at the proposed landfill site, include recently re-planted radiata pine forest, recently cleared macrocarpa forest, exotic grasslands, weeds and scrub, four regenerating native forest gullies (two of which are dominated by kanuka trees), and a small wetland area with associated waterways. More specific vegetation names and community descriptions are provided in Section 3.2.1.

The desktop review provided a base list of 51 bird species that use, or may use, these habitats at the landfill site and adjacent areas (Robertson et al., 2007; Ryder Environmental Limited, 2019). This list was narrowed down to 31 species, when species were excluded as their primary habitats were not within the project area, and / or are likely to be very rare visitors to the site. The list of 31 species is provided in Table 11 and includes two At Risk native species (eastern falcon and red-billed gull), 17 Not Threatened native species and 12 introduced species.

During the surveys conducted on site, 20 bird species were observed; two additional species (spur-winged plover and brown creeper) were observed incidentally, bringing the total number of species observed on site to 22 species out of the 31 species in the aforementioned list (Table 11). Of the 22 species observed, 14 were native and eight were introduced. One At-Risk species, eastern falcon (*Falco novaeseelandiae*), was observed on site. Seventy-three percent of the observations were of exotic birds and 27% of native birds. The most abundant native birds on site were tui and harrier hawk; collectively they made up approximately 10% of all observations (Table 12). It must be noted however, that the abundances of small passerines were greater than that reported, given the difficulty to accurately identify and count flocks of birds traversing the site. Overall, the avifauna community assemblage at the proposed landfill site was characterised by an abundance and diversity of passerines and occasional harrier hawks, black-backed gulls, magpies and ducks, as well as at least one falcon pair.

[34] Data accessed 6 December 2019 from https://ebird.org/newzealand/hotspot/L522600 and https://ebird.org/newzealand/hotspot/L523022

Table 11. Avifauna species present, or likely to be present, within the proposed landfill designation site. Data from the OSNZ square that encompasses the site and current field surveys. Species observed on site are indicated with an 'X'.

Species	Scientific Name	Conservation Status[35]	Native Forest	Exotic Forest	Scrub/shrubland	Farmland/open country	Freshwater/wetlands	Coastal/estuary	Residential	Observed at landfill site
Eastern falcon	*Falco novaeseelandiae "eastern"*	At Risk – Recovering[DP St]								X
Kereru	*Hemiphaga novaeseelandiae*	Not Threatened								X
Shining cuckoo	*Chrysococcyx l. lucidus*	Not Threatened								X
Kingfisher	*Todiramphus sanctus vagans*	Not Threatened								X
Brown creeper	*Mohoua novaeseelandiae*	Not Threatened								X
South Island fantail	*Rhipidura fuliginosa fuliginosa*	Not Threatened								X
South Island tomtit	*Petroica macrocephala macrocephala*	Not Threatened								
Bellbird	*Anthornis m. melanura*	Not Threatened								X
Tui	*Prosthemadera n. novaeseelandiae*	Not Threatened								X
Blackbird	*Turdus merula*	Introduced & Naturalised								X
Grey warbler	*Gerygone igata*	Not Threatened								X
Silvereye	*Zosterops lateralis lateralis*	Not Threatened								X
Yellowhammer	*Emberiza citrinella*	Introduced & Naturalised								
Chaffinch	*Fringilla coelebs*	Introduced & Naturalised								X
Greenfinch	*Carduelis chloris*	Introduced & Naturalised								X
Goldfinch	*Carduelis carduelis*	Introduced & Naturalised								X
Redpoll	*Carduelis flammea*	Introduced & Naturalised								X
House sparrow	*Passer domesticus*	Introduced & Naturalised								
Starling	*Sturnus vulgaris*	Introduced & Naturalised								X
Magpie	*Gymnorhina tibicen*	Introduced & Naturalised								X
Swamp harrier	*Circus approximans*	Not Threatened								X
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened								X
Skylark	*Alauda arvensis*	Introduced & Naturalised								X
Welcome swallow	*Hirundo n. neoxena*	Not Threatened								X
Dunnock	*Prunella modularis*	Introduced & Naturalised								
Song thrush	*Turdus philomelos*	Introduced & Naturalised								X
Paradise shelduck	*Tadorna variegata*	Not Threatened								X
Pukeko	*Porphyrio m. melanotus*	Not Threatened								
Black-backed gull	*Larus d. dominicanus*	Not Threatened								X
Red-billed gull	*Larus novaehollandiae scopulinus*	Declining								
White-faced heron	*Egretta novaehollandiae*	Not Threatened								

[35] Robertson et al. (2017)

Table 12. Birds observed at the proposed landfill site during baseline point count surveys conducted between May 2019 and February 2020. Species observed incidentally are not included as their abundance was not recorded.

Species	Introduced / Native	Abundance	Proportion of observations (%)
Goldfinch	Introduced	196	49.7
Unidentified finch sp.	Introduced	33	8.4
Tui	Native	20	5.1
Harrier hawk	Native	18	4.6
Greenfinch	Introduced	17	4.3
Redpoll	Introduced	16	4.1
Bellbird	Native	14	3.6
Welcome swallow	Native	13	3.3
Chaffinch	Introduced	11	2.8
South Island fantail	Native	11	2.8
Grey warbler	Native	10	2.5
Blackbird	Introduced	8	2.0
Black-backed gull	Native	7	1.8
Kereru	Native	4	1.0
Silvereye	Native	4	1.0
Australian magpie	Introduced	3	0.8
Shining cuckoo	Native	3	0.8
Eastern falcon	Native	2	0.5
Paradise shelduck	Native	2	0.5
Skylark	Introduced	1	0.3
Song thrush	Introduced	1	0.3
Total		394	100%

With respect to falcon, two observations were made during the formal survey periods constituting 0.5% of all observations made during the survey period; one was recorded during the May 2019 survey, the other during the July 2019 survey. On both occasions the falcon was heard calling. During the May observation the falcon was observed interacting with a harrier hawk above a stand of exotic conifers to the west of the site. During the July observation the falcon flew south-east over the site into an adjacent pine forest block. Two falcons 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. Falcon 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 were detected on site during the breeding season survey conducted. A falcon pair, however, did nest on site the previous breeding season (Fulton Hogan, *pers. comm.* 2019) and four falcon pairs have been recorded at, and/or in, the vicinity of the Smooth Hill area (Graham Parker, *pers. comm*. 2020). Falcon were heard in native forest to the north of McLaren Gully Road in June 2020.

Pre-dominant flight patterns observed by the species on site included short, low flights to and from the gullies, between the gully areas and patches of mature pine forest and recently re-planted pine, and within the recently re-planted pine. Exceptions to this were black-backed gulls, falcon and harrier hawks. These species were observed flying and soaring at higher elevations above the site and adjacent pine blocks and in the case of the black-backed gulls five of the seven observations headed west or north-west from the coast towards the Taieri Plains. The average flight height of black-backed gulls ranged between 20 and 25 m and the maximum flight height recorded was approximately 25 m.

3.3.3 Ecological Values at the Proposed Landfill Site

No *Threatened* species were recorded on the proposed landfill site, nor are any likely to utilise the site. Eastern falcon was the only species recorded on the proposed landfill site that has an *At Risk* classification (refer to Table 12); according to the EIANZ guidelines (refer to Table 5) this species is considered to be of Moderate ecological value based on its *At Risk – Recovering* classification. In addition, all the native *Not Threatened* and introduced species recorded on site (Table 12) are considered to have Low and Negligible ecological value (refer to Table 5).

3.4 Herpetofauna

3.4.1 Wider Landscape

The wider environment consists of highly modified land with some remnant native forest and scrub fragments, dominated by plantation forestry and farmland. Although there have been few formal surveys within the area, there is potential for lizards to be present within a variety of habitats, including rank grassland.

Three indigenous herpetofauna species, were found in the DOC Bioweb database. These records occur from 1967 to 2019 (Table 13). The few records lodged in the database are likely to reflect a lack of recent formal surveys in the area, rather than a lack of lizard presence. Table 13 includes species which are likely to occur within the area, and habitat types that they may utilize.

Table 13: 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.

Species	Common name	Threat classification	Nearest record	Preferred habitats	Likelihood of presence within designation site
Oligosoma* aff. *polychroma **Clade 5**	Southern grass skink	At Risk – Declining (Taxonomically Indeterminate)	7.5 km	Rank grassland, weedy areas of cutover pine forest, marginal habitats	High
Oligosoma maccannii	McCann's skink	Not Threatened	None recorded	Rank grassland, weedy areas of cutover pine forest, cobble / rock outcrops	Low
Naultinus gemmeus	Jewelled gecko	At Risk - Declining	15 km	Scrub, forest	Low
Oligosoma inconspicuum	Cryptic skink	At Risk - Declining	None recorded	Scrub, rock outcrops	Very Low
***Woodworthia* "Otago/Southland large"**	Korero gecko	At Risk – Declining (Taxonomically Indeterminate)	7 km	Rock outcrops, schist, scrub	Very Low

3.4.2 Proposed Landfill Site and Roadsides

The existing environment consists of variable, low to high quality habitat for native lizards. Habitat types that lizards often persist in are considered to be low value ecologically, such as rank grasslands, weed fields and regenerating scrub. Habitat types of this sort are present within the designation site and along roadsides; these have been described earlier (see Section 3.2.1).

No lizards were found under the ACOs when these were checked in March 2020. However, skink sign (scat) was observed on some ACOs, which indicates a potential population of skinks within the designation site (Dr Mandy Tocher, Ryder Environmental Ltd., *pers. comm.* 2020). This skink scat was found in ACOs located in areas immediately adjacent to the kānuka forest in West Gully 3. No ACOs were placed along McLaren Gully Road and only in some areas of grassland adjacent to Big Stone Road. No manual searches for lizards occurred within the designation site or along roadsides (see Section 2.5).

Based on the habitat types present and records held within the DOC Bioweb database, the following species may be present within the landfill designation site and along roadsides (see Table 13).

- 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 (recorded in 2002; Table 13), 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 roadsides. 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. Korero gecko is classified as At Risk – Declining.

- Based on species distribution in the wider area, McCann’s skink 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. 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 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.

Overall, the current habitat available for native lizards (particularly southern grass skink) may provide habitat for reasonably high densities within certain areas of the designation site and along roadsides (in a generally narrow strip of grassland between the road and boundary fences).

3.4.3 Ecological Value

No *Threatened* species were recorded on the proposed landfill site or along roadsides, nor are any likely to utilise these areas.

Southern grass skink may be present within the (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. According to the EIANZ guidelines, this species is considered to be of High ecological value based on its At Risk – Declining classification (Table 5).

McCann’s skink might be present within radiata pine - gorse / cocksfoot - Yorkshire fog shrubland / treeland found within the site. This species is considered to be of Low ecological value based on its Not Threatened classification (Table 5).

Jewelled gecko (At Risk – Declining) might be present within the kānuka forest (specifically West Gully 3). While the presence of this species is considered of a low likelihood, the species is considered of High ecological value based on its At Risk – Declining classification (Table 5).

Cryptic skink and Korero gecko, if present (a very low likelihood), are both classified as (At Risk – Declining) and are of High ecological value (Table 5).

3.5 Freshwater Ecology

There are two watercourses shown on the topographical map, which pass through the cutover pine plantation areas. No defined channels were found on site where the topographical streamlines were located. We also observed that gullies 3 and 4 had ephemeral flow paths under or at the base of the indigenous vegetation, but there were no clearly defined beds and a general absence in natural stream bed substrates. Wilding and Parkyn (2006) found that streamlines shown on topographic maps typically extend further up the catchment than headwater areas might on the ground; these streamlines often include reaches classified as ephemeral or intermittent.

The watercourses within designation site may have surface flow but only due to overland flow during rainfall events and did not provide any intermittent or permanent habitat for freshwater macroinvertebrate or fish fauna. With the absence of surface flow and wet conditions, these ephemeral flow paths will not provide habitat for indigenous fish, aquatic invertebrates, or indigenous aquatic plants that depend on flowing waterbodies.

In addition, there were isolated areas of standing water associated with the swamp wetland habitat located at the bottom / north of the site and connected to the valley floor marsh wetland. The swamp wetland and valley floor marsh wetland forms part of the headwaters of the Ōtokia Creek catchment, which flows to the sea at Brighton Beach. The swamp wetland and defined channel connecting it to the valley floor marsh wetland (within the designation site) may contain some surface water throughout the year. However, it's unlikely that there is sufficient water depth or permanence to support indigenous fish populations within the designation site, except possibly juvenile eels (see below for further information).

Conversely, the downstream reaches (receiving environment) between the designation site and McLaren Gully Road appeared to be perennial, or likely having surface water present all (or most) of the year based on observations from June 2020. There was a well-defined channel along much of the c.1 km reach (Figure 8).

Our observations on site, from multiple site visits over a range of seasons and during varied weather conditions, confirm this. We've based our assessment on the following definitions from Storey and Wadhwa (2009): an ephemeral stream is when concentrated flow occurs for short periods of time during and / or after rainfall but is otherwise dry for most of the time; there is no defined banks. Intermittent streams are neither perennial nor ephemeral; having intermittent flow and / or intermittent pools for the majority of the time and is confined in a channel with defined banks. Perennial streams have continuous flow contained within a well-defined channel.

While the defined channel was narrow (often only 200 – 300 mm wide) and meandering, the wetted width was variable and much wider, being c.1-2 m in most places and up to 5-10 m wide on occasion. Water depth was variable along the tributary, ranging from c.100 mm or shallower, to c.500-700 mm in pools.

A large and deep pond (probably human made) surrounded by pūrei is located approximately 200-300 m downstream of the designation site and just upstream of East Gully confluence above an historic artificial bund (last photo in Figure 8). This deep pond was similar in appearance (wetted extent) in April 2021 to what was observed in June 2020. However, the waterway (between the designation site and McLaren Gully Road) was found to be dry, with only occasional isolated pools where water was impounded (e.g. upstream of McLaren Gully Road culvert), in April 2021, after a prolonged and dry summer (Figure 9).

Figure 8. Some of the freshwater habitats present along Ōtokia Creek tributary, from (top to bottom) McLaren Gully Road to the designation site, June 2020.

Figure 9. Ōtokia Creek tributary at the McLaren Gully Road culvert (top left: downstream of culvert; top right: upstream of culvert) and the large pond approx. 200-300 m downstream to the designation site, April 2021.

The vegetation along this tributary has been described in Section 3.2. The freshwater system is described as a macrophyte-dominated, headwater tributary. The bed substrates were predominately fine silts and sands, with some small coarse substrates including gravel and cobbles. Thick black anoxic sediment was present in places. Iron deposits were present in the lower parts of the c.1 km reach surveyed.

The RHA Scores, assessed at four sites along the c.1 km reach, indicated habitat opportunities available for aquatic species were suboptimal. Total RHA scores ranged from 25 to 42 (out of a possible 100). The scores were due to a combination of limited hydraulic heterogeneity and low diversity in substrate and habitat availability for macroinvertebrates and fish. However, bank vegetation cover and shading, with stable undercut banks and relatively deep pools are present throughout the c.1 km reach.

The macroinvertebrate community, which provides a good indication of stream or ecosystem health, was dominated by "soft-bottom taxa" that tend to be more tolerant of slow-flowing waterways and / or degraded conditions. The community found at each of the four sites surveyed was similar, with seed shrimps (Ostracod), the ubiquitous native mud snail, *Potamopyrgus*, freshwater clams (Sphaeriidae), and other freshwater crustaceans (Cladocera and Copepoda) dominating the macroinvertebrate community. Aquatic worms, springtails, and other freshwater snails and freshwater hydra were also common. A single *Triplectides* caddisfly was collected from one site along the tributary. Damselfly nymphs (*Austrolesthes* and *Ischnura*), freshwater beetles (Scirtidae) and true fly larvae were also found in the waterway, but in low numbers.

Macroinvertebrate taxa vary in their tolerances, or sensitivities, to habitat and water quality. As most macroinvertebrates spend most of their life cycles in freshwater, they can provide a long-term picture of the stream or ecosystem health. The macroinvertebrate community index (MCI), and its variant (SQMCI), indicated this tributary of Ōtokia Creek had "poor" stream health and water quality (based on Stark & Maxted 2007; cf. Table 1) (MCI scores: 49.7-74.4; SQMCI scores: 1.9-2.3).

No fish were found during our survey in June 2020, however, habitat suitable for fish species (e.g. pools with overhanging vegetation) was present in the survey reach. It is important to note that this survey was conducted in winter and outside of the November to April timeframes recommended for fish surveys (Joy et al. 2013).

~~It's likely that banded kokopu, possibly eels and kēkēwai (freshwater crayfish) may be present in the Otokia Creek tributary downstream of the designation site. The New Zealand Freshwater Fish Database records show that Otokia Creek catchment supports indigenous fish species including koaro, banded kokopu, longfin eel, giant kokopu and inanga in the lower catchment.~~

~~It is important to note that this survey was conducted in winter and outside of the November to April timeframes recommended for fish surveys (Joy et al. 2013). Additional surveys of the reach between McLaren Gully Road and designation site are recommended to be completed in spring or summer to clarify the June 2020 survey results. At this same time, it would be worthwhile to also conduct a survey of the fish fauna and determine if any barriers to fish passage are present, on adjacent private land downstream of McLaren Gully Road.~~

In April 2021, the only location within the downstream receiving environment with sufficient surface water present for assessing fish communities was the large pond located approx. 200-300 m downstream of the designation site. The nature of the pond (extent and depth) also made it difficult to set nets and eDNA could not be collected. Despite these challenges, one longfin eel (*Anguilla dieffenbachii*) and two shortfin eel (*Anguilla australis*) were captured in the two baited fyke nets. Longfin eel has a conservation status of "At risk, declining"; shortfin eel is "Not threatened" (Dunn et al. 2018).

Both species of eel are migratory species, requiring access between freshwater and marine environments. Eels are very long-lived species, living in freshwater habitats for many decades before migrating to sea for a single reproductive event.

The three eels captured were all approximately 500 mm in length. Accurately aging eels is complex and requires killing individuals to measure their otoliths or "ear bones". Further, the size of an eel is not always a good indicator of its age, as growth rates can be variable depending on where they live (e.g. a 500 mm length eel could be 2 years old if growing in certain habitat conditions, but could be 30 years old in a cold lake). It is possible that the eels captured in the pond downstream of the designation were a few years old and would have migrated up the tributary from Ōtokia Creek. It is also possible that, despite the limited presence of surface water in the defined channel in April 2021, the surrounding wetland soils were still

relatively water-logged in places. It is plausible (based on experience in similar habitats around the South Island) that these adjacent wetlands provide refuge habitats for fish (in this case eels) during drier periods when surface water in the stream channels is limited or absent.

3.5.1 Ecological Value

The ecological value of the swamp wetland (within the designation site) and of the valley floor marsh wetland (downstream receiving environment) has been described in terms of values associated with indigenous wetland vegetation in Section 3.2.

There are no stream habitats within the designation site, so the ecological value within the designation site has not been assessed further.

The Ōtokia Creek tributary, between the designation site and McLaren Gully Road, is of low or very low representativeness, with modified habitat and water-quality conditions. However, it is thought to be perennial for much (or all) of the reach surveyed downstream of the designation site, noting that surface water was largely absent in April 2021 after a prolonged and dry summer. Rarity is moderate: the waterway supports at least two indigenous species of freshwater fish, including an at-risk species (longfin eel). The macroinvertebrate fauna is relatively depauperate and considered "pollution tolerant", including ubiquitous taxa typically found in slow-flowing, modified watercourses[36]. Diversity and pattern is moderate: aquatic habitats present are typically modified with some being degraded due to forestry practices; while these habitats support indigenous fauna, including an At-Risk species, these communities are impacted and indicative of "poor" stream health. The waterway does form part of the wetland system that is the valley floor marsh wetland. As described in Section 3.2, although modified and degraded, it is a naturally occurring wetland feature and occurs on a Category 2 land environment (Walker et al. 2015) and is of moderate importance in terms of ecological context. Further, the waterway provides connectivity along the valley floor marsh wetland, to the pond and between these habitats and the Ōtokia Creek and the sea.

Considering the above, the waterway is of ~~low~~ moderate ecological value as far as freshwater ecology values are concerned. ~~However, the presence of At-Risk migratory freshwater fish species in lower reaches of Otokia Creek catchment suggests that the waterway may support some of these fish species.~~

Shortfin and longfin eel was found in the pond and may be present in areas throughout the wetland and stream system between the designation site and McLaren Gully Road. According to the EIANZ guidelines, longfin eel is considered to be of High ecological value, based on its At-Risk, Declining status; shortfin eel is considered to be of Low ecological value based on its Not Threatened status (Table 5).

~~If this waterway supports freshwater fish species (e.g. banded kokopu and longfin eel) and possibly kōkōwai, its ecological value would be considered moderate, not low.~~

~~Given the fish surveys were not conducted in the recommended season, we have applied the precautionary principle and consider the overall ecological value, for freshwater, as **moderate**.~~

[36] No Threatened, At-Risk or locally endemic species, or any other species of conservation concern were found in the macroinvertebrate community, noting that species-level identifications are very difficult for the taxa found in this waterway.

3.6 Summary of Ecological Values & Significance

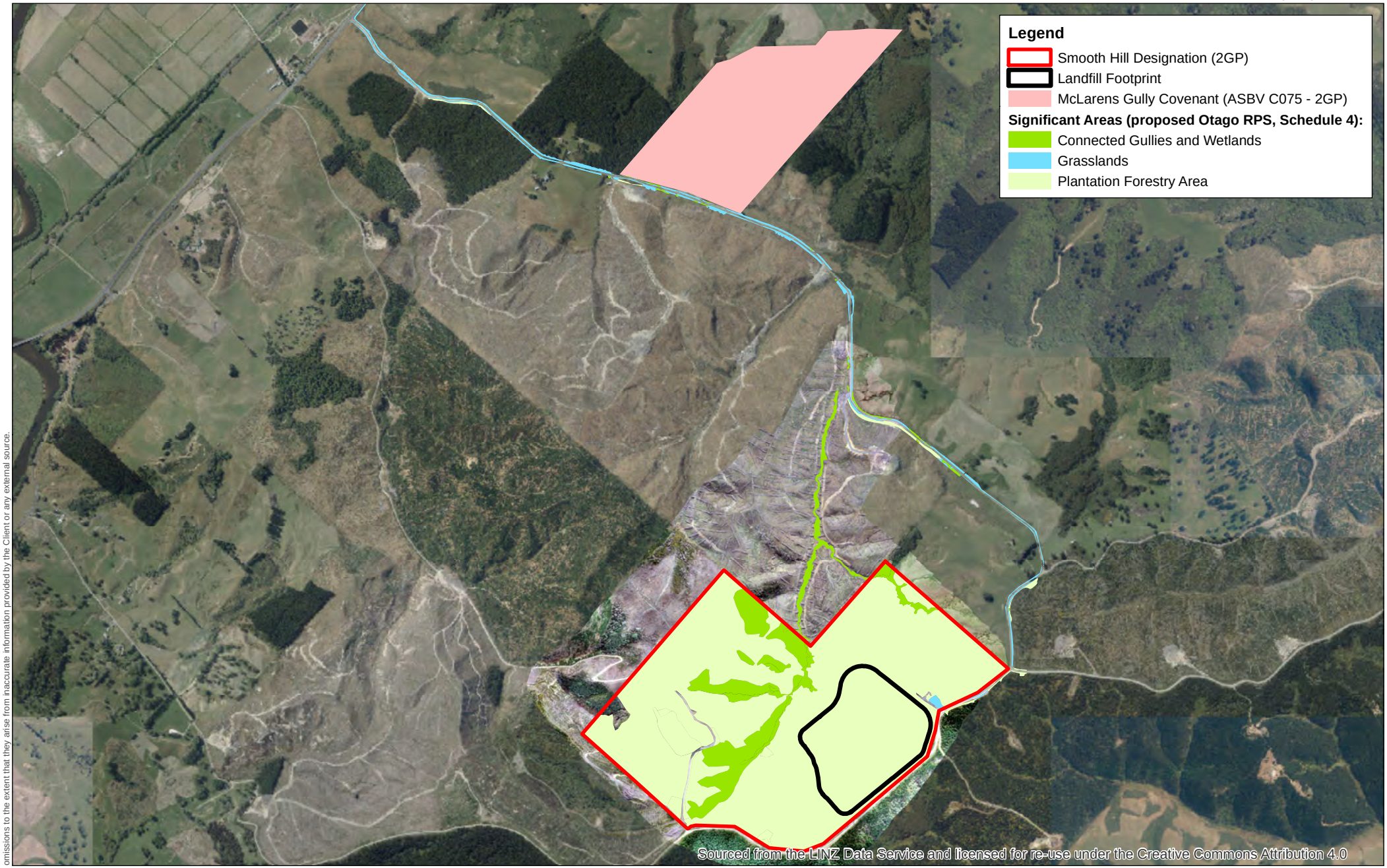
Table 15 and Figure 10 summarises the vegetation types present within the designation site that are significant under proposed RPS criteria, and that are significant under the equivalent criteria in the proposed 2GP.

Table 14. Summary of the ecological significance of the vegetation and habitats within the landfill footprint against the Partially Operative Otago RPS (ORC 2019) matters for determining significant indigenous biodiversity.

Habitat Type	Meets at Least One Criteria?	Overall Matters Met
Connected gullies and wetlands	Yes	1, 2a-b, 3, 5a-c
Plantation forestry area	Yes	2a, 5c
Grasslands	Yes[37]	2a, 5c
Working farmland	No	-

Table 16 summarises our assessment of ecological values following the EIANZ guidelines (Roper-Lindsay et al. 2018) (see Section 2.8).

[37] If southern grass skink or other At-Risk lizard species are present, see Section 3.4.



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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

Significant Areas Within / Adjacent to the Designation Site and Road Widening Area

Date: 20 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: TBl

Figure 10

Table 15. Summary of ecological values assigned to vegetation, habitats and communities and indigenous fauna within the site.

Ecosystem Component	Representativeness	Rarity / Distinctiveness	Diversity and Pattern	Ecological Context	Overall Ecological Value
Terrestrial Vegetation and Habitats					
(Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland	Low-Moderate	High	Low	Moderate	Moderate
[Large-leaved pohuehue] / (Himalayan honeysuckle) – gorse scrub	Very Low	Moderate	Very Low	Moderate	Moderate
Harakeke – gorse / (pūrei – rautahi) flaxland	Moderate	High	Low-Moderate	Moderate	Moderate
Kānuka forest	Moderate	Moderate-High	Moderate-High	Moderate-High	High
[Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland	Low	Low	Low	Low-Moderate	Low
Radiata pine / gorse / cocksfoot – Yorkshire fog treeland	Very Low	Very Low	Very Low	Moderate	Negligible
(Yorkshire fog) – cocksfoot grassland	Very Low	Moderate	Very Low	Moderate	Moderate
~~Macrocarpa forest~~	~~Very Low~~	~~Very Low~~	~~Very Low~~	~~Moderate~~	~~Negligible~~
[Pūrei] – wīwī / rautahi – exotic grass rushland	Low	High	Very Low	Low	Moderate
Gorse scrub	Very Low	Very Low	Very Low	Very Low	Negligible
Exotic grass grassland / fodder crops	Very Low	Very Low	Very Low	Very Low	Negligible
Avifauna					
Eastern falcon	At Risk - Recovering				Moderate
Native *Not Threatened* species (refer to Table 11)	Not Threatened				Low
Introduced species (refer to Table 11)	Introduced				Negligible
Herpetofauna					
Southern grass skink	At Risk – Declining (Taxonomically indeterminate)				High
Jewelled gecko	At Risk – Declining				High
Cryptic skink	At Risk - Declining				High
Korero gecko	At Risk – Declining (Taxonomically indeterminate)				High
McCann's skink	Not Threatened				Low
Freshwater Ecology					
Ōtokia Creek Tributary	Very Low-Low	~~High (or Low if fish are not present)~~Moderate	~~Low~~Moderate	Moderate	Moderate ~~(or Low if fish are not present)~~
Longfin eel	At Risk – Declining				High
Shortfin eel	Not Threatened				Low

4.0 Description of Proposed Works

The project involves the staged construction, operation, and aftercare of a class 1 landfill for the disposal of municipal solid waste, and associated upgrades to McLaren Gully Road (including its intersection with State Highway 1) and Big Stone Road.

The following is a summary of the physical components of the project, taken from the Assessment of Environmental Effects:

4.1 General Landfill Description

The project involves the staged construction, operation, and aftercare of a class 1 landfill for the disposal of municipal solid waste and hazardous wastes, and associated upgrades to McLaren Gully Road (including its intersection with SH1) and Big Stone Road.

The landfill will have a capacity of approximately 2.94 million cubic metres and expected life at current Dunedin disposal rates of approximately 40 years.

Compared with the original proposal as lodged, the landfill size has been reduced under the updated design as a result of moving the toe of the landfill to avoid the wetland areas within the site. The landfill lies within the footprint of Stage 1 and Stage 2 of the original design, with the western Stages 3, 4 and 5 no longer included.

In overall terms:

- the footprint of the landfill is reduced from 44.5 ha to 18.6 ha.
- landfill (gross) capacity is reduced from appropriately 7.9 million cubic metres to 3.3 million cubic metres.
- net waste capacity is reduced from 6.2 million cubic metres to 2.94 million cubic metres.
- Based on the lower predicted waste generation rates (from 90,000 tonnes per year to 60,000 tonnes per year), the predicted landfill life has reduced from 55 years to approximately 40 years.

In addition, practical adjustments to the general construction of the landfill, have been made including:

- Landfill staging and construction sequencing, to a more typical ‘bottom-up’ filling methodology, which improves the intermediate and overall landform stability of the new design.
- Leachate containment and collection systems adjusted to reflect the updated construction sequencing.
- Construction phase systems for stormwater diversion, treatment and control.
- Relocation of the attenuation basin to the west of the updated landfill footprint rather than immediately downstream of the landfill toe.

The scope of the project includes the following components:

- Earthworks to construct the required landfill shape including the base grade and final cap.
- Low permeability lining system to prevent leachate seepage into the surrounding environment, including a groundwater collection system beneath the liner.
- Leachate collection system above the low permeability lining system, and storage of leachate, prior to transport by tanker from the site for disposal.
- Stormwater control around the landfill and other areas of the site with appropriate treatment and attenuation of stormwater before it discharges to watercourses within the site.
- LFG collection system, and destruction of LFG by combustion. In future LFG may also be used electricity generation, and space has been reserved for generating plant.
- Progressive filling of the landfill, including application of daily and intermediate cover, and final capping.
- Vehicle movements to and from the site, and within the site, including heavy vehicles, and vehicles for staff, contractors, and visitors.
- Operational infrastructure, including weighbridge and vehicle wheel wash.
- Additional ancillary services including operation of small backup diesel generator to power leachate extraction pumps.
- Facilities for site staff.
- Maintenance facilities for site plant and equipment.
- Overhead power supply lines to the site capable of HV transmission of electricity from future LFG fired generating plant.
- Provision of water supplies for operational (non-potable) and staff (potable) requirements.
- Landscape and ecological mitigation, including perimeter planting.
- Environmental monitoring infrastructure, including groundwater and LFG wells.
- Upgrade and sealing of McLaren Gully Road, including its intersection with SH1, and Big Stone Road.
- Landfill site access from Big Stone Road, and permanent and temporary internal roads required to access the various parts of the site.

4.2 Waste Types

The landfill will accept municipal solid waste (MSW), and hazardous waste that meets the leachability limits in the Ministry for the Environment Module 2: Hazardous Waste Guidelines (2004) - Class A. Contaminated soils and special wastes that meet these criteria will be accepted, including biosolids from the Green Island Waste Water Treatment Plant.[38]

[38] Special waste is material that requires special handling at the landfill to ensure it does not pose a risk to the environment or human health during the disposal process and includes sludge, animal carcases, asbestos and ashes.

Generally, cleanfill such as demolition waste, and organic bulk green waste will be diverted from the waste stream and managed at facilities closer to Dunedin. It is however expected that some cleanfill or organic green waste will be intermingled with other waste and be deposited in the landfill.

4.3 Landfill Siting, Capacity, and Staging

The concept landfill operational area occupies approximately 18.6 ha of the 177.8 ha landfill site.

Construction, filling, and final capping of the completed landfill will occur progressively in four stages supported by a 10m high toe embankment constructed at the northern end of the site. Stage 1 involves filling behind the toe embankment. Stages 2 to 4 will then progress in a clockwise fashion from northeast to 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. The filling sequence will be developed during detailed design. 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.

4.4 Landfill Formation

The landfill concept has been designed to ensure that it will be stable during construction, filling, and in the long-term following closure. The landfill is buttressed against existing hill sides on three sides, with the northern low end of the landfill being supported by a 10m high toe embankment constructed from engineered fill, which facilitates placement and retention of waste, and containment of leachate. The embankment will be constructed in its entirety across the base of the landfill as part of the initial landfill development works.

Construction of each stage of the landfill will require cutting into the existing valley to remove compressible/problematic soils. This includes removal of all loess and organic soils and some of the underlying weathered and unweathered breccia rock. Excavated material (other than unsuitable organic soils) will be used to form the landfill base grade. The final cap will be progressively established as filling is completed.

4.5 Leachate Containment and Management

Leachate is the liquid by-product of waste degradation which typically combines with rain water percolating through the placed waste. As these liquids percolate downwards, they further combine and collect dissolved and/or suspended matter from the waste profile. The landfill concept has been designed to both minimise the volume of leachate produced, and contain and collect any leachate to prevent it from the entering the underlying soils, groundwater, or downstream receiving environment.

The volume of leachate generated will be managed through the following measures:

- Preventing clean upslope surface water from entering the placed waste mass and leachate collection system.
- Minimising the size of the active waste tipping area where waste is exposed to rainfall.

- Covering areas with intermediate cover or final capping as soon as is practicable so that as much water as possible is diverted to stormwater collection systems and to further prevent water ingress to placed waste.

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.

4.6 Surface Water Management

The landfill will be constructed at the upper end of the McColl Creek catchment. Ephemeral watercourses convey flows of water during rainfall events into the downstream tributary of the Ōtokia Creek. Stormwater management and control will be required across the landfill construction, operation, and aftercare phases to divert and separate stormwater from construction areas and waste; minimise and contain sediment runoff; and discharge diverted stormwater into the Ōtokia Creek receiving environment in a way that avoids adverse effects on downstream flows and water quality.

Surface water collection and conveyance will comprise both permanent and temporary systems. Consistent with the WasteMINZ guidelines, the permanent systems will be designed to accommodate a 1% AEP storm event, and temporary systems designed to accommodate a 10% AEP storm event. The stormwater systems will divert and enable separation of all stormwater flow from areas where waste is placed. They will also enable monitoring of stormwater from areas of intermediate cover or final cover and ability to redirect contaminated surface water to the leachate system if it is found to be contaminated.

The stormwater management systems include:

- For stage 1 only, stormwater outlet pipes through the toe bund for the discharge of stormwater collected within the stage 1 area to the downstream ephemeral watercourse. This recognises that for stage 1, the base of the landfill and stormwater control systems are at a lower elevation than the perimeter swale drain (described below), and gravity drainage of the stormwater to the swale drain is not possible. Once stage 1 is complete, the pipes through the bund will be permanently sealed, and stormwater from the completed stage 1 surface will be directed to the swale drain and attenuation basin.
- Permanent perimeter swale drain to intercept upslope flows and divert them around the landfill to the attenuation basin to the west of the landfill (described below). As there is no significant external catchment this drain will primarily collect stormwater from the interim and final landfill surfaces. This is except for stage 1, for which stormwater will be drained via pipes through the toe bund to the downstream watercourse until stage 1 is completed (as described above). The swale drain will remain in operation following closure of the landfill.
- Permanent attenuation basin, receiving stormwater from 35.4 ha of the landfill site, including from: the perimeter swale drain; pre-construction areas; construction areas; western stockpile 2, landfill operational areas not subject to waste contamination; the upper facilities areas; and the final cap. As noted above, stormwater from stage 1 will be drained via pipes to the downstream watercourse until stage 1 is completed, after which

stormwater will be directed via the swale drain to the attenuation basin. The basin will remain in operation following closure of the landfill.

- Sediment retention ponds (SRPs). SRPs will be constructed to collect and provide primary treatment of stormwater from the eastern stockpile 1, western stockpile 2, and lower facilities area to remove sediment prior to discharge. In addition, within the landfill footprint a SRP will be constructed at the immediate base of the excavation for each stage of the landfill. The SRP for each stage will remain in operation for the life of that stage until subsequent stage works require their removal. An SRP will then be installed for the subsequent development stage. Stormwater from the SRP's will be discharged either to the attenuation basin or downstream watercourses.
- Temporary stormwater drains and grades on the landfill operational surfaces, as required for the stage of operation, that diverts all stormwater to the landfill perimeter drain. This is except stormwater that has come into contact with waste, which will be diverted to the leachate collection system.
- Grading of the final cap to flow to the perimeter swale drain. Where final cap slopes exceed 1V:5H, permanent contour drains discharging to the perimeter swale drains will be installed up slope to control flows.
- Stormwater generated by the upgraded roads outside the site will continue to discharge either via roadside swales, or directly to roadside watercourses and wetlands as currently occurs.

The perimeter swale drain will be constructed progressively as the landfill stages are developed and will provide for a continuous down gradient flow from the southern high point of the landfill. The drain will be constructed to accommodate a 1% AEP storm event (plus 300 mm freeboard), and consist of a mix of grass channel, reinforced earth (grass root matting), and rock rip-rap to provide scour protection where flows exceed 0.8 m/s.

The attenuation basin will be constructed as part of the initial landfill development works. The attenuation basin is designed to accommodate a 1% AEP storm event and will attenuate increased surface runoff from the landfill site and provide additional water treatment prior to discharge to the Ōtokia Creek receiving environment. Surface runoff will first enter an unlined "wet" forebay. The forebay will provide initial treatment and for soakage to recharge the downstream groundwater system. Higher flows that exceed the capacity of the forebay will pass through a waioro filter consisting of gabion baskets, and enter a second unlined "dry" basin for infiltration or discharge via a low flow outlet to the Ōtokia Creek.

The second basin will have a retaining structure with a spillway, and will contain up to 5,000 m^3 in a 1% AEP storm event. Flows exceeding this volume in a 1% AEP event will pass over the stabilised spillway downstream. The basin will otherwise typically be dry. The base of the dry basin will be planted with appropriate wetland type plant species. The low flow outlet pipe from the attenuation basin will also be provided with an emergency shut off value that can be closed in the event that leachate contaminated stormwater enters the basin. This will enable containment and removal of the stormwater off site.

The majority of stormwater from the construction and operational areas of the site will report to the attenuation basin, except for the eastern stockpile 1which is located in a sub-catchment gully (East Gully), and the lower facilities area that also drain to the downstream tributary of the Ōtokia

Creek. Stormwater collected from these areas will first pass through permanent SRPs, prior to discharge downstream. Furthermore, as noted above, stormwater from stage 1 will also be drained via pipes to the downstream watercourse until stage 1 is completed, after which stormwater will be directed via the swale drain to the attenuation basin.

4.7 Groundwater Management

Excavation to create the landfill base grade may expose groundwater seepages. Control and drainage of groundwater will be installed beneath the low permeability liner system to avoid the creation of uplift pressures and risks of localised failures of the liner.

Control of groundwater will be achieved by constructing a network of subsoil drains below the upslope toe of the bund and low permeability liner system as part of the development of each stage of the landfill. The groundwater drainage consists of perforated pipework, encased in graded aggregates and filter fabric to prevent soil particle loss to the drainage. In the very unlikely event that leachate seeps through the liner system, the subsoil drains also provide a collection system for leachate seepage.

Collected groundwater will gravitate to the low end of the landfill from where it will be collected and discharged to the watercourse north of the toe embankment or pumped to non-potable water supply storage tanks.

Groundwater levels are expected to fall below the elevation of the drains in response to the loss of recharge caused by progressive landfill liner construction. It is therefore anticipated that only minor volumes of groundwater will be abstracted through the subsoil drainage system over the life of the landfill, with the greatest rates of dewatering (maximum estimated discharge in the range of 87 m^3/day (approximately 1 litre/second)) occurring when dewatering systems are initially installed.

4.8 Landfill Access

Vehicle access to the site will be from SH1 via McLaren Gully Road and Big Stone Road. Secondary alternative access is also available via Big Stone Road which connects through Brighton and Dunedin, in the event that SH1 or McLaren Gully Road are inaccessible.

Traffic will access the site from Big Stone Road from a new access located approximately 350 m from the intersection of McLaren Gully Road and Big Stone Road. The access will be used by all operational staff, construction traffic, and waste and leachate trucks. No public access will be allowed. The access is approximately 200 m long and will be formed with an 8 m wide sealed carriageway and have a lockable gate at the entrance. Stormwater from the access will be collected and discharged to the landfill perimeter drain and attenuation basin.

Access arrangements within the landfill include:

- Internal roads constructed from aggregate providing access from the upper facilities area to the landfill operational area, lower facilities area, and soil stockpile areas. Stormwater from these roads will be directed to the attenuation basin.

- Temporary roads constructed from aggregate on the landfill operational area to provide passage of the waste delivery trucks. These temporary access roads will be amended regularly as each cell is progressively filled.
- Perimeter access track constructed from aggregate to enable access around the site for environmental monitoring and maintenance purposes. The track will be constructed in its entirety as part of the initial construction works.

Outside of the site, the SH1 / McLaren Gully Road intersection is proposed to be upgraded, including adding a southbound left turn lane on the state highway, and lighting. McLaren Gully Road and Big Stone Road will also be upgraded, widened, and sealed as far as the new site access to ensure they can safety accommodate two-way traffic and increased traffic demands arising from the operation of the landfill.

The updated design for the upgrade of McLaren Gully Road and Big Stone Road has taken into account the occurrence of wetlands along the road margins. To the extent practicable, wetlands have been avoided through the updated road design. This has included adjustment of the road centreline and grade.

4.9 Landfill Facilities

Various site facilities are proposed to support the operation of the landfill. The majority of these are intended to be located within a facilities area on a high platform located to the east of the landfill and accessed from the site access from Big Stone Road (upper facilities area). Other facilities will be located on a lower platform to the north of the landfill and accessed from an unsealed access from the main facilities area (the lower facilities area).

4.10 Landfill Construction

Construction of the landfill will occur progressively over the life of the landfill, and include initial development works, works associated with the development of each stage, and works associated with landfill closure.

Construction of the landfill across all stages will involve vegetation clearance, followed by bulk earthworks. Bulk earthworks to construct the landfill base grade of each stage are expected to typically involve cuts of 5 m depth, but will be deeper on some ridges. Excavated topsoil, loess, and some underlying weathered and unweathered breccia will be progressively stripped, separated, and stockpiled, for reuse over the life of the landfill development.

Stockpiles will be established in the landfill footprint, or two dedicated stockpile areas located to the east (stockpile 1), and west (stockpile 2) of the landfill.

Sediment control measures including stabilisation, temporary and permanent cover such as grass, silt fences, sediment retention ponds (SRP), and cut off drains will be established in the stockpile areas to ensure sediment is retained and does not run off into watercourses, and ultimately downstream to the Ōtokia Creek.

5.0 Assessment of Effects

The following assessment of effects on the ecological values within the designation site is in accordance with the EIANZ EcIA guidelines (Roper-Lindsay et al. 2018).

We determine the magnitude of the potential effects of the proposed activities and then the likely level of effect without mitigation. The assessment has been limited to the potential effects of activities on the ecological values within the designation site, the downstream wetland / stream and widening of McLaren Gully and Big Stone Roads.

A typical scale of magnitude ranges from very high to negligible.

The level of effect (without mitigation) ranges from “very high” to “very low” or “net gain” for positive effects.

The level of effect provides guidance on the extent and nature of the ecological management response required.

5.1 Terrestrial Vegetation and Wetlands

The following potential construction and operational phase effects were considered for this assessment:

- vegetation removal or disturbance;
- loss of threatened or At-Risk species;
- weed encroachment and introduction; and
- downstream effects on wetlands.

5.1.1 Vegetation Removal or Disturbance

Construction of the landfill requires large-scale vegetation clearance and earthworks across a range of habitat types within the designation site. Section 3.2 describes the vegetation communities and habitats within the designation site and road expansion footprint that could potentially be affected by the proposed activities. ~~These vegetation communities and habitats sit on a spectrum with respect to the level of modification and the diversity and dominance of indigenous species, ranging from highly modified communities with no or few indigenous species, to less modified indigenous-dominated communities.~~

No works will occur in or otherwise adversely affect an Area of Significant Conservation Value near McLaren Gully Road (McLarens Gully Covenant, Site Number C075) scheduled in the 2GP maps.

We understand that some aspects of the landfill layout are still in development. Therefore, vegetation clearance calculations (using GIS analysis) were made based upon the following design specifications:

- Construction footprints for the landfill, construction of access roads within the designation site, a stockpile, infrastructure / buildings, and a stormwater attenuation basin – georeferenced designs were provided to Boffa Miskell by GHD on 18 August

2020 (prepared by GHD, 'General Arrangement Plan McLaren Gully Road Option' – Drawing 51-12506381-01-C102 Revision 1).

- Construction footprints for the widening of McLaren Gully Road and Big Stone Road – georeferenced designs were provided to Boffa Miskell by GHD on 13 May 2021. This design replaces a 26 May 2020 and a 06 April 2021 version, both of which would have encroached more substantially upon wetland habitats.

For the purposes of this assessment, we have assessed the overall ecological impact of the total clearance and areas of permanent loss of the terrestrial vegetation and habitats within this footprint of works. We have assumed that the outer design extents provided by GHD are the maximum extent of all works and that any infrastructure required to prevent effects beyond this footprint (e.g. including construction footprint, stormwater / leachate interception drains, silt fences, other erosion and sediment control measures) are contained within this design footprint. Further, our assessment has generally not been broken down in terms of landfill staging or works type within the designation site. However, ecological effects due to road widening are differentiated where relevant. Minor changes to the precise location and layout of landfill structures, roads, embankments and other infrastructure during further design stages of the project is not considered likely to substantially alter our assessment, unless there is encroachment into indigenous vegetation and / or if alterations to road design alter the extent of any impacts to ecologically significant habitats (specifically wetlands, see Section 3.2.2).

Table 17 shows the approximate area of vegetation removal proposed as part of landfill development and road widening. Appendix 6 shows the approximate area of vegetation removal proposed, broken down by the infrastructure / works type.

Table 16. Vegetation community description, its ecological value and significance and the extent (hectares), if any, of these vegetation communities that will be removed or disturbed by overall landfill construction and road widening.

Vegetation Community	Ecological Value[39]	Ecologically Significant[40]	Vegetation Removal / Disturbance (m^2 and ha)
(Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland	Moderate	Yes	~~0.72~~[41]13.8 m^2; 0.0014 ha
(Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub	Negligible	Yes	0.10[42]none
Harakeke – gorse / (pūrei – rautahi) flaxland	Moderate	Yes	~~0.08~~[43]none
[Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland	Low	Yes	~~4.52~~none

[39] See Section 6.1

[40] See Section 3.2.2.

[41] ~~An area of this vegetation type will be cleared to construct a stormwater attenuation basin. No surrounding infrastructure beyond the final pond location is indicated in the current landfill layout (provided 18 August 2020), but it is considered probable that additional clearance of this habitat type will occur through vehicle movements and earthworks to construct the pond that are not shown in the layout available. While the extent of this additional clearance is not presently known, it does not alter our assessment in this section in terms of magnitude or levels of ecological effect, but does have implications in terms of 'no net loss' of habitat, discussed in Section .~~

[42] ~~As above.~~

[43] ~~As above.~~

Radiata pine / gorse / cocksfoot – Yorkshire fog treeland	Negligible	Yes	~~34.92~~338,830 m²; 33.88 ha
~~Macrocarpa forest~~	~~Negligible~~		~~8.80~~
(Yorkshire fog) - cocksfoot grassland	Moderate	Yes	31,475 m²; 3.15 ha~~4.73~~
[Pūrei] – wīwī / rautahi – exotic grass rushland	Moderate	Yes	2.7 m²; 0.00027 ha~~0.19~~
Gorse scrub	Negligible	No	4,057 m²; 0.41 ha~~0.27~~
Exotic grass grassland and fodder crop herbfields	Negligible	No	6,891 m²; 0.69 ha~~1.68~~
Total			**381,270 m²; 38.13 ha~~56.00~~**

The potential effects of vegetation removal or disturbance on those vegetation communities that are of greater than negligible ecological value[44] are discussed below.

5.1.1.1 (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland

~~Construction works associated with landfill construction will result in the loss of at least 0.37 ha of this habitat type, at the base of West Gully 4 during stage 5, and in the swamp wetland for construction of a stormwater attenuation basin.~~

Pursuant to a s92 request the road design was resurveyed. As part of this exercise a project shaping process was applied to avoid (as much as practical) impacts to wetland vegetation, including this vegetation type. Multiple road design iterations were tested and assessed on the basis of their potential impacts (in terms of clearance) to wetlands.

Ultimately, GHD has advised that it is not possible to construct a road to a suitable standard to meet the required road width and road safety measures that entirely avoids wetlands. There are 10 small areas where the McLaren Gully Road upgrade design overlaps this wetland vegetation type (ranging in size from 0.009 m² to 4.34 m²). The total area of this wetland vegetation type that may be lost is 13.8 m² / 0.0014 ha. This degree of loss is ecologically trivial / a *de minimis* effect[45]. The clearance would likely affect a small number of plants comprising exotic grass, rush, and herb species, and some rautahi sedges and wīwī rush (these species are extremely common and widespread Not Threatened species). Modification would be confined to very narrow margins (10s of cm wide) at the already modified edge of substantial (i.e. multi hectare) wetland features. ~~Up to a further 0.35 ha would be cleared during the widening of McLaren Gully Road.~~

It is not expected that any meaningful hydrological changes (and subsequent indirect wetland loss or gain) to adjacent wetland areas on McLaren Gully Road would occur due to the road upgrade because, to some extent, these wetland areas probably exist because the existing road already acts to impounds surface water flows from tributary valleys. Unless existing road culverts are substantially modified (e.g. shifted or enlarged), a minor expansion in the road footprint may not appreciably alter this process except perhaps to enhance it. Surface runoff from a sealed road would also be unlikely to differ in effect compared to runoff from the existing

[44] The radiata pine / gorse / cocksfoot – Yorkshire fog treeland vegetation type, while of Negligible ecological value, has been assessed as significant because (in terms of ecological context) it provides some feeding habitat for eastern falcon (see Section 3.2.2.2). Section 5.2.1 of this report address potential adverse effects to that species and a draft Falcon Management Plan has been prepared as part of this application. Clearance of the Negligible value and almost entirely weedy / planted exotic plants that comprise this area is not of sufficient ecological concern to warrant detailed assessment from a vegetation perspective.

[45] The original proposal lodged in August 2020 would have impacted 0.72 ha of this vegetation type (and 0.99 ha of wetland vegetation types overall).

dirt road (it may indeed contain less sediment – a possible benefit). In terms of nearby areas and the wider Tokomairiro ED, gully wetlands supporting habitats such as this (in a similar or better condition to what is present in the designation site) frequently occur in poorly draining gullies / valley floors within plantation forestry, regenerating native forest and farmland. ~~The indigenous species present that would be cleared as part of the proposed activities are common and widespread.~~

Therefore, the loss of a portion of this habitat ~~within the designation site due to landfill construction and~~ due to road widening is expected to have a ~~**Low**~~ **Negligible** magnitude of effect (a *very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation*). A low magnitude of effect on a habitat type with **Moderate** ecological value (Section 3.2.3.1) equates to a ~~**Low**~~ **Very Low** level of ecological effect.

~~5.1.1.2 (Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub~~

~~To construct a stormwater attenuation basin in the swamp wetland, the current layout suggests that at least 0.10 ha of this exotic scrub (that possibly supports indigenous lizard species) would be cleared. Weedy scrub areas with scarce indigenous species are extensive in the immediate and wider area. In terms of habitat loss, clearance at the landfill site corresponds to a **Negligible** magnitude of effect (*having negligible effect on the known population or range of the element / feature*). A negligible magnitude of effect on a habitat type with **Moderate** ecological value (Section 3.2.3.2) equates to a **Very Low** level of ecological effect.~~

~~The potential impact on lizard species is discussed in Section 5.3.~~

~~5.1.1.3 Harakeke – gorse / (pūrei – rautahi) flaxland~~

~~Landscaping and works associated with landfill construction will lead to a loss of at least 0.08 ha of this habitat type in the swamp wetland. In terms of nearby areas and the wider Tokomairiro ED, gully wetlands supporting swamp habitats such as this (in a similar or better condition to what is present in the designation site) occasionally occur. These are found in poorly draining gullies / valley floors particularly within plantation forestry and regenerating native forest. The indigenous species present in the flaxland that would be cleared are common and widespread. A nearby very large wetland complex in the ED (the Lake Waihola-Lake Waipori-Sinclair wetland area) contains extensive areas of flaxland vegetation. However, these areas occur on a very different landform, so the ecological effect of the loss of even a relatively small flaxland area in the designation site due to landfill construction is not negligible. The loss of this habitat type of **Moderate** ecological value (Section 3.2.3.3) is considered a **Low** magnitude of effect (*having a minor effect on the known population or range of the element / feature*) and, therefore, a **Low** level of ecological effect.~~

~~5.1.1.4 [Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland~~

~~Based on our understanding of the works proposed, landfill construction would lead to permanent loss of all of the treeland in West Gully 4 (4.52 ha) during stages 4-5 of landfill construction. The treeland vegetation present that would be lost is a relatively poor-quality example of regenerating indigenous forest and is of low ecological value. The indigenous species present in the treeland that would be cleared are common and widespread species at the level of the ED and nationwide. In comparison to other areas of regenerating / secondary forest in the ED, this treeland is small and degraded. Nearby much larger areas of vegetation with similar species composition are present in areas with statutory protection at Hope Hill Scenic Reserve and Taieri Mouth Scenic Reserve, and other similar or more intact patches are present in nearby gullies in adjacent catchments. The loss of this **Low** ecological value habitat~~

~~type (Section 3.2.3.5) equates to a **Negligible** magnitude of effect (*having negligible effect on the known population or range of the element / feature*) and, therefore, a **Very Low** level of ecological effect.~~

5.1.1.5 (Yorkshire fog) – cocksfoot grassland

Around ~~0.66~~ 0.17 ha of rank grassland would be cleared within the designation site. Up to a further ~~4.07~~2.98 ha would be cleared during the widening of McLaren Gully Road and Big Stone Road. Rank grassland, an induced exotic vegetation type common in fallow pasture or on disturbed habitat edges, is extensive in the immediate and wider (ED) area. In terms of habitat loss, and the plant species present, clearance of the almost entirely weedy and exotic plants that comprise this vegetation type corresponds to a **Negligible** magnitude of effect (a *very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation*). A negligible magnitude of effect on a **Moderate** ecological value (Section 3.2.3.7) equates to a **Very Low** level of ecological effect.

It is important to note that this vegetation type may support and provide a corridor for indigenous lizard species. The potential impact on lizard species is discussed in Section 5.3.

5.1.1.6 [Pūrei] – wīwī / rautahi – exotic grass rushland

There is one small area where the McLaren Gully Road upgrade design overlaps this wetland vegetation type, and up to ~~0.19 ha~~2.7 m^2 / 0.00027 ha of [pūrei] – wīwī / rautahi – exotic grass rushland ~~wetland vegetation alongside McLaren Gully road~~ would be cleared during road widening. This vegetation type has likely been induced by vegetation clearance and grazing, and extensive similar areas of permanently or periodically wet pastures occur in the local and wider (ED) area. The *de minimis* loss of this habitat type of **Moderate** ecological value (Section 3.2.3.8) is considered a **Negligible** magnitude of effect (a *very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation*) and, therefore, a **Very Low** level of ecological effect.

5.1.2 Loss of Threatened and At-Risk Species

No Threatened or At-Risk plant species were found at the designation site or in surrounding habitats, excluding kānuka (which is excluded from specific assessment and discussed in Section 3.2.3.9).

5.1.3 Weed Encroachment and Introduction

Indigenous vegetation types present in the designation site are already extensively degraded by a wide range of weed species, ranging from weedy herbs and grasses, to shrub and tree weed species (gorse, broom, Himalayan honeysuckle, elder). However, vegetation clearance and operation of machinery can disturb the ground and create further opportunities for weed invasion or may introduce additional weed species to the site on machinery or vehicles. ~~In addition, construction activities that affect relatively small areas of forest margins may compromise the integrity of relatively large areas of remnant forest by introducing weeds and causing 'edge effects' whereby smaller areas of forest are relatively weedier due to encroachment.~~

~~Our understanding is that indigenous forest remnants in West Gully 2 and 3 are not proposed to be subject to direct physical disturbance, and these areas are already weedy at their edges.~~

There are other potentially problematic weeds that appear to be absent from the designation site (e.g. sycamore, banana passionfruit) but are present nearby and could be accidentally introduced on machinery or in soils and hard fill brought on site. It can further be expected that green waste introduced as part of ordinary landfill operation will introduce seeds or other viable material from additional weed species. We understand that in general green waste will be processed elsewhere, and that the landfill infrastructure includes a wheel wash facility; these factors reduce this risk substantially. Therefore, in the context of the existing level of modification, the potential magnitude of ecological effect on all vegetation types not subject to clearance[46] at the project site due to weed encroachment or weed introduction is **Negligible** (*a very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation*), corresponding to an overall **Very Low** level of ecological effect.

5.1.4 Downstream Effects on Wetlands

Landfill construction is likely to lead to an alteration in water supply to the 'swamp wetland' (immediately below the landfill toe) and potentially the downstream 'valley floor marsh wetland' (which occupies most of the valley bottom draining the designation site to Ōtokia Creek) (refer to Figure 2). Based on GHD's Assessment of Effects to Groundwater and GHD's Surface Water Assessment (GHD 2021a, 2021b), the possible effects that are relevant to downstream wetlands include:

- discharge of contaminants due to possible leakage through landfill lining or the leachate interception system;
- ongoing sediment runoff from stockpiles; and
- alterations in water supply, including:
    - temporarily increased runoff in areas where the landfill liner is initially exposed;
    - permanently reduced groundwater recharge from the landfill footprint as a result of landfill lining, capping, and interception of leachate and other runoff,
    - permanently increased groundwater recharge from areas outside the landfill footprint, due to groundwater infiltration from the stormwater attenuation pond; and
    - permanently reduced runoff from the landfill footprint due to increased evapotranspiration (when the cap is ultimately grassed).

This may have indirect effects on wetlands throughout the landfill lifespan and the hydrological changes will largely persist even following landfill decommissioning (GHD 2021a, 2021b).

Discharge of contaminants: in terms of contaminants, the GHD (2020~~1~~1a) report states: "*change in land use from forestry to landfill is expected to result in a net reduction in total flux of all contaminants to the groundwater system beneath the landfill footprint*." Because some existing contaminant runoff from the landfill site (nitrates) may be beneficial to plant growth, but others (large amounts of iron) may be detrimental, it cannot be predicted ~~with confidence~~ exactly what effect an overall reduced contaminant flux from the designation site will have on downstream wetland vegetation. However, GHD (2021a) also notes that the "*long-term effects of the landfill in terms of sediment management may be largely beneficial as the sediment*

[46] i.e. those areas that will remain intact after landfill construction, and which could therefore be further degraded by further weed invasion.

discharge from the final cap and swale drains will be minimal compared to the existing forestry operations during periods of cutting, clearing and replanting / re-establishment." Overall, changes to surface water quality due to the landfill proposal are most likely to be overall a **Positive** effect.

It is understood that "*surface runoff currently occurs at the site and in the immediate downstream environs only during and immediately after periods of persistent or high rainfall*" (GHD 2021a). In terms of shallow groundwater, GHD (2021b) has identified that there is presently very little storage capacity in the shallow aquifer at the site. Taken together, these findings suggest that rapid runoff from rainfall is the only important wetland hydrological driver. In a worst-case scenario, landfill construction would effectively intercept (reduce) up to 20% of the existing annual runoff into the swamp wetland (GHD 2021b, our own separate GIS analysis supports this estimate), and the groundwater table at the lower (northern) end of the designation site could be reduced by less than 1 metre. However, this scenario, in terms of groundwater, does not account for the mitigating influence of the attenuation basin. GHD states that groundwater infiltration from the proposed stormwater attenuation basin "*is anticipated to provide sufficient soakage to greatly mitigate the loss of groundwater recharge* [from the landfill footprint]." Furthermore, this is a substantially lesser percentage than with the original landfill proposal, and importantly the amended proposal retains a large area of regenerating forest (West Gully 4) where greater vegetation cover and soil development could be expected to better buffer rainfall runoff to downstream wetlands than the highly modified low-permeability soils that allow for rapid runoff from the existing forestry area. ~~In a worst-case scenario, up to 50% of the existing annual runoff into the valley floor marsh wetland is likely to be lost (GHD 2020), and the groundwater table at the lower (northern) end of the designation site is likely to be reduced by several metres.~~ Ecological effects of any alteration to downstream water ~~supply~~ flows ~~will~~ become relatively far less important downstream of the swamp wetland as recharge of the valley floor marsh wetland occurs from other tributaries (e.g. East Gully) and as the relative proportion of the overall catchment affected by the landfill decreases.

Sediment runoff from stockpiles: GHD (2021a) states that "*appropriate sediment control measures which may include the use of soils stabilisers, biodegradable cover or silt fences for the smaller stockpiles or sediment retention ponds and cut off drains for the larger stockpile areas*" will be used. Where robust erosion and sediment control measures are used for the duration of the landfill construction works, such measures would entirely avoid adverse sediment effects to downstream wetlands, and this possibility is therefore not discussed further.

Alteration in water supply: a reduction in water supply (due to interception of surface flows) may lead to slightly altered composition ~~and extent~~ of wetland vegetation ~~and wetland functioning~~ in the swamp wetland and the valley floor marsh wetland. Presently, the vegetation present in both wetland areas is suggestive of an environment where:

- a narrow channelised area of obligate wetland vegetation (sweetgrass and watercress, bordered by occasional or frequent pūrei) retains permanent or near-permanent surface water largely derived from surface flows; and
- a much wider band of ~~marsh~~ facultative wetland vegetation across ~~the~~ valley floor areas (comprising facultative wetland species including harakeke, rautahi, Yorkshire fog, and wiwi) surrounds the permanently wetted area and is likely to be adapted to periodic / seasonal inundation, overland flows and seepages from gully systems.

Based on the anticipated slight changes in the surface water and shallow groundwater system (GHD 2021a, 2021b), ~~If up to half the water supply to the wetland is lost,~~ it ~~can be~~ is expected that the swamp wetland and valley floor marsh wetland will persist as wetland features. At worst, ~~permanently wet area and resultant swamp~~ some individual obligate wetland ~~vegetation~~

plants may ~~contract or~~ disappear from some areas, being most likely nearest the designation site, and such an effect would likely be associated with an expansion of the surrounding ~~marsh~~ facultative wetland plant species ~~vegetation may expand to occupy this area but may do so at the expense of a loss at the existing marsh edges, because the permanently and periodically wetted soil width may contract overall~~. The main obligate wetland species that are most vulnerable to an altered (reduced) water supply, in terms of cover, are exotic species (sweetgrass and watercress) and as such are not considered to have intrinsic ecological value in terms of ecological effects assessment (Roper-Lindsay et al. 2018). Pūrei, which could possibly reduce in extent, is a Not Threatened indigenous species that is extremely common in the surrounding area and at the level of the ED.

~~It is a practical impossibility to say with certainty the precise magnitude of effect,~~ It is noted that this continuous overall wetland feature (within and below the designation site) has a number of hydrological influences that will alter with time irrespective of the landfill proposal (including climate change effects, and land use changes in other tributaries, i.e. ongoing maturation of adjacent pine forest and regeneration of native forest in gullies). Such factors~~, and because it cannot be predicted with any confidence precisely the extent to which soil moisture conditions may be reduced to the point that wetland plant species are excluded.~~

~~Other environmental factors~~ render it difficult to assess the likelihood or extent of possible wetland changes.

For example, it is likely that ongoing plantation forestry at the site would have negative effects on the swamp wetland (e.g. reduced water supply as pines mature, and introduction of weeds and sediment especially during harvest cycles). In this context, the impacts of an alteration in land use (the landfill) may be similar or perhaps better (this assumption is uncertain and has been excluded from the assessment below).

This applies also to the valley floor marsh wetland, but this area is likely better buffered (in terms of water supply) by a large deep pool surrounded by pūrei. This pool occupies an area of the wetland c.300 m below the designation site, just upstream of the East Gully confluence above an historic artificial bund. It is likely to be important for the hydrology of the valley floor marsh wetland overall by buffering the water supply both upstream and downstream (by impounding flows and retaining water upstream, and by releasing water slowly downstream in dry periods). This pond was observed in April 2021 to have retained substantial deep water despite very dry conditions in the preceding months. It is unlikely that the seasonal rainfall / runoff retained by this system (and water contributions downstream in turn) would diminish due to the influence of the landfill. Taking into account the uncertainties and assumptions noted above, the worst case effect of the landfill, in terms of potential habitat changes (change in wetland species composition) is assessed as a **Low** magnitude effect for the swamp wetland and a **Negligible** magnitude of effect for the better-buffered valley floor marsh wetland below. No hydrological effects of the landfill proposal on the wetland vegetation at the base of West Gully 3 and 4 upstream of the swamp wetland (see Figure 7) are expected because of the non-existent and insignificant contribution (respectively) of the proposed landfill footprint to the catchments for these areas.

Overall effect: ~~The main plant species that are most vulnerable to reduced water supply, in terms of cover, are exotic species (floating sweetgrass and watercress) and as such are not typically considered to have intrinsic ecological value in terms of ecological effects assessment (Roper-Lindsay et al. 2018). Pūrei, which may also reduce in extent, is a Not Threatened indigenous species common in the surrounding area and at the level of the ED. In terms of terrestrial ecology, a total loss of these particular species within the valley floor marsh wetland of **Moderate** ecological value (Section 3.2.3.1) is considered a **Low** magnitude of effect () and, therefore, a **Low** level of ecological effect.~~

~~The valley floor marsh wetland covers around 2.0 ha upstream of McLaren Gully Road to the designation site. Around 0.8 ha is immediately downstream of the designation site and upstream of the East Gully confluence. As discussed, any reduction in wetland extent cannot be estimated with confidence. A possible effect, at the severe end of the spectrum, would be a near-total loss of wetland vegetation (not just the pūrei) above the East Gully confluence, if water runoff from the landfill site is insufficient to retain permanent water in the large pool and upstream. This area comprises a mix of largely exotic species and indigenous wetland plant species that are all common in the area and the wider (ED) landscape, but the entirety of the wetland, and in particular its large length, is likely to be of importance in buffering runoff and sediment flows into Otokia Creek downstream. In this context, the loss of perhaps 0.8 ha of wetland would amount to a **Low to Moderate** magnitude of effect ('moderate' means *a loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed*[47] and, therefore, a **Low to Moderate** level of ecological effect.~~

taking into account the potential **Positive** effect of the landfill proposal on surface water quality and the potential **Low**-**Negligible** effect in terms of potential changes to wetland species composition due to changes in surface water and shallow groundwater quantity, the magnitude of effect of the landfill construction and operation is assessed as:

- an overall **Low** magnitude of effect, and therefore, a **Low** level of effect for the swamp wetland; and
- a **Negligible** magnitude of effect, and therefore, a **Very Low** level of effect for the valley floor marsh wetland. ~~overall estimate of an overall **Low to Moderate** level of ecological effect on downstream wetlands reflects uncertainty regarding the effects of reduced wetland water supply as a result of landfill construction.~~

5.2 Avifauna

The following potential construction and operational phase effects of the proposal were considered for this assessment:

- direct effect of habitat loss during construction;
- indirect effect of disturbance and displacement during construction and operation;
- direct effect of mortality during construction;
- indirect effect of increased mortality (via predation) during operation; and
- indirect effect of bird strike with aircrafts during operation.

For the purpose of this assessment, we have considered only the effects on native bird species.

5.2.1 Construction Effects

5.2.1.1 Habitat Loss

Construction of the landfill and road widening will result in the permanent loss of avifauna habitat. With respect to falcon, the habitat lost includes ~~3.83 ha of regenerating native treeland (the [large-leaved pohuehue] / [makomako – kōtukutuku] / Himalayan honeysuckle treeland~~

[47] ~~Following the methodology of Roper-Lindsay et al. (2018)~~

~~community), 8.68 ha of macrocarpa forest, and~~ 33.8 ha of re-planted radiata pine plantation (refer to Figure 7). This habitat may be used by falcon for foraging, roosting and nesting. Given the fact that none of the surrounding native gully habitat on site will be lost, that these habitat types are very abundant in the surrounding landscape, and that falcon are highly mobile species (with large home ranges) that can move to alternative habitat, we consider that the magnitude of effect of habitat loss on falcon will be **Negligible** (*a very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation*). A negligible magnitude of effect on a **Moderate** ecological value (Section 3.3.3) equates to a **Very Low** level of ecological effect.

Likewise, with respect to native Not Threatened birds, we consider that although habitat will be lost on site, those birds effected will be able to disperse to and utilise the areas of native habitat that will remain on site as well as native gully habitats present in the surrounding environment. As such, we consider that the magnitude of effect of habitat loss on native Not Threatened birds present on site will be **Negligible** (*a very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation*). A negligible magnitude of effect on a **Low** ecological value equates to a **Very Low** level of ecological effect. These species will also benefit in the long term from the vegetation re-planting mitigation required for this proposal as well as proposed weed control, fencing of vegetation, in-fill planting and predator control (refer to Section 6.0).

5.2.1.2 Disturbance and Displacement During the Non-Breeding Season

The noise and activities associated with construction of a landfill and road widening may disturb foraging, roosting and nesting activities of local birds and potentially displace them from the construction site and nearby areas.

With respect to falcon, four pairs have been recorded at and / or in the general vicinity of the proposed landfill site; falcon are also known in the wider, surrounding areas of plantation forestry. During construction activities[48], falcon will likely be disturbed and displaced from the area. If construction activities occur outside of the breeding season for falcon (i.e. between 1 June and 31 July), we expect that falcon, which are a highly mobile species, will disperse and utilise other areas of their extensive home ranges (9 km^2 at Kaingaroa Forest (Seaton, 2007) and up to 75 km^2 has been reported in indigenous forest (Fox, 1977)). So, it is likely that this disturbance will only be in a small portion of their territory. Based on these factors, we consider that the magnitude of effect of disturbance and displacement during construction will be **Negligible** for falcon outside of the breeding season. A negligible magnitude of effect on a **Moderate** ecological value equates to a **Very Low** level of ecological effect.

For native Not Threatened species, we also consider the magnitude of effect of disturbance and displacement during construction will be **Negligible**. A negligible magnitude of effect on a **Low** ecological value equates to a **Very Low** level of ecological effect. This is based on the temporary nature of this effect, that most of the habitat they utilise on site will remain and that if displaced there is other habitat nearby that they can disperse to and utilise.

5.2.1.3 Disturbance, Displacement and Mortality During the Breeding Season

A falcon pair has been reported nesting on the proposed site (the location of nesting was not provided; Fulton Hogan, *pers. comm*. 2019). If construction activities occur during the falcon breeding season (i.e. between 1 August and 31 May) and birds are nesting on the site,

[48] Construction activities include tree felling / vegetation clearance, earthworks, and constructing roads and other infrastructure. It is recommended to avoid conducting these activities during falcon breeding season, where practicable. Measures to minimise the effects of construction activities undertaken during the falcon breeding season may include undertaking surveys for breeding falcons and establishing exclusion zones around nests. These measures will be detailed in the Falcon Management Plan.

disturbance and displacement of nesting adults may compromise the survival of eggs and / or chicks.

Without the implementation of avoidance or mitigation measures we, therefore, consider that the magnitude of effect of disturbance, displacement and egg and / or chick mortality during construction will be **Low** for falcon during the breeding season (based on Table 6; i.e. having a minor effect on the known population) if they are nesting on site. A low magnitude of effect on a **Moderate** ecological value equates to a **Low** level of ecological effect.

However, this risk can be managed by avoiding construction activities during the falcon breeding season (i.e. carry out construction activities between 1 June and 31 July), or if this is not practicable, a pre-construction nesting falcon survey should be conducted on site by a suitably qualified ecologist to determine if falcon are nesting in the area. If no nesting birds are detected, construction activities can commence. If nesting birds are detected, management actions can be implemented, such as establishing construction-free exclusion zones around nests[49] until nesting activities are completed.

If such measures are implemented, we consider that the magnitude of effect of disturbance, displacement and mortality during construction can be reduced to a **Negligible** effect for falcon during the breeding season. This would reduce the level of effect to **Very Low**, if these measures are implemented.

With respect to native Not Threatened birds, as most of their habitat on site will remain, we consider that the magnitude of effect of disturbance, displacement and mortality during the breeding season will be **Negligible**, which equates to a **Very Low** level of effect.

5.2.2 Operational Effects

5.2.2.1 Disturbance and Displacement

Similar to landfill construction, the noise and activities associated with operation of a landfill may disturb foraging, roosting and nesting activities of local birds and may potentially displace them from the surrounding area.

With respect to falcon, four pairs have been recorded at and / or in the vicinity of the proposed landfill site (one has nested at the site) (Fulton Hogan, *pers. comm*. 2019) and falcon are known in the wider, surrounding areas of plantation forestry (Parker Conservation, 2015, 2017). We consider that initially there may be some operational disturbance of falcon, however, it is likely that they will habituate to these activities, so disturbance, although on-going, will only be a temporary effect as a result of habituation. Furthermore, given that falcons have large home ranges (Fox, 1977; Seaton, 2007) it is likely that this disturbance in a small portion of their territory will have a negligible magnitude of impact on the birds. Falcon is also a highly mobile species, so if disturbed they are capable of dispersing to alternative habitat available in the wider area. Based on these factors, we consider that the magnitude of effect of operational disturbance and displacement will be **Negligible** for falcon. A negligible magnitude of effect on a **Moderate** ecological value equates to a **Very Low** level of ecological effect.

With respect to native Not Threatened birds, we also consider that the magnitude of effect of operational disturbance and displacement will be **Negligible**, given that most of their habitat will remain on site, they will likely become habituated to operational activities and they are capable

[49] The standard size of construction-free exclusion zones for falcon nests is a 200 m radius centred from the nest.

of dispersing to alternative, nearby habitat if disturbed. A negligible magnitude of effect on a **Low** ecological value equates to a **Very Low** level of ecological effect.

5.2.2.2 Increased Mortality (via predation)

Increased food supplies at landfills can attract rodents and increase local rodent populations (Waste Management Institute New Zealand, 2018). This can have a negative effect on local bird populations given that rodents can prey on nesting birds and / or eggs and chicks, including the eggs and chicks of falcon (Lawrence, 2002). Vermin numbers can be controlled at landfills by prompt and good compaction and application of cover soil. Further control can be achieved by having regular visits by a pest control contractor to trap and poison rodents. With the implementation of these actions (Centre for Advanced Engineering, 2000; Waste Management Institute New Zealand, 2018), we consider that the magnitude of effect of increased nesting bird, egg and chick predation by rodents in the surrounding area will be **Negligible**. A negligible magnitude of effect on a **Low** to **Moderate** ecological values equates to a **Very Low** level of ecological effect.

5.2.2.3 Bird Strike with Aircraft

We note that this assessment is based on the implementation of best practise landfill operation and bird management at the proposed Smooth Hill landfill.

We also note that this assessment is of the potential effect on birds of potential strike with aircraft (i.e. a bird / ecological perspective), rather than an assessment of bird strike risk to aircraft (i.e. a human perspective). This approach is used as we are assessing the potential effects of the proposed landfill on ecological values not people.

A number of bird species are at risk from strike with aircraft (Belant et al., 1995; Cook et al., 2008; Ryder Environmental Limited, 2019). This includes species of waterfowl, gulls, shags, passerines and other species listed in Table 18. All of these potentially vulnerable species are present in the farmland-dominated landscape of the Taieri Plains (including many species at Dunedin Airport) and the nearby Lake Waihola-Waipori and Sinclair wetland complex (Table A5-1, Appendix 5). Not only are these species present, some are present in very high abundances, particularly passerines in farmland and along roadsides, and waterfowl at the wetland complex (thousands of birds are regularly recorded; (Otago Fish and Game, 2019; Ryder Environmental Limited, 2019). Gulls and a few other coastal bird species that are at risk from strike with aircraft also traverse between the Otago coast and the Taieri Plains and other inland habitats.

A wildlife hazard assessment commissioned by Dunedin International Airport Ltd (DIAL) and conducted in 2018 by Avisure, an aviation risk consultancy in Australia, concluded (among other things) that:

- Dunedin Airport has a high bird-strike risk based on professional survey data (in 2017 there was a strike rate of 2.1 bird strikes per 10,000 aircraft movements; this was lower than each of three previous years[50]); and
- there is extensive availability of bird habitats at, and around, Dunedin Airport and that there is an abundance of birds currently associated with these habitats, including birds that present moderate, high and very high risk to aircraft (Avisure, 2018).

[50] The current strike rate is less than 5 strikes per 10,000 aircraft movements (G. Pleasants, pers. comm. 3 August 2020).

Communications had with Dunedin Airport indicate that black-backed gulls, spur-winged plovers, sparrows and blackbirds pose the biggest strike risk to aircraft at the Airport, and that susceptibility changes with time of year (G. Pleasants, *pers. comm*. 3 August 2020).

These findings indicate that birds that pose a strike risk to aircraft (and as such are at risk themselves from strike) are already currently common in the local and wider landscape surrounding Dunedin Airport.

With respect to the Smooth Hill landfill proposal, an important consideration to be made is that landfills attract birds, particularly scavenging species, some of which are at risk from strike with aircraft (Table 18) if a landfill is located near an airport[51] (Belant et al., 1995; Centre for Advanced Engineering, 2000; Ryder Environmental Limited, 2019; Stantec, 2019). Gull species, especially black-backed gulls, are of particular concern in New Zealand. Black-backed gulls are the species most attracted to landfills and because they are large birds that often soar at high elevations (i.e. between 1000-3000 feet (approximately 305-914 m above ground level)) (Robertson 1992 and Avisure 2016 in (Bell & Harborne, 2018)) where they may potentially encounter aircraft, they are at risk from strike (Ryder Environmental Limited, 2019). The Smooth Hill site is approximately 4.5 km south-west of Dunedin Airport and is located within the Airport's flight fan (Figure 11). Normal flight patterns are north / south along the Taieri Plains, however, during westerly and southerly winds commercial aircraft prefer to fly to the east rather than west of Dunedin Airport (i.e. over or near the Smooth Hill site). Smaller aircraft fly over the Smooth Hill area if the cloud base is at least 500 feet above the terrain (c.150 m) (G. Pleasants, *pers. comm.* 3 August 2020). The heights at which general aviation aircrafts and commercial aircrafts fly over the Smooth Hill site[52] overlap with the elevations that black-backed gulls soar at (determined from communications had with personnel at Dunedin Airport (G. Pleasants, *pers. comms*. 3 August 2020)). As such, bird strike at the landfill site is a potential effect of the proposal.

[51] A guideline presented to reduce strike is to have a 6.5 km separation distance between landfills and airports (T. Caithness, personal communication, 1992).

[52] General aviation aircraft often fly at c.1000-2000 feet (c.305-610 m) above the ground over the Smooth Hill site. Commercial aircraft departing to the south normally fly at c.2500 feet (c.762 m) above ground over the Smooth Hill site. When there are westerly winds, commercial aircraft prefer to fly east when approaching to land runway 03 at c.2000-4000 feet (c.305-915 m) over the Smooth Hill site. Jets normally fly at c.6500-7500 feet (c.1982-2286 m) above ground over the Smooth Hill site.

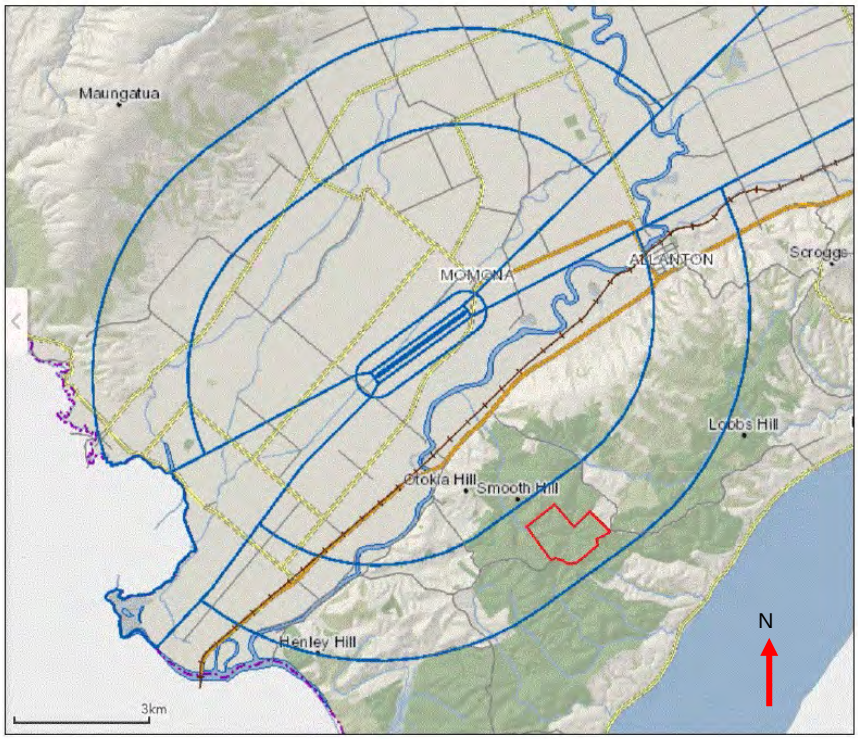

Figure 11. Dunedin Airport's flight fan (blue ovals) in relation to the proposed Smooth Hill site (red polygon). The two outer ovals are approximately 4 km and 6.2 km from the outer edge of the Airport's runway (blue rectangle).

The Smooth Hill site provides habitat for a diversity of bird species, however, no species are present at the site that are both attracted to landfills and are at risk from strike with aircraft (Table 18). Seven black-backed gulls were observed traversing the site during surveys conducted for this assessment, however, the birds were not using the site itself, merely crossing it, most likely to reach the Taieri Plains. In doing so these birds currently traverse through the flight fan, including the Smooth Hill site, and potentially at heights where they may encounter aircraft. It should be noted that black-billed gulls and red-billed gulls were not observed crossing the site during the surveys conducted, and they were not observed at Dunedin Airport. As such, the focus of the bird strike assessment is black-backed gulls (a species with a large population size that is most attracted to landfills, has a presence in the wider environment and presents a strike risk).

Table 17. Bird species that are attracted to landfills, are at risk from strike with aircraft and were observed during surveys conducted at the proposed Smooth Hill landfill site traversing to or from the Taieri Plains (Avisure, 2018; Ryder Environmental Limited, 2019).

Species	Attracted to landfills (Yes/No)	At risk from strike with aircraft (Yes/No)	Observed at site traversing to or from the Taieri Plains
Southern black-backed gull	Yes	Yes	Yes[53]
Red-billed gull	Yes	Yes	No

[53] Black-backed gulls may traverse at heights where they may potentially encounter aircraft.

Black-billed gull	Yes	Yes	No
Australian magpie	No	Yes	No
Spur-winged plover	No	Yes	No
Harrier hawk	No	Yes	No
Starling	Possibly	Yes	No
Redpoll	No	Yes	No
Goldfinch	No	Yes	No
Greenfinch	No	Yes	No
Chaffinch	No	Yes	No
Yellowhammer	No	Yes	No
House sparrow	Yes	Yes	No
Canada goose	No	Yes	No
Black swan	No	Yes	No
Mallard duck	No	Yes	No
Grey duck	No	Yes	No
Various shag species	No	Yes	No
Feral pigeon	No	Yes	No
South Island pied oystercatcher	No	Yes	No
Pukeko	No	Yes	No

Upon operation of the landfill, black-backed gulls traversing between the Smooth Hill site and the Taieri Plains and surrounds will detect the site. To manage black-backed gull numbers to very low levels at the landfill and present a negligible strike risk, it is critical that strict and well executed landfill practises are implemented, both operational and with respect to bird management (deterrence) / control.

In the literature, both national and international, operational practises to minimise the attraction of birds to landfills are listed (Centre for Advanced Engineering, 2000; ISWA Working Group for Landfill, 2010; Stantec, 2019; Waste Management Institute New Zealand, 2018; Waste Management NZ Ltd, 2018). It is noted that good operational practises are crucial and if effectively maintained can keep bird numbers at low levels. The most effective operational practise to prevent birds from establishing at a landfill is to exclude putrescible (organic) waste from the waste stream as this denies birds a food source. If this is not possible, organic waste should be reduced as much as possible. Other important operational practises include:

- good litter control;
- separating putrescible and general waste streams (if possible);
- transporting waste to the landfill in sealed containerised trucks (if possible);
- minimising the uncovered working face;
- prompt and thorough compaction of waste;
- covering waste at the end of the day;
- special handling of highly organic waste; and
- minimising areas of exposed earthworks and related shallow pools and puddles of water.

At Kate Valley landfill (a modern landfill north of Christchurch with very low bird numbers), an additional operational method that may contribute to very low bird numbers is the unloading of

organic waste into a 'V' pit that is formed by the parallel lines of general waste (this waste is then compacted and covered at the end of each day). The "V" pit makes organic waste difficult for birds to access as they would need to go into the pit, which would likely be unsettling for them to enter (Avisure, 2021). These sorts of operational methods of bird control / deterrence and active bird deterrence methods may be employed. If birds are present at the active tip face, it is recommended that deterrence methods are used to stop them from settling and accessing waste. Methods employed may include the use of stock whips, pyrotechnics, starters pistols and portable distress callers. A dedicated team of trained personnel is often responsible for this task.

If birds develop a pattern of attraction to the landfill, additional deterrence and control measures are employed to reduce bird numbers (Baxter, 2001; Centre for Advanced Engineering, 2000; DeFusco, 2007; ISWA Working Group for Landfill, 2010; Waste Management Institute New Zealand, 2018; Waste Management NZ Ltd, 2018), including:

- increasing the thickness of the cover;
- changing the cover type, density, or frequency of application;
- using mobile high wires;
- treating waste with a chemical that makes it inedible to birds[54];
- using special kites, including realistic models of the birds' natural predators;
- using sonic scaring devices;
- using bird distress calls;
- gas guns and direct shooting of species not protected by law;
- installing anti-roosting strips on buildings; and
- installing a net over the landfill (this is a potential final escalation step to prevent birds from accessing organic waste at the landfill).

Other control methods used to reduce bird numbers relate to maintenance of the landfill grounds. One method is to have a consistent long grass sward around the landfill areas (minimum 200 mm, preferably 300 mm). This reduces the attractiveness of the area to birds to roost and makes it more difficult for birds to land and take off. Birds may also be fearful of predators in areas of long grass. Another method is to make sure that there are no hollows or depressions around the landfill where water can pool as birds will use these areas to drink and clean themselves (Avisure, 2018; Centre for Advanced Engineering, 2000; Waste Management Institute New Zealand, 2018).

It is noted that these methods have variable success individually and that birds can become habituated to one particular control method. However, bird numbers can be kept low by implementation of a control strategy that has an escalating approach. That is, the control strategy should employ operational and deterrence methods, stepping up to lethal methods if birds persist at the landfill, climaxing at installation of a net over the landfill to enclose it and exclude birds. Further, a variety of control methods should be used regularly and randomly 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. It is also noted that bird management and associated operational processes are on-going actions that require strict adherence, vigilance, persistence

[54] AB Lime covers waste material with lime material that make the food unpalatable to birds and deters them from foraging. Methylanthranilate mixed with ProGuard SB is used at Crow Wing County landfill in Minnesota, USA.

and maintenance. If applied properly, bird numbers at landfill sites can be managed to low levels (Cook et al., 2008; ISWA Working Group for Landfill, 2010; Stantec, 2019; Waste Management Institute New Zealand, 2018).

Discussions had in 2018 by Stantec with two local New Zealand landfill operators (Midwest Disposals and Envirowaste) highlighted the following practises as being most effective at reducing the attractiveness of putrescible landfills to birds and keeping bird numbers low (Stantec, 2019).

- Providing daily, plentiful cover of the waste in the open tip face. This denies birds a food source and as such does not provide a foraging opportunity.
- Scaring birds using gas-powered bird scarers (gas guns) and shooting them using shot guns. These methods should both be used as birds can become habituated to one type of method, reducing its effectiveness over time.

As part of this current assessment, communications were also had with personnel associated with Green Island landfill in Dunedin (L. Coe, *pers. comm.* February 2, 2020 and May 2021; P. Withers, *pers. comm.* February 19, 2020 and May 2021) and Kate Valley landfill in Teviotdale, north of Christchurch (R. Ward, *pers. comm.* February 24, 2020[55]).

Kate Valley landfill is a large, modern landfill that is available to the same assemblage of bird species as those at the Smooth Hill site. Bird control at Kate Valley landfill has been very successful over the 15 years it has been operating, resulting in very low bird numbers at the site. The landfill is held in high esteem with regards to bird control and is considered to have very good bird management (P. Withers, *pers. comm.* February 19, 2020). Providing good daily cover was highlighted as a key way to reduce bird numbers, as well as reducing organic waste in the waste stream (over the past five years it is estimated that organic waste comprised 3-16% of all waste) and it was assumed that the deposition of organic waste into a 'V' pit between the inorganic waste lines behaviourally deters birds from accessing waste (Avisure, 2021; as discussed above). Additionally, daily movement of the active tip face reduces attractiveness of the site to birds as this means that waste is not pushed very far, which minimises open exposure to waste material.

Another method employed at Kate Valley that successfully deters or kills birds is that whenever black-backed gulls are observed on site, a licensed shooter who is registered with the Department of Conservation is called and, when it is safe to do so, the birds are shot and / or warning shots are fired[56].

Bird control has been less successful at Green Island landfill as this is an old landfill site where black-backed gulls became established before control measures were implemented and they are now resident at the site.

Key take home message from these communications include:

- the importance of preventing birds from becoming established at the landfill (through the use of operational, deterrence and control methods), as once birds have established it is very difficult to get rid of them.

[55] As part of the bird management plan updates, Phil Shaw from Avisure also had communications with A. Krishna from Kate Valley landfill in May 2021.

[56] Black-backed gulls are a native, Not Threatened species. They are not a protected species. Culling is occasionally conducted at some airports in New Zealand. 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, and given that they are predators of other native species, culling may have an overall positive ecological outcome. Culling is only appropriate for this gull species – not red-billed gulls or black-billed gulls, which are At Risk and Threatened species, respectively.

- the importance of setting high operational standards, in particular with respect to bird management, from the commencement of landfill operation and maintaining them throughout the life span of the landfill.

With regards to Smooth Hill, based on the literature review conducted, the habitats and species present at the proposed Smooth Hill site (and wider area) and communications had with personnel involved in other landfills in New Zealand, we consider that with good, sanitary and effective operational procedures as well as reducing the proportion of organic waste in the waste stream, good bird management and control (i.e. the implementation of the operational practises, deterrence methods, control measures and insights noted above) and good bird monitoring (including the establishment of bird threshold levels above which bird management and control must be escalated), bird numbers (particularly black-backed gulls) at the Smooth Hill landfill can be kept to very low numbers and therefore be subject to a negligible strike risk with aircraft. A high standard of operation, control, discipline and vigilance will need to be sustained to achieve this. This conclusion was also reached by:

- T.A. Caithness, a consultant ornithologist, in a letter written in 1992 that assessed potential bird hazards presented by a landfill at Smooth Hill. Mr Caithness reported that a well-controlled, sanitary landfill "should result in no attraction for gulls".
- Ryder Environmental Limited in a feasibility report produced for Dunedin City Council in 2019 for this proposal, that considered whether bird strike hazard would be affected by a landfill at Smooth Hill. They concluded that "with good landfill practises, birds numbers at a landfill should be able to be managed to very low levels" and that "bird strike posed by a well-managed landfill at the Smooth Hill site would be very low, and certainly much lower than the existing risks presented by the diversity and abundance of birds on agricultural land and wetlands around Dunedin Airport".
- Stantec in a Smooth Hill technical feasibility report produced for Dunedin City Council in 2019 that states that "it is expected that suitable bird scare procedures and regular soil covering will be sufficient to allow a sanitary landfill to operate and minimise attraction to seagulls. It is considered that there is a reasonable separation distance to the airport and the landfill is not expected to increase the risk of bird strike".

In summary, we conclude that the magnitude of effect of the Smooth Hill landfill adding to the possibility of strike with aircraft from Dunedin Airport will be **Negligible** for black-backed gulls, assuming the implementation of good landfill operational techniques, bird management, monitoring and control, which will be detailed in the Smooth Hill Bird Management Plan. A negligible magnitude of effect on a **Low** ecological value equates to a **Very Low** level of ecological effect.

5.2.2.3.1 Other Bird Strike Considerations

If there are large areas of open water present at a landfill, species of waterfowl and shags may be attracted to the site (Ryder Environmental Limited, 2019). Waterfowl and shags were not observed at the Smooth Hill site, however, they are present in high abundances in the wider landscape. These species are also at risk of strike with aircraft. A stormwater attenuation basin is proposed within the landfill site, which will have the capacity to store up to approximately 5,000 m^3 in a 1% AEP (annual exceedance probability) storm event (GHD 2021a). However, we understand that the attenuation basin will normally be empty and will be planted so open water will not be present. Given that there is an extremely large wetland complex in the Taieri Plains that provides extensive habitat for waterfowl and shags, we do not anticipate that the pond will be used by many birds (particularly given that it will normally be empty) or increase bird strike risk relative to the risk in the wider area that the extensive number of waterfowl utilising the wetland complex are already subject to. As such, we consider that the magnitude of effect of the

Smooth Hill landfill site adding to the possibility of strike with aircraft will be **Negligible** for waterfowl and shags, which equates to a **Very Low** level of effect.

5.3 Herpetofauna

The following potential construction and operational phase effects of the proposal were considered for this assessment:

- habitat loss during construction;
- disturbance and displacement to unsuitable surrounding habitat;
- injury and mortality during vegetation clearance and site works; and
- increased predation rates during operation.

5.3.1 Habitat Loss

Construction of the landfill will result in the permanent loss of potential native lizard habitat.

For southern grass skink, which is likely to be present, the habitat lost includes~~ 4.52 ha of regenerating native treeland (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub community~~), 0.~~66~~ 0.17 ha of (Yorkshire fog) - cocksfoot grassland (within or surrounding radiata pine / gorse / cocksfoot – Yorkshire fog treeland) in the designation site, and up to ~~4.07~~2.98 ha of (Yorkshire fog) - cocksfoot grassland on roadsides during road widening. We understand that the landfill cap may ultimately be grassed and grazed, potentially providing lizard habitat in future. However, due to uncertainty about the timing and nature (vegetation composition and grazing regime) of this process, the impact of the proposal has been assessed based on the assumption that the landfill cap will not provide future habitat for lizards.

The kānuka forest is potential habitat for jewelled gecko, which might be present. None of this habitat will be lost.

The areas of potentially suitable habitat within the designation site are small and isolated – further habitat loss may render some areas too small to sustain a population. Likewise, the areas of potentially suitable (Yorkshire fog) - cocksfoot grassland habitat alongside McLaren Gully and Big Stone roads forms a narrow strip adjacent to the road and generally does not extend beyond nearby boundary fence lines.

5.3.2 Displacement into Unsuitable Habitat

As mentioned above, the lizard habitats within the site are isolated, meaning that any lizards present that are displaced through construction would be dispersing into less suitable or entirely unsuitable habitat, or into habitat that may already be occupied to capacity. Displacement may expose lizards to increased competition for refuge habitats and increased exposure to predators.

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. jewelled gecko – if present) and / or predominantly ground dwelling (i.e., southern grass skink, McCann's skink). The increase in both vehicle movements and people across the landfill will increase the potential for disturbance to lizards.

5.3.3 Injury / Mortality

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.

Lizard mortality and injury are recommended to be avoided as much as practicable by salvaging lizards immediately prior to vegetation / habitat clearance.

5.3.4 Increased Predation

Any increase of human presence and disturbance is likely to increase the number of predators within an area. The proposed landfill may increase levels of predation significantly, such as increased densities of rodents, mustelids and avifauna predators. Increased predation may have population level effects on native lizards.

5.3.5 Magnitude of Effect

The potential lizard habitats within the designation site and on roadsides are of generally low quality and are expected to house low numbers of lizards (if any). However, At Risk lizard species may be present within the site (e.g. **High** ecological value), 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) shrubland) should 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.

This recommendation includes the preparation of a draft Lizard Management Plan (see Section 6.0), which includes:

- descriptions of the lizard habitats present within the footprint;
- lizard species that are expected to be present;
- legal and permitting requirements;
- salvage and relocation methods (if required);[57]
- measures to mitigate adverse effects during and post-construction; and
- procedures for incidental discovery of lizards during works.

In addition, to mitigate any effects on lizards, revegetation within the designation site should incorporate a species mix which would provide habitat and food resources for native herpetofauna (e.g. *Muehlenbeckia complexa*). Wooden debris should also be included, which would provide suitable refugia for lizards (as well as invertebrates).

Based on a **High** ecological value and with an appropriate Lizard Management Plan and habitat enhancement, the magnitude of effect on the wider populations is likely to be **Low** (*having a*

[57] We note that undertaking of any lizard salvage operation would be consistent with the key principles outlined in DOC's guidelines on this topic (Department of Conservation, 2019).

minor effect on the known population or range of the element / feature) and, therefore, a **Low** level of ecological effect.

5.4 Freshwater Ecology

As described in Section 3.5, no waterways are present within the designation site and subsequently there are no anticipated impacts on habitat for indigenous fish, aquatic invertebrates, or indigenous aquatic plants within the designation site. Potential effects on the ecology of the swamp wetland in the lower (northern) end of the designation site is discussed in Section 5.1.4.

Freshwater ecology effects within the designation site are not considered any further.

~~As discussed in Section 5.1.4, landfill construction is likely to lead to an alteration in the water quantity and quality supplied to the downstream receiving environment, which may result in effects on the ecology of the downstream tributary of Otokia Creek.~~

The potential effects of the proposed landfill on downstream freshwater ecology values of the wetland and stream system that is a tributary of Ōtokia Creek include:

- habitat loss; and
- discharge of sediments and contaminants.

5.4.1 Habitat Loss

As discussed in Section 5.1.4, landfill construction is likely to lead to an slight alteration in the water quantity supplied to the downstream receiving environment, which may result in effects on the ecology of the downstream tributary of Ōtokia Creek.

~~The potential effects of the discharge of contaminants due to possible leakage through landfill lining or the leachate interception system; and reduction in water supply due to changes in groundwater recharge, evapotranspiration and reduced runoff on wetlands have already been discussed.~~

~~There is uncertainty regarding the potential effects of discharges of contaminants (and therefore water quality) on the ecology of Otokia Cree Tributary, as little is known about the existing surface water quality and further information is required to fully assess any impacts on the freshwater ecology values.~~

GHD's surface water assessment (GHD 2021a) states that *surface runoff currently occurs at the site and in the immediate downstream environs only during and immediately after periods of persistent or high rainfall*. Further, the predicted worst-case scenario is that up to 20% of the existing annual runoff would be intercepted as a result of the landfill construction (GHD, 2021b). This change in annual runoff could lead to a "down-valley" shift in the perennial flow transition (i.e. the point at which the system shifts from valley floor marsh wetland system to a permanently flowing waterway system). However, given the proposed attenuation basin, which GHD anticipates will provide sufficient soakage to mitigate the loss of groundwater recharge, the alteration to downstream water flows is expected to result in only a slight change. Moreover, it is anticipated that any changes in downstream water quantity is likely to be limited to the first (upstream) 300 m of waterway (i.e. 300 m section between the swamp wetland within the designation site and the large pond discussed in Section 3.5.

As discussed in Section 5.1.4, this large, deep pond, located approx. 200-300 m downstream of the designation site, is likely to act as a water supply buffer to the freshwater habitats downstream of it. The pond was observed to be of a similar extent in April 2021, during a very dry period when upstream and downstream surface water was largely absent from the defined stream channels, as compared to June 2020 when surface water was present along the entire length of the downstream tributary (from the designation site to McLaren Gully Road).

Given this above information, we anticipate that any changes in downstream water quantity are likely to be only slight changes and limited to the first (upstream) 300 m of waterway. Further, based on the assessment in Section 5.1.4, we anticipate only a slight change to the wetland habitat between the designation site and the large pond – the pond will likely buffer (if any) downstream effects of changes in water quantity. This is assessed as having a **Negligible** magnitude of effect on the freshwater ecology values of the upper 300 m of the tributary waterway. A negligible magnitude of effect on a **Moderate** value equates to a **Very Low** level of effect. It is also assessed as having a **Negligible** magnitude of effect on any juvenile eels using this habitat; a negligible magnitude of effect on a high ecological value equates to a **Very Low** level of effect.

~~**Negligible** magnitude of effect on the freshwater ecology values of the tributary waterway. A negligible magnitude of effect on a **Moderate** value equates to a **Very Low** level of effect.~~

5.4.2 Discharge of Sediments and Contaminants

The landfill construction and operation could result in the disturbance and mobilisation of soils into stormwater and into the downstream receiving environment of Ōtokia Creek Tributary. This has the potential to result in sediment runoff into the river, if robust sediment control measures are not established.

Suspended sediment can alter water chemistry (including lowering dissolved oxygen concentrations), increase turbidity and reduce light penetration and visual clarity downstream. Elevated turbidity can have adverse ecological effects, particularly if it is sustained for a long period of time. Increased turbidity levels can result in reduced photosynthesis and, therefore, affect growth of aquatic plants and algae (the food source of many macroinvertebrates). Feeding activity and foraging success can be reduced by elevated turbidity (Cavanagh et al. 2014), by both limiting abilities to detect prey and reducing availability of food. It can limit the ability of visually foraging fish to feed (e.g. trout) and result in avoidance behaviour of indigenous species such as banded kokopu (Richardson et al. 2001). High loads of suspended sediments can also damage fish gills and make them more susceptible to disease, or even result in mortality (Rowe et al. 2009).

Most of New Zealand's aquatic species (that have been included in laboratory tests) are likely able to withstand and survive exposure of high suspended sediment loads for short durations. However, if sediment is discharged to the river, it is most likely to settle out on downstream riverbed and this can clog the interstitial spaces between substrates, settle on macroinvertebrates (clogging gills) and smother food (algae and macroinvertebrate) resources.

Further, there is the potential for leachate to be discharged into the downstream receiving environment during operation of the landfill. Leachate would form when rainfall enters the landfill and mixes with landfill materials, including decomposing organic materials, liquids and chemicals. If this was discharged into the Ōtokia Creek wetland it would likely be toxic and may kill freshwater flora and fauna. The proposed leachate management system will intercept and collect potential leachate to avoid it leaking / discharging into the downstream receiving environment. There are also several down gradient monitoring wells proposed to be installed,

which we understand will provide advance warning of any leachate leakage before it reaches the downstream receiving environment.

The potential effects of the discharge of contaminants due to possible leakage through landfill lining or the leachate interception system; and reduction in water supply due to changes in groundwater recharge, evapotranspiration and reduced runoff on wetlands have already been discussed (Section 5.1.4).

GHD (2021a) reports that the proposed change in land use (from forestry to landfill) is expected to result in a net reduction in total flux of all contaminants to groundwater. The surface water technical assessment (GHD, 2021a) also states that no significant downstream effects on surface water quality associated with waste disposal and leachate generation are anticipated as surface water runoff will be kept separate from landfill waste. Further, the long-term effects of the landfill on sediment discharge, due to the final cap and swale drains, will be minimal (likely improved) compared to the existing forestry operations.

The tributary currently receives runoff and stormwater from the pine plantation, and our observations suggest that there are few erosion and sediment control measures in place under the existing operation. Based on our understanding of this project's proposed management system, there could be an overall positive effect, only a very slight change from the existing baseline condition (i.e. **Negligible** magnitude of effect), to surface water quality due to the landfill proposal is expected. Monitoring (for sediment and contaminant, including leachate, management) during the construction programme of the landfill is proposed in GHD's surface water assessment (GHD 2021a). ~~we expect that sediment discharges to the Otokia Creek Tributary may be, or could be better than currently occurs (a positive magnitude of effect). A negligible magnitude of effect on a **Moderate** value equates to a **Very Low** level of effect.~~

With this management system in place, we consider that the magnitude of effect will be **Negligible**, with a **Very Low** level of effect.

~~The proposed stormwater management system should capture any sediment laden water and ensure that fine materials are not discharged into Otokia Creek Tributary.~~

Other contaminants, such as fuels and lubricants from machinery, can enter waterways when machinery is used in / nearby river beds (Scales 2014). Contaminants can have toxic and lethal, or sublethal, impacts and may adversely affect aquatic communities and stream health. The impacts are likely to be infrequent and short in duration, with effects relatively localised and temporary in nature. However, longer duration works, or large spills, may have further reaching (in time and space) effects on ecological values.

It will be essential to establish robust erosion and sediment control measures for the duration of the landfill construction and operation works. This may include measures to avoid sediment and other contaminants inputs into waterways (as is proposed by the stormwater and leachate management systems); staging works to minimise the total area of exposed soil; stabilising exposed soils as soon as possible (e.g. replanting, grassing, biodegradable matting[58]); keeping refilling / refuelling of machinery outside of / away from flow paths to waterways.

5.4.3 Fish passage

The upgrades / road widening to McLaren Gully and Big Stone roads may include upgrading or extending culverts in waterways. The installation / upgrade / extension of these culverts has the potential to impede the movement of fish and other aquatic fauna along waterways. This is most

[58] We recommend that fully biodegradable options are used to avoid plastic remnants remaining in the environment.

relevant for migratory fish species that need to move between freshwater and marine environments to complete life cycles, but also of relevance to non-migratory species.

In New Zealand, there are legislative requirements to ensure that activities within waterways do not impede / create barriers to the free movement of fish along waterways.

New, modified or upgraded culverts must meet the fish passage regulations of the National Environmental Standards for Freshwater (NES-F 2020). It is recommended that a suitably qualified freshwater ecologist experienced in construction activities and fish passage oversees these works.

Based on our understanding of the proposed activity, only a very slight change from the existing baseline condition (i.e. **Negligible** magnitude of effect) is expected. With this management system in place, we consider that the magnitude of effect will be **Negligible**, with a **Very Low** level of effect.

5.5 Overall Summary of Ecological Effects

A summary of the overall levels of ecological effects associated with the construction and operation of the Smooth Hill landfill and widening of McLaren Gully and Big Stone Roads is provided in Table 19. This assessment assumes implementation of a Falcon Management Plan, Bird Strike Management Plan and a Lizard Management Plan. Any additional impact management measures are not accounted for (i.e. without mitigation) ~~does not take into account potential impact management measures in relation to terrestrial vegetation and freshwater fauna, but does take into account the implementation of a Falcon Management Plan and Bird Strike Management Plan (avifauna) and a Lizard Management Plan (herpetofauna)~~.

Table 18. Assessment of levels of effects, without mitigation but assumes implementation of a Falcon Management Plan, Bird Strike Management Plan and a Lizard Management Plan. Ecosystem components of negligible ecological value are excluded from this assessment.

Ecosystem Component	Ecological Value	Magnitude of Effect	Level of Effect
Terrestrial Vegetation and Wetlands - Vegetation Removal and Disturbance			
• (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland	Moderate	~~Low~~ Negligible	Very Low
~~• Harakeke – gorse / (pūrei – rautahi) flaxland~~	~~Moderate~~	~~Low~~	~~Low~~
~~• [Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland~~	~~Low~~	~~Negligible~~	~~Very Low~~
• Cocksfoot – (Yorkshire fog) - cocksfoot grassland	Low	Negligible	Very Low
• [Pūrei] – wīwī / rautahi – exotic grass rushland	Moderate	Negligible	Very Low
Terrestrial Vegetation and Wetlands – Other			
• Loss of Threatened and At-Risk Species	n/a – does not apply for kānuka	n/a	n/a
• Weed encroachment and introduction	Negligible – Moderate (all habitats)	Negligible	Very Low

Ecosystem Component	Ecological Value	Magnitude of Effect	Level of Effect
• Downstream effects – Swamp wetland ~~on Wetlands~~	Moderate	Low ~~– Moderate~~	Low ~~– Moderate~~
• Downstream effects – Valley floor marsh wetland	Moderate	Negligible	Very Low
Avifauna			
• Habitat loss – eastern falcon	Moderate	Negligible	Very Low
• Habitat loss – native, Not Threatened species	Low	Negligible	Very Low
• Disturbance and displacement of falcon during the non-breeding season on falcon (construction)	Moderate	Negligible	Very Low
• Disturbance and displacement of native, Not Threatened birds during the non-breeding season (construction)	Low	Negligible	Very Low
• Disturbance, displacement and mortality of eastern falcon during the breeding season (construction)	Moderate	Negligible or Low[59]	Very Low or Low[59]
• Disturbance, displacement and mortality of native, Not Threatened birds during the breeding season (construction)	Low	Negligible	Very Low
• Disturbance and displacement of eastern falcon (operation)	Moderate	Negligible	Very Low
• Disturbance and displacement of native, Not Threatened birds (operation)	Low	Negligible	Very Low
• Increased egg and chick predation (eastern falcon)	Moderate	Negligible	Very Low
• Increased nesting bird, egg and chick predation (native, Not Threatened species)	Low	Negligible	Very Low
• Strike risk with aircraft (black-backed gull)	Low	Negligible[60]	Very Low
• Strike risk with aircraft (native, Not Threatened waterfowl and shag species)	Low	Negligible[60]	Very Low
• Strike risk with aircraft (At Risk – Recovering or Naturally Uncommon waterfowl and shag species)	Moderate	Negligible[60]	Very Low
Herpetofauna			

[59] The magnitude / level of effect is only Low if birds are nesting. If they are not nesting the magnitude / level of effect would be Negligible.

[60] This magnitude of effect is assessed with the implementation of best practise landfill operation and bird management (i.e. with mitigation) as the landfill will not operate without best practise or bird management.

Ecosystem Component	Ecological Value	Magnitude of Effect	Level of Effect
• Southern grass skink	High	Low[61]	Low
• Jewelled gecko	High	Negligible[61]	Low
• McCann's skink	Low	Negligible[61]	Very Low
Freshwater			
• Habitat loss	Moderate	Negligible	Very Low
• Discharge of sediments and contaminants	Moderate	Negligible	Very Low

6.0 Recommendations

The RMA and related statutory planning documents (including the National Policy Statement for Freshwater Management, the Partially Operative Otago RPS, the Otago Regional Waste Plan, the Otago Regional Water Plan and the Proposed Dunedin 2GP) set a range of objectives and rules with respect to effects on streams and wetlands, areas of significant indigenous vegetation and significant habitats for indigenous fauna.

The relevant provisions of these documents identify that adverse effects on streams, wetlands and other significant vegetation types identified in this report are to be avoided; and if avoidance is not practicable, the applicant must ensure that there is no net loss and preferably a net gain in the indigenous biodiversity values of the area. 'No net loss' in the proposed 2GP refers to matters such as "*type, amount and condition*," and specifically refers to "*indigenous biodiversity values*" and does not mean net habitat area per se. However, net area, or net area and current condition are useful metrics upon which to make recommendations.

For this project, this means that if vegetation types / habitats (including wetlands) that have been identified as significant (see Section 3.2.2) are cleared or otherwise negatively affected by construction of the landfill, measures are required to ensure that there is no net loss of the significant ecological values in those vegetation types. These requirements are irrespective of the ecological value, magnitude of impact, and overall level of ecological effect identified in Section 5.5, which describes the effect of the proposal in relation to the existing environment rather than its significance in terms of the RPS / 2GP.

In summary, the following impact management measures are recommended to avoid, remedy, mitigate, offset or compensate for any adverse effects of landfill construction and operation. These are provided in order of priority for ecological impact management, following the effects management hierarchy of Roper-Lindsay et al. (2018), where:

- avoidance: means to modify a project proposal to prevent any environmental damage or loss of an ecological or environmental feature or function,
- remediation: means to reverse or stop any environmental damage.

[61] This magnitude of effect is assessed with the implementation of best practise lizard salvage and the recommendations of a Lizard Management Plan (i.e. with mitigation) in place.

- mitigation: means to alleviate, or to abate, or to moderate the severity of something (environmental damage), and typically occurs at the point of impact.
- biodiversity offset: means a measurable conservation outcome resulting from actions designed to compensate for residual, adverse biodiversity effects arising from activities after appropriate avoidance, remediation, and mitigation measures have been applied. The goal of a biodiversity offset is to achieve no net loss, and preferably a net gain, of indigenous biodiversity values. Best practice for biodiversity offset methodology is described in Roper-Lindsay et al. (2018) and New Zealand Government (2014). In summary, adverse effects must be offset by the restoration, enhancement, or averted loss of biodiversity values of 'ecological equivalence[62]'. In this case, biodiversity offset means restoration and enhancement of similar vegetation types, of similar ecological functioning, as close to the site of impact as possible.
- environmental compensation: means a non-quantified biodiversity benefit offered to compensate for biodiversity losses. The compensation actions may benefit different biodiversity to that lost (out-of-kind compensation), including biodiversity of a lesser conservation concern than that lost. Compensation is not quantified or balanced with losses and may involve subjective decision-making subject to socio-political influences.

6.1 Avoid and Minimise

Terrestrial Vegetation and Wetlands

- ~~Avoid indigenous vegetation clearance in West Gully 3 (the kānuka forest and harakeke – gorse / (pūrei – rautahi) flaxland) at the edge of the landfill footprint, and avoid vegetation clearance in West Gully 1 and West Gully 2 to allow these areas to regenerate (these areas are not proposed to be cleared based on the current landfill layout, and are largely not currently planted in plantation forestry). Avoid indigenous vegetation clearance and~~
- Avoid vehicle or machinery movements ~~in areas of indigenous vegetation~~ outside the ultimate footprint of works, to minimise unnecessary impacts to areas of vegetation that are within the designation site but not within the final landfill footprint. In particular, during road construction, use GPS-enabled machinery, string lines, or other appropriate strategies to contain vegetation clearance and construction effects to only the area within the final road widening design extent, to avoid any further encroachment on wetland vegetation types beyond what is currently anticipated (16.5 m^2 / 0.0017 ha).
- ~~Avoid, as much as practicable, earthworks and clearance of indigenous (rautahi – Yorkshire fog) - cocksfoot / watercress – floating sweetgrass grassland and harakeke – gorse / (pūrei – rautahi) flaxland in the swamp wetland in areas outside the ultimate stormwater attenuation basin area, in order to minimise the loss of wetland habitat.~~
- Avoid further weed incursions during construction of the landfill by ensuring that construction equipment is appropriately cleaned prior to use, and that external sources of gravel, soil, etc., are free from seeds or other viable plant material. Introduction of weed species during landfill operation likely cannot be avoided, but further encroachment into vegetation communities remaining in the designation site can be managed.

[62] See New Zealand Government (2014). *Guidance on good practice biodiversity offsetting in New Zealand*. New Zealand Government.

- In relation to grassland habitats, it is considered that the recommendations made elsewhere in this report with respect to avoidance of adverse effects on indigenous lizards and enhancement of lizard habitat (see Sections 5.3 and below) are sufficient to effect '**no net loss**' of significant lizard habitat and herpetofauna ecological values in the context of this project.
- In relation to plantation forestry areas, it is considered that the recommendations made elsewhere in this report with respect to avoidance of adverse effects on eastern falcon (see Sections 6.1 and below) are sufficient to effect '**no net loss**' of the significant indigenous biodiversity values of this habitat type in the context of this project.

Avifauna

- Avoid or minimise construction effects on falcon potentially nesting at the site, as detailed in the draft Falcon Management Plan. The draft Falcon Management Plan has been prepared by a suitably qualified ecologist and includes details regarding the time of year to avoid construction (falcon breeding season; broadly the start of August to the end of May) and measures to minimise effects on potentially nesting birds where avoiding the breeding season is not possible (e.g. conducting pre-construction falcon surveys, establishing exclusion zones around nests (if identified) whereby construction activities cannot occur until nesting activities are completed), and monitoring nesting birds and, if disturbed, extending the size of the exclusion zone/s[49]. When finalising the draft Falcon Management Plan, it is recommended that relevant stakeholders are consulted, including a suitably qualified ornithologist[63].

Herpetofauna

- Avoid potential effects of habitat loss and fragmentation on lizards ensuring that key areas of habitat, which provide dispersal mechanisms between surrounding habitats and existing remaining fragments, are left within the designation site. Areas must remain connected to ensure dispersal of ground dwelling lizards between areas of vegetation. For, example, fencing the remaining vegetation around West Gully 3 and protecting this from any clearance, to prevent loss of lizards from these areas, with specific note to jewelled gecko, which (if present) are only likely to be found in this location.

Freshwater

- Avoid changes to the extent of perennial reaches of waterway along the Ōtokia Creek tributary downstream of the designation site, particularly where these support freshwater fish and / or large macroinvertebrates.

6.2 Remediation

Terrestrial Vegetation and Wetlands

- ~~Remediation of areas of the swamp wetland that are impacted by construction of the stormwater attenuation basin should follow recommendations below (as part of a Wetland Restoration Plan).~~

[63] We understand that falcons within and adjacent to the Smooth Hill area (including the wider Wenita production pine forestry areas) are monitored by Parker Conservation (a local ecological consultancy), and that there are banded falcons in the area. Reporting to Parker Conservation of any banded falcon encountered is recommended.

- Remediating impacts to some ~~terrestrial~~ significant vegetation types (wetland areas) due to ~~landfill construction~~ road widening is not a practical step, because those vegetation types are either wholly lost (due to clearance ~~and landscaping / contouring~~) or not.

Herpetofauna

- 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. Therefore, specific lizard habitat enhancement will be required as part of a mitigation process in a draft Lizard Management Plan (see section 6.3).

6.3 Mitigation

Terrestrial Vegetation and Wetlands

- Effects to wetlands due to widening of McLaren Gully Road cannot be mitigated at the point of impact as these are on private land. Therefore, ecological offset is required for loss of wetland habitats along McLaren (see Section 6.4).
- Potential effects to the swamp wetland arising from altered water supply are to be mitigated as described in a draft Vegetation Restoration Management Plan attached to the Landfill Management Plan. The existing swamp wetland area is currently degraded by weeds and subject to periodic disturbance during forestry harvest cycles. The proposed mitigation measures address a possible change in abundance of obligate wetland plant species (e.g. pūrei) in a small proportion (c.25%) of the 0.47 ha wetland that is presently dominated by such species. These measures include fencing and exclusion of pests (e.g. pigs) from a connected sequence (5.8 ha) of forest and wetland habitats (which includes the swamp wetland itself, and West Gully 3), ongoing protection, removal of weeds (extensive gorse), indigenous plantings (to replace / exclude exotic weeds) in both the wetland itself and a surrounding 10 m buffer on its southern and eastern sides (presently the wetland is immediately bordered by plantation forest in these places). Such measures are likely to lead to a substantial improvement (a **Net Gain**) in the condition of the swamp wetland overall, and particularly considering that the permitted existing land use (ongoing forestry impacts) may degrade the wetland further.

- ~~The following vegetation types have ecological values that will be subject to permanent loss as a result of landfill construction in a way that cannot be totally avoided or remediated by the current proposal (see Section 5.1.1):~~
    - ~~[Pūrei] / (Yorkshire fog) – rautahi – cocksfoot / (watercress – floating sweetgrass) grassland;~~
    - ~~Harakeke – gorse / (pūrei – rautahi) flaxland;~~
    - ~~[Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland;~~
    - ~~Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland;~~
    - ~~(Yorkshire fog) - cocksfoot grassland;~~
    - ~~Macrocarpa forest; and~~
    - ~~(Pūrei) – wiwi / cocksfoot rushland.~~

Herpetofauna

- Areas surrounding vegetation and habitats to be cleared should be temporarily fenced with silt-fence material to prevent the dispersal of lizards out of these areas into the construction footprint.
- A draft Lizard Management Plan has been prepared by a herpetologist, and will be finalised and implemented with input as required from project engineers and other specialists. This Plan covers any avoidance, remediation, mitigation and monitoring that may be carried out in association with the construction of the landfill. Recommendations follow the key principles to lizard salvage as described in DOC (2019).
- Conduct vegetation clearance activities during warmer months, when lizards are active (October – April).
- Lizard salvage and translocation is recommended from the following areas, prior to their clearance: (Yorkshire fog) - cocksfoot grassland (bordering / within radiata pine / gorse / (cocksfoot – Yorkshire fog) treeland); and (Yorkshire fog) - cocksfoot grassland alongside McLaren Gully Road and Big Stone Road.
- Because landfill activities and disturbance will be ongoing for many years, salvaged lizards will need to be relocated to prepared areas outside of the landfill footprint. Site preparation may include habitat enhancement (e.g. plantings of native grasses and shrubs) prior to release of salvaged lizards. ~~This will be outlined in the Lizard Management Plan. For example, an area between West Gully 2 and West Gully 1, which is north-facing and surrounded by regenerating scrub / forest, but currently planted in pines, could be used.~~ This proposed habitat enhancement is described in a Vegetation Restoration Management Plan attached to the Landfill Management Plan ~~has been considered and included in the project's General Arrangement Plan Stages 1-3 (prepared by Boffa Miskell, version 7, dated 18 August 2020)~~. This would have the benefit of consolidating the areas proposed for forest / treeland and grassland habitat mitigation, simplifying the process of pest control, fencing, and plantings and creates a single area of enhanced indigenous habitats. The exact relocation site location (whether inside or outside the designation site) will be identified and outlined in the Lizard Management Plan.
- An appropriate predator control programme is to be designed and implemented for the designation site as part of the Landfill Management Plan 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 and be enhanced, such as West Gully 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.

~~**Freshwater**~~

~~Where monitoring of the valley floor marsh wetland and Otokia Creek Tributary following landfill construction (see Section 6.6) shows substantial loss of perennial freshwater habitat, enhance or create similar or better habitat in adjacent mitigation areas. For example, in the East Gully wetland system, which is connected to the valley floor marsh wetland.~~

6.4 Offsetting

Terrestrial Vegetation and Wetlands

- Effects on wetlands due to widening of McLaren Gully Road cannot be mitigated at the point of impact as these areas include private land. Therefore, ecological offset is required for the small loss of wetland habitats (the (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland and [pūrei] – wīwī / rautahi – exotic grass rushland vegetation types). These vegetation types are significant and no net loss is required.

  An extremely small area of around 16.5 m^2 / 0.0017 ha of total wetland vegetation will be cleared by road widening. The vegetation types affected have an average of around 50% canopy cover of indigenous vegetation[64] and are generally in poor condition with abundant exotic weeds.

  To mitigate these ecological impacts and achieve 'no net loss' of significant wetland habitat impacted by landfill construction, a draft Vegetation Restoration Management Plan has been prepared by a suitably qualified and experienced ecologist. This draft plan will be refined with input as required from project engineers and other specialists prior to implementation. This Plan outlines a process in which:

    - problem weeds (gorse, crack willow) are to be removed from the 0.49 ha wetland vegetation upstream of the swamp wetland at the designation site (at the base of West Gully 3 and 4); and
    - plantings of ecologically appropriate wetland species, including tree species that would have historically been present in valley floor wetlands in the wider area but that are absent from McLaren Gully Road / the designation site (e.g. kahikatea) are to occur throughout this 0.49 ha area, at a low density.

  The benefits of weed removal would accrue almost immediately and provide new opportunities for expansion of indigenous wetland plants. Maturation of species such as kahikatea would take substantial time (c.100 years or more) but these trees would rapidly become the tallest trees in the wetland area (excluding adjacent pines), improving habitat complexity and providing nesting opportunities for birds. Confidence in the success of these very straightforward enhancement measures is high.

  To determine whether the proposed offset actions are sufficient to effect 'no net loss,' the methods and calculation tools of the Biodiversity Offsets Accounting Model for New Zealand (Maseyk et al. 2015) were used (see Appendix 7). The calculations assessed the pre- and post-impact percentage cover of indigenous species and species diversity at the 0.0017 ha impact site, yielding an average score of -0.0008 for the loss of the 'present biodiversity value' (relative units). The estimated pre- and post-rehabilitation state of the 0.49 ha offset site, and the confidence in the offset actions, gave an average offset gain score of 0.0954 ('offset biodiversity value', relative units). This therefore equates to a 0.0946 net gain in biodiversity value and means that the estimated loss is, by this calculation method, roughly 100-fold offset by the measures proposed. The proposed offset measures therefore constitute a substantial **Net Gain.**

6.5 Other

- Implementation of ongoing plant and animal pest control (as detailed in the draft Landfill Management Plan) across the wider landfill site will provide benefits for vegetation, birds and other indigenous biodiversity in the landfill site, and will avert future losses of indigenous values as a result of the landfill attracting mammalian pests. This is of also

[64] Some variability exists between different areas of similar vegetation, but the overall 50% figure is conservative.

of importance as the landfill will likely create new opportunities for predators that may cause additional indirect adverse effects on indigenous biodiversity at the site and in adjacent areas.

- The draft Bird Strike Management Plan must be adhered to in order to minimise bird numbers at the landfill site and to reduce aircraft strike risk. It is intended that this is a dynamic document that is reviewed annually and updated based on lessons learned (adaptive management). It is also recommended that regular communication with other landfills is used to keep up to date with the most effective bird management and control techniques. This information should be incorporated into the bird management plan during biannual reviews of the plan.

6.6 Monitoring

Terrestrial Vegetation and Wetlands

- In order to ensure that 'no net loss' of significant habitats has been achieved, monitoring at 2 and 5 years following the implementation of ecological mitigation / offset steps (such as planting and pest / weed control) to ensure that any plantings of indigenous species have been successful, and that the availability and quality of habitats for indigenous fauna are overall of a similar or better than the habitats found in the existing environment.
- Recommendations for specific monitoring protocol are contained within the draft Vegetation Restoration Management Plan.

Herpetofauna

- Success of lizard translocations should be monitored for up to 5 years following translocation. Relevant measures are outlined in the draft Lizard Management Plan.

~~**Freshwater Ecology**~~

- ~~Further investigations, during the months of November to April and prior to landfill construction activities, are recommended to determine if freshwater fish and / or freshwater crayfish are present in Otokia Creek Tributary (downstream of the designation site).~~
- ~~Baseline and post-site establishment surface flow / water level monitoring in the valley floor marsh wetland and Otokia Creek tributary is required to address the uncertainty of the potential downstream effects on groundwater and surface water flows (as per the recommendations in Appendix D of GHD 2020). It is currently expected up to 50% of the runoff downstream could be lost. If, based on improved baseline monitoring, this effect is still anticipated, the following monitoring is required:~~
- ~~In order to establish a baseline for the potential loss of downstream wetland habitat (described in Section 5.1.4, and noted as being highly uncertain), a pre-construction survey by a suitably qualified and experienced wetland ecologist should determine the total wetland extent in this area and establish monitoring points (permanent transects or plots) and appropriate wetland delineation techniques.~~
- ~~Surveys by a suitably qualified and experienced freshwater ecologist should also establish a habitat baseline (e.g. stream cross-section and faunal surveys) in the Otokia Creek tributary below the designation site. Suitable mitigation / offsetting must be established if any significant adverse effects are detected.~~

- ~~Where surface flow / level monitoring conducted following site establishment (see Appendix D of GHD 2020) demonstrates a substantial, ongoing reduction in water supply to these habitats, further recommendations may apply:~~
- ~~Wetland and freshwater habitat extent / quality should be monitored every 5 years (using locations / methods established for baseline monitoring), and where a substantial reduction in habitat extent / quality is detected, an offset will be required as described in Section 6.3 and 6.4. This offset should account for the area of any wetland habitat already lost and avert any future loss anticipated due to further stages of landfill construction. This would involve creation of the same area of habitat as what is (or is expected to be) lost.~~

7.0 Summary of Predicted Effects and Proposed Mitigation

The following table (Table 20) summarises the results of Sections 3.0-6.0. It provides an assessment of the residual impact with the recommended impact management measures implemented for adverse ecological effects, with emphasis on steps required to effect 'no net loss' for significant habitats and / or levels of effect that are assessed as being greater than 'very low.'

Table 19. Summary of predicted impacts, proposed mitigation and residual effects after the implementation of impact avoidance, minimisation and mitigation measures.

Subject or Location of Impact	Predicted Impact Without Impact Management Measures	Summary of Impact Management Measures Recommended	Recommended Location of Impact Management Measures (if applicable)	Residual Effects After Implementation of Impact Management Measures
~~Loss of wetland habitat in the swamp wetland and West Gully 4~~	~~Loss of at least 0.45 ha of grassland and flaxland wetland habitat in these areas constitutes a low level of ecological effect, but these habitats are significant under RPS and 2GP criteria and no net loss, or net gain, is required.~~	~~A Wetland Restoration Plan, which outlines steps to enhance or create wetland habitat of an equivalent overall area, should be prepared and implemented prior to or during landfill construction. This Plan would likely require fencing, planting, weed and pest control, and monitoring, and is considered likely to be successful.~~	~~Expansion of wetland would ideally take place near the site of impact (in West Gully 3, around stormwater attenuation basin) or within designation site (East Gully).~~	~~The habitat types lost are degraded by weeds and pests, and implementation of an appropriate Wetland Restoration Plan would result in no net loss or net gain (a positive effect) in wetland habitat in the vicinity of the landfill.~~
Terrestrial / Wetland Ecosystems and Habitats ~~Loss of wetland habitat adjacent to roadsides~~ ~~Loss of at least 0.53 ha of grassland, rushland and flaxland habitat in these areas constitutes a low level of ecological effect, but these habitats are significant under RPS and 2GP criteria and no net loss, or net gain, is required.~~ ~~A Wetland Restoration Plan, which outlines steps to enhance wetland habitat in remaining wetland areas, should be prepared and implemented prior to or during road widening. This Plan would likely require planting, weed control, and monitoring, and is considered likely to be successful.~~ ~~Enhancement of wetland would ideally occur in the same wetlands affected by road widening. However, it is anticipated that an offset at another site will occur (e.g. in East Gully or in an area within the land to be owned by DCC, outside the designation area to the west).~~ ~~Implementation of an appropriate Wetland Restoration Plan would result in no net loss or net gain (a positive effect) in wetland habitat in the vicinity of the roads.~~				
Loss of significant wetland habitat adjacent to roadsides	Loss of **0.0017 ha** of wetland (0.0014 ha of sedgeland and 0.00027 ha of rushland) habitat	A draft Vegetation Restoration Management Plan, which outlines steps to enhance wetland	Enhancement of wetland would ideally occur in the same wetlands	Implementation of an appropriate Vegetation Restoration Management Plan would result in a

Subject or Location of Impact	Predicted Impact Without Impact Management Measures	Summary of Impact Management Measures Recommended	Recommended Location of Impact Management Measures (if applicable)	Residual Effects After Implementation of Impact Management Measures
	in these areas constitutes **a very low level of ecological effect,** but these habitats are significant under RPS and 2GP criteria and no net loss, or net gain, is required.	habitat in a nearby wetland area, has been prepared and will be implemented prior to or during road widening. This Plan recommends appropriate fencing, planting, weed control, and monitoring, and is considered likely to be successful.	affected by road widening. However, because the impact site is on private land, an offset would occur within a similar wetland habitat. **The offset area is an area of existing wetland vegetation upstream of the swamp wetland at the designation site** at the base of West Gully 3 and West Gully 4, (comprising 0.49 ha in total).	substantial **net gain (a positive effect)** in wetland habitat due to gains at the offset site (e.g. **fencing, plantings and weeding across 0.49 ha of higher quality wetland,** upstream of the swamp wetland) compared to losses at the 0.0017 ha impact site.
Downstream effects on significant wetlands below landfill	Altered ~~reduction in~~ groundwater and runoff from the landfill footprint may affect the **0.47 ha swamp wetland** ~~**valley floor marsh wetland. The degree to which reduced water supply might reduce wetland extent is highly uncertain.**~~ Possibly, changes to vegetation structure, with loss of some indigenous wetland species that generally favour wetter conditions (pūrei), would occur. ~~**Wetland loss / changes cannot be predicted with confidence.**~~ **A low ~~to moderate~~ level of ecological effect**	A draft Vegetation Restoration Management Plan, which outlines steps to enhance ~~existing wetland habitat, ideally in downstream / nearby wetland areas~~ and improve the integrity of the swamp wetland, should be prepared and implemented prior to or during landfill construction. This Plan recommends appropriate fencing, planting, weed control, and monitoring, and is considered likely to be successful. ~~This Plan would likely require planting, weed control, and monitoring. Adaptive management may be required to monitor wetland loss (if any) and ensure wetland enhancement is adequate to account for an as-yet unknown~~	~~**Enhancement of wetland would ideally occur within the valley floor marsh wetland, most likely downstream of the designation where enough water supply to support wetland vegetation is likely to persist. However, it is anticipated that an offset at another site will occur (e.g. in East Gully or in an area within the land to be owned by DCC, outside the designation area to the west).**~~ **Mitigation will occur within the swamp wetland** itself.	Implementation of an appropriate Vegetation Restoration Management Plan (including **fencing, infill plantings and weeding across the currently degraded 0.47 ha wetland**, including **planting of an 0.4 ha buffer of indigenous dryland vegetation** around the wetland) would result in a **net gain (a positive effect)** to the swamp wetland. ~~Monitoring of wetland loss (if any) and subsequent implementation of an appropriate Wetland Restoration Plan (if required) would result in enhancement of indigenous biodiversity in remaining wetland areas and would result in no net loss or net gain (a positive effect) in indigenous biodiversity in the~~

Subject or Location of Impact	Predicted Impact Without Impact Management Measures	Summary of Impact Management Measures Recommended	Recommended Location of Impact Management Measures (if applicable)	Residual Effects After Implementation of Impact Management Measures
	is possible. No net loss, or net gain, is required.	~~impact on the valley floor marsh wetland.~~		~~remaining wetland habitat.~~ ~~However, even if there is no net loss of wetland habitat, in terms of area and type, the downstream buffering effects of the existing wetland to Otokia Creek may be reduced. This may constitute up to a low level of ecological effect.~~
~~Treeland vegetation in West Gully 4~~	~~Loss of 4.52 ha of treeland habitat in West Gully 4 constitutes a low level of ecological effect, but these habitats are significant under RPS and 2GP criteria and no net loss, or net gain, is required.~~	~~A Terrestrial Vegetation Restoration Plan, which outlines steps to enhance and create habitat, should be prepared and implemented prior to clearance of vegetation during landfill stage 4-5. This Plan would likely require fencing, planting, weed and pest control, and monitoring, and is considered likely to be successful.~~	~~Expansion and enhancement of treeland would ideally occur between West Gully 2 and 3 to link existing indigenous forest patches and take into account natural spread of native seedlings.~~	~~The habitat types lost are degraded by weeds and pests, and implementation of an appropriate Terrestrial Vegetation Restoration Plan would result in no net loss or net gain (a positive effect) in treeland / forest habitat in the vicinity of the landfill, and represents an opportunity to introduce tree species lost from the area but which would have been historically present (also a net gain / positive effect).~~
Plantation forestry that provides significant eastern falcon habitat ~~Grassland vegetation that provides lizard habitat~~	Loss of 33.88 ha of the exotic vegetation itself is not of ecological concern. For avoidance / mitigation of any residual effects to eastern falcon, see below in Avifauna section of table.			
Grassland that likely provides significant lizard habitat	Loss of 3.15 ha of the exotic vegetation itself is not of ecological concern. For avoidance / mitigation of any residual effects to lizards, see below in Herpetofauna section of table.			

Subject or Location of Impact	Predicted Impact Without Impact Management Measures	Summary of Impact Management Measures Recommended	Recommended Location of Impact Management Measures (if applicable)	Residual Effects After Implementation of Impact Management Measures
~~Plantation forestry~~				
Avifauna				
Eastern falcon	Disturbance, displacement and mortality[65] of falcon during the breeding season (construction).	Preparation of a Draft Falcon Management Plan. This Plan includes details regarding the time of year to avoid construction (falcon breeding season; i.e. broadly the start of August to the end of May) and if this is not practicable, how to minimise effects on potentially nesting birds (such as conducting pre-construction falcon surveys and establishing exclusion zones around nests (if identified), whereby construction activities cannot occur until nesting activities are completed).	Across site.	There will be a negligible / low magnitude[66] of residual effect (a **very low / low level of effect**) after correct implementation of the Falcon Management Plan.
Herpetofauna				
Southern grass skink and other indigenous herpetofauna	Indigenous lizard species may be present in the designation site, most likely Southern grass skink (At Risk – Declining). **3.15 ha of grassland vegetation that is proposed to be cleared** for landfill construction and road upgrades represent low quality habitat for this species. All	A Draft Lizard Management Plan has been prepared and will implemented. This plan manages effects on lizards primarily by salvage and translocation away from the site of impact, and through predator control efforts as part of the plant and animal pest control (as detailed in the draft Landfill Management Plan). It also outlines a range of measures to enhance	The extent of lizard translocation / habitat enhancement required is dependent upon the as-yet unknown population size and current locations of lizards. The draft Vegetation Restoration Management Plan includes a range of measures to enhance and protect a potential lizard	There will be a negligible magnitude of residual effect (a **low level of effect**) after correct implementation of the Lizard Management Plan.

[65] There is only a potential mortality risk if falcon are nesting on site.

[66] The magnitude / level of effect is only Low if birds are nesting. If they are not nesting the magnitude / level of effect would be Negligible.

Subject or Location of Impact	Predicted Impact Without Impact Management Measures	Summary of Impact Management Measures Recommended	Recommended Location of Impact Management Measures (if applicable)	Residual Effects After Implementation of Impact Management Measures
	native lizard species are absolutely protected under the Wildlife Act 1953.	and protect a potential lizard release site via fencing and planting.	release site at **West Gully 3** (the protected site includes some surrounding regenerating / wetland vegetation). **Enhancement and protection of habitat would occur across a c.5.8 ha area.**	
Freshwater ecology				
Downstream effects on Ōtokia Creek Tributary (below the designation site)	A reduction in groundwater and surface water / runoff from the designation site may reduce the perennial extent of the waterway. The degree to which reduced water supply might reduce the extent of the perennial reaches is likely to be limited to 200-300 m downstream of the designation (and upstream of the large pond). Changes to perennial reaches would result in a slight change to poor quality freshwater habitat. The large pond, which supports two species of indigenous fish, is unlikely to be affected. This constitutes to a **very low level of ecological effect**.	Impact measures such as best practice erosion and sediment control measures, implementation of attenuation basin, etc. are already assumed. The draft Vegetation Restoration Management Plan is also required as mitigation for the potential changes to the 0.47 ha swamp wetland, which sits within the tributary. No additional mitigation for freshwater is required.	Mitigation will occur within the swamp wetland itself.	Implementation of an appropriate Vegetation Restoration Management Plan will result in a net gain (a positive effect) to the swamp wetland. This will result in improvement of freshwater habitat downstream, resulting in a **positive effect**, or a **very low level** of residual effect.
~~Downstream effects on~~	~~A reduction in groundwater and~~	~~Adaptive management may be required to~~	~~Enhancement of freshwater habitat~~	~~Monitoring of loss / shift of perennial~~

Subject or Location of Impact	Predicted Impact Without Impact Management Measures	Summary of Impact Management Measures Recommended	Recommended Location of Impact Management Measures (if applicable)	Residual Effects After Implementation of Impact Management Measures
~~Otokia Creek Tributary (below the designation site)~~	~~surface water / runoff from the designation site may reduce the perennial extent of the waterway. The degree to which reduced water supply might reduce the extent of the perennial reaches is highly uncertain. Changes to perennial reaches would result in a loss of habitat for freshwater species, potentially including freshwater fish and freshwater crayfish.~~	~~monitor loss of freshwater habitat (if any) and ensure enhancement is adequate to account for an as-yet unknown impact on the freshwater ecology values downstream.~~	~~would ideally occur within the same valley floor marsh wetland / Otokia Creek Tributary downstream of the designation where enough water supply is found to create perennial flows. However, it is anticipated that an offset at another site may be required.~~	~~reaches (if any) and subsequent implementation of appropriate mitigation / offset. See Section 6.6.~~

8.0 Conclusions

Existing environment:

- A range of vegetation types are present within the Smooth Hill landfill designation site, downstream areas, and areas adjacent to roads that may be widened (McLaren Gully Road and Big Stone Road). These range from highly modified plantation forestry areas of negligible ecological value, to wetland habitats of moderate ecological value, and regenerating / secondary indigenous forest habitat of high ecological value. No At-Risk, Threatened, or locally uncommon or important plant species, excluding kānuka, were found on site.
- Regenerating forest / treeland / scrub in gullies the designation site contributes to a local mosaic of forest fragment habitats in the wider area, and a range of widespread and common indigenous bird species are present, as well as introduced species. The At-Risk – Recovering species eastern falcon (of moderate ecological value) is present, and area of kānuka forest is of importance to this species at the site and has been used for breeding.
- No indigenous herpetofauna were observed on site as part of this work, but historical records and evidence (scat) of skinks having utilised 'artificial cover objects' deployed on site in this study strongly suggest that lizard species are present, most likely Southern grass skink (At Risk – Declining; high ecological value). Some areas of vegetation that are proposed to be cleared for landfill construction represent typical habitat for this species.
- An interconnected area of regenerating forest / treeland / scrub habitats and flaxland / sedgeland wetland habitats is of ecological significance as significant vegetation and significant habitat of indigenous biodiversity in terms of the proposed Otago RPS and proposed Dunedin 2GP.
- No ecological values relating to freshwater habitats, such as streams or lakes, are present (excepting wetland vegetation) within the designation site. Some wetland habitats receive ephemeral overland flows, but the wetland habitats are unlikely to provide important habitat indigenous fishes.
- Ōtokia Creek Tributary, downstream of the designation site, appears to be perennial for most of the c. 1 km between the site and McLaren Gully Road. This waterway supports a ubiquitous and 'tolerant' freshwater macroinvertebrate community, commonly found in similar soft-bottomed, slow-moving waterways within linear wetlands. Shortfin and longfin eels were found to inhabit the large pond, approx. 200-300 m downstream of the designation site, and these species may also inhabit the Ōtokia Creek tributary when sufficient surface water is present.

Effects of landfill construction and road widening

- Within the designation site, vegetation clearance during landfill construction ~~and clearance of vegetation types present represents~~ would occur within plantation forestry areas and adjacent exotic grassland only. The landfill proposal assessed in this report does not include any clearance of regenerating forest or wetland areas within the designation site. The ecological effects of vegetation clearance in this area constitute Negligible ~~or very low~~ magnitudes of effect, as the vegetation is almost entirely dominated by exotic species, including weeds, and the total areas cleared are relatively

minor in comparison to the extent of similar vegetation types in the wider area and at the level of the ED. Adverse effects, in terms of vegetation, are of a Very Low overall level of ecological effect, but RPS and 2GP rules require 'no net loss' or 'net gain' of the significant ecological values of these vegetation types (in that they provide falcon and lizard habitat, see below).

- Vegetation clearance during upgrade of McLaren Gully Road and Big Stone Road would impact plantation forestry areas, exotic rank grassland, gorse scrub, intensively improved crop / pasture farmland areas, and small areas of wetland. The ecological effects of vegetation clearance associated with the road upgrade constitute Negligible magnitudes of effect and Very Low levels of ecological effect. An iterative road redesign process intended to avoid wetland habitats has resulted in an amended road upgrade proposal that was unable to totally avoid effects to wetlands in places where there is wetland vegetation at the immediate road edge on both sides of McLaren Gully Road. As a result, road widening would lead to 16.5 m^2; 0.0017 ha of wetland clearance. These effects, while extremely slight, occur in significant habitat (requiring no net loss / net gain) and cannot be remediated / mitigated at the point of impact (requiring an offset). An offset proposal outlined in the draft Vegetation Restoration Management Plan results in a substantial net gain in terms of wetland habitat.

- Finalisation and implementation of the draft Vegetation Restoration Management Plan is required to mitigate ~~(or offset, as applicable) the adverse effects of landfill construction and road widening (vegetation clearance) and~~ the potential adverse downstream effects of landfill construction (change in vegetation composition in a swamp wetland) and to offset the adverse effects of road widening (vegetation clearance) on significant wetlands to effect 'no net loss' or 'net gain.' ~~These effects can be managed on site through such Plans by expansion and enhancement of similar habitats to those impacted, outside the landfill footprint. An area of wetland vegetation in East Gully, and a further area west of the designation area, but within the land to be acquired by DCC, is available and these areas could be enhanced and expanded as required to mitigate or offset wetland loss associated with landfill construction.~~

- ~~Downstream effects on wetlands are uncertain and may constitute a low to moderate level of ecological effect (without mitigation at the point of impact or offset in the locations described above) due primarily to a reduction in water supply (runoff) from the designation site. With mitigation / offsetting in place, effects are likely to be positive (net gain) in terms of wetland habitat, as existing wetland habitats contain extensive areas of exotic species and remediation / creation of higher quality wetland habitat has a high likelihood of success. However, the downstream buffering effects of the existing wetland to Otokia Creek may be reduced. This may constitute up to a low level of ecological effect even with creation (offset) of similar habitat elsewhere. Therefore, if future land purchases for the Smooth Hill landfill are considered, acquiring an area of land immediately downstream of the designation site that contains a large wetland pond (above the East Gully confluence) would allow this wetland to be enhanced and managed[67] to:~~

    - ~~Mitigate any wetland loss in that area; and~~

[67] ~~Any such enhancement / management would be additional to what has been accounted for in Section 7.0 and has not been considered in the assessment of impact management measures or residual effects.~~

- ~~Avoid or minimise potential effects on the freshwater values further downstream, as this pond is likely to be contributing to the perennial flows (and, therefore, freshwater habitats) downstream.~~

- In order to mitigate adverse effects on avifauna and herpetofauna due to landfill construction, to enhance these ecological values, and to avert future losses associated with a potential influx in mammalian pests due to landfill operation, preparation and implementation of plant and animal pest control (as detailed in the draft Landfill Management Plan) is required.
- As the proposed landfill is located close to the Dunedin International Airport, a separate draft Bird Strike Management Plan has been prepared pertaining to requirements for managing the risk of aircraft bird strike from avifauna attracted to the site by landfill operation.
- Construction during the breeding period, or direct impacts to important areas of eastern falcon habitat may have adverse effects on this species at the site. Finalisation and implementation of a brief draft Falcon Management Plan outlining best practices to minimise these effects should lead to negligible effects to eastern falcon at the site.
- Indigenous lizard species are protected by the Wildlife Act 1953 and Southern grass skink is of conservation concern. To minimise impacts to lizard species that may be present on site, further surveys may be required, and a draft Lizard Management Plan has been developed and will be implemented. This plan describes the appropriate measures to manage effects on lizards primarily by salvage and translocation away from the site of impact, and through predator control efforts as part of the plant and animal pest control (as detailed in the draft Landfill Management Plan) .
- This report has recommended that a Vegetation Restoration Management Plan be prepared. This plan describes the fencing, weeding, and plantings of indigenous vegetation measures required to avoid / mitigate / offset the ecological effects of landfill construction and road widening, particularly in relation to wetlands and herpetofauna. A single location for these activities has been recommended, ~~incorporating slopes between West Gully 1 and 3~~ centred on West Gully 3 and the swamp wetland within the designation site ~~currently used for plantation forestry~~. Consolidating the areas proposed for habitat mitigation is intended to simplify the process of pest control, fencing and plantings, and to create a single large area of enhanced indigenous habitat. However, because enhancement measures in the swamp wetland cannot be both a mitigation for adverse effects to the swamp wetland itself and an offset for road widening wetland impacts, it is suggested that an offset for the road impacts ~~wetland habitat enhancement, due to a need to incorporate naturally wet areas,~~ would occur ~~in East~~ at the base of West Gully 4 nearby. ~~(within the designation site), and in other existing wetland areas within the land to be acquired by DCC (just to the west of the designation site).~~
- Successful implementation of the measures recommended in the draft Lizard, Bird Strike, Falcon, and Vegetation Restoration Management Plans as part of the landfill proposal constitute overall Low, Very Low or Net Gain levels of ecological effect.

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Appendix 1: Plant Species List

Plant species lists in the main vegetation types potentially affected by the landfill proposal are included in the tables below[68].

Table A1-1. Species found in the (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland (valley floor marsh wetland, West Gully 4, and East Gully area).

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
*Acaena novae-zelandiae**	Bidibid; piripiri;	Dicot Herb	Indigenous non-endemic	Not Threatened
Agrostis capillaris	Browntop	Grass	Exotic	
Agrostis stolonifera	Creeping bent	Grass	Exotic	
Austroblechnum penna-marina	Little hard fern	Fern	Indigenous non-endemic	Not Threatened
Carex geminata	Rautahi / cutty grass	Sedge	Indigenous endemic	Not Threatened
Carex secta	Pūrei	Sedge	Indigenous endemic	Not Threatened
Carex uncinata	Kamu, hook sedge	Sedge	Indigenous endemic	Not Threatened
Carex virgata	Swamp sedge	Sedge	Indigenous endemic	Not Threatened
Cirsium arvense	Californian thistle	Dicot herb	Exotic	
Cirsium vulgare	Scotch thistle	Dicot Herb	Exotic	
Clematis vitalba	Old man's beard	Climber/Vine	Exotic	
Coprosma propinqua	Mikimiki	Shrub	Indigenous endemic	Not Threatened
Crepis capillaris	Hawksbeard	Dicot Herb	Exotic	
Cytisus scoparius	Scotch broom	Shrub	Exotic	

[68] Note that a complete plant species list for the macrocarpa forest and the (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub in West Gully 1 within the designation site was not recorded. This area, described in section 3.2.1 of this report, is dominated by exotic species, and has not been proposed to form part of the landfill footprint in either this proposal or in an earlier assessed proposal. Any indigenous species present are relatively scarce individuals of common and widespread species found throughout the other habitat types in the designation site. Complete species lists for (pūrei) – wiwi / cocksfoot grassland, gorse scrub, and exotic grass grassland / fodder crop herbfield vegetation types were not recorded.

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Dactylis glomerata	Cocksfoot	Grass	Exotic	
Digitalis purpurea	Foxglove	Dicot Herb	Exotic	
Eleocharis acuta	Sharp spike sedge	Sedge	Indigenous non-endemic	Not Threatened
Epilobium atriplicifolium	Willowherb	Dicot Herb	Indigenous endemic	Not Threatened
Epilobium pallidiflorum	Tarawera, Swamp willow herb	Dicot Herb	Indigenous non-endemic	Not Threatened
Erythranthe guttata	Monkey musk	Dicot Herb	Exotic	
Glyceria sp.	Sweetgrass	Grass	Exotic	
Histiopteris incisa	Mata, water fern	Fern	Indigenous non-endemic	Not Threatened
Holcus lanatus	Yorkshire fog	Grass	Exotic	
Hypochaeris radicata	Cats ear	Dicot Herb	Exotic	
Isolepis inundata	Clubrush	Sedge	Indigenous non-endemic	Not Threatened
Juncus bulbosus	Bulbous rush	Rush	Exotic	
Juncus edgariae	Wiwi, Edgars rush	Rush	Indigenous endemic	Not Threatened
Juncus effusus	Soft rush	Rush	Exotic	
Leycesteria formosa	Himalayan honeysuckle	Grass	Exotic	
Malva sp.	Mallow	Dicot Herb	Exotic	
Muehlenbeckia australis	Large-leaved pohuehue	Liane	Indigenous non-endemic	Not Threatened
Nasturtium officinale OR Nasturtium microphyllum	Watercress	Dicot Herb	Exotic	
Parablechnum montanum	Kiokio, hard fern	Fern	Indigenous endemic	Not Threatened
Phormium tenax	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
Polystichum vestitum	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
Rubus fruticosus agg.	Blackberry	Shrub	Exotic	
Rumex acetosella	Sheep's sorrel;	Dicot Herb	Exotic	
Rumex obtusifolius	Dock	Dicot Herb	Exotic	
Ranunculus multiscapus	Grassland buttercup	Dicot Herb	Indigenous endemic	Not Threatened

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Rununculus repens	Creeping buttercup	Dicot Herb	Exotic	
Senecio minimus	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
Senecio vulgaris	Groundsel	Dicot Herb	Exotic	
Solanum dulcamara	Bittersweet	Dicot Herb	Exotic	
Solanum laciniatum	Poroporo	Shrub	Indigenous non-endemic	Not Threatened
Sonchus asper	Sow thistle	Dicot Herb	Exotic	
Sonchus oleraceus	Sow thistle	Dicot Herb	Exotic	
Trifolium repens	Clover	Dicot Herb	Exotic	
Ulex europaeus	Gorse	Shrub	Exotic	

*Only recorded in the valley floor marsh wetland, outside the designation site.

Table A1-2. Species found in the harakeke – gorse / (pūrei – rautahi) flaxland (in the swamp wetland).

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Agrostis capillaris	Browntop	Grass	Exotic	
*Aristotelia serrata**	Makomako	Tree	Indigenous endemic	Not Threatened
Austroblechnum penna-marina	Little hard fern	Fern	Indigenous non-endemic	Not Threatened
Carex coriacea?	Rautahi / cutty grass	Sedge	Indigenous endemic	Not Threatened
Carex geminata	Rautahi / cutty grass	Sedge	Indigenous endemic	Not Threatened
Carex secta	Pūrei	Sedge	Indigenous non-endemic	Not Threatened
Carex flagellifera	Trip me up	Sedge	Indigenous endemic	Not Threatened
Carex leporina	Oval sedge	Sedge	Exotic	
Carex sp. (*Carex dipsacea*?)	Teasel sedge?	Sedge	Indigenous endemic	Not Threatened
Carex uncinata	Kamu, hook sedge	Sedge	Indigenous endemic	Not Threatened
Carex virgata	Swamp sedge	Sedge	Indigenous endemic	Not Threatened

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Cirsium arvense	Californian thistle	Dicot herb	Exotic	
Cirsium vulgare	Scotch thistle	Dicot Herb	Exotic	
Coprosma dumosa	Mikimiki	Shrub	Indigenous endemic	Not Threatened
Coprosma propinqua	Mikimiki	Shrub	Indigenous endemic	Not Threatened
Dactylis glomerata	Cocksfoot	Grass	Exotic	
Epilobium pallidiflorum	Swamp willow herb	Dicot Herb	Indigenous non-endemic	Not Threatened
Eleocharis acuta	Sharp spike sedge	Sedge	Indigenous non-endemic	Not Threatened
Geranium molle	Doves foot geranium	Dicot Herb	Exotic	
Glyceria sp.	Sweetgrass	Grass	Exotic	
Hedera helix	Climbing ivy	Liane	Exotic	
Holcus lanatus	Yorkshire fog	Grass	Exotic	
Juncus articulatus	Jointed rush	Grass	Exotic	
Juncus edgariae	Wiwi, Edgars rush	Grass	Indigenous endemic	Not Threatened
Juncus effusus	Soft Rush	Grass	Exotic	
Muelenbeckia australis	Climbing vine	Liane	Indigenous non-endemic	Not Threatened
Nasturtium officinale OR Nasturtium microphyllum	Watercress	Dicot Herb	Exotic	
Pinus radiata	Radiata pine	Tree	Exotic	
Phormium tenax	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
*Pittosporum eugenoides**	Tarata	Tree	Indigenous endemic	Not Threatened
Polystichum vestitum	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
Pteridium esculentum	Bracken	Fern	Indigenous non-endemic	Not Threatened
Ranunculus repens	Creeping buttercup	Dicot Herb	Exotic	
Rubus fruticosus agg.	Blackberry	Shrub	Exotic	
Senecio minimus	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
Solanum dulcamara	Bittersweet	Dicot Herb	Exotic	

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Stellaria graminae	Stitchwort	Dicot Herb	Exotic	
Trifolium pratense	Red clover	Dicot Herb	Exotic	
Ulex europaeus	Gorse	Shrub	Exotic	

Table A1-3. Species found in the kānuka forest (West Gully 2 and 3 – a similar vegetation type in East Gully unaffected by vegetation clearance was not assessed).

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Adiantum cunninghamii	Maidenhair fern	Fern	Indigenous endemic	Not Threatened
Aristotelia serrata	Makomako, wineberry	Tree	Indigenous endemic	Not Threatened
Asplenium bulbiferum	Pikopiko, hen and chicken fern	Fern	Indigenous endemic	Not Threatened
Carex coriacea?	Rautahi / cutty grass	Sedge	Indigenous endemic	Not Threatened
Carex geminata	Rautahi / cutty grass	Sedge	Indigenous endemic	Not Threatened
Carpodetus serratus	Marbleleaf	Tree or Shrub	Indigenous endemic	Not Threatened
Cirsium arvense	Californian thistle	Dicot Herb	Exotic	
Coprosma foetidissima	Stinkwood	Tree or Shrub	Indigenous endemic	Not Threatened
Coprosma lucida	Shining karamu	Tree or Shrub	Indigenous endemic	Not Threatened
Coprosma rotundifolia	Round-leaved coprosma	Tree or Shrub	Indigenous endemic	Not Threatened
Cordyline australis	Cabbage tree	Tree	Indigenous endemic	Not Threatened
Cranfillia fluviatillis	Kiwakiwa, creek fern	Fern	Indigenous non-endemic	Not Threatened
Cytisus scoparius	Scotch broom	Shrub	Exotic	
Dactylis glomerata	Cocksfoot	Grass	Exotic	
Dicksonia squarrosa	Rough tree fern	Fern	Indigenous endemic	Not Threatened
Fuchsia excorticata	Tree fuchsia	Tree or Shrub	Indigenous endemic	Not Threatened
Holcus lanatus	Yorkshire fog	Grass	Exotic	

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Kunzea robusta	Kānuka	Tree or Shrub	Indigenous endemic	Threatened – Nationally Vulnerable
Lastreopsis hispida	Hairy fern	Fern	Indigenous endemic	Not Threatened
Leycesteria formosa	Himalayan honeysuckle	Shrub	Exotic	
Lomaria discolor	Crown fern	Fern	Indigenous endemic	Not Threatened
Melicytus ramiflorus	Māhoe	Tree or Shrub	Indigenous non-endemic	Not Threatened
Microsorum pustulatum	Kowaowao, hounds tongue fern	Fern	Indigenous non-endemic	Not Threatened
Muelenbeckia australis	Large-leaved pohuehue	Liane	Indigenous non-endemic	Not Threatened
Parablechnum procerum	Small kiokio	Fern	Indigenous non endemic	Not Threatened
Parablechnum montanum	Kiokio, hard fern	Fern	Indigenous endemic	Not Threatened
Parapolystichum glabellum	Smooth shield fern	Fern	Indigenous endemic	Not Threatened
Phormium tenax	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
Pneumatopteris pennigera	Gully fern	Fern	Indigenous endemic	Not Threatened
Polystichum neozelandicum subsp. zerophyllum	Black shield fern	Fern	Indigenous endemic	Not Threatened
Polystichum vestitum	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
Pseudopanax arboreus	Whauwhaupaku, five-finger	Tree	Indigenous endemic	Not Threatened
Pseudowintera colorata	Horopito, pepper tree	Tree or Shrub	Indigenous endemic	Not Threatened
Pteridium esculentum	Rarauhe, bracken fern	Fern	Indigenous non-endemic	Not Threatened
Ranunculus repens	Creeping buttercup	Dicot Herb	Exotic	
Ripogonum scandens	Kareao, supplejack	Liane	Indigenous endemic	Not Threatened
Rubus cissoides	Bush lawyer	Liane	Indigenous endemic	Not Threatened
Rubus squarrosus	Leafless bush lawyer	Liane	Indigenous endemic	Not Threatened
Schefflera digitata	Pate, seven-finger	Tree	Indigenous endemic	Not Threatened
Solanum laciniatum	Popoporo	Shrub	Indigenous non-endemic	Not Threatened

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Stellaria parviflora	New Zealand chickweed	Dicot Herb	Indigenous non-endemic	Not Threatened

Table A1-4. Species found in the [large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland (West Gully 4).

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Aristotelia serrata	Makomako, wineberry	Tree	Indigenous endemic	Not Threatened
Asplenium bulbiferum or Asplenium gracillimum	Pikopiko, hen and chicken fern	Fern	Indigenous endemic	Not Threatened
Carex geminata	Rautahi / cutty grass	Sedge	Indigenous non-endemic	Not Threatened
Cirsium arvense	Californian thistle	Dicot Herb	Exotic	
Cirsium vulgare	Scotch thistle	Dicot Herb	Exotic	
Coprosma propinqua	Mikimiki	Shrub	Indigenous endemic	Not Threatened
Coprosma rotundifolia	Round leaved coprosma	Shrub	Indigenous endemic	Not Threatened
Cordyline australis	Cabbage tree, ti kouka	Tree	Indigenous endemic	Not Threatened
Crataegus monogyna	Hawthorn	Tree	Exotic	
Cyathea colensoi	Rough tree fern	Fern	Indigenous endemic	Not Threatened
Cytisus scoparius	Scotch broom	Shrub	Exotic	
Dactylis glomerata	Cocksfoot	Grass	Exotic	
Dicksonia squarrosa	Rough tree fern	Fern	Indigenous endemic	Not Threatened
Erythranthe guttata	Monkey musk	Dicot Herb	Exotic	
Fuchsia excorticata	Tree fuchsia	Tree	Indigenous endemic	Not Threatened
Galium aparine	Cleavers	Dicot Herb	Exotic	
Griselinia littoralis	Broadleaf	Tree	Indigenous endemic	Not Threatened

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Hebe salicifolia	Koromiko	Shrub	Indigenous non-endemic	Not Threatened
Hypolepis ambigua	Pig fern	Fern	Indigenous endemic	Not Threatened
Leptospermum scoparium	Mānuka	Tree	Indigenous endemic	At Risk - Declining
Leycesteria formosa	Himalayan honeysuckle	Shrub	Exotic	
Jacobaea vulgaris	Ragwort	Dicot Herb	Exotic	
Kunzea robusta	Kānuka	Tree	Indigenous endemic	Threatened - Nationally Vulnerable
Melicytus ramiflorus	Māhoe, whiteywood	Tree	Indigenous endemic	Not Threatened
Muehlenbeckia australis	Large-leaved pohuehue	Shrub	Indigenous non-endemic	Not Threatened
Parablechnum montanum	Kiokio, mountain hard fern	Fern	Indigenous endemic	Not Threatened
Phormium tenax	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
Pinus radiata	Radiata pine	Tree	Exotic	
Pittosporum eugeniodes	Tarata, lemonwood	Shrub	Indigenous endemic	Not Threatened
Polystichum vestitum	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
Pteridium exculentum	Rarauhe, bracken fern	Fern	Indigenous non-endemic	Not Threatened
Solanum laciniatum	Poroporo	Tree	Indigenous non-endemic	Not Threatened
Ulex europaeus	Gorse	Shrub	Exotic	

Table A1-5. Species found in the Radiata pine / gorse / cocksfoot – Yorkshire fog treeland (cutover pine forest)[69].

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Agrostis capillaris	Yorkshire fog	Grass	Exotic	
Aristotelia serrata	Makomako, wineberry	Tree	Indigenous endemic	Not Threatened
Carex geminata	Rautahi / cutty grass	Sedge	Indigenous endemic	Not Threatened

[69] Not all exotic species were recorded.

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Carex breviculmis	Grassland sedge	Sedge	Indigenous non-endemic	Not Threatened
Centella uniflora	Centella	Dicot Herb	Indigenous non-endemic	Not Threatened
Cirsium arvense	Californian thistle	Dicot Herb	Exotic	
Coprosma dumosa	Mikimiki	Tree or Shrub	Indigenous endemic	Not Threatened
Coprosma lucida	Shining karamu	Tree or Shrub	Indigenous endemic	Not Threatened
Coprosma rotundifolia	Round-leaved coprosma	Tree or Shrub	Indigenous endemic	Not Threatened
Cordyline australis	Cabbage tree	Tree	Indigenous endemic	Not Threatened
Cupressus macrocarpa	Macrocarpa	Tree	Exotic	
Cytisus scoparius	Scotch broom	Shrub	Exotic	
Dactylis glomerata	Cocksfoot	Grass	Exotic	
Digitalis purpurea	Foxglove	Dicot Herb	Exotic	
Epilobium atriplicifolium	Willowherb	Dicot Herb	Indigenous endemic	Not Threatened
Epilobium pallidiflorum	Tarawera, Swamp willow herb	Dicot Herb	Indigenous non-endemic	Not Threatened
Epilobium species	Willowherb	Dicot Herb	Indigenous non-endemic	Not Threatened
Erigeron sumatrensis	Fleabane	Dicot Herb	Exotic	
Erythranthe guttata	Monkey Musk	Grass	Exotic	
Eucalyptus sp.	Eucalyptus	Tree	Exotic	
Fuchsia excorticata	Tree fuchsia	Tree or Shrub	Indigenous endemic	Not Threatened
Glyceria sp.	Sweetgrass	Grass	Exotic	
Histiopteris incisa	Mata, water fern	Fern	Indigenous non-endemic	Not Threatened
Holcus lanatus	Yorkshire fog	Grass	Exotic	
Hypochaeris radicata	Cats ear	Dicot Herb	Exotic	
Isolepis inundata	Clubrush	Sedge	Indigenous non-endemic	Not Threatened
Juncus articulatus	Jointed rush	Rush	Exotic	
Juncus bufonius	Toad rush	Rush	Exotic	

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Juncus bulbosus	Bulbous rush	Rush	Exotic	
Juncus conglomeratus	Soft rush	Rush	Exotic	
Juncus edgariae	Wiwi, Edgars rush	Rush	Indigenous endemic	Not Threatened
Juncus effusus	Soft rush	Rush	Exotic	
Kunzea robusta	Kānuka	Tree or Shrub	Indigenous endemic	Threatened – Nationally Vulnerable
Leycesteria formosa	Himalayan honeysuckle	Grass	Exotic	
Malva sp.	Mallow	Dicot Herb	Exotic	
Melicytus ramiflorus	Māhoe	Tree or Shrub	Indigenous non-endemic	Not Threatened
Microsorum pustulatum	Kowaowao, hounds tongue fern	Fern	Indigenous non-endemic	Not Threatened
Muehlenbeckia australis	Large-leaved pohuehue	Liane	Indigenous non-endemic	Not Threatened
Nasturtium officinale OR Nasturtium microphyllum	Watercress	Dicot Herb	Exotic	
Phormium tenax	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
Pinus radiata	Radiata pine	Tree	Exotic	
Polystichum vestitum	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
Pteridium esculentum	Rarauhe, bracken fern	Fern	Indigenous non-endemic	Not Threatened
Prunella vulgaris	Selfheal	Dicot Herb	Exotic	
Ranunculus multiscapus	Grassland buttercup	Dicot Herb	Indigenous endemic	Not Threatened
Ranunculus repens	Creeping buttercup	Dicot Herb	Exotic	
Rubus cissoides	Bush lawyer	Liane	Indigenous endemic	Not Threatened
Rubus fruticosus	Blackberry	Shrub	Exotic	
Rumex acetosella	Sheep’s sorrel	Dicot Herb	Exotic	
Rumex obtusifolius	Dock	Dicot Herb	Exotic	
Senecio minimus	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Senecio guadridentatus	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
Senecio vulgaris	Groundsel	Dicot Herb	Exotic	
Solanum laciniatum	Poroporo	Shrub	Indigenous non-endemic	Not Threatened
Sonchus asper	Sow thistle	Dicot Herb	Exotic	
Sonchus oleraceus	Sow thistle	Dicot Herb	Exotic	
Trifolium repens	Clover	Dicot Herb	Exotic	
Ulex europaeus	Gorse	Shrub	Exotic	
Verbascum thapsus	Wooly mullein	Dicot Herb	Exotic	
Verbascum virgatum	Moth mullein	Dicot Herb	Exotic	

Table A1-6. Species found in (Yorkshire fog) – cocksfoot grassland[70] (in areas alongside roads, and in some other locations generally at the border of other vegetation types within the designation site).

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Acaena species	Bidibid	Dicot Herb	Indigenous	
Achillea millefolium	Yarrow	Dicot Herb	Exotic	
Agrostis capillaris	Yorkshire fog	Grass	Exotic	
Alopecurus species		Grass	Exotic	
Aristotelia serrata	Makomako, wineberry	Tree	Indigenous endemic	Not Threatened
Austroderia richardii	Toitoi	Grass	Indigenous endemic	Not Threatened
Carex geminata	Rautahi / cutty grass	Sedge	Indigenous endemic	Not Threatened
Cirsium arvense	Californian thistle	Dicot Herb	Exotic	
Cirsium vulgare	Scotch thistle	Dicot Herb	Exotic	
Coprosma dumosa	Mikimiki	Tree or Shrub	Indigenous endemic	Not Threatened
Cordyline australis	Cabbage tree	Tree	Indigenous endemic	Not Threatened

[70] Not all exotic species were recorded.

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Crataegus monogyna	Hawthorn	Tree	Exotic	
Crepis capillaris	Smooth Hawksbeard	Dicot Herb	Exotic	
Cupressus macrocarpa	Macrocarpa	Tree	Exotic	
Cytisus scoparius	Scotch broom	Shrub	Exotic	
Dactylis glomerata	Cocksfoot	Grass	Exotic	
Digitalis purpurea	Foxglove	Dicot Herb	Exotic	
Epilobium atriplicifolium	Willowherb	Dicot Herb	Indigenous endemic	Not Threatened
Epilobium species	Willowherb	Dicot Herb	Indigenous non-endemic	Not Threatened
Erigeron sumatrensis	Fleabane	Dicot Herb	Exotic	
Erythranthe guttata	Monkey Musk	Grass	Exotic	
Eucalyptus sp.	Eucalyptus	Tree	Exotic	
Fuchsia excorticata	Tree fuchsia	Tree or Shrub	Indigenous endemic	Not Threatened
Galium aparine	Cleavers	Dicot Herb	Exotic	
Histiopteris incisa	Mata, water fern	Fern	Indigenous non-endemic	Not Threatened
Holcus lanatus	Yorkshire fog	Grass	Exotic	
Hypochaeris radicata	Cats ear	Dicot Herb	Exotic	
Hypolepis ambigua	Pig fern	Fern	Indigenous	
Ilex aquifolium	Holly	Tree or Shrub	Exotic	
Juncus articulatus	Jointed rush	Rush	Exotic	
Juncus edgariae	Wiwi, Edgars rush	Rush	Indigenous endemic	Not Threatened
Juncus effusus	Soft rush	Rush	Exotic	
Kunzea robusta	Kānuka	Tree or Shrub	Indigenous endemic	Threatened – Nationally Vulnerable
Lamium galeobdolon	Artillery plant	Dicot Herb	Exotic	
Lepidosperma australe	Square sedge	Rush	Indigenous endemic	Not Threatened
Leycesteria formosa	Himalayan honeysuckle	Grass	Exotic	

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Lolium arundinaceum	Tall Fescue	Grass	Exotic	
Lotus pedunculatus	Lotus	Dicot Herb	Exotic	
Moss species		Moss	Indigenous	
Malva sp.	Mallow	Dicot Herb	Exotic	
Melicytus ramiflorus	Māhoe	Tree or Shrub	Indigenous non-endemic	Not Threatened
Microsorum pustulatum	Kowaowao, hounds tongue fern	Fern	Indigenous non-endemic	Not Threatened
Muehlenbeckia australis	Large-leaved pohuehue	Liane	Indigenous non-endemic	Not Threatened
Parablechnum montanum	Kiokio, hard fern	Fern	Indigenous endemic	Not Threatened
Phormium tenax	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
Pinus radiata	Radiata pine	Tree	Exotic	
Poa colensoi	Blue tussock	Grass	Indigenous endemic	
Polystichum vestitum	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
Pteridium esculentum	Rarauhe, bracken fern	Fern	Indigenous non-endemic	Not Threatened
Prunella vulgaris	Selfheal	Dicot Herb	Exotic	
Ranunculus multiscapus	Grassland buttercup	Dicot Herb	Indigenous endemic	Not Threatened
Ranunculus repens	Creeping buttercup	Dicot Herb	Exotic	
Rubus fruticosus	Blackberry	Shrub	Exotic	
Rumex acetosella	Sheep's sorrel	Dicot Herb	Exotic	
Rumex obtusifolius	Dock	Dicot Herb	Exotic	
Salix cinerea	Grey willow	Tree	Exotic	
Senecio minimus	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
Senecio guadridentatus	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
Senecio vulgaris	Groundsel	Dicot Herb	Exotic	
Solanum laciniatum	Poroporo	Shrub	Indigenous non-endemic	Not Threatened
Sonchus asper	Sow thistle	Dicot Herb	Exotic	

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
Sonchus oleraceus	Sow thistle	Dicot Herb	Exotic	
Stellaria gracilenta	Slender chickweed	Dicot Herb	Exotic	
Trifolium repens	Clover	Dicot Herb	Exotic	
Trifolium pratense	Red clover	Dicot Herb	Exotic	
Ulex europaeus	Gorse	Shrub	Exotic	
Verbascum thapsus	Wooly mullein	Dicot Herb	Exotic	
Verbascum virgatum	Moth mullein	Dicot Herb	Exotic	
Vicia sativa	Vetch	Dicot Herb	Exotic	

Appendix 2: Bird Survey Weather Conditions

Table A2-1. Weather conditions during the point count surveys conducted between May 2019 and February 2020 at the proposed Smooth Hill landfill site, around Dunedin Airport, and at Lake Waihola.

Survey Date	Weather Conditions
23.05.19	Partly cloudy, no rain, mild temperature (11-16°C), calm
24.05.19	Partly cloudy, no rain, cool temperature (5-11°C), light breeze
17.07.19	Overcast, no rain, cool temperature (5-11°C), light westerly breeze
18.07.19	Overcast, no rain, cold (0-5°C) to cool (5-11°C) temperature, light northerly breeze
31.10.19	Overcast, no rain, cool (5-11°C) to mild (11-16°C) temperature, fresh to strong south-westerly wind, choppy at Lake Waihola
01.11.19	Overcast, no rain, cool (5-11°C) to mild (11-16°C) temperature, fresh to strong south-westerly wind, choppy at Lake Waihola
10.02.20	Fine, sunny, no rain, warm temperature (16-22°C), fresh south westerly wind, choppy at Lake Waihola
11.02.20	Fine, sunny, no rain, mild temperature (11-16°C), fresh south-westerly wind, choppy at Lake Waihola

Appendix 3: Site and Vegetation Photographs

Figure A3.1. (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland in West Gully 4.

Figure A3.2. (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland. This area shows an association of watercress and sweetgrass associated with an inundated channel in the valley floor marsh wetland. This wetland extends from McLaren Gully Road to the swamp wetland in the designation site.

Figure A3.3. [(Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland bordering harakeke – gorse / (pūrei – rautahi) flaxland in the swamp wetland.

Figure A3.4. (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland in the valley floor marsh wetland downstream of the designation site.

Figure A3.5. The valley floor marsh wetland looking upstream to the designation site.

Figure A3.6. (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland south of McLaren Gully Road below Gledknowe Hill.

Figure A3.7. (Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub on hill slopes between West Gully 1 and 2, above the swamp wetland.

Figure A3.8. Harakeke – gorse / (pūrei – rautahi) flaxland in the swamp wetland.

Figure A3.9. Harakeke – gorse / (pūrei – rautahi) flaxland at the base of West Gully 3.

Figure A3.10. Kānuka forest in West Gully 3.

Figure A3.11. Diverse understory species in the kānuka forest in West Gully 3.

Figure A3.12. One of two small kānuka forest patches in West Gully 2.

Figure A3.13. Kānuka forest in East Gully, with radiata pine / gorse / cocksfoot – Yorkshire fog treeland in the main cutover area in the foreground.

Figure A3.14. [Large leaved pohuehue] / [makomako – kōtukutuku] / Himalayan honeysuckle treeland in West Gully 4.

Figure A3.15. Scarce unfelled pine trees in the [Large leaved pohuehue] / [makomako – kōtukutuku] / Himalayan honeysuckle treeland in West Gully 4.

Figure A3.16. Radiata pine / gorse / cocksfoot – Yorkshire fog treeland in the main cutover area, and West Gully 4 in the background.

Figure A3.17. Radiata pine / gorse / cocksfoot – Yorkshire fog treeland in the main cutover area, and West Gully 4, 3 and 2 in the background from left, and the swamp wetland centre right.

Figure A3.18. (Yorkshire fog) – cocksfoot grassland fringing treeland in West Gully 4.

Figure A3.19. Former macrocarpa forest at left (2020 photo, now harvested and bare), radiata pine / gorse / cocksfoot – Yorkshire fog treeland in the cutover area in the foreground, and West Gully 4 in the background.

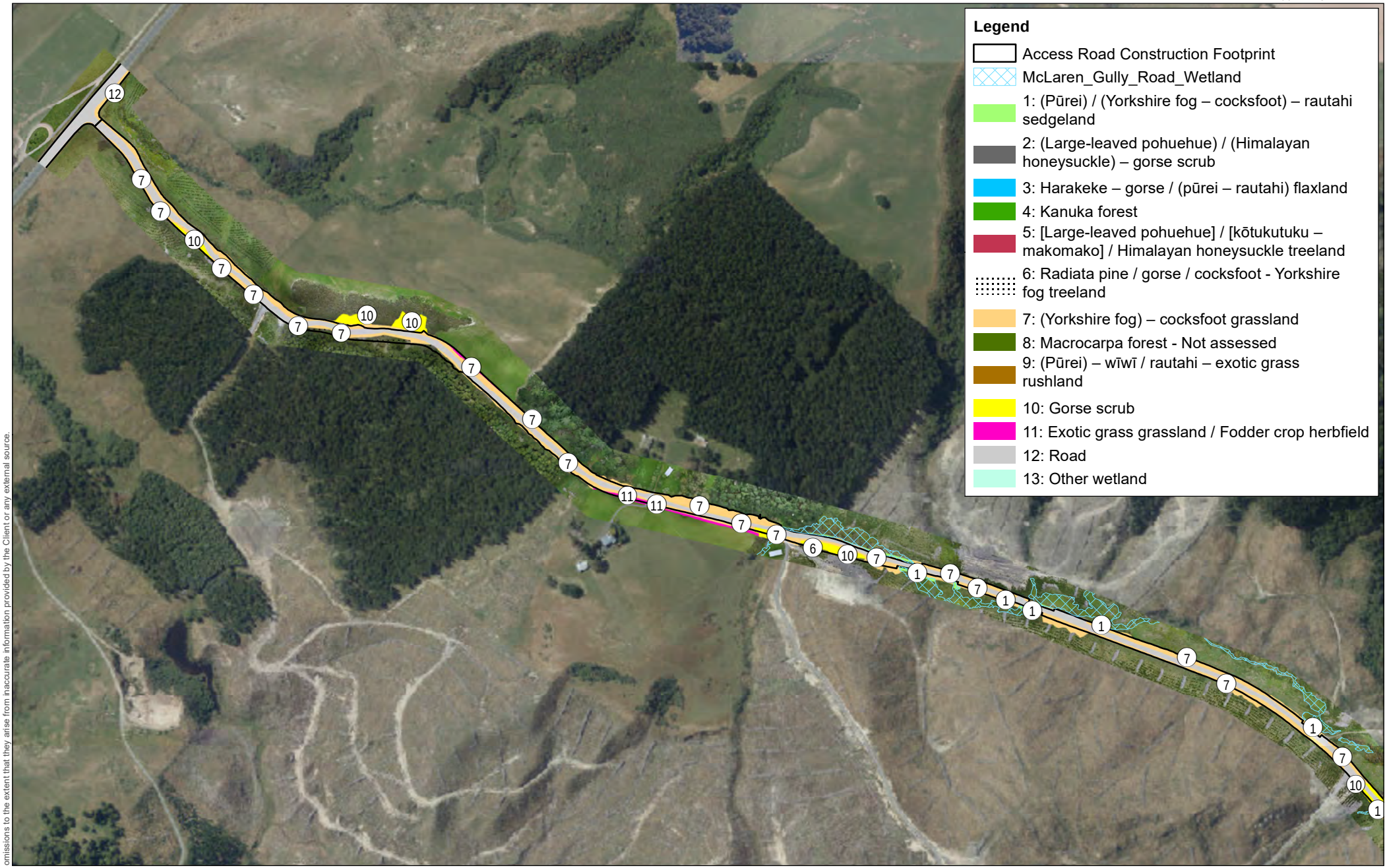
Figure A3.20. [Pūrei] – wīwī / rautahi – exotic grass rushland north of McLaren Gully Road

Figure A3.21. Gorse scrub adjacent to McLaren Gully Road.

Figure A3.22. Exotic grass grasslands (improved pasture) at left, in grazed paddocks adjacent to McLaren Gully Road. Rank (Yorkshire fog) – cocksfoot grassland at right.

Figure A3.22. Fodder crop herbfields at left, in grazed paddocks adjacent to McLaren Gully Road. Rank (Yorkshire fog) – cocksfoot grassland along road margins. Exotic grass grasslands (improved pasture) at right.

Appendix 4: Vegetation Types Map



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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

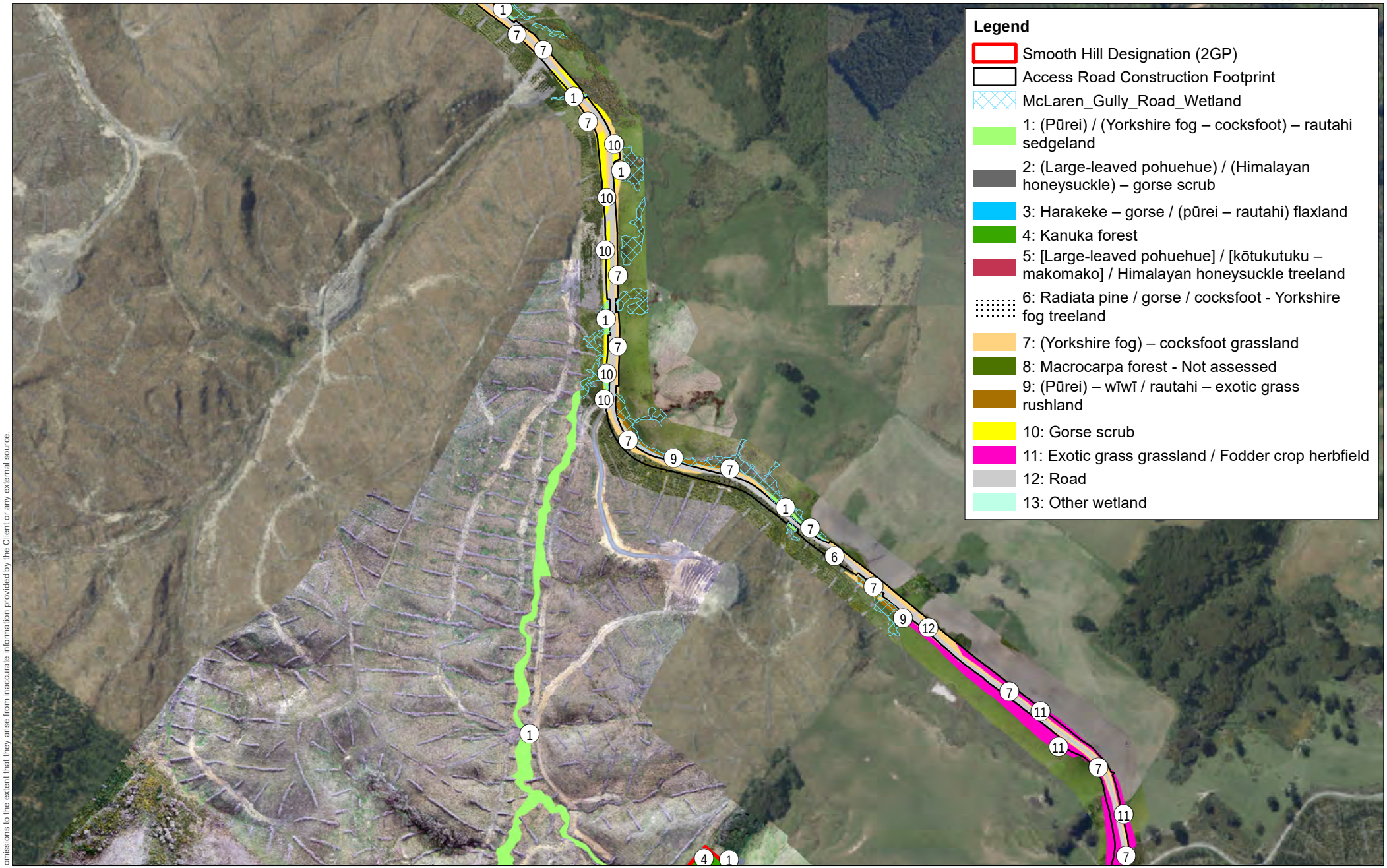
SMOOTH HILL LANDFILL

APPENDIX 4 - Vegetation Map 1

Date: 17 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: JMo



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Data Sources:
Designation sourced from DCC 2GP online
Landfill design and road footprint sourced from GHD

Projection: NZGD 2000 New Zealand Transverse Mercator

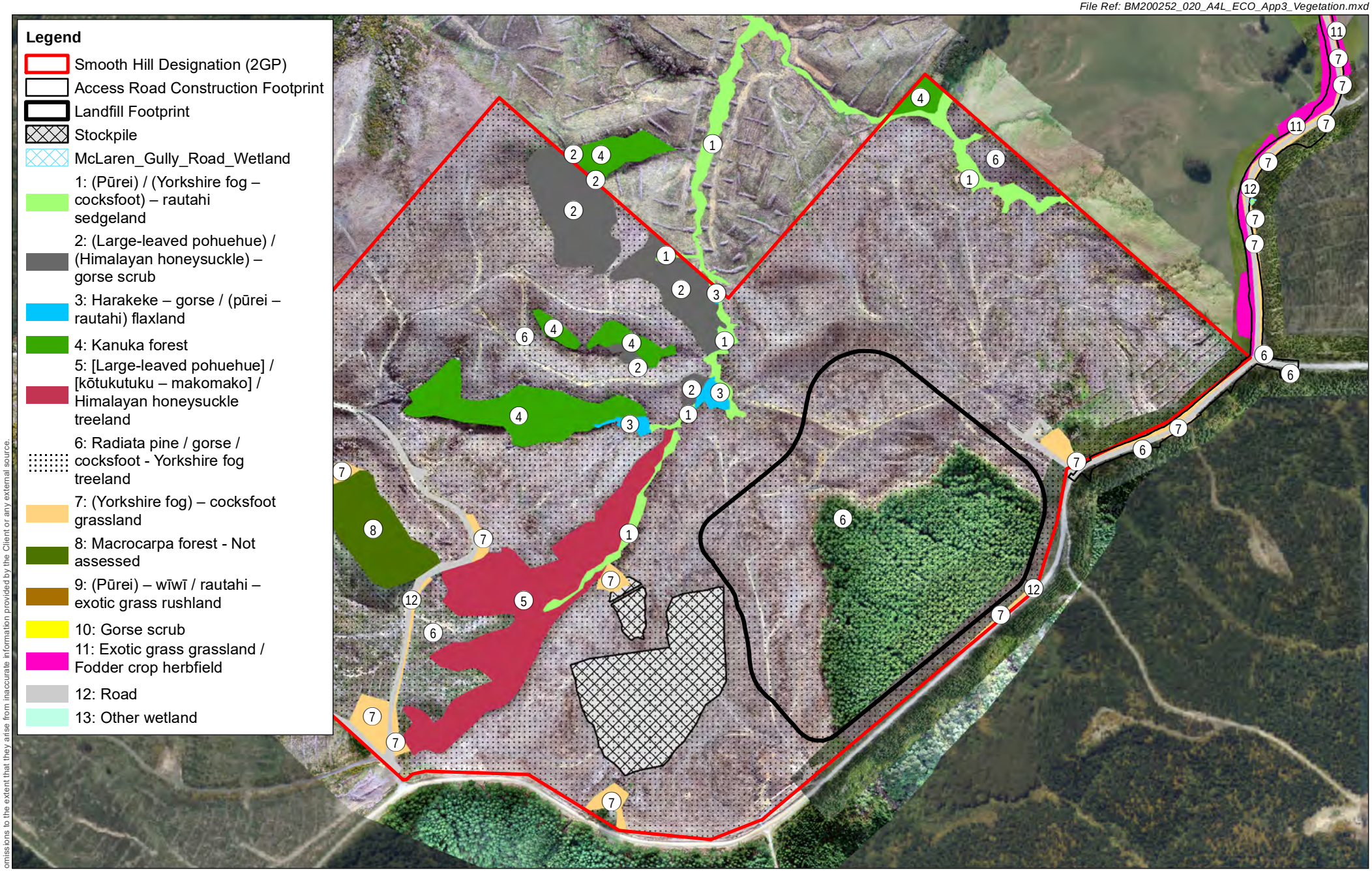
SMOOTH HILL LANDFILL

APPENDIX 4 - Vegetation Map 2

Date: 17 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: rachael.eaton@boffamiskell.co.nz | Drawn: BMc | Checked: JMo



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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

APPENDIX 4 - Vegetation Map 3

Date: 17 May 2021 | Revision: 0

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: tanya.blakely@boffamiskell.co.nz | Drawn: BMc | Checked: JMo

Appendix 5: OSNZ Squares Bird List and Survey Data for the Project Site and Wider Landscape.

Table A5-1. Avifauna species recorded for the three OSNZ squares that encompass the proposed Smooth Hill landfill site and wider landscape, as well those species recorded during the point count surveys conducted between May 2019 and February 2020 at the proposal site, Dunedin Airport and Lake Waihola (species observed incidentally are also recorded). Primary habitats for each species are indicated as is the conservation status of each species.

				Habitat								OSNZ Square			Current Survey Sites		
Species	Scientific Name	Conservation Status		Native Forest	Exotic Forest	Scrub/shrubland	Farmland/open country	Freshwater/wetlands	Coastal/estuary	Oceanic	Residential	546, 228 (Wetland Complex)	547, 229 (Dunedin Airport / Taieri plains)	546, 229 (Landfill Site and Coast)	Sites 1 to 4 (Dunedin Airport / Taieri Plains)	Sites 5 and 6 (Smooth Hill Proposal Site)	Lake Waihola Survey Site
Bush falcon	*Falco novaeseelandiae ferox*	At Risk	Recovering[DP St]	■								y	y	y		y	
Kereru	*Hemiphaga novaeseelandiae*	Not Threatened	Not Threatened[CD Inc]	■								y	y	y		y	
Shining cuckoo	*Chrysococcyx l. lucidus*	Not Threatened	Not Threatened[DP]	■								y	y	y		y	
Morepork	*Ninox n. novaeseelandiae*	Not Threatened	Not Threatened	■								y					
Kingfisher	*Todiramphus sanctus vagans*	Not Threatened	Not Threatened	■				■				y		y			
South Island rifleman	*Acanthisitta chloris chloris*	Not Threatened	Not Threatened	■								y					
Brown creeper	*Mohoua novaeseelandiae*	Not Threatened	Not Threatened	■								y		y		y	
South Island fantail	*Rhipidura fuliginosa fuliginosa*	Not Threatened	Not Threatened[EF]	■								y	y	y	y	y	
South Island tomtit	*Petroica macrocephala macrocephala*	Not Threatened	Not Threatened	■								y		y			
Bellbird	*Anthornis m. melanura*	Not Threatened	Not Threatened	■								y	y	y	y	y	
Tui	*Prosthemadera n. novaeseelandiae*	Not Threatened	Not Threatened[OL St]	■								y	y	y		y	

Species	Scientific Name	Conservation Status		Habitat								OSNZ Square			Current Survey Sites		
				Native Forest	Exotic Forest	Scrub/shrubland	Farmland/open country	Freshwater/wetlands	Coastal/estuary	Oceanic	Residential	546, 228 (Wetland Complex)	547, 229 (Dunedin Airport / Taieri plains)	546, 229 (Landfill Site and Coast)	Sites 1 to 4 (Dunedin Airport / Taieri Plains)	Sites 5 and 6 (Smooth Hill Proposal Site)	Lake Waihola Survey Site
Cirl bunting	*Emberiza cirlus*	Introduced	Introduced & Naturalised[SO]									y					
Eastern rosella	*Platycercus eximius*	Introduced	Introduced & Naturalised[SO]									y	y				
Blackbird	*Turdus merula*	Introduced	Introduced & Naturalised[SO]									y	y	y	y	y	y
Grey warbler	*Gerygone igata*	Not Threatened	Not Threatened									y	y	y	y	y	
Silvereye	*Zosterops lateralis lateralis*	Not Threatened	Not Threatened[SO]									y	y	y		y	
Yellowhammer	*Emberiza citrinella*	Introduced	Introduced & Naturalised[SO]									y	y	y	y		
Chaffinch	*Fringilla coelebs*	Introduced	Introduced & Naturalised[SO]									y	y	y	y	y	y
Greenfinch	*Carduelis chloris*	Introduced	Introduced & Naturalised[SO]									y	y	y	y	y	
Goldfinch	*Carduelis carduelis*	Introduced	Introduced & Naturalised[SO]									y	y	y	y	y	
Redpoll	*Carduelis flammea*	Introduced	Introduced & Naturalised[SO]									y	y	y	y	y	y
House sparrow	*Passer domesticus*	Introduced	Introduced & Naturalised[SO]									y	y	y	y		y
Starling	*Sturnus vulgaris*	Introduced	Introduced & Naturalised[SO]									y	y	y	y		y
Magpie	*Gymnorhina tibicen*	Introduced	Introduced & Naturalised[SO]									y	y	y	y	y	
Rook	*Corvus frugilegus*	Introduced	Introduced & Naturalised[SO]									y					
Cattle egret	*Ardea ibis coromanda*	Non-resident Native	Migrant[SO]											y			

Species	Scientific Name	Conservation Status		Habitat								OSNZ Square			Current Survey Sites		
				Native Forest	Exotic Forest	Scrub/shrubland	Farmland/open country	Freshwater/wetlands	Coastal/estuary	Oceanic	Residential	546, 228 (Wetland Complex)	547, 229 (Dunedin Airport / Taieri plains)	546, 229 (Landfill Site and Coast)	Sites 1 to 4 (Dunedin Airport / Taieri Plains)	Sites 5 and 6 (Smooth Hill Proposal Site)	Lake Waihola Survey Site
Canada goose	*Branta canadensis*	Introduced	Introduced & Naturalised[SO]									y		y			y
Swamp harrier	*Circus approximans*	Not Threatened	Not Threatened[SO]									y	y	y	y	y	y
Spur-winged plover	*Vanellus miles novaehollandiae*	Not Threatened	Not Threatened[SO]									y	y	y	y	y	
Little owl	*Athene noctua*	Introduced	Introduced & Naturalised[SO]									y					
Skylark	*Alauda arvensis*	Introduced	Introduced & Naturalised[SO]									y	y	y	y	y	
Welcome swallow	*Hirundo n. neoxena*	Not Threatened	Not Threatened[Inc SO]									y	y	y	y	y	y
NZ pipit	*Anthus n. novaeseelandiae*	At Risk	Declining									y	y				
Dunnock	*Prunella modularis*	Introduced	Introduced & Naturalised[SO]									y	y	y			
Song thrush	*Turdus philomelos*	Introduced	Introduced & Naturalised[SO]									y	y	y	y	y	
South Island fernbird	*Bowdleria punctata punctata*	At Risk	Declining									y		y			
Black shag	*Phalacrocorax carbo novaehollandiae*	At Risk	Naturally Uncommon[SO Sp]									y	y	y			y
Pied shag	*Phalacrocorax varius varius*	At Risk	Recovering									y					
Little shag	*Phalacrocorax melanoleucos brevirostris*	Not Threatened	Not Threatened[Inc]									y	y	y			
Foveuax shag	*Leucocarbo stewarti*	Threatened	Nationally Vulnerable											y			
White heron	*Ardea modesta*	Threatened	Nationally Critical[OL SO St]									y					
Australasian bittern	*Botaurus poiciloptilus*	Threatened	Nationally Critical[DP Sp TO]									y					
Black swan	*Cygnus atratus*	Not Threatened	Not Threatened[SO]									y	y	y			y

Species	Scientific Name	Conservation Status		Habitat								OSNZ Square			Current Survey Sites		
				Native Forest	Exotic Forest	Scrub/shrubland	Farmland/open country	Freshwater/wetlands	Coastal/estuary	Oceanic	Residential	546, 228 (Wetland Complex)	547, 229 (Dunedin Airport / Taieri plains)	546, 229 (Landfill Site and Coast)	Sites 1 to 4 (Dunedin Airport / Taieri Plains)	Sites 5 and 6 (Smooth Hill Proposal Site)	Lake Waihola Survey Site
Feral goose	*Anser anser*	Introduced	Introduced & Naturalised[SO]									y		y			
Paradise shelduck	*Tadorna variegata*	Not Threatened	Not Threatened									y	y	y	y	y	
Muscovy duck	*Cairina moschata*	Introduced	Introduced, Not Established											y			
Mallard	*Anas platyrhynchos*	Introduced	Introduced & Naturalised[SO]									y	y	y	y		y
Grey duck	*Anas s. superciliosa*	Threatened	Nationally Critical[SO]									y	y	y			
Grey teal	*Anas gracilis*	Not Threatened	Not Threatened[Inc SO]									y	y	y			y
NZ shoveler	*Anas rhynchotis variegata*	Not Threatened	Not Threatened									y		y			y
NZ scaup	*Aythya novaeseelandiae*	Not Threatened	Not Threatened[Inc]									y					y
Pukeko	*Porphyrio m. melanotus*	Not Threatened	Not Threatened[Inc SO]									y	y	y	y		
Australian coot	*Fulica atra australis*	At Risk	Naturally Uncommon[Inc SO]									y					
South Island pied oystercatcher	*Haematopus finschi*	At Risk	Declining									y	y	y	y		
Pied stilt	*Himantopus h. leucocephalus*	Not Threatened	Not Threatened									y	y	y			
Black-fronted dotterel	*Charadrius melanops*	At Risk	Naturally Uncommon[SO Sp]										y				
Black-billed gull	*Larus bulleri*	Threatened	Nationally Critical[RF]									y	y				y
Black-fronted dotterel	*Charadrius melanops*	At Risk	Naturally Uncommon[SO Sp]											y			
White-fronted tern	*Sterna s. striata*	At Risk	Declining[DP]											y			
Spotted shag	*Stictocarbo p. punctatus*	Not Threatened	Not Threatened											y			

Species	Scientific Name	Conservation Status		Habitat								OSNZ Square			Current Survey Sites		
				Native Forest	Exotic Forest	Scrub/shrubland	Farmland/open country	Freshwater/wetlands	Coastal/estuary	Oceanic	Residential	546, 228 (Wetland Complex)	547, 229 (Dunedin Airport / Taieri plains)	546, 229 (Landfill Site and Coast)	Sites 1 to 4 (Dunedin Airport / Taieri Plains)	Sites 5 and 6 (Smooth Hill Proposal Site)	Lake Waihola Survey Site
White-faced heron	*Egretta novaehollandiae*	Not Threatened	Not Threatened[SO]									y	y	y	y		
Royal spoonbill	*Platalea regia*	At Risk	Naturally Uncommon[Inc RR SO]									y		y			
Variable oystercatcher	*Haematopus unicolor*	At Risk	Recovering[Inc]											y			
Black-backed gull	*Larus d. dominicanus*	Not Threatened	Not Threatened[SO]									y	y	y	y	y	y
Red-billed gull	*Larus novaehollandiae scopulinus*	At Risk	Declining									y		y			y
Sooty shearwater	*Puffinus griseus*	At Risk	Declining[SO]											y			
Australasian gannet	*Morus serrator*	Not Threatened	Not Threatened[De Inc SO]											y			
Arctic skua	*Stercorarius parasiticus*	Non-resident Native	Migrant[SO]											y			
Rock pigeon	*Columba livia*	Introduced	Introduced & Naturalised[SO]									y	y		y		

Appendix 6: Vegetation Clearance

Table A6-1. Description of works type and approximate resulting clearance in hectares of vegetation community types as a result of landfill construction works and road expansion, arranged by works type. Calculations were made based upon design specifications provided to Boffa Miskell by GHD on 18 August 2020 ('General Arrangement Plan McLaren Gully Road Option' – Drawing 51-12506381-01-C102 Revision 1, for construction footprints for landfill staging, infrastructure / buildings, construction of access roads within the designation site, a stockpile, and a stormwater attenuation basin) and 13 May 2021 (for construction footprints for the widening of McLaren Gully Road and Big Stone Road).

Description of works type and resulting clearance of vegetation community types	Sum of Area in Ha
McLaren Gully Road and Big Stone Road widening	**4.8675**
[Pūrei] – wīwī / rautahi – exotic grass rushland	0.0003
(Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland	0.0014
(Yorkshire fog) – cocksfoot grassland	2.9726
Exotic grass grassland / Fodder crop herbfield	0.6891
Gorse scrub	0.4057
Radiata pine / gorse / cocksfoot - Yorkshire fog treeland	0.7984
Facilities	**5.0602**
(Yorkshire fog) – cocksfoot grassland	0.1125
Radiata pine / gorse / cocksfoot - Yorkshire fog treeland	4.9476
General earthworks	**5.4113**
(Yorkshire fog) – cocksfoot grassland	0.0382
Radiata pine / gorse / cocksfoot - Yorkshire fog treeland	5.3730
Landfill	**18.6002**
Radiata pine / gorse / cocksfoot - Yorkshire fog treeland	18.6002
Stockpile	**4.1879**
(Yorkshire fog) – cocksfoot grassland	0.0241
Radiata pine / gorse / cocksfoot - Yorkshire fog treeland	4.1638
[Pūrei] – wīwī / rautahi – exotic grass rushland	0.0003
(Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland	0.0014
Total	**38.127**

Table A6-2. Description of vegetation type and approximate resulting clearance in hectares as a result of landfill construction works and road expansion, arranged by vegetation type. Calculations were made based upon design specifications provided to Boffa Miskell by GHD on 18 August 2020 ('General Arrangement Plan McLaren Gully Road Option' – Drawing 51-12506381-01-C102 Revision 1, for construction footprints for landfill staging, infrastructure / buildings, construction of access roads within the designation site, a stockpile, and a stormwater attenuation basin) and 13 May 2021 (for construction footprints for the widening of McLaren Gully Road and Big Stone Road).

Description of vegetation type and resulting clearance as a result of construction	Sum of Area in Ha
[Pūrei] – wīwī / rautahi – exotic grass rushland	**0.0003**
Access road	0.0003
(Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland	**0.0014**
Access road	0.0014
(Yorkshire fog) – cocksfoot grassland	**3.1475**

Description of vegetation type and resulting clearance as a result of construction	Sum of Area in Ha
Access road	2.9726
Facilities	0.1125
General earthworks	0.0382
Stockpile	0.0241
Exotic grass grassland / Fodder crop herbfield	**0.6891**
Access road	0.6891
Gorse scrub	**0.4057**
Access road	0.4057
Radiata pine / gorse / cocksfoot - Yorkshire fog treeland	**33.8830**
Access road	0.7984
Facilities	4.9476
General earthworks	5.3730
Landfill	18.6002
Stockpile	4.1638
[Pūrei] – wīwī / rautahi – exotic grass rushland	**0.0003**
Access road	0.0003
(Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland	**0.0014**
Access road	0.0014
Total	**38.127**

Appendix 7: Road Wetland Loss Offset Calculations

Table A7-1. Offset calculations to demonstrate net gain / no net loss for the proposed actions to offset the loss of wetland extent during the upgrade of McLaren Gully Road. A calculator (spreadsheet) from the *Biodiversity Offsets Accounting Model for New Zealand* (Maseyk et al. 2015) was used and has been modified to better fit this page.

This section captures which elements of biodiversity, and over what area, will be impacted by the proposal					This section is where the change in measure of each Biodiversity Attribute due to the proposed Impact is quantified, and Attribute Biodiversity Value calculated. Inputs are derived from direct measures, existing data or models where available, or expert estimated predictions			
Biodiversity Component	**Biodiversity Attribute**		**Measurement Unit**	**Area of Impact (ha)**	**Benchmark**	**Measure prior to Impact**	**Measure after Impact**	**Biodiversity Value**
Road Wetland	**0.1a**	Cover of indigenous species	Percentage	0.0017	90	40	0	-0.0008
	0.1b	Number of wetland vegetation tiers (canopy / subcanopy etc.) in valley floor wetland	Count	0.0017	4	2	0	-0.0009

This section captures which elements of biodiversity are to be accounted for, and the benchmark value for the Attribute. The information matches that in the Impact Model	These cells provide information about the proposed Offset Actions	Calculations can be made for a finite end point, or at five yearly time-steps over 35 years. Indicate preference in Column K and Follow the instructions in Column L	This section is where the marginal change in the measure of Biodiversity Attribute due to the Offset Action is quantified. Inputs are derived from direct measure, existing data or models where available, or expert estimated predictions. Attribute Biodiversity Value at the Offset Site is compared to the Attribute Biodiversity Value at the Impact Site to calculate the Net Present Biodiversity Value for each Attribute

Biodiversity Component	Biodiversity Attribute		Measurement Unit	Benchmark	Proposed Offset Actions	Offset area (ha)	Confidence in Offset Actions			Measure prior to Offset	Measure after Offset	Time till endpoint (years)	Biodiversity Value at Offset Site	Biodiversity Value at Impact Site	Attribute Net Present Biodiversity Value
Road Wetland	**0.1a**	Cover of indigenous species	Percentage	90	Clear weeds upstream of swamp wetland (West Gully 3/4)	0.49	Confident 75-90%	Finite end point	Continue to Column M	50	70	5	0.0898	-0.0008	**0.0891**
	0.1b	Number of wetland vegetation tiers (canopy / subcanopy etc.) in valley floor wetland	Count	4	Plantings of e.g. kahikatea above swamp wetland (West Gully 3/4)	0.49	Confident 75-90%	Finite end point	Continue to Column M	3	4	100	0.1011	-0.0009	**0.1002**

This is the average Net Present Biodiversity Value for the Biodiversity Component
Component Net Present Biodiversity Value
0.0946

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.

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