

Appendix 11: Ecological Impact Assessment Report







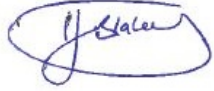
Smooth Hill Landfill

Ecological Impact Assessment
Prepared for Dunedin City Council

19 August 2020



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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 (EclA) 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 Otokia 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.
- 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 Otokia Creek catchment, had suboptimal habitat and a macroinvertebrate community commonly found in soft-bottomed and slow-flowing waterways. While fish were not found in June 2020, the tributary may support freshwater fish species (e.g. eels and banded kokopu) and kēkēwai.

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 Wetland Restoration Plan and Terrestrial Vegetation 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 a Pest Management Programme 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 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 (EclA) 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 EclA is limited to assessing the potential ecological effects of the proposed:

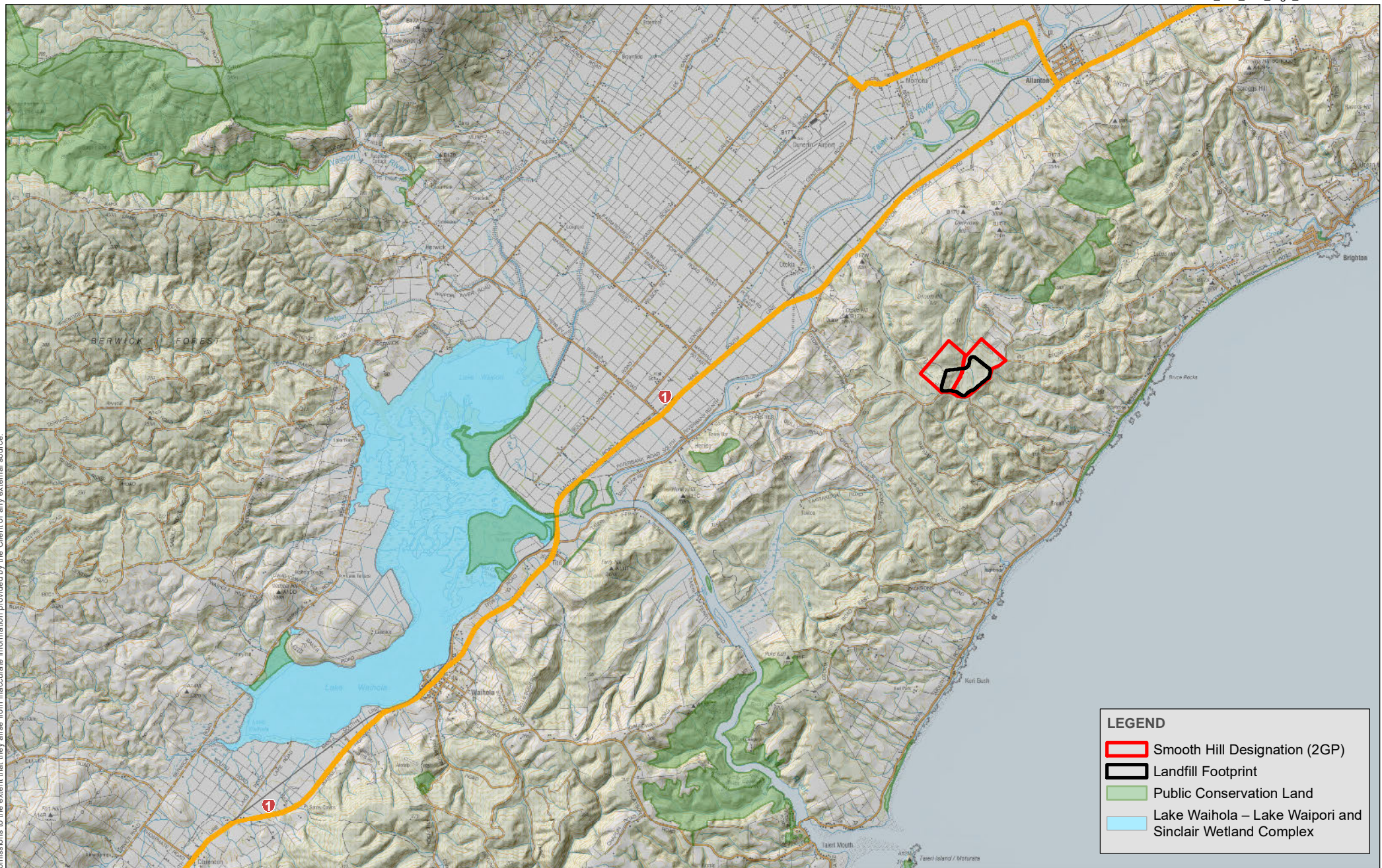
- Landfill construction and operation on the ecological values within the designation site;
- Widening of McLaren Gully and Big Stone Roads to access the landfill site on the ecological values along these roads; and
- Landfill on a wetland / stream that forms part of the Otokia Creek catchment immediately downstream of the designation site (the receiving environment).

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

1.2 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 these effects (Section 6.0);
- Summarise the predicted effects and proposed mitigation (Section 7.0); and
- Provide conclusions (Section 8.0).



2.0 Methodology

A combination of desktop (relevant databases, published and unpublished reports) and field investigations were undertaken to obtain information regarding the ecology associated with the designation site. 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 / stream that forms part of the Otokia Creek catchment immediately downstream of the designation site (the receiving environment).

For each area of ecology (vegetation and wetlands, avifauna, herpetofauna and freshwater) the existing information relied on is described first, followed by the methodologies used in field investigations. We then describe the methodology used to assess the effects on ecological values and the effects hierarchy approach we have used.

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

2.1 Limitations and Assumptions

- 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 EclA 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 Otokia 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. Vegetation present in an area called 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 were not subject to survey.
- 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. Furthermore, no surveys of the road-side vegetation along McLaren Gully or Big Stone Roads was carried out.
- Freshwater surveys of the downstream tributary of Otokia 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.

2.2 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 (Hons, I) 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 (Professional) at Boffa Miskell since early 2019. He has published a range of peer-reviewed papers in botanical and scientific journals, held Tutor and Teaching Fellow roles in Botany and Ecology at the University of Otago, is an associate member of the Environmental Institute of Australia and New Zealand, and 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 Mātū / 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 the field of Environmental Studies from Victoria University Wellington, a Postgraduate Diploma in the field of environmental management from the University of Auckland and a Master of Science in the field of 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 (Professional) 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 (Hons, I) 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 several technical ecological reports 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; and is the Chair of the New Zealand Fish Passage Advisory Group.



2.3 Vegetation and Wetlands

2.3.1 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. (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.
 - Allen, R.B. (1993). Gore and Wilding Pine Management, Maungatua Scientific Reserve. Conservation Advisory Science Notes No. 8, Department of Conservation, Wellington. 22p.

2.3.2 Site Investigations

Katherine Dixon (Ecologist, Boffa Miskell¹) visited the designation site on 30 May and 6 June 2019 to carry out the main terrestrial ecology survey. On 30 May the weather was poor with rain and cold temperatures. On 6 June conditions were mild and calm with no precipitation.

Jaz Morris (Ecologist, Boffa Miskell) visited the designation site on 24-25 March 2020 to familiarise himself with the vegetation of the designation site and capture any additional information not previously recorded. 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. 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. Conditions on 10-11 June were fine with mild temperatures.

Field assessments and surveys were carried out as below.

2.3.2.1 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

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

(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 communities² (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 area described in Section 3.2.1, except for the 'Macrocarpa forest' and 'West Gully 1 and 2', which she viewed from a distance using binoculars³.
- Jaz Morris prepared plant species lists and described the vegetation communities adjacent to McLaren Gully and Big Gully Road and the 'valley floor marsh wetland' downstream of the designation area. 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. Within the designation area, 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 in order to supplement existing plant species lists, but no deliberate searches or detailed survey methods were used in this area.

2.3.2.2 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 provided to Boffa Miskell was used in conjunction with field notes, photographs, and GPS records made during the field surveys.

2.4 Avifauna

An avifauna desktop review and 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 landfill⁴ 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

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

³ West Gully 2 and West Gully 1 are entirely dominated by extremely dense (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub, making access impractical. The limitations of vegetation survey methods are listed in Section 2.7.

⁴ Bird management is standard practise at landfills and is conducted to reduce the number of nuisance birds attracted to and present at the site.

what abundances, are already present in surrounding areas. This information is used to help inform the risk of aircraft strike associated with the proposed landfill.

The methods employed during these investigations are described below.

2.4.1 Desktop Review

Data from the Ornithological Society of New Zealand's (OSNZ) atlas (C. J. R. 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 Waiholo-Waipori and Sinclair wetland complex; Figure 3).

The primary and secondary habitats⁵ 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 (H. A. 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.

2.4.2 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 summer⁶) 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

⁵ 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.

⁶ 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.

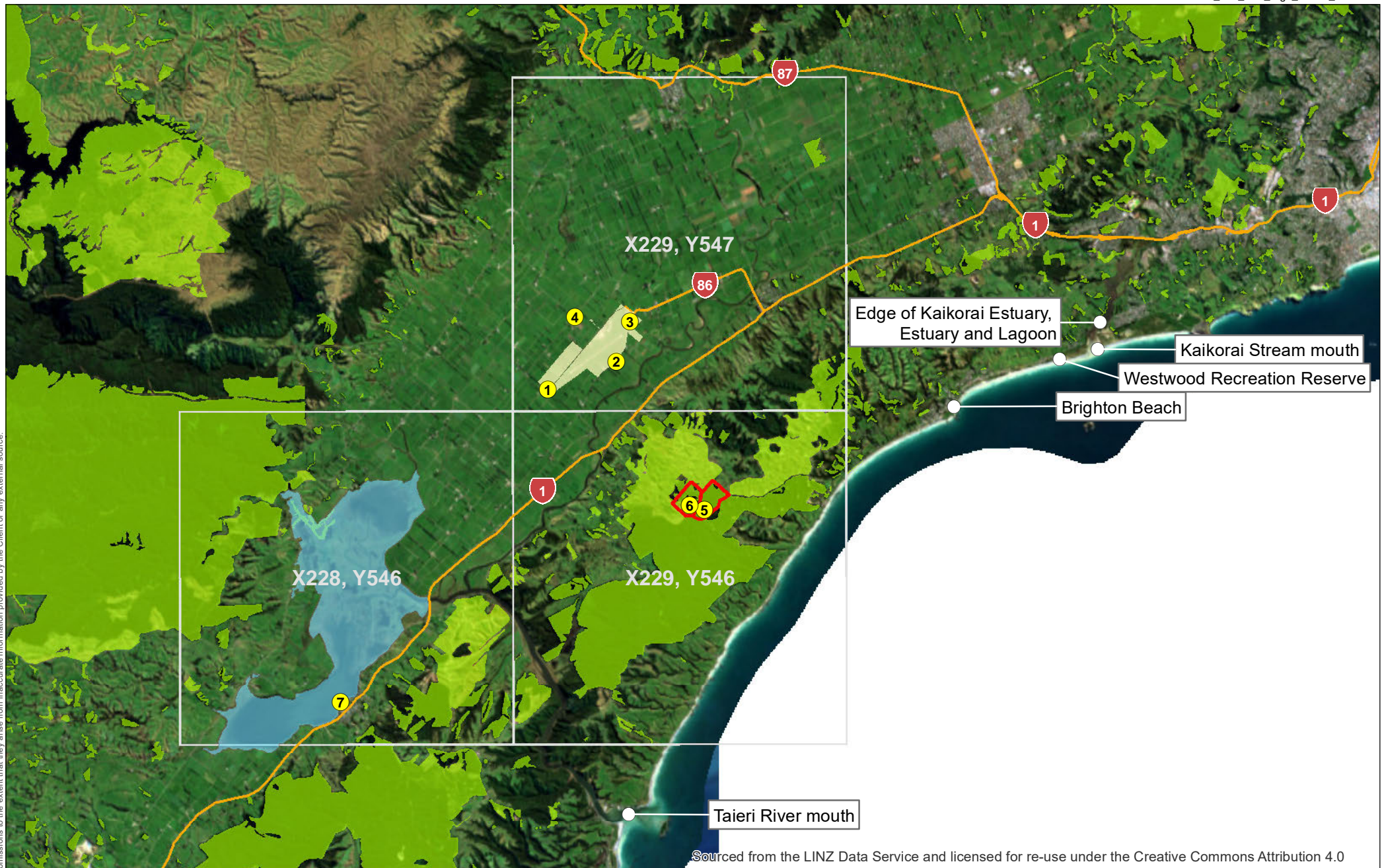
included: visibility, cloud cover (as a percentage of the sky), precipitation, temperature (°C), wind strength and wind direction (Table A2-1, Appendix 2).

A survey for nesting falcon was also conducted on site on 30 October 2019 (within the falcon breeding season which broadly spans between the start of September and the end of February (i.e. spring/summer)). This involved playing playbacks of falcon calls at different locations around the site and looking and listening for any responses.

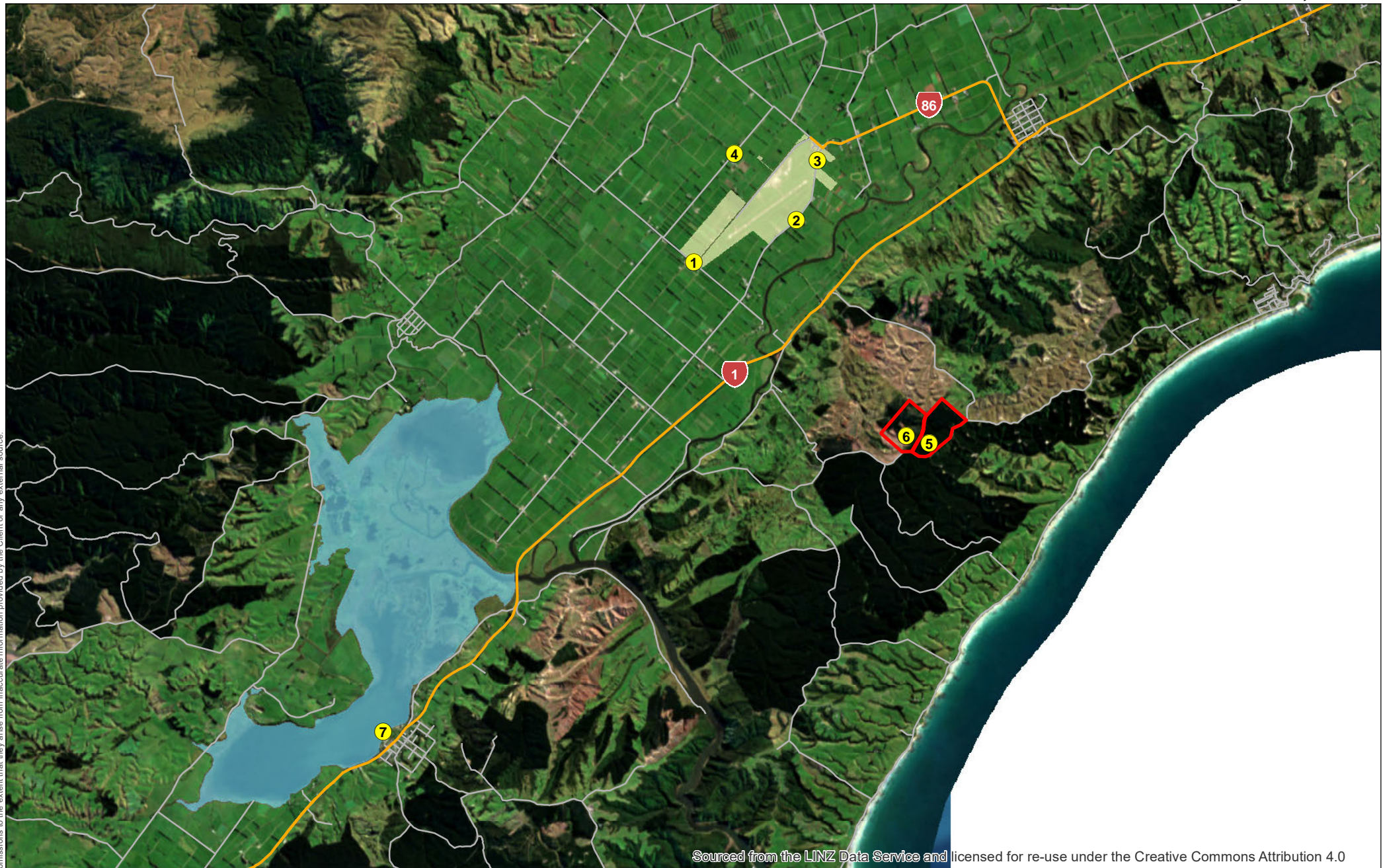
Two 20-minute water bird count surveys were also conducted at Lake Waihola in spring and summer⁷ to obtain an understanding of the bird assemblage at this location (Figure 4). Each survey was conducted over two consecutive days and each site was surveyed twice, once in the morning and once in the afternoon. 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.

⁷ The spring survey was conducted on 31-October-1 November 2019 and the summer survey was conducted on 10-11 February 2020.



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2.5 Herpetofauna

2.5.1 Desktop Review

The Department of Conservation online database for herpetofauna was accessed in May 2019, to determine if there were any recent records of herpetofauna within a 20 km radius of the designation site.

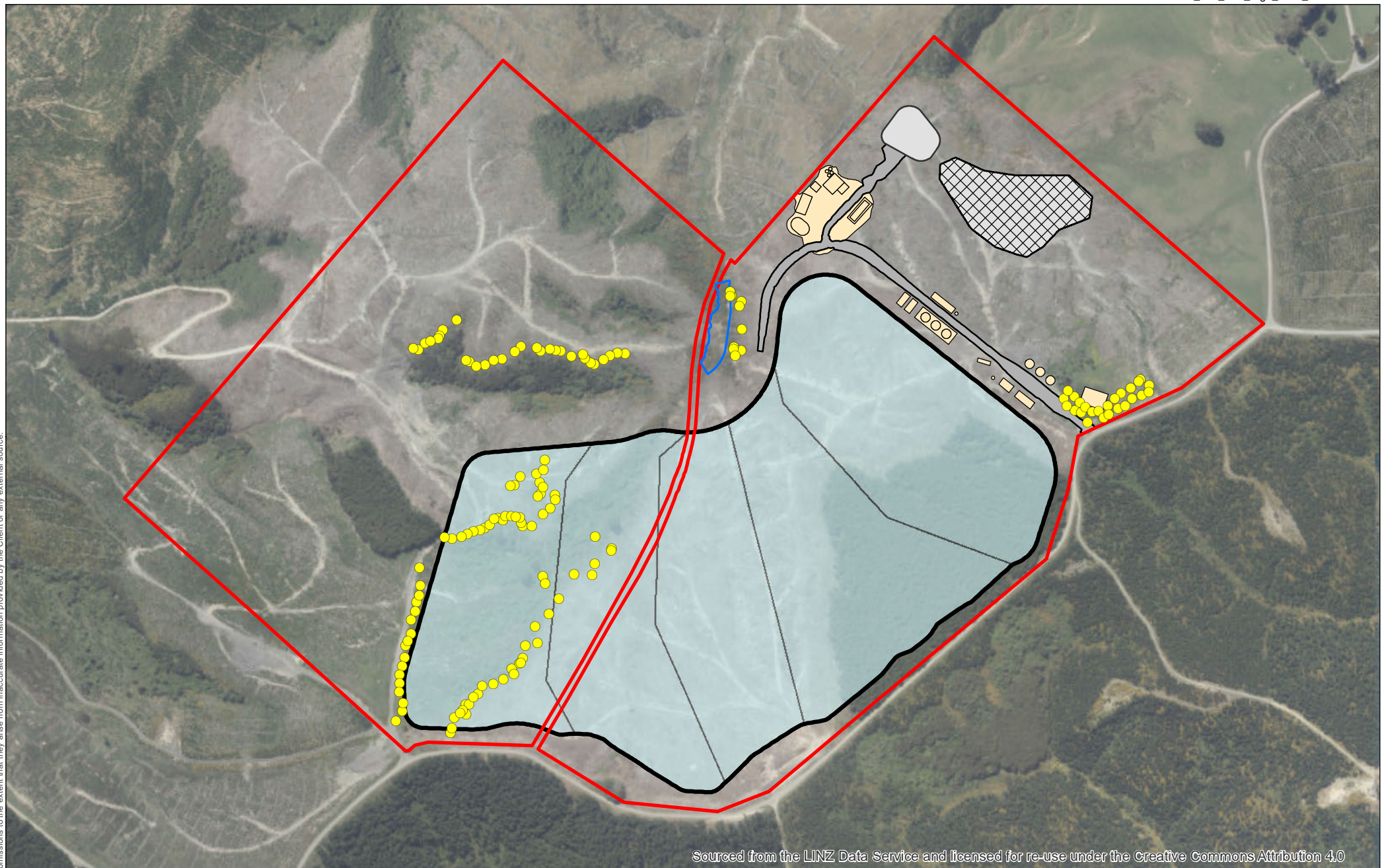
In addition to this interrogation of the database records, the known distributions of native lizards were analysed to determine if these distributions overlapped with the designation site. This included the McCann's skink (*Oligosoma maccanni*).

2.5.2 Site Investigations

Samantha King (Ecologist, Boffa Miskell), Tanya Blakely (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 (ACOs) 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 Authorisation Act requirements).

ACOs were checked and collected by Tanya Blakely and Jaz Morris on 24-25 March 2020. Due to restrictions on inter-regional travel (due to the COVID crisis), the project herpetologist, Samantha King, was unable to be on site when the ACOs were checked. Mandy Tocher (Herpetologist, Ryder Environmental Ltd.) was on site with Tanya Blakely and Jaz Morris on 24 March 2020. 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.



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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

- Artificial Cover Object
- Smooth Hill Designation (2GP)
- Access Road
- Landfill Footprint
- Stormwater Attenuation Pond
- Operations Area
- Infrastructure
- Landfill Staging
- Stockpile

SMOOTH HILL LANDFILL
Location of Artificial Cover Objects

Date: 12 August 2020 | Revision: 2

Plan prepared for DCC by Boffa Miskell Limited

Project Manager: tanya.blakely@boffamiskell.co.nz | Drawn: BMC | Checked: TBI

Figure 5

2.6 Freshwater Ecology

2.6.1 Desktop Review

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

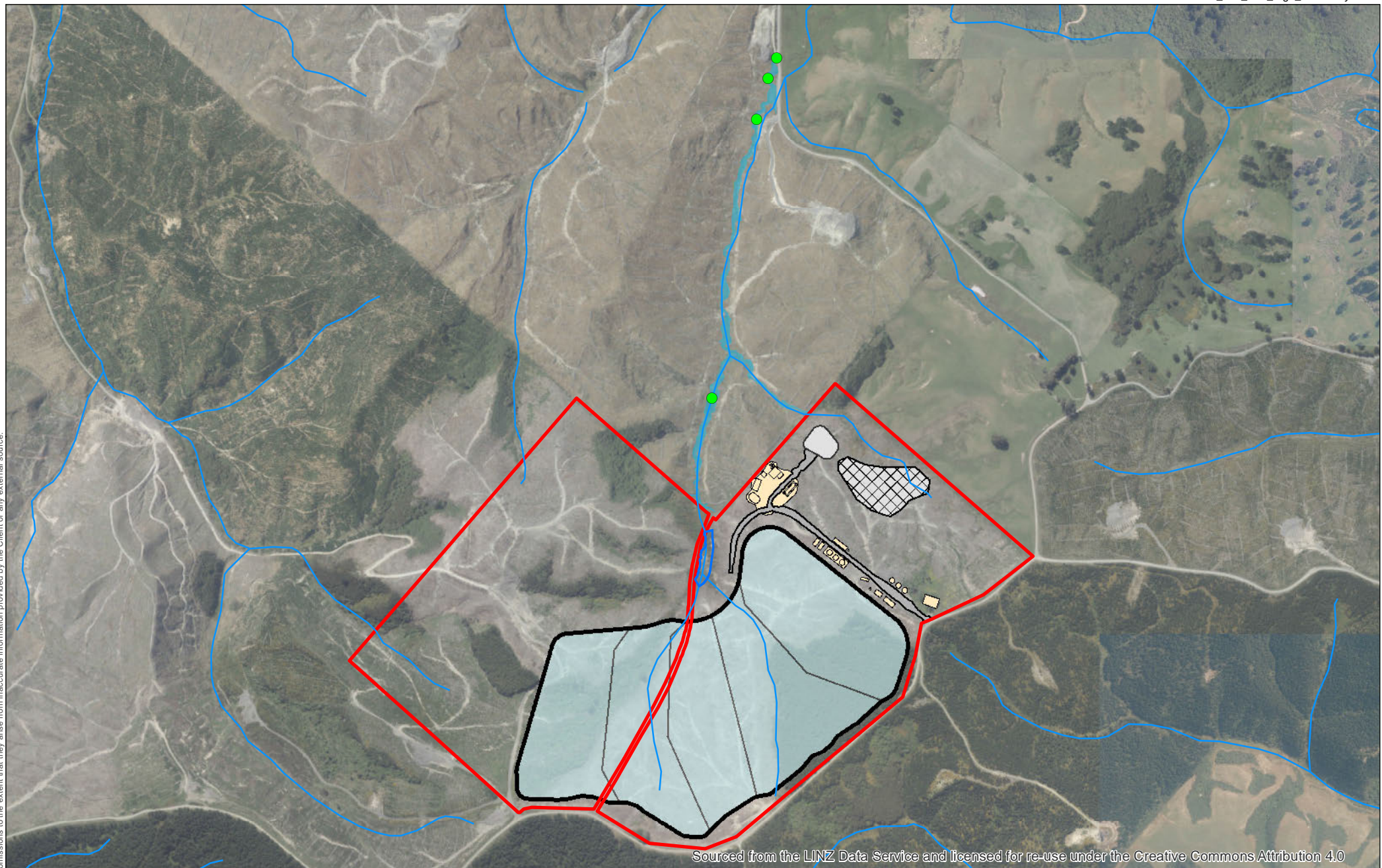
- GIS (Geographic Information System) databases and aerial imagery, including:
 - The NIWA-administered New Zealand Freshwater Fish database (NZFFD): this database holds records of freshwater fish distributions and occurrences based on previous surveys.

2.6.2 Site Investigations

Tanya Blakely (Senior Principal / Ecologist) visited the site 30 May, 7-8 October 2019 and 24-25 March 2020, which included site walkovers to assess if waterways were present within the designation site 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 paths to convey overland surface flows during rain fall events.

The freshwater ecology was investigated at four sites by Tanya Blakely (Senior Principal / Ecologist, Boffa Miskell) on 11 June 2020. The sites were located along Otokia Creek Tributary between the designation site and McLaren Gully Road (Figure 6). At each site, basic habitat conditions (Rapid Habitat Assessment; Clapcott 2015), macroinvertebrate and fish communities were assessed.



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LEGEND

- | | |
|---|--|
|  Valley Floor Marsh Wetland |  Infrastructure |
|  MCI Survey Locations |  Landfill Footprint |
|  Smooth Hill Designation (2GP) |  Landfill Staging |
|  Stormwater Attenuation Pond |  Stockpile |
|  Access Road |  Operations Area |

SMOOTH HILL LANDFILL
Waterways and Sampling Sites

Date: 12 August 2020 | Revision: 2

Plan prepared for DCC by Boffa Miskell Limited

Drawn: BMC | Checked: TBI

Figure 6

2.6.2.1 Habitat Conditions

Rapid Habitat Assessment (RHA), involves ranking the following parameters between 0 and 108 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.

2.6.2.2 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 0.3m² 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% ethanol 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. Of the commonly used biotic metrics, 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.

⁸ 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.

2.6.2.3 Fish community

The fish community was surveyed⁹ on 11 June 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, which is outside of the November to April timeframes recommended for fish surveys.

2.7 Supporting Information

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

- GHD's Landfill Concept Design Report, draft April 2020;
- GHD's Stormwater Assessment, draft June 2020; and
- GHD's Assessment of Effects to Groundwater and Surface Water, draft June 2020.

2.7.1 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).

⁹ 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 North Canterbury branch of Fish and Game to use an electric fishing machine under regulation 51 of the Freshwater Fisheries Regulations 1983 and Section 262R of the Conservation Act 1987.

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)¹⁰, 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 similar¹¹.

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 (EclA) guidelines (Roper-Lindsay et al. 2018).

In summary, the EclA 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.

¹⁰ 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).

¹¹ 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 (from Roper-Lindsay et al. 2018).

MATTERS	ATTRIBUTES TO BE CONSIDERED
Representativeness	<p>Criteria for representative vegetation and aquatic habitats:</p> <ul style="list-style-type: none"> – 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 <p>Criteria for representative species and species assemblages:</p> <ul style="list-style-type: none"> – Species assemblages that are typical of the habitat – Indigenous species that occur in most of the guilds expected for the habitat type
Rarity/distinctiveness	<p>Criteria for rare/distinctive vegetation and habitats:</p> <ul style="list-style-type: none"> – Naturally uncommon, or induced scarcity – Amount of habitat or vegetation remaining – Distinctive ecological features – National priority for protection <p>Criteria for rare/distinctive species or species assemblages:</p> <ul style="list-style-type: none"> – 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	<ul style="list-style-type: none"> – 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	<ul style="list-style-type: none"> – 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 (from Roper-Lindsay et al. 2018).

MATTERS	ATTRIBUTES TO BE ASSESSED
Representativeness	<ul style="list-style-type: none"> – Extent to which site / catchment is typical or characteristic – Stream order – Permanent, intermittent, or ephemeral waterway – Catchment size – Standing water characteristics
Rarity/distinctiveness	<ul style="list-style-type: none"> – Supporting nationally or locally¹² Threatened, At Risk or uncommon species – National distribution limits – Endemism – Distinctive ecological features – Type of lake / pond / wetland / spring
Diversity and pattern	<ul style="list-style-type: none"> – Level of natural diversity – Diversity metrics – Complexity of community – Biogeographical considerations – pattern, complexity, size, shape
Ecological context	<ul style="list-style-type: none"> – 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 (from 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 matters, 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.

¹² Locally – defined as within the relevant Ecological District

Table 5. Factors to consider in assigning value to species for EclA (from 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 (from 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 (from 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 Classification¹³, 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 ED¹⁴, 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 (~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 (~500

¹³ 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.

¹⁴ 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.

ha) to the south; and scattered, small areas of covenanted private land, the nearest of which is immediately to the north of McLaren Gully Road around 1.5 km north of the designation site.

3.2 Terrestrial Vegetation and Wetlands

3.2.1 Vegetation Communities

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 Otokia 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.

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 ecological features listed below.

Vegetation communities	Location within Designation site
(Pūrei - rautahi – Yorkshire fog) - cocksfoot / floating sweetgrass – watercress grassland	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
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	Recently cutover pine 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) – wiwi / cocksfoot 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

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'¹⁵ and an assessment of their ecological significance¹⁶, and an assessment of their ecological value¹⁷.

A summary of ecological significance and ecological value of the vegetation and wetlands are provided in Sections 3.2.2 & 3.2.3, respectively.

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).

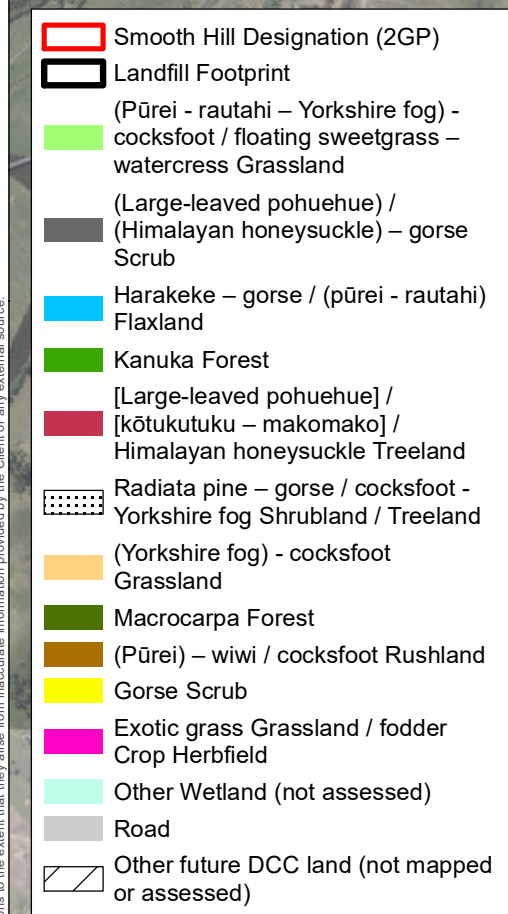
Avifauna and herpetofauna that inhabit these vegetation types are mentioned briefly within this section of the report, but are dealt with substantially in Sections 3.3 and 3.4, respectively.

Other fauna that may be present are introduced mammalian pests. Browsing 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.

¹⁵ 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.

¹⁶ 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.

¹⁷ Ecological value was determined using the EIANZ methodology (Roper-Lindsay et al. 2018).



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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: 19 August 2020 | Revision: 3

Plan prepared for DCC by Boffa Miskell Limited

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

Figure 7

3.2.1.1 (Pūrei – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland

A grassland dominated by cocksfoot with abundant rautahi (*Carex geminata*) and Yorkshire fog 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)). Watercress and floating sweetgrass are abundant or dominant 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). More specifically, 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'; and
- 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). This area contains relatively higher levels of rautahi than elsewhere, but is included within this vegetation type for simplicity.

Excluding rautahi, 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, pūrei, 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 also occasional in this vegetation community.

A deep pool downstream from the designation area 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.

Carex coriacea (also commonly called rautahi or cutty grass) is also present but is rare or occasional in this community; reference to 'rautahi' in this document, unless otherwise specified, means *Carex geminata*, which in general is far more abundant than *C. coriacea* at the study site.

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;
- 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 also sits at the confluence of several minor eastern gully systems. It likely receives year-round seepage and periodic overland flows and has areas of standing water with frequent pūrei. Rautahi is present on the edge of the flaxland, which are surrounded by rautahi – Yorkshire fog 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 (>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 (both *Carex geminata* and *C. coriacea*) 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 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.

A very small strip of essentially similar vegetation is also located along a fenceline near Big Stone Gully, surrounded largely by (Yorkshire fog) – cocksfoot grassland, and may enhance the quality of skink habitat in this area.

3.2.1.6 Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland

The majority of the designation site comprises recently cutover and re-planted radiata pine, with 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 also extensive 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. Other areas of plantation forestry adjacent to McLaren Gully Road and Big Stone Road are included in this vegetation type – where pines are more mature, the vegetation type could be described as a treeland.

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 recent forestry harvest;
- Along fence lines and roadsides;
- 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. wiwi, 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.

3.2.1.9 Additional vegetation types along roadsides

Some areas among seasonally wet pasture in paddocks bordering McLaren Gully Road contain (pūrei) – wiwi / cocksfoot rushland. This vegetation type contains exotic grasses (largely cocksfoot), dominant wiwi rushes, occasional or patchy pūrei, and a small number of tī kōuka trees; these areas are best described as marsh wetlands with some minor areas of swamp.

On McLaren Gully Road above 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 scarce native tree or shrub species, unlike gorse scrub habitats in the designation site 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 fodder crop herbfield (cultivated brassicas).

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

3.2.1.10 Threatened, At Risk Plants or Locally Uncommon Plants

Threatened, At Risk or locally uncommon plants identified within the designation site during the study were kānuka (Threatened – Nationally Vulnerable)¹⁸. 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

Ecological significance 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 Otokia 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.

¹⁸ Kānuka are common and widespread in habitats such as these. However, due to the threat posed to kānuka by myrtle rust, it is precautionarily considered to be Threatened (de Lange et al. 2018).

Indigenous vegetation (under the 2GP definition) includes the (pūrei – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland, the harakeke – gorse / rautahi – pūrei flaxland, kānuka forest, and [large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan 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.

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) Otokia 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 – rautahi – Yorkshire fog) - cocksfoot / watercress – floating sweetgrass grassland;
- The swamp wetland, comprising harakeke – gorse / rautahi – pūrei flaxland and comprising (pūrei – rautahi – Yorkshire fog) - cocksfoot / watercress – floating sweetgrass grassland;
- Wetland habitats well outside the designation area but which are also tributaries of Otokia Creek and are connected to the above wetlands. This includes (rautahi – Yorkshire fog) - cocksfoot / watercress – floating sweetgrass grassland, and (pūrei) – wiwi / cocksfoot rushland;
- West Gully 1 kānuka forest;
- Exotic (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub that fringes the swamp wetland and connects it to West Gully 1, 2, and 3¹⁹;
- West Gully 2 and areas that connect it to the swamp wetland; comprising patches of kānuka forest, (pūrei – rautahi – Yorkshire fog) - cocksfoot / watercress – floating sweetgrass grassland; and small areas of exotic radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland with occasional indigenous trees;
- West Gully 3, containing kānuka forest and harakeke – gorse / rautahi – pūrei flaxland in; and
- West Gully 4, comprising [large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland, comprising (pūrei – rautahi – Yorkshire fog) - cocksfoot / watercress – floating sweetgrass grassland, and immediately fringing (Yorkshire fog) - cocksfoot grassland.

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 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

¹⁹ 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 1²⁰ (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 2a²¹ (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 2b²² (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, while not all occurring on such chronically 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 3²³ (2GP criterion 2.2.3.2 f). 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 (pūrei – rautahi – Yorkshire fog) - cocksfoot / watercress – floating sweetgrass grassland and flaxland wetland areas also have an important buffering effect by moderating the water supply to downstream wetland habitats and the Otokia Creek. This area is therefore significant in terms of RPS criteria 5a, 5b, and 5c²⁴ (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.

²⁰ 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*

²¹ 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.*

²² 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.*

²³ 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.*

²⁴ 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 macrocarpa forest and the main cutover area (radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland) type does not include indigenous²⁵ vegetation types. However, this vegetation type 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 indigenous²⁵, this vegetation type 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 and fodder crop herbfields 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 – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland

In terms of ecological value, this vegetation type is slightly to moderately representative of intact valley floor wetland habitats in the Tokomairiro ED, where rautahi-dominated grasslands or sedgelands naturally occur in frosty, intermittently or permanently wet valley basins. However, this grassland 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 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 so-called chronically threatened 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

²⁵ 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.

induced wetland type resulting from historical forest clearance. However, the species present within this vegetation 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 shrubland / 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 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.

3.2.3.8 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.

3.2.3.9 Other vegetation types

Areas of wetland with (pūrei) – wiwi / cocksfoot 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 herbage 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.

3.2.3.10 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.

3.3 Avifauna

3.3.1 Wider Landscape

The proposed landfill and designation site is part of a wider landscape providing habitat for avifauna. This includes: Taieri Plain (pre-dominantly agricultural land and includes Dunedin Airport); Lake Waihora – 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 km² 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 Waihora 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
South Island fantail	Native	1	0.1

Species	Introduced / Native	Abundance	Proportion of observations (%)
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 eBird²⁶. 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, 2019²⁷). High numbers of black-backed gulls (180), starlings (200) and lesser redpolls (320) have also been recorded in this area²⁸. 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 crane.

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.

²⁶ Data accessed 6 December 2019 from <https://ebird.org/newzealand/hotspot/L1082293>.

²⁷ An eBird list accessed 6 December 2019 from <https://ebird.org/newzealand/hotspot/L1082293> also reports observations of thousands of waterfowl.

²⁸ Data accessed 29 November 2019 from <https://ebird.org/newzealand/hotspot/L1645480>.

Table 10. Birds observed at Lake Waiholo 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 eBird²⁹).

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, mature 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 (C. J. R. 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.

²⁹ 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. 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 ³⁰	Native Forest	Exotic Forest	Scrub/shrubland	Farmland/open country	Freshwater/wetlands	Coastal/estuary	Residential	Observed at landfill site
Eastern falcon	<i>Falco novaeseelandiae</i> "eastern"	At Risk – Recovering ^{DP St}								X
Kereru	<i>Hemiphaga novaeseelandiae</i>	Not Threatened								X
Shining cuckoo	<i>Chrysococcyx l. lucidus</i>	Not Threatened								X
Kingfisher	<i>Todiramphus sanctus vagans</i>	Not Threatened								X
Brown creeper	<i>Mohoua novaeseelandiae</i>	Not Threatened								X
South Island fantail	<i>Rhipidura fuliginosa fuliginosa</i>	Not Threatened								X
South Island tomtit	<i>Petroica macrocephala macrocephala</i>	Not Threatened								
Bellbird	<i>Anthornis m. melanura</i>	Not Threatened								X
Tui	<i>Prosthemadera n. novaeseelandiae</i>	Not Threatened								X
Blackbird	<i>Turdus merula</i>	Introduced & Naturalised								X
Grey warbler	<i>Gerygone igata</i>	Not Threatened								X
Silveryeye	<i>Zosterops lateralis lateralis</i>	Not Threatened								X
Yellowhammer	<i>Emberiza citrinella</i>	Introduced & Naturalised								
Chaffinch	<i>Fringilla coelebs</i>	Introduced & Naturalised								X
Greenfinch	<i>Carduelis chloris</i>	Introduced & Naturalised								X
Goldfinch	<i>Carduelis carduelis</i>	Introduced & Naturalised								X
Redpoll	<i>Carduelis flammea</i>	Introduced & Naturalised								X
House sparrow	<i>Passer domesticus</i>	Introduced & Naturalised								
Starling	<i>Sturnus vulgaris</i>	Introduced & Naturalised								X
Magpie	<i>Gymnorhina tibicen</i>	Introduced & Naturalised								X
Swamp harrier	<i>Circus approximans</i>	Not Threatened								X
Spur-winged plover	<i>Vanellus miles novaehollandiae</i>	Not Threatened								X
Skylark	<i>Alauda arvensis</i>	Introduced & Naturalised								X
Welcome swallow	<i>Hirundo n. neoxena</i>	Not Threatened								X
Dunnock	<i>Prunella modularis</i>	Introduced & Naturalised								
Song thrush	<i>Turdus philomelos</i>	Introduced & Naturalised								X
Paradise shelduck	<i>Tadorna variegata</i>	Not Threatened								X
Pukeko	<i>Porphyrio m. melanotus</i>	Not Threatened								
Black-backed gull	<i>Larus d. dominicanus</i>	Not Threatened								X
Red-billed gull	<i>Larus novaehollandiae scopulinus</i>	Declining								
White-faced heron	<i>Egretta novaehollandiae</i>	Not Threatened								

³⁰ 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 11); 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 11) 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.

A total of 27 observations, of six introduced and native herpetofauna species, were found in the DOC Bioweb database. These records occur from 1967 to 2020 (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. Herpetofauna species recorded in the DOC Bioweb Herpetofauna Database, accessed May 2019. Note that distance and year recorded of introduced species has not been listed.

Species	Threat Classification	Number of observations	Distance from designation (km)	Year observed
Brown tree frog (<i>Litoria ewingii</i>)	Introduced - Naturalised	3	-	-
Southern Bell frog (<i>Litoria raniformis</i>)	Introduced - Naturalised	14	-	-
Undetermined gecko species	-	1	8	1992
Korero gecko (<i>Woodworthia</i> "Otago large")	Taxonomically indeterminate; At Risk – Declining	4	8	1967
Jewelled gecko (<i>Naultinus gemmeus</i>)	At Risk - Declining	1	15	1980
Undetermined skink species	-	3	12	1990
Southern grass skink (<i>Oligosoma</i> aff. <i>polychroma</i> Clade 5)	Taxonomically indeterminate; At Risk - Declining	1	8	2002

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 14).

- 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 2020; Table 13), may be within the designation footprint, 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.
- 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 area. The jewelled gecko is classified as At Risk – Declining and is not locally abundant within the south Dunedin area.

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).

Table 14. Lizard species that may be present in habitats within the designation site, their threat classification and likelihood of presence within the site.

Species	Habitat preference (within site)	Likelihood of presence within designation	Threat classification
Southern grass skink	Grassland (cutover pine / Yorkshire fog), gorse scrub and kānuka forest	High	At Risk – Declining *taxonomically indeterminate
McCann's skink	Cutover pine / Yorkshire fog Scrubland	Low	Not Threatened
Jewelled gecko	Kānuka forest	Low	At Risk - Declining

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).

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. The watercourses 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 watercourses 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 Otokia Creek catchment, which flows to the sea at Brighton Beach.

The swamp wetland and defined channel connecting it to the valley floor marsh wetland 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.

The downstream reaches (receiving environment) within the valley floor marsh wetland and further downstream in the Otokia Creek catchment were assessed in June 2020 (between the designation site and McLaren Gully Road).

This tributary of Otokia Creek, between the designation site and McLaren Gully Road appeared to be perennial, or likely having surface water present all (or most) of the year. There was a well-defined channel along much of the c. 1 km reach (Figure 8).

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) is located approximately 200-300 m downstream of the designation site (last photo in Figure 8).



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

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 *Tripletides* caddisfly was collected from one site along the tributary. Damselfly nymphs (*Austrolestes* 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 Otokia 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’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.

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 area, so the ecological value within the designation site has not been assessed further.

The Otokia Creek tributary, between the designation site and McLaren Gully Road, is of low or very low representativeness, with modified conditions. However, it is thought to be perennial for much (or all) of the reach surveyed downstream of the designation site. Rarity is very low as no threatened or at-risk species (e.g. freshwater fish) were found in the waterway, although noting that this needs to be confirmed with further surveys conducted in a more appropriate season. Diversity is low, as the water supports a relatively depauperate and “tolerant” macroinvertebrate community, including ubiquitous taxa found in a variety of similar habitats in the wider area and likely throughout New Zealand³¹. 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 so-called chronically threatened land environment (Walker et al. 2015) and is of moderate importance in terms of ecological context.

Considering the above, the waterway is of low 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.

If this waterway supports freshwater fish species (e.g. banded kokopu and longfin eel) and possibly kēkēwai, 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**.

3.6 Summary of Ecological Values & Significance

Table 15 and Figure 9 summarises the vegetation types present within the designation area that are significant under proposed RPS criteria, and that are significant under the equivalent criteria in the proposed 2GP.

Table 15. 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 ³²	2a, 5c
Working farmland	No	-

³¹ 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.

³² If southern grass skink is present, see Section 3.4.

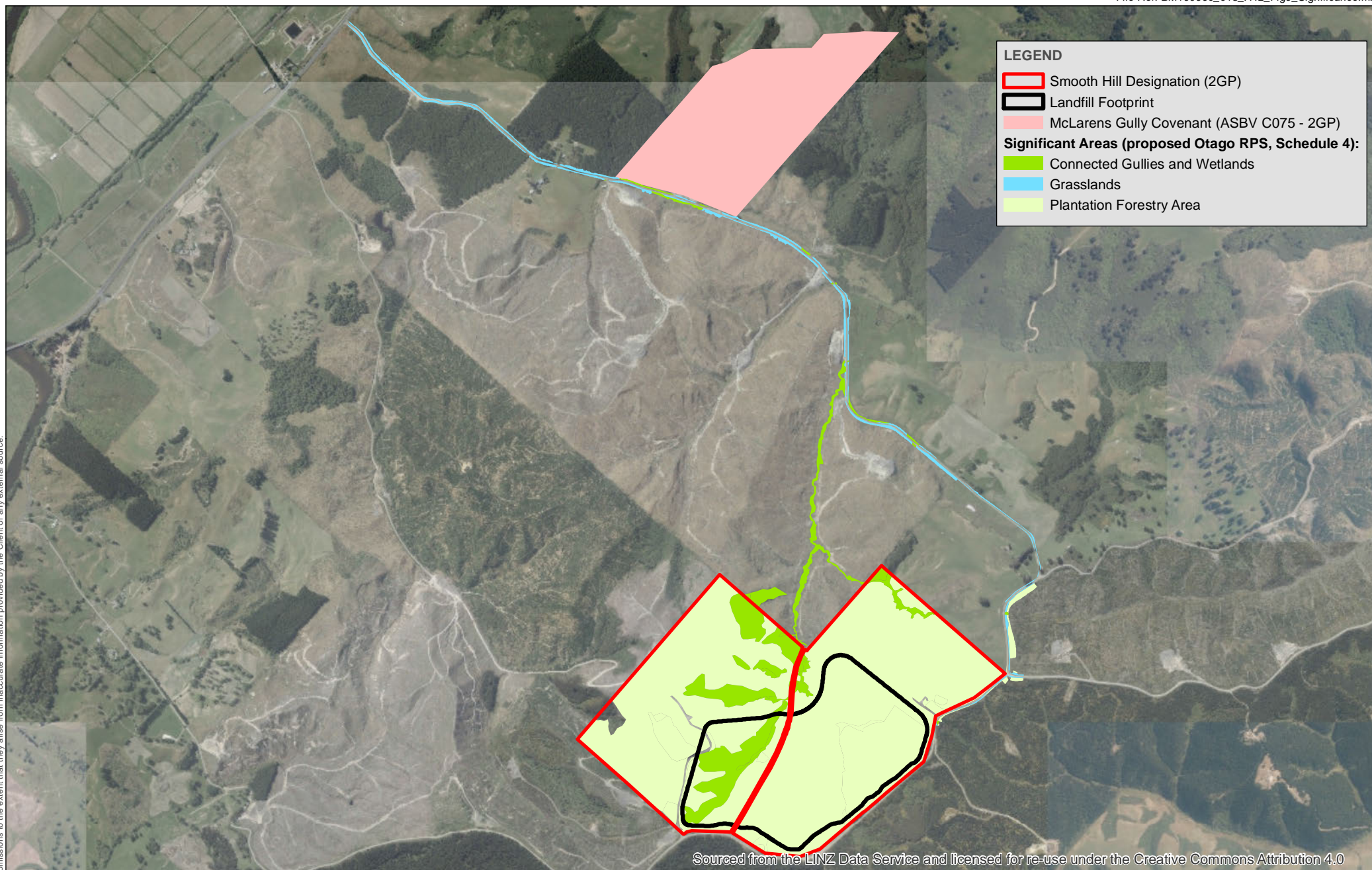


Table 16 summarises our assessment of ecological values following the EIANZ guidelines (Roper-Lindsay et al. 2018) (see Section 2.8).

Table 16. 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 – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland	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 shrubland / 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) – wiwi / cocksfoot 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 <i>Not Threatened</i> species (refer to Table 11)	Not Threatened				Low
Introduced species (refer to Table 11)	Introduced				Negligible
Herpetofauna					
Southern grass skink	At Risk - Declining				High
Jewelled gecko	At Risk – Declining (Taxonomically indeterminate)				High
McCann's skink	Not Threatened				Low
Freshwater Ecology					
Otokia Creek Tributary	Very Low-Low	High (or Low if fish are <u>not</u> present)	Low	Moderate	Moderate (or Low if fish are <u>not</u> present)

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 landfill will have a capacity of approximately 6 million tonnes, and expected life at current Dunedin disposal rates of approximately 55 years.

The landfill will be developed in stages, with one stage being filled with waste while the next stage is constructed.

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

- 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 (further described below).
- Leachate collection system above the low permeability lining system, and storage of leachate, prior to transport by tanker from the site for disposal (further described below).
- Stormwater control around the landfill and other areas of the site with appropriate treatment and attenuation of stormwater before it leaves the site (further described below).
- Landfill gas collection (LFG) system, and destruction of LFG by flaring. In future LFG may also be used for 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.
- Facilities for site staff.
- Maintenance facilities for site plant and equipment.
- Provision of water supplies for operational (non-potable) and staff (potable) requirements.
- Landscape and ecological mitigation, including perimeter planting.
- Environmental monitoring systems, including groundwater and LFG wells.
- Upgrade of McLaren Gully Road, including its intersection with State Highway 1, 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.

4.1 Leachate Management

Leachate management will be via the following measures:

- Preventing clean upslope surface water from entering the leachate collection system;
- Minimising the size of the active waste tipping area where waste is exposed to rainfall; and
- Covering areas with intermediate cover or final capping as soon as is practicable so that as much water as possible is shed into the stormwater collection system and minimising percolation of water through these layers into the underlying 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.

Under the lining systems, leachate is contained and will flow to a leachate collection system at the base of the landfill toe embankment from where it will be removed off site for treatment and disposal. Leachate storage tanks will be located in the upper landfill facilities area. Leachate volumes will be relatively low during the initial period of landfill development. The DCC proposes to install a pipeline from the site along public roads to the nearest connection into the WWTP system at Brighton, approximately 7.5 km to the north east of the site. This may occur during stage 2 of the landfill and consent is not sought for the pipeline as part of this application. Several down gradient monitoring wells will be installed between the landfill toe embankment and northern site boundary to provide advance warning of any leachate leakage that may affect the downstream receiving environment.

4.2 Stormwater Management

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 Otokia Creek receiving environment in a way that avoids adverse effects on downstream flows and water quality.

The proposed stormwater management systems include:

- Permanent perimeter swale drain to intercept upslope flows and divert them around the landfill to an attenuation basin below the landfill toe embankment. The swale drain will remain in operation following closure of the landfill. As there is no significant external catchment this drain will primarily be collecting stormwater from the interim and final landfill surfaces.
- Permanent attenuation basin, which will receive stormwater from 69 ha of the landfill site, including from: upslope gullies; the perimeter swale drain; pre-construction areas; construction areas; landfill operational areas not subject to waste contamination; facilities areas; and the final cap. The basin will remain in operation following closure of the landfill.
- Sediment control ponds constructed at the base of excavation prior to construction of each stage of the landfill to collect and provide primary treatment of runoff to remove sediment, prior to discharge to the attenuation basin. The sediment control ponds constructed to capture sediment runoff from each stage will remain in operation for the

life of that stage until subsequent stage works require its removal. A sediment control pond will then be installed for the subsequent development stage.

- 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:10H, permanent contour drains discharging to the perimeter swale drains will be installed every 50 metres to control flows.

4.3 Groundwater Management

Excavation to create the landfill base grade is expected to expose groundwater seepages towards the landfill toe and at the junction of the landfill base and side walls. Control and drainage of groundwater will therefore be required beneath the low permeability liner system to avoid the creation of uplift pressures that could cause a local failure of the liner.

Control of groundwater will be achieved by constructing a network of subsoil drains below the low permeability liner system as part of the development of each stage of the landfill. The groundwater drainage will consist of perforated pipework designed to withstand the design loads. The perforated drainage pipework will be encased in graded aggregates and the entire drain encased in filter fabric to prevent soil particle loss to the drainage.

Collected groundwater will gravitate to the low end of the landfill from where it will be discharged to the attenuation basin, or pumped to a non-potable water supply storage in the lower facilities area where it will be used for firefighting supply, dust suppression, and operation of the wheel wash and machinery wash bay. The quantity of groundwater collected by the system is predicted to be up to 4m³ per day. In the highly unlikely event of leachate contamination, collected groundwater will instead be directed to the leachate collection system for disposal.

5.0 Assessment of Effects

The following assessment of effects on the ecological values within the designation area is in accordance with the EIANZ EclA 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.

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

- For construction footprints for landfill staging, construction of access roads within the designation site, a stockpile, infrastructure / buildings, and a stormwater attenuation basin – 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).
- For construction footprints for the widening of McLaren Gully Road and Big Stone Road – designs were provided to Boffa Miskell by GHD on 17 August 2020. This design

replaces a 26 May 2020 version which would have encroached upon a flaxland below Gledknowe Hill.

- We understand that the construction footprint for widening of McLaren Gully and Big Stone Roads provided on 17 August 2020 is larger than what may be cleared. We have, therefore, assessed a worst-case-scenario in the absence of more precise construction specifications.

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 wetland habitats within this footprint of works. Our assessment has generally not been broken down in terms of landfill staging or works type within the designation site. However, effects due to road widening are differentiated. 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, except where alterations are made to works in significant habitats (e.g. 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 17. Description, ecological value, and extent (hectares) of vegetation communities that will be removed or disturbed by overall landfill construction and road widening.

Vegetation Community Categories	Ecological Value ³³	Vegetation Removal / Disturbance (ha)
(Pūrei - rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland	Moderate	0.72 ³⁴
(Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub	Negligible	0.10 ³⁵
Harakeke – gorse / (pūrei – rautahi) flaxland	Moderate	0.08 ³⁶
[Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland	Low	4.52
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	Negligible	34.92
Macrocarpa forest	Negligible	8.80
(Yorkshire fog) - cocksfoot grassland	Moderate	4.73
(Pūrei) – wiwi / cocksfoot rushland	Moderate	0.19
Gorse scrub	Negligible	0.27
Exotic grass grassland and fodder crop herbfields	Negligible	1.68
Total		56.00

³³ From Section 6.1

³⁴ 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 6.1.

³⁵ As above.

³⁶ As above.

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

5.1.1.1 (Pūrei – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland

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. Up to a further 0.35 ha would be cleared during the widening of McLaren Gully Road. It is not expected that large hydrological changes (and subsequent indirect wetland loss) to adjacent wetland areas on McLaren Gully Road would occur because, to some extent, these wetland areas probably exist because the existing road impounds surface water flows from tributary valleys. Unless existing road culverts are shifted / enlarged, a minor expansion in the road footprint may not substantially alter this process except perhaps to enhance it. 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 road widening is expected to have a **Low** magnitude of effect (*having a minor effect on the known population or range of the element / feature*). A low magnitude of effect on a habitat type with **Moderate** ecological value (Section 3.2.3.1) equates to a **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 Waiholā-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 ha of rank grassland that likely supports indigenous lizard species would be cleared within the designation site. Up to a further 4.07 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, 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 **Moderate** ecological value (Section 3.2.3.7) equates to a **Very Low** level of ecological effect.

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

5.1.1.6 (Pūrei) – wiwi / cocksfoot rushland

Up to 0.19 ha of (pūrei) – wiwi / cocksfoot rushland wetland vegetation alongside McLaren Gully road could 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 loss of this habitat type of **Moderate** ecological value (Section 3.2.3.9) is considered 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.

5.1.2 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 3.2.3.10).

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 clearance³⁷ at the project site due to weed encroachment or weed introduction is **Negligible**, 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 valley floor marsh wetland that occupies most of the valley bottom draining the designation site to Otokia Creek. Based on an assessment of groundwater / surface water effects of the landfill (GHD 2020), 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; and
- Reduction in water supply due to reduced groundwater recharge as a result of landfill lining and capping, increased evapotranspiration across the landfill footprint, and due to interception of leachate and reduced runoff below a stormwater attenuation basin.

This may have indirect effects on wetlands throughout the landfill lifespan and the hydrological changes will largely persist even following landfill decommissioning (GHD 2020).

In terms of contaminants, the GHD (2020) report states: "*considering the reduction in contaminant flux and the levels of dilution predicted, the effects to groundwater quality in the immediate vicinity of the site are expected to be negligible.*" 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 what effect an overall reduced contaminant flux from the designation site will have on downstream wetland vegetation; possibly, the effect may be positive.

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. Effects of the altered water supply will become relatively less important downstream as recharge occurs from other tributaries (e.g. East Gully) and as the relative proportion of the catchment affected by the landfill decreases.

³⁷ i.e. those areas that will remain intact after landfill construction, and which could therefore be further degraded by further weed invasion.

A reduction in water supply may lead to altered composition and extent of wetland vegetation and wetland functioning in the valley floor marsh wetland. Presently, the vegetation present is suggestive of an environment where:

- A narrow strip of swamp vegetation (floating sweetgrass and watercress, bordered by occasional or frequent pūrei) receives permanent or near-permanent groundwater³⁸ and / or surface flows, and surface water is a perennial feature of this vegetation strip throughout much of the wetland extent;³⁹ and
- A much wider band of marsh vegetation across the valley floor (comprising facultative wetland species including 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.

If up to half the water supply to the wetland is lost, it can be expected that the permanently wet area and resultant swamp vegetation may contract or disappear from some areas, being most likely nearest the designation site. The surrounding marsh 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. It is a practical impossibility to say with certainty the precise magnitude of effect, because this large wetland has a number of hydrological influences that will alter with time (including other tributaries, and ongoing maturation of adjacent pine forest), 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 loss in this area. A large deep pool surrounded by pūrei occupies an area of the wetland ~300 m below the designation site, just upstream of the East Gully confluence, above what appears to be a manufactured bund. This area 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). It is unknown whether the water retained by this system would diminish appreciably due to landfill construction and whether, in turn, water contributions downstream during dry periods would diminish.

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 (*having a minor effect on the known population or range of the element / feature*) 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

³⁸ The amount of annual rainwater in the designation site lost to the shallow groundwater system that is available downstream for wetland recharge is estimated to be minor (1-2%) compared to surface runoff (GHD 2020).

³⁹ Floating sweetgrass, watercress and pūrei are obligate wetland species that do not typically grow in areas that are only seasonally wet. In several places in the valley floor marsh wetland, floating sweetgrass was observed to have a leaf morphology (floating 'strap' leaves) that indicates adaptation to permanent surface water / flows.

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*⁴⁰) and, therefore, a **Low to Moderate** level of ecological effect.

The 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 community), 8.68 ha of macrocarpa forest, and 33.80 ha of re-planted radiata pine plantation (refer to Figure 7). These habitats are variously used by falcon for foraging, roosting and nesting. Given that only a small proportion of the native gully habitat on site will be lost, that all of 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 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 negligible magnitude of effect on a **Low** ecological value

⁴⁰ Following the methodology of Roper-Lindsay et al. (2018)

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 activities⁴¹, falcon will likely be disturbed and displaced from the area. If construction activities occur outside of the breeding season for falcon (i.e. between the start of March and end of August), we expect that falcon, which are a highly mobile species, will disperse and utilise other areas of their extensive home ranges (9 km² at Kaingaroa Forest (Seaton, 2007) and up to 75 km² 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 the start of September and the end of February) and birds are nesting on the site, 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, 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

⁴¹ 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.

detected, management actions can be implemented, such as establishing construction-free exclusion zones around nests⁴² 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 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

⁴² The standard size of construction-free exclusion zones for falcon nests is a 200 m radius centred from the nest.

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. However, the latter can be inferred from the former.

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 Waiholo-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 years⁴³); 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).

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 airport⁴⁴ (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

⁴³ The current strike rate is less than 5 strikes per 10,000 aircraft movements (G. Pleasants, *pers. comm.* 3 August 2020).

⁴⁴ A guideline presented to reduce strike is to have a 6.5 km separation distance between landfills and airports (T. Caithness, personal communication, 1992).

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 10). 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 (~150m) (G. Pleasants, *pers. comm.* 3 August 2020). The heights at which general aviation aircrafts and commercial aircrafts fly over the Smooth Hill site⁴⁵ overlap with the elevations that black-backed gulls soar at (determined from communications had with personnel at Dunedin Airport (G. Pleasants, *pers. comm.* 3 August 2020)). As such, bird strike at the landfill site is a potential effect of the proposal.

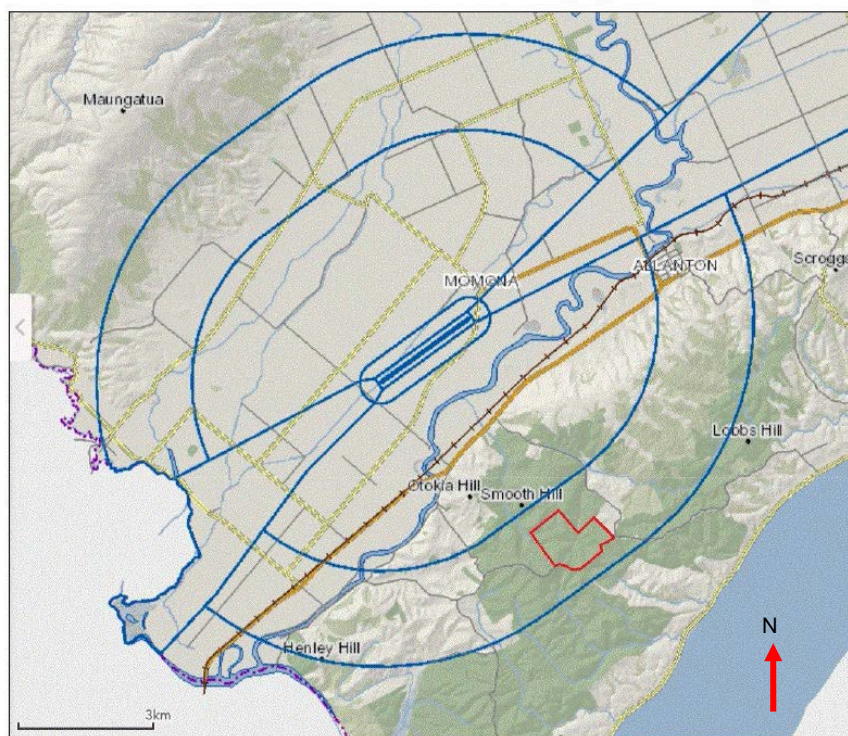


Figure 10. Dunedin Airport's flight fan (blue ovals) in relation to the proposed Smooth Hill site (red polygon). The two outer ovals are approximately 4 km and 6.2 km from the outer edge of the Airport's runway (blue rectangle).

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

⁴⁵ General aviation aircraft often fly at ~1000-2000 feet (~305-610 m) above the ground over the Smooth Hill site. Commercial aircraft departing to the south normally fly at ~2500 feet (~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 ~2000-4000 feet (~305-915 m) over the Smooth Hill site. Jets normally fly at ~6500-7500 feet (~1982-2286 m) above ground over the Smooth Hill site.

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 18. 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 <u>Traversing to or From the Taieri Plains</u>
Southern black-backed gull	Yes	Yes	Yes ⁴⁶
Red-billed gull	Yes	Yes	No
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 / 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. These practises include:

⁴⁶ Black-backed gulls may traverse at heights where they may potentially encounter aircraft.

- Good litter control;
- 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.

If birds develop a pattern of attraction to the landfill, additional 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 birds⁴⁷;
- 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; and
- Installing anti-roosting strips on buildings.

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 uses a variety of control methods that are 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 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).

⁴⁷ AB Lime covers waste material with lime material that make the food unpalatable to birds and deters them from foraging. Methylantranilate mixed with ProGuard SB is used at Crow Wing County landfill in Minnesota, USA.

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 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; P. Withers, *pers. comm.* February 19, 2020) and Kate Valley landfill in Teviotdale, north of Christchurch (R. Ward, *pers. comm.* February 24, 2020).

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 also highlighted as a key way to reduce bird numbers. Furthermore, whenever black-backed gulls are observed on site, a licensed shooter that 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 fired⁴⁸. An operational aspect that also reduces the attractiveness of the site to birds is daily movement of the active tip face. This means that waste is not pushed very far, which minimises open exposure to waste material.

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, as once they are established it is very difficult to get rid of them.
- 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 good bird monitoring, management and control (i.e. the implementation of the operational practises, control measures and insights noted above), 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:

⁴⁸ 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.

- 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 with the implementation of good landfill operational techniques, bird management, monitoring and control. 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 3,300 m³ in a 1% AEP (annual exceedance probability) storm event. 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 ha of (Yorkshire fog) - cocksfoot grassland (within or surrounding radiata pine) – gorse / (cocksfoot – Yorkshire fog) shrubland) in the designation site, and up to 4.07 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 Road and Big Stone Road 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 Lizard Management Plan (LMP) (see Section 6.0), which will include:

- 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;⁴⁹
- 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 salvage plan and habitat enhancement, the magnitude of effect on the wider populations is likely to be **Low** (*having a minor effect on the known population or range of the element / feature*) and, therefore, a **Low** level of ecological effect.

5.4 Freshwater Ecology

5.4.1 Habitat Loss

As described in Section 3.5, no freshwater ecology values 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.

⁴⁹ 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).

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 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 the Otokia Creek 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 technical report (GHD 2020) suggests in a worst-case scenario up to 50% of the existing annual runoff into the Otokia Creek Tributary is likely to be lost. The assessment also suggests that this change in annual runoff may 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). GHD predicts that this down-valley shift may be around 50 m, however, we assume this estimate is based on an assumption that the existing perennial flow transition point is at, or around, McLaren Gully Road (based on GHD's field observations). Our assessment on 11 June 2020 indicated that this transition point may be several hundred metres upstream from the road, and much of the c. 1 km of the Otokia Creek tributary from McLaren Gully Road to the designation site appeared to be perennial.

It is not possible to determine the magnitude of effect of this change on the ecology values until the extent of potential change (from perennial to intermittent or ephemeral reaches) is understood.

Based on the assumption that the shift from perennial to intermittent or ephemeral reaches is 50 m, this is expected to have a **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 Otokia 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.

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

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, we expect that sediment discharges to the Otokia Creek Tributary may be only a very slight change from the existing baseline condition (i.e. **Negligible** magnitude of effect), 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.

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

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 matting⁵⁰); keeping refilling / refuelling of machinery outside of / away from flow paths to waterways.

5.5 Overall Summary of Ecological of Effects

A summary of the overall levels of ecological effects, without mitigation, 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 does not take into account mitigation that has been identified through this assessment (Section 9).

⁵⁰ We recommend that fully biodegradable options are used to avoid plastic remnants remaining in the environment.

Table 19. Assessment of levels of effects without mitigation. 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 – rautahi – Yorkshire–fog) - cocksfoot / watercress – floating sweetgrass grassland	Moderate	Low	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) – wiwi / cocksfoot 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
• Downstream Effects on Wetlands	Moderate	Low – Moderate	Low – Moderate
Avifauna			
• Habitat loss - 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 falcon during the breeding season (construction)	Moderate	Low ⁵¹	Low
• Disturbance, displacement and mortality of native, Not Threatened birds during the breeding season (construction)	Low	Negligible	Very Low
• Disturbance and displacement of falcon (operation)	Moderate	Negligible	Very Low
• Disturbance and displacement of native, Not Threatened birds (operation)	Low	Negligible	Very Low

⁵¹ The magnitude of effect is only Low if birds are nesting. If they are not nesting the magnitude of effect would be Negligible.

Ecosystem Component	Ecological Value	Magnitude of Effect	Level of Effect
<ul style="list-style-type: none"> Increased egg and chick predation (falcon) 	Moderate	Negligible	Very Low
<ul style="list-style-type: none"> Increased nesting bird, egg and chick predation (native, Not Threatened species) 	Low	Negligible	Very Low
<ul style="list-style-type: none"> Strike risk with aircraft (black-backed gull) 	Low	Negligible ⁵²	Very Low
<ul style="list-style-type: none"> Strike risk with aircraft (native, Not Threatened waterfowl and shag species) 	Low	Negligible ⁵²	Very Low
<ul style="list-style-type: none"> Strike risk with aircraft (At Risk – Recovering or Naturally Uncommon waterfowl and shag species) 	Moderate	Negligible ⁵²	Very Low
Herpetofauna			
<ul style="list-style-type: none"> Southern grass skink 	High	Low ⁵³	Low
<ul style="list-style-type: none"> Jewelled gecko 	High	Negligible ⁵³	Low
<ul style="list-style-type: none"> McCann's skink 	Low	Negligible ⁵³	Very Low
Freshwater			
<ul style="list-style-type: none"> Habitat loss – freshwater fish and crayfish 	Moderate ⁵⁴	Negligible ⁵⁵	Very Low
<ul style="list-style-type: none"> Discharge of sediments / 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*

⁵² 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.

⁵³ 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.

⁵⁴ This is based on the precautionary principle that migratory species such as eels and banded kokopu may be present on site. It assumes that Nationally Threatened species are not present in the waterway.

⁵⁵ Given that GHD's assessment predicts that the perennial reaches may shift downstream by 50 m only.

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 that have been identified as significant, including wetlands, are cleared for construction of the landfill, mitigation is 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.
- 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 equivalence⁵⁶’. 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 vehicle or machinery movements in areas of indigenous vegetation outside the ultimate footprint of works, to minimise unnecessary impacts to

⁵⁶ See New Zealand Government (2014). *Guidance on good practice biodiversity offsetting in New Zealand*. New Zealand Government.

areas of vegetation that are within the designation site but not within the final landfill footprint.

- 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.
- Avoid as much as possible road widening that encroaches on wetland vegetation ((rautahi – Yorkshire fog) - cocksfoot / watercress – floating sweetgrass grassland on either side of McLaren Gully Road, and (pūrei) – wiwi / cocksfoot rushland north of the road in an area immediately above where the valley floor marsh wetland draining the designation site meets McLaren Gully Road). At present, the overlap between the proposed road widening footprint and wetland vegetation is minor in most places and may be able to be avoided by extending road cuts / fill to the north or south as required, or by contracting the road footprint.

Avifauna

- Avoid or minimise construction effects on falcon potentially nesting at the site, as detailed in a Falcon Management Plan. The Falcon Management Plan is to be prepared by a suitably qualified ecologist and should include, but is not limited to, the time of year to avoid construction (falcon breeding season) 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/s⁵⁷. When developing the Falcon Management Plan, it is recommended that relevant stakeholders are consulted, including a suitably qualified ornithologist⁵⁷.

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 between Gully 2 and 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.

⁵⁷ 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.

Freshwater

- Avoid changes to the extent of perennial reaches of waterway along the Otokia 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).
- Remediating impacts to some terrestrial vegetation types due to landfill construction 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 Lizard Management Plan (see section 6.3).

6.3 Mitigation

Terrestrial Vegetation and Wetlands

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 – rautahi – Yorkshire fog) – 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.

In addition, regional and district rules require no net loss (and preferably net gain) of areas that have been identified as wetlands, significant vegetation or significant habitats for indigenous fauna. The vegetation types that are identified as significant, and for which 'no net loss' must be achieved, are those listed above.

Wetland Habitats

An area of around 0.99 ha of total wetland vegetation will be cleared by landfill construction and road widening. Of this, c.0.5 ha is within the designation site. The three vegetation types

affected have an average of around 50% canopy cover of indigenous vegetation⁵⁸ and are generally in poor condition with abundant exotic weeds.

Where impacts are within the designation site, mitigation should occur as near as possible to the areas impacted (i.e. in the remaining swamp wetland, in East Gully, and in similar habitats elsewhere within the designation site and adjoining DCC land).

Effects due to widening of McLaren Gully and Big Stone Roads and any effects on downstream wetlands 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 Gully and Big Stone Roads and downstream of the designation site (see Section 6.4).

To mitigate these ecological impacts and achieve 'no net loss' of significant wetland habitat impacted by landfill construction, a Wetland Restoration Plan should be prepared by a suitably qualified and experienced ecologist, with input as required from project engineers and other specialists. This Plan should outline a process in which:

- An area of wetland habitat greater than 50% of that which will be lost within the designation site⁵⁹ should be created (i.e. >0.25 ha); or
- Existing areas greater than 100% of the size (i.e. >0.5 ha, containing similar species composition and habitat pattern) should be substantially enhanced by weed control, fencing, in-fill planting, and pest control to achieve c.100% indigenous vegetation cover.
- If practical, a combination of enhancement and creation methods could be used (to achieve an additional >0.5 ha of new indigenous wetland vegetation in the remaining wetland areas);
- Wetland creation could include expansion of existing wetland habitat by remediation and expansion of habitat surrounding the stormwater attenuation basin, or outside the landfill footprint in East Gully. This could involve incorporating the stormwater attenuation basin as an ephemeral open water area forming part of an overall constructed wetland. If this is not practical for operational reasons, gully toes or the area below the stormwater attenuation basin could be bunded to increase the area where water is retained in soils. This would provide appropriate conditions for expansion of flaxland and other wetland types. Newly created wetlands should be fenced to exclude browsing animals and plant and animal pests controlled (see below for further details).
- Wetland enhancement could also occur further from the landfill footprint (e.g. suitable wetland areas exist in East Gully and in an area of land that will be acquired by DCC, just west of the designation).
- Both wetland creation and wetland enhancement would likely involve:
 - Planting appropriate structurally dominant species (harakeke, pūrei, rautahi, swamp kiokio, prickly shield fern, mikimiki). Plantings should be of appropriately eco-sourced specimens free from weeds;
 - Fencing wetlands to exclude wandering stock and feral browsing animals (deer, goats, pigs); and
 - Weed and predator control in wetland areas. Weed and predator control should be ongoing within the landfill lifetime and carried out at sufficient intervals to

⁵⁸ Some variability exists between different areas of similar vegetation, but the overall 50% figure is conservative.

⁵⁹ The area of wetland habitat to be enhanced does not need to be the same size as what is lost because only ~50% of the vegetation cover is indigenous, and 2GP / RPS rules state that no net loss applies to indigenous biodiversity values.

effect zero or near-zero density of mammalian predators and weedy tree, shrub and vine species (especially pines, gorse, crack willow).

Wetland restoration techniques have been used in construction and conservation projects for decades but require careful design to ensure that the wetland hydrology is appropriate for the intended habitat type being created (in this case marsh and swamp, with a permanently high-water table and small pockets of standing water). The species present in the wetland habitats to be created / enhanced are relatively straightforward to propagate and relatively fast growing. Thus, it is considered that mitigation by creation of c.0.25 ha of new habitat, or enhancement of an effectively equivalent area to that lost (i.e. 0.5 ha) with appropriate planting and weed control as described above, will achieve no net loss (or net gain) in wetland habitat in the vicinity of the landfill area, for effects within the landfill designation.

Effects outside the designation require an additional offset (see Section 6.4).

Treeland Habitats

A total area of c.4.5 ha will be cleared, which has roughly 50% canopy cover of indigenous vegetation and is in poor condition with abundant exotic weeds. To mitigate this ecological impact and achieve 'no net loss' of significant treeland habitat impacted by construction (the [large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland in West Gully 4), a Terrestrial Vegetation Restoration Plan should be prepared by an ecologist, with input as required from project engineers and other specialists, which should consider the following matters:

- An area of the treeland habitat greater than 50% of that will be lost (>2.25 ha) should be created by expansion of existing forest areas, and the overall expanded and original forest area should be substantially enhanced by weed control, fencing, in-fill planting, and predator control. Because there will likely be a >decade delay in the establishment of new plantings, and a delay in the response of existing vegetation to pest / weed control efforts, this process should begin during stage 1 of landfill construction, so that an equivalent or greater than like-for-like area of habitat is available for indigenous species prior to vegetation clearance in West Gully 4 during stage 4 and 5.
- Because non-indigenous vegetation in West Gully 4 contributes somewhat to the overall habitat for indigenous avifauna, both mitigation steps (expansion of forest, and enhancement of existing forest) are considered necessary to mitigate the loss of habitat, rather than accounting only for the net area of indigenous vegetation lost.
- Creation of treeland / forest habitat by expansion of the existing forest habitat immediately outside the construction footprint, between West Gully 2 and West Gully 3. This could involve:
 - Clearing pine, gorse, broom and other exotic trees, shrubs and exotic vines in the cutover area between / surrounding West Gully 2 and 3, as much as is required for plantings⁶⁰ (described below) across an area at least half of that lost in West Gully 4;
 - Retaining existing indigenous trees and shrubs that are already spreading beyond existing kānuka forest patches in these areas;
 - Planting appropriate species (e.g. kōtukutuku, makomako, māhoe, tī kōuka, putaputaweta) which can rapidly form a canopy of indigenous species. Natural regeneration of understory species including fern species is acceptable and

⁶⁰ Gorse in particular is impractical to clear and can provide nursery habitat during the growth of plantings.

planting of understory species may not be successful until a closed canopy is achieved. Plantings should be of appropriately eco-sourced specimens free from weeds;

- Fencing to exclude wandering stock and feral browsing animals; and
- Weed and predator control (see recommendations in section 6.5 below) within the existing forest patches and in new planting areas. Weed and predator control should be ongoing within the landfill lifetime and carried out at sufficient intervals to effect zero or near-zero density of mammalian predators and problematic weedy tree, shrub and vine species.

It is likely that populations of indigenous bird and lizard species currently utilising habitats in West Gully 4 are limited by predation, low habitat quality, and the lack of large forest patches in the immediate area. In this context, expansion and / or enhancement of existing habitats (as described above) provides an acceptable and equivalent, or better outcome, in the short to the long-term, with regards to habitat availability and habitat quality for indigenous bird and lizard species. As part of this process, the opportunity exists to introduce tree species that would formerly have been found in the designation site, such as Halls tōtara, matai, small-leaved kowhai, and narrow-leaved houhere, and successful introduction of these species in an expanded area of closed-canopy indigenous forest would constitute an ecological net gain in the long term (>50 years).

Grassland Habitats

It is considered that the recommendations made elsewhere in this report with respect to avoidance of adverse effects on indigenous lizards (see Sections 5.3 and below) are sufficient to effect 'no net loss' of lizard habitat and herpetofauna ecological values in the context of this project.

Plantation forestry

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 in this habitat type in the context of this project.

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 Lizard Management Plan should be prepared by an ecologist, with input as required from project engineers and other specialists. This Plan should cover any avoidance, remediation, mitigation and monitoring that may be carried out in association with the construction of the landfill. This will also cover 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 prior to areas of identified potential lizard habitat⁶¹ is cleared, including (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub community); (Yorkshire fog) - cocksfoot grassland (bordering / within

⁶¹ With the exception of the kānuka forest in Gully 3, as this is likely to remain intact.

radiata pine) – gorse / (cocksfoot – Yorkshire fog) shrubland); 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 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 large area of enhanced indigenous habitats. The exact relocation site location (whether inside or outside the designation area) will be identified and outlined in the Lizard Management Plan.
- An appropriate Predator Control Programme is to be designed and implemented within the designation site to prevent large scale influx of rodents and mustelids prior to the construction on site, which includes focusing on areas which are likely to remain, such as Gully 2 and 3. Lizards are acutely threatened by mice and rats, as well as mustelids such as weasels and stoats. We recommend that ongoing trapping is implemented in these areas.

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

The loss of up to c.0.5 ha of wetland habitat outside the designation area, due to the widening of McLaren Gully and Big Stone Roads cannot be mitigated at the point of impact (the areas are on private land) and an ecological offset is required. The offset for the loss of grassland and rushland wetland vegetation types could occur via expansion and enhancement of existing wetlands as described in Section 6.3.

It is generally considered appropriate to account conservatively for habitat loss when applying ecological offset, to ensure no net loss or a net gain. Therefore, although only c.50% of the vegetation in these wetland areas to be lost is indigenous, we recommend an equivalent area to that lost should be created (i.e. c.0.5 ha). Alternatively, an existing area twice the size of that lost (i.e. c.1.2 ha) could be enhanced to offset the effects of road construction.

We note that the 0.5 ha amount may be an overestimate as the indicative footprint of the proposed road widening in the plans currently available may be greater than what is actually required. Therefore, the precise requirements for wetland offsetting would be refined based upon final designs for the road widening footprint.

Where substantial loss of downstream wetland habitat (described in Section 5.1.4, noting that the potential effects on these downstream habitats are highly uncertain) is detected by monitoring (see Section 6.6), this would also require a further offset of an equal area to that lost (as described above and in Section 6.3) to ensure no net loss and preferably a net gain.

The Wetland Restoration Plan, to be prepared by a suitably qualified and experienced ecologist should detail the wetland offsetting required to achieve 'no net loss'. This Plan should follow the best practice recommendations for offsetting (in Roper-Lindsay et al. 2018, New Zealand Government 2014) to ensure that the offset design appropriately accounts for the type of wetland habitat lost, for the dominant indigenous plant species in the existing wetland (and numbers), and for the indigenous fauna species and their population sizes that the existing and offset habitat (will) support(s). As described in Section 6.3, the relevant indigenous species in these habitats are relatively fast growing and easy to propagate. Therefore, the likelihood of successful implementation of this offset (in terms of recreating similar habitat, in better condition) is considered high.

6.5 Other

- Implementation of an ongoing Predator Control Programme 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 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 Bird Management Plan must be adhered to in order to minimise bird numbers at the landfill site. 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 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 should be contained within the Wetland Restoration Plan and the Terrestrial Vegetation Restoration Plan.

Herpetofauna

- Success of lizard translocations should be monitored for up to 5 years following translocation.

Freshwater Ecology and Downstream Wetlands

- 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, 4, 5, and 6. 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' and levels of effect that are assessed as being greater than 'very low.'

Table 20. 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
Terrestrial and Wetland Ecosystems and Habitats				
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.
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.

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
Downstream effects on wetlands below designation site	A reduction in groundwater and runoff from the designation site may affect the 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 is possible. No net loss, or net gain, is required.	A Wetland Restoration Plan, which outlines steps to enhance existing wetland habitat, ideally in downstream / nearby wetland areas, should be prepared and implemented prior to or during landfill construction. 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 impact on the valley floor marsh wetland.	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).	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 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	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,	Expansion and enhancement of treeland would ideally occur between West Gully 2 and 3 to link existing indigenous forest patches and take into account	The habitat types lost are degraded by weeds and pests, and implementation of an appropriate Terrestrial Vegetation

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, or net gain, is required.	weed and pest control, and monitoring, and is considered likely to be successful.	natural spread of native seedlings.	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).
Grassland vegetation that provides lizard habitat	See below in Herpetofauna section of table.	See below in Herpetofauna section of table.	See below in Herpetofauna section of table.	See below in Herpetofauna section of table.
Plantation forestry	See below in Herpetofauna section of table.	See below in Herpetofauna section of table.	See below in Herpetofauna section of table.	See below in Herpetofauna section of table.
Avifauna				
Falcon	Disturbance, displacement and mortality ⁶² of falcon during the breeding season (construction)	Preparation of a Falcon Management Plan. This plan should include, but is not limited to, the time of year to avoid construction (falcon breeding season) 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	Across site.	There will be negligible residual effects after correct implementation of the Falcon Management Plan.

⁶² There is only a potential mortality risk if falcon are nesting on site.

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
		until nesting activities are completed).		
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). Some areas of vegetation that are proposed to be cleared for landfill construction represent typical habitat for this species. All native lizard species are absolutely protected under the Wildlife Act 1953.	A Lizard Management Plan must be prepared and implemented. This plan would manage effects on lizards primarily by salvage and translocation away from the site of impact, and through predator control efforts as part of the Pest Management Programme.	Whether lizard translocation / habitat enhancement is required is dependent upon the as-yet unknown population size and current locations of lizards.	There will be negligible residual effects after correct implementation of the Lizard Management Plan.
Freshwater ecology				
Downstream effects on Otokia 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 highly uncertain. Changes to perennial reaches would result in a loss of habitat for freshwater species, potentially including freshwater fish and freshwater crayfish.	Adaptive management may be required to 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.	Enhancement of freshwater habitat 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.	Monitoring of loss / shift of perennial 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 designation site at the Smooth Hill landfill 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.
- 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 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 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 (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.
- Otokia 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. No fish were found in June 2020, but this waterway may support species such as eels, banded kokopu and freshwater crayfish.
- Otokia Creek catchment is known to support a variety of freshwater fishes, including *At Risk – Declining* species.

Effects of landfill construction and road widening

- Landfill construction and clearance of vegetation types present represents negligible or very low magnitudes of 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, but RPS and 2GP rules require 'no net loss' or 'net gain' of the significant ecological values of these habitats.
- Preparation and implementation of a Wetland Restoration Plan and a Terrestrial Vegetation Plan by a suitably qualified and experienced ecologist is required to mitigate (or offset, as applicable) the adverse effects of landfill construction and road widening (vegetation clearance) and potential downstream effects on wetlands 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, 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 managed⁶³ to:
 - Mitigate any wetland loss in that area; and
 - 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 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 a Pest Management Programme is required.
- As the proposed landfill is located close to the Dunedin International Airport, a separate 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. Preparation and

⁶³ 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.

implementation of a brief 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 Lizard Management Plan developed and implemented. This plan would describe 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 Pest Management Programme.
- This report has recommended that plantings of indigenous treeland / forest and grassland (for lizard habitat) are required to mitigate the ecological effects of landfill construction and road widening. A single location for these areas has been recommended, incorporating slopes between West Gully 1 and 3 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, it is suggested that wetland habitat enhancement, due to a need to incorporate naturally wet areas, would occur in East Gully (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).

9.0 References

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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 below⁶⁴.

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

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

⁶⁴ Note that complete plant species lists for the macrocarpa forest and the (large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub in West Gully 1 within the designation site were not recorded. These areas, described in section 3.2.1 of this report, are dominated by exotic species, and 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
<i>Dactylis glomerata</i>	Cocksfoot	Grass	Exotic	
<i>Digitalis purpurea</i>	Foxglove	Dicot Herb	Exotic	
<i>Eleocharis acuta</i>	Sharp spike sedge	Sedge	Indigenous non-endemic	Not Threatened
<i>Epilobium atriplicifolium</i>	Willowherb	Dicot Herb	Indigenous endemic	Not Threatened
<i>Epilobium pallidiflorum</i>	Tarawera, Swamp willow herb	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Erythranthe guttata</i>	Monkey musk	Dicot Herb	Exotic	
<i>Glyceria flutians</i>	Floating sweetgrass	Grass	Exotic	
<i>Histiopteris incisa</i>	Mata, water fern	Fern	Indigenous non-endemic	Not Threatened
<i>Holcus lanatus</i>	Yorkshire fog	Grass	Exotic	
<i>Hypochaeris radicata</i>	Cats ear	Dicot Herb	Exotic	
<i>Isolepis inundata</i>	Clubrush	Sedge	Indigenous non-endemic	Not Threatened
<i>Juncus bulbosus</i>	Bulbous rush	Rush	Exotic	
<i>Juncus edgariae</i>	Wiwi, Edgars rush	Rush	Indigenous endemic	Not Threatened
<i>Juncus effusus</i>	Soft rush	Rush	Exotic	
<i>Leycesteria formosa</i>	Himalayan honeysuckle	Grass	Exotic	
<i>Malva sp.</i>	Mallow	Dicot Herb	Exotic	
<i>Muehlenbeckia australis</i>	Large-leaved pohuehue	Liane	Indigenous non-endemic	Not Threatened
<i>Nasturtium officinale</i> OR <i>Nasturtium microphyllum</i>	Watercress	Dicot Herb	Exotic	
<i>Parablechnum montanum</i>	Kiokio, hard fern	Fern	Indigenous endemic	Not Threatened
<i>Phormium tenax</i>	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
<i>Polystichum vestitum</i>	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
<i>Rubus fruticosus</i> agg.	Blackberry	Shrub	Exotic	
<i>Rumex acetosella</i>	Sheep's sorrel;	Dicot Herb	Exotic	
<i>Rumex obtusifolius</i>	Dock	Dicot Herb	Exotic	
<i>Ranunculus multiscapus</i>	Grassland buttercup	Dicot Herb	Indigenous endemic	Not Threatened

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

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

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
<i>Agrostis capillaris</i>	Browntop	Grass	Exotic	
<i>Aristotelia serrata</i> *	Makomako	Tree	Indigenous endemic	Not Threatened
<i>Austroblechnum penna-marina</i>	Little hard fern	Fern	Indigenous non-endemic	Not Threatened
<i>Carex coriacea</i>	Cutty grass	Sedge	Indigenous endemic	Not Threatened
<i>Carex geminata</i>	Cutty grass	Sedge	Indigenous endemic	Not Threatened
<i>Carex secta</i>	Pūrei	Sedge	Indigenous non-endemic	Not Threatened
<i>Carex flagellifera</i>	Trip me up	Sedge	Indigenous endemic	Not Threatened
<i>Carex leporina</i>	Oval sedge	Sedge	Exotic	
<i>Carex</i> sp. (<i>C. dipsacea</i> ?)	Teasel sedge?	Sedge	Indigenous endemic	Not Threatened
<i>Carex uncinata</i>	Kamu, hook sedge	Sedge	Indigenous endemic	Not Threatened
<i>Cirsium arvense</i>	Californian thistle	Dicot herb	Exotic	

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

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Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Ulex europaeus</i>	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
<i>Adiantum cunninghamii</i>	Maidenhair fern	Fern	Indigenous endemic	Not Threatened
<i>Aristotelia serrata</i>	Makomako, wineberry	Tree	Indigenous endemic	Not Threatened
<i>Asplenium bulbiferum</i>	Pikopiko, hen and chicken fern	Fern	Indigenous endemic	Not Threatened
<i>Carex coriacea</i>	Cutty grass	Sedge	Indigenous endemic	Not Threatened
<i>Carpodetus serratus</i>	Marbleleaf	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Cirsium arvense</i>	Californian thistle	Dicot Herb	Exotic	
<i>Coprosma foetidissima</i>	Stinkwood	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Coprosma lucida</i>	Shining karamu	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Coprosma rotundifolia</i>	Round-leaved coprosma	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Cordyline australis</i>	Cabbage tree	Tree	Indigenous endemic	Not Threatened
<i>Cranfillia fluviatillis</i>	Kiwakiwa, creek fern	Fern	Indigenous non-endemic	Not Threatened
<i>Cytisus scoparius</i>	Scotch broom	Shrub	Exotic	
<i>Dactylis glomerata</i>	Cocksfoot	Grass	Exotic	
<i>Dicksonia squarrosa</i>	Rough tree fern	Fern	Indigenous endemic	Not Threatened
<i>Fuchsia excorticata</i>	Tree fuchsia	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Holcus lanatus</i>	Yorkshire fog	Grass	Exotic	
<i>Kunzea robusta</i>	Kānuka	Tree or Shrub	Indigenous endemic	Threatened – Nationally Vulnerable
<i>Lastreopsis hispida</i>	Hairy fern	Fern	Indigenous endemic	Not Threatened
<i>Leycesteria formosa</i>	Himalayan honeysuckle	Shrub	Exotic	

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Lomaria discolor</i>	Crown fern	Fern	Indigenous endemic	Not Threatened
<i>Melicytus ramiflorus</i>	Māhoe	Tree or Shrub	Indigenous non-endemic	Not Threatened
<i>Microsorium pustulatum</i>	Kowaowao, hounds tongue fern	Fern	Indigenous non-endemic	Not Threatened
<i>Muelenbeckia australis</i>	Large-leaved pohuehue	Liane	Indigenous non-endemic	Not Threatened
<i>Parablechnum procerum</i>	Small kiokio	Fern	Indigenous non endemic	Not Threatened
<i>Parablechnum montanum</i>	Kiokio, hard fern	Fern	Indigenous endemic	Not Threatened
<i>Parapolystichum glabellum</i>	Smooth shield fern	Fern	Indigenous endemic	Not Threatened
<i>Phormium tenax</i>	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
<i>Pneumatopteris pennigera</i>	Gully fern	Fern	Indigenous endemic	Not Threatened
<i>Polystichum neozelandicum</i> subsp. <i>zerophyllum</i>	Black shield fern	Fern	Indigenous endemic	Not Threatened
<i>Polystichum vestitum</i>	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
<i>Pseudopanax arboreus</i>	Whauwhaupaku, five-finger	Tree	Indigenous endemic	Not Threatened
<i>Pseudowintera colorata</i>	Horopito, pepper tree	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Pteridium esculentum</i>	Rarauhe, bracken fern	Fern	Indigenous non-endemic	Not Threatened
<i>Ranunculus repens</i>	Creeping buttercup	Dicot Herb	Exotic	
<i>Ripogonum scandens</i>	Kareao, supplejack	Liane	Indigenous endemic	Not Threatened
<i>Rubus cissoides</i>	Bush lawyer	Liane	Indigenous endemic	Not Threatened
<i>Rubus squarrosus</i>	Leafless bush lawyer	Liane	Indigenous endemic	Not Threatened
<i>Schefflera digitata</i>	Pate, seven-finger	Tree	Indigenous endemic	Not Threatened
<i>Solanum laciniatum</i>	Popoporo	Shrub	Indigenous non-endemic	Not Threatened
<i>Stellaria parviflora</i>	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
<i>Aristotelia serrata</i>	Makomako, wineberry	Tree	Indigenous endemic	Not Threatened
<i>Asplenium bulbiferum</i> or <i>Asplenium gracillimum</i>	Pikopiko, hen and chicken fern	Fern	Indigenous endemic	Not Threatened
<i>Carex coriacea</i>	Rautahi, Cutty grass	Sedge	Indigenous non-endemic	Not Threatened
<i>Cirsium arvense</i>	Californian thistle	Dicot Herb	Exotic	
<i>Cirsium vulgare</i>	Scotch thistle	Dicot Herb	Exotic	
<i>Coprosma propinqua</i>	Mikimiki	Shrub	Indigenous endemic	Not Threatened
<i>Coprosma rotundifolia</i>	Round leaved coprosma	Shrub	Indigenous endemic	Not Threatened
<i>Cordyline australis</i>	Cabbage tree, ti kouka	Tree	Indigenous endemic	Not Threatened
<i>Crataegus monogyna</i>	Hawthorn	Tree	Exotic	
<i>Cyathea colensoi</i>	Rough tree fern	Fern	Indigenous endemic	Not Threatened
<i>Cytisus scoparius</i>	Scotch broom	Shrub	Exotic	
<i>Dactylis glomerata</i>	Cocksfoot	Grass	Exotic	
<i>Dicksonia squarrosa</i>	Rough tree fern	Fern	Indigenous endemic	Not Threatened
<i>Erythranthe guttata</i>	Monkey musk	Dicot Herb	Exotic	
<i>Fuchsia excorticata</i>	Tree fuchsia	Tree	Indigenous endemic	Not Threatened
<i>Galium aparine</i>	Cleavers	Dicot Herb	Exotic	
<i>Griselinia littoralis</i>	Broadleaf	Tree	Indigenous endemic	Not Threatened
<i>Hebe salicifolia</i>	Koromiko	Shrub	Indigenous non-endemic	Not Threatened
<i>Hypolepis ambigua</i>	Pig fern	Fern	Indigenous endemic	Not Threatened
<i>Leptospermum scoparium</i>	Mānuka	Tree	Indigenous endemic	At Risk - Declining
<i>Leycesteria formosa</i>	Himalayan honeysuckle	Shrub	Exotic	
<i>Jacobaea vulgaris</i>	Ragwort	Dicot Herb	Exotic	
<i>Kunzea robusta</i>	Kānuka	Tree	Indigenous endemic	Threatened - Nationally Vulnerable

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Melicytus ramiflorus</i>	Māhoe, whiteywood	Tree	Indigenous endemic	Not Threatened
<i>Muehlenbeckia australis</i>	Large-leaved pohuehue	Shrub	Indigenous non-endemic	Not Threatened
<i>Parablechnum montanum</i>	Kiokio, mountain hard fern	Fern	Indigenous endemic	Not Threatened
<i>Phormium tenax</i>	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
<i>Pinus radiata</i>	Radiata pine	Tree	Exotic	
<i>Pittosporum euginiodes</i>	Tarata, lemonwood	Shrub	Indigenous endemic	Not Threatened
<i>Polystichum vestitum</i>	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
<i>Pteridium exculentum</i>	Rarauhe, bracken fern	Fern	Indigenous non-endemic	Not Threatened
<i>Solanum laciniatum</i>	Poroporo	Tree	Indigenous non-endemic	Not Threatened
<i>Ulex europaeus</i>	Gorse	Shrub	Exotic	

Table A1-5. Species found in the Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland (cutover pine forest)⁶⁵.

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Agrostis capillaris</i>	Yorkshire fog	Grass	Exotic	
<i>Aristotelia serrata</i>	Makomako, wineberry	Tree	Indigenous endemic	Not Threatened
<i>Carex coriacea</i>	Cutty grass	Sedge	Indigenous endemic	Not Threatened
<i>Carex breviculmis</i>	Grassland sedge	Sedge	Indigenous non-endemic	Not Threatened
<i>Centella uniflora</i>	Centella	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Cirsium arvense</i>	Californian thistle	Dicot Herb	Exotic	
<i>Coprosma dumosa</i>	Mikimiki	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Coprosma lucida</i>	Shining karamu	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Coprosma rotundifolia</i>	Round-leaved coprosma	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Cordyline australis</i>	Cabbage tree	Tree	Indigenous endemic	Not Threatened

⁶⁵ Not all exotic species were recorded.

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Cupressus macrocarpa</i>	Macrocarpa	Tree	Exotic	
<i>Cytisus scoparius</i>	Scotch broom	Shrub	Exotic	
<i>Dactylis glomerata</i>	Cocksfoot	Grass	Exotic	
<i>Digitalis purpurea</i>	Foxglove	Dicot Herb	Exotic	
<i>Epilobium atriplicifolium</i>	Willowherb	Dicot Herb	Indigenous endemic	Not Threatened
<i>Epilobium pallidiflorum</i>	Tarawera, Swamp willow herb	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Epilobium species</i>	Willowherb	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Erigeron sumatrensis</i>	Fleabane	Dicot Herb	Exotic	
<i>Erythranthe guttata</i>	Monkey Musk	Grass	Exotic	
<i>Eucalyptus sp.</i>	Eucalyptus	Tree	Exotic	
<i>Fuchsia excorticata</i>	Tree fuchsia	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Histiopteris incisa</i>	Mata, water fern	Fern	Indigenous non-endemic	Not Threatened
<i>Holcus lanatus</i>	Yorkshire fog	Grass	Exotic	
<i>Hypochaeris radicata</i>	Cats ear	Dicot Herb	Exotic	
<i>Isolepis inundata</i>	Clubrush	Sedge	Indigenous non-endemic	Not Threatened
<i>Juncus articulatus</i>	Jointed rush	Rush	Exotic	
<i>Juncus bufonius</i>	Toad rush	Rush	Exotic	
<i>Juncus bulbosus</i>	Bulbous rush	Rush	Exotic	
<i>Juncus conglomeratus</i>	Soft rush	Rush	Exotic	
<i>Juncus edgariae</i>	Wiwi, Edgars rush	Rush	Indigenous endemic	Not Threatened
<i>Juncus effusus</i>	Soft rush	Rush	Exotic	
<i>Kunzea robusta</i>	Kānuka	Tree or Shrub	Indigenous endemic	Threatened – Nationally Vulnerable
<i>Leycesteria formosa</i>	Himalayan honeysuckle	Grass	Exotic	
<i>Malva sp.</i>	Mallow	Dicot Herb	Exotic	
<i>Melicytus ramiflorus</i>	Māhoe	Tree or Shrub	Indigenous non-endemic	Not Threatened

Appendix 1: Plant Species List

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Microsorium pustulatum</i>	Kowaowao, hounds tongue fern	Fern	Indigenous non-endemic	Not Threatened
<i>Muehlenbeckia australis</i>	Large-leaved pohuehue	Liane	Indigenous non-endemic	Not Threatened
<i>Nasturtium officinale</i> OR <i>Nasturtium microphyllum</i>	Watercress	Dicot Herb	Exotic	
<i>Phormium tenax</i>	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
<i>Pinus radiata</i>	Radiata pine	Tree	Exotic	
<i>Polystichum vestitum</i>	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
<i>Pteridium esculentum</i>	Rarauhe, bracken fern	Fern	Indigenous non-endemic	Not Threatened
<i>Prunella vulgaris</i>	Selfheal	Dicot Herb	Exotic	
<i>Ranunculus multiscapus</i>	Grassland buttercup	Dicot Herb	Indigenous endemic	Not Threatened
<i>Ranunculus repens</i>	Creeping buttercup	Dicot Herb	Exotic	
<i>Rubus cissoides</i>	Bush lawyer	Liane	Indigenous endemic	Not Threatened
<i>Rubus fruticosus</i>	Blackberry	Shrub	Exotic	
<i>Rumex acetosella</i>	Sheep's sorrel	Dicot Herb	Exotic	
<i>Rumex obtusifolius</i>	Dock	Dicot Herb	Exotic	
<i>Senecio minimus</i>	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Senecio quadridentatus</i>	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Senecio vulgaris</i>	Groundsel	Dicot Herb	Exotic	
<i>Solanum laciniatum</i>	Poroporo	Shrub	Indigenous non-endemic	Not Threatened
<i>Sonchus asper</i>	Sow thistle	Dicot Herb	Exotic	
<i>Sonchus oleraceus</i>	Sow thistle	Dicot Herb	Exotic	
<i>Trifolium repens</i>	Clover	Dicot Herb	Exotic	
<i>Ulex europaeus</i>	Gorse	Shrub	Exotic	
<i>Verbascum thapsus</i>	Woolly mullein	Dicot Herb	Exotic	
<i>Verbascum virgatum</i>	Moth mullein	Dicot Herb	Exotic	

Table A1-6. Species found in (Yorkshire fog) – cocksfoot grassland⁶⁶ (in areas alongside roads, and in some other locations generally at the border of other vegetation types within the designation area).

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Acaena species</i>	Bidibid	Dicot Herb	Indigenous	
<i>Achillea millefolium</i>	Yarrow	Dicot Herb	Exotic	
<i>Agrostis capillaris</i>	Yorkshire fog	Grass	Exotic	
<i>Alopecurus species</i>		Grass	Exotic	
<i>Aristotelia serrata</i>	Makomako, wineberry	Tree	Indigenous endemic	Not Threatened
<i>Austroderia richardii</i>	Toitoi	Grass	Indigenous endemic	Not Threatened
<i>Cirsium arvense</i>	Californian thistle	Dicot Herb	Exotic	
<i>Cirsium vulgare</i>	Scotch thistle	Dicot Herb	Exotic	
<i>Coprosma dumosa</i>	Mikimiki	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Cordyline australis</i>	Cabbage tree	Tree	Indigenous endemic	Not Threatened
<i>Crataegus monogyna</i>	Hawthorn	Tree	Exotic	
<i>Crepis capillaris</i>	Smooth Hawksbeard	Dicot Herb	Exotic	
<i>Cupressus macrocarpa</i>	Macrocarpa	Tree	Exotic	
<i>Cytisus scoparius</i>	Scotch broom	Shrub	Exotic	
<i>Dactylis glomerata</i>	Cocksfoot	Grass	Exotic	
<i>Digitalis purpurea</i>	Foxglove	Dicot Herb	Exotic	
<i>Epilobium atriplicifolium</i>	Willowherb	Dicot Herb	Indigenous endemic	Not Threatened
<i>Epilobium species</i>	Willowherb	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Erigeron sumatrensis</i>	Fleabane	Dicot Herb	Exotic	
<i>Erythranthe guttata</i>	Monkey Musk	Grass	Exotic	
<i>Eucalyptus sp.</i>	Eucalyptus	Tree	Exotic	

⁶⁶ Not all exotic species were recorded.

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Fuchsia excorticata</i>	Tree fuchsia	Tree or Shrub	Indigenous endemic	Not Threatened
<i>Galium aparine</i>	Cleavers	Dicot Herb	Exotic	
<i>Histiopteris incisa</i>	Mata, water fern	Fern	Indigenous non-endemic	Not Threatened
<i>Holcus lanatus</i>	Yorkshire fog	Grass	Exotic	
<i>Hypochaeris radicata</i>	Cats ear	Dicot Herb	Exotic	
<i>Hypolepis ambigua</i>	Pig fern	Fern	Indigenous	
<i>Ilex aquifolium</i>	Holly	Tree or Shrub	Exotic	
<i>Juncus articulatus</i>	Jointed rush	Rush	Exotic	
<i>Juncus edgariae</i>	Wiwi, Edgars rush	Rush	Indigenous endemic	Not Threatened
<i>Juncus effusus</i>	Soft rush	Rush	Exotic	
<i>Kunzea robusta</i>	Kānuka	Tree or Shrub	Indigenous endemic	Threatened – Nationally Vulnerable
<i>Lamium galeobdolon</i>	Artillery plant	Dicot Herb	Exotic	
<i>Lepidosperma australe</i>	Square sedge	Rush	Indigenous endemic	Not Threatened
<i>Leycesteria formosa</i>	Himalayan honeysuckle	Grass	Exotic	
<i>Lolium arundinaceum</i>	Tall Fescue	Grass	Exotic	
<i>Lotus pedunculatus</i>	Lotus	Dicot Herb	Exotic	
<i>Moss species</i>		Moss	Indigenous	
<i>Malva sp.</i>	Mallow	Dicot Herb	Exotic	
<i>Melicytus ramiflorus</i>	Māhoe	Tree or Shrub	Indigenous non-endemic	Not Threatened
<i>Microsorium pustulatum</i>	Kowaowao, hounds tongue fern	Fern	Indigenous non-endemic	Not Threatened
<i>Muehlenbeckia australis</i>	Large-leaved pohuehue	Liane	Indigenous non-endemic	Not Threatened
<i>Parablechnum montanum</i>	Kiokio, hard fern	Fern	Indigenous endemic	Not Threatened
<i>Phormium tenax</i>	Harakeke / lowland flax	Grass	Indigenous endemic	Not Threatened
<i>Pinus radiata</i>	Radiata pine	Tree	Exotic	

Scientific Name	Common Name	Growth Form	Origin	Threat Classification
<i>Poa colensoi</i>	Blue tussock	Grass	Indigenous endemic	
<i>Polystichum vestitum</i>	Prickly shield fern	Fern	Indigenous endemic	Not Threatened
<i>Pteridium esculentum</i>	Rarauhe, bracken fern	Fern	Indigenous non-endemic	Not Threatened
<i>Prunella vulgaris</i>	Selfheal	Dicot Herb	Exotic	
<i>Ranunculus multiscapus</i>	Grassland buttercup	Dicot Herb	Indigenous endemic	Not Threatened
<i>Ranunculus repens</i>	Creeping buttercup	Dicot Herb	Exotic	
<i>Rubus fruticosus</i>	Blackberry	Shrub	Exotic	
<i>Rumex acetosella</i>	Sheep's sorrel	Dicot Herb	Exotic	
<i>Rumex obtusifolius</i>	Dock	Dicot Herb	Exotic	
<i>Salix cinerea</i>	Grey willow	Tree	Exotic	
<i>Senecio minimus</i>	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Senecio quadridentatus</i>	Fireweed	Dicot Herb	Indigenous non-endemic	Not Threatened
<i>Senecio vulgaris</i>	Groundsel	Dicot Herb	Exotic	
<i>Solanum laciniatum</i>	Poroporo	Shrub	Indigenous non-endemic	Not Threatened
<i>Sonchus asper</i>	Sow thistle	Dicot Herb	Exotic	
<i>Sonchus oleraceus</i>	Sow thistle	Dicot Herb	Exotic	
<i>Stellaria gracilentia</i>	Slender chickweed	Dicot Herb	Exotic	
<i>Trifolium repens</i>	Clover	Dicot Herb	Exotic	
<i>Trifolium pratense</i>	Red clover	Dicot Herb	Exotic	
<i>Ulex europaeus</i>	Gorse	Shrub	Exotic	
<i>Verbascum thapsus</i>	Woolly mullein	Dicot Herb	Exotic	
<i>Verbascum virgatum</i>	Moth mullein	Dicot Herb	Exotic	
<i>Vicia sativa</i>	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 – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland in the valley floor marsh wetland. This wetland extends from McLaren Gully Road to the swamp wetland in the designation site.



Figure A3.2. (Pūrei – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland in West Gully 4. In this area, the watercress and floating sweetgrass are largely absent and relatively more rautahi is present than in other areas of this overall vegetation type.



Figure A3.3. (Pūrei – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland (also with relatively higher levels of rautahi than elsewhere) bordering harakeke – gorse / (pūrei – rautahi) flaxland in the swamp wetland.



Figure A3.4. 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 – rautahi – Yorkshire fog) – cocksfoot / watercress – floating sweetgrass grassland 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 shrubland / 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 shrubland / treeland in the main cutover area, and West Gully 4 in the background.



Figure A3.17. Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / 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. Macrocarpa forest at left, radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland in the cutover area in the foreground, and West Gully 4 in the background.



Figure A3.20. (Pūrei) – wiwi / cocksfoot rushland north of McLaren Gully Road



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

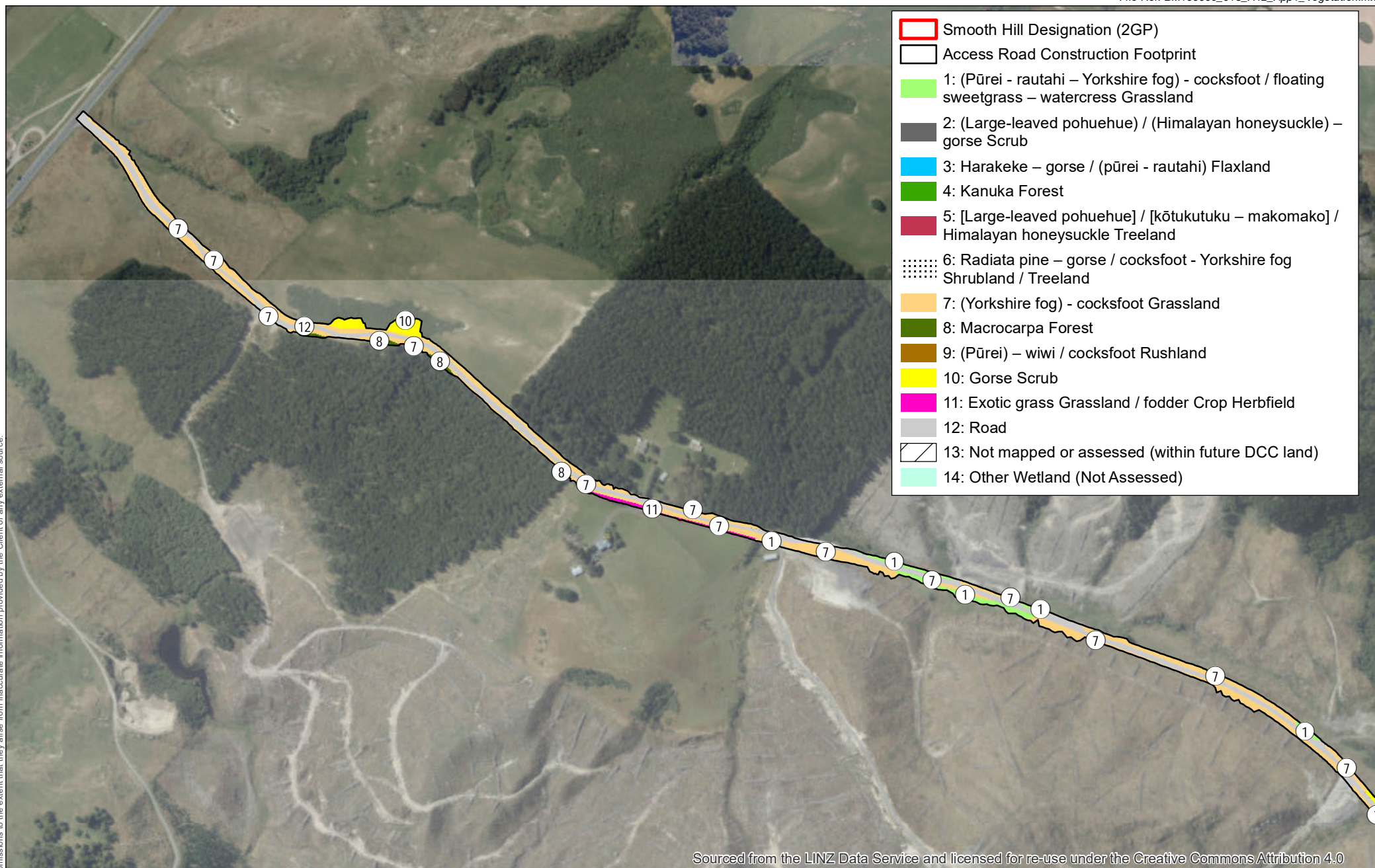


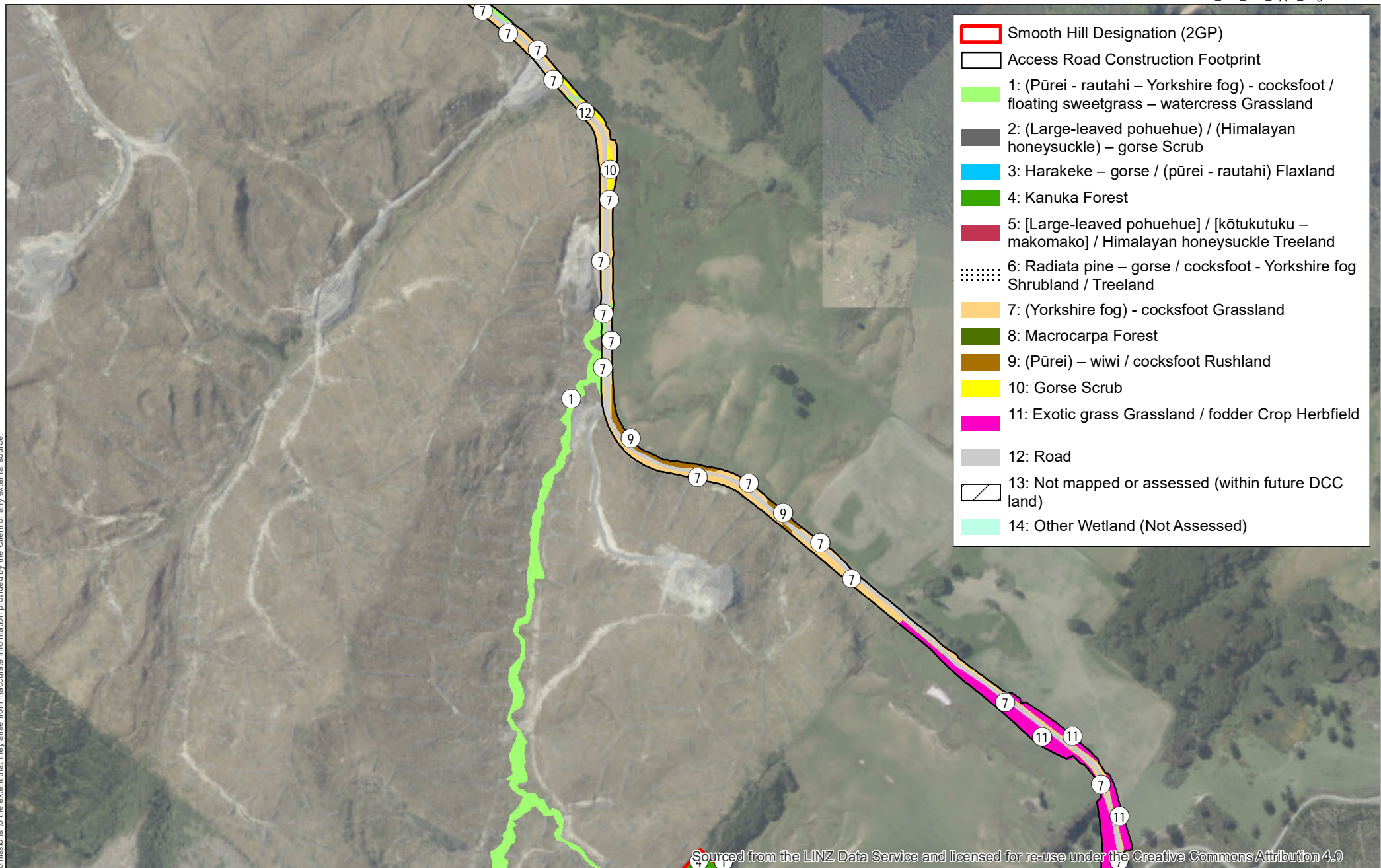
Figure A3.22. Exotic grass grasslands (improved pasture) at left, in grazed paddocks adjacent to McLaren Gully Road. Rank (Yorkshire fog) – cocksfoot grassland at right.

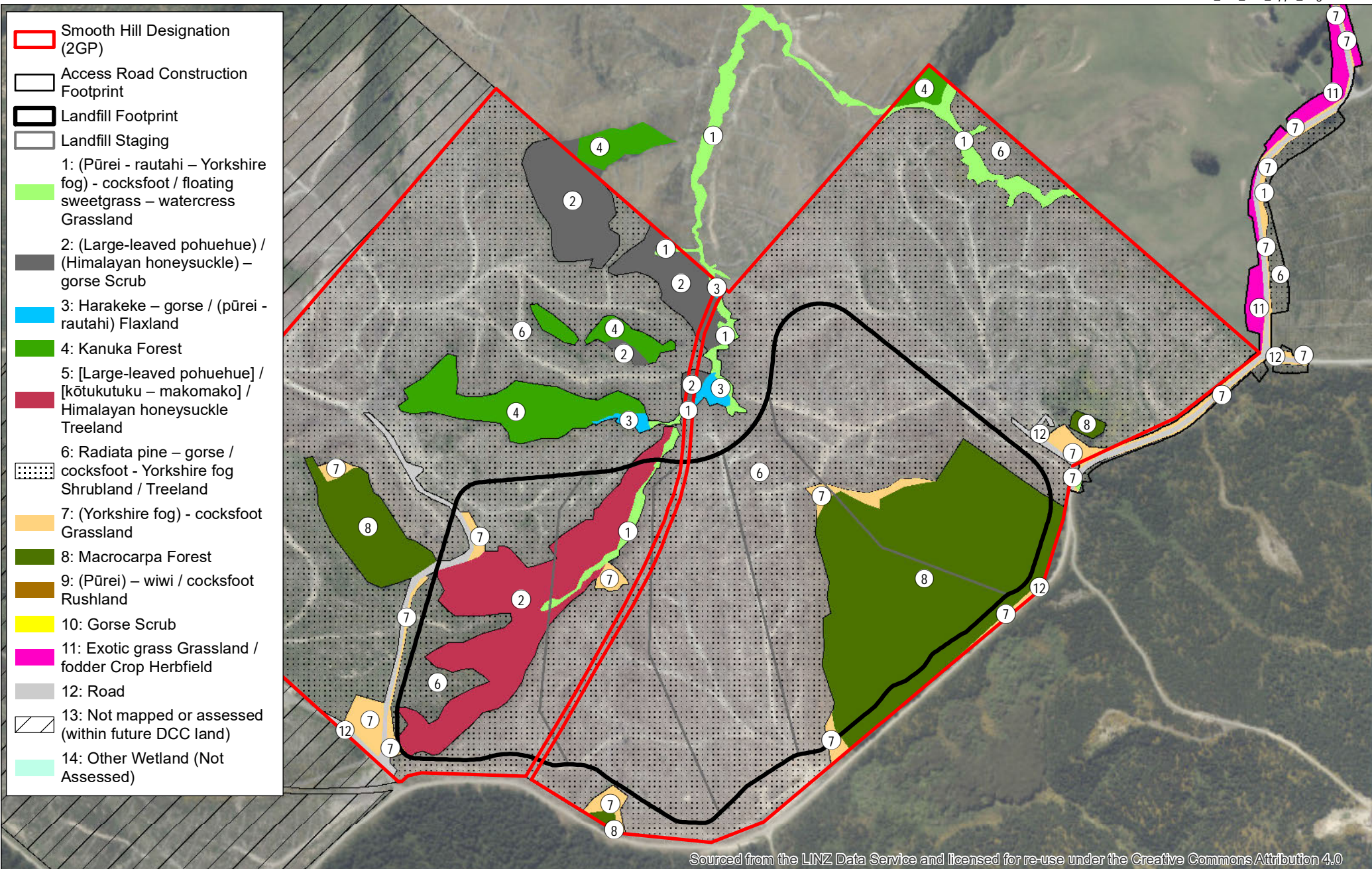


Figure A3.22. Fodder crop herbfields at left, in grazed paddocks adjacent to McLaren Gully Road. Rank (Yorkshire fog) – cocksfoot grassland along road margins. Exotic grass grasslands (improved pasture) at right.

Appendix 4: Vegetation Types







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 Waiholā (species observed incidentally are also recorded). Primary habitats for each species are indicated as is the conservation status of each species.

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 Waiholā Survey Site
Bush falcon	<i>Falco novaeseelandiae ferox</i>	At Risk	Recovering ^{DP St}									y	y	y		y	
Kereru	<i>Hemiphaga novaeseelandiae</i>	Not Threatened	Not Threatened ^{CD Inc}									y	y	y		y	
Shining cuckoo	<i>Chrysococcyx l. lucidus</i>	Not Threatened	Not Threatened ^{DP}									y	y	y		y	
Morepork	<i>Ninox n. novaeseelandiae</i>	Not Threatened	Not Threatened									y					
Kingfisher	<i>Todiramphus sanctus vagans</i>	Not Threatened	Not Threatened									y		y			
South Island rifleman	<i>Acanthisitta chloris chloris</i>	Not Threatened	Not Threatened									y					
Brown creeper	<i>Mohoua novaeseelandiae</i>	Not Threatened	Not Threatened									y		y		y	
South Island fantail	<i>Rhipidura fuliginosa fuliginosa</i>	Not Threatened	Not Threatened ^{EF}									y	y	y	y	y	
South Island tomtit	<i>Petroica macrocephala macrocephala</i>	Not Threatened	Not Threatened									y		y			
Bellbird	<i>Anthornis m. melanura</i>	Not Threatened	Not Threatened									y	y	y	y	y	
Tui	<i>Prosthemadera n. novaeseelandiae</i>	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 Waiholo Survey Site
Cirl bunting	<i>Emberiza cirlus</i>	Introduced	Introduced & Naturalised ^{SO}									y					
Eastern rosella	<i>Platycercus eximius</i>	Introduced	Introduced & Naturalised ^{SO}									y	y				
Blackbird	<i>Turdus merula</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y	y	y
Grey warbler	<i>Gerygone igata</i>	Not Threatened	Not Threatened									y	y	y	y	y	
Silvereye	<i>Zosterops lateralis lateralis</i>	Not Threatened	Not Threatened ^{SO}									y	y	y		y	
Yellowhammer	<i>Emberiza citrinella</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y		
Chaffinch	<i>Fringilla coelebs</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y	y	y
Greenfinch	<i>Carduelis chloris</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y	y	
Goldfinch	<i>Carduelis carduelis</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y	y	
Redpoll	<i>Carduelis flammea</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y	y	y
House sparrow	<i>Passer domesticus</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y		y
Starling	<i>Sturnus vulgaris</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y		y
Magpie	<i>Gymnorhina tibicen</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y	y	
Rook	<i>Corvus frugilegus</i>	Introduced	Introduced & Naturalised ^{SO}									y					
Cattle egret	<i>Ardea ibis coromanda</i>	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 Waiholo Survey Site
Canada goose	<i>Branta canadensis</i>	Introduced	Introduced & Naturalised ^{SO}									y		y			y
Swamp harrier	<i>Circus approximans</i>	Not Threatened	Not Threatened ^{SO}									y	y	y	y	y	y
Spur-winged plover	<i>Vanellus miles novaehollandiae</i>	Not Threatened	Not Threatened ^{SO}									y	y	y	y	y	
Little owl	<i>Athene noctua</i>	Introduced	Introduced & Naturalised ^{SO}									y					
Skylark	<i>Alauda arvensis</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y	y	
Welcome swallow	<i>Hirundo n. neoxena</i>	Not Threatened	Not Threatened ^{Inc SO}									y	y	y	y	y	y
NZ pipit	<i>Anthus n. novaeseelandiae</i>	At Risk	Declining									y	y				
Dunnock	<i>Prunella modularis</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y			
Song thrush	<i>Turdus philomelos</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y	y	
South Island fernbird	<i>Bowdleria punctata punctata</i>	At Risk	Declining									y		y			
Black shag	<i>Phalacrocorax carbo novaehollandiae</i>	At Risk	Naturally Uncommon ^{SO Sp}									y	y	y			y
Pied shag	<i>Phalacrocorax varius varius</i>	At Risk	Recovering									y					
Little shag	<i>Phalacrocorax melanoleucos brevirostris</i>	Not Threatened	Not Threatened ^{Inc}									y	y	y			
Foveaux shag	<i>Leucocarbo stewarti</i>	Threatened	Nationally Vulnerable											y			
White heron	<i>Ardea modesta</i>	Threatened	Nationally Critical ^{OL SO St}									y					
Australasian bittern	<i>Botaurus poiciloptilus</i>	Threatened	Nationally Critical ^{DP Sp TO}									y					
Black swan	<i>Cygnus atratus</i>	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 Waiholo Survey Site
Feral goose	<i>Anser anser</i>	Introduced	Introduced & Naturalised ^{SO}									y		y			
Paradise shelduck	<i>Tadorna variegata</i>	Not Threatened	Not Threatened									y	y	y	y	y	
Muscovy duck	<i>Cairina moschata</i>	Introduced	Introduced, Not Established											y			
Mallard	<i>Anas platyrhynchos</i>	Introduced	Introduced & Naturalised ^{SO}									y	y	y	y		y
Grey duck	<i>Anas s. superciliosa</i>	Threatened	Nationally Critical ^{SO}									y	y	y			
Grey teal	<i>Anas gracilis</i>	Not Threatened	Not Threatened ^{inc SO}									y	y	y			y
NZ shoveler	<i>Anas rhynchotis variegata</i>	Not Threatened	Not Threatened									y		y			y
NZ scaup	<i>Aythya novaeseelandiae</i>	Not Threatened	Not Threatened ^{inc}									y					y
Pukeko	<i>Porphyrio m. melanotus</i>	Not Threatened	Not Threatened ^{inc SO}									y	y	y	y		
Australian coot	<i>Fulica atra australis</i>	At Risk	Naturally Uncommon ^{inc SO}									y					
South Island pied oystercatcher	<i>Haematopus finschi</i>	At Risk	Declining									y	y	y	y		
Pied stilt	<i>Himantopus h. leucocephalus</i>	Not Threatened	Not Threatened									y	y	y			
Black-fronted dotterel	<i>Charadrius melanops</i>	At Risk	Naturally Uncommon ^{SO Sp}										y				
Black-billed gull	<i>Larus bulleri</i>	Threatened	Nationally Critical ^{RF}									y	y				y
Black-fronted dotterel	<i>Charadrius melanops</i>	At Risk	Naturally Uncommon ^{SO Sp}											y			
White-fronted tern	<i>Sterna s. striata</i>	At Risk	Declining ^{DP}											y			
Spotted shag	<i>Stictocorbo p. punctatus</i>	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)
White-faced heron	<i>Egretta novaehollandiae</i>	Not Threatened	Not Threatened ^{SO}													
Royal spoonbill	<i>Platalea regia</i>	At Risk	Naturally Uncommon ^{Inc RR SO}													
Variable oystercatcher	<i>Haematopus unicolor</i>	At Risk	Recovering ^{Inc}													
Black-backed gull	<i>Larus d. dominicanus</i>	Not Threatened	Not Threatened ^{SO}													
Red-billed gull	<i>Larus novaehollandiae scopulinus</i>	At Risk	Declining													
Sooty shearwater	<i>Puffinus griseus</i>	At Risk	Declining ^{SO}													
Australasian gannet	<i>Morus serrator</i>	Not Threatened	Not Threatened ^{De Inc SO}													
Arctic skua	<i>Stercorarius parasiticus</i>	Non-resident Native	Migrant ^{SO}													
Rock pigeon	<i>Columba livia</i>	Introduced	Introduced & Naturalised ^{SO}													

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 17 August 2020 (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	7.48
(Pūrei - rautahi – Yorkshire fog) - cocksfoot / floating sweetgrass – watercress grassland	0.35
(Pūrei) – wiwi / cocksfoot rushland	0.19
(Yorkshire fog) - cocksfoot grassland	4.07
Exotic grass Grassland / fodder Crop herbfield	1.68
Gorse Scrub	0.27
Macrocarpa forest	0.09
Radiata pine – gorse / cocksfoot - Yorkshire fog shrubland / treeland	0.85
Access roads within designation site	1.26
(Yorkshire fog) - cocksfoot grassland	0.10
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	1.15
Infrastructure	1.33
(Yorkshire fog) - cocksfoot grassland	0.09
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	1.25
Operations area	0.48
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	0.48
Stage 1	10.31
(Yorkshire fog) - cocksfoot Grassland	0.18
Macrocarpa Forest	3.89
Radiata pine – gorse / cocksfoot - Yorkshire fog shrubland / treeland	6.24
Stage 2	9.38
(Yorkshire fog) - cocksfoot Grassland	0.14
Macrocarpa Forest	4.74
Radiata pine – gorse / cocksfoot - Yorkshire fog shrubland / treeland	4.51
Stage 3	7.33
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	7.33
Stage 4	8.13
(Pūrei - rautahi – Yorkshire fog) - cocksfoot / floating sweetgrass – watercress grassland	0.26
(Yorkshire fog) - cocksfoot grassland	0.13
[Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland	1.22
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	6.52
Stage 5	7.93
(Pūrei - rautahi – Yorkshire fog) - cocksfoot / floating sweetgrass – watercress grassland	0.02

Description of works type and resulting clearance of vegetation community types	Sum of Area in Ha
(Yorkshire fog) - cocksfoot grassland	0.11
[Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland	3.30
Radiata pine – gorse / cocksfoot - Yorkshire fog Shrubland / treeland	4.51
Stockpile	2.04
(Pūrei - rautahi – Yorkshire fog) - cocksfoot / floating sweetgrass – watercress grassland	0.01
Radiata pine – gorse / cocksfoot - Yorkshire fog shrubland / treeland	2.03
Stormwater attenuation basin	0.33
(Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub	0.10
(Pūrei - rautahi – Yorkshire fog) - cocksfoot / floating sweetgrass – watercress grassland	0.10
Harakeke – gorse / (pūrei – rautahi) flaxland	0.08
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	0.05
Total	56.00

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 17 August 2020 (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
(Large-leaved pohuehue) / (Himalayan honeysuckle) – gorse scrub	0.10
Stormwater attenuation basin	0.10
(Pūrei - rautahi – Yorkshire fog) - cocksfoot / floating sweetgrass – watercress grassland	0.72
McLaren Gully Road and Big Stone Road widening	0.35
Stage 4	0.26
Stage 5	0.02
Stockpile	0.01
Stormwater attenuation basin	0.10
(Pūrei) – wiwi / cocksfoot rushland	0.19
McLaren Gully Road and Big Stone Road widening	0.19
(Yorkshire fog) - cocksfoot grassland	4.73
McLaren Gully Road and Big Stone Road widening	4.07
Access roads within designation site	0.10
Stage 1	0.18
Stage 2	0.14
Stage 4	0.13
Stage 5	0.11
[Large-leaved pohuehue] / [kōtukutuku – makomako] / Himalayan honeysuckle treeland	4.52
Stage 4	1.22
Stage 5	3.30
Exotic grass grassland / fodder crop herbfield	1.68
McLaren Gully Road and Big Stone Road widening	1.68
Gorse scrub	0.27
McLaren Gully Road and Big Stone Road widening	0.27
Harakeke – gorse / (pūrei – rautahi) flaxland	0.08
Stormwater attenuation basin	0.08
Macrocarpa forest	8.80
McLaren Gully Road and Big Stone Road widening	0.09
Access roads within designation site	0.09
Stage 1	3.89
Stage 2	4.74
Radiata pine – gorse / cocksfoot – Yorkshire fog shrubland / treeland	34.92
McLaren Gully Road and Big Stone Road widening	0.85
Access roads within designation site	1.15
Infrastructure	1.24
Operations area	0.48
Stage 1	6.24
Stage 2	4.51

Description of vegetation type and resulting clearance as a result of construction	Sum of Area in Ha
Stage 3	7.33
Stage 4	6.52
Stage 5	4.51
Stockpile	2.03
Stormwater attenuation basin	0.05
Total	56.00

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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