Under	the Resource Management Act 1991 (**RMA**)
In the matter of	an application by **Dunedin City Council** to develop a landfill at Smooth Hill, Dunedin.
	Applicant

Statement of evidence of Dr Jaz Nye Morris

29 April 2022

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Qualifications and experience

1 My name is Dr Jaz Nye Morris.

2 I am an ecologist with Boffa Miskell Limited (Boffa Miskell), a national multi-disciplinary environmental planning and design consultancy. I have a Doctor of Philosophy from the University of Otago (2018), and a Bachelor of Science with Honours First Class in Botany (2011) from the University of Otago. I am a full member of the Environmental Institute of Australia and New Zealand, and a member of the Canterbury Botanical Society and the New Zealand Plant Conservation Network.

3 I have practiced as a full-time consultant ecologist for three years, since joining Boffa Miskell's Christchurch office in 2019. Between 2010 and 2018, largely alongside postgraduate study in the Botany Department of the University of Otago, I held various part-time ecology or botany research assistant / teaching assistant roles; many of these included ecological surveys (principally botanical surveys) in the Dunedin district and wider Otago region. I have published ecological and botanical research in both national and international journals.

4 In my role at Boffa Miskell I provide ecological consultancy services to a wide range of clients throughout the South Island. I specialise in the survey and assessment of terrestrial ecological values (including wetland habitats), and preparation of ecology reports for Assessment of Effects on the Environment.

5 I have worked on numerous projects that have involved the surveying, monitoring, assessment, mapping and classification of terrestrial vegetation and wetlands for both consenting and conservation management purposes. My consulting experience includes wetland assessments for the Waitaki Power Scheme for Meridian Energy Limited, and for the Waipori Power Scheme for Trustpower Limited.

Project involvement

6 I have been involved in Dunedin City Council’s proposed Smooth Hill landfill project since early 2020. I was asked to undertake an ecological impact assessment of the proposed landfill development and road upgrades (the landfill project) on terrestrial vegetation and wetlands. At that time, a terrestrial vegetation and wetland survey of the landfill designation (designation D659: the **landfill site**) had already been undertaken based on an initial landfill design, and a site species list, vegetation maps, and

general vegetation descriptions had already been prepared[1]. I have subsequently undertaken my own observations of the landfill site and downstream receiving environment, as well as ecological survey alongside McLaren Gully Rd and Big Stone Rd (the road upgrades area), on five separate occasions between March 2020 and February 2022.

7 I authored the terrestrial vegetation, wetlands, and significance assessment sections of the "Smooth Hill Landfill Ecological Impact Assessment", dated 19 August 2020, which accompanied an initial application that included a larger landfill footprint. I authored the same sections of the subsequent track-changed assessment (the **EcIA**), dated 28 May 2021, in response to the reduced landfill extent to which this current application relates. The overall EcIA examines the existing terrestrial vegetation, wetland, avifauna, herpetofauna, and freshwater ecological values of the landfill site, downstream receiving environment, and road upgrades area, and assesses the effects of the landfill project on these ecological values.

8 I was also the author of the "Smooth Hill Landfill – Vegetation Restoration Draft Management Plan," dated 4 June 2021 (the **draft VRMP**), which forms Appendix 2 to the draft Landfill Management Plan (the **LMP**). The LMP was submitted as part of the Assessment of Environmental Effects lodged with the application; it outlines ecological mitigation / offset steps to be undertaken in relation to the landfill project.

Code of Conduct

9 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

10 I have been asked to prepare evidence in relation to the potential ecological effects to terrestrial vegetation, including wetlands, of the landfill project.

11 My evidence, which is within my area of expertise, will cover the following topics:

(a) Methodology and limitations;

(b) Existing ecological environment;

[1] This work was completed by Dr Katherine Dixon, who has since left Boffa Miskell.

(c) The proposed landfill project and associated ecological mitigation / offset;

(d) Ecological Impact Assessment in relation to terrestrial vegetation and wetlands;

(e) Response to ORC reports, and additional questions on ecology matters raised by ORC on 2 March 2022;

(f) Response to ORC and DCC Section 42A reports; and

(g) Response to matters raised in relevant submissions.

Executive summary

12 My evidence has been prepared in relation to the ecological effects of the landfill development and associated road upgrades (the proposal) on terrestrial vegetation and wetland habitats in the proposal's construction footprint and receiving environment.

13 The proposal would directly affect areas of recently cutover plantation forestry and exotic roadside grasslands. Whilst no areas of indigenous vegetation or wetlands are directly affected by the proposal; indirect hydrological impacts to a downstream 'swamp wetland' (and in turn, and to a lesser degree, a downstream 'valley floor marsh wetland') have been considered (locations names referred to in this document are mapped in Figure 1 of my evidence). These wetlands are of a modified nature but nevertheless are of some importance in the local terrestrial and freshwater habitat context.

14 Without mitigation, the degree of hydrological impacts to wetlands is considered to result in, at worst, low level ecological effects to the swamp wetland. This wetland is proposed to be substantially enhanced, and with the mitigation measures from a Vegetation Restoration Management Plan (**VRMP**) in place, the outcome for the swamp wetland is a net gain. I do not expect any measurable adverse effects to arise to either the valley floor marsh wetland or roadside wetlands. This reflects their existing degree of modification, the natural resilience of the wetland types (and the species within them) to variable water inputs, the limited consequential change to catchment water yield (via groundwater and runoff), and the intensive land uses under which these wetlands have established and / or currently persist.

15 Expert peer review and comments contained in ORC's s95 and s42a reports have primarily focused on the expected degree of hydrological

effects to wetlands, the extent to which this would be monitored, and the methods by which an appropriate ecological response would be implemented and quantified. My evidence discusses these matters further and in summary:

(a) I maintain that adverse ecological effects due to hydrological change would be slight, and there would be no loss of wetland extent, because I consider that the swamp wetland is a feature that is tolerant of existing regime of highly changeable runoff volumes inputs arising from climatic variability and the effects of current land use;

(b) I agree that the previously proposed monitoring was insufficient, and this is now addressed with additional baseline wetland monitoring and a proposed Receiving Waters Environment Monitoring Plan (**RWEMP**);

(c) I expect that implementation of the proposed restoration measures would see a net gain for the swamp wetland area that sits beneath the proposed landfill toe and for two upstream wetlands in West Gully 3 and 4, with comprehensive monitoring and response measures in place to ensure the outcome that any adverse effects are fully mitigated (to a net gain level) at the point of impact. Beyond these areas, I do not consider that there would be any adverse effects of the landfill to any significant vegetation or habitat in terms of amount, type, or condition.

16 Furthermore, whilst I do not expect that the degree of hydrological impacts would lead to any net loss of either wetland extent or the existing values in terms of indigenous wetland plant species, monitoring and upfront restoration actions are proposed via a draft VRMP (as part of the LMP) and other proposed consent conditions. These include pre-construction baseline monitoring of wetland extent and water levels, and implementation of a vegetation restoration plan that would see weed control, indigenous planting, and planting of a buffer of indigenous dryland species around the existing swamp wetlands. This restoration will improve their condition relative to current state (a net gain) and increase their resilience to any water level changes that may occur. Any unexpected adverse changes would be detected by the proposed ongoing monitoring of wetland extent and water levels post-construction and the Freshwater and Wetlands Monitoring Management Plan (**FWMMP**), with response measures to account for any observed adverse effects.

Methodology and limitations

17 The terrestrial vegetation and wetlands desktop review, field investigations, and vegetation and wetland mapping methodology applied is set out in full in Section 2.4 of the EcIA; and the ecological significance, ecological value and effects assessment methodology employed is set out in Sections 2.8-2.9 of the EcIA. The ecological impact assessment methodology is an industry best-practice method developed by the Environmental Institute of Australia and New Zealand (the **EIANZ EcIA method**[2]).

18 Briefly, the assessment method that I applied involved field and desktop investigations to assess the type, amount, and condition of terrestrial vegetation and wetland[3] habitats present at the landfill site, downstream receiving environment and road upgrades area, in consideration of the ecological context of the site in relation to the immediate area and wider Tokomairiro Ecological District (**ED**).

19 The findings of the investigations above enable a significance assessment in terms of section 6c of the RMA, where the assessment outcome is that a site / habitat type within a site is either significant or not. In addition, following the EIANZ EcIA method, the findings allow for an assessment of each habitat type's ecological value, on a five-point scale ranging from negligible to very high[4]. The activities of the landfill project, and their zone of influence (in relation to the types and extents of similar habitat in the immediate landfill site / road upgrade area and wider ED) provides the basis for an assessment of the magnitude of ecological effects of the proposal. Magnitude means the degree to which a feature will change or be lost, on a five-point scale (for adverse effects) from negligible to very high. A matrix approach then applies the ecological value of a feature, and the magnitude of effect, allowing an overall level of ecological effect to be determined

[2] Roper-Lindsay et al. (2018). Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

[3] Wetland extents within the landfill site were initially mapped in May 2019 by Dr Katherine Dixon (as described in the EcIA). This was based on her expert assessment of the presence of and relative dominance of wetland vegetation, rather than by hydrological, soil indicators, or formal vegetation plot methods more recently adopted as standard practice following implementation of the NPS-FM 2020. I determined wetland extents along McLaren Gully Rd and in the valley floor marsh wetland by the same method as Dr Katherine Dixon, and (based on my main visit to the swamp wetland in March 2020, and improved aerial imagery that became available) I refined Dr Dixon's mapped wetland boundaries at the landfill site slightly.

[4] For the purposes of the effects assessment for vegetation specifically, exotic plant species themselves are generally considered to have negligible value, but I note that a plant community dominated in terms of cover by exotic species may nevertheless have value depending on the sorts of indigenous species present.

(again on a five-point scale from very low to very high for adverse effects, positive effects are considered a net gain).

20 Discussion of the existing environment and potential effects in terms of avifauna (birds) and herpetofauna (lizards) that may inhabit the terrestrial vegetation and wetland habitats at the landfill site and the road upgrades area is provided in the evidence of Ms Sievwright and Ms King, respectively.

21 As it is a key matter raised by ORC's technical peer reviewer and submitters, much of my evidence will address the likely ecological impacts (in terms of hydrological change and subsequent effects to habitat) to wetlands in the downstream receiving environment (areas described in the EcIA: the 'swamp wetland', at the toe of the proposed landfill; and the 'valley floor marsh wetland', which runs north from the swamp wetland to McLaren Gully Rd and forms the drainage of the landfill site; see Figure 1. In my original assessment in the EcIA, my understanding of the likely effects of the landfill development on the swamp wetland and valley floor marsh wetland due to changes in surface water hydrology, catchment water balance, and groundwater supply was based on the information presented in two reports prepared by GHD Limited (*Dunedin City Council Waste Futures Phase - Smooth Hill Landfill Surface Water Assessment*, dated 13 August 2020; and *Dunedin City Council Waste Futures - Smooth Hill Landfill Assessment of Effects to Groundwater*, dated 17 August 2020). The findings of these reports and additional commentary regarding effects to wetlands are now presented in the evidence of Mr Ingles and Mr Kirk, and my discussion in relation to downstream wetland hydrology is reliant on their evidence.

22 Discussion of the existing environment and potential effects in terms of aquatic fauna and freshwater habitat, to the extent that these occur within parts of some wetland areas, is contained in Dr Blakely's evidence.

Existing ecological environment

23 I will describe six broad habitat types[5] in three general areas that may be impacted by the landfill project:

[5] The EcIA report describes these areas specifically in terms of their overall vegetation classification (noting some areas contain more than one vegetation type), but they are described in my evidence more generally.

(a) 'Cutover plantation forestry area[6]' (this area contains the entire landfill works footprint).

(b) 'Swamp wetland[7]' (below the landfill bund footprint, downstream receiving environment).

(c) 'Upstream wetlands' (upstream of the swamp wetland; one is at the base of West Gully 3[8], and the other is in West Gully 4 beneath the landfill's proposed attenuation basin and stockpile[9] and forms part of the downstream receiving environment).

(d) 'Valley floor marsh wetland[10]' (below the swamp wetland, and in East Gully, the downstream receiving environment).

(e) 'Roadside paddocks, grasslands, and scrub[11]' (along McLaren Gully Rd and Big Stone Rd; road upgrades area).

(f) 'Roadside wetlands[12]' (along McLaren Gully Rd and Big Stone Rd; road upgrades area).

24 Descriptions of wetland areas and their hydrological influences are relatively more detailed, to provide context for a later discussion of the likely effects of the proposal. Location names of wetlands, gullies, and other features within and downstream of the landfill site as referred to in my evidence are shown on Figure 1. (appended).

Cutover plantation forestry area

25 The cutover plantation forestry area is largely an area where radiata pine was harvested, cleared, and then replanted again in radiata pine shortly prior to the initial field investigations conducted for the EcIA in 2019. Aside from radiata pine, the vegetation cover is generally gorse or exotic grasses, and there are numerous forestry slash piles and machinery access tracks.

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[6] The vegetation of this area, as described in the EcIA, is largely radiata pine / gorse / cocksfoot – Yorkshire fog treeland but also includes a small component of (Yorkshire fog) – cocksfoot grassland.

[7] Harakeke – gorse / (pūrei – rautahi) flaxland and (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland.

[8] Harakeke – gorse / (pūrei – rautahi) flaxland.

[9] (Pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland.

[10] As above, this area is (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland.

[11] The vegetation of this area as described in the EcIA is largely (Yorkshire fog) – cocksfoot grassland but also contains areas of radiata pine / gorse / cocksfoot – Yorkshire fog treeland, gorse scrub, and exotic grass grassland / fodder crop herbfield.

[12] The vegetation of this area as described in the EcIA is (pūrei) / (Yorkshire fog – cocksfoot) – rautahi sedgeland and [pūrei] –wīwī / rautahi –exotic grass rushland.

An area of macrocarpa plantation forestry along Big Stone Rd was harvested more recently in 2020-2021; this area has not been surveyed in detail, but I have recently briefly observed (in March 2022, from Big Stone Rd) that it is largely or entirely covered in exotic plants typical of recently disturbed areas, and scattered remnant shrubs or various small trees that survived the harvest cycle. The cutover plantation forestry area is of negligible ecological value as vegetation, in that it almost entirely comprises deliberately planted exotic trees among various exotic weedy shrubs, herbs, and grasses. As described in the EcIA, this area could be described as ecologically 'significant' only to the extent it may provide or provides marginal habitat for indigenous lizards or kārearea / eastern falcon respectively (as noted in the evidence of Ms King and Ms Sievwright); in terms of the vegetation itself I consider it has no ecological significance.

Swamp wetland area

26 The swamp wetland is a small (c.0.5 ha) feature that occupies the lowest point of the central part of the landfill designation at the confluence of several small gully systems, between West Gully 3 and the downstream (northern) end of the landfill designation. It is largely surrounded by the cutover plantation forestry area. At its core, the swamp wetland is a harakeke flaxland with frequent tall gorse, and pūrei and rautahi / cutty grass are scattered throughout or form patchy areas of sedgeland. Both pūrei and rautahi are indigenous sedges associated with wetlands. The swamp wetland does not contain large expanses of permanent surface water, and outer parts of the wetland (especially sedgelands) may be better described as marsh, meaning in this case that their soils are likely dry at times with a high degree of water level variability. The indigenous species present are widespread and common, and also typical of the many larger, more intact, and / or more diverse flaxland / sedgeland wetland features located elsewhere within the wider area (the Tokomairiro ED[13]). I have assessed the swamp wetland as having moderate ecological value and consider it to be part of an ecologically significant wetland and forest gully feature (in conjunction with other wetland areas described below).

27 At the centre of the swamp wetland is a narrow, defined channel that is visible in older aerial imagery of the site (1940s-1970s) when the site was

[13] For example, flaxlands and sedgelands cover many hundreds of hectares at nearby Lakes Waipori and Waihola, and there are at least two very similar wetlands (of a similar or greater size, but with a generally more diverse indigenous flora and less weed cover) elsewhere in the Ōtokia Creek headwaters near McLaren Gully Rd. Many gully bottom areas in the Ōtokia Creek and Tokomairiro ED area have similar wetland vegetation where they sit below plantation forestry (including both mature and recently harvested areas).

apparently in farmland and was overall less densely vegetated[14]. This channel is occasionally blocked by sediment or debris and forms small pools; these are the only permanent or near-permanent surface water areas in the wetland. I have observed these holding standing or slowly seeping water (and they may do so much of the year); they usually contain a thatch of exotic grasses and herbs. Mr Ingles notes that runoff from larger rain events (around 13% of total runoff) would largely be flushed through these areas relatively quickly. The circumstances suggest to me that the extent or even presence of wetland vegetation beyond these channels reflects the influence of land-use change and accumulation of poorly-draining soil runoff[15] at the valley bottom. This is inferred in an ecological sense due to the position of the wetland near the top of the catchment, the pattern of wetland and non-wetland vegetation surrounding this narrow channel, and the land use history of pastoral farming and forestry with episodes of major soil disturbance and runoff. This conclusion is consistent with the evidence of Mr Ingles and Mr Kirk that that the swamp wetland is driven by rainfall inputs (shallow groundwater makes a negligible contribution, and deep groundwater is unlikely to contribute at all). Later parts of my evidence provide further discussion on the hydrological drivers of the swamp wetland in the context of the possible effects of landfill construction.

Upstream wetland areas

28 There are two upstream wetlands that sit above the swamp wetland in West Gully 4 and West Gully 3 (see Figure 1).

(a) The upstream wetland in West Gully 4 is a rautahi sedgeland, very similar in character and composition overall to the valley floor marsh wetland. It would sit beneath the proposed attenuation basin, and other works would occur in its catchment (although none would be the actual landfill), and it is hence part of the receiving environment of the development. It notably contains several large and small crack willow trees; this species is a notorious wetland weed and potentially a spreading risk down-valley.

(b) An area of flaxland similar to that in the swamp wetland occupies the base of the adjacent West Gully 3 (with kānuka forest). This wetland

[14] I note that it is uncertain to me from this imagery whether the swamp wetland existed at all at these times or if it is fully or partly a more recent (but certainly naturally developed) feature. I suspect it is at least partly recent and, if so, it has expanded during the plantation forestry period.

[15] The evidence of Mr Ingles also describes this process as an outcome of existing forestry harvest.

is outside the landfill footprint and in a different sub-catchment; it is not in the receiving environment of the landfill.

29 These two upstream wetlands are likely both important to the hydrology of the swamp wetland, by contributing surface and / or groundwater flows. I have assessed that for the same reasons that apply to the swamp wetland these two areas have moderate ecological value and form part of the same ecologically significant wetland and gully feature.

Valley floor marsh wetlands

30 The valley floor marsh wetland is a linear wetland system that occupies gully bottom areas from the swamp wetland north (down-valley from the landfill designation boundary) towards McLaren Gully Rd and the main Ōtokia Creek (see Figure 1). As described in Dr Blakely's evidence, this area contains intermittent stream reaches. An additional arm of the wetland extends from a gully catchment in the east of the designation (East Gully) that would contain some of the landfill operations area, but not the actual landfill itself. The valley floor marsh wetland is comprised of a rautahi sedgeland including a defined channel (a continuation of the channel at the centre of the swamp wetland). Within the valley floor marsh wetland is a pond approx. 300 m downstream of the landfill designation boundary that is surrounded by pūrei sedges and was apparently created by construction of a bund in the 1970s. The valley floor marsh wetland contains indigenous rushes and sedges scattered throughout, and rautahi forms a sward in places. The vegetation is modified with a substantial cover of exotic species and similar weeds to those described in the swamp wetland. The waterlogged channel contains a dense thatch of exotic herb and grass species and I expect the low energy seepage environment, and the excess groundwater nutrients described in the evidence of Mr Kirk drive this dense growth. The overall size and length of the valley floor marsh wetland is of importance in terms of providing connected wetland habitat from the swamp wetland to Ōtokia Creek, including buffering intermittent downstream seepage / diffuse flows. As described in Dr Blakely's evidence, the downstream pond supports eels. I have assessed that the valley floor marsh wetland has moderate ecological value and forms part of the same ecologically significant wetland and gully feature as the swamp wetland.

Roadside grasslands and scrub

31 The roadside grasslands, paddocks, and scrub area along McLaren Gully Rd and Big Stone Rd (road upgrades area) includes road margins and adjacent production land areas of pasture or plantation forestry. Vegetation cover is exotic and subject to various ongoing disturbance (grazing,

cultivation, harvest, and the immediate roadsides are likely mown, and I have observed that the swale is sprayed with herbicide at times). I recorded a number of indigenous plant species within it, but these are essentially individual plants that have opportunistically spread from a variety of nearby habitats. As described in the EcIA, rank grasslands in this area were assessed as being of low ecological value but could be described as 'significant' to the extent they may provide habitat for At Risk indigenous lizards (as noted in the evidence of Ms King). However, in terms of the vegetation itself I consider these areas have no ecological significance and negligible ecological value.

Roadside wetlands

32 Roadside wetlands along McLaren Gully Rd and Big Stone Rd (road upgrades area) occur at the edge of farmland and on gully bottom habitat and essentially form the balance of the roadside habitat aside from the grasslands and scrub noted above. There are three main areas of roadside wetland.

(a) The first is below (and is partially within) the 'McLarens Gully Covenant[16]' and contains a flaxland (broadly similar to the swamp wetland) and then a sequence of rautahi sedgeland areas (broadly similar to the valley floor marsh wetland) on either side or occasionally on both sides of McLaren Gully Rd. In several places, wetland vegetation occurs right to the existing dirt road surface. It is ecologically significant, and of moderate ecological value.

(b) The second area is where the valley floor marsh wetland meets McLaren Gully Rd about 900 m downstream of the landfill designation boundary.

(c) The third area, which occurs largely within low-lying farm paddocks adjacent to the immediate roadside, is a rushland with patchy wīwī rushes and pūrei and rautahi sedges. Being nonetheless a wetland, it meets broad ecological significance criteria, and applying the EIANZ EcIA method I find it has moderate ecological value overall.

33 I have left aside a description of additional habitats (gullies and hill faces with regenerating native forest or scrub) that are within the overall landfill designation but that are fully outside the proposed landfill footprint and

[16] A site scheduled in the Dunedin 2GP as an area of significant biodiversity value (ASBV C075).

would not be subject to any adverse effects, whether directly or indirectly; these areas are described in full in Section 3.2 of the EcIA.

The proposed Activity and associated ecological mitigation / offset

34 A full description of the landfill project is described in the application and in the evidence of Mr Coombe and Mr Dale. Briefly, the main points relevant to terrestrial vegetation and wetlands are:

(a) Progressive earthworks and vegetation clearance would occur over c.33.2 ha of the landfill site (the landfill itself would occupy c.18.6 ha), and road upgrades would occur across c.4.9 ha (excluding the existing road surface area). This would involve direct clearance of 33.2 ha of the cutover plantation forestry area (of negligible ecological value as vegetation), and clearance of c.4.9 ha of roadside grassland (of negligible ecological value as vegetation, but low ecological value overall). The c.18.6 ha landfill area would be gradually filled, capped, and vegetated in exotic grass. Outside the 33.2 ha, remaining areas of the site would generally retain their existing cover of either plantation forestry or regenerating native bush. The revised application included clearance of 16.5 m^2 of roadside wetlands[17] (of three types, but this has been avoided entirely by an updated road design prepared in March 2022. The evidence of Andrew Whaley discusses this change to the application and includes updated road upgrade plans.

(b) Construction and operation of the landfill (and associated stockpiles and infrastructure) requires the construction of perimeter drains and other means of stormwater management to direct clean[18] rainfall runoff from capped landfill or other areas to an attenuation basin (to be located upstream of the swamp wetland and connected sedgeland in West Gully 4). In addition, landfill lining and leachate management systems direct rainfall that contacts exposed landfill waste or other seepage to the separate leachate collection system for removal off site. These may lead to altered hydrological inputs to wetlands, particularly the swamp wetland, as described in paragraph 38 below.

[17] This highly precise figure had been generated by overlaying wetland mapping I had prepared with road design data using GIS. Several areas of 10s of cm-wide wetland habitat appeared to be within the road design as included in the revised application. I understand that the road has been redesigned and now fully avoids overlap with all wetland areas.

[18] I.e., clean of waste / leachate contaminants. Runoff may contain residual sediment from worked areas that will first pass through sediment retention pond (SRPs) before being directed to the basin.

35 The main ecological mitigation steps for terrestrial vegetation and wetlands are outlined in the draft VRMP. As drafted, this outlines the process for the enhancement of two connected areas:

(a) A 'Smooth Hill Reserve' that includes the swamp wetland, and the upstream connected flaxland and kānuka forest in West Gully 3. In this area, potential changes in vegetation composition in the 'swamp wetland' will be mitigated by weeding, planting, monitoring, and ongoing protection, within the swamp wetland itself; and

(b) A 'wetland offset area' where the loss of 16.5 m^2 (0.0017 ha) of roadside wetlands would have been offset by the enhancement of a 0.49 ha area of similar wetland habitat that sits within the landfill site and is upstream of and connected to the swamp wetland (it is generally located below West Gully 4). While an offset is no longer required because adverse effects to roadside wetlands, via road realignment, have been fully avoided by an updated road design, the applicant intends to undertake the restoration actions in this area in accordance with the draft VRMP.

Ecological Impact Assessment in relation to terrestrial vegetation and wetlands

36 All vegetation clearance required to construct the landfill itself would occur in the cutover plantation forestry area, and the entirety of works in the road upgrades area would affect roadside grasslands, paddocks, and scrub. These areas are of negligible value as vegetation and are not indigenous vegetation types; their clearance in terms of the plant species present is not of ecological concern and is largely permitted in the context of existing forestry and farming land uses. In terms of direct effects to the populations or extent of any indigenous plant species that incidentally occur within these areas, I consider this to be of negligible magnitude and a very low (less than minor) level of effect. Effects to roadside wetlands are now fully avoided by an updated road design.

37 The potential for introduction or spread of weeds in or beyond the landfill footprint due to landfill construction works (or spread from green waste) is a general concern for large vegetation clearance projects such as this. I am satisfied that insofar as the site is already very weedy and there are management measures included to prevent this possible effect (e.g., wheel wash facilities and the processing of green waste elsewhere) the landfill project would cause negligible magnitude and hence very low level (less than minor) effects in this regard. Further, a Plant and Animal Pest Control

Programme is proposed as part of the draft LMP and draft consent conditions, to reduce pest plant populations below current levels.

38 The landfill development avoids any reclamation of or direct impact to wetland areas within the landfill site (the swamp wetland and upstream wetland areas described earlier). However, the potential for indirect (hydrological) impacts was considered in the EcIA and has also been raised in a technical review[19] of the EcIA prepared for ORC's s95 report, and in the revised review[20] that accompanied ORC's s42a report.

39 Hydrological effects are possible because two gullies with ephemeral runoff to the southeast and east (upstream) of the swamp wetland would be fully occupied by the landfill, and ultimately the swamp wetland would sit immediately beneath an earth bund at the landfill toe. Hence, landfill works, including large scale earthworks, systems to manage runoff and intercept leachate, and landfill capping have the potential to alter downstream water supply and quality. This matter is a key concern of ORC's ecology technical reviewer and submitters, and accordingly I provide here additional analysis, some of which was not included in the earlier EcIA.

40 The effect of the landfill works, from the evidence of Mr Kirk and Mr Ingles, is to alter the catchment water balance and hence alter the hydrological inputs to wetlands at the site in a number of ways, owing to:

(a) Direct rainfall interception where this rainfall contacts exposed landfill and is treated as leachate and directed to the leachate collection system;

(b) Prevention of soakage to shallow and deep groundwater due to landfill lining;

(c) Altered evapotranspiration rates, particularly from a grassed landfill cap; and

(d) Stormwater runoff from most areas reporting to the attenuation basin rather than direct runoff downslope.

41 In terms of the existing hydrology of the wetlands, my understanding from the evidence of Mr Kirk and Mr Ingles is that is that the wetlands are almost entirely rainfall driven. Because there is little capacity for storage in the

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[19] *Technical Review to Inform Notification Decision: Smooth Hill Landfill -Appendix 11 -Ecology Assessment*. Report prepared by Tonkin & Taylor Ltd. for Otago Regional Council. Dated 3 September 2021. I understand that the reviewer also had regard to the draft LMP and draft VRMP in preparing their review.

[20] Dated 5 April 2022.

impermeable soils of the shallow aquifer, deep groundwater is unlikely to provide any important recharge to these areas. Hence, the wetlands occur where surface runoff is impounded in the low-gradient valley floor where shallow groundwater frequently sits at or near ground surface, and due to underlying low permeable geology there is minimal underdrainage. Mr Kirk discusses that monitoring of a borehole BH01 adjacent to the swamp wetland indicates a very stable groundwater level in response to rainfall and seasonal drought in the wetland and hydraulically connected soils. This is consistent with what would be expected for an area of swamp.

42 Mr Kirk assesses that shallow groundwater supply to wetland would drop by around a third, but that groundwater is only around 1% of catchment yield and this change therefore represents a reduction in wetland water supply of 0.3%.

43 The evidence of Mr Kirk is that net stormwater surface runoff (which is by far the main wetland water source) for the swamp wetland would be reduced in the worst case by 20%, (based on average rainfall conditions) due to altered surface runoff patterns, direct leachate interception, and relatively increased evapotranspiration from the grassed landfill cap compared to existing ground cover. However, both Mr Kirk and Mr Ingles note that these predicted changes do not account for changes in catchment water balance over time due to existing forestry land uses.

44 It was previously understood (and stated in the EcIA) that the net outcome of the combined effects to shallow groundwater and surface runoff above would be a reduction in groundwater levels at the northern (downstream) end of the designation site (i.e., in the swamp wetland) by less than 1 m.

45 Based on further discussion with (and the evidence of) Mr Kirk, I now understand this less than 1 m change applies at the landfill toe, slightly upslope of and not within the swamp wetland itself. I understand it reflects a change in the subsurface groundwater gradient in the slope beneath the landfill rather than an overall reduction in groundwater level at the topographical valley bottom. Mr Kirk nevertheless considers that a lowering of the swamp wetland's water level is possible but will be mitigated by two factors.

46 First, the reduction in groundwater supply would be greatly mitigated by capture of stormwater in the attenuation basin and hence an increased capacity for soakage and recharge of the shallow groundwater and surface water system; Mr Kirk's evidence describes how this would occur. Second, any lowering of groundwater levels provides increased capacity for surface water soakage during and following rainfall. Ultimately, I understand from

Mr Kirk's evidence that long term changes in the swamp wetland's water level and frequency of inundation would be negligible and difficult to detect against natural background change.

47 Mr Ingles concurs with this assessment and notes that for both the swamp wetland and valley floor marsh wetland the reduction in surface runoff would be within the range of natural variation, and less than what would be expected to occur already via afforestation of the catchment.

48 Mr Kirk and Mr Ingles consider the hydrological impacts to wetlands due to the landfill development to be slight, and essentially undetectable reduction in water supply. I nevertheless precautionarily consider it possible that the landfill may somewhat exacerbate or increase the frequency or duration of low water level conditions (even if this is within the range of natural or already permitted variation).

49 In considering the possible ecological effects of a potential reduction in water level, it is important to note that different types of wetlands vary enormously in the degree to which they are inundated (peak water levels may be above, at, or just below ground surface), and the duration of that inundation (permanent, seasonal, or following rain events or other periodic inputs). As I have described, the swamp wetland has only limited areas where water sits above ground level (and this is in channels that sit below the main wetland level), and wetland margins that are likely dry for long periods (such as I have observed on site in late summer conditions). In this context, the worst-case effect of an increased frequency or duration of lower wetland water levels in the swamp wetland would primarily be to alter habitat suitability within this area for some existing wetland plant species.

50 I consider that effects would arise primarily to exotic wetland species (herbs and grasses such as watercress and sweetgrass) that currently occupy waterlogged channel areas where any water level reduction would be most likely to be apparent. I expect that the indigenous species present elsewhere in the swamp wetland will be resilient to this change; they give the area its character as habitat and its ecological value.

51 I do not think that such a change would compromise the persistence of the swamp wetland as such (i.e., convert it fully or convert any appreciable portion of its extent to dryland habitat). In the EcIA I have assessed the likely magnitude of effect due to hydrological changes as low (which equates to a low level of effect, i.e., a less than minor to minor effect). In the context of the further discussion on expected wetland hydrological effects (i.e., in my evidence and in that of Mr Kirk and Mr Ingles), this a very conservative assessment. I also consider the magnitude of effects to the

upstream sedgeland in West Gully 4 and downstream valley floor marsh wetland to be neutral or positive (i.e., no effect or net gain) and negligible (very low level) respectively. The reasons behind this assessment are further explained later in my evidence.

52 No indigenous plant species I have observed in the swamp wetland are fully reliant on permanent or near-permanent inundation. Indeed, most are so-called 'facultative' or 'facultative wetland' species, meaning they occur naturally outside wetlands, and many are typical of wetland types that naturally have a variable water table. While pūrei is an 'obligate' wetland species, meaning it typically grows in soils that are often or constantly saturated with water during the growing season and it is rarely found in non-wetlands, it is also adapted to occasional and even prolonged dry periods such as may occur at present during summer. This also applies to harakeke and rautahi to a similar or greater degree, being that these are 'facultative wetland' species that can often be found in non-wetlands. In light of the above discussion on the degree to which runoff would change under the landfill scenario, I do not see the hydrology effects of the landfill reaching a tipping point altogether for these species in the swamp wetland but consider in the worst case a slight contraction of suitable habitat for obligate wetland species is possible (in the swamp wetland, for indigenous species, this applies only to pūrei and one other common sedge species). However, if this slight contraction of suitable habitat for obligate species occurs (because water levels drop somewhat), existing well-established sedges will likely persist. I therefore consider habitat will remain generally suitable for the existing indigenous plant species in the swamp wetland, across a similar extent, maintaining the overall type and condition of this habitat. The situation would be different were the wetland occupied by more sensitive species such as raupō or indigenous aquatic plants (which do not tolerate long dry periods), or if it was a wetland type that featured large shallow water areas or was otherwise particularly sensitive to a specific inundation regime. Instead, the evidence is that the swamp wetland's water levels are relatively stable, and the plants within it are tolerant of variable water levels.

53 Mr Ingles describes in his evidence the existing situation of variable runoff rates and water quality depending on the stage of the forestry cycle. Maturing plantation forests gradually take up more water, reducing net runoff in terms of yield, low flows, and peak flows. In contrast, native forest and wetland areas are generally understood to deliver runoff relatively more slowly following rain compared to exotic forest areas, providing the basis for higher base flows. The catchments of West Gully 2, 3, and 4 (to the southwest and west, which also support wetland habitat) supply water to the swamp wetland, would remain entirely or largely separate from the landfill footprint, and would retain their existing cover of regenerating forest

patches and maturing radiata pines. These areas comprise around half the swamp wetland's catchment; changes in these areas will also influence the swamp wetland in time.

54 With respect to the sedgeland upstream of the swamp wetland (below West Gully 4), under the landfill scenario this would receive more stable recharge following rain because it would receive gradual runoff / soakage from the attenuation basin, as described by Mr Kirk. None of the catchment of this area is landfill, so although some of the catchment would be occupied by the attenuation basin and a stockpile area, all existing runoff would essentially continue (i.e., none would be intercepted as leachate) along with additional clean runoff reporting to the attenuation basin from areas not currently in the West Gully 4 catchment. Ecological effects to the sedgeland due to hydrological change were assessed as neutral in the EcIA, but this did not fully take into account the retention of runoff in the attenuation basin and use of a floating decant to deliver it gradually downstream as described by Mr Kirk.

55 I now consider the effect may in fact be positive (a net gain for this area) given its effective catchment would increase following construction of the attenuation basin, and there may be some capacity to sustain an expanded width of wetland habitat in this area and / or for conditions to exclude 'facultative upland' weeds (such as gorse). Increased flows from the attenuation basin via the upstream sedgeland (along with sedgeland enhancement via draft VRMP recommendations) would assist in delivering downstream recharge to the swamp wetland, more than making up for the loss of groundwater, buffering the effect of large rainfall events, and hence stabilising swamp wetland water supply.

56 Wetland enhancement measures in the VRMP would enhance the diversity and cover of indigenous species in the swamp wetland and would also maintain resilience to and mitigate the effects of any changes in water supply. These measures include removal of forestry slash that may be attenuating material and raising the ground level in places, and removal of fast-growing exotic weeds that may compete with indigenous species for water. In addition, dense infill planting of wetland species that are appropriate to the wetland type and are also adapted to periodic drying would occur, along with planting of terrestrial vegetation in a buffer around wetland areas to reduce weed reinvasion. The presence of dense buffering vegetation would likely reduce excess sediment inputs from forestry harvest or other currently unmanaged runoff and would likely promote soil development and increased moisture retention. These measures would be implemented across the entire swamp wetland and upstream wetlands

(c.0.96 ha) as an upfront restoration irrespective of the actual observed magnitude of hydrological effects.

57 The above matters lead to four broad conclusions that form the basis of my assessment of low level ecological effects to the swamp wetland:

(a) First, the swamp wetland is comprised of indigenous species tolerant of periodic or even prolonged dry periods and is located in an area of stable groundwater levels due to low gradients and minimal underdrainage. The wetland has established and / or persisted against an existing regime of variable runoff, including climatic variability and the likely greatly reduced runoff of mature pine forests as compared to the current scenario following recent forestry harvest. It is entirely possible that wetland water levels (i.e., a wetted channel with dense exotic herb / grass growth) observed in preparation of the EcIA are currently and temporarily higher than they have been in recent years, prior to harvest.

(b) Second, and in relation to the above point, landfill effects of reduced runoff to the swamp wetland should be considered against the permitted baseline scenario due to forestry, in which trees would otherwise continue to mature across most of the catchment, also leading to reduced runoff to wetland areas, compared to existing levels. The existing forestry land use also leads to effects in terms of sediment and contaminant runoff to wetlands.

(c) Third, beneficial effects following implementation of VRMP measures to the upstream sedgeland in West Gully 4, the kānuka forest and flaxland beneath it in West Gully 3, and the effect of the attenuation basin on the upstream sedgeland could be expected to deliver improved / stabilised downstream recharge to the swamp wetland as the integrity of these habitats improves. Other surrounding areas of plantation forestry would maintain their existing variable runoff rates depending on the stage of the forestry.

58 Fourth, I think it is highly unlikely that the entire annual runoff from the entirety of the swamp wetland's catchment would be required per se to sustain wetland habitat vegetation, considering the area is a narrow low-angle area of valley floor with poorly draining soils where water will naturally accumulate. The fact that several much smaller gullies (sub-catchments with much lesser catchment yields) in the area (such as in West Gully 3) also sustain similar wetland habitat strongly supports this conclusion. Further, Mr Kirk's and Mr Ingles' evidence is that there is little existing soakage beyond shallow groundwater, and around 13% of annual runoff

from larger rain events runs off rapidly through the swamp and valley floor marsh wetland systems. Therefore, the reduction of up to 20% of current catchment yield would be of low consequence, especially as any reduction in base water supply due to the landfill may simply be mitigated by an increased capacity to capture a relatively higher proportion of otherwise excess runoff during larger rain events, and stabilised runoff from upstream.

59 For the valley floor marsh wetland, downstream hydrology effects to this wetland are assessed as negligible, being a very low (less than minor) level of effect. This conclusion is reached considering Mr Kirk's and Mr Ingles' combined evidence regarding the low degree of change to the swamp wetland and the capacity to retain a greater proportion of rainfall if water levels diminish. Further, there is a gradually decreasing influence of the landfill site down valley as a proportion of the valley floor marsh wetland's catchment. The same points regarding variable runoff due to forestry under the current scenario also apply to the valley floor marsh wetland; forestry along its length was harvested shortly prior to the harvest in the landfill site area.

60 Further, I have observed in two dry periods (April 2021 and February 2022) a large, constructed pond in the valley floor marsh wetland retaining substantial deep water and slowly releasing it downstream. Mr Ingles notes that this feature (and the swamp wetland connected upstream) is likely of importance in buffering downstream water flows (particularly in channel areas) in the valley floor marsh wetland system, and most (c. 3/4) of the length of this wetland is below the downstream pond. His evidence is that the swamp wetland and pond would continue to retain excess water following small to medium rain events for later downstream recharge. What this practically means for wetland vegetation and habitat is that for the area immediately below the designation, the influence of the swamp wetland and downstream pond would likely buffer the effects of any change in net runoff due to the landfill upstream. I therefore do not expect any net loss of the significant features of the valley floor marsh wetland habitat, nor change to its extent or condition resulting from the landfill development.

Response to ORC section 95 report and additional questions on ecology matters raised by ORC

61 In a technical review of the EcIA prepared for ORC's s95 report, Josh Markham of Tonkin & Taylor Ltd. (T+T) requested supporting information in relation to the EcIA's assessment of downstream wetland effects. The review stated that the "*magnitude and level of effect* […] *appear to be understated without sufficient supporting information. The construction and management of the landfill has the potential to significantly alter hydraulic*

connectivity or input into any downstream wetlands which could cause a decrease in wetland area and the alteration or loss of species assemblages." These matters were discussed further with Josh Markham and Mike Lake from T+T in a phone conversation on 14 March 2022 which highlighted the need to further consider the change to hydrology and baseflow, and also nutrient / leachate runoff and the subsequent effects of this to wetland vegetation.

62 In response to the second matter, I refer to Section 5.1.4 of the EcIA, in which the matter of contaminant discharge (i.e., nutrient / leachate runoff) to wetlands is discussed in relation to the findings of GHD's surface and groundwater assessments (i.e., Mr Ingles' and Mr Kirk's evidence). Mr Kirk's evidence is that a large number of groundwater and surface water contaminants already exceed water quality guidelines in the proposed landfill's catchment due most likely to fertilisers and other chemicals used for forestry. I have already described that this may drive the dense thatch of exotic herb and grass growth seen in wetland channel areas. Mr Kirk also states that, due to landfill lining, the flux of most water quality parameters would decrease following the landfill development. On this basis the EcIA assessed the effects to wetlands in terms of contaminant runoff were likely a net positive impact. In terms of leachate runoff, I understand that a revised performance assessment of the landfill liner in the evidence of Mr Kirk has predicted a slight increase in leachate leakage of up to a "*peak of 1.4 m^3/year*[21] *during both Stage 4 and after closure. Contaminant concentrations in the leaked leachate are likely to be greatest when waste is exposed during operation and will then decrease after closure*." Mr Kirk describes this in detail but concludes (in what he describes as a conservative assessment) that water quality effects to surface water and shallow groundwater (which could both influence wetlands) are ultimately less than minor.

63 The specific contaminants that are likely to increase (from the evidence of Mr Kirk) and that in my view are of concern to the growth of vegetation are iron, lead, dissolved reactive phosphorus (DRP), ammoniacal nitrogen, and chromium. Ammoniacal nitrogen (once transformed in soils by microbial action to nitrate) and DRP are generally plant fertilisers. Heavy metals on the other hand are typically detrimental to plant growth. However, wetland habitats are particularly well-adapted to contaminant mitigation due to microbial and chemical reactions in inundated soils (indeed they are popularly referred to as earth's 'kidneys'). Further, one of the chief

[21] As against up to 46,300 m^3/year intercepted by the leachate system and compared to a predicted annual water yield of clean runoff of c.270,000 m^3/year to the swamp wetland during landfill operation and closure.

components of the vegetative cover in narrow wetted channel areas of the swamp wetland and valley floor marsh wetland (where I expect surface runoff and shallow groundwater to emerge) is watercress, an exotic species known to tolerate and accumulate large concentrations of contaminants including chromium (although I understand it is not quite considered a 'hyperaccumulator' of toxins, unlike related brassica species). From this further analysis, I conclude that my assessment in the EcIA of a positive impact remains, or even if I adopt a more conservative view (based on the revised liner assessment) at worst there is a neutral effect given baseline conditions.

64 In a technical review of the EcIA prepared for ORC's s95 report, in an ORC ecology 'matters for further discussion' document (dated 2 March 2022), the inadequacy of proposed wetland monitoring during landfill operation was raised. ORC stated: "*Monitoring should be established to ensure that the actual magnitude of effects is negligible or low. Wetlands are particularly sensitive to changes in hydrology, and it would therefore be appropriate to monitor changes in wetland extent as well*. *If the magnitude of effects is moderate or higher then additional effects management will need to be triggered.* […] *No ecological monitoring is proposed to ensure that the actual effects will be as low as predicted."*

65 In response, I have discussed the specific sensitivity of the swamp wetland previously in my evidence, and I note my general agreement with the need to monitor adverse effects. Accordingly, monitoring of wetland extent and condition (as well as the success of restoration efforts) was proposed in the draft VRMP. I do however acknowledge that the proposed monitoring approach was not particularly detailed, as it largely referred to the use of existing national protocols for wetland monitoring. Updated draft consent conditions have subsequently been developed that now refer to the use of detailed hydrological monitoring (for both levels and water quality) as part of the proposed RWEMP. The proposed monitoring locations are also shown on GHD water monitoring locations plan (drawing no. C309) attached to Mr Kirk's evidence.

66 T+T also considered that the EcIA and responses to s92 requests provided insufficient information to support a Biodiversity Offset Accounting Model (BOAM, see Appendix 7 of the EcIA) used to demonstrate the adequacy of a wetlands offset proposal. T+T was hence unsatisfied that no net loss (or net gain) had been sufficiently demonstrated in relation to wetland impacts. For vegetation and wetlands, the only adverse ecological effect identified in the EcIA that would not be mitigated at the point of impact, and hence would be offset, was the effect of 16.5 m^2 of roadside wetland reclamation (which would have been offset by VRMP measures to enhance 0.49 ha of wetland

enhancement upstream of the swamp wetland below West Gully 4). Since further updates to the road design now avoid roadside wetland reclamation entirely, I consider that further discussion on the BOAM matter in my evidence is no longer required.

67 Further, as noted previously, the applicant still intends to enhance the West Gully 4 wetland area, despite the lack of roadside wetland reclamation to require an offset on an effects basis. The draft VRMP outlines an overall wetland restoration for the entire connected wetland area in the landfill designation (the swamp wetland, and upstream wetlands in West Gully 3 and 4). This is despite the fact there would be no adverse effects to West Gully 3 or 4 themselves; but it nevertheless is a logical step to restore the connected upstream wetlands as well, rather than the swamp wetland in isolation.

68 Draft conditions proposed by T+T and raised in the ORC ecology 'matters for further discussion' document made a number of references to the use of biodiversity offset and compensation modelling approaches such as BOAM, including a draft condition that: "*residual adverse effects associated with construction and / or operational activities on freshwater, terrestrial and wetland ecology must be offset and / or compensated using the effects management hierarchy and methodologies as set out in Stream Ecological Valuation (SEV): a method for assessing the ecological functions of Auckland Streams (October 2011), Biodiversity Offsetting Under the Resource Management Act* [BOAM]*: a guidance document (September 2018),* [and] *A Biodiversity Compensation Model* [BCM] *for New Zealand: a user guide – version 1 (October 2021).*"

69 In response, first, the EcIA assessment for vegetation and wetlands concluded low to very low levels of ecological effect prior to any implementation of any enhancement measures (such as VRMP measures). The ultimate level of effect to the swamp wetland following implementation of the proposed impact management measures was assessed as a net gain. Because no direct intervention in the valley floor marsh wetland (or in plantation forestry or roadside grassland areas) is proposed, the assessment remains as very low. Following the EIANZ EcIA method, which states that "*Low and Very Low levels should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects*", residual effects to vegetation and wetlands do not require offsetting.

70 In my view, very low-level effects do not necessarily imply there are measurable residual adverse effects; in my assessment it means that a possible effect has been considered and found to be essentially

inconsequential or below any reasonably discernible threshold. What the assessment of very low effects for the valley floor marsh wetland means is that I do not expect any net loss of the significant features of this area (in terms of wetland type, extent, or condition).

71 Based on Mr Kirk's and Mr Ingles' evidence in relation to downstream flows, this assessment is made regardless of whether VRMP measures are implemented in the swamp wetland upstream. However, it follows to me that a net gain outcome (in terms of condition, and resilience to hydrological change) for the swamp wetland following VRMP measures means that downstream there would remain no discernible difference in downstream water supply, and in fact there would be an increase in indigenous seed source, and quality of adjacent habitat for fauna. Hence, I do not expect there to be any residual adverse effects to the valley floor marsh wetland system.

72 Second, unexpected or greater than predicted wetland effects detected through monitoring (see my response to ORC Section s42a report) may still be remedied or mitigated at the point of impact (i.e., within the swamp wetland itself) through the application of an adaptive management approach. If these unexpected or greater than predicted wetland effects can be remedied or mitigated in accordance with the effects management hierarchy, they would not require offset or compensation. Offset or compensation broadly refer to actions taken elsewhere and / or actions that do not directly relate to the type of adverse effect being managed.

73 Third, while I consider that there is no ecological reason why a modelling approach is absolutely required to determine appropriate actions, I agree that models may assist the process. I do note that the application and development of the BCM and BOAM models is a relatively recent and evolving area of best practice.

74 I am therefore of the opinion that expressly conditioning the use of the BOAM / BCM methods in their current form (i.e., the methods as published in 2018 and 2021 respectively) risks setting in stone methods that are likely to be further refined and improved by ecology practitioners over the 35-year lifetime of the landfill. A separate and accepted draft condition requires expert peer review of management plans and provides an additional layer of confidence that appropriate and adaptive management actions will be undertaken, and this approach allows for better flexibility as best practice methodologies evolve. Further discussion on the BOAM / BCM matter is provided elsewhere in my evidence.

Response to ORC Section 42A report

75 ORC's s42a report refers to ongoing uncertainty with respect to the assessment of downstream hydrology effects to wetlands. ORC's expert Mr Cochrane stated he was "*unable to draw a confident conclusion regarding the effect of reduced surface runoff on wetland hydrology due to the following reasons:*

- "*The magnitude of this effect on surface water flows, water level changes and the swamp wetland (and potentially valley floor wetlands) has not been quantified or evaluated.*
- "*The extent to which soakage from the base of the Attenuation Pond will mitigate this effect is not quantified and there are no details in the application on how the Attenuation Pond would achieve this and maintain recharge in the long-term.*
- *"It is not clear whether the discharge from the Attenuation Pond's low-level outlet will affect the swamp wetland hydrology (and potentially valley floor wetland hydrology). Furthermore, recommended monitoring of water levels in the swamp wetland has not been included in the proposed consent conditions. I am not, therefore, satisfied that adverse effects on the swamp wetland and valley floor wetland have been adequately addressed.*"

76 In response, I refer back to my earlier discussion of the degree of hydrological change to the swamp wetland, which is based on the evidence of Mr Kirk and Mr Ingles and in turn what I would expect as an ecological response. The magnitude of effect to the swamp wetland was quantified as low and was evaluated in terms of a possible shift in habitat suitability for a small number of largely exotic plant species. Detail regarding the attenuation basin is provided in Mr Kirk's evidence. Briefly, from an ecological perspective, increasing and stabilising the supply of water (in this case from the attenuation basin) to wetland types such as these is entirely beneficial.

77 ORC's s42a report also noted Mr Markham's comment *"that there still isn't enough specific information on the tolerance of these wetlands to any potential alteration of hydraulic regime to make a conclusion regarding the quantum of ecological effects."* Further discussion of the tolerance of wetlands at the site (particularly the swamp wetland) to a variable hydrological regime is included in my evidence.

78 Aside from the need for further assessment detail, I suggest that the crucial outstanding matters in ORC's s42a report with respect to wetland effects could be summarised as:

(a) A need for monitoring (addressed in my evidence above, and in updated draft conditions including those requiring preparation of a RWEMP and a FWMMP), and;

(b) The response to residual effects, and whether specific modelling methods must be the means by which any responses are quantified and measured.

79 In respect of (b), ORC's s42a report notes "*the applicant did not provide BOAM's [sic] for potential residual effects on […] terrestrial/freshwater habitats. Consequently, Mr Markham recommends that the Freshwater and Wetland Management Plan […] include[s] a residual effects assessment using BOAM or BCM modelling, and that these plans define offset or compensation outcomes that appropriately address any residual effects.*"

80 For terrestrial habitats (other than a now-redundant BOAM for roadside wetland impacts), no BOAM was provided due to the very low level of effect arising to negligible value habitats (cutover plantation forestry and roadside grasslands; negligible value in terms of vegetation), meaning that in some areas there is essentially no adverse ecological effect to justify any offset. For the swamp wetland, as the VRMP measures are a mitigation of the expected effect at the point of impact, no BOAM was provided because the measures proposed are not offsets. Further, I have assessed the result of these measures to equate to a net gain, meaning there are no residual adverse effects to account for. Indeed, I consider it to be a substantive net gain – a wetland with substantial exotic weed cover and no existing fencing or buffer from adjacent land use would receive intensive weed control, indigenous planting, fencing, and predator control, as against a slight hydrological effect – and I do not think a modelling approach is required to demonstrate this point as against a plain reading. I accept the utility of using models in situations where the proposed measures stray towards a minimal response to achieve a neutral / no net loss outcome. However, in this case, the applicant has accepted a very comprehensive ecological restoration plan despite the adverse effects of the landfill proposal arising to an already degraded wetland area being of a low level (and potentially of a lesser level than likely changes due to forestry).

81 Regarding monitoring, to detect any water level changes due to landfill construction, RWEMP measures include continuous wetland monitoring via piezometers. These would be installed at locations WT1-6 and effectively

monitor a vertical and horizontal cross-section of representative wetland areas below the landfill and a control location in West Gully 3. The RWEMP is also discussed in the evidence of Mr Ingles and Mr Kirk, and monitoring locations are mapped in Drawing C309 of Mr Kirk's evidence). Water level monitoring at the swamp wetland's outer edges (WT2 and WT4) will investigate the likely most variable areas (in terms of water level), and other monitoring points would look at relatively more stable central wetland areas above, beneath, and further below the landfill. Wetland vegetation monitoring requires repeat baseline measures of wetland extent and cover prior to landfill construction and finalisation of the VRMP. Following construction and implementation of VRMP measures, further monitoring is required in accordance with relevant consent conditions in relation to the success of VRMP measures (planting survival and growth). Finally, ongoing monitoring of wetland extent against the baseline, and adaptive response measures, are both required by consent condition to develop a FWMMP. Restoration and monitoring plans are required to be certified and regularly reviewed an independent peer-review panel in consultation with local rūnanga.

82 VRMP measures will alter (improve) wetland vegetation composition (via planting and weeding) within the swamp wetland and at the margins, and this will confound to a degree the water level and vegetation monitoring that will be implemented[22]. In this context, it is not clear what other residual effects to wetlands might occur (none have been identified in the s95, s42a, or peer review reports), nor how these might be detected. Assuming this means an unexpected degree of effect (rather than a new type of effect) the most obvious scenario would be that in a worst-case water level changes mean that the current wetland extent is not maintained, and / or that restoration efforts are unsuccessful (e.g., plantings do not establish).

83 If a reduction in wetland extent was observed, it would be possible to use an engineered bund[23] to increase water retention in the swamp wetland to increase water levels and reverse this loss. This approach to wetland expansion is relatively standard, but I suggest that it be a last-resort adaptive management option that would be detailed in the proposed FWMMP (the FWMMP would have an adaptive management framework; I did not include this option in the draft VRMP which relates largely to upfront restoration measures). Such an intervention would be justified only if effects were due to wetland water level changes resulting from the landfill development (detected via the RWEMP and FWMMP) rather than due to

[22] Hence, baseline monitoring is important prior to plan implementation, including at control locations.

[23] I note such an activity would likely require an additional resource consent.

background climatic changes[22]. Although I think this scenario is highly unlikely, the point is that well-tested and relatively straightforward measures are available to address a worse than expected outcome. I consider the outcome for the swamp wetland to be the critical matter requiring both monitoring and response. Being downstream, the valley floor marsh wetland will generally reflect what happens in the whole catchment above, and it appears well buffered against even a more substantive hydrological change than what is expected (by other catchment inputs, the influence of the downstream pond, and by the same circumstances of low gradient and minimal drainage).

84 Whilst I have already responded to the BOAM / BCM matter in elsewhere in my evidence , I note the following statement in relation to offset and compensation from the ORC s42a report: *"the key difference here is that Mr Markham's standalone condition is more specific in that all residual adverse effects on freshwater, terrestrial and wetland ecology must be offset and/or compensated, whereas the applicant's advice note may result in some uncertainty regarding when/where offsetting/compensation is required."* I agree with this analysis but disagree with the implication. For terrestrial and wetland vegetation, no adverse effects (following implementation of VRMP measures) are of more than a very low level, and even these very low-level effects (to cutover plantation forestry, roadside grasslands, or the valley floor marsh wetland) would not result in any net loss of the significant feature of those areas.

85 In some cases, the significant feature of an area is the presence or possible presence of fauna, not the vegetation. For example, for eastern falcon that may occupy cutover plantation forestry areas (and I refer to Ms Sievwright's evidence) it is the specific management of that species to avoid direct impacts that ensures 'no net loss' of the ecologically significant feature. I do not consider 'no net loss' in this instance to mean an exotic pine forest area cannot itself be cleared because it is occupied by such a species when ample similar habitat for it is available in the immediate area. This means that there are some 'very low' level effects to vegetation that I do not consider are residual adverse effects that warrant a response. And, for areas of greater concern (e.g., the swamp wetland), remedy or mitigation measures are available that directly address adverse effects at the point of impact even if greater than expected effects (detected by wetland and water level monitoring) arise – such measures would not necessarily be offsets or compensation, nor do they necessarily require a modelling approach to determine an appropriate response (or quantum of response).

Response to matters raised in relevant submissions

86 Many submitters[24] have raised the matter of adverse effects to wetlands, particularly hydrology effects, similarly to what has been raised in ORC's s95 report, s42a report, and expert peer review. Submitters have raised the national loss of wetland habitats as a key concern and note the recent implementation of the National Policy Statement for Freshwater Management 2020 and the National Environmental Standards for Freshwater 2020 (NES-F) in relation to wetlands and freshwater. Discussion of the NES-F rules that apply to the project is addressed in the planning evidence of Maurice Dale, but I note my broad agreement with submitters that wetland effects should be avoided as a matter of priority. I consider that the redesigns of the landfill and road upgrades meet this goal, especially now that a further updated road design means that there is no wetland reclamation resulting from the proposal. The limited degree of likely impact to downstream wetlands is discussed earlier in my evidence; this discussion is intended to provide further detail in relation to submitters' concerns. Further, I consider implementation of the draft VRMP measures would fully mitigate possible low level adverse effects of the proposal to the swamp wetland and would see clear benefits (net gain) to the existing swamp wetland and upstream wetland areas at the landfill site, by reducing existing substantial weed cover, reducing the ongoing impacts of forestry, and by improving indigenous plant species cover and diversity. Adaptive responses via the FWMMP are also available to ensure the expected outcomes occur.

87 The submission on behalf of the Director General of Conservation requests conditions that require continuous monitoring of wetland water level and that contain clear and effects-based objectives and performance standards such as annual monitoring of measures of wetland health (wetland extent and vegetation cover). I agree with the submission and acknowledge that while the draft VRMP lodged with the application did include general wetland monitoring measures, these did not include wetland water level monitoring nor detail regarding adaptive management responses (because, in my opinion, worst case adverse effects would have been addressed upfront to a net gain level). This matter has been discussed earlier in my evidence and is now addressed in the updated draft conditions that require continuous wetland water level monitoring (via a RWEMP), baseline

[24] For example, similar matters are raised in the submissions of Big Stone Forest (S & A Ramsey); Ingrid Leary MP for Taieri; Ōtokia Creek and Marsh Habitat Trust; and the Royal Forest and Bird Protection Society; among many others.

wetland monitoring, and post-construction monitoring of planting success, wetland extent, and response measures (via the FWMMP).

88 A submission by the Ōtokia Creek and Marsh Habitat Trust was critical of EIANZ EcIA method used in EcIA preparation (including vegetation and wetlands assessment) but does not suggest an alternative method. The EIANZ EcIA method is an industry best-practice approach first published in 2015, with substantive review last undertaken in 2018. It has been widely applied in consenting processes since that time and is also the accepted assessment method of ORC's EcIA technical peer reviewers from T+T.

89 The submission of A & M Granger suggests that the landfill site should be surrounded in predator-proof fencing and converted to native forest following closure. I encourage the intent of the submitter, but I understand that establishment of deep-rooted vegetation on the landfill cap is not possible due to the need to maintain the integrity of the capping surface. Regenerating native forest and wetland areas would be at least partially fenced (refer to the draft VRMP) but this is not proposed to be predator-proof. Generally, it is only cost-effective and ecologically beneficial to apply predator-proof fencing to large areas (100s-1000s of ha) of existing (and preferably mature) indigenous forest habitat. Predator trapping (as in the LMP's proposed Plant and Animal Pest Control Programme) is effective, especially in small areas, in the absence of predator-proof fencing.

90 Many submitters express concern in relation to the possible risk of escape of landfill leachate affecting wetland habitat, including in areas as far downstream as the coast at Brighton. I leave discussion in regard to the likelihood of this scenario to the evidence of Mr Kirk, and Mr Ingles. However, based on their evidence, I have considered the potential effects of contaminants (leachate leakage) to wetlands immediately downstream of the landfill (the swamp wetland and valley floor marsh wetland) where any influence of the landfill would be greatest. I conclude there is a positive or neutral effect to wetlands immediately below the landfill (the swamp wetland and valley floor marsh wetland), given elevated surface and groundwater contaminants are already present, and lining of the landfill and leachate interception would reduce (rather than increase) the flux of many existing contaminants, and these contaminants are variously beneficial or detrimental to the growth of vegetation.

91 The submission of the Royal Forest and Bird Protection Society requests "*no earthworks for the landfill or road upgrades to occur within, or within 100m of natural wetlands where those earthworks may result in the partial drainage of the wetland*." No earthworks would occur in wetlands, because the works footprint for the McLaren Gully Rd upgrade now avoids these

areas. The extent to which landfill construction will result in wetland reclamation or hydrological effects (i.e., possible 'partial drainage') to the swamp wetland or valley floor marsh wetland is discussed earlier in my evidence. It is likely similar broad effects would arise from a similar landfill design located further upslope of the wetland, so in this case the 100 m distance is arbitrary, and I do not consider such a condition likely to have ecological benefit. Road upgrades are highly unlikely to have any hydrological effects to wetlands or cause 'partial drainage' because works would occur only in the existing road corridor (in areas immediately adjacent to wetlands) and avoid wetland areas themselves. Upgrades are proposed to use existing culverts or culverts dug to the same level, meaning that existing water retention and drainage patterns would be maintained. Finally, the roadside wetlands would still naturally receive all runoff from surrounding land areas (including runoff from the upgraded road) since both they and the road occupy the valley bottom.

Conclusion

92 The conclusion of my assessment of ecological effects to terrestrial vegetation and wetland habitats is that the proposed landfill development and road upgrades would directly affect areas of recently cutover plantation forestry and exotic roadside grasslands. I find that these areas are exotic vegetation types that are already generally subject to intensive land uses (plantation forestry, farming, and road maintenance). They contain only scarce individuals of indigenous plant species that are locally and nationally common and are typical of recently disturbed or heavily modified areas. Other than the need to appropriately manage effects to fauna that may occupy these areas (discussed in the evidence of Ms Sievwright and Ms King), I find that the clearance of these areas for landfill works is not of ecological concern.

93 Below the landfill and other site works, ecologically significant wetland areas of moderate ecological value occupy poorly draining and low gradient valley bottoms. The potential for the landfill development to have indirect ecological effects due to changes (reductions) in hydrological inputs to these wetland areas has been the main focus of my ecological assessment, of technical review, of ORC's s95 and s42a reports, and for submitters. The evidence of others in relation to groundwater and surface water concludes that not only would any hydrological changes be slight, and scarcely detectable, they would be within the already expected range of fluctuation due to natural climate variability and existing land use.

94 In turn, I find that any reduction in water levels may at worst slightly alter habitat suitability for largely exotic species that occupy a currently wetted

channel in a ‘swamp wetland’ area at the landfill toe but would not alter the extent or indigenous plant values of the swamp wetland. Implementation of VRMP measures would enhance this habitat, fully addressing possible low-level effects due to hydrological change to achieve a net gain outcome. Comprehensive wetland vegetation monitoring and continuous water level monitoring both prior to and during landfill construction / operation (via the RWEMP) allow for an adaptive management framework (via the FWMMP) to ensure effects of the landfill are appropriately managed to ensure the outcome that any adverse effects are fully mitigated (to a net gain level) at the point of impact.

95 Upstream of the swamp wetland, connected wetland areas would receive the benefits of additional runoff from an attenuation basin and / or by restoration actions outlined in a draft VRMP required under condition of consent. Downstream, in a valley floor marsh wetland area, I do not expect any net loss of the significant features of the valley floor marsh wetland habitat, nor change to its extent or condition resulting from the landfill development. Being downstream, the valley floor marsh wetland will generally reflect what happens in the whole catchment above, and it appears well buffered against even a more substantive hydrological change than what is expected. I also do not expect any adverse effects to roadside wetlands, which are now to be fully avoided due to a road design update.

96 The general matter of residual ecological effects and how responses might be appropriately addressed and quantified as also been a focus of expert peer review and the s95 and s42a process. To me, this matter turns firstly on whether there are reasonably measurable residual adverse effects, secondly whether these can be remedied or mitigated in accordance with the effects management hierarchy, or if they would require offset or compensation, and thirdly on whether modelling is the only acceptable approach to quantify responses. Proposed draft consent conditions would require the use of BOAM / BCM modelling approaches to demonstrate an appropriate quantum of response. I agree that models may assist the process but consider that there is no ecological reason why a modelling approach is required. In my opinion monitoring, an adaptive management framework, and the requirements of consent conditions for management and restoration plans to be certified and regularly reviewed by an independent peer-review panel in consultation with local rūnanga ensures responses will be appropriate and adapted in accordance with ongoing development of ecological best practice, over the lifetime of the landfill.

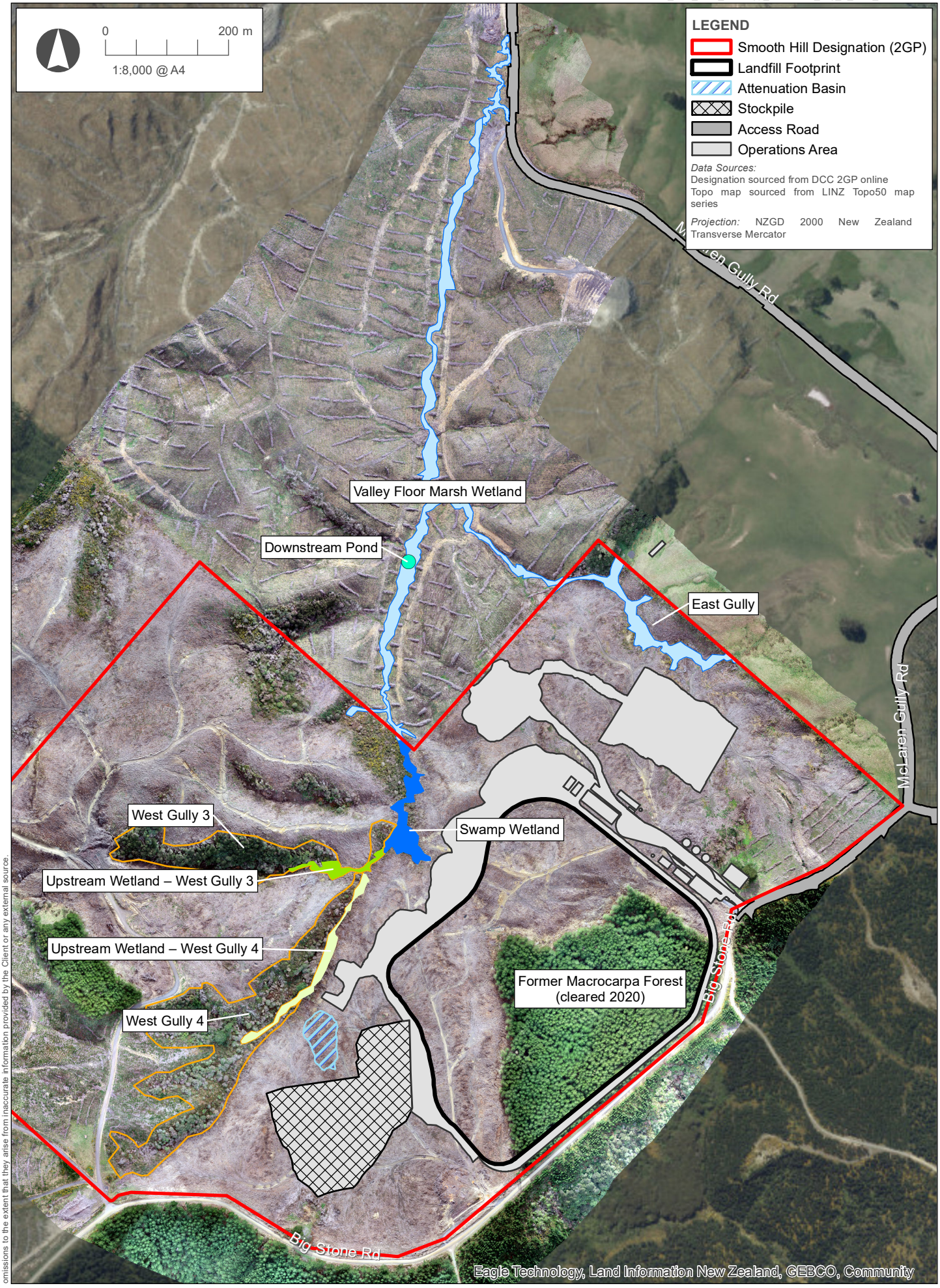
97 This leads me to the overall conclusion that the adverse ecological effects of the landfill to vegetation and wetland habitats would be either inconsequential or undetectable in most areas; these are typically highly

modified and / or exotic habitat types. Elsewhere, effects would be managed to achieve a beneficial outcome (a net gain) in ecologically more important wetland habitats.

Dr Jaz Nye Morris

29 April 2022

File Ref: BM200252_039_A4P_Ecology_Evidence_Fig_1_Site_Names.mxd



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SMOOTH HILL LANDFILL

Location Names Used in this Document

Date: 29 March 2022 | Revision: 1

Plan prepared for DCC by Boffa Miskell Limited

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Figure 1