ASSESSMENT OF ECOLOGICAL EFFECTS FOR A PROPOSED EXPANSION OF C & D LANDFILL, HAPPY VALLEY, WELLINGTON

JANUARY 2012

Contract Report No. 2438b

Prepared for:

C. & D. LANDFILL LIMITED
2 HAPPY VALLEY ROAD
OWHIRO BAY
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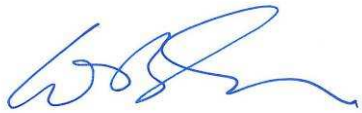

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1. INTRODUCTION

C&D Landfill Ltd have operated a construction and demolition materials landfill at 2 Landfill Road, Happy Valley, Owhiro Bay, Wellington, since about 1970's. Resource consents for continuance of the landfill operation have been issued by both the Wellington City Council and the Greater Wellington Regional Council. However, due to the configuration of the past landfill cells, and legal issues regarding works in the stream, works in part of the landfill site require additional resource consents. Also, since the issuing of the consents, risks have been identified with ongoing reliance on the pipe under the landfill and with the steepness of the batter slopes above the pipe. The current landfill configuration has the potential to act as a catchment dam (Photograph 1) and the continuing dependence on the pipe drain is no longer appropriate for either Burrell Demolition Ltd (owners of C&D Landfill Ltd) or the landowner Wellington City Council. Extension of the landfill area is, in part, to remedy the risk of this potential dam and to assist with the eventual re-establishment of overland flows. Further development of the landfill is the only practical way of funding the work needed to resolve these risks. It may be possible to stage further development of the landfill area over some 30 years (W. Miller pers. comm. 23 March 2011).

Currently, the unnamed stream (hereafter referred to as Landfill Road Stream Tributary) is piped beneath the landfill in a 900 mm diameter pipe, *c.*500 m long, which then flows beneath and along Landfill Road, to eventually join with the Owhiro Stream. The proposed extension will require additional piping of the stream, and clearance of vegetation currently within the proposed extension area. The current extent and proposed extension of the C&D landfill site are shown in Figure 1.

Wellington Regional Council has requested additional information and clarification on the resource consent application lodged by Burrell Demolition Limited (19 August 2009). This is to include:

- An ecological assessment of the Landfill Road Stream Tributary of the Owhiro Stream, to determine biota present upstream of the existing culvert. This assessment should assess the length of the proposed works (indicated to be c. 600 m) and provide comments on what effect the extension may have on the habitat of biota found.
- An assessment of existing culvert system and receiving stormwater network, as the condition and capacity of these are currently unknown. There are concerns that these could fail, particularly if additional fill is placed over them, and result in adverse effects upstream of the culvert.
- Details on proposed placement of pipe extensions and the construction of the overland flow path.
- Provide an erosion and sediment control plan for the site.

This report summarises the ecological assessment of the Landfill Road Stream Tributary, undertaken to determine what biota is present upstream of the existing culvert and the environmental and ecological issues associated with the proposed extension of the landfill.

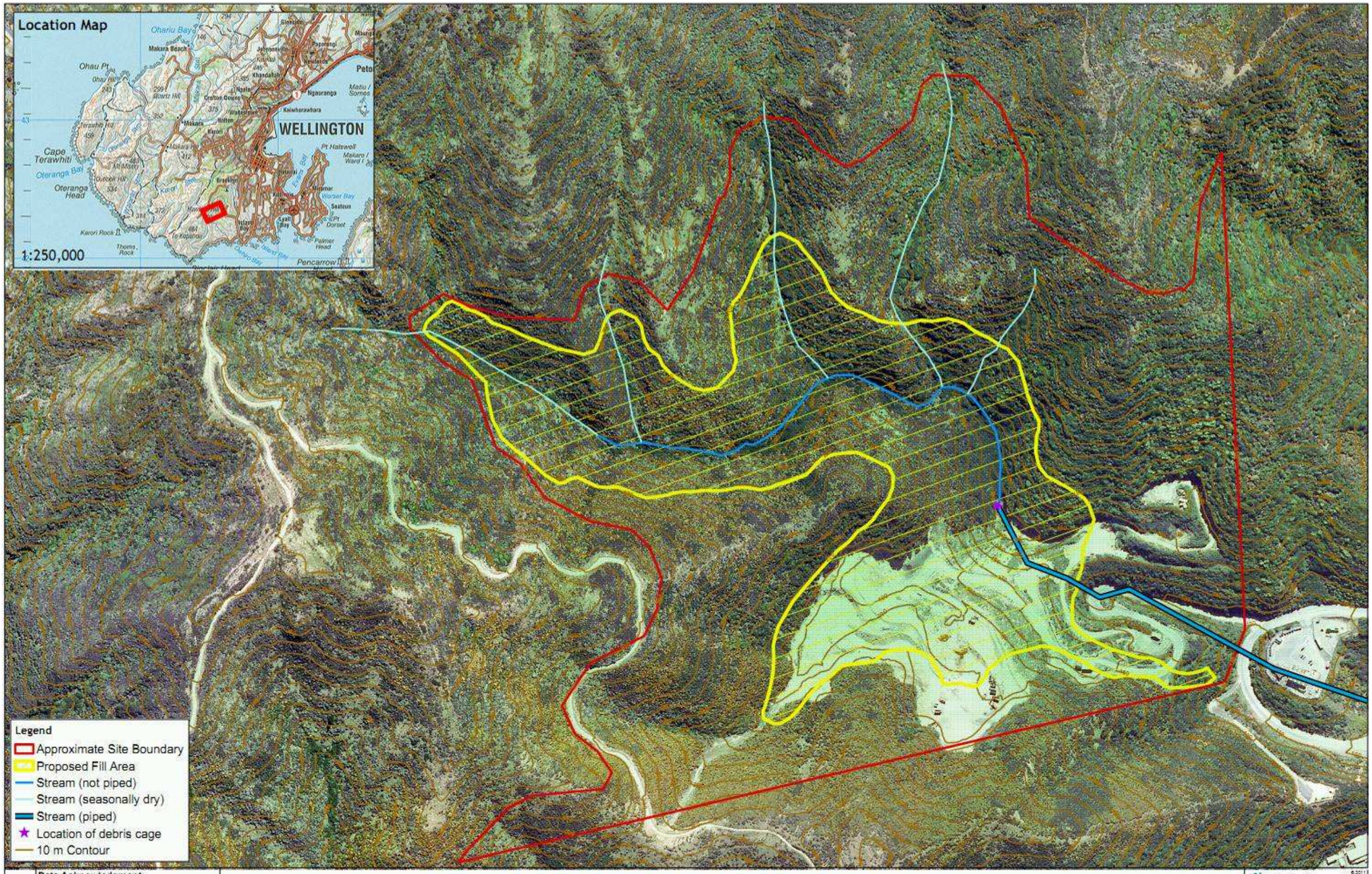
2. GENERAL SITE DESCRIPTION

The C&D Landfill site lies to the southwest of the Wellington Municipal Landfill site on Happy Valley Road, inland from Owhiro Bay, and to the southwest of Wellington City. The landfill site is leased from Wellington City Council and apparently includes the area up to the 300 m contour line (site boundary as indicated in Figure 1). Access is from Happy Valley Road via a hairpin road that climbs up previously-deposited layers of fill and previous cuttings. Most of the fill operation currently is to the southwest of the Landfill Road Stream Tributary (hereafter called the C&D Landfill Tributary). There are a number of filled platforms, or platforms that are currently being used for the deposition of building materials and other such waste. Overview photographs of the site can be found in Appendix 2, Photographs 1, 17 and 18.

The C&D Landfill Tributary is piped, via a 900 mm diameter pipe, for *c*.500 m beneath part of the site, as well as Landfill Road and the Wellington City Council waste recycling centre (Figure 1). This pipe has been installed and lengthened over several decades. Approximately 304 m of this piped section of stream lies within the subject site. Alex Burrell (pers. comm. 3 March 2011) indicated that the sections relevant to the C&D landfill site were installed in 1978, 1984, and 1999. At the upstream end of the pipe there is a steel cage which prevents larger debris from entering the pipe (Photograph 2). At this point the stream is at an elevation of c.132 m above sea level (a.s.l.). It is estimated that the stream has permanently flowing water for at least another 554 m upstream of the debris cage, to an elevation of *c*.250 m a.s.l. (Mahoney 2009). There are at least four smaller tributaries, often on very steep slopes, that feed in to the Owhiro Tributary. These had water in them at the time of the site visits, but may be seasonally dry for parts of the year.

Due to legal issues regarding works in the stream, works within the C&D Landfill Tributary has halted. Resource consents for other parts of the site have been issued by both the Wellington City Council and Greater Wellington Regional Council (W. Miller pers. comm. 23 March 2011) and these areas are still being filled. This has resulted in a very steep gradient embankment (c.40º from the horizontal, or 1:1.25; Mahoney 2009) of up to *c*.50 m tall descending into the stream valley (Vegetation type 8. 'Concrete' in Figure 2, Photographs 1, 3, 4, 5, 17, and 18). This embankment is, in part, covered with layers of waste concrete (Photographs 3, 4, and 5). It is estimated that the depth of fill over the pipe is up to 150 m in places (Mahoney 2009).

The fill method used at the site involves depositing large concrete debris on the edge of the escarpment, then filling up to this barrier, and the spaces between the large concrete debris, with smaller waste. At times, waste soil is available and this is used to cover the outer face of the fill sites. Soil depth on the faces is therefore likely to be thin. There has been no attempt to manage vegetation on the fill faces, either by sowing of desirable soil-retaining species, or by reducing weed species. When waste hot-seal, or other roading material, is available then this is used to build and reinforce the haul roads.



Data Acknowledgment
Aerials sourced from Greater Wellington
http://apps.wcc.govt.nz/WebServiceHandler/Public_Data/Orthophotography/MapServer/WCSServer

Report: 2438b
Client: C&D
Ref: 05 0119
Path: Erigis\Astrid van Meeuwen-Dijkgraaf\Wellington Burrell
File: landfill\Figures\Figure 1 Burrell Landfill.mxd

Figure 1. C&D Landfill Site, Happy Valley, Showing Approximate Site Boundary and Proposed Extent of Fill Area

0 100 200 m

Wildlands
Scale: 1:3,500
Date: 09/03/11
Cartographer: RPB
Format: A3R

3. ASSESSMENT METHODS

A brief site visit was made to obtain a general overview of the site on 24 May 2010. A more extended visit was undertaken on 28 January 2011, to map the vegetation and habitat types on to a previously prepared aerial photograph (scale 1:3,000) with the indicative site and proposed fill boundaries superimposed.

On 28 January 2011 a section of the stream was spotlighted from dusk until 2 hours after dark. Notes were made on species present, quality and extent of habitats, and any ecological issues. Relevant information was collated from reference material and District and Regional Plans.

4. STATUTORY PLAN REQUIREMENTS

The site lies within the Wellington City Council and Greater Wellington Regional Council has regional-level jurisdiction.

This report comprises an assessment of the ecological effects of this proposal and addresses the ecological matters identified in Parts 5, 6, and 7 of the Resource Management Act (1991). The objectives of this assessment were to:

- Describe the ecological features and conservation values in and adjacent to the site;
- Identify actual or potential effects of development focusing on the ecology of the site, and rare or threatened plants, animals, terrestrial and aquatic habitats;
- Recommend ways that any identified potential adverse effects can be avoided, remedied, or mitigated;
- Provide guidance on whether ongoing monitoring is required.

In the preparation of this report, the following statutory documents have been taken into consideration:

- Regional Policy Statement;
- The Regional Soil Plan;
- The Regional Freshwater Plan;
- The Wellington City District Plan;
- The Wellington City Council Outer Green Belt management plan;
- Wellington Conservation Management Strategy.

In summary, the policies, objectives and regulations in these documents require that the following matters are addressed:

- Outstanding or rare indigenous plant communities;
- Areas containing nationally rare or threatened species;
- Areas and habitats important to the continued survival of indigenous species (the Outer Green Belt management plan advocates the protection and enhancement of areas of indigenous vegetation);

- Areas important for migratory species and to vulnerable stages of common indigenous species;
- Ecological corridors;
- Protection of ecosystems vulnerable to modification, including estuaries and wetlands;
- The potential for restoration and rehabilitation of natural character;
- Areas of scientific values;
- The quality of freshwater entering the coastal area;
- Cumulative effects.

5. ECOLOGICAL CONTEXT AND SITE HISTORY

The site lies within the Wellington Ecological District (McEwen 1987) and ecodomain '9b-Inland hill country and basins, Wellington Peninsula area' (Boffa Miskell Limited 2002). This area is dominated by high, steep hills and ridgelines and has deeply incised streams. All of Wellington was predominantly forested at the time of European arrival (Boffa Miskell 1988), but virtually the entire area was subsequently cleared. In the vicinity of the site, these forests would have comprised podocarp broadleaved forests including totara (*Podocarpus totara*), matai (*Prumnopitys taxifolia*), rimu (*Dacrydium cupressinum*), rata (*Metrosideros robusta*), tawa (*Beilschmiedia tawa*), mapou (*Myrsine australis*), and kohukohu (*Pittosporum tenuifolium*) on hills and kahikatea (*Dacrycarpus dacrydioides*), pukatea (*Laurelia novae-zelandiae*), kohekohe (*Dysoxylum spectabile*), rangiora (*Brachyglottis repanda*), five-finger (*Pseudopanax arborea*), lemonwood (*Pittosporum eugenioides*), and mahoe (*Melicytus ramiflorus*) forest in more sheltered valleys (Boffa Miskell 1988; McEwen 1987).

The indigenous vegetation currently present at and adjacent to the site is entirely secondary vegetation that has regenerated following post-European arrival forest clearance. Nevertheless, due to the extensive clearing of vegetation in Wellington, the Department of Conservation have indicated that they consider the regenerating forest surrounding both this site and the Municipal Landfill to be of sufficient ecological value to warrant 'ecosite' status and have called it "Owhiro Bush". This does not provide any legal protection over the area, and merely indicates that the vegetation and habitat types are sufficiently mature and diverse to be considered of ecological significance. Essentially the entire valley between Polhill trig and Red Rocks has been included in one of six 'ecosites'.

With regards to indigenous flora, *Melicytus obovatus* is known from the adjacent Spooky Gully (de Lange *et al.* 2009; Mitcalfe and Horne 1997) and is a Cook Strait endemic (only known to occur in Owhiro Bay-Island Bay area). It is a low-growing, hermaphrodite shrub which has a national threat ranking of 'At Risk-Naturally Uncommon' (national plant threat rankings as per de Lange *et al.* 2004). A range of regionally significant plant species (identified in Sawyer 2004) are also known from the wider area. Speargrass (*Aciphylla squarrosa*, regionally threatened), leafless clematis (*Clematis afoliata*, Regionally in Gradual Decline), gully tree fern (*Cyathea cunninghamii*, regionally sparse) and *Senecio rufiglandulosus* (regionally data deficient) are known from nearby Te Kopahou Ridge and Long Gully (Mitcalfe and

Horne 1998; Mitcalfe and Logan 1999; Sawyer 2004). These species, with the exception of speargrass that occurs at higher altitudes, could also occur at the subject site.

Various threatened fauna species occur in the wider area. Speargrass on the Te Kopahau and Hawkins ridge hosts the 'Acutely Threatened-Nationally Endangered' *Stephanorhynchus insolitus* weevil (national invertebrate threat classifications as per Hitchmough *et al.* 2007) and is also part of the last stronghold for Hutton's speargrass weevil (*Lyperobius huttoni*) in the North Island (regionally threatened, although not threatened at a national level). Bats are reported from the wider area, these are most likely to be long-tailed bats (*Chalinolobus tuberculatus*) (Acutely Threatened-Nationally vulnerable, Hitchmough *et al.* 2007). There are anecdotal reports of regular but perhaps seasonal use of the area by New Zealand falcon (*Falco novaeseelandiae*, (Acutely Threatened-Nationally vulnerable, Hitchmough *et al.* 2007). A wide range of threatened species have been introduced into Karori Sanctuary (Zealandia). It is possible that some of these threatened species may use the site at times.

6. PROTECTED AREAS AND AREAS OF SIGNIFICANCE

6.1 Protected Areas

There are no legally protected areas, e.g. Department of Conservation reserves, Queen Elizabeth II National Trust Covenants, Nga Whenua Rahui kawenata. The land is owned by the Wellington City Council.

6.2 National Priorities

Four national priorities have been identified for the protection of indigenous biodiversity on private land (Ministry for the Environment 2007a, 2007b), and the site has been assessed against each of these, as set out below:

National Priority 1: To protect indigenous vegetation associated with land environments, (defined by Land Environments of New Zealand at Level IV), that have 20 percent or less remaining in indigenous cover.

Habitats at the site are classified as 'At Risk' land environments (20–30% of indigenous cover remains), not 'Acutely Threatened' (<10% indigenous vegetation cover remaining) or 'Chronically Threatened' (10-20% indigenous vegetation cover remaining). Thus indigenous vegetation at this site is not considered to be a national priority for protection.

National Priority 2: To protect indigenous vegetation associated with sand dunes and wetlands; ecosystem types that have become uncommon due to human activity.

The steepness of subject site ensures that there are no substantive wetlands. Any small seeps or wetlands associated with the C&D Landfill Tributary are too small to be considered significant.

National Priority 3: To protect indigenous vegetation associated with 'originally rare' terrestrial ecosystem types not already covered by Priorities 1 and 2.

No originally rare ecosystem types (as per Williams *et al*. 2007) have been recorded at the site.

National Priority 4: To protect habitats of Acutely and Chronically Threatened[1] indigenous species.

A range of 'At Risk' species (see below) have been reported from aquatic habitats at the site (Section 9.1). Although not seen, some 'At Risk' lizard species are likely to be present at the site (Section 9.3). It is also possible that regionally threatened plant species could be present at the site (Section 8). The current proposal does not protect the habitats (streams and indigenous vegetation) of these species.

6.3 New Zealand species threat classification

Population trends for most New Zealand species have been assessed and ranked. Not all types of species are assessed simultaneously and the classification system has also been updated. Until the threat classifications are updated for all biota, lists of threatened taxa in this report include a mixture of threat categories from both systems. Furthermore, the two systems, Molloy *et al*. (2002) and Townsend *et al*. (2008), differ in their definitions of 'Threatened' taxa (Table 1).

Ranking of a species' threat status is primarily determined by the known or likely size of the population in New Zealand, the distribution of the population (number of independent breeding populations), and the level (rate) and causes of decline. A species which still has reasonable numbers, but is declining quickly, can have a higher threat classification than a rarer species for which numbers are stable or increasing.

As well as the national threat classification systems, many Department of Conservation conservancies also rank the status of species within their area. These 'regional threat' rankings often differ from the 'national rankings' for that species. National threat rankings will be capitalised, but regional threat rankings will lower case, i.e. 'Threatened' or (Threatened-Nationally Vulnerable) vs. 'regionally threatened'. Threatened species will be referred to as a collective group e.g. threatened species, threatened birds, and this can include 'Threatened', 'At Risk' and 'regionally threatened' species.

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[1] 'Acutely Threatened' and 'Chronically Threatened' have recently been combined into the 'Threatened' category, with 'At Risk' now in a separate category (it was previously part of the 'Threatened' category).

Table 1: Comparison of threatened species classifications currently used in New Zealand, and the groups addressed under each system.

Classification System	
Molloy *et al*. (2002)	**Townsend *et al*. (2008)**
Threat Ranking	
Extinct	Extinct
Acutely Threatened-Nationally Critical	Threatened-Nationally Critical
Acutely Threatened-Nationally Endangered	Threatened-Nationally Endangered
Acutely Threatened-Nationally Vulnerable	Threatened-Nationally Vulnerable
Chronically Threatened-Serious Decline	At Risk-Declining
Chronically Threatened-Gradual Decline	At Risk-Recovering
At Risk-Sparse	At Risk-Relict
At Risk-Range Restricted	At Risk-Naturally Uncommon
Data Deficient	Data Deficient
Not threatened	Not Threatened
Coloniser	Non-resident Native - Coloniser
Vagrant	Non-resident Native - Migrant
Introduced and Naturalised	Non-resident Native - Vagrant
	Introduced and Naturalised
Species Categorised Under Molloy *et al*. (2002) System and Classification Source	**Species Categorised Under Townsend *et al*. (2008) System and Classification Source**
Biota **other than** birds, reptiles, frogs, freshwater fish, bats, marine mammals, marine invertebrates, and vascular plants (Hitchmough *et al.* 2007)	Birds - Miskelly *et al*. (2008)
	Vascular plants - de Lange *et al*. (2009)
	Reptiles - Hitchmough *et al.* (2010)
	Frogs - Newman *et al*. (2010)
	Freshwater fish - Allibone *et al.* (2010)
	Marine mammals - Baker *et al*. (2010)
	Marine invertebrates - Freeman *et al.* (2010)
	Bats - O'Donnell *et al.* (2010)

6.4 Sites of Local and Regional Significance

A second order stream of high quality runs through the site. Historic records indicate that it contained a range of indigenous species including threatened species (refer to Section 9.1). The stream has an indigenous closed canopy for the majority of its length, which contributes to maintaining low water temperatures, low sediment volumes, and supplies nutrients for aquatic species.

A primary forest remnant (site 03707.6; Park 1999) occurs within the 300 m site contour and will be partially cleared if the proposed extension is undertaken (Vegetation Type 1, Figure 2). Primary forest remnants contain naturally-occurring canopy tree species characteristic of the district's primary forests. In other words they are either relatively unmodified or have regenerated to such an extent that vegetation composition approaches what would have occurred there prior to human arrival. This particular site contains nikau (*Rhopalostylis sapida*), wineberry (*Aristotelia serrata*), and mamaku (*Cyathea medullaris*), as well as tree hebe (*Hebe parviflora*) and mahoe.

The site also falls within a site of ecological significance in Wellington City (ranked 6th overall) as it is contiguous with, and structurally part of, the Carey Gully Reserve (Wildland Consultants 2009). This is a large area with a compact shape which is moderately representative of vegetation types within Wellington City and within the

Western Hills Ecodomain (Boffa Miskell Limited 2002; Wildland Consultants 2009). It has high connectivity to, and buffering and of, other ecologically important areas. The vegetation and habitat types are common in Wellington City and site was not known to have high diversity or special features. However the riparian vegetation is well developed and considered to have significant ecological values. Key management issues for this ecologically significant site include fragmentation, vegetation clearance, the need for ongoing weed and pest control, and a requirement to integrate landfill management with ecological values (Wildland Consultants 2009).

To the south of the subject site, another four ecologically significant areas have been identified. Essentially the entire valley from Wrights Hill to Owhiro Bay has been assessed as being of ecological significance (Wildland Consultants 2009).

Carey's Gully Reserve is considered to be a Key Native Ecosystem (KNE) and pest control is therefore funded by Greater Wellington Regional Council, with bait stations along the stream within the subject site maintained jointly between Wellington City and Wellington Regional Council. This area is also connected to numerous other KNE sites, including Karori Sanctuary, Long Gully, Happy Valley, and pest control within this area contributes to maintaining low possum and goat densities over a wider area.

6.5 Outer Green Belt

The landfill site falls within an area zoned as Outer Green Belt (Wellington City Council 2004). The Outer Green Belt is an extensive open space framework for Wellington, providing a green outlook onto grazed hilltops or regenerating vegetation from most places. A summarised vision for the Outer Green Belt (OGB) is ***"A continuous green belt following the ridges west of the city from the South Coast to Colonial Knob, in which indigenous vegetation is restored and an informal recreation network is widely accessible."*** (Wellington City Council 2004). The Outer Green Belt management plan advocates the protection and enhancement of areas of indigenous vegetation.

The following criteria and principles, amongst others, help define the Outer Green Belt concept (Wellington City Council 2004):

- *Indigenous ecosystems and important ecological features:* To recognize and protect indigenous ecosystems and important ecological features, and in particular the streams and significant areas of indigenous vegetation from which a more continuous band of vegetation will grow.
- *Landscape and landform:* To recognise and protect natural landscape and landform characteristics of the ridge system on the western side of the city.
- *Recreational places and linkages:* To identify and protect important existing or potential recreational sites and linkages (entrance points, tracks, routes and destinations).

The OGB concept is centred on a predominantly and nearly continuous green ridgeline dominated by ridge top and hilltop environments (as identified in Boffa Miskell Limited 2001). Significant vegetation that is contiguous with these ridge and hilltops are included (especially bush remnants and streams) as are areas that provide

opportunities to create ecological and recreation linkages. The Outer Green Belt Management plan, in general terms, promotes a combination of densely-forested slopes and gullies with areas of open ridges and hilltops above (Wellington City Council 2004; p43)

The main ridge that lies above the landfill area is considered to be a secondary linkage that provides a green connection through and beyond the OGB and is considered to be important for recreation and viewscape opportunities (Wellington City Council 2004). The ecological objective for this area is to foster the enhancement of bush corridors through the prevention of fire and the management of pest plants and animals.

Well developed forests in the southern and eastern parts of the Outer Green Belt, particularly adjoining Karori, Ngaio, and Wadestown, are an important landscape element that gives character to these areas. They also provide an example of the vision that this Plan promotes for the entire Outer Green Belt – which is a combination of densely forested slopes and gullies with areas of open ridges and hilltops above (Wellington City Council 2004).

6.6 Ridgetops and hilltops

Upper parts of the site could also encroach in to the ridgetops and hilltops overlay identified within the Wellington City Council District Plan (Boffa Miskell Limited 2001). Part of the Tip Track Spur has high visibilities within the Happy Valley community and is valued as a visual backdrop with a mix of retired farm land and regenerating indigenous forest.

There are very few buildings along the main ridgeline. Generally the Council wants to prevent or reduce the level of development on or in close proximity to major ridgelines and nowhere is this more important than in the Outer Green Belt. Even with a clear edge to the built environment that is below the main ridgetops, the values of these areas are still potentially threatened. The main threats are:

- placement of utilities and building utility access roads;
- unsympathetic land use – such as the planting of pine blocks or wind breaks in prominent ridgetop areas;
- development of lifestyle properties along the main ridge and the placement of residential dwellings in prominent ridgetop areas (Wellington City Council 2004).

6.7 Open Space B

The aim for Open Space B land is that the natural character, informal open spaces and opportunities for recreation are maintained and valued and, in the broadest sense, do not involve buildings or structures. The objective for these areas is to maintain and enhance natural features (including landscapes and ecosystems) that contribute to Wellington's natural environment, with a policy to encourage retention of existing native vegetation and where appropriate re-introduce indigenous cover (Wellington City Council 2006).

6.8 Proposed Regional Policy Statement

Vegetation at the site potentially could be considered to have significant biodiversity values, as outlined under the Proposed Regional Policy Statement (Greater Wellington Regional Council 2009b). The area contains a range of indigenous ecosystems (permanent stream, indigenous riparian vegetation, and more mature vegetation types, refer to Sections 1.1 and 7.3). Some nationally 'At Risk' or regionally rare species are known, or thought, to be present (Section 8 and 9). Nevertheless a high proportion of the area is occupied by adventive species (i.e. gorse). The site was identified as an Ecological Site in part because of inherent biodiversity values but also because it provides linkages to other areas of ecological value. Parts of the site are well on their way to develop into a more indigenous and species-rich forest community.

6.9 Regional Fresh Water Plan

None of the streams in the Owhiro Stream catchment, including the C&D Landfill Tributary which crosses the subject site, are considered to be ecologically important waterways in the Regional Fresh Water Plan (Greater Wellington Regional Council 1999). There are, however, a number of Rules within the plan that are relevant to the site.

7. VEGETATION AND HABITATS

7.1 Overview

The predominant vegetation cover in the lower valley and along the stream margins is closed canopy mahoe dominant forest with a range of other species in the canopy and understorey (bright green vegetation in Figure 1). This vegetation is bounded by a belt of gorse (*Ulex europaeus*) dominated vegetation (dull green vegetation in Figure 1), which nevertheless has a significant indigenous component, indicating that it is well on the way to becoming mahoe forest. Within the gorse belt there are grassy clearings with scattered indigenous and exotic shrubs. The more exposed hill tops are also predominantly grassy with scattered shrubs and at higher altitudes could include silver tussock (*Poa cita*) and the indigenous speargrass (*Aciphylla squarrosa*) in areas less accessible to goats. Figure 2 maps the terrestrial habitats within the site in relation to the proposed area of fill.

7.2 Terrestrial vegetation and habitat descriptions

This section describes the ten terrestrial vegetation and habitat types noted at the site and briefly outlines the relative ecological ranking for each. Descriptions of the various vegetation types present in the Study Area are provided below, and mapped in Figure 2.

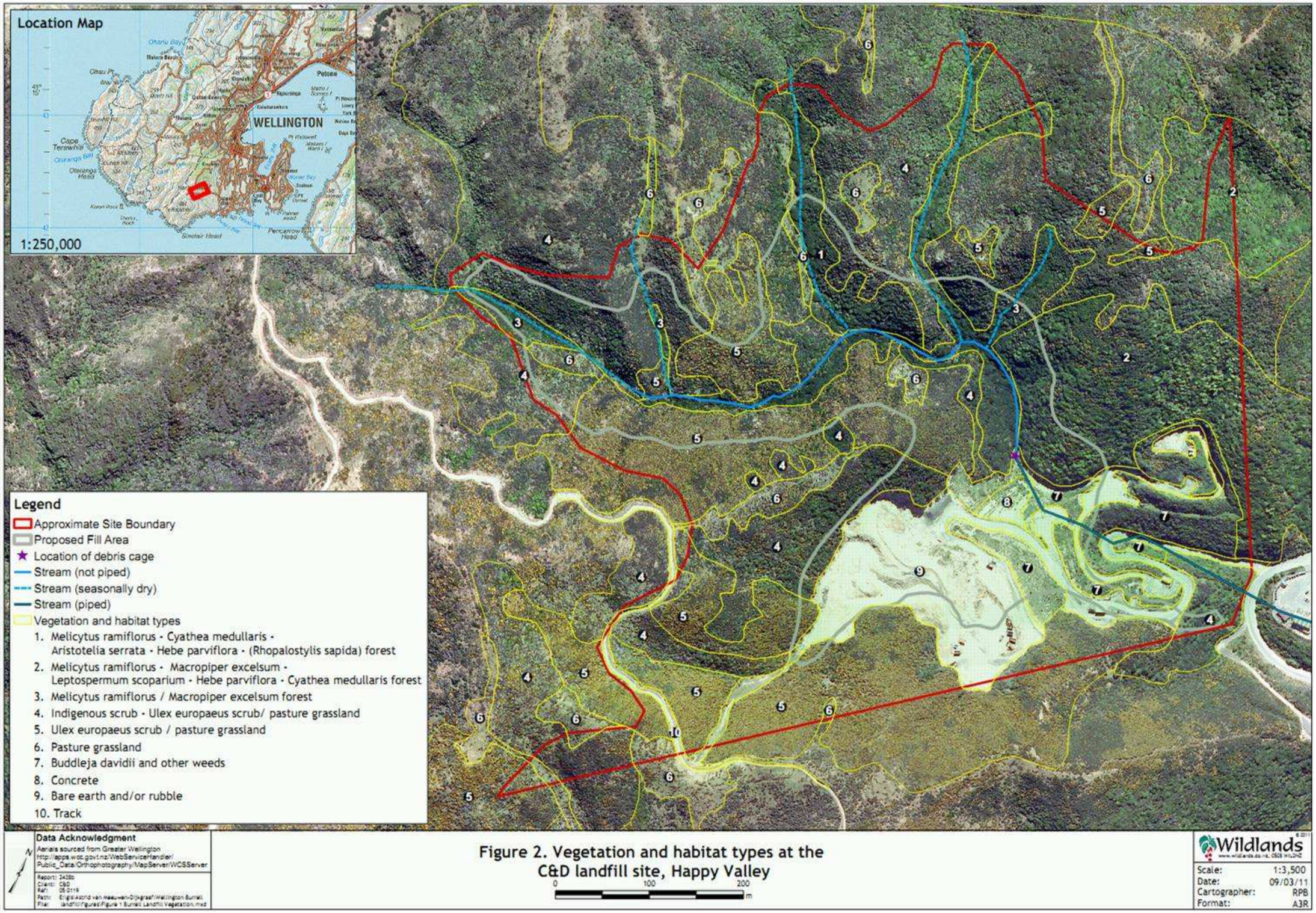


Figure 2. Vegetation and habitat types at the C&D landfill site, Happy Valley

1. Mahoe (*Melicytus ramiflorus*) - mamaku (*Cyathea medullaris*) – wineberry (*Aristotelia serrata*) – tree hebe (*Hebe parviflora*) – nikau (*Rhopalostylis sapida*) forest

   This area was not visited during the survey and the description is from Park (1999). The height of the canopy, and range of understorey species, will be similar to Vegetation Type 2.

   Ecological value: Moderate-high (more diverse than just mahoe forest, but not complete suite of forest species, closed canopy helps retain soil and sediment on steep slopes)

2. Mahoe (*Melicytus ramiflorus*) – kawakawa (*Macropiper excelsum*) – manuka (*Leptospermum scoparium*) – tree hebe (*Hebe parviflora*) –and mamaku (*Cyathea medullaris*) forest

   Mahoe trees up to 10-20 m with trunks up to 10-20 cm diameter at breast height (dbh) comprise more than 50% of the canopy with kawakawa in lesser amounts (Photograph 11). The height of the canopy decreases upslope and in exposed areas, but trunk diameter stays within the same size range. Other key canopy species include tree hebe, manuka and mamaku (tree fern). The height of the canopy decreaseswith increasing altitude and increased exposure to seawinds. The understorey is variable depending on canopy density and shading, slope steepness and the amount of loose scree. In places there is a good understorey comprising species such as rangiora, pate, *(Schefflera digitata*) putaputaweta (*Carpodetus serratus*), karamu (*Coprosma robusta*), kanono (*Coprosma grandifolia*), hangehange (*Geniostoma rupestre* var. *ligustrifolium*), koromiko (*Hebe stricta* var. *atkinsonii*) and occasional mingimingi (*Leucopogon fasciculatus*). There is quite a diverse fern flora, although filmy ferns were notable by their absence. Vine species were generally scarce, but include clematis (*Clematis forsteri*), climbing rata (*Metrosideros diffusa*), pohuehue (*Muehlenbeckia australis* and *Muehlenbeckia complexa*) and bush lawyer (*Rubus cissoides*).

   Ecological value: Moderate-high (more diverse than just mahoe forest, but not complete suite of forest species, closed canopy helps retains soils and sediment on steep slopes)

3. Mahoe (*Melicytus ramiflorus*) / kawakawa (*Macropiper excelsum*) forest

   Mahoe and kawakawa are co-dominant. Along the stream the canopy is 10-20 m high with mahoe trunks up to 20 cm dbh (Photograph 6). On steeper slopes the canopy was 4-6 m tall with trunks of up to 8 cm dbh. Along the stream the understorey species are similar to that described in Vegetation Type 2, with the addition of ongaonga (*Urtica ferox*), supplejack (*Ripogonum scandens*), kiekie (*Freycinetia banksii*), and a greater variety of fern species (Photograph 12). On steep slopes the understorey is sparse and dominated by loose shifting gravel screes (Photograph 13). Understorey species occur in more stable areas, or on the

edges of the vegetation type. The species are similar to those for Vegetation Type 2 but in reduced densities, except for on the edges of open spaces.

Ecological value: Moderate (mahoe forest types are common in the region, riparian protection)

4. Indigenous scrub – gorse (*Ulex europaeus*) scrub/ pasture grassland

A mosaic of regenerating indigenous shrub species and gorse (Photographs 14 and 15). Canopy density varies from nearly closed to about 20% closed. The density of indigenous scrub versus gorse varies spatially with indigenous species often more dominant in less exposed places. Mahoe is the most common indigenous with lesser amounts of tauhinu (*Ozothamnus leptophyllus*), pate, and tree hebe. Pasture grassland species and *Leptinella squalida* can be found where the canopy is more open and in small clearings.

Ecological value: Moderate-low (next successional stage to mahoe forest type, common in the region, mostly closed canopy retains soils and sediment on steep slopes)

5. Gorse (*Ulex europaeus*) / pasture grassland

Nearly pure gorse with only a few indigenous shrub species (Photograph 15). Gorse density varies from closed canopy to 20%. Where the canopy is more open, and in clearing too small to map, pasture grassland is the understorey.

Ecological value: Low-moderate (part of succession to mahoe forest type, help retains soils and sediment on steep slopes, common in the region)

6. Pasture grassland

Rough grassland dominated by browntop (*Agrostis capillaries*) and in places by sweet vernal (*Anthoxanthum odoratum*), but mixed with a range of other introduced grass species such as creeping fog (*Holus mollis*), Kentucky bluegrass (*Poa pratensis*), perennial rye grass (*Lolium perenne*), Cocksfoot (*Dactylis glomerata*), and occasional indigenous grass species such as *Microlaena polynoda*. A range of other species are generally dotted around the clearing including hangehange, tauhinu, pohuehue, and a range of fern species. Ongaonga and clematis could at times be conspicuous along the margins. Lower altitude sites can be infested by Mexican daisy (*Erigeron karvinskianus*) (Photograph 16), and ragwort (*Senecio jacobaea*) is occasional throughout.

Ecological value: Low (helps retains soils and sediment on steep slopes)

7. Buddleja and other weeds

The finished faces of the landfill are dominated by buddleja (*Buddleja davidii*) and a range of other weed species (Photographs 3, 4, 5, 17, and 18), including tree lupin (*Lupinus arboreus*), blackberry (*Rubus fruticosus agg.*), pampas (*Cortaderia selloana*), burdock (*Arctium minus*), fleabane (*Conyza albida* and *Conyza*

canadensis), pink ragwort (*Senecio glastifolius*), ragwort (*Senecio jacobaea*), tutsan (*Hypericum androsaemum*), inkweed (*Phytolacca octandra*), wild radish (*Raphanus raphanistrum*), climbing dock (*Rumex sagittatus*), bittersweet (*Solanum dulcamara*), black nightshade (*Solanum nigrum*), woolly mullein (*Verbascum thapsus*), vetch (*Vicia sativa*), as well as a range of pasture species. Brush wattle (*Paraserianthes lophantha*), sycamore (*Acer pseudoplatanus*), nasturtium (*Tropaeolum majus*) and old man's beard (*Clematis vitalba*) were noted in smaller areas. A number of the exotic species here are Unwanted Organisms under the Biosecurity Act 1993, or included in the Greater Wellington Pest Management Strategy (RPMS) (Greater Wellington Regional Council 2004)

Ecological value: Low (source of weeds for other areas, helps retains soils and sediment on steep slopes)

8. Concrete

The steep gradient bank, *c*.50 m high, that slopes down into the stream valley is, in part, coated with layers of concrete (Photographs 3, 4, 5, 17, and 18). Concrete appears to be poured from the top of the fill. Cement is very toxic to aquatic life. The steepness of the bank also increases the risk of slope collapse into stream. Other constructed slopes, further away from the stream, are also coated with concrete but these new areas were not yet visible on the aerial photograph and will have less potential impact on aquatic species (Photograph 18).

Ecological value: Negligible

9. Bare earth and/or waste debris

Most of the active site comprises demolition rubble, bare soil, concrete, or roads (tarseal and gravel).

Ecological value: Negligible

10. Track

There are various walking and cycling tracks that connect Te Kopahau Ridge with Happy Valley Road. These are predominantly bare or gravelled surfaces, with pasture grass species, bounded by gorse and/or indigenous scrub.

Ecological value: Negligible

7.3 Aquatic habitat description

C&D Landfill Tributary is 3.2 km from the sea where the downstream end of the pipe finishes, which is at an elevation of about 112 m a.s.l. The total catchment area is about 99 hectares. The mean flow is estimated to be 15 L/s and the mean annual low flow 1 L/s (NIWA 2011). Above the debris cage there is at least another 554 m of permanently flowing stream and c.1170 m of potentially seasonally dry stream.

The C&D Landfill Tributary lacks a vegetation canopy from the debris cage (Photograph 2) upstream for about 20 m (Photograph 6). All other upstream areas have a vegetation canopy of some sort. Generally a canopy of mahoe and kawakawa (Photographs 7 and 12), but in more open areas indigenous and exotic shrubs, and various low growing species, still provide sufficient cover to help keep the stream cool (Photograph 9). In stream temperatures on the 28 January 2011 visit were estimated to be about 15°C.

Stream width varied from 1 m to 2 m, and stream depth from 10-30 cm. The water was clear (Photograph 8) on both visits (despite heavy rain the week before the May 2010 visit) and flows over a substrate of 20% fines, 30% gravels, 50% boulders and rocks. Fines were more abundant in pools. The stream is essentially a series of pools connected by small falls (up to about 1 m high) or riffles. There was still a significant amount of water flow during the summer visit (Photograph 7, 28 January 2011).

One of the smaller tributaries was investigated and was also still found to have good flows (Photograph 10). The Photograph was taken about 60 m upstream from the confluence with the C&D Landfill Tributary at an altitude of *c.*195 m a.s.l. (60 m higher in altitude than the debris cage).

Around the area of the debris cage, at the time of the 24 May 2010 visit, a strong chemical smell (rather like acetone) was present and a blue container (similar to a chemical container) as wedged beside the cage. For about 60 m upstream of the culvert, other debris, including plastic bags, and corflute board, was found within the stream or sometimes caught up in tree branches. Both these issues were much improved on the 28 January visit.

7.4 Ecological rankings of vegetation and habitats

Each of the terrestrial vegetation and habitat types has been assigned a relative ecological rank based on the age of the vegetation, species diversity, contributions to ecosystem services (e.g. soil protection), and how common the vegetation and habitat type is within Wellington City and Wellington Region.

Mahoe-dominant scrub and forest is relatively common around Wellington (City and Region), and reflects the recovery of cleared areas, often through a gorse phase, to a more indigenous system. Many mahoe-dominant habitats don't as yet have a good diversity of species, but it has taken many years (often 50 or more) to develop from pasture to a mahoe-dominant ecosystem. Hence vegetation types nearly completely dominated by mahoe have been ranked as being of Moderate ecological value.

Forest types that have a greater diversity of indigenous species apparent in the canopy and understorey have been ranked as of Moderate-high ecological value. Habitat types with co-dominance of indigenous and exotic species has been ranked as Moderate-Low. Habitat dominated mainly by exotic species, but with small amounts of indigenous species, or likely to become dominated by indigenous species, has been ranked as Low-moderate ecological value. Other habitat types that are dominated by introduced and/or weedy species are considered to have Low ecological value, whilst build areas and tracks will have negligible ecological values.

Despite being located in an area that has been modified in the past (by vegetation clearance and pastoral farming) and currently being designated an industrial area, the C&D Landfill Tributary is currently not significantly affected by works or stock access above the pipe. The waters are clear and support indigenous fauna, and they comprise the headwaters of this tributary. Permanently flowing streams, with predominantly indigenous riparian vegetation, are considered to have High ecological value. Potentially seasonally dry stream, with predominantly indigenous riparian vegetation, are considered to have High-moderate ecological value.

8. FLORA

Sixty-nine indigenous plant species were recorded during the field survey (Appendix 1). This number could increase during more detailed survey. None of the species recorded are considered to the 'Threatened' or 'At Risk' nationally. A number of regionally threatened species could occur but have not yet been observed; including leafless clematis (*Clematis afoliata*), gully tree fern (*Cyathea cunninghamii*), *Senecio rufiglandulosus*, and *Melicytus obovatus* (nationally At Risk-Naturally Uncommon). If any of these species are located within the site then the ecological significance of those parts of the site would increase.

Fifty-five introduced species were recorded. Weedy species were most prominent in and amongst the landfill debris, indicating that these species may have been brought to the site in demolition or soil material. Species of particular concern, those classified as Unwanted Organisms under the Biosecurity Act 1993 and/or listed in RPMS (Greater Wellington Regional Council 2009a), are summarised in Table 2. Old man's beard is more prevalent at the adjacent Municipal Landfill but all other species listed in the table were much more abundant at the C&D landfill site than in the surrounding landscape. Thus the subject site is likely to be acting as a seed source for weedy and undesirable species into the surrounding landscape, including the ecosites and KNE sites.

Table 2: Weed species listed as Unwanted Organisms under the Biosecurity Act 1993 or listed in the Wellington RPMS (2009).

Scientific name	Common name	Listing
Clematis vitalba	Old man's beard	Unwanted - Biosecurity Act 1993
Cortaderia selloana	Pampas	Unwanted - Biosecurity Act 1993
Erigeron karvinskianus	Mexican daisy	Unwanted - Biosecurity Act 1993
Hypericum androsaemum	Tutsan	Unwanted- Biosecurity Act 1993
Clematis vitalba	Old man's beard	Site-Led pest category management programmes – Boundary Control - RPMS
Ulex europaeus	Gorse	Site-Led pest category management programmes – Boundary Control - RPMS
Rubus fruticosus agg.	Blackberry	Site-Led pest category management programmes – Human Health - RPMS
Senecio jacobaea	Ragwort	Site-Led pest category management programmes – Human Health - RPMS
Acer pseudoplatanus	Sycamore	KNE - RPMS
Berberis darwinii	Darwin's barberry	KNE - RPMS
Buddleja davidii	Buddleia	KNE - RPMS
Cortaderia selloana	Pampas	KNE - RPMS
Cytisus scoparius	Broom	KNE - RPMS
Rumex sagittatus	Climbing dock	KNE - RPMS
Senecio glastifolius	Pink ragwort	KNE - RPMS

9. FAUNA

9.1 Fish

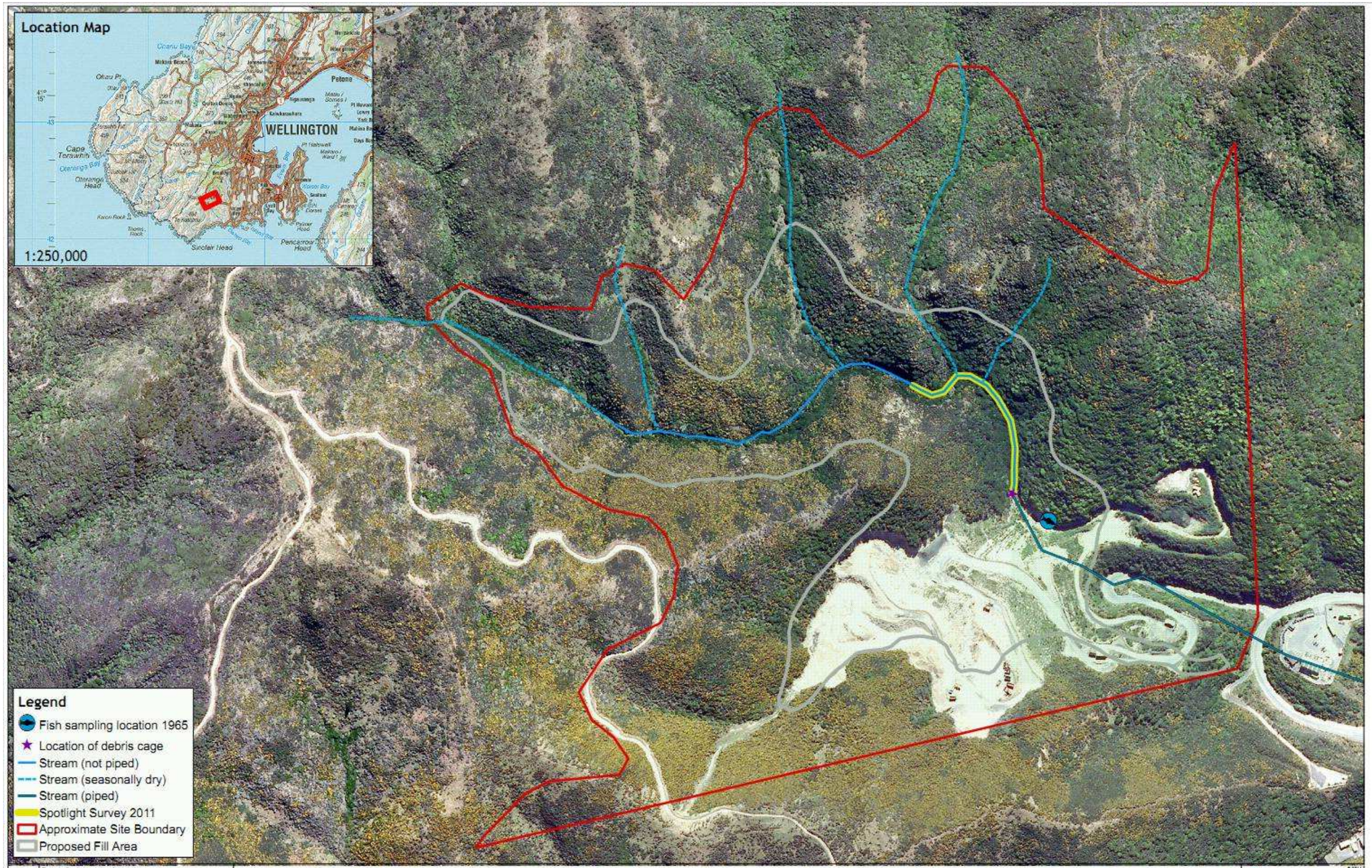
Aquatic life in the stream was investigated in 1965 (NIWA 2011). The actual sampling location is no longer available as that site has been filled (Figure 3). At that time shortjaw kokopu (*Galaxias postvectis*, At Risk-Declining) were found and banded kokopu (*Galaxias fasciatus*, Not Threatened), redfin bully (*Gobiomorphus huttoni*, Not Threatened), longfin eel (*Anguilla dieffenbachia*, At Risk-Declining) and koaro (*Galaxias brevipinnis*, At Risk-Declining) were common (Table 3).

Table 3 lists the fish and koura seen in more recent surveys, including; downstream of the pipe, midway along Landfill Road; just upstream of the confluence of the Landfill Road Tributary with Owhiro Stream; and just downstream of the confluence (fish national threat status as per Allibone *et al.* 2010).

Table 3: Aquatic fauna records for the Owhiro Tributary and upstream and downstream reaches of the Owhiro Stream.

Location	Sampling year	Scientific name	Common name	Threat status
C&D Landfill Tributary - within landfill.	1965	*Anguilla dieffenbachii*	Longfin eel	At Risk-Declining
		Galaxias brevipinnis	Koaro	At Risk-Declining
		Galaxias fasciatus	Banded kokopu	Not Threatened
		Galaxias postvectis	Shortjaw kokopu	At Risk-Declining
		Gobiomorphus huttoni	Redfin bully	At Risk-Declining
Midway along Landfill Road (Landfill Road Stream).	1982	*Anguilla dieffenbachii*	Longfin eel	At Risk-Declining
		Galaxias brevipinnis	Koaro	At Risk-Declining
		Gobiomorphus huttoni	Redfin bully	At Risk-Declining
Owhiro Stream - just upstream of confluence with Landfill Road Stream.	1979	*Anguilla australis*	Shortfin eel	Not Threatened
		Galaxias argenteus	Giant kokopu	At Risk-Declining
		Galaxias brevipinnis	Koaro	At Risk-Declining
		Galaxias maculatus	Inanga	At Risk-Declining
		Galaxias postvectis	Shortjaw kokopu	At Risk-Declining
		Gobiomorphus huttoni	Redfin bully	At Risk-Declining
		Paranephrops	Koura	At Risk-Gradual decline
Owhiro Stream - downstream of confluence with Landfill Road Stream.	2005	*Anguilla australis*	Shortfin eel	Not Threatened
		Gobiomorphus huttoni	Redfin bully	At Risk-Declining

A 250 m section of stream was spotlighted on 28 January 2011 (Figure 3). We noted 5 small (2-7 cm long) koura (freshwater crayfish), two banded kokopu, and eight koaro (summarised in Table 4). Koaro were found in nearly every pool greater than about 1 m across, in water depths from 10 cm to 30 cm. Koaro require rocky, tumbling streams, with very clean waters and cool temperatures, and are generally only found in forested areas. This is the only the only recent record of koaro in the Owhiro catchment and is the only known population of koaro within Wellington City Council, although koaro may also occur in the stream above the Municipal Landfill. Koaro are more widely known from the Wellington Region. The presence of koura (freshwater crayfish) indicates that this is a permanently flowing waterway.



Data Acknowledgment
Aerials sourced from Greater Wellington
http://apps.wcc.govt.nz/WebServiceHandler/Public_Data/Orthophotography/MapServer/WCSServer

Report: 2438b
Client: C&D
Ref: 05 0119
Path: E:\gis\Astrid van Meeuwen-Dijkgraaf\Wellington Burrell
File: landfill\figures\Figure 3 Burrell Landfill fish and lizards.mxd

Figure 3. Fish Records from the general location of the C&D landfill site, Happy Valley

0 100 200 m

Wildlands
www.wildlands.co.nz, 0508 WILDNZ

Scale:	1:3,500
Date:	09/03/11
Cartographer:	RPB
Format:	A3R

Shortfin eels were not seen but are known from the Owhiro Stream and are likely to be present in the C&D Landfill Tributary. The habitat is also suitable for longfin eel, and they could possibly be present.

Table 4: Aquatic species seen on 28 January 2011, and likely to occur in the C&D Landfill Tributary, upstream of the debris cage.

Location	Occurrence	*Scientific name*	Common name	Threat status
Within landfill site boundaries in C&D Landfill Tributary upstream of the debris cage	Seen (8)	*Galaxias brevipinnis*	Koaro	At Risk-Declining
	Seen (2)	*Galaxias fasciatus*	Banded kokopu	Not Threatened
	Seen (5)	*Paranephrops*	Koura	At Risk-Gradual decline
	Possible	*Anguilla dieffenbachii*	Longfin eel	At Risk-Declining
	Likely	*Anguilla australis*	Shortfin eel	Not Threatened

9.2 Birds

Only three bird species were noted during the visits: two indigenous species, tui (*Prosthemadera novaeseelandiae*) and silvereye (*Zosterops lateralis*), and one introduced species, goldfinch (*Carduelis carduelia*). None of these species are considered threatened (as per Miskelly *et al.* 2008). Other indigenous, non-threatened, indigenous species are likely to occur at this site, such as kingfisher (*Todiramphus sanctus*), morepork (*Ninox novaeseelandiae*), grey warbler (*Gerygone igata*), and possibly shining cuckoo (*Chrysococcyx lucidus lucidus*). Additional introduced species may also occur here. Bird species density may vary seasonally according to food availability. As the vegetation matures, and the diversity of plant species increases, additional bird species could be attracted to the vegetation.

9.3 Lizards

No lizard species were recorded during either survey. This does not imply that lizards are not present, merely that they were not seen. The list of lizard species recorded within 5 km of the site indicates species which may also be present at this location (Department of Conservation Herpatofauna Database, Accessed 10 March 2011). Densities may be low, as only possum control is undertaken in the area, and this may not reduce lizard predator numbers.

Table 5: Lizard species known to occur within 5 km of the site. Lizard threat status is as per Hitchmough *et al.* (2010)

Scientific name	Common name	Threat status
Naultinus elegans punctatus	Wellington green gecko	At Risk-Declining
Oligosoma ornatum	Ornate skink	At Risk-Declining
Hoplodactylus maculatus	Common gecko	Not threatened
Hoplodactylus 'Marlborough mini'	Marlborough mini gecko	Not threatened
Hoplodactylus 'southern North Island forest gecko'	Southern North Island forest gecko	Not threatened
Oligosoma aeneum	Copper Skink	Not threatened
Oligosoma nigriplantare polychroma	Common skink	Not threatened
Oligosoma zelandicum	Brown skink	Not Threatened
Litoria raniformis	Southern bell frog	Introduced and naturalised

9.4 Other species

Whilst spotlighting for fish we noted the presence of glow-worms (*Arachnocampa luminosa*) and at least 10 different species of spider.

Feral goats (*Capra hircus*), fallow deer (*Dama dama*) and sheep (*Ovis aries*) are known to graze the adjacent property and may graze grassland areas at the top of the site. Goats are likely to graze throughout the site unless numbers are very low. Occasional pig (*Sus scrofa*) sign has also been noted from the wider area, but was not noted during the field survey. Other smaller mammals that are likely to occur at the site are mustelids (stoats and ferrets), hedgehogs, feral cats, ship and Norway rats and mice. Table 6 list mammal pest species that are likely to occur within the site, and their pest status in the Wellington Regional Pest Management Strategy (Greater Wellington Regional Council 2009a).

Table 6: Pest species that are likely occur at the site and their status in the Wellington RPMS.

Scientific name	Common name	Pest status in RPMS
Erinaceus europaeus occidentalis	European hedgehog	KNE
Mustela furo	Ferret	KNE
Mus musculus	House mouse	KNE
Rattus norvegicus	Norway rat	KNE
Rattus rattus	Ship rat	KNE
Mustela erminea	Stoat	KNE
Felis catus	Feral cat	KNE
Capra hircus	Feral goat	KNE
Sus scrofa	Feral pig	KNE

10. LIKELY EFFECTS OF PROPOSED LANDFILL EXPANSION

The main effects of the proposed landfill expansion will be

- loss of stream habitat;
- loss of aquatic species; and
- loss of indigenous vegetation and some ecosystem functions.

These aspects are discussed in more detail below.

10.1 Loss of stream habitat

Wetland and lowland stream ecosystems are coming under particular pressure. Some of the activities that can impair the ecosystem function of streams and rivers are listed in the Proposed Regional Plan (Greater Wellington Regional Council 2009b), and include:

(a) filling in gullies and ephemeral streams and straightening or piping small streams;
(b) lining stream banks and beds with rock or concrete;
(c) removing streamside vegetation;
(d) works in waterways, particularly during low flows;
(e) the introduction and spread of aquatic pests and weeds in wetlands;

(f) creating impermeable land within a catchment through asphalting, concreting and building structures;

Table 7 summarises the total length of stream (metres) within the subject site for the section that is currently piped, the section that is thought to be permanently flowing, and the potentially seasonally dry tributaries. These sections are illustrated on Figures 1 to 3.

If the area of fill were to be extended to the Proposed Fill Area indicated on these Figures then this requires that an additional 1,192 m of stream would need to be piped. All of the permanently flowing stream and more than 50% of the seasonally dry streams and would be lost as stream habitat. Only about 533 m (26% of the length within the subject site) of potentially seasonally-dry stream would remain unmodified. These steep gradient, potentially seasonally-dry, streams are unlikely to provide suitable habitat for the suite of aquatic species known, or likely, to occur at the site. Riparian vegetation surrounding the stream would also be lost (refer to Section 10.3)

This loss of stream habitat could in part be, eventually, mitigated by creating a 'natural' looking overland flow, and this option has been discussed with the client. This will require considerable thought and careful design as to how to provide access for aquatic species to the site once the fill is completed, as the additional elevation (especially the completed steep fill-cells nearest to Landfill Road) has the potential to create fish barriers. It will take many years before the new overland flow stream will have 'settled' in its course and for riparian vegetation to provide sufficient shelter for the newly created stream to be attractive to indigenous fish species. Even if this work was undertaken it could not be guaranteed that indigenous fish would re-colonise the newly created stream.

Table 7: Length and types of stream potentially affected by the proposed Landfill Expansion.

	Stream length (m) within subject site	Additional length of stream affected
Stream (piped)	304[2]	
Stream (not piped)	554	554
Stream (seasonally dry)	1171	638
Total length	**2029**	**1192**
Total not piped	**1725**	**533**

10.2 Loss of aquatic species

It is unlikely that many of the aquatic species presently known from the site, or likely to occur at the site, can be retained during the life of the fill. Koura (freshwater crayfish, At Risk-Gradual Decline) require permanently flowing water to survive and will not be able to persist, especially if the steeper streams are seasonally dry. Koaro (At Risk-Declining) do not tolerate increased sediment levels and are likely to be lost from the stream even if very effective sediment retention mechanisms were employed.

[2] The total length of the pipe is c.500 m, but only 304 m occurs within the boundary of the subject site.

The other species require at least permanent pools, connected by a stream during higher flows, to survive. Piping of the waterway, for nearly its entire length, will remove all such pools. The total length of pipe (nearly 1,500 m, of which 1,000 m comprises permanent flowing water) exceeds the abilities of most aquatic species to travel through and can not be relied upon to re-establish aquatic species.

As indicated careful and considered reconstruction of overland flow patterns may be able to, eventually, recreate habitat for some of these aquatic species, but this would only be upon the fill site being retired. Evidence from other streams indicates that it is unlikely for indigenous species to migrate up a stream if the "smell" of that particular species is not carried on the current. Given that the entire stream will be modified it won't be possible to retain any of the aquatic species during the works and it seems unlikely that the stream would be recolonised by koaro (At Risk-Declining), koura (At Risk-Gradual decline), banded kokopu (Not Threatened), or other indigenous aquatic species.

10.3 Loss of indigenous vegetation and some ecosystem functions

Due to the steep terrain, a Triangulated Irregular Network model was used in ArcGIS 9.3.1 to better estimate the actual amount of vegetation clearance. Horizontal (flat) and topography adjusted estimates of vegetation clearance for each vegetation and habitat type are presented in the tables below.

Each of the habitat and vegetation types has been assigned a relative ecological significance ranking (Section 7.4 and Table 8). The proposed fill area will encompass 18.73 ha (adjusted for topography, equivalent of 14.27 ha flat) of the *c*.50 ha site, including 2.36 ha of habitat ranked Moderate-high for ecological value, 2.59 ha ranked Moderate, and 4.63 ha ranked Moderate-low. Thus *c*.9.58 ha of habitat dominated by indigenous species would be lost. Habitats dominated by introduced species (ranked Low-moderate or Low) comprise 5.83 ha of the proposed fill area (as shown in Figure 1) and the remainder comprises habitats with negligible ecological value.

Loss of the vegetation cover from the site will result in the loss of habitat for a range of species and will reduce the ecosystem services provided. Ecosystem services particularly affected will be retention of soil and scree, sediment control, cooling and oxygenation of the stream, water retention and gradual release.

Table 8: Vegetation and habitat types potentially affected by the proposed Landfill Expansion.

			Within subject site		Within fill area		% of vegetation type (adjusted for topography)
Veg Type	**Vegetation description**	**Ecological value**	**Flat (ha)**	**Topography adjusted (ha)**	**Flat (ha)**	**Topography adjusted (ha)**	
1	*Melicytus ramiflorus* - *Cyathea medullaris – Aristotelia serrata – Hebe parviflora* – (*Rhopalostylis sapida*) forest	Moderate-high	1.15	1.55	0.82	1.12	72%
2	*Melicytus ramiflorus* – *Macropiper excelsum* – *Leptospermum scoparium – Hebe parviflora* –and *Cyathea medullaris* forest	Moderate-high	4.17	5.5	0.87	1.25	23%
3	*Melicytus ramiflorus* / *Macropiper excelsum* forest	Moderate	3.09	4.1	1.94	2.59	63%
4	Indigenous scrub – *Ulex europaeus* scrub/ pasture grassland	Moderate-low	13.15	17.02	3.41	4.63	27%
5	*Ulex europaeus* / pasture grassland	Low-moderate	9.28	11.93	2.97	4.04	34%
6	Pasture grassland	Low	1.3	1.61	0.38	0.53	33%
7	*Buddleja davidii* and other weeds	Low	2.67	3.23	1.05	1.25	39%
8	Concrete	Nil	0.18	0.22	0.18	0.22	100%
9	Bare earth and/or rubble	Nil	4.21	4.93	2.64	3.09	63%
10	Track	Nil	0.3	0.35	0.01	0.01	4%
	Total		**39.49**	**50.44**	**14.27**	**18.73**	**37%**

10.4 Options to minimize potential adverse effects

Under the Resource Management Act 1991, environmental effects should be avoided, minimised and/or mitigated. It is unlikely that the effects at this site can be entirely avoided as it appears unlikely that the 'dam' that has been built up over the C&D Landfill Tributary can be removed. Hence some ongoing filling is required to alleviate this issue and this will affect the C&D Landfill Tributary. The client proposes to create an overland flow channel, and thus reduce reliance on the pipe under the landfill. Options for this overland flow channel to recreate a 'natural' stream and fish habitat are briefly discussed below.

Some established secondary indigenous vegetation will also need to be removed as a consequence of the requirement for ongoing filling. The more mature vegetation types tend to be located adjacent to the stream, and their loss can therefore not be avoided or minimized. The client proposes to undertake a staged replanting programme using indigenous species to offset the loss of this indigenous vegetation.

Currently another adverse effect of the landfill operation is the introduction of novel weed species to the area (such as sycamore and brush wattle) and high density of weed species at the site that will seed into adjacent areas. As part of the minimization of potential effects the client will develop a weed management plan which will indicate which weed species will be actively controlled at the site, and where required, replaced by indigenous species or less weedy exotic species.

11. MITIGATION

Adverse environmental effects at this site can not be avoided, due to the requirement to reduce reliance on the pipe beneath the landfill. Thus there will be residual effects that will need to be mitigated. The client has drawn up a Site Rehabilitation Plan that proposes to undertake the following.

11.1 Mitigation for the loss of stream habitat

The client has amended the proposed the stormwater overland flow channel and discharge system so as to try and maintain aquatic species onsite if at all possible. This includes ensuring fish passage, modifications to the stilling basin to ensure fish can bypass it during high flows, and providing fish friendly habitat by providing pools and shelter through replanting.

Options to recreate fish habitat have been extensively discussed but given the uncertainty with regards to recolonisation by indigenous fish this may not be the best and most cost effective option. If fish habitat creation is the most preferred option then an overland flow with a 'natural' appearance will need to be created, with meandering waterways that contains pools, falls and riffles.

The base of such a 'natural' overland flow channel would comprise compacted rocks and soils, rather than a concrete channel as originally proposed. The overland flow channel detailing would include the placement of rocks to provide flow riffles to promote fish travel, and the construction of pools at 10 metre intervals over the length

of the overland flow by deepening the depth of the channel by lowering the invert level by 300 mm. On steep slopes these pools would be arranged so that the nominal horizontal distance between them would not exceed 1 metre.

This overland flow will need to be surrounded by appropriate, eco-sourced, indigenous forest species, for a width of at least 10 m either side of the newly created overland flow (Drawing 9402/01). Plants along the overland flow channel will be spaced as close as practicable to help create rapid canopy cover and help shade the stream and should include indigenous grasses (closest to the waterway), shrubs and larger trees to provide shade.

11.2 Mitigation for the loss of aquatic fauna

There is no guarantee that aquatic fauna can be retained or re-established on-site, within the life of the consent, hence off-site mitigation may be required. Given the uncertainty this may be a preferred option over re-creating a 'natural' overland flow. The client proposes to discuss this option with Greater Wellington Regional Council. Ideally a stream would be nominated for remediation that has an existing restoration group (or could be adopted by an existing restoration group) that could undertake the work. The client is proposing to contribute $5,000 per annum for a period of 10 years towards the remediation, provided that the consents sought are issued.

11.3 Mitigation for the loss of indigenous vegetation

The client proposes to undertake a staged replanting programme. The first phase will consist of the selective removal and/or spraying of noxious and non-indigenous weeds from the existing landfill area and progressive planting as indicated on the drawing 9402/01 attached to the Site Management Plan. This phase will commence as soon as practicable after the granting of resource consents for the landfill extension.

The second phase will consist of the rehabilitation of new landfill areas, and will commence on the completion of areas of the landfill that can be appropriately rehabilitated. As fill compartments are finalised the area will be shaped to create landforms that are stable, allow appropriate drainage and carry sufficient soils to allow the establishment of appropriate species. If a 'natural' overland flow channel was the preferred option then planting the new overland flow channel, to provide replacement aquatic habitat (Drawings 9402/06 and 9402/01), would be prioritised. Environmental weed species that may occur on these finished faces will be selectively removed. Indigenous species that have already established will be retained to assist with the rehabilitation. Appropriate eco-sourced indigenous plant species will be planted in cleared areas to speed rehabilitation.

Browsing animals such as goats and possums may need to be controlled to ensure that newly planted species establish and thrive. This will be implemented as required within the site.

The replanting of the fill faces, in conjunction with the denser planting around the overland flow channel, will address the loss of indigenous vegetation over the life of the clean fill.

11.4 Mitigation for the presence of environmental weed species

The client will develop a weed management plan, in association with Greater Wellington Regional Council, which will indicate which weed species will be actively controlled at the site, and where required, replaced by indigenous species or less weedy species.

11.5 Suitability of mitigation options

The client has made a genuine attempt to provide for opportunities to create fish habitat within the site including a 'natural' looking overland flow with rocky tumbles and pools that koaro require as habitat. However, indigenous fish species can not be maintained on-site for the length of the requested consent due to removal of stream habitat, removal of overhanging vegetation and increased silt loading of the stream.

Koaro (At Risk-Declining) are generally found in forested habitats with very clean water and it will take considerable time for this to be achieved upon the completion of the fill. The gradient of the overland flow will be much shallower than the current pool-small cascade system. Thus, even after creation of fish habitat, the overland flow may still not be suitable as koaro habitat.

It will take a more than a decade before newly planted vegetation surrounding the overland flow is mature enough to start resembling forest cover. Thus there will be an extended period where fish habitat will not be available. Also the loss of fish from the C&D Landfill Tributary, and the subsequently created overland flow channel, means that the fish 'smell', that guides fish up streams, will be lost and this makes it unlikely that fish will recolonise.

If re-creation of fish habitat on-site is the preferred option then it needs to be taken into account that the steep front faces of fill cells nearest Landfill Road could pose limitations for fish passage. The clients' proposal for the new fill areas has tried to ensure that a sufficiently shallow gradient is achieved, and/or resting pools are provided to maintain fish passage, and that fish passage is provided for all in-stream structures. The base substrate within the flow channel is to comprise compacted soils and/or gravels, rather than concrete.

The proposed replanting of the area will help advance the progression to an indigenous forest system and the scale of the planting proposed is sufficient mitigation for the loss of indigenous components.

The mitigation measures suggested by the client, if well-managed and executed, could be sufficient to offset the loss of stream and terrestrial habitat over time, but it is unfortunately not guaranteed that koaro, and other threatened aquatic species, will re-establish themselves within the modified landscape. Given the uncertainty with regards to recolonisation of the overland flow by indigenous fish species off-site mitigation, such as rehabilitating another stream, may be a preferred and more guaranteed option.

The client has indicated that the works are required to alleviate the reliance of the underground pipe and that no alternatives are available.

12. CONCLUSIONS

There are habitats of High ecological value (permanent stream with indigenous riparian vegetation) and Moderate ecological value (potentially seasonally dry streams with riparian vegetation and terrestrial vegetation dominated by indigenous species) within the proposed landfill expansion. A range of nationally 'At Risk' fauna is known to, or could, occur within the site and habitats.

The client has indicated that he needs to address the problem of the deterioration of the existing pipe carrying the stream. He proposes to do this by the addition of more cleanfill and redirecting the stream over the fill rather under it, as at present. This will result in the loss of significant vegetation and threatened fish and their habitat.

The client proposes to revegetate the site with indigenous plant species to deal with loss of indigenous vegetation, and to attempt to recreate a natural looking overland flow to help offset the loss of the stream and threatened fish habitat. Significant changes have been made to the proposed overland flow design to ensure fish passage and to recreate a habitat that would be suitable for fish. However recolonisation of the overland flow path by fish is not guaranteed, hence off-site mitigation may be preferred instead. The revegetation and the stream habitat creation, provided the proposed mitigation is well-executed and successful in establishing suitable indigenous vegetation, will largely offset the loss of indigenous terrestrial and aquatic habitat. If the overland flow can be recolonised by indigenous fish species including koaro, then the mitigation, in the longer-term, will completely offset the loss of significant habitat and species. If this proves to be not possible then off-site rehabilitation of a stream could help compensate for loss of fish population from this site.

In our opinion the overall effects of this proposal will be moderate.

REFERENCES

Allibone R., David B., Hitchmough R., Jellyman D., Ling N., Ravenscroft P., Waters J. 2010: Conservation status of New Zealand freshwater fish, 2009. New Zealand Journal of Marine and Freshwater Research iFirst publication 27 September 2010.

Boffa Miskell 1988: Wellington's native vegetation. A brief survey of early historical records. Prepared for Wellington City Council, Wellington. 23 pp.

Boffa Miskell Limited 2001: Wellington's ridgetops and hilltops - the natural and amenity values. Prepared for Wellington City Council, Wellington.

Boffa Miskell Limited 2002: Wellington ecodomain delineation. Wellington City Council, Wellington. 17 pp.

de Lange P.J., Norton D.A., Courtney S.P., Heenan P.B., Barkla J.W., Cameron E.K., Hitchmough R., Townsend A.J. 2009: Threatened and uncommon plants of New Zealand (2008 revision). New Zealand Journal of Botany 47. 61-96.

de Lange P.J., Norton D.A., Heenan P.B., Courtney S.P., Molloy B.P.J., Ogle C.C., Rance B.D., Johnson P.N., Hitchmough R. 2004: Threatened and uncommon plants of New Zealand. New Zealand Journal of Botany 42. 45-76.

Greater Wellington Regional Council 1999: Regional freshwater plan for the Wellington Region. *Policy document No. WRC/RP-G-99/31*. Greater Wellington Regional Council, Wellington. 244 pp.

Greater Wellington Regional Council 2004: Pest Management Plan: Plan for the management of weeds and pest animals. Greater Wellington, Wellington. 105 pp.

Greater Wellington Regional Council 2009a: Greater Wellington – Regional Pest Management Strategy. 2002 – 2022 Five Year Review 2007. *Regional Pest Management Strategy No. GW/BIO-G-08/188.* Greater Wellington Regional Council, Wellington. 168 pp.

Greater Wellington Regional Council 2009b: Proposed Regional Policy Statement for the Wellington region 2009. *No. GW/EP-G-08/200.* Greater Wellington Regional Council, Wellington. 189 pp.

Hitchmough R., Bull L., Cromarty P. 2007: New Zealand Threat Classification System lists 2005. Department of Conservation, Wellington.

Hitchmough R., Hoare J., Jamieson H., Newman D., Tocher M., Anderson P., Lettink M., Whitaker A. 2010: Conservation status of New Zealand reptiles, 2009. New Zealand Journal of Zoology 37(3). 203-224.

Mahoney A.G. 2009: Geotechnical egnineering report - stability. C&D Landfill, Landfill Rd, Happy Valley, Wellington. *Aurecon Contract Report No. 42373/001*. Prepared for C&D Landfill, Wellingotn. 15 pp.

McEwen W.M., (Ed.) 1987: Booklet to accompany SHEET 3: descriptions of Districts in central New Zealand, from Eastern Wairarapa to Akaroa; also Chathams, not shown on map. Ecological Regions and Districts of New Zealand. Wellington, Department of Conservation. 139 pp.

Miskelly C.M., Dowding J.E., Elliott G.P., Hitchmough R.A., Powlesland R.G., Robertson H.A., Sagar P.M., Scofield R.P., Taylor G.A. 2008: Conservation status of New Zealand birds, 2008. Notornis 55. 117-135.

Mitcalfe B.J., Horne J.C. 1997: Some indigenous vascular plants of Spooky Gully. New Zealand Plant Conservation Network, Wellington. 4 pp.

Mitcalfe B.J., Horne J.C. 1998: Some indigenous vascular plants of Lot 2, Long Gully. New Zealand Plant Conservation Network, Wellington. 5 pp.

Mitcalfe B.J., Logan R. 1999: Some indigenous vascular plants of Lot 1 DP. 82764, Long Gully. New Zealand Plant Conservation Network, Wellington. 3 pp.

NIWA 2011: Freshwater Biodata Information System New Zealand.

Park G. 1999: An inventory of the surviving traces of the primary forest of Wellington city. Wellington City Council, Wellington. 11 plus appendices pp.

Sawyer J.W.D. 2004: Plant conservation strategy, Wellington Conservancy (excluding Chatham Islands), 2004–2010. Department of Conservation, Wellington. 91 pp.

Wellington City Council 2004: Wellington's Outer Green Belt management plan. Wellington City Council, Wellington. 169 pp.

Wellington City Council 2006: Wellington City District Plan - Chapter 17. Open Space Rules *Volume 1: Objectives, Policies & Rules* Wellington City Council, Wellington. 28 pp.

Wildland Consultants 2009: Biodiversity survey - ecological survey and assessment of some of the areas of ecological significance in Wellington City. *Wildland Consultants Ltd Contract Report No. 2142.* Report prepared for Wellington City Council, Wellington. 86 pp.

VASCULAR PLANT SPECIES RECORDED THE C&D LANDFILL SITE

Scientific Name	Māori Name	Common Name
INDIGENOUS SPECIES		
Dicot. trees and shrubs		
Aristotelia serrata	makomako	wineberry
Brachyglottis repanda	rangiora	rangiora
Carpodetus serratus	putaputaweta	marbleleaf
Coprosma crassifolia		
Coprosma grandifolia	kanono	
Coprosma rhamnoides		
Coprosma robusta	karamu	karamu
Geniostoma rupestre var. ligustrifolium	hangehange	hangehange
Hebe parviflora	taranga	tree hebe
Hebe stricta var. *atkinsonii*	koromiko	koromiko
Knightia excelsa	rewarewa	
Leptospermum scoparium	manuka	manuka
Leucopogon fasciculatus	mingimingi	mingimingi
Macropiper excelsum	kawakawa	kawakawa
Melicytus ramiflorus	mahoe	whiteywood
Ozothamnus leptophyllus	tauhinu	tauhinu
Pseudopanax arborea		
Schefflera digitata	pate	pate
Solanum laciniatum	poroporo	poroporo
Urtica ferox	ongaonga	tree nettle
Monocot. trees and shrubs		
Cordyline australis		cabbage tree
Monocot. lianes		
Ripogonum scandens	kareao	supplejack
Freycinetia banksii	kiekie	kiekie
Dicot. lianes		
Clematis forsteri	pikiarero	clematis
Metrosideros diffusa	rataa	climbing rata
Muehlenbeckia australis	pohuehue	large-leaved muehlenbeckia
Muehlenbeckia complexa	pohuehue	pohuehue
Rubus cissoides	tatamoa	bush lawyer

Scientific Name	Māori Name	Common Name
Ferns		
Adiantum cunninghamii	huruhuru tapairu	maidenhair
Asplenium bulbiferum	mouku	hen and chicken
Asplenium flaccidum	makawe o Raukatauri	hanging spleenwort
Asplenium hookerianum var. hookerianum		Hookers spleenwort
Asplenium oblongifolium	huruhuruwhenua	shining spleenwort
Asplenium appendiculatum		
Blechnum chambersii	nini	
Blechnum discolor	piupiu	crown fern
Blechnum fluviatile	kiwakiwa	
Blechnum minus		
Blechnum penna-marina		
Blechnum novae-zealandiae	kiokio	kiokio
Ctenopteris heterophylla		comb fern
Cyathea medullaris	mamaku	mamaku
Histiopteris incisa	mata	water fern
Lastreopsis glabella		
Paesia scaberula	mataa	ringfern
Pellaea rotundifolia	tarawera	
Phymatosorus pustulatus	kowaowao	hound's tongue
Polystichum richardii	pikopiko	shield fern
Pteridium esculentum	rarahu	bracken
Pteris macilenta		
Grasses		
Microlaena stipoides		
Microlaena polynoda		
Poa cita	wii	silver tussock
Sedges		
Carex flagellifera	manaia	
Carex secta	puurei	
Uncinia uncinata	matau a Maui	hook grass
Isolepis distigmatosa		
Rushes		
Luzula picta var. *limosa*		
Monocot. herbs other than orchids, sedges, rushes		
Astelia fragrans	kakaha	
Phormium cookianum	wharariki	coastal flax

Scientific Name	Māori Name	Common Name
Phormium tenax	harakeke	flax
Composite herbs		
Helichrysum filicaule		
Leptinella squalida subsp. *squalida*		
Senecio minimus		
Dicot. herbs other than composites		
Cardamine sp.		
Epilobium rotundifolium		
Epilobium nummulariifolium		
Lobelia angulata		pratia
Nertera depressa		bead plant

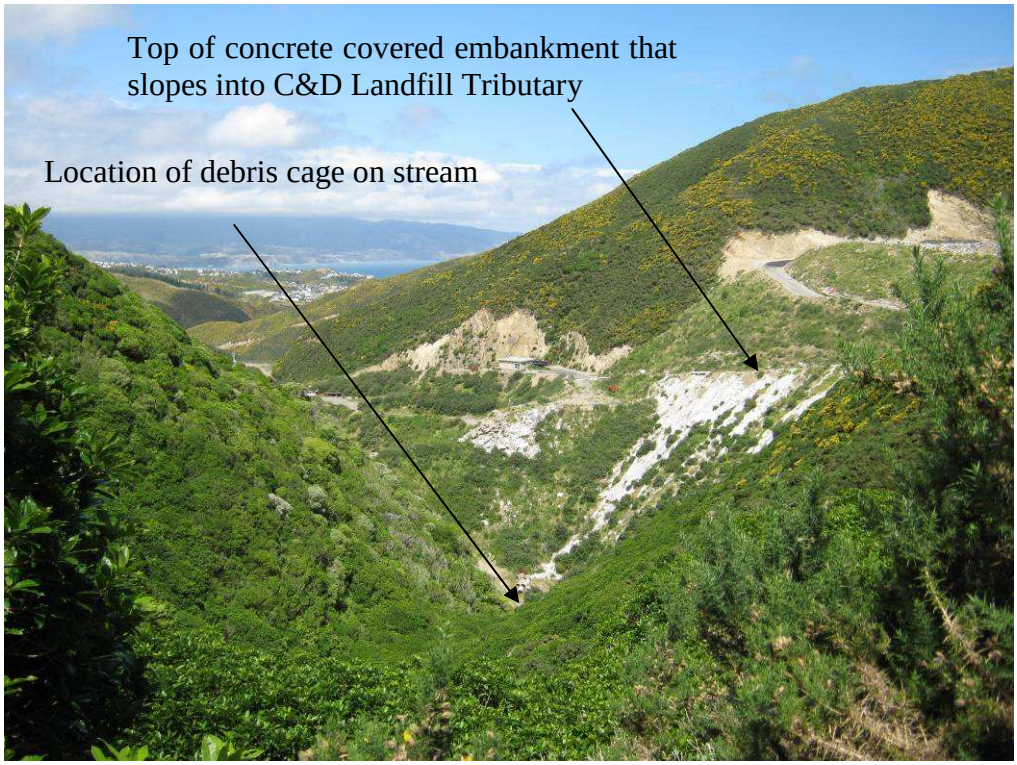
ADVENTIVE SPECIES

Dicot. trees and shrubs	
Paraserianthes lophantha	brush wattle
Berberis darwinii	Darwin's barbarry
Buddleja davidii	buddleia
Erica lusitanica	Spanish heath
Acer pseudoplatanus	Sycamore
Ulex europaeus	gorse
Lupinus arboreus	tree lupin
Dicot. lianes	
Clematis vitalba	Old man's beard
Rubus fruticosus agg.	blackberry
Grasses	
Agrostis capillaries	browntop
Cortaderia selloana	pampas
Holus mollis	creeping fog
Poa pratensis	Kentucky bluegrass
Lolium perenne	perennial rye grass
Dactylis glomerata	Cocksfoot
Anthoxanthum odoratum	sweet vernal
Cyperus eragrostis	Umbrella sedge
Monocot. herbs other than orchids, sedges, rushes	

Scientific Name	Māori Name	Common Name
Landoltia punctata		Purple-backed Duckweed
Composite herbs		
Arctium minus		burdock
Cirsium arvense		Californian thistle
Conyza albida		fleabane
Conyza canadensis		Canadian fleabane
Crepis capillaries		hawksbeard
Erigeron karvinskianus		Mexican daisy
Mycelis muralis		wall lettuce
Senecio glastifolius		pink ragwort
Senecio jacobaea		ragwort
Sonchus oleraceus		sow thistle
Taraxacum officinale		dandelion
Dicot. herbs other than composites		
Dichondra micrantha		mercury bay weed
Digitalis purpurea		foxglove
Foeniculum vulgare		fennel
Fumaria muralis		scrambling fumitory
Galega officinalis		goat's rue
Galium aparine		cleavers
Galium palustre		marsh bedstraw
Hypericum androsaemum		tutsan
Lamium purpurpeum		red dead nettle
Lotus pedunculatus		Lotus
Medicago lupulina		black medick
Nasturtium officinale		Watercress
Orobanche minor		broomrape
Phytolacca octandra		inkweed
Plantago coronupus		buck's horn plantain
Plantago lanceolata		narrow-leaved plantain
Plantago major		broad-leaved plantain
Prunella vulgaris		Self heal
Ranunculus repens		creeping buttercup
Raphanus raphanistrum		wild radish
Rumex sagittatus		climbing dock
Solanum dulcamara		bittersweet
Solanum nigrum		black nightshade
Stachys silvatica		hedge stachys
Trifolium repens		white clover
Tropaeolum majus		nasturtium
Verbascum thapsus		woolly mullein
Vicia sativa		vetch

APPENDIX 2

SITE PHOTOGRAPHS

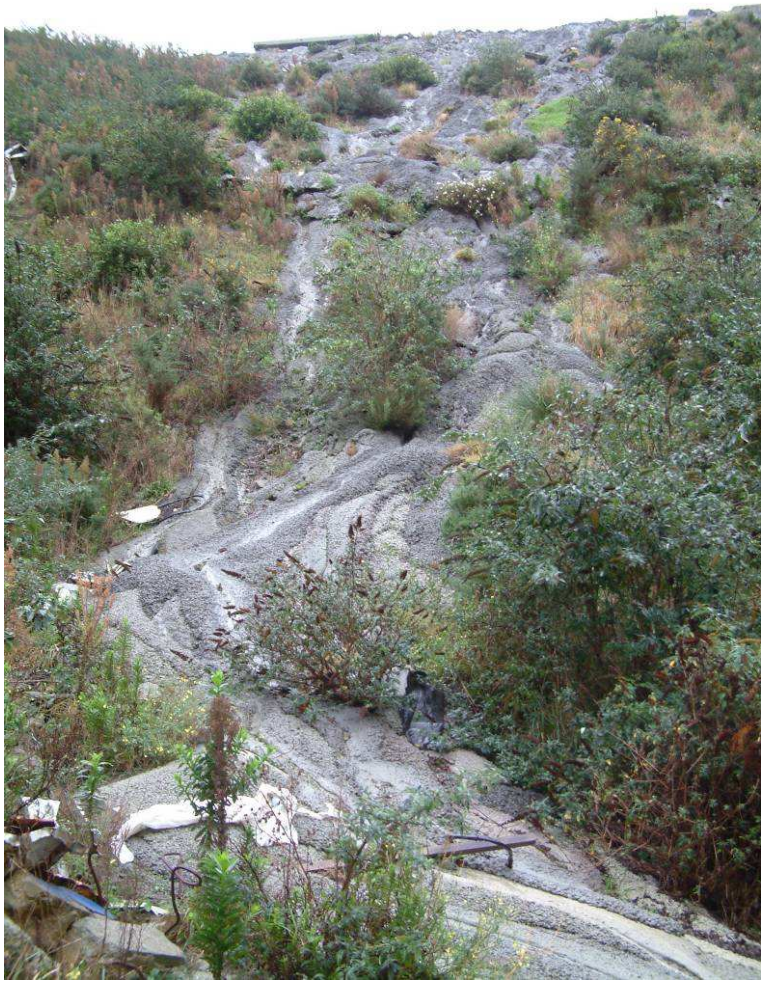


Photograph 1. View down into to landfill site from one of the ephemeral streams. This illustrates the potential 'dam' and the amount of fill that has been placed over the piped sections of the Owhiro Stream Tributary.

Photograph 2. Debris cage installed in front of 900 mm pipe through which C&D Landfill Tributary has been diverted beneath the landfill.

Photograph 3. Landfill embankment immediately adjacent to C&D Landfill Tributary, 24 May 2010. Note concrete poured from the top and patches of buddleia.

Photograph 4. Landfill embankment immediately adjacent to C&D Landfill Tributary, 28 January 2011. Note the increased cover of buddleia in just 8 months.



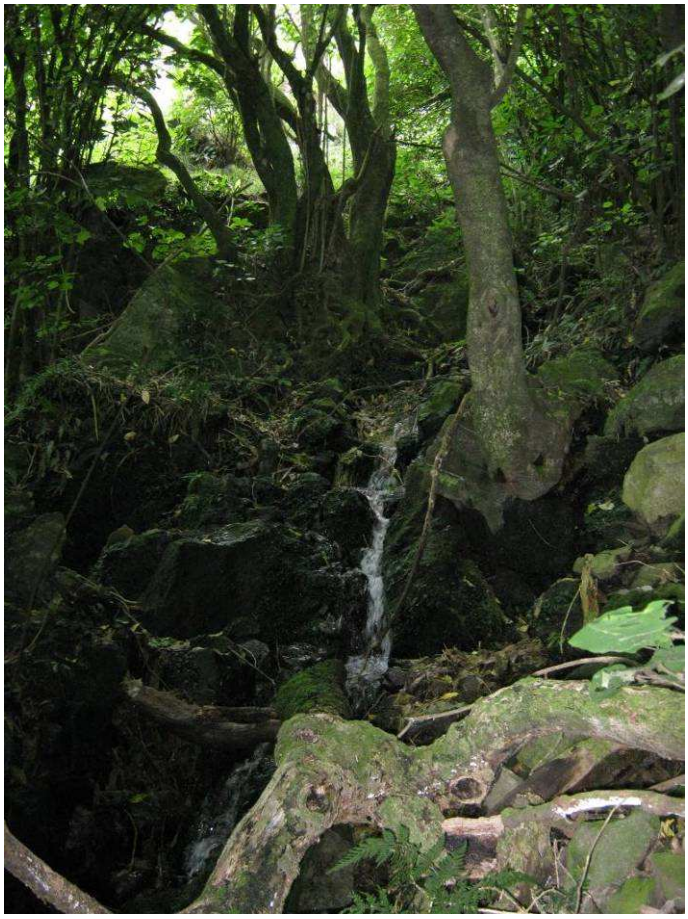
Photograph 5. Uncontained flow of waste concrete occasionally comes very close to the C&D Landfill Tributary. Debris cage is about 5 m to the right of this image, 24 May 2010.

Photograph 6. Just upstream from debris cage, looking upstream into the valley through which the C&D Lanfill Tributary flows, 24 May 2010.

Photograph 7. C&D Landfill Tributary, 28 January 2011, beneath mahoe and kawakawa canopy (Vegetation Type 3) with fern understorey.

Photograph 8. Clarity of water and substrate in C&D Lanfill Tributary, 28 January 2011.

Photograph 9. Riparian margin of C&D Landfill Tributary, in small clearing, 28 January 2011.



Photograph 10. One of the small tributaries feeding into the C&D Landfill Tributary, 28 January 2011.

Photograph 11. Mahoe (*Melicytus ramiflorus*) - kawakawa (*Macropiper excelsum*) - manuka (*Leptospermum scoparium*) - tree hebe (*Hebe parviflora*, flowering) - and mamaku (*Cyathea medullaris*) forest canopy (Vegetation Type 2), 28 January 2011.

Photograph 12. Fern and shrub understorey along C&D Landfill Tributary beneath Mahoe (*Melicytus ramiflorus*) / kawakawa (*Macropiper excelsum*) forest (Vegetation Type 3), 28 January 2011.

Photograph 13. Sparse understorey and scree on steep slopes beneath Mahoe (*Melicytus ramiflorus*) / kawakawa (*Macropiper excelsum*) forest (Vegetation Type 3, 28 January 2011).

Photograph 14. Indigenous scrub – gorse (*Ulex europaeus*) scrub/ pasture grassland on left flank (Vegetation Type 4) and gorse (*Ulex europaeus*) / pasture grassland on the right flank (Vegetation Type 5, 28 January 2011).

Photograph 15. Areas of Indigenous scrub – gorse (*Ulex europaeus*) scrub/ pasture grassland (Vegetation Type 4) mixed in with areas of gorse (*Ulex europaeus*) / pasture grassland (Vegetation Type 5, 28 January 2011).

Photograph 16. Small clearing halfway up the hill, ongaonga (*Urtica ferox*) in the foreground, Mexican daisy in amongst the pasture grasses (Vegetation Type 6, 28 January 2011).

Photograph 17. View of active faces at the landfill site from below (24 May 2010).

Photograph 18. Same view of landfill site from below (28 January 2011).