NZ TRANSPORT AGENCY
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Roads of national significance

16 20 Western Ring Route – Waterview Connection

Assessment of Terrestrial Vegetation Effects

Boffa Miskell

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Assessment of Terrestrial Vegetation Effects

Contents

1. INTRODUCTION

1.1 Background

In 2009 the New Zealand Transport Agency (NZTA) confirmed its intention that the 'Waterview Connection Project' (the Project) would be lodged with the Environmental Protection Authority as a Proposal of National Significance. The Project includes works previously investigated and developed as two separate projects, being the SH16 Causeway Upgrade and the SH20 Waterview Connection. A detailed description of the elements associated with the Project is given in section 4 of the Assessment of Environmental Effects report. The key elements of the Project are:

- Completing the Western Ring Route (which extends from Manukau to Albany via Waitakere);
- Improving resilience of the SH16 causeway between the Great North Road and Rosebank Interchanges to correct historic subsidence and "future proof" it against sea level rise;
- Providing increased capacity on the SH16 corridor (between the St Lukes and Te Atatu Interchanges);
- Providing a new section of SH20 (through a combination of surface and tunneled road) between the Great North Road and Maioro Street Interchanges; and
- Providing a cycleway throughout the surface road elements of the Project corridor.

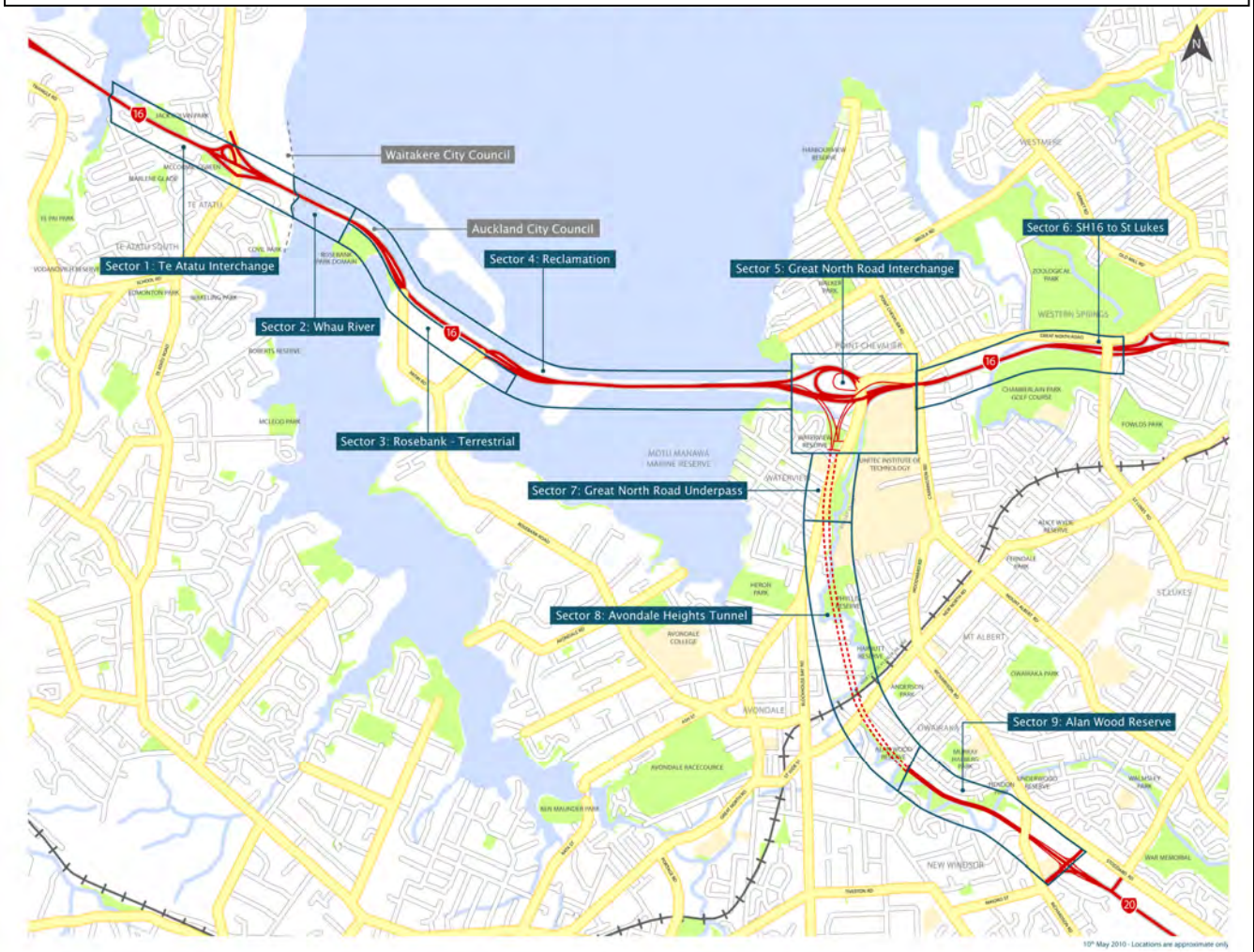
1.2 Purpose

The purpose of this Assessment of Terrestrial Vegetation Effects report is to identify the terrestrial botanical values within the Project footprint, to consider the actual and potential effects of the Project on these values, and to propose options to avoid, remedy or mitigate any such adverse effects.

For the purposes of this report, terrestrial vegetation is defined as that which is growing above Mean High Water Springs (MHWS). As such, mangroves are generally excluded from the following discussion (and instead are included in the Assessment of Marine Ecological Effects report – Boffa Miskell Ltd (BML), 2010a), while salt marsh and salt meadow are included herein.

The report structure is based around the 9 sectors that the Project area has been divided into (Figure 1).

Figure 1. Western Ring Route : Waterview Connection (SH16-20) – Sector Diagram



2. Investigations and Methods

The terrestrial vegetation investigations were undertaken by experienced botanists in two discrete sections, being the SH20 Waterview Connection footprint (completed by BML) and the SH16 Upgrade footprint (completed by Bioresearches Group Ltd [BGL]), as shown in Figure 2.

Figure 2

The field studies for the SH20 Waterview Connection section (i.e. the corridor between the recently consented Maioro Street Interchange project (adjacent to the termination of SH 20 Mt Roskill) and the existing SH16 Great North Road Interchange) were conducted by BML. Mr D. Slaven undertook these surveys. The field studies for the SH16 Upgrade section were conducted by BGL along both sides of the existing North-Western motorway (SH 16). Dr. R. Gardner undertook these surveys.

The vegetation patterns and characteristics of the Project Area enabled the use of survey methods which provided complete coverage (via non-randomised transects) of the Project footprint.

In addition to field work, a literature review was undertaken to identify any records of "at risk" species of flora that had been previously recorded within the Project area. As a result the following records were identified:

- *Mimulus repens* – this is a small creeping endemic maritime herb, presently classified as Naturally Uncommon (de Lange et al., 2009) and Regionally Endangered (Stanley et al., 2005). It had historically been found in a few localities alongside the SH16 causeway in the vicinity of Traherne Island (Sector 4).

- *Doodia squarrosa* – this is a small and inconspicuous endemic fern, presently classified as Naturally Uncommon (de Lange et al., 2009) and Regionally Sparse (Stanley et al., 2005). It had historically been found growing within the basalt block walls of certain channelised sections of Oakley Creek within Alan Wood Reserve and Hendon Park (Sector 9).

- *Fissidens berteroi* – this is an aquatic moss, presently classified as Nationally Endangered (Hitchmough et al., 2007). It had historically been found growing in Oakley Creek within Hendon Park (Sector 9), and in Meola Creek (Sector 6).

- *Geranium* aff. *retrorsum* "Oakley Creek" - this is a small and inconspicuous herb, being a tap-rooted geranium. It has only recently been "discovered", growing alongside Oakley Creek in Hendon Park (Sector 9). Within New Zealand it appears to be known only from this location. The taxonomic position, origins and consequent 'rarity status' of this plant are presently problematic. It seems to be part of the *Geranium solanderi / Geranium retrorsum* complex (Dr. R. Gardner, *pers. comm*.), with both of these species being present in Australia and New Zealand. While it has similar traits to both it is actually neither, but instead appears to be a distinct species and a new arrival in the country (Dr. R. Gardner, *pers. comm*.), getting to New Zealand either via natural means or by inadvertent human introduction. If it arrived here with human help it would be classified as a weed, but if it arrived here naturally it will be of greater botanical significance. Unfortunately there appears to be no imminent plans by NZ taxonomic botanists to resolve this matter, and its status looks likely to remain indeterminate for the foreseeable future.

Surveys were undertaken in 2009 and 2010 by both BML and BGL botanists, targeted specifically at locating any of the "at risk" species of flora identified in the literature review (as discussed above).

Further to the above, in addition to "at risk" species of flora, the literature review also investigated rare or uncommon vegetation types that have previously been reported from within the wider Project area. Only one such vegetation type was identified, being 'rock forest'. This was once a characteristic (although never particularly common) vegetation community of the basalt lava fields of the Auckland Isthmus. Few examples presently remain (with the better known ones being at Withiel Thomas Reserve, Gribblehurst Park, Old Government House and the Almorah Road basalt fields), and this vegetation type is considered to be botanical value. While none of the sites listed above is at any threat from the Project, this particular forest type was identified as being one to specifically search for within the Project area, given its basalt geology.

The desk top analysis also included a review of aerial photography of the Project footprint and its environs. From analysis of these it was evident that the SH16 causeway widening would impinge upon saline wetlands, including mangroves, salt marsh and salt meadow. Saline wetlands are considered to be botanically (and ecologically) valuable.

As a result of the desk top analyses, a distinction was made between three different vegetation types, as follows:

- Significant Vegetation – all officially listed "at risk" flora (ie. *Mimulus repens, Doodia squarrosa*, *Fissidens berteroi)* as well as the presently indeterminate *Geranium* aff. *retrorsum* "Oakley Creek");
- Valued Vegetation – all vegetation that is of some botanical interest and value (ie. saline wetlands and rock forest);
- All other vegetation which is neither Significant Vegetation nor Valued Vegetation.

The reason for the distinction between these three types is to identify that vegetation and flora which are sufficiently significant to require the avoidance of adverse effects, as compared to that vegetation and flora which are sufficiently valued to require the minimisation of adverse effects to the fullest extent practicable (where avoidance is not possible), as compared to that vegetation and flora which are of no particular botanical conservation value.

The sites of Significant Vegetation and Valued Vegetation are mapped in Figures 3A – 3E. The rationale for the inclusion of these sites in either of these two categories is given in the Results section of this report (see Section 3)[1].

[1] With the exception of mangroves, which are dealt with instead in the Assessment of Marine Ecological Effects report.


Valued Vegetation (Saline)
N
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Figure 3A. Western Ring Route - Waterview Connection
SH16 Significant and Valued Vegetation
0
0.5 Km
1:15,000 @ A4
Data Sources: ALGGi (2008 Aerials), Boffa Miskell
File: A09178_Fig3A_Vegetation.mxd; Printing Date: 22/07/2010; Author: mattd
Boffa Miskell
www.boffamiskell.co.nz © Boffa Miskell 2009


Significant Vegetation (Saline)
Valued Vegetation (Saline)
Valued Vegetation (Terrestrial) - Native Flora Only
N
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Figure 3B. Western Ring Route - Waterview Connection
SH16 Significant and Valued Vegetation
Data Sources: ALGGi (2008 Aerials), Boffa Miskell
File: A09178_Fig3B_Vegetation.mxd; Printing Date: 22/07/2010; Author: mattd
0
0.5 Km
1:15,000 @ A4
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Significant Vegetation (Saline)
Valued Vegetation (Saline)
Valued Vegetation (Terrestrial) - Native Flora Only
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Figure 3C. Western Ring Route - Waterview Connection
SH16 Significant and Valued Vegetation
Data Sources: ALGGii (2008 Aerials), Boffa Miskell
File: A09178_Fig3C_Vegetation.mxd; Printing Date: 22/07/2010; Author: mattd
0
0.5 Km
1:15,000 @ A4
Boffa Miskell

Figure 3D. Western Ring Route - Waterview Connection
Hendon Park Significant Vegetation

Data Sources: ALGGi (2008 Aerials), Boffa Miskell
File: A09178_Fig3D_Vegetation.mxd; Printing Date: 22/07/2010; Author: mattd


Valued Vegetation (Terrestrial) - Native Flora Only
These plans have been produced as a result of information provided by the client and/or sourced by or provided to Boffa Miskell Limited by a third party for the purposes of providing the services. No responsibility is taken by Boffa Miskell Limited for any liability or action arising from any incomplete or inaccurate information provided to Boffa Miskell Limited by either from the client or a third party). These plans are provided to the client for the benefit and use by the client and for the purpose for which it is intended.
Figure 3E. Western Ring Route - Waterview Connection
Harbutt Reserve Valued Vegetation
Data Sources: ALGGii (2008 Aerials), Boffa Miskell
File: A09178_Fig3E_Vegetation.mxd; Printing Date: 22/07/2010; Author: mattd
0 50 100 Meters
1:4,000@ A4
Boffa Miskell

3. Results : Existing Vegetation

3.1 Sector 1 (Te Atatu Interchange)

Very little natural vegetation occurs in this area with the exception of extensive tracts of mangroves and small patches of saline wetland in Henderson Creek, including within the estuarine mouth of Pixie Stream at Jack Colvin Park. Elsewhere there are planted trees and shrubberies within the motorway designation. None of this planted vegetation has any particular botanical value.

The Project footprint along the landward side would take in a wedge-shaped piece of ground, much of which is covered in young mangroves (up to 1.5m tall). Above the mangroves in the direction of the bridge, the lower rocky part of the motorway-verge supports only a few salt marsh plants (needlegrass, glasswort and *Samolus*). Higher up the slope there is a weedy scrubland, including privet species, karamu and pampas grass.

Further westwards, the edge of the Project footprint will include several large crack willows. Associated native species found here include the sedges *Carex flagellifera*, *Carex geminata* agg., *Isolepis cernua*, and the climbing fern hounds tongue. Most of the ground cover under the willows is wandering jew and other weeds.

The Project footprint on the seaward side includes a band of young mangroves and an area of salt marsh. On the ground rising westwards there is an exotic scrubland (brush wattle, pampas grass and Spanish cane) and a recent native planting (manuka, kanuka, flax, karamu and cutty grass). It would also just include the self-sown stand of coastal gum. Associated native species in this gum stand are mapou, bracken and sword sedge.

Apart from saline wetlands, neither Significant Vegetation nor Valued Vegetation is present within Sector 1.

3.2 Sector 2 (Whau River Bridge)

At the Whau River crossing the only vegetation within the Project footprint are mangroves. The effects of the Project on these mangroves are discussed in the Assessment of Marine Ecological Effects report (BML, 2010a).

3.3 Sector 3 (Whau River to Rosebank Peninsula)

The plantings at the Rosebank Road-Patiki Road interchange are relatively recent and are made up of flax, *Hebe* cultivars, pohutukawa, ngaio, *Coprosma repens*, and other native trees and shrubs. In places brush wattle and Sydney golden wattle have begun to overtop these plantings or replace them completely. No individual specimen here has any particular botanical significance.

In the vicinity of the access road to the Rosebank Road Domain (i.e. the go-kart track) the area within the Project footprint is dominated by small to medium-sized exotic trees (Sydney golden wattle, black wattle and shining privet) together with gorse, bracken, pampas grass, kikuyu and blackberry. Here there is only a limited amount of native coastal species (including salt marsh ribbonwood, pohuehue, glasswort and oioi). Several fairly young planted pohutukawa trees (all approximately 7m tall) are also present here.

In the vicinity of the Whau River channel the motorway-verge vegetation consists of kikuyu and associated small trees and shrubs. These include brush wattle, gorse, blackberry and other exotics (including two radiata pines approximately 15m tall), with scattered bushes of salt marsh ribbonwood, pohuehue, karamu and oioi (mostly along the rock revetment at the base of the verge).

Salt marsh occupies the coastal edge here, with mangroves only present at its eastern and western edges. The salt marsh has developed on a rather sandy substrate and consists of open sparse growths of glasswort among a mosaic of sea-rush, together with needlegrass and salt marsh ribbonwood on slightly higher ground.

Southwards from here towards the eastern edge of the salt marsh there is an abundance of coastal tree-daisy – at least one hundred individuals, including numerous older trees of up to 2m tall and ≥ 5cm diameter at breast height (dbh). However, these are well outside of the Project footprint and will not be affected by the works.

Apart from saline wetlands, neither Significant Vegetation nor Valued Vegetation is present within Sector 3.

3.4 Sector 4 (Rosebank Peninsula to Great North Road)

Away from Traherne Island, on the southern side of the existing SH16 between Great North Road and the Rosebank Road off-ramp, the motorway is adjoined by a cycleway. To the south of this the ground cover is mostly of mown kikuyu grass, but with a broken fringe of numerous 1m tall bushes of salt marsh ribbonwood, together with a few specimens of Auckland's common salt marsh plants, including sea-rush, needlegrass and glasswort, together with flax, karamu and karo.

Away from Traherne Island, on the northern side of SH16 within Sector 4, wetter areas are characterised either by mature crack willows or by flax, *Polygonum* species, *Paspalum distichum* and pampas grass, together with a few small patches of *Baumea articulata*, *Polygonum salicifolium* and *Eleocharis acuta*. The drier areas are grass-dominated (predominantly *Paspalum urvillei*, *Anthoxanthum odoratum* and *Microlaena stipoides*).

Privet, boneseed and Sydney golden wattle dominate in places, and planted cabbage trees, flax, manuka and karo also occur within this sector, in abundance in places. The liverworts *Chiloscyphus semiteres* and *Frullania pentapleura* are also found here, as well as the moss *Bryum capillare*. None of these are "at risk" species.

Along the MHWS margins common salt marsh species are present, including salt marsh ribbonwood, needlegrass, glasswort, sea-rush, needlegrass, knobby club rush, *Samolus repens* and *Selliera radicans*.

On the southern side of SH16 alongside Traherne Island, the vegetation consists of a dense scrub of tall flax, in which brush wattle and Sydney golden wattle are regenerating copiously. Between the cycleway and the edge of the flax, the outer strip (approximately 5m wide) is partly grassy and partly covered in salt-marsh species such as needlegrass, sea-rush, jointed rush and *Baumea juncea*. Within this area there is a shallow 1.5m wide drain, now partly effaced (by recent vehicle activities, and also apparently by past dumping of soil). It is imperfectly connected with the adjacent salt marsh on the northern side of the island, but presumably does receive some inflow of brackish water during spring tides. It contains *Samolus repens, Triglochin striatum, Cotula coronopifolia*, and several square metres of the "at risk" herb *Mimulus repens* (Figure 4).

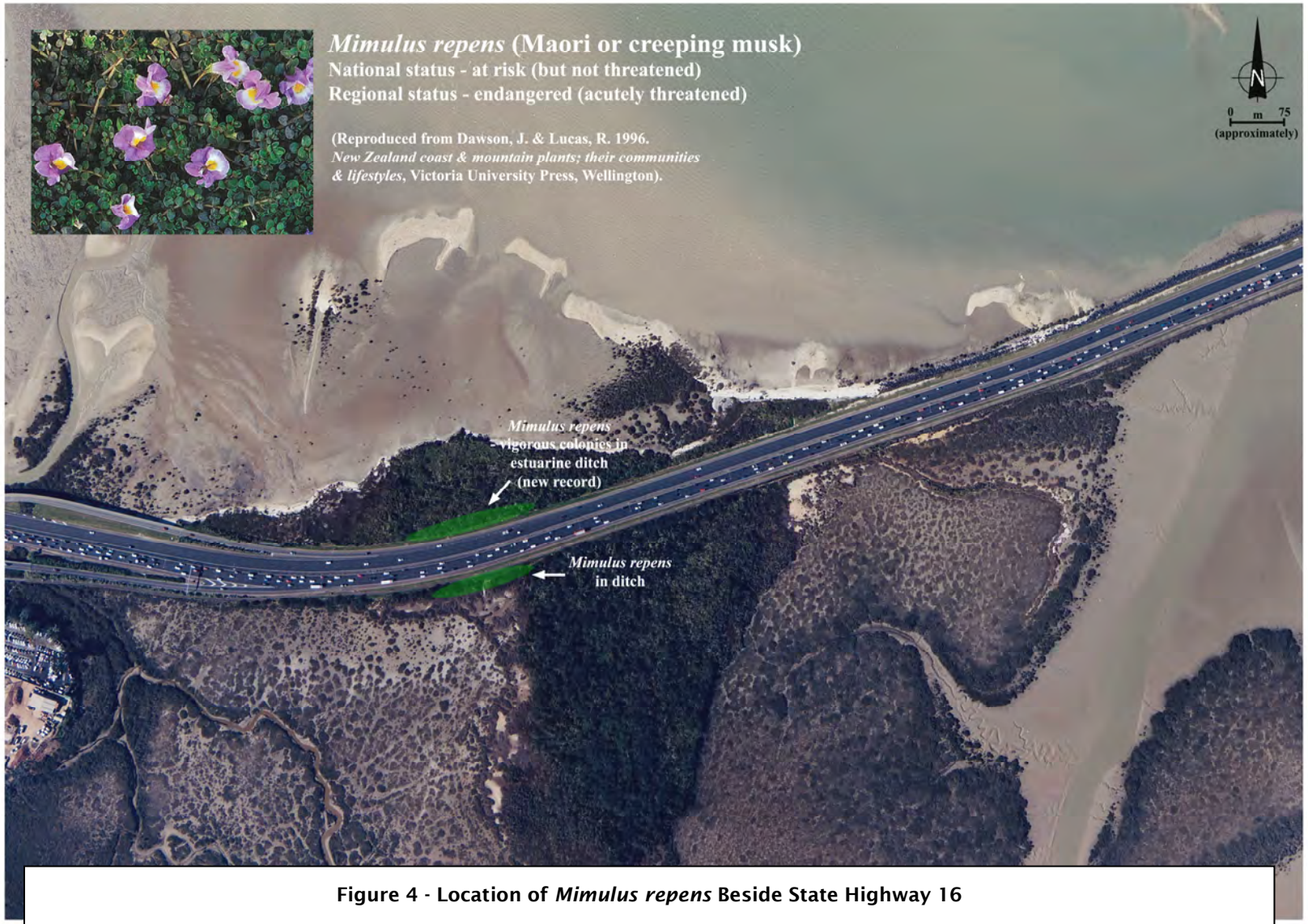

Figure 4 - Location of *Mimulus repens* Beside State Highway 16

Mimulus repens is described in de Lange et al. (2009) as being Naturally Uncommon, with the qualifiers of being Sparse but Secure Overseas, and by Stanley et al. (2005) as Regionally Endangered. It is described by the New Zealand Plant Conservation Network (NZPCN) as being a widespread, naturally uncommon biologically sparse species uncommon in the North Island, but becoming progressively more abundant south of the Waikato.

Mimulus is a strictly coastal species, being a succulent perennial herb that forms a mat, and is usually found at the upper reaches of salt marshes and estuaries in permanently damp or soggy saline-influenced soils, in locations that are periodically flooded during high, spring or king tide events. It is easily grown from rooted pieces, as well as from stem cuttings and fresh seed (NZCPN *web site*).

On the northern side of SH16 alongside Traherne Island, the vegetation consists of tall and healthy flax, among which are lesser amounts of young planted karo, karamu, cabbage trees and manuka, as well as self-introduced brush wattle. This area also includes a sizeable population of *Mimulus* (Figure 4). It grows towards the upper end of a very shallow (but tidally influenced) ditch, forming vigorous colonies that are doing at least as well as the associated salt-marsh natives, such as sea-rush, *Triglochin striatum, Samolus repens* and *Isolepis cernua*. The high (spring) tide reaches up this ditch to a depth of perhaps 10cm. The short bank on the outer side of the ditch supports dense flax, but this doesn't appear to be adversely shading the *Mimulus*. It is understood that the ditch was scraped 'clean' approximately 4 years ago, so it is possible that the colonies here have arisen from buried seed.

This general area also includes several good-sized individuals of coastal tree daisy, which while not officially classified as an "at risk" species (either nationally or regionally) is nevertheless considered by some botanists (e.g. Dr. A. Julien, *pers. comm*.) to be of a somewhat localised distribution within the Auckland Region.

The patches of *Mimulus* are identified in this report as being Significant Vegetation, while Traherne Island is identified in this report as including Valued Vegetation (i.e. its native components) (see Figure 3B).

3.5 Sector 5 (Oakley Creek Mouth and Waterview Interchange)

3.5.1 Oakley Creek Mouth

The stream-side banks at the mouth of Oakley Creek (Plates 1 and 2) form one of the more densely vegetated areas within the Project footprint. Given this, detailed botanical investigations were undertaken here, with the results being given in Table 1.

3.5.1.1 North Bank Bush

The north bank of the mouth of Oakley Creek is rock forest, with large basalt boulders present especially close to the creek. However, this rock forest is primarily exotic, with the dominant species being tree privet. The canopy is generally comprised of medium-sized specimens (approximately 15m tall and 20-40cm dbh). In addition to the tree privet, hawthorn and white poplar occur locally, mainly close to the creek. Most of the hawthorn trees are very mature, with saplings and young trees being very infrequent. Chinese privet and Sydney golden wattle are also common here.

Plate 1 - Oakley Creek Near the Great North Road Culvert

Plate 2 - Oakley Creek North Bank Vegetation

Table 1. Flora of the Mouth of Oakley Creek

Botanical Name	Common Name	Location
Avicennia marina subsp. *australasica*	Mangrove	TRB / TLB
Plagianthus divaricatus	Salt marsh Ribbonwood	TRB
Corynocarpus laevigatus	Karaka	TRB
Racosperma dealbata	Wattle	TRB / TLB
Racosperma melanoxylon	Tasmanian Blackwood	TRB/ TLB
Myrsine australis	Mapou	TRB
Ligustrum lucidum	Tree privet	TRB
Ulex europeus	Gorse	TRB
Hedychium gardnerianum	Kahili ginger	TRB
Chrysanthemoides monilifera	Boneseed	TRB
Gahnia xanthocarpa	Cutty grass	TRB
Cortaderia selloana	Pampas grass	TRB
Agapanthus praecox	Agapanthus	TRB
Coprosma robusta	Karamu	TRB
Salix spp.	Willow	TRB
Tradescantia fluminensis	Wandering Jew	TRB / TLB
Allium triquetrum	Wild garlic (three cornered)	TRB / TLB
Euonymous europaeus	Spindle tree	TRB / TLB
Calystegia sepium	Convolvulus	TRB / TLB
Araujia sericifera	Moth plant	TRB / TLB
Musaparadisica Saoientum	Banana palm	TLB
Magnolia spp.	Magnolia	TLB
Aloe vera	Aloe	TLB
Zantedeschia aethiopica	Arum lily	TLB
Solanum mauritianum	Tobacco weed	TLB
Senecio mikanioides	German ivy	TLB
Nephrolepis spp.	Ladder fern	TLB
Vinca major	Periwinkle	TLB
Pennisetum clandestinum	Kikuyu	TLB
Pseudosasa japonica	Bamboo	TLB
Cupressus macrocarpa	Macrocarpa	TLB
Phormium tenax	Flax	TLB
Leptocarpus similus	Oioi	TLB
Carex flagillifera	Pendulous sedge	TLB
Pittosporum crassifolium	Karo	TLB
Rhododendron spp	Rhododendron	TLB
Pteridium esculentum	Bracken	TLB

TLB = True Left Bank

TRB = True Right Bank

A few young and somewhat older (up to 12m) lemonwood trees are also present. It is possible that these lemonwood are naturally occurring here as opposed to being planted specimens.

Mapou is the most common native species in the understorey, and is most frequent right at the creek edge. Karaka is very abundant in places here, but the largest one is only approximately 8m tall. Juvenile karakas are abundant around these adults, but are uncommon in the bush as a whole.

Weeds are abundant here, with the most conspicuous including periwinkle, elaeagnus and wandering jew. Native species occurring in the ground cover include bracken, pukupuku and hookgrass. A feature of this area is the wide variety and abundance of native and introduced bryophytes (liverworts and mosses) that are present (Gardner & de Lange, 2008 – see Appendix A).

While the vegetation here would normally have little botanical value, the fact that it is rock forest elevates its significance. This is even despite the fact that it is primarily exotic rock forest (although this fact does detract from its botanical significance to some extent). Notwithstanding its overall (general) value as rock forest, there are key areas of botanical value within this north bank bush, being those localities where native species are present in any abundance. In particular this would include the copses of karaka that are scattered at a few localities within this area, as well as concentrations of other native trees and shrubs (such as lemonwood and mapou) and indigenous bryophytes. These areas are identified in this report as Valued Vegetation (see Figure 3C).

3.5.1.2 South Bank Bush

On the southern side of the mouth of Oakley Creek large tree privet is very infrequent, and the cover here is comprised instead of various other exotic species, including a number of English oaks some of which appear to be of considerable age. Old poplar trees are also present here, and there is a large old relic radiata pine near the end of Cowley Street.

In addition to the oaks, further to the west the vegetation is comprised of a low scrappy growth of Chinese privet over periwinkle and ladder fern. Native plants are very infrequent here, being comprised of very few (and small) karamu, karo and mapou, and occasional clumps of *Gahnia lacera* near the creek. A few tree ferns are also present (mainly ponga up to 3m tall, but also one 9m tall mamaku) and a few young cabbage trees, with some flax present at the shore line.

Neither Significant Vegetation nor Valued Vegetation is present within the south bank bush at the mouth of Oakley Creek.

3.5.1.3 Great North Road Interchange

The existing motorway (and ramp) margins here are predominantly in a cover of mown grass, with patches of planted native shrub species (e.g. kanuka, flax, cabbage tree, ngaio and karamu). These plantings are relatively young. In addition to these plantings a small stand of willow has established in a damp hollow within the central “cloverleaf” area. Both the plantings and willows are within the Project footprint.

Where the highway margins adjoin private property in this area, weeds tend to dominate (i.e. grass, gorse, wattle, woolly nightshade, pampas, tree privet and wattle). This vegetation has no coherence, little habitat structure, and is of no botanical significance.

To the east, bordering the Unitec property, there is a sizeable stand of mature oak trees. Alongside these there are several mature pohutukawa of similar size. This stand of vegetation appears to be some of the oldest within the wider Project area, and was presumably planted here for amenity purposes many decades previously. Weed species are present throughout the ground tier here, with wandering jew, morning glory and great bindweed most prevalent. These trees appear to be on the periphery of the Project footprint, and any damage to them should be generally avoidable.

Neither Significant Vegetation nor Valued Vegetation is present within this area.

3.6 Sector 6 (Great North Road Interchange to St Lukes Interchange)

The existing vegetation within Sector 6 is reflective of the fact that it has, for the most part, been planted as part of earlier SH16 motorway-verge landscaping treatments. As such the vegetation within the Project footprint here is largely restricted to planted shrubberies, with dozens of kohuhu, pohutukawa and totara (many up to 5-8m tall), together with cabbage trees, karamu, flax, ngaio, karo and akeake.

Exotic trees and weeds are prevalent here, and include small phoenix palms, a variety of pine species (*P. canariensis*, *P. radiata*, *P. patula*), Sydney golden wattle and cotoneaster. In the more damp locations medium sized crack willows are dominant.

Damper areas also support notable amounts of the native herb *Glossostigma elatinoides*, and also *Hydrocotyle tripartita* and *Myriophyllum propinquum*. The presence though of *Baumea juncea, Alisma plantago-aquatica* and an exotic member of Acanthaceae, tends to suggest that these damp areas have been landscaped, probably at the time that the batter's planting was done.

The mouth of the existing Meola Creek culvert beneath SH16 is very weedy (i.e. *Polygonum* sp., *Callitriche stagnalis*, elodea and vallisneria). The Nationally Endangered aquatic moss *Fissidens berteroi* is absent from this area, although it is present in Meola Creek lower down (outside of the Project footprint), near the Great North Road culvert.

Neither Significant Vegetation nor Valued Vegetation is present within Sector 6.

3.7 Sectors 7 & 8 (Great North Road Interchange to New North Road)

The vegetation in these two sectors is found within the riparian zone of Oakley Creek. It is primarily mature exotic forest with small pockets of native bush. The exotics are characterised by tree privet, mature pines, oaks, poplar, willow, macrocarpa, wattle, plane trees, Chinese privet and (in places) bamboo. Also commonly occurring in this exotic forest are woody weeds such as woolly nightshade, hawthorn and gorse, together with invasive vines (Japanese honeysuckle, blackberry, great bindweed, morning glory, asparagus fern, and moth plant) and herbaceous weeds (black nightshade, fennel, ginger, wandering jew and nasturtium).

Native species occurring within this exotic forest are both natural arrivals and the result of revegetation plantings. They include mamaku, ponga, karamu, shining karamu, mapou, mahoe, kohuhu, ngaio, flax, puriri, cabbage tree, tarata and koromiko.

Cut and cover tunnels will begin in Sector 7 and traverse beneath Sector 8 as driven tunnels. Within Sector 7 the cut and cover tunnels will not impact upon any vegetation except that which is within existing house sections, although it is noted that the point where the driven tunnels join the cut-and-cover tunnels is in close proximity to some riparian bush of Oakley Creek. While this bush is primarily exotic, it does provide riparian benefits to this lower part of Oakley Creek, which has the highest freshwater values of the entire creek system (refer to the Assessment of Freshwater Ecological Effects report – BML, 2010b). Within Sector 8 the tunnels will be deep underground and therefore should have no associated direct effects on surface vegetation.

While the vast bulk of the vegetation in these 2 sectors is not of particularly high botanical conservation value, consisting in the main of exotic and weedy vegetation restricted to the riparian margins of Oakley Creek, there is a single exception to this, being a tiny thicket (around 700m^2) of remnant rock forest situated at Harbutt Reserve, growing on a basalt boulder tumble immediately above the west bank of Oakley Creek (see Figure 3E). Rock forest is a very rare vegetation type in Auckland, which is (in general) normally comprised of mahoe and/or karaka, mangeao and titoki.

The remnant at Harbutt Reserve contains some 50 or so mahoe, together with an abundance of emergent exotic trees and a very weedy ground cover. The mahoe range in height between 6-9m, with the majority (>60%) being between 10-20cm dbh (with the largest (single-stemmed) specimen measuring 28cm dbh). Given the maturity of the mahoe trees here it is likely that they are naturally occurring and represent a vestige of the historic rock forests of Auckland. Hence, despite the exotic emergent trees present here (and the conspicuous presence of exotic trees in the canopy), this small remnant is considered to be Valued Vegetation.

With the exception of the rock forest remnant at Harbutt Reserve as discussed above, neither Significant Vegetation nor Valued Vegetation is present within Sectors 7 and 8.

3.8 Sector 9 (Alan Wood Reserve/Hendon Park & East of Richardson Road)

3.8.1 Alan Wood Reserve/Hendon Park

Alan Wood Reserve and Hendon Park are at the southern end of the Project Area (Sector 9). These Parks are predominantly grassed open space, and include the confluence of the main stem of Oakley Creek with its tributary emanating from the Maioro Street Interchange to the east (termed the Stoddard Road tributary).

As it exits from the culvert beneath Richardson Road, this tributary flows through a wooded riparian strip comprised in the main of mature crack willows together with other woody and herbaceous weeds, such as woolly nightshade, Chinese privet and nasturtium. The upper part of this tributary (back towards Richardson Road) is well-shaded by the stands of crack willow on each side. The lower 60m or so is relatively well-illuminated, the willows being replaced by patches of privet scrub and grassland. In the stream here there are patches of watercress and alligator weed and a tall weedy knotweed. There is also a small stretch of swifter-flowing water in the last 5m before the confluence with Oakley Creek, and here the basalt boulders are well-covered by the aquatic moss *Leptodicyton riparium* and by starwort.

A small amount of the Nationally Endangered aquatic moss *Fissidens berteroi* was found recently in this 60m section by P. de Lange (a botanist from the Department of Conservation). It was "*growing on willow roots*" (P. de Lange, *pers.comm*. to Dr. R. Gardner). This species was not observed during the recent botanical surveys undertaken here as part of the Project ecological investigations, despite being specifically targeted, and appears now to be absent from this area.

In the remainder of the Alan Wood Reserve / Hendon Park, for the most part Oakley Creek is devoid of riparian vegetation. The exceptions to this are where either landscape plantings have been undertaken or where exotic woody vegetation has become established. In one area in particular (within the Project footprint) Chinese privet has established as a dense and sizeable thicket, with a weedy understorey and ground cover.

In Sector 9 the Oakley Creek channel is mostly confined between basalt-block facings of approximately 1.5m height. The stream bed is comprised of angular cobbles, gravel and silt, and is only lightly vegetated with alligator weed, *Egeria densa*, *Leptodicyton riparium*, *Polygonum* spp. and starwort. During its summer low-flow state a filamentous green alga was very abundant.

The basalt blockwork of the channel walls is mostly free of larger plants, suggesting that there is regular herbicide application here. For example, small plants of pohutukawa rooted between the blocks are quite common, but none are more than 50cm or so tall. Small colonies of the fern *Pteris tremula* occur sporadically on the blockwork, and at one place there are a few specimens of the small native fern *Doodia squarrosa*, a species classified as Naturally Uncommon (de Lange et al., 2009) and Regionally Sparse (Stanley et al., 2005). As a result this small colony here is identified in this report as being Significant Vegetation (see Figure 3D).

Mowing takes place right to the upper edges of the blockwork, where the coarse grasses of the main parts of the reserve are replaced mostly by smaller herbaceous plants. One of these, a taprooted geranium, is quite abundant. There are a few hundred individuals of this around the stream's perimeters, from the confluence of the Stoddard Road tributary with Oakley Creek down until the houses below Bollard Avenue are approached.
A few specimens also grow on the basalt blockwork or in soil exposed where the blockwork has broken away.

As noted earlier in Section 2 of this report, this species has only recently been “discovered”, and is currently only known from this single population growing alongside Oakley Creek in Alan Wood Reserve and Hendon Park. Its taxonomic position, origins and consequent ‘rarity status’ are presently problematic. It appears to be a distinct species and a new arrival in the country (Dr. R. Gardner, *pers. comm*.), getting to New Zealand either via natural means or by inadvertent human introduction. If it arrived here with human help it will be classified as a weed, but if it arrived here naturally it will be of greater botanical significance. Given this uncertainty, this colony here is identified in this report as being Potentially Significant Vegetation (see Figure 3D).

3.8.2 East of Richardson Road

From Hendon Park the Project footprint follows the Stoddard Road tributary through the industrial back-blocks of Stoddard Road up to its junction with the Maioro Street Interchange. This locality is dominated by a mix of rank grass (kikuyu), weed fields and exotic bush. The stream margins are characterised by willows, with the occasional tall tree (including macrocarpa and eucalypt). The stands of exotic bush are dominated by wattle, Chinese privet and willow, with much Japanese honeysuckle.

The weed fields are a mix of overgrown grass with blackberry, gorse, cape honeysuckle, nasturtium, wandering jew, ginger, smilax, blackberry, great bindweed, morning glory, inkweed, woolly nightshade, wattle, agapanthus and ivy. The occasional native plant is also present, but only as scattered individuals. These include cabbage tree, ponga and karamu. This vegetation is of no particular botanical significance.

3.8.3 Synopsis of Significant Vegetation and Valued Vegetation

3.8.3.1 SH16 Causeway and Approaches

The majority of the SH16 corridor is characterised by mown grass strips with plantings (and self-colonisations) of exotic and native species. Further from the carriageway the grass verges tend toward a mix of natives and exotic weed species. The causeway margins (at sea level) support salt marsh vegetation and mangroves, and the drains on either side of the motorway at Traherne Island provide habitat for the Regionally Endangered *Mimulus repens*. These populations have been identified in this report as constituting Significant Vegetation.

The Motu Manawa (Pollen Island) Marine Reserve adjacent to the causeway provides habitat for a range of salt marsh species including salt marsh ribbonwood and various rushes and succulents. Also present here in local abundance is coastal tree daisy. Traherne Island supports a mix of native-exotic vegetation, with the native component considered in this report to be Valued Vegetation.

Within Sector 6, the Nationally Endangered aquatic moss *Fissidens berteroi* is known to be present in Meola Creek, in the vicinity of the Great North Road culvert. However, this is downstream of the Project footprint

3.8.3.2 SH20 Oakley Creek Catchment

In Sector 9 the Alan Wood Reserve / Hendon Park area supports a few individuals of an "at risk" species of fern (*Doodia squarrosa* – Naturally Uncommon (de Lange et al., 2009) and Regionally Sparse (Stanley et al. 2005)), growing at one location within the blockwork of the channelised walls of Oakley Creek. This colony has been identified in this report as constituting Significant Vegetation.

The Nationally Endangered aquatic moss *Fissidens berteroi* has historically been found growing in Oakley Creek within Hendon Park, but seems to have become locally extinct here.

In addition to the above species of known taxonomic status, a tap-rooted geranium (*Geranium* aff. *retrorsum* "Oakley Creek") known only from Hendon Park and Alan Wood Reserve is locally abundant along the riparian margins of Oakley Creek. It has only recently been "discovered", and the taxonomic position, origins and consequent 'rarity status' of this plant are presently problematic. It seems to be part of the *Geranium solanderi / Geranium retrorsum* complex (Dr. R. Gardner, *pers. comm.*), with both of these species being present in Australia and New Zealand. While it has similar traits to both it is actually neither, but instead appears to be a distinct species and a new arrival in the country (Dr. R. Gardner, *pers. comm.*), getting to New Zealand either via natural means or by inadvertent human introduction. If it arrived here with human help it would be classified as a weed, but if it arrived here naturally it will be of greater botanical significance. Unfortunately there appears to be no imminent plans by NZ taxonomic botanists to resolve this matter, and its status looks likely to remain indeterminate for the foreseeable future. Given its uncertain status, this population has been identified in this report as constituting Potentially Significant Vegetation.

In Sector 5 the mouth of Oakley Creek supports riparian vegetation, while the Waterview Interchange supports large mown motorway verges together with exotic tree-land. In general the only areas where indigenous tree species have a notable presence are in places where it is believed they have been planted. The exception to this is the bush on the northern bank of the mouth of Oakley Creek which, while being dominated by exotic species (in particular tree privet), also supports a native element, with a conspicuous presence of young and semi-mature karaka. This bush is growing upon a basalt substrate and provides an example of (presently much modified) rock forest.

While this bush would normally have little botanical value, the fact that it is rock forest elevates its significance. This is even despite the fact that it is primarily exotic rock forest (although this fact does detract from its botanical significance to some extent). Notwithstanding its overall (general) value as rock forest, there are key areas of botanical value within this north bank bush, being those localities where native species are present in any abundance. In particular this includes the copses of karaka that are scattered within this area, as well as concentrations of other native trees and shrubs (such as lemonwood and mapou) and indigenous bryophytes. These areas are identified in this report as Valued Vegetation.

In summary, other than the few specific areas of significance described above, the botanical values present within the Project footprint are considered to be negligible.

4. Assessment of Project Effects on Vegetation

4.1 Clearance of Indigenous Vegetation (Excluding Significant Vegetation)

The removal of indigenous vegetation may result in direct adverse ecological effects in a number of ways. Firstly, it reduces the overall size of a habitat, and if significant enough, this may affect the functionality of that habitat. Secondly, it may alter the shape of a habitat and facilitate either more pronounced or greater penetration of edge effects into the existing habitat interior, with consequent impacts on natural processes. Thirdly, it may result in the removal of rare plants (or communities).

However, there are three important factors to keep in mind when addressing the issue of vegetation clearance in relation to the expected magnitude of adverse effects, as follows:

(i) The extent of the clearance (i.e. how much is going to be removed);
(ii) The location of the clearance (i.e. where is it going to be removed from);
(iii) The type of vegetation to be cleared (i.e. its botanical conservation value and quality).

Where clearance involves the removal of large areas of good quality native bush, in such a way as to fragment the existing habitat, then the adverse effects of such clearance tend to be maximised. Conversely, where it involves lesser quality and younger stands of native vegetation (e.g. plantings) then the effects are far less significant, and where it involves the removal of weeds or invasive exotic trees, then the ecological effects are normally positive.

The specific effects of vegetation clearance in each of the Project sectors are discussed in the following sub-sections of this report.

4.1.1 Sector 1 (Te Atatu Interchange)

For the most part, the vegetation affected in Sector 1 involves planted shrubberies and mangroves, together with lesser amounts of salt marsh and salt meadow. While maritime wetlands are an important habitat type, the extent of their loss here is relatively small. Furthermore, it is likely that these plant communities will re-establish along the new shoreline in time. There are also no plant species of any botanical conservation significance that would be impinged upon by the proposed works in this sector. Given the above, the effects of the Project on the botanical values of this sector are considered to be less than minor.

4.1.2 Sector 2 (Whau River Bridge)

For the most part the vegetation affected in Sector 2 involves mangroves, which have been identified in this report as being Valued Vegetation. While mangrove wetlands are an important habitat type, the extent of their loss here is relatively small. Furthermore, it is likely that this plant community will re-establish along the new shoreline in time. There are also no plant species of any botanical conservation significance that would be impinged upon by the proposed works in this sector. Given the above, the effects of the Project on the botanical values of this sector are considered to be less than minor.

4.1.3 Sector 3 (Whau River to Rosebank Peninsula)

For the most part the vegetation in this sector is relatively young, with the majority of it (outside of the coastal marine area) having been planted. The areas of terrestrial vegetation within the Project footprint here are neither botanically notable nor significant.

Reclamation and construction works associated with the Patiki off-ramp and the Rosebank on-ramp are likely to result in some loss of mangrove and sea-rush habitat in these areas. Additionally, on the southern side of the corridor near the Whau River, there will be a small amount of reclamation required with subsequent loss of mangroves. Notwithstanding that saline wetlands are an important habitat type and have been identified in this report as Valued Vegetation, it is noted that the extent of their loss here is relatively small. Furthermore, it is likely that these plant communities will re-establish along the new shoreline in time. There are no plant species of any botanical conservation significance that would be affected by the proposed works in this sector.

Notwithstanding the above, it is noteworthy that a substantial colony of coastal tree daisy (considered by some botanists to be of local distribution within the Auckland region) is present in this general area. This colony numbers at least one hundred individuals, and includes numerous older trees of up to 2m tall and ≥ 5cm dbh). However, it is well outside of the Project footprint and should not be affected b the proposed works in this sector.

Given the above, the effects of the Project on the botanical values of this sector are considered to be less than minor.

4.1.4 Sector 4 (Rosebank Peninsula to Great North Road)

The terrestrial vegetation within the Project footprint in this sector is dominated by weed and exotic species of flora (recognising that the vast majority of Traherne Island is outside of the Project footprint and won't be affected by the works). Notwithstanding this, there will be the loss of some mangrove, salt marsh and salt meadow habitats that have historically established along the shorelines in this sector as a result of the existing causeway structures. While saline wetlands are an important habitat type and have been identified in this report as Valued Vegetation, the extent of their loss here is relatively small. Furthermore, it is likely that these plant communities will re-establish along the new shoreline in time.

Works in the vicinity of Traherne Island, in the absence of pre-emptive mitigation measures, would adversely affect two small populations of *Mimulus repens*, a species classified as being Naturally Uncommon (de Lange et al., 2009) and Regionally Endangered (Stanley et al., 2005). This is discussed further in Section 4.2 of this report, and measures designed to avoid any such adverse effects are described in Section 5.

This general area also includes an abundance of coastal tree daisy, which while not officially classified as an "at risk" species (either nationally or regionally) is nevertheless considered by some botanists to be of a somewhat localised distribution within the Auckland Region. None of these specimens will be affected by the Project works.

Given the above, together the measures discussed later in Section 4.2 and Section 5 of this report, the effects of the Project on the botanical values of this sector are considered to be less than minor.

4.1.5 Sector 5 (Oakley Creek Mouth and Great North Road Interchange)

There are four vegetation types within Sector 5, being firstly saline wetlands (predominantly mangroves), secondly rock forest (dominated by exotic trees – found on the north bank of the mouth of Oakley Creek), thirdly open mowed grass, and fourthly exotic treeland (on the south bank of the mouth of Oakley Creek and within the existing Great North Road Interchange "cloverleaf"). The former two vegetation types are identified in this report as being Valued Vegetation. The remainder of the vegetation in this sector is of low botanical conservation value.

The most notable indigenous element in this sector is the young-to-semi-mature (up to 8m in height) karaka growing on the basalt boulder substrate on the northern banks of the mouth of Oakley Creek. Karaka is one of the species that is known to characterise some of the historic rock forests of the Auckland Isthmus. These particular specimens are growing in a predominantly exotic (privet) forest, and none of the specimens present are mature. Given this it is considered that they represent a relatively recent colonisation here, albeit by natural means. In addition to the karaka, the north bank bush also includes other native elements. The key areas of botanical value within this area are those localities where native species are present in any abundance. In particular this includes the copses of karaka that are present, as well as concentrations of other native trees and shrubs (such as lemonwood and mapou) and indigenous bryophytes. These areas are Valued Vegetation.

On the western side, this north bank bush will be crossed by the SH20-SH16 west-bound connecting bridge (termed Ramp 2), as well as the SH20-SH16 south-bound connecting bridge (termed Ramp 3). On the eastern side it will be crossed by the SH20-SH16 south-bound connecting bridge (termed Ramp 1) and the H20-SH16 city-bound bridge (termed Ramp 4). These ramps are all elevated structures (bridges) and will need to be supported by piers. The construction of these piers will involve the clearance of some of the vegetation along the northern and southern margins of the mouth of Oakley Creek, for both the piers themselves together with temporary haul roads and crane platforms.

Ramps 1 and 2 appear to generally avoid the key areas of botanical value (i.e. the Valued Vegetation) of the north bank bush, with the copses of karaka trees in particular being located in between these two ramps. However, it appears that Ramps 3 and 4 may potentially affect some of the key areas (although they appear to avoid the main concentrations of karaka). If at all practicable the key areas in this rock forest (especially the karaka groves) should be avoided via adjustments to the locations of piers, haul roads and crane platforms in this north bank bush. If such avoidance cannot be achieved and some of these key areas need to be cleared, then their loss is considered to constitute an adverse effect, and as such will need to be mitigated. Indeed, further to the above even if such avoidance of key areas can be achieved it is considered that the damage to the wider rock forest at this locality as a result of the Project will still need to be mitigated.

The loss of the additional (exotic) vegetation on the south bank of the mouth of Oakley Creek is considered to be of little botanical concern.

The construction of some of the ramps and bridges will also necessitate the location of piles and piers within the coastal marine area (CMA) at the mouth of Oakley Creek. The saline vegetation here is predominantly mangroves, and these are discussed in the Assessment of Marine Ecological Effects report (BML, 2010a). Small discrete areas of saline wetlands (both salt marsh and salt meadow) are also present. While saline wetlands are an important habitat type and have been identified in this report as Valued Vegetation, the extent of their loss here is relatively small, and the adverse effects of this loss is considered to constitute an adverse effect of less than minor significance.

4.1.6 Sector 6 (Great North Road Interchange to St Lukes Interchange)

In Sector 6 the Project footprint is small, involving the widening of the existing SH16 by one lane on both sides. The footprint of this widening is sufficiently small as to mainly encroach upon the existing highway shoulders, and will involve only minor loss of motorway-verge plantings and self-seeded exotic species.

The only notable specimen-trees within the Project footprint here are the group of a score or so pines, which make a conspicuous grouping between the cycle track and the golf course. It seems these trees are likely to be lost to the proposed widening here. The loss of these trees is not an adverse botanical effect, and all in all the effects of the Project on the botanical values of this sector are considered to be less than minor.

4.1.7 Sectors 7 & 8 (Great North Road Interchange to New North Road)

The SH20 motorway will traverse through these 2 sectors by way of cut-and-cover tunnels (Sector 7) and driven tunnels (Sector 8). No direct loss of vegetation is anticipated in these two sectors. Potential effects in relation to changes to the existing groundwater regime and/or possible ground settlement are discussed later in this report (see sections 4.5 and 4.6).

All in all the effects of the Project on the botanical values of this sector are considered to be less than minor.

4.1.8 Sector 9 (Alan Wood Reserve/Hendon Park & East of Richardson Road)

The most dense and coherent vegetation in Sector 9 is along the riparian margins of the Stoddard Road tributary, in particular above Richardson Road, and along the south side of the meander of Oakley Creek that follows Methuen Road (to the immediate east of the proposed southern tunnel portal). At the Stoddard Road tributary the vegetation is weedy and dominated by rank grasses (kikuyu), woody weeds and exotic trees (with willow and privet in particular). At the Methuen Road meander the vegetation is dominated by Chinese privet and is very weedy. Neither of these two areas is of any botanical conservation value.

The remainder of Alan Wood Reserve and Hendon Park are in a mown grass cover, together with amenity plantings at various locations as well as infestations of woody weeds (e.g. privet) at specific places. With the exception of one species of "at risk" flora and a possible second such species (discussed in section 4.2. below), none of the vegetation in Sector 9 is of any botanical significance.

All in all, for the most part the effects of the Project on the botanical values of this sector are considered to be less than minor. However, this is dependent upon the Significant Vegetation present here being appropriately managed (see Section 4.2 below).

4.2 Clearance of Significant Vegetation

The loss of Significant Vegetation (i.e. the officially recognised "at risk" species) within or adjacent to the Project footprint would be an adverse ecological effect. Within the Project footprint this includes at least two such species (*Doodia media* and *Mimulus repens*) and possibly a third (*Geranium* aff. *retrorsum* "Oakley Creek"). These are discussed below.

In Sector 4 there are two small populations of *Mimulus repens*, which is classified as Naturally Uncommon (de Lange et al. 2009) and Regionally Endangered (Stanley et al. 2005). These populations are directly within the Project footprint, and they will need to be physically uplifted prior to the commencement of works at Traherne Island and replanted at appropriate locations elsewhere (or planted back close to their original locations once the works around Traherne Island have been completed).

The uplifted *Mimulus* is considered likely to survive (with due care), given that the New Zealand Plant Conservation Network records that it is easily propagated from rooted pieces and from stem cuttings, as well as being easily grown from fresh seed. Further to this, a recent small scale translocation trial of this species has been successfully undertaken by Dr. R. Gardner, with the uplifted material expanding from its original size to cover its entire holding container (Dr. R. Gardner, *pers. comm.*). Of note was that the plant material was kept damp with freshwater only (i.e. not brackish water which is its usual habitat), and it has flourished under such conditions (including producing flowers). Notwithstanding this, the material failed to set fruit, and the reasons for this are unclear (although the NZ Plant Conservation Network notes that *Mimulus* is short lived and needs frequent repotting to maintain itself, so the lack of fruiting could possibly be the result of senescence or a lack of the necessary repotting – or for an entirely different and presently unknown reason). While further work in this regard would seem to be warranted it is clear that the species nevertheless transplants readily.

In Sector 9 there are a few specimens of the fern *Doodia squarrosa* growing within the blockwork of a channel wall within the main stem of Oakley Creek. This is classified as Naturally Uncommon (de Lange et al. 2009) and Regionally Sparse (Stanley et al. 2005). The plants are grouped together and are outside of the Project footprint, and hence it is unlikely that construction works will have any direct adverse effects on them.

However, it is noted that they are in proximity to one of the operational phase stormwater treatment ponds. Given this it is appropriate that the discharge outlet to this pond will be located downstream of these ferns (Tonkin & Taylor, 2010). In addition, it is noted that in this area the wider Project mitigation proposals include rehabilitation works that would involve the replacement of many of the Creek's blockwork walls with more natural stream banks. In such a scenario it will be important to either retain the *Doodia* in situ (and ensure any blockwork wall rehabilitation is kept away from the specimens), or to relocate the plants to other appropriate safe locations (preferably within the Alan Wood Reserve / Hendon Park area).

There is another plant within Sector 9 that may need some special attention also, being *Geranium* aff. *retrorsum* "Oakley Creek". However, at this stage the taxonomic position, origins and consequent 'rarity status' of this species is undetermined, and as such it could be either an introduced species (or form there-of) or a newly-arrived native species (or form there-of). Regardless however, a significant proportion of the population in Hendon Park is outside of the Project footprint. In addition, it transplants readily, as demonstrated by a recent small scale translocation trial involving a single plant which has now self seeded and produced a score or more new individuals, all of robust growth (Dr. R. Gardner, *pers. comm.)*.

It is likely that the presently indeterminate status of this geranium will not have been determined before construction works commence in this area. Should this be the case, then it would be prudent to take a precautionary approach and act as if it were a confirmed new (and probably 'at risk') native species. As such special management measures would be required. These are described in Section 5 of this report, and include measures to directly protect this species (where practicable), or alternatively (where protection is not practicable) to either relocate the more dense swards (or turfs) of this population to safe places elsewhere or otherwise to propagate new plant material for planting at appropriate (and safe) new locations.

Notwithstanding the above, if the status of this species has been clarified prior to the commencement of Project works in this area and it has been determined to be an introduced species (i.e. a weed), then no such special management measures would be necessary.

While the rare aquatic moss *Fissidens berteroi* has been previously reported from the Hendon Park area (within the Stoddard Road tributary), it was not observed to be present despite a targeted survey in this area by BGL and BML in 2010. As a consequence it is believed that this 'at risk' species is no longer present in this locality.

While *Fissidens berteroi* is present in Sector 6 within Meola Creek downstream of the Project footprint, given the limited scale of the proposed works in this sector (i.e. minor earthworks and a new operational-phase stormwater treatment pond), it is considered unlikely that this species will be adversely affected as a result of the Project. To the contrary, this new pond will improve upon the existing situation where untreated highway storm water from the carriageway is discharged to the creek. The *Fissidens* is more likely to be affected by other influences, in particular being shaded out (possibly to the point of local extinction) by overhead vegetation (e.g. willows) or water weeds (e.g. oxygen weed) that are presently characteristic of this creek.

4.3 Shading and Rain Shadow Effects

All vegetation requires both sunlight and moisture for survival. In general the moisture requirements are directly met by virtue of precipitation (with the exception of wetlands which derive their moisture from groundwater sources). Where sunlight and precipitation sources are intercepted then vegetation cannot survive. Such interception may result from the construction of new highway structures (i.e. bridges and overpasses) which span over and above individual plants and stands of bush, depriving them of light and rain.

The extent to which new structures may result in light and rain shadow effects is dependent upon the width of the structure as well as its height above the vegetation in question – if it is sufficiently narrow or sufficiently well elevated then it is likely that sufficient amounts of both light and rain will be able to reach the underlying vegetation, and the plants will be able to survive. Conversely, should the structure be too low and/or too wide then sufficient interception of light and rain will occur, to the detriment of the underlying vegetation.

The mouth of Oakley Creek will be crossed by four bridge structures (Ramps 1 – 4). The bottom of the superstructure associated with Ramp 1 (city-to-tunnel) crosses the northern banks of the mouth of Oakley Creek at 6.3m elevation above ground level and crosses the southern banks at 9.4m elevation. The bottom of the superstructure associated with Ramp 2 (tunnel-to-west bound) crosses the southern side of the creek at 2.2m elevation and the northern margins at 4.8m elevation. The bottom of the superstructure associated with Ramp 3 (west-to-tunnel) crosses the northern side of the creek at 10.1m elevation and the southern side at 8.8m. The bottom of the superstructure associated with Ramp 4 (tunnel-to-city) crosses the southern side of the mouth of Oakley Creek at 18m and the northern side at 19m elevation.

At these elevations, there will only be adverse shading and/or rain shadow effects on the vegetation that will be underlying Ramp 2. The terrestrial vegetation crossed by this Ramp is comprised of exotic trees and weeds on the south bank, and by privet and other woody/shrubby weeds on the north bank. None of the key areas of the Valued Vegetation (i.e. the karaka groves) will be affected by this Ramp. As such the effects of this shading on terrestrial vegetation are considered to be minor.

There will be no adverse shading or rain shadow effects in relation to the other 3 Ramps.

4.4 Edge Effects

Another factor which needs to be assessed is the extent to which new edges will be created within areas of existing habitat/ vegetation, and the likely adverse effects which may eventuate as a result. Edge effects refer to the differences in micro-climatic conditions as well as vegetation composition and structure that exist between forest margins and forest interior. These micro-climatic variables are generally those associated with air temperature, solar radiation, relative humidity and wind. These can alter the natural processes and species composition of habitat interiors.

Studies have shown that edge effects may penetrate up to 50m into habitat interiors. This issue is important when edge effects reduce the extent of habitat interior conditions, but is not such a significant issue where the areas to be affected are already substantially characterised by edge conditions, species and processes. Edge effects are likely to be more of an issue in forested habitats which would be truncated by a new motorway, and are generally of far less concern in relation to new highways in urban areas where edge conditions, species and processes are likely to already dominate.

In this particular instance there are likely to be few issues regarding such effects, since there is unlikely to be any habitat interior present within the bush patches that will be affected. Furthermore, in all instances the new edges will be created within existing edge-dominated portions of the affected patches of vegetation (all of which are entirely characterized by edge conditions).

To elaborate, in Sector 9 the works east of Richardson Road are within weed-fields and young exotic forest (dominated by wattle). These have negligible botanical conservation values and are wholly characterized by edge conditions and processes already. The Project will reduce the extent of these weed-fields in this area.

In Sector 5, the highway alignment traverses through predominantly exotic forest on the shores of the mouth of Oakley Creek. This bush is characterised by an absence of habitat-interior conditions. The effects of the vegetation clearance here will therefore not result in any change to the existing dominance of edge processes and conditions at this site.

4.5 Loss of Vegetation through Changes to Groundwater

A significant portion of the new highway will be below ground level. As such there is the potential for it to affect the local groundwater regime, in particular by potentially causing a draw-down effect within the immediately adjacent soils. Excavation into the underlying bedrock in the areas of basalt geology may exacerbate these effects also. However, it is noted that terrestrial vegetation is dependent upon soil moisture (derived from direct precipitation) as opposed to permanent groundwater. The only exceptions to this are with respect to wetlands, which are normally reliant upon permanent surface water sourced from groundwater reservoirs.

In addition to the above, the more shallow excavations of top-soil and sub-soil (for highway “cuts”) could potentially exert a drainage effect on the moisture content of the soil in the immediate vicinity of such excavations. If severe enough this may have consequential adverse effects on the health of trees immediately adjacent to such works. In light of this, it is possible that the substantial surface cuts associated with the Waterview Connection could exert an influence on soil moisture that results in water-related stress to nearby vegetation, such as at the southern portal in Sector 9.

Notwithstanding this however, as described earlier in this report virtually the entire vegetation within this Sector is either in mown grass or exotic / weedy vegetation. Hence, even in the unlikely event of any die-back of trees along the margins of the motorway here as a result of changes to soil moisture, the loss of such vegetation would not constitute a significant adverse botanical effect.

4.6 Loss of Vegetation through Ground Settlement

Tunnel excavation generally induces ground settlement. The extent of such movement is dependent upon a number of factors, including the tunnel size and depth, the ground and groundwater conditions in between the tunnel and the surface, the tunnelling method used and the standard of workmanship.

Given this number of variables, predicting the degree of settlement is not a precise science. Notwithstanding this however, an assessment of settlement was undertaken by BCHF (2010a), and a plan depicting the total estimated settlement contours was included in that report. This is shown in Appendix B of this present report.

Based upon the Beca assessment, the degree of ground settlement that is estimated to occur as a result of the tunnels is between 0 - >200mm, and is restricted to the immediate vicinity of the tunnels. Along the alignment of the tunnels there is overlying coherent vegetation only at a few locations, with all of these being associated with riparian vegetation alongside Oakley Creek. The degree of ground settlement in these areas is estimated to be predominantly between 20-50mm, with isolated instances of 50-100mm closer to the tunnels and one instance (opposite the southern end of UniTec, in the vicinity of the Oakley Creek waterfall) of >200mm.

While the resultant effects on vegetation as a result of this estimated degree of settlement are considered to be negligible, it is also noted that the vegetation directly within the settlement zones is predominantly exotic. At the site of greatest estimated settlement (in the vicinity of the Oakley Creek waterfall), the cover is characterised by a canopy of wattle, poplar and flame tree, together with emergent pines. The mid-tier is a mix of woody weeds (i.e. Chinese privet, bamboo) together with planted and self-introduced natives (e.g. mamaku, ponga, mapou, kohuhu, mahoe, ngaio and akeake).

The solitary stand of Valued Vegetation within the zone of estimated settlement is the small vestige of rock forest (mahoe-dominated) present within the Harbutt Reserve. This is located some 70m to the east of the eastern tunnel, and the estimated settlement in this area is between 20-50mm. Given this, it is considered very unlikely that ground settlement will affect this small stand of rock forest.

5. Avoidance, Remediation and Mitigation

While the design of the Project has been modified to avoid or minimise adverse effects on terrestrial vegetation where possible, there are still some areas where adverse effects will occur. The following describes the offsetting mitigation / environmental compensation opportunities associated with the Project.

5.1 Sector 1 (Te Atatu Interchange)

On the upstream side of the eastern shore of the Henderson Creek crossing, a portion of the salt marsh plant community will be lost as a consequence of the bridge widening and construction of new abutments. Replanting of the new embankment and abutment with locally sourced and appropriate native species will offset that loss.

In addition to this, native coastal fringe vegetation is intended to be planted into sheltered parts of the causeway embankment revetment, primarily along the southern side but also in some parts of the northern side. This will replace some of the coastal margin habitat lost through the coastal works.

Further to the above, the stormwater treatment wetland pond proposed for Jack Colvin Park will also include locally sourced and appropriate indigenous species in the planting programme for its wetland component, thereby enhancing the botanical biodiversity of this Sector and further enhancing the wider ecological functionality of this device. In addition, the coastal margins and any swales or drains associated with the new stormwater system in this Sector may provide opportunities to plant rare coastal species such as *Carex litterosa.* This would offset the loss of native plants as a result of the construction of the stormwater treatment devices here, and would enhance the botanical values of a degraded area of coastal habitat within Henderson Creek.

Alternatively (or additionally) it may be possible to create some habitat here that would be suitable for transplanting *Mimulus repens* into (offsetting the loss of *Mimulus* habitat at Traherne Island in Sector 4 – see Section 5.4).

Weed control within this sector will also be undertaken as part of routine highway network maintenance.

5.2 Sector 2 (Whau River Bridge)

The downstream area of the western shore of the Whau Creek crossing may provide opportunities to relocate *Mimulus repens* to offset against the loss of *Mimulus* habitat at Traherne Island (see Section 5.4).

5.3 Sector 3 (Whau River to Rosebank Peninsula)

Replanting of the new embankment with locally sourced and appropriate native species will offset the loss of both naturally occurring and planted native species.

In addition to the above, native coastal fringe vegetation is intended to be planted into sheltered parts of the causeway embankment revetment, primarily along the southern side but also in some parts of the northern side. This will replace some of the coastal margin habitat lost through the coastal works.

There may be opportunities on the southern or northern sides of the widened corridor for the relocating of *Mimulus repens* to offset against the loss of *Mimulus* habitat at Traherne Island (see Section 5.4).

Weed control within this sector will also be undertaken as part of routine highway network maintenance.

5.4 Sector 4 (Rosebank Peninsula to Great North Road)

The populations of *Mimulus repens* present in Sector 4 (see Figure 4) will be physically uplifted prior to construction activities commencing at Traherne Island, and replanted at appropriate safe locations. These translocation sites are likely to be along the margins of the SH16 causeway.

Translocation of the *Mimulus* will need to be undertaken by experienced experts prior to the initiation of the proposed works in this sector. The uplifted *Mimulus* is considered likely to survive (with due care), given that the NZ Plant Conservation Network records that it is easily propagated from rooted pieces and from stem cuttings, as well as being easily grown from fresh seed. Further to this, Dr. R. Gardner has recently successfully transplanted *Mimulus* in a small field trial (Dr. R. Gardner, *pers. comm*.). The uplifted specimens of *Mimulus* should be replanted at appropriate locations elsewhere, with the key word being "appropriate" (i.e. where they are likely to thrive as a result of optimum environmental conditions).

Weed control within this sector to remove privet and other weed species would be of ecological benefit, especially in relation to Traherne Island (a site of Valued Vegetation). Planting and vegetation management with respect to Traherne Island comes under the ambit of the Traherne Island Management Plan which has been developed by the Traherne Island Technical Working Group. The Plan addresses pest plant management, regeneration of natural vegetation and wildlife in the broader scale, and makes provision for those aspects of the Island's ecology that need to be addressed due to the widening of SH16 in this area (i.e. including the relocation of the *Mimulus*).

In addition to the above, native coastal fringe vegetation is intended to be planted into sheltered parts of the causeway revetment, primarily along the southern side but also in some parts of the northern side. This will replace some of the coastal margin habitat lost through the coastal works.

Outside of the Traherne Island area, replanting of the new embankment with locally sourced and appropriate native species will offset the loss of both naturally occurring and planted native species.

5.5 Sector 5 (Oakley Creek Mouth and Great North Road Interchange)

The only notable vegetation in this Sector is the bush located on the northern side of the mouth of Oakley Creek, which is an example of rock forest. Here exotic trees dominate (in particular tree privet), but a notable indigenous element is also conspicuous, comprised in the main of semi-mature and young karaka, along with lemonwood and mapou. The size of the native trees here indicates a relatively recent colonisation, albeit by natural means.

The key areas of botanical value within this north bank bush would be those localities where native species are present in any abundance. In particular this would include the copses of karaka that are present, as well as concentrations of other native trees and shrubs (such as lemonwood and mapou) and indigenous bryophytes. Such areas constitute Valued Vegetation. If at all practicable these key areas (especially the karaka groves) should be avoided, via adjustments to the locations of piers, haul roads and crane platforms in this bush.

Notwithstanding the aspiration to avoid (as far as practicable) or otherwise minimise clearance of the Valued Vegetation within the north bank bush, the rock forest habitat here (and indeed the rock forest landform itself) will, to some degree, be modified as a result of bridge pier placement and construction. Mitigation for this unavoidable damage is required. The proposed mitigation involves the restoration and enhancement of the remaining rock forest on the north bank. This proposal is given further detail in the Assessment of Visual and Landscape Effects report (Stephen Brown Environments, 2010). It is also noted that this rock forest restoration initiative here would need to be integrated with the lizard management objectives of the Project.

The stormwater treatment wetland pond proposed for Waterview Park will also include locally sourced and appropriate indigenous species in the planting programme for its wetland component, thereby enhancing the botanical biodiversity of this Sector and further enhancing the wider ecological functionality of this device.

Weed control within this sector will also be undertaken as part of routine highway network maintenance.

5.6 Sector 6 (Great North Road Interchange to St Lukes Interchange)

The stormwater treatment wetland pond proposed for Sector 6 will include locally sourced and appropriate indigenous species in the planting programme for its wetland component, thereby enhancing the botanical biodiversity of this Sector and further enhancing the wider ecological functionality of this device.

5.7 Sectors 7 & 8 (Great North Road Interchange to New North Road)

Given the predicted absence of any adverse ecological effects in these two Sectors, no specific off-setting mitigation initiatives would be required in this area.

5.8 Sector 9 (Alan Wood Reserve/Hendon Park & East of Richardson Road)

The two stormwater treatment wetland ponds proposed for Hendon Park and Alan Wood Reserve will include locally sourced and appropriate indigenous species in the planting programme for their wetland components, thereby enhancing the botanical biodiversity of this Sector and further enhancing the wider ecological functionality of these devices.

The small population of *Doodia squarrosa* presently growing in the blockwork of the channel wall in Oakley Creek will be left in situ and remain undisturbed by the Project (although it may potentially need to be moved (to an appropriate and safe place) to allow some rehabilitation of the banks of Oakley Creek in this area, which is proposed as mitigation for the freshwater effects associated with the Project (refer to the Assessment of Freshwater Ecological Effects report – BML, 2010b). The Alan Wood Reserve stormwater treatment device (i.e. the one in close proximity to the *Doodia*) will have its discharge outlet set downstream of this colony.

The area of *Geranium* aff. *retrorsum* "Oakley Creek" that is outside of the Project footprint will be clearly demarcated as a no-go zone for construction activities (although appropriate stream-side rehabilitation works will be permitted in this area). Within the Project footprint, damage to this species will be avoided where practicable. Where avoidance is not practicable, then alternative measures could include the more dense swards (or "sods") being uplifted and translocated to an appropriate and safe place (away from the highway construction works), preferably within the Hendon Park and Alan Wood Reserve area. Alternatively, the measures could include the commissioning of an experienced nursery to collect and propagate new plant material sourced from the Hendon park population, with this material being grown-on and eventually planted out at new safe and appropriate locations.

Notwithstanding the above, should the status of this species have been confirmed prior to the Project works commencing, and should it have been determined to be an introduced species (i.e. a weed), then no such special management measures will be necessary.

The riparian margins of Oakley Creek within Sector 9 are generally devoid of native tree or shrub vegetation. These creek-side margins within Hendon Park and Alan Wood Reserve (as well as the wider grassed areas of these open spaces) will be planted with a range of indigenous species, according to the landscaping plans for this Sector (refer to the Assessment of Visual and Landscape Effects report (Stephen Brown Environments, 2010). These landscaping plans have been developed in collaboration with the proposals to rehabilitate the channelised margins of Oakley Creek in these reserves (i.e. refer to the Oakley Creek Re-alignment and Rehabilitation Guidelines, attached to the Assessment of Freshwater Ecological Effects report – BML 2010b).

Weed control within this sector will also be undertaken as part of routine highway network maintenance.

6. Vegetation Management and Monitoring

The means by which the ecological values of the Project Area will be managed and monitored over the course of the construction of the Project is specified in the Ecological Management Plan (ECOMP). The sections of the ECOMP relevant to terrestrial vegetation are attached to this report as Appendix C.

7. Conclusions

In Sectors 1 – 3, the vegetation affected are small areas of salt marsh and mangroves, together with highway-verge landscape plantings and self-introduced exotic and weed species. The effects of the Project on the botanical values of these sectors are considered to be less than minor.

In Sector 4, the *Mimulus repens* that occurs in two locations on Traherne Island will be physically uplifted and translocated to appropriate and safe alternative locations. In this way the potential adverse effects of the Project on the botanical values of this sector will be less than minor.

In Sector 5, an area of rock forest on the north bank of Oakley Creek will be affected by virtue of four highway ramps and bridges traversing through and across it. While this bush is presently dominated by tree privet, it also supports key areas of representative (although relatively young) rock forest. These key areas are identified in this report as Valued Vegetation. The damage to the wider rock forest at this locality as a result of the Project will need to be mitigated. The proposed mitigation is the enhancement of this degraded rock forest, by way of weed control and appropriate restoration planting.

In Sector 6, the vegetation affected is highway-verge landscape plantings and self-introduced exotic and weed species.

In Sectors 7 – 8, the Project involves cut-and-cover and driven tunnels. It is anticipated that there will be no adverse effects on terrestrial vegetation as a result of these activities.

In Sector 9, the area to the east of Hendon Reserve is an urban wasteland set within an industrial landscape, and is dominated by weeds and exotic species. The botanical conservation values associated with this part of the Project Area are negligible, and the Project will not generate any significant adverse effects in this area in terms of terrestrial vegetation.

In relation to the Significant Vegetation within this Sector, the *Doodia squarrosa* will be retained in situ (and the discharge outlet to the Alan Wood Reserve stormwater treatment pond will be positioned downstream of it). Furthermore, despite the present uncertainty in relation to its taxonomic position, origins and consequent 'at risk' status, the *Geranium* aff. *retrorsum* "Oakley Creek" will be treated as if it were a rare native species. Consequently, that portion of it which is outside of the Project footprint will be clearly demarcated as a no-go zone for construction activities. Within the Project footprint, damage to this species will be avoided where practicable. Where avoidance is not practicable, then the more dense swards (or "sods") could be uplifted and translocated to an appropriate and safe place (away from the highway construction works), preferably within the Hendon Park and Alan Wood Reserve open space area. Alternatively, an experienced nursery could be commissioned to collect and propagate new plant material sourced from the Hendon park population, with this material being grown-on and eventually planted out at new safe and appropriate locations.

All in all, provided that the avoidance, remediation and mitigation initiatives described in this report are implemented, it is concluded that the Project is very unlikely to generate any significant adverse effects in relation to indigenous vegetation within the Project Area.

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