Assessment of Remnant Mahoe Rock Forest at Phyllis and Harbutt Reserves, Oakley Creek

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Prepared on Behalf of Auckland Council

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1.0 INTRODUCTION

The Oakley Creek Walkway Project is an excellent example of the local community, Auckland Council (previously Auckland City Council) and various stakeholders working together to deliver long-lasting environmental benefits to an important urban riparian corridor. The Friends of Oakley Creek have been heavily involved in this ecological restoration project since 2004 - carrying out weed control, revegetation planting, species monitoring and more recently animal pest control - with support from contractors, numerous volunteers and Council staff.

Major ecological gains have been made along the Oakley Creek corridor through reducing the presence of environmental weeds and restoring the vegetation cover to appropriate streamside native species, especially in the lower stream reaches of the project area. This has had wider benefits of creating habitat for native wildlife, increasing shade over the stream, helping to stabilise banks and reduce erosion, improving water quality and working towards reducing the effects of stormwater flows.

In 2005 Te Ngahere produced "The Environmental Weed Control and Native Revegetation Programme for Oakley (Te Auaunga) Creek" plan in order to guide ecological restoration work, and this was subsequently reviewed in 2009 to update the achievements made [Referred to in this document as the Oakley Creek Restoration Plan (Te Ngahere, revised 2009)].

Te Ngahere have been carrying out weed control along the Oakley Creek Walkway since 2001 (initially as the WCBNA contract, then the ERBNA contract and since November 2012 the ERC contract). This work has been mainly restricted to the areas from Management Units 1 to 7, which extend from Great North Road at the northern end of the walkway to just south of Unitec (Waterview Downs). The Te Ngahere report (2005, reviewed 2009) mentioned above, covers the walkway as far as Phyllis Reserve (Management Units 8 & 9). Limited amounts of weed control and planting have taken place in Management Units 8 & 9, whilst work in Harbutt Reserve has mainly been restricted to some weed control by volunteers (up until June 2013).

During the recent planning process for the now approved Waterview Connection Project (SH20 to SH 16 motorway extension/ connection), an assessment was carried out by Boffa Miskell of the Significant and Valued Vegetation in the project area, which includes Oakley Creek (Boffa Miskell / Bioresearches, July 2010). This assessment states that, *"A remnant of a rare mahoe (Melicytus ramiflorus) rock forest ecosystem type, around 700m^2* (=0.07ha), *occurs within the Phyllis St Reserve section."*

Local knowledge has suggested that there are other areas of mahoe rock forest present along Oakley Creek, where the volcanic substrate had not been disturbed by landfill activities. There is therefore a need to assess the actual extent and nature of mahoe rock forest habitat present in the southern section of the Oakley Creek Walkway project, which includes MU 8, MU 9 and Harbutt Reserve.

At the same time there is the opportunity to review the ecological restoration priorities for Management Units 8 and 9 and to consider the restoration requirements of the riparian corridor in Harbutt Reserve (which is currently not included in the Oakley Creek Restoration Plan mentioned above).

Auckland Council have contracted Te Ngahere to carry out an assessment of the extent of the remnant mahoe rock forest in Management Units 8 and 9, as well as within Harbutt Reserve (excluding railway owned land). This report outlines the habitat assessment findings, proposes a restoration methodology, suggests suitable species for planting and outlines associated restoration costs.

2.0 SITE LOCATION

The Oakley Creek Walkway follows the Oakley Creek riparian corridor from the Great North Road NW Motorway (SH 16) intersection and continues south, running parallel to Great North Road and Blockhouse Bay Road, past the Unitec campus and through Phyllis Reserve. It extends as far as the southern boundary of Harbutt Reserve, where the site meets the western railway line.

See location map below (Illustration 1).

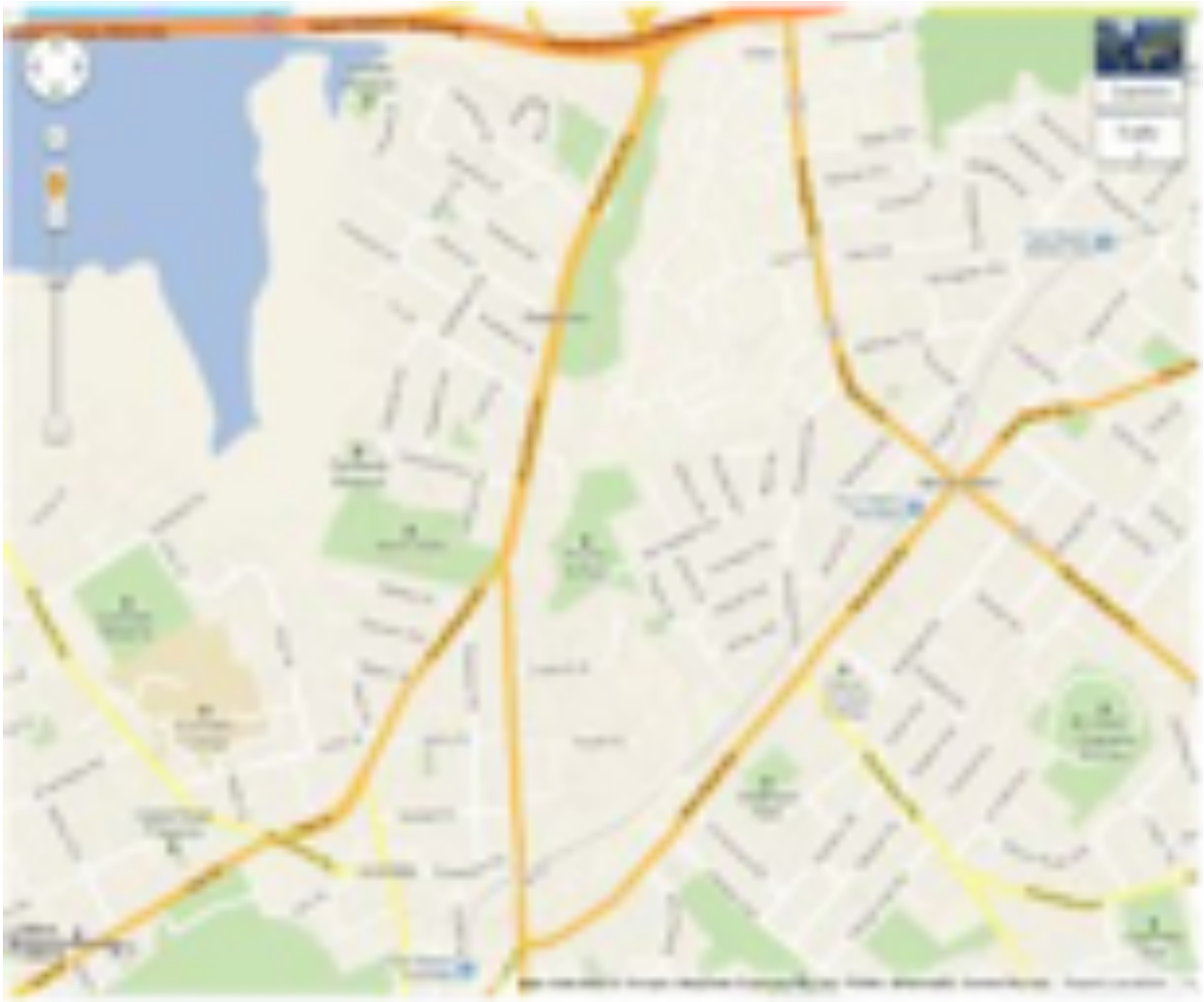

Illustration 1: Location Map of Oakley Creek Walkway

(extracted from Google Maps http://maps.google.co.nz/ - July 2012)

2.1 Management Units

In order to guide ecological restoration efforts the Oakley Creek project area has been divided into Management Units 1-9. See maps below (Illustration 2). Up until July 2012 weed control was carried out by the ERBNA contract (replaced by the Central Ecological Restoration contract from November 2012). The work area covered management units 1 through to the northern half of management unit 7, while limited weed control has occurred before 2012 in MU 8 and 9. The southern half of Harbutt Reserve has not been classified into management units and comprehensive weed control has not been undertaken in this area.

Illustration 2: Maps showing Management Units for Oakley Creek

2.2 Mahoe Rock Forest Asssessment Area

This Assessment Report will focus on the southern section of the Oakley Creek Walkway, from the northern boundary of MU 8 (starting from the footbridge near the Phyllis Reserve Sports Pavilion), through MU 9 (northern part of Harbutt Reserve), to the southern limit of Harbutt Reserve (in Auckland Council ownership). Refer to the map below showing the Mahoe Rock Forest assessment area (Illustration 3).

Illustration 3: Mahoe Rock Forest Assessment Area at Oakley Creek, Mt Albert

(extracted from http://maps.aucklandcouncil.govt.nz/aucklandcouncilviewer)

3.0 BACKGROUND

3.1 Extent of lava flow forest in Auckland

Of the estimated 8,000 hectares of lava flows in the Auckland area only a few hectares are still covered in original vegetation. Some of the vegetation would have been lost during Maori occupation through clearance and natural fires. European occupation would have further reduced the original vegetation through farming and urbanisation (Manukau City Council).

There are now only a restricted number of lava flow forest remnants (associated with the Auckland volcanic field) which remain across Auckland City. These sites are often small and many are at least partly in private ownership. Several of these remnants have been identified as Significant Ecological Areas in the City of Auckland District Plan (Isthmus Section - Operative 1999 and updated in Plan Change 88), including the Government House Lava Flow Forest, Withiel Lava Flow Forest (including Withiel Thomas Reserve), Almorah Lava Flow Forest, Newmarket Lava Flow Forest and Gribblehurst Lava Flow Forest. Other lava flow habitats identified as Significant Ecological Areas include: Anns Creek Lava Flow Wetland & Shrubland and the Meola Reef Reserve Lava Flow Saline Vegetation & Saltmarsh.

The Otuataua Stonefields in Mangere retain two patches of volcanic rock forest that form part of an interesting volcanic landscape of cones, lava flows and lava caves. Mt Eden was cleared early on (before European settlers arrived) and may have had areas of rock forest on the scoria cone and lava flows. Another example is the Pohutukawa dominated lava vegetation of Rangitoto Island, which has a different character to the mainland lava forests (Julian, 2005 and Esler, 2004).

Oakley Creek is a significant landscape feature which follows the path of the Mt Albert lava flow to the coast. The geology of Oakley Creek is made up of Quaternary basalt deposits, which are visible as large volcanic rocks in many places along the stream. Remnants of Mahoe rock forest, a type of lava flow forest, exist along the steep banks of this creek.

3.2 Waterview Connection Assessment

The Waterview Connection Project Assessment of Terrestrial Vegetation Effects (Boffa Miskell / Bioresearches, July 2010) identified a small area of 'rock forest' along Oakley Creek, described as:

"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...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."

'Rock forest' was also identified by the Boffa Miskell (2010) report at the mouth of Oakley Creek, to the west of the NW motorway Great North Road interchange (which falls outside the Oakley Creek Walkway Project area) and has previously been described by Rhys Gardner and Peter de Lange (2008). The Boffa Miskell report states: *"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 very small area of mahoe rock forest that was identified along the Oakley Creek Walkway through the Waterview Connection Assessment is within Management Unit 8 and is shown as partly covering private property adjacent to Phyllis Reserve (not Harbutt Reserve). Refer to Figure 1 showing area identified. The Boffa Miskell report (2010) is not representative of the full extent of the mahoe rock forest habitat along Oakley Creek. During volunteer activities along Oakley Creek, such as weed and animal pest control, it has been noted that other areas of Mahoe dominated canopy and exposed volcanic rock exist.

Figure 1: Map showing area identified as 'rock forest' in Boffa Miskell Assessment of Terrestial Effects Report for Waterview Connection Project (2010)

4.0 SITE DESCRIPTION

4.1 Survey methodology

Vegetation surveys and site visits were carried out in MU 8, MU 9 and Harbutt Reserve from October 2011 to May 2012. Surveys established canopy type, native species present, areas of volcanic substrate, presence of remnant mahoe rock forest and existing weed issues. Other issues such as rubbish dumping, potential archaeological features and management requirements were also noted. Refer to APPENDIX 1 and APPENDIX 2 for lists of native plants and weed species recorded during the assessment surveys. These species lists are not exhaustive and other species are likely to occur in this area of Oakley Creek.

Habitat types were identified according to presence of dominant canopy species and native understorey species. The ground cover in the bush areas surveyed was generally dominated by weed species, such as Tradescantia (*Tradescantia fluminensis*) and Climbing Asparagus (*Asparagus scandens*), and therefore was not indicative of habitat type.

Existing Management Units were divided into separate blocks according to changes in vegetation, for example weed dominated open slope or Mahoe dominated forest. Obvious features e.g. steps, large exotic trees and pest control distance markers (see Illustration 4), were used to separate MU blocks/ sections, so that boundaries could easily be identified for future restoration management. The character of each MU block is described below and identified Mahoe Rock Forest Areas are shown on the associated maps.

In the Oakley Creek Restoration Plan (Te Ngahere, revised 2009) the vegetation type for Management Units 8 and 9 was broadly identified as Tree Privet/ Mahoe/ Blue Morning Glory Shrubland. The Mahoe Rock Forest assessment has shown that the forest vegetation in this southern section of Oakley Creek (Phyllis and Harbutt Reserves) consists of distinct Mahoe dominated and Tree Privet dominated areas.

4.2 Management Unit 8

Management Unit 8 extends south from the footbridge (across Oakley Creek), which is accessed from the steep path down from Phyllis Reserve sports pavilion carpark, to where the block of private land extends down to the stream from house number 10 Phyllis Street. Three distinct areas of interesting remnant Mahoe rock forest were identified in MU 8, and were named Mahoe Rock Forest Areas A, B & C. Refer to Figure 2 for a map showing locations of Mahoe Rock Forest Areas in MU 8. The small area identified in the Boffa Miskell Waterview Connection report (2010) was re-visited and found to be more extensive than the 700m^2 indicated (see description in Section 4.2.7).

4.2.1 MU 8 - Phyllis Reserve bridge to 1.5km pest control marker

The northern end of this block, adjacent to the path junction and towards the bridge has been planted with native species in 2010 and 2011, with mulch used to suppress weeds. An area on the western side of the stream to the south of the bridge has also been planted recently. This area has been identified as suitable habitat for lizards due to the mix of low vegetation, a sunny bank and availability of shelter.

Canopy:

Heading south along the walkway, this section is relatively open with a limited canopy apart from scattered large Willows (*Salix sp.*). There was occasional Mahoe (*Melicytus ramiflorus*) saplings, Kawakawa (*Macropiper excelsum subsp. excelsum*), Karamu (*Coprosma robusta*) and Harakeke/ Flax (*Phormium tenax)*. The bank on either side of the path, which slopes down steeply to the stream, is dominated by ground cover weeds.

At the edge adjacent to the playing fields, there were mature Ngaio (*Myoporum laetum*), Tree Privet (*Ligustrum lucidum*) and Pohutukawa (*Metrosideros excelsa*) trees.

Weeds:

There are a range of weed and exotic species present including: Hemlock (*Conium maculatum*), Tutsan (*Hypericum androsaemum*), Nasturtium (*Tropaeolum majus*), Spear Thistle (*Cirsium vulgare*), Prickly Ox-tongue (*Picris hieracioides*), Wattle sp. (*Acacia sp.*) seedlings, Chinese Privet (*Ligustrum sinense*) seedlings, Castor Oil plant (*Ricinus communis)*, Canna Lily (*Canna indica*), Woolly Nightshade (*Solanum mauritianum*), Japanese Honeysuckle (*Lonicera japonica*), Umbrella Sedge (*Cyperus eragrostis*) and Black Nightshade (*Solanum nigrum*).

Other issues:

The flat terrace area adjacent to the path was planted in winter 2012 by Friends of Oakley Creek.

Remnant Mahoe Rock Forest / volcanic substrate:

No evidence of remnant mahoe rock forest or obvious volcanic substrate.

4.2.2 MU 8 - 1.5km marker to 1.55km marker

Canopy:

The canopy in this section consisted of Tree Privet, Kanuka (*Kunzea ericoides var. ericoides*), Willow and occasional Cabbage Tree (*Cordyline australis*). There were a number of very large Woolly Nightshade trees and occasional mature Wattle.

Sub-canopy and groundcover:

In the sub-canopy there was Silver Fern / Ponga (*Cyathea dealbata*), medium-sized Chinese Privet and Lemonwood (*Pittosporum eugenioides*). The ground cover was weed dominated, apart from infrequent Haloragis (*Haloragis erecta*) patches and Karaka (*Corynocarpus laevigatus*) seedlings.

Weeds:

Weed species included: Tradescantia, Bear's Breeches (*Acanthus mollis*), Montbretia (*Crocosmia x crocosmiiflora*), Bindweed (*Calystegia sp.*), Kahili Ginger (*Hedychium gardnerianum*), Moth Plant *(Araujia hortorum*), Buddleia (*Buddleja davidii*), Japanese Honeysuckle, Madeira Vine (*Anredera cordifolia*) and Chinese and Tree Privet saplings. There were only small amounts of Climbing Asparagus present.

Other issues:

This section of MU 8 has been affected by landfill activities, which has lead to disturbed loose soil and a lack of visible volcanic rocks. This steep slope was bare in places with large quantities of exposed metal and old bottles.

Remnant Mahoe Rock Forest / volcanic substrate:

No evidence of remnant mahoe rock forest or obvious volcanic substrate, due to the disturbed ground and dumping of landfill material.

Illustration 4: Example of pest control distance markers used to separate Management Unit sections

4.2.3 MU 8 - 1.55 marker to corner of Phyllis Reserve playing fields - Mahoe Rock Forest Area A

Canopy:

The vegetation character changes to a predominantly native canopy from marker 1.55 and includes all the land enclosed by the bend in the stream (up to the area opposite 12C Cradock Street). The native canopy consisted of a mix of mature trees of Houhere/ Lacebark (*Hoheria populnea*), Kanuka, Lemonwood, Puriri (*Vitex lucens*), Mapou, Kowhai (*Sophora chatamica*), Totara (*Podocarpus totara var. totara*), Ponga and frequent Mahoe. Large Mahoe trees were also growing at the top of the quarry on the rock substrate, refer to Illustration 5. There were occasional larger Tree Privet and Woolly Nightshade trees present.

Illustration 5: Large multi-stemmed Mahoe trees in Mahoe Rock Forest Area A

Sub-canopy:

The sub-canopy was relatively open and contained a range of native species, as well as some weed trees. It was made up of Mapou, Hangehange (*Geniostoma ligustrifolium var. ligustrifolium*), Houhere/ Lacebark, Lemonwood, Cabbage Tree, Tree Privet, Chinese Privet and even Rimu (*Dacrydium cupressinum*). There was a good amount of natural regeneration of Totara, Mahoe, Karaka, Mapou, Houhere, Karamu and Houpara (*Pseudopanax lessonii*) taking place, with frequent seedlings and young saplings seen.

Ground cover:

The ground cover was relatively bare with occasional Forest Sedge (*Carex lambertiana*) and infrequent patches of Tradescantia and Bear's Breeches. Climbing Asparagus was abundant in places, scrambling across the ground and climbing trees. Rasp Fern (*Doodia australis*) was common on the quarry wall and exposed rocks - see photo below (Illustration 6).

Illustration 6: Rasp Fern (*Doodia australis*) growing amongst basalt rocks in MU 8 Mahoe Rock Forest Area A

Weeds :

There were occasional large Tree Privet, Woolly Nightshade and Wattle sp. present in the canopy. Climbing Asparagus formed a dense layer in the understorey. Patches of Bear's Breeches, Tradescantia and Madeira Vine were noted. Other weed species recorded in this section included Elaeagnus (*Elaeagnus x reflexa*), Gorse (*Ulex europaeus*), Taiwan Cherry (*Prunus campanulata*), Japanese Spindle (*Euonymus japonicus*), Loquat (*Eriobotrya japonica*), Kahili Ginger, Montbretia and Japanese Honeysuckle.

Other issues:

There was a large quarry with steep walls that formed an interesting central feature and supported a diverse range of native species, especially ferns.

Remnant Mahoe Rock Forest / volcanic substrate:

There are a number of large Mahoe trees present as well as a diverse range of native canopy species in this area. Basalt rocks were abundant on the ground and there was a large rock quarry. This area has good ecological restoration potential due to the limited exotic species in the canopy, the existing regeneration of the understorey and the native fern species present. The total area of this block of remnant Mahoe rock forest is approximately 0.38ha, named Mahoe Rock Forest Area A. This area covers the whole peninsula, which extends steeply down to the stream.

4.2.4 MU8 - Weed dominated slope from corner of Phyllis Reserve playing fields heading east

Canopy:

There are no trees or understorey species on this steep weed dominated slope.

Weeds:

This bank is covered in dense scrambling weed species including Nasturtium, Tradescantia, Ginger, Bindweed sp., Madeira Vine and Honeysuckle. Ginger and Bear's Breeches are also frequent.

Other issues:

There is a significant amount of rubbish hidden by the weed cover.

Remnant Mahoe Rock Forest / volcanic substrate:

No evidence of remnant Mahoe rock forest or exposed volcanic substrate. Rocks may be obscured by dense exotic vegetation and rubbish.

The land opposite this section, on the southern bank of Oakley Creek (adjacent to 12C and the units at 14 Cradock Street), is Council Esplanade and is currently unmanaged. It was dominated by large Kanuka and Ponga, with a bare understorey (viewed from Phyllis Reserve streamside but not surveyed).

4.2.5 MU 8 - Area of bush adjacent to southern boundary of Phyllis Reserve playing fields (extends to just east of 1.65km marker) - Mahoe Rock Forest Area B

Canopy:

This section of bush includes the whole bend of the creek and extends to the east towards the carpark entrance from the end of Springleigh Ave. There was a mixed canopy, with a range of native and exotic species. Native canopy species included large Mahoe, Karaka, Mapou, Kanuka, Cabbage Tree and Ponga. There were occasional large Tree Privet and Woolly Nightshade.

Sub-canopy and ground cover:

The sub-canopy was quite sparse with Mapou saplings, Chinese Privet, Hangehange, Karaka, Lemonwood, Houhere and Mahoe saplings. The ground cover was weed dominated with occasional Karaka and Mapou seedlings.

Weed Species:

The forest ground cover consisted of frequent Climbing Asparagus and dense Tradescantia. At the eastern and western edges of this bush section, the boundary trees were covered in climbing vines (which are invading from the open weed dominated banks) such as Nasturtium, Bindweed sp., Japanese Honeysuckle and Blue Morning Glory (*Ipomoea indica*). In the central area of this block there was a dry ridge with mature Wattle sp., Pampas sp., tall Kanuka, Gorse and Gahnia sp. This area consists of a steep rock wall to the east that drops directly to the creek. Along the stream edge there was an abundance of weed species including Plectranthus (*Plectranthus ciliatus*), Tutsan, African Clubmoss (*Selaginella kraussiana*), Lemon Balm (*Melissa officinalis*), Montbretia, Ginger, Tradescantia and German Ivy (*Delairea odorata*).

Remnant Mahoe Rock Forest / volcanic substrate:

There were a number of large Mahoe trees and an abundance of exposed volcanic rock in this area, and a steep rock wall on the eastern slope. The total area of this block of remnant Mahoe rock forest is approximately 0.33ha, named Mahoe Rock Forest Area B.

4.2.6 MU 8 - Weed dominated slope to east of Mahoe Rock Forest Area B (adjacent to Akarana Dog Training Club)

Canopy:

This slope is weed dominated with only a few individual Mahoe trees that had been smothered in Blue Morning Glory, which is restricting their future survival. Refer to Illustration 7 below.

Weeds:

This weed dominated slope was covered in dense Nasturtium, Elephant's Ear (*Alocasia brisbanensis*), Blue Morning Glory, Arum Lily (*Zantedeschia aethiopica*), Hemlock, Woolly Nightshade and a few Willow trees. Also along the path edge there is the black/red flowered Arum (*Arum palaestinum*).

Other issues:

There is a significant amount of rubbish hidden under the weeds, including plastic and metal.

Remnant Mahoe Rock Forest / volcanic substrate:

No evidence of remnant mahoe rock forest or exposed volcanic substrate.

Opposite this section, on the southern bank of Oakley Creek, the land is owned by NZTA and dominated by mature trees (viewed from northern bank but not surveyed). Species included Pine sp., Chinese Privet, Oak sp. (*Quercus sp.*), Mahoe, Kanuka and Lemonwood.

Illustration 7: Weed dominated bank at Phyllis Reserve between Mahoe Rock Area B and C
(photo by Wendy John)

4.2.7 MU 8 - East of Akarana Dog Club to start of MU 9 - Mahoe Rock Forest Area C

This area extends from the end of the weed dominated bank, past the steps and old quarry to the boundary with the private property at 10 Phyllis Street.

Canopy:

The canopy was Mahoe dominated with occasional Wattle sp., Ponga and Whau (*Entelea arborescens*). There was a very large multi-stemmed Mahoe tree by the edge of the field. The sub-canopy was particularly sparse with occasional Mapou, young Mahoe, Ponga, and rarely Hangehange and Houhere.

Weeds:

There was an abundance of weeds with Climbing Asparagus and Blue Morning Glory climbing and starting to smother trees. Tradescantia, Bear's Breeches, Madeira Vine, Climbing Dock (*Rumex sagittatus*), English Ivy (*Hedera helix*) and Woolly Nightshade were present. A form of glossy Kawakawa (*Macropiper sp.*), either a hybrid or the Three King's variety, was also found in this section. Along the stream Montbretia, Hedge Woundwort (*Stachys sylvatica*) and Alligator Weed (*Alternanthera philoxeroides*) were locally frequent.

Other issues:

The two small quarries above the steps are an interesting feature.

Remnant Mahoe Rock Forest / volcanic substrate:

As can be seen in the picture below (Illustration 8), the Mahoe trees adjacent to the wooden steps are generally not very mature or multi-stemmed, yet Mahoe is dominant and there is an abundance of basalt rocks. Due to the limited canopy structural variation and lack of diversity of native species, Mahoe rock forest Area C is not as ecologically diverse as other mahoe rock forest areas along Oakley Creek. This area does not include the private blocks at numbers 10, 8 and 6 Phyllis Street which have a canopy dominated by Macrocarpa (*Cupressus macrocarpa*).

This remnant Mahoe rock forest area covers a total of approximately 0.14ha, which is double the area identified by the Boffa Miskell assessment.

Illustration 8: Mahoe rock forest remnant Area C, adjacent to wooden steps

Figure 2: Map showing identified remnant Mahoe Rock Forest Areas in Management Unit 8

4.3 Management Unit 9

Management Unit 9 includes the northern section of Harbutt Reserve and extends as far as the access path just before the 2.15 km marker. Two areas of remnant Mahoe rock forest were identified in MU 9, which have significant potential for ecological restoration. Refer to Figure 3 for a map showing locations of Mahoe Rock Forest Areas D and E in MU 9.

4.3.1 MU 9 - Northen end of Harbutt Reserve to Mahoe Rock Forest Area D

Canopy:

There is no established canopy at the northern end of MU 9. MU 9 starts at the boundary with private property blocks (from 10 Phyllis Street) that lead down to the stream edge. Where the stream bends sharply forming a peninsula, there has been specimen tree planting of Kahikatea (*Dacrycarpus dacrydioides*) and Puriri. This area is mown and is prone to flooding. Adjacent to here there is a large Tortured Willow (*Salix matsudana*) and a weed dominated bank.

Heading south along the walkway towards the wooden steps, there has been large specimen tree planting (size PB 18) in winter 2011 of Taraire (*Beilschmiedia tarairi*), Titoki (*Alectryon excelsus*), Puriri, Pohutukawa and Karaka.

Weeds:

There are a number of weeds on the specimen tree planted slope including Blue Morning Glory, Castor Oil Plant, Hemlock, German Ivy, Nasturtium and Bindweed sp. On the weed-dominated bank behind the Tortured Willow, Woolly Nightshade, Bamboo (*Bambusa sp.*) and Tradescantia were abundant.

Remnant Mahoe Rock Forest / volcanic substrate:

Land filling has taken place at this northern end of Harbutt Reserve which has resulted in landscaped banks and a lack of natural rock features.

4.3.2 MU 9 - Adjacent to steps to opposite Cradock Street Community - Mahoe Rock Forest Area D

Canopy:

The canopy adjacent to the steps consists of semi-mature Mahoe with Five-Finger (*Pseudopanax arboreus*), Kohekohe (*Dysoxylum spectabile*) and Wharangi (*Melicope ternata*) planted in the understorey. To the east there are established native plantings at the top of the bank dating from 2004/2005. The understorey and ground cover are relatively bare near the steps, as some weed control has been previously undertaken.

Further south the canopy is also Mahoe dominated, with a mix of other natives present including Karamu, Ponga and Cabbage Tree. The understorey is very dense with weed species dominating.

Weeds: Wattle sp., Tree Privet and Taiwan Cherry were occasional in the canopy layer. Climbing Asparagus, Ginger, Japanese Honeysuckle and Chinese Privet formed a dense layer in the understorey. Woolly Nightshade and Moth plant were also frequent. The ground cover was dominated by Tradescantia.

Remnant Mahoe Rock Forest / volcanic substrate:
This small area opposite the Cradock Street Community on the northern bank of Oakley Creek, consists of a predominantly Mahoe canopy and has an abundance of volcanic rocks present. This remnant Mahoe rock forest is approximately 0.16 ha in size and is called Mahoe Rock Forest Area D. The understorey in this area has significant weed issues (refer to Illustration 9), yet following weed control there is great potential for restoration.

Illustration 9: Mahoe Rock Forest Area D - note Mahoe canopy and numerous weed issues

4.3.3 MU 9 - Between Mahoe Rock Forest Areas D and E

Canopy and sub-canopy:

Immediately beyond Mahoe Rock Forest Area D, the vegetation becomes dominated by exotic species. Occasional large Willows, Wattle sp. and Cabbage Tree form the well-spaced canopy. The understorey contained Woolly Nightshade, Chinese Privet, Karamu, Cabbage Tree, Tree Privet, Lemonwood and Flax.

Weeds:

Additional weed species that were frequent included Ginger, Tradescantia, Banana Palm, German Ivy, Climbing Asparagus, Canna Lily, Pampas, Arum Lily, Montbretia, Moth Plant, Japanese Honeysuckle and Palm Grass (*Setaria palmifolia*). There is a large stand of Bamboo present towards the stream.

Other issues:

Planting of large specimen trees of Kahikatea, Pukatea (*Laurelia novae-zelandiae*) and Swamp Maire (*Syzygium maire*) has occurred on the floodplain. The groundcover vegetation under the plantings consisted of Nasturtium, Onion weed (*Allium triquetrum)* and annual weeds.

Remnant Mahoe Rock Forest / volcanic substrate:

No evidence of remnant mahoe rock forest or noticeably visible exposed volcanic substrate.

4.3.4 MU 9 - Northeast of the Tibetan Buddhist Centre - Mahoe Rock Forest Area E

Canopy and sub-canopy:

The canopy in this area is Mahoe dominated, with frequent Ponga and occasional Lemonwood. Sub-canopy species included Karo, Mapou, Karamu, Cabbage Tree, Five-finger, Pigeonwood (*Hedycarya arborea*) and Hangehange. Bracken (*Pteridium esculentum*) was also recorded. There was a significantly large multi-stemmed Taiwan Cherry tree in this area.

Weeds:

In the canopy there were occasional large Woolly Nightshade, Tree Privet and Wattle sp. Climbing Asparagus was dense in the understorey with Taiwan Cherry, Chinese Privet and Wattle sp., Gorse, Ginger, Japanese Honeysuckle, Pampas, German Ivy and Japanese Spindle present. Jasmine (*Jasminum polyanthum*) and Tradescantia were particularly abundant near the rock gully.

Remnant Mahoe Rock Forest / volcanic substrate:

The canopy was predominantly Mahoe and the slopes of this forest area were covered with basalt rocks. There was also a rock gully present. This area was identified as Mahoe Rock Forest Area E, and was approximately 0.29 ha in size. Mahoe Rock Forest Area E extends slightly beyond the southern boundary of MU 9 into MU 10.

Figure 3: Map showing remnant Mahoe Rock Forest Areas in Management Unit 9

(extracted from http://maps.aucklandcouncil.govt.nz/aucklandcouncilviewer)

4.4 Southern Section of Harbutt Reserve

The area of Harbutt Reserve that extends south of MU 9 was not included in the Oakley Creek Restoration Plan (Te Ngahere, revised 2009). This southern section of Harbutt Reserve has now been surveyed through this Mahoe Rock Forest assessment and will be defined as Management Units 10 and 11 (see map Figure 4), in order to aid prioritisation of ecological restoration work.

Exposed volcanic rocks were abundant on the slopes throughout this southern section (refer to photo below, Illustration 10), yet the vegetation character varied. The presence of a predominantly Mahoe canopy was used as the main assessment criteria for determining areas of remnant Mahoe rock forest.

Illustration 10: Typical view of Mahoe Rock Forest in Management Unit 11

Figure 4: Map showing Management Units 10 and 11, with Mahoe Rock Forest Areas E and F

4.5 Management Unit 10

Management Unit 10 incorporates a small part of Mahoe Rock Forest Area E (see Section 4.3.4), then continues south past the weedy gully and finishes at the southern end of the large bamboo stand, opposite the Pak n' Save building. The canopy is dominated by large Tree Privet in MU 10, with a few mature Mahoe trees towards the southern end of the unit. There is some native regeneration occurring in the understorey, yet weed species were dominant.

4.5.1 MU 10 - From Mahoe Rock Forest Area E to weedy gully by railway line

Canopy:

South of Mahoe Rock Forest Area E the canopy was Tree Privet dominated, with two large Macrocarpa trees. There was also Chinese Privet, Woolly Nightshade, Mamaku, Ponga and a few Mahoe present in the canopy.

Sub-canopy:

Pigeonwood, Taiwan Cherry, Karamu, Tree Privet, Mapou, Woolly Nightshade, Hangehange, Chinese Privet and rarely Mahoe were present in the sub-canopy.

Weeds:

Weed species were dominant in the understorey and included Climbing Asparagus patches, Japanese Honeysuckle, Pampas, English Ivy, Ginger (which was abundant by the stream), Japanese Spindle, German Ivy, Blue Morning Glory, Bear's Breeches and Tradescantia. Periwinkle (*Vinca major*) and Jasmine occurred in abundance near the Macrocarpa. Willow was present adjacent to the stream.

Other issues:

Between the Macrocarpa trees there was a smaller weed gully with a basalt stone drain.

Remnant Mahoe Rock Forest / volcanic substrate:

There was no mahoe rock forest apparent in this section as the canopy was dominated by large exotic species, especially Tree Privet.

4.5.2 MU 10 - Weed gully to stone wall near 2.4 km marker

Where Harbutt Reserve meets the railway line there is a large weed infested gully, which leads to a channel and concrete pipe that flow into Oakley Creek. This gully is covered in Blue Morning Glory and Nasturtium, with Wattle, Woolly Nightshade and Ginger frequent. These weeds along with Moth Plant, Japanese Honeysuckle and Chinese Privet are invading into the forest edge to the south.

Canopy:

South of the weed gully and channel / concrete pipe Tree Privet is the main canopy species. There are some large Willow trees near the stream. On the lower slope near the stone wall there are a few large Mahoe trees.

Sub-canopy and ground cover:

The sub-canopy consisted of Pigeonwood saplings, Ponga, Karaka, Karamu and Chinese Privet. Near the top of the slope the ground was relatively bare while to the north there was an abundance of English Ivy. Mapou and Lemonwood seedlings were present and there was an abundance of Karaka regeneration near the stone wall.

Weeds:

Weed species were frequent in this forest area and included: Ginger, Moth Plant, Japanese Honeysuckle, Climbing Asparagus, Woolly Nightshade, German Ivy, Tradescantia and Palm Grass. There were two areas of Bamboo, a smaller patch next to the railway by the weedy gully, and a large stand that extended three quarters of way down the slope. The floodplain was dominated by Ginger, Honeysuckle, Tradescantia, Nasturtium and Willow regrowth.

Other issues:

There is a low stone wall, made of volcanic rocks, that runs in a straight line down the slope from the forest edge near the railway towards the stream. Refer to photo below (Illustration 11), showing main stone wall. There would appear to be other similar stone walls in the immediate vicinity, yet they are shorter in length. On the Auckland Council GIS Viewer there is an archaeological site identified at this location, known as "R11/2207, Dry stone wall - stockyard/ stockpen? (CHI computer number 14351)". Refer to section 5.1 for further details.

Remnant Mahoe Rock Forest / volcanic substrate:

Even though occasional Mahoe trees were present, this section could not be classified as mahoe rock forest as the canopy was dominated by Tree Privet.

Illustration 11: Stone Wall in Management Unit 10, recorded as an archaeological site (R11/2207)

4.6 Management Unit 11

Management Unit 11 starts at the southern end of the large bamboo stand before the stone wall. It narrows after the 2.5km marker, as the strip of land adjacent to the railway is not in Auckland Council ownership. This unit continues as far as the limit of the eastern stream bank, where a large culvert enters from under the railway line. Between marker 2.5 and 2.55, the character of the forest changes significantly with large Mahoe trees becoming more frequent or forming the dominant canopy. This area is defined as Remnant Mahoe Rock Forest Area F.

At the southern end of MU 11 Tree Privet dominates again with some younger Mahoe trying to establish in the understorey. There are significant weed issues throughout this unit with Climbing Asparagus forming a dense carpet in many areas.

4.6.1 MU11 - Stone wall (near 2.4 marker) to start of Mahoe dominated canopy (near 2.5 marker)

Canopy:

The canopy consisted of Tree Privet, Mahoe and Ponga. There were occasional larger Mahoe trees nearer to the stream and towards the top of the bank. There were also large Wattles and Willow on the upper slope.

Sub-canopy and ground cover:

Hangehange was frequent with Tree Privet, Mahoe, Karaka, Cabbage Tree, Chinese Privet. Pigeonwood and Taiwan Cherry were also present. There were a number of seedlings of Karamu, Pigeonwood, Mapou, Chinese Privet and Tree Privet.

Weeds:

Weed species in the understorey included Tradescantia, Ginger, Climbing Asparagus, Pampas, Japanese Honeysuckle and Wattle. Woolly Nightshade, Montbretia and Willow were found by the stream.

Remnant Mahoe Rock Forest / volcanic substrate:

Mahoe formed a frequent component in the canopy with Tree Privet and Ponga, yet was not dominant. This area should be considered as a buffer zone to the adjacent Mahoe dominated canopy to the southwest. With gradual removal of large Tree Privet and the reduction of weeds, this area has significant restoration potential.

4.6.2 MU 11 - Mahoe dominated canopy (between 2.5 and 2.55 marker) - Mahoe Rock Forest Area F

Canopy:

This interesting section consisted of Mahoe from 35-40cm DBH (diameter at breast height), including many multi-stemmed specimens, to smaller trees. Refer to photo below showing large multi-stemmed Mahoe (Illustration 12). The area of exclusive Mahoe canopy was approximately 30 metres wide (in a south east - south west direction) and extended from the top of slope to the stream. Further to the south west, larger Mahoe trees were more occasional.

Illustration 12: Multi-stemmed Mahoe in MU 11 Mahoe dominated Area

Sub-canopy and groundcover:

In the sub-canopy there was Ponga, Hangehange, Pigeonwood, Tree Privet and Mahoe. The groundcover was relatively bare underneath the dense Mahoe with some Mahoe, Pigeonwood and Karo seedlings establishing.

Weeds:

At the top of the slope near the railway line there were several large Wattle trees and a sizeable Tree Privet. There were some areas of dense Climbing Asparagus, especially on the upper slope. Other weed issues included Tradescantia, Ginger, Japanese Spindle, Chinese Privet, Woolly Nightshade, Madeira Vine and Japanese Honeysuckle.

Remnant Mahoe Rock Forest / volcanic substrate:

This is the best example of mature Mahoe rock forest along Oakley Creek due to the number and size of Mahoe trees present. There is a native dominated understorey with good regeneration occurring. Weed issues still persist through this area and it is recommended that weed control is carried out to enhance this important remnant habitat. This area of high quality remnant mahoe rock forest is identified as Mahoe Rock Forest Area F. It covers approximately 0.25 ha.

4.6.3 MU11 - Section between 2.55 marker to 2.6 marker

Canopy:

Tree Privet was the dominant canopy species, with some large trees present. Tall Mahoe were only occasional.

Sub-canopy and Groundcover:

There was an established sub-canopy of Karamu, Mapou, Mahoe, Ponga, Karaka, Cabbage Tree, Chinese Privet and Pigeonwood. Groundcover species included Rasp Fern, Karaka seedlings and Hounds Tongue Fern *(Microsorum pustulatum*) growing on rocks.

Weeds:

Climbing Asparagus was abundant in this section, forming dense sprawling mats, refer to photo below (Illustration 13). Ginger, Monkey Apple / Acmena (*Syzygium smithii*), Montbretia, Wattle, Loquat, Japanese Spindle, German Ivy, Tradescantia, Elaeagnus, Woolly Nightshade and Taiwan Cherry were also present. Along the stream, Crack Willow, Tradescantia, Nasturtium and Ginger were frequent.

Remnant Mahoe Rock Forest / volcanic substrate:

This section can not be classified as remnant mahoe rock forest as the canopy was dominated by large Tree Privet, with only very occasional tall Mahoe present.

Illustration 13: Climbing Asparagus invading understorey and ground layer in MU 11

4.6.4 MU 11 - 2.6 marker to southern end of Harbutt Reserve

Canopy:

The canopy was made up of Tree Privet only, which were mainly smaller than 25cm DBH. There was one large Mahoe tree by the stream.

Sub-canopy and Groundcover:

The sub-canopy consisted mainly of Tree Privet and was relatively open at the southern end of this area. Taiwan Cherry, Cabbage Tree, Chinese Privet and Ponga were rare with occasional Mahoe saplings. Seedlings of Karo, Mapou, Titoki, Karamu and Pigeonwood were present. The following ferns were recorded: Rasp Fern, Kiokio (*Blechnum novae-zelandiae)* - along stream, and Shining Spleenwort (*Asplenium oblongifolium)*.

Weeds:

Chinese Privet saplings, Woolly Nightshade, Japanese Honeysuckle, Palm Grass, Monkey Apple, Loquat, Japanese Spindle, Montbretia, Wattle and Elaeagnus were present. Taiwan Cherry, Tutsan and Pampas were only found rarely. Tradescantia occurred along the stream.

Remnant Mahoe Rock Forest / volcanic substrate:

Even though occasional tall Mahoe (some over 8m tall) were found in this section, the canopy was dominated by Tree Privet. Therefore this area is not considered as remnant mahoe rock forest.

4.6.5 Railway land

The strip of land adjacent to the railway at the southern end of Harbutt Reserve is not in Auckland Council ownership. The forest in this area had a Tree Privet dominated canopy. Karamu, Mahoe, Mapou and Karo saplings were occasional in the understorey. Chinese Privet, English Ivy and Ginger were present. Climbing Asparagus was dense and smothering large areas.

There was a rock quarry present on the mid-slope of the railway land, between km marker 2.60 and 2.65. This is recorded as an archaeological site on the Auckland Council GIS viewer, as "R11/2247 Historic Quarry/ Railway Bridge/ Embankment (CHI Computer number 16664)."

Figure 5: Approximate location of Mahoe Rock Forest Area F in MU 11

5.0 ARCHAEOLOGICAL CONSIDERATIONS

5.1 Archaeological Sites

Archaeological sites were assessed by Druskovich (2009) along Oakley Creek in relation to the revegetation programme proposed in the Oakley Creek Restoration Plan (Te Ngahere, revised 2009). This archaeological assessment covered management units 1-9 along the Oakley Creek Walkway, but did not include the Harbutt Reserve extension.

The following extract from Druskovich (2009) describes Management Unit 8 & 9:

"***4.13 Management Units 8 and 9***
No archaeological sites have been recorded within these management units, however evidence of both Maori occupation (R11/2109 and R11/2248) and historic farming practices (R11/2208) have been recorded nearby (Figures 7 and 8). No archaeological evidence has been found on or immediately adjacent to the walkways and grassed areas, or Oakley Creek itself. All of the vegetated banks in these management units are steep, and in places impossible to adequately survey. It would appear unlikely, but possible that archaeological evidence maybe found on these slopes, the most likely being midden deposits thrown down the slopes. It is therefore recommended that;

nn) If in the future the banks are cleared of vegetation an archaeologist should be given the opportunity to resurvey these areas."

5.1.1 Observations

During Mahoe Rock Forest Assessment surveys, rock quarries were noted in Mahoe Rock Forest Area A and C in Management Unit 8, but do not appear to be recorded as archaeological sites. Since the mahoe rock forest surveys, a shell midden was discovered in April 2013 at the top one of the small quarries in Mahoe Rock Forest Area C by consultant archaeologist Brent Druskovich (site R11/2836).

In MU 10 from weedy gully to below large Bamboo stand, there is a line of large basalt rocks at the base of the slope running parallel to the stream. This was investigated by Brent Druskovich in May 2013 and was found to be of more recent origin and therefore not of archaeological interest. The slope is thought to have been mechanically regraded in recent times and rocks relocated as part of this realignment.

Near the boundary between Management Unit 10 and 11, stone walls (made from basalt rocks) were noted during Mahoe Rock Forest Assessment surveys. This is assumed to be the recorded archaeological site R11/2207 (Dry Stone Wall) - see description and photo in Section 4.5.2 . A site visit was carried out with Brent Druskovich in May 2013 to look at these stone wall structures. Their age and origin is still uncertain, yet several walls seem to be connected running down the slope and along the stream. Restoration works will need to be carried out carefully in this area and specific recommendations are given in Section 5.2.1 .

In the railway land adjacent to the southern section of Harbutt Reserve (outside Auckland Council ownership), a quarry was also observed which appears to be in the same location as the recorded archaeological site R11/2247 (Historic Quarry/ Railway Bridge/ Embankment). This site falls outside the project work area.

5.2 Ecological Restoration Works

Future ecological restoration works in MU 8-11 will focus mainly on weed control with some restoration planting, in order to enhance the important remnant Mahoe rock forest habitat along Oakley Creek. Any restoration works will need to take into consideration existing archaeological features and potential features that may be present yet obscured by vegetation or exist at a sub-surface level (such as shell midden, hangi, storage pits). Cultural importance of sites to tangata whenua should also be taken into consideration and liaison held with local iwi representatives.

As weed control progresses as part of the Mahoe rock forest restoration project it is recommended that an archaeologist is engaged to carry out further archaeological assessments from MU 8 to MU 11, especially before any planting is undertaken. This should be undertaken in conjunction with the review of the NZ Historic Places Trust 'Authority to Modify'.

Contractors and volunteers need be aware that archaeological features could be discovered at any time and that works must be stopped and advice sought from an archaeologist if archaeological evidence is suspected, as recommended in Druskovich (2009):

"***4.14 General Recommendations***
The following recommendation are made for all management units and for any volunteer plantings that may occur outside the management units, and recognises that it is possible that other undiscovered archaeological sites may exist within any of the management units. These recommendations should be passed onto all stakeholders who are involved in the revegetation of Oakley Creek and maintenance of the infrastructure that runs along and across it.

oo) That if any areas of shell, drystone walling, or other evidence that may be archaeological evidence is discovered during planting, vegetation removal or other works, all works in that vicinity should cease and an archaeologist called in to assess and give further advice."

In addition, if a koiwi (human remains) are uncovered, work should cease immediately and the tangata whenua and police should be contacted so that appropriate arrangements can be made.

5.2.1 Specific recommendations

Brent Druskovich has recommended that the following tasks should be carried out in relation to the stone wall archaeological feature in MU 11, known as R11/2207 (Dry stone wall - stockyard/ stockpen?) - approximate GPS location E1751987, N5915785:

- weeds should be controlled/removed in the central open space and in the vicinity of the stone walls, including small-medium-sized weed saplings e.g. privet.
- small weeds growing in or on the stone walls should be controlled carefully by cut stump methods.
- large weed trees growing within the wall and near the wall, need to be assessed carefully and in future should be removed by trained arborists, ensuring no damage to the rock walls e.g. through root uplift or tree felling methods.
- native species should be allowed to establish naturally in the central open area, as long as they are not within the vicinity of the walls.
- no planting should be undertaken within 10m of the stone wall features.

6.0 ECOLOGICAL RESTORATION PROGRAMME

6.1 Aims and Objectives

6.1.1 Aim

To retain areas of remnant Mahoe rock forest (a form of lava flow forest) present along Oakley Creek and to enhance their ecological diversity through a programme of ecological restoration work.

6.1.2 Long-term Goal

Ecological restoration of the remnant Mahoe rock forest areas along Oakley Creek will lead to a structurally and ecologically diverse forest habitat, with a high component of Mahoe in the canopy. This forest composition will consist of predominantly native species, with weed species significantly reduced and will provide important habitat and food sources for native fauna. A long-term ecological restoration approach is required and this goal would be expected to be achieved in a 20-30 year time-frame.

6.1.3 Objectives

The following objectives have been identified for carrying out ecological restoration of Mahoe rock forest areas along Oakley Creek:

1. To reduce the presence of pest plants and exotic species through a comprehensive programme of weed control. This will allow natural regeneration to occur leading to a more diverse forest structure, which will benefit native birds, lizards and invertebrates.

2. To carry out revegetation planting, where appropriate, to enhance the forest structure, increase species diversity, and in certain areas to stabilise steep slopes or riparian banks. Eco-sourced plants appropriate to Mahoe rock forest habitat will be selected.

3. To involve the local community (e.g. through the Friends of Oakley Creek) in carrying out restoration tasks in Mahoe rock forest areas, in order to foster local ownership of these sites and raise awareness of the importance of this rare forest habitat.

4. In future, if funding and volunteer capacity are available, it would be beneficial to extend animal pest control to include the whole of Phyllis and Harbutt Reserves.

6.2 Restoration Priorities

This assessment survey has identified six areas of remnant Mahoe rock forest along Oakley Creek, covering a total area of 1.55 hectares, as summarised in the table below (Table 1) and shown in map Figure 6. The aim of this report is to outline a 5 Year restoration programme for these remnant Mahoe rock forest areas, with the aim of a long-term restoration approach.

All identified Mahoe rock forest sites have significant pest plant issues, with weed species generally dominating the understorey and ground cover layers. Ecological restoration work has been steadily continuing south along Oakley Creek walkway from MU 1 and has now progressed to the start of MU 8. It was therefore decided to begin restoration of the Mahoe rock forest from Area A and work southwards, moving onto other identified Mahoe rock forest areas as funding allows. A sustainable approach is required to ensure that any weed control that is carried out is followed up with ongoing maintenance, to prevent regrowth and re-invasion of weeds.

Mahoe Rock Forest Area	Management Unit	Size of Mahoe rock forest area (hectares)	Restoration considerations
A	8	0.38	High priority to connect up with restoration being carried out to north.
B	8	0.33	Threat of invasion of weeds from adjacent weed dominated banks.
C	8	0.14	Threat of invasion of weeds from adjacent weed dominated banks. Understorey quite bare and would benefit from revegetation planting.
D	9	0.16	Significant adjacent weed issues. Tradescantia dominates ground layer.
E	9 and 10	0.29	Significant weed issues, including along riparian edge. Climbing Asparagus and Jasmine are problems.
F	11	0.25	Best example of remnant Mahoe rock forest, therefore a weed-controlled buffer should be created into surrounding Tree Privet dominated area. Climbing Asparagus frequent problem.

Table 1: Restoration considerations for identified Mahoe rock forest areas

Figure 6: Map showing six identified remnant Mahoe rock forest areas

(extracted from http://maps.aucklandcouncil.govt.nz/aucklandcouncilviewer)

NB: Area F in map includes restoration buffer area.

6.3 Weed Control

A long-term programme of weed control is needed to reduce the presence of pest plants, which are restricting natural regeneration through competing for light and nutrient resources. Weed control will enhance the habitat quality of these important remnant Mahoe rock forest areas as a more diverse forest structure will be able to develop. This will provide wide ranging benefits for native wildlife, including providing feeding and nesting habitat for birds, lizards and invertebrates.

Limited weed control has been undertaken in parts of MU 8 and 9, such as cutting of vines and/or preparation for planting, yet has not specifically targeted Mahoe rock forest habitat. The southern section of Harbutt Reserve (now called MU 10 and 11), has so far been mainly beyond the scope of restoration efforts along Oakley Creek. The identification of Mahoe rock forest areas at Oakley Creek will enable weed control to be prioritised through focused restoration in these areas.

It is recommended that the 'forest restoration framework', which was developed by Te Ngahere, is used to address a site-led weed control approach. This framework is necessary to achieve a targeted approach that focuses efforts in an effective and efficient manner. The framework aims to restore native bush by controlling invasive weeds in a manner which minimises the use of herbicides and ultimately creates an ecologically viable and self sustaining system. The programme works from initial weed control, to follow-up maintenance and progresses to the seedbank being monitored and then onto forest protection phase to limit re-invasion of weeds from neighbouring seed sources. Supplementary phases are needed for Tradescantia control and where gradual removal of weeds is required, for example if there is an erosion risk. The following table summarises the main phases of the 'forest restoration framework' (see Table 2).

Framework Phase	**Description**
Initial Control	Initial control targets all plants and aims to eliminate plant pest reproduction within the site. This is achieved by cut stump application and following with an initial foliar spray application.
Follow Up Control	Follow up control targets all plants that were missed or failed to die due to numerous factors. If this phase is implemented in spring and autumn, usually only one calendar year is required to achieve this objective.
Seedbank Control	The seedbank control phase begins when all existing plants have been eliminated. Seedbank control targets the remaining seed in the soil layer. This phase needs implementation once a year in mid-summer to be effective. Implementation at this time allows for spring germination and enough biomass production for effective control. The duration of this phase is dependent on the seed viability of the targeted plant. It is commonly 2-4 years.
Forest Protection	The protection phase is achieved when all seeds and seed sources are eliminated from the area. This phase is focussed on the prevention of plants establishing from incoming seed from adjacent areas. This is required to prevent a site from slipping back to the start of the process.

Table 2: Description of Restoration Framework Phases

6.4 Revegetation

There is an established canopy in the identified remnant Mahoe rock forest areas, which is dominated by natives (with a high component of Mahoe) with occasional large weed trees present. Currently the understorey and ground layer are dominated by weed species. Therefore there is a lack of natural forest structure in the lower vegetation layers. As restoration progresses, large exotic trees will be controlled and weed issues will be reduced in the understorey.

Therefore natural regeneration of native seedlings should be encouraged wherever possible and is starting to occur in more open areas with limited weed presence. Seedlings and young saplings of Mahoe, Karaka, Titoki, Pigeonwood, Karo, Karamu, Houhere, Mapou and Lemonwood were seen during assessment surveys.

In some areas where the understorey is particularly bare and regeneration is expected to occur very slowly, or the location has high visual public amenity value e.g. it is adjacent to a track, then it will be appropriate to carry out revegetation planting.

The aim of revegetation is to restore the habitat structure of the existing Mahoe rock forest, through mirroring the composition of native species which are present across the six identified remnant Mahoe rock forest areas along Oakley Creek. Mahoe Rock Forest is a type of lava flow forest, and this unusual habitat is restricted to only a few small sites in central Auckland. The rock forests at Oakley Creek appear to differ from those at Mt Eden sites and Withiel Thomas Reserve, as they are notably lacking in some typical volcanic rock forest species, such as Puka (*Griselinia lucida*), Shining Karamu (*Coprosma lucida*) and Mangeao (*Litsea calicaris*) - yet these species are planted elsewhere along Oakley Creek. Also Pohutukawa, Kohekohe and Puriri were particularly scarce and were planted in some cases.

Revegetation should aim to maintain a high component of Mahoe in these Oakley Creek rock forest remnants, whilst supplementing the understorey with forest diversity species associated with volcanic slopes and lava flow forests. The following planting list has been prepared for carrying out revegetation of the identified remnant Mahoe rock forest areas at Oakley Creek (Table 3). It draws on findings from Oakley Creek rock forest survey assessments, various planting lists for volcanic slopes in the Auckland Region and published articles / reports on Auckland lava flow forest sites (see References).

Revegetation should follow best practice planting principles, as outlined in the Oakley Creek Restoration Plan (Te Ngahere, revised 2009). Of particular importance is eco-sourcing of plants, as this ensures plants are obtained from local seed sources and are adapted to local conditions, as well as maintaining genetic variability. Planting sites will need to be checked at the planning stage by a consultant archaeologist to ensure there are no archaeological features present.

Table 3: Recommended Native Species for Planting in Remnant Mahoe Rock Forest Areas along Oakley Creek

Common Name	Scientific Name	Oakley Creek observations
Understorey species		
Mahoe	*Melicytus ramiflorus*	
Titoki	*Alectryon excelsus*	
Karamu	*Coprosma robusta*	
Pigeonwood	*Hedycarya arborea*	
Mapou	*Myrsine australis*	
Houhere/ Lacebark	*Hoheria populnea*	Not specifically a volcanic soil species, but commonly found in MU 8 Mahoe rock forest sites at Oakley Creek.
Hangehange	*Geniostoma ligustrifolium var. ligustrifolium*	
Kawakawa	*Macropiper excelsum subsp. excelsum*	
Canopy species		
Mahoe	*Melicytus ramiflorus*	Dominant canopy species in rock forest areas at Oakley Creek.
Karaka	*Corynocarpus laevigatus*	
Kohekohe	*Dysoxylum spectabile*	Occurs rarely.
Potential species: low priority - further discussion as to suitability required		
Puka	*Griselinia lucida*	Not recorded in Mahoe rock forest areas at Oakley Creek.
Puriri	*Vitex lucens*	Only found rarely occurring naturally in rock forest MU 8 areas. Mainly planted near Mahoe rock forest areas at Oakley Creek.
Shining Karamu	*Coprosma lucida*	Not noted in Mahoe rock forest areas at Oakley Creek (but may be present). Planted elsewhere along Oakley Creek.

NB: This planting list provides recommended species to enhance the forest structure and provide shade conditions for natural regeneration to occur. When the forest structure is established in future, further enhancement plantings such as ferns, could be considered if required.

6.4.1 Revegetation sites

The following revegetation sites have been identified for Mahoe rock forest areas along Oakley Creek for the next 5 years (Table 4).

Thorough site preparation will be required at planting sites, to ensure that weed species are controlled and will not re-invade, threatening the establishment and survival of plantings. Planting maintenance will also be required for a minimum of 3 years following planting, to ensure the long-term success of revegetation.

Archaeological assessments will need to be carried out prior to any planting is planned to determine whether any archaeological evidence is likely to be present. A consultant archaeologist should visit proposed planting areas, after site preparation / weed control has been undertaken so that the ground surface is easier to examine. Archaeological guidance will need to be followed after archaeological assessments as to the suitability of sites for revegetation.

Year	Period	Planting location	Approximate plant numbers
1	Winter 2012	None, as weed control is needed	None
2	Winter 2013	MU 8 Area C - understorey & riparian	understorey - 450; riparian - 200
3	Winter 2014	MU 9 Area D - adjacent to steps	300
4	Winter 2015	MU 9 Area D - understorey	500
5	Winter 2016	To be decided	500

Table 4: Proposed Mahoe rock forest revegetation sites

6.5 Community involvement

Ecological restoration along Oakley Creek has been initiated and continues to be driven by an active group of volunteers, called the 'Friends of Oakley Creek'. Community engagement is encouraged through a regular programme of events and significant advances have been made in restoring the ecological diversity of this important urban stream.

As restoration progresses through the identified Mahoe rock forest remnants along Oakley Creek there will be opportunities for volunteers to become involved in restoration tasks and they will be essential to the long-term sustainability of this project. It would also be beneficial to work with neighbouring landowners, such as the Cradock St Community, Tibetan Buddhist Centre, Unitec and the owners of the railway land, to control weed issues on their properties which are acting as a key weed invasion source.

It is recommended that comprehensive programme of weed control is undertaken by qualified contractors due to the variety and extent of weed issues that exist across the Mahoe rock forest areas, which require spraying to be managed effectively. Restoration tasks that are ideally suited to volunteers and would make a significant contribution to this project include: some manual weed control (such as cutting of vines), planting, planting maintenance, animal pest control and biodiversity monitoring e.g. birds, lizards and stream quality.

6.6 Programme of work and costings

6.6.1 Year 1 (2011-2012)

A programme of weed control was initiated, after assessment surveys had identified remnant Mahoe rock forest areas. Initial weed control was carried out in Mahoe Rock Forest Areas A, B and C (in MU 8) and Area D (in MU 9) from March-April 2012. Follow-up control was carried out in these areas in June-July 2012.

Season	Task
Autumn 2012	Initial weed control in Mahoe Rock Forest Areas A, B C & D.
Winter 2012	Follow-up weed control in Mahoe Rock Forest Areas A, B, C & D.

Year 1 Ecological Restoration Cost $18,000.00

6.6.2 Year 2 (2012-2013)

Season	Task
Spring 2012	Follow-up weed control in Mahoe Rock Forest Areas A, B C & D.
Summer 2012/13	Initial weed control in Mahoe Rock Forest Area E.
Summer 2012/13	Tradescantia control visit in Mahoe Rock Forest Areas A, B, C & D.
Autumn 2013	Follow-up weed control in Mahoe Rock Forest Areas A, B, C & D.
Autumn 2013	Planting preparation in Area C.
Winter 2013	Start initial weed control in Mahoe Rock Area F (if budget allows).
Winter 2013	Planting of 650 plants by community in Mahoe Rock Forest Area C - understorey and riparian edge.

Year 2 Ecological Restoration Estimated Cost $25,825.00

The 2012-13 weed control programme was completed successfully. Follow-up control in Areas A-D, has led to a significant reduction in weeds. Initial control was undertaken in Areas E and F.
A community planting event was held to carry out the understorey and riparian enhancement plantings in Mahoe Rock Forest Area C.

Te Ngahere also carried out initial control in the rest of MU 10 and MU 11 in winter 2013 through the Central Ecological Restoration Contract, which will help to buffer Mahoe rock forest areas from weed invasion.

6.6.3 Year 3 (2013-2014)

Season	Task
Spring 2013	Complete initial weed control in Mahoe Rock Forest Area F.
Spring 2013	Follow-up weed control in Mahoe Rock Forest Area E.
Summer 2013/14	Seedbank control in Mahoe Rock Forest Areas A, B, C & D.
Autumn 2014	Follow-up weed control in Mahoe Rock Areas E & F.
Autumn 2014	Planting preparation in Area D.
Autumn 2014	Tradescantia control visit in Mahoe Rock Forest Areas A, B, C & D.
Winter 2014	Planting of 300 plants by community in Mahoe Rock Forest Area D - adjacent to steps.

Year 3 Ecological Restoration Estimated Cost $26,200.00

6.6.4 Year 4 (2014-2015)

Season	Task
Spring 2014	Follow-up weed control in Mahoe Rock Forest Area F.
Summer 2014/15	Seedbank control in Mahoe Rock Forest Areas A, B, C, D, E & F.
Autumn 2015	Planting preparation in Area D.
Autumn 2015	Tradescantia control visit in Mahoe Rock Forest Areas A, B, C, D, E & F.
Winter 2015	Planting of 500 plants by community in Mahoe Rock Forest Area D - understorey.

Year 4 Ecological Restoration Estimated Cost $25,100.00

6.6.5 Year 5 (2015-2016)

Season	Task
Spring 2015	Follow-up weed control in Mahoe Rock Forest Area F.
Summer 2015/16	Seedbank control in Mahoe Rock Forest Areas A, B, C, D, E & F.
Autumn 2016	Planting preparation - planting location to be determined.
Autumn 2016	Tradescantia control visit in Mahoe Rock Forest Areas A, B, C, D, E & F.
Winter 2016	Planting of 500 plants by community - location in Mahoe Rock Forest Areas to be determined.

Year 5 Ecological Restoration Estimated Cost $23,680.00

7.0 REFERENCES

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8.0 APPENDIX 1

The following native species were recorded during Mahoe rock forest assessment surveys along Oakley Creek. This list is not exhaustive and further botanical surveys are recommended as restoration of this area is undertaken.

Table 5: Native species recorded in Mahoe rock forest areas along Oakley Creek during assessment surveys

Common Name	Scientific Name	Status
Cabbage tree / ti kouka	*Cordyline australis*	
Five-finger / whauwhaupaku	*Pseudopanax arboreus*	planted
Flax / harakeke	*Phormium tenax*	
Forest sedge	*Carex lambertiana*	
Gahnia sp.	*Gahnia sp.*	
Haloragis / toatoa	*Haloragis erecta*	
Hangehange	*Geniostoma ligustrifolium var. ligustrifolium*	
Houhere / lacebark	*Hoheria populnea*	
Houpara	*Pseudopanax lessonii*	
Kahikatea	*Dacrycarpus dacrydioides*	planted
Kanuka	*Kunzea ericoides var. ericoides*	
Karaka	*Corynocarpus laevigatus*	
Karamu	*Coprosma robusta*	
Karo	*Pittosporum crassifolium*	
Kawakawa	*Macropiper excelsum subsp. excelsum*	
Kohekohe	*Dysoxylum spectabile*	mainly planted
Kohuhu	*Pittosporum tenuifolium*	
Kowhai	*Sophora chathamica*	
Lemonwood / tarata	*Pittosporum eugenioides*	
Lowland ribbonwood	*Plagianthus regius subsp. regius*	
Mahoe	*Melicytus ramiflorus*	
Mamaku / black tree fern	*Cyathea medullaris*	
Mapou	*Myrsine australis*	
Ngaio	*Myoporum laetum*	
Pigeonwood / porokaiwhiri	*Hedycarya arborea*	
Pohutukawa	*Metrosideros excelsa*	planted
Pukatea	*Laurelia novae-zelandiae*	planted
Puriri	*Vitex lucens*	

Common Name	Scientific Name	Status
Rimu	*Dacrydium cupressinum*	
Silver fern / Ponga	*Cyathea dealbata*	
Swamp maire	*Syzygium maire*	planted
Taraire	*Beilschmiedia tarairi*	planted
Titoki	*Alectryon excelsus*	some planted
Totara	*Podocarpus totara var. totara*	
Wharangi	*Melicope ternata*	planted
Whau	*Entelea arborescens*	
Ferns		
Bracken	*Pteridium esculentum*	
Hounds tongue / paraharaha	*Microsorum pustulatum subsp. pustulatum*	
Kiokio	*Blechnum novae-zelandiae*	
Rasp fern / pukupuku	*Doodia australis*	
Shining spleenwort / huruhuruwhenua	*Asplenium oblongifolium*	

9.0 APPENDIX 2

Table 6: Weed and exotic species recorded in Mahoe rock forest areas along Oakley Creek during assessment surveys

Common Name	Latin Name	Auckland RPMS*
African Clubmoss	*Selaginella kraussiana*	Surveillance
Alligator Weed	*Alternanthera philoxeroides*	Surveillance
Annual Meadow Grass	*Poa annua*	
Arum Lily	*Zantedeschia aethiopica*	Surveillance
Bamboo sp.	*Bambusa sp.*	
Banana Palm	*Musa sp.*	
Bear's Breeches	*Acanthus mollis*	
Bindweed (probably hybrid sp.)	*Calystegia sp.*	
Black Nightshade	*Solanum nigrum*	
Blackberry	*Rubus fruticosus agg.*	Surveillance
Blue Morning Glory	*Ipomoea indica*	Surveillance
Buddleia	*Buddleja davidii*	Surveillance
Canna Lily	*Canna indica*	
Castor Oil Plant	*Ricinus communis*	Surveillance
Cape Gooseberry	*Physalis peruviana*	
Climbing Asparagus	*Asparagus scandens*	Surveillance
Climbing Dock	*Rumex sagittatus*	Surveillance
Elaeagnus	*Elaeagnus x reflexa*	Surveillance
Elephant's Ear	*Alocasia brisbanensis*	Surveillance
English Ivy	*Hedera helix*	Surveillance
Fennel	*Foeniculum vulgare*	
German Ivy	*Delairea odorata*	Surveillance
Kahili Ginger	*Hedychium gardnerianum*	Surveillance
Gorse	*Ulex europaeus*	Surveillance
Hedge Bedstraw	*Galium mollugo*	
Hedge Woundwort	*Stachys sylvaticus*	
Hemlock	*Conium maculatum*	Surveillance
Japanese Honeysuckle	*Lonicera japonica*	Surveillance
Japanese Spindle Tree	*Euonymus japonicus*	Surveillance
Jasmine	*Jasminum polyanthum*	Surveillance
Kawakawa hybrid / Three King's sp. (unconfirmed)	*Macropiper sp.*	
Lemon Balm	*Melissa officinalis*	

Common Name	**Latin Name**	**Auckland RPMS***
Loquat	*Eriobotrya japonica*	
Macrocarpa	*Cupressus macrocarpa*	
Madeira Vine	*Anredera cordifolia*	Surveillance
Monkey Apple / Acmena	*Syzygium smithii*	Surveillance
Montbretia	*Crocosmia x crocosmiiflora*	Surveillance
Moth Plant	*Araujia hortorum*	Surveillance
Nasturtium	*Tropaeolum majus*	
Oak sp.	*Quercus sp.*	
Onion Weed / Three-cornered Garlic	*Allium triquetrum*	
Oxalis sp.	*Oxalis sp.*	
Palm Grass	*Setaria palmifolia*	Surveillance
Pampas sp.	*Cortaderia jubata / selloana*	Surveillance
Periwinkle	*Vinca major*	Surveillance
Phoenix Palm	*Phoenix canariensis*	Surveillance
Pine sp.	*Pinus sp.*	
Plectranthus	*Plectranthus ciliatus*	Surveillance
Prickly Ox-tongue	*Picris hieracioides*	
Privet, Chinese	*Ligustrum sinense*	Surveillance
Privet, Tree	*Ligustrum lucidum*	Surveillance
Purple Vervain / Verbena	*Verbena bonariensis*	
Queensland Poplar	*Homalanthus populifol*	Surveillance
Queen of the Night	*Cestrum nocturnum*	Research
Spear Thistle	*Cirsium vulgare*	
Strawberry, Wild	*Fragaria vesca*	
Taiwan Cherry	*Prunus campanulata*	
Tradescantia	*Tradescantia fluminensis*	Surveillance
Tutsan	*Hypericum androsaemum*	Surveillance
Umbrella sedge	*Cyperus eragrostis*	
Wattle sp. (incl. Brush & Black)	*Acacia sp.*	Brush Wattle is Surveillance
Willow, Crack	*Salix fragilis*	Surveillance
Willow, Tortured	*Salix matsudana*	
Woolly Nightshade	*Solanum mauritianum*	Containment
Yorkshire Fog	*Holcus lanatus*	

* Auckland RPMS = Auckland Regional Pest Management Strategy 2007-2012 Pest Plant Category